**Military Satellites**

**Overview**

Communications is vital to the modern military establishment. Satellites permit direct communications with units on the battlefield. Light-weight mobile terminals can be erected in a matter of hours, keeping advancing troops in constant contact with higher authorities. Today the soldier in the field can use satellite links to establish direct and instantaneous communication with the National Command Authorities. The United States maintains several geostationary communications satellite networks, which were extensively used during the Operation Desert Storm.

The Defense Satellite Communications System (DSCS), is used by all four military services and a number government agencies.(1) The nominal constellation includes five operational and two spare satellites.(2) Three DSCS II satellites, launched in the late 1970 and the 1980s, remain in service, along with four of the more capable and survivable DSCS III spacecraft launched in the 1980s. Beginning in 1991, DSCS III satellites will be launched singly on upgraded Atlas II boosters, with ten launches planned through 1997.(3)

The Navy uses a wide range of military communications satellites. The Gapfiller transponders on three Marisat satellites, in service since 1976, were finally taken our of service in 1990. The Fleet Satellite Communications (FLTSATCOM) constellation consists of three backup satellites, launched in 1978, 1979 and 1980, and FLTSATCOM 4, FLTSATCOM 6, and FLTSATCOM 7 launched in 1980, 1986 and 1989 respectively, in front line service. The Navy's other major system is the Leased Satellite (LEASAT) system, which consists of four Syncom IV spacecraft leased from Hughes, which is also the satellites manufacturer. The final launch of the LEASAT program was completed on 9 January by the Space Shuttle.(4) The Navy's new satellite project, the Ultra-High Frequency (UHF) Follow-On (UFO) program, will launch 10 satellites beginning in 1992.(5)

The two satellites of the Satellite Data System (SDS) support near-real time communications between low altitude photographic intelligence satellites and ground control stations, using highly elliptical semi-synchronous Molniya-type orbits, optimized for coverage of the North polar region. SDS F-5 and F-5A, launched in 1983 and 1984 respectively, probably remain in service. NASA's Tracking and Data Relay Satellite System (TDRSS), supports near-real time data transmission from the Lacrosse low altitude imaging intelligence satellites.(6)

The Milstar satellite system, which has been under development since the early 1980s to provide survivable and jam resistant Extremely High Frequency (EHF) communications to strategic and tactical users,(7) has experienced major cost and technical problems.(8) The program experienced a major reorientation in 1990, away from support of strategic nuclear warfighting with the Soviet Union,(9) toward support of conventional forces in the Third World.(10) The constellation will be limited to no more than 6 satellites, rather than the 10 originally planned,(11) and the system focused on support of tactical users.(12) First Milstar launch aboard a Titan 4 from the Eastern Test Range was anticipated in late 1992,(13) although subsequent flights will be delayed.(14)

The DoD Space Architect was established in the 27 September 1995 USD (A&T) memorandum to consolidate the responsibilities for space missions and system architecture development into a single organization.  The memorandum also directed that the immediate effort of the DoD Space Architect shall be to develop a future Military Satellite Communications architecture which encompasses core DoD capabilities; allied, civil, and commercial augmentation; and global broadcast capabilities.

 Several key factors contributed to the need for developing an objective MILSATCOM architecture.

* The current fielded MILSATCOM systems will require replenishment in the first decade of the next century
* The explosive growth in satellite communication technologies and services in the commercial sector merit exploitation of these capabilities for the warfighter
* Warfighter needs and requirements for the coming decades are changing and growing

The DOD Space Architect's MILSATCOM Architecture Development Team (ADT) developed four architecture alternatives.  From the analysis of performance, utility, cost, and risk on the four alternatives, findings were made concerning terminals, frequency spectrum, the space segment, the commercial satellite communications industry, and military requirements and operations.  Several themes emerged concerning an objective MILSATCOM architecture.

**FINDINGS**: First, there is enormous potential for improved capability and lower unit cost over current systems.  Significant technology and many revolutionary commercial satellite communications systems will be demonstrated over the next five to ten years, including switched, crosslinked, and processed systems; large constellations of varied earth orbits; dynamic communications control; and low cost, low maintenance terminals.  Though new frequency spectrum allocations are unlikely, there is potential for commercial synergy in the Ka band.

 Second, future vision and doctrine will require more satellite communications service than a simple evolution of present systems will provide.  The force structures of 2003-2010 presume availability of the types of information and communications support in operation today, and depend critically on high performance MILSATCOM services such as protected, survivable, and netted mobile.  Additionally, bandwidth-intensive emerging capabilities, such as mobile-netted services and global broadcast, are not currently reflected in weapons system concept of operations.

 Third, changes to the ground segment of the architecture are as critical as changes to the space segment.  Over 100 types of terminals are fielded today, and they have not previously been treated as a variable in architecture or transition development.  Current operations and support costs for terminals are significant, yet not highly visible.

From stakeholder feedback on the four architecture alternatives, objectives of high performance with improved capacity, flexibility, and assured support emerged.  This led to the formation of a set of MILSATCOM Objectives for 2010-2025:

* Provide the right communications to the right user at the right time by being information services driven
* Be fully integrated with the Defense Information Systems Network (DISN)
* Reduce the satellite communications 'footprint' of terminals, radios, antennas, RF signature, people, etc.
* Be user friendly and interoperable

A transition approach to the objective was recommended to mitigate risk and reduce the cost in research and development.  The Transition Goals for 2003-2015 will help achieve the objective architecture in an affordable manner.  The Transition Goals are:

* Ensure continuity of service through satellite replenishment, operations management, or risk trade-offs
* Within limits of low or medium acquisition risk and acceptable funding, take significant steps towards the MILSATCOM Objectives, with no barriers to evolution
* Enable evolution to new warfighting visions by facilitating demonstrations and operational use
* Accelerate on going changes in terminal developments toward flexibility and systems efficiency
* Fully integrate MILSATCOM into the overall communications architecture
* Take advantage of international cooperative opportunities

The JSMB approved the objective architecture goals and strategy, in concept, with the understanding that long-term resource decisions would be predicated upon a cost constrained requirements analysis.  A Senior Warfighters Forum (SWarF)(flag level users from the CINCs, services, communications and acquisition communities) was started to balance capabilities versus future needs, available funding, and risk for the transition period.  The SWarF's recommendations were centered around funding for Wideband, Protected, and Narrowband SATCOM:

 Wideband

* + 3 or more Gapfiller satellites – 2004 launch
  + X-band/GBS (Ka)/2-Way Ka
  + Offload "fixed" users
  + Watch commercial market

 Protected

* + 4 Advanced EHF satellites
  + Polar – 24 hour coverage

Narrowband

* + Understand UFO risks
  + Mitigate with hedges
  + Assess commercial systems
  + Look at objective system for 2007 and beyond
  + The SWarF's recommendations were approved by the JROC on 2 Oct 97.

