Satellite Communications
Operating Together for National Defense

By CW2 Garth R. Hahn,
CW2 Anthony Kellar & CW2 Steven Stubblefield

C4ISR

SMDC/ARSTRAT plans for and executes the integration of Army C4ISR forces and capabilities. This area for command, control, communications, computers, intelligence, surveillance and reconnaissance is responsible for developing interoperable command and control systems to integrate, synchronize, coordinate, assess and convey necessary information for the employment of Army forces.

Walking up to the wideband satellite communications station at Fort George G. Meade, Md., one immediately notices the signs announcing the presence of two separate units, Bravo Company, 1st Satellite Control Battalion and Bravo Company, 302nd Signal Battalion. These signs give an immediate clue to the type of missions performed at the satellite station on top of the hill: satellite control and satellite communications. Despite the similar outward appearance of large buildings and several huge antennae of these two companies, the missions being executed within their respective areas are separate and distinct. The six co-located wideband satellite communication Earth Terminals operate in symbiotic relationship with the Wideband Satellite Operations Centers located around the world. They perform separate missions and answer to a different chain of command.

The relationship between the Wideband Satellite Operations Centers and the co-located Earth Terminals is defined in a Defense Information System Agency circular as, "Operations and Control of the Defense Satellite Communications System." This document is known as the bible for satellite controllers because it outlines specific roles and responsibilities for each area. The Defense Satellite Communications System, or DSCS is a major subsystem in the global information grid, or GIG, providing high-throughput, long-haul communications to Department of Defense and other special governmental users. It provides a portal into the grid for services and government users around the world through its widespread collection of satellite Earth Terminals and geosynchronous satellite constellation.

There are three segments of the DSCS system: Space, ground and control. These segments interact to provide access to the many products available on the GIG to critical users, such as SIPRNET, NIPRNET, video teleconferencing, Defense Red Switch Network and many other information services. Because access to these services is critical to the warfighter, the system enables access from anywhere on the globe. Each of the three segments plays such a vital role that removing any one of them would jeopardize our ability to serve the warfighter.

Space Segment

The Space segment of the defense satellite communications system provides worldwide coverage by maintaining the satellites in a geostationary orbit above Earth. In doing so, it would appear to someone on the ground that the satellite is in the exact same location all of the time. This is accomplished after launch by matching the satellite's orbital period with the Earth's sidereal day and maintaining distances daily along specific X, Y and Z axes. During a 24-hour cycle, a satellite (based upon its position) will normally possess the same orbital characteristics that are caused by solar pressure and gravity effects. Through onboard electronics and station-keeping maneuvers provided by the 3rd Space Operations Squadron, the satellite maintains its same location for its users.

Complete coverage is maintained by placing the satellites

at specific locations around the world. Each satellite is able to visibly "see" only certain portions of Earth on account of the fact that the planet is round. As a result, five discrete satellite locations provide Earth-wide coverage. The satellite locations are the East Pacific, West Pacific, East Atlantic, West Atlantic and Indian Ocean. Each location has both a primary and a residual satellite, which provide redundancy and additional communications payload support.

At any time, each satellite provides hundreds of separate voice, data and video links to users. Most users communicate by transmitting and receiving on separate frequencies. Each satellite allows for 500 megahertz of bandwidth support in the Super High Frequency/X-band frequency range, tunable at the user's location. Bandwidth on the satellite is usually determined by the data rate and coding at the user location. The satellite only accepts a user transmit frequency range from 7.9 to 8.4 gigahertz; a frequency translation transfers that signal back to the distant end user at 7.25 to 7.75 gigahertz. It accomplishes the frequency translation through a transponder, which is why the program is known as a "transponded" system (frequencies are changed on the spacecraft, respectively). Satellite frequencies are not user-selected. Since the frequency range is finite, satellite managers provide the user with the appropriate transmit and receive frequencies on their satellite authorization document.

Each satellite provides the 500-megahertz of support through six discrete amplification units and channels. Only a fixed amount of power and bandwidth is supportable by each satellite amplification unit on each channel. It is the responsibility of the applicable satellite controller to manage the power and bandwidth of the satellite to ensure that all users can communicate effectively and protect the spacecraft's assets. Satellite power is individually allocated based upon the user's terminal type, antenna size and location.

