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Introduction

The Army's land power is hinged in space.

General Gordon R. Sullivan

Throughout US history, the military services have fought to guard US national interests on land, on sea, and in the air. Historically, whoever held and used the "high ground" had a significant advantage over his adversaries. While holding high ground in itself does not ensure victory, it has restricted the enemy's freedom to maneuver. Space, the ultimate high ground, has joined land, sea, and air as a medium in which national defense can be prosecuted. Therefore, the Army has a vital interest in the farseeing aspects of space technology.

Space offers the Army unique or enhanced capabilities to achieve land dominance. Space systems provide communications, positioning and navigational data, early warning, weather, environmental, and surveillance and targeting capabilities that are essential for national security and the prosecution of land warfare. Space capabilities are particularly important where the operational area lacks the infrastructure to support Army operations, These capabilities apply across the entire spectrum of military operations, to include military operations other than war (MOOTW), and to all echelons of command. In the post-Cold War era, Army forces' effective use of space capabilities and products is as critical to global operations as land, sea, and air power are today.

The US Army has always played an important role in exploring and defending new frontiers. Its role in space is no exception. Army rocket development and early space exploration first received impetus when Dr. Wernher von Braun and other German scientists joined the Army's missile effort in 1945. In the following years, the Army engineered the first US space rockets and led the development of space technology.

In 1958, the Army space program became the nucleus of the newly created National Aeronautics and Space Administration (NASA), whose task was to direct all civilian space development activities. Later that year, NASA, using an Army Redstone missile, launched the first operational US satellite. In 1961, another modified Redstone missile carried Commander Alan B. Shepard, USN, the first American astronaut to reach space, into suborbital flight.

Although during the intervening years the Army's role and influence in space activities declined as NASA and other civil and military agencies assumed its space responsibilities, Department of Defense (DOD) established the US Army Satellite Communications Agency in April 1961. The agency was the single point of control to accomplish research, development, and production

of both strategic and tactical satellite communications ground terminals for use by all military services. In addition, the Army continued research and development efforts that focused on air and strategic ballistic missile defense and on the tactical applications of national space capabilities. The Army Space Program Office (ASPO), established in 1973, was given responsibility for leveraging national capabilities as part of the Joint Tactical Exploitation of National Capabilities (TENCAP) Program. The result has been the fielding of a number of systems that support tactical operations. The US Army Strategic Defense Command (USASDC) represented the outgrowth of the Army's early involvement in the Ballistic Missile Defense (BMD) Program.

The development of the Army's AirLand Battle doctrine in the 1980s focused on a battlefield that was expanding in depth and lethality. Studies and operations completed in the 1980s showed that space systems incorporating maturing technologies could be used to support many of the Army's missions. These studies identified the space-related technologies and capabilities applicable to Army missions and functions. Army leaders used this information to chart a course for developing and acquiring the necessary technologies and capabilities. By-products of this effort resulted in the publication of *The Army Operational Concept for Space Operations* in 1987 and the first version of *The Army Space Architecture* in 1988. These two documents incorporated the most promising ideas and space-related technologies that could be developed to fulfill Army requirements.

In support of its evolving role in space, the Army formed additional organizations to-

- Provide training and to perform combat development of potential space technologies.
- Serve as the proponent for space-development activities.
- Provide operational support and interaction with unified operations.
- Perform the research, development, testing, and evaluation of strategic and tactical BMD and other space-related technologies.
- Provide forces for space support operations for DOD.

In 1985, DOD established the United States Space Command (USSPACECOM). A short time later, the Army Space Agency was created and became the Army's representative to USSPACECOM. Designated the US Army Space Command (USARSPACE) in 1988, it became the Army component to USSPACECOM. In 1993, USARSPACE and USASDC were combined into one organization designated the US Army Space and Strategic Defense Command (USASSDC). Within this organization, USARSPACE remains the operational component to USSPACECOM, and USASSDC remains the Army leader in missile defense technology, continuing its research and development to support both strategic and tactical missile defense systems.

The 1993 version of FM 100-5 recognizes the contribution of space to Army operations. Under this emerging doctrine, space-related systems no longer merely supplement and complement terrestrial systems; in many instances they are the primary means, with terrestrial systems serving as backup. In some instances, space systems will replace existing and programmed

terrestrial systems. This utility of space capabilities must be considered and articulated in operational plans and programmatic decisions. The doctrinal shift to a force projection Army has profound implications for the use of space assets, as manifested during Operation Desert Storm and operations in Somalia and Macedonia. Lessons learned from recent operations and emerging conceptual and doctrinal changes dictate the full integration of space-related capabilities into future operations. The Army will continue to "leverage" existing space capabilities and exploit technological opportunities to improve the execution of its missions in a global environment.

Associated space research and product development continue to provide invaluable technologies applicable across the full range of military operations. A variety of space systems is now available to support strategic communications, early warning of missile launches, the National Command Authorities (NCA), and the military services' reconnaissance requirements. This involvement in space activities over the years has provided the Army an appreciation of space and an understanding of the value of space systems to its operations.

In the past, space assets primarily supported echelons above corps. This is no longer true. Today, most missions and every soldier on the battlefield can benefit from space systems and products. To improve its effectiveness and increase the survivability of its forces, the Army must continue to exploit the military potential of space systems.

In the future, because of the speed with which a crisis may erupt and the lethality of the weapons used, the need for better and near-real-time information will be more demanding. Space systems will provide the Army the leverage needed to conduct more effective and efficient missions in the area of information operations (IO). Space-based assets can provide decision makers with a more accurate assessment of the enemy situation before a state of war is declared or a decision made to commit land forces, thereby enhancing the possibility of successfully achieving the first objective of the Army: deterrence without a round expended or the loss of one life. Only through space can the information needed to assure such a victory be distributed in the time, quantity, and array required. Exploitation of space-based assets requires diligent planning to ensure accurate and timely information is available when needed. Every effort should be made during peacetime to ensure that the Army force of the future will be properly equipped, trained, and manned to conduct successful IO or any other military operations.

Preface

I'm very bullish on space. I want the Army to stay in space. The Army is in space, and we're remaining in space.

General **Gordon R. Sullivan**
Chief of Staff, US Army, 1994

PURPOSE

FM 100-18 establishes doctrine for the Army's use of space, enumerates current space system capabilities, and provides guidelines for the use and application of space capabilities to support Army operations. It emphasizes the enhancements that space assets provide in meeting numerous requirements of land forces: surveillance, navigation, mapping, targeting, communications, early warning, terrain and weather, to name the most common. In short, space systems are essential to obtaining and transmitting vital information needed in the planning and execution of military operations. This manual provides a foundation for leader development, training, and space-related modernization initiatives that support the force projection Army's missions and provide soldiers with a decisive advantage across the full range of military operations.

SCOPE

The Army is involved in space because it can no longer effectively and efficiently execute its missions and maintain a technological advantage without exploiting space-based capabilities to meet worldwide command and control, communications, and intelligence requirements. This document focuses on the use of space capabilities across the full range of military operations. In this regard, FM 100-18 is more than a doctrinal statement about space support to the Army. It provides space support doctrine that is not only consistent with current doctrine of the various mission areas, but should drive the future development of doctrine within those areas. The bottom line is to aggressively use space to support the attainment of terrestrial objectives. It is relevant from the highest levels of command down to the soldier in the foxhole.

The proponent of this manual is HQ TRADOC. Send comments and recommendations on DA Form 2028 directly to Commander, US Army Training and Doctrine Command, ATTN: ATCD-HS, Fort Monroe, VA 23651 - 5000.

Masculine pronouns in this publication do not refer exclusively to men.

Chapter 1

Space Policy

Army doctrine has evolved to match the changing world environment. The doctrinal shift to a force projection Army has profound implications that necessitate the exploitation of space capabilities that will enhance mission accomplishment. This chapter provides an explanation of national, DOD, Joint Staff, and Army space policies. It addresses the external forces and trends that shape Army doctrine in general and at the same time suggests the increased importance of space to the Army as it poises itself to execute national military strategy.

NATIONAL SPACE POLICY

The National Space Policy states that the primary goal of space activity is to ensure the security of the United States. It recognizes the importance of space in achieving national security, scientific, technical, economic, and foreign policy goals. It contains guidelines and implementing actions relative to the conduct of space programs and related activities.

DEPARTMENT OF DEFENSE SPACE POLICY

DOD space policy focuses on operational capabilities that enable the military services to fulfill national security objectives. It enumerates three space-related efforts that guide the military services: (1) deter or, if necessary, defend against enemy attack; (2) enhance the operations of US and allied forces by employing space systems; and (3) ensure that forces of hostile nations cannot prevent our use of space. These space-related efforts include protecting the peace and decreasing the incentives for attack and enemy escalation. Joint Chiefs of Staff (JCS) Pub 3-14 provides the doctrine and principles by which military forces should plan, prepare, and execute military space operations. JCS Pub 0-2 defines the Army's responsibilities for space operations as follows:

- To organize, train, equip, and provide Army forces to support space operations.
- To develop, in coordination with the other military services, tactics, techniques, and equipment employed by Army forces for use in space operations.
- To conduct individual and unit training of Army space operations forces.
- To participate in joint space operations, training, and exercises as mutually agreed to by the services concerned or as directed by competent authority.

ARMY SPACE POLICY

Current Army space policy is consistent with national and DOD policy and stems from an evolution of Army involvement in space. It articulates the Army's position and serves as a

framework for the Army's future direction in space based on the premise that space products are becoming an increasingly important element of successful military operations. The Army's space policy calls for—

- Accessing national, civil, military, allied, and commercial space products.
- Exploiting space-based assets, capabilities, and products.
- Conducting space and space-related activities that enhance operational support to warfighters.
- Influencing future space system design and developmental initiatives.
- Organizing and training forces to take full advantage of space-based capabilities.

To accomplish these policy objectives, the Army must adapt all the elements of doctrine, training, leader development, organization, materiel development, and soldiers (DTLOMS) to capitalize on the unique capabilities afforded by space systems. In so doing, the Army can successfully exploit the potential of space to support operations and maintain land force dominance well into the twenty-first century.

The Army's space capabilities to support its missions will evolve from the use of ground receivers in the near term to direct satellite-to-user linkage in the far term. The implementation strategy may be summarized as follows:

- In the near term, acquire receivers to take advantage of or leverage currently deployed space system capabilities.
- In the midterm, acquire or develop processors for more complete integration and direct interface with space systems.
- In the far term, influence the development of future space systems that have been totally or partly designed to meet specific Army requirements.

These three phases occur concurrently, not sequentially. To gain the advantages in the mid and far terms, appropriate actions must be initiated in the near term that will result in the desired outcome.

EXTERNAL FORCES AND TRENDS

The external forces and trends that have had a major influence in shaping our space doctrine include-

- New military strategy.
- Continued regional instability.
- The broad spectrum of missions.
- Worldwide infusion of advanced technology.
- Declining resources.
- Joint, interagency, and multinational operations.

New Military Strategy

The US has adopted a new, regionally oriented military strategy as a result of fundamental changes in our environment both at home and abroad. Today, the Army must be able to specifically design force packages to satisfy diverse worldwide missions. The new strategy requires the Army to have capabilities unique to this environment-supporting combat operations as well as MOOTW. The transition to a force projection Army from one oriented to fighting Warsaw Pact forces in Central Europe requires development of greater versatility and flexibility. Implementing this new strategy requires the Army to fully exploit the capabilities of existing and programmed systems, including space-based assets.

The international security environment has undergone fundamental changes since the collapse of the Soviet Union. The dissolution of the Warsaw Pact has created numerous power voids, government upheaval, and a period of uncertainty, expanding opportunities for the US and other nations to form new international relationships. While US relationships will center around those nations that share fundamental moral, political, and security interests, the US may enter into coalitions with other nations on short notice. Space systems can provide and facilitate the exchange of information required to support and sustain multinational and coalition operations.

Continued Regional Instability

Political instability, divergent political interests, and economic disparity among and

within nations may result in increased economic or political competition, leading to acts of terrorism, insurgency, and regional conflict that involve armed confrontation. To protect US national interests, the Army maybe deployed into areas with little or no infrastructure to assist in the restoration of stability and regional balance. Space systems can enhance Army capabilities during operations in remote or underdeveloped regions and may be the only feasible solution to unique requirements associated with this environment and the specific Army mission. For example, space systems can provide an intratheater communications infrastructure when one does not exist or is insufficient to support operations. Likewise, space systems can be used to produce image products to partially satisfy mapping requirements when maps do not exist or are outdated.

Broad Spectrum of Missions

The US will face an increasingly broad spectrum of challenges across the full range of military operations. While the Army's focus remains on the missions of the warfighter, it will assume greater responsibilities for MOOTW, such as noncombatant evacuations, nation building, security assistance, peacekeeping, disaster relief, countering drugs, and search and rescue missions. These operations can have an importance equal to combat operations because they can preempt or prevent crisis situations from arising by reestablishing regional stability. The diversity of these operations provides a special challenge since many will likely be conducted in regions with little or no infrastructure to support the Army. Space-based systems provide options that permit commanders to mitigate conditions that may be found in austere environments.

Worldwide Infusion of Advanced Technology

The infusion of advanced technology into military capabilities will continue. More nations will acquire significant numbers of modern lethal weapon systems and develop more capable armed forces. The proliferation of weapons and technology, including space capabilities, may allow less influential nations to become more assertive in international affairs. The Army must preserve, expand, and exploit its space capabilities to ensure land warfare dominance in the face of spreading technologies.

Declining Resources

The Army's fiscal resources probably will decline over the next few years, resulting in a smaller force. Consequently, the Army must optimize the value of each dollar to ensure a competitive edge in warfare. The Army must be more selective in determining which systems and technologies to pursue in order to hedge against the unknown and to ensure that they develop only capabilities not already available from other DOD activities. Space systems can enhance the Army's operational effectiveness and mitigate the impact of a smaller force. Use of space capabilities will also support the Army's requirements for versatility and agility. These systems have applications in peacetime such as nation assistance, humanitarian assistance, disaster relief, contingency planning, and training. They also provide support unique to combat operations.

Joint, Interagency, and Multinational Operations

To protect US national interests, the Army will be involved with other military services, government departments and agencies (for example, Departments of State, Transportation, Interior, and Commerce and the Drug Enforcement Agency), and other nations and their forces. Space system capabilities, such as communications, multispectral imaging, and position/navigation (POS/NAV), enhance interoperability and facilitate coordination during joint and multinational operations. Space-based systems provide the capabilities and infrastructure required to operate in an austere environment. Satellites, when combined with terrestrial communications systems, can provide worldwide responsiveness and the interoperability needed for information exchange. Access to these assets by joint, interagency, and multinational organizations facilitates coordination, standardization, and understanding of intent across the full range of Army operations.

NATIONAL MILITARY STRATEGY (NMS)

The Army must support requirements that may result from three NMS fundamental demands:

- Peacetime engagement.
- Deterrence and conflict prevention.
- Fight and win our nation's wars.

In addition to these requirements, the NMS has necessitated new Army doctrine as contained in FM 100-5.

US national military strategy continues to be based on deterrence. It emphasizes force projection with capability across the full range of military operations. The Army must be more versatile, providing an increased number of strategic options for the NCA, including the protection of the US, its allies, and deployed US forces. The Army's roles in support of the unified commander in chiefs (CINC) implementation of the NMS include-

- Providing forces for forward presence.
- Maintaining combat-ready forces for power projection.
- Maintaining forces for reinforcement.
- Participating in interagency operations and providing support to civil authority.
- Contributing to regional stability through support to allies.

To execute the NMS, the Army must maintain forces to support the projection of US power and influence anywhere in the world. This means that the Army must be capable of full-dimensional operations, employing all means available to accomplish the mission decisively and at the least cost. Campaigns, whether in support of combat operations or MOOTW, will begin and end with the movement of troops and equipment. Land, sea, air, and space capabilities will be employed as part of a joint, interagency, or multinational force to achieve the desired end state, requiring an Army capable of executing different types of missions simultaneously. To accomplish these missions, the Army must project its power and influence from the continental United States (CONUS) or other staging areas to anywhere in the world. Force projection requirements to support this strategy include timely worldwide reconnaissance and surveillance; effective communications and dissemination of information; capability to manage split-based operations; accurate location of assets and forces; and the ability to deny the enemy knowledge of friendly operations, capabilities, or intentions. This strategy requires a new definition of intelligence readiness, calling for the commander to develop broad knowledge on priority contingency areas, update those data bases regularly, and be prepared to drive the intelligence system to surge in support of emerging missions.

The use of space capabilities increases the Army's ability to satisfy these force projection requirements. Space capabilities are a vital and integral component of each of the Army's strategic roles and are important "force multipliers" for operational and tactical missions. Satellites on orbit are mission-ready and responsive to user requirements around the world. The Army can use satellites to acquire and distribute timely information that reduces the level of uncertainty about a given situation or condition without revealing interest or intent. The worldwide presence of space systems enhances stability by permitting the US and its allies to see the area of operations and provides early warning of operations adverse to US interests. This information can be used to support both combat and MOOTW.

During combat operations, Army forces will be employed and synchronized with a wide range of systems and organizations to defeat the enemy. Simultaneous attacks throughout the battle area are designed to seize the initiative, control the enemy's tempo, and destroy his will to fight. At each echelon, deep, close, and rear operations are arranged to ensure the mission is accomplished as rapidly as possible. The earlier Army forces can cause enemy operations to begin to fail, the more rapidly enemy follow-on operations and exploitations are jeopardized, thus limiting the enemy's chance for success.

The importance of MOOTW is increasing. Army forces conduct these types of operations as

part of the NMS to prevent or preempt situations that, although less threatening, could eventually affect US access to critical regions of the world, our credibility among our allies, or the confidence of other nations in our abilities and resolve. In the future, development of campaign and operations plans may be based entirely on MOOTW requirements. During MOOTW, space systems provide essential information to support security assistance, nation building, disaster relief, and humanitarian assistance. Satellites also provide the means for assessing disasters, predicting crop growth, and analyzing a nation's infrastructure (for example, lines of communication, sources of energy and power, and trafficability situations). These space capabilities, if implemented, can complement the Army's ability. They support US interests, both at home and abroad, and often are an integral part of the overall MOOTW campaign plan.

Chapter 2

Impact of Space on Force Projection Army Operations

Due to the fact that space systems are "force multipliers" able to support missions across the full range of military operations, commanders at all levels must understand space capabilities and fully integrate them into Army operations. This chapter describes how space systems impact the full range of force projection Army operations. It relates the value added by space to the Army's characteristics and addresses the relationship between space and the tenets of Army operations. Finally, it discusses the impact of space on the combat functions: intelligence, maneuver, fire support, air defense, mobility and survivability, logistics, and battle command.

THE STRATEGIC ARMY

Faced with challenges that are constantly changing the range of operations, today's Army must be prepared to quickly adapt and to deliver decisive military force upon demand. Only by employing every available asset will the strategic Army succeed. Mission accomplishment depends upon how well the Army exploits the use of space systems and space forces and support from Air Force, Navy, Marine Corps, and allied and coalition forces. Participation in joint and multinational training exercises provides the Army an opportunity to refine its interoperability and deployability plans and strategic role. Exploitation of space capabilities is a must if political, economic, diplomatic, and national security interests are to be assured strategically. Space capabilities enhance the Army's ability to be better prepared, better equipped, and more capable of—

- Conducting full-dimensional operations.
- Exercising more efficient and effective battle command when participating in joint, multinational, United Nations, or interagency force-level training exercises.
- Meeting the "deployable" demands of a force projection Army.
- Responding to expansible requirements associated with changes and surges that may occur during various phases of military operations.
- Ensuring the combat power needed to assure a decisive victory in achieving the overall national security strategy.

