Space Systems Modeling and Simulation Functional Requirements Document

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HQ AFSPC/XPXA

DEPARTMENT OF THE AIR FORCE
AIR FORCE SPACE COMMAND

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EXECUTIVE SUMMARY

National Space Systems have provided the US Joint Warfighter unquestionable information superiority. Since Operation Desert Storm in the early 1990s, US and Allied forces have had the advantage of overwhelming and unmatched Force Enhancement space support throughout every phase of every engagement in every operation and action. During Desert Storm, US Space capabilities and reliance were kept very secret and close-hold. Now, US space-based capabilities and dependence are well known to our joint warfighters. Unfortunately, these capabilities and our corresponding reliance are also known by our future adversaries, and now are considered vital targets for disruption and denial.

The Report of the Commission to Assess United States National Security Space Management and Organization, January 11, 2001 identified the US Space Infrastructure as a **"top national security issue."** The Commission Report cites the emerging threat to target commercial, civil, military, and intelligence space resources, and the critical growing dependence of our nation's economy on the ability to access space-based systems. This report echoed the findings of the earlier report of the Defense Science Board, February 2000. Beginning with the October 2000 attack on the USS Cole and the subsequent September 11th, 2001 attacks upon our nation, US policy makers have been shown the new nature of warfare in the 21st Century. The concern of this document is preparing the joint warfighter for the emerging dimensions of space and information warfare existing in the future battlespace, highlighting both advantages to be gained and vulnerabilities that exist from our expanding economic and military dependence on National Space Systems.

A common conclusion to the above-referenced reports, and others, is that the Department of Defense has not effectively employed modeling and simulation to provide the joint warfighter community the appropriate fidelity and level of space representation needed to organize, equip, and train for future conflicts.

Since 1995, multiple senior advisory groups have provided modeling and simulation guidance with respect to Space integration, including: (a) the General Accounting Office (GAO) Report on Improvements Needed in Military Space Systems' Planning and Education, (b) Defense Science Board Report on Space Superiority, (c) Corona Tasker on "dynamic space play in exercises and wargames", and (d) the Space Commission Report. These reports summarize the Modeling and Simulation deficiencies, needs, and requirements that must be addressed in future Department and Component Service long-range planning. Summary results from these reports highlight guidance provided to date.

- **GAO/NSIAD-00-81, p. 9.** "In addition, DoD lacks the modeling and simulation tools that are necessary to comparatively assess the efficiency and effectiveness of space systems with plausible terrestrial system alternatives. The US Space Command states that this deficiency not only impairs its ability to effectively plan, but also significantly affects its ability to articulate the benefits of space systems. In the DoD 1999 space policy, modeling and simulation is a requirement for demonstrating the military worth of space systems and their application to mission accomplishment."
- **DSB Task Force on Space Superiority, ADB252150, p. 21.** "The Nation currently lacks the necessary modeling and simulation capabilities required to fully and appropriately assess the military utility and worth of national security space systems. This deficiency

undermines our ability to correctly balance funding priorities between space systems, weapons systems, and other support functions to maximize US military force combat effectiveness."

- **Aerospace Integration Plan, Vol. 1, p. 20. (Response to the Corona Tasker)** "Integrate Dynamic Space Scenarios in Exercises…The planning and execution of future Air Force computer-assisted exercises must ensure the integration and accurate portrayal of the contributions of all aerospace assets, as well as the impacts of degraded combat capabilities that result from their absence or misuse. During an exercise, participants must be required to coordinate or address these available assets.
- **Space Commission Report, 11Jan01, p. 78.** "The Department of Defense uses models and simulation to help develop system requirements, test new system concepts, plan acquisition and conduct useful but less expensive training. Historically, DoD has measured the potential combat effectiveness of new systems by simulating their employment in mock combat. Because the value of communications, intelligence, and space systems can be difficult to quantify, their contributions to warfighting are not accurately captured in current models and simulations. To support exercises, experiments and wargames, the Department must develop and employ modeling and simulation tools based on measures of merit and effectiveness that will quantify the effects of space-based capabilities."

Currently the US Joint Warfighter enjoys the advantage of our national space infrastructure, including commercial, civil, military, and intelligence space resources. However, our adversaries, both national state entities and non-traditional terrorist groups, have observed this national advantage and will now target this new center of gravity (COG) in future conflicts.

Space Commission Report

"In July, 2000, the Xinhua news agency reported that China's military is developing methods and strategies for defeating the U.S. military in a high-tech and space-based future war." (p. xiv)

Action is needed now to avoid a "Space Pearl Harbor".

We must educate and train our joint warfighters to not only recognize the operational effectiveness and utility of national space resources, but to also be aware of the operational limitations and vulnerabilities of these resources. This Functional Requirements Document (FRD) begins the process of addressing the problems cited.

This document provides the coordinated space community's foundation of space functional requirements for incorporation into military modeling and simulation efforts across the gamut of education and training programs for current and future implementation efforts. It supercedes previous requirements sets, and provides additional information from the most current Air Force Space Command (AFSPC) Strategic Master Plan and the revised AFDD 2-2 Space Doctrine Document.

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1.0 INTRODUCTION

1.1 Abstract. This document provides the space functional requirements for incorporation into military modeling and simulation efforts. It validates previous requirements sets, and provides additional information from the most current Air Force Space Command (AFSPC) Strategic Master Plan and the revised AFDD 2-2 Space Doctrine Document.

1.2 Scope. The space requirements are organized by AFSPC mission area and capabilities. Army and Navy Space organizations, operations, and units are not described in the functional requirements. The description of Air Force Space units, missions, and tasks may serve as a foundation for future Joint space modeling and simulation requirements.

1.3 Joint Training Modeling and Simulation Guidance. The Joint Staff directs that the combatant commands and Defense agencies document their mission requirements as Joint Mission Essential Task Lists (JMETL) and Agency Mission Essential Task Lists (AMETL), and use approved joint doctrine and the "Universal Joint Task List" (UJTL), CJCSM 3500.04B, as a common reference.

The Joint Staff J-7 is the CJCS proponent to formulate policies for the joint training of the Armed Forces. The J-7 facilitates and coordinates CJCS and combatant commander-sponsored training and exercises. Joint Forces Command (JFCOM) and the Joint Warfighting Center (JWFC) focus joint resources on more efficient and effective joint training. To assist JFCOM, the Joint Training Master Plan (JTMP) provides guidance for implementing a standardized process for conducting common joint training events and Joint Task Force Headquarters training. The JTMP assists the JWFC by providing guidance on assisting all joint commands in prosecuting their joint training and exercise programs, and the integration of JWFC's efforts in joint doctrine, JV 2010, modeling and simulations, and the Joint Center for Lessons Learned conclusions into joint training support. The Joint Training Master Plan, CJCSI 3500.02C, provides the envisioned joint training environment.

"The desired end state of joint training is the improved readiness of joint forces, a training and exercise strategy aligned with the 'National Military Strategy' NMS, improved interoperability among joint forces and with external agencies, complete integration of the entire DOD team (including the interagency process), a more stable way to optimize the application of scarce service resources, and a unified Department of Defense (DOD) training and exercise effort that includes incorporation of CSAs, interagency participants, multinational partners, and the Reserve Components."

(Reference: CJCSI 3500.02C Enclosure B, Section 1, Paragraph e)

Historically, training has been conducted within a combatant command without regard to its effect on or participation by another combatant command….The interface between supported and supporting commands should be identified and exercised often within the supported command's exercise program….The USJFCOM UE series provides an excellent environment to synchronize and link joint training events between various levels of command. (UJTL task: ST6.1.3—Establish Theater Space System Force Enhancement Operations.)"
(Reference: CJCSI 3500.02C Enclosure B, paragraph 3d)

"JSIMS is being developed to support training and education of ready forces by providing realistic training across all phases of military operations for all types of missions…JSIMS is a critical element in the reduction of PERSTEMPO associated with joint training. "
(Reference: CJCSI 3500.02C enclosure C, paragraph 5.(2))

1.4 Space Modeling And Simulation. Since the early 1990s, joint warfighters have become increasingly reliant on the services provided by space-based systems. The Global Positioning System (GPS) directly supported the tactics successfully employed to conduct Operation Desert Storm. Missile warning information from the Defense Support Program (DSP) was critical to defense for allied forces and to target Scud missile launchers. The Combined Air Operations Center (CAOC) concept totally integrates space capabilities into the joint battlespace environment. Through the SPACEAF Aerospace Operations Center (SAOC) at Vandenberg AFB, the Joint Air Forces Component Commander (JFACC) staff directly requests allocation of space assets in support of the theater air tasking orders (ATOs).

Joint training and exercise practices must accurately reflect the interfaces and capabilities of space systems. These practices must also reflect the global nature of the services provided by national space-based systems. Likewise, modeling and simulation inputs will be required to present the global mission nature, and not favor a total dedication of space resources to a single theater of operations. AFSPC modeling and simulation space requirements exist for the four mission areas: Force Enhancement, Space Support, Space Control, and Force Applications. To provide the structure for modeling and simulation requirements, each AFSPC mission area was examined. Shown in Figure 1-1, these mission areas provide the structure for Space Modeling and Simulation requirements with traceability to the Department's CJCSM 3500.04B, the Universal Joint Task List (UJTL) for the Warfighting Commanders-in-Chiefs (CINCs).

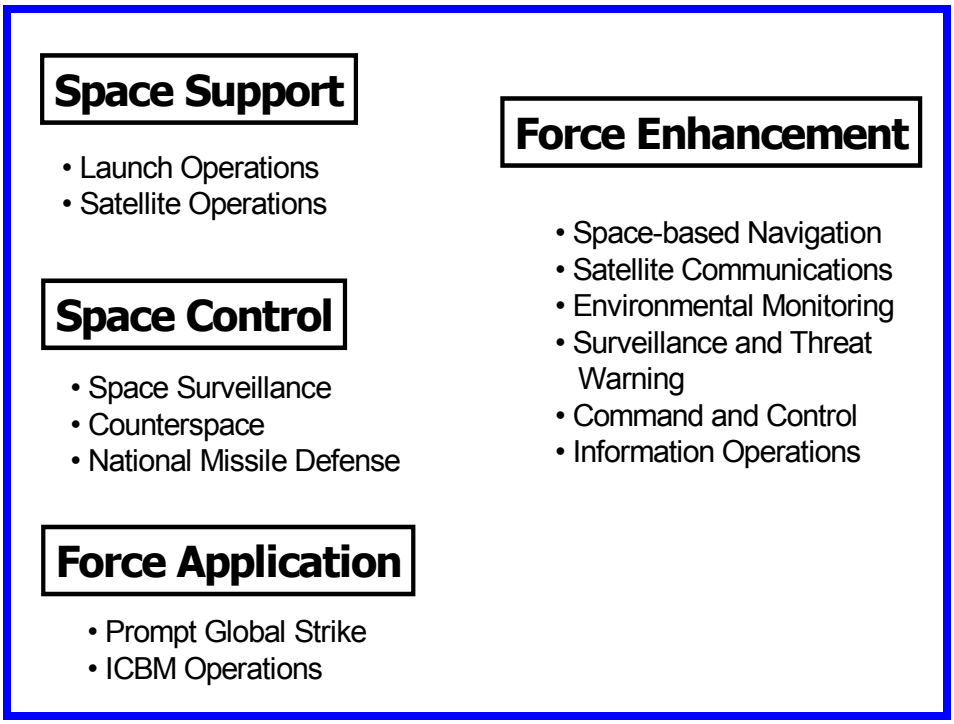

Figure 1-1. AFSPC Mission Areas

1.4.1 The **Force Enhancement** mission area focuses on capabilities that enable or support military air, land, sea, and space operations. Force Enhancement consists of six sub-mission functional areas: Space-based Navigation, Satellite Communications (SATCOM), Environmental Monitoring (EM), Surveillance and Threat Warning (S&TW), Command and Control (C2), and Information Operations (IO). These missions support the UJTL strategic national (SN) and strategic theater (ST) tasks provided in Table 1.1.

Table 1.1. Force Enhancement Mission Area (CINCSPACE)

UJTL REFERENCE	TASK DESCRIPTION
SN 2.2	Collect Strategic Information
SN 2.3	Process and Exploit Collected Strategic Information
SN 3.4	Protect Strategic Forces and Means
SN 3.4.2	Provide Integrated Tactical Warning and Attack Assessment
SN 5.1.2	Establish and Direct National Military C4 Systems Worldwide for Communicating Strategic Information
ST 2.2.1	Collect Information on Theater Strategic Situation
ST 2.4.2.1	Provide Theater Strategic Indications And Warning
ST 6.1.5	Organize And Coordinate Theater Missile Defense

1.4.2 The **Space Support** mission area focuses on providing the critical infrastructure, capabilities, and technologies that enable the Force Enhancement, Space Control, and Force Applications mission areas to effectively perform their missions. Space Support consists of two functional areas: Launch Operations and Satellite Operations. These missions support the UJTL strategic national (SN), strategic theater (ST), and Operational (OP) tasks provided in Table 1.2.

Table 1.2. Space Support Mission Area (CINCSPACE)	
UJTL REFERENCE	**TASK DESCRIPTION**
SN 3.5.1	Provide Space Support
SN 4.2.3	Reconstitute Theater Forces
OP 1	Conduct Operational Movement and Maneuver

1.4.3 The **Space Control** mission area focuses on capabilities to gain and maintain control of activities conducted in or through space**.** Space Control includes three functional areas: Space Surveillance, Counterspace, and National Missile Defense (NMD). These missions support the UJTL strategic national (SN) and strategic theater (ST) tasks provided in Table 1.3.

Table 1.3. Space Control Mission Area (CINCSPACE)	
UJTL REFERENCE	**TASK DESCRIPTION**
SN 3. 2	Manage National Strategic Firepower (Nuclear/Conventional)
SN 3.4.6	Provide Space Control

1.4.4 Force Applications focuses on missions carried out by weapons systems operating in or through space for holding terrestrial targets at risk. Force Applications includes both nuclear and conventional strike capabilities. These missions support the UJTL strategic national (SN) and strategic theater (ST) tasks provided in Table 1.4.

Table 1.4. Space Control Mission Area (US Strategic Command: CINCSTRAT)	
UJTL REFERENCE	**TASK DESCRIPTION**
SN 3.2	Manage National Strategic Firepower (Nuclear/Conventional)
SN 3.3	Employ National Strategic Firepower (Nuclear/Conventional)

1.5 Space Operations Roles and Responsibilities. United States Space Command (USSPACECOM) is the functional command responsible for synchronizing and integrating US military space components and executing assigned space missions. United States Strategic Command (USSTRATCOM) is the functional command responsible for deterring military attack on the US and its allies, and should deterrence fail, employ forces to achieve national objectives. The Unified Command Plan details the assigned missions for these joint warfighters.

Air Force Space Command (AFSPC) is the Major Command (MAJCOM) whose primary role is to organize, train, and equip Air Force Space elements supporting USCINCSPACE and USCINCSTRAT. The Air Force elements are the 14th Air Force and the 20th Air Force.

Within this structure, the 14th Air Force Component for Space (SPACEAF) is responsible to plan and execute the Figure 1-2 assigned missions and functions of space control, space support, and force enhancement. Force application is envisioned as a future assigned role in the Prompt Global Strike capacity. The 20th Air Force and its subordinate units support the Intercontinental Ballistic Missile (ICBM) force application element.

To conduct assigned missions, USCINCSPACE exercises Combatant Command (COCOM) over the component forces assigned. These are shown in Figure 1-2. Commander, SPACEAF exercises Operational Control (OPCON) over the Air Force component forces so missions can be executed as assigned by USCINCSPACE. The four Space Wing components are also shown in the figure.

COCOM of the strategic forces is exercised by USCINCSTRAT. The 20th Air Force has the OPCON of ICBM units including the 341st Space Wing (Malmstrom AFB), the 91st Space Wing (Minot AFB), and the 90th Space Wing (F.E. Warren AFB).

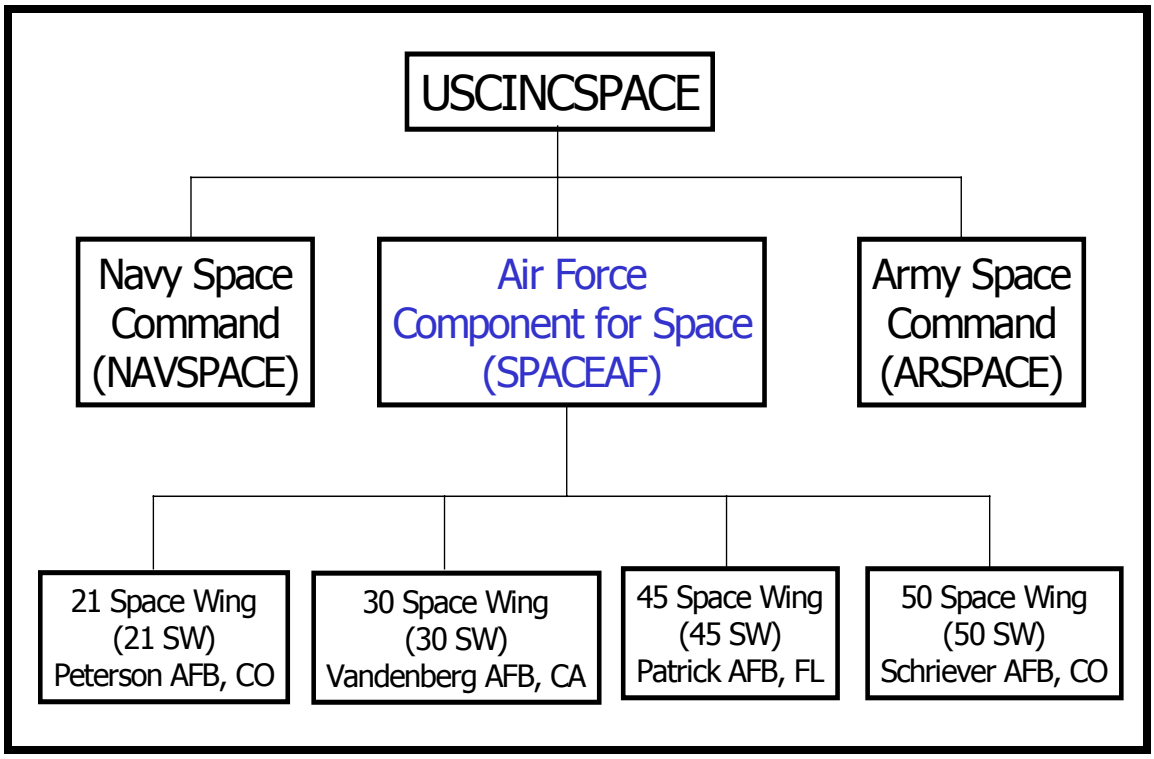

Figure 1-2. SPACEAF Organization

Assigned units, locations, and taskings are described in the functional requirements definition for each AF space mission area.

"Today's AFSPC space mission capabilities significantly contribute to the combatant commander and are the starting point along the path for achieving the warfighting Aerospace Force envisioned for the future."

Air Force Space Command's Strategic Master Plan

1.6 Space Operations Doctrine. AFDD 2-2 Space Operations Doctrine addresses command and control (C2) of space capabilities to achieve desired effects. Space activities can either have global effects or theater-only effects. Global space effects are those that impact multiple theaters. Global space forces are those that have global tasking and are controlled by Commander in Chief United States Space Command (USCINCSPACE). Control includes the capability, authority, responsibility, and accountability to execute those forces. Theater effects are those that are primarily limited to a single theater and have little or no impact outside the theater Area of Responsibility (AOR). Theater space forces are those that have theater specific tasking and are controlled by regional Commanders in Chief (CINCs).

To conduct space operations airmen employ space assets, space forces, and space systems. Space assets available to our nation include military, civil, commercial, and foreign space systems, their supporting infrastructure, terrestrial elements with the primary mission of affecting space systems and the personnel who operate them. Space forces are the units under which military space assets are organized.

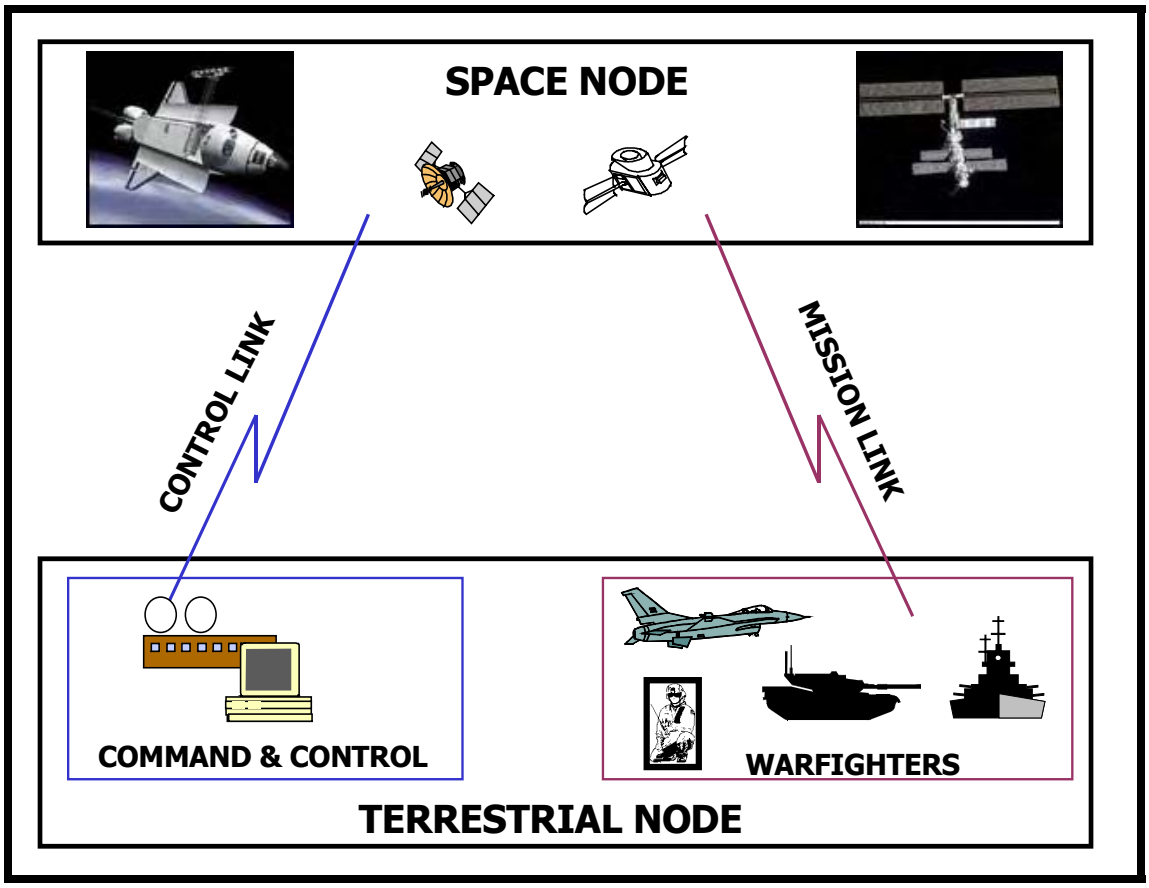

Figure 1-3. Space Assets, Forces, and Systems

Space systems are comprised of nodes and links, as shown in Figure 1-3. There are two types of nodes: terrestrial and space. The nodes are tied together with links. There are two types of links: control and mission.

The space node includes satellites, space stations, or reusable space-transportation systems like the space shuttle. The terrestrial node includes any land, sea, or airborne equipment used to interact with a space node. The link is the information conduit between the terrestrial and the space nodes. Control links enable telemetry, tracking, and commanding (TT&C) of the space node. Mission links provide information access to the warfighters.

1.7 Space Modeling and Simulation Functional Requirements. AFSPC/XPXA used the Figure 1-4 process to determine the functional requirements. USSPACECOM/J-37 provided the warfighter input; the Space Warfare Center (SWC) and AFSPC/DO/DR offices provided exercise and wargame inputs. Opportunities for modeling and simulation were identified from the joint training requirements. The resultant functional requirements are traceable to the UJTL and joint training requirements.

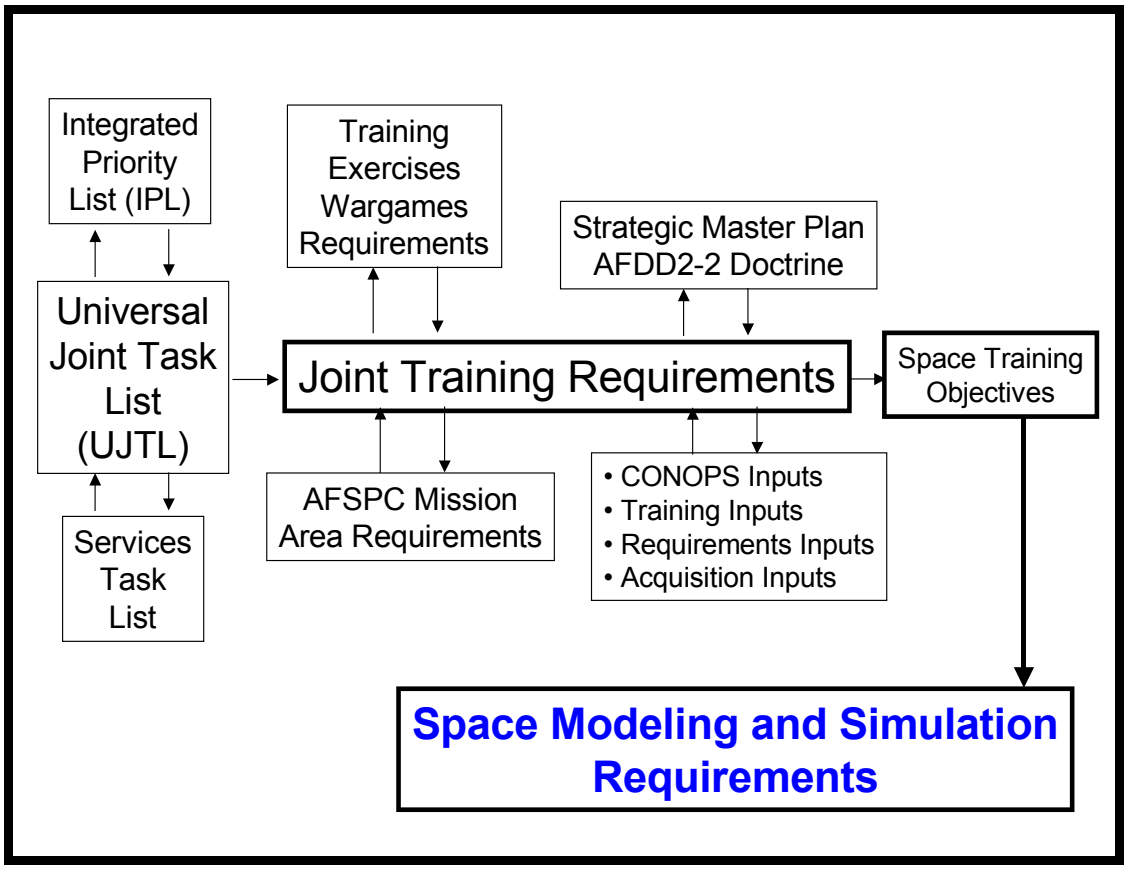

Figure 1-4. Requirements Determination Process

"...a robust modeling and simulation capability underpins our ability to make an effective acquisition decisions and evaluate space system performance in every mission area...Operationally, modeling and simulation allows us to hone wafighter skills by providing a realistic environment to conduct training, exercises, and course of action selection. Our space system models must interact seamlessly with other models so they may integrated easily into large-force joint exercises and computer simulations.

FY04-09 CINCSPACE Integrated Priority List, 21 November 2001

1.8 Space Modeling and Simulation Tools. Existing space modeling and simulation tools support joint wargames, exercises, experiments, and demonstrations (WEED) providing inputs to the Theater Battle Management Staff component of the Combined Aerospace Operations Center (CAOC). These inputs are summarized in Figure 1-5.

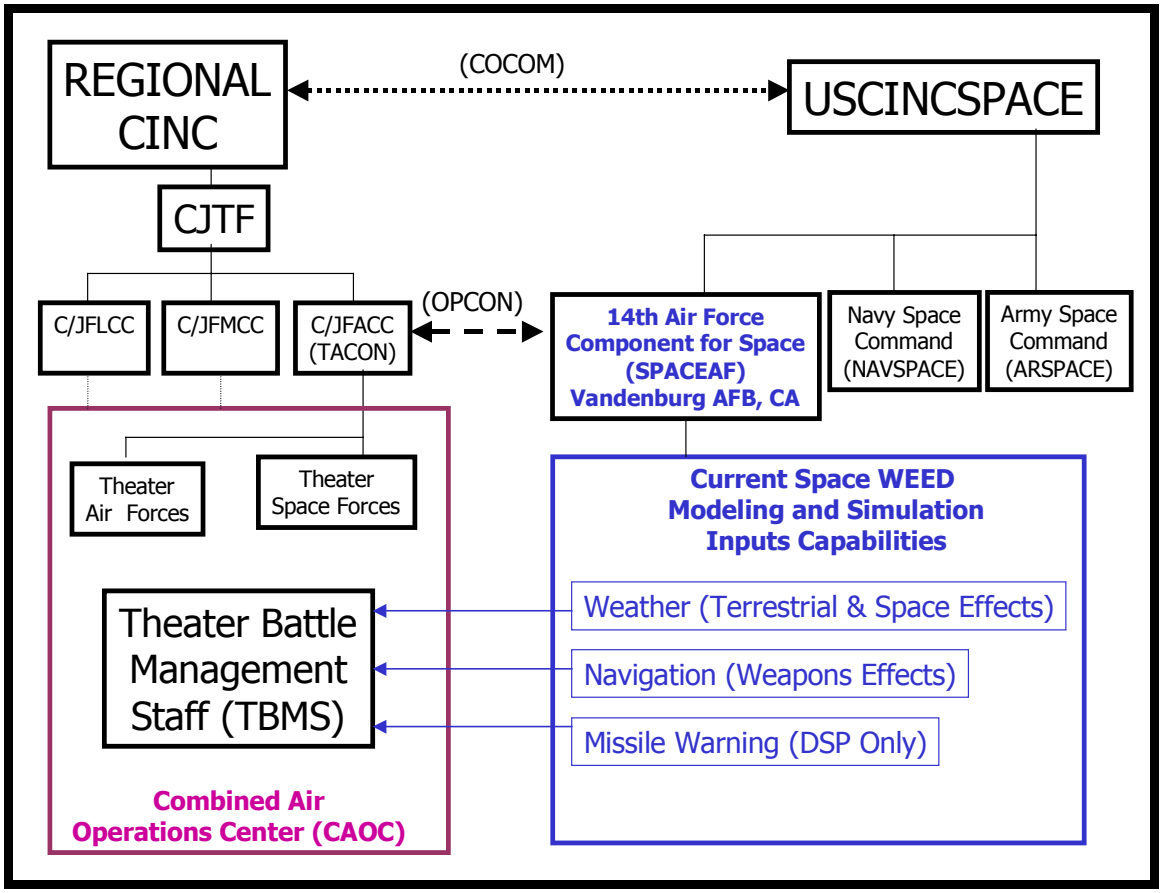

Figure 1-5. Current Space Modeling and Simulation Support

1.9 Document Organization. Section 2.0 discusses the four Space Mission Areas and Capabilities. It provides an overview of the missions and systems that compose the current national military space infrastructure. Future capabilities are also provided. Section 3.0 provides the current Wargames, Exercises, Experiments, and Demonstrations, and summarizes the methods and structures employed. Section 4.0 discusses current modeling and simulation capabilities, and joint training simulation initiatives in-progress. Section 5.0 documents references included in this document.

Thirteen Appendices define the functional requirements for the four AFSPC mission areas:

Appendix A: Force Enhancement: Space-based Navigation
Appendix B: Force Enhancement: Satellite Communications (SATCOM)
Appendix C: Force Enhancement: Environmental Monitoring (EM)
Appendix D: Force Enhancement: Surveillance and Threat Warning (S&TW)

Appendix E: Force Enhancement: Information Operations (IO)
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Appendix L: Force Applications: Prompt Global Strike
Appendix M: Force Applications: ICBM Operations

The Appendices provide the detailed space functional requirements. Each AFSPC submission area is addressed. These requirements are based on the operational structure of Figure 1-3, Space Assets, Forces, And Systems. Table 1.5 defines the nodes and links.

Table 1.5. Functional Requirements Definition

Nodes and Links	Description
Terrestrial Command & Control Node	This terrestrial node includes the COCOM and OPCON units responsible for providing space services to the joint warfighters. For example, the 2nd Space Operations Squadron (2 SOPS) is a terrestrial node that operates the Global Positioning System (GPS) constellation via the control link.
Control Link Communications	Control links enable telemetry, tracking, and commanding (TT&C) of the space node. For example, the 2 SOPS sustains the GPS using S-Band communications up/downlinks with signals generated at four ground antenna sites worldwide.
Space Node(s)	The space node includes satellites, space stations, or reusable space-transportation systems like the space shuttle. For example, the GPS Space Node consists of 21 satellites with 3 on-orbit active spares.
Mission Link(s)	The link is the information conduit between the terrestrial and the space nodes. Mission links provide information access to the warfighters. For example, GPS satellites broadcast downlink navigation and timing information on two L-Band Links designated L1 and L2.
Terrestrial Warfighter Nodes	This terrestrial node includes any land, sea, or airborne warfighter equipment used to interact with a space node. A pilot in the cockpit, with a GPS receiver, is a terrestrial warfighter node of the GPS space system.

2.0 SPACE MISSION CAPABILITIES

Stated in Section 1.0, Air Force Space Command (AFSPC) supports four mission areas: Force Enhancement, Space Support, Space Control, and Force Applications. These are now detailed.

2.1 Force Enhancement. The Force Enhancement mission area focuses on providing capabilities to enable or support air, land, sea, and space military operations. It is the means by which AFSPC helps achieve information superiority. Our space-related Force Enhancement capabilities provide the US military with a means of gathering and disseminating highly accurate information to provide our joint warfighting forces with situational awareness, effective C2 and maximum force effectiveness.

"Today's Force Enhancement capabilities provide vital situational awareness and C2 support to theater CINCs"

Air Force Space Command's Strategic Master Plan

Our current Force Enhancement capabilities are depicted in Figure 2-1 for the six sub-missions (functions) of Space-based Navigation, Satellite Communications, Environmental Monitoring, Surveillance and Threat Warning, Command and Control, and Information Operations.

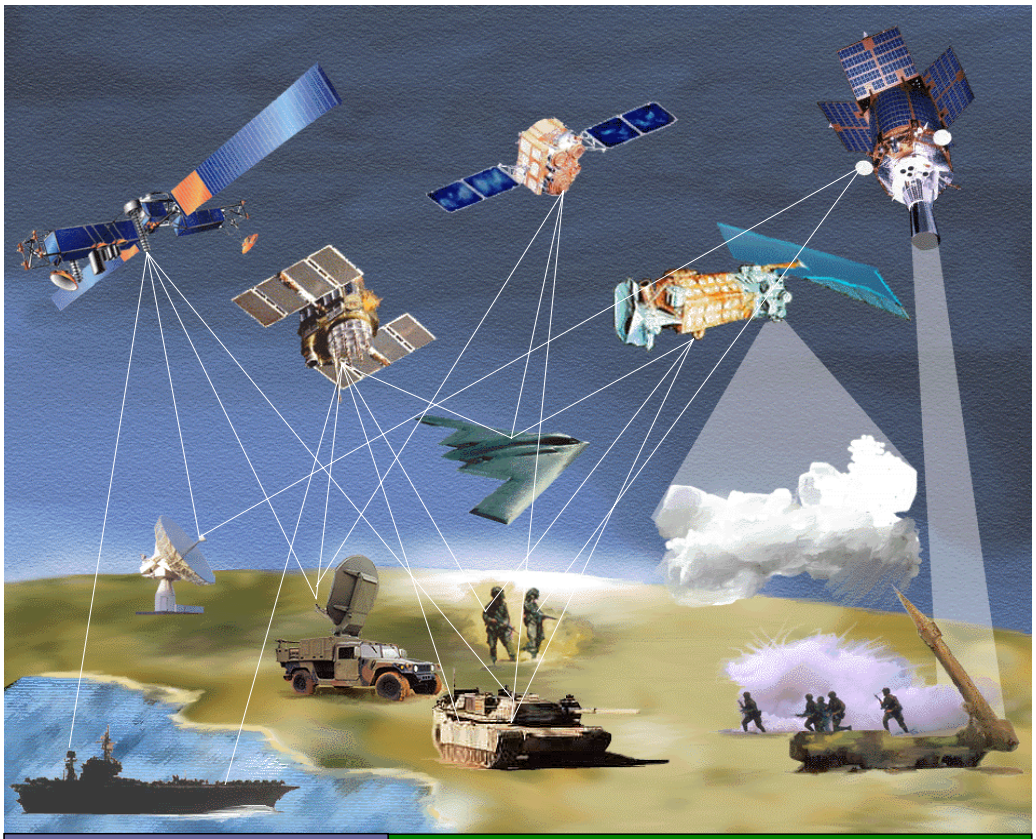
2.1.1 **Space-based Navigation Systems** provide three-dimensional position data and a timing standard to military, civil and commercial users worldwide, 24 hours a day. Precision positioning and timing provide targeting and geolocation information critical to coordinated and accurate force application by any platform in any medium. Today's space-based navigation systems provide nearly worldwide coverage out to low earth orbit (LEO).

AFSPC's current positioning and timing capabilities center on the GPS which is comprised of a nominal 24-satellite constellation, a Control Segment that includes a Master Control Station at Schriever AFB CO and a User Segment consisting of a variety of GPS receivers.

Though current GPS capabilities are very effective in meeting most of today's warfighting needs, there are some known shortfalls, and demands are growing rapidly. As operations move into global regions previously not addressed by our military, 100% global navigation support is needed under a variety of operating

conditions (e.g., through foliage and land structures, in jamming environments, etc.).

Demands for military operations to further lessen collateral damage around targets and to increase the effectiveness of intercepting airborne threats dictate increased accuracy. A huge increase in the use of complex communications networks also drives the need for improved timing data.



Current Systems	Current Capabilities/ *Limitations*	
GPS IIA/IIR	**Navigation**	- Global positioning/timing - *Vulnerable to jamming* - *Insufficient accuracy for future needs*
DSCS/Milstar/EHF Polar	**SATCOM**	- Near-global, high-capacity comm - *Limited bandwidth, capacity & polar coverage*
DMSP/SEON	**Environmental Monitoring**	- Terrestrial & space environment data - *Slow refresh rates & limited spectrum coverage*
DSP/BMEWS/PARCS/ PAVE PAWS	**S&TW**	- Missile launch detection - *Limited missile tracking* - *Limited warning of TBM attacks*
NORAD & USSPACECOM Command Center/AFSPACE AOC/ Missile Operations Center	**Command & Control**	- Global C2 of space and missile forces - *Stovepiped systems limit ability to monitor, assess, plan and execute operations*
Encryption/Physical Protection/ Computer Network Security	**Information Operations**	- Protected communications/mission critical data - *Limited DCI capabilities, no OCI capabilities*

Figure 2-1. Current Force Enhancement Capabilities

With the heavy reliance on GPS for all military operations, it has become paramount that our forces have assured access to precise navigation information in a challenged environment. Selective denial is also important to ensure future adversaries cannot use our systems against us. Finally, our reliance on GPS and the precision required of future operations raises the need for warning of signal degradation or failure. The GPS network must continue to evolve to meet these growing demands.

