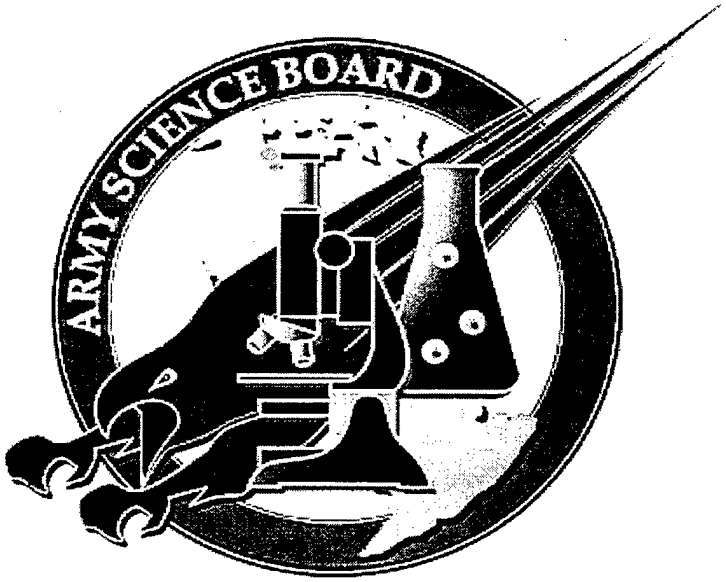
ARMY SCIENCE BOARD

SUMMER STUDY

FINAL REPORT



DEPARTMENT OF THE ARMY
ASSISTANT SECRETARY OF THE ARMY
(ACQUISITION, LOGISTICS AND TECHNOLOGY)
WASHINGTON, D.C. 20310-0103

"PRIORITIZING ARMY SPACE NEEDS"

July 1999

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CONFLICT OF INTEREST

Conflicts of interest did not become apparent as a result of the Panel's recommendations.

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13. ABSTRACT (Maximum 200 words)

The Army Science Board was tasked to analyze current Army space uses and needs for future space systems to ensure adequate support for Army XXI and AAN. The Study highlights the importance of space products to the Army warfighters and recommends more active Army participation in the planning and execution of future US space systems.

The study provides numerous assessments and recommendations in the areas of: organization/personnel, national space systems, use of commercial space capabilities, and non-space systems. The study also outlines time-urgent organization/process recommendations and time-urgent program opportunities requiring immediate attention from Army leadership.

14. SUBJECT TERMS

Army Space Requirements, Army Space Careers, DOD Space Organization, Satellite Communications, Situational Awareness, Space Capabilities, ISR, WTEM, POS/NAV, GPS, GBS, Information Operations, Command and Control, DTED

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Army Science Board Summer Study

FINAL REPORT

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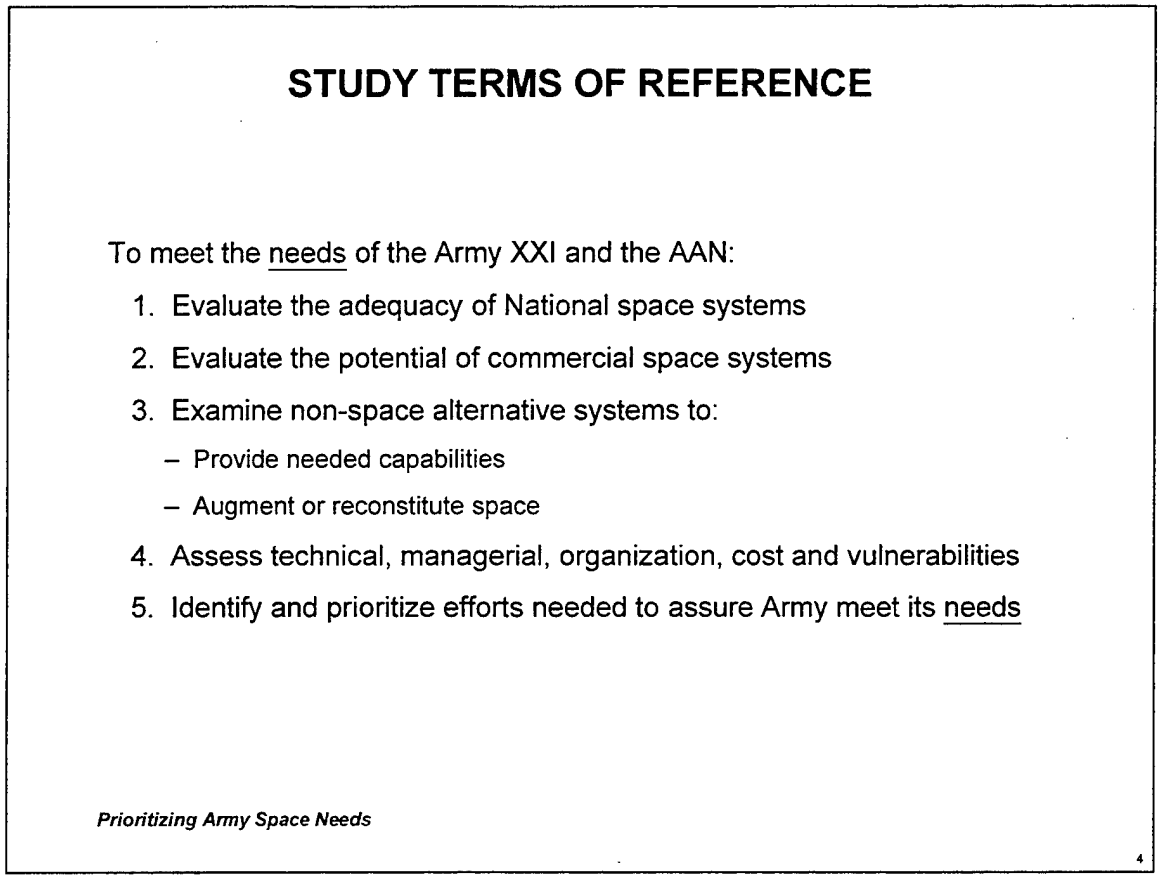
Study Background



Study Terms of Reference

The background and motivation for the study includes:

a. In order for Army information system materiel developers to make maximum use of current and future space assets specifically focused on national security needs, the Army will need to have in-depth understanding of the attributes and limitations of both existing and future space assets, regardless of which sector they are focused on supporting. This Army understanding will be needed to exploit national security space assets by continuing and expanding its already successful Tactical Exploitation of National Capabilities (TENCAP) program. The Army will need to establish new means to allow it to work cooperatively with the commercial space system developers with the goal of making commercial space systems as supportive as possible of Army needs with minimal or modest Army investments.

b. Although many of the Army's needs for better surveillance, intelligence, navigation, targeting, communications and environmental sensing capabilities may be achieved by use of existing and future space systems, alternative "nonspace" means should be considered from the point of view of technology, tasking restraints and cost-effectiveness.

c. Alternative "nonspace" ways to obtain the desired capabilities are associated with the use of organic assets (e.g., GuardRail, tactical UAVs, tethered balloon systems, etc.). Other capabilities may be provided from shared or joint assets, such as Rivet Joint, JSTARS, AWACS, and the emerging high-altitude, long-endurance UAV systems, Dark Star and Global Hawk.

d. This study is motivated by a recently revamped Army space organizational structure

thus making this an appropriate time to reexamine each of the Army's space efforts as new capabilities are identified against the backdrop of continued budget constraints.

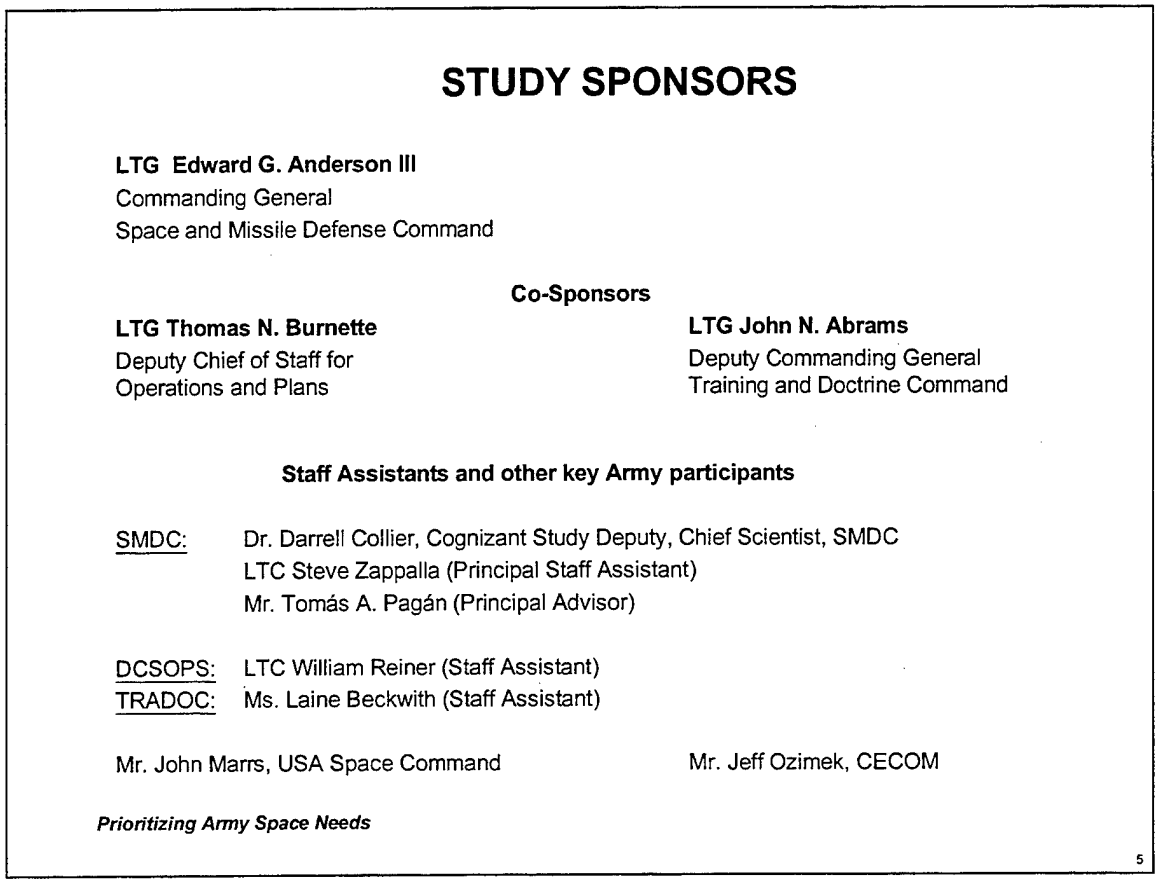
e. The Army's initiative in digitizing the battlefield portends a number of new possibilities for the utilization of space assets. Space assets are potentially the major enablers of information dominance in the 21st Century. A clear understanding of the full potential of space platforms is therefore demanded.

f. The Army has a long, successful history of capitalizing on the national investment in space assets through such efforts as the TENCAP program. However, the traditional Army approach has been more to take advantage of what is available as opposed to influencing the requirements for space assets. The Army must develop a stronger voice in asserting the warfighter's needs for space capabilities.

g. The proliferation of a whole host of new and rapidly evolving commercial space systems provides an important new source for the satisfaction of important Army information system needs. The Army must capitalize on the potential value of these systems.

h. There are other new, organic Army and joint system development activities evolving. Tradeoffs between use of space and "nonspace" systems need to be carefully evaluated in order to maximize the effectiveness of the Army's limited resources. (a-h are verbatim from the TOR)

Finally, it is important to mention that cost aspects were a consideration included in the formal terms of reference. Although cost is clearly an important factor, the study panel recognized that to develop a common and current cost baseline and reasonable cost projections would be exceptionally complicated. Therefore, a conscious decision was made to exclude cost from the scope of our study effort.



Study Sponsors

Early in his tenure as the Commanding General of the Space and Missile Defense Command, LTG Edward Anderson approached the ASB in regard to how it might help enhance his new responsibility for Army Space. A number of suggestions made by the ASB resulted in the study's terms of reference shown on the previous slide. Shortly after the study was initiated, LTG Anderson enlarged the sponsorship of the study to include senior Army participation from DCSOPS and TRADOC, primarily because of their key roles in the requirements-setting processes. In retrospect, it would also have been beneficial to the study to have had both DISC4 and DCSINT as sponsors, especially in regard to the ASB's examination of how space requirements are generated and approved.

The study received almost continuous direct support from the Chief Scientist of SMDC as well as support from Army personnel within SMDC, DCSOPS, and TRADOC. Participants from CECOM and the Army Space Command were also available during the course of the study. The study was carried out at classified levels, which allowed full disclosure of relevant sensitive space-related programs. However, it has been possible to prepare the product of the study at an unclassified level so that it can receive Army-wide distribution and attention.

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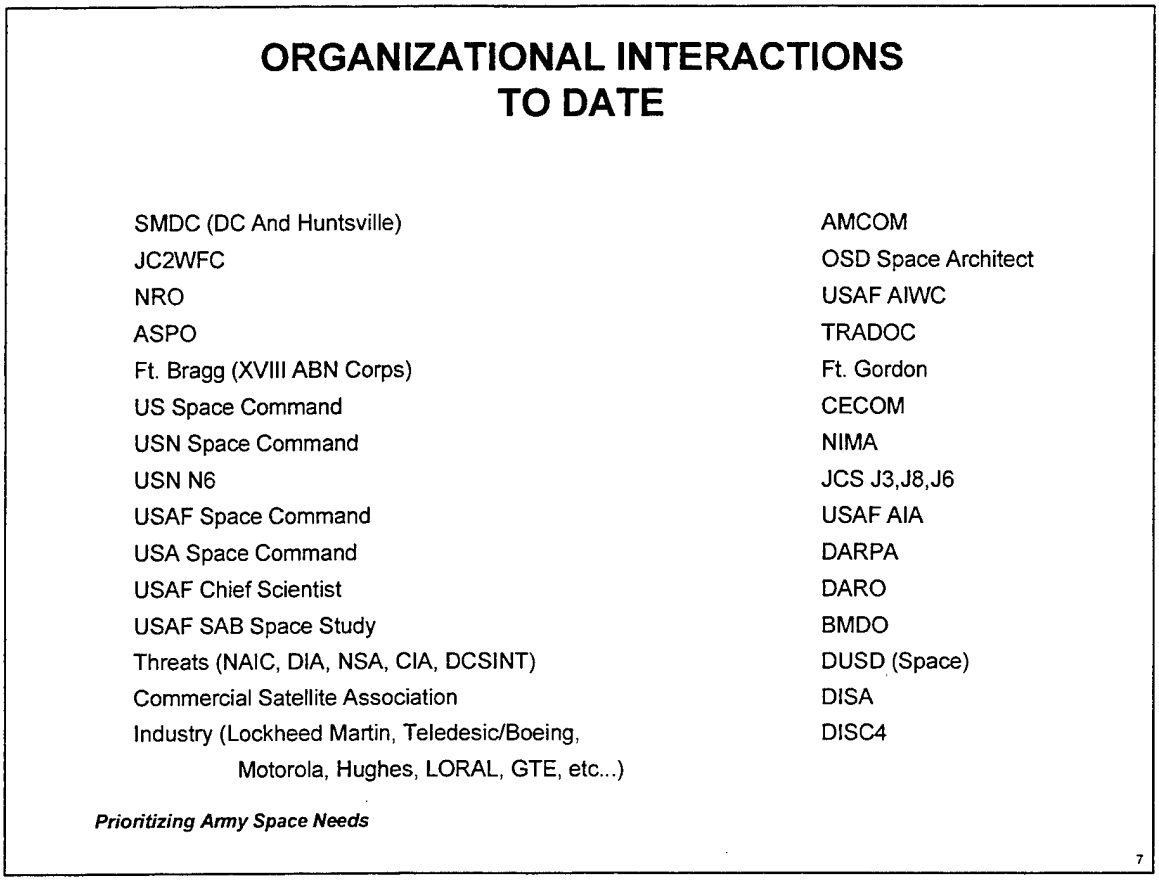
Study Panel Participants

In staffing the ASB study with ASB members, special attention was given to selecting individuals with either considerable experience in the space program development and use environment or who were currently involved in such activities.

An additional effort was made by ASB management to encourage participation of individuals from other DOD advisory activities. Arrangements were made to include members of the scientific advisory boards of the Air Force, the National Security Agency, the Defense Intelligence Agency, the Navy, and the National Science Board as active study participants. This greatly broadened the understanding of the study panel in regard to the many and complex technical and political nuances of space. In addition, several of the study panel members were associated with commercial space development activities, which greatly improved the ability of the panel to examine the potential contributions of commercial space systems to meeting Army needs.

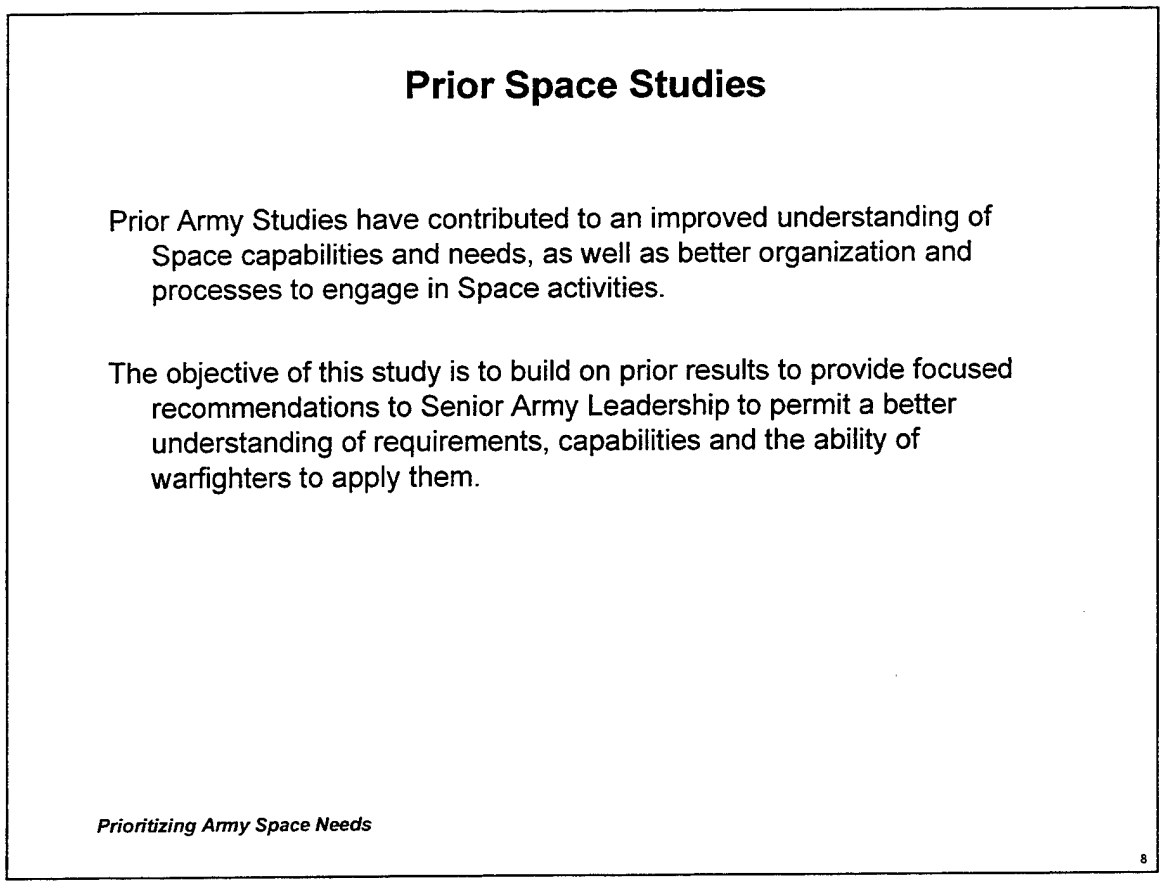


Organizational Interactions

The study team interacted with virtually all military, industry, and other government organizations significantly involved in space activities.

Close interaction with the Air Force took place, since the Air Force Science Advisory Board (AFSAB) was concurrently conducting a space study.

Commercial activities that are developing personal satellite communications provided the study with an indepth understanding of the nature of these soon-to-be-deployed satellite communication systems. This information allowed the study team to explore how commercial entities might be utilized by Army warfighters.



Prior Space Studies

Over the past decade, the Army has examined its interaction with space—its systems, providers, and products—and has made significant changes in the way it carries out the Army activities that provide space products to its warfighting commanders and forces.

Previous studies of the Army space processes, by both the Army Science Board (ASB) and the National Research Council's Board on Army Science and Technology (BAST), indicated a need for greater Army involvement in the planning and requirements-setting processes for new national and military department space program developments. The lack of sufficient space-knowledgeable personnel within the Army space activities is consistently regarded as the most important Army space process deficiency. This deficiency not only prevents the Army from exerting influence on emerging space system programs but also has limited consistency/continuity within the Army, a requirement for achieving maximum exploitation of space products. Prior studies also indicate that the Army organizations involved in space matters are unable to be as influential as possible because there is no common Army Space Activity to which they all report.