CAPABLE OF FULL-DIMENSIONAL OPERATIONS

Space-based assets provide the force multipliers needed to successfully conduct full-dimensional operations. Today's Army must be capable of conducting a variety of military operations on short notice and at minimum cost in lives and other resources. The most efficient and effective means available must be employed to accomplish this goal. Space systems offer enhancements in many of the mission areas that are critical to success. Battle command, synchronization of resources, enhanced information dissemination, parallel

planning, concentration of fires, and the massing of other combat power are but a few of the benefits that are available and may be realized through the use of space systems. Commanders and staff planners at every level should become thoroughly familiar with the space assets available and ensure their use in every aspect of the planned operations.

TRAINED TO FIGHT AS PART OF A JOINT OR MULTINATIONAL FORCE

The Army will become more involved with other services, national agencies, and nations to protect US national interests. The ability of the Army to conduct a wide variety of operations under joint/multinational command and control relationships will be essential in future operations. The Army must be capable of supporting war as well as MOOTW requirements. The diversity of missions, coupled with anticipated budget restrictions, mandates that the Army do more with less. As a result, it must use all available training facilities, opportunities, and capabilities to increase the operational effectiveness of the force. The use of space assets enables the Army to support this wider range of missions with increased effectiveness and *efficiency.*

DEPLOYABLE

Force projection is the cornerstone of the successful implementation of the national military strategy. No longer can the Army plan on being in the area of operations prior to a crisis. Operations will start with the movement of forces and equipment to the area of operations. Space systems currently in orbit are already deployed and can support the Army prior to and during deployment, providing information that reduces ambiguity and improves decision making. Satellites provide the initial communications, surveillance, and weather system infrastructures to support deployment. They gather information and provide a means for rapid dissemination of data to appropriate echelons of command. Data from space assets is integrated with other sources of information to facilitate mission planning and ensure knowledgeable entry into the area of operations. Additionally, data from space systems facilitates in-transit visibility and total asset visibility. Space systems permit accurate tracking of critical equipment en route to the deployment area. Space systems also enhance the Army's deployability by providing information to accurately tailor the force package, potentially reducing the amount and size of ground-based equipment that must be transported. The forces arid equipment deployed can also be reduced through split-based operations, facilitated by the capabilities of space systems to provide and transmit information.

CAPABLE OF DECISIVE VICTORY

Lethality is essential for the rapid defeat of an adversary. The ability of the commander to effectively command and control forces and to see the battlefield, regardless of size or maturity, permits Army forces to react faster than the enemy. This quick reaction can be obtained and enhanced by the application of space-related capabilities. The use of space-based communications and intelligence data, accurate position and navigation information, and weather, terrain, and environmental monitoring directly enhances target acquisition and engagement opportunities and improves weapon system performance and lethality for Army forces. The capabilities of space systems to support information operations will also contribute to decisive victory by allowing our forces to be informed simultaneously, thereby enhancing their responsiveness and improving battle command.

EXPANSIBLE

The Army must be able to meet several threats to US national interests simultaneously. This may require expanding the size of the active Army by activating reserve components, creating new units, and mobilizing the industrial base to support increased requirements. Likewise, space assets can be reallocated, moved, leased, or purchased to improve the operational effectiveness of the expanding force. The use of civil and commercial systems, on-orbit spares, and a robust launch capability will increase the number of space assets available to support Army users.

SPACE AND THE TENETS OF ARMY OPERATIONS

By collecting data and disseminating information, space capabilities support the tenets identified in FM 100-5: initiative, agility, depth, synchronization, and versatility.

INITIATIVE

Space systems provide intelligence support for indications and warnings to US forces—an essential element for supporting the NMS. In an environment in which uncertainty and instability are major threats, global situational awareness is critical. Satellite systems help commanders see the enemy situation, understand terrain, know the current and future weather conditions, and accurately position forces and track resources. Not only does this information reduce the element of surprise and the vulnerability of the force, it facilitates planning by allowing military forces to anticipate events. Once planning is completed, communications satellites provide a means to transmit information necessary to execute the plan. The capability to seize the initiative with certainty and to act decisively as a result of near-real-time information may exhaust the enemy's options and avert further escalation.

AGILITY

Access to data from space systems enhances the commander's situational awareness and provides a better understanding of the battlefield, which, in turn, facilitates decision making. The timely information afforded by space-based systems improves the ability of Army forces to act and react faster than hostile forces. Space-based communication assets provide the connectivity required to transmit the necessary information to support command and control of maneuver elements over extended distances, which further enhances the agility of the force. Positioning information from Global Positioning System (GPS) satellites can be used to help reduce fratricide, facilitate force positioning, and enable commanders to track resources throughout the area of operations. These capabilities enable commanders to synchronize operations and ensure concentration of effort at the right time and place.

DEPTH

Space capabilities ensure vital coverage of the battle space. Additionally, they provide the multiplicity of data needed to support intelligence, targeting, navigation, weather, terrain, environmental monitoring, and command and control functions. Satellites enable commanders to see the area of operation and battle space in sufficient depth (deeper than land or air platforms) and detail to anticipate likely enemy options and to evaluate the effectiveness of friendly operations. This extension allows the Army to locate and identify enemy assets, plan operations that will disrupt the enemy's tempo, and conduct simultaneous attacks throughout the battle space. In force projection operations, information broadcast from satellites will permit simultaneous situational awareness throughout the battlefield.

SYNCHRONIZATION

Space capabilities facilitate unit coordination and management of critical resources necessary to ensure that the end state identified in the campaign plan is achieved. Satellites play a key role in synchronization. They permit forces to share information and enable commanders to combine resources and operations at the decisive time and place. Sequencing and combining operations reinforce and amplify the effects of each specific operation and ensure unity of effort in the application of resources.

VERSATILITY

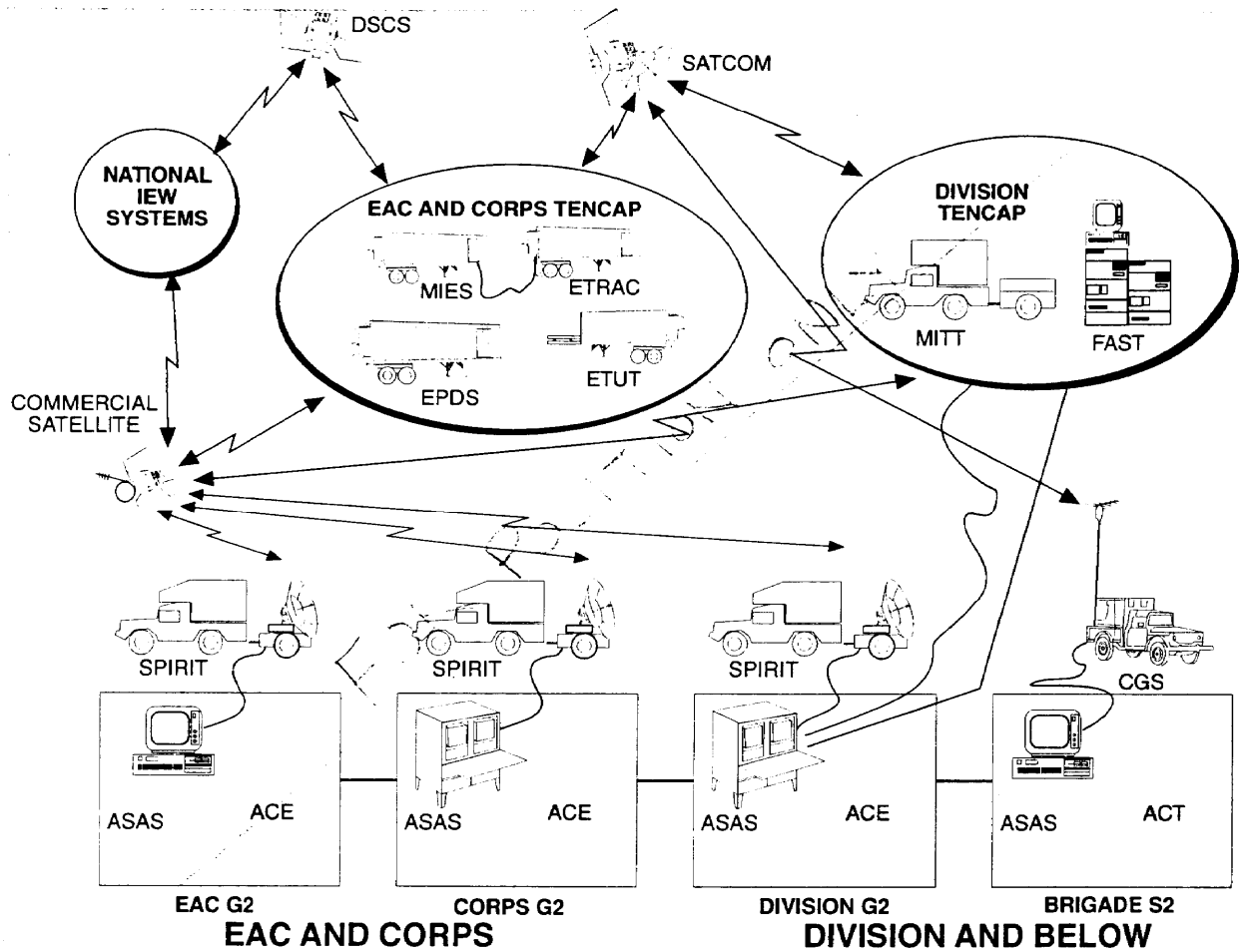
The diverse and multifuctional array of space systems offers unique advantages that increase the Army's versatility and can have a dramatic effect on all Army missions. Satellites are in orbit, have worldwide coverage, and can support training, MOOTW, and combat equally well. The POWNAV satellites-NAVSTAR GPS-enable anyone with a passive receiver to know his position more accurately. Military and civilian communications satellites offer worldwide links with virtual line of sight to anyone. Weather and terrain information is available from Defense Meteorological Satellite Program (DMSP) and civil environmental satellites, such as the US-launched civil earth imaging satellites (Landsat), Japanese-launched marine observation satellite (MOS-1),

and France's *Systeme Probatoire d'Observation de* la *Terre* (SPOT) satellite, to support intelligence preparation of the battlefield (IPB), planning, and rapid decision making. Space systems provide reconnaissance, intelligence, surveillance, and target acquisition (RISTA) and communications support to tactical commanders. The Army's TENCAP Program provides the interface between space-based intelligence and electronic warfare (IEW) sensors and the all-source analysis system (ASAS) within the analysis and control element (ACE) located at echelons above corps (EAC), corps, divisions, separate brigades, and armored cavalry regiments (see Figure 2-1).

COMBAT FUNCTIONS

To successfully accomplish strategic, operational, and tactical military objectives, the force at each level of war performs the combat functions of intelligence, maneuver, fire support, air defense, mobility and survivability, logistics, and battle command. Commanders integrate and coordinate these functions to synchronize battle effects in time, space, and purpose. The use of space systems as a force enhancer multiplies the commander's effectiveness when executing combat functions.

Figure 2-1. Space Connectivity to the TENCAP and IEW Architecture



Note: TENCAP systems are normally assigned to division or higher; depending on METT-T and task organization, they may be allocated to echelons below division.

INTELLIGENCE

Intelligence is the collection of functions that generate knowledge of the enemy, weather, and geographical features that a commander requires in planning and conducting operations. It is derived from an analysis of the information provided by multiple sources on the enemy's capabilities, intentions, vulnerabilities, and the battle space environment.

Army commanders use intelligence, electronic warfare, and counterintelligence support to conduct combat operations. The intelligence cycle phases of directing, collecting, processing, and disseminating place tremendous demands on command, control, and communications, reconnaissance, and surveillance assets, which are critical to the intelligence effort. Space systems provide special advantages for IEW operations.

Dedicated and nondedicated ground, airborne, and space systems are employed to provide critical intelligence functions and subfunctions support. Communications satellites support the flow of all types of information and intelligence connectivity to all IEW users, improved communications security, fewer terrain-dependent operations, increased capacity, less downtime for movement, global coverage, more survivable redundant systems, and continuity of service. On-orbit position location and navigation systems provide the IEW system accurate and timely data needed to support targeting and weapons delivery.

Surveillance and reconnaissance efforts are a part of national intelligence gathering and the systematic observation process. Surveillance operations are effected to collect information continuously from the air, land, and sea. Reconnaissance operations are directed toward specific targets. Through surveillance and reconnaissance, varied data, such as meteorological, hydrographic, geographic, electronic, and communications characteristics, can be collected on any given area of the earth's surface.

The tactical commander will need to gain timely intelligence from the full integration of national and theater assets. The ability of theater or national intelligence sources to fulfill tactical intelligence requirements and to remain responsive to dynamic, lower echelon needs is key. Force projection operations need accurate and responsive tactical intelligence. Intelligence preparation must begin as early as possible to allow commanders to develop adequate plans. The deploying force achieves this through split-based operations, which integrate CONUS-based national systems with forward deploying tactical systems.

MANEUVER

Maneuver is the employment of forces on the battlefield through movement and direct fires, in combination with fire support, to achieve a position of advantage in respect to enemy ground forces in order to accomplish the mission. It pertains to all combat, combat support, and combat service support. Space systems to support maneuver focus primarily on force enhancement to improve the effectiveness of combat forces. Forces must be capable of operating on a highly mobile, nonlinear lethal battlefield, continuously, night and day, in all weather, on any terrain. Space offers an added dimension to maneuver capabilities of the force. Space assets provide a global view of theaters of conflict, an operational view of the battlefield, accurate movement, and the ability to assess the terrain and weather, locate enemy forces, and help determine their vulnerabilities and intent. Space assets also assist in deceiving the enemy, expediting maneuver, and striking the enemy throughout the full depth of the battlefield. Near-real-time assessment of the location and progress of subordinate units enables the commander to rapidly shift or reinforce the main effort, exploit enemy vulnerabilities, and sustain the momentum of the force. Combat forces benefit directly from space capabilities. Multicapable sensors and navigation devices facilitate command and control of ground maneuver forces and provide the commander with knowledge of the enemy and terrain. Regardless of the terrain or distance, satellites provide a communications link, thus allowing the commander to exercise effective command and control. Space systems help the commander to see deep, move fast, and engage the enemy across the breadth and depth of the battlefield.

FIRE SUPPORT

The fire support system is the collective and coordinated use of target acquisition data, indirect-fire weapons, armed aircraft (less attack helicopters), and other lethal and nonlethal means against ground targets in support of maneuver force operations. It includes artillery, mortar, and other non-line-of-sight fires, naval gunfire, close air support, and electronic countermeasures. Space systems, due to their unique high-ground vantage point, provide data on terrain and weather as well as communications capabilities, allowing fire support systems to operate in a wide range of geographic circumstances and in all weather conditions. Space systems integrated with intelligence systems provide target acquisition, identification, and tracking information to fire support control systems. The range, flexibility, and speed provided by space systems complement the technologies employed on the fast-moving nonlinear battlefield.

Access to satellite communications provides secure, robust range extension of tactical communications nets to maneuver commanders; GPS satellites provide highly accurate, real-time, three-dimensional positioning and navigation data; weather satellites scan the battlefield and transmit reports" and atmospheric profiles from space; and other earth resource satellites produce topographic products. All are used to assist battlefield movement and to provide other critical fire support data needed to destroy, neutralize, suppress, degrade, or disrupt threat formations and systems in support of the maneuver commander.

AIR DEFENSE

Tactical air defense artillery units have the mission of nullifying or reducing the effectiveness of enemy attack or surveillance aircraft and/or missiles. Strategic air defense forces have the mission of providing attack warning and attack assessment of air and ballistic missile attacks on North America. A family of weapons is employed to provide the needed air defense coverage since no single air defense system is capable of protecting the wide variety of critical strategic and tactical assets that are potential targets for the enemy. A mix of ground, sea, air, and space-based sensors provides early warning, detection, tracking, discrimination, identification, targeting, and other vital information to the force. Communications satellites allow for wide-area-surveillance net broadcasting, near-real-time targeting transfer, and command and control over extremely large areas. Space-based position location and navigation systems greatly enhance air defense operations with worldwide, accurate position location, which can be integrated with near-real-time intelligence and accurate weather and terrain data to give the maneuver force commander complete situational awareness.

MOBILITY AND SURVIVABILITY

Mobility and survivability describe the functions associated with providing friendly forces freedom of movement over battlefield terrain against obstacles while denying the same to the adversary. These functions also reduce friendly force vulnerability to the effects of enemy weapon systems and natural occurrences. Space system capabilities offer considerable enhancements to the success of mobility and survivability missions. Multicapable sensors, navigation systems, and satellite communications facilitate command and control of widely dispersed forces with the transfer of timely intelligence and information data. Space observation platforms and sensors provide commanders with an operational view of the battlefield, which significantly adds to the ability to detect natural and man-made obstacles, ensuring timely information on routes, bridges, water-crossing sites, employed obstacles, and minefield locations. Weather, terrain, and environmental monitoring systems give information on terrain features, obscurants, and trafficability, which can pose mobility restrictions to the movement of large forces and on lines of communication. Topographic products and information provided through the use of space-based imagery intelligence maps, charts, overlays, and digital terrain data bases support precise positioning of artillery, command, control, and communications, and intelligence systems. Also, space-supported topographic products can

assist in the precise positioning of obstacle zones, belts, and groups to turn, fix, block, and disrupt the enemy. Position location and navigation systems provide increased navigation capability, which enhances maneuverability and responsiveness.

LOGISTICS

Logistics are those functions directly related to the development and maintenance of maximum combat power through the sustainment of combat forces. Included are personnel service support, health services, general supply, field services, maintenance, transportation, facilities, and quality of life. At the tactical level, logistics focus on the combat service support (CSS) functions of arming, fixing, fueling, manning, moving, and sustaining soldiers and their equipment.

Logistics support must be flexible enough to support a force projection force operating on widely dispersed battlefields anywhere in the world under varying climatic and terrain conditions and with varying degrees of host nation support and infrastructure. This support will require a mix of sustaining base assets capable of pushing supplies and maintenance assets forward and forward-based logistics units capable of providing immediate support as needed, To support forces in this type of an environment, the logistics system will require enhanced access to timely, accurate intelligence and weather information; improved logistics management processes; more rapid, responsive, and reliable transportation; better methods for assessing battlefield damage; and robust and fast communications and automatic data processing support. Space systems will provide these capabilities to help ensure success on the future battlefield.