2.1.2 Current **DoD Satellite Communications** (SATCOM) capabilities provide military forces with near-global, high-capacity voice, data, and video communications links. These systems provide the essential conduits to supply combatant commanders with the information vital to the full range of successful military operations to include global power projection. Our SATCOM network provides the near-global coverage and flexibility unavailable through terrestrial-based communications networks.

The present SATCOM architecture includes both military-unique systems and DoD use of commercial services. SATCOM assets encompass the satellite payload, payload control facilities, platform control facilities and terminal capabilities required for Ultra High Frequency (UHF), Super High Frequency (SHF), and Extremely High Frequency (EHF) communications. Each frequency band has operational advantages while the aggregate combination of frequency bands provides a robust, complementary SATCOM architecture for combatant commander applications.

Mobile communications allow military commanders and battle managers to remain in contact with deployed forces and are vital to effective military operations. The Navy's UHF Follow-On (UFO) is the DoD's primary system for UHF SATCOM which best supports mobile communications. UFO also carries the current Phase 2 of the Global Broadcast System (GBS) providing high-capacity broadcast communications. AFSPC was responsible for UFO spacecraft control until it transferred to the Navy in 1999.

Robust, high-capacity communications provide the bulk of our military communications. Defense Satellite Communications System (DSCS) satellites provide SHF communications for both dedicated and common user elements throughout peacetime and conflict. AFSPC is responsible for DSCS spacecraft control while the Defense Information Systems Agency (DISA) is responsible for network and payload control.

Many users, including our President and Secretary of Defense (SECDEF), require secure, dedicated communications links to our forces around the globe. Our current Milstar satellites provide highly robust, protected and secure EHF

communications to tactical and strategic forces and the President/SECDEF. AFSPC provides for Milstar spacecraft control and communications management.

Though our existing SATCOM architecture provides adequate communication support to our joint forces, the demand for SATCOM will continue to grow and will exceed the capacity of our current SATCOM network. Additionally, UFO, DSCS and Milstar satellites all reside in geosynchronous orbits and are unable to provide communications to military forces at latitudes greater than about 65° N or below 65° S. Our current polar SATCOM capability consists of non-protected UHF services and limited protected EHF packages on classified host satellites.

2.1.3 The **Environmental Monitoring** (EM) sub-mission has two primary tasks: (a) provide terrestrial and tropospheric environmental data from space and (b) collect and provide space environmental information to specify and forecast the impact of the space environment on military activities.

Data from terrestrial and tropospheric sensors are used to support military planning and employment across all conflicts. Examples are mission planning forecasts, target forecasts for air tasking orders, tropical storm location and forecasting, forecasting for reconnaissance and surveillance systems, sea surface conditions for maritime operations and aviation conditions supporting global power projection.

To meet global and theater weather forecasting needs, the DoD weather satellite architecture is comprised of a combination of military, civil and international satellite systems. AFSPC provides a limited, but vital, piece of this architecture with the Defense Meteorological Satellite Program (DMSP). The National Oceanographic and Atmospheric Administration's (NOAA) Polar-orbiting Operational Environmental Satellite (POES) and Geostationary Operational Environmental Satellite as well as foreign geostationary satellites also provide civil augmentation.

The 6th Satellite Operations Squadron operated the DMSP satellites until May 1998. As the first part of a presidential-directed convergence of Department of Commerce and DoD polar-orbiting environmental satellite programs, responsibility for operating and maintaining the DMSP constellation was transferred to NOAA, with DoD backup performed by 6th Space Operations Squadron (Air Force Reserves) at Schriever AFB CO.

The DMSP constellation provides global coverage, but a key limitation is that revisit times range from three to nine hours. This results in an inability to assess the changes of significant weather features critical for accurate short range forecasts, such as needed for precision-guided munitions sorties. The constellation is also unable to collect measurements for key DoD user

requirements, such as low level winds over ground surfaces for forecasting the dispersion of NBC weapon effluents. Additionally, the data dissemination architecture results in data taking up to two hours to reach national centers for exploitation in forecast products.

The second major task for EM is to provide space weather information. The information is used to assess the space environment impacts on DoD systems. Key products include forecasts for degradation of communications capabilities, especially high frequency radio communications and SATCOM. Products also support ground- and space–based surveillance and reconnaissance systems. Environmental anomaly evaluations on space platforms are produced for system operators to assess natural versus man-made malfunctions. These assessments will be increasingly useful as adversary threats increase through the planning horizon.

Currently, a combination of ground- and space-based sensors feed space environment data to the 55th Space Weather Squadron, Schriever AFB CO, where warnings, forecasts, and analyses are prepared to support DoD operations. The space-based architecture includes DMSP augmented by civil, other DoD, and international space-based systems to provide a baseline of space environment measurements. In addition to satellite systems, AFSPC operates ground-based systems, such as the Solar Electro-Optical Network and an ionospheric measurement network, to augment the space-based measurements.

A limitation of the current network includes a lack of key parameter measurements needed to support all DoD requirements. For example, ionospheric disturbances, which blank out SATCOM in low latitudes, cannot be measured. In addition to the lack of core measurements, many existing measurements lack sufficient refresh and have excessive dissemination times, impacting the utility of the data to support real time operations. Data to forecast the onset of spacecraft charging events that degrade system capabilities is often not available until hours after the onset of the charging storm. Most current forecasting models of these types of phenomena only provide proxies for the information actually needed for user applications.

2.1.4 **Surveillance and Threat Warning** (S&TW) sub-mission capabilities enable worldwide situational awareness of terrestrial activities and threats affecting US and allied interests and provide attack assessment and warning to command authorities and deployed forces. Space-based S&TW capabilities provide surveillance and warning of high-interest threats, to include key fixed, moving and relocatable targets, as well as ballistic missiles.

Today's S&TW capabilities consist of satellites and ground stations for warning of missile and aircraft attacks. Geosynchronous Defense Support Program (DSP)

satellites provide Space-based capabilities of detecting missile launches, space launches, and nuclear detonations. Ground-based radars provide launch verification and warhead tracking. The current ground-based radars include the Ballistic Missile Early Warning System (BMEWS), Precision Acquisition Vehicle Entry Phased-Array Warning System (PAVE PAWS) and the Perimeter Acquisition Radar Characterization System (PARCS).

DSP was designed as a Cold War system to detect ICBM and Submarine Launched Ballistic Missile attacks on the US. Because missiles and weapons of mass destruction (WMD) are proliferating among nations and non-nation states, follow-on capabilities are needed to detect, track, and identify theater-ballistic missiles, cruise missiles, and other objects in all mediums worldwide.

The difficulties of intercepting these threats, once airborne, are great, warranting an ability to negate before launch. Hence, greatly improved surveillance and warning capabilities are needed to more accurately determine launch positions to guide counter-attacks; predict points of impact to minimize operations disruption; and discriminate among fixed, relocatable, mobile, and moving targets for pre-launch neutralization. The need for high reliability of these S&TW activities further warrants the use of multi-phenomenology rather than reliance on single phenomena such as infrared.

2.1.5 The **Command and Control** (C2) sub-mission enables situational awareness and provides the ability to command and control air, space, and missile forces at all levels of command. The C2 sub-mission focuses on getting the right information to the right forces in time to be effective.

The C2 infrastructure allows for the exercise of authority and direction over assigned forces including the processing, analysis, use, and dissemination of information to shape and dominate the battlespace.

The NORAD and USSPACECOM Command Center is the C2 node to accomplish worldwide warning of space and missile threats. The center also provides information on air threats. The NORAD and USSPACECOM Command Center and its related operations centers in Cheyenne Mountain CO have undergone communications and computer systems upgrades since the late 1980s to improve missile warning, space control and air defense C2 operations. AFSPACE (14th Air Force) at Vandenberg AFB CA is the Air Force warfighting component supporting the USSPACECOM mission.

The AFSPACE Aerospace Operations Center (AOC) monitors, plans and executes space force missions to control and exploit space for USCINCSPACE and theater components worldwide. The SPACEAF AOC represents an in-place space counterpart to the theater Air Operations Center and provides reachback space

operations support to theater operations by fusing intelligence, combat planning, combat operations and Battle Staff functions as shown in Figure 2-2.

The 20th Air Force (20 AF) at F.E. Warren AFB WY is the Air Force ICBM Task Force 214 to USSTRATCOM. The 20 AF Missile Operations Center provides the capability to command, control and monitor all ICBM forces. It supports USCINCSTRAT operational control of all alert ICBM forces and provides C2 of non-alert ICBM forces for AFSPC.

To give our unified CINCs the information superiority needed for full spectrum dominance, data from land, sea, air and space must be integrated, easily understood and accessible. Today's air, space, and missile C2 infrastructure consists of stovepiped networks. There is no single, multi-faceted point of contact for combatant commander space requirements. CINCs must extract what space and missile information they can and combine it with information from sources on land, sea, and air. To enable full spectrum dominance, this integration must be automated.

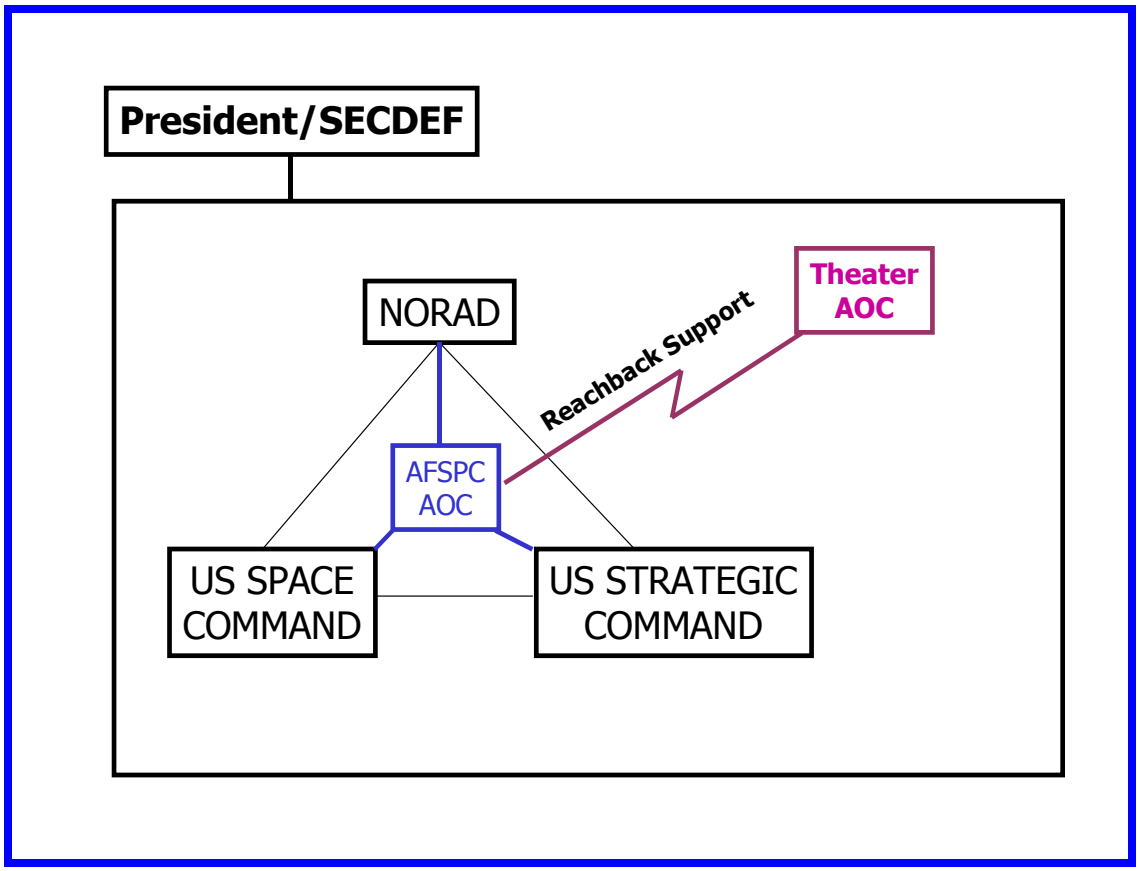


Figure 2-2. Command and Control: SPACEAF Aerospace Operations Center (SAOC)

2.1.6 **Information Operations** (IO) comprise those actions taken to gain, exploit, defend, or attack information and information systems. IO is conducted throughout all phases of an operation and across the range of military operations.

IO is divided into two different categories – *Information-in-Warfare* and *Information Warfare*. Information-in-Warfare includes operations to gain and exploit information. Current capabilities are provided by the other Force Enhancement sub-mission areas addressed above. Information Warfare, on the other hand, is IO conducted to defend friendly information and information systems or attack an adversary's information and information systems. Information Warfare consists of the function of counter information and its two subsets:

- *Defensive Counter-Information (DCI)* includes actions that protect information, information systems, and IO from any potential adversary.

- *Offensive Counter-Information (OCI*) includes actions taken to control the information environment. OCI operations are designed to limit, degrade, disrupt, or destroy adversary information capabilities.

To protect our most critical information links to and from satellites, we currently employ techniques such as encryption, frequency hopping, spot beams, and hardening. Physical protection measures for our ground sites and computer network security also provide some protection. However, we are becoming ever more reliant on space-based capabilities for military operations with an increased reliance on commercial space services that do not require the same level of protection as dedicated military systems. These trends, coupled with increasing threats to our information systems, highlight our need for improved DCI capabilities, which extend across other AFSPC mission areas.

The Air Force currently has limited capabilities to attack enemy information systems. Offensive operations include psychological warfare, electronic warfare, military deception, physical attack of an information system or integrated support system, or an information attack. As a command, however, AFSPC has little to no capability to attack enemy information systems. We must develop an OCI capability, especially as potential adversaries gain increased access to space-based services. Future OCI capabilities, as well and current and future DCI capabilities, will extend across other AFSPC mission areas (e.g., Space Control and Force Applications).

2.2 Space Support. The Space Support mission area advocates for and provides the capabilities to launch assets to space; reposition, recover, and service assets on-orbit; and operate the space assets as required. Space

Support consists of two sub-mission areas: Launch Operations and Satellite Operations. In addition, the Space Support mission area is the champion for AFSPC's Modeling, Simulation, and Analysis (MS&A) and Force Development Evaluation (FDE) planning activities. Current Space Support systems and capabilities are depicted in Figure 2-3.

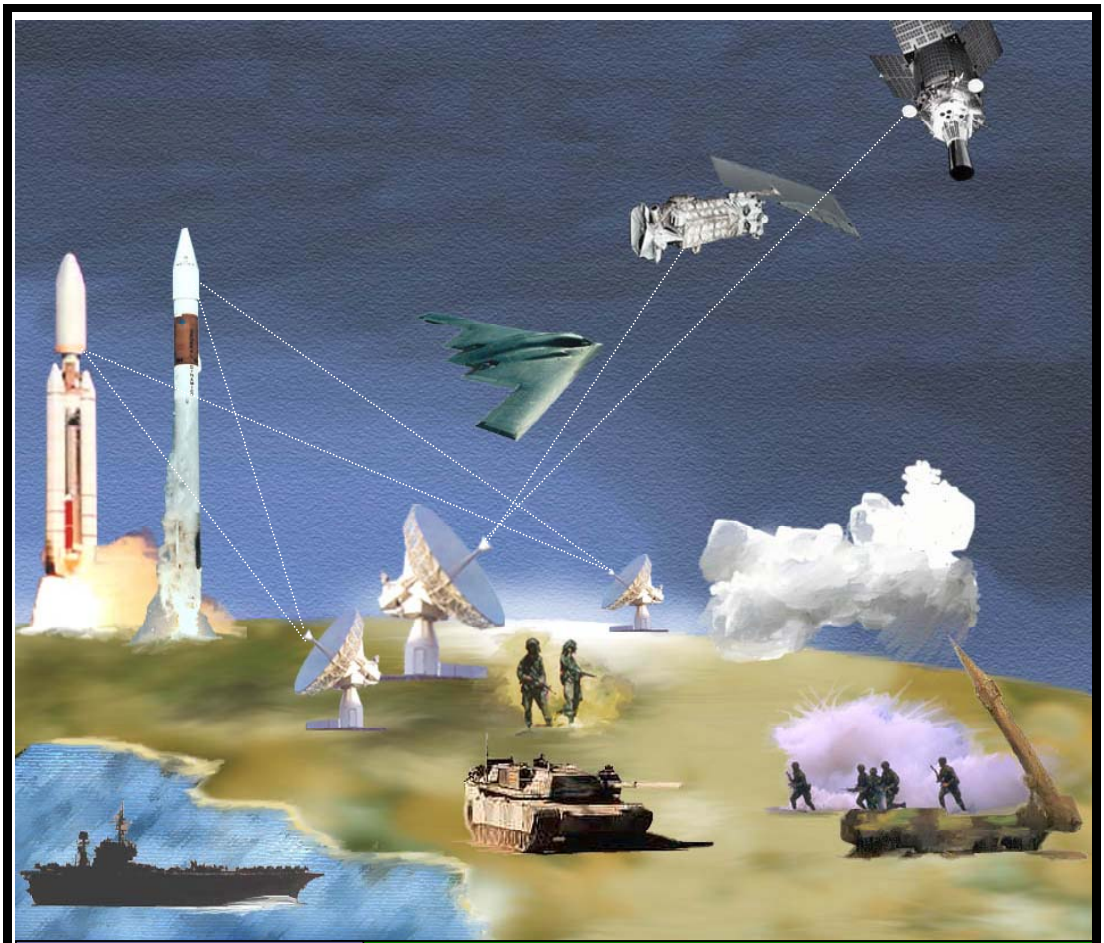
Though today's capabilities for conducting launch and satellite operations are, for the most part, provided through military-unique systems, an evolution from dedicated military systems to commercial and/or common government systems is underway. Specialized, expendable military launch vehicles; non-interoperable, non-standard satellite operations capabilities; and high operations and maintenance (O&M) costs characterize today's launch and satellite operations capabilities. Improving these capabilities to meet growing demands while reducing costs can free investment dollars to evolve other space and missile capabilities.

2.2.1 **Launch Operations** encompasses the traditional spacelift mission of delivering payloads to orbit, plus emerging missions such as on-orbit servicing, recovery, and repositioning. AFSPC's current capabilities for launch operations include launch vehicles, ranges, and infrastructure (e.g., space launch complexes, launch vehicle and payload processing facilities, etc.) for placing payloads in their required orbits. AFSPC does not currently have on-orbit servicing or recovery capabilities.

AFSPC's current fleet of launch systems is composed of a mix of medium and heavy lift expendable boosters. The Delta II, Atlas II, and Titan II provide AFSPC's medium lift capability, whereas the Titan IV provides heavy lift. In addition, AFSPC can access other sources to augment its launch requirements, though this practice is the exception and not the norm. If required, AFSPC can turn to private industry for use of small launch vehicles.

Collectively, these launch systems adequately meet our current peacetime demands for sustaining constellations. However, complex, non-standard launch vehicle-to-payload interface designs and lengthy processing timelines lead to costly operations for both payload and launch vehicle. Future operations demand a reduction in preparation and integration timelines from months to hours and a substantial reduction in O&M costs.

The Space Launch Range System (SLRS) consists of two ranges, the Eastern Range at Cape Canaveral AS FL and the Western Range at Vandenberg AFB CA. The favorable geographic location of both spacelift ranges ensures that launches occur away from major population centers. The Eastern Range and Western Range support the pre-launch, launch and tracking of DoD, Civil, and Commercial launch vehicles. In addition, the ranges support Space Shuttle landings, ballistic



Current Systems	Current Capabilities/ *Limitations*	
Atlas/Delta/Titan/Centaur/ Inertial Upper Stage Eastern and Western Ranges	**Launch Operations**	- Expendable medium/heavy lift launch vehicles - Expendable upper stages - Non-commercial, military unique - *Limited, aging infrastructure with high O&M costs* - *Launch-on-schedule capability only*
AF Satellite Control Network Program-Unique Architectures	**Satellite Operations**	- TT&C, mission data retrieval and LEO&A - *Non-interoperable, non-standardized infrastructure with high O&M costs*
PSM/OSCARS/SMAT/ASP/ THUNDER/SEAS **System-Unique FDE Capabilities**	**MS&A/FDE**	- Tools for system performance studies, exercises & wargames - *Minimal capability to quantify military value of space systems* - *Little to no FDE commonality across systems*

Figure 2-3 Space Support Systems Launch and Control DoD Space Assets

missile testing, and various guided weapons and aeronautical-related test and evaluation activities.

Though today's peacetime launch demands can be satisfied with this infrastructure, there are many signs of strain. Numerous components are either obsolete or are on the verge of obsolescence. Non-standard logistics for many one-of-a-kind pieces of range hardware reduce operability and result in higher O&M costs. Total infrastructure capabilities and its associated operability are a limiting factor in the monthly launch throughput at each range. Additionally, the current launch infrastructure is unable to support any new launch systems that come on-line that can be ready for launch within hours instead of today's weeks or months. The current Range Standardization and Automation (RSA) program is focused on improving operational efficiency through increased responsiveness, improved reliability, improved supportability, and reduced O&M costs. This modernization, scheduled to be completed in FY06, aims to accomplish a single, standard design for both ranges with standardized hardware, software, and procedures.

2.2.2 **Satellite Operations** consist of three tasks – TT&C; mission data retrieval; and Launch, Early Orbit and Anomaly resolution (LEO&A) support. With respect to the TT&C task, telemetry involves downlinking space asset bus and payload telemetry to a terrestrial point so that the space asset's health and status can be monitored. Tracking involves determining the position of the space asset so that the required antennas will be pointed in the correct orientation for future contacts with the space asset. Tracking also permits orbital accuracy for the position, orientation, and footprint calculations for each satellite's mission. Commanding involves uplinking instructions to the bus and payload so that they will perform the necessary operations. Mission data retrieval is the downlinking of information that is gathered by the payload. LEO&A involves a TT&C task being performed during the launch and ascent of the space asset, the separation of the space asset from the launch vehicle and during the initial phase of the space asset's life on-orbit. Anomaly resolution involves performing TT&C when an on-orbit space asset is experiencing problems.

Currently, common user and program-unique ground stations located around the world provide access to on-orbit assets. The Air Force Satellite Control Network (AFSCN) is a worldwide terrestrial-based infrastructure of ground stations and control centers that provides satellite operations services to select DoD, Allied and Civil satellites. The AFSCN is composed of two primary control nodes at Schriever AFB CO and Onizuka AS CA, eight remote tracking stations, and other control facilities around the world. The 1995 Congressionally-mandated Base Realignment and Closure Act identified Onizuka AS for realignment. Since then, the Air Force has been planning, as well as transitioning, satellite operations missions and critical support functions (e.g., network scheduling and collision avoidance) currently performed at Onizuka AS to Schriever AFB. The end result will be a single control node located in Colorado.

Today's AFSCN does not perform all satellite operations services for all satellite missions (i.e., DoD, Allied, and Civil satellite programs). Typically, the AFSCN provides an LEO&A service for the majority of satellite missions and provides a Telemetry, Tracking and Commanding (TT&C) service (prime or back up) for select satellite missions. The AFSCN provides mission data retrieval support for very few satellite missions. In the instances that the AFSCN does not support the satellite missions, those missions have program-unique ground stations and associated infrastructure in place to meet their specific satellite operations requirements. Although current AFSCN common user capabilities meet today's needs, lack of standardization and interoperability, an aging unique proprietary C2 system, high O&M costs, manpower intensive operations, and limited ground-based autonomy prevent the AFSCN from completely supporting the Space Support Vision of on-demand satellite operations execution.

When taken together, the AFSCN and the program-unique infrastructures provide the total satellite operations infrastructure that the Space Support mission area advocates. Although current common user and program-unique satellite operations infrastructures meet today's operational needs, the challenge is to align their future development paths so that they support the AFSPC Satellite Operations Vision End State of on-demand operations execution of any US Government on-orbit space assets to support the full spectrum of worldwide military operations.

2.3 Space Control. The Space Control mission area ensures the freedom of operations within and through the space medium, while denying its use to our adversaries, if required. As space has become an area of vital national interest, we must be prepared to protect and defend it. Space Control is thus essential to achieving the force multiplying effect of all space and missile capabilities. It includes three sub-missions: Space Surveillance, Counterspace, and NMD. Figure 2-4 depicts our current Space Control systems and capabilities.

2.3.1 **Space Surveillance** provides the ability to detect, track, characterize, classify, catalog, monitor, and disseminate information about all man-made space objects, whether operational platforms or debris. Near-real-time space situational awareness is a key contributor to controlling the space medium. These capabilities provide an awareness to the theater CINC of overhead activities (e.g., intelligence gathering or communication satellite windows) that could impact operations. They also provide awareness of dangers to friendly satellites that may warrant maneuvers to preclude loss or degradation of capabilities, anomalies in adversarial space operations that provide insights to changes in terrestrial force operations and changes in friendly space operations that warrant actions to remedy lost or degraded capabilities.

Current Systems	Current Capabilities/ *Limitations*	
GEODSS/MOSS/DSTS/Eglin/ BMEWS/PAVE PAWS/ PARCS	**Space Surveillance**	- Ground-based systems to identify, track & catalog space objects - *Limited against small objects (all altitudes)* - *Limited in timeliness*
None	**Counterspace**	- Some survivability countermeasures - *No negation capability*
None	**NMD**	- *No current capability*

Figure 2-4. Today's Space Control Systems Focus on Space Surveillance

We currently employ a combination of ground-based radars, passive radio-frequency tracking sites and optical sensors to perform Space Surveillance. Dedicated sensors, those with the primary missions of space surveillance, include the Naval Space Command Fence, Ground-based Electro-Optical Deep Space Surveillance System (GEODSS), Mobile Optical Surveillance System, Deep Space Tracking System, and Eglin Radar. Collateral sensors such as BMEWS, PAVE PAWS, and PARCS, whose primary missions are other than space surveillance, augment these systems. Contributing sensors, such as the Lincoln Space

Surveillance Complex and Kwajalein Missile Range, provide data through leasing or other sharing agreements.

Today's systems detect, identify, characterize, track, and catalog man-made space objects. However, the network cannot consistently detect small debris and has limited capability to detect, track, and characterize objects in high-altitude orbits. Further, neither the surveillance capabilities, nor the space surveillance data processing capabilities are currently adequate to meet the event processing timelines mandated by USSPACECOM and get space surveillance information to the unified CINCs in near-real-time. With more and more nations and commercial organizations exploiting space, surveillance is rapidly growing in importance. As other missions evolve to become more dependent on space platforms for information, communications, and possible combat operations in and through space, it is paramount that we have high reliability and timeliness of situational awareness of this medium. Real-time characterization of space platforms, from initial deployment through operational life, will become critical to assess potential threats from space maneuvers, foreign ISR, and configuration changes to space-based or space-transient weapons. More sensors of higher quality, better orbit coverage and better observational data are needed to locate, track, and characterize objects more precisely.

2.3.2 **Counterspace** – our increasing reliance on space systems and information derived from space creates a center of gravity that potential adversaries clearly understand. Counterspace provides the capability to exploit that center of gravity. Defensive Counterspace (DCS) involves the protection of US and Allied space assets from adversary attack or exploitation. DCS includes active and passive measures to detect, assess the impact of, and minimize threats (natural or man-made) to, friendly space systems or the unauthorized use or exploitation of those systems. Offensive Counterspace (OCS) involves negating an adversary's ability to use space systems and assets. OCS includes the ability to deny, disrupt, deceive, degrade, or destroy (D5) an adversary's space systems or services. It involves military actions to target ground support sites, ground-to-space links, and space platforms, when required by command authorities.

Today's Counterspace capabilities are very limited. Survivability countermeasures have been added on a case-by-case basis to US and Allied satellite systems for protection against jamming, signal interception and nuclear detonation. However, AFSPC has limited abilities to detect, characterize, and assess intrusions into friendly space operations, limited ability to prevent an adversary from exploiting AFSPC systems and no current capability to negate an adversary's use of space.

One measure being taken to protect our space assets is the development of a space aggressor capability by the Space Warfare Center (SWC). During FY99

exercises, the SWC employed a limited space aggressor capability. To expand this capability, the SWC is currently standing-up a Space Aggressor Squadron (SAS). The mission of the SAS will be to perform the role of a space adversary in support of exercises, testing, training and Air Expeditionary Force (AEF) preparation. The goal of the SAS is to increase awareness of threats from space-capable adversaries and improve US ability to defend against them.

2.3.3 **National Missile Defense** (NMD) focuses on protecting North America against limited ballistic missile attacks. This capability is achieved through integration of the NMD system elements with the Integrated Tactical Warning and Attack Assessment system to execute the NMD mission. This sub-mission area only addresses the neutralization of threats. Surveillance and threat warning of attacks and the C2 of NMD intercepts are part of the Force Enhancement mission area.

Despite the reduced threat from the former Soviet Union, the ballistic missile threat has not disappeared. The proliferation of missile technology and WMD has raised the concern over potential limited attacks on the US, thereby threatening our political and economic well-being.

Today, the ICBM force is deployed for deterrence, but that deterrence carries varied credibility, depending on the nature of a potential adversary, whether nation or terrorist group. It also provides no defense against missile attacks, once launched. The US currently has no NMD capability.

2.4 Force Applications. The overarching objective of the Force Applications mission area is to conduct global operations by the direct and prompt application of force from and through space against terrestrial targets. The primary goal is to provide precise, prompt, global strike capability with selective lethality thus deterring aggression or achieving military objectives when use of force is directed. Figure 2-5 depicts our current Force Applications systems and capabilities.

Force Applications capabilities focus on holding a finite number of terrestrial targets at risk anywhere, anytime with nearly instantaneous attack from or through space. They provide increased speed of response, short cycle times to counter high-value targets, a high probability of target neutralization and, hence, a high deterrent value to preclude hostilities.

Today's Force Applications systems consist of nuclear-armed Minuteman III and Peacekeeper ICBMs. These ICBMs provide strategic deterrence by holding hostile targets at risk, as well as employing the capability to destroy, disrupt, or neutralize those targets. The Peacekeeper provides the most credible capability against many high-value targets; however, Peacekeeper is planned to be retired

once the Strategic Arms Reduction Treaty (START) II is ratified by Russia and is entered into force. Until such time, effective Peacekeeper operations require continued funding for spare parts, replacement equipment, and possible modernization. Peacekeeper manning levels are also a potential stumbling block in the Future Years Defense Program (FYDP).

Current Systems	Current Capabilities/ *Limitations*
Minuteman III **Peacekeeper**	**Prompt Global Strike** - Nuclear-armed ICBMs provide deterrence *- No conventional strike capability for neutralizing adversary targets*

Figure 2-5. Force Applications Current Capabilities

Manning for the Peacekeeper program begins to drop off of unit manning documents starting in FY00. Vandenberg AFB loses its Peacekeeper instructor slots in FY00, and F.E. Warren AFB loses all crewmember slots by the third quarter of FY02. To sustain Peacekeeper, Air Staff will have to restore manpower authorizations during the FYDP.

Currently, the US has few options for conventional, low risk, prompt strike. The ability to apply conventional force from or through space would add options for deterrence and flexible response for the President/SECDEF when time is absolutely critical, risk associated with other options is too high, or when no

other courses of action are available. Such actions may be warranted in limited conflicts, but could also provide significant benefits during the early stages of major conflicts, buying time for additional air, land, and sea forces to respond.

3.0 WARGAMES, EXERCISES, EXPERIMENTS, AND DEMONSTRATIONS (WEED) REQUIREMENTS

The AFSPC's Space Warfare Center (SWC) is the designated major command lead executing space participation in joint and service components WEED. Modeling and simulation capability is critical to effective WEED support. This dynamic support must model all aspects of global and theater space doctrine, command and control relationships, and space systems capabilities and vulnerabilities. Figure 3-1 overviews this total space force participation in the aerospace concept of operations.

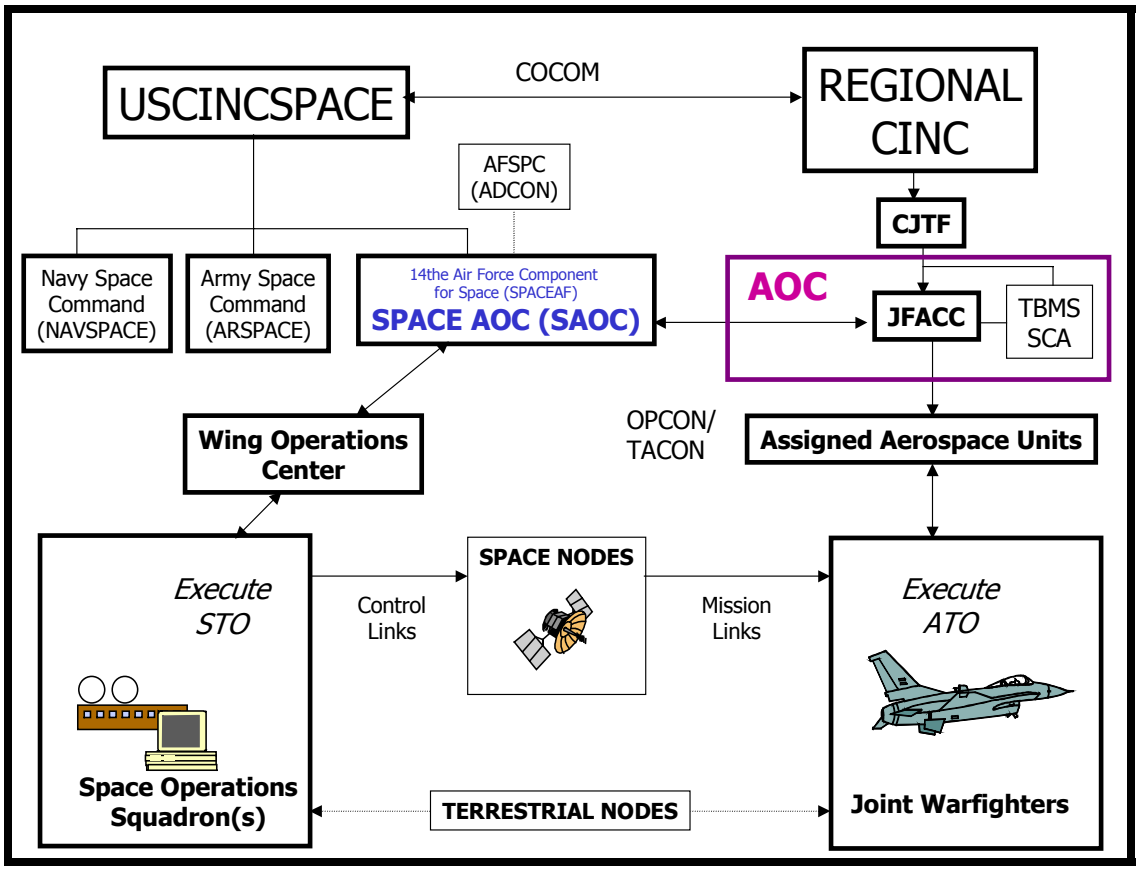


Figure 3-1. Global And Theater Space Doctrine, Command and Control, and Nodes and Links

The Air Tasking Order (ATO, also referred to as the Aerospace Tasking Order) provides the order and tempo of air operations within theater or Area of Responsibility (AOR). In parallel, Space Forces execute the Space Tasking Order (STO) to configure on-orbit space assets and theater deployable space forces to support the ATO, Land, and Sea operations. Command relationships, and assigned missions and tasks are pointed out in Figure 3-1. Missions and tasks

execution is carried out by the AOR joint warfighters supported by the tasked SOPS using the nodes and links introduced in Section 1.0.

3.1 Combatant Command (COCOM). The Unified Command Plan (UCP) establishes USSPACECOM as the functional unified command for space. The USCINCSPACE has COCOM of all global space forces. All activities, either offensive or defensive, that affect the space node must be coordinated with USSPACECOM. This ensures the global nature of space support is sustained for all Areas of Responsibility (AORs).

USSPACECOM operates assigned military space forces through its service component commands: Army Space Command (ARSPACE), Naval Space Command (NAVSPACE) and SPACEAF, the Air Force component. The mission of SPACEAF is to employ space forces for ballistic missile warning, navigation, communications, spacelift, and counterspace, and to provide satellite operations capabilities.

Non-military Space assets can provide critical space capabilities for commanders. USSPACECOM neither operates nor controls space assets assigned to national agencies such as the National Aeronautics and Space Administration (NASA), National Reconnaissance Office (NRO), National Oceanic and Atmospheric Administration (NOAA), or those owned by civilian corporations and international consortiums such as International Telecommunications Satellite Organization and International Maritime Satellite. Many non-military organizations have established coordination channels through the theater staffs (including liaison officers in theater). Joint force commanders may request USSPACECOM assistance in coordinating with these non-military organizations for optimal utilization of their capabilities.

The regional CINC provides the theater prioritization of space requirements to USCINCSPACE. After USCINCSPACE determines how to meet the requirements, USCINCSPACE will provide feedback on how, or if, those requirements will be met to support the regional CINC. USCINCSPACE and the regional CINC will determine the command relationships necessary to meet the requirements.

USSPACECOM executes national strategy based on requests from multiple theaters, requirements for national defense A and maintenance of on-orbit space assets. USSPACECOM uses the Space Operations Center (SPOC) to publish mission-type orders in the format of an Operations Order (OPORD) for its components to execute to meet space requirements.

Deconfliction for theater counterspace effects must include both a global and a theater perspective. Global deconfliction is the responsibility of USCINCSPACE. Theater deconfliction is the responsibility of the regional CINC, or if delegated, the CJTF. The regional CINC or his designated CJTF and USCINCSPACE work together

to ensure proper integration of space effects and minimize unintended consequences.

3.2 Theater Operational Control (OPCON) Responsibilities. Command and control of theater forces is normally delegated to the Commander, Joint Task Force (CJTF), or one of the component commanders. The CJTF serves as the appointing authority of the Space Coordinating Authority (SCA). The SCA's sphere of influence and focus is the JTF as a member of the Theater Battle Management Staff (TBMS). Nominally, The Joint Force Air Component Commander (JFACC)/Commander Air Force Forces (COMAFFOR) represents space within the JTF including that of SCA and supported commander for the aerospace campaign, which is the combination of air, information, and space effects. Within the CJTF, the JFACC is responsible for the Aerospace Task Order (ATO). The SPACEAF is delegated the responsibility and authority to provide the JFACC theater space support through SCA coordination with the theater Aerospace Operations Center (AOC).

The SCA serves as the focal point for gathering space requirements within the JTF from the J-staff and each component commander. These requirements include requests for space forces (i.e., Naval Space Support Team), requests for space effects (i.e., Denial of adversary access to SATCOM), and requests for implementation of specific command relationships (i.e., A direct support relationship between the AOC and 11th Space Warning Squadron for theater missile warning). The SCA develops a recommended prioritized list of space requirements for the CJTF. The SCA will prioritize the requirements based on the JTF objectives. While the SCA can facilitate non-traditional uses of the space assets, JTF planning staffs should utilize the established processes for fulfilling intelligence and communications requirements. Once the prioritized requirements are approved by the CJTF, the approved list would be provided to the regional CINC.

3.3 SPACEAF Operational Control (OPCON) Responsibilities. USCINCSPACE normally delegates OPCON of assigned forces to the Service components. COMSPACEAF has OPCON for Air Force-controlled space forces that produce global effects. The Space Tasking Order (STO) is the SPACEAF AOC's main product. SPACEAF uses its standing AOC to translate the OPORD into the STO for the execution of AF global space forces.