All ships must have a minimum of 128 kilobits per second to be able to meet the fundamental requirements to support messaging and to maintain a common tactical picture. This core capability is needed to support traditional mission areas, as well as the new mission of theater missile defense for our cruisers and guided missile destroyers. IT 21 provides the core capability.

* BUILD ONE If high resolution imagery and collaborative planning are required as part of the ships mission, then additional bandwidth is required. This additional bandwidth typically will go to carriers, command ships and amphibious assault ships.
* BUILD TWO This will support the missions of precision engagement, joint task force commander, joint forces air component commander, and operational maneuver from the sea.
* BUILD THREE In order to support the area air defense coordinator mission on cruisers, they need the additional bandwidth required for collaborative planning.

Joint Vision 2010 utilizes dispersed, well informed, connected forces to achieve massed effects. These forces will require more throughput and significantly improved information management. Today the Navy achieves high throughput using large antennas. These antennas can’t fit on all the Navy's smaller ships. Large antennas impact radar cross section, another factor for our ships. Dispersed forces of the future will need to have the same throughput utilizing much smaller antennas.

**A - Army**

**33142A SATCOM Terminals**(15)

Military Satellite Communications (MILSATCOM) systems are joint program/project efforts with each Service, Joint Chiefs of Staff (JCS), National Security Agency (NSA), and Office of the Secretary of Defense (OSD) assigned specific responsibilities as specified in JCS Memorandum of Polity (MOP) 178. There are three worldwide MILSATCOM systems: the ultra high frequency (UHF) Fleet Satellite /Air Force Satellite (FLTSAT/AFSAT) system; the super high frequency (SHF) Defense Satellite Communications System (DSCS); and the extremely high frequency (EHF) Military Strategic/Tactical Relay (MILSTAR) system. MOP 178 designates Army as the Executive Agent for MILSATCOM Ground Subsystems. As Executive Agent for MILSATCOM Ground Subsystems Army is responsible for developing, procuring, and life cycle logistics support for satellite terminals; satellite control subsystems; communications subsystems; and all related equipments required to achieve end-to-end connectivity to satisfy JCS command, control, communications, and intelligence (C3I) supporting the President; JCS; Commanders in Chief (CINCS); Military Deputies (MILDEPS); Department of State; and other Departments and Agencies of the government.

**DSCS/DCS** - This program element provides funds required to develop strategic and tactical Ground Subsystem equipment to support Joint Chiefs of Staff (JCS) validated unique Command, Control, Communications and Intelligence (C31) for the worldwide super high frequency (SHF) Defense Satellite Communications System (DSCS) program.

In-house efforts are accomplished by the **PM Satellite Communications** under the management of **Program Executive Office (PEO Communications Systems**, Fort Monmouth, NJ. Major contractors are Magnavox, Torrance CA; Loral Corp, Colorado Springs, CO; Stanford Telecommunications, Inc., Santa Clara, CA and Colorado Springs, CO; John Hopkins University/Applied Physics Laboratory, Laurel, MD; PM Training Devices, Orlando, FL.

**TACSATCOM 5832** - The Ground Mobile Forces Satellite Communications (GMFSC) or TACSATCOM System program provides funds for the development of tactical satellite communications terminals and control systems for the Defense Department. Developments under this program provide rapid, reliable, effective communications to support tactical command, control, communications, and intelligence (C3I) requirements for tactical commanders and Commander in Chiefs (CINCs).

Recent activities include initiation of TSQ-173 conceptual testing at Ft. Detrick, completion of the technical specifications and award of the development contract for the Enhanced Manpack UHF Terminals (EMUT) PSC-3 and VSX-7, and evaluation of bid samples for ND-I PSC-5 EMUT.

In-house efforts are accomplished by the **PM Satellite Communications** and US Army **Communications and Electronics Command (CECOM) Center for Space Systems**, Fort Monmouth, NJ, with additional support from **Tobyhanna Army Depot**, Tobyhanna, PA and MITRE, Boston, MA. Major contractors are Harris Corp., Melbourne, FL; Martin Marietta Corp., Orlando, FL; GE Corp., Camden, NJ; and Applied Physics Laboratory, Laurel, MD.

**Project #D455 MILSTAR** - This program provides funds for the four Army MILSTAR programs: (1) The Secure Mobile Anti-Jam Tactical Terminal (SMART-T) will provide a range extension capability to the Army's Mobile Subscriber Equipment (MSE) to support the Airland Operations, specifically to provide a satellite interface to permit uninterrupted communications as our advancing forces move beyond the line-of-sight capability of MSE. (2) The Single Channel Anti-Jam Man-portable (SCAMP) terminal will provide a man-portable, secure, anti-jam satellite communications capability to Army and Air Force units which cannot be served by larger less mobile terminals. (3) The Single Channel Objective Tactical Terminal (SCOTT) will be fielded to satisfy the critical operational need for extremely reliable, extended range, highly mobile and flexible single channel tactical communications with high anti-jam and nuclear survivability capability. (4) The MILSTAR Ground Command Post (GNDCP) terminals are being developed and procured by the Air Force. They will provide a survivable, enduring worldwide communications capability, replacing the present AN/GSC-40 equipment. The Army will design and field a transportable configuration.