Space-based sensors identify sources for water, food, and fuel. Support facilities such as hospitals, major roads, airports, and seaports are located to assist planners in determining the level of support and the kinds of materiel needed. Weather, terrain, and climatic conditions are also studied to assess their impact on the logistics system. Space-based systems provide force enhancement capabilities that facilitate information transfer and processing. Space-based tracking devices maintain location of units and supply bases and provide in-transit visibility. Satellite communications provide a true split-based capability, allowing logisticians to communicate through data transfer from the theater of operations back to the sustaining base in CONUS or elsewhere. Position and navigation devices allow tracking of the movement of transportation assets and supplies, giving commanders total asset visibility. This capability, coupled with reliable space-based communications, weather, terrain, and environmental monitoring systems and space-based intelligence, provides real-time command and control to commanders. Commanders are able to tailor and adjust CSS missions and assets in response to the situational awareness gained by having these capabilities available throughout the area of operations.

Advanced automation equipment that receives and transmits logistics information via satellite systems allows for supply and maintenance requests to be received, consolidated, and requisitioned from appropriate sources, facilitating unitized, modularly configured packages. Near-real-time battle damage assessment data provided through space systems and advanced automation enables maintenance efforts to concentrate on specific problems, shortening the time required for equipment to be returned to an operational status.

Health services support, replacement operations, casualty reporting, strength accounting, finance services, chaplain activities, postal services, legal services, public affairs, and morale, welfare, and recreation activities are enhanced through the application of telecommunications, navigational satellite transmission and reception communications stations, computers, audio-video equipment, satellite retransmission of television programming, digitized facsimile telemetry, and other space-produced capabilities. The use of space-based assets will result in timely and accurate processing of financial information in support of contracting (local vender support),

disbursing, payroll, and accounting information. This capability will provide better management information to commanders and increased support to service members.

Rapid force projection from CONUS, extended lines of communications, and potential forcible entry into logistically bare-based areas of operations require an Army logistics system that is versatile, deployable, and expandable. Administrative and logistical support, to include split-based operations, will be more efficient and timely due to utilizing space-based assets for enhanced tracking, requisitioning, position location and navigation, and imagery operations. The improved CSS Battle Command System will link logistical asset sources to the total distribution system in the theater of operation and CONUS. Using total asset visibility combined with advanced information communication flow will ensure that required material will be immediately ordered, its location identified, and its delivery tracked through precise inventory accountability transfer. Personnel replacement and medical support operations will also improve significantly because of enhanced capabilities derived from using space assets.

All space-based systems deployed in support of contingency operations or MOOTW have weaknesses, limitations, and vulnerabilities. Support plans—that is, the space operations annex—must adequately identify and address these factors to ensure maximum benefits are realized from the space capability.

BATTLE COMMAND

Battle command is a properly designated commander's exercise of authority and direction over assigned forces to accomplish a mission. It specifies those functions that leaders must perform in making sound and timely decisions and in directing the activities of assigned and supporting units. Information is the medium of the battle command process, which results in decisions and directives at every echelon and in every branch. Battle command is the process of acquiring information, assessing whether any new actions are required, determining what these actions should be, and directing the appropriate one. Information about the mission, enemy, terrain and weather, troops available, and time (METT-T) is acquired through a variety of means. The information is sent and received; the means of communicating the information is managed; and the information is maintained in a form convenient to the decision-making process. The battle command functions are necessary to execute the intelligence, maneuver, fire support, air defense, logistics, mobility, and survivability combat functions. The battle command function is substantially aided by the availability y of space-based systems. Space-based communications equipment and the attendant ground terminals offer communications support to facilitate information transfer, for example, to transmit orders, control measures, changes to orders, unit status, and requests for support. Space-based systems that identify targets can also determine which fire support means should engage a target. Space systems provide rapid information on the enemy, his movements, and his intentions. They can provide the commander with real-time and near-real-time intelligence, target acquisition, environmental and trafficability analysis, logistics, and so forth. These capabilities enable the combat, combat support, and CSS elements to take appropriate actions and play a significant role in enhancing efficiency and responsiveness.

Chapter 3

Use of Space Systems

As the Army continues its transition from a Cold War European-oriented force, requirements of a force projection Army will be further defined and new problems uncovered. Many of these requirements can be met by using space systems. This chapter explains the Army's doctrinal application of space systems and their capabilities to support Army operations. It focuses on planning considerations and the operational context of the space system capabilities further described in Chapter 4. It describes, using joint terminology, the four military space functions and the general planning considerations for space support, from the strategic to the tactical levels, including joint planning.

MILITARY SPACE FUNCTIONS

Army planners must be familiar with the space support available and its capabilities, as well as the procedures for requesting support from space systems not directly allocated to or supporting their operation (see Figure 3-1). Personnel and equipment not organic to a deploying unit must be made available to support these operations. Required in many cases is the reallocation or redistribution of space assets or the development and maintenance of contingency space support packages for use by deploying units. To describe the aggregate warfighting capability offered to combat forces, space system capabilities are further divided into four military space functions: force enhancement, force application, space control, and space forces support. Each of these functions should be considered during the initial stage of mission planning.

FORCE ENHANCEMENT

The Army's involvement in space is largest in this functional area. Force enhancement involves space support that helps the land force accomplish its terrestrial mission. It is analogous to combat support with space capabilities that improve the effectiveness of forces across the full range of military activities. It includes, but is not limited to, communications, navigation, weather, terrain, environmental monitoring, and surveillance support. The efficiencies resulting from the use of these space capabilities can have a dramatic effect on Army operations: reducing uncertainty, facilitating battle command, and moderating the effects of friction and fog of war. As one of the biggest users of satellite systems—GPS receivers, satellite communications (SATCOM) terminals, multispectral imagery (MSI) processors, and TENCAP systems—the Army is responsible for articulating its requirements, influencing the satellite design process, and acquiring ground terminals to satisfy its space needs.

FORCE APPLICATION

Force application addresses the conduct of combat operations from, in, or through space with the intent to destroy terrestrial targets. While force application capabilities from space are limited, the role of space in force

Figure 3-1. Space Support to Army Operations

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application is evolving. It consists of the offensive and defensive use of space and space-related capabilities to project combat power and defend US military forces and their allies from attack. In the broadest sense, any space system capable of providing and disseminating information contributes to force application. Consistent with treaty obligations and national policy, this capability could include the use of space- and ground-based systems to provide protection from ballistic missiles, in programs such as national missile defense (NMD) and theater missile defense (TMD), and to extend the Army's force projection range against surface targets.

The strategic defense of the US is one of the Army's most important missions. When strategic defense systems are fielded, the Army is an integral part of the total system, providing command and control facilities and ground-based sensors and interceptors to support the defeat of strategic and theater ballistic missiles. An important component of the TMD system is the transportable equipment that can be moved into *a* theater or region to protect Army contingency and allied forces. As a result, the Army will continue to upgrade the existing systems and support research and development efforts designed to extend the range and effectiveness of follow-on sensors and interceptors.

SPACE CONTROL

Space control, like control of the air, is a mission shared with the US Air Force and other military services. The purpose of this function is counterspace operations, that is, to ensure freedom of action in space for friendly

forces while denying it to the enemy. It includes the conduct of offensive and defensive space operations to prevent an enemy's space forces from gaining and maintaining space superiority and to ensure survivability and protection of friendly space systems. The Army's role in this function will be from the terrestrial perspective, such as jamming up/ downlink frequencies and attacking satellite control nodes and facilities from the ground.

Our force projection Army will continue to support the requirement for a counterspace system to facilitate space control, assure space support, and deter nations from attacking US satellites. Access to a counterspace capability by more nations may increase over time. The impact could be significant. For example, the destruction of US space-based surveillance systems would limit the ability of commanders at all echelons to see the battlefield clearly. A commander's freedom of action can be enhanced by counterspace operations that provide freedom from space-based surveillance. Space control facilitates mobilization, deployment, and employment of Army units.

SPACE FORCES SUPPORT

The US Air Force has the primary responsibility for space support, with other services providing assistance as needed. This function addresses the military infrastructure to deploy and maintain military space systems. It includes the forces and activities responsible for launching, maintaining telemetry, tracking and commanding space systems, recovering spacecraft, and providing logistics support for space systems and their ground control elements. The Army has limited involvement in this function.

PLANNING CONSIDERATIONS

Joint Pub 0-2 sets forth principles and policies to govern the joint activities and performance of the US armed forces. It provides guidance for use and employment of space assets by the Army and other services. Joint Pub 3-14 provides doctrine and principles for joint forces to plan, prepare, and execute military space operations. FM 100-5 is the Army's keystone warfighting doctrine. FM 101-5 provides the Army staff officer with instructions on how to plan and document Army operations. The space operations annex to the operations plan is where the use of space systems in support of Army operations should be addressed. A template on what such an annex should look like is provided at Appendix A. Broadcast dissemination of intelligence and targeting information (see Figure 3-2) is an important element in providing commanders at multiple echelons with a common picture of the battlefield that facilitates parallel planning. Broadcast provides a "dial-up" intelligence capability for commanders. Additionally, space systems enable commanders to "pull" information from strategic through tactical echelons.

STRATEGIC-LEVEL PLANNING

Space systems provide a global perspective that supports strategic-level planning done by all services. Planners at this level use space capabilities to focus on reducing uncertainty. The capabilities of space systems help strategic planners to assess the risk of using the military and other instruments of national power. The information provided enables them to formulate and coordinate appropriate responses and to tailor the force for the mission.

OPERATIONAL-LEVEL PLANNING

At the operational level, planners focus on the design and conduct of campaigns and major operations to accomplish the unified commander or higher military authority's strategic objectives. Projecting the force may require the use of split-based operations in which significant support is provided the operational commander from elements that remain in CONUS or elsewhere and do not deploy to the theater of operations. During split-based logistical operations, fully integrating supply and transportation

Figure 3-2. Broadcast Intelligence Dissemination Via Space Systems

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functions into a vertical distribution system is critical. Enhanced, assured communications from space-based assets allow some logistics management functions to be accomplished from CONUS or another theater, deploying only those functions necessary. This stretches the lines of communications from CONUS ports and support areas to the theater of operations. The Army must develop and employ space system capabilities to enhance

the operational commander's capability to support operations throughout the theater. Split-based operations reduce the burden on the deployment flow and prevent unnecessary stockage in theater. Specifically, space systems provide information to support planning, a means for disseminating information, tracking and managing assets, and controlling forces during war or MOOTW.

TACTICAL-LEVEL PLANNING

At the tactical level, planners focus on operations that will achieve the desired operational results during the conduct of close, deep, and rear operations. The boundaries between these operations are not firm and often shift, depending upon the mission. However, they are synchronized and are usually conducted in a manner that appears to the enemy as one continuous operation. Planners must concentrate on areas that can affect the outcome of the force's immediate operation as well as future operations. During combat, space capabilities enhance the synchronization of close operations where Army forces are in contact with the enemy. Seeing deep is critical to disrupting the enemy's tempo and the effectiveness of his follow-on operations. Space systems provide weather, targeting, terrain, and ingress/egress information needed to support deep operations. Rear operations are designed to sustain current close and deep operations and to posture the force for future operations, Space systems support operations from the port all the way to the operational area by improving command and control, facilitating freedom of action, and ensuring continuity of operations.

JOINT PLANNING

Both deliberate and crisis action planning that involves two or more military services will be conducted under Joint Operations Planning and Execution System policy and procedures. Since space is an integral component of the NMS, and force projection operations in particular, space operations planners need to be brought into the planning process from the beginning. From the planner's perspective, the primary advantage of using space assets is their near-continuous presence, enabling planners to focus on specific problem areas and to develop viable recommendations and alternatives for commanders. This is particularly important given unforeseen and continually changing conditions that may have precluded detailed contingency planning. The information needed to support planning includes not only military-related intelligence, but also political, economic, geographical, and demographic data. Data from supporting systems can be processed, collated, and disseminated simultaneously to multiple users. This capability speeds the planning process at all echelons of command and greatly facilitates parallel planning. As plans are developed, the planning staff must understand and optimize the type and amount of space support required for the various stages of the operation to satisfy mission requirements and to achieve terrestrial objectives: deterrence and stability.

APPLICATION OF SYSTEM CAPABILITIES

Application of space capabilities should be considered for all phases of a force projection operation, whether supporting a combat mission or MOOTW. Planning is inherently joint and it generally follows a logical sequence. The stages in this sequence, however, may not be distinct and often will blend together or overlap. FM 100-5 identifies the stages of force projection as mobilization, predeployment activities, deployment, entry operations (unopposed and opposed), operations, war termination and postconflict operations, redeployment and reconstitution, and demobilization. Active and reserve forces should be trained, to include proficiency in applying space capabilities during each stage of force projection operations. While the leverage offered by space-based systems is significant during all phases, to reduce redundancy the stages have been grouped into three broad areas: predeployment, deployment, and entry operations; operations; and redeployment and reconstitution.

PREDEPLOYMENT, DEPLOYMENT, AND ENTRY OPERATIONS

The key to ensuring successful operations is the early identification or situation assessment of the problem or threat, including identification of enemy activity, operational capabilities, vulnerabilities, and limitations. Many of the decisions concerning which units will be deployed and when will be based on information gathered and disseminated by space systems. These systems and their capabilities enhance the deployability of Army forces by facilitating a knowledgeable entry, whether opposed or unopposed, into the area of operations. Based on this information, deploying units and sustainment operations will be tailored for the mission and then sequenced and tracked into the area of operations.

During peacetime operations, prior to any deployment decision, the Army must monitor world situations and prepare its units for missions across the full range of military operations. National space systems can cross international boundaries unobstructed and perform reconnaissance, These reconnaissance efforts are focused on building and maintaining data bases to satisfy the Army's training and operational requirements associated with force projection. This information may allow the US to reach a political settlement to an emerging crisis situation without deploying Army forces. The information also facilitates the development of predictive models, situation displays, and simulations useful for planning and training prior to deployment. Specifically, the Army uses space systems to detect the problem, provide early warning, identify information gaps, reduce the vulnerability of its forces, and facilitate entry into the theater of operation.

Spaced-based assets are especially useful in acquiring and providing support to early-entry forces. Regardless of the early-entry category—unopposed when no combat conditions exist, unopposed under combat conditions, or forcible entry—assured communications, reliable intelligence, necessary logistical support, and dependable and accurate fire support can be greatly enhanced when space systems are employed. Many unknowns and questions can be eliminated regarding the area where the early-entry force will be inserted. Space systems can provide insights and risibilities to the commander that will reduce the uncertainties and facilitate situational awareness and battle command throughout the force.

Communications

Military satellite communications (MILSATCOM) systems provide communications connectivity prior to deployment and while en route from CONUS or forward staging areas to the destination, The deploying units use single and multichannel terminals that are part of the unit's table of organization and equipment (TOE) or are the result of redistribution as part of the contingency plan. These systems facilitate command and control, split-based operations, data base/information updates, readiness reporting, mission and movement, and planning and coordination. The unit signal officer should plan for the use of MILSATCOM systems to support communications surges during the initial and follow-on phases of the operation. The connectivity provided by satellite communications systems enhances the flexibility, agility, and battle command of Army forces once in the area of operations. Specific MILSATCOM applications and considerations during this phase of the operation include the use of—

- The Defense Satellite Communications System (DSCS) to provide strategic, long-haul, super-high-frequency (SHF), high-data-rate communications between NCA/ Joint Chiefs of Staff (JCS), CINCs, and other JCS-approved users via multichannel terminals such as the AN/TSC-85/93. Allocation or redistribution of these terminals to other units or to lower echelons is possible depending on the mission and communications requirements. These terminals provide the user with data connectivity through the Worldwide Military Command and Control System (WWMCCS), which provides long-haul communications for the deploying unit.
- Fleet satellite (FLTSAT) systems, Air Force satellite communications (AFSATCOM),

and leased commercial satellite (LEASAT) systems provide UHF, single-channel, secure-voice, low-data-rate communications to support requests and the dissemination of information/data necessary for mission planning and battle command via receivers such as the AN/PSC-3, AN/VSC-7, AN/PSC-10 (LST-5), AN/PSC-7 (MST-20 Plus), and enhanced manpack UHF terminal AN/PSC-5. JCS has mandated that UHF MILSATCOM systems be demand-assigned, multiple-access compatible, and provide the necessary communications security required. The Army response to this mandate is the AN/PSC-5, which will satisfy the need for single-channel communications at corps echelons and below. Special operations, airborne, and light division forces, and the corps and division warfighter net will primarily employ the terminal. The AN/PSC-5 will eventually replace the AN/PSC- 10 LST-5), AN/PSC-3, AN/VSC-7, and the AN/PSC-7 (MST-20 Plus) systems. Redistribution to lower echelons can be requested depending on mission requirements.

- Commercial international satellite systems, such as the International Telecommunications Satellite (INTELSAT) and International Maritime Satellite (INMARSAT), provide worldwide voice and low-data-rate communications through commercial phone systems at fixed sites or through portable terminals such as very small aperture terminals (VSAT).

Milstar is the next generation US military communications satellite. It will provide highly survivable, jam-resistant, worldwide secure communications to strategic, operational, and tactical forces (currently planned down to division level). Milstar primarily uses extremely high frequency (EHF) for uplink and downlink, but the satellite also has some UHF capability for broadcast communications. This system will reduce some of the load on DSCS and Army reliance on FLTSAT and AFSATCOM. The single-channel antijam man-portable terminal and the secure, mobile, antijam reliable tactical terminal (SMART-T) transceivers will be used to support this system.

RISTA

Intelligence is fundamental to effective planning and vital prior to beginning operations. Data' bases and regional assessments developed during peacetime should provide planners information on the availability of infrastructure such as roads, ports, and airfields as well as existing resources and facilities, Data bases also will provide seasonal weather and terrain conditions, the capabilities of potential adversaries, and other impediments to stability. As planning progresses and deployment decisions are made, requirements for information accuracy and timeliness are increased. Both vary by echelon of command and both affect operational decisions.

National space systems are capable of providing worldwide surveillance and reconnaissance and can satisfy many predeployment intelligence requirements. While these systems are controlled at the national level, Army forces can receive this information through the TENCAP Program, TENCAP provides Army commanders with high-leverage equipment that can leverage, process, correlate, exploit, and disseminate data provided by national space systems. Initially, equipment such as the Digital Imagery Test Bed and Interim Tactical Electronic Processor were developed for corps utilization. Through preplanned product improvement and technology insertion, systems were modernized and downsized to field at EAC, corps, and echelons corps and below. These systems include the Modernized Imagery Exploitation System (MIES), Enhanced Tactical Radar Correlator (ETRAC), Electronic Processing and Dissemination System (EPDS), Enhanced Tactical Users Terminal (ETUT), Mobile Integrated Tactical Terminal (MITT), and Forward Area Support Terminal (FAST). Redistribution can be made to other units in accordance with mission requirements. Factors affecting these decisions vary

according to the nature of the command, the priority and timeliness of the requested information, and the type of intelligence requested, for example, imagery and signals.

During the mobilization and pre-deployment phase, space systems provide the critical linkage between the contingency area and the units in CONUS (see Figure 3-3). This link allows units still in CONUS to perform IPB and tactically tailor the force to be sent to the contingency area.

During deployment and entry operations, the deployable intelligence support element (DISE) (see Figure 3-4) provides the deployed commander accurate, detailed, continuous, and timely intelligence via direct downlinks from IEW sensors and communications satellites providing broadcast dissemination,

Weather, Terrain, and Environmental Monitoring

Knowledge of current weather and terrain in the area of operations, along with an accurate prediction of future conditions, will support deployment decisions and operational planning. Analysis of weather, terrain, and other environmental factors is a critical step in the planning process for the deploying unit. Satellite systems provide Army units imagery data to support mission planning, terrain analysis, and mapping, and the meteorology information to support trafficability analyses and route selection.