The SPACEAF AOC synchronizes its battle rhythm with the theaters. The theater operations drive SPACEAF's schedule requirements. By adjusting its operational schedule, SPACEAF will maximize support to the theater. If more than one theater is being supported, an operational schedule will be adjusted to maximize support to all theaters.

SPACEAF, assisted by the Wing Operations Center (WOC) translates the OPORD into the daily STO issued to the Space Operations Squadrons (SOPS). The STO production cycle is based on the six-step targeting cycle described in Joint Publication 3-56.1, *Command and Control of Joint Air Operations*. The cycle is designed around the joint standard of 72 hours (48 hours for planning and 24 hours for execution). However, the cycle is flexible and can be lengthened or shortened to meet battle rhythm requirements.

3.4 Joint Training Employing Modeling and Simulation Capabilities. Current space representation inputs are highlighted in Figure 3-2. Current modeling and simulation support requires interaction between the joint warfighter, AOC, SAOC, and the WOC and SOPS to provide timely, effective mission support.

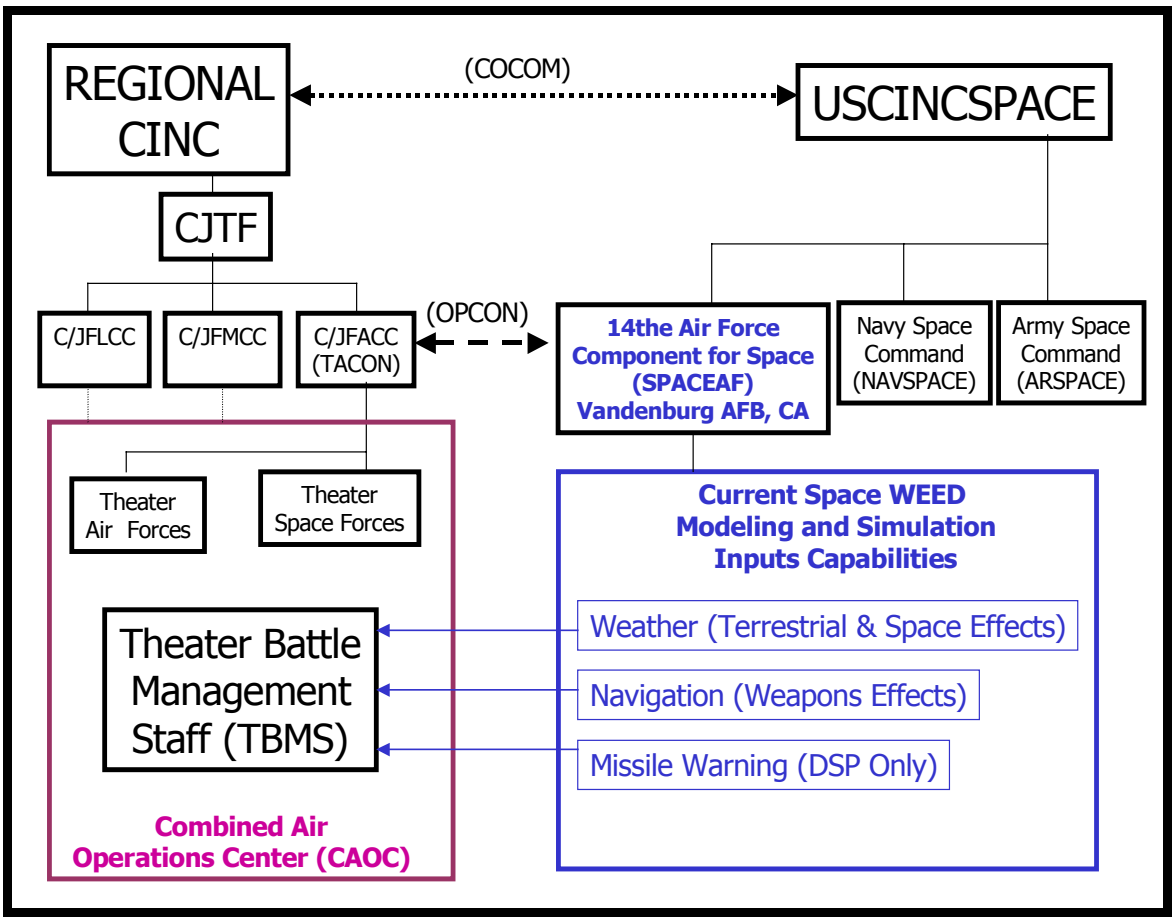


Figure 3-2. Current (2001) Space Representation Inputs to WEED

The Joint Expeditionary Force Experiment (JEFX) conducted during August and September 2000 provides an example of the entire modeling and simulation architecture. The air, land, sea, and space elements participating in JEFX 2000 are shown in Figure 3-3. The JEFX 2000 profile is given in Table 3.1.

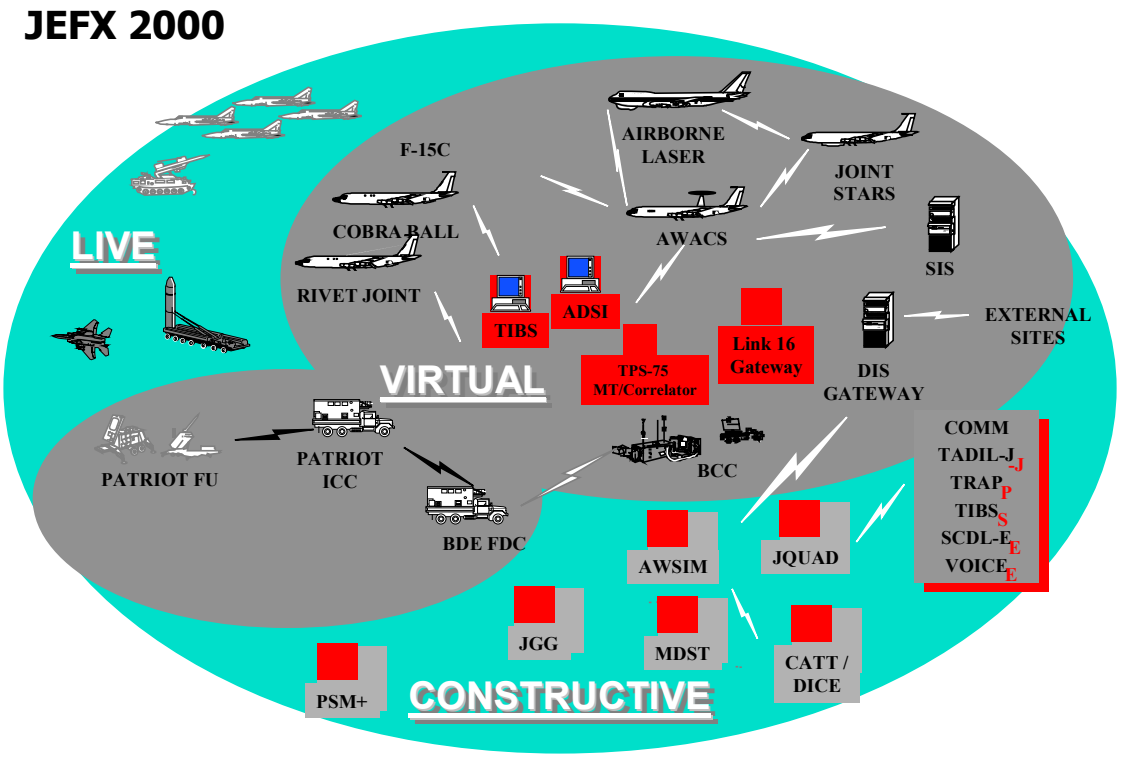


Figure 3-3: Advanced Distributed Simulation (ADS) Architecture

Table 3.1. JEFX 2000 Profile	
Date	**Event**
25 August 2000	Training & Team Building
31 August 2000	Vignettes
8 September 2000	Defensive ATO
9 September 2000	D-Day; Offensive Ops
11 September 2000	Full Live-Fly & Simulation
14 September 2000	End of Exercise
15 September 2000	Debrief

The JEFX 2000 Combined AOC (CAOC) was located at Hurlburt Field, FL. Other participating locations are shown in Figure 3-4. Modeling and simulation tools provided the constructive element of the ADS architecture.

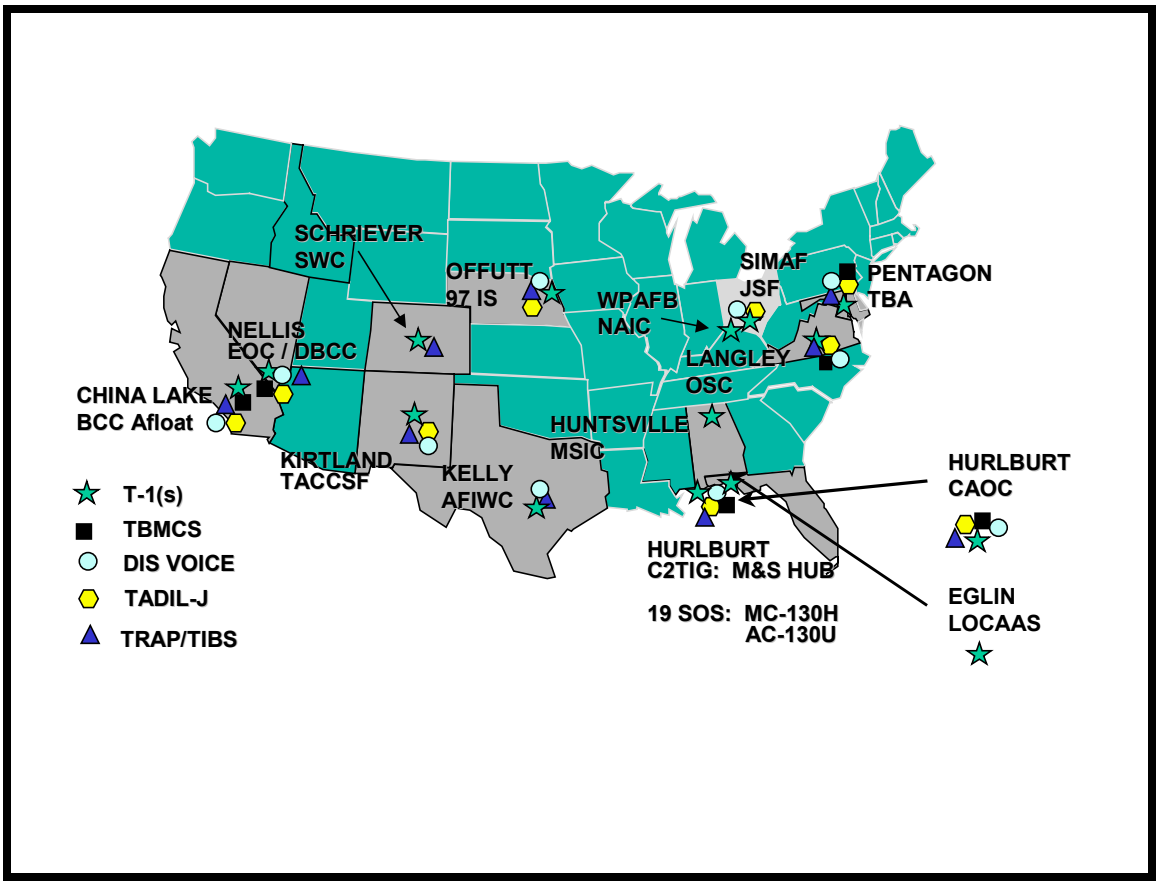


Figure 3-4 Participating Locations

The existing tools and capabilities used to support this scale of WEED are described in Section 4.0. For JEFX 2000, the Satellite and Missile Analysis Tool (SMAT) was used to provide accurate modeling and simulation of orbital and ground-based systems. Portable Space Model Plus (PSM+) generated high fidelity GPS performance information to other simulation entities. The Geophysical Environmental Effects Distributor (GEED) determined weather effects on the sensors and weapons systems performance - specifically lock-on ranges. This information was also be used to adjust the probability of kills based on the entities generated.

The Missile Defense Space Tool (MDST) provided simulated missile launch warning message approval/coordination/dissemination. The Logistics Simulation (LOGSIM) model provided the simulated logistics chain required to sustain the operational tempo.

Information databases from these tools were input into the Aggregate Level Simulation Protocol (ALSP) network. The ALSP for JEFX 200 consisted of the JOVE, JQUAD, and AWSIM components providing the "constructive" inputs into the ADS.

The Joint Operational Visualization Environment (JOVE) allowed three-dimensional representation and visualization of the information model databases in the constructive form of the joint battlespace. JOVE will be located in exercise control to be utilized by the senior exercise controller and control staff.

The JQUAD is an interactive suite of four different simulations: Joint Electronic Combat/Electronic Warfare Simulation (JECEWSI), Joint Command and Control (C2) Attack Simulation (JCAS), Joint Networks Simulation (JNETS), and Joint Operations Information Simulation (JOISIM). The JQUAD suite provided the ground environment and intelligence and electronic warfare profiles.

The Air Warfare Simulation (AWSIM) generated the air operations environment during JEFX 2000. Figure 3-5 overviews the JEFX 2000 modeling and simulation architecture, and Figure 3-6 provides the C4I Interfaces.

The current scope of Exercises and Wargames supported by space modeling and simulation tools of this type are presented in Tables 3-2 and 3-3.

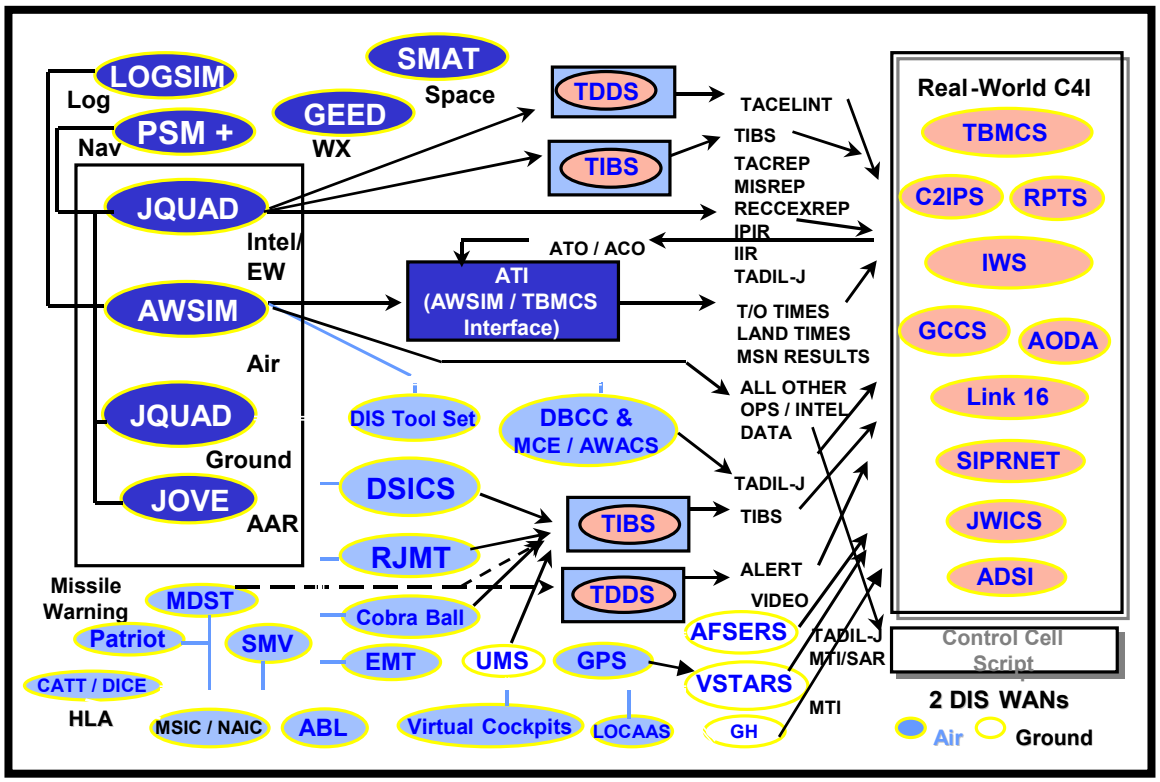


Figure 3-5: JEFX 2000 Modeling and Simulation Architecture

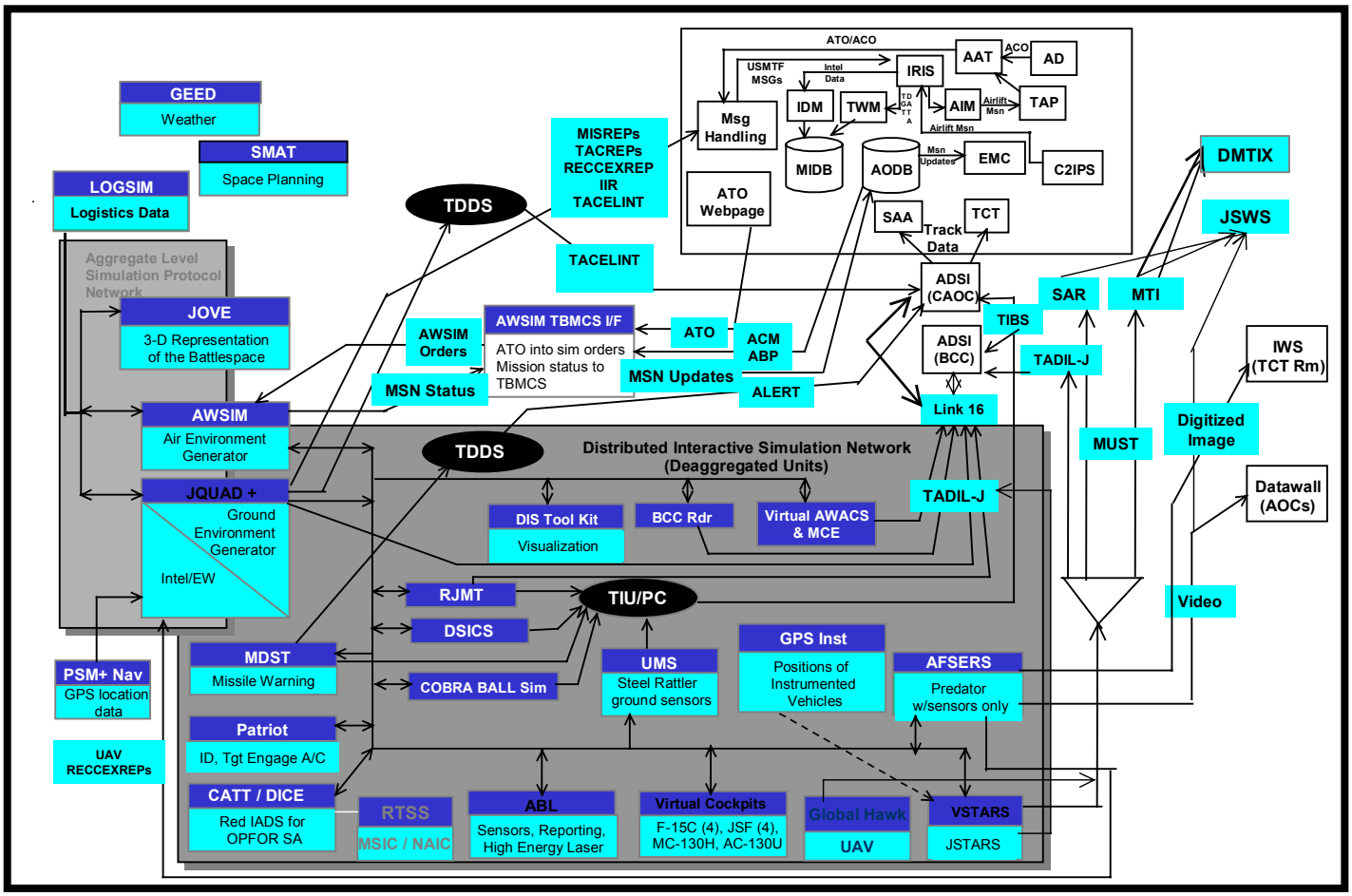


Figure 3-6: JEFX 2000 C4I Interfaces

TABLE 3.2. KEY EXERCISE EVENTS
Ulchi Focus Lens/Apollo Lens **Sponsoring Organization: USFK, 7AF & USSPACE** *Purpose:* UFL is an annual ROK-US Combined Forces Command Post Exercise designed to provide the Theater, Component Commanders and Army Corps commanders/staffs with an advanced training environment to improve their war fighting skills.
Northern Edge/Cope Thunder **Sponsoring Organization: ALCOM** *Purpose:* An interdiction exercise hosted by the 354th FW at Eielson AFB and the 3rd WG at Elmendorf AFB. All PACAF flying units are required to attend at least one of the four Cope Thunders each year. Space members will be integrated into the AOC to create the ATO.
Cobra Gold *Sponsoring Organization: PACOM/USCINCPAC* *Purpose:* Designed to train combined Thai/USPACOM joint and combined commanders/staffs on task force operations. It is a three part exercise; CPX, FTX and CALFEX.
Union Flash *Sponsoring Organization: USAFE* *Purpose:* The USAFE Warrior Preparation Center conducts Union Flash to train combat leaders and support battle staff in command, control and intelligence procedures for different theaters of operation. Space members are exposed to theater AOC operations and participate in formulating the ATO.
Internal Look *Sponsoring Organization: CENTCOM* *Purpose:* Battle Staff exercise to train JTF staffs on command, control, communications, countermeasures and intelligence (C4I).
Blue Flag *Sponsoring Organization: ACC & 8AF, 9AF or 12AF* *Purpose:* Air Force directed and sponsored, multi-service, Joint Air Operations Center (JAOC) training exercises conducted at the operational level of war. Gulf Flag will include multinational forces and will take place in the JTF-SWA AOR. Blue Flags will emphasize theater battle management training in a joint/combined air

TABLE 3.2. KEY EXERCISE EVENTS
operations center setting incorporating constructive simulations and a generic scenario set in a fictitious AOR.
Roving Sands *Sponsoring Organization: USJFCOM/ACC* *Purpose:* Roving Sands is an annual Joint Tactical Air Operations (JTAO)/Theater Missile Defense (TMD) exercise employing Army, USAF, USN, USMC and Allied air defense.

Table 3.3. KEY WARGAMING EVENTS
Aerospace Future Capabilities Wargame (AFCW) - Title X Air Force Future Wargame Series *Sponsoring Organization:* HQ USAF/XPX *Purpose*: Explore alternate paths leading to AF Vision.
Focused Logistics Wargame *Sponsoring Organization:* JS/J-4 *Purpose:* Assess Service logistic support capability.
Global Engagement (GE) Wargame - Title X Air Force Operational Wargaming Series *Sponsoring Organization:* HQ USAF/XOC *Purpose:* Focus on future operational issues.
Schriever 200X Wargame *Sponsoring Organization:* AFSPC *Purpose:* Explore Air, Space and Information Operations integration, looking to enable future space doctrine, strategy, force structures and warfighting capabilities.
Army Transformation War Game (ATWG) - Title X Army Wargame Series *Sponsoring Organization:* USA TRADOC *Purpose:* Army War College seminar wargames, current focus is for strategic/global deployment and conflict termination and operational/tactical level operations of the Objective Force in one CJTF.

Table 3.3. KEY WARGAMING EVENTS
Navy Global Wargame – Title X Navy Wargame Series *Sponsoring Organization:* Chief of Naval Operations *Purpose:* Focus on future Navy issues.
Joint Land, Aerospace, and Sea Simulation (JLASS) Wargame *Sponsoring Organization:* six Senior Service Colleges *Purpose:* JLASS promotes the joint professional military education of all participants by addressing key issues at the strategic and operational levels of war.

4.0 SPACE MODELING AND SIMULATION TOOLS

4.1 AFSPC Space Modeling and Simulation Tools. Existing space modeling and simulation tools support joint wargames, exercises, experiments, and demonstrations providing inputs to the Theater Battle Management Staff component of the Combined Air Operations Center (CAOC). Tools currently in use by AFSPC/SWC and/or under development are listed in the following four tables, 4.1 through 4.4.

Table 4.1. Force Enhancement Area Current Space Modeling and Simulation Tools	
Space-based Navigation	The Portable Space Model Enhance Navigation (PSM+ Nav) is an approved model for all ALSP and DIS exercises. PSM+ connects directly to the Joint Command and Control Attack Simulation (JCAS) model, an entity of the JQUAD suites of tools. PSM+ has incorporated the Space Navigation Accuracy Prediction Model (SNAPM) for modeling navigation accuracy, the TAOS weather model for incorporating scintillation effects, and some basic receiver and jamming code to model different munitions-receiver pairings and rudimentary Navigation Warfare (NAVWAR) scenarios.
Satellite Communications (SATCOM)	The SIAM model addresses some aspects of communications networks within the links and nodes architectures. SIAM and COSMOS models communications networks from a links and nodes perspective, and can include throughput thresholds and time-delays. SMAT can model satellite communication coverage and links between satellites and ground stations. Specific frequencies (UHF, EHF, SHF) are not explicitly modeled, nor is throughput.
Environmental Monitoring (EM)	Total Atmospheric Ocean Service (TAOS) is an ESC product that uses real-world and simulated databases and has been integrated with MDST for cloud cover and PSM+ Nav for scintillation. TAOS is currently the model of choice for Weather products. AFWA OL-S has integrated weather aspects into SMAT. This capability affects line-of-sight from space entities to areas on the ground based on forecast cloud cover. Future activities will address importing real-time weather, affecting TBM warning with cloud cover and addressing space weather affects on navigation and communication assets and mission. Space Battle Management Core Systems (SBMCS) has developed linkages to 55th Space Weather Squadron to give warfighters real-time updates of pre-defined weather products, and also gives status and constellation updates.

Table 4.1. Force Enhancement Area Current Space Modeling and Simulation Tools	
Surveillance and Threat Warning (S&TW)	Missile: Strategic and Theater Attack Modeling Process (STAMP) can model the booster portion of single- and two-stage to orbit rockets. SMAT is working on incorporating those algorithms to model satellite insertion from launch to orbit. Missile Detection: SMAT models the Satellite Surveillance Network that can emulate ground-based missile warning detection and dissemination. The TACCSF at Kirtland AFB is heading an integrated effort to model Tactical Air Warning System (TAWS) that would combine space, ground and air-based missile detection assets and fuse/correlate the data to help the active missile defense mission. SMAT and MDST have both been looked at for the space-based detection piece; COBRA BALL simulation will address the air piece; and several ground-sensor models are being considered for the ground-based detection simulations. ISR: SMAT models ISR collector location and propagation, as well as sensor Field of View. SMAT can also model other sensor volumes, such as "butterfly" and "donut" patterns. SMAT can do rudimentary TPED modeling by showing satellite-to-ground-station look angles, but does not model specific tasking or data flow. Through the space gateway integration, SMAT has "flown" space-based ISR sensors and reported TADIL-J traffic on appropriate air and ground entities. SMATRAN is a special version of SMAT that specifically addresses the capabilities of foreign and commercial ISR assets. It has been used for operational analysis as well as wargaming support. SMATRAN utilizes Satellite Reconnaissance Advance Notice (SATRAN) algorithms with extra SMAT capabilities for graphics and reporting. COSMOS is the ISR tool used for planning, assessment and operations during Title X wargames. Sensor Platform Allocation Analysis Tool (SPAAT) is used to determine the optimal mix of sensors and platforms required to accomplish the reconnaissance and surveillance mission. This optimization fits in the overall picture of the OODA (observe, orient, decide, act) loop at the orient/decide phase. ISR optimization bounds the feasible region of the trade space. An ISR mix that produces improved battlespace knowledge can be fed into campaign or mission models to illustrate/quantify the military worth of ISR.
Command and Control	The Space and Information Analysis Model (SIAM) analyzes information flows on the battlefield to determine effects-based target priorities and information degradation from weapons use. Displays communications paths, identifies choke points, prioritized targets, analyzes strategies/courses of action, and identifies intelligence gathering shortfalls.
Information Operations (IO)	The USSPACECOM Computer Network Operations JTF is currently consolidating requirements.

Table 4.2. Space Support Area Current Space Modeling and Simulation Tools	
Launch Operations	Strategic and Theater Attack Modeling Process (STAMP) can model the booster portion of single- and two-stage to orbit rockets. SMAT is working on incorporating those algorithms to model satellite insertion from launch to orbit.
Satellite Operations	The Space Operations Scheduling and Management System (SOPSMAN) is designed to automate the up to 400 commands per day to approximately 100 satellites monitored by fifteen ground antennas located worldwide, and provide an integrated contact schedule.

Table 4.3. Space Control Area Current Space Modeling and Simulation Tools	
Space Surveillance	ISRSIM SSNAM is a tool used by the AFSPC Space Analysis Center (AFSPC/XPY) (formerly HQ SWC/AES, then AFSPC/CVY) to analyze the performance of the Space Surveillance Network (SSN). Satellite and Missile Analysis Tool (SMAT) visually models the SSN and can report objects passing through sensor fences or volumes. This capability has not been integrated into an exercise in the past, but could be included through the space gateway tool that links SMAT to air and ground models. SMATRAN is a special version of SMAT that specifically addresses the capabilities of foreign and commercial ISR assets. It has been used for operational analysis as well as wargaming support. SMATRAN utilizes Satellite Reconnaissance Advance Notice (SATRAN) algorithms with extra SMAT capabilities for graphics and reporting. The Intelligence and Data Analysis Space Simulation (IDASS) tool is operated by AFRL/VS at Kirtland. It has been used for analysis of space entities for purposes of intelligence gathering. IDASS primarily runs at the SCI level, as should SMAT orbitology and visualization within the IDASS analysis model.

Table 4.3. Space Control Area Current Space Modeling and Simulation Tools	
Counterspace	Protection: Explicit modeling not required. Prevention: SMAT can model satellite and ground station locations, and the sensor interaction between points on the ground and space assets. Denial of space-based information can be modeled with existing SMAT functions; increased linkages to other Intel models to show the impact are being addressed with current SMAT upgrades. The Space Information Analysis Model (SIAM) is modeling space assets within an integrated network and subsequent intelligence flow, both for US and non-US entities. Negation: SMAT has several algorithms to address naval, ground, and space based directed and kinetic energy weapons. Modeling of microsats does not currently exist within SMAT, but there are engineering level models being developed at AFRL Kirtland for the XSS-10/11 microsat programs.
National Missile Defense (NMD)	Missile: Strategic and Theater Attack Modeling Process (STAMP) can model the booster portion of single- and two-stage to orbit rockets. SMAT is working on incorporating those algorithms to model satellite insertion from launch to orbit. Missile Detection: SMAT models the Satellite Surveillance Network that can emulate ground-based missile warning detection and dissemination. The TACCSF at Kirtland AFB is heading an integrated effort to model Tactical Air Warning System (TAWS) that would combine space, ground and air-based missile detection assets and fuse/correlate the data to help the active missile defense mission. SMAT and MDST have both been looked at for the space-based detection piece; COBRA BALL simulation will address the air piece; and several ground-sensor models are being considered for the ground-based detection simulations. Models SMAT has included several algorithms regards Space Based Laser (SBL) operations, including dwell time and satellite removal. SMAT-based SBL "clear the skies" analysis was an integral part of the Schriever 2001 CAVs from the program office at Eglin in order to better model this space-based Force Application methodology. SMAT does not inherently model de-orbiting of vehicles, thus it cannot model the concept of de-orbiting space vehicles into deep-strike targets.

Table 4.4. Force Application Area Current Space Modeling and Simulation Tools	
Prompt Global Strike	Analysis of Alternatives (AoA) is projected to start in FY04. Modeling and Simulation tools developed for the AoA are possible candidates for future use.
ICBM Operations	USSTRATCOM uses a number of ICBM related models and planning tools to include AEM; AWPS; JMASS, MEM, and RISOP. STAMP is the NAIC approved model for ICBM trajectory algorithms and ballistic missile profiling.

4.2 Industry Listing of Space Modeling and Simulation Tools. Table 4.5 provides the industry listing and status of tools available to support modeling and simulation requirements.

Table 4.5 Current Modeling and Simulation Tools	
	FUNCTION
ARC3VAL: *Architecture C3 Validation*	Establishes a distributed command, control and communications system architecture and assesses detailed mission and communication performance against a variety of input mission scenarios. Legacy use for KE ASAT System.
ArcView (ESRI)	GIS/ comprehensive desktop mapping tool.
CATS (aka HiTEES): *Coverage Acquiring Tracking Simulation*	N-State Kalman Filter used for multiple active and/or passive sensor track estimation for ground, air and space based sensors. Incorporates effects of solar and target detection outages.
COSMOS (ISRSIM): *C4ISR Space and Missile Operations Simulator* (*Intelligence, Surveillance, and Reconnaissance Simulator)*	A concurrent execution interfaced set of C4ISR and Ballistic Missile Defense (BMD) simulators for use in systems and architecture analyses spanning the spectrum of global, national and Theater Ballistic Missile Defense (TBMD). ISRSIM models space, air, ground and sea based sensors and weapons as well as space/air recon. sensors, intelligence processing, battle management and connectivity to assess performance of TBMD architecture/systems.

MODEL NAME	FUNCTION
DAPAM: *Distributed Architecture Performance Assessment Model*	Sensor-Weapon-Target feasibility coordinated and autonomous battle management, fire control, object accounting with interface to 6-DOF models. (Curtis)
DVM: *Dynamic Visibility Module*	Accurately estimates the observability or "visibility" of SBIRS, FEWS targets moving within the portion of the atmosphere containing clouds. Target visibility is a function of the dynamic interaction of the LOS between moving target, sensors and the clouds.
EADSIM: *Extended Air Defense Simulation*	Mission-level simulation used to assess the effectiveness of Theater Missile Defense (TMD) and air defense systems against the full spectrum of extended air defense threats
Geophysical Environmental Effects Distributor (GEED)	Determines weather effects on the sensors and weapons systems performance, specifically lock on ranges. This information was also be used to adjust the probability of kills based on the entities generated.
ENVI *Environment for Visualizing Images*	Image-processing system designed to provide comprehensive analysis of satellite and aircraft remote sensing data.
GEODE: *Geometrical Emulation and Orbital Development Environment*	3-D Target & Sensor generates trajectories, transforms coordinates, calculates LOS Motion, creates SSGM viewing geometry parameters and generates SASSI target position and area radiance files.
GIANT:	GIANT is a one versus many constructive and repeatable simulation tool used to determine GPS/INS system performance and operational effectiveness in a GPS Threat environment. It addresses single GPS/INS platforms, zero to many GPS denial jammers, DTED, GPS performance and position error output measures. Also, GIANT can aggregate target kills and attrition across multiple missions to perform battle effectiveness analyses.
HITRAN	Atmospheric Transmission & Emission Calculation NPOESS with High Fidelity (Line by Line) calculations. (See also, MODTRAN and LOWTRAN)

MODEL NAME	FUNCTION
ION: *Insertion of Noise*	(SASSI-related) Introduces nuclear sensor effects into the processing stream.
KSAT:	Initializes space based targets and space based kinetic energy weapons. Propagates weapons and targets and determines intercept windows and engagement characteristics.
Leakage Budget	Establishes a performance probability tree (Markhov chain) for simple to complex systems. Quickly generates Monte Carlo performance results of system using thousands of cases. If high fidelity models are used to back up individual performance probabilities, can be a powerful/meaningful tool for system performance assessment.
LOWTRAN	Atmospheric Transmission & Emission Calculation FEWS, EADD with Low Fidelity calculations. (See also, MODTRAN and HITRAN)
MapInfo	GIS/ comprehensive desktop mapping tool.
MODSAF	Government model for virtual simulation of combat for ground and air forces. Models individual entities (tanks, planes, etc.) following real world tactics. Follows Distributed Interactive Simulation (DIS) standard. Runs on PC or Unix box.
MODTRAN	Atmospheric Transmission & Emission Calculation SBIRS, EADD with Medium Fidelity calculations. (See also, LOWTRAN and HITRAN)
OPAL: *Object Processing Algorithm Library*	Processes image sequences produced by SASSI with spike adaptive filters, etc. Provides the image processing algorithms necessary to detect and create object-sighting messages.
PSM+ *Portable Space Model Plus*	High fidelity GPS performance model which supplies GPS performance to other simulation entities.

MODEL NAME	FUNCTION
RADARSIM: *Radar Simulation*	Space-Based radar simulation for high-level architecture studies of SAR and AMTI utility. Includes ability to interact with real-world interactive wargames as demonstrated at SMC in the DSL.
SASSI: *Signature & Sensor System Investigator*	Simulates with high fidelity passive staring/scanning EO systems accounting for optical blur and temporal effects (LOS motion, drift, jitter) and including detector gain, responsivity, and noise. It outputs realistic raw, pre-processed image sequences.
SBIRS (S3): *Space-Based Infrared System Simulation*	Real time SBIRS representation. Takes in constellation parameters and input threat scenarios, generates messages in real time representing SBIRS Increment 1 or 2 performance.
SCREAM:	The SCREAM code models the propagation of nuclear particles caused by an exoatmospheric nuclear event. The model calculates dose rates experienced by satellites in various orbits over time until a full steady state pumped belt condition is achieved.
SEAS: *System Effectiveness Analysis Simulation*	Air Force model that acts as a multi-mission, two-sided, force-on-force, Monte Carlo combat model with explicit sensor geometry and information network topology constrained by circuit time delays.
SMAT: *Satellite and Missile Analysis Tool*	SMAT is Space Command's premier modeling and simulation tool for space analysts, mission planners, educators, trainers, and warfighters. SMAT is used to support many operations, exercises such as Blue Flag and Union Flash, wargames such as Global Engagement, and experiments such as the Joint Expeditionary Force Experiment. SMAT uses standardized algorithms for accurate modeling and simulation of orbital and ground-based systems. Among these are SGP4, Overfly, LAMOD, SATRAN, STAMP, and COMET.

MODEL NAME	FUNCTION
SPECTOR: *Satellite Performance of Earth Coverage and Tracking with Outage Regions*	SMAT is verified and validated in accordance with DODI 5001.61 and AFI 16-1001. The SWC/CC has accredited SMAT as a modeling, simulation, and analysis (MS&A) tool to support Command-directed Analyses, Education, Exercises, Wargames, Experiments and Demonstrations.
STAMP: *Strategic and Theater Attack Modeling Process*	STAMP is a ballistic missile and space launch vehicle flight generator and engineering analysis tool. It models missile flights from launch to impact, and presents extensive flight characteristics and trajectory descriptions. STAMP can also model numerous US and Foreign space launch vehicles from launch to orbital insertion.
STK: *Satellite Tool Kit*	Tool for analyzing complex land, sea, air and space scenarios and determine optimal solutions with the ability to present results in graphical and test formats for interpretation and analysis.
STK VO: *Satellite Tool Kit Visualization Option*	STK Option which displays 3D views of space, airborne and terrestrial assets, sensor projections, orbit trajectories, etc.
Total Atmospheric Ocean Service (TAOS)	ESC product that uses real-world and simulated databases and has been integrated with MDST for cloud cover and PSM+ (Nav) for scintillation.
THUNDER/STORM: *I(Synthetic Theater Operations Research Model)*	A theater level warfare simulation (developed under USAF sponsorship) used to evaluate force structures, conduct AoA studies, develop strategies and tactics, and facilitate senior staff training through war-gaming.
TEAM: *Target Error Analysis Model*	Initializes ground based surveillance radars and space based orbiting or ballistic objects. Uses 6-state Kalman Filter to establish error ellipsoids resulting from radar measurements. Propagates errors and keeps track of objects as they pass from one radar to the next. Can be used to cue weapon simulations. For ballistic targets, used for impact point prediction.