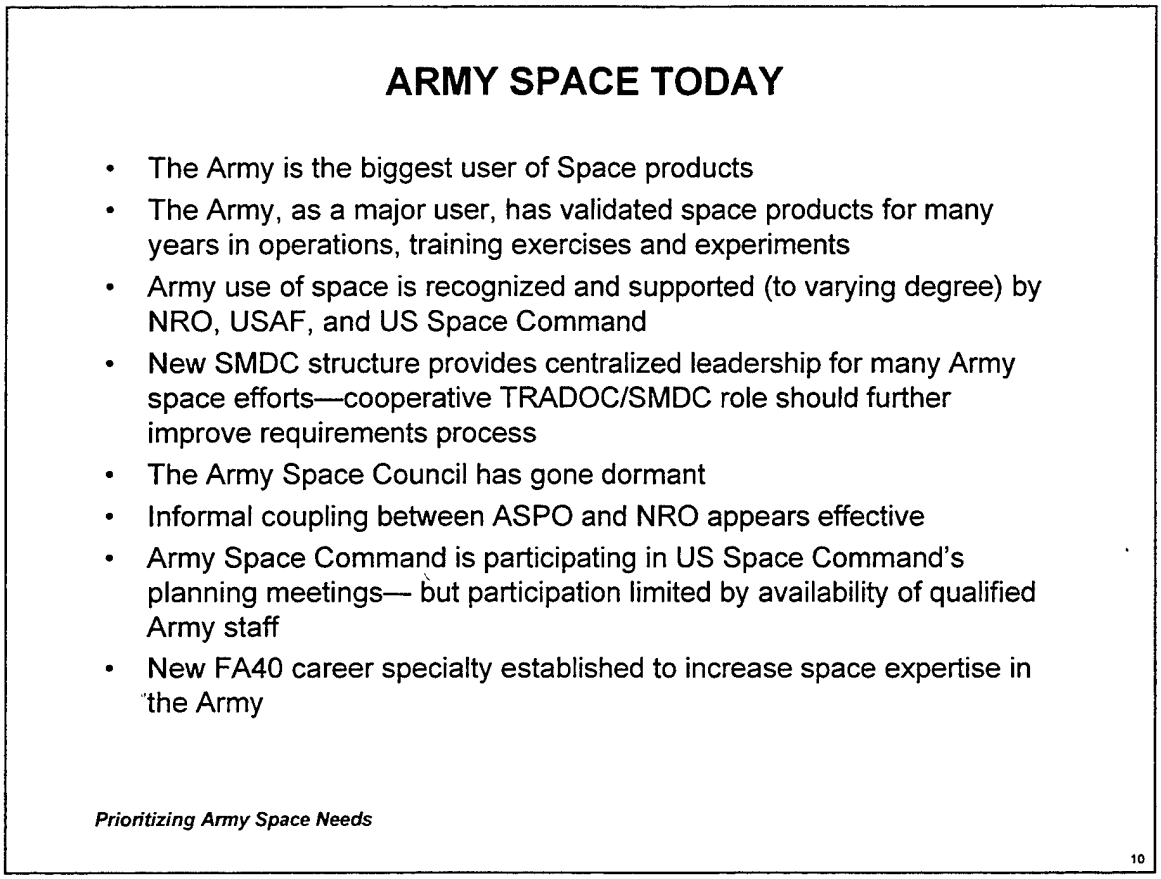
A more recent ASB study examining the organizational arrangements of the Army's missile activities and the Ballistic Missile Defense Organization (BMDO) reviewed both the missile-related structures and the space structures. This study recommended unification of all the Army space-related activities under a common organization. As a result, within the past year, the Army has reorganized the prior strategic missile activities and its space activities in a new common organizational structure named Space and Missile Defense Command (SMDC). This new arrangement embraces the Army Space Programs Office (ASPO) and the Army Component

Command (ARSPACE) to US SPACECOM. In addition, in accordance with ASB recommendations, the SMDC and TRADOC activities are working together under a memorandum of understanding (MOU) to maximize the effectiveness of the Army's space requirements determination process.

With the many changes in the world's political arrangements, the major restructuring of the way in which the United States now considers its national space systems, burgeoning new commercial space initiatives (for clients both in the United States and abroad), and the possibility that Army information system needs might be met by unmanned aerial vehicle (UAV) systems, it was appropriate for a comprehensive new look at Army space needs. The ASB was tasked to do this and chose to do it during a focused Summer Study.

The results of the study include a number of findings about the current deficiencies associated with the Army use of space and recommendations regarding opportunities to provide even more relevant capabilities to its warfighters.

Current Environment and Needs



Army Space Today

Army utilization of space products and services continues to expand as rapidly as these can be adapted to Army doctrine, concepts and missions. Although it's difficult to perform a rigorous analysis, the panel believes that the "digitized" Army is the largest user of DOD space systems. Recent warfighting missions, warfighting exercises and technology experiments continue to validate a reliance on Space to achieve Information Dominance.

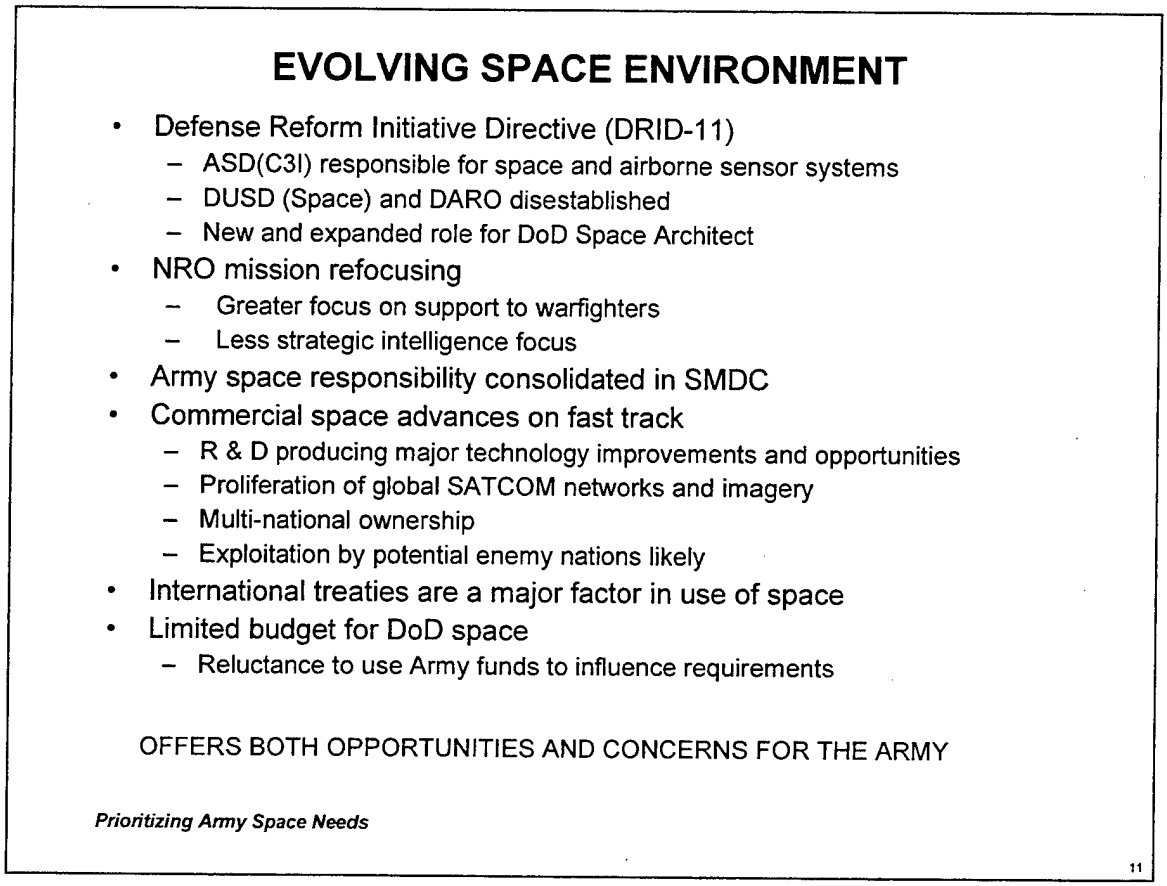
The providers of space systems, the USAF and the National Reconnaissance Office (NRO), have a difficult job in attempting to satisfy the disparate needs of numerous customers. Clearly, the Army has met with varying success in articulating its needs and having them recognized and supported during the acquisition process. The Army Space Program Office (ASPO) is a good example of how the Army, through extraordinary measures, has been able to work with NRO to bring space intelligence products directly to the battlefield.

The reorganization of the Space and Strategic Defense Command provides an opportunity to establish an Army focal point for space activities (including requirements and acquisition) within the Joint arena. The close relationship between TRADOC and SMDC regarding the establishment of requirements could lead improved coordination among the Battlefield Operating System (BOS) and evaluation of a total "system of systems" architecture.

However, it should be noted that the Army Space Council, which could and should be the senior forum to address major space issues, has gone dormant. Such a forum, with the CG SMDC added to the original membership, would be invaluable in the vetting of Army space policy, requirements and major issues.

The challenge remains that the number of personnel with space expertise is woefully inadequate to meet needs and to exploit the opportunities available within the National, Joint, civil and foreign space communities. Personnel who can articulate Army needs, positions, and requirements are needed in the planning of many major space systems under consideration or in early development.

The ASB Study Panel commends the Army on the formation of the special space personnel category: FA40. This is a positive step in creating a permanent cadre of space-knowledgeable staff.



Evolving Space Environment

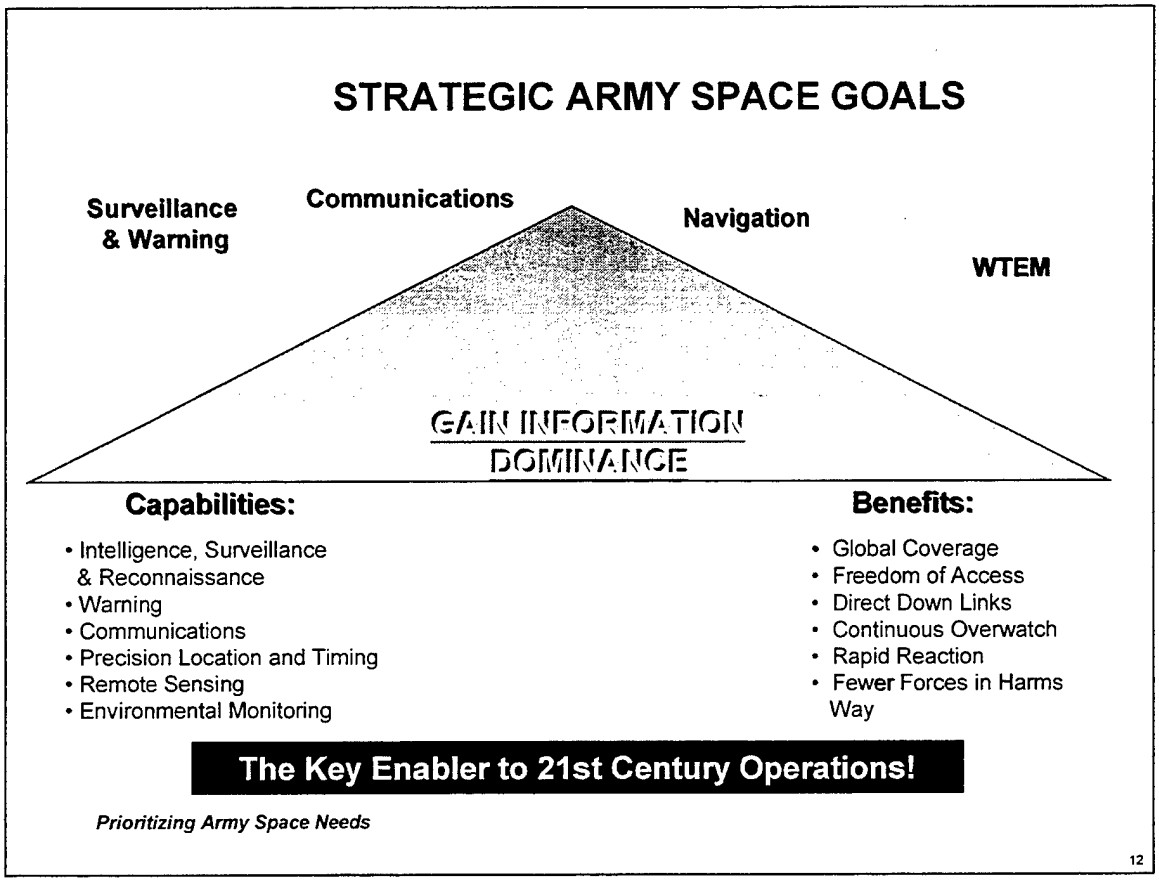
The US space environment, which is continuously in a state of flux, has recently experienced major organization changes regarding the way that Military and National Space Programs are managed. DOD has approved Defense Reform Initiative Directive 11 (DRID-11) which changes the relationship between DOD and National Reconnaissance Office programs. The effects of these changes are discussed in detail later in this report.

The U.S. space environment is in a state of flux. DRID-11 has effected major organizational changes in the way OSD and the Intelligence Community manage National Space Programs which are executed by the NRO. Changes within the NRO include the establishment of a new joint National Security Space System Architect (NSSA) position.

Most of the Army space activities are now focused in SMDC and, except for intelligence requirements for space systems, a TRADOC/SMDC MOA places the responsibilities for the development of Space requirements on the SMDC with approval by CG, TRADOC.

In recent years a large number of international business consortia have formed to develop space systems to satisfy burgeoning communication, remote sensing and other needs. Huge investments (far beyond the military R & D budgets) are being made by these concerns as they race to provide service in a competitive environment. Although these commercial capabilities offer a major opportunity to satisfy many Army/DOD needs, it remains to be determined how best "to do business" in this arena. Furthermore, the multinational characteristic of this industry, virtually assures that this capability will be available to future adversaries at a price. The Army at all levels must learn how to react to this eventuality.

It was clear to the ASB Study Panel members that, with the severely restricted Army budgets of recent (and projected) years, there is little enthusiasm to support Space needs with Army funding. It therefore remains for the Army to do the very best it can to influence, and make its voice heard in the joint arena that decides how to meet Service requirements with space capabilities. Having said that, the panel further believes that the Army space community must continue to sell the virtues of "space" in order to compete for Army dollars as they may be needed to meet unique Army space requirements.



Strategic Army Space Goals

The focus of this study is an examination of how the Army can exploit space to support information dominance on the battlefield.

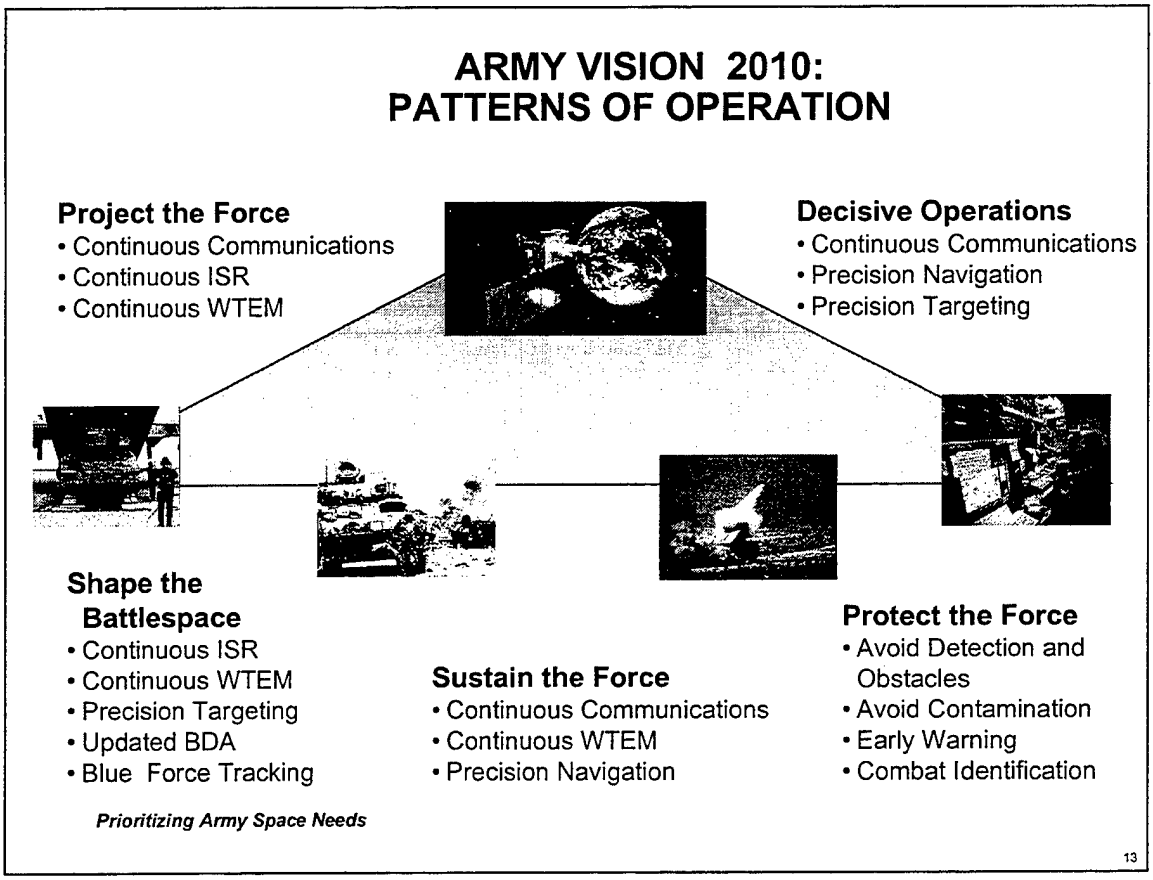
Space capabilities and assets have a proven track record of enhancing situational awareness and providing robust communications that are timely and accurate. Space is a key enabler for information operations.

The communications, navigation, ISR and WTEM data become key building blocks for Information Dominance:

- Seamless, secure communications
- Near real-time information for situational awareness (SA)
- Targeting to disrupt enemy operations
- The only available weather data for enemy held territory

Through a multitude of technologies, DOD and the Army benefit from the space assets to achieve information superiority. Global coverage from satellite and "nonspace" means allows the commander to manage the battlespace. Wireless communications and access to direct downlinks support strategic, operational and tactical missions. Through remote sensing and national assets, continuous overwatch and blue-force tracking are feasible and attainable. Evolving doctrine to develop sensor-to-shooter links puts threat forces in harm's way.

Given that information dominance will be the key enabler in 21st century operations, the information provided by space-based assets is critical to the Army's success.

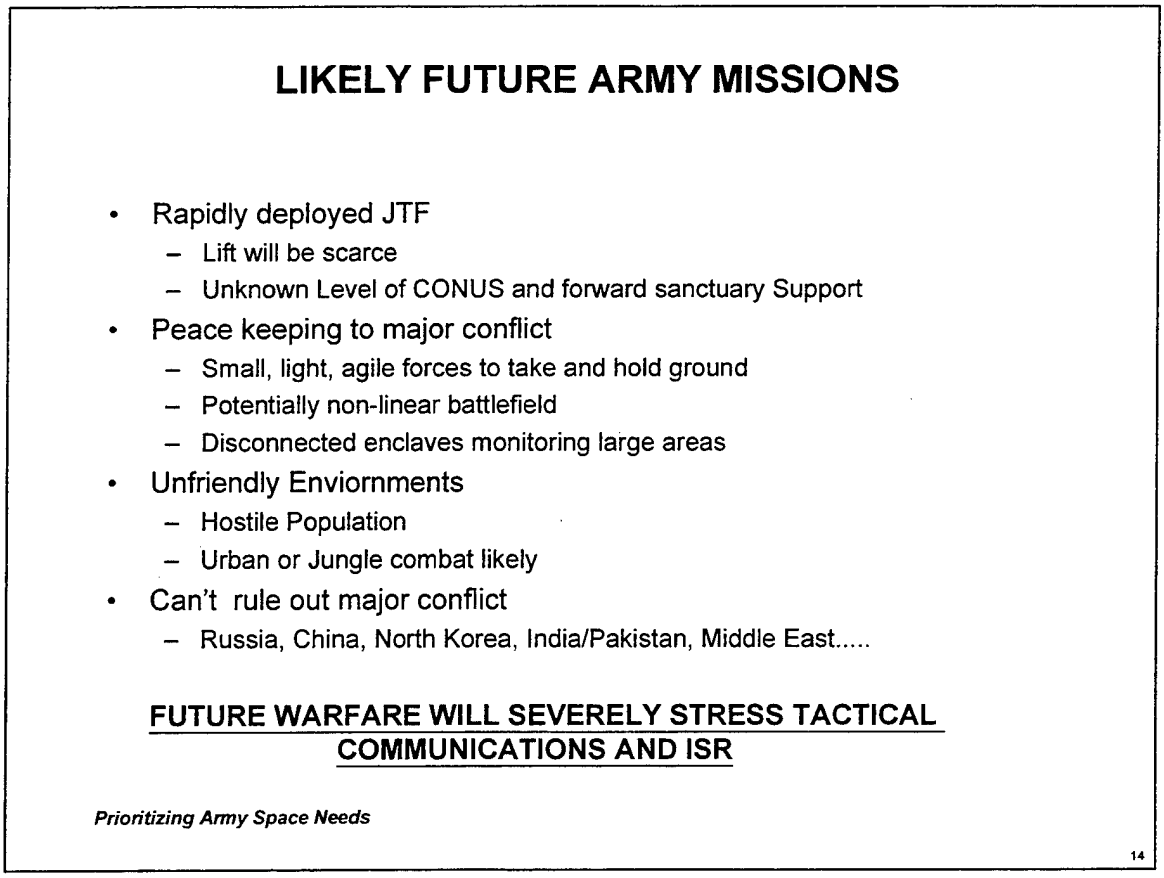


Army Vision 2010: Patterns of Operation

Army Vision 2010 provides a high-level view of the future battlefield. What is lacking on this chart is the element of completeness -- the need to provide these capabilities to all elements of the force, including brigade, battalion, company and platoon.

All component commanders need continuous communications, ISR and weather. These capabilities shape the battlespace. Blue forces can capitalize on precision target location data, employ precision weapons, and conduct BDA, thereby maximizing munition effectiveness. Precision navigation is necessary to both targeting and avoidance of fratricide.

A critically important aspect of this chart is the stated need for **continuous** ISR, **continuous** communications, **continuous** WTEM, precision navigation and precision targeting -- which implies **continuous** surveillance on a mobile battlefield. Our current capabilities clearly do not meet these needs!



Likely Future Army Missions

The Terms of Reference of this study asked for an evaluation of the role of space in meeting the needs of Army XXI and the AAN. In an effort to define these needs, the study panel reviewed the likely future missions of the Army in light of evolving doctrine.

Since the end of the Cold War, the mission of the U.S. defense forces (particularly the Army) has changed dramatically. The US military does not have a peer competitor. Recent missions have it responding to a variety of situations ranging from major combat in Operation Desert Storm to peacekeeping operations in Bosnia and Haiti.

The typical mission of the 1990's called for rapid deployment of a Joint Task Force, often with allied support, to an environment that had not previously been viewed as a potential area of combat. The scarcity of dedicated military sealift and the limited number of military and CRAF aircraft resulted in a finite capability to move major forces overseas. This necessitated the rationing of lift to the most important elements of the force.

The aftermath of Desert Storm generated much discussion of sanctuary support for deployed forces (that is, leaving support personnel and their equipment in the CONUS or in some forward deployed areas rather than deploying them to the theater). Discussion included leaving intelligence support elements at home stations and providing "just-in-time logistics" to avoid stockpiling large quantities of materiel in the theater. During this study, however, we heard little about sanctuary support; the doctrine of sanctuary support needs to be fully developed.

The range of missions and the desire to limit the number of deployed troops often result in small agile forces deployed in very low densities to maintain the peace. This low-density discontinuous force creates a difficult challenge for both the communications systems, which connect the various force elements, and ISR systems, since a robust ISR capability is required to monitor unoccupied areas to deny the enemy sanctuary.