The SMART-T was previously designated the Extremely High Frequency Medium Data Rate (EHF MDR) terminal. Additionally, requirements were refined to dissolve the need for a single low data rate terminal (previously identified as the EHF LDR) terminal) and create a single LDR/MDR terminal (i.e., the SMART-T). Also, the recent requirement to assess the potential material enhancement of the SMART-T to include a Demand Access (DAMA) capability has been identified.

SMART-T AND SCAMP: In-house: PM MILSTAR (Army) Program Office, Fort Monmouth, NJ, under the management of Program Executive Officer for Communications Systems (PEO-COMM), with support provided by U.S> Army Communications-Electronics Command (CECOM), Fort Monmouth, NJ. Major Contractors to be determined.

SCOTT: In-house: PM MILSTAR (Army) Fort Monmouth, NJ under the management of Program n Executive Officer Communications Systems (PEO-COMM) with support provided by U.S. Army Communications-Electronics Command (CECOM) Fort Monmouth, NJ. Major Contractors; Magnavox, Ashburn, VA and Rockwell, Tx; Raytheon Corp., Marlborough, MA; Lincoln Laboratories, Bedford, MA. Training Simulator program is managed by PM TRADE with Statistica, Inc., Rockville, MD.

GNDCP: Terminals developed and provided by USAF utilizing two (2) contractors, Raytheon Mass and Rockwell International, Texas. PM MILSTAR (Army) is integrating these terminals into the Army Force Structure.

Includes civilian and military personnel authorizations and related support equipment, necessary facilities and the associated costs specifically identified and measurable to the following: Resources for research, development, engineering, construction, procurement, testing, installation, product improvement, and operation and maintenance of the ground segment (earth terminals) and associated communications subsystems as part of the DCS. Includes tools; repair parts; test, measuring, diagnostic and calibration equipment; repair facilities; satellite communications control equipment; new equipment training; system evaluation; life cycle logistic support; interconnect and technical control facilities; site survey, preparation activation, and environmental control; construction; and electromagnetic compatibility. Resources for research, development, engineering, testing, and procurement of ground terminals for Army mobile forces communications satellite capability, a corollary to the DSCS under overall control of the JCS, to be operated by ground units from the Division Brigade back to and including the Theater Army headquarters. Personnel and direct support of the Army SATCOM Project Manager at Fort Monmouth. Excludes leased circuits for the DSCS chargeable to PE 331260; Program 7 Central Supply and Maintenance functions of the **Army SATCOM Project Manager** at Fort Monmouth; and operation of tactical satellite terminals chargeable to PE 22615A.(16)

**33998A Management Headquarters (Communications)**(17)

Includes personnel authorizations, peculiar and support equipment, necessary facilities and the associated costs specifically identified and measurable to the Army Information Systems Command Headquarters, 5th Signal Command - Europe HQ, 6th Signal Command - Pacific HQ, 7th Signal Command.

**B - Navy**

**26313M Marine Corps Telecommunications**

**Project C0040 Satellite Communication Equipment USMC**(18)

This project supports Marine Corps monitoring of developments of tactical Ultra High Frequency (UHF), Super High Frequency (SHF), and Extremely High Frequency (EHF) Satellite Communications (SATCOM) terminals. It also supports development of modifications to the **AN/TSC-96** UHF SATCOM system to maintain interoperability with the Navy SATCOM network. Other projects under this program element also support development of improvements to other terrestrial multi-channel radio systems. Recent activities include installation of Demand Assigned Multiple Access (DAMA) and KY-99 advanced narrow-band digital secure voice modifications to the AN/TSC-96 terminals.

Work is performed by **NESEC**, Vallejo, CA; **PM SATCOM**, Ft. Monmouth, NJ, and **MARCORSYSCOM**, Quantico, VA.

**33109N Satellite Communications Terminals**(19)

Fleet Satellite Communications provide the backbone of Naval communications worldwide. It employs six communications satellite systems: Fleet Satellite (FLTSAT) Communications, Leased Satellite (LEASAT) Communications, Defense Satellite Communications System (DSCS), Ultra High Frequency Follow-On (UFO) satellite, NATO Allied System, and Air Force Satellite Communications (AFSATCOM). System missions include providing global, continuous, secure communications among US and Allied Forces, providing secure and anti-jam communications between joint command centers and fleet commanders using DSCS satellites, and providing fleet broadcast services to all Navy ships, Over-The-Horizon Targeting data for Tomahawk and flat configured ships, submarine communications, intelligence data, and various other battle group and joint task force communication services.

The **Miniature Demand Assigned Multiple Access (mini-DAMA AN/USC-42(V))** system will provide the same satellite channel utilization efficiencies for aircraft and submarines that are now enjoyed by surface ships and shore stations equipped with the larger version TD-1271 DAMA multiplexer. Mini-DAMA is being developed in three versions. The (V)1 is the submarine ship-shore applications, (V)2 updates (V)1 with automatic operations, and (V)3 is the airborne application.

The **Tactical Data Information Exchange Subsystem (TADIXS)** server as the primary shore-to-ship communications link for providing over-the-horizon targeting data to Tomahawk missile equipped ships, and Ocean Surveillance Products to all ships. TADIXS Phase IV provides world-wide connectivity and interoperability through gateways at major Naval telecommunications stations.

**Officer in Tactical Command Information Exchange Subsystem (OTCIXS)** Phase II software will be developed to provide OTCIXS Battle Group command and control data on a DAMA channel on the satellite. Sending OTCIXS data on DAMA frees valuable satellite channels for other fleet operational use.

The **Tactical Intelligence Information Exchange Subsystem Phase II (TACINTEL-II)** implements the Integrated Special Intelligence Communications (INSICOM) portion of the Copernicus Architecture to provide services for transfer of Special Intelligence (SI) information between ships, aircraft, and shore activities in support of joint and combined operations. TACINTEL-II will provide real-time indications and warning support to joint and component commanders through reliable high-speed transfer of sensor data and intelligence information. Enhanced interoperability with other serves, agencies, and allies will permit a level of integration of SI operations not achievable with current systems.