Figure 3-3. ACE Support During Mobilization/Premobilization

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DMSP and geostationary operational environmental satellite (GOES) data is received at the Air Force Global Weather Central where it is processed. Weather-related products are disseminated to users throughout the world, including staff weather teams supporting the Army. The primary use of DMSP during predeployment is to provide atmospheric data for input into weather prediction models. Requests for DMSP data will be received via mail or courier and formatted in hard copy or on tapes and disks. Currently, DMSP does not link directly to tactical Army units, but some prototype receivers—small weather terminals (SWT)—providing this capability have been developed and may be available down to the division level. When tasked by Army DCSOPS, USARSPACE Army Space Support Teams (ARSSTs) can deliver direct downlink high-resolution satellite weather receivers (DMSP-capable) to deploying Army divisions or corps. The SWT will be integrated into the Integrated Meteorological System (IMETS) in the future. The staff weather officer (SWO) must plan for and request the use of DMSP prototypes,

Figure 3-4. ACE/DISE Support to Early-Entry Operations

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particularly when Army aviation operations play a significant role in the anticipated mission.

Data and imagery from satellites facilitate deployment planning, knowledgeable entry into the area of operations, the selection of assembly areas, trafficability analyses, and route selection. Numerous countries have developed satellite systems to gather data on the earth's environment from space. The US's Landsat and GOES, France's SPOT, Japan's MOS, and Europe's ERS-1 are all capable of providing a variety of imagery and other data ranging from 5- to 80-meter spatial resolution. This data supports deployment decisions and operational planning and is also useful in computer-assisted analyses of terrain in denied areas.

To support the other phases of operational planning, Landsat and SPOT MSI data maybe procured to-

- Update geographical data and data bases.
- Support mapping requirements.
- Analyze trafficability.
- Develop predictive models.
- Display situations.
- Develop simulations.
- Support mission planning and rehearsal.
- Train.

MSI data can also be used to identify potential assembly areas, main supply routes, and location of battlefield control measures. MSI prototype workstations, using commercial software and hardware, are available to the terrain teams supporting tactical units—normally the division-to enhance images and merge MSI data. The USARSPACE ARSST delivers compact MSI processing and exploitation equipment to deploying Army divisions and corps when directed by Army DCSOPS.

Position and Navigation

Accurate, responsive position determination and navigation are essential to the conduct of all military operations. By establishing connectivity with NAVSTAR GPS, users anywhere in the world will be able to receive signals from at least four satellites at all times, providing three-dimensional position, velocity, and time information. Approximately 40,000 GPS receivers are being distributed throughout the Army. These include small numbers of expensive, bulky, first-generation receivers (AN/ASN-149, AN/WRN-6), commercial hand-held receivers (AN/PSN- 10), and large numbers of the current second-generation receiver, the precision lightweight GPS receiver (PLGR), AN/PSN- 11. Over the next decade, the PLGR will remain the primary hand-held GPS receiver. It will be supplemented by the use of embedded GPS, wherein GPS is built into a variety of mobile systems including armored vehicles and weapons firing platforms. Prototype hardware and software systems that integrate GPS and other SATCOM systems, such as the GPS Army Battle Command System (ABCS), are being developed and will be used to support resource tracking,

Missile Warning

Army forces are particularly vulnerable prior to and during deployment, Using space capabilities, missile warnings can be provided to Army forces during predeployment and deployment operations. Data from Defense Support Program (DSP) satellites is centrally processed and warning is transmitted to tactical units via satellite communications systems using the Tactical Event Reporting System (TERS) or similar capability. The information provided is used to protect the force during all phases of the operation, although during other phases the capability is available to direct downlink DSP data to joint tactical ground stations (JTAGSS).

OPERATIONS

Successful operations require the ability to anticipate situations, to respond with greater agility and capability than the enemy force, and to support an increased operational tempo. Timely and accurate information is necessary to plan operations, promote stability, deter conflict, and defeat the warfighting capabilities of potential adversaries. Whether in combat or

noncombat operations, the force commander must establish conditions conducive to effective and decisive operations. He accomplishes this by isolating the enemy force or impediments to stability-for example, nontraditional threats—and seizing and maintaining the initiative. Helping develop economic infrastructures and training and equipping indigenous security forces are examples of noncombat operations that help create conditions to support economic and/or political programs. In combat situations, friendly forces are positioned to facilitate decisive operations—for example, shaping the battlefield to avoid enemy strengths and generating overwhelming combat power that leads to a quick victory. The timeliness of these actions is critical to establishing conditions for decisive operations and protection of the force. Supporting the allocation of resources requires a current and accurate assessment of the situation.

Communications

Space-based communications systems provide the global connectivity necessary to support the command and control functions of planning, coordinating, directing, and controlling. This capability is essential for the real-time direction of operations at each echelon of command and for the establishment of a global communications capability. Requirements for military satellite communications support must be submitted to the CINC, who prioritizes the requests in accordance with the theater operations plan. These requests are then forwarded to the JCS for action.

SATCOM systems with multichannel capability provide range extension for mobile subscriber equipment (MSE) and the Joint Tactical Communications System (Tri-Tat), SATCOM also support joint service interoperability. Single-channel terminals support battlefield voice and data communications as part of combat radio net and Army special communications for force management, emergency action message **(EAM)** dissemination, and special operations forces (SOF) communications. These systems provide responsive, beyond-the-line-of-sight communications throughout the battlefield and permit users to access large data bases necessary to support strategic, operational, and tactical missions. Coupled with space-based intelligence support, tactical forces are afforded improved capabilities to target the enemy, coordinate fires, conduct operational maneuver on both linear and more open, less structured battlefields, assess the effects of previous operations, and anticipate enemy actions.

RISTA

A variety of satellites provides links to ground stations for timely dissemination of information to enable Army forces to recognize critical events as they occur, influence the decision-making process, enhance IPB, and support total force positioning within the battle space. Observation, terrain sensing, weather, communication, and positioning and navigation satellite systems provide information that updates and increases the commander's situational awareness.

Timely information is essential to support the operational tempo required to shape the battlefield and to attain positional advantage. Space-based sensors have the advantage of unrestricted access over battlefields and other areas that are difficult to observe due to political or military reasons. Space systems allow commanders to see some areas of operations far better than current terrestrial systems; however, cloud cover can affect the use of space systems operating in the visible spectrum. Commanders can receive deep operations information as quickly and as accurately as close operations information. When information derived from space-based reconnaissance, surveillance, and target-acquisition sensors is merged with information from ground and airborne systems, situational awareness is improved and uncertainty reduced.

The availability of information from national space systems via the MIES, FAST, and MITT will be critical to establishing the tempo of Army operations. Space systems facilitate the maintenance of a high tempo by providing accurate and timely information. During offensive operations, commanders seek a tempo that maintains relentless pressure on the enemy to prevent him from recovering from

the effects of the attack. In the defense, commanders seek to disrupt the enemy's tempo and synchronization. Near-real-time information available from space systems permits Army forces to observe enemy activities and to determine their intent. This facilitates rapid decision making, coordination of fires, and maneuver of friendly forces. It enables the force to avoid enemy strengths and to exploit enemy weaknesses. Access to data from space-based observation platforms also limits the ability of the enemy to strike unexpectedly. Satellites provide early warning data that can be integrated directly with Army terrestrial weapon systems and capabilities of other services to attack, separate, isolate, and attrit enemy forces. This makes massing difficult for hostile forces, making them vulnerable to decisive maneuver by friendly forces. Space-based sensors also provide information essential to the battle damage assessment process. This information greatly enhances the efficiency of deep fires by reducing the number of reconnaissance missions and the redundant expenditure of munitions.

Weather, Terrain, and Environmental Monitoring

Each theater of operations is supported by an Air Force weather team that has a transportable DMSP receiver, the Mark IV van. DMSP support to the Army is indirect—via facsimile or courier to the SWOs and G2s. DMSP prototype receivers may be available to support weather requirements, movement decisions, trafficability analyses, and so forth. SWOs supporting deployed divisions and separate brigades use the Wraase weather receiver to provide near-real-time local weather images. Wraase receivers operate independently of land line communications. MSI and hyperspectral imagery (HSI) from space have proven invaluable for mapping and monitoring vegetative, geological, oceanographic, and environmental conditions and changes. This data provides timely and unique information to terrain analysts that can be integrated with other intelligence to support IPB for a more complete picture of the battlefield. MSI/HSI workstations, normally operated by terrain teams, are used to manipulate multispectral data to support terrain analyses and provide up-to-date, large-area views of the battle space. Specific applications include-

- Change detection.
- Perspective views to support mission planning, route selection, and so forth.
- Battle damage assessment.
- Obstacle overlays.

Position and Navigation

NAVSTAR GPS satellites enhance command and control, support fast-paced operations, permit efficient maneuver, and reduce fratricide by providing extremely accurate, three-dimensional location data for continuous day and night operations. Passive receivers convert signals from the satellites into timing, position, and navigation data to support Army forces worldwide. This capability enhances joint and multinational operations by providing a common datum grid (for example, World Geodetic System-84) upon which all operations can be based. Positioning and navigation satellites facilitate the rapid and accurate survey necessary for positioning weapon systems, sensors, and minefield without the use of traditional survey teams. The integration of these capabilities with weapon systems will improve weapon system performance. Other applications of GPS include-

- Enhancing coordination with the other services and allied units.
- Facilitating synchronization of combat operations by providing universal timing and common grid information.
- Precisely positioning indirect fire systems, thus improving weapon system performance.
- Tracking critical assets.
- Assisting in linkups and coordinating offensive/defensive responsibilities.
- Reducing the potential for fratricide due to friendly fires.

Missile Warning

The ability to detect and track potential threats—for example, aircraft and missile launches—and to warn designated ground systems is essential to protect the force, facilitate freedom of movement, and retain the initiative. For example, DSP satellites can provide the first indications of ballistic missile attack. This data is transmitted to control segment ground stations for processing. Subsequently, it is passed to air defense and other units deployed in theater. Army forces can receive the warning within two to four minutes of launch, reducing the element of surprise. Using DSP data, units can determine the location of the launch point and the probable point of impact. Other national satellite systems can be used to provide early warning of enemy troop activities, movements, and critical events (see discussion on RISTA).

Space control operations facilitate freedom of action in the area of operations as well as in space. These operations include surveillance of space activities and systems and antisatellite operations designed to ensure space support to Army forces. Space control operations, when directed, suppress and negate enemy space capabilities, permitting land forces tactical, operational, and strategic flexibility and preventing an adversary's satellites horn monitoring ground operations. The development of a force application capability from space will extend the power projection capability of terrestrial forces. This capability will support deterrence and will permit the attack of high-value targets throughout the area of operations. Additionally, it will facilitate maneuver and assist in protecting land forces from attack by strategic and tactical aircraft and missiles,

REDEPLOYMENT AND RECONSTITUTION

Reconstitution of the force relies on communications and the transfer of information in order to anticipate requirements. Responsive and efficient actions to respond to such requirements are facilitated by the range and data capability of space-based systems and their ability to collect information on all forces and the environment. Asset visibility and movement tracking are essential for effective reconstitution operations. They enable CSS units to tailor and adjust assets in response to the needs of the force. Using the versatility of modern computers, communications satellites can be linked with space-based position location and navigation systems to provide the requisite asset visibility, decrease the length and size of the logistical pipeline, and ensure real-time battle command of all CSS assets within the area of operation, Space capabilities also support real-time battlefield damage assessment, casualty reporting, and asset location, routing, and tracking. These capabilities facilitate unity of effort and economy of force.

Communications

Military and commercial space-based communications satellites-DSCS, FLTSAT, INTELSAT, INMARSAT, and so forth-can be used to provide long-haul strategic communications between the redeploying unit, CINC, and CONUS to support movement planning and coordination. During this phase of the operation, these systems can be used as the theater communications infrastructure while the unit is preparing for redeployment and dismantling other supporting communications systems, for example, MSE. The DSCS provides strategic communications via the AN/TSC-85/93 terminals, which interface with the WWMCCS. Availability of these systems may be limited based on national priorities. When required, commercial satellite systems capable of voice and low-data-rate communications through telephones and portable terminals may be employed to support communications needs, coordinate movement, update data bases, and report readiness of redeploying units. INTELSAT and INMARSAT terminals cannot be utilized during movement; however, industry is developing systems that may be available to support Army communications requirements during mobile operations. Signal officers at each echelon of command plan and coordinate for use of these systems.

RISTA

During reconstitution and redeployment operations, national space systems can be used to

maintain situational awareness, monitor postconflict operations, and assess the condition and availability of the host nation infrastructure-for example, roads, ports, airfields. These systems can also support crisis and battle damage assessments. The near-real-time information available from space systems is vital to the planning and execution of reconstitution and redeployment operations. It facilitates decision making, helps prevent surprises, and makes regaining the initiative difficult for hostile forces. The capability of these systems to collect information on all forces and activities enables commanders to tailor and adjust assets in response to operational requirements and to facilitate unity of effort and economy of force.

Commanders must clearly define and articulate RISTA requirements during this phase of an operation since the number of receivers and processors may be limited. Equipment not required for subsequent operations will be redeployed to the home theater and prepared for future missions. Redistribution of assets may be required to ensure adequate support born national systems. Depending on the requirements in the area of operation, these assets may be centralized, moving from tactical units to higher echelons of command.

Weather, Terrain, and Environmental Monitoring

Near-real-time weather information on the local area can be received at tactical units using the Wrasse receiver. These receivers provide sufficient weather information to support redeployment activities and planning. Normally, the SWO or supporting Air Force weather team will continue to provide DMSP data to support weather prediction and redeployment planning. DMSP data may only be available via land line-normally via facsimile-depending on the location of the DMSP receiver and disposition of Army forces.

During reconstitution and redeployment operations, multispectral imagery can be used to support mapping requirements, trafficability analysis, and overall weather, terrain, and environmental monitoring. Coupled with data obtained via weather satellites, units can determine equipment assembly and preparation areas in theater and the conditions in the areas to which the units are redeploying. Accurate recording of actual postwar conditions may be a key mission for departing terrain analysis teams assembling updated ground observations for corrections to existing maps. Hand-held data-logging computers coupled with GPS receivers can provide effective reconnaissance recording to augment imagery coverage of areas of interest.

Position and Navigation

GPS receivers are used for navigating, tracking, and positioning units and assets to support reconstitution operations. Depending on the number of receivers available, units may have to redistribute the assets during the reconstitution phase to support continuing operations, Redistribution also may be necessary to support redeployment operations. Applications in either phase would be about the same as those used in combat, but would be focused primarily on transportation support and logistics operations. The data available from these receivers increases the efficiency and effectiveness with which Army forces maintain asset visibility.

Missile Warning

Once a crisis has been terminated or the decision made to withdraw Army support, national systems—in conjunction with any sensors remaining in the theater of operations—will be used to monitor the situation to ensure stability and support the withdrawal of forces. DSP assets will continue to monitor the area of operations and to provide warning information needed to protect redeploying forces.

OPERATIONS DEMANDING SPECIAL EMPHASIS

Operations demanding special emphasis include MOOTW, special operations, and information operations.

MILITARY OPERATIONS OTHER THAN WAR

The use of Army forces in support of MOOTW is becoming more frequent and

requires commanders and staff planners to exercise a very high degree of global situational awareness. Using space system capabilities can significantly enhance the provision of short-notice assistance due to natural disasters, to include floods, forest fires, earthquakes, and so forth. The efficiency and effectiveness of conducting successful MOOTW within the US and abroad also can be greatly improved when space systems are employed. Employment of space systems during peacekeeping, disaster relief, noncombatant evacuation, and other MOOTW provides the agility needed to ensure success.

SPECIAL OPERATIONS

For the most part, special operations differ from other land operations in that they span the full range of possible military operations, including covert and clandestine operations. Short of war, the main purpose of a special military operation may be psychological, the focus being to undermine the legitimacy of the government or influence the attitudes of the people. When planning for the organization and deployment of SOF, the best systems for communications, navigation, and intelligence support are required. Due to the nature of special operations, precise location of targets and low-probability-of-detection-and-intercept operations are the norm. Space assets can provide the edge needed in areas where these capabilities do not exist.

INFORMATION OPERATIONS

According to FM 100-5, "... the primary purpose of the Army is deterrence; but should deterrence fail, the Army's purpose is to win the nation's wars by fighting as part of a joint force of the United States." Only by leveraging and protecting the wide array of current and evolving space-based capabilities in support of information and other Army operations can the US remain capable of deterring, or if called upon, winning the nation's wars.

When supporting a national-level information warfare campaign, IO can prevent the initiation of hostilities by imposing the perception that taking hostile actions against the US or its allies would not be in the best interest of a potential adversary, Space-based systems offer an unrestricted environment to affect these operations.

Space-based systems offer an extensive array of active and passive capabilities to support IO. They facilitate the use of IO to deter war and, if required, can support IO throughout the spectrum of conflict. Space-based systems offer significant political and technical advantages to force projection operations, allowing global monitoring and the assessment of capabilities without concern for national boundary restrictions. Space-based assets are particularly supportive of intelligence during force projection with supplementary input from non-DOD and non-US systems. Additionally, these systems support IO by compressing the friendly decision cycle while allowing means to access and influence the adversaries.

Space-based systems provide commanders reconnaissance, surveillance, navigation, and positioning that greatly facilitate battle command. They significantly upgrade the speed and accuracy of information that commanders exchange with subordinates.

The efficiencies resulting from the use of space capabilities have a dramatic effect on ground combat operations. Precise knowledge of the location of friendly and enemy forces allows decision making, quick adjustments of fires, and greater protection of the force.

Space-based support to IO is varied and global. Military and civilian communications satellites provide responsive, worldwide, line-of-sight communications links to tactical forces. TENCAP also provides reconnaissance, surveillance, and target acquisition support to tactical units. The DMSP and civilian environmental monitoring satellites provide weather and terrain information.

IO battle space is also global, requiring the full integration of strategic, operational, and tactical capabilities. This means that space systems must be integrated into the Army's IEW capabilities for support to the warfighter to ensure commonality of graphically depicted

data and overall focus. Commanders and operators alike must be trained on the capabdities and limitations of national systems and how the entire warfighter support process can be strengthened through the synchronization of organic, theater, and national systems. Proper training will ensure better understanding of, ensure more effective use of, and capitalize on the advantages of all systems to meet the warfighter requirements: accuracy, timeliness, resolution. No one suite of systems or echelon of support can do it all.

US ARMY SPACE ORGANIZATIONS, OPERATIONS, AND PROGRAMS

Army decision makers, staff planners, organization designers, and resource managers at every level must ensure that the importance and dependence of today's force projection Army on space systems is fully recognized, planned for, and addressed in force requirements documents. Mission success across the full range of military operations is directly dependent upon the efficiencies employed to ensure realization of effective battle command. Space systems are needed to establish assured communications, disseminate orders, and promulgate passage of the commander's intent throughout the command. To accomplish this mission, the Army has committed resources to form dedicated space organizations and to implement space-specific programs to ensure continued support of the Army's space policy requirements and attainment of national security objectives.