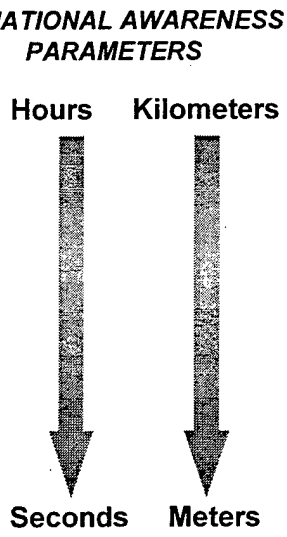
The role of the U.S. forces may be further complicated by a population that may not be supportive of operations. As we saw in Somalia, the operation of remote ISR and/or communications sites was undesirable or infeasible. In addition, despite the great progress that has been made in ISR systems, we still do not have adequate capability to monitor and target enemy forces operating in a densely vegetated environment, certainly not in a rain forest or areas with imperfect coverage, such as mid-latitude forests typical in Europe or North America.

Despite the demise of the Soviet Union, the United States cannot ignore or discount the possibility of major conflict against a heavy force from countries such as Iran, Iraq, Korea, China, India/Pakistan, or Russia. We must maintain the capability to conduct an MRC anywhere in the world with minimal loss of life.

Each of these environments puts significant stress on our communications, both within the theater and from the theater to the CONUS. The need for real-time ISR to be available to every echelon of command in the theater is only now beginning to be satisfied through the concept of "situational awareness" in the digitized tactical forces.

SITUATIONAL AWARENESS

- CINC/JTF/Service component
  - National/JCS priority
  - Strong CONUS based intelligence and logistics support
  - Robust SATCOM
- Joint tactical warfighting operations - Brigade & below
  - New doctrine requires increased BLOS communications
  - Accurate ground truth to avoid fratricide
  - Rapid, accurate targeting to impact operations
  - Accurate, current SAM Order of Battle to avoid losses
  - Tactical information needs NOT a high priority at JTF HQs



Prioritizing Army Space Needs

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Situational Awareness

In the early 1970's, General Bill Depuy, then the Commander of TRADOC, coined the phrase "see the battlefield." Over the ensuing years, the improvement in sensor technology and the ability to network heterogeneous communications capabilities into a tactical internet have provided the tools to implement Depuy's vision under the now used term of situational awareness (SA). With SA, one day all commanders will have access to a current display of the battlefield within their areas of responsibilities to the level of resolution necessary for conduct of operations. The current implementation tends to favor the needs of the senior commanders, as opposed to the commanders and soldiers at Brigade and below.

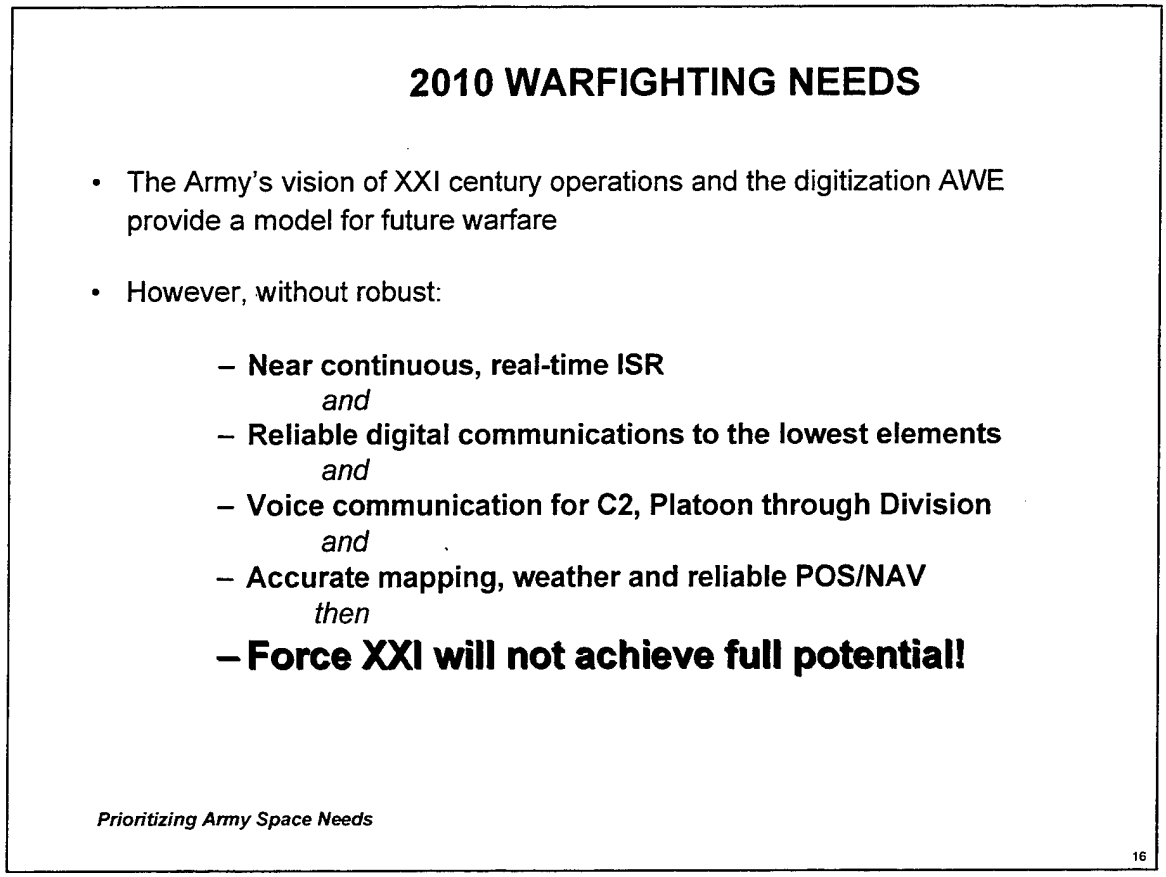
At the Joint Task Force and at the service component headquarters, the level of information and the timeliness needed to satisfy the SA requirements are relatively easy to meet. Information on the location and composition of major elements of the threat forces current to within hours provides enough data to meet the planning and response timelines of the commander and his staff. Most of the information needed can be derived from National Technical Means (NTM) which are exploited in the CONUS by the defense agencies. This non-real-time information is provided to the JTF via MILSATCOM or leased commercial satellite. Thus, the CONUS defense establishment is, in essence, providing sanctuary support to the JTF operations.

However, at the joint tactical echelons, brigade and below, a number of factors reduce the adequacy of this SA to both the Army and its sister Services. To successfully execute joint tactical operations, the commanders need:

- Accurate, real-time target acquisition data if they are to deny the enemy free access to unoccupied areas.
- Complete and accurate representation of all blue-force elements to avoid fratricide while controlling the battlespace.
- Accurate description of the threat air defenses so that Army and USMC rotary wing attack helicopters, as well as Navy, USAF, and USMC fast movers, can operate in the battlespace with minimal loss

Satisfaction of these needs is exacerbated by inadequate BLOS communications to connect distributed ground forces and to maintain continuous contact with joint and allied aircraft operating over the battlefield. Furthermore, SA provided by CONUS support to the JTF is insufficient in that it generally is not real time and does not provide the level of detail needed to support effective fires, i.e., the location of every blue combat element and the precise location of critical red elements. Existing surveillance systems lack the capability to support continuous, real-time SA. The detailed tactical needs of the combatants are usually "below the radar screen" at the JTF headquarters.

The ASB Study Panel is concerned that Army leadership fails to realize that the needs of the joint tactical warfighters are not being met and that it will take major concerted efforts to mitigate this deficiency and to advance the vision of the digitized battlefield.



2010 Warfighting Needs

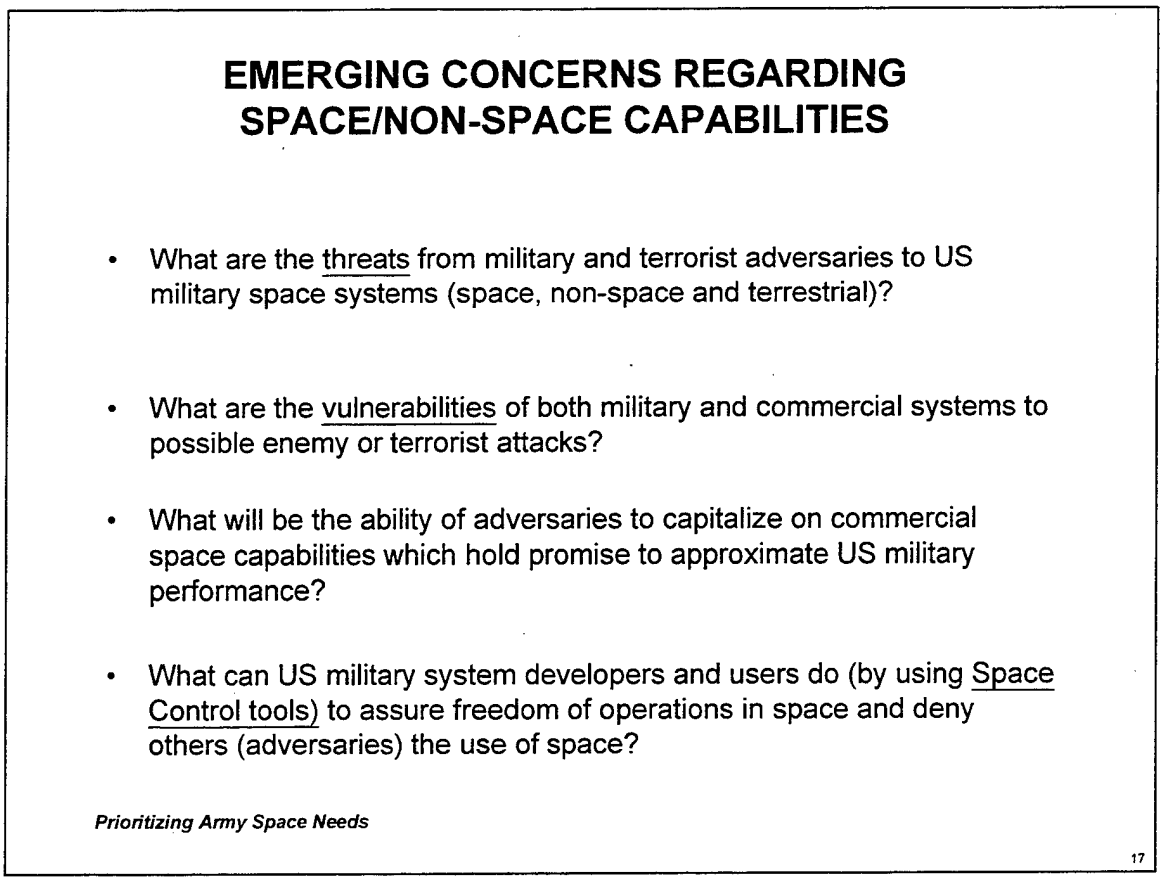
The Depuy vision of "seeing the battlefield" began to evolve in hardware and software in battle lab experiments at Ft. Knox a decade ago. These early experiments looked at the power of interconnecting tank commanders in M1's to improve coordination among the elements of the platoon, company, and battalion. This was done by providing real-time reporting of the position of each track and the ability to coordinate fire and to maneuver among units.
These early trials led to the Army digitization program, which has been evaluated experimentally in a series of FTXs and CPXs from 1994 to the present. The observations from these exercises formed the basis of the Army vision of XXI. The experiments to date have been limited in scope and have suffered the growing pains of implementing some very complex technology in demanding military environments. For example, the Tactical Internet, which supports the distribution of SA products to the warfighters, is built to the commercial standards of the internet. Unfortunately, civilian users have not demanded mobile operation on an "unprepared environment" representative of the future battlefield and this important standard has yet to be established.

Multiple factors limit the Army's ability to realize the vision of the digital battlefield:

- High-resolution spaceborne sensors do not have the ability to provide continuous coverage of an area unless the number of spacecraft is very large. Likewise, most manned sensor platforms are not operated in a small geographic area due to the inherent danger to the system and its crew. This lack of continuous coverage is a serious limitation on the future battlefield.
- Technology is not available to "fly" and process real-time imaging systems with the capacity and resolution needed to continuously describe the tactical battlefield

- The communications to and among the lowest elements of the force are not adequate to deliver the real-time data flow to support SA and voice coordination, which is an inherent element of battle command
- Our ability to develop map products for a new area, the ability to provide micro weather information to support precise artillery fire and air operations hundreds of kilometers into enemy territory, and robust position location/navigation are not yet available

The vision of Force XXI cannot be realized until each of these problems is solved. Space systems can be major enablers in the solutions to these complex problems.

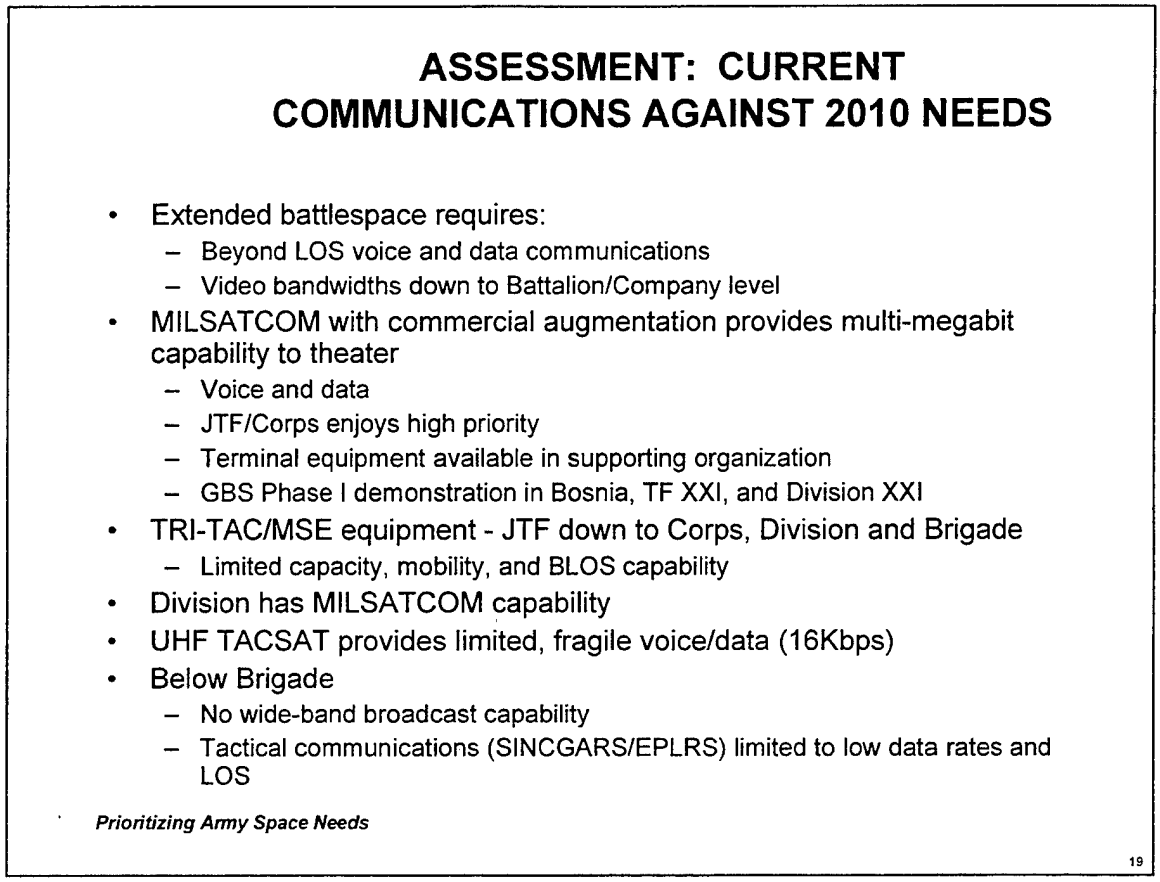


Emerging Concerns Regarding Space / Non-Space Capabilities

The study panel was highly sensitive to the need to assess Space threats and vulnerabilities. Recognition was given to the fact that the nature of world politics has made dramatic turns in the past decade. The questions above indicate the areas explored during the conduct of the study. In addition to the classic concern of how to protect U. S. systems, it quickly became evident that the burgeoning commercial capability being brought on line is creating a new concern for Army commanders. It is highly likely that future adversaries will have access to substantial space capability as long as they can afford to pay for it. It is incumbent that the Army knows and understands the extent of these capabilities and be prepared to counter them.

Much of the work done by the panel relative to threat and vulnerability is classified. The classified findings and recommendations have been briefed to the Army leadership. In order to keep this report unclassified and achieve the widest possible distribution, only the unclassified findings and recommendations are discussed later in this document.

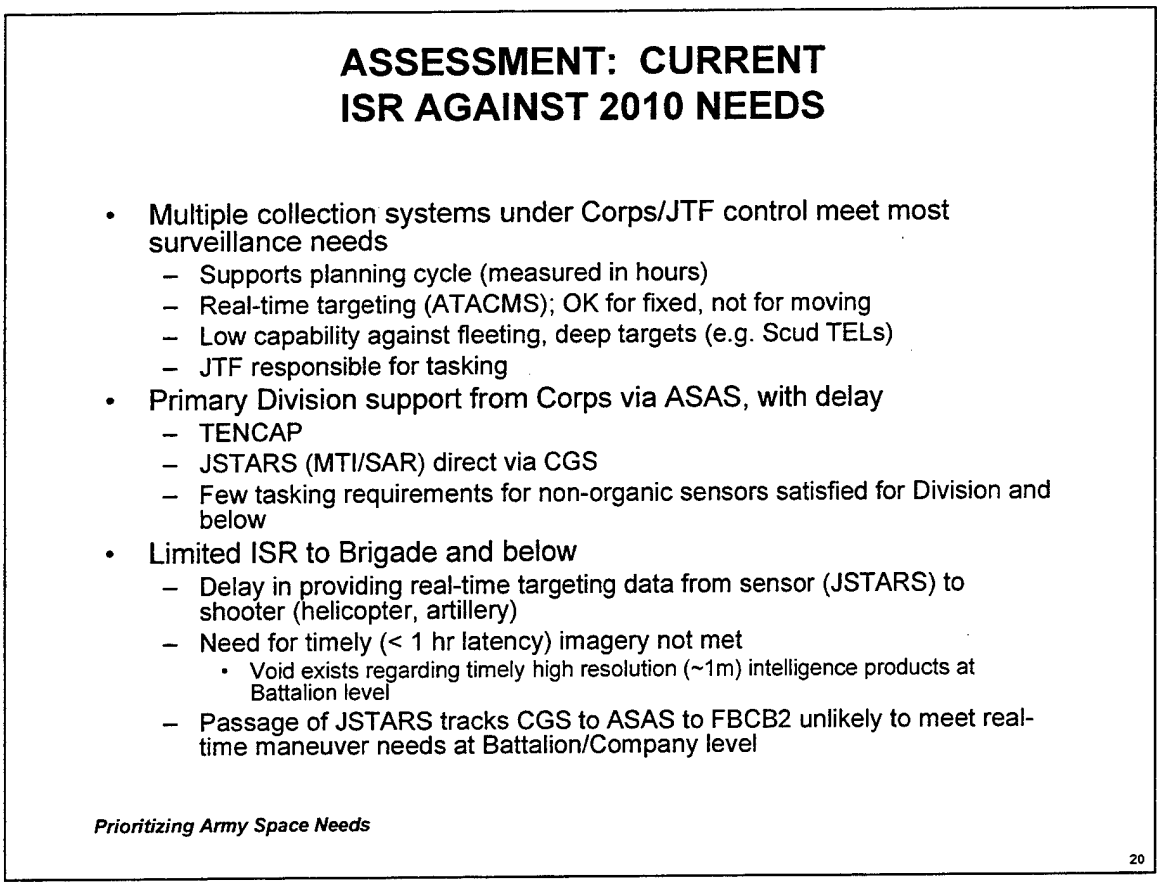
Assessments against 2010 Needs



Current Communications against 2010 Needs

Examination of communications needed to adequately support Army missions in the post-2010 time frame immediately points to requirements of units at Brigade and below to transport large quantities of information beyond line of sight. In addition, recent Army requirements (such as Video-Teleconferencing among commanders) call out video bandwidth down to company level. MILSATCOM has planned upgrades that will satisfy the higher echelons of Army command, such as at the JTF/Corps level. GBS is programmed evolve to a more satisfactory capability than now exists in Bosnia and should satisfy the need to get video, intelligence, logistics, medical and other large datafiles down to the tactical-level forces.

Unfortunately, given capacity limitations of the planned MILSATCOM architecture, the planned capabilities do not appear adequate to provide beyond-line-of-sight voice and data communications to the lower echelons, such as at the battalion and company levels, sufficient to meet the goals of Army digitization. SINCGARS/EPLRS will be available, but these systems will be limited to low data rates and LOS.



Fielded ISR against 2010 Needs

The improvements in ISR that will evolve over the next decade will be substantial with respect to coverage, revisit times, integrated asset management, and product dissemination to the field. Still, these will be evolved capabilities, not the revolutionary capabilities that will be available beyond the 2010 timeframe. None of the advanced new ISR systems that are currently in the planning stage (e.g., Discoverer II, IOSA) will be operational by that time. However, many of the new processing and dissemination initiatives will be in place to provide better support to military units. Army TENCAP will continue to be a key element of the direct-to-battlefield dissemination architecture of the Army. In any case, the Corps will continue to have very limited deep targeting capability under its control and therefore must rely on Joint and National sensors for this vital function.

Capabilities are being planned to better use the JSTARS information and disseminate it to the tactical forces, even though it is not expected to meet real-time maneuver needs at battalion/company levels. Airborne ISR systems will continue to provide battlefield support and the dissemination within the battlefield will improve. Systems such as GBS with in-theater rebroadcast will support improved product dissemination, as will common ground stations and data link standards.

It is possible that some new capabilities might come into existence due to the new HALE UAV platforms, but since these programs are still experimental, there is no assurance that they will become operational by 2010.

Some enhancement of ISR capabilities can take place due to tactical UAV capabilities that might be available by 2010. However, the current situation with the Army TUAV offers little confidence that the Army tactical forces will have a truly usable TUAV for enhanced ISR by 2010 unless major restructuring of the current TUAV program is implemented soon.
Major improvements are possible in the areas of integrated tasking, processing, exploitation, and dissemination (TPED). Integrated and tightly coupled tasking and management of the broad spectrum of ISR systems (space, airborne, and ground) will be improved by 2010, but the availability to the lower echelon forces will remain constrained, with little ability to effectively task the integrated system within the required timelines at brigade level and below (minutes versus days).