MODEL NAME	FUNCTION
TRACK	Initializes ground and space based surveillance systems and ballistic or orbiting targets. Propagates objects, rotates earth and develops surveillance windows of all targets. Can be used to establish commit times and cues for weapons simulations. Also used for surveillance system performance characterization.
SIMTOOLS	SAIC product, which provides a virtual view of DIS entities on the battlefield. Includes realistic terrain displays in 3 dimensions. Allows users to station his view from any modeled entity or to position themselves at any location. Runs on PC under Microsoft NT>

5.0 REFERENCES

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1999 FORCE ENHANCEMENT MISSION AREA PLAN

1999 SPACE CONTROL MISSION AREA PLAN

1999 SPACE SUPPORT MISSION AREA PLAN

APPENDIX A
Space-Based Navigation

Joint Simulation Functional Requirements Definition

Mission: Force Enhancement **Function: Space-based Navigation**

Navigation support objects must serve to model the application and impacts of Global Positioning System (GPS) services from space to service receiver. The GPS Signal-in-Space is used by a multitude of systems for military specific applications. Applications include location awareness, orientation, navigation, precise time and time interval (PTTI), position and velocity accuracy determination, aiming and targeting, munitions guidance, synchronization, fratricide prevention, maneuver, intelligence, battlefield damage assessment, electronic warfare, aviation, and combat service support.

Resident space navigation support objects must allow wargame planners to adjust course of action for GPS availability, signal integrity, accuracy, coverage, reconstitution, and supportability.

A.1. TERMS and DEFINITIONS.

Space systems are comprised of nodes and links, as shown in Figure A-1. There are two types of nodes: terrestrial and space. The nodes are tied together with links. There are two types of links: control and mission.

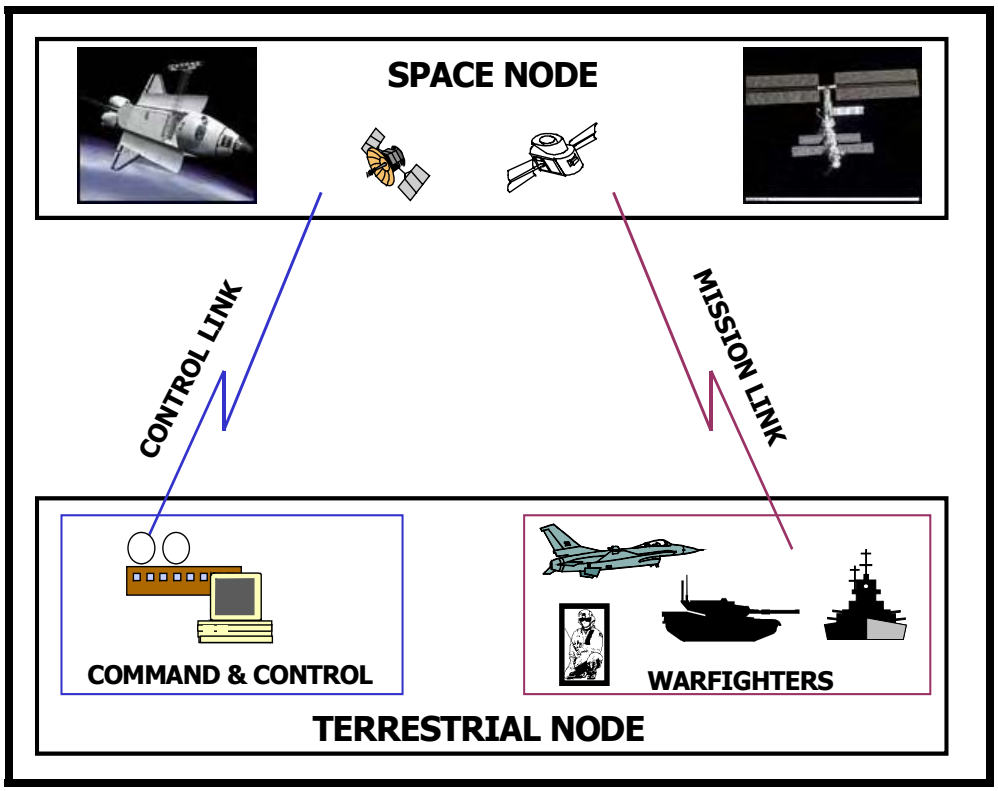

Figure A-1

The space node includes satellites, space stations, or reusable space-transportation systems like the space shuttle. The terrestrial node includes any land, sea, or airborne equipment used to interact with a space node. The link is the information conduit between the terrestrial and the space nodes. Control links enable telemetry, tracking, and commanding (TT&C) of the space node. Mission links enable space effects.

A.2. TERRESTRIAL NODE COMMAND AND CONTROL.

The 2nd Space Operations Squadron (2 SOPS), assigned to the 50th Space Wing operates the GPS Master Control Station located at Schriever AFB, CO. Functional relationships are shown in Figure A-2. 2 SOPS employs monitor stations located at Schriever AFB, Cape Canaveral, Ascension Island, Diego Garcia, Kwajalein Atoll, and Hawaii sites. These five stations capture the L-band user signal-in-space; the information is used to update the signal content and to provide integrity indications. Four ground antenna sites, collocated at Schriever AFB, Cape Canaveral, Ascension Island, Diego Garcia, and Kwajalein Atoll provide the S-band TT&C to control the constellation configuration.

The USSPACECOM Space Operations Center (SPOC) issues operations orders and the SPACEAF Aerospace Operations Center (SAOC) issues tasking orders for operational control.

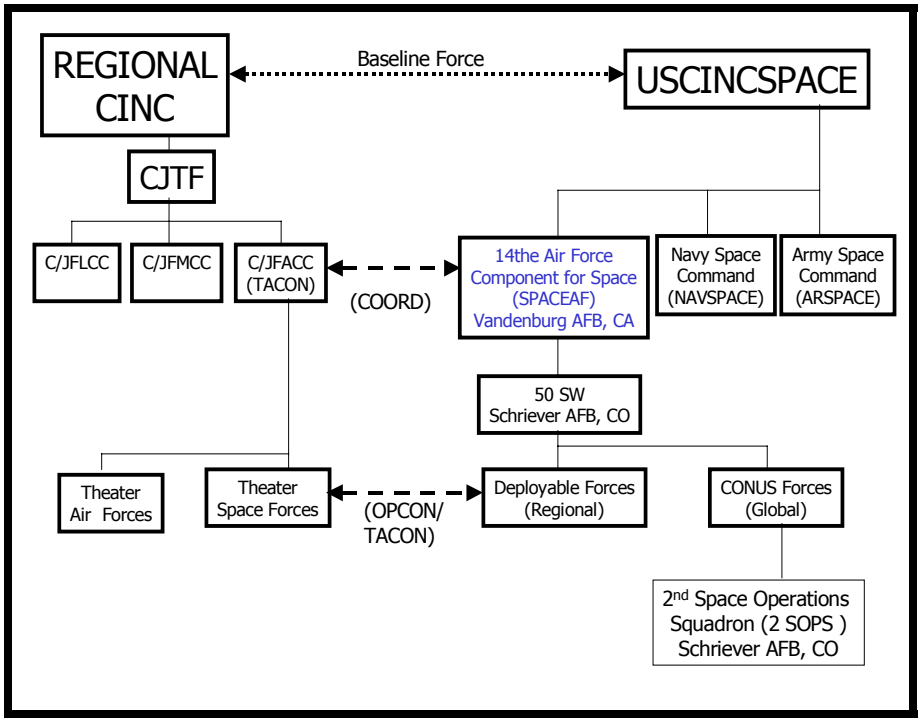

Figure A-2

A.3. CONTROL LINK COMMUNICATIONS.

Communications includes description of ground site to satellite links and broadcast navigational data monitor station downlinks. Characteristics include transmission/modulation scheme, vulnerability to jamming/countermeasures/ environmental effects, power, bandwidth, frequency, antenna specifications and hardness specifications.

A.4. SPACE NODE FUNCTIONALITY.

GPS Satellites. Characteristics include orbital location, vulnerability to attack, communications capability, geographic coverage, NAVWAR capabilities and environmental interactions.

GPS Satellite Navigation Payload. Characteristics include operating frequency, timing stability, output power, antenna specifications and accuracy of navigational data.

A.5. MISSION COMMUNICATIONS LINK.

Communications includes description of broadcast navigational data downlinks. Characteristics include transmission/modulation scheme, vulnerability to jamming/countermeasures/ environmental effects, power, bandwidth, frequency, antenna specifications and hardness specifications.

A.6. TERRESTRIAL NODE: WARFIGHTER.

GPS Receiver Systems. Characteristics include required signal to noise ratio, noise rejection capabilities, processing time, navigational accuracy, frequency, antenna specifications, and vulnerability to natural interference (ionospheric scintillation).

A.7. EXISTING MODELS AND SIMULATIONS.

The Portable Space Model Enhance Navigation (PSM+ Nav) is an approved model for all ALSP and DIS exercises. PSM+ connects directly to the Joint Command and Control Attack Simulation (JCAS) model, an entity of the JQUAD suites of tools. PSM+ has incorporated the Space Navigation Accuracy Prediction Model (SNAPM) for modeling navigation accuracy, the TAOS weather model for incorporating scintillation effects, and some basic receiver and jamming code to model different munitions-receiver pairings and rudimentary Navigation Warfare (NAVWAR) scenarios. SWC/DOG is looking at replacing SNAPM with the SBMCS navigation accuracy algorithms (Verified and validated for operational use) and

incorporating certain aspects of the GPS Interference and Navigation Tool (GIANT) model for jamming.

SBMCS is implementing the navigation accuracy algorithms developed during the TENCAP project Space Information and Data Architecture (SPIDAR). These algorithms were V&V'd by SWC/AEA for accuracy and are accessible by operators in the field through the SBMCS system for GPS accuracy predictions and GSP system health and status.

GIANT is a GPS Joint Program Office-developed and approved tool for GPS effectiveness analyses modeling. GIANT is a constructive and repeatable mission-level simulation used to determine navigation performance and its impact upon air-to-ground and surface-to-surface operational effectiveness.

OMEGA is a laptop-based tool to perform GPS accuracy predictions. It was developed by the 76 SOPS as an interim capability until SNAPM. SNAPM never reached the field and thus OMEGA is still being used as SBMCS evolves.

SMAT has recently incorporated some of the OMEGA algorithms for the purpose of creating GPS accuracy prediction charts for PDOP values.

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APPENDIX B
Satellite Communications (SATCOM)

Joint Simulation Functional Requirements Definition

Mission: Force Enhancement **Function: Satellite Communications**

SATCOM capabilities provide military forces with near-global, high-capacity voice, data and video communications links. These systems provide the essential conduits to supply combatant commanders with the information vital to the full range of successful military operations to include global power projection. The SATCOM network provides the near-global coverage and flexibility unavailable through terrestrial-based communications networks. The present SATCOM architecture includes both military-unique systems and DoD use of commercial services. SATCOM assets encompass the satellite payload, payload control facilities, platform control facilities and terminal capabilities required for Ultra High Frequency (UHF), Super High Frequency (SHF) and Extremely High Frequency (EHF) communications. Each frequency band has operational advantages while the aggregate combination of frequency bands provides a robust, complementary SATCOM architecture for combatant commander applications.

B.1. TERMS and DEFINITIONS.

Space systems are comprised of nodes and links, as shown in Figure B-1. There are two types of nodes: terrestrial and space. The nodes are tied together with links. There are two types of links: control and mission.

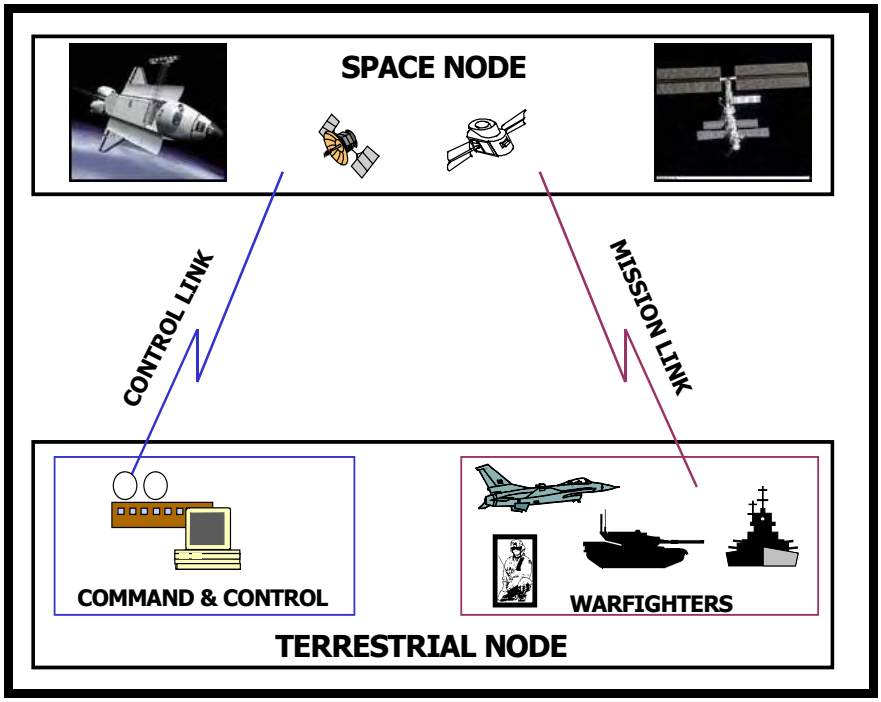

Figure B-1

The space node includes satellites, space stations, or reusable space-transportation systems like the space shuttle. The terrestrial node includes any land, sea, or airborne equipment used to interact with a space node. The link is the information conduit between the terrestrial and the space nodes. Control links enable telemetry, tracking, and commanding (TT&C) of the space node. Mission links enable space effects.

B.2. TERRESTRIAL NODE COMMAND AND CONTROL. 50th Space Wing assigned squadrons provides command of Air Force military satellite communications capabilities.

The Defense Satellite Communications System (DSCS) is operated by the 3rd Space Operations Squadron (3 SOPS), located at Schriever AFB, CO and the 5th Space Operations Squadron (5 SOPS), located at Onizuka AS, CA. The 4th Space Operations Squadron (4SOPS), located at Schriever AFB, CO operates the Milstar System. Functional relationships are shown in Figure A-2-1.

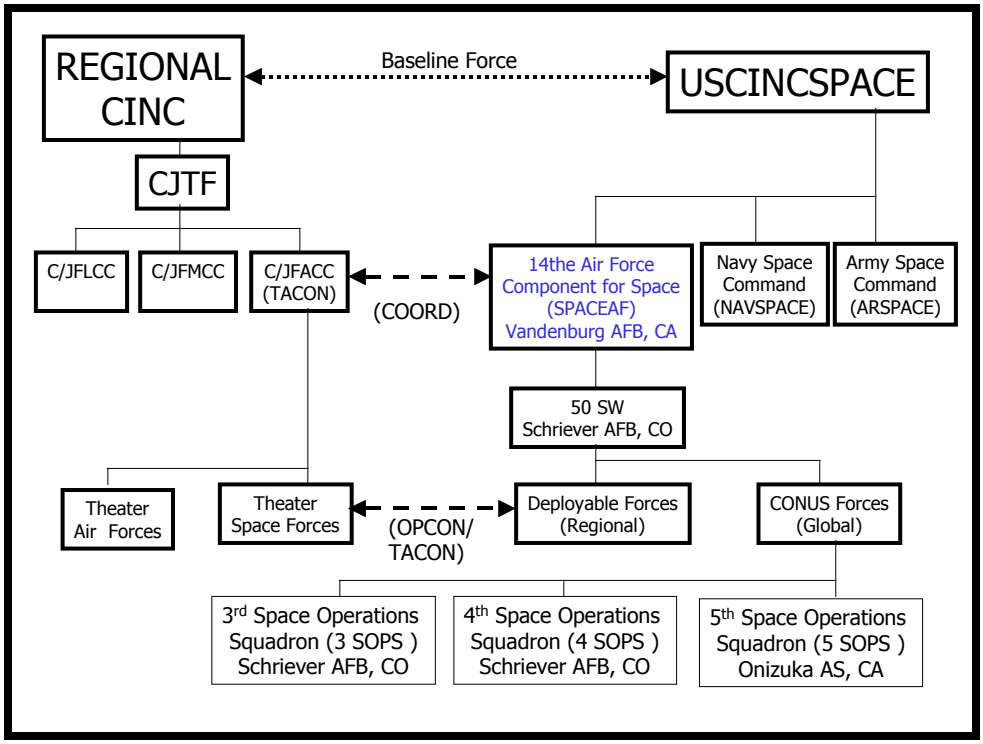

Figure B-2

The USSPACECOM Space Operations Center (SPOC) issues operations orders and the SPACEAF Aerospace Operations Center (SAOC) issues tasking orders for operational control. Execution of commands is provided to the satellites via ground stations (may be relayed by other satellites and for some systems will be executed by the satellite operations squadrons linked to the various ground

stations located worldwide). SATCOM Terrestrial node command and control nodes include:

1. UHF Ground Control Stations. Characteristics include satellite vehicle control (TT&C), communications payload(s) control, location, footprint, and vulnerabilities.
2. SHF Ground Control Stations. Characteristics include satellite vehicle control (TT&C), communications payload(s) control, location, footprint, and vulnerabilities.
3. EHF Ground Control Stations. Characteristics include satellite vehicle control (TT&C), communications payload(s) control, location, footprint, and vulnerabilities.
4. COMSAT Ground Control Stations. Characteristics include satellite vehicle control (TT&C), communications payload(s) control, location, footprint, and vulnerabilities.
5. Global Broadcast System (GBS) Ground Control Stations. Two types- fixed and mobile in-theater. Characteristics include satellite vehicle control (TT&C), communications payload(s) control, location, footprint, and vulnerabilities.
6. Global SATCOM Support Center(s) are collocated with SPACECOM Space Operations Center (SPOC) and in defined Regional Areas. These support operational management in accordance with CJCSI 6250.01, Satellite Communications.

B.3 CONTROL LINK COMMUNICATIONS. Communications includes ground site to satellite links. Characteristics include bandwidth, transmission media type, transmission/modulation scheme, and vulnerability to jamming/countermeasures/environmental effects, output power, frequency, antenna specifications and hardening specifications.

B.4 SPACE NODE FUNCTIONALITY. Examples include DSCS, Milstar, Global Broadcast System (GBS), AFSATCOM, Wideband Gapfiller, NATO IV/SKYNET, IRIDIUM, and other commercial systems contracted by DISA.

(a) UHF Satellites. Characteristics include orbital description, satellite description, payload(s) and transponders, communications links, TT&C links, vulnerability to attack, and type of channel access.
(b) UHF Satellite Transponders. Characteristics include number of transponders, transponder(s) bandwidth, transponder(s) capacity, coverage area, and vulnerabilities (physical, environmental, electromagnetic, and radiation hardening).
(c) SHF Satellites. Characteristics include orbital description, satellite description, payload(s) and transponders, communications links, TT&C links, vulnerability to attack, and type of channel access.

(d) SHF Satellite Transponders. Characteristics include number of transponders, transponder(s) bandwidth, transponder(s) capacity, coverage area, and vulnerabilities (physical, environmental, electromagnetic, and radiation hardening).

(e) EHF Satellites. Characteristics include orbital description, satellite description, payload(s) and transponders, communications links, TT&C links, vulnerability to attack, and type of channel access.

(f) EHF Satellite Transponders. Characteristics include number of transponders, transponder(s) bandwidth, transponder(s) capacity, coverage area, and vulnerabilities (physical, environmental, electromagnetic, and radiation hardening).

(g) Commercial SATCOM (COMSAT) Satellites. Characteristics include orbital description, satellite description, payload(s) and transponders, communications links, TT&C links, vulnerability to attack, and type of channel access.

(h) COMSAT Satellite Transponders. Characteristics include number of transponders, transponder(s) bandwidth, transponder(s) capacity, coverage area, and vulnerabilities (physical, environmental, electromagnetic, and radiation hardening).

(i) Global Broadcast System (GBS) Satellites. Characteristics include orbital description, satellite description, payload(s) and transponders, communications links, TT&C links, vulnerability to attack, and type of channel access.

(j) GBS Satellite Transponders. Characteristics include number of transponders, transponder(s) bandwidth, transponder(s) capacity, coverage area, and vulnerabilities (physical, environmental, electromagnetic, and radiation hardening).

(k) Integrated Broadcast System (IBS) will serve as the communications architecture supporting the relay of theater missile event data from ground processing segments to Theater Data Processors (TDPs). Existing communications networks and supporting segments, which will be integrated under the IBS initiative, include the Tactical Data Dissemination System (TDDS) networks, along with their supporting satellites.

B.5 MISSION COMMUNICATIONS LINK. Communications includes satellite links to ground sites. Characteristics include bandwidth, transmission media type, transmission/modulation scheme, and vulnerability to jamming/countermeasures/environmental effects, output power, frequency, antenna specifications and hardening specifications. GBS and IBS characteristics include link(s) integrity, content, frequency, bandwidth, vulnerability to countermeasures, vulnerability to naturally occurring phenomena (e.g., scintillation, solar effects…etc) and reliability given their current design features and limitations.

B.6 TERRESTRIAL NODE: WARFIGHTER.

(a) UHF User Segment/Terminals. Characteristics include single channel, voice or data, secure or non-secure, data rate, vulnerabilities, and environmental interactions.
(b) SHF User Segment/Terminals. Terminal types include fixed strategic, and deployable, tactical. Characteristics include multi-channel, high quality voice, data rate, location, footprint, and vulnerabilities (physical, electromagnetic-has some limited anti-jam capabilities and secure channels, and environmental – SHF signals are affected by some extent by ionospheric scintillation, to a greater extent by heavy rain, can be affected by solar radio noise as well).
(c) EHF User Segment/Terminals. A terminal may simultaneously be a member, serve as a communications controller, and/or antenna controller. Characteristics include multi channel, voice or data, secure or non-secure, data rate, vulnerabilities, and environmental interactions. Environmental vulnerabilities of the EHF signal include heavy rain and solar radio noise.
(d) COMSAT User Segment/Terminals. Characteristics include single channel, voice or data, secure or non-secure, data rate, vulnerabilities, and environmental interactions.
(e) GBS User Segment Receiver Suites. Characteristics include multi-channel, very high data rate, multiple levels of security, fixed and/or tactical terminal, and vulnerabilities (physical, environmental, and electromagnetic).
(f) Integrated Broadcast System (IBS) will serve as the communications architecture supporting the relay of theater missile event data from ground processing segments to Theater Data Processors (TDPs). Existing communications networks and supporting segments, which will be integrated under the IBS initiative, include the Tactical Data Dissemination System (TDDS) networks, along with their supporting ground receivers (e.g.; Multi-Access Tactical Terminals (MATT) radios, Tactical Receive System (TRS) receivers), and user segments/terminals.

B.7 EXISTING MODELS AND SIMULATIONS. The SIAM model from SWC/SAY addresses some aspects of communications networks within the links and nodes architectures.

SMAT can model satellite communication coverage and links between satellites and ground stations. Specific frequencies (UHF, EHF, SHF) are not explicitly modeled, nor is throughput.

SIAM and COSMOS models communications networks from a links and nodes perspective, and can include throughput thresholds and time-delays.

APPENDIX C
Environmental Monitoring (EM)

Joint Simulation Functional Requirements Definition

Mission: Force Enhancement Function: Environmental Monitoring (EM)

Weather services provided by space assets supply timely and accurate environmental information, including both space environment and atmospheric weather, to commanders for their objectives and plans at the strategic, operational, and tactical levels.

Systems include the Defense Meteorological Satellite Program (DMSP), National Polar Orbiting Environmental Satellite System (NPOESS), National Oceanographic and Atmospheric Administration (NOAA) satellite system, and Geostationary Operational Environmental Satellite (GOES).

C.1. TERMS and DEFINITIONS.

Space systems are comprised of nodes and links, as shown in Figure C-1. There are two types of nodes: terrestrial and space. The nodes are tied together with links. There are two types of links: control and mission.

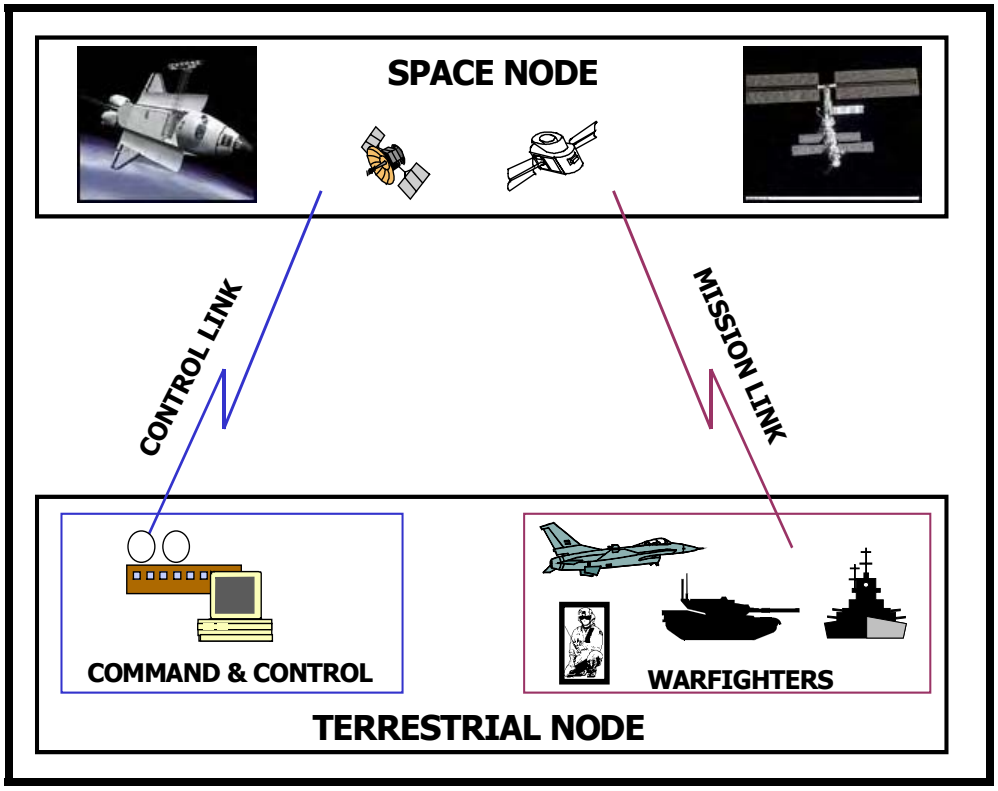

Figure C-1

The space node includes satellites, space stations, or reusable space-transportation systems like the space shuttle. The terrestrial node includes any land, sea, or airborne equipment used to interact with a space node. The link is

the information conduit between the terrestrial and the space nodes. Control links enable telemetry, tracking, and commanding (TT&C) of the space node. Mission links enable space effects.

C.2. TERRESTRIAL NODE COMMAND AND CONTROL. The Defense Meteorological Satellite Program (DMSP) is the principle source of environmental data to military users. DMSP is a joint use system employed by DoD, DoC, and NASA. Supplemental information is provided by other civil sector systems. The National Oceanic and Atmospheric Administration (NOAA), Suitland, MD, an agency of the Department of Commerce, provides command and control of the DMSP satellites. The 310th Space Group, Schriever AFB, CO, provides backup command and control.

C.3. CONTROL LINK COMMUNICATIONS. Communications includes description of ground site to satellite uplinks/downlinks and satellite to ground site downlinks. Characteristics include output power, bandwidth, frequency, transmission/modulation scheme, and vulnerability to jamming/countermeasures/environmental effects, resistance to natural environmental influences (e.g., ionospheric disturbances, heavy rain events, solar radio noise….etc), antenna specifications and hardness specifications.

C.4 SPACE NODE FUNCTIONALITY.

(a) Weather Satellites. Characteristics include orbital description, payloads, vulnerability to attack, sensors type, communications capability and environmental interactions.

(b) Satellite Weather Sensors. Characteristics include sensor phenomenology, operating wavelength, scan technique, field of view, selectivity, resolution, sensitivity, and vulnerability to environmental factors, onboard processing capability, processing time constraints and vulnerability to countermeasures.

C.5. MISSION COMMUNICATIONS LINK. Communications includes description satellite downlinks. Characteristics include output power, bandwidth, frequency, transmission/modulation scheme, and vulnerability to jamming/countermeasures/environmental effects, resistance to natural environmental influences (e.g., ionospheric disturbances, heavy rain events, solar radio noise . . . etc), antenna specifications and hardness specifications.

C.6. TERRESTRIAL NODE: WARFIGHTER. Tracking stations at New Boston AFS, NH, Thule Air Base, Greenland, and Kaena Point, HI receive the downlink DMSP information. The information is forwarded to two military weather centers at Offutt AFB, NE and Monterrey, CA. Properly equipped field and sea-based warfighters can also receive data directly from the satellites.

(a) Weather Factors. These include endoatmospheric (terrestrial) and exoatmospheric (space) environmental conditions that impact missions. Characteristics include visibility, humidity, precipitation and cloud cover, sea and wave conditions, and solar effects.
(b) Weather Satellite Ground Support Stations. Converts satellite weather sensor data to usable data and weather forecasts for theater use. Characteristics include location, fixed or mobile, size, manning, processing functions and timelines, communications links, vulnerability to attack, and environmental interactions.
(c) Theater Ground Processing Weather Units. Weather support teams receive data via direct downlink or processed weather via satellite communications. Characteristics include location, fixed or mobile, size, manning, processing functions and timelines, communications links, vulnerability to attack, and environmental interactions.
(d) Ground Based Sensors. Information used to refine the weather forecast. Sensors with the capability to provide a variety of weather observations such as precipitation, wind speed and direction, barometric pressure…etc. Sensors will be automated and transmit data via SATCOM.

C.7. EXISTING MODELS AND SIMULATIONS. Total Atmospheric Ocean Service (TAOS) is an ESC product that uses real-world and simulated databases and has been integrated with MDST for cloud cover and PSM+ (Nav) for scintillation. TAOS is currently the model of choice for Weather products.

AFWA OL-S has integrated weather aspects into SMAT. This capability affects line-of-sight from space entities to areas on the ground based on forecast cloud cover. Future activities will address importing real-time weather, affecting TBM warning with cloud cover and addressing space weather affects on navigation and communication assets and mission.

Space Battle Management Core Systems (SBMCS) has developed linkages to 55th Space Weather Squadron to give warfighters real-time updates of pre-defined weather products, and also gives status and constellation updates.

APPENDIX D
Surveillance and Threat Warning (S&TW)

Joint Simulation Functional Requirements Definition

Mission: Force Enhancement **Function: Surveillance and Threat Warning (S&TW)**

S&TW sub-mission capabilities enable worldwide situational awareness of terrestrial activities and threats affecting US and Allied interests and provide attack assessment and warning to command authorities and deployed forces. Space-based S&TW capabilities provide surveillance and warning of high-interest threats, to include key fixed, moving and relocatable targets, as well as ballistic missiles. S&TW capabilities consist of satellites and ground stations for warning of missile and aircraft attacks. Geosynchronous Defense Support Program (DSP) satellites used for detecting missile launches, space launches and nuclear detonations provide space-based capabilities. Ground-based radars provide launch verification and warhead tracking. The current ground-based radars include the Ballistic Missile Early Warning System (BMEWS), Precision Acquisition Vehicle Entry Phased-Array Warning System (PAVE PAWS) and the Perimeter Acquisition Radar Characterization System (PARCS).

ST&W Intelligence provides clear, brief, relevant, and timely analysis of foreign capabilities and intention for planning and conducting military operations. The overall objective of intelligence is to enable commanders and combat forces to know the enemy. Commanders should consider exploiting the information gained from various space assets for possible intelligence value.

ST&W Surveillance is the function of systematically observing air, space, surface, or subsurface areas, place, persons, or things, by visual, aural, electronic, photographic, or other means. For example, the space surveillance network (SSN) allows the United States to maintain awareness of the position, nature, and capabilities of man-made objects in Earth orbit.

ST&W Reconnaissance complements surveillance in obtaining, by visual observation or other detection methods, specific information about the activities and resources of an adversary or potential adversary, or in securing data concerning the meteorological, hydrographic, or geographic characteristics of a particular area. Multi-spectral, and in the future hyper-spectral, imagery obtained from space assets provide a new dimension to imaging the battlespace.

D.1. TERMS and DEFINITIONS.

Space systems are comprised of nodes and links, as shown in Figure D-1. There are two types of nodes: terrestrial and space. The nodes are tied together with links. There are two types of links: control and mission.

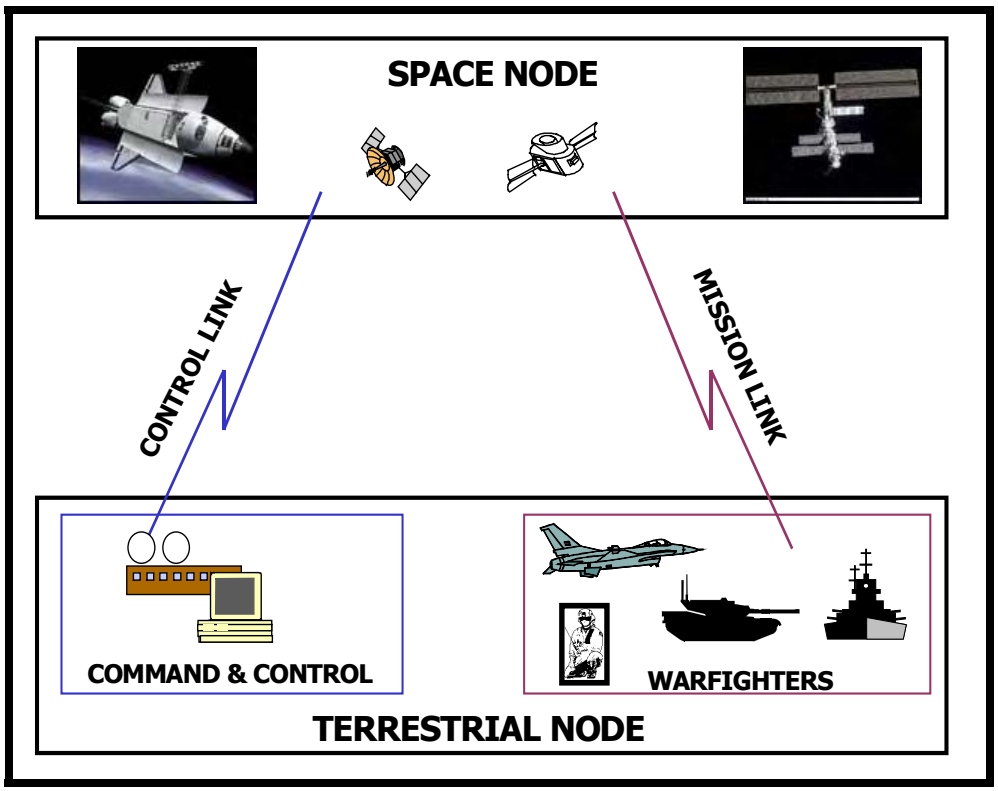

Figure D-1

The space node includes satellites, space stations, or reusable space-transportation systems like the space shuttle. The terrestrial node includes any land, sea, or airborne equipment used to interact with a space node. The link is the information conduit between the terrestrial and the space nodes. Control links enable telemetry, tracking, and commanding (TT&C) of the space node. Mission links enable space effects.

D.2. TERRESTRIAL NODE COMMAND AND CONTROL. The NORAD/USSPACECOM Warfighting Support System (N/UWSS) initiative is the Integrated Command and Control (ISC2) effort supporting both Integrated Tactical Warning/Attack Assessment (ITW/AA) strategic mission elements and Theater Event System (TES) components. The Missile Analysis and Reporting System (MARS) supports both Surveillance and Threat Warning (S&TW) functions employing track data level fusion algorithms and correlation algorithms to improve event evaluation and reduced missile over-counting.

Command/tasking of the ITW/AA Sensor Network is provided by the Missile Warning Center located in Cheyenne Mountain (Strategic and long range systems). Sensors include ground and space-based resources at the locations shown in Figure D-2. Missile warning sensor management is by performed the 21st Space Wing Operations Center with back up provided by the SPACEAF Aerospace Operations Center (SAOC). The 21st Operations Group (OG) manages

all operational units in the 21st Space Wing. The 2nd Space Warning Squadron (SWS), located at Buckley ANGB, CO, controls, receives, processes, and reports Defense Support Program (DSP) mission information. The 11th SWS, Schriever AFB, CO uses data from the DSP satellites processing through the TES to provide near instantaneous short-range ballistic missile attack warnings. The 137th SWS, Greeley, CO is a National Guard asset that provides mobile DSP missile warning and reporting.

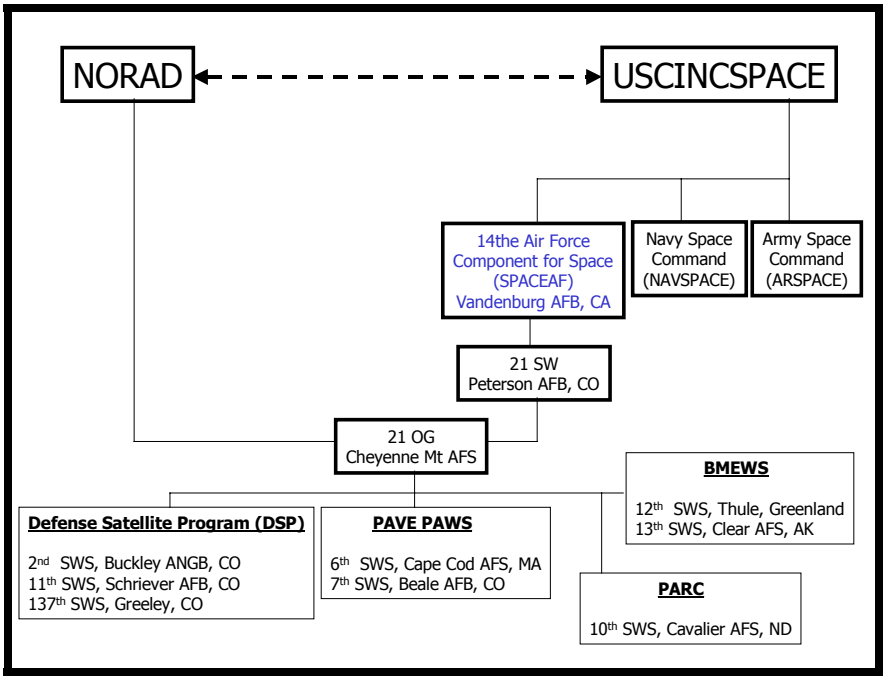

Figure D-2 AFSPC ITW/AA Sensor Network

The 6th SWS, Cape Cod AFS, MA and 7th SWS, Beale AFB, CA using the PAVE PAWS system, provide Submarine Launch Ballistic Missile warnings. Ballistic Missile Early Warning System (BMEWS) units include the 12th SWS, Thule, Greenland, and the 13th SWS at Clear AFS, AK. The 10th SWS, Cavalier AFS, ND operates the Perimeter Attack Radar Characterization System (PARCS).

Command/tasking of the TES network is provided by the USSPACECOM Space Operations Center (SPOC) and relayed through its warfighting components, SPACEAF and ARSPACE. Shown in Figure D-3, AFSPC TES elements provide processed data to the USSPACECOM Missile Warning Center (MWC) and user-level tactical data processors (TDPs).