US ARMY SPACE AND STRATEGIC DEFENSE COMMAND

The USASSDC is the Army's space organization directly responsible to the Chief of Staff, Army, for ensuring Army efforts are focused on finding ways that space systems can best serve the warfighter. USASSDC works with other Army major commands to ensure space systems required by Army forces are properly identified, developed, and fielded to the warfighters. As the responsible command for the development and deployment of the Army's integrated air and missile defense systems, USASSDC operates the Army's portion of the technology and research base of the Ballistic Missile Defense Organization. Through the ASPO, USASSDC manages its mission of leveraging the exploitation of national space assets through the TENCAP Program.

US ARMY SPACE PROGRAM OFFICE

ASPO, a field operating activity of USASSDC, is responsible for executing the Army's TENCAP Program. As the Army's interface to classified national space programs, ASPO leverages those efforts to deliver systems that provide commanders with space-derived data to support operations. ASPO is responsible for working with national programs to develop, procure, test, field, and sustain TENCAP systems.

Due to the exceptional nature of the TENCAP Program, ASPO receives direction and guidance from the Headquarters, Department of the Army DCSOPS. A TENCAP General Officer Steering Group provides strategic guidance and oversight for the TENCAP Program.

TENCAP systems currently function both as preprocessors and as correlation and fusion systems. As the ASAS and the common ground station (CGS) mature, TENCAP systems will assume the role of preprocessors with both direct and indirect links to national and theater systems, feeding that data to ASAS or the CGS.

US ARMY SPACE COMMAND

USARSPACE, a major part of USASSDC, serves as the Army component to USSPACECOM. It is responsible for commanding the Defense Satellite Communications System operations centers (DSCSOCS), managing joint tactical use of DSCS, conducting "user" planning of Army BMD forces, serving as the "user" representative for

BMD, assuring access to and use of space capabilities to enhance accomplishment of Army operations, and executing the Army Space Exploitation Demonstration Program (ASEDP). Support from specially trained space forces, such as the ARSST based at USARSPACE, will often form the nucleus of space support augmentation to deploying Army forces. Availability of these resources is essential, since the application of space capabilities directly impacts on the effectiveness of the force.

US ARMY SPACE EXPLOITATION DEMONSTRATION PROGRAM

The ASEDP managed by USARSPACE is not a training program per se; however, it provides an opportunity to introduce Army personnel to space-related capabilities that can enhance the execution of Army operations. Numerous capabilities have been demonstrated to Army units since the program's inception in 1986. The program focuses on new ideas and technologies to solve deficiencies and satisfy requirements that the Army identifies. Some demonstrations have resulted in operational capabilities such as small lightweight GPS (SLGR) and Wrasse receivers; others have been deployed to support Army missions throughout the world. Operations Desert Storm and Restore Hope are examples. The demonstration program has been instrumental in showing the field Army the value added by space capabilities.

The Army is exploiting space capabilities through the battle laboratories and Louisiana Maneuver processes. Lessons learned from these processes must be passed to tactical units and then applied in a field training environment to ensure adequate support is provided to the deploying space capabilities and personnel. These space-related capabilities do not have the benefit of an embedded traditional support system. If the Army is well versed in using space capabilities, the normal train-up period required to effectively use them in an operational environment will be reduced significantly. Simply stated, the Army needs to train with space systems to make them a normal part of Army operations.

USARSPACE ARMY SPACE SUPPORT TEAMS

Recognizing the value of space-related capabilities to current contingency operations, Army leadership directed the establishment of the ARSST concept, with the ARSSTS assigned to USARSPACE. These teams possess communications, weather, and battlefield visualization equipment whose utility was proven via the ASEDP during Operations Desert Shield/ Storm and many subsequent military operations. ARSSTs are provided to selected forces when responding to contingencies. For example, these teams are presently equipped with briefcase-size INMARSAT terminals ideal for early/forced-entry communications in force projection operations. Numerous other communications satellite systems are capable of providing similar services. This capability can be used to augment military systems. Staff planners responsible for communications and unit signal officers need to determine requirements and request this support as early as possible in the planning phase of the operation.

Army DCSOPS approves apportionment of these teams, which are sized to support a division-size commitment such as Operation Restore Hope in Somalia, to augment Army component units in the planning and execution of contingency operations. ARSSTs may be tailored to fit a variety of contingencies and may be augmented by newly developed technology that impacts warfighting.

During peacetime, ARSSTs participate in division- and corps-level exercises to train unit personnel on space system exploitation and to develop the habitual relationships vital to effective operations. As improved space-based capabilities mature, new systems may be added to the ARSST equipment inventory. Army planners and staff personnel must know the capabilities of the ARSST, how to support the team when deployed, and how to obtain its support through the DCSOPS.

BALLISTIC MISSILE DEFENSE

While the risk of strategic attack has decreased significantly over the past few years, deterring attack must remain a high priority for the US. Strategic deterrence results in part from development of defensive capabilities that

will guard against the possibility of an attack. The goal is to discourage an enemy attack. The Army has a role in a number of areas that have strategic defense deterrence value.

The Army began its involvement in programs to defend the United States against intercontinental ballistic missiles (ICBMs) in the 1950s. In recent years, the Army has been an important participant in the Strategic Defense Initiative (SDI) Program (see Figure 3-5) and has received more than one-third of the program's funding for research and development. The Army's participation in the SDI Program focused on the ground-based interceptors and sensors. This research and development reflect an innovative technology base supported by careful economic planning capable of sustaining it. The Soviet Union realized that nothing was to be gained from an arms race with the US. This provided the US with the arms control leverage necessary to successfully negotiate the Strategic Arms Treaty which resulted in a significant reduction in the numbers of nuclear weapons on both sides.

Over the years, as US security policy has changed from one of retaliatory offense to one of strategic defense, the concepts of how to achieve ballistic missile defense have evolved significantly:

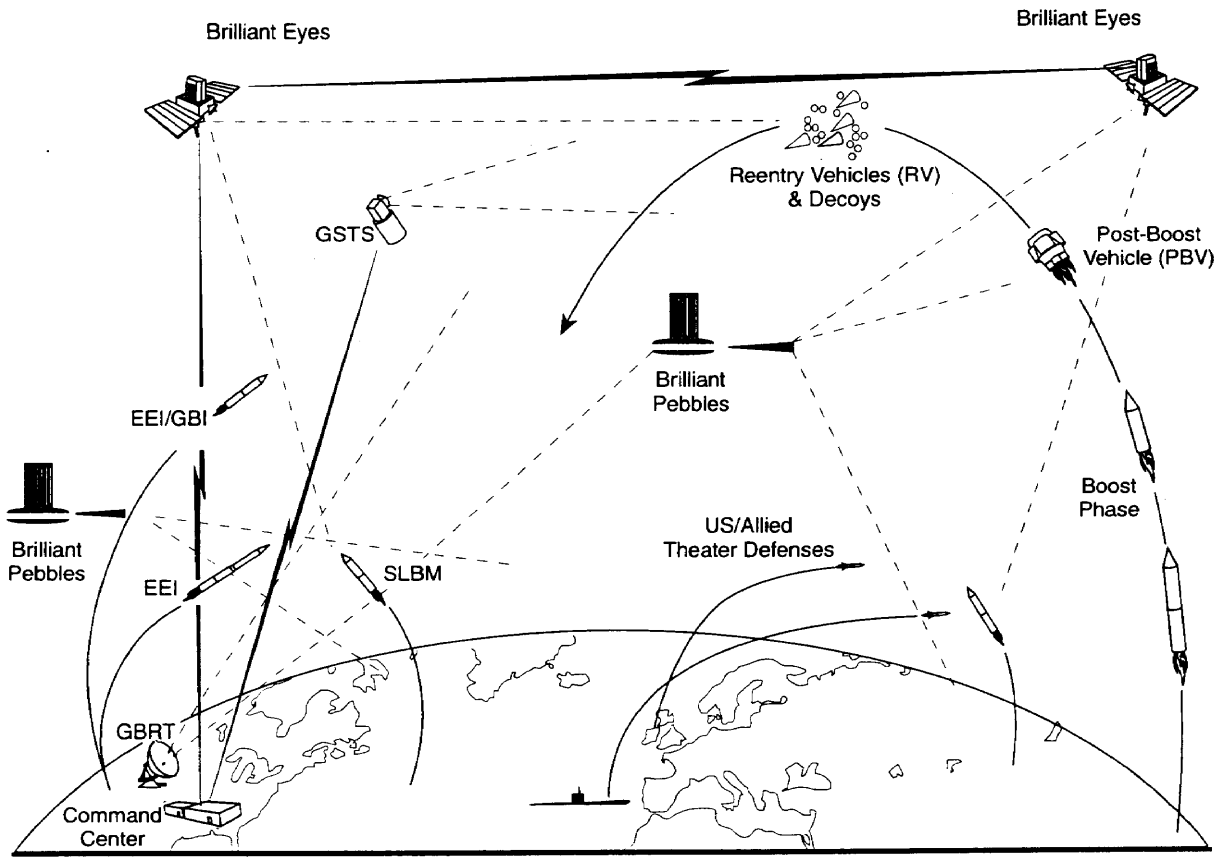
- March 23, 1983 - President Ronald Reagan announced the original concept of a near-perfect "star wars" shield to protect the US from an all-out surprise attack.
- January 29, 1991 - President George Bush redirected the US missile defense efforts to focus on limited or accidental missile attacks. This concept, known as global protection against limited strikes, included the research and development of tactical, theater, and strategic ballistic missile capabilities to provide protection to the US and deployed forces. Under this concept, the Army was to operate the ground-based sensors and interceptors in support of USSPACECOM.
- May 13, 1993 - Defense Secretary Les Aspin declared the official end of the "star wars" era and established the Ballistic Missile Defense Organization to focus primarily on ground-based defense systems. Space-based weapons systems were relegated to the laboratory to support follow-on technologies.

Present policy divides ballistic missile defense into three categories: TMD, NMD, and supporting follow-on technologies. The highest priority is given to TMD, with a goal of countering Scud-type missiles. The Army's experience in missile defense technology developed over the last 40 years postures the Army to be a major contributor in both the TMD and NMD programs. The pursuit and ultimate deployment of TMD and NMD systems will lead to full-up objective systems that will provide a new level of strategic security. With the Army's historical role in missile defense technology and emerging national priorities, the Army will probably operate ground-based sensors, interceptors (at both higher and lower altitudes), and battle command networks.

COUNTERSPACE AND ANTISATELLITE OPERATIONS

The rationale for developing a counterspace capability is to protect the force from enemy satellites and assure friendly access to space. With the collapse of the Soviet Union, the threat to US satellites has been greatly reduced in the near term; however, the acquisition of space capabilities by potential adversaries has increased. Currently, the only means available to the Army to defeat an adversary's space capabilities is to jam or destroy the ground segment of the space system. As the ground segments become smaller and more mobile, finding and targeting them will become more difficult. In some situations, ground or air attacks may be too risky or politically unacceptable. Given the proliferation and potential of space capabilities, if an adversary's ground segment cannot be destroyed or neutralized, a capability to destroy or neutralize the space segment is required to support force projection operations and the national military strategy.

Figure **3-5. Original SDI Concept**



DSCS OPERATIONS

The DSCS is a high-capacity, SHF system designed to provide worldwide, long-haul, secure-voice, high-data-rate communications to support strategic, operational, and tactical requirements. It is a subsystem of the Defense Communications System (DCS). USARSPACE, as the operational component of the Army Space and Strategic Defense Command, has a critical role in the operation of DSCS. USARSPACE performs payload and network control, supports tactical users from all services, and trains DSCS personnel for contingency operations. USARSPACE also operates ground stations for the DCS network for national communications in accordance with joint services tasking and in support of US SPACECOM. To perform these functions, USARSPACE uses—

- The DSCSOCs .
- The Satellite Communications Control Centers (AN/MSQ-114).
- The Regional Space Support Centers (RSSCs).
- The DSCS Operations Control system Certification Facility (DCF).

The DSCSOCS exercise strategic/tactical network and payload control with the assistance of the mobile satellite control terminals for tactical ground mobile forces (GMF) communications requirements. The RSSCs control network planning and power/

bandwidth allocation for GMF missions. The DCF performs a critical DOD mission by providing training to selected Army individuals in platform, payload, and network control of the DSCS satellites.

KWAJALEIN ATOLL

To support strategic offensive and defensive program testing, the USASSDC operates the US Army Kwajalein Atoll (USAKA) as a national test range asset. The range is capable of collecting highly accurate data vital to both testing and space surveillance. It enhances strategic security by reducing the chance of surprise with regard to space objects. The Army also operates radars that support data collection for the terminal and midcourse portions of ICBM trajectories.

The Army's development and operation of Kwajalein supports DOD and other government agencies in tracking and collecting data on missiles and space launches. USAKA provides sensor support to USSPACECOM, under the scientific and technical direction of the Massachusetts Institute of Technology Lincoln Laboratory, for space surveillance and space object identification (SOI). The USASSDC executes daily operations in support of NMD and TMD testing. USARSPACE monitors the USASSDC contractors to ensure optimal support to the space surveillance task. It coordinates with USSPACECOM and USAKA for any new sensor mission requirements.

ARMY ASTRONAUT DETACHMENT

The Army Astronaut Detachment provides a means for testing space capabilities that may have potential applications for command, control, communications, and intelligence functions for the warfighter. One of its missions is to explore and provide information on the operational utility of applying man's unique power of observation and decision making to the space environment. Information provided by Army astronauts can be measured by conducting various concept evaluations on the space shuttle, Concept evaluations are described as those manned space flight activities that evaluate man's ability to enhance or conduct military operations in or horn space. Concept evaluations attempt to discover what man can do in space to improve the effectiveness of military operations. Human observation, interpretation, versatility, dexterity, motivation, adaptivity, and decision making are capabilities that machines cannot duplicate. To accomplish this mission, the Army maintains a detachment at the Johnson Space Center in Texas under operational control of NASA. Just as Army members were instrumental in exploring our nation's western frontier, today our Army astronauts are playing a key role in exploring the frontier of space. The detachment's other missions are---

- To support the national manned space program.
- To provide engineering expertise for human interface.
- To enhance Army doctrine by focusing Army manned efforts in space operations and requirements.

TRAINING

A final note on the application of space systems: We must train the way we intend to fight. Training to high standards is essential. Emphasis must be on integrating training related to space systems into formal leadership-officer, NCO, and civilian—courses throughout the Army training community, Defense Mapping Agency (DMA), and other DOD activities appropriate to the individual's level of involvement with such systems. This training must include the use and application of space systems available to these individuals in their current assignment. Special management of officers who have been awarded Skill Code 3Y (Space Activities) are required to ensure maximum utilization of their space skills in support of operational requirements.

The value of using space systems has been demonstrated in war and MOOTW. During past operations, space assets were made available at the last minute, providing little or

no opportunity for training and developing ways to best exploit them in support of ongoing operations. Since space systems are leading-edge technology and may still be in research and development or demonstration stages, the incorporation of support requirements and lessons learned from past deployments into training is essential. As space awareness increases and the use of space systems and capabilities becomes common across the Army, increase in operational effectiveness should result. Soldiers and leaders need access to space systems and capabilities as a routine part of training in the classroom and field environment. This access can either be to the actual systems or to surrogate computer-generated simulations.

Chapter 4

Space System Capabilities and Limitations

This chapter addresses the capabilities of space systems without regard to their general application in an operational setting as was done in Chapter 3. Here, they are considered within the major functional areas of communications, reconnaissance, intelligence, surveillance, and target acquisition, weather, terrain, and environmental monitoring, position and navigation, and missile warning. These capabilities reinforce the importance of space systems as force multipliers, increasing the effectiveness and efficiency of the force. The advantages gained through the use of space systems are vital and integral to the success of any Army operation; however, the limitations associated with the use of space systems must also be considered.

SYSTEM CAPABILITIES

Space system capabilities increase the effectiveness and efficiency of Army forces, whether training, supporting MOOTW, or conducting combat operations. Army planners must optimize the use of space capabilities to enhance land operations. Generally, the CINC, or in the case of most contingency operations, the Army service component commanders (ASCCS), develop operational requirements and then forward them to the Department of the Army staff for resolution. Requirements vary, depending on the specific area of operations, the mission, the maturity of the theater, and the situation. However, space systems may satisfy many of these requirements. The CINC, through apportionments from the JCS, decides what space support is available or can be made available to the ASCC. Generally, space capabilities enhance the Army's ability to-

- Accurately assess the current situation.
- Adapt to the demands of the situation, that is, to modify plans.
- Anticipate enemy actions.
- Act and react faster than the enemy.
- Exploit opportunities and enemy vulnerabilities.
- Identify targets for fire support systems.
- Command and control its forces.
- Maximize use of terrain.

However, access to and availability of space capabilities depend to a degree on the echelon of command. The staff's responsibility is to know what capabilities are available and to optimize them. As forces are tailored to satisfy mission requirements, space system user terminals may have to be redistributed and space support teams created. To ensure adequate space support for the deploying force, a USARSPACE ARSST can form the nucleus of a tailored space support team.

Each space system consists of three segments: a space segment—the satellites; a control segment—ground control stations and managers; and a user segment—the equipment necessary to receive the satellite signals (see Figure 4-1). Following is a general discussion of

space systems and associated terminals available to support the Army.

COMMUNICATIONS

High ground has always played an important role in effective military communications, Communicating with forces dispersed across the battlefield or deployed great distances from their home bases has always been a major challenge. The importance of communications increases as the Army's mission becomes more complex and force levels decrease. Combat net radios for ultrahigh frequency (UHF) and very high frequency (VHF) are limited by line of sight (LOS) and have to rely on radio relays located on high ground to overcome terrain restrictions. Satellite communications systems are less hampered by LOS restrictions and can significantly enhance Army communications capabilities by extending ranges and reliability. Satellites offer an effective means of overcoming the physical limitations of LOS radios, extending the range of terrestrial communications systems, such as MSE, throughout the area of operations.