ASSESSMENT: FIELDED WTEM, & POS/NAV AGAINST 2010 NEEDS

- Weather & Environmental Monitoring - Essential to optimize force operations
  - Weather balloons (every 4 hrs); acoustical sounder for low altitude data
  - Communication links to Defense Meteorological Support Program (DMSP)-cloud cover, but not cloud bottom, and course wind data with 4 hrs latency (vs. wind velocity + 2 m/s NRT)
  - Weather/trafficability interaction not available
  - GOES cloud cover with 1 km resolution
- Terrain - Mandatory for battlefied visualization (BV) envisioned for digitized force
  - Global DTED Level 2 required for BV--less than 5% of earth covered
  - DTED Level 4-5 required for targeting--less than 1% of earth covered
  - Very limited feature data
  - Near term change data not available
  - Rapid terrain data acquisition and exploitation over denied areas not possible (Corps area coverage in 12 days)
- POS/NAV - Critical for 2010 force operations
  - GPS use widespread
  - Very vulnerable to jamming (airborne KW jammers preclude use over wide area)
  - Selective availability disabled no later than 2006
  - Radio POS/NAV infrastructure deteriorating

Prioritizing Army Space Needs

Fielded WTEM & POS/NAV against 2010 Needs

Weather and Environmental Monitoring

Weather and Environmental Monitoring are essential to optimizing force operations. Weather impacts a variety of combat elements. For example, inaccuracies in wind data can significantly affect the number of artillery rounds required to neutralize a target. Visibility and wind data are also important in planning and executing helicopter operations. A third area in which wind data are vital is in predicting chemical/biological agent dispersion. Cloud bottom data are important to USAF delivery of smart munitions and affects close air support operations. Cloud bottom data can also affect helicopter route planning. Moisture content in the soil affects its trafficability and thus the maneuver options and timing.

The Army sources of weather data include weather balloons and acoustical sounders. These systems have certain shortcomings. The byproducts of launching weather balloons have an adverse environmental impact; there is latency (depending on time from launch), and the area collected is dependent on winds aloft. Acoustical sounders can only provide low-altitude wind data in the vicinity of the sounder.

Communication links exist to the ground segment for the Defense Meteorological Satellite Program (DMSP). Through this system, cloud cover data are available with 4-hour latency from the time of the satellite pass. (Note that cloud cover information is not cloud bottom data, which the USAF needs.) Algorithms have been developed to generate course and wind data. The accuracy is dependent on the surface (land or sea) and, as with the cloud data, there is latency from the time of the satellite pass.

At the present time, there is no capability to determine the soil moisture content and its consequent interaction on trafficability. Hyperspectral imagery can yield an indication of moisture content; however, the capability does not exist to incorporate these data with soil type for estimation of impact on trafficability.

Terrain

Digitized terrain data are mandatory for the digitized force's battlefield visualization (BV). Digitized terrain elevation data (DTED) have been prepared for a large fraction of the earth to Level 1, i.e., 100-meter posting and 50-meter absolute accuracy. However, Level 2, with 30-meter posting (which is required for BV) is available for less than 5 percent of the earth. Higher absolute accuracy is required for targeting (5 to 10 meters) and is available with DTED Levels 4–5. This higher accuracy can increase artillery effectiveness for preplanned fires by 17 to 25 percent. Only a very small fraction of the earth is covered at these levels.

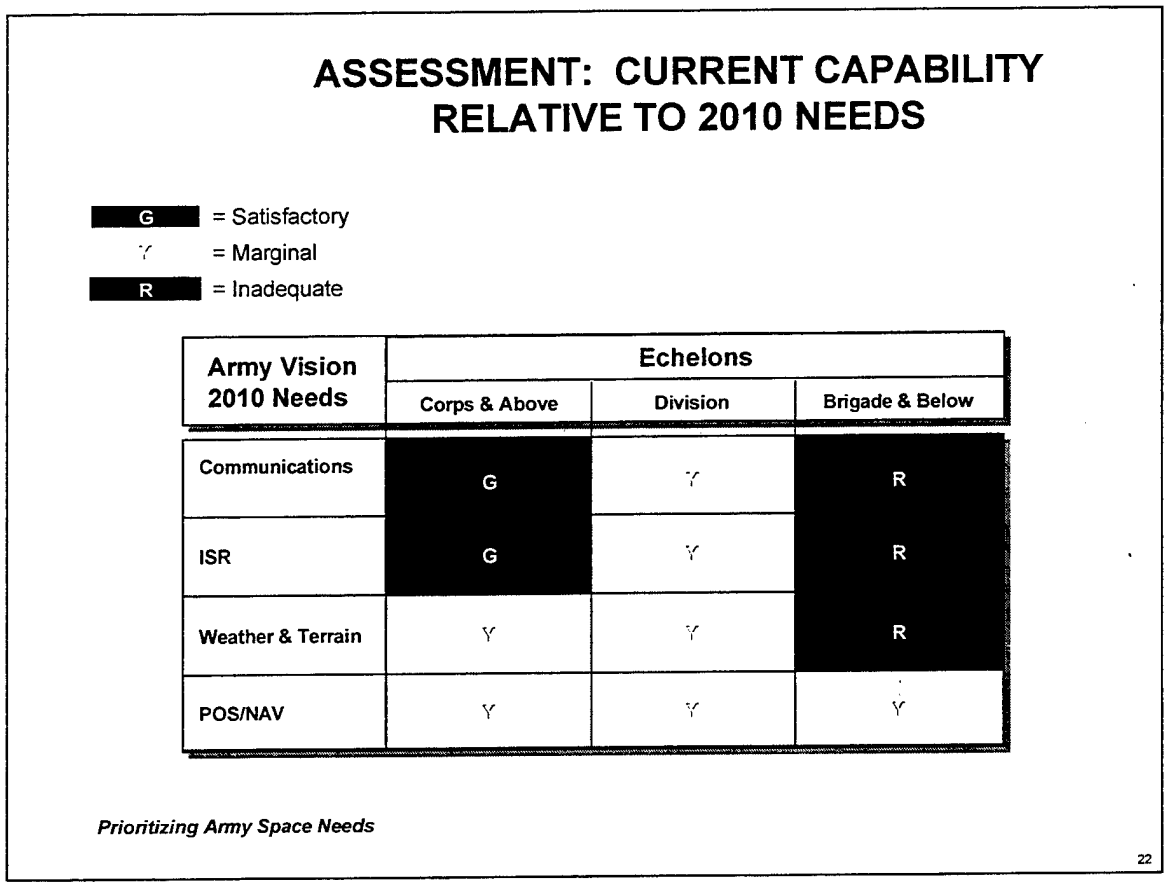
Feature data that include buildings, roads, bridges, forested areas, etc., are integral to maneuver planning but are largely not available in digitized form—neither are recent change data such as a washed out bridge or a barricade under construction.

A rapid collection and exploitation capability of terrain data over denied areas does not exist. Terrain data are currently available for contingency areas such as Korea and Iraq; however, in many third world areas, data are sparse, and so a rapid collection and exploitation capability is required. It should be noted there may be significant inaccuracies (on the order of 300 meters) between map coordinates and GPS coordinates. These potential inaccuracies prompt the need for rapid collection. The timeliness requirement is for a corps-sized area (300 km by 300 km) to be collected and exploited within 12 days.

POS/NAV

Accurate position location and navigation are integral to 2010 force operations and are facilitated through the widespread use of GPS. Many munitions such as JDAM and guided MLRS are also dependent on GPS for increased accuracy. Unfortunately, GPS is very susceptible to jamming. Heliborne jammers can block use of GPS over a very wide area. Other jammers are hockey-puck-sized and can block GPS locally; these are cheap and can be constructed with Radio Shack parts.

The threat may also rely on GPS. Selective availability was designed to preclude such usage, but, with the widespread commercial use of GPS, national policy states that this capability shall not be invoked after 2006. The infrastructure that supports radio navigation systems, such as LORAN, is deteriorating as a result of switching to GPS.



Current Capability relative to 2010 Needs

This chart presents a consensus summary of the ASB subjective assessment of the current capabilities that are available to the force to support Army operations in 2010. This assessment is subdivided by functional area (communications, ISR, weather and terrain, POS/NAV) against echelon. Overall, the assessment of current capabilities was marginal at division and above. At brigade and below, capabilities are inadequate.

Communications

As previously discussed the Army communications needs at corps and above are satisfactorily met by MILSATCOM systems with the continued augmentation of commercial capabilities such as INMARSAT. The limited access at division to DSCS along with the limited and fragile capacity offered by UHF TACSAT, is marginally adequate support needs. At Brigade and below, current communications is inadequate when measured against 2010 Army needs.

The digitized force of 2010 requires high data rates (in the megabit per second range) among the brigade and below units. The CONOPS requires support beyond line of sight. These requirements are not met by the limited fragile capacity of the beyond-line-of-sight systems (TACSAT) and tactical radio (SINGARS/EPLRS). Thus, communication is assessed to be inadequate at brigade and below.

ISR

The theater/task force is supported by the national ISR capability and sets tasking priorities for the entire force. The theater/task force commander controls theater organic capabilities such as

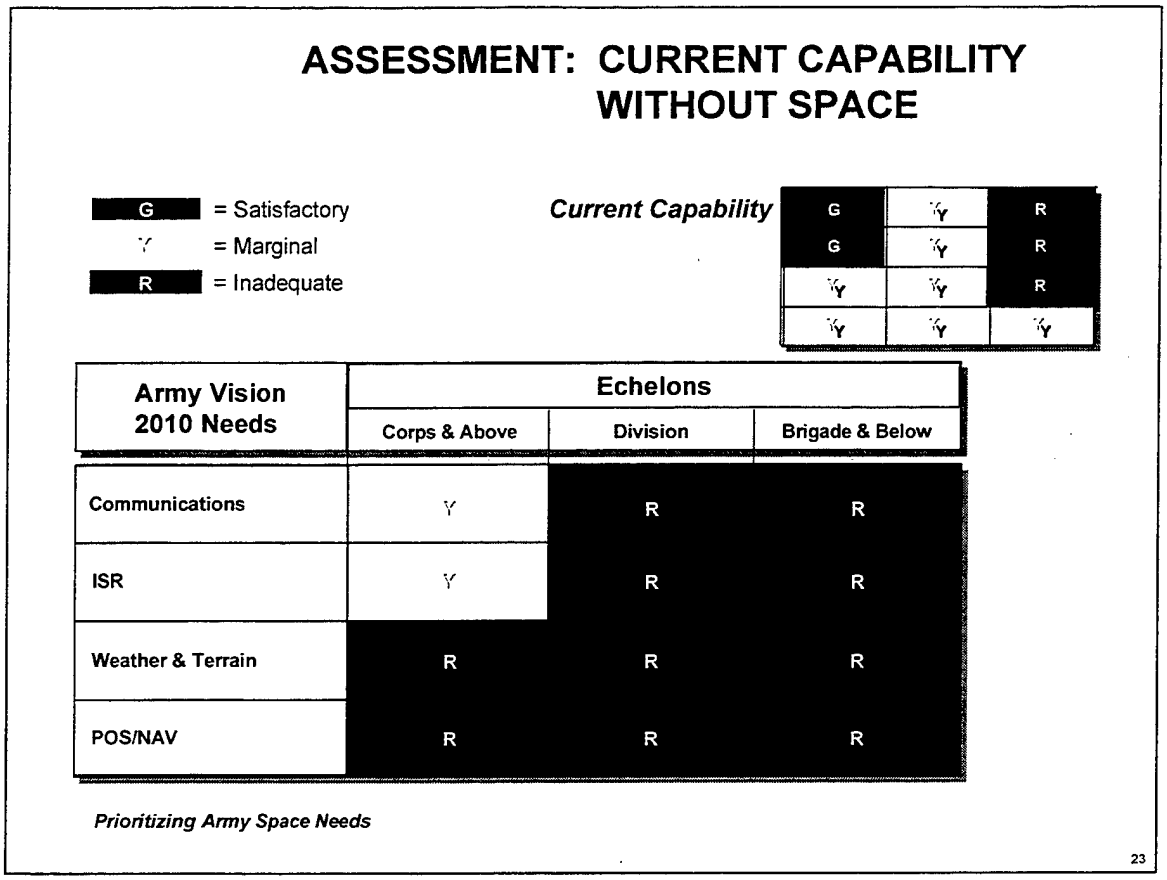
JSTARS. These capabilities are assessed to be satisfactory in meeting most of the corps and above ISR requirements. As previously identified, a significant exception is the deep targeting mission of the Corps. The division has only limited access, including tasking, to national and theater joint ISR systems. Thus, the increased ISR needs commanded by the 2010 force are only marginally supported. Brigade and below have little priority on national and theater capabilities, but the brigade and below ISR needs are more demanding in resolution, frequency, and latency. Ground based scout patrols with their SINGARS cannot meet coverage and latency needs. The Army UAV could provide much needed capability if available but considered doubtful at this time. Thus, the ISR support to the brigade and below is inadequate for 2010 operations.

Weather and Terrain

Current capabilities provide weather information that is very coarse relative to Army operations and is nominally at least 4 hours old. Weather data is marginal for division and above, however it is not of sufficient resolution to support optimized operations at brigade and below. DTED-2 is required for battlefield visualization and planning. DTED-1 is available for approximately 70 percent of the earth and can be used with marginal effectiveness for planning and visualization when coupled with high-resolution imagery. For these reasons, division and above weather and terrain capabilities are assessed as marginal. [The inability to provide high resolution weather and terrain data to support operations leads to an inadequate assessment for brigade and below.]

POS/NAV

As discussed previously, good POS/NAV is essential to Army operations in the 2010 timeframe. It is fundamental to the digitization of the force. GPS has become the underpinning technology to provide this essential capability. Jamming, even at moderate power levels can preclude the use of GPS receivers over a large area of the battlefield. Alternative POS/NAV systems such as LORAN are not being maintained and units are not issued the necessary equipment. Thus, the Army is totally dependent on GPS, which provides excellent capability but is subject to simple jamming; therefore, the current capability is assessed to be marginal across the echelons.



Current Capability without Space

This slide dramatizes the contribution of space resources to Army warfighting needs. Comparing this slide, which addresses current capability minus space assets, with the preceding slide shows that those areas which were marginal with space assets are now inadequate and those that were satisfactory are now marginal.

Communications

Without satellite communications (SATCOM) the Army would revert to terrestrial communications. At Corps and above such media as transoceanic cable and fiber, host nation communications (military and PTT) and military beyond line of sight, such as HF and Tropospheric communications, would probably meet minimal requirements. But at Division and below, the increased needs of the 2010 Army could not be met without SATCOM.

ISR

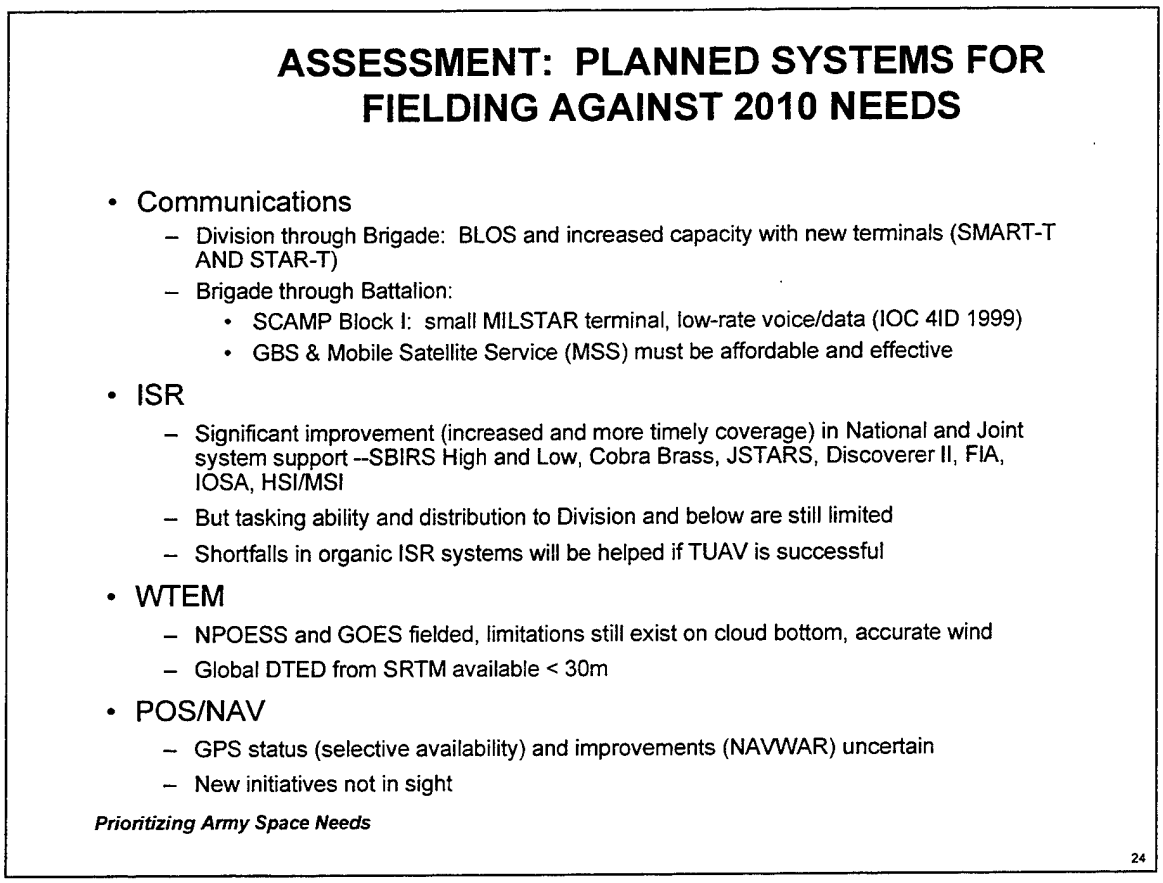
With no national ISR and no space communications, the corps and above ISR needs are marginally met by organic assets. The absence of beyond-line-of-sight communications, coupled with limited tasking priority, makes for an inadequate ISR capability in support of the division and below.

Weather and Terrain

A significant portion of weather and terrain data are currently collected by space-borne systems. Terrain data can be collected by airborne assets in a benign situation (e.g., Bosnia data collected by ERIM airborne IFSAR). Weather balloons can provide localized data over uncertain areas. These limited capabilities are inadequate to support Army operations in 2010.

POS/NAV

The Army has become totally dependent on GPS, and alternate capabilities are no longer maintained and deployed in adequate numbers to support Army operations in 2010. Thus, without space-borne GPS, there is inadequate POS/NAV support to a digitized force.



Systems Planned for Fielding Against 2010 Needs

Communications and ISR

A number of communications and ISR developments are being planned to meet 2010 needs of the Army warfighters. The Army has, or will have, on contract acquisition of new terminals for use with UFO, DSCS, MILSTAR and Commercial (CSCI) satellites.

Included in the MILSATCOM architecture are two undefined systems, which, if successfully implemented, will add significant capability. GBS Phase III should overcome the shortfalls of the existing system, but the Army must ensure that terminals are affordable and tactically usable. DOD is already experimenting with commercial systems (Iridium and Globalstar) as an answer to beyond line of sight mobile users. The MILSATCOM architecture designates this capability, though the specific system, the Mobile Satellite System (MSS), remains to be determined. For ISR capabilities, a number of new adjuncts of current systems should improve the ISR capability for Army tactical forces. Also, there is a "new" commitment of NRO, NIMA, NSA and DIA to be relevant to the tactical needs. The new SBIRS High and Low system should provide the Army much needed new surveillance and reconnaissance capabilities.

The range of capabilities being planned to address the 2010 needs is phenomenal, but most will come into full operation beyond 2010. However, as these systems become operational, the Army will have the opportunity to have significantly improved ISR results delivered to the fighting units. The entire range of existing systems will be augmented by new systems such as Discoverer II with MTI and SAR by evolving HSI/MSI systems and a more robust communications system to provide more timely dissemination. The Army will have the opportunity (by engaging in the design and specifications now) to refine these systems to support Army needs. Perhaps the most

critical area is the TPED (tasking, processing, exploitation, and dissemination) architecture that will be evolved to support these future systems as part of the integrated DOD ISR architecture of the future. TPED for national and theater ISR systems will continue to provide very limited support to brigade and below. This could be substantially improved in the 2010 timeframe if appropriate actions were taken by the Army.

Weather, Terrain, and Navigation

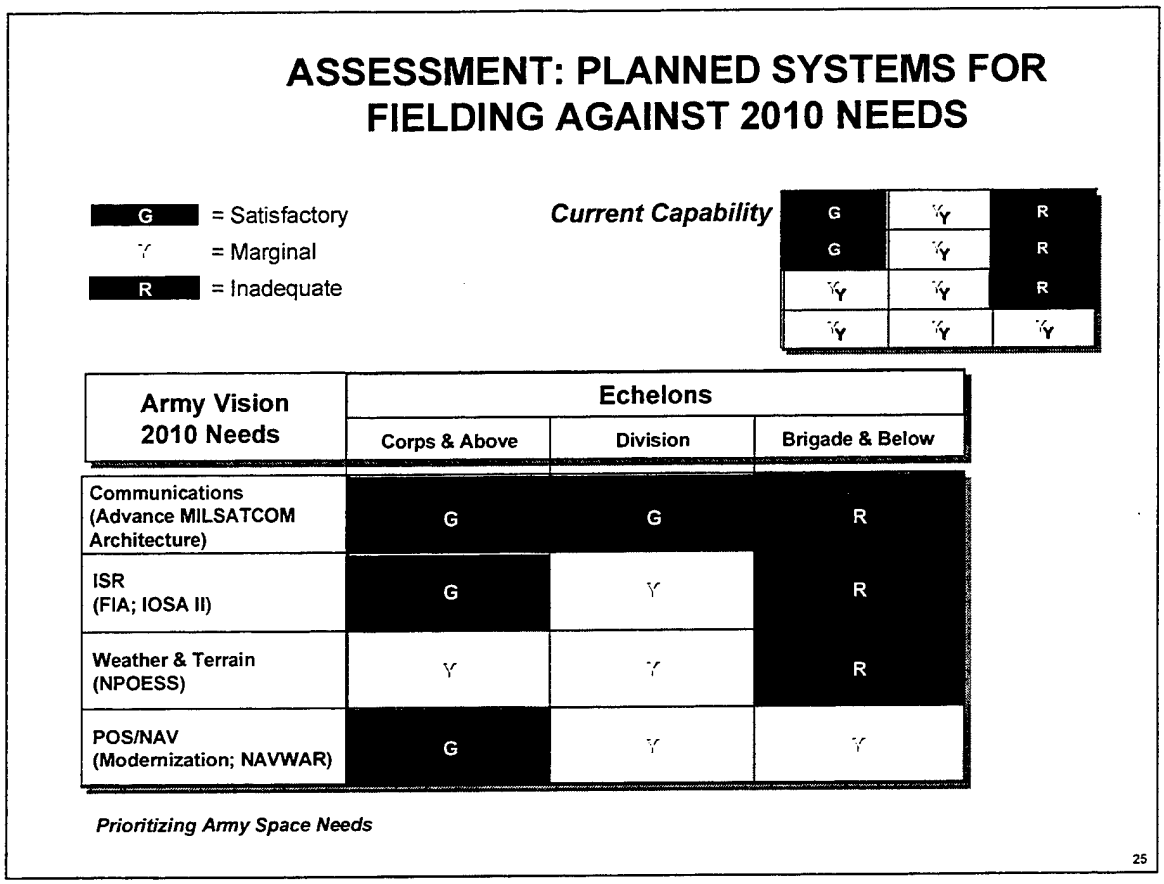
Within weather and environmental monitoring, the major planned system is the National Polar Orbiting Environmental Sensor System (NPOESS). The capability of NPOESS to support military operations is similar to that described for DMSP. NRT cloud cover data will be available through direct downlink. Cloud data from other systems such as GOES will complement the NPOESS data. Nevertheless, cloud bottoms and accurate wind and weather/terrain interaction data will still not be available.