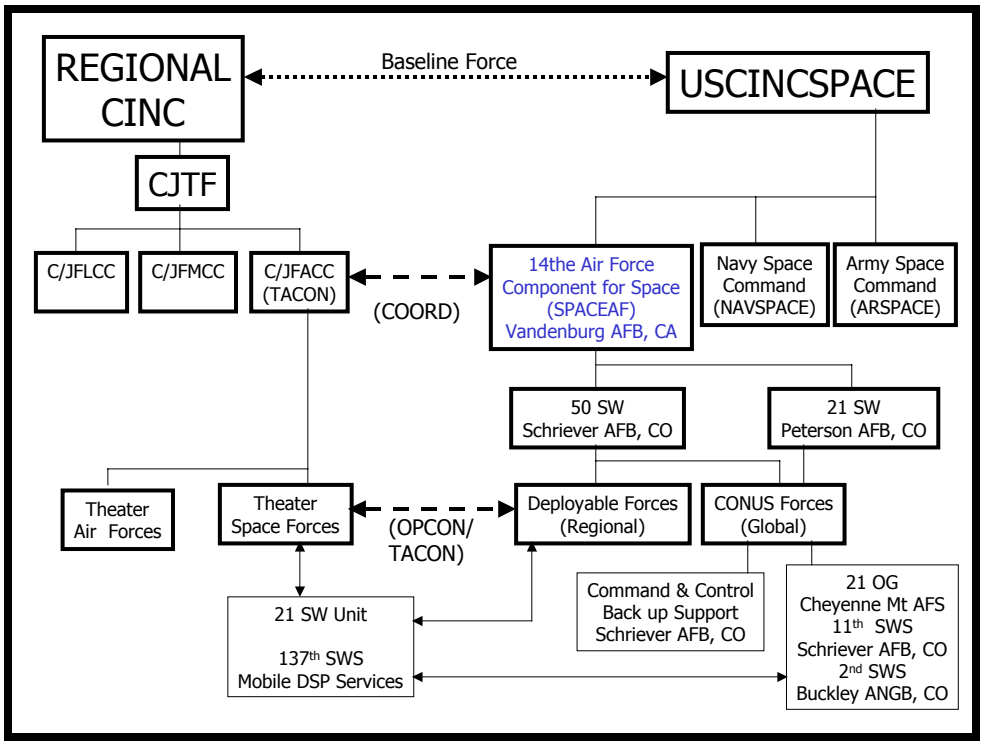

Figure D-3 TES Elements

The 21st Space Wing provides primary command and control of the DSP satellites; backup, anomaly resolution, and the 50th Space Wing provides launch/early on-orbit command and control. The ground processing stations controls payload data. Command and control objects include:

(a) Ground-Based Missile Warning Site. Characteristics include location, vulnerability to attack and environmental interactions.
(b) Ground-Based Missile Warning Sensor. Characteristics include sensor phenomenology, operating wavelength, scan method, output power, detection thresholds, track level fusion and correlation capability, processing time constraints, processing capability, resolution, vulnerability to countermeasures and environmental influences (e.g., ionospheric disturbances, heavy rain events, solar radio noise . . . etc), and selectivity.
(c) Ground-Based Missile Warning Correlation/Assessment Center. Includes Theater-based Missile Warning Ground Processing Stations and the Missile Analysis and reporting System (MARS). Characteristics include transportable or fixed, location, size, manning, deployment footprint, processing functions and timelines (includes time to dual phenomenology verification), processing capacity (#targets/events), assessment accuracy including accuracy and probability of correct threat identification, and environmental interactions.
(d) Ground-based Processing Centers. Characteristics include processing timelines, discrimination, processing capacity (# targets/events) and resolution.

(e) Strategic Unmanned (UAVs). Characteristics include location of airfield, range of vehicle, sensors, flight path, time on-station, electro optical resolution, connectivity to air and ground stations (includes relays), connectivity to satellite relays, physical characteristics of the platform, take-off and landing requirements, communications linkages (and their environmental vulnerabilities), and aerial flight capabilities (i.e., altitude and speed characteristics).

D.3. CONTROL LINK COMMUNICATIONS. Communications includes description of ground site or satellite to processing/command center links. Characteristics include bandwidth, transmission media type, connectivity routes, frequency, antenna specifications, transmission/modulation scheme, vulnerability to jamming/countermeasures/environmental effects, resistance to natural environmental influences (e.g., ionospheric disturbances, heavy rain events, solar radio noise, etc), and hardening specifications.

D.4. SPACE NODE FUNCTIONALITY.

(a) Missile Warning Satellite. Characteristics include orbital location, vulnerability to attack, sensor type, communications capability and environmental interactions.
(b) Missile Warning Satellite Sensor. Characteristics include sensor phenomenology, operating wavelength, terrestrial and space weather, scan technique, sensitivity, selectivity, onboard processing capability, processing time constraints, vulnerability to countermeasures and functions/availability of counter-countermeasures.
(c) Military Space Plane. Characteristics include launch location, flight path, max velocity, lift, drag, basing limitations, recycle time orbital description, and payload capacity/type. Sensor characteristics include sensor phenomenology, operating wavelength, terrestrial and space weather, scan technique, sensitivity, selectivity, onboard processing capability, processing time constraints, vulnerability to countermeasures and functions/availability of counter-countermeasures.
(d) Space-based Radar Satellite. Characteristics include orbital location, vulnerability to attack, communications capability and environmental interactions.
(e) Space-Based Radar Sensor. Characteristics include operating wavelength, scan method, output power, detection thresholds, processing time constraints, resolution, power requirements, vulnerability to countermeasures and selectivity.
(f) Imaging Satellites. Characteristics include orbital location, vulnerability to attack, sensor type, communications capability and environmental interactions.

(g) Imaging Sensors. Characteristics include resolution, sensitivity, vulnerability to environmental factors, scan technique, onboard processing capability, processing time constraints and vulnerability to countermeasures.

D.5. MISSION COMMUNICATIONS LINK. Communications includes description of ground site or satellite to processing/command center links. Characteristics include bandwidth, transmission media type, connectivity routes, frequency, antenna specifications, transmission/modulation scheme, vulnerability to jamming/countermeasures/environmental effects, resistance to natural environmental influences (e.g., ionospheric disturbances, heavy rain events, solar radio noise….etc), and hardening specifications.

D.6. TERRESTRIAL NODE: WARFIGHTER.

(a) Ballistic Missile Threat (Theater, Intermediate Range, and Long Range). Characteristics include fixed or mobile, launch location, missile type, warhead configuration (single or multiple RVs), maximum/minimum range, guidance and control configuration and error, on-board countermeasures, communications links, mass, shape, ballistic coefficient, reflectance, and radar cross section.
(b) Cruise Missile Threat. Characteristics include fixed or mobile, launch location, missile type, warhead configuration, maximum/minimum range, guidance and control configuration and error, on-board countermeasures, communications links, mass, shape, drag coefficient, reflectance, and radar cross section.
(c) Theater-based Unmanned Aerial Vehicles (UAVs). Characteristics include location of airfield, range of vehicle, sensors, flight path, time on-station, electro optical resolution, connectivity to air and ground stations (includes relays), connectivity to satellite relays, physical characteristics of the platform, take-off and landing requirements, communications linkages (and their environmental vulnerabilities), and aerial flight capabilities (i.e., altitude and speed characteristics).
(d) Theater Ground Processing Units. ST&W/ISR support teams receive data via direct downlink or processed via satellite communications. Characteristics include location, fixed or mobile, size, manning, processing functions and timelines, communications links, vulnerability to attack, and environmental interactions.

D.7. EXISTING MODELS AND SIMULATIONS.

Missile: Strategic and Theater Attack Modeling Process (STAMP) can model the booster portion of single- and two-stage to orbit rockets. SMAT is working on incorporating those algorithms to model satellite insertion from launch to orbit.

Missile Detection: SMAT models the Satellite Surveillance Network that can emulate ground-based missile warning detection and dissemination. The TACCSF at Kirtland AFB is heading an integrated effort to model Tactical Air Warning System (TAWS) that would combine space, ground and air-based missile detection assets and fuse/correlate the data to help the active missile defense mission. SMAT and MDST have both been looked at for the space-based detection piece; COBRA BALL simulation will address the air piece; and several ground-sensor models are being considered for the ground-based detection simulations.

ISR: SMAT models ISR collector location and propagation, as well as sensor Field of View. SMAT can also model other sensor volumes, such as "butterfly" and "donut" patterns. SMAT can do rudimentary TPED modeling by showing satellite-to-ground-station look angles, but does not model specific tasking or data flow. Through the space gateway integration, SMAT has "flown" space-based ISR sensors and reported TADIL-J traffic on appropriate air and ground entities.

SMATRAN is a special version of SMAT that specifically addresses the capabilities of foreign and commercial ISR assets. It has been used for operational analysis as well as wargaming support. SMATRAN utilizes Satellite Reconnaissance Advance Notice (SATRAN) algorithms with extra SMAT capabilities for graphics and reporting.

COSMOS is the ISR tool used for planning, assessment and operations during Title X wargames.

Sensor Platform Allocation Analysis Tool (SPAAT) is used to determine the optimal mix of sensors and platforms required to accomplish the reconnaissance and surveillance mission. This optimization fits in the overall picture of the OODA (observe, orient, decide, act) loop at the orient/decide phase. ISR optimization bounds the feasible region of the trade space. An ISR mix that produces improved battlespace knowledge can be fed into campaign or mission models to illustrate/quantify the military worth of ISR.

The Military Space Plane (MSP) Program Office (AFRL/VSE) is working on algorithms to model the launch and orbit insertion capabilities of the MSP family of systems. This launch capability will be associated with some sort of mission planning system, most likely an advanced version of the SMV Ops tool. The MSP Program Office is working with SMAT to incorporate their capabilities in the future.

APPENDIX E
Information Operations

Joint Simulation Functional Requirements Definition

Mission: Force Enhancement **Function: Information Operations (IO)**

This sub-mission area includes Defensive Counter-Information (DCI) and Offensive Counter-Information (OCI). Counter-information is the function that seeks to establish information superiority through the control of the information realm.

Information Operations (IO) comprises those actions taken to gain, exploit, defend, or attack information and information systems. IO is conducted throughout all phases of an operation and across the range of military operations.

IO is divided into two different categories - *Information-in-Warfare* and *Information Warfare*. Information-in-Warfare includes operations to gain and exploit information. The other Force Enhancement sub-mission areas addressed above provides current capabilities. Information Warfare, on the other hand, is IO conducted to defend friendly information and information systems or attack an adversary's information and information systems. Information Warfare consists of the function of counter information and its two subsets: (a) DCI includes actions that protect information, information systems and IO from any potential adversary; (b) OCI includes actions taken to control the information environment. OCI operations are designed to limit, degrade, disrupt, or destroy adversary information capabilities.

Since the focus of aerospace operations is on achieving effects, the label placed on a given action is best determined by the combination of function performed and effect achieved, rather than by the type of weapons (information, electronic, or physical attack) used. An example of this would be the use of space assets to jam or disrupt an adversary's communications links between its fielded forces and command nodes. In such a case, the space assets would be engaged in an "information attack." In this example, the function of offensive counterspace would support the function of offensive counter-information.

Space, Control, and User Segments of Military, Civil, and, Commercial Systems used in all assigned Mission Areas; Space, Control, and User Segments of Military, Civil, and, Commercial Systems for REDFOR Satellites, Neutral Satellites, Commercial Satellites, and Multinational Satellites

E.1. TERMS and DEFINITIONS.

Space systems are comprised of nodes and links, as shown in Figure E-1. There are two types of nodes: terrestrial and space. The nodes are tied together with links. There are two types of links: control and mission.

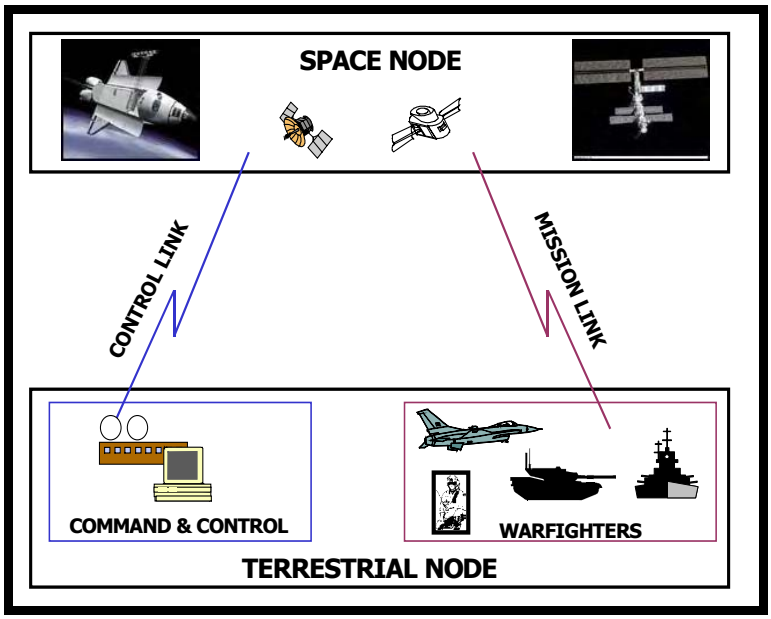

Figure E-1

The space node includes satellites, space stations, or reusable space-transportation systems like the space shuttle. The terrestrial node includes any land, sea, or airborne equipment used to interact with a space node. The link is the information conduit between the terrestrial and the space nodes. Control links enable telemetry, tracking, and commanding (TT&C) of the space node. Mission links enable space effects.

E.2. TERRESTRIAL NODE COMMAND AND CONTROL. The USSPACECOM Space Operations Center (SPOC) issues operations orders and the SPACEAF Aerospace Operations Center (SAOC) issues tasking orders for operational control. Objects include Computer Network Security implementation characteristics, and physical protection measures for fixed locations and mobile systems.

E.3. CONTROL LINK COMMUNICATIONS. Characteristics include techniques designed to enhance security/reliability of data transmission. Characteristics include security level, hardening specifications, anti-jam thresholds, and spread spectrum specifications.

E.4. SPACE NODE FUNCTIONALITY. Defensive Space Segments measures designed to protect space assets from hostile threats. Characteristics include security level, hardening specifications, anti-jam thresholds, spread spectrum specifications and degradation levels/time to recover. Offensive Space Segments used to implement OCI tactics, techniques, and procedures.

E.5. MISSION COMMUNICATIONS LINK. Characteristics include techniques designed to enhance security/reliability of data transmission. Characteristics include security level, hardening specifications, anti-jam thresholds, and spread spectrum specifications.

E.6. TERRESTRIAL NODE: WARFIGHTER. Measures designed to protect users from hostile threats. Characteristics include security level, hardening specifications, anti-jam thresholds, spread spectrum specifications and degradation levels/time to recover. This includes physical protection measures for fixed locations.

E.7. EXISTING MODELS AND SIMULATIONS. The USSPACECOM Computer Network Operations JTF is currently consolidating requirements. These will be incorporated into the functional requirements for all space segments when available.

APPENDIX F
Command and Control (C2)

Joint Simulation Functional Requirements Definition

Mission: Force Enhancement **Function: Command & Control (C2)**

The Command and Control (C2) sub-mission enables situational awareness and provides the ability to command and control air, space and missile forces at all levels of command. The C2 sub-mission focuses on getting the right information to the right forces in time to be effective. The C2 infrastructure allows for the exercise of authority and direction over assigned forces including the processing, analysis, use and dissemination of information to shape and dominate the battlespace.

The NORAD and USSPACECOM Command Center is the C2 node to accomplish worldwide warning of space and missile threats. The center also provides information on air threats. The NORAD and USSPACECOM Command Center and its related operations centers in Cheyenne Mountain CO have undergone communications and computer systems upgrades since the late 1980's to improve missile warning, space control and air defense C2 operations. AFSPACE (14th Air Force) at Vandenberg AFB CA is the Air Force warfighting component supporting the USSPACECOM mission.

The AFSPACE Aerospace Operations Center (AOC) monitors, plans and executes space force missions to control and exploit space for USCINCSPACE and theater components worldwide. The SPACEAF AOC represents an in-place space counterpart to the theater Air Operations Center and provides reachback space operations support to theater operations by fusing intelligence, combat planning, combat operations and Battle Staff functions. (See Figure 2-1-5).

The 20th Air Force (20 AF) at F.E. Warren AFB WY is the Air Force ICBM Task Force 214 to USSTRATCOM. The 20 AF Missile Operations Center provides the capability to command, control and monitor all ICBM forces. It supports USCINCSTRAT operational control of all alert ICBM forces and provides C2 of non-alert ICBM forces for AFSPC. These are not addressed here.

F.1. TERMS and DEFINITIONS.

Space systems are comprised of nodes and links, as shown in Figure F-1. There are two types of nodes: terrestrial and space. The nodes are tied together with links. There are two types of links: control and mission.

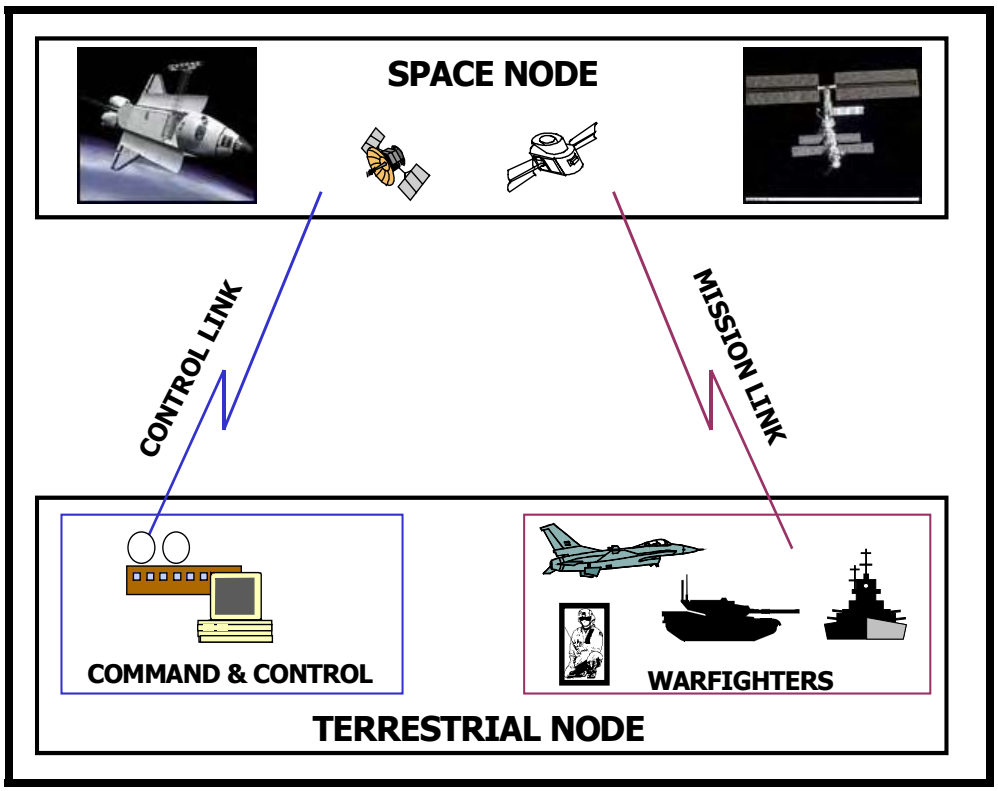

Figure F-1

The space node includes satellites, space stations, or reusable space-transportation systems like the space shuttle. The terrestrial node includes any land, sea, or airborne equipment used to interact with a space node. The link is the information conduit between the terrestrial and the space nodes. Control links enable telemetry, tracking, and commanding (TT&C) of the space node. Mission links enable space effects.

F.2. TERRESTRIAL NODE COMMAND AND CONTROL. During theater or area of responsibility (AOR) operations, theater commanders will integrate space effects into their campaign. Theater space effects can be achieved through global space forces, deployable space forces, and theater organic space forces. A global space force is a military space asset that potentially could be used by multiple theaters. Deployable space forces are space forces that can move forward to a theater to support operations. Organic space forces are those that are embedded in theater in anticipation of their use in theater operations. Global space forces, deployable space forces, and theater organic space forces require different command relationships and levels of coordination to achieve theater space effects. Figure F-2 provides the SPACEAF Aerospace Operations Center (AOC) operations concept.

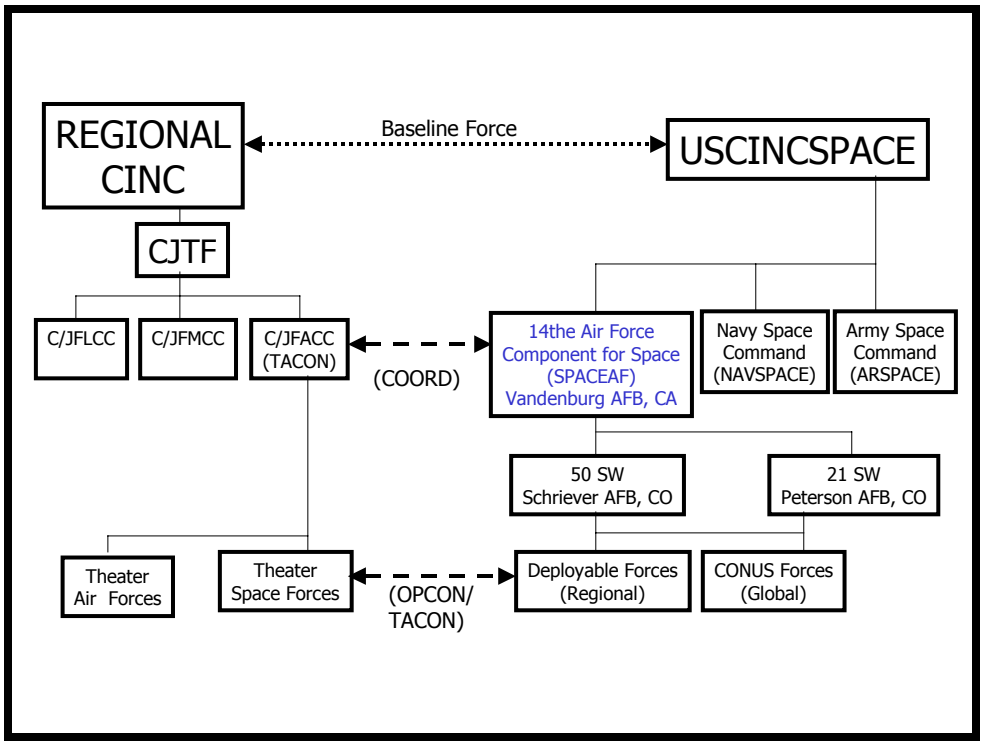

Figure F-2. Theater CINC Support

There are many situations where control of military space assets will be retained within USSPACECOM due to the space assets' global nature. Specialized command relationships are established to ensure theater military space requirements are met. These specialized command relationships allow theaters to coordinate with the space provider to synchronize battle rhythms (schedules) and maximize the effects of space tactics employed. DIRLAUTH is the normal method used to synchronize global effects with theater operations.

The SPACEAF AOC should synchronize its battle rhythm with the theaters. The theater operations drive SPACEAF's schedule requirements. By adjusting its operational schedule, SPACEAF will maximize support to the theater. If more than one theater is being supported, an operational schedule will be adjusted to maximize support to all theaters.

The SCA serves as the focal point for gathering space requirements within the JTF from the J-staff and each component commander. These requirements include requests for space forces (i.e. Naval Space Support Team), requests for space effects (i.e. Denial of adversary access to SATCOM), and requests for implementation of specific command relationships (i.e. A direct support relationship between the AOC and 11th Space Warning Squadron for theater missile warning). The SCA develops a recommended prioritized list of space requirements for the CJTF. The SCA will prioritize the requirements based on the JTF objectives. The SCA's sphere of influence and focus is the JTF. While the

SCA can facilitate non-traditional uses of the space assets, JTF planning staffs should utilize the established processes for fulfilling intelligence and communications requirements. Once the prioritized requirements are approved by the CJTF, the approved list would be provided to the regional CINC.

F.3. CONTROL LINK COMMUNICATIONS. No explicit object modeling is required; objects from other functions will input into the command and control processes.

F.4. SPACE NODE FUNCTIONALITY. No explicit object modeling is required; objects from other functions will input into the command and control processes.

F.5. MISSION COMMUNICATIONS LINK. No explicit object modeling is required; objects from other functions will input into the command and control processes.

F.6. TERRESTRIAL NODE: WARFIGHTER. Reachback from Theater interface to include process, information flows (inputs and outputs), decision trees and processing times, prioritization hierarchies, processing capabilities, and communications capabilities. The CJTF should serve as the appointing authority of the Space Coordinating Authority (SCA). During times of conflict or large-scale contingencies it is important to have a SCA within the JTF structure to appropriately represent the space requirements of the CJTF.

F.7. EXISTING MODELS AND SIMULATIONS. The Space and Information Analysis Model (SIAM) analyzes information flows on the battlefield to determine effects-based target priorities and information degradation from weapons use. Displays communications paths, identifies choke points, prioritized targets, analyzes strategies/courses of action, and identifies intelligence gathering shortfalls.

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APPENDIX G
Launch Operations

Joint Simulation Functional Requirements Definition

Mission: Space Support **Function: Launch Operations**

Launch Operations encompasses the traditional spacelift mission of delivering payloads to orbit, plus emerging missions such as on-orbit servicing, recovery and repositioning. AFSPC's current capabilities for launch operations include launch vehicles, ranges and infrastructure (e.g., space launch complexes, launch vehicle and payload processing facilities, etc.) for placing payloads in their required orbits. AFSPC does not currently have on-orbit servicing or recovery capabilities.

AFSPC's current fleet of launch systems is composed of a mix of medium and heavy lift expendable boosters. The Delta II, Atlas II and Titan II provide AFSPC's medium lift capability, whereas the Titan IV provides heavy lift. In addition, AFSPC can access other sources to augment its launch requirements, though this practice is the exception and not the norm. If required, AFSPC can turn to the National Aeronautics and Space Administration (NASA) for use of the Space Transportation System and to private industry for use of small launch vehicles.

Spacelift projects power by delivering satellites, payloads, and materiel, to, or through space. Spacelift is the enabler of all space operations. Currently, the Air Force has three strategies for spacelift.

- Launch to deploy is a strategy defined as a launch, or series of launches, required to initially achieve a satellite system's designed operational capability. This strategy uses a launch-on-schedule approach where launches are planned in advance and executed in accordance with the current launch schedule.
- Launch to sustain is a strategy to replace satellites nearing the end of their useful life, predicted to fail, or that fail abruptly.
- Launch to augment is a strategy to increase operational capability above the designed operational capability in response to war, crisis, or contingency. This strategy uses a launch-on-demand approach, responding to crisis actions, subject to operational constraints and global considerations.

Ultimately, a multi-based all-weather spacelift capability, responsive within days or hours, may be essential to meet future war-fighting needs. Furthermore, the Air Force may need to develop an on-orbit servicing (OOS) capability. An OOS capability would minimize the need to maintain a large and expensive launch to sustain program.

G.1. TERMS and DEFINITIONS.

Space systems are comprised of nodes and links, as shown in Figure G-1. There are two types of nodes: terrestrial and space. The nodes are tied together with links. There are two types of links: control and mission.

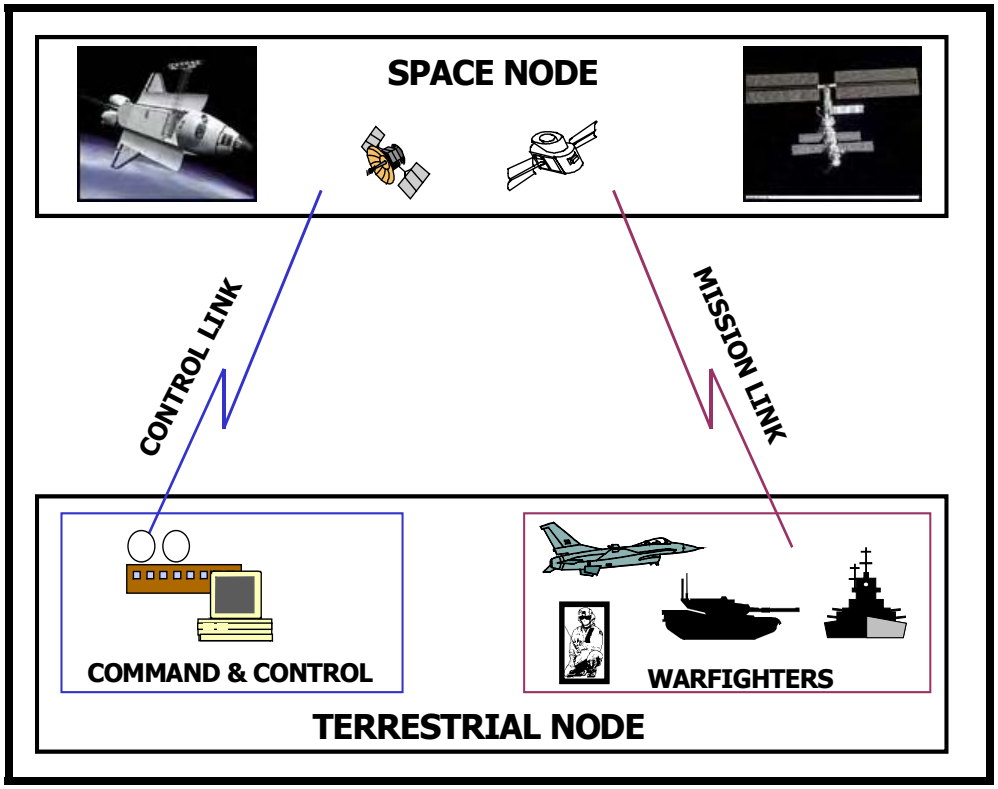

Figure G-1

The space node includes satellites, space stations, or reusable space-transportation systems like the space shuttle. The terrestrial node includes any land, sea, or airborne equipment used to interact with a space node. The link is the information conduit between the terrestrial and the space nodes. Control links enable telemetry, tracking, and commanding (TT&C) of the space node. Mission links enable space effects.

G.2. TERRESTRIAL NODE COMMAND AND CONTROL. Support of Launch Operations is the mission of the 45th Space Wing, Patrick AFB, FL, and the 30th space Wing, Vandenberg AFB, CA. Operational Control (OPCON) is the 14th Air Force SPACEAF in accordance with the organization structure given in Figure G-2.

The 45th Space Wing, with subordinate Groups and Squadrons is responsible for management and operations of the Eastern Missile Test Range supporting Military, Civil, and International Commercial clients. The 3rd Space Launch Squadron is responsible for processing and launching the Space Shuttle, Atlas,

and Titan-class vehicles; payloads include the Milstar, DSP, and DSCS systems in addition to commercial systems.

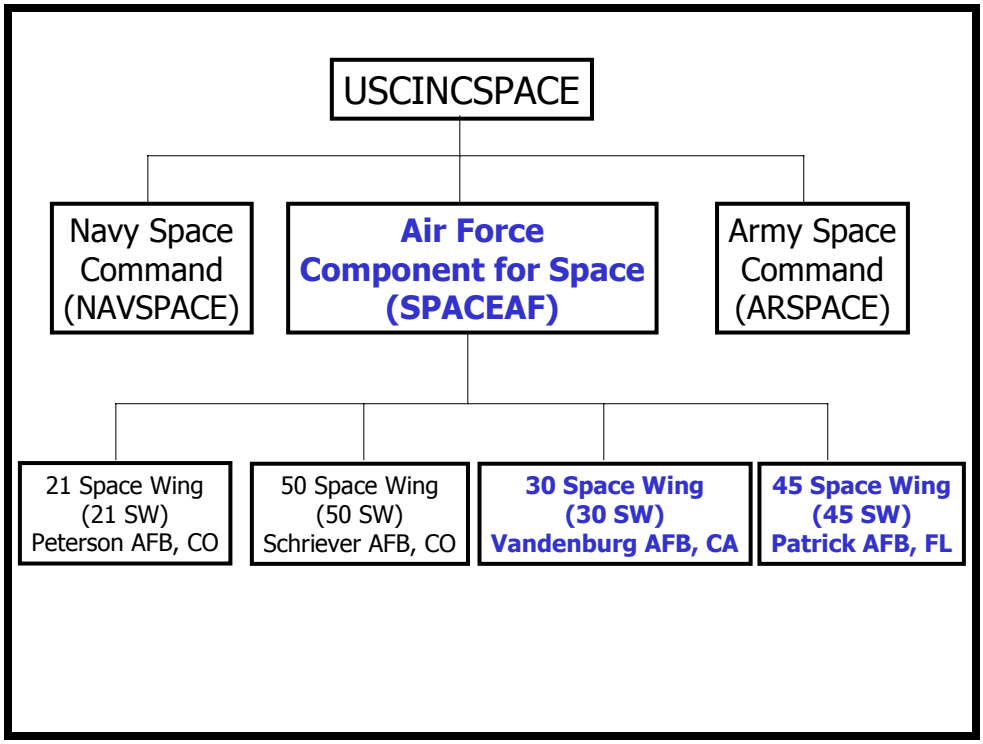

Figure G-2 Space Launch Operations

The 30th Space Wing is responsible for management and operations of the Western (Pacific) Missile Test Range supporting Military, Civil, and International Commercial clients. All satellites destined for near polar orbit are launched from Vandenberg AFB. The 2nd Space Launch Squadron is responsible for processing and launching the Delta, Atlas, and Titan-class vehicles.

At both locations, operational command and control of launch vehicles is provided by a ground-based launch control facility. Feedback from the launch vehicle (telemetry) is analyzed by the launch control facility and the controllers command the vehicle accordingly.

G.3. CONTROL LINK COMMUNICATIONS. Communications includes description of launch control facility to launch vehicle links and downlinks for launch vehicle telemetry data. Characteristics include output power, transmission/modulation scheme, vulnerability to jamming/countermeasures, bandwidth, frequency, antenna specifications and hardness.

G.4. SPACE NODE FUNCTIONALITY. Operational Control (OPCON) is the 14th Air Force SPACEAF in accordance with the organization given in Figure G-2.

Launch, Early on-orbit, and Anomaly Resolution (LEO&A) are provided by the assigned SOPS.

G.5. MISSION COMMUNICATIONS LINK. Communications includes payload TT&C systems. Characteristics include output power, transmission/modulation scheme, vulnerability to jamming/countermeasures, bandwidth, frequency, antenna specifications and hardness.

G.6. TERRESTRIAL NODE: WARFIGHTER. This sub-mission serves all warfighters with respect to each system defined herein.

G.7. EXISTING MODELS AND SIMULATIONS. Strategic and Theater Attack Modeling Process (STAMP) can model the booster portion of single- and two-stage to orbit rockets. SMAT is working on incorporating those algorithms to model satellite insertion from launch to orbit.

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APPENDIX H
Satellite Operations

Joint Simulation Functional Requirements Definition

Mission: Space Support **Function: Satellite Operations**

Satellite Operations consist of three tasks – TT&C; mission data retrieval; and Launch, Early Orbit and Anomaly resolution (LEO&A) support. With respect to the TT&C task, telemetry involves downlinking space asset bus and payload telemetry to a terrestrial point so that the space asset's health and status can be monitored. Tracking involves determining the position of the space asset so that the required antennas will be pointed in the correct orientation for future contacts with the space asset. Tracking also permits orbital accuracy for the position, orientation and footprint calculations for each satellite's mission. Commanding involves uplinking instructions to the bus and payload so that they will perform the necessary operations. Mission data retrieval is the downlinking of information that is gathered by the payload. LEO&A involves a TT&C task being performed during the launch and ascent of the space asset, the separation of the space asset from the launch vehicle and during the initial phase of the space asset's life on-orbit. Anomaly resolution involves performing TT&C when an on-orbit space asset is experiencing problems.

Because most space assets have global capability/coverage, responsibility for commanding and controlling them must reside with those who have the means to execute this responsibility. Thus, responsibility for balancing global space assets belongs to USCINCSPACE. Nowhere would such a need be greater than if the United States found itself engaged in two near simultaneous major theater wars (MTWs). USCINCSPACE is the centralized C2 authority responsible for proper prioritization of global space forces.

Currently, common user and program-unique ground stations located around the world provide access to on-orbit assets. The Air Force Satellite Control Network (AFSCN) is a worldwide terrestrial-based infrastructure of ground stations and control centers that provides satellite operations services to select DoD, Allied and Civil satellites. The AFSCN is composed of two primary control nodes at Schriever AFB CO and Onizuka AS CA, eight remote tracking stations and other control facilities around the world.

H.1. TERMS and DEFINITIONS.

Space systems are comprised of nodes and links, as shown in Figure H-1. There are two types of nodes: terrestrial and space. The nodes are tied together with links. There are two types of links: control and mission.

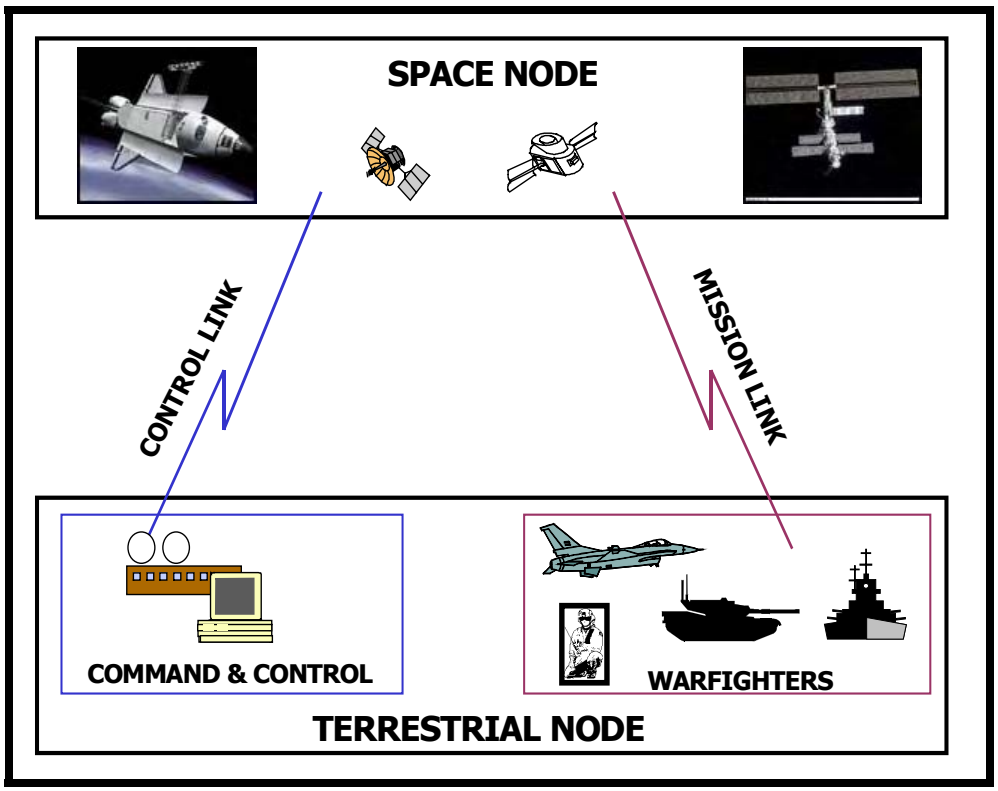

Figure H-1

The space node includes satellites, space stations, or reusable space-transportation systems like the space shuttle. The terrestrial node includes any land, sea, or airborne equipment used to interact with a space node. The link is the information conduit between the terrestrial and the space nodes. Control links enable telemetry, tracking, and commanding (TT&C) of the space node. Mission links enable space effects.