The SHF terminals operate within the Defense Satellite Communication System. SHF provides high capacity Anti-Jam/Low-Probability of Intercept (AJ/LPI) communications to major combatants and provides Navy connectivity to Allied and Joint Force Command networks via the DSCS. The Universal Modem is a joint US/UK development to provide US and Allied interoperability for command and control networks over SHF circuits.

Work is performed by **NAVOCEANSYSCEN**, San Diego, CA; **NAVELEXSYSENGACT**, St. Inigoes, MD; **NAVELEXSYSENGCEN**, Vallejo, CA; **NAVELEXSYSENGCEN**, Charleston, SC, and **NUSC**, New London, CT. Contractors include Advanced Digital Systems, Inc, San Diego, CA; MA/COM, San Diego, CA; Computer Science Corporation, Falls Church, VA; Advanced Communications Systems, Inc., Arlington, VA; Scientific Research Corp., Atlanta, GA; and Klien & Stump Inc., Arlington, VA.

**33109N? Arctic Satellite Communications**

This program supports development of an EHF polar adjunct for the Milstar satellite communications system to provide connectivity and war-fighting support for attack submarines operating under the arctic ice pack. This program was initiated following the termination of plans to place Milstar satellites in highly inclined polar synchronous orbits, which would have satisfied this mission requirement.

**33113N Navy Communications (NAVCOM)**(20)

Includes manpower authorizations, peculiar and support equipment, necessary facilities and the associated costs of MaJor Communication Facilities (worldwide), including NAVCAMMSTAS, NAVCAMMUS; and NAVRADSTA. National Naval Reserve Master Control Radio Station, Arlington, Virginia. Leased costs related to AUTOVON, AUTODlN, and AUTOSEVCOM programs and other leased costs related to worldwide communications requirements. Special Communications. \*Communications equipment for other shore (field) activities supported by the CNA. \*Communications equipment for major Marine Corps Command ashore. \*Support (excluding equipment) identified to other elements.

Excludes elements of Headquarters, Naval Communications Command, related to cryptographic functions (see appropriate elements in this program); Satellite Communications resources (see Satellite Communications element in this program); Naval Telecommunications Command Management Headquarters resources included in PE 339980); NAVELEXSYSCOM Management Headquarters resources included in PE 728980; and OPNAV Support included in PE 923980.

**33124M Marine Corps Terminal AN/TSC-85A**

This project supports Marine Corps monitoring of developments of tactical Super High Frequency (SHF) Satellite Communications (SATCOM) terminals. It supports development of modifications to the **AN/TSC-85A** SHF SATCOM system to maintain interoperability with the Joint DSCS SATCOM network.

**33603N MILSTAR**(21)

The MILSTAR program is comprised of satellites, control stations, and air, ship and ground terminals to provide world-wide, secure, anti-jam, survivable communications for the National Command Authority, Specified/Unified CINCs, and operational commanders. The MILSTAR Joint Terminal Program Office (JTPO) coordinates and directs the development of user terminals by ensuring terminal interoperability, joint integrated logistics (ILS) planning, conducting joint interoperability tests, writing terminal specifications and standards, monitoring service terminal designs, and providing technical support to OSD, OJCS, CINCs and users.

The JTPO is coordinating and directing the development of interoperable medium data rate (MDR) protocols, as well as updating and reissuing the joint ILS plan to accommodate the reduced number of low data rate (LDR) terminals and new terminal initiatives for MDR terminals. It is also conducting interoperability testing in support of an Army production decision, developing and LDR/MDR terminal specification for MILSTAR II satellites, evaluating engineering changes to ensure tri-service interoperability, and providing technical assistance in the areas of requirements as well as enhancing the MILSTAR Information Exchange System.

Work is performed by **NOSC**, San Diego, CA; **NADC**, Warminster, PA; **Air Force Wright Laboratories**, Dayton, OH; **SSD/NSSA**, Los Angeles, CA. Contractors include Booz, Allen & Hamilton, Bethesda, MD, and Galaxy Scientific Corporation, Alexandria, VA.

**33998N Management Headquarters (Communications)**(22)

Includes personnel authorizations, peculiar and support equipment, necessary facilities and the associated costs specifically identified and measurable to the Naval Computer & Telecommunications Command Headquarters.

**63741N Satellite Laser Communications**

Laser Communications provides for the development of a long-range, very high data rate satellite communication links. Current technology cannot meet projected Air Force requirements. This project is developing flight-qualified hardware and a brass board heterodyne laser communications system (LASERCOM) using frequency modulation that is more efficient than current pulsed-type systems. The system will ground demonstrate an inter-satellite data networking capability that can improve real-time global connectivity, reduce dependence on ground relay sites, increase coverage time for low-orbit satellites, and enhance survivability by shared redundancy.

**64577N EHF Satcom (on FLTSATCOM)**(23)

Navy Extremely High Frequency (EHF) Satellite Communications Program provides for the development and production of terminals to provide anti-jam, low probability of intercept communications capability for Command and Control of the fleet. The terminals are designed to provide physical and electro-magnetically survivable, worldwide communications in the current and projected electromagnetic and nuclear threat. Navy EHF terminals are interoperable with Army and Air Force terminals and will operate with MILSTAR as well as EHF packages on-board Ultra-High Frequency (UHF) Follow-on (UFO) satellites four through nine. Navy terminals operated during Desert Storm with EHF packages on-board Fleet Satellite 8. The increased capability provided by EHF terminals is accomplished by the use of the wider bandwidth available at extremely high frequencies, narrow antenna beam width, spread spectrum techniques, on-board satellite processing and advanced signal processing technology.

The Navy EHF Communications Controller (NECC) provides automated netted tactical data exchange (IXS) over jam resistant EHF satellite links. The NECC will establish EHF SATCOM networks, control data flow over the networks, and act as a gateway between networks.

The lead agency is **NAVOCEANSYSCEN**, San Diego, CA, with additional work performed at **NUSC**, New London, CT, **NAVELEXSYSENGCEN**, Vallejo, CA, **NRL**, Washington, DC, **NAVSWC**, New London, CT, **NAVELEXSYSENGCEN**, Portsmouth, VA, and **NAVELEXSYSENGCEN**, Charleston, SC. Contractors include Raytheon, Sudbury, MA, and Booz, Allen & Hamilton, Bethesda, MD.