The digital-terrain elevation data situation will have improved, largely through the shuttle mission scheduled for the Fall of 1998 [flew in February 2000], which will produce global DTED Level 2 data. Limited feature data will be collected; however, no funding for exploitation has been provided. The Rapid Terrain Visualization ACTD will be complete, and a residual capability will exist to collect the DTED via UAV within timeliness requirements, given access to the collection area.

Discoverer II will have the capability to collect DTED at Levels 4–5. Some feature data may also be available. Despite these described gains in collection capabilities, processing of feature data remains time consuming and manpower intensive. The cost associated with this effort suggests there will continue to be a substantial gap in providing these data to the field. (Note: a suggested workaround is to "drape" imagery over the DTED data. This enables the user to see the roads, buildings, forested areas, etc., and plan accordingly. Change data may be available through imagery sources, however, distribution issues still remain.

The POS/NAV situation will also be improved. Some elements of the NAVWAR program will have been implemented, but the degree to which this program is implemented remains to be seen. Elements under consideration include increased power in the next-generation GPS satellites, addition of pseudo-lites to recreate, and higher power local positioning system and improved jam-resistant receivers. The potential use of low-cost inertial navigation systems could bridge some gaps in GPS availability.

The situation with regard to selective availability and radio POS/NAV is not projected to change from previous discussions.



Assessment: Systems Planned for Fielding against 2010 Needs

This chart presents a summary of how well the new systems planned for fielding will meet the 2010 needs.

Communications
STAR-T increases bandwidth capability to the division and above. GBS adds significant information dissemination down to the battalion. SCAMP adds protected forward operations communications capability. SMART-T provides protected bandwidth capability to the division. Thus, division communications are assessed to be improved sufficiently to be considered satisfactory.

ISR
Improvements in national systems provide increased capability for the corps and above, but shortfalls at division and below are not overcome. Planned systems provide little improvement for division and below. Latency and revisit requirements will not be met by currently planned capabilities. However, improvements in the latency and revisit can be made through the TPED process, which would substantially reduce the latency and tasking problems for lower echelons units. These need to be championed by the Army over the next decade.

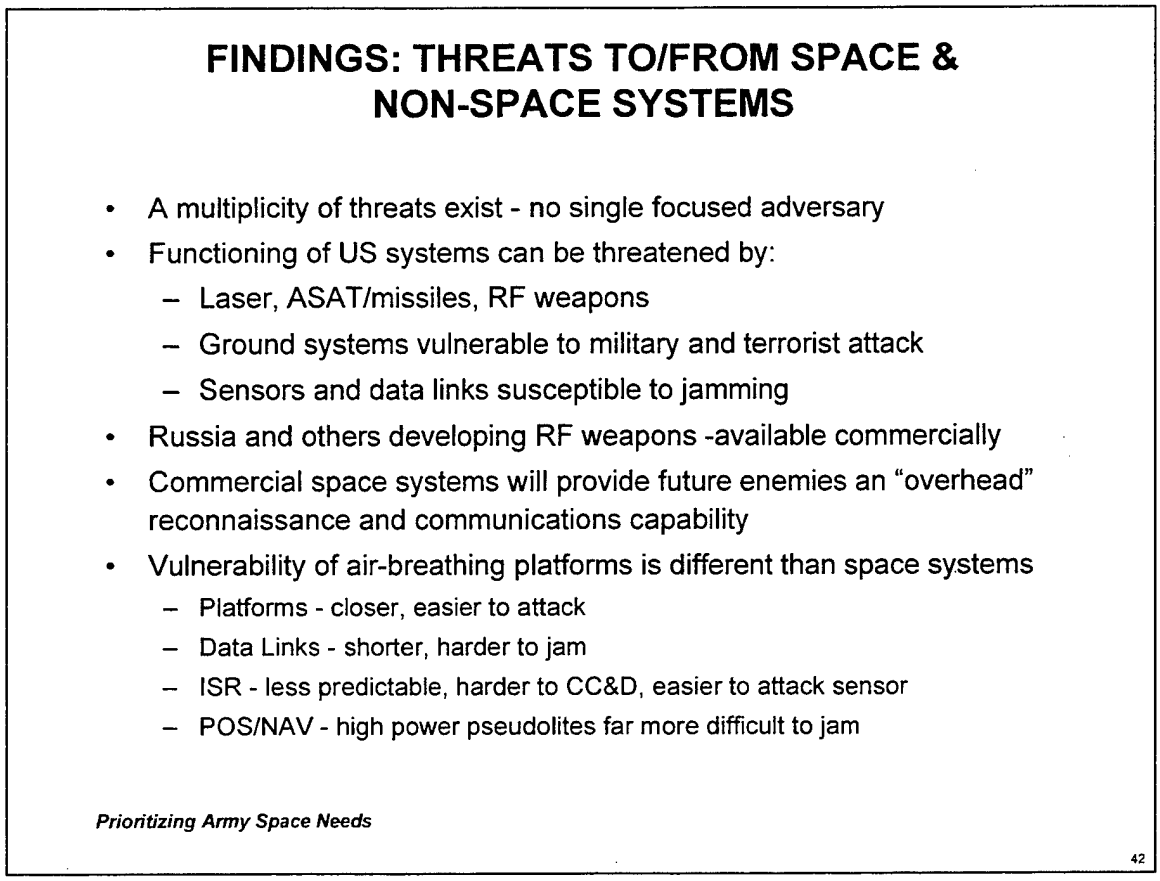
Weather and Terrain

DTED Level 4 data will be available from planned programs by 2010. The combined high-resolution DTED and imagery data enhance operations at all echelons. Also, IMETS and NPOESS will provide additional weather data. Timely wind and cloud bottom data still will not be available in theater to optimize operations. Concerns also remain about the availability of feature data; timely terrain/feature change information; and weather impact on trafficability.

POS/NAV

The GPS constellation will be virtually unchanged by systems now planned, although there will be a few satellites with higher power. NAVWAR analyses will identify potential mitigation techniques against the jamming of GPS. This reduced vulnerability will provide some benefit at a distance from the threat and enhance reliability on GPS above the division level.

Findings and Recommendations



Space Threats

In the foreseeable future, the space threat to the Army and the United States defense posture can be characterized as follows:

- Unlike the Cold War era, the space threat to the United States is becoming increasingly diffuse. It will be scattered across an increasing number (now more than a dozen) of emerging second- and third-tier nations, as well as terrorist interests world-wide.

- The threat includes hazards to both the space segment and the supporting ground segments of our space systems.

- Technologically, the threat includes radio-frequency (RF), optical (laser) and kinetic attacks on space systems, and physical or cyber attacks on ground segments and communications links.

- Russia and a number of other more advanced nations (friendly or not) are proliferating the means to attack space assets to any who will pay for the technology.

In addition to the diffusion and proliferation of classical military space threats, there is an explosion of commercial space activities of all types (communications and EO/IR/MS/HS imaging) of satellite systems and related services in a growing number of countries. These systems constitute a threat to the Army in the sense that potential adversaries are likely to have access, for the first time, to highly capable and affordable communications and overhead

reconnaissance capabilities. These capabilities will approach the capabilities possessed by the U.S. military/intelligence community in imaging and perhaps radar capabilities.
Given the foregoing discussion it is clear that alternative platforms (to satellites) be employed to provide similar capabilities. As indicated, air-breathing platforms -- both manned and unmanned -- provide a suitable alternative and have an intrinsically different set of vulnerabilities -- both the platform and the payload.

RECOMMENDATIONS: THREATS TO/FROM SPACE & NON-SPACE SYSTEMS

- Extend existing reconnaissance satellite warning system to include commercial reconnaissance systems
- Task the Survivability/Lethality Assessment Division (SLAD) to track emerging threats and evaluate the vulnerability of US and Commercial C4ISR, WETM and POS/NAV systems
- Based on these vulnerability assessments, ensure that warfighters are aware of system weaknesses and TRADOC should develop tactics, techniques and procedures (TTP) to mitigate their vulnerabilities and counter commercial systems exploitation (CC&D -Conceal, Cover and Deception).
- Develop unmanned, non-space systems to compliment space capabilities to provide robust capability with reduced overall vulnerability

Prioritizing Army Space Needs

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Recommendations: Threats to/from Space and Non-Space Systems

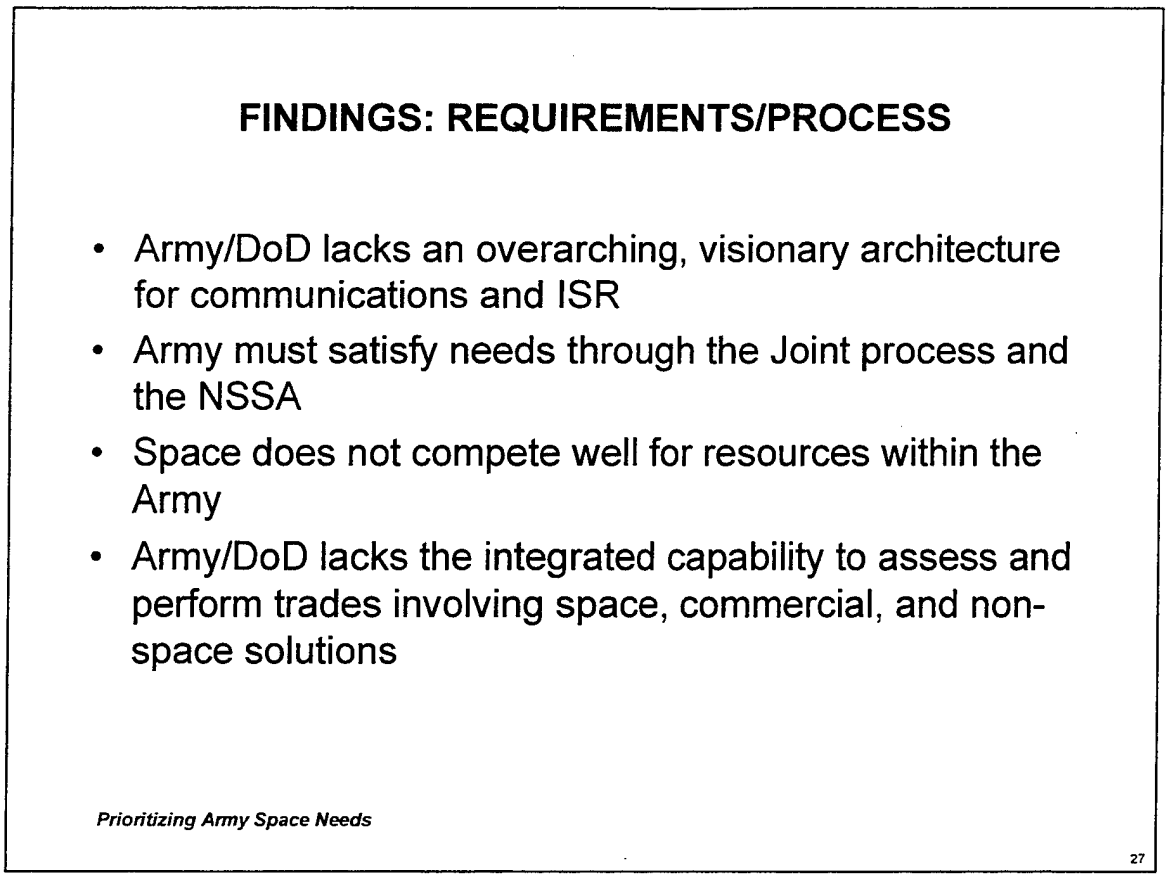
In the early days of Satellite reconnaissance, a warning system was established which advised US commanders when they were to be imaged by Soviet systems. As Commercial ISR satellites are launched, a process should be established to advise the warfighter when he is within the field of view of any ISR bird. Without this capability the clandestine "Left Hook" of Desert Storm will be a thing of the past.

As the US fields more complex, networked, systems of systems it becomes more important that:

- The vulnerability of new systems be understood
- The users of these systems are aware of these vulnerabilities

The Army Research Laboratory (ARL) has established an organization, SLAD, which is chartered to perform these assessments. This organization should be used to fill this void. Given that the system weaknesses are known, TRADOC and the warfighters need to develop and practice TTP to mitigate the vulnerabilities. Concealment, cover and deception will become more critical when the threat can "buy" a world-class ISR system.

Manned and unmanned C4ISR platforms present the threat with a significantly different counter measure challenge to that of satellites. To maximize the threat's problems and increase the likelihood of adequate blue coverage, air-breathing collectors are an important part of the C4ISR mix.



Findings: Requirements/Process
The organizations which support the warfighter's communications and ISR have developed architectures for their systems. DISA has produced an architecture for the long-haul communications, and the Space Architect is currently producing architectures in its FIA, IOSA, and FCA. The Army/DOD needs overarching operational and system architectures for all of the C4ISR system that addresses joint tactical needs. These architectures must address the needs of the end user, particularly at the lower echelons with the necessary mobility, latency, bandwidth, weights, volume, etc. To fully capitalize on the commercial technology explosion, these networked systems can not be realized as an evolutionary upgrade of the current stove-piped systems.

Space systems are essential to all Services and all echelons in 2010. Development of these systems is a joint process in which the USAF, Navy, or NRO are usually given responsibility to acquire the systems. The Army must influence the systems development process to ensure that its needs are met. The primary available mechanisms are through the DOD Space Architect and the developer's requirement process. The UHF TACSAT program is an example in which the Army successfully influenced the requirements to provide limited support for beyond-line-of-sight communications at echelons brigade and below.

Tanks and helicopters are essential to the fulfillment of Army commitments, and they are assigned the highest priority in planning and budgeting. Further, space does not compete well within the Army, primarily because its benefits are not well understood by the leadership. As a result, funding for space related programs frequently "falls through the cracks."

SMDC has been tasked to integrate the use of space to satisfy warfighter needs. This mission includes assessing commercial space and non-space solutions and evaluating them against the requirements of the tactical warfighter. A balance of solutions is needed to achieve the robustness and performance that future operations require, particularly given the digitized, geographically distributed forces of the future.

A major deficiency is the inability of the Army/DOD to evaluate complex C4ISR capabilities in a tactical context. Without such a tool the trade-off between and among military and commercial candidates will continue to be made on a less than rigorous basis.

RECOMMENDATIONS: REQUIREMENTS/PROCESS

- SMDC lead an ICT to develop integrated future operational and system architecture for communications and ISR with TRADOC, DISC4, SARDA, DCSINT, Team Ft. Monmouth
- Build on SMDC/CECOM/STRICOM capabilities to establish ISR and comm modeling test bed to support continuing evaluation of Space Programs
- Build on test bed results (validated in AWEs) and trained people to evaluate, demonstrate, and advocate Army solutions in the Joint Arena

Prioritizing Army Space Needs

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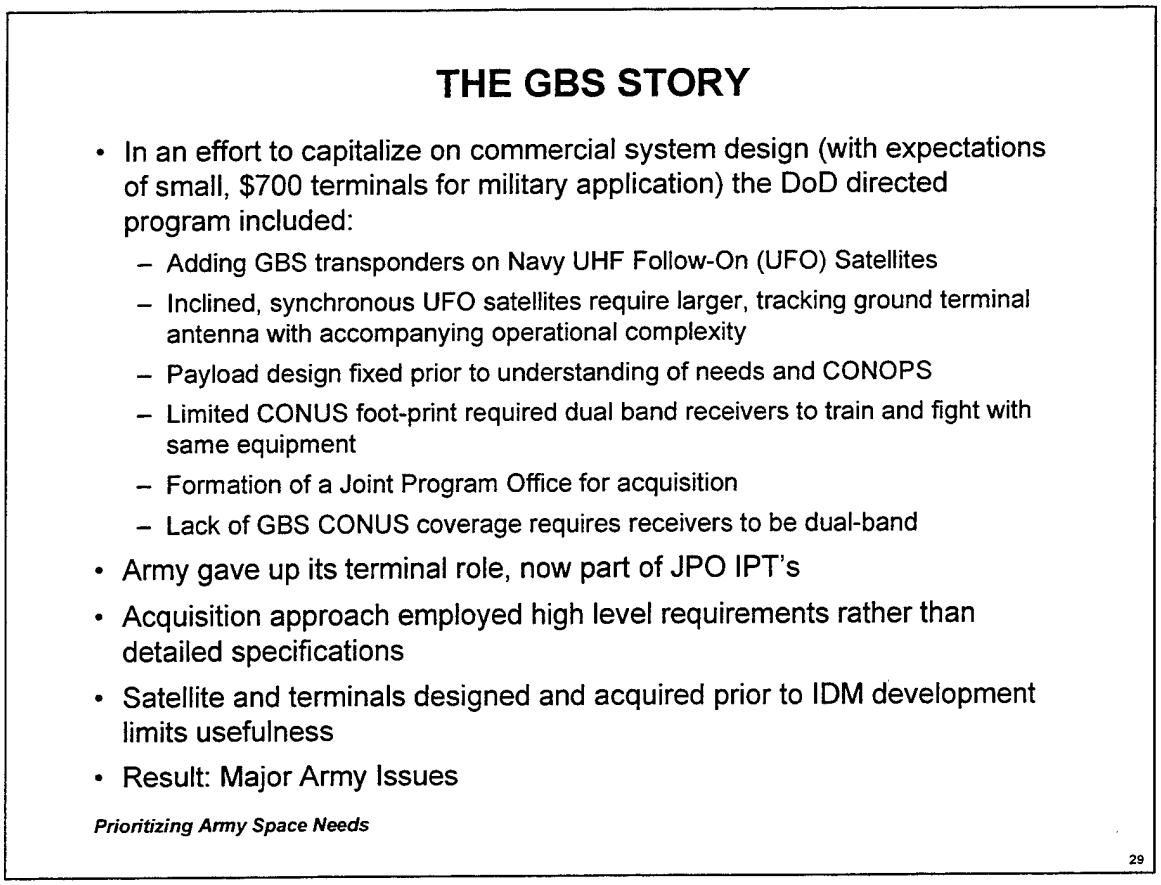
Recommendations: Requirements/Process

SMDC has been given the mission to focus space within the Army and has an MOU with TRADOC to fulfill the Army mission for space requirements. Under these agreements, SMDC should lead an ICT to develop integrated future operational and system architectures for communications and ISR. Membership should include the TRADOC, DISC4, ASAALT, DCSINT, and Team Ft. Monmouth (CECOM and PEOs) on the ICT. As the Army lead, SMDC would coordinate these architectures with the Marine Corps, Air Force, and Navy. These products will then provide a basis for Army input to the national space architectures. Perhaps the best opportunity for the Army then will be to effectively influence the NSSA validated space architectures of the future to satisfy the integrated information and support needs of Army 2010 and the AAN. This will require a strong, single Army position across the broad spectrum of ISR, WTEM, and communications to provide the vision for the future. With this developed, the NSSA can be used as an effective single focus to put in place the architectures that will provide the Army with integrated support on the battlefield from space, air, and ground systems.

As the focus for space, the Army should build on SMDC/CECOM/STRICOM capabilities to develop a comprehensive ISR and communications modeling and simulation testbed to support the continuing evaluation of Army, NRO, and DOD selected programs. This testbed should be capable of supporting a variety of tradeoff analyses including platforms (i.e., spacecraft, manned airborne, unmanned airborne, ground-based), ground terminal versus spacecraft capability, communications bandwidth versus processing capability, etc. Finally, testbed results need to be validated in AWEs. This investment will open the possibility of strongly influencing national

space policy, architectures, and systems to benefit the Army with a very high return on investment.

The SMDC/TRADOC MOU should be the vehicle for evaluating, demonstrating, and advocating space solutions for Army requirements. The Army needs to build on the results gained and people trained to evaluate, demonstrate, and advocate solutions to future Army needs. As a critical component of this advocacy, SMDC must insure appropriate career paths, education and meaningful assignments for Army space personnel.



The GBS Story

The evolution of the Global Broadcast Service program provides an interesting case study of DOD's approach to space systems development. The DOD GBS program began as a "technology push" to capture new commercial technology to rapidly provide significant wide-bandwidth capability via direct SATCOM broadcast. It offered the promise of numerous channels of video and the transfer of large data files into the tactical equivalent of a VCR-sized $700 satellite receiver. The rush to apply the technology resulted in a DOD decision to add wide band transponders to the already on contract UHF Follow On (UFO) satellites. This decision and subsequent implementation, long before Army requirements and CONOPS were mature, resulted in first generation receivers far larger and more expensive than envisioned. In addition the design created a need to provide a larger, tracking antenna vice an 18" fixed dish. Noticeably lacking were plans to implement an information dissemination management system, without which the GBS system would have marginal utility.

The acquisition management was assigned to a joint program office, with the Army to buy the ground terminals. The Army later acquiesced to passing the acquisition of the ground terminals to the JPO under a single contract. The JPO acquisition strategy provided the contractor with high-level requirements without sufficient detail to ensure that size, weight, and cost goals would be achieved.

The lesson learned from this program is not unique. The DOD approach to space development historically has been to determine a space architecture, fix the satellite design and then allow the user terminal to follow in a highly sub-optimized fashion. This approach precludes the system

trade-offs between satellite and user terminals at the time it would have the largest payoffs. The commercial industry does not repeat these errors. They have adopted a paradigm which first completes the user requirements (size, weight, cost and functionality) and then has the satellite designed to complete the system.