Each satellite provides communication support through an array of amplifiers and antennae. The amplifier and antenna connectivity can be modified for mission accomplishment. This onboard equipment gives the satellite both flexibility and redundancy as it satisfies ground user requirements. It further provides jammer location and nulling capabilities so control stations can continue communication support even under hostile actions.

Clearly, the system provides outstanding wideband coverage for warfighters around the globe. Its combination of steerable, configurable antennae and robust constellation gives users access to the GIG regardless of location. However, its transponded nature and finite resources require close coordination between the ground and control segments of the system to maximize assets available to all users.

Ground Segment

The ground segment (also known as the terminal segment), oversight of the control segment. It interfaces authorized users from around the world with the GIG. Using the Defense Satellite Communications System satellite, the ground segment provides access to information services needed to protect and defend the United States and its allies. The system has the flexibility needed to satisfy the many different requirements and equipment configurations of the various users.

The DSCS Earth Terminals come in many shapes and sizes, conforming to the needs of the users it supports. There are two general types of terminal categories in the ground segment that are directly related to the type of user: strategic and tactical (also known as fixed and mobile, respectively).

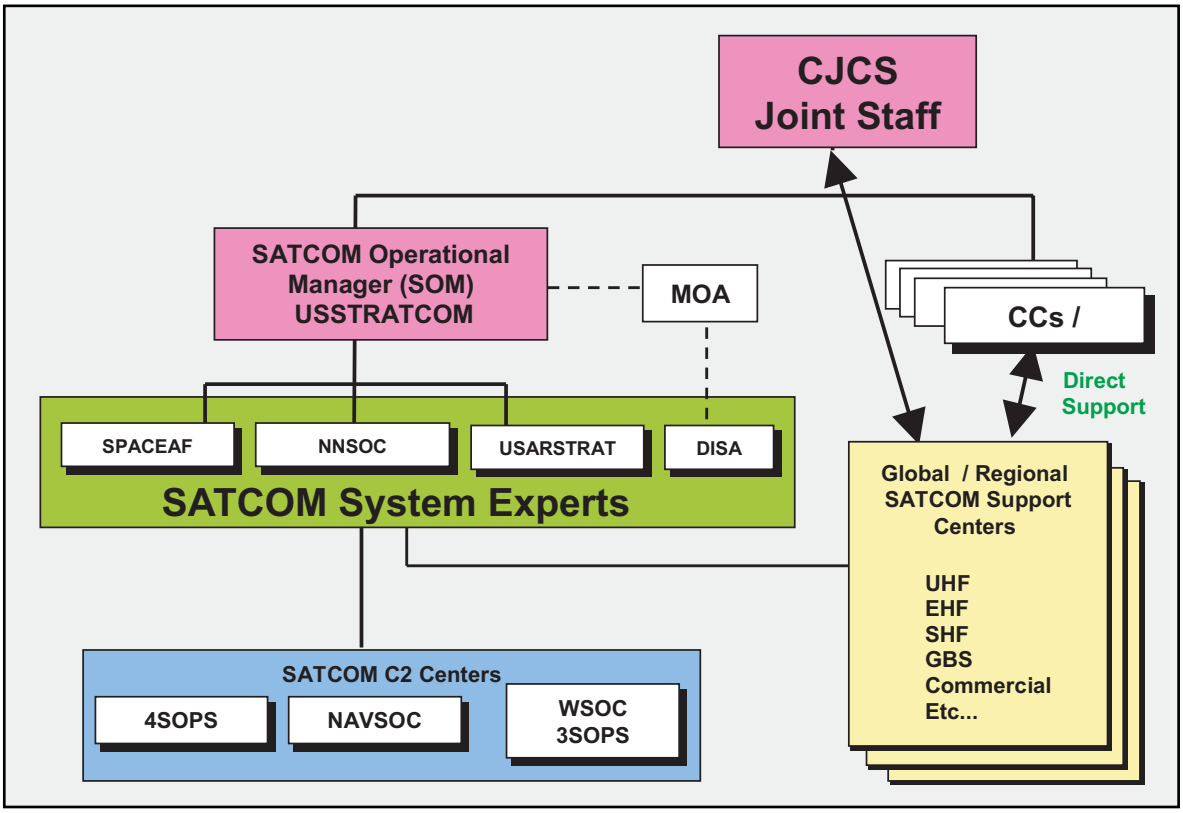
The U.S. Army is a major operator of the Earth Terminal units. The U.S. Army Network Command operates many fixed Earth Terminals around the world, including most of those co-located with the operations centers. The 21st Signal Brigade, a subordinate unit to Network Command, runs many of the fixed units in the United States. The 1st and 7th Signal Brigades have tactical satellite companies supporting U.S. forces in Korea and U.S. Army units in Europe. Every service has fixed or mobile sites spread around the world supporting various national or service-affiliated commands. These can range from shipborne Navy terminals, to airborne Air Force terminals, to the tactical satellite terminals of the Army and Marines.