Systems examples include Global Positioning System (GPS) Operational Control System (OCS), Defense Support Program (DSP) Ground System, and the Air Force Satellite Control Network (AFSCN).

H.2. TERRESTRIAL NODE COMMAND AND CONTROL. Space Operations is the mission of the 50th Space Wing with routine on-orbit support provided by contracted and DoD personnel located at remote locations and at space operations squadrons located at Schriever AFB, CO, and Onizuka Air Force Station, CA. Operational Control (OPCON) is the 14th Air Force SPACEAF in accordance with the organization given in Figure H-2.

Anomalies reported by users are relayed through the respective command centers to the controllers. Reconfigurations/reallocations of capabilities during crises would flow from the President/SECDEF to command centers to the controllers.

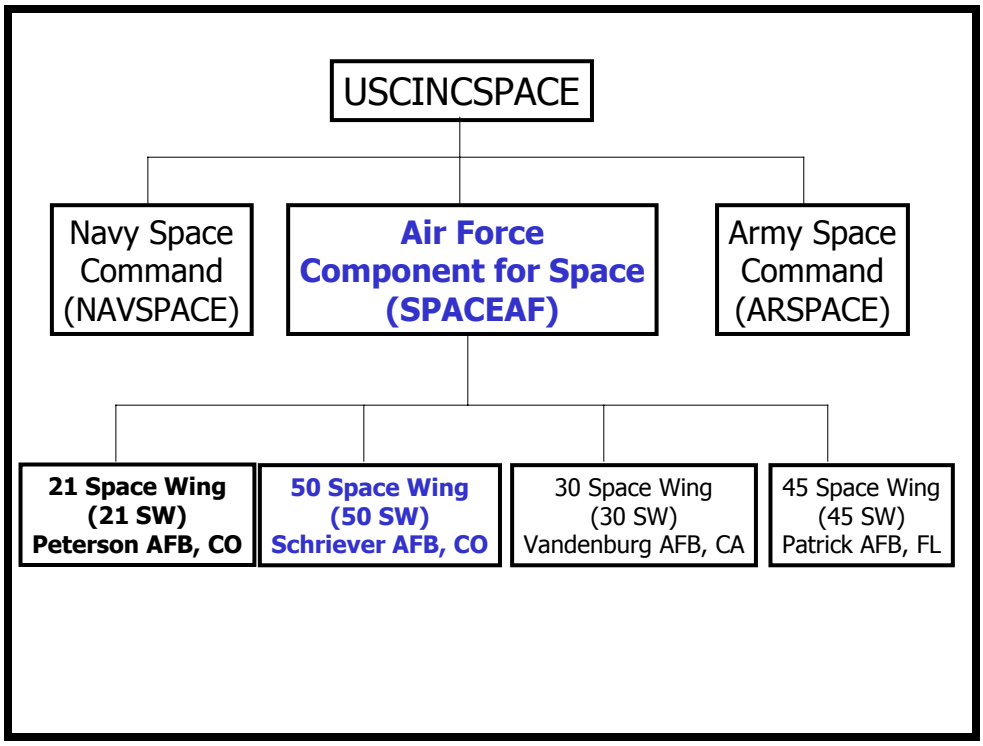

Figure H-2 Space Operations

Ground-Based Command and Control Site characteristics include location, vulnerability to attack and environmental interactions.

H.3. CONTROL LINK COMMUNICATIONS. Communications includes description of ground site to command center, ground site to satellite and satellite to ground station downlinks. Characteristics include bandwidth, transmission media type, transmission/modulation scheme, vulnerability to jamming/countermeasures/environmental effects, output power, frequency, antenna specifications and hardening specifications.

H.4. SPACE NODE FUNCTIONALITY. Satellite Systems with characteristics including orbital location, vulnerability to attack, sensor type, communications capability, environmental interactions and ground traces.

H.5. EXISTING MODELS AND SIMULATIONS. We are currently unaware of any prominent models for modeling Satellite C2 networks. The AFRL/VSD (Microsat program office) is working on algorithms to model on-orbit servicing missions in conjunction with the XSS-10/11 programs.

AFRL is also developing software for Spacecraft Operations: the Space Operations Scheduling and Management System (SOPSMAN) is designed to

automate the up to 400 commands per day to approximately 100 satellites monitored by fifteen ground antennas located worldwide, and provide an integrated contact schedule.

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APPENDIX I
Space Surveillance

Joint Simulation Functional Requirements Definition

Mission: Space Control **Function: Space Surveillance**

Space Surveillance provides the ability to detect, track, characterize, classify, catalog, monitor and disseminate information about all man-made space objects, whether operational platforms or debris. Near-real-time space situational awareness is a key contributor to controlling the space medium. These capabilities provide an awareness to the theater CINC of overhead activities (e.g., intelligence gathering or communication satellite windows) that could impact operations. They also provide awareness of dangers to friendly satellites that may warrant maneuvers to preclude loss or degradation of capabilities, anomalies in adversarial space operations that provide insights to changes in terrestrial force operations and changes in friendly space operations that warrant actions to remedy lost or degraded capabilities.

Space Situational Awareness (SSA) forms the foundation for all counterspace actions. It includes knowledge of the position, mission, users, and capabilities of space systems, as well as debris considerations and space weather conditions. SSA encompasses traditional space surveillance, detailed reconnaissance of specific space assets, and analysis of the space environment. It also encompasses the use of traditional intelligence sources to provide insight into adversary space operations.

AFSPC currently employs a combination of ground-based radars, passive radio-frequency tracking sites and optical sensors to perform Space Surveillance. Dedicated sensors, those with the primary missions of space surveillance, include the Naval Space Command Fence, Ground-based Electro-Optical Deep-space Surveillance System (GEODSS), Mobile Optical Surveillance System, Deep Space Tracking System and Eglin Radar. Collateral sensors such as BMEWS, PAVE PAWS and PARCS, whose primary missions are other than space surveillance, augment these systems. Contributing sensors, such as the Lincoln Space Surveillance Complex and Kwajalein Missile Range, provide data through leasing or other sharing agreements.

Today's systems detect, identify, characterize, track and catalog man-made space objects.

I.1. TERMS and DEFINITIONS.

Space systems are comprised of nodes and links, as shown in Figure I-1. There are two types of nodes: terrestrial and space. The nodes are tied together with links. There are two types of links: control and mission.

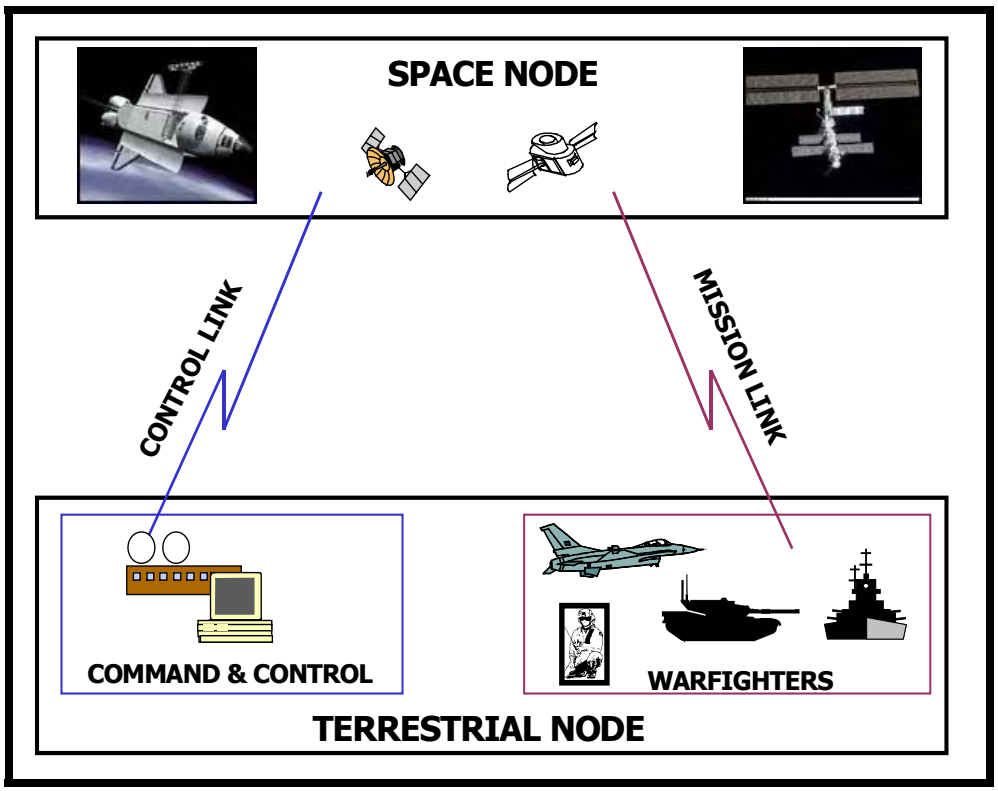

Figure I-1

The space node includes satellites, space stations, or reusable space-transportation systems like the space shuttle. The terrestrial node includes any land, sea, or airborne equipment used to interact with a space node. The link is the information conduit between the terrestrial and the space nodes. Control links enable telemetry, tracking, and commanding (TT&C) of the space node. Mission links enable space effects.

I.2. TERRESTRIAL NODE COMMAND AND CONTROL. The primary location is Cheyenne Mountain Space Control Center; the Alternate Space Control Center at Dahlgren, VA is the secondary site. Processed data is provided to operational units and the President/SECDEF.

The Space Surveillance Network (SSN) management is performed by the 21st Space Wing Operations Center with back up provided by the SPACEAF Aerospace Operations Center (SAOC).

Units supporting missile warning contribute to the SSN. The 6th SWS, Cape Cod AFS, MA and 7th SWS, Beale AFB, CA (using the PAVE PAWS system), Ballistic Missile Early Warning System (BMEWS) units including the 12th SWS, Thule, Greenland, and the 13th SWS at Clear AFS, AK, and the 10th SWS, Cavalier AFS, ND operating the Perimeter Attack Radar Characterization System (PARCS) contribute to the SSN.

The 1st Command and Control Squadron (CCS), Cheyenne Mountain AFS, CO provides the satellite cataloging of objects in orbit. The 20th Space Surveillance Squadron (SSS), Eglin AFB, FL provides dedicated active radar space surveillance. The Deep Space Tracking System (DSTS) fields sensors at the 3rd SPSS, Misawa AB, Japan, and 5th SPSS, RAF Feltwell, UK. The 5th SPSS also operates the Low Altitude Space Surveillance (LASS) system. The 4th SPSS, Holloman AFB, NM performs mobile space surveillance communications and space data relay.

The 21st Space Wing also controls and operates optical space tracking systems under the 18th SPSS, Edwards AFB, CA. Detachment 1, Socorro, NM; Detachment 2, Diego Garcia, British Territories; Detachment 3, Maui, HI; and Detachment 4, Moron, Spain, operate the Ground-Based Electro-Optical Deep Space System (GEODSS).

Systems include the AN/FPS-123 (Clear), AN/FPS-115 (PAVE PAWS - Cape Cod, Beale), AN/FPS-85 (Eglin), GEODSS (White Sands, Diego Garcia, Maui), and AN/FPQ-16 (PARCS - Cavalier)

(a) Space Surveillance Network (SSN) Ground Stations/Sensors and Contributing Sensors. Includes both primary, worldwide Space Surveillance Network locations, and missile warning radars whose secondary mission is space surveillance. Station characteristics include location, vulnerability to attack on facilities, obscura, coverage limits, limitations on number of objects tracked simultaneously, communications links, and environmental interactions. Sensor characteristics include sensor phenomenology (radar, optical), space object identification (SOI) capability, operating wavelength, scan method, output power, detection thresholds, processing time constraints, resolution, vulnerability to countermeasures and selectivity.
(b) Satellite Reconnaissance Advance Notice (SATRAN). Specific characteristics and content are classified. SATRAN provides timely notice to commanders of potential hostile satellite reconnaissance of US forces deployed worldwide. Predicts when selected satellites will be in position to perform intelligence collection against US Forces and installations.

I.3 CONTROL LINK COMMUNICATIONS. Communications includes description of SSN communications links (voice and data; secure and non-secure) between surveillance stations/sensors and command and control centers (Space Control Center and Alternate Space Control Center). Characteristics include bandwidth, transmission media type, transmission/modulation scheme, vulnerability to jamming/countermeasures/environmental effects, frequency, antenna specifications and hardening specifications.

I.4. SPACE NODE FUNCTIONALITY.

(a) BLUEFOR Space Order of Battle Satellites. Characteristics include object type and function, orbital description, mission, reflectance, radar cross-section, image, signature, vulnerability to threats, communications links (mission data, TT&C), and environmental interactions (solar flares, drag, meteorites/debris).
(b) REDFOR Space Order of Battle Satellites. Characteristics include object type and function, orbital description, mission, reflectance, radar cross-section, image, signature, vulnerability to threats, communications links (mission data, TT&C), and environmental interactions (solar flares, drag, meteorites/debris).
(c) Neutral, Civil, Commercial, and Multinational Satellites. Characteristics include object type and function, orbital description, mission, reflectance, radar cross-section, image, signature, vulnerability to threats, communications links (mission data, TT&C), and environmental interactions (solar flares, drag, meteorites/debris).
(d) Micro- and Pico-Satellite Future Systems. The US and other space-faring nations are looking closely at these emerging technologies. Recent wargames indicate that miniaturized satellites could pose a significant challenge to on-orbit systems and the space surveillance platforms, which monitor their location and activity. Functionality would be as defined above.
(e) Space Debris. Characteristics include object type and orbital description.

I.5. MISSION COMMUNICATIONS LINK. Communications includes description of SSN communications links (voice and data; secure and non-secure) between surveillance stations/sensors and command and control centers (Space Control Center and Alternate Space Control Center). Characteristics include bandwidth, transmission media type, transmission/modulation scheme, vulnerability to jamming/countermeasures/environmental effects, frequency, antenna specifications and hardening specifications.

I.6. TERRESTRIAL NODE: WARFIGHTER. Offensive Threats (RED, BLUE, and GRAY). Each space object is potentially vulnerable to known space threats:

(a) Nuclear Weapons
(b) EW/IW threats to sensor and communications
(c) Kinetic Energy Weapons
(d) Directed Energy Weapons.

I.7. EXISTING MODELS AND SIMULATIONS. ISRSIM SSNAM is a tool used by the AFSPC Space Analysis Center (AFSPC/CVY) (formerly HQ SWC/AES) to

analyze the performance of the Space Surveillance Network (SSN). Satellite and Missile Analysis Tool (SMAT) visually models the SSN and can report objects passing through sensor fences or volumes. This capability has not been integrated into an exercise in the past, but could be included through the space gateway tool that links SMAT to air and ground models.

SMATRAN is a special version of SMAT that specifically addresses the capabilities of foreign and commercial ISR assets. It has been used for operational analysis as well as wargaming support. SMATRAN utilizes Satellite Reconnaissance Advance Notice (SATRAN) algorithms with extra SMAT capabilities for graphics and reporting.

The Intelligence and Data Analysis Space Simulation (IDASS) tool is operated by AFRL/VS at Kirtland. It has been used for analysis of space entities for purposes of intelligence gathering. IDASS primarily runs at the SCI level, as should SMAT orbitology and visualization within the IDASS analysis model.

APPENDIX J
Counterspace

Joint Simulation Functional Requirements Definition

Mission: Space Control **Function: Counterspace**

Offensive Counterspace (OCS) operations (Negation) destroy or neutralize an adversary's space systems or the information they provide at a time and place of our choosing. Offensive counterspace operations may target adversary forces or third-party space assets supporting those forces using lethal or non-lethal means to neutralize a target using five different methods: deception, disruption, denial, degradation, and destruction of space assets or capabilities. The "Five Ds" represent a continuum of options, from spoofing the enemy to hard-kill of a space asset. There are tradeoffs along the continuum. At one end—the hard-kill end—airmen can be completely confident that an adversary's space-derived effect has been eliminated, but may produce undesirable collateral effects. At the other end of the continuum—the spoofing end—airmen have less confidence in achieving the desired effect, but have not produced irreversible damage.

- Deception is employing manipulation, distortion, or falsification of information to induce adversaries to react in a manner contrary to their interests.
- Disruption is the temporary impairment of a space system's capability to produce effects, usually without physical damage.
- Denial is the temporary elimination of a space system's capability to produce effects, usually without physical damage.
- Degradation is the permanent impairment of a space system's capability to produce effects, usually with physical damage.
- Destruction is the permanent elimination of a space system's capability to produce effects, usually with physical damage.

Assets designed for the OCS mission may be used to conduct or support counter air, counter sea, counter information, or strategic attack missions where the adversary's vulnerable node is a space system.

Defensive Counterspace (DCS) operations (Protection and Prevention) consist of active and passive actions to protect US space-related capabilities from adversary attack or interference. DCS actions may also safeguard assets from unintentional "interference" such as space debris, radio frequency (RF) interference, space and terrestrial weather environment effects, and other natural occurring events. When dealing with deliberate enemy attack, DCS relies on elements of defensive counter information (DCI) operations and force protection measures.

- Active defense seeks to detect, track, identify, intercept, or neutralize adversary threats to friendly space capabilities.

- Passive defense seeks to reduce the vulnerabilities and to protect and increase the survivability of friendly space assets, and the information they provide.

J.1. TERMS and DEFINITIONS.

Space systems are comprised of nodes and links, as shown in Figure J-1. There are two types of nodes: terrestrial and space. The nodes are tied together with links. There are two types of links: control and mission.

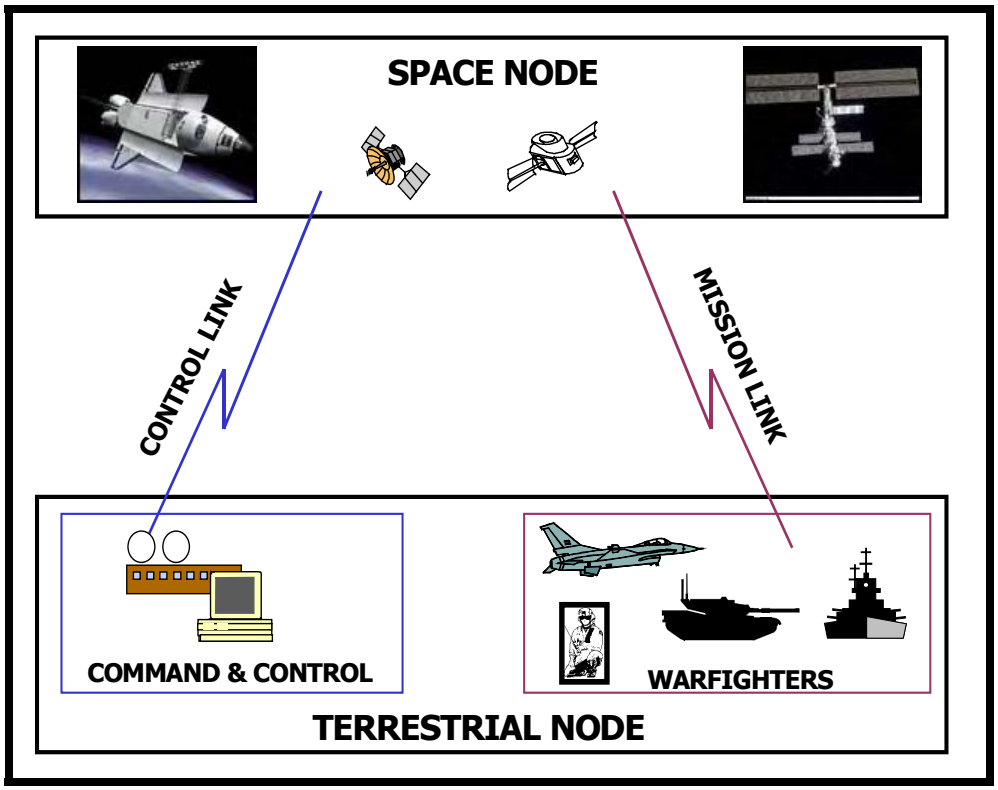

Figure J-1

The space node includes satellites, space stations, or reusable space-transportation systems like the space shuttle. The terrestrial node includes any land, sea, or airborne equipment used to interact with a space node. The link is the information conduit between the terrestrial and the space nodes. Control links enable telemetry, tracking, and commanding (TT&C) of the space node. Mission links enable space effects.

J.2. TERRESTRIAL NODE COMMAND AND CONTROL. For Protection (Defensive Counterspace) of resources, the SPACECOM Space Operations Center (SPOC) has combatant command (COCOM) of assigned space forces and issues operations orders for space operations. The Space Control Center located in the Cheyenne Mountain Operations Center performs operational management of

protective measures. The service components requests are processed through the SPACEAF Aerospace Operations Center (AOC) which tasks assigned space forces. Space operations squadrons provide tactical control of space assets. A regional CINC potentially may be tasked to respond to an attack.

Prevention is the use of techniques, technologies, and diplomatic initiatives and other forms of persuasion to deny the use of friendly and third party military and commercial space assets to hostile countries. U.S. systems invoke prevention techniques such as encryption, point denial, and hostile GPS prevention tactics. SPACECOM Space Operations Center (SPOC) is the repository for space order of battle information based on inputs from service components, SPACEAF Aerospace Operations Center (AOC), and intelligence. Executive authority rests with the National Command Authority, Department of State, and the Joint Staff.

Offensive Counterspace (Negation) employment of weapons is initiated by the space defense operations center located at Cheyenne Mountain AFS, CO or SPACEAF, Vandenberg AFB, CA; and executed by Space Operations Squadrons located at Schriever AFB and other locations, including in theater.

J.3. CONTROL LINK COMMUNICATIONS. Communications includes description of satellite or ground site to command center or ground site links. Characteristics include bandwidth, transmission media type, frequency, antenna specifications, transmission/modulation scheme, vulnerability to jamming/countermeasures/environmental effects, and hardening specifications.

J.4. SPACE NODE FUNCTIONALITY. Protection (Defensive Counterspace) measures designed to protect space assets from hostile threats or to actively respond to threats and attacks. Characteristics include security level, hardening specifications, anti-jam thresholds, spread spectrum specifications, and degradation levels/time to recover, active countermeasures, and active responses. Examples: Encryption devices, equipment hardening (kinetic, laser, RF and nuclear), anti-jam measures, anti-spoof measures and spread spectrum techniques; attack detection and characterization systems to include measures and equipment designed to geolocate the source of EMI/RFI interference and/or laser/HPM attack, nuclear detonations, or kinetic energy ASATs; measures designed to determine the intent of an adversary employing counter-space weapons, and measures to respond to an attack on our space system(s).

Vulnerabilities must all examine the less elegant hostile employment of Special Operations Forces (SOF), sleeper agents, and asymmetric attack on ground stations (fixed and mobile)

(Prevention) Actual objects will be modeled for other space functions, explicit modeling is not required. Implicit modeling-linked on/off scenario dynamic, flag

toggle is adequate. Examples include Russian Government sale of imagery, SPOT and LANDSAT imagery, INMARSAT and INETLSAT communications, hostile use of GPS services, and hostile use of U.S. SATCOM.

- Denied Space Assets. Includes target communications, navigation, weather, or ISR systems and their associated C&C links and centers.
- Department Of State, Foreign Governments, And Commercial Space Service Providers and Hostile Dependencies on Friendly Systems. Behavior characteristics and communications links should be modeled to allow for US intervention to deny hostile forces support from third-party systems, commercially available space assets, or surreptitious use of U.S. Space Systems.

Negation includes denial, disruption, degradation, and destruction. Negation mechanisms include kinetic energy, directed energy, blocking/direct capture, and nuclear directed against space assets; includes the use of conventional weapons against ground elements of these space assets; and information operations.

- Air/Sea/Ground-Launched Kinetic Energy. Launcher characteristics include location, vulnerability to attack, range, on-station times, firing rate/frequency/capacity limitations, and environmental interactions. Booster characteristics include range, final orbital velocity, vulnerability to attack, accuracy, timely retargeting, and environmental interactions. Warhead characteristics include targeting limitations (range, speed, azimuth, elevation), sensor characteristics (Radar/IR/EO wavelength, effective radiated power, sensitivity, anti-jam/clutter rejection characteristics), and lethality (burst radius and probability of kill).
- Space-Based Kinetic Energy. Platform characteristics include orbital description, orbital maneuver capability, vulnerability to attack, self-protection functionality (active and passive), communications capability, and environmental interactions. Warhead characteristics include targeting limitations (range, speed, azimuth, elevation), sensor characteristics (Radar/IR/EO wavelength, effective radiated power, sensitivity, anti-jam/clutter rejection characteristics), and lethality (burst radius and probability of kill).
- Ground-based Directed Energy. (Laser, Particle Beam, X-Ray, or Microwave). Site characteristics include location, vulnerability to attack, range, on-station times, and environmental interactions. Weapon characteristics include operating wavelength, bandwidth, transmission loss data, targeting limitations (range, speed, azimuth, and elevation), target susceptibility, targeting accuracy, dwell time, firing rate/frequency/capacity limitations, sensor characteristics (Radar/IR/EO wavelength, effective radiated power, and lethality (probability of kill).

- Air or Sea-based Directed Energy. Platform characteristics include location, vulnerability to attack, range, on-station times, and environmental interactions. Weapon characteristics include operating wavelength, bandwidth, transmission loss data, targeting limitations (range, speed, azimuth, and elevation), target susceptibility, targeting accuracy, dwell time, firing rate/frequency/capacity limitations, sensor characteristics (Radar/IR/EO wavelength, effective radiated power, and lethality (probability of kill).
- Space-Based Directed Energy. Platform characteristics include orbital description, orbital maneuver capability, vulnerability to attack, self-protection functionality (active and passive), communications capability, and environmental interactions. Weapon characteristics include operating wavelength, bandwidth, transmission loss data, targeting limitations (range, speed, azimuth, and elevation), target susceptibility, targeting accuracy, dwell time, firing rate/frequency/capacity limitations, sensor characteristics (Radar/IR/EO wavelength, effective radiated power, and lethality (probability of kill).
- Air/Sea/Ground-Launched Nuclear. Platform characteristics include location, vulnerability to attack, range, on-station times, and environmental interactions. Booster characteristics include range, final orbital velocity, vulnerability to attack, target susceptibility, targeting accuracy, and environmental interactions. Warhead characteristics include yield, fusing, reliability and targeting limitations (range, speed, azimuth, elevation).
- Blocking/Direct Capture. Platform characteristics (Military Space Plane and/or Orbit Transfer Vehicle) include responsiveness, availability, reliability, turnaround time, range, payload type and limitations, altitude, orbital description, maneuverability, and mission planning times.

J.5. MISSION COMMUNICATIONS LINK. Characteristics include techniques designed to enhance security/reliability of data transmission, systems to pass detection and characterization data, and systems to pass COA direction. Commercial and government terrestrial and satellite voice and data, secure and non-secure are employed.

J.6. TERRESTRIAL NODE: WARFIGHTER. For Protection (Defensive Counterspace) of resources, the SPACECOM Space Operations Center (SPOC) has combatant command (COCOM) of assigned space forces. For Prevention, SPACECOM Space Operations Center (SPOC) is the repository for space order of battle information based on inputs from service components, SPACEAF Aerospace Operations Center (AOC), and intelligence. Executive authority rests with the National Command Authority, Department of State, and the Joint Staff.

Offensive Counterspace (Negation) employment of weapons is initiated by the space defense operations center located at Cheyenne Mountain AFS, CO or

SPACEAF, Vandenberg AFB, CA; and executed by Space Operations Squadrons located at Schriever AFB and other locations, including in theater.

J.7. EXISTING MODELS AND SIMULATIONS.

(Protection) Several scenarios have been played using Space Maneuver Vehicle (SMV) and Solar Orbit Transfer Vehicle (SOTV) portraying space protection assets. End-state element sets were injected into SMAT to visualize this mission. However, SMAT does not currently model/represent maneuvering space assets dynamically. SMAT programmers are investigating satellite maneuver algorithms to address this type of modeling.

- (Prevention) SMAT can model satellite and ground station locations, and the sensor interaction between points on the ground and space assets. Denial of space-based information can be modeled with existing SMAT functions; increased linkages to other Intel models to show the impact are being addressed with current SMAT upgrades. The Space Information Analysis Model (SIAM) is modeling space assets within an integrated network and subsequent intelligence flow, both for US and non-US entities.
- (Negation) SMAT has several algorithms for Negation to address naval, ground, and space based directed and kinetic energy weapons. Modeling of microsats does not currently exist within SMAT, but there are engineering level models being developed at AFRL Kirtland for the XSS-10/11 microsat programs.

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APPENDIX K
National Missile Defense (NMD)

Joint Simulation Functional Requirements Definition

Mission: Space Control **Function: National Missile Defense**

K.1. TERMS and DEFINITIONS.

Space systems are comprised of nodes and links, as shown in Figure K-1. There are two types of nodes: terrestrial and space. The nodes are tied together with links. There are two types of links: control and mission.

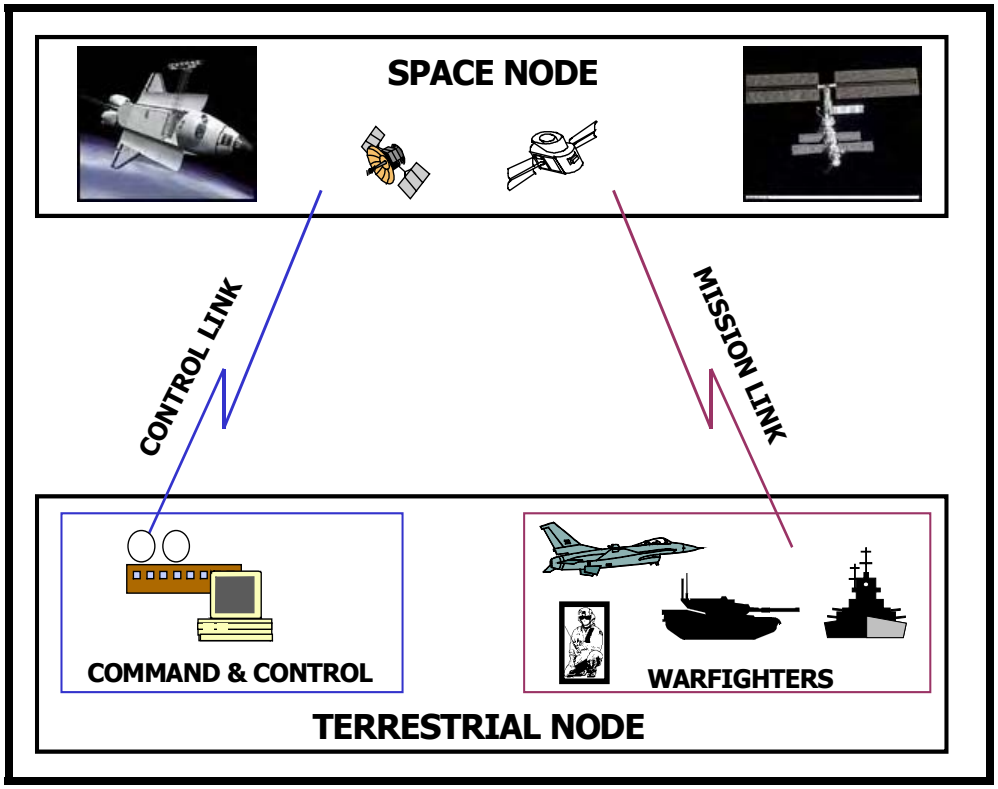

Figure K-1

The space node includes satellites, space stations, or reusable space-transportation systems like the space shuttle. The terrestrial node includes any land, sea, or airborne equipment used to interact with a space node. The link is the information conduit between the terrestrial and the space nodes. Control links enable telemetry, tracking, and commanding (TT&C) of the space node. Mission links enable space effects.

K.2. TERRESTRIAL NODE COMMAND AND CONTROL. USSPACECOM is the proposed Combatant Command (COCOM) for NMD. NMD will be a combination of existing S&TW sensors combined with multi-service shooter platforms, not yet defined. Employment of weapons is initiated by the space defense operations center located at Cheyenne Mountain AFS.

The ITW/AA missile-warning center located in Cheyenne Mountain (for strategic and long-range systems) and the Missile Analysis and Reporting System (MARS) at Schriever AFB provide command/tasking of the NMD sensor-to shooter network (for tactical systems). Processed data is provided to operational units and the President/SECDEF.

Sensor examples include both Integrated Tactical Warning/Attack Assessment (ITW/AA) strategic mission elements and Theater Event System (TES) components. These include: Defense Support Program (DSP) satellites/platforms and ground stations, Space Based Infrared System (SBIRS) satellites and ground stations; AN/FPS-123 (Clear), AN/FPS-115 (PAVE PAWS - Cape Cod, Beale) sensors; Missile Warning Center (Cheyenne Mountain), Missile Analysis and Reporting System (MARS), and the Alternate Missile Warning Center (Offutt AFB, NE).

(a) Ground-Based Missile Warning Site. Characteristics include location, vulnerability to attack and environmental interactions.
(b) Ground-Based Missile Warning Sensor. Characteristics include sensor phenomenology, operating wavelength, scan method, output power, detection thresholds, processing time constraints, processing capability, resolution, vulnerability to countermeasures and selectivity. Examples:
(c) Ground-based missile warning correlation/assessment center. Includes Theater-based Missile Warning Ground Processing Stations) Characteristics include transportable or fixed, location, size, manning, deployment footprint, processing functions and timelines (includes time to dual phenomenology verification), processing capacity (# targets/events), assessment accuracy including accuracy and probability of correct threat identification, and environmental interactions.
(d) Missile Warning Satellite. Characteristics include orbital location, vulnerability to attack, sensor type, communications capability and environmental interactions.
(e) Missile Warning Satellite Sensor. Characteristics include sensor phenomenology, operating wavelength, scan technique, sensitivity, selectivity, onboard processing capability, processing time constraints, vulnerability to countermeasures and functions/availability of counter-countermeasures.

K.3. CONTROL LINK COMMUNICATIONS. Communications includes description of ground site or air vehicle to processing/command center links. Characteristics include bandwidth, transmission media type, frequency, antenna specifications, transmission/modulation scheme, vulnerability to jamming/countermeasures/environmental effects, and hardening specifications.

K.4. SPACE NODE FUNCTIONALITY.

(a) Ballistic Missile Threat (Theater, Intermediate Range, and Long Range). Characteristics include fixed or mobile, launch location, missile type, warhead configuration (single or multiple RVs), maximum/minimum range, guidance and control configuration and error, on-board countermeasures, communications links, mass, shape, ballistic coefficient, reflectance, and radar cross section.
(b) Air-Launched Kinetic Energy Weapon. Characteristics include carrier vehicle description, flight route, launch location, carrier missile characteristics, vulnerability to attack, environmental interactions, targeting limitations (range, speed, azimuth, elevation), firing rate/frequency/capacity limitations and single shot probability of damage (SSPD).
(c) High Powered Microwave (HPM) Weapon. Characteristics include fixed or mobile, location, vulnerability to attack, environmental interactions, operating wavelength, bandwidth, transmission loss data, targeting limitations (range, speed, azimuth, elevation), firing rate/frequency/capacity limitations, and single shot probability of damage (SSPD).

K.5. MISSION COMMUNICATIONS LINK. Communications includes description of ground site or air vehicle to tasked warfighter links. Characteristics include bandwidth, transmission media type, frequency, antenna specifications, transmission/modulation scheme, vulnerability to jamming/countermeasures/environmental effects, and hardening specifications.

K.6. TERRESTRIAL NODE: WARFIGHTER. Future Shooter Systems to be defined; example systems are the AEGIS, THAAD and HELSTF.

(a) Cruise Missile Threat. Characteristics include fixed or mobile, launch location, missile type, warhead configuration (single or multiple RVs), maximum/minimum range, guidance and control configuration and error, on-board countermeasures, communications links, mass, shape, drag coefficient, reflectance, and radar cross section.
(b) High Powered Microwave (HPM) Weapon. Characteristics include fixed or mobile, location, vulnerability to attack, environmental interactions, operating wavelength, bandwidth, transmission loss data, targeting limitations (range, speed, azimuth, elevation), firing rate/frequency/capacity limitations, and single shot probability of damage (SSPD).

(c) Ground-Based Kinetic Energy Weapon. Characteristics include fixed or mobile, location, vulnerability to attack, environmental interactions, targeting limitations (range, speed, azimuth, elevation), firing rate/frequency/capacity limitations and single shot probability of damage (SSPD).

(d) Ground-Based Laser Weapon. Characteristics include fixed or mobile, location, vulnerability to attack, environmental interactions, operating wavelength, bandwidth, transmission loss data, targeting limitations (range, speed, azimuth, elevation), firing rate/frequency/capacity limitations, and single shot probability of damage (SSPD).

K.7. EXISTING MODELS AND SIMULATIONS.

Missile: Strategic and Theater Attack Modeling Process (STAMP) can model the booster portion of single- and two-stage to orbit rockets. SMAT is working on incorporating those algorithms to model satellite insertion from launch to orbit.

Missile Detection: SMAT models the Satellite Surveillance Network that can emulate ground-based missile warning detection and dissemination. The TACCSF at Kirtland AFB is heading an integrated effort to model Tactical Air Warning System (TAWS) that would combine space, ground and air-based missile detection assets and fuse/correlate the data to help the active missile defense mission. SMAT and MDST have both been looked at for the space-based detection piece; COBRA BALL simulation will address the air piece; and several ground-sensor models are being considered for the ground-based detection simulations.

Models: SMAT has included several algorithms regarding Space Based Laser (SBL) operations, including dwell time and satellite removal. SMAT-based SBL "clear the skies" analysis was an integral part of the Schriever 2001 CAVs from the program office at Eglin in order to better model this space-based Force Application methodology. SMAT does not inherently model deorbiting of vehicles, thus it cannot model the concept of deorbiting space vehicles into deep-strike targets.

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APPENDIX L
Prompt Global Strike

Joint Simulation Functional Requirements Definition

Mission: Force Applications **Function: Prompt Global Strike**

NOTE: Subject to AF Requirements Oversight Council (AFROC) and the Joint Requirements Oversight Council (JROC) approval, a Prompt Global Strike Analysis of Alternatives (AoA) is projected to start in FY04.

The overarching objective of the Force Applications mission area is to conduct global operations by the direct and prompt application of force from and through space against terrestrial targets. The primary goal is to provide precise, prompt, global strike capability with selective lethality thus deterring aggression or achieving military objectives when use of force is directed.

Force Applications capabilities focus on holding a finite number of terrestrial targets at risk anywhere, anytime with nearly instantaneous attack from or through space. They provide increased speed of response, short cycle times to counter high-value targets, a high probability of target neutralization and, hence, a high deterrent value to preclude hostilities.

AFSPC has developed a Mission Need Statement (MNS) for a prompt global strike capability. The MNS, currently in coordination within the Air Force, responds to Defense Planning Guidance to "maintain the ability to respond to crises that threaten our security interests anywhere on the globe." The DPG also adds, "Effective and efficient global power projection is the key to the flexibility demanded of US forces and ultimately provides national leaders with more options in responding to potential crises and conflicts. Being able to project power allows the US to shape, deter and respond even when it has no permanent military presence or only limited infrastructure in a region." The PGS MNS describes the need to globally, swiftly, and precisely apply forces in a multi-theater environment against specific targets to achieve desired effects. The need includes the ability to strike high-value, difficult-to-defeat targets when they are most vulnerable, from beyond the range of an adversary's ability to militarily respond, thus minimizing effects from their anti-access strategies.