**O&M GAPFILLER**

The GAPFILLER transponders on three Marisat satellites launched in 1976 continue to be leased from the COMSAT Corporation, although these are now relegated to a backup role.

**O&M Leased Satellite**

The Navy's other major system is the Leased Satellite (LEASAT) system, which consists of three Syncom IV spacecraft leased from Hughes, which is also the satellites manufacturer. The final launch of the LEASAT program occurred in early 1990 on the Space Shuttle.

**O&M Satellite Telemetry & Control**

Includes personnel authorizations, peculiar and support equipment, necessary facilities and the associated costs specifically identified and measurable to satellite telemetry and control activities of the Naval Space Command Headquarters.

**O&M FLTSATCOM Equipment Installation**

Includes personnel authorizations, peculiar and support equipment, necessary facilities and the associated costs specifically identified and measurable to FLTSATCOM equipment installation.

**C - Air Force**

**33110F Defense Satellite Communications System (DSCS)**(24)

DSCS provides Super High Frequency (SHF) satellite communications for secure voice and high data rate transmissions. The system provides unique national security communications for world wide military command and control, crisis management, relay of intelligence and early warning data, treaty monitoring and surveillance information, and diplomatic communications. Specific national security communications networks supported by DSCS include the National Command Authorities, Worldwide Military Command and Control System, Diplomatic Telecommunications Service, White House Communications Agency, and Ground Mobile Forces of all services. In addition, DSCS relays critical satellite telemetry, tracking and command data from Remote Tracking Stations within the Air Force Satellite Control Network (AFSCN).

Includes manpower authorizations, peculiar and support specifically identified and measurable to equipment, necessary facilities and the associated costs of research and development, procurement, and operations resources for the space and ground segments of the Defense Satellite Communications System (DSCS); procurement and modification of launch vehicles, and other DSCS management and acquisition functions assigned to the Space and Missile organization (SAMSO) of the Air Force Systems Command. The ground terminal equipment to be operated by the Air Force will be funded by Air Force and procured by Army.(25)

**Air Force Space Systems Division**, Los Angeles, CA is responsible for the DSCS space segment. TRW, Redondo Beach, CA, is the prime contractor for DSCS II, and General Electric Co., Valley Forge, PA, is the prime contractor for DSCS III. The Aerospace Corporation, El Segundo, CA, provides systems engineering and integration to the **Satellite Communications (SATCOM) Program Office**, Los Angeles AFB, CA.

**33144F Electromagnetic Compatibility Analysis Center (ECAC)**(26)

Includes personnel authorization, peculiar and support equipment, necessary facilities and the associated costs specifically identified and measurable to all resources (RDT&E, Military Construction, O&M, Military Personnel and Personnel) identified to the Electromagnetic Compatibility Analysis Center (ECAC) which is a DoD facility established under DoD Directive S160.57 to provide advice and assistance on electromagnetic compatibility matters to the Secretary of Defense, Joint Chiefs of Staff, the Military Departments, and other DoD Components. The Center, located at the Naval Ship Research and Development Center, Annapolis, MD., consists of a small military and civil service management cadre and a technical operations contractor currently providing approximately 380 man-years of effort. Administrative management and fiscal support are provided by the Air Force and detailed policy and technical advice by the ASD(C31) and the Joint Chiefs of Staff. Work includes establishment and maintenance of data bases which include an environmental data file, an equipment characteristics file, and a terrain data file; development of mathematical models and computer programs; provision for convenient and rapid access to the data bases and analysis techniques for investigation of electromagnetic compatibility problems; analysis of characteristics of electromagnetic equipment in use, under development or proposed, to determine its electromagnetic compatibility with other equipment in present or projected environments; and operation of a Frequency Resource Record System in support of frequency management; analysis projects and other efforts in support of Joint entities such as the Joint Frequency Management Panel, the CINCs, and the Unified and Specified Commands. Excludes funds reaching the Center by reimbursement from customer sources, and Army, Navy, and Marine Corps military personnel in ECAC.

**33601F Air Force Satellite Communication System AFSATCOM**(27)

Includes personnel authorizations, peculiar and support equipment, necessary facilities and the associated costs specifically identified and measurable to the following: Research, development, procurement, and operations to support a strategic satellite communications for command and control of SlaP forces. This program acquires the space and terminal hardware to support approved programs and develops the technology required to provide future satellite communications systems. The projects are:

Project A - Satellite Terminals - Ultra High Frequency: UHF terminals will be developed and procured . the Navy FLTSATCOM System and the polar satellite communications transponders. Terminals will be installed on Airborne Command Post (ABNCP) and SlaP strike aircraft. An airborne terminal for Advanced Airborne Command Post (ABNCP) and SlaP strike aircraft. An airborne terminal for Advanced Airborne Command Post (AABNCP) aircraft will be developed for use with the Defense Satellite Communications System (DSCS) Phase 11 satellites.

Project B - Space Communications Technology: This will develop and demonstrate advances space communications subsystems in the optical space communications and advanced microwave communications areas. The Lincoln Laboratory Experimental Satellites (LES) are supported by procurement of hardware and development of K-band terminal.

Project D - Polar Satellite Communications: on-going satellite programs with suitable polar orbits have been selected to act as host for UHF communications transponders that augment the coverage provided by the Navy FLTSATCOM program and will be compatible with the UHF terminals procured in Project A.

Project F - Survivable Satellite Communications System: All resources specifically dedicated to a Survivable Satellite Communications System.

**33601F MILSTAR Terminals**(28)

Milstar is a joint service program to develop and acquire Extremely High Frequency (EHF) satellite mission control segment, and new or modified communication terminals for survivable, jam-resistant, worldwide, secure communications for the strategic and tactical warfighter up through the early stages of nuclear war.