Regardless of the type of terminal used to access the system or service affiliation of the operators, Earth Terminal units are responsible for the operation and maintenance of their equipment. Each unit is responsible to maintain approved satellite operational parameters and ensure optimum performance. Proper maintenance of satellite communication equipment is important because that equipment must meet stringent military standards of operation. Improperly aligned or defective equipment may cause problems on the satellite that prevent other users from communicating.

DSCS Operation and Certification Centers

- A Company — Fort Detrick, Md.
- B Company — Fort George G. Meade, Md.
- C Company — Landstuhl, Germany
- D Company — Camp Roberts, Calif.
- E Company — Okinawa, Japan
- Headquarters and Headquarters Company — Schriever Air Force Base, Colo.

The Earth Terminals are a vital part of the system connectivity for the ground, the sea or in the sky with the GIG, thus enabling critical command and control throughout our forces and our government. Operators and maintainers keep their equipment operating within established parameters to facilitate the sharing of scarce satellite resources. The control segment establishes those parameters and monitors compliance of Earth Terminals around the world.



Control Segment

The control segment of the Defense Satellite Communications System is a multilayered organization of management offices, from the Joint Chiefs of Staff to the satellite command and control centers. It ensures the proper apportionment of limited satellite communication resources. The Chairman of the Joint Chiefs of Staff Instruction 6250.01B outlines the responsibility for military satellite control in the above diagram.

The diagram identifies three levels of control. Level one is oversight of the system and is performed by the joint staff. Level two is the system staff and management level performed by the satellite operational manager, U.S. Strategic Command, and the assigned satellite system expert or SSE. U.S. Strategic Command recently assigned SMDC/ARSTRAT as the consolidated wideband SSE for DSCS. The SSE directs action at the Satellite Command and Control Centers, which for DSCS are the 3rd Space Operations Squadron, located at Schriever Air Force Base, Colo., and the geographically located Wideband Satellite Operations Centers of the 1st Satellite Control Battalion. U..S. Army Space and Missile Defense Command/U.S. Army Forces Strategic Command, through the 1st Satellite Control Battalion, performs command and control, as well as operational direction.

The control aspect is a vital part of ensuring continued access to all authorized users of a critical national asset. It gives the chairman of the Joint Chiefs of Staff the capability to rapidly plan, adjudicate and execute apportionment of satellite communications resources. It provides the supported combatant command and other users the ability to dictate resource utilization of their apportioned resources.

The various operations centers provide the 24-hour control of the platform, payload and networks. They provide the direct link to the satellite for control purposes as they conduct the day-to-day activities that keep the satellite constellation and the networks operating effectively.

The health and welfare of the satellite platform is part of the responsibility of the 3rd Space Operations. Squadron. They utilize the Air Force Satellite Control Network to do this. This responsibility includes the duties of satellite station keeping, on-orbit testing and anomaly resolution to monitor activities directly related to the satellite. This command and control is done in "windows" — short blocks of time when commands optimize satellite performance. These windows are coordinated through the Air Force Satellite Control Network using a network of satellite Earth Terminals to communicate with orbiting satellites.

The five wideband satellite operations centers are geographically located to provide 24-hour coverage of all assigned satellites. Each lettered company is strategically positioned to provide command and control for one or more satellites. The satellite control is dispersed as follows:

- A Company — Fort Detrick, Md.
- B Company — Fort George G. Meade, Md.
- C Company — Landstuhl, Germany
- D Company — Camp Roberts, Calif.
- E Company — Okinawa, Japan
- Headquarters and Headquarters Company, located in Colorado Springs, Colo., has a contingency mission in support of U.S. Northern Command, U.S. Strategic Command, as well as administrative support for the battalion.

In addition to primary satellites, many operations centers are responsible for control of residual satellites and for providing backup control capabilities to other centers. This collection of geographically dispersed operation centers provides the critical control needed for U.S. military and government communications around the world.