L.1. TERMS and DEFINITIONS.

Space systems are comprised of nodes and links, as shown in Figure L-1. There are two types of nodes: terrestrial and space. The nodes are tied together with links. There are two types of links: control and mission.

The space node includes satellites, space stations, or reusable space-transportation systems like the space shuttle. The terrestrial node includes any land, sea, or airborne equipment used to interact with a space node. The link is the information conduit between the terrestrial and the space nodes. Control

links enable telemetry, tracking, and commanding (TT&C) of the space node. Mission links enable space effects.

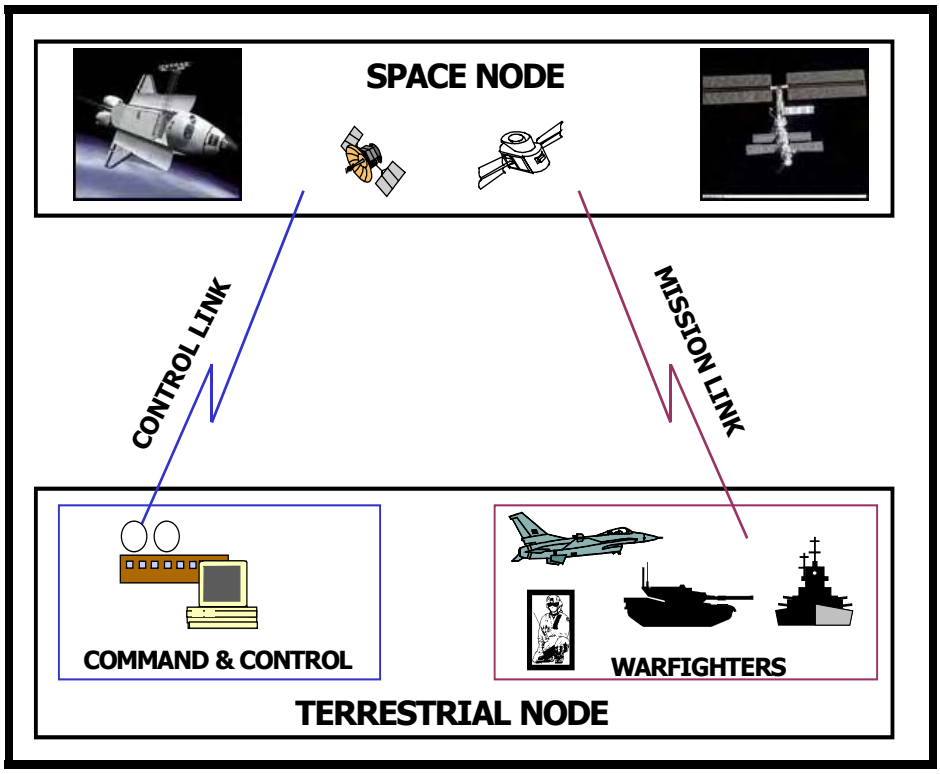

Figure L-1

L.2. TERRESTRIAL NODE COMMAND AND CONTROL. Employment of weapons is envisioned to be initiated by a space defense operations center with possible delegation to the theater commander.

L.3. CONTROL LINK COMMUNICATIONS. Command center to terrestrial, air or space satellite links will be required for PGS candidate solutions listed above. Characteristics include reducing vulnerability to jamming/countermeasures/environmental effects, bandwidth, hardening specifications, transmission/modulation scheme, frequencies and spread-spectrum capabilities.

L.4. SPACE NODE FUNCTIONALITY. Candidate AoA solutions include:

(a) Hypersonic Cruise Vehicle (HCV). This solution requires development of a manned or unmanned HCV to deliver precision-guided weapons in either standoff or direct-attack modes.
(b) Space Operations Vehicle (SOV). Technology maturation and demonstrations may lead to a new, reusable launch vehicle or space plane that could carry a Common Aerospace Vehicle (CAV) space delivery vehicle

to aid in weapon delivery capability. The SOV would deliver payloads in a pop-up maneuver or from low earth orbit.

(c) Ground or Sea-based Expendable Launch Vehicle. This solution consists of either modification of current missiles or building a new missile to deliver conventional payloads. An advanced reentry vehicle or CAV space delivery vehicle could be developed to support these missile systems. Both land-based and sea-based missile systems are candidates for concept exploration.

(d) Space-based Platform. This concept consists of a manned or unmanned platform in low earth orbit. The platform could release a CAV space delivery vehicle with conventional weapons, fire kinetic energy weapons or employ directed energy weapons.

(e) Air-Launched Global Strike System. This system consists of a large aircraft, such as a B-52 with heavy store pylons or a commercial aircraft variant that will air-launch Pegasus-like lift vehicles with a CAV space delivery vehicle. Propelled by this partially reusable lift system, the CAV would use its lifting body flight capabilities to reach global targets and dispense payloads.

(f) Directed Energy Strike System. Solutions consist of space-based lasers, ground-based lasers with orbital relay mirrors, and high-powered microwave concepts and architectures designed to provide global coverage supporting a spectrum of missions including ballistic missile defense, counter space, counter air, and ISR.

L.5. MISSION COMMUNICATIONS LINK. Operations cell to terrestrial, air or space satellite links will be required for PGS candidate solutions listed above. Characteristics include reducing vulnerability to jamming/countermeasures/environmental effects, bandwidth, hardening specifications, transmission/modulation scheme, frequencies and spread-spectrum capabilities.

L.6. TERRESTRIAL NODE: WARFIGHTER. Execution will be by a space operations squadron yet to be determined.

L.7. EXISTING MODELS AND SIMULATIONS. Analysis of Alternatives (AoA) is projected to start in FY04. Modeling and Simulation tools developed for the AoA are possible candidates for future use.

APPENDIX M
ICBM Operations

Joint Simulation Functional Requirements Definition

MISSION: Force Application **FUNCTION: ICBM Operations**

Today's Force Applications systems consist of nuclear-armed Minuteman III and Peacekeeper ICBMs. These ICBMs provide strategic deterrence by holding hostile targets at risk, as well as employing the capability to destroy, disrupt, or neutralize those targets.

Air Force Space Command (AFSPC) currently provides ICBM forces that are assigned nuclear missions in the Single Integrated Operational Plan (SIOP). ICBM mission requirements are based on AFSPC's assessment of U.S. Strategic Command's (USSTRATCOM) needed capability to maintain and hold assigned targets at risk. The 20th Air Force has the OPCON of ICBM units including the 341st Space Wing (Malmstrom AFB), the 91st Space Wing (Minot AFB), and the 90th Space Wing (F.E. Warren AFB).

M.1. TERMS and DEFINITIONS.

Space systems are comprised of nodes and links, as shown in Figure M-1. There are two types of nodes: terrestrial and space. The nodes are tied together with links. There are two types of links: control and mission.

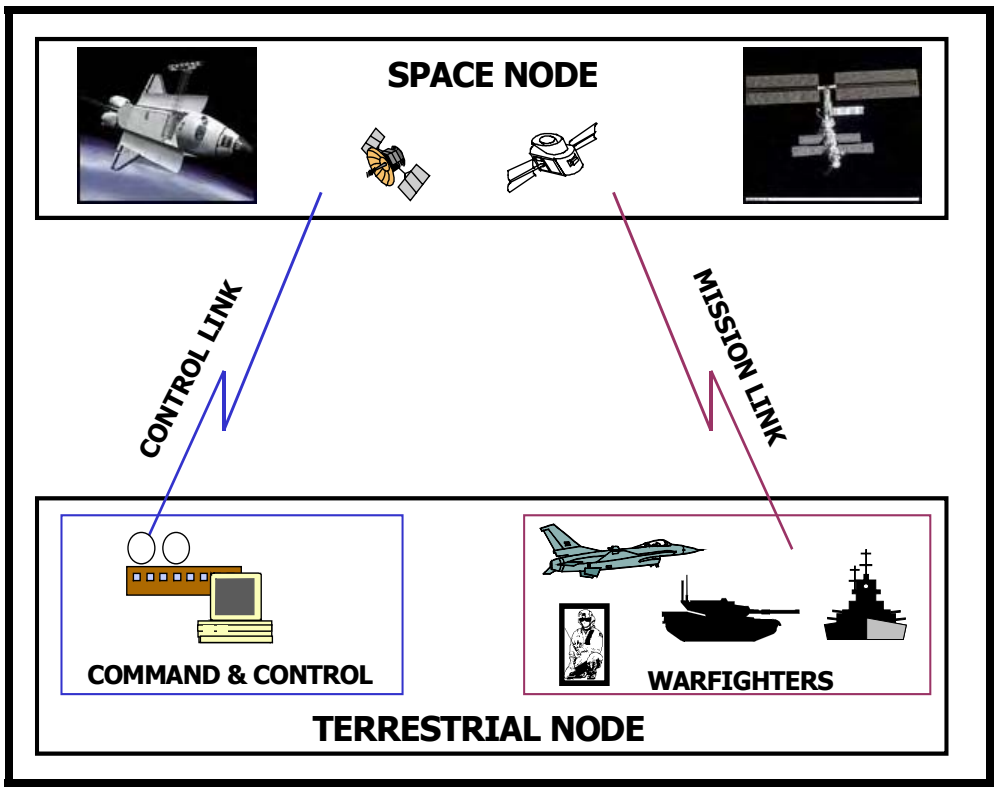

Figure M-1

The space node includes satellites, space stations, or reusable space-transportation systems like the space shuttle. The terrestrial node includes any land, sea, or airborne equipment used to interact with a space node. The link is the information conduit between the terrestrial and the space nodes. Control links enable telemetry, tracking, and commanding (TT&C) of the space node. Mission links enable space effects.

M.2. TERRESTRIAL NODE COMMAND AND CONTROL. Combatant Command (COCOM) of the strategic forces is exercised by USCINCSTRAT. ICBM doctrine is discussed in AFDD 2-1.2, Strategic Attack, and AFDD 2-1.5, Nuclear Operations.

M.3. CONTROL LINK COMMUNICATIONS. Missile launch crews respond to Presidential/SECDEF directives as executed by CINCSTRAT. The USSTRATCOM Command Center, Offutt AFB, transmits the Presidential/SECDEF directives to strategic aircraft, submarine, and missile forces. Located in the Command Center is the Alternate Processing and Correlation Center (APCC) providing an alternate missile warning correlation center to Cheyenne Mountain AFS. The APCC is the prime source of missile warning data for USSTRATCOM for force survival and management.

Should command capability be lost between the Launch Control Centers (LCCs) and remote missile launch facilities, specially configured airborne E-6B Take Charge and Move Out (TACAMO) aircraft, called the Airborne Launch Control System (ALCS), automatically assume control of and are capable of launching those isolated missile. Fully qualified airborne missile combat crews aboard the TACAMO aircraft would execute the Presidential/SECDEF orders for these missiles.

M.4. SPACE NODE FUNCTIONALITY. Single and Multiple Reentry Vehicles (RV) are the space node; ICBMs are configured with either the MK12, MK12A, or MK21 warhead. Characteristics include: Yield; fusing; countermeasures; and reliability.

M.5. MISSION COMMUNICATIONS LINK. Missiles are dispersed in hardened silos and connected to underground Launch Control Centers (LCCs) through a system of hardened cables and redundant radio links (564 MS). Launch crews consisting of two officers perform around-the-clock alert duty in the LCC. A variety of communication systems provide the President/SECDEF with highly reliable, virtually instantaneous direct contact with each launch crew. The Primary Alerting System uses dedicated telephone circuits to approximately 200 operating locations worldwide including the LCCs and the National Military Command Center, Washington DC. Through satellites and radio networks (VLF, LF, UHF, HF, EHF), USSTRATCOM can also communicate with force elements

deployed worldwide. Communications includes description of missile site or aircraft to command center and missile site or aircraft to missile links. Characteristics include: Bandwidth; transmission media type; frequency; antenna specifications; transmission/modulation scheme; vulnerability to jamming/environmental effects; and hardening specifications.

M.6. TERRESTRIAL NODE: WARFIGHTER. ICBM Forces provided by AFSPC include Minuteman III and the Peacekeeper Systems.

(a) ICBM sites. Characteristics include location, vulnerability to attack, and environmental interactions. Minuteman III sites include: 319/320/321 MS (FE Warren); 10/12/490/564 MS (Malmstrom); and 740/741/742 MS (Minot). Peacekeeper site: 400 MS (FE Warren).

(b) ICBM Weapon System. The START I -bounded ICBM force consists of 500 Minuteman IIIs (350 equipped with up to three warheads each, 150 equipped with Single Re-entry Vehicles (SRV) and 50 Peacekeeper missiles with up to 10 warheads each. ICBMs provide a reliable and low-cost force on continuous alert with a high readiness rate and the capability to immediately react under strict control of the President/SECDEF. The ICBM weapon systems are valued for their promptness, reliability, accuracy, connectivity, survivability, and availability for employment in a nuclear conflict. ICBM systems also provide substantial strategic deterrence and warfighting capability at relatively low cost compared to other strategic systems. Characteristics include: Range (max/min); payload capacity (throw weight); flight control systems; targeting capabilities; vulnerability to physical and electromagnetic attack; guidance system accuracy; reliability data.

(c) Future ICBM Systems. Recent Defense Planning Guidance has directed the AF to pursue concepts for missile systems to begin replacing the Minuteman III by 2020. The Defense Science Board Task Force on Nuclear Deterrence also noted that the AF needs a new ICBM with production beginning around 2017. It is projected that, by 2020, certain Minuteman III components will age out and spare items will have been exhausted due to flight-testing and other destructive analyses. It is not yet possible to state with confidence much about the design capabilities or configuration of the next-generation ICBM. Peacekeeper is slated for deactivation under START II. Peacekeeper deactivation will allow AFSPC to replace the MK12 warhead with either the MK21 or MK12A warhead. The AFROC validated Land Based Strategic Nuclear Deterrence MNS and subsequent AoA will help clarify some of the lingering future ICBM issues and questions.

M.7. EXISTING MODELS AND SIMULATIONS. USSTRATCOM uses a number of ICBM related models and planning tools to include AEM; AWPS; EPW,

JMASS, JMS, MEM, and RISOP. STAMP is the NAIC approved model for ICBM trajectory algorithms and ballistic missile profiling.

Appendix N
ACRONYMS AND ABBREVIATIONS

2 SOPS..... 2nd Space Operations Squadron
14 AF.....14th Air Force
20 AF ..... 20th Air Force
21 SW..... 21st Space Wing
45 SW..... 45th Space Wing
50 SW..... 50th Space Wing

A

ABM..... Anti-Ballistic Missile
AC2ISRC ..... Aerospace Command & Control Intelligence Surveillance & Reconnaissance Center (AC2ISRC)
ACC ..... Air Combat Command
ACTD ..... Advanced Concept Technology Demonstration
ADS ..... Advance Distributed Simulation
AEF..... Air Expeditionary Force
AEM..... Arsenal Exchange Model
AETC..... Air Education and Training Command
AEW ..... Air Expeditionary Wing
AF..... Air Force
AFB..... Air Force Base
AFCG ..... Aerospace Future Capabilities Wargame
AFDD ..... Air Force Doctrine Document
AFMC ..... Air Force Materiel Command
AFPP ..... Air Force Program Projection
AFRC..... Air Force Reserve Command
AFRL..... Air Force Research Laboratory
AFROC ..... Air Force Requirements Oversight Council
AFROCM..... Air Force Requirements Oversight Council Memorandum
AFSCN..... Air Force Satellite Control Network
AFSP ..... Air Force Strategic Plan
AFSPC..... Air Force Space Command
AFSST ..... Air Force Space Support Teams
AFWA..... Air Force Weather Agency
AITF ..... Aerospace Integration Task Force
ALCOM..... Alaskan Command
ALSP ..... Aggregate Level Simulation Protocol
AMETL ..... Agency Mission Essential Task List
AMTI..... Air Moving Target Indicator
AoA ..... Analysis of Alternatives

AOC..... Aerospace Operations Center
AOR..... Area of Responsibility
APOM..... Amended POM
APPG ..... Annual Planning and Programming Guidance
ARC ..... Air Reserve Component
ARC3VAL..... Architecture C3 Validation
ARSPACE..... Army Space Command
AS ..... Air Station
ASAT..... Anti-Satellite
ASIIS ..... Aerospace Integrated Investment Study
ASP..... AFSCN Scheduling Program
AT/FP..... Anti-Terrorism/Force Protection
ATD ..... Advanced Technology Demonstration
ATO ..... Air Tasking Order
ATWG ..... Army Transformation War Game
AWACS..... Airborne Warning And Control System
AWSIM..... Air Warfare Simulation
AWPS..... Automated Windowing Planning System

B

BMDO ..... Ballistic Missile Defense Organization
BMEWS ..... Ballistic Missile Early Warning System
BMR..... Ballistic Missile Requirements

C

C&I..... Communications and Information
C/JFACC..... Commander, Joint Force Air Component Command
C/JFLCC ..... Commander, Joint Force Land Component Command
C/JFMCC ..... Commander, Joint Force Maritime Component Command
C/NOFS..... Communications/Navigation Outage Forecast System
C2 ..... Command and Control
C3 ..... Command, Control and Communications
C4 ..... Command, Control, Communications and Computers
C4I ..... Command, Control, Communications, Computers and Intelligence
CA ..... Commercial Activity
CAOC..... Combined Air Operations Center
CATS..... Coverage Acquiring Tracking Simulation
CAV ..... Common Aero Vehicle
CC&D..... Camouflage, Concealment and Deception
CCS ..... Command and Control System

CE ..... Civil Engineering
CEASE..... Compact Environmental Anomaly Sensor
CENTCOM ..... US Central Command
CINC..... Commander(s)-in-Chief
CINCSPACE ... Commander-in-Chief, United States Space Command
CINCSTRAT ... Commander(s)-in-Chief, United Strategic Space Command
CITS ..... Combat Information Transport System
CJCS ..... Chairman of the Joint Chiefs of Staff
CJCSI..... Chairman of the Joint Chiefs of Staff Instruction
CJCSM..... Chairman of the Joint Chiefs of Staff Manual
CJTF ..... Combined Joint Task Force or Commander, Joint Task Force
COCOM ..... Combatant Command
COG..... Center of Gravity
COMAFFOR.... Commander Air Force Forces
CONOPS..... Concept of Operations
CONUS..... Continental United States
COSMOS ..... C4ISR Space and Missile Operations Simulation
COTS ..... Commercial Off The Shelf
CRG ..... Compliance Review Group
CSOS ..... Commercial Space Opportunities Study

D

D5 ..... Deny, Disrupt, Deceive, Degrade, or Destroy
DAPAM..... Distributed Architecture Performance Assessment Model
DCI..... Defensive Counter-Information
DCS ..... Defensive Counterspace
DDR&E..... Deputy Director for Research & Engineering
DDT..... Delay and Denial Technologies
DHP ..... Defense Health Program
DISA ..... Defense Information Systems Agency
DMSP..... Defense Meteorological Satellite Program
DMT..... Distributed Mission Training
DO..... Director of Operations
DoD ..... Department of Defense
DP ..... Development Plan
DPG ..... Defense Planning Guidance
DR..... Director of Requirements
DSB ..... Defense Science Board
DSCS ..... Defense Satellite Communications System

DSP ..... Defense Support Program
DSTS ..... Deep Space Tracking System
DVM ..... Dynamic Visibility Module

E

EADSIM..... Extended Air Defense Simulation
EAF..... Expeditionary Aerospace Force
ECS..... Expeditionary Combat Support and Electronic Security Command

EELV ..... Evolved Expendable Launch Vehicle
EELV-TI..... Evolved Expendable Launch Vehicle - Technology Insertion
EHF ..... Extremely High Frequency
ELV..... Expendable Launch Vehicle
EM ..... Environmental Monitoring
ENVI ..... Environmental for Visualizing Images
EO ..... Electro-Optical
EOD..... Explosive Ordnance Disposal
ESC..... Electronic Systems Center
EUCOM ..... European Command

F

F2T2EA ..... Find, Fix, Target, Track, Engage and Assess
FDE ..... Force Development Evaluation
FINPLAN ..... Financial Plan
FOC ..... Full Operational Capability
FOT&E ..... Follow-On Test & Evaluation
FP/AT..... Force Protection and Anti-Terrorism
FRD ..... Functional Requirements Document
FY..... Fiscal Year
FYDP..... Future Years Defense Program

G

GAO..... Government Accounting Office
GBS ..... Global Broadcast System
GCCS ..... Global Command and Control System
GCSS-AF..... Global Combat Support System-Air Force
GE ..... Global Engagement
GEED ..... Geophysical Environmental Effects Distributor
GEODE..... Geometric Emulation and Orbital Development Environment
GEODSS..... Ground-Based Electro-Optical Deep space Surveillance System

GIANT..... GPS Interference And Navigation Tool
GMTI ..... Ground Moving Target Indicator
GOES ..... Geostationary Operational Environmental Satellite
GP ..... General Purpose
GPS ..... Global Positioning System
GRP ..... Guidance Replacement Program

H

HAX ..... Haystack Auxiliary
HITRAN..... High Resolution Transmission Model
HQ..... Headquarters
HSI ..... Hyperspectral Imagery
HSPP..... High-Speed Precision Penetrator
HUSIR..... Haystack Ultra-Wideband Satellite Imaging Radar

I

ICBM..... Intercontinental Ballistic Missile(s)
IDASS ..... Intelligence Data Analysis System for Satellites
IIA..... Integrated Investment Analysis
IMA ..... Individual Mobilization Augmentee
IO..... Information Operations
IOC..... Initial Operational Capability
ION ..... Insertion of Noise
IPL..... Integrated Priority List
IPP ..... Integrated Planning Process
IPT ..... Integrated Product Team
IR..... Infrared
IRIP..... Integrated Roadmap and Investment Plan
ISOON ..... Improved Solar Optical Observing Network
ISR ..... Intelligence, Surveillance and Reconnaissance
ITW/AA..... Integrated Tactical Warning and Attack Assessment

J

JCAS ..... Joint Attack Simulation
JECEWSI ..... Joint Electronic Warfare Simulation
JEFX ..... Joint Expeditionary Force Experiment
JFACC ..... Joint Air Force Component Commander
JFC ..... Joint Force Commander
JFCOM ..... Joint Forces Command
JLASS..... Joint Land, Aerospace, and Sea Simulation

JMASS..... Joint Modeling And Simulation System
JMETL..... Joint Mission Essential Task List JNETS-Joint Networks Simulation
JOISIM..... Joint Operations Information Simulation
JOVE..... Joint Operational Visualization Environment
JSTARS ..... Joint Surveillance and Target Attack Radar System
JTMP..... Joint Training Master Plan
JV ..... Joint Vision
JWFC ..... Joint Warfighting Center

K

KMR..... Kwajalein Missile Range
KSAT..... Kaman Satellite Analysis Tool

L

LEO ..... Low Earth Orbit
LEO&A ..... Launch, Early Orbit and Anomaly resolution
LF ..... Launch Facility
LIDAR ..... Light Detection and Ranging
LIS..... Logistic Information System
LOGSIM ..... Logistics Simulation
LOWTRAN ..... Low Resolution Transmission (Model)
LRP..... Long Range Plan
LSSC..... Lincoln Space Surveillance Complex

M

MAA..... Mission Area Assessment
MAF ..... Missile Alert Facility
MAJCOM..... Major Command
MAP ..... Mission Area Plan
MASINT..... Measurement and Signature Intelligence
MCS ..... Mission Control Station
MDST..... Missile Defense Space Tool
MEECN..... Minimum Essential Emergency Communications Network
MEM ..... Multiple Engagement Module
METL ..... Mission Essential Task List
MILCON ..... Military Construction
MILSATCOM .. Military Satellite Communications
MLV ..... Medium Launch Vehicle
MM ..... Minuteman
MMP ..... Minuteman MEECN Program

MNA..... Mission Needs Analysis
MNS..... Mission Needs Statement
MODSAF..... Modular Semi-Automated Forces
MOSS..... Mobile Optical Surveillance System
MP/AI ..... Modernization Planning/Aerospace Integration
MPP ..... Modernization Planning Process
MS&A..... Modeling, Simulation and Analysis
MSA ..... Mission Solution Analysis
MSP ..... Mission Support Plan
MSX/SBV ..... Mid-course Space Experiment/Space-Based Visible
MT ..... Mission Team

N

N/UWSS ..... NORAD/USSPACECOM Warfighting Support System
NASA ..... National Aeronautics and Space Administration
NAVSPACE..... Navy Space Command
NAVWAR ..... Navigation Warfare
NBC ..... Nuclear, Biological, Chemical
NCA ..... National Command Authority
NCC ..... Network Control Center
NIMA ..... National Imagery and Mapping Agency
NMD ..... National Missile Defense
NMS..... Non-Materiel Solution
NOAA..... National Oceanographic and Atmospheric Administration
NORAD ..... North American Aerospace Defense Command
NOSC..... Network Operations and Security Center
NPOESS ..... National Polar-orbiting Operational Environmental Satellite System
NRO..... National Reconnaissance Office
NSIAD..... National Security and International Affairs Division (GAO)
NSS ..... National Security Strategy
NUDET..... Nuclear Detonation

O

O&M ..... Operations and Maintenance
OCI..... Offensive Counter-Information
OCS ..... Offensive Counterspace
OJCS..... Office of the Joint Chiefs of Staff
OODA ..... observe, orient, decide, act
OPAL ..... Object Processing Algorithm Library
OPCON..... Operational Control

OPORD ..... Operations Order
OPR ..... Office of Primary Responsibility
OPSEC ..... Operations Security
ORD..... Operational Requirements Document
OPTEMPO..... Operations Tempo
OSCARS ..... Operational Satellite Constellation Availability and Reliability Simulation
OSD ..... Office of the Secretary of Defense
OT&E ..... Operational Test and Evaluation
OTV ..... Orbit Transfer Vehicle

P

PARCS..... Perimeter Acquisition Radar Characterization System
PAS..... Personal Alarm System
PAVE PAWS ... Precision Acquisition Vehicle Entry Phased-Array Warning System
PCS..... Permanent Change of Station
PK ..... Peacekeeper
PME ..... Professional Military Education
POC ..... Point of Contract
POES ..... Polar-Orbiting Operational Environmental Satellite
POM..... Program Objective Memorandum
PRC ..... Program Review Committee
PRP..... Propulsion Replacement Program
PSM ..... Portable Space Model

Q

QOL..... Quality Of Life

R

RAU ..... Reserve Associate Unit
RADARSIM .... Radar Simulation
RF ..... Radio Frequency
RISOP ..... Red Integrated Strategic Operational Plan
RPMA..... Real Property Maintenance Activity
RRC ..... Requirements Review Committee
RSA ..... Range Standardization and Automation
RTS ..... Remote Tracking Station
RV ..... Reentry Vehicle

S

S&T ..... Science and Technology

S&TW ..... Surveillance and Threat Warning
SAOC ..... Space Aerospace Operations Center
SAS..... Space Aggressor Squadron
SASSI..... Signature & Sensor System Investigator
SATA..... Small Aperture Telescope Augmentation
SATCOM..... Satellite Communications
SATRAN ..... Satellite Reconnaissance Advance Notice
SBEON ..... Space-Based Electro-Optical Network
SBIRS ..... Space-Based Infrared System
SBIRS/IOSA... Space-Based Infrared System/Integrated Overhead SIGINT Architecture
SBL..... Space-Based Laser
SBLR..... Space-Based Launch Range
SBMCS ..... Space Battle Management Core Systems
SBR ..... Space-Based Radar
SCA ..... Space Coordinating Authority
SCI ..... Sensitive Compartmented Information
SCINDA..... Scintillation Network Decision Aid
SCN ..... Satellite Control Network
SCOUT ..... Space Command Optimizer of Utility Toolkit
SEAS..... System Effectiveness Analysis Simulation
SECDEF..... Secretary of Defense
SEON ..... Solar Electro-optical Observing Network
SERV..... Safety Enhanced Reentry Vehicle
SHF ..... Super High Frequency
SIAM..... Space & Information Analysis Model
SIGINT..... Signals Intelligence
SJA ..... Staff Judge Advocate
SLBM ..... Submarine Launched Ballistic Missile
SLRS..... Space Launch Range System
SLRSC..... Space Launch Range System Contract
SMAT ..... Satellite and Missile Analysis Tool
SMC..... Space and Missile Systems Center
SMEI..... Solar Mass Ejection Imager
SMP ..... Strategic Master Plan
SMV ..... Space Maneuver Vehicle
SN ..... Strategic National
SNAPM..... Space Navigation Accuracy Prediction Model
SOPS ..... Space Operations Squadron

SOPSMAN..... Space Operations Scheduling and Management System
SOV ..... Space Operations Vehicle
SPAAT..... Sensor-Platform Allocation Analysis Tool
SPACEAF ..... Air Force Component for Space
SPECTOR ..... Satellite Performance of Earth Coverage and Tracking with Outage Regions
SSN ..... Space Surveillance Network
SSPARS..... Solid State Phased Array Radar Systems
SSTO ..... Single-Stage-To-Orbit
ST ..... Strategic Theater
STAMP ..... Strategic and Theater Attack Modeling Process
START..... Strategic Arms Reduction Treaty
STEDE..... Space Training, Education and Exercise
STK..... Satellite Tool Kit
STK VO ..... Satellite Tool Kit Visualization Option
STO ..... Space Task Order
STORM..... Synthetic Theater Operations Research Model
STS..... Space Transportation System
STW&ARS ..... Satellite Threat Warning and Attack Reporting System
SWC ..... Space Warfare Center
SWICS ..... Space Weather Ionospheric Characterization System
SWXS..... Space Weather Squadron

T

TACCSF..... Theater Air Command and Control Simulation Facility
TACOM ..... Tactical Communications
TAOS ..... Total Atmosphere-Ocean Services
TAWS..... Tactical Air Warning System
TBD ..... To Be Determined
TBM..... Theater Ballistic Missile
TBMS ..... Theater Battle Management Staff
TEAM ..... Target Error Analysis Model
TF..... Task Force
TMD..... Theater Missile Defense
TOA ..... Total Obligation Authority
TPED ..... Tasking, Processing, Exploitation and Dissemination
TPIPT..... Technical Planning Integrated Product Team(s)
TRACKS..... Test, Research, and Analysis of Celestial Kinetics for Spacetrack
TSPR..... Total System Performance Responsibility

TSTO ..... Two-Stage-To-Orbit
TT&C ..... Telemetry, Tracking and Commanding

U

UCAR ..... University Consortium for Atmospheric Research
UFO ..... UHF Follow-On
UHF ..... Ultra High Frequency
UJTL ..... Universal Joint Task List
UQT ..... Unit Qualification Training
US ..... United States
USAF..... United States Air Force
USAFE..... United States Air Forces in Europe
USFK..... United States Forces, Korea
USSPACECOM United States Space Command
USSTRATCOM United States Strategic Command

V

VTC ..... Video Teleconference

W

WEED ..... Wargames, Exercises, Experiments, and Demonstrations
WMD ..... Weapons of Mass Destruction
WOC..... Wing Operations Center
WRM..... War Reserve Materiel
WX ..... Weather

X

XPXA..... Analysis Branch, Plan Division, Directorate of Plans and Programs
XPY..... Space Analysis Center, Directorate of Plans and Programs

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APPENDIX O
US Space Command 1998 Requirements

UNITED STATES SPACE COMMAND

18 MAY 1998

MEMORANDUM FOR SPJ3V
SPJ3
IN TURN

FROM: HQ USSPACECOM/J37 (formerly J33Z)
250 S. Peterson Blvd Ste 116
Peterson AFB CO 80914-3002

SUBJECT: National Air and Space [Warfare] Model (NASM) Functional Requirements Document (FRD) Space Annex

1. Sir, we have been working with the Air Force Agency for Modeling and Simulation (AFAMS), the NASM Executive Agent, since last October drafting and refining the subject annex. The attached document represents our missions as defined in the Unified Command Plan and describes the objects NASM must model in order to simulate space functions.

2. We have coordinated this document at the action officer level across the other directorates, and it represents the consensus of the headquarters.

3. AFAMS originally requested CAPT Huffine's signature as the closest ranking counterpart to BGen Sandstrom. Now, with his promotion to Major General, they request your coordination. My POC is Mr. Dave Peck, ext. 4-5451.

J. A. CROOKSTON, Colonel, USMC
Chief, Jt Training, Exercises & Education

Attachment:
AF/XOC letter, Approval of the National Air and Space [Warfare] Model (NASM) Functional Requirements Document (FRD), 31 March 1998

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON, DC

MAR 31 1998

MEMORANDUM FOR SEE DISTRIBUTION

FROM: AF/XOC
1480 Air Force Pentagon
Washington DC 20330-1480

SUBJECT: Approval of the National Air and Space [Warfare] Model (NASM) Functional Requirements Document (FRD)

In December we asked for your assistance in defining functional requirements for NASM. Your support has been instrumental in helping us compile an FRD that accurately describes air and space missions, organizations, and training requirements. Attached is the FRD appendix that addresses specific areas that fall under your organization's area of expertise. We have incorporated your staffs' comments, and the appendix is now ready for your approval and signature.

Your signature indicates that the document accurately describes the systems and/or processes your organization uses to carry out its assigned missions. Additionally, your signature commits your organization to supporting NASM development with Subject Matter Experts (SMEs) who will provide the knowledge necessary to support model development and validation.

Once again, thanks for your superb NASM support. Your continued support will ensure that we build a system capable of meeting our future training needs. Our POC for this effort is Capt Brett Telford at the Air Force Agency for Modeling and Simulation. He can be contacted at DSN 970-5750 or email Telford.Brett@afams.af.mil. Please return your signed documents to:

AFAMS
12350 Research Parkway
Orlando FL 32826-3276

JAMES E. SANDSTROM, Maj Gen, USAF
Director of Command and Control
DCS, Air and Space Operations

Attachments:
1. Distribution List
2. FRD Appendices (as applicable)

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Atch 1

Annex C
Space Operations

Purpose: The space operations annex focuses on the employment of space assets in support of the warfighter. This annex identifies the missions, describes the processes, and defines terms used in USSPACECOM operations. In addition it will identify the organizations that will support NASM modeling of space operations. It is essential that these organizations assist AFAMS in identifying the platforms and systems that need to be modeled, as well as obtain the data necessary to support model development. Without significant user input NASM will be unable to deliver a viable training product.

JAMES E. SANDSTROM
Major General, USAF
Director, Command and Control
DCS, Air and Space Operations
HQ United States Air Force

Date:_____

RODNEY P. KELLY
Major General, USAF
Director of Operations
USSPACECOM

Date: 20 MAY 98

INTRODUCTION: This annex lists the U.S. Space Command (USSPACECOM) requirements to be included in the National Air and Space Warfare Model (NASM). These requirements will be included in the building of the Air and Space conceptual model, as well as mission space objects to be used in the Joint Simulation System (JSIMS). The seven USSPACECOM missions will be modeled: Space Control, Force Enhancement, Force Application, Space Forces Support, Combatant Command Support, Ballistic Missile Defense (BMD) Planning, and Warning and Assessment.

NASM must represent all space functions that support the warfighter. USSPACECOM envisions using NASM to drive space events in joint and service-level Computer Aided Exercises (CAX), providing training opportunities for space training objectives of the regional and functional CINCs and their component commands, as well as those of USSPACECOM and its components.

The USSPACECOM exercise program is externally focused--USSPACECOM participates in four to eight major exercises per year. Examples include the USACOM UNIFIED ENDEAVOR series, USCENTCOM's INTERNAL LOOK and ROVING SANDS exercises, USEUCOM's TRAILBLAZER and ATLANTIC RESOLVE, USPACOM's COBRA GOLD, USFK's ULCHI/FOCUS LENS, NORAD's VIGILANT OVERVIEW, and USSTRATCOM's GLOBAL GUARDIAN. Space play in these exercises supports both host CINC and USSPACECOM training objectives.

USSPACECOM components actively play in many of the above exercises, and participate in service-level exercises as well. Service exercises involving USSPACECOM components include the BLUE FLAG series, CJTFEXes, and PRAIRIE WARRIOR.

USSPACECOM MISSIONS DEFINED

USSPACECOM conducts assured space operations and warfighter support during peacetime, crisis, regional conflict, or general war through all phases of conflict. Each mission includes relevant task references from the Universal Joint Task List (UJTL):

1. Space Control: Operations that provide freedom of action in space for friendly forces while denying it to the enemy. Space control functions include surveillance, prevention, negation and protection.
   - SN 3.2: Apply National Strategic Firepower
   - SN 3.4.6: Provide Space Control

2. Force Enhancement: Operations conducted using space and space-related systems to improve the effectiveness of both terrestrial and space-based forces. Force enhancement functions include theater missile warning and assessment, weather, navigation, communications and intelligence, surveillance and reconnaissance.
   - SN 3.4: Provide DoD/Government-wide support
   - SN 5.1.2: Manage National C4 Systems Worldwide for Communicating Strategic Information
   - ST 2.2.1: Collect Information on the Strategic Situation ... Climate ....
   - ST 6.1.5: Provide Theater Missile Defense

3. Force Application: Although no forces are currently assigned, this mission is defined as combat operations conducted to engage and defeat the enemy from, through, and within space. It also ensures protection of US national interests and investments in space. Force Application is a future mission, with no UJTL tasks yet assigned.

4. Space Forces Support: This mission is defined as the development and advocacy of requirements for reliable, responsive, and affordable spacelift vehicles to assure continued space access, and the effective employment of spacelift and space systems operations to optimize combat and mission effectiveness.

- SN 3.4.4: Generate, Launch, and Deploy Space Systems
- SN 3.4.5: Monitor and Maintain On-Orbit Systems

5. Combatant Command Support: USSPACECOM performs a Chairman, Joint Chiefs of Staff (CJCS)-directed role as the advocate for military space capabilities to support US military strategy. This role involves working with each combatant command and Service to identify and articulate space requirements. USSPACECOM also provides direct support to combatant commands and theater joint task forces (JTFs) to facilitate effective use of space for force enhancement. This includes educating CINCs and staffs on space and missile intelligence capabilities and availability.

6. Ballistic Missile Defense (BMD) Planning: The CJCS has tasked USCINCSPACE with the following BMD-related responsibilities:

a. Plan for and develop requirements for strategic BMD and space-based tactical BMD.

b. Coordinate development of concepts and plans for the integrated strategic defense of North America as CJCS coordinating authority for strategic defense planning. Strategic defense includes air, space, and missile defense.

7. Warning and Assessment: Warning and Assessment consists of providing support to NORAD's Integrated Tactical Warning/Attack Assessment (ITW/AA) function and to regional CINCs through ballistic missile surveillance, warning of ballistic missile launches, and participation in the DoD Indications and Warning (I&W) network. USSPACECOM uses intelligence, radar, and infrared (IR) signatures to detect, immediately report, and assess ballistic missile launches. Warning and Assessment addresses the following UJTL tasks:

- SN 2.2: Collect Strategic Information
- SN 2.3: Provide Baseline Intelligence Assessment and Reassessment
- SN 3.X (to be defined in updated UJTL): Provide Integrated Tactical Warning and Attack Assessment
- ST 2.2.1: Collect Information on the Strategic Situation . . . Climate . . .
- ST 2.3.5: Develop Indications and Warning

USSPACECOM Objects and Authoritative Data Sources

The attached (attachments 1 - 14) object descriptions detail the objects USSPACECOM requires to be modeled. In addition, the attachments list an individual who will act as the authoritative data source for all information required to model the object's capabilities and behaviors. This individual will be responsible for answering questions, obtaining source data and documents, and coordinating for subject matter expert (SME) support when required.