ISSUES WITH PHASE II GBS

- Ground terminals: 6 configurations, large, and costly:

	Lowest	Highest
Cost	$90K	$190K
Cases	9	13
Weight	550 lb	950 lb
Volume	49 cu ft	55 cu ft

- Satellite system design:
  - Requires larger, tracking ground terminal antennas
  - Requires additional path for reachback and request links
  - Access may not be continuously available to Army component, down-link beam may be repositioned often within a day
  - Up-link antennas preclude geographically separated TIP's and PIP's
  - Limits TIP capacity to less than full receiver capability

Prioritizing Army Space Needs

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Issues with Phase II GBS

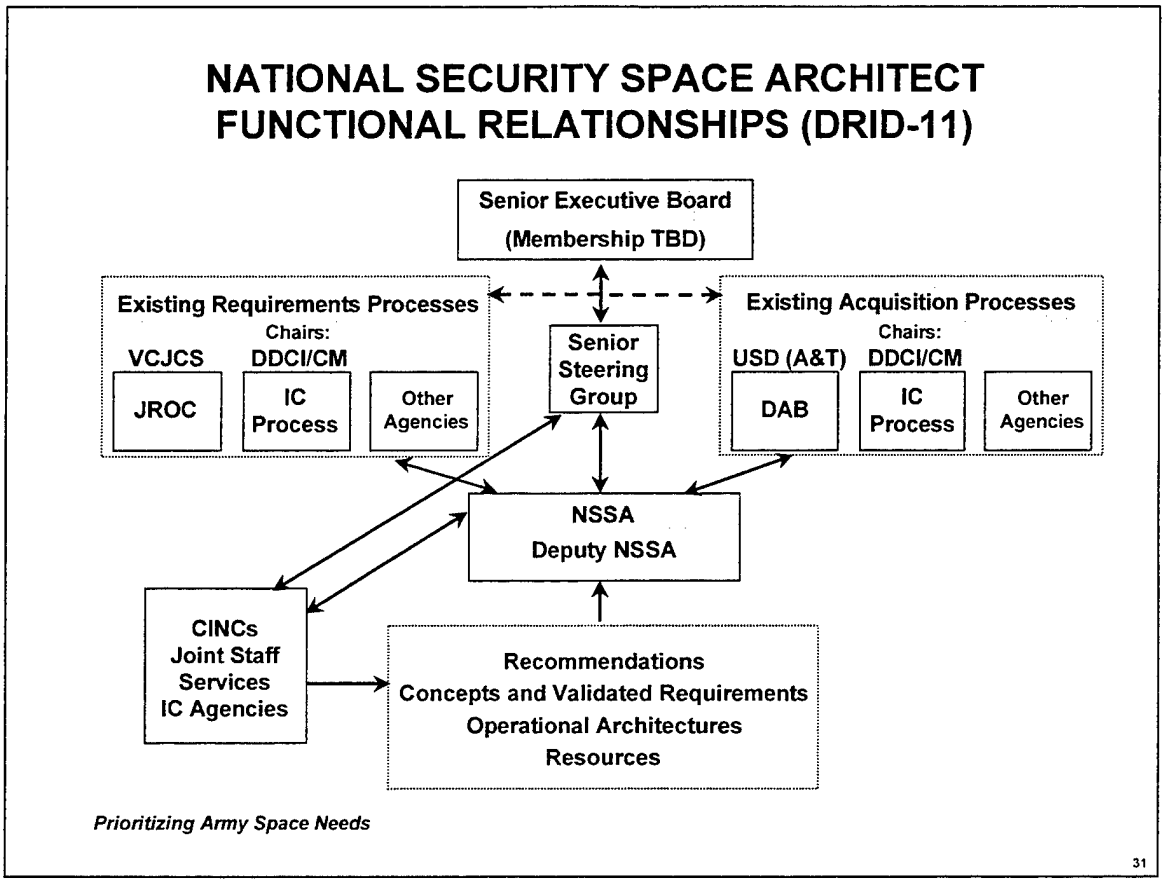
This chart provides some details on the problems created by the GBS decisions:
A major concern of the Army is the size of the receiver system, which consists of a tracking antenna, workstation, and separate com-sec box. The family of terminals coming out of the contract at the time of the first design review had the characteristic shown above.

The addition to size, weight, and cost create the following operational issues that must be resolved in order for the Army to receive capability that complements its method of tactical operations.

- The satellite does not provide a path to get in-theater data to the uplink for broadcast nor does it integrate a path for the users to request specific information.
- Emerging operating plans have the satellite downlink antennas moving around throughout the course of a day. This means the Army may not have the continuous coverage it needs.
- Similarly, because the satellite antennas are narrow beam, uplinking from geographically separate locations may not be possible.

GBS holds the promise of dramatic improvement in information delivery. But, as this example shows, the benefits are diminished by the awkwardness of its implementation.

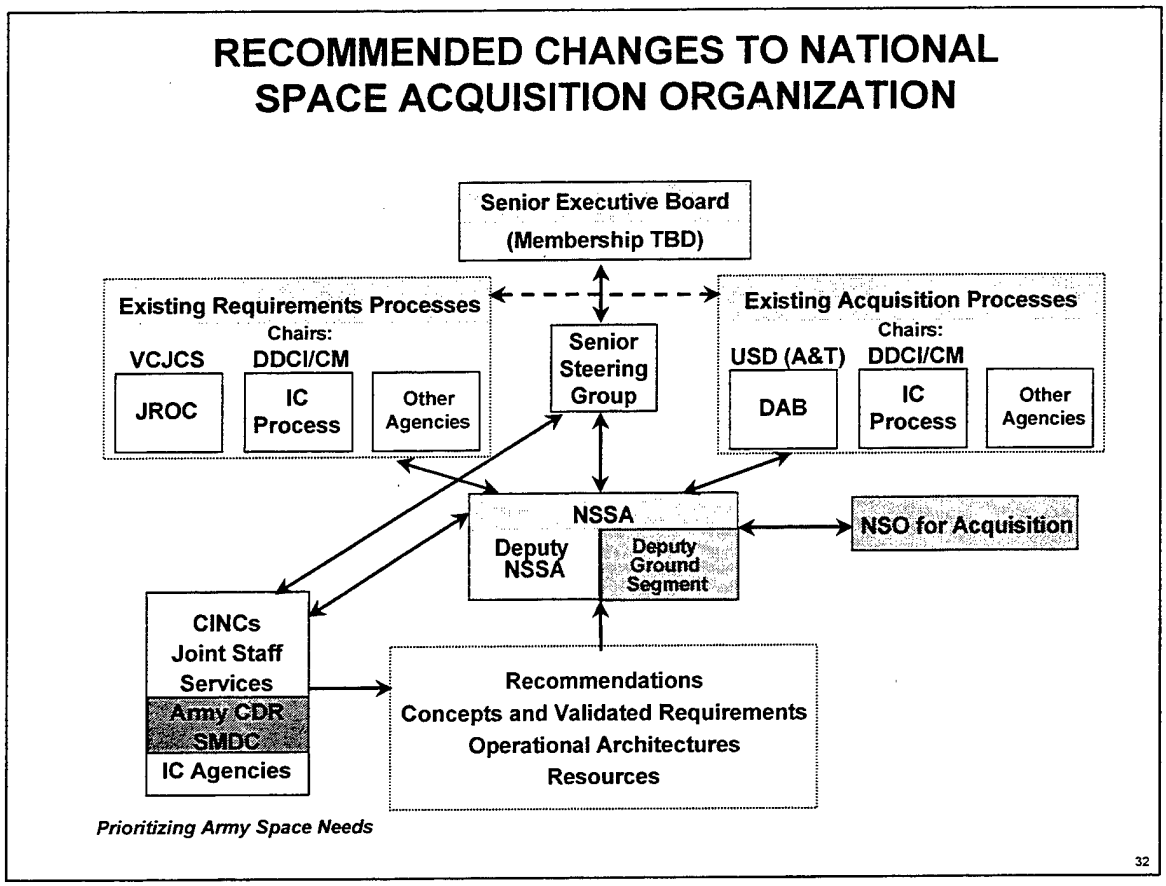
The GBS outcome indicates the need for the Army to take an active and controlling interest in all aspects of space systems design and implementation.



New National Security Space Functional Relationships

This new organizational structure for national space system development called out under DRID-11 has features that make it potentially more responsive to the needs of all the Services. Key to the new organization is the designation of a new joint National Space System Architect (NSSA) for all systems. The NSSA reports directly to the Senior Steering Group, which is made up of the ASD(C3I), the Deputy Director, Central Intelligence (DCI), the Vice-Chairman, JCS (VCJCS), and others who are major stakeholders in the development of space systems. The position of Deputy Under Secretary of Defense (DUSD) Space has been eliminated and Space responsibility within OSD has been assigned to ASD(C3I). A special advisory group has been formed to work directly with the NSSA and with the Senior Steering Group. This advisory activity consists of the CINCs, Joint Staff, Military Department Representatives, and Intelligence Community Agencies.

A key to the new organization is that ALL space requirements will go through the JROC process, to be assigned to the NSSA for incorporation into a common architecture and be managed within DOD by the standard DAB process. This new organization affords the potential to eliminate the duplication and conflicts resulting from two separate organizations responsible for complementary but not independent space systems. It should also aid in the transition of emphasis of national assets from strategic support of the top leadership of the U.S. Government to tactical support of the warfighting forces.



New National Security Space Organization with ASB Recommended Army Additions

The ASB applauds the changes brought about by DRID-11 and has studies them to assess how the Army can exert a greater influence on future national space system developments to better serve Army users. We have three recommendations which we believe can significantly improve the bottom-line result of delivering space capabilities and products to the Army that are affordable, timely, tactically applicable and reasonably survivable. The first of these recommendations can be accomplished unilaterally; the others require consensus agreement of OSD, the other Services and other major space stakeholders.

First, the ASB recommends the designation of the CDR, SMDC as the Army representative to the Joint Steering Group with the responsibility of coordinating all pertinent space issues and positions with appropriate Army stakeholders.
Second, the ASB recommends that the Army promotes the establishment of a second Deputy NSSA (Ground Segment) responsible for representing user needs to ensure their consideration in a balanced system approach to space architecture.

Third, the ASB recommends that the Army promote establishing a new special joint procurement organization that could be designated the National Space Organization (NSO). This NSO would consolidate the space acquisition responsibilities of NRO and USAF and become the acquisition authority for all space systems. DOD budgets for these activities should be removed from service TORs and put into a "purple" DOD budget line. The significance of doing this is to create a process that whereby National/Joint systems are responsive to total warfighter needs as opposed to "how much money" any individual service/shareholder brings to the table. As an example,

such an organization will bring new emphasis to tasking, processing, exploitation and dissemination (TPED) of intelligence and afford the Army the proper forum to influence future architectures with regard to its TPED requirements.

FINDINGS: ORGANIZATION AND PERSONNEL

- National Space systems do not incorporate an overall system approach to space/ground segment design to insure overall cost-effectiveness including affordable ground terminals
- Inactivity of Army Space Council has inhibited Space policy review and emphasis
- Lack of leadership and the resultant limited space trained personnel have reduced Army's ability to influence the Joint Space Process
- SMDC, because of funding imbalance, is skewed to missile defense

Prioritizing Army Space Needs

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Findings: Organization and Personnel

The DOD implements the space segment with one organization (primarily the NRO or the AF) and the ground segment with the user organization (e.g., NSA, NIMA, the Army). As a consequence, the space segment is optimized as a standalone system. The minimal cost solution that meets the requirements results in the ground segment being larger, heavier, more sophisticated, and more expensive than it needs to be. From a total system perspective, the complete system, including ground terminals, is not cost effective and the operational suitability/utility is reduced. In contrast, the satellite communications industry started with the terminal specification (e.g., the dish and receiver for direct broadcast TV and the handset for satellite cellular phone). This has driven the satellite design and resulted in more user-friendly, less-expensive solutions. The bottom line is that DOD systems require an overall system approach to space/ground segment design.

Space is acknowledged to be important to everything the Army does. However, there is a lack of leadership focus and attention. This is validated by the inactivity of the Army Space Council. As a result, the number of space-knowledgeable personnel in the Army is relatively small, at least an order of magnitude smaller than that of the Air Force. Further, the space education of Army warfighters and leadership is inadequate. Few know, understand, and appreciate the value of, and the Army's dependence on, space systems. As a consequence, space represents a very large national investment that is inadequately influenced and leveraged by the Army.

SMDC is currently skewed to focus on missile defense, with approximately 84 percent of the workforce assigned to missile defense and only 16 percent assigned to space-related functions.

The Army invests little in space, so few staff are assigned. Space represents a very large investment of other agencies' money that the Army could leverage to benefit the Army and save Army investments (e.g., in ground terminals). Staff needs to be assigned on the basis of potential return of value to the Army.

Recommendations: Organization and Personnel

- Propose changes to DRID-11:
  - Create an NSO for acquisition of all DoD space systems
  - Establish a Deputy NSSA for earth segment with Army candidate
- Re-establish Army Space Council with CG SMDC as a principal
- Establish O-7 DCG SMDC (Space) and assign responsibility for FA-40
- Significantly increase Army representatives in key high payoff space programs and organizations
  - Candidate organizations include NRO (NSO), NSSA, DARPA, NIMA
  - Candidate programs include ACN, DISCOVERER II, FIA, IOSA, GBS

Prioritizing Army Space Needs

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Recommendations: Organization and Personnel

Multiple organizations acquire space assets resulting in an overlap of efforts, additional costs, and difficulty in influencing solutions to meet the users' needs. We recommend the establishment of a single DOD/IC acquisition organization (National Space Organization (NSO)) for the acquisition of all space systems. This would improve the acquisition of DOD space assets and would be more responsive to all service user needs. Such an organization should be truly "purple" and move urgently to institute a systems approach (satellite and user equipment defined simultaneously) to space acquisition. Service needs would no longer be addressed at the services funding level.

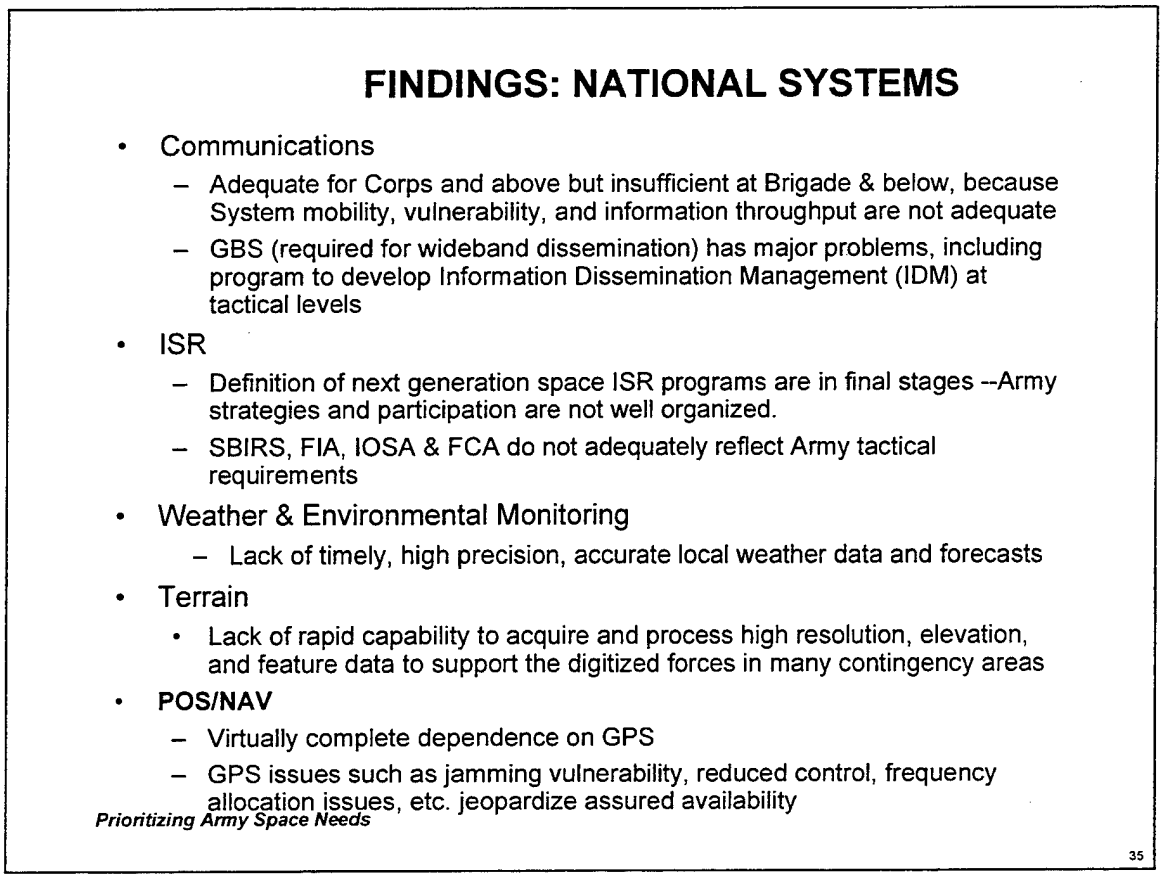
For many years the VCSA chaired a pace council which focused Army Space Policy. We recommend that the Army Space Council be reestablished with CG SMDC as principal. This will provide greater focus on space matters within the Army and support the SMDC commander in executing his space role.

We recommend that the Army propose a Deputy NSSA for user segments be established and that they nominate a candidate for the position. This would raise the visibility of the ground segment in the architectures and assist in developing a total system acquisition approach.

Establishing an O-7 DCG SMDC (Space) would be a start toward making space an equal to missile defense within SMDC, providing a focal point for space at the command level. As a GO, the DCG could also represent the commander to interface with external organizations on space

issues. The DCG SMDC (Space) could also be assigned responsibility for FA40, including establishing career paths to flag-level offices for critical national positions, managing personnel assignments in FA40 and educating warfighters in the use of space. The goal is to greatly increase the numbers of space-knowledgeable personnel in the Army, through a stable program of career progression.

The DOD spends significant dollars in space and non-space systems. With few Army staff assigned to these programs, the situation will remain the same. To influence others to spend their organizations' money in the Army's behalf requires significantly greater numbers representing the Army on staffs of these programs. To increase Army involvement will require a reversal of its position of heavily supporting those programs involving large Army investments to one of support based on the total benefit to the Army.



Findings: National Systems

Desert Storm clearly demonstrated that communications are adequate for corps and above but insufficient at brigade and below. Solving these deficiencies will require direct Army participation in the definition and development of the next generation of space and terrestrial communications systems.

The Space Architect (NSSA) is developing an integrated architecture from a set of intelligence requirements documents which will define future national capabilities.

The Future Imagery Architecture (FIA) is a National Reconnaissance Office (NRO) program to provide balance in tasking, processing, exploitation and dissemination capabilities at the strategic, operational and tactical levels for the next generation of imagery systems. There is a lack of understanding within the national intelligence community concerning the need for specific direct support for the Army.

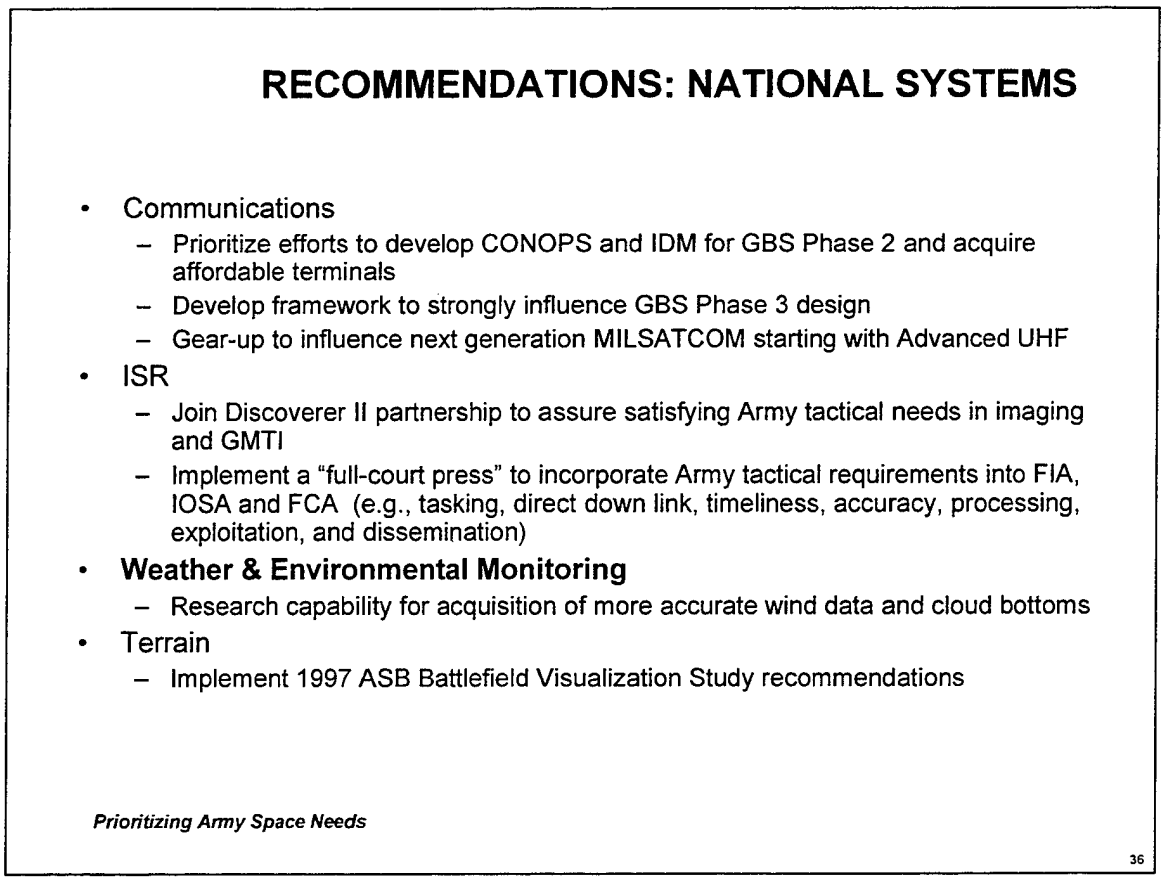
The results of this DIA process, done in coordination with the services will allow the JROC to validate military requirements that best support the evolving military doctrine of the Army. This provides the and opportunity for Army concurrence in the requirements.

The area of changing military doctrine is a critical issue for the future. Enclaves of Army units interdispersed within hostile areas will raise substantial issues concerning the use of airborne and ground assets, what national assets TPED issues will be, and how this will be communicated to and from these enclave units. While the capabilities of the future architecture units such as FIA

will add substantial potential value, the true value will be realized if Army doctrine can be used to effectively influence future architectures and adjust to their final capabilities.

Of particular concern for the Army in both the FIA and IOSA II studies are data links to tactical commands. This capability is needed to fulfill the Army requirements outlined in the Mission Need Statement dated July 2, 1990, for assured receipt of imagery. The Army is a strong proponent of the data link and has funded the ground architecture, hardware, and resources to support and demonstrate its viability. Failure to have this capability suboptimizes the Army's investment and potentially constrains the Army's ability to exercise future warfighting concepts. There will be a lack of capability to provide timely, high-precision, accurate weather data. The technology to support this need from space is simply lacking. The Army weather support, although possibly the best in the world, is based on traditional forecasting methods based on available data -- local surface observations and satellite data.

Information dominance requires a detailed understanding of current elevation, feature data, and vegetation. Recent contingencies in support of MOOTW have revealed a lack of digital and vegetation data in the planning and execution of deployments. The digital Army of XXI requires digital terrain databases of high resolution to support division, brigade, and battalion operations. The digital vehicle we build will need to be "towed" if we don't also have the digital terrain databases required to understand and exploit the battlefield of the future. DCSINT/DCSOPS provided the impetus for the shuttle radar topographic mission (SRTM) which will provided DTED Level 2. DCSINT is supporting NIMA in obtaining land cover maps. Finally, the high reliance on GPS for POS/NAV and its fragility with respect to threat jamming are a key concern.