Communications satellites are the cornerstone of the Army's battle command architecture. They operate in a wide band of radio frequencies and provide the link between theater and CONUS for split-based operations and range extension between subordinate commands in the theater (see Figure 4-2). UHF satellite communications systems, such as the FLTSAT and AFSATCOM systems, are used to support battle command requirements for high-priority users, to include EAM dissemination, force direction, and JCS/CINC netting. SHF communications systems, such as the DSCS, support worldwide, long-haul, secure-voice and high-data-rate communications for battle command, early warning, crisis management, and internetting between the NCA/JCS and the combatant commanders. Milstar, the next

Figure 4-1. Space System Segments

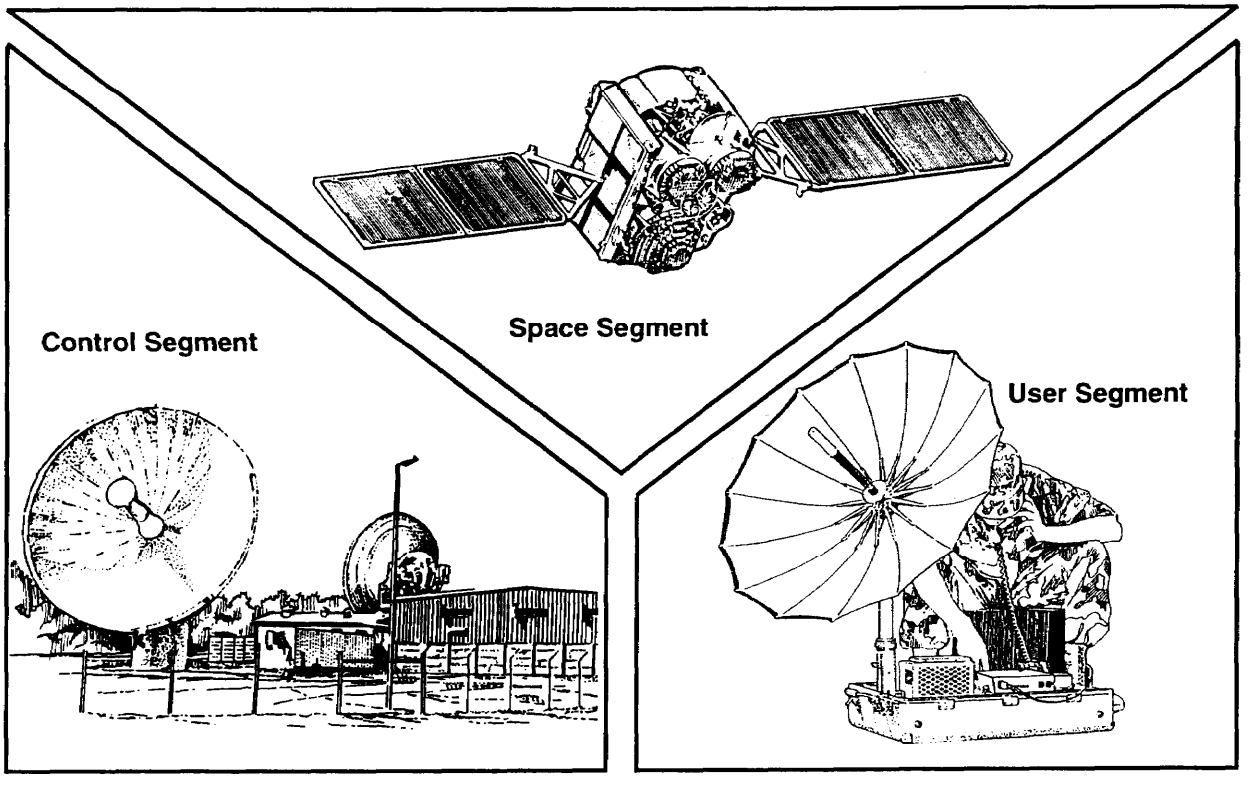
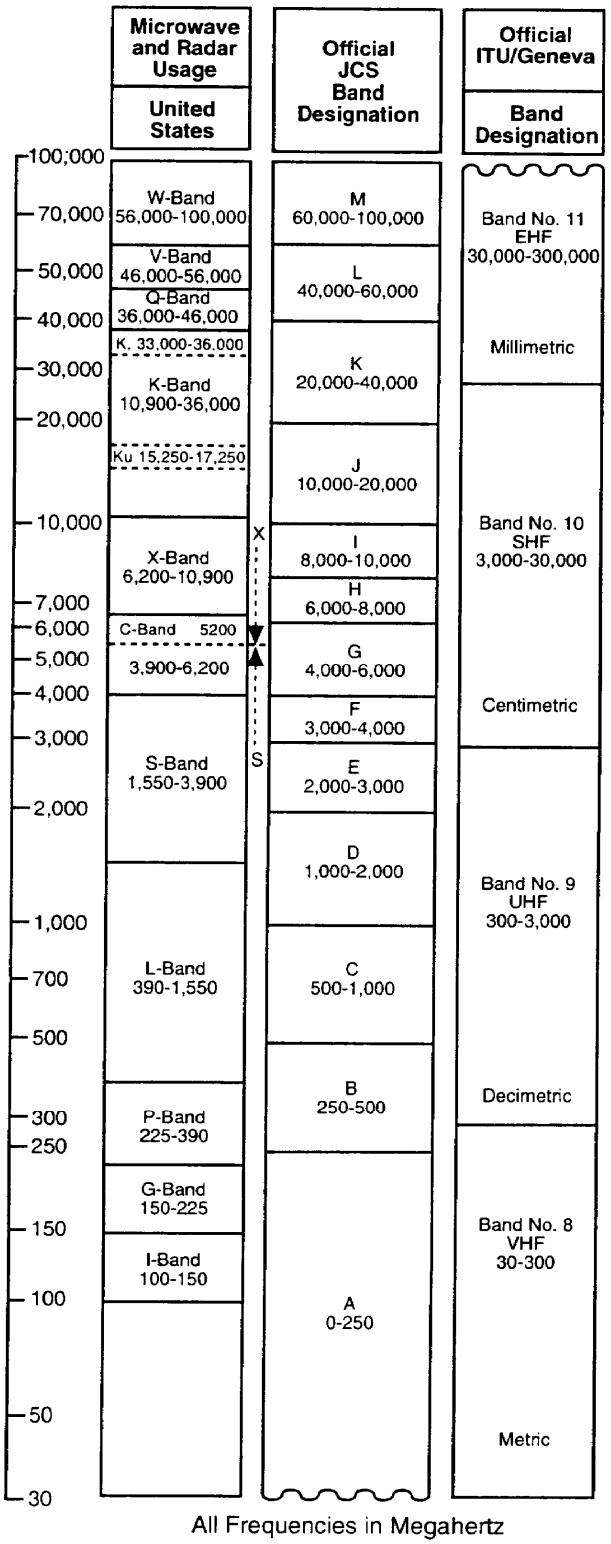


Figure 4-2. Satellite Communication Frequency Band



generation military satellite communications system, is an EHF system capable of jam-resistant secure worldwide communications during all levels of conflict.

The modern battlefield is volatile and requires synchronization of operations throughout its depth. Success on the battlefield demands flexible, highly mobile, responsive, reliable, secure, jam-resistant, and survivable communications, unhindered by terrain masking or other LOS constraints. Currently, satellites are used primarily to augment ground-based communications systems, providing communications links not only to forces employed in an area of responsibility, but also to deploying forces while en route. However, during deployments to contingency areas having little or no infrastructure to support command and control, satellites will become the primary means of communications. Satellite communications provide the following advantages, which make them ideal for force projection operations:

- Greater freedom from siting restrictions.
- Extended range, capacity, and coverage.
- Real-time and store-and-forward capabilities.
- Stand-alone capability and reduced logistical support on the battlefield.
- Freedom from rigid network configurations.
- Mobility and rapid emplacement.
- Extremely high circuit reliability.

Military and commercial satellite communications systems are invaluable assets that can be used at all echelons of command. Military battle command nets are usually routed through military satellites due to the low probability of intercept and the increased communications capability (for example, to pass higher data rates and imagery) that they afford. Administrative and logistics networks may use either military or commercial satellites, which routinely support force projection and split-based operations around the world. These same systems may also be available to support selected training exercises. Military satellite communications systems,

however, are considered joint assets and are controlled by the JCS, who allocate the resources based on need. JCS Memorandum of Policy 37 specifies access priorities. More often than not, demand exceeds the capabilities of the systems; therefore, access to military satellite channels is at a premium and closely monitored. Consequently, Army forces must clearly define and articulate their requirements for critical battle command connectivity. The Army also must consider the use of commercial satellites, such as the INTELSAT and the INMARSAT terminals, as an alternative means of satisfying their communications requirements. Space is not the panacea for all communications shortfalls; however, it is an important element of the flexible, responsive, and integrated battle command system required for Army operations.

POSITION AND NAVIGATION

The NAVSTAR GPS satellite is a space-based, all-weather, continuous-operation radio navigation system that provides military users highly accurate worldwide position and location data, as well as velocity information and precision time. While GPS receivers do not replace the map and compass or some of the other navigation systems currently available, these lightweight man-portable systems satisfy more of the Army's requirements than other available systems. GPS receivers provide the soldier much useful information, such as positioning and timing data; however, some other advantages to using the GPS are equally significant:

- First, because GPS receivers do not transmit any signals, they are not electronically detectable.
- Second, the number of simultaneous GPS users is unlimited.
- Third, although the accuracy of GPS is subject to certain influences, it does not vary over time as does the accuracy of inertial navigation aids. Ongoing technical refinements promise to strengthen the robustness and reliability of the GPS signal. GPS can quickly regain precision accuracy after momentary disruptions without further operator actions.

GPS greatly improves the commander's ability to locate units and to control them on the battlefield, facilitating situational awareness and improving agility and the ability to synchronize forces. GPS receivers increase the ability to accurately locate assets and to move them long distances over difficult terrain, especially during poor weather or lighting conditions. The GPS, when used in conjunction with maps or image products, can assist in all-weather, day-or-night rendezvous at designated points and times under radio silence. Accurate positioning data on friendly troops and on the location of minefield emplaced by friendly units can simplify the passage of lines and reduce fratricide.

GPS output can be in any one of the three commonly used coordinate systems: geographic, universal transverse mercator, or military grid reference. Joint and combined operations benefit from a common user grid. This grid allows units to use their specific coordinate position system and then to convert it rapidly to common coordinates or into similar systems used by other services or nations. Common positioning also reduces the minimum separation distance requirements for artillery, naval fire support, or close air support. The GPS's inherent accuracy increases the accuracy of requested fires, reducing the expenditure of ammunition as well as the risk of casualties caused by friendly fire.

The commander can also use GPS to manage critical assets that support the battle, to include weapon convoys, fuel, and ammunition supply points. The true value of POS/NAV equipment is that, for the first time, ground forces have access to small, lightweight navigational tools—that is, the SLGR and its replacement, the PLGR, AN/PSN-1l—that are capable of providing very accurate information. This capability can provide POS/NAV information under most terrain and weather conditions. It will also profoundly influence azimuth determination, air traffic control, munitions guidance, and gun-laying operations.

The Army also has a limited number of commercial off-the-shelf (COTS) geodetic-quality receivers that provide positioning accuracies within millimeters. While engineers primarily use these systems to support terrain analysis and mapping requirements, they can also be used to support battle command and targeting. The cost and the necessity for specially trained operators limit the use of these receivers.

RECONNAISSANCE, INTELLIGENCE, SURVEILLANCE, AND TARGET ACQUISITION

Space-based sensors have the advantage of unrestricted access over battlefields and other areas that are difficult to observe due to political or military reasons. Space systems allow the commander to see his area of operations and battle space, often far better than terrestrial systems, and permit near-real-time exploitation of favorable situations. This capability improves the agility, flexibility, and synchronization of the force-important aspects of current Army doctrine. Commanders can receive deep operations information as quickly and as accurately as close operations information. When information derived from space-based RISTA sensors is merged with information from ground and airborne systems through the ASAS, IPB is enhanced, situational awareness improved, and uncertainty reduced.

The Army's TENCAP Program, as executed by the ASPO, focuses on tactical applications of national space systems. The program provides Army commands with equipment (see Figure 4-3) that can receive and process data from these systems. The result has been the development and fielding of limited production equipment as operational systems that provide a valuable adjunct to organic sensors.

The commander benefits from access to data on enemy troop movements, lines of communications, and terrain conditions. He can use such information to determine the enemy's intent through direction and mass of enemy movement. The favored avenues of approach and the direction of the main attack can point to the most effective time and location for targeting friendly fires. Such information also offers opportunities for target damage assessment after deep attack by fire. See The Joint Tactical Exploitation of National Systems (J-TENS) manual for further information on the TENCAP Program and system capabilities. The J-TENS manual contains the procedures tactical commanders follow to obtain TENCAP support.

MISSILE DEFENSE

The DSP offers an early warning missile surveillance capability during operations. The DSP satellite constellation recognizes the launch of strategic and certain tactical missiles using infrared sensors to detect heat from missile plumes. Warning information consists of an assessment of the time and place of launch, the type of missile launched, and the missile's estimated course/direction. This information is provided to supported CINCs via voice and data communications. SATCOM is used to disseminate voice warning, and the TERS is used for data. The TERS is a worldwide distribution system currently made up of the Tactical and Related Applications (TRAP), Tactical Information Broadcast Service (TIBS), and Joint Operation Tactical System Communications Network. This launch warning data is communicated to Army forces within a theater to support TMD operations. Today, warning information is both centrally processed in CONUS and transmitted to the user via JTAGS prototypes that are actively serving tactical users with direct in-theater downlinks today. They will be replaced by van-mounted objective systems in the near future.

WEATHER, TERRAIN, AND ENVIRONMENTAL MONITORING

Detailed analysis of the environment, that is, weather and terrain, is a critical step in the IPB process. Weather and terrain conditions impact on friendly and enemy capabilities to move, shoot, and communicate. To optimize the capabilities of modern weapons systems, the tactical commander requires real-time weather and terrain information about his battle space. Satellites with weather and terrain monitoring

Figure 4-3. Equipment That Can Receive and Process TENCAP Data

SYSTEM	MOBILITY	PROCESS	PRODUCT	COMMUNICATIONS
ETUT	C-130	CORRELATE/INTEGRATE ANALYSIS/RAPID REPORTING/COLL MGT 4 WORKSTATIONS	INTEL REPORTS ANNOTATED IMAGERY TARGET DATA TASKING DATA	SUCCESS/AUTODIN TROJAN/STU-III MSE CK
EPDS	C-130	CORRELATE/INTEGRATE ANALYSIS/RAPID REPORTING/REAL TIME DDL/2 WORKSTATIONS	INTEL REPORTS TARGET DATA	SUCCESS/AUTODIN TROJAN/STU-III MSE CK S-BAND SATCOM SOURCE DL
MIES	C-141 C-5A LIMITED	NATIONAL/THEATER IMAGERY	INTEL REPORTS ANNOTATED IMAGERY TARGET DATA	SUCCESS/AUTODIN TROJAN/STU-III DSCS
ETRAC	C-141 C-130	NATIONAL/THEATER IMAGERY	INTEL REPORTS ANNOTATED IMAGERY TARGET DATA	SUCCESS/AUTODIN TROJAN/STU-III MSE CK/SOURCE DL CTT-H
MITT	C-130 RAPID RO/RO HMMWV (2 EA)	ETUT PROCESSES EXCEPT COLL MGT 2 WORKSTATIONS	INTEL REPORTS ANNOTATED IMAGERY TARGET DATA	SUCCESS AUTODIN TROJAN/STU-III MSE CK/SOURCE DL
FAST	RAPID 7 CASES	SECONDARY IMAGERY SIGNAL DATA	INTEL REPORTS ANNOTATED IMAGERY TARGET DATA	SUCCESS/AUTODIN TROJAN/STU-III MSE CK/DSCS
SUCCESS	SAME AS THE ASSOCIATED PLATFORM	UHFSATCOM TRANSCVR FOR TADIX-B/STRAP/SID	SIMULTANEOUS RCV/XMIT RADIO	2 CONFIGURATIONS 2 RCV/1 XMIT OR 2 RCV/2 XMIT
CHARIOT	RAPID	S-BAND	RCV/XMIT	SUCCESS/DSN TROJAN/STU III MSE CK MZZ
CTT-H	SAME AS THE ASSOCIATED PLATFORM	UHF SATCOM AND AIRBORNE RELAY TRANSCVR FOR TADIXS-B/TRAP/TIBS/SID/ TRIXS	SIMULTANEOUS RCV/XMIT, W/EMBEDDED COMSEC	2 CONFIGURATIONS 3 RCV/1 XMIT W/MDX SECURE VOICE 3 RCV ONLY

sensors are a vital component in the information collection system. Weather and terrain information must be collected and downlinked to a ground processing unit where it can be used to prepare tailored products to support decision making by tactical commanders.

Weather

Military and civil weather satellites provide worldwide, near-real-time weather information. DMSP satellites obtain comprehensive information on weather phenomena and atmospheric data. They can image weather phenomena in both visual and infrared spectral bands. Simultaneously, they record the temperature and moisture data throughout the swath width and at various altitudes. Large DMSP receiver systems, known as Air Force Mark IV vans, normally deploy to rear areas in mature theaters where they receive data and relay products to corps and division SWOs via facsimile. There it is analyzed and combined with other local weather information that may be received through the IMETS to forecast conditions throughout the battle space.

Civil geostationary satellites such as the GOES provide a hemispherical view of weather

patterns, while polar-orbiting satellites, such as the television infrared observation satellite (TIROS), provide a low earth view of the weather as they pass overhead. Wraase weather receivers receive weather facsimile (WEFAX) and automatic picture transmission images from US, Russian, Japanese, and European civil weather satellites. They do not receive DMSP or other data, for example, atmospheric temperatures and moisture content, transmitted by civil satellites. Using the Wrasse weather receiver to exploit near-real-time satellite-gathered weather data and making it available down to division level has significantly improved forecasting at the tactical level of operations. The public and private sectors have jointly made great advances in exploiting space technologies, resulting in the rapid accumulation and dissemination of weather data in immediately usable form to Army forces.

Terrain

Understanding the limitations and opportunities of terrain is a fundamental military skill. Terrain forms the natural structure of the battlefield. Commanders must recognize the its drawbacks and potential to protect friendly operations and to put the enemy at a disadvantage. Terrain analysis is critical to current and projected operational uses of specific terrain.

Much of the world is not adequately mapped to support Army operations. Satellites collecting MSI can provide reasonably accurate, medium-resolution data (see Figure 4-4) to aid in mapping and terrain analysis. The DMA and some engineer topographic (TC)PO) units can create MSI maps primarily to be used as map substitutes in areas of the world that are not adequately mapped to large scale. Satellite image mapping capabilities can provide the most current data worldwide. Terrain-sensing satellites using MSI can provide accurate 5-to-80 -meter-resolution terrain data to support mapping and other analytical requirements. In the near future, satellites will be capable of providing HSI data that will further enhance map-producing capabilities.