Development of the Milstar mission control, and AF terminal segments is managed by a program office located at AF Materiel Command's **Space and Missile Systems Center** Los Angeles AFB, CA under the direction of the AF Program Executive Officer (PEO) for Space. Milstar SMCS are developed by Lockheed Missiles & Space Co., Sunnyvale, CA. Milstar terminals are developed by Raytheon Company, Sudbury, MA and Rockwell International, Dallas, TX. Systems Engineering and technical support is provided by the Aerospace Corporation, El Segundo, CA; MITRE Corporation, Bedford, MA; and Lincoln Laboratory, Bedford, MA.

**33603F MILSTAR**(29)

Milstar is a joint service program to develop and acquire Extremely High Frequency (EHF) satellites. satellite mission control segment, and new or modified communication terminals for survivable, jam-resistant, worldwide, secure communications for the strategic and tactical warfighter up through the early stages of nuclear war.

Development of the Milstar space segment is managed by a program office located at AF Materiel Command's **Space and Missile Systems Center** Los Angeles AFB, CA under the direction of the AF Program Executive Officer (PEO) for Space. Milstar satellites are developed by Lockheed Missiles & Space Co., Sunnyvale, CA. Systems Engineering and technical support is provided by the Aerospace Corporation, El Segundo, CA; MITRE Corporation, Bedford, MA; and Lincoln Laboratory, Bedford, MA.

**33605F Satellite Communications Terminals**(30)

This program develops military satellite communications terminals and associated modulator/demodulator (modem) equipment for use by the Air Force, and other Services. Developments currently underway address strategic and tactical deficiencies of US Military Satellite Communications (MILSATCOM) systems. There are three satellite terminal projects in this program element. The SCTS program was previously programmed and funded under PE 33601, Milstar. The funding associated with this pays for continuing support for the SCTS program.

Includes the development and acquisition of selected satellite communications terminals. Terminals will be developed and acquired primarily to meet the communications needs of the Tactical Air Forces. Such needs include external-to-the-theater, long haul communications and internal theater communications. Internal theater communications include interconnection of Air Force component headquarters, tactical air bases, the tactical air control system, and some types of aircraft.

Project 3594, Single Channel Transponder System (SCTS): Research and engineering conducted on the space segment of the SCTS program is required on a continuing/yearly basis in order to keep the aging DSCS, Polar, AFSATCOM (package on FLTSATCOM) satellite systems healthy and their transponders technically in tact until the Milstar program is fully operational. The SCTS program is part of the overall transition from AFSATCOM to Milstar, providing required jamming and nuclear effects protection for critical National Command Authorities (NCA) communications. More specifically, SCTS provides an Emergency Action Message (EAM) and Force Direction Message (FDM) dissemination capability to selected command centers and force elements.

**Space and Missile Center** (SMC)/AFMC, Los Angeles AFB CA manages the program for the Air Force. Work is performed by Aerospace Corporation and General Electric of Los Angeles, CA.

Project 3163, UHF Satellite Terminal System (USTS): The USTS program was established to prove the then Military Airlift Command (now Air Mobility Command) a satellite communications terminal which incorporated Demand Assigned Multiple Access (DAMA) and Automatic Narrowband Digital Secure Voice Terminal (ANDVT) capabilities. Air Force was also designated lead agency in the development of the 5 kHz DAMA waveform for DOD.

The USTS program is related to the Navy developed 25 kHz UHF DAMA scheme, and the Army developed UHF manpack terminal (Enhanced Manpack UHF Terminal - EMUT) which incorporates the USTS 5 kHz DAMA scheme into their designs There is no unnecessary duplication of effort within the Air Force or the Department of Defense.

**Electronic Systems Center** (Air Force Materiel Command), Hanscom AFB MA, manages the program for the Air Force. Work was performed by Titan/Linkabit, San Diego CA. The Air Force was not able to obtain terminals under this program and is currently in negotiations with the contractor to establish acceptable terms for contract termination.

Project 3164, Ground Mobile Forces Terminals (GMFT): The Air Force GMFT program requires a small, lightweight SHF satellite communications terminal to provide reliable, secure voice and data for highly mobile combat teams such as Forward Air Controllers, Special Operations Forces, and Air Mobility Command (AMC) Combat Control Teams. This project will conduct a demonstration/validation effort for lightweight SHF satellite ground terminal technology to assess the feasibility of meeting user requirements with SHF manpack units. The development must achieve very compact lightweight units that can support flexible networks of many users with minimal impact on satellite resources. GMFT is a joint service program addressing tactical force's satellite communications requirements of the Army, Air Force and Marine Corps.

**Electronic Systems Center** (Air Force Materiel Command), Hanscom AFB, MA manages the program for the Air Force. Work is performed by RCA, Camden NJ.

**33606F UHF Satellite Communications**(31)

AFSATCOM provides reliable, enduring, world-wide command and control communications to designated Single Integrated Operational Plan (SIOP)/ nuclear capable users for: Emergency Action Message (EAM) dissemination, JCS-CINC internetting, force direction, and force report back. Additionally, AFSATCOM capacity is provided for a limited number of high priority non-SlOP users for operational missions, contingency/crisis operations, exercise support and technical operator training. AFSATCOM is also a program to develop, acquire, and field a Demand Assigned Multiple Access (DAMA) network control system and interoperable satellite communication terminals. The AFSATCOM System is presently being ,, restructured to accommodate the new satellite channel configuration supported by the UHF Follow-On satellites. AFSATCOM Systems enhancements accommodate increased demand for beyond line-of-sight communications and joint service interoperability.

The development and acquisition of the AFSATCOM DAMA Network Control and terminal upgrades are managed by the program office located at **Air Force Materiel Command's Space and Missile Systems Center**, Los Angeles AFB, CA under the direction of the Air Force Program Executive Office (PEO) for Space. The prime contractors for this program effort are yet to be determined.

**33998F Management Headquarters (Communications)**(32)

Includes personnel authorizations, peculiar and support equipment, necessary facilities and the associated costs specifically identified and measurable to the Air Force Communications Command HQ.

**35158F SDS Satellite Data System**(33)

Includes resources of the Satellite Data System (SDS) which is a multi-purpose communications satellite which has in conjunction with FLTSATCOM and the DSCS, the high priority mission of supporting communications for strategic forces and, additionally, will support communications between Satellite Control Facility Ground Stations. Excludes personnel.