Recommendations: National Systems

The Army needs to give priority attention to the development of a realistic and implementable CONOPS for GBS Phase 2, as well as active involvement in the development of an information dissemination management system for GBS phase 2. The Army must continue to give priority attention to translating user needs to space technical requirements to be in a position to influence planned MILSATCOM systems such as GBS Phase 3 and Advanced EHF.

Space ISR programs like the DARPA–Air Force moving target indicator (MTI) radar planned for Discoverer II could provide MTI continuous (in a practical sense) depth of coverage in conjunction with airborne systems, including JSTARS, ARL, EP-3, and U-2 MTI programs. Army partnerships in this demonstration program are strongly encouraged.
Concurrently, implementing a "full-court press" in the cited NRO studies can have a significant impact on Army intelligence, communications, and operations. This requires a coordinated ARSTAFF, TRADOC, SMDC, and INSCOM effort.

With respect to weather, there is a need to support research in technologies that could provide more accurate wind velocity data and determine ways to estimate the altitude of the cloud bottoms. Specific solutions have been pursued, such as Army artillery developing and fielding a radar wind profile. As indicated, this ASB Study Group fully supports the recommendations formulated by the ASB Summer Study of 1997 on battlefield visualization.

RECOMMENDATIONS: NATIONAL SYSTEMS (2)

- **POS/NAV**
  - TRADOC evaluate GPS vulnerability by platform/application to determine hardening requirements
  - Actively pursue recommendations coming out of the Joint NAVWAR Program including support for higher power GPS satellites as soon as possible
  - Importance of GPS to virtually all military operations obliges proactive Army role in setting DOD and National postitions

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Recommendations: National Systems (2)

The NAVWAR program Analysis of Alternatives is ongoing. As a part of this analysis, the relative cost effectiveness of the alternative solutions will be calculated. When an alternative is selected and funded, then TRADOC needs to evaluate the vulnerability of GPS and of Army systems dependent on GPS. This is not limited to platforms but applies also to munitions in which GPS is an integral guidance element.

FINDINGS: COMMERCIAL SPACE

- Commercial space drives systems and technology development
- Opportunity to benefit by competing commercial ventures
- Communications
  - CSCI provides a valuable augmentation to WB MILSATCOM fixed users
  - Emerging commercial solutions for Mobile Satellite Service (MSS) have potential to solve tactical beyond LOS communications, but how to acquire remains an issue
- ISR
  - Commercial products have potential to support Army tactical units
- Weather & Environmental Monitoring
  - Can complement DoD/Civil sources
- Terrain
  - Wide array of commercial/foreign imaging satellites
  - Raises concern of information leveling

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Findings: Commercial Space

The commercial space industry is exploding with many new systems and applications in development. The years of DOD being the principal source of funding for space development has ended. Commercial investment in space may exceed $0.5 trillion by 2010. This burgeoning of services and applications is true not only in communications but is also happening in remote sensing and other areas.

Commercial vendors have a vested interest in reducing their costs. They will be relatively conservative in adding a new technology unless a return on investment can be identified. However, the commercial application of technology and manufacturing methods will, in general be on time schedules much shorter than those typical of government-owned systems. Although the private sector will avoid risky new technology, it will implement proven technology with generation changes that can be designed and incorporated in new satellites in less than 5 years. This compares favorably to government systems that may not be flow until 10 to 20 years after their design was frozen.

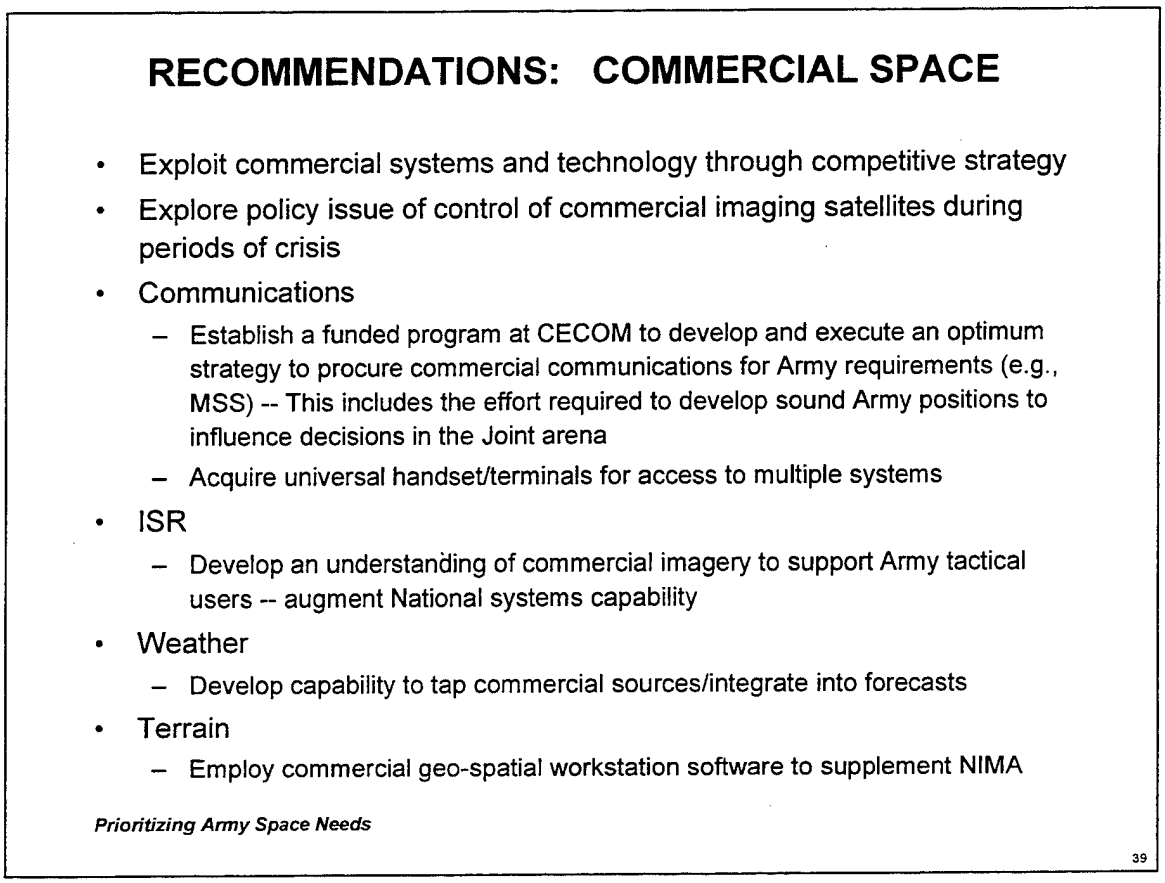
Commercial ventures constantly look for profit opportunities. Many of them are willing to enter joint ventures with the government or sell their services to the government. The government funding of an Iridium ground station and the USAF partnership with industry to fly a hyperspectral imaging payload are examples of cooperative activities. US Space Command's Long Range Plan calls for the development of global partnerships to take advantage of these types of opportunities.

Communications is the area with the most opportunities to exploit commercial investments. The Commercial Satellite Communication Initiative (CSCI) already provides a mechanism to augment wideband military satellite communication for fixed users. Commercial leasing or buying of on-orbit capabilities will continue to be of interest and, in the current environment of reduced DOD budgets, may be the politically acceptable solution to add capacity. Emerging capabilities in mobile subscriber systems offer the opportunity for worldwide cellular phone capabilities. Point-to-point communications of this type will pose both advantages and risks to military operations. One obvious risk is the ready availability of this communications capability by threat forces in a relatively protected mode. The nature of multi-national satellite communications would preclude destructive targeting of these systems for a number of reasons.

In remote sensing, both commercial and foreign systems are being developed or are currently being flown with the intent to sell imagery and other products on the open market. Commercial imagery at 1 meter will soon be widely available. Russian imagery in the 2 meter or less resolution range is available now. Although not provided in time for targeting of mobile systems, such imagery is certainly relevant for fixed targets as well as for a variety of planning functions.

The weather terrain and environmental monitoring space systems remain a government function. However, many commercial satellites produce data that have environmental applications and can serve to augment civil and/or foreign sources.

The remote sensing satellites in the commercial arena tend to be focused on terrain exploration and/or vegetation assessment. Both functions are militarily useful. Visible and infrared imagery, multispectral imagery, and, in the near future, hyperspectral imagery will provide significant capabilities. Many of these capabilities will be available to our adversaries. A relatively technically impoverished enemy which utilizes the available access to sophisticated space capabilities in the commercial arena will benefit from the leveling effect on the playing field for future conflict.



Recommendations: Commercial Space

The Army should continue and expand its efforts to exploit commercial systems and space-related technologies. It is imperative, however, that DOD apply conservative strategies to take maximum advantage of commercial capability. The Army/DOD should be able to leverage the substantial commercial investments with relatively little requirement for funding from Army/DOD research and development. However it is imperative that the Army establish a funded program designed to understand all aspects of the commercial space industry, to learn how to best translate military requirements into commercial capabilities, and to develop an optimal procurement model which points to the most efficient way to acquire needed capability.

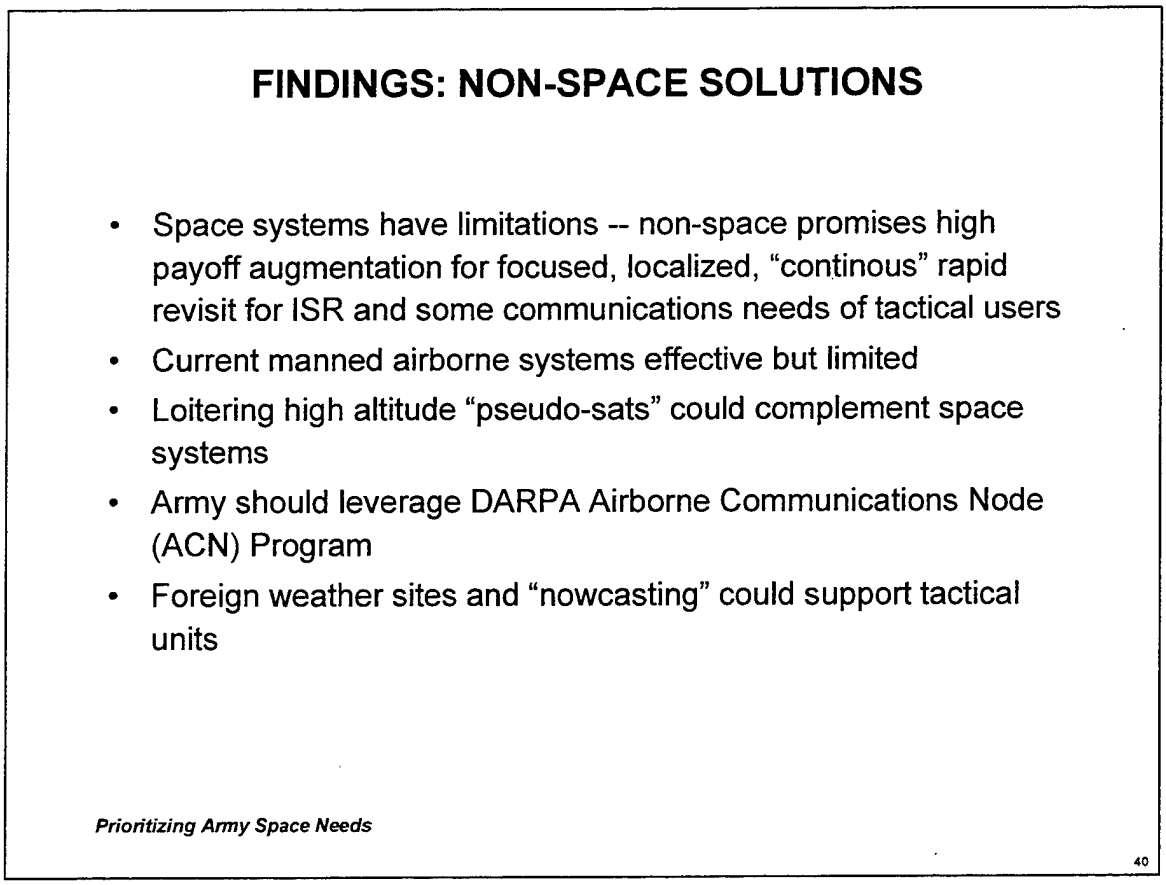
The issue of commercial imaging satellites providing valuable information to an adversary during periods of crisis is one that deserves serious attention. A first step may be to raise these concerns to OSD in order to prompt an exploration developing a national policy to deal with this problem.

Within the area of communications the Army should give priority to the category of systems designated as mobile subscriber systems. These systems could provide an immediate solution to the critical beyond line of sight battlefield communications needs of Army warfighters. The funded program mentioned above could search for innovative business practices that could be applied to developing partnerships with leading vendors. As part of this effort the Army should determine if market forces are likely to produce multimode, multisystem (universal) handsets/terminals. If not, the Army should apply research and development funds in this area.

The Army should develop a thorough understanding of the availability and use of commercial imagery to support tactical users. This understanding must be comprehensive and include not just intelligence and engineering functions but also logistics and other support functions.

The Army should determine how commercial imagery systems could supplement standard weather satellite systems to improve the methods by which forecasts for tactical forces are produced. The Integrated Meteorological System should include access to commercial products as well as existing government systems.

The Army should address tactical needs by ensuring that commercial geospatial workstation technology is rapidly moved to the field to supplement traditional NIMA products with tailored products that combine terrain data from commercial and other sources.



Findings: Non-Space Solutions

Space-based systems have limitations. Low earth orbit (LEO) satellites provide excellent image resolution and short delays for communications. LEO satellites, however, do not stay overhead for very long and may not provide coverage in remote areas. Furthermore, unless constellation density is high, there will be revisit delays. Geosynchronous (GEO) satellites maintain a fixed position overhead, but their distance from earth introduces a significant communication delay (~0.25 second) and limited image resolution. Each satellite's payload and power budget may limit access to imaging and communications channels. High concentrations of troops and platforms in remote areas may overtax limited satellite coverage for both communications and imaging.

Airborne systems can be used to augment space-based capabilities. Loitering high-altitude platforms could be based and supported outside the theater and used to augment space-based communications and ISR capabilities. These high-altitude, long-endurance (HALE) platforms have operational limitations and vulnerabilities. Communications relay platforms would be strong emitters and must, therefore, stay well back of forward areas to reduce exposure. Imaging platforms must still fly near or over hostile territory at greater risk.

DARPA's Airborne Communications Node (ACN) is an experiment in augmenting space-based communications capabilities from a HALE platform. This ambitious program is investing heavily in very advanced technology to demonstrate the capability to relay many channels of radio communications in a modest package. This technology has high potential for other

applications including other HALE platforms, tactical UAVs, manned platforms or lighter than air craft.

Other non-space systems, such as ground-based weather stations in foreign countries, can be used to augment information collected by satellites. Some information, such as very localized weather, winds at low altitudes, and cloud bases must still be collected by non-space means. Very current, very localized weather forecasting, known as "nowcasting," depends on local weather measurements and is highly desirable but not yet available.

RECOMMENDATIONS: NON-SPACE SOLUTIONS

- Army assume lead for a Joint HALE unmanned system to provide ISR, communications, GPS pseudolite capability, rapid terrain and weather data
- Expand role to full partner with DARPA on ACN and assign Army Deputy PM
- Pursue development of unattended ground met/NBC stations for "Now-casting"

Prioritizing Army Space Needs

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Recommendations

The Requirements stated earlier for near-continuous real-time coverage of the tactical battlefield argues for loitering unmanned C4ISR platforms. Likewise, augmentation of GPS, communications and weather collection capabilities are logical applications for this class of Platform.

Based on the needs of each of the services, a case can be made for a joint tactical C4ISR platform(s) to support tactical warfighters. To enable this idea we recommend that the Army take the lead in defining and developing a joint HALE C4ISR system. Certain "rice bowls" must be broken to avoid USAF dominance of the program, but the focus must be on the utilities of the capability to tactical warfighters rather than who "flies" the platform.

To fully capitalize on the DARPA investment in the ACN the panel proposes expanded participation in the program. The DARPA PM should be augmented by assignment of an Army Acquisition Corps Deputy PM. This DPM would provide interpretation of Army requirements, day-to-day Army input and coupling with the Army Tech base of CECOM to facilitate transfer of ACN technology to other applications. Specifically, ACN subsystems could provide communications payload packages to the Army TUAV programs.

In the interval since Vietnam much progress has been made in unattended ground sensor technology. Capitalizing on these advantages one can envision remote sensors capable of:

- Broadcasting instant local weather, winds, cloud cover, cloud decks, visibility, and other meteorological data

- Broadcasting NBC warnings to local users. (The detection of some Chemical and most Biological agents remains a challenge that must be addressed.)

Action Opportunities

TIME-URGENT PROGRAM OPPORTUNITIES RECOMMENDATIONS

System/ Activity	Agency	Capabilities	POM $ Billions	Adequacy of Army Involvement	
				Resources	Needs Statement
GBS III	JPO	WB data to tactical users	1.4		X
BADD/IDM	DARPA/DISA	Info manager for GBS	0.3		
Discoverer I	DARPA	Near-continuous coverage	0.1 Demo		
MSS	Commercial	Cell phone anywhere anytime	>100		X
ACN	DARPA	Battlefield command relay	0.1		X
SBIRS H	AFSPC	Early Warning, NRT meteorology (potential)	>2		
SBIRS L	AFSPC	MD ground targets	>2		
FIA	NRO	Imagery to Army shooters	>2		X
IOSA	NRO	SIGINT to Army shooters	>2		X
FCA	NRO	Timely data to Army shooters	>2		

(On the order of) $100 billion

Army objectives should be to:

- Focus Program Direction
- Leverage investments
- Refine requirements
- Harvest Technology

Near-term cost to Army; A few smart people

Prioritizing Army Space Needs

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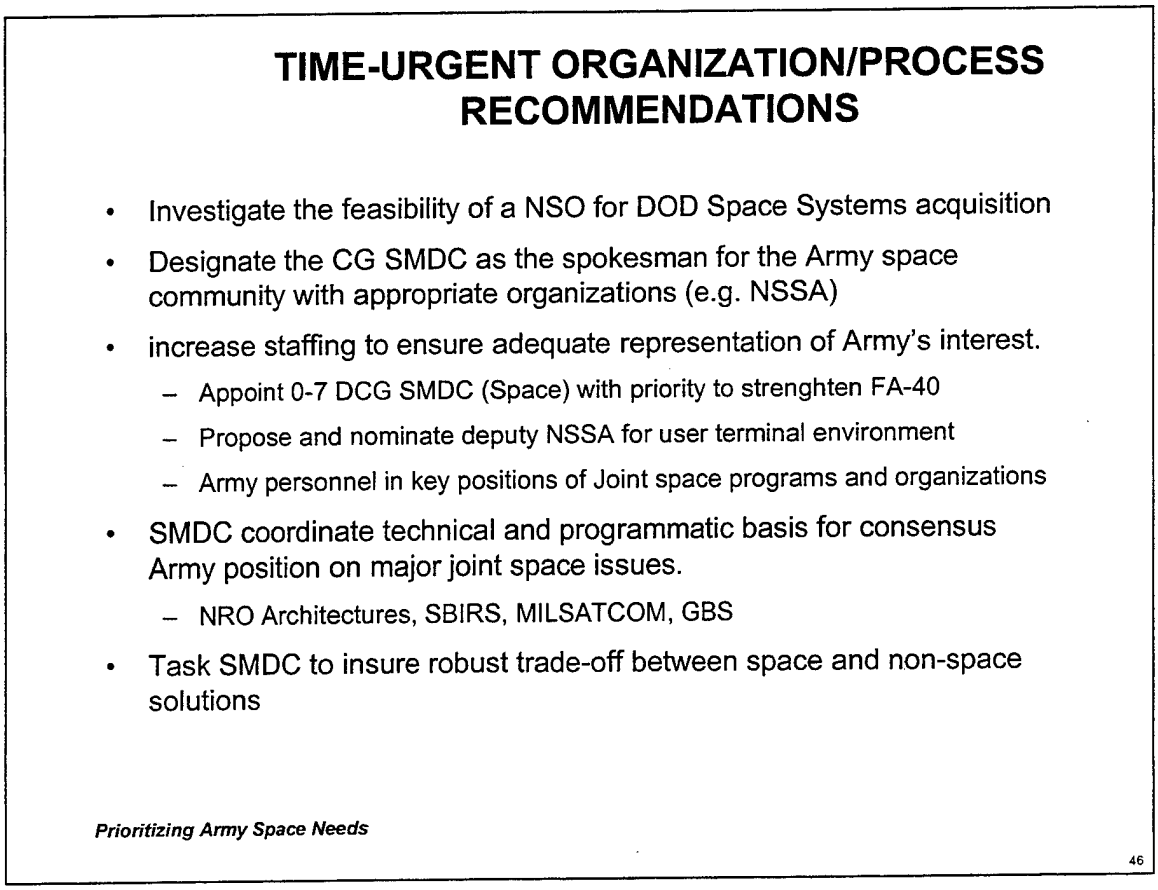
Time-Urgent Program Opportunity Recommendations

Beyond the personnel/organization recommendations made, we found that there are on the order of a dozen major programs which have great potential benefit to the Army. The list includes GBS (Global Broadcast System) and MSS (Mobile Satellite Service), future communications systems that build on the current commercial revolution in space. The Battlefield Awareness and Data Distribution/Information Dissemination Manager systems (BADD/IDM) are information management programs that will be necessary to effectively manage the flow of information through wideband links like GBS. The DARPA Airborne Communications Node (ACN) relay program, will develop radio relay technology with direct application to the tactical battlefield. Discoverer II, a DARPA demonstration project, and SBIRS High and Low represent opportunities to leverage next-generation space systems. Future architectures will define the next generation of national collectors. Collectively, the programs represent an investment on the order of $100 billion.

The investment of one or two Army individuals in each program/study can help to focus the results to meet Army needs. By being involved in the shaping of the programs, the Army should be able to leverage the results for a fraction of the total program cost. Exposure to these programs, and their analyses and/or demonstration will help the Army refine its own requirements and, in many cases, may lead to the development of joint requirements. If the demonstration programs fail to transition to the field, there is still a major opportunity to harvest technology developed with non-Army dollars.

We believe the investment of 12 to 20 individuals in the near-term can reap major returns in the future.



Time-Urgent Organization/Process Recommendations

The recommendations presented here are time-urgent actions that the Army should address immediately.

The creation of the National Security Space Architect has brought focus to the DOD and national space community development. As this new organization settles into its responsibilities, the Army has an opportunity to join the effort by ensuring that it speaks with one voice on space issues. The first step to ensure that the Army presents a unified position on all space issues is to designate the CG, SMDC as **The Army Spokesman** to NSSA and other space-focused organizations.