The Army may establish purchasing accounts through the DMA to obtain MSI/HSI data from sources outside the US, such as data from France's SPOT earth resources satellite or Japan's MOS-1. This data will normally be delivered to the requesting unit. The primary source of data for Army units is collected with the earth imaging satellite Landsat, which is channeled through the DMA through theater mapping, charting, and geodesy channels. However, several other Army organizations (Topographic Engineering Center [TEC] and USARSPACE) have been funded to procure Landsat imagery. DOD involvement in the Landsat program and the creation of a worldwide data base will vastly increase the availability and use of MSI data within DOD. Using digital map data as a base, satellite images can be fused to provide information, often only days old, that is invaluable to commanders. Today, the Army's organic MSI manipulation and analytical capabilities are just getting established. The ARSST at USARSPACE is equipped and trained to bring COTS processors with these capabilities to deploying units. Topographic support teams at the corps and division levels manipulate MSI data using these processors. These products can be used to support military engineering requirements and IPB by identifying—

- Vegetation characteristics--cover and concealment.
- Soil characteristics,
- Snow/ice characteristics.
- Fording locations—water depth.
- Landing/drop zones.
- Lines of communications.
- Energy resources/facilities.
- Lodgment areas.
- Enemy fortifications.
- Urban and cultural features

Environmental Monitoring

Merging MSI data with digital TOPO data and digital terrain elevation data produced by the DMA provides three-dimensional perspective views. These views highlight observation and

Figure 4-4. MSI and Radar Satellite Characteristics

SATELLITE	NATION	SENSOR	MODE	ALTITUDE (KM)	GROUND RESOLUTION (METERS)	SWATH WIDTH (KM)	REPEAT CYCLE (DAYS)	FREQ BANDS
NOAA	USA	AVHRR	MSI	833	1,100	2,400	0.5	5
LANDSAT	USA	MSS TM	MSI MSI	705	80 30	185 185	16 16	4 7
MOS	JAPAN		MSI	909	50	100	17	4
SPOT	FRANCE	HRV	MSI Panchromatic	832	20-30 10	60 60	26 26	3 1
RESURS-O	RUSSIA	CCD Conical Microwave	MSI MSI MSI	625	45 240 17-90	350 600 1,200	14 14 14	3 5 4
RESURS-F	RUSSIA	Photo	MSI	270	5-8	150	2 passes before deorbit.	3
IRS-1B	INDIA	LISS Scanner 1 LISS Scanner 2	MSI MIS	900	72 32	120 120	16 16	4 4
ERS-1	ESA	Altimeter Synthetic Aperture Scatterometer	Radar Radar Radar	675	0.5 (alt) 30 2 m/sec	80 80 80	3 3 3	1 1 1

fields of fire from both the aerial and ground perspectives. A rough analysis of these images will show potential ingress and egress routes and aid in the development of trafficability assessments. This information could include soil trafficability, mobility corridors, and perspective views of denied areas, including enemy-controlled territory, contaminated areas, minefields, smoke, forest fires, and many other conditions that may arise in the operational environment that may critically impact battle space awareness. In the IPB process, MSI is useful in determining maneuverability and possible areas of enemy concealment and operations.

SYSTEM LIMITATIONS

While satellites can provide the Army many valuable capabilities, planners and users must understand some of their general limitations. Though not all-inclusive, the following limitations represent areas that must be considered when planning and requesting space support.

ACCESS

Launch operations are complex, time-consuming, manpower-intensive, and costly, For these reasons, military satellites are national resources supporting the NCA, CINCs, other services, and tactical users. As a result, requirements may exceed system capacity and capabilities. A validation process to determine what requirements will be satisfied is based on priority and system availability. Potentially, this process limits the Army's accessibility to satellite capabilities. Not only are these systems limited, most are owned, controlled, or dedicated to exclusively

supporting other missions and may not be available to support Army requirements. Furthermore, many satellites do not provide direct links to the ultimate user, often requiring significant processing time by a third party to convert data into usable media. This conversion further delays distribution to Army users. As a result of having limited access, Army planners should explore the use of commercial space systems when developing military operations plans.

VULNERABILITY

Satellites are designed to survive the harsh space environment and have a degree of hardiness that many ground systems do not have. While in orbit, they may be affected by temperature extremes, radiation, solar flares, meteoroids, and space debris. Imaging systems used for reconnaissance can be affected by clouds, fog, and smoke.

METT-T affects employment of satellite ground terminals. They are also affected by line-of-sight disruptions such as high foliage areas, low take-off angles, placement in fringe areas of coverage, high usage in small and close areas, and susceptibility to whatever military capability—such as destruction, denial, disruption—an enemy force may have to use against any other ground system in the area of operation. The ground control and user segments represent the most likely targets for an adversary. When planning the use of satellite systems, the planner must consider alternatives in the event these systems are lost .

Satellites can be attacked, but they are not easy targets. Russia has demonstrated a limited capability to attack and destroy satellites in low earth orbit. Jamming satellite systems or the link between the satellite and the ground segment of the system is also a threat. Not lost on Operations Desert Shield/ Storm observers was how much dependence was placed on the use of satellite systems, Therefore, jam-resistant satellite capabilities such as Milstar must become the backbone of our satellite systems. Also imperative is that the Army should place more emphasis on influencing their design and survivability. Military use of commercial satellites must be expanded; however, risk as well as benefits must be considered, given the vulnerability of these systems.

UTILITY

Operationally, the Army is dependent upon systems currently in orbit, although these systems may or may not be suited to a particular Army mission. Many satellites do not provide continuous coverage; for example, Landsat sensors revisit equatorial points on the earth approximately every 16-18 days. Moving a satellite to a more advantageous orbit or position takes time and is limited to the amount of fuel on board since satellites cannot be refueled. Satellites are normally built with a high degree of survivability and redundancy, but once damaged or having experienced component failure, their utility and reliability are degraded. Furthermore, they are difficult to repair.

Generally, the orbital characteristics of a space system are related to the function of the satellite (see Figure 4-5). Satellites may be at a relatively fixed altitude (circular orbits) or vary in altitude (elliptical orbits). Low orbits, being closer to the earth, best support sensing requirements. The disadvantage of a low orbit is a limited view of the earth and a relatively short time over any particular location. As altitude increases, the field of view increases, but the ability to resolve small objects decreases.

Another factor affecting the use of satellites is inclination—the angle the satellite's orbital plane makes with the earth's orbital plane. A higher inclination generally means that more of the earth is covered. For example, a satellite in polar orbit (90 degrees inclination) will observe the entire globe as the earth rotates through the orbital plane. Inclinations from 0 to 90 degrees cover increasingly higher latitudes for low-altitude satellites. The length of time between satellite coverage of a particular location (that is, revisit time) depends upon the number of satellites in

For updated graphic click here.

a constellation and the capabilities of the payload, such as direct versus slant view, type of frequency, band width, data transmission rates, and sensor footprint size.

Appendix

Space Operations Annex

This appendix provides a template for developing a space operations annex to an operations plan. However, much of the information presented may not be required, depending on the echelon of command and the amount of detail contained in other annexes supporting the plan. To avoid duplication, refer to the basic operation plan and other annexes addressing space support where possible.

When preparing a space operations annex and supporting appendixes:

- Focus on unique space capabilities and their application to the operation.
- Refer to the space operations annex of the next higher command's OPLAN/OPORD.
- Cross-reference other annexes; avoid unnecessarily repeating information contained in other annexes.

Appendixes addressing the following topics may be included: communications; environment; navigation; reconnaissance, surveillance, and target acquisition; tactical warning, space control, and external space support. *Complete them only as required for amplifying details.*

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ANNEX _, SPACE OPERATIONS, to OPLAN or OPORD [nnnn-yy - Issuing Headquarters]

1. ( ) REFERENCES. List the space operations annex of the next higher command's OPLAN or OPORD and other documents, maps, overlays, and SOPS that provide guidance and information required for use with this annex.]

2. ( ) TIME ZONE USED THROUGHOUT THE ORDER:

3. ( ) SITUATION.

a. ( ) General. [Describe planned and available space support to the OPLAN. Explain how to obtain and coordinate space support. List operational constraints and shortfalls. Describe relationships between supporting and supported organizations. Refer to other annexes or provide enough information about the overall situation to give subordinate and supporting units a clear understanding of the contemplated operations that require space operations support.]

b. ( ) Enemy,

(1) ( ) [Describe enemy space capabilities, how they will be used, and their value to the enemy.]

(a) ( ) [Estimate the impact of enemy space capabilities on friendly operations. Describe notification or warning reports to friendly units of enemy space activities, including enemy reconnaissance, intelligence, surveillance, and target acquisition of friendly forces by manned and unmanned space systems. Refer to Annex _, *Intelligence,* for amplifying information.]

(b) ( ) [Identify enemy space weaknesses and vulnerabilities, such as inadequate coverage, poor resolution, inability to launch new or replacement systems, and inability to counter the capabilities of friendly space systems.]

(2) ( ) [Describe what the enemy is capable of doing and probably will do with his space, air, surface, or subsurface assets to interfere with friendly space systems and space operations that support the missions and tasks envisioned in this plan. Describe any known hostile space activities that deny access to space, deny the full capabilities of friendly space assets, or restrict friendly surface resources required by these space assets. Refer to Annex _, *Intelligence,* for amplifying information.]

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c. ( ) Friendly. [In separate numbered subparagraphs, state the capabilities of external commands, units, forces, or agencies to provide space support to the operation, such as USSPACECOM, USARSPACE, Defense Information Systems Agency, DIA, NOAA, and NASA. Include non-DOD agencies and systems such as INTELSAT and INMARSAT. Identify systems available for communications, environment, navigation, surveillance, tactical warning, space control, nuclear detonation detection, or other application categories. Identify friendly space weaknesses and vulnerabilities. Describe changes or modifications to established procedures and memoranda of agreement or understanding that may be in effect. Use an appendix for detailed information. Refer to the next higher command and adjacent commands' space operations annex.]

d. ( ) Assumptions. [State any assumptions not included in the basic plan relating to friendly, enemy, or third party capabilities and operations that may affect, negate, or compromise space capabilities. If any are critical to the success of the plan, indicate alternative courses of action.]

4. ( ) MISSION. [State in concise terms the space tasks to be accomplished in support of the operations in the basic plan and describe the desired results in support of this OPLAN.]

5. ( ) EXECUTION. [Space activities may range from satellite communications and intelligence support to space control operations. The functions required may vary greatly within the area of operations, the echelon of command, or between phases of the operation. This paragraph may, therefore, require considerable detail and development of alternative courses of action to accomplish the mission. Use appendices as necessary to provide detailed guidance.]

a. ( ) Concept of Operations.

(1) ( ) General. [State the general concept of space operations required to support the forces in the task organization of the OPLAN and briefly describe how they fit into the entire operation or refer to the basic plan. Emphasize the aspects of the basic plan that till require space support and that may affect space capabilities. State operations security (OPSEC) planning guidance for tasks in this annex arid cross-reference other OPSEC Planning guidance for functional areas addressed in other annexes.]

(2) ( ) Employment. [If the operation is phased, discuss the employment of space assets during each phase. Include discussion of priorities of access, usage, and capabilities in each phase. Discuss ability to launch new or replacement space systems.]

b. ( ) Space Support. [Identify space support and procedures that will support the OPLAN. Include the following areas or add additional areas, as applicable. Use appendices for detailed discussion and information.]

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(1) ( ) Communications. [Describe space systems that will support communications plans as described in the annex listing military and commercial satellites and ground systems that will provide support. Provide information sufficient to determine the time and duration of SATCOM support, including procedures for obtaining additional support. Refer to Annex _, *Command, Control and Communications Systems,* for amplifying in formation.]

(2) ( ) Environment. Describe environmental support information—for example, meteorologic, oceanographic, geodetic—provided by space assets. List receivers and processors available and describe capabilities, products, and availability of weather and multispectral satellite data. Describe provisions to acquire, receive, or gain access to data from weather, multispectral, and other satellites that cannot be received by systems in the theater of operations. Describe provisions to deny the enemy access to data from civil weather satellites. Refer to Annex _, *Environmental Services,* for amplifying information.]

(3) ( ) Navigation. Describe the capabilities of space-based navigation systems that will aid the position location and navigation of the force. Describe types of GPS receivers available to subordinate units and identify which receivers are unable to compensate for selective availability. Quantify the error caused by selective availability. If continuous three-dimensional coverage is not available, describe outage periods or times of reduced coverage. Describe requirements to jam or spoof GPS receivers that the enemy may be using. Describe requirements for differential GPS.]

(4) ( ) Reconnaissance, Intelligence, Surveillance, and Target Acquisition. Describe systems, capabilities, and products available to friendly forces, including TENCAP, SIGINT, multispectral, and others. Describe intertheater and intratheater dissemination architecture and procedures. Refer to Annex_, *Intelligence,* for amplifying information.]

(5) ( ) Tactical Warning. [Describe the capabilities of space systems to detect enemy ballistic missile attack or other enemy activities. Describe the capabilities of available systems (for example, the TERS) and identify coordination and channels needed to disseminate warnings quickly. Describe linkage and coordination with ground- and air-based radar systems. Refer to Annex _, *Intelligence,* for amplifying information.]

(6) ( ) Space Control. [Describe actions performed by space, air, or surface assets to ensure friendly forces access to space or deny enemy forces unrestricted use of space and space assets. Include planned or anticipated actions in response to the enemy's use of space or denial of friendly access to space and space systems.]

c. ( ) Tasks and Responsibilities. [In separate numbered subparagraphs, assign tasks and responsibilities to applicable subordinate units, supporting commands, or agencies providing support to the plan. For each of these tasks, provide a concise statement of the mission to be performed, providing sufficient

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detail to ensure that all elements essential to the operational concept are properly described.]

d. ( ) Coordinating Instructions. [Provide necessary guidance common to two or more components, subdivisions, or agencies. Describe liaison requirements, if any.]

6. ( ) SERVICE SUPPORT. [Provide broad guidance concerning administrative and logistics support for space operations, Address support of mobile or fixed space system assets within the area of operations or refer to another annex where this information is available. Describe support needed and who will provide it for any space-related ground stations supporting the command, Describe resupply procedures for cryptologic supplies. Refer to Annex _, *Logistics,* or pertinent command directives for amplifying information.]

7. ( ) COMMAND AND CONTROL.

a. ( ) [Indicate the difference, if any, between the command channels for the conduct of space activities and the command relationships established in the annexes. If applicable, state requirements for augmentation of appropriate headquarters with space operations personnel. Refer to the appropriate section of the applicable annex or the basic plan for general battle command support of space activities.]

b. ( ) [Summarize requirements for general battle command systems support of space activities. Refer to the appropriate annex.]

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Glossary

ABCS Army Battle Command System

ACE analysis and control element

ACT analysis and control team

AFSATCOM Air Force satellite communications

ALT altitude

AO area of operations

ARSST Army Space Support Team

ASAS all-source analysis system

ASAT antisatellite

ASCC Army service component commander

ASEDP Army Space Exploitation Demonstration Program

ASI additional skill identifier

ASPO Army Space Program Office

ATACMS Army Tactical Missile System

AUTODIN Automatic Digital Network

AVHRR advanced very high resolution radiometer

BDE brigade

BMD ballistic missile defense

C^2 command and control

$C^2$0TM command and control on the move

CCD charge coupled device

CEP circular error probable

CGS common ground station

CIA Central Intelligence Agency

CINC commander in chief

CK circuit

CMO collection management officer

COLL MGT collection management

CONUS continental United States

COTS commercial off-the-shelf

CSS combat service support

CTT-H commander's tactical terminal - hybrid

DCF DSCS Operations Control System Certification Facility

DCS Defense Communications System

DCSOPS deputy chief of staff for operations and plans

DDL data downlink

DIA Defense Intelligence Agency

DISE deployable intelligence support element

DL downlink

DMA Defense Mapping Agency

DMSP Defense Meteorological Satellite Program

DOD Department of Defense

DSCS Defense Satellite Communications System

DSCSOC DSCS operations center

DSP Defense Support Program

DTLOMS doctrine, training, leader development, organization, materiel development, and soldiers

EAC echelons above corps

EAM emergency action message

EEI elements of essential information

EHF extremely high frequency

EPDS Electronic Processing and Dissemination System

ERS-1 Earth Resourcing Satellite-1 (Japanese)

ESA European Space Agency

ETRAC Enhanced Tactical Radar Correlator

ETUT Enhanced Tactical Users Terminal

FAST Forward Area Support Terminal

FAST-I forward area secondary imagery dissemination and TRAP-improved

FLOT forward line of own troops

FLTSAT fleet satellite

FM field manual

G2 division/corps intelligence staff officer

GBI ground-based interceptor

GBRT ground-based radar terminal

GMF ground mobile forces

GOES geostationary operational environmental satellite

GPS Global Positioning System

GRCS guardrail radar common sensor

GSM ground station module

GSTS Ground-Based Surveillance and Tracking System

HMMWV high-mobility multipurpose wheeled vehicle

HRV high-resolution-visible range instruments

HSI hyperspectral imagery

ICBM intercontinental ballistic missile

IES Imagery Exploitation System

IEW intelligence and electronic warfare

IHFR improved high-frequency receiver

IMETS Integrated Meteorological System

INMARSAT international maritime satellite

INSCOM Intelligence and Security Command

INTEL intelligence

INTELSAT international telecommunications satellite

IO information operations

IPB intelligence preparation of the battlefield

IRS-1B India's remote sensoring satellite

JCS Joint Chiefs of Staff

JIC Joint Intelligence Center

JTAGS joint tactical ground station

J-TENS Joint Tactical Exploitation of National Systems

Landsat civil earth imaging satellite

LEASAT leased commercial satellite

LEO low earth orbit

LISS low-imaging sensing satellite

LOS line of sight

LRSU long-range surveillance unit

MDX multiplex data exchange

METT-T mission, enemy, terrain and weather, troops available, and time

MIES Modernized Imagery Exploitation System

MILSATCOM military satellite communications

Milstar military strategic, technical, and relay

MITT Mobile Integrated Tactical Terminal

MOOTW military operations other than war

MOS-1 Marine observation satellite

MSE mobile subscriber equipment

m/sec meters per second

MSI multispectral imagery

MSS multispectral scanner

NA not applicable

NASA National Aeronautics and Space Administration

NAVSTAR navigation system using timing and ranging

NCA National Command Authorities

NCO noncommissioned officer

NMD national missile defense

NMJIC National Military Joint Intelligence Center

NMS national military strategy

NOAA National Oceanic and Atmospheric Administration

NSA National Security Agency

OPLAN operations plan

OPORD operations order

OPSEC operations security

PBV post-boost vehicle

PLGR precision lightweight GPS receiver

POSNAV position/navigation

RCV receive

RDTE research, development, testing, and evaluation

RESURS-F Russian earth resourcing satellite

RESURS-O Russian earth observation satellite

RISTA reconnaissance, intelligence, surveillance, and target acquisition

RO/RO roll on/roll off

RSOC Regional SIGINT Operations Center

RSSC regional space support center

RV reentry vehicle

S2 brigade or battalion intelligence staff officer

SAR synthetic aperture radar

SATCOM satellite communications

SDI Strategic Defense Initiative

SHF superhigh frequency

SID secondary imagery dissemination

SIGINT signals intelligence

SLBM submarine-launched ballistic missile

SLGR small lightweight GPS receiver

SMART-T secure, mobile, antijam reliable tactical terminal

SOF special operations forces

SOI space object identification

SPOT *Systeme Probatoire d 'Observation De La Terre*

SSO special security office

STU-III secure telephone unit, third model

SUCCESS synthesized UHF computer-controlled equipment subsystem

SWO staff weather officer

SWT small weather terminal

TADIX-B Tactical Data Information Exchange System - B

TEC Topographic Engineering Center

TENCAP tactical exploitation of national capabilities

TERS Tactical Event Reporting System

TIBS Tactical Information Broadcast Service

TIROS television infrared observation satellite

TM thematic mapper

TMD theater missile defense

TOE table of organization and equipment

TOPO topographic

TRAC tactical radar correlator

TRAP tactical and related applications

TRI-TAC Joint Tactical Communications System

TRIXS Tactical Reconnaissance Intelligence Exchange System

UAV-E unmanned aerial vehicle - extended

UHF ultrahigh frequency

USAKA US Army Kwajalein Atoll

USARSPACE US Army Space Command

USASDC US Army Strategic Defense Command

USASSDC US Army Space and Strategic Defense Command

USN US Navy

USSPACECOM US Space Command

USSR United Soviet Socialist Republic

VHF very high frequency

VSAT very small aperture terminal

WEFAX weather facsimile

WWMCCS Worldwide Military Command and Control System

XMIT transmit

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A R M Y S P A C E P O L I C Y

J U L Y 1 9 9 4

Future success of Army forces will be critically dependent upon exploitation of space assets, capabilities, and products across the entire spectrum of military operations. In an environment of rapid political, technological, and economic change, Army access to national, civil, allied, military, and commercial space capabilities and products is essential to successful operations.