**62702F Command, Control, and Communications (C3)**(34)

This Science and Technology program is the primary source of new concepts, feasibility demonstrations, and exploratory technology for Air Force C3. Current developments include: increased operational availability of C3 systems through improving reliability, diagnostic capability, and electromagnetic atmospheric performance; improving effectiveness and survivability through secure communications; improving surveillance range and detection capabilities against low-observable threats and enemy electronic countermeasures; and improving the timeliness and quality of data for decision making. Projects address the following technology areas: reliability sciences; surveillance; communications; information; electromagnetics; and command and control. Increased FY 1994 funding supports the increased emphasis on C3 technologies that support the theater commander.

Project 06RA. C3 Laboratory Operations: This project provides for the management, support, and operation of Rome Laboratory, Griffiss AFB, NY, and the two directorates of Rome Laboratory at Hanscom AFB, MA. It provides the non-reimbursable pay and related cost of civilian scientists, engineers, and support personnel; transportation of equipment; rents; communications and utilities costs; reproduction services; and procurement of supplies, equipment, and contractor support services for these facilities. Funds support and complement other projects within this PE.

Project 4519 Communication Technology - The Air Force needs technologies that will provide global communications that enable the rapid application of air combat power via assured connectivity for timely, reliable, responsive, affordable transfer of information. This project will develop enabling technologies that support lightweight experimental communications such as antennas, solid state devices, and data links. Communications must provide transparent, user-friendly connectivity using all available communications media and providing all types of communications services including the ability to surge as necessary to support rapid build-up of U.S. presence abroad. This program provides the technologies for enduring multi-level, secure, seamless networks; advanced communications processors; anti-jam and low probability of intercept techniques; and modular, programmable, low-cost radios and terminals for ground, airborne, and space command, control, and communications across the electromagnetic and optical spectrums. It includes electronic and photonic technologies for advanced processors and devices, advanced network protocols, artificial intelligent communications management and control, and advanced algorithms and signal processing techniques.

Project is managed by **Rome Laboratory**, Griffiss AFB, NY. Major contractors are: Westinghouse Electric, Baltimore, MD; University of Massachusetts Amherst, MA; Physical Optics Corp., Torrance, CA; Cornell University, Ithaca, NY- ITT Avionics Corp., Nutley, NJ; and Rockwell, Thousand Oaks, CA.

**63238F Air Defense / Precision Strike Technology Demonstration**

**Project 4216 Global Grid**(35)

Directly supports Advanced Technology Demonstrations under the revised OSD Science and Technology (S&T) Investment Strategy by developing and demonstrating key technologies to support Precision Strike and Air Superiority and Defense thrusts. Project 4185 will simulate, integrate, and demonstrate air vehicle, strike planning, and weapon technologies to meet the capability to achieve affordable, adverse-weather (night/day) precision strike (less than three meters circular error probable (CEP)) with conventional munitions from standoff distances against time-critical fixed and mobile (stationary) surface targets. This includes: enroute targeting, using data from on-board sensors or data from off-board assets such as a reconnaissance aircraft; responsive mission planning; precision weapon delivery; and battle damage assessment. The focus includes: fusion of multi-source sensor data; linking information to shooter aircraft to produce required targeting data for download to weapon; command, control, communication, and near-real-time (minutes not hours) mission planning; strike option generation and analysis; battle damage assessment; and replan/restrike decisions. Project 4216 will simulate, integrate, and demonstrate technologies required to extend the global grid concept into any theater of conflict, at any time, in support of any mission. The project focus is on employing existing commercial fiber-optic communication infrastructure in the world coupled with additional links from the "end-points" of the commercial network to the war-fighting force. Project 4217 will simulate, integrate, and demonstrate technologies for assured superiority in aerial combat environments, spanning from beyond-visual-range to within-visual-range, to successfully engage, kill, and survive existing threats. The project focus is on improved combat situation awareness, expanded weapon launch and lethal envelopes, and improved abilities to defeat or avoid threats with an advanced air-to-air attack capability. Simulations, both digital and pilot-in-the-loop, will be used to determine design requirements and most cost-effective method of providing assured air superiority.

Project 4216. Global Grid: Providing the war-fighter a world-wide global grid communication infrastructure while making use of existing commercial fiber-optic infrastructure requires additional technologies to extend the capability into any theater of conflict, at any time, in support of any mission. In order to leverage scarce DoD resources, commercial off-the-shelf telecommunications technology will be used to the maximum extent possible.

**63401F Advanced Spacecraft Technology**(36)

**3784 Advanced Space Communications and Sensor Technology**

This program develops and demonstrates advanced spacecraft technologies in integrated space flight and ground experiments. These experiments will decrease the required transition time for innovative spacecraft technologies and reduce the associated development risks and costs. Efforts are focused on four high payoff areas: advanced space-qualifiable microelectronics; affordable high quality space applications software; assured, secure space sensors and communications; and compact, affordable, and survivable space power conversion, conditioning, and storage. This PE will supply the space-unique software and computer systems hardware technology for future satellite programs. This PE also investigates advanced spacecraft flight dynamics. Beginning in FY 1994, this effort will assess low-cost adverse-weather sensor and related structures, and processing technologies.

Project 3784, Advanced Space Communications and Sensor Technology develops and demonstrates Super High Frequency (SHF), Extremely High Frequency (ELF), and other advanced space communications and sensor technologies. The primary focus of the project is in EHF (60 gigahertz (GHz)) satellite-to-satellite communications to enhance constellation survivability and decrease dependency on multiple/overseas ground stations. The thrust of the technology program is improved affordability, reliability, and performance as well as a five times reduction in communications/ sensors payload size, weight, and power requirements.

Managed by the **Phillips Laboratory's Space and Missiles Technology Directorate, Space Sensors Division**, Kirtland AFB, NM. Contractors are: General Electric, Valley Forge, PA, and Syracuse, NY; Chang Industries, LaVerne, CA; RDL, Culver City, CA; MPB Technologies, Pointe Claire, Quebec, Canada; MIT-Lincoln Laboratories, Lexington, MA; and RDL, Culver City, CA.