ATTACHMENT 1

MISSION: Space Control FUNCTION: Space Surveillance

OBJECTS: Each object is subject to four categories of offensive threats, reflecting presently known space threats. 1) Nuclear Weapons, characteristics include detonation of small nuclear device to damage or disable a payload; 2) Electronic Warfare/ Information Warfare, characteristics include use of radio frequency (RF) or electro-optical (EO) signals to defeat the intelligence gathering and/or communications capabilities of a payload; 3) Kinetic Energy Weapons, characteristics include use of a chemical explosion and/or projectiles to damage or disable a payload; and 4) Directed Energy Weapons, characteristics include use of electromagnetic radiation to deposit enough energy on or in a payload to damage or disable it. In addition, the overflight intelligence threat to ground/terrestrial forces must be considered.

1. Space Surveillance Network Ground Stations/Sensors and Contributing Sensors. Includes world-wide Space Surveillance Network locations (including missile warning radars whose secondary mission is space surveillance and contributing sensors, such as the Army's Kwajalein Missile Range Sensors). Characteristics include location (geocentric) vulnerability to attack (physical and electromagnetic) on facilities, obscura, coverage limits (azimuth/elevation), limitations on number of objects tracked simultaneously, communications links and environmental interactions (weather and atmospheric effects).

2. Satellite Reconnaissance Advance Notice (SATRAN). Characteristics (classified). Provides timely notice of potential hostile satellite reconnaissance of U.S. forces worldwide; predicts when selected satellites will be in a position to perform intelligence collection against U.S. forces and military/military-related installations, and makes these predictions available to installation commanders.

3. Environment - should be populated largely by other requirements for space vehicle modeling (neutral, commercial and multinational), however, as a minimum, all BLUEFOR and REDFOR Space Order of Battle Satellites should be modeled. Characteristics include reflectance (image signature), radar cross section, on orbit location, vulnerability to above threats and communications links (mission data, telemetry, tracking and control - TT&C) and environmental interactions (solar flares, drag, meteorites/debris).

COMMUNICATIONS: Communications includes description of type of spacecraft TT&C communications from command and control facilities, communications links from satellite(s) to processing ground site(s) links, processing site(s) to command and alternate command center links and processing site to user links. Characteristics include signal gain, signal frequency, transmission scheme, resistance to jamming/spoofing and bandwidth (land and SATCOM).

COMMAND AND CONTROL: Command and control of the satellite surveillance network is provided through the Cheyenne Mountain Space Control Center and its Alternate Space Control Center at Dahlgren, VA.

POCs:

1. Modeling & Simulation: Mr. Dave Peck, USSPACECOM/J37, DSN 692-5451, (719) 554-5451; Mr. Rob Hegstrom, SWC/AE, DSN 560-9195, (719) 567-9195; Mr. John Crown, USARSPACE, DSN 692-8734, (719) 554-8734.

2. Functional: Maj Greg Chapman, USSPACECOM/J33O, (offense), DSN 692-9020, (719) 554-9020; Lt Col Mike Murray, USSPACECOM/J33Y (defense), DSN 692-0183, (719) 554-0183; Mr. Bill Furr, USARSPACE, DSN 692-8724, (719) 554-8724.

EXISTING MODELS AND SIMULATIONS: The Space Surveillance Network Analysis Model (SSNAM) is an analytical tool being developed by the Electronic Systems Center and the Space Warfare Center and is scheduled to be available by 1998. Model POC is: Dr. Joseph Liu, SWC/AE DSN 560-9044, (719) 567-9044

The Space and Missile Analysis Tool (SMAT) is currently available to use as a visualization tool for satellite location and movement. Model POC is: Mr. Marc Herklotz, SWC/AE, DSN 560-9247, (719) 567-9247

ATTACHMENT 2

MISSION: Space Control FUNCTION: Prevention

OBJECTS: Prevention is the use of diplomacy and other forms of persuasion to deny the use of third country and commercial space assets to hostile countries. The execution of prevention is not dependent on specific forces or C4I systems. Potential objects include:

1. Denied Space Asset: Includes target communications, navigation, weather or ISR systems and their associated C2 links and command centers. Note, however, that these objects will be modeled for other space functions, and should not need to be modeled for the Prevention task.

2. Department of State, foreign governments and commercial space service providers. Behavior characteristics and communications links should be modeled to allow for US intervention to deny hostile forces support from third-party systems or commercially available services. Examples include Russian government sale of imagery, SPOT and LANDSAT imagery, and INMARSAT and INTELSAT communications services.

COMMUNICATIONS: Commercial and government terrestrial and satellite voice and data, secure and non-secure.

COMMAND AND CONTROL: The US Department of State undertakes diplomatic overtures via diplomatic channels in consultation with the Joint Staff.

POC: Lt Col Mike Murray, USSPACECOM/J33Y (defense), DSN 692-0183, (719) 554-0183.

EXISTING MODELS AND SIMULATIONS: None.

ATTACHMENT 3

MISSION: Space Control FUNCTION: Negation

OBJECTS: Anti-Satellite (ASAT) systems can be grouped into three categories: Ground-based, air, sea, or ground-launched, and spaced-based (satellites). Kill mechanisms include kinetic energy, directed energy (laser, particle beam, x-ray or microwave), and nuclear.

1. Air/Sea/Ground Launched Kinetic Energy: Launcher characteristics include location, vulnerability to attack, range, on-station times, and weather interactions. Booster characteristics include range, final orbital velocity, vulnerability to attack and weather interactions. Warhead characteristics include targeting limitations (range, speed, azimuth, elevation), sensor characteristics (radar/IR/EO wavelength, effective radiated power, sensitivity, anti-jamming/clutter rejection characteristics), and lethality (burst radius/probability of kill).

2. Space-Based Kinetic Energy: Satellite characteristics include orbital location, orbital maneuver capability, vulnerability to attack, communications capability, self-protection functionality (active and passive) and environmental interactions. Warhead characteristics are as per Air/Sea/Ground Launched Kinetic Energy.

3. Ground-Based Directed Energy: Site characteristics include location, vulnerability to attack, and weather interactions (cloud cover, etc.). Weapon characteristics include operating wavelength, bandwidth, output power, transmission loss data, targeting limitations (range, speed, azimuth, elevation) and firing rate/frequency/ capacity limitations.

4. Air or Sea-Based Directed Energy: Platform characteristics include location, vulnerability to attack, range, on-station times, and weather interactions. Weapon characteristics include operating wavelength, bandwidth, output power, transmission loss data, targeting limitations (range, speed, azimuth, elevation) and firing rate/frequency/ capacity limitations.

5. Space-Based Directed Energy: Satellite characteristics include orbital location, orbital maneuver capability, vulnerability to attack, communications capability, self-protection functionality (active and passive) and environmental interactions. Weapon characteristics include operating wavelength, bandwidth, output power, transmission loss data, targeting limitations (range, speed, azimuth, elevation) and firing rate/frequency/ capacity limitations.

6. Ground, Air or Sea-Launched Nuclear ASAT: Platform/site characteristics include location, vulnerability to attack, range, on-station times, and weather interactions. Booster characteristics include range, final orbital velocity, vulnerability to attack and weather interactions. Warhead characteristics include yield, fusing, reliability and targeting limitations (range, speed, azimuth, elevation).

COMMUNICATIONS: Communications includes description of satellite, launch platform or ground site to command center links. Characteristics include bandwidth, transmission medium, frequency, antenna specifications, transmission/modulation scheme, vulnerability to jamming/countermeasures and hardening specifications.

COMMAND AND CONTROL: Employment of weapons will be initiated by the Space Defense Operations Center, located in Cheyenne Mountain AFS, CO, and executed by Space Operations Squadrons located at Falcon AFB, CO and other locations.

POCs:

- Modeling and Simulation: Mr. Rob Hegstrom, Space Warfare Center (SWC)/AE, DSN 560-9195, (719) 567-9195 (primary). Mr. John Crown, USARSPACE, DSN 692-8734, (719) 554-8734 (alternate/US Army issues).

- Functional: Maj Greg Chapman, USSPACECOM/J33O, (offense), DSN 692-9020, (719) 554-9020; Mr. Duane Roberts, USARSPACE, DSN 692-8738, (719) 554-8738.

EXISTING MODELS AND SIMULATIONS: Intelligence, Surveillance and Reconnaissance Simulation (ISRSIM), and Space Force Engagement Model (SFEM), SWC/AE. POCs Mr. Rob Hegstrom (ISRSIM) and Dr. Al Bevan (SFEM), DSN 560-9365, (719) 567-9365.

ATTACHMENT 4

MISSION: Space Control FUNCTION: Protection

OBJECTS: Measures designed to protect space assets from hostile threats. Characteristics include security level, hardening specifications, anti-jam thresholds, spread spectrum specifications and degradation levels/time to recover. Examples: Encryption devices, equipment hardening (kinetic, laser, RF and nuclear), anti-jam measures, anti-spoof measures and spread spectrum techniques. Also includes measures designed to geolocate the source of EW/RFI interference and/or laser/HPM attack, measures designed to determine the intent of an adversary employing counter-space weapons, and measures to respond to an attack on our space system(s).

COMMUNICATIONS: Characteristics include techniques designed to enhance security/reliability of data transmission.

COMMAND AND CONTROL: Employment of protective measures is initiated by the Space Defense Operations Center located in Cheyenne Mountain; this mission migrates to the USSPACECOM Space Operations Center (SPOC) in FY 01; and executed by space operations squadrons located at Falcon AFB. A regional CINC potentially may be tasked to respond to an attack.

POC: Lt Col Mike Murray, USSPACECOM/J33Y, DSN 692-0183, (719) 554-0183.

EXISTING MODELS AND SIMULATIONS: ISRSIM, POC Mr. Rob Hegstrom, SWC/AE, DSN 560-9195, (719) 567-9195.

ATTACHMENT 5

MISSION: Force Enhancement

FUNCTION: Theater Ballistic Missile Warning and Assessment

OBJECTS: USSPACECOM provides worldwide warning of the launch of hostile ballistic missiles, both strategic and theater, to U.S. and certain allied forces. This task applies specifically to warning of the launch of theater ballistic missiles. Objects include:

1. Theater Ballistic Missiles (TBMs): Characteristics include number of reentry vehicles (RVs), launch location, missile location (trajectory of RV(s), rocket body and post boost vehicle, if they exist), location uncertainty, mass, shape, ballistic coefficient, reflectance (image signature), radar cross section, vulnerabilities to attack (kinetic energy weapons (KEW), directed energy weapons (DEW), nuclear weapons), maximum range, guidance and control, RVs, countermeasures, and communications links. NASM must also portray threat infrastructure, decoys, and support systems (i.e., forward operating bases for mobile systems). NASM also should not constrain the opposing force(s) from potential threat tactics such as volley firing of large numbers of missiles in an attempt to overwhelm friendly defensive systems. Example: SCUDs.

2. Missile Warning Satellite: Characteristics include location (orbit), reflectance (image signature), radar cross section, vulnerabilities to attack (KEW, DEW, nuclear, information attacks), payload (sensor), communications links (mission data, TT&C), and environmental interactions (solar flares, drag, meteorites). Examples: Defense Support Program (DSP), Space-Based Infrared System (SBIRS) High, SBIRS Low, and SBIRS HEO.

3. Missile Warning Satellite Sensor: Characteristics include sensor phenomenology (IR, Radar, E-O, etc.), operating wavelength, vulnerability to countermeasures, terrestrial weather, scan technique, resolution, sensitivity (detection thresholds), selectivity (noise rejection), field of view, onboard processing abilities and time. Example: DSP sensors, SBIRS sensors.

4. Theater Missile Warning Ground Processing Stations: Convert satellite sensor data to missile warning messages over appropriate theater data links for training audience. Characteristics include location (fixed or transportable), size, manning, deployment footprint, processing functions and timelines, parameter characteristics including accuracy and probability of correct identification of threat, communications links, vulnerability to attack (physical - conventional and NBC, EW, IW, etc.), and environmental interactions (weather and terrain). Examples: JTAGS, ALERT, and TACDAR.

5. Ground-Based Missile Warning Sensor: Characteristics include sensor phenomenology, operating wavelength, scan method, output power, detection thresholds, processing time constraints, processing capability, resolution, vulnerability to countermeasures and selectivity. Examples: AN/FPS-123 (Thule), AN/FPS-50 & 92 (Clear), AN/FPS-115 (PAVE PAWS - Cape Cod, Beale), PATRIOT Fire Control radar.

COMMUNICATIONS: Communications links include missile warning satellite to ground processing stations and ground processing stations to warfighter user. Characteristics include bandwidth, frequency, antenna specifications, transmission/modulation scheme, connectivity, data rate, signal strength, resistance to EW, resistance to nuclear effects, and resistance to natural interference.

COMMAND AND CONTROL: Command/tasking of the sensor network is provided a missile warning center located in Cheyenne Mountain (for strategic and long-range systems) and the ALERT facility at Falcon AFB (for tactical systems). Processed data is provided to operational units and the NCA. Command and control of the DSP satellites is provided by the 50th Space Wing at Falcon AFB. Payload data is controlled by the ground processing stations.

POCs:

1. Modeling & Simulation: Mr. Dave Peck, USSPACECOM/J33Z, DSN 692-5451, (719) 554-5451.

2. Functional: Overall, LCDR Robert Vaughn, USSPACECOM/J33O, DSN 692-5084, (719) 554-5084;
   For JTAGS LTC Reitinger, USARSPACE, at DSN 692-4571, (719) 554-4571.
   For TACDAR Mr. Jeff Peterson, NAVSPACE, at (703) 808-4113
   For ALERT Capt Pease, AFSPC, at DSN 560-9127, (719) 567-9127
   For SBIRS Mr. Jack Tomkovich, USARSPACE, at DSN 692-8769, (719) 554-8769
   For DSP Col Steve Gast, AFSPC, at DSN 692-3202, (719) 554-3202

EXISTING MODELS AND SIMULATIONS: The Portable Space Model (PSM) is the currently approved real-time space model in the Aggregate Level Simulation Protocol (ALSP) confederation for joint and service training exercises. PSM currently models missile warning simulations of the Theater Event System (TES) which includes JTAGS, ALERT and TACDAR. PSM is also compatible with the Distributed Interactive Simulation (DIS) protocol.

ATTACHMENT 6

MISSION: Force Enhancement FUNCTION: Weather Support

OBJECTS: Space weather support objects must support the following three training objectives: Provide real space weather data to the training audience for use in theater planning process; provide to the training audience the capability to successfully plan for weather conditions with appropriate rewards and to penalize those planners/operators who do not plan for weather conditions; and provide weather factors such as visibility, humidity, precipitation, etc. to the simulation as a whole as they might impact real operations.

1. Weather Satellite: Characteristics include location (orbit), reflectance (image signature), radar cross section, vulnerabilities to attack (KEW, DEW, IW, nuclear), payload (sensor), communications links (mission data, TT&C), and environmental interactions (solar flares, drag, meteorites). Examples: Defense Meteorological Support Program (DMSP), National Polar Orbiting Environmental Satellite System (NPOESS), Geostationary Operational Environmental Satellite (GOES), and National Oceanic and Atmospheric Administration (NOAA) satellites.

2. Satellite Weather Sensor: Characteristics include sensor phenomenology (IR, Radar, E-O, etc.), operating wavelength, vulnerability to countermeasures, scan technique, resolution, sensitivity (detection thresholds), selectivity (noise rejection), field of view, onboard processing abilities and time. Example: DMSP sensors and GOES sensors.

3. Weather Satellite Ground Support Stations: Converts satellite weather sensor data to usable data and weather forecasts for theater warfighter use. Characteristics include location (fixed or mobile), size, manning, processing functions and timelines, communications links, vulnerability to attack (physical - conventional and NBC, EW, IW, etc.), and environmental interactions (weather and terrain). Examples: DMSP Processing Stations.

4. Theater Ground Processing Weather Units: Weather support teams receive data via direct downlink or processed weather data via satellite communications. Characteristics include location (fixed or mobile), size, manning, deployment footprint, processing functions and timelines, communications links, vulnerability to attack (physical - conventional and NBC, EW, IW, etc.), and environmental interactions (weather and terrain). Examples: Army Division Weather team with Integrated Meteorological System (IMETS) terminals.

5. Ground based sensors: Sensors with the capability to provide a variety of weather observations such as precipitation, wind speed and direction, barometric pressure, etc. Sensors would be automated and transmit data via satellite communications. This enables the staff weather officer to refine the weather forecast. Examples: The Meteorological Automated Sensor and Transceiver (MAST) demonstration.

COMMUNICATIONS: Communications links include weather satellite to ground processing stations and ground processing stations to warfighter user or direct downlink from weather satellite to warfighter user. Characteristics include frequency, connectivity, data rate, signal strength, transmission scheme, resistance to EW, resistance to nuclear effects, and resistance to natural interference.

COMMAND AND CONTROL: Command and control of the DMSP satellites is provided by the 50th Space Wing at Falcon AFB. Payload data is controlled by the ground processing stations. GOES and NOAA weather satellites are controlled through their respective ground control stations located at Wallops Island, VA.

POC:

1. Modeling & Simulation: Mr. Dave Peck, USSPACECOM/J33Z, DSN 692-5451, (719) 554-5451.

2. Functional: Mr. Mike Baker, USSPACECOM/J33W, DSN 692-6985, (719) 554-6985; Mr. Jeff Faunce, USARSPACE, DSN 692-4552, (719) 554-4552 or MAJ Plaisted, USARSPACE, DSN 692-4524, (719) 554-4524

EXISTING MODELS AND SIMULATIONS:

1. IMETS: The U.S. Army uses IMETS terminals to receive, process and display real weather data. POC: Mr. Marvin Dubbin, PD-IMETS, DSN 258-1984, (505) 678-1984.

2. Total Atmospheric Ocean Services (TAOS), by TASC, Inc., intakes real-world historical weather data and uses weather community standard models to generate weather effects which TAOS can the distribute to multiple simulations. POC: Mr. Pat Rugg, SWC, DSN 560-9885, (719) 567-9885.

3. Deployable Weather Satellite Workstation (DWSW). Direct downlink of weather satellite imagery and sensor data. POC: Mr. Jeff Faunce, DSN 692-4552, (719) 554-4552.

4. EDGE Environmental Work Bench and Weatherscape by Autometric. For 3D display of weather data and 3D weather modeling. POC: John Kreisa, Autometric, Comm 703-658-4000.

ATTACHMENT 7

MISSION: Force Enhancement FUNCTION: Navigation Support

OBJECTS: Navigation support objects must serve to model the application and impacts of Global Positioning System (GPS) services from space to service receiver equipment. GPS signals transmitted from space are used by a multitude of systems for military specific applications. Applications include location awareness, orientation, navigation, position and velocity accuracy determination, aiming and targeting, munitions guidance, synchronization, fratricide prevention, maneuver, intelligence, battlefield damage assessment, electronic warfare, aviation, and combat service support. NASM and its resident space navigation support objects must allow wargame planners to adjust course of action for GPS availability, signal integrity, accuracy, coverage, reconstitution and supportability.

1. Global Positioning System (GPS) Satellites: Characteristics include orbital location, vulnerability to attack, communications capability, geographic coverage, NAVWAR capabilities and environmental interactions.

2. GPS Satellite Navigation Payload: Characteristics include operating frequency, timing stability, output power, antenna specifications and accuracy of navigational data.

3. GPS Receiver Systems: Characteristics include required signal to noise ratio, noise rejection capabilities, processing time, navigational accuracy, frequency and antenna specifications.

4. GPS Control Stations: Characteristics include satellite vehicle control (telemetry, tracking and command), navigation data message update/control, location, footprint, and vulnerability (physical, and electromagnetic).

COMMUNICATIONS: Communications includes satellite transponder to GPS receiver link (down), control station to NAVSTAR satellite link (up, down), GPS navigation signal characteristics (frequency, spread spectrum, selective-availability/anti-spoofing) and environmental effects (natural and man-made).

COMMAND AND CONTROL: Command and control of the NAVSTAR satellites is provided by the 50th Space Wing at Falcon AFB in Colorado Springs, CO (location of Master Control Station). Monitor stations are located at on Ascension Island, Diego Garcia, Kwajalein, and Hawaii.

POCs:

1. Modeling & Simulation: Mr. Dave Peck, USSPACECOM/J33Z, DSN 692-5451, (719) 554-5451; Mr. Rob Hegstrom, SWC/AE, DSN 560-9195, (719) 567-9195.

2. Functional: CDR John Broomfield, USSPACECOM/J33O, DSN 692-5770, (719) 554-5770; Mr. Stewart Stout, USARSPACE, DSN 692-8776, (719) 554-8776.

EXISTING MODELS AND SIMULATIONS:

OMEGA - GPS performance prediction model. AFSPC SWC, Capt Dave Lucia, DSN 560-9286, (719) 567 9286.

SNAPM - Satellite Navigation Accuracy Prediction Model. AFSPC SWC, Capt Dave Lucia, DSN 560-9286, (719) 567-9286.

ATTACHMENT 8

MISSION: Force Enhancement FUNCTION: Communications Support

OBJECTS: (Note: The four types of SATCOM described below are military in nature. Commercial systems augmenting these capabilities exist, and must be modeled/ simulated.)

1. UHF SATCOM

a. UHF Satellites - Characteristics include location (orbit), payload (transponders), communication links (telemetry, tracking and command), vulnerability (physical, electromagnetic, and radiation), and type of channel access (Dedicated, Demand Assigned Multiple Access (DAMA) and Demand Assigned Single Access (DASA)). Examples: Fleet Satellite Communications System (FLTSATCOM), UHF Follow On (UFO), and Gapfiller.

b. UHF Satellite Transponders - Characteristics include: transponder bandwidth, number of transponders (capacity), coverage area, and vulnerability (physical, electromagnetic, and radiation).

c. UHF User Segment/Terminals - Characteristics include: single channel, voice or data, secure, data rate (low and medium), vulnerability (UHF signals are easily detected, intercepted and jammed), and environmental interactions (UHF signals are easily disrupted by natural scintillation). Examples: AN/PSC-5.

d. UHF Ground Control Stations - Characteristics include: satellite vehicle control (telemetry, tracking and command), communications payload control, location, footprint, and vulnerability (physical and electromagnetic).

e. Emerging Mobile Satellite Services (MSS). These new commercial services are creating a worldwide personal communications services UHF communications environment. Characteristics of the satellites, payloads and ground control stations will be similar to those above.

2. SHF SATCOM

a. SHF Satellites - Characteristics include location (orbit), payload (transponders), communication links (telemetry, tracking and command), and vulnerability (physical, electromagnetic, and radiation). Examples: DSCS III. (The DSCS provides the primary transmission path for much of the DoD's highest priority communications).

b. SHF Satellite Transponders - Characteristics include: transponder bandwidth, power, number of transponders (capacity), antennas (spot and beam coverage), and vulnerability (physical, electromagnetic - has some limited anti-jam capabilities, and radiation).

c. SHF User Segment/Terminals - Characteristics include: multichannel, high quality voice, data rate (medium /high), location, footprint, vulnerability (physical and electromagnetic - has some limited anti-jam capabilities and secure channels). SHF terminals include strategic terminals (fixed station, heavy or medium earth terminals that provide the international satellite trunking for the Defense Communications System through Standardized Tactical Entry Points) and tactical terminals (deployed to support echelons from theater/JTF down to brigade level, compatible with the area common user systems). Examples: Strategic - AN/FSC-78, AN/FSC-79, AN/GSC-39, modified AN/GSC-49, AN/GSC-52, and AN/TSC-86. Tactical - AN/TSC-85B, and AN/TSC-93B.

d. SHF Ground Control Stations - Characteristics include: satellite vehicle control (telemetry, tracking and command), communications payload control, satellite communications network control, location, footprint, and vulnerability (physical and electromagnetic).

3. EHF SATCOM

a. EHF Satellites - Characteristics include location (orbit), payload (transponders), communication links (telemetry, tracking and command), and vulnerability (physical). Examples: MILSTAR

b. EHF Satellite Transponders - Characteristics include: transponder bandwidth, number of transponders and/or demodulators (capacity), antennas (spot and beam coverage), crosslink between satellites, and vulnerability (physical).

c. EHF User Segment/Terminals - Characteristics include: A terminal may simultaneously be a member, a communications controller, and an antenna controller. Secure Mobile Anti-Jam Reliable Tactical Terminal (SMART-T) - transportable tactical r ichannel satellite communications terminal, processes data and voice communications at both medium and low data rate simultaneously, can survive biological and chemical attack as well as severe EW and EMP environments. Single Channel Anti-Jam Manportable Terminal (SCAMP) - manpackable, processes data and voice at a maximum data rate of 2400 bps, low probability of interception, low probability of detection, can be paged while in motion.

d. EHF Ground Control Stations - Characteristics include: satellite vehicle control (telemetry, tracking and command), communications payload control, satellite communications network control, location, footprint, and vulnerability (physical and electromagnetic).

4. Global Broadcast System (GBS) SATCOM

a. GBS Satellites - Characteristics include location (orbit), payload (transponders), communication links (telemetry, tracking and command), and vulnerability (physical, electromagnetic, and radiation).

b. GBS Satellite Transponders - Characteristics include: transponder bandwidth, power, number of transponders (capacity), antennas (earth coverage and spot beam), and vulnerability (physical, electromagnetic, and radiation).

c. GBS User Segment/Terminals - Characteristics include: multichannel, very high data rate, multi-level security, location, footprint, vulnerability (physical and electromagnetic), fixed and tactical terminals (deployed to support echelons from theater/JTF and down). Critical characteristic is this is a one way broadcast system with information injected at the ground control stations. Similar to the commercial Direct Broadcast Satellite TV.

d. GBS Ground Control Stations - Two types - fixed (permanent in place) and mobile in-theater injection into the broadcast system. Characteristics include: satellite vehicle control (telemetry, tracking and command), communications payload control, location, deployability, footprint, and vulnerability (physical, and electromagnetic).

COMMUNICATIONS: Communications includes ground site to satellite links. Characteristics include bandwidth, transmission media type, transmission/modulation scheme, vulnerability to jamming/countermeasures, output power, frequency, antenna specifications and hardening specifications. Characterization of actual communication segments will be provided by DISA.

COMMAND AND CONTROL: Command of the satellite communications capabilities is provided by various command authorities. Execution of commands is provided to the satellites via ground stations (may be relayed by other satellites and for some systems will be executed by satellite operations squadrons linked to the various ground stations).

POC:

1. Modeling & Simulation: Mr. Dave Peck, USSPACECOM/J33Z, DSN 692-5451, (719) 554-5451.

2. Functional: Overall, Maj McBreen, NORAD/USSPACECOM J6, DSN 692-3708, (719) 554-3708.

a. MILSTAR: Mr. Keith Kuhn, USARSPACE, DSN 692-8707, (719) 554-8707.

b. UFO: Mr. Jeff Simon, USARSPACE, DSN 692-8706, (719) 554-8706.

c. SHF: Mr. Dan Hannan, USARSPACE, DSN 692-8708, (719) 554-8708.

d. GBS: Mr. Tom Meals, USARSPACE, DSN 692-8785, (719) 554-8785.

EXISTING MODELS AND SIMULATIONS:

NATE/STRATC2AM - Combines Strategic Command, Control and Architecture model (POC AFSAA/SA, Ms. Corinne Wallshein, DSN 227-6086) with NATE (NUICCS Analyst Tool Environment, POC USSPACECOM/AN, Mr. Ron Roehrich, DSN 692-3638) and uses OMNI for visual scenario playback.

ATTACHMENT 9

MISSION: Force Enhancement

FUNCTION: Intelligence/Surveillance/ Reconnaissance

OBJECTS: Coverage of this task is limited to USSPACECOM assets and responsibilities, which does not include the launch, operation and tasking of national intelligence systems. Information on these systems can be obtained from the National Reconnaissance Office. Coverage of this task will include USSPACECOM requirements as a producer and consumer of intelligence.

1. Unmanned Aerial Vehicles (UAV). Characteristics include location of airfield, range of vehicle, sensors, flight path, time on station, electro optical resolution, connectivity to air and ground stations/relays, connectivity to satellite relay system, physical characteristics of platform, take-off and landing requirements, communication linkages, and aerial flight capabilities i.e. altitude and speed characteristics. Examples include Predator and Outrider.

2. Space Imaging Satellites. Characteristics include location (orbit), reflectance (imagine signature), radar cross section, vulnerabilities to attack (KEW, HPM, laser, EW, IW, radiation), payload (sensor), communications links (mission data, TT&C), and environment interactions (solar flares, drag meteorites). Examples include LANDSAT, SPOT, Lewis, Clark, Earlybird, RADARSAT, National Satellites and Commercial Remote Sensing Satellite (Space Imaging System).

3. Space Imaging Satellite Sensor. Characteristics include sensor phenomenology (IR, Radar, E-O, etc.), operating wavelength, vulnerability to countermeasures, scan technique, resolution, sensitivity (detection thresholds), selectivity (noise rejection), field of view, onboard processing abilities and time.

4. Space-based radar satellite. Characteristics include orbital location, vulnerability to attack, communications capability and environmental interactions.

5. Space-based radar sensor. Characteristics include operating wavelength, scan method, output power, detection thresholds, processing time constraints, resolution, power requirements, vulnerability to countermeasures and selectivity.

6. Ground Processing Stations (Fixed and Mobile). Convert RISTA sensor data to processed digitized information that can be transmitted to users over appropriate theater links for the training audience. Characteristics include location (fixed and mobile), size manning, processing functions such as target tracking, timelines, parameter characteristics including accuracy and probability of correct identification of threat in a "cluttered" battlefield environment, communications links, vulnerability to attack (physical, conventional, NBC, EW, IW, etc.), and environmental interactions (weather, terrain, day and night). Examples include Eagle Vision II, Clark Mobile Ground Station, fixed satellite ground station.

COMMUNICATIONS: Communications includes description of space plane or satellite to ground site or command center links. Characteristics include bandwidth, frequency, transmission/modulation scheme, vulnerability to jamming/countermeasures, antenna specifications and hardening specifications.

COMMAND AND CONTROL: Command/tasking of the sensor network is provided by centers located in Cheyenne Mountain or other locations. Processed data is provided to operational units and the NCA.

POC: Maj Kevin Formolo, NORAD/USSPACECOM J2X, DSN 692-6980, (719) 554-6980.

EXISTING MODELS AND SIMULATIONS:

1. ISRSIM

2. Extended Air Defense Simulation (EADSIM) provides a many-on many theater-level simulation of air and missile warfare, an integrated analysis tool to support joint and combined force operations, and a tool to augment maneuver force exercises at all echelons. POC is Jim Watkins, Battle Integration Center, SSDC Huntsville DSN 645-1681, CIV 205-955-1681.

3. Synthetic Imagery Generation System (SIGS) is an interactive, computer-based system designed to provide simulated national level imagery for military exercises. SIGS can also support direct hardcopy images or secondary imagery dissemination networks. POC is CPT Al Hendricks, OSO, DSN 294-6733, CIV 202-279-6733.

4. The National Wargaming System (NWARS) is an interactive intelligence asset simulator that supports training, exercises, and military operations by modeling tasking, collection, and reporting of national systems. POC is CPT Al Hendricks, OSO, DSN 294-6733, CIV 202-279-6733.

5. THUNDER is an Air Force campaign model that has recently been modified to include a RISTA capability. POC is Mr. Gary Streets, SWC, DSN 560-9153, CIV 719-567-9153.

ATTACHMENT 10

MISSION: Force Application FUNCTION: Prompt Global Strike

OBJECTS:

1. Conventional ICBMs. Characteristics include max/min range, payload capacity (throw weight), types of warheads available, flight control systems, specific thrust, vulnerability to physical and electromagnetic attack, guidance system accuracy, available countermeasures and reliability data. Examples: Minuteman III, Peacekeeper.

2. Space-Based Laser Weapon Satellite. Characteristics include orbital location, vulnerability to attack, communications capability, self-protection functionality (active and passive) and environmental interactions.

3. Space-Based Laser Weapon. Characteristics include operating wavelength, bandwidth, transmission loss data, targeting limitations (range, speed, azimuth, elevation) and firing rate/frequency/capacity limitations.

4. Military space plane. Characteristics include range, lethality, altitude, orbital capabilities, payload limitations, recovery time and mission planning time.

COMMUNICATIONS: Command center/operations cell to satellite, missile or space plane links. Characteristics include vulnerability to jamming/countermeasures, bandwidth, hardening specifications, transmission/modulation scheme, frequencies and spread-spectrum capability.

COMMAND AND CONTROL: Employment of weapons is initiated by a space defense operations center located in Cheyenne Mountain and executed by space operations squadrons located at Falcon AFB and other locations.

POC: COL Jerry Hatley, USSPACECOM/J5, DSN 692-9999, (719) 554-9999.

EXISTING MODELS AND SIMULATIONS: ISRSIM

ATTACHMENT 11

MISSION: Force Application FUNCTION: ICBM Operations

OBJECTS:

1. Nuclear and conventional ICBM sites. Characteristics include location, vulnerability to attack and environmental interactions. Examples: Peacekeeper site - 400 Missile Squadron (MS) (F.E. Warren); Minuteman III sites - 319/320/321 MS (F.E. Warren), 446/447/448 MS (Grand Forks), 564/12 MS (Malmstrom), 740/741/742 MS (Minot).

2. Nuclear and conventional ICBMs. Characteristics include max/min range, payload capacity (throw weight), types of warheads available, flight control systems, targeting limitations, specific thrust, vulnerability to physical and electromagnetic attack, guidance system accuracy, available countermeasures and reliability data. Examples: Minuteman III, Peacekeeper.

3. Nuclear and conventional ICBM warheads. Characteristics include yield, fusing, and reliability.

4. Ballistic Missile launch aircraft. Characteristics include minimum stand-off distance, launch processing time constraints, payload capacity, range and navigation system accuracy.

COMMUNICATIONS: Communications includes description of missile site or aircraft to command center and missile site or aircraft to missile links. Characteristics include bandwidth, transmission media type, frequency, antenna specifications, transmission/modulation scheme, vulnerability to jamming/countermeasures and hardening specifications.

COMMAND AND CONTROL: Employment of weapons is initiated by NCA and command center located at STRATCOM and executed by individual missile sites or aircraft.

POC: Maj Troy Caudle, AFSPC/XPA, DSN 692-4104, (719) 554-4104.

EXISTING MODELS AND SIMULATIONS: STAMP (POC: Lt Kenyon Orme, NAIC/TABS)

ATTACHMENT 12

MISSION: Space Forces Support FUNCTION: Launch/Spacelift

OBJECTS:

1. Launch Vehicles. Characteristics include timelines, thrust, reliability, availability and payload limitations (size, weight). Examples: Delta II, Atlas II, Titan II, Titan IV, commercial small lift (Pegasus, Taurus, Athena), Space Operations Vehicle (a.k.a. military space plane) and Evolved Expendable Launch Vehicle (EELV).

2. Launch Control Facility. Characteristics include orbital plane limitations, turnaround time, mission processing time constraints, location, vulnerability to attack and environmental interactions. Examples: Cape Canaveral, Vandenberg

COMMUNICATIONS: Communications includes description of launch control facility to launch vehicle links and downlinks for launch vehicle telemetry data. Characteristics include output power, transmission/modulation scheme, vulnerability to jamming/countermeasures, bandwidth, frequency, antenna specifications and hardness.

COMMAND AND CONTROL: Command of launch vehicles is provided by a ground-based launch control facility. Feedback from the launch vehicle (telemetry) is analyzed by the launch control facility and the vehicle is commanded accordingly by the controllers.

POC: Maj Marti Fallon, USSPACECOM/J35, DSN 692-9014, (719) 554-9014.

EXISTING MODELS AND SIMULATIONS: STAMP (POC: Lt Kenyon Orme, NAIC/TABS), OSCAR

ATTACHMENT 13

MISSION: Space Forces Support

FUNCTION: Satellite Command and Control/On-Orbit Support

OBJECTS:

1. Ground-Based Command and Control Site. Characteristics include location, vulnerability to attack and environmental interactions. Examples: Global Positioning System (GPS) Operational Control System (OCS), Defense Support Program (DSP) Ground System and Air Force Satellite Control Network (AFSCN).

2. Satellite Systems. Characteristics include orbital location, vulnerability to attack, sensor type, communications capability, environmental interactions and ground traces. Examples: GPS, DSP, MILSTAR, etc.

COMMUNICATIONS: Communications includes description of ground site to command center, ground site to satellite and satellite to ground station downlinks. Characteristics include bandwidth, transmission media type, transmission/modulation scheme, vulnerability to jamming/countermeasures, output power, frequency, antenna specifications and hardening specifications.

COMMAND AND CONTROL: Routine on-orbit support is provided by contracted and DoD personnel located at remote locations and at satellite control squadrons located at Falcon AFB. Anomalies reported by users are relayed through the respective command centers to the controllers. Reconfigurations/reallocations of capabilities during crises would flow from the NCA to command centers to the controllers.

POC: Capt Scott Herrick, USSPACECOM/J33, DSN 692-5525, (719) 554-5525.

EXISTING MODELS AND SIMULATIONS: None.

ATTACHMENT 14

MISSION: Warning and Assessment

FUNCTION: Integrated Tactical Warning/ Attack Assessment (ITWAA)

OBJECTS:

1. Missile Warning Satellite. Characteristics include orbital location, vulnerability to attack, sensor type, communications capability and environmental interactions. Examples: Defense Support Program (DSP) satellites, Space Based Infrared System (SBIRS) satellites.

2. Missile Warning Satellite Sensor. Characteristics include sensor phenomenology, operating wavelength, scan technique, sensitivity, selectivity, onboard processing capability, processing time constraints, vulnerability to countermeasures and functions/availability of counter-countermeasures.

3. Ground-Based Missile Warning Site. Characteristics include location, vulnerability to attack and environmental interactions.

4. Ground-Based Missile Warning Sensor. Characteristics include sensor phenomenology, operating wavelength, scan method, output power, detection thresholds, processing time constraints, processing capability, resolution, vulnerability to countermeasures and selectivity. Examples: AN/FPS-123 (Thule), AN/FPS-50 & 92 (Clear), AN/FPS-115 (PAVE PAWS - Cape Cod, Beale)

5. Ground-based missile warning correlation/assessment center. Characteristics include processing timelines (includes time to dual phenomenology verification), processing capacity (#targets/events) and assessment accuracy. Example: Missile Warning Center (Cheyenne Mountain), ALERT (Falcon AFB)

COMMUNICATIONS: Communications includes description of ground site or satellite to processing/command center links. Characteristics include bandwidth, transmission media type, frequency, antenna specifications, transmission/modulation scheme, vulnerability to jamming/countermeasures and hardening specifications.

COMMAND AND CONTROL: Command/tasking of the sensor network is provided a missile warning center located in Cheyenne Mountain (for strategic and long-range systems) and the ALERT facility at Falcon AFB (for tactical systems). Processed data is provided to operational units and the NCA.

POC: Maj Nancy Taylor, USSPACECOM/J33O, DSN 692-3603, (719) 554-3603.

EXISTING MODELS AND SIMULATIONS: ISRSIM, PSM, NORAD/USSPACECOM Command and Control Simulation (NUCCS). NUCCS is a network simulation of the communications and processing of missile warning data from warning sensors through displays and processing in Cheyenne Mountain to dissemination of processed ITWAA data to end users. Model POC is LTC John Weatherford, N/SPANS, DSN 692-2495.