Consistent with national and Department of Defense policies and in cooperation with other services and agencies, the Department of the Army will conduct space and space-related activities that enhance operational support to warfighters and contribute to successful execution of Army missions. Furthermore, the Army will consider space to include those regions from, through, or in which space or space-surrogate systems operate. Employment of space products that meet land warfighter requirements will provide a force multiplier essential to our power projection force. Information technology, which enables success on the battlefield, relies heavily on space solutions. Beyond affecting future space systems design and developmental initiatives, the Army, in joint and combined operations, will organize and train Army forces using space capabilities and products to make them more responsive, flexible, interoperable, survivable, and sustainable. Space and space-related capabilities are essential contributors to Army modernization objectives. In addition to exploiting existing space systems, the Army will ensure that new systems support land component requirements. Space applications will be embedded in Army doctrine, training scenarios, wargames, exercises, and plans. The use of space products will be normalized in the preparation for and conduct of assigned missions.

Successful execution of this policy requires developing, maintaining, and enhancing Army space expertise, to include provision for training of space-knowledgeable soldiers and civilians and the development of space concepts, doctrine, requirements, and equipment. The Army will seek to normalize the direct and immediate in-theater response to commanders from evolving space-based capabilities.

Aggressive exploitation of space capabilities and products normalized in concepts, doctrine, training, operations, and modernization will ensure that the Army is able to maintain land force dominance well into the twenty-first century. The Army's future is inextricably tied to space.

Gordon R. Sullivan
General, United States Army
Chief of Staff

Togo D. West
Secretary of the Army

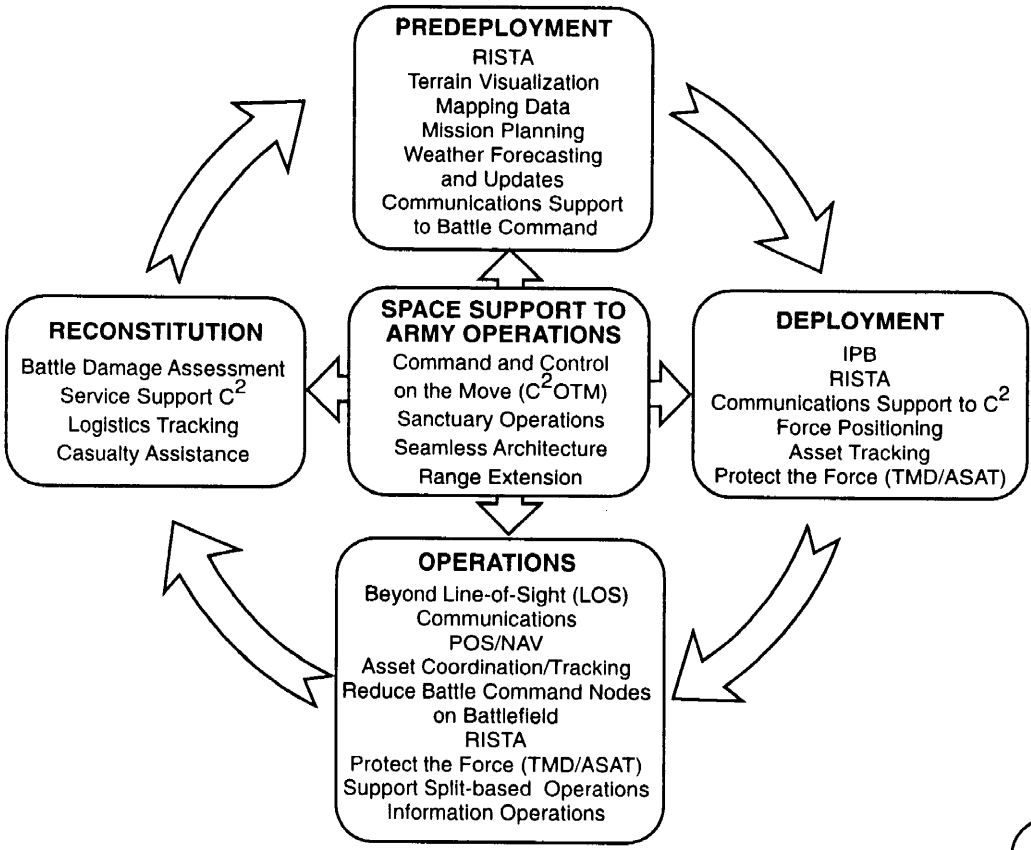


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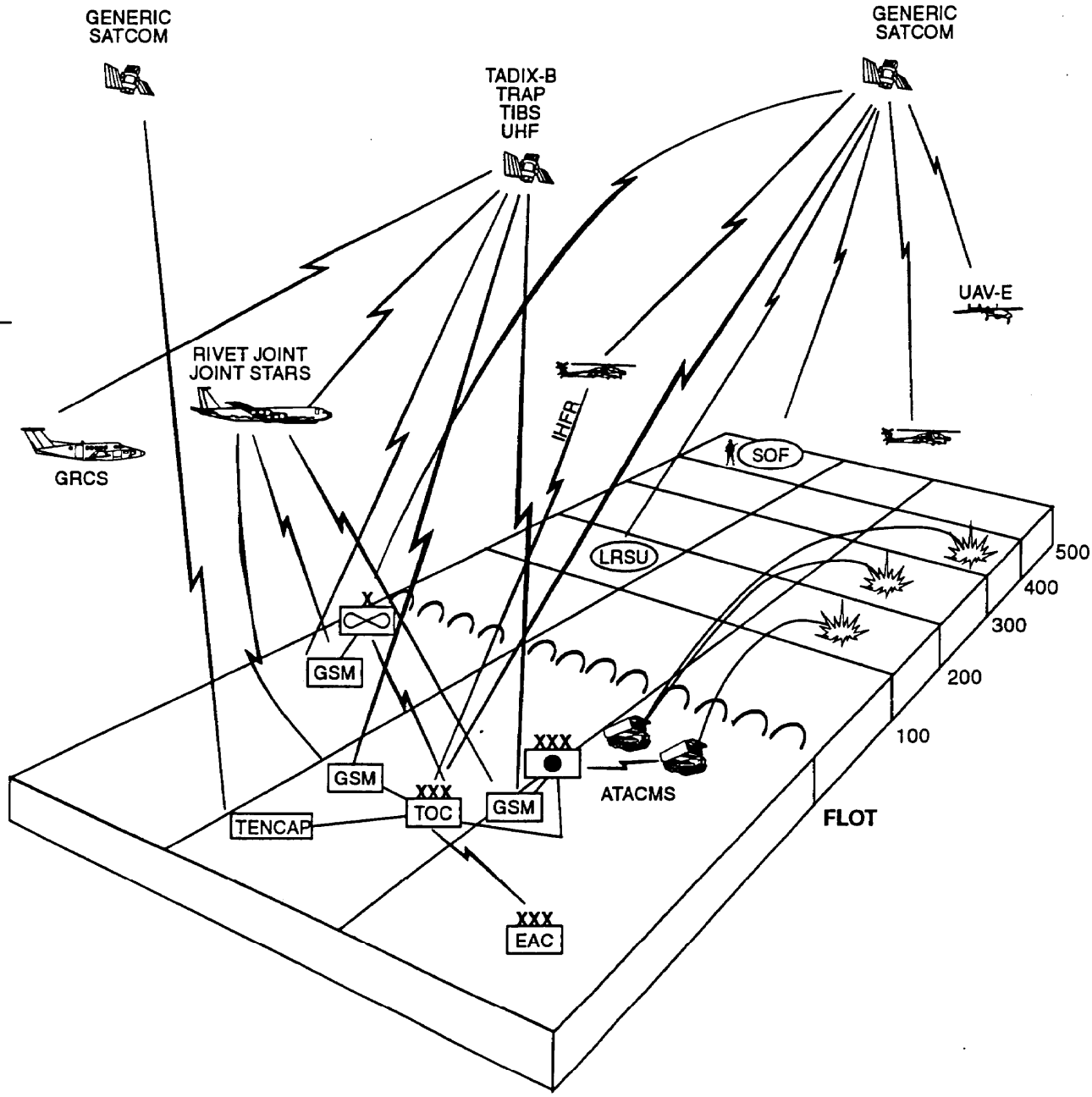


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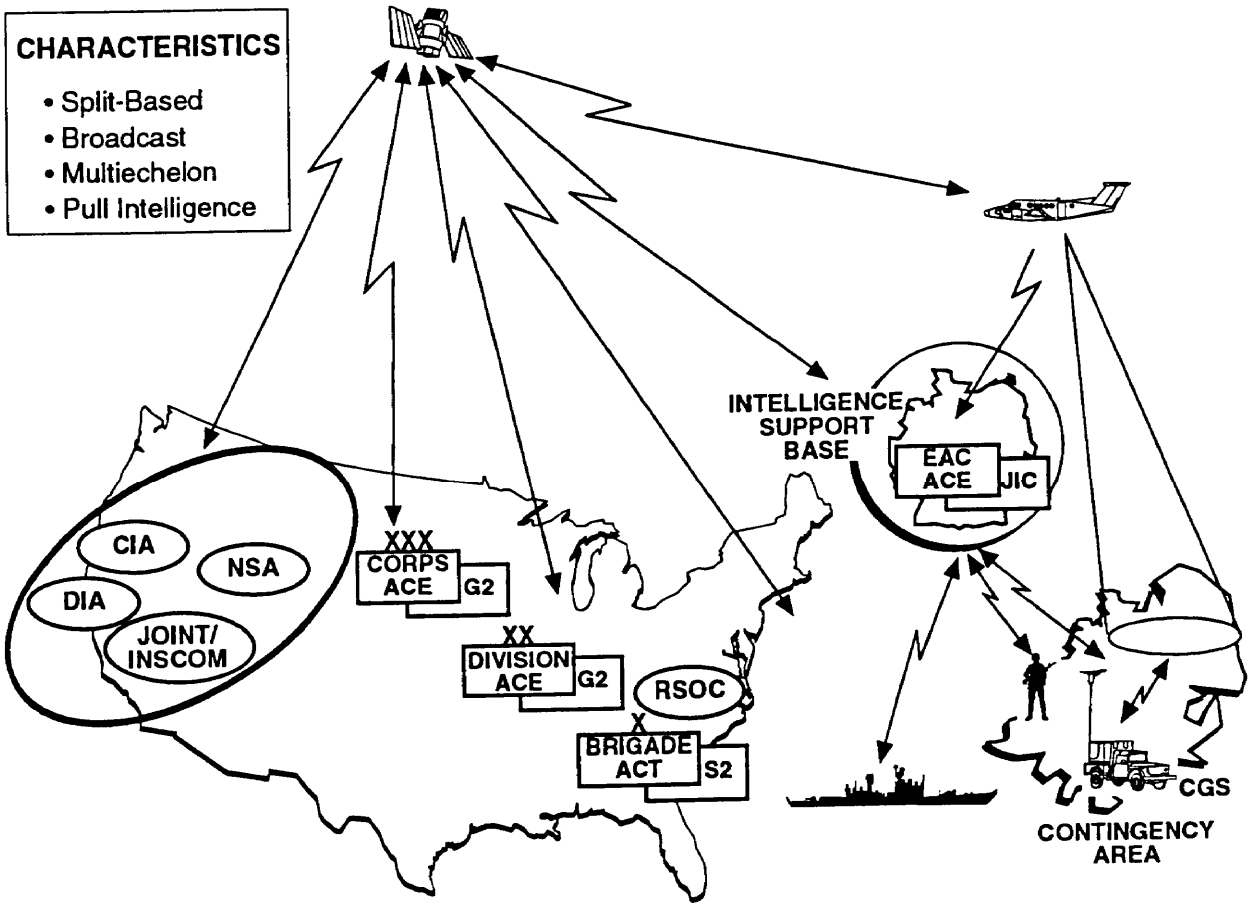
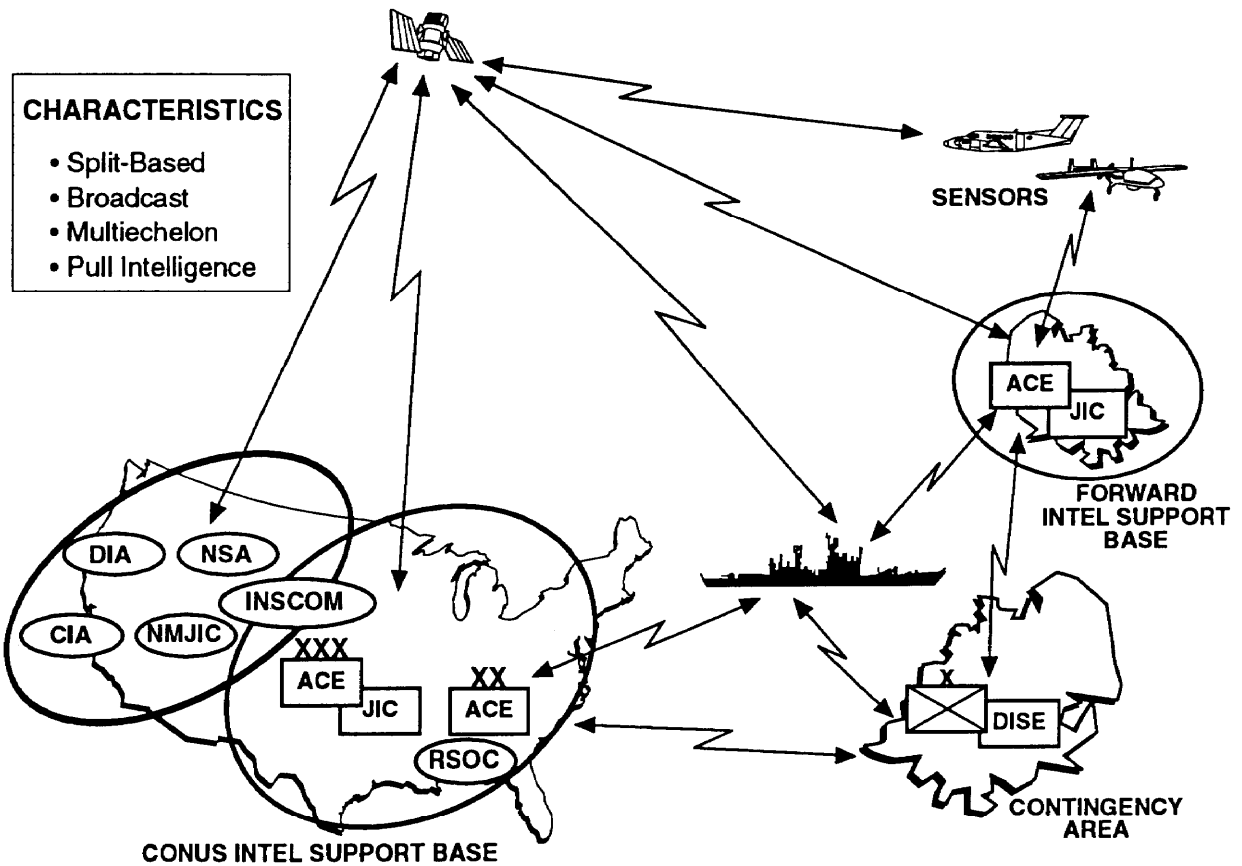


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Direct access to
national technical means
and data bases

DISE– Communications +
Automated Intelligence Fusion +
Broadcast Downlink
Seamless through joint/national level

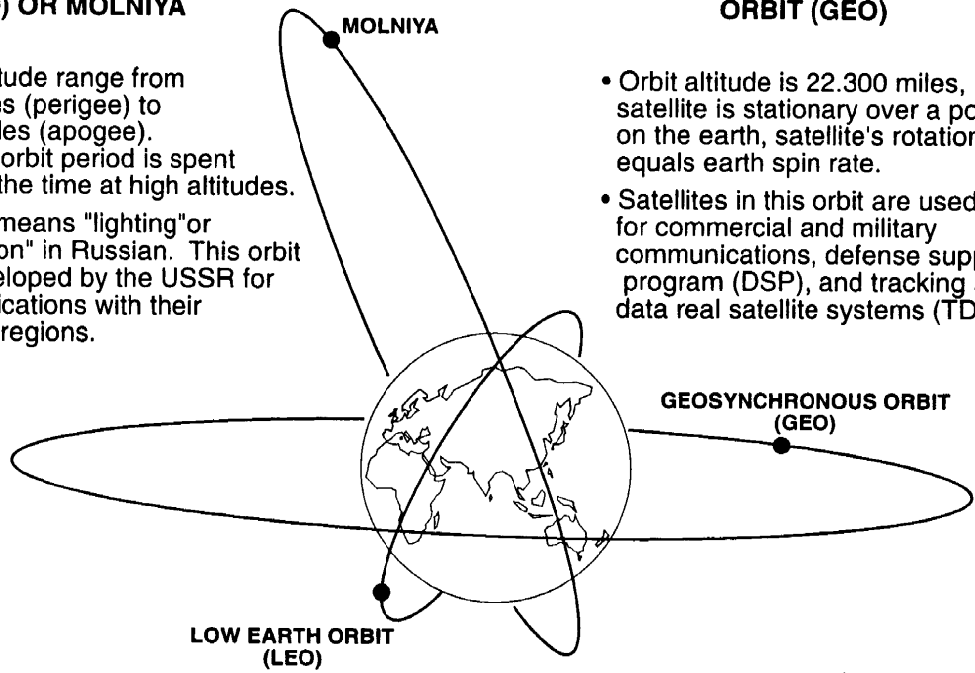
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HIGHLY ELLIPTICAL ORBIT (HEO) OR MOLNIYA

- Orbit altitude range from 300 miles (perigee) to 2500 miles (apogee). 12-hour orbit period is spent most of the time at high altitudes.
- Molniya means "lighting"or "first edition" in Russian. This orbit was developed by the USSR for communications with their northern regions.

GEOSYNCHRONOUS EQUATORIAL ORBIT (GEO)

- Orbit altitude is 22.300 miles, satellite is stationary over a point on the earth, satellite's rotation equals earth spin rate.
- Satellites in this orbit are used for commercial and military communications, defense support program (DSP), and tracking and data real satellite systems (TDRSS).



LOW EARTH ORBIT (LEO)

- Orbit altitude is approximately 90-500 miles. The satellite orbit period is approximately 90 minutes and the satellite traces a different path over earth with each orbit.
- Satellites in this orbit are weather, earth resources, space shuttle, space station, space telescope, and gamma-ray observatory.

TYPES OF ORBITS

Circular vs elliptical low-, medium-, or high-altitude inclined, equatorial, polar, geostationary

ISSUES WITH ALTITUDE

- **Coverage, Outage, Revisit Times**
- **Operational Complexity – Acquisition, Pointing**
- **Number of Satellites Required**
- **Path Loss, Antenna Patterns**
- **Sensor Satellites – Resolution**

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