The Wideband Satellite Operations Centers around the world control a total of 12 defense satellite communication payloads. Payload control is performed as power levels, frequency assignments and antenna beam focus is controlled. The centers constantly monitor the health and welfare of assigned satellites, primary and residual, by watching for anomalies or problematic trends on the spacecraft.

The centers act as the "honest broker" by implementing the rules of access, bandwidth and frequency allocations laid out by the Joint Chiefs of Staff. Through this system, the centers provide continuous worldwide support to the Commander in Chief, Joint Chiefs of Staff, Department of State, intelligence communities, combatant commanders and the services in their various communication missions. They monitor electronic counter-countermeasures networks, frequency division multiple access networks and several different sub-networks.

The Soldiers that operate and maintain these systems spend almost a year at Fort Gordon, Ga., learning the technical information that is vital to their successful operational capabilities. Each Soldier receives further instruction in satellite payload control and undergoes a thorough process of training and certification. This multiyear process is necessary to ensure that highly trained individuals are available to operate and maintain the high-tech equipment at the centers.

Co-location makes sense

The situation of the wideband satellite operations centers and co-located Earth Terminals is a fine example of the close integration of two of the three system segments. Both areas have unique missions of control and communications, but are able to use synergies to better achieve those individual missions.

Although they can certainly work from separate locations, having them co-located makes sense because of the ability to share resources. The primary shared resource is the antennae. Each station has multiple antennae capable of seeing two or more different satellites. For instance, the Landstuhl satellite station has access to four of the Earth Terminal's antennae, looking at the IO and West Atlantic primary and residual satellites. These antennae are used for communication links with other Earth Terminals, both strategic and tactical. The satellite operations center at Landstuhl, Germany, uses these same antennae to control the satellites and their associated networks. This configuration saves millions of dollars by eliminating the duplication of assets as it simplifies maintenance.

Access to ground communications is another reason for co-location. Typically, the Earth Terminal is part of a communication hub that allows convenient access to the GIG. At the Landstuhl satellite station, there is a technical control facility that houses asynchronous transfer mode and integrated data network exchange switching hubs, allowing the terminal to seamlessly merge satellite communications with the GIG. This also allows the wideband satellite operations center to access the GIG to pass its terrestrial and other command and control circuit links. Once again, this is a money-saving situation because the center does not have to construct a facility to access the GIG.

Co-locating an operations center and Earth Terminal saves the cost of acquiring land and the difficulties associated with securing frequency clearance. Having both units occupy the same location essentially negates the need for large, separated and expensive Earth stations with all the inherent force protection issues that a single unit faces. Furthermore, sharing the same frequency spectrum simplifies the need for frequency clearance in comparison to two separated stations using the same frequencies. By co-locating these two organizations, they can conduct their different missions of communications and control with the use of shared resources.

Conclusion

The Defense Satellite Communications System is a highly managed and effective subsystem of the GIG. It uses three segments to achieve wideband access for users to the GIG: Space, ground and control. These segments allow joint staff-authorized units to access the GIG regardless of geographic location.

There are synergies gained by having the wideband satellite operations centers co-located with Earth Terminals. The sharing of resources ensures the most cost-effective delivery of world-class services to the warfighter.

Chief Warrant Officer Garth Hahn serves as a Satellite Network Chief in the 1st Satellite Control Battalion, 1st Space Brigade. He served with the 44th Signal Battalion performing voice and data switching, and wide-area network management in Germany and Bosnia-Hercegovinia. During his 12-year tenure as an enlisted satellite systems operator-maintainer, he held various staff and operations positions in tactical and strategic satellite stations. This includes a tour at Fort Meade, Md., as a satellite controller.

CW2 Steven Stubblefield is serving as an operations officer at the DSCS Certification Facility in Colorado Springs, Colo. His previous satellite assignments include High Wycombe, UK., Camp Roberts, Calif., Fort Richardson, Alaska, Fort Detrick, Md., and RAF Menwith Hill, UK.

CW2 Anthony Kellar is serving as a maintenance officer at the DSCS Certification Facility in Colorado Springs, Colo. His previous satellite support assignments include Berlin, Camp Roberts, Calif., and Coltano, Italy, culminating with his first warrant officer assignment as a battalion operations officer in Seoul, Korea.