**63431F Space Communications (including Laser Communications)**(37)

Includes RDT&E funds to provide communications to the National Command Authorities (NCA) and the Commander in Chiefs (ClNCs) for the command and control of the Single Integrated operation Plan (SIOP) forces throughout all phases of a general or limited war. The effectiveness with which our SIOP forces can be employed will be greatly enhanced by survivable global communications which permit continual force direction, inter-netting among the ClNCs and Advanced Airborne Command Posts (AABNCPs), and two-way communications with the strike force. Present or programmed systems do not provide this capability; communications satellites offer the potential to satisfy this critical requirement. The Advanced Space Communications Program develops the technology base needed to implement survivable satellite communications that can be deployed in the mid-1980s and evolve through the early 1990s. The projects are: Project 1227, Terminal Segment Technology, will develop and demonstrate advanced airborne terminal subsystems and techniques to ensure force element compatibility with increased satellite capabilities; Project 2028, Space Segment Technology, will develop and demonstrate techniques, components and subsystems to enhance the electromagnetic and physical survivability of DoD communications satellites in global employment; and Project 202, systems analyses/demonstrations, accomplishes preliminary system analyses from which future airborne, ground, and space requisite technologies can be identified. A preliminary concentration of these systems analyses will be future military satellite communications system solutions for the strategic and tactical/mobile forces. Excludes civilian and military personnel and their related costs and military construction costs which are included in appropriate management and support elements in this program.

**63789F Command, Control, and Communications (C3I) Advanced Technology Development**

**Project 3433 Laser Communications**(38)

This advanced technology development program integrates and demonstrates ground-, air-, and space-based C3 technologies required to maintain Air Force capabilities in a fast-paced, sophisticated, high threat, and intense jamming environment. Better surveillance/communications technology must be developed to counteract an enemy's jamming of US surveillance capabilities and to restore critical surveillance and communications capabilities to maintain combat advantage. The technologies developed in this program include: detection and identification of low-observable/stealth aircraft at long ranges under combat conditions; reliable, secure, jam resistant communications, including satellite cross-linking techniques; and battle management technology that assimilates this crucial C3 information into a form that facilitates and supports the military leader's combat decisions in response to the dynamics of the battlefield. Increased FY 1994 funding supports increased emphasis on C3 technologies that support the theater commander.

Project 3433 Laser Communications provides for the development of a long-range, very high data rate satellite communication links. Current technology cannot meet projected Air Force requirements. This project is developing flight-qualified hardware and a brass board heterodyne laser communications system (LASERCOM) using frequency modulation that is more efficient than current pulsed-type systems. The system will ground demonstrate an inter-satellite data networking capability that can improve real-time global connectivity, reduce dependence on ground relay sites, increase coverage time for low-orbit satellites, and enhance survivability by shared redundancy.

This project is managed by **Rome Laboratory**, Griffiss AFB, NY. Major contractors are: Rome Research Corp., New Hartford, NY; Hazeltine, Long Island, NY; Advance Decision Systems, Mountain View, CA; and GTE, Needham, MA.

**D - Defense Advanced Research Projects Agency**

**62301E ST-9 Submarine Laser Comm**

Laser Communications provides for the development of a long-range, very high data rate satellite communication links. Current technology cannot meet projected Air Force requirements. This project is developing flight-qualified hardware and a brass board heterodyne laser communications system (LASERCOM) using frequency modulation that is more efficient than current pulsed-type systems. The system will ground demonstrate an inter-satellite data networking capability that can improve real-time global connectivity, reduce dependence on ground relay sites, increase coverage time for low-orbit satellites, and enhance survivability by shared redundancy.

**E - Defense Information Systems Agency**

**32019K Satellite Communications**

**Project 3000 MILSATCOM Systems**

This project includes resources necessary to support planning for development and acquisition and for operation, maintenance and management of all components of satellite communications, including space vehicles, associated terminals, control facilities/services, interconnect, and technical control facilities.

**33126K Long-Haul Communications (DCS)**(39)

**Project 1110 DSCS**

**Leased Commercial Satellite Communications**

Includes personnel authorizations, peculiar and support equipment, necessary facilities and the associated costs of All long-haul, point-to-point leased and Government-owned communications facilities, material, and associated personnel end costs identifiable and measurable to the Defense Communications System (DCS). In accordance with the project structure prescribed in DoD Instruction 7045.12, it includes, but is not limited to:

Transmission Subsystem Projects (Non-tactical): Satellite (DISA only), High Frequency, Microwave, Land Cable, Submarine Cable, Tropospheric Scatter, other Transmission Subsystem Project, Digital Transmission.

Support Subsystem Projects (Non-tactical): Technical Control, Technical Evaluations, Power, European C3 System, Classified Activities, DCS Entry Stations for Contingency operations, Survivability, other Support Subsystem Projects, Systems Control , Commercial Equipment Evaluation.

Other Projects: Presidential Communications.

All NCS operations not included in other program elements, as follows: Area operations, Station operations, Leases, Engineering and Installation (excludes Air Force).

This program element includes: DCA Operations Center (DCAOC), Defense Communications/Engineering Center (DCEC), White House Communications Agency (WHCA), DCA Areas and Regions, DCS RDT&E.

Excludes AUTODIN 11, DISA Headquarters, test ranges, weather service, Program 6 communications, telecommunications categories of satellite base communications, tactical, intelligence, COMSEC, command and control, and special purpose communications; and Management Headquarters resources included in PEs 33998 and 72980.

**33998K Management Headquarters (Communications)**(40)

Includes personnel authorizations, peculiar and support equipment, necessary facilities and the associated costs specifically identified and measurable to the Defense Information Systems Agency Headquarters.

**F - National Aeronautics & Space Administration**

**TDRSS**

NASA's Tracking and Data Relay Satellite System (TDRSS), which plays a major though generally unappreciated role in supporting near-real time data transmission from low altitude reconnaissance satellites such as the Lacrosse.(41)

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