To ensure that the Army's needs are addressed, the Army should place manpower in critical locations in the DOD and national space communities and ensure that it has a visible effective commitment to space activities. The panel recommends that a DCG (Space) general officer position be created within SMDC. At present, the only DCG position is devoted primarily to missile defense issues, and the amount of space activities requiring flag officer involvement is too great to be handled by this position or that of the CG, SMDC.

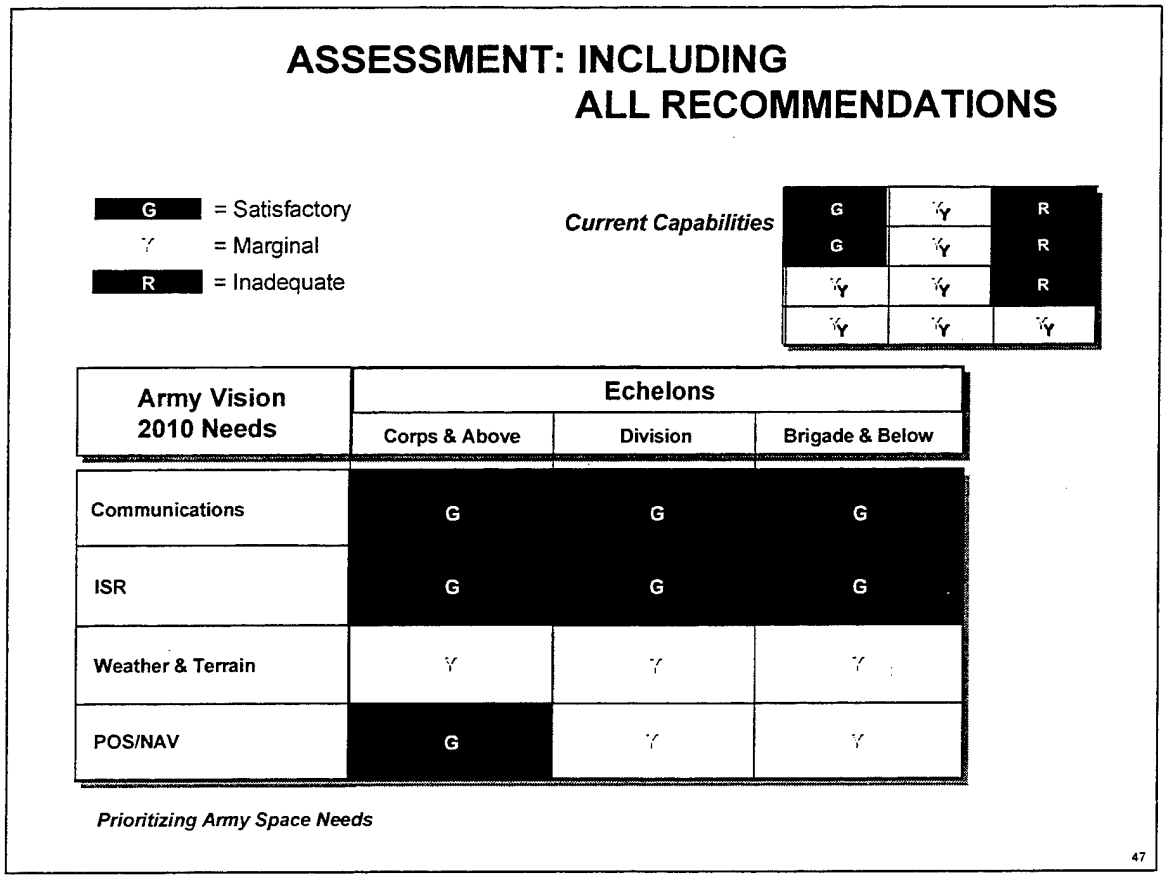
The principal risk to the Army in the creation of the NSSA is the continuance of an attitude of designing space systems from the satellites to the ground rather than looking at the ground requirements and working up to the satellites. The panel recommends that the Army strongly advocate the creation of an additional deputy NSSA for the user terminal environment and offer a General Officer/SES to fill the position. The FA40 category will need a senior officer to oversee it and ensure that it becomes and stays healthy. The panel recommends that the new SMDC DCG

(Space) perform this function. FA40 personnel need to know that space is a viable and well-defined career path from company grades to general officers.

The need to put more space-qualified Army personnel in the space development agencies (e.g., NIMA, NRO, US Space Command, DARPA) is highlighted by the fact that NRO assignments are: 54 percent USAF, 24 percent CIA, 8 percent Navy, 12 percent NRO internal infrastructure, and less than 1 percent Army!

A major revolution is taking place in space systems and capabilities. Many old systems will be replaced (MILSATCOM and DSP) and new capabilities such as Discoverer II, hyperspectral imaging, and commercial systems will be added in the next 10 to 20 years. The potential of these systems to address Army needs will materialize only if there is thorough technical analysis to formulate requirements and articulate personnel directly involved in the development of these systems. To operate effectively in the joint space community the Army must have an analytical basis undergirding its positions. (Note the Army is taxed to support these programs, but does not fund them directly.) SMDC should be prepared to execute the lead role in coordinating all Army efforts related to space systems.

The analyses and tradeoffs between space and non-space solutions must also be addressed. Again, the panel recommends that this effort be led by SMDC, the Army's focal point for space.



Assessment: Including All Recommendations

The ASB Study Panel believes that the capabilities to provide information dominance will be significantly enhanced if all the recommendations are implemented. The investment in space-borne capabilities at the national level and by the commercial sector by 2010 will be very large (total dollars, comparison to Army investment in modernization, etc.). The challenge for the Army is to wisely and effectively leverage this investment to meet its needs with a minimal investment of its own. Our recommendations will provide a basis for the Army to achieve the upgraded assessments reflected in this chart.

Communications

The Army could have a much smarter communications user community in regard to space systems and their alternatives. Commercial communications could be better exploited to meet Army requirements. MSS could provide very mobile beyond-line-of-sight capability. Military plus commercial SATCOM with UAV augmentation could provide robust mobile versatility and sufficiently wide bandwidth to satisfactorily support all Army communications needs in 2010.

ISR

Influencing the national ISR systems capabilities has the potential for high payoff. As previously discussed, new systems will augment current ISR capabilties significantly. Discoverer IIA, deployed in a 24-satellite constellation, and combined with an Army HALE ISR capability employing effective tasking from all echelons and dissemination capability, could provide the responsive capability to meet the revisit, coverage, and latency requirements of the lower

echelons. Under these assumptions, ISR capabilities would be satisfactory to support all echelons in 2010. (The division ISR capabilities are assessed to change from marginal to satisfactory. Similarly, the brigade and below capability is assessed to change from inadequate to satisfactory.)

Weather and Terrain

Weather data collection and forecasting will be enhanced but still not judged adequate to optimize operations. High resolution terrain elevation data will be available, thus, brigade and below operations will be significantly enhanced. This is the basis for assessing the weather and terrain monitoring capability at brigade and below to be upgraded to marginal from inadequate. Nevertheless, concerns remain about the availability of feature data, timely terrain/feature change information and weather trafficability inaction.

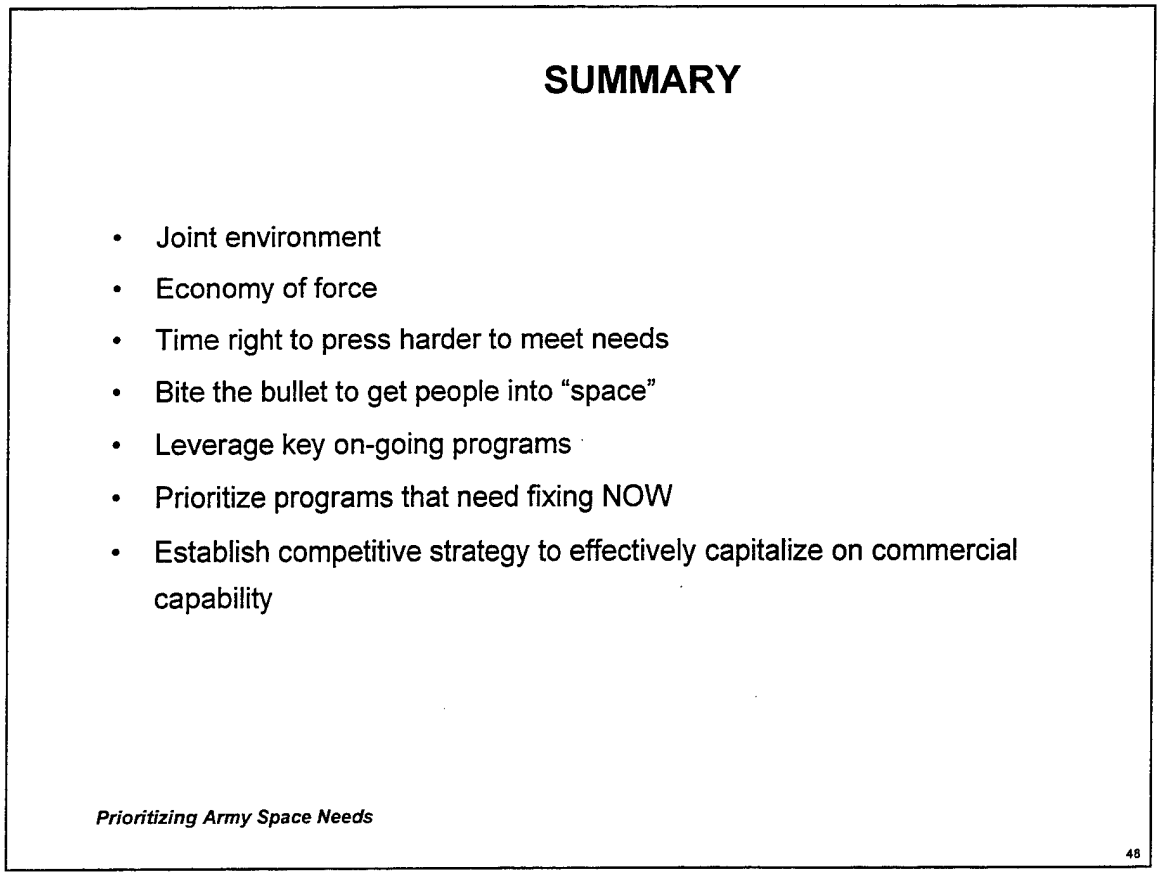
POS/NAV

GPS jamming vulnerabilities will not be entirely solved by 2010. Thus, the POS/NAV assessment remains marginal for division and below. NAVWAR analyses will likely identify some means (operational procedures and receiver enhancements) for mitigating vulnerability to standoff high-power jamming. Assuming that the Army implements these recommendations, the POS/NAV situation would be significantly improved.

Summary

The study panel recognizes the personnel stress and financial burden that will face top Army decision makers as they consider which are the most important opportunities. Determining how best to pursue them in the environment of personnel cuts and budget downsizing will not be easy. However, pursuing a course that fails to exploit these opportunities will, in our opinion, seriously limit the Army's goal of achieving and maintaining information dominance.

We urge the Army to take the high road and continue to improve its posture regarding exploitation of space and to ready its forces for possible future missions.



Summary

Early in the study it became clear that most space activities are Joint and that the Army must operate in this Joint environment if it is to get what it wants from space.

The Army has exercised economy of force in space with relatively good success in the TENCAP program. Projected budget limitations suggest the Army stay in this mode, but aggressive participation in the Space Program offices can maximize the benefit of space to the warfighter.

As illustrated by this study, space is vital to military operations. The time is right to press the Joint environment (NSSA) to provide the Army better products. To do that, the Army must identify, train and assign a relatively few people to key positions in both staff and leadership roles.

The ASB has identified a number of key programs that can pay huge dividends if the Army leverages them through more active participation.

There are ongoing programs, GBS, for example, that deserve Army attention *now*! Operational input can help to focus the program aimed at capitalizing on the commercial technology.

The multi-billion investment being made in Commercial Space Systems can be a windfall to financially strapped military users. The tailoring of these commercial systems to military use and the selection of the "Best of Breed" represent a significant challenge to the Acquisition Corps. A spectrum of approaches needs to be evaluated, ranging from straight leasing to CRAF-like system

modifications, to purchase of a percentage of system capacity and might include the purchase of a "duplicate" system which could be leased back to the industry in peace time.

APPENDIX A

TERMS OF REFERENCE

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
RESEARCH DEVELOPMENT AND ACQUISITION
103 ARMY PENTAGON
WASHINGTON DC 20310-0103

23 DEC 1997

REPLY TO
ATTENTION OF

Dr. Michael S. Frankel
Chair, Army Science Board
103 Army Pentagon
Washington, DC 20310-0103

Dear Dr. Frankel:

Request that the Army Science Board (ASB) initiate a study: "Prioritizing Army Space Needs." This study, as a minimum, must address the Terms of Reference (TOR) described below. The ASB members appointed will consider the TOR as guidelines and may include in their discussion related issues deemed important by the sponsor. Modification to the TOR must be coordinated with the ASB office.

Background.

a. In order for Army information system materiel developers to make maximum use of current and future space assets specifically focused on national security needs, the Army will need to have in-depth understanding of the attributes and limitations of both existing and future space assets, regardless of which sector they are focused on supporting. This Army understanding will be needed to exploit national security space assets by continuing and expanding its already successful Tactical Exploitation of National Capabilities (TENCAP) program. The Army will need to establish new means to allow it to work cooperatively with the commercial space system developers with the goal of making commercial space systems as supportive as possible of Army needs with minimal or modest Army investments.

b. Although many of the Army's needs for better surveillance, intelligence, navigation, targeting, communications and environmental sensing capabilities may be achieved by use of existing and future space systems, alternative "nonspace" means should be considered from the point of view of technology, tasking restraints and cost-effectiveness.

c. Alternative "nonspace" ways to obtain the desired capabilities are associated with the use of organic assets (e.g., Guard Rail, tactical UAVs, tethered balloon systems, etc.). Other capabilities may be provided from shared or joint assets, such as Rivet Joint, JSTARS, AWACS, and the emerging high-

altitude, long-endurance UAV systems, Dark Star and Global Hawk.

d. This study is motivated by a recently revamped Army space organizational structure thus making this an appropriate time to reexamine each of the Army's space efforts as new capabilities are identified against the backdrop of continued budget constraints.

e. The Army's initiative in digitizing the battlefield portends a number of new possibilities for the utilization of space assets. Space assets are potentially the major enabler of information dominance is the 21st Century. A clear understanding of the full potential of space platforms is therefore demanded.

f. The Army has a long, successful history of capitalizing on the national investment in space assets through such efforts as the TENCAP program. However, the traditional Army approach has been more to take advantage of what is available as opposed to influencing the requirements for space assets. The Army must develop a stronger voice in asserting the warfighter's needs for space capabilities.

g. The proliferation of a whole host of new and rapidly evolving commercial space systems provides an important new source for the satisfaction of important Army information system needs. The Army must capitalize on the potential value of these systems.

h. There are other new, organic Army and joint system development activities evolving. Tradeoffs between use of space and "nonspace" systems need to be carefully evaluated in order to maximize the effectiveness of the Army's limited resources.

Terms of Reference.

In order to provide the senior leadership of the Army with a new "future-oriented" Army Space System Alternatives Plan, the Army Science Board is requested to undertake a study that focuses on the following tasks:

a. Examine the ability of current and future national space systems to provide the surveillance, intelligence, navigation, targeting, communications and environmental sensing capabilities that Army XXI and Army After Next need.

b. Determine those existing and planned capabilities of the civilian space program which may provide some of the capabilities that Army XXI and Army After Next need. Also identify instances in commercially driven space development efforts where the Army might make modest investments or propose alternatives that could serve to satisfy critical Army needs.

c. Examine "nonspace" means to achieve needed surveillance,

intelligence, navigation, targeting, communications and environmental sensing capabilities for the Army. In particular, examine the use, in theater, of High Altitude, Long Endurance UAV's to act as either augmentation to or reconstitution of space-based capabilities.

d. Critically assess the technical, managerial, organizational, cost and vulnerabilities of the capabilities provided by each class of systems described in the foregoing paragraphs.

e. Identify and prioritize those efforts needed to ensure that recommended capabilities are appropriately leveraged in Army XXI and Army After Next.

Study Support. Cosponsors of this study are LTG Edward G. Anderson, Commanding General, U.S. Army Space and Missile Defense Command; LTG Thomas N. Burnette, Deputy Chief of Staff for Operations and Plans; LTG John N. Abrams, Deputy Commanding General, TRADOC. The Study Cognizant Deputies are Dr. Darrell Collier, Chief Scientist, SMDC and Dr. Herb Fallin, Director, Assessment and Evaluation, Office of the Assistant Secretary of the Army (Research, Development and Acquisition). The primary staff assistant is LTC Zappalla, SMDC; other staff assistants are LTC William Reiner, ODCSOPS; Mr. Andy Scharein, HQ TRADOC.

Schedule. The study panel will initiate the study immediately and conclude its effort at the report writing session to be conducted 13-23 July 1998 at the Beckman Center on the campus of the University of California, Irvine. As a first step, the study cochairs will submit a study plan to the sponsors and the Executive Secretary outlining the study approach and schedule. Conclusion of this study group will result in a final report to the sponsors in December 1998.

Special Provisions. It is not anticipated that this inquiry will go into any "particular matters" within the meaning of Section 208, Title 18, of the United States Code.

Sincerely,

Kenneth J. Oscar
Acting Assistant Secretary of the Army
(Research, Development and Acquisition)

APPENDIX B

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PARTICIPANTS LIST

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SUMMER STUDY ON
PRIORITIZING ARMY SPACE NEEDS

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Mr. Jeff Ozimek
CECOM

Mr. John Marrs
USA Space Command

APPENDIX C

ACRONYMS

ABN	Airborne
ACC	Air Combat Command
ACN	Airborne Communications Node
ACTD	Advanced Concept Technology Demonstration
AF SAE	Air Force Service Acquisition Executive
AFSPC	Air Force Space Command
AJ	Anti-Jamming
AMCOM	Aviation and Missile Command
AOR	Area of Responsibility
ASAS	All Source Analysis System
ASAT	Anti-Satellite
ASB	Army Science Board
ASD(C31)	Assistant Secretary of Defense (Command & Control, Communications, and Intelligence)
ASPO	Army Space Program Office
ATACMS	Army Tactical Missile System
AWE	Advanced Warfighting Experiments
BADD/IDM	Battlefield Awareness and Data Distribution/Information Dissemination Manager
BDA	Battle Damage Assessment
BLOS	Beyond Line Of Sight
BMDO	Ballistic Missile Defense Organization
BV	Battlefield Visualization
CDR	Commander
CECOM	Communications-Electronics Command
CG SMDC	Commanding General, Space and Missile Defense Command
CGS	Common Ground Station
CIA	Central Intelligence Agency
CINCSPACE	Commander-In-Chief Space
CONOPS	Concept of Operations
CONUS	Continental United States
CSA	Chief of Staff
CSCI	Commercial Satellite Communication Initiative
DAB	Defense Acquisition Board
DARO	Defense Airborne Reconnaissance Office
DARPA	Defense Advanced Research Projects Agency

DCG SMDC	Deputy Commanding General Space and Missile Defense Command
DCI	Director of Central Intelligence
DCSINT	Deputy Chief of Staff for Intelligence
DCSOPS	Deputy Chief of Staff for Operations
DIA	Defense Intelligence Agency
DISA	Defense Information Systems Agency
DISC4	Director of Information Systems for Command, Control, Communications, and Computers
DNRO	Director of the National Reconnaissance Office
DRID-11	Defense Reform Initiative Directive 11
DTED	Digital Terrain Elevation Data
DUSD	Deputy Under Secretary of Defense
FA40	Functional Area 40 -- Space Operations Officer
FBCB2	Force XXI Battle Command Brigade and Below System
FCA	Future Communications Architecture
FIA	Future Imaging Architecture
GBS	Global Broadcasting System
GOES	Geostationary Operational Environmental Satellite
GPS	Global Positioning System
HALE	High Altitude Long Endurance
HSI/MSI	Hyperspectral Imagery / Multispectral Imagery
ICT	Integrated Concept Team
IDM	Improved Data Modem
IPT	Integrated Process Team
ISR	Intelligence, Surveillance and Reconnaissance
JCS	Joint Chiefs of Staff
JPO	Joint Program Office
JPO	Joint Program Office
JROC	Joint Requirements Oversight Council
JSTARS	Joint Surveillance and Target Attack Radar System
JTF	Joint Task Force
LOS	Line of Sight
MCCDC	Marine Corps Combat Development Command
MILSATCOM	Military Satellite Communications
MILSTAR	Military Strategic, Tactical and Relay (Satellite Communications)

MOA	Memorandum of Agreement
MSS	Mobile Satellite Service
MTI/SAR	Moving Target Indicator / Synthetic Aperture Radar
NAIC	NATO Intelligence Center
NAVWAR	Navigation Warfare
NBC	Nuclear, Chemical, Biological
NIE	National Intelligence Estimate
NIMA	National Imaging and Mapping Agency
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NRAC	Naval Research Advisory Board
NRO	National Reconnaissance Office
NRT	Near Real Time
NSA	National Security Agency
NSO	National Security Office
NSSA	National Security Space Architect
OA	Operational Architecture
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
PIP	Product Improvement Program
PM	Program Manager
POS/NAV	Positioning/Navigational
RF	Radio Frequency
ROW	Rest of the World
SA	Secretary of the Army
SAM	Surface to Air Missile
SAR/MTI	Synthetic Aperture Radar/
SARDA	Secretary of the Army for Research Development and Acquisition
SATCOM	Satellite Communications
SBIRS	Space Based Infrared System
SBIRS H	Space Based Infrared System - High
SBIRS L	Space Based Infrared System - Low
SCAMP	Single Channel Anti-Jam Manportable terminal (MILSTAR)
SIGINT	Signal Intelligence
SINCGARS/EPLRS	Single Channel Ground Airborne Radio System / Extended Position Locating and Reporting System
SMART-T	Secure Mobile Anti-Jam Reliable Tactical Terminal (MILSTAR)

SMDC	Space and Missile Defense Command
SPAWAR	Space and Naval Warfare Systems Command
SRTM	Shuttle Radar Topography Mission
TENCAP	Tactical Exploitation of National Capabilities
TRADOC	Training and Doctrine Command
TRI-TAC/MSE	Tri-Service Tactical Communications / Mobile Subscriber Equipment
UHF TACSAT	Ultra High Frequency Tactical Satellite
USAF AIA	Air Intelligence Agency of the USAF
USD(A&T)	Under Secretary of Defense for Acquisition and Technology
WB	Wide Band
WIN-T	Warfigther Information Network - Telecommunications
WTEM	Weather, Terrain and Environment Monitoring

APPENDIX D

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