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Military Space Communications

George A. Harter

Vice-President and General Manager, Space Vehicles Division, TRW Systems, Redondo Beach, California

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George A. Harter
Vice-President and General Manager
Space Vehicles Division
TRW Systems
Redondo Beach, California

ABSTRACT

A worldwide network of military communication satellites is now being deployed to function both as a long-haul strategic trunking system and as a system capable of supporting contingency operations. Another network is under development to handle voice and teletype messages between users with small mobile terminals. Other more specialized satellite systems are well along in the planning stage. This paper describes the evolving deployment and utilization of satellite-based systems and anticipates the trend in future operational capability.

INTRODUCTION

Military communication systems utilizing satellite relay are rapidly coming of age. The public sector is generally aware of commercial systems using satellites through publicity about the Intelsat System, but it is relatively unaware of the expanded use of satellites for military communications. With little fanfare, the military has already progressed through a series of experimental programs, some of which have provided a limited initial operational capability. These initial systems are now being replaced by a truly operational capability.

In the not so distant past, communication with forces in the field or at sea could be a very tenuous proposition. Routine messages to remote installations could take hours, days or even weeks. Mobile communications were not dependable over the horizon. Enter communication satellites. In barely more than one decade, satellites have revolutionized communications for civilians and the military. Electronic advances have opened the way not only for high priority channels but for routine day-to-day traffic as well.

The result will eventually be a totally integrated operational system allowing a steady two-way flow of secure communications between major commands, field headquarters, and mobile units of all sizes. In addition, the system will be geared to react in emergencies. New terminals will be brought on-line at crisis locations in a matter of hours.

PRESENT DAY OPERATIONAL SYSTEMS

The mainstay of military communications for the 1970's is the Defense Satellite Communication System, Phase 2 (DSCS-2). Four high-powered multi-use satellites built by TRW Systems will girdle the globe in synchronous orbits providing unique capabilities including service for the two major segments of the Defense Communication System—Autovon (Automatic Voice Network) and Autodin (Automatic Digital Network). DSCS-2 is part of the Defense Communication System and functions both as a long-haul strategic trunking system and as a system capable of supporting military contingency operations. In addition, the system is capable of supporting service to small tactical users, as needed.

By operating from nearly stationary points above the equator, the DSCS-2 satellites replace and expand an initial system of 26 smaller satellites circling the earth in lower orbits. The first pair of DSCS-2 satellites went into orbit in November 1971, and a second pair incorporating improved features is scheduled for launch in the third quarter of 1973. A third and final pair will be held for later use. Design life time for each satellite is five years.

DSCS-2 carries antennas for both narrow beam and full earth coverage— Figure 1. The narrow beams, which can be pointed to any position within the earth viewing area, provide an earth footprint of about 1000 miles in diameter. The antenna systems are cross coupled to allow transmission or reception in any combination of narrow or broad beam coverage.

The satellite's earth coverage antennas are intended for use with relatively large earth terminals. Ground antenna installations are typically 20-40 feet in diameter, operating at transmit power levels of about 8 kilowatts. Although designed for limited portability, these large terminals are intended for long term, semifixed installation. Primary utilization is for long-haul trunking of message and data traffic.

The satellite's narrow coverage antennas, having 13.2 db higher gain than earth coverage, allow operation with smaller earth terminals. The ground antenna in this case can range from 6 to

18 feet, depending on the application. Terminals with 6 to 8 foot antennas are designed for airborne, shipboard, and vehicular applications. An 18-foot antenna terminal is designed for semi-fixed installation, but with capability of being air transportable by one aircraft. Thus, a headquarters facility can be moved within a theater of operations with relative ease without impact on communication capability.

The heart of DSCS-2 is its wide-bandwidth, low-distortion repeater operating at the SHF X-band. The satellites provide multiple channels for voice, high bit-rate data, or television transmission—Figure 2.

Military communications, unlike commercial systems, must provide for transmission security and antijam protection. Spread spectrum techniques are used with the DSCS-2 both to protect secure traffic and to provide an effective antijam capability.

The DSCS-2 system now has 29 land-based terminals, with firm plans for system expansion. Future terminals will be shipboard and airborne, as well as truck mounted units. DSCS-2 thus will become the military's most versatile means of communication. However, it cannot satisfy the total requirements of a host of very mobile users who must operate in a tactical environment. This additional need is for a system to replace the present-day HF communications.

A second system is necessary—one that provides two-way communications between small, mobile units at distances beyond the horizon. The need is for short operational messages by teletype or for people talking to people. This is best handled by truly portable UHF terminals, small and reliable enough for use on naval vessels, various sized aircraft, and motor vehicles.

Such a satellite communications system is being designed and built by TRW Systems as a joint Navy/USAF program. It is the new Fleet Satellite Communications System (FLTSATCOM)—Figure 3.

FLTSATCOM will have several semi-independent functions including fleet broadcast. It will be the first communications satellite to be capable of converting a single SHF uplink into a multichannel downlink to all ships in view. In addition the total system can provide more than 30 voice or equivalent channels and 24 addressable teletype channels for other mobile user operations.

Four satellites—each with a 16-foot deployable parabolic UHF antenna, an SHF horn, and an S-band omnidirectional telemetry antenna—will be put in synchronous equatorial orbits starting in 1975. Overlap between satellites will give full Earth coverage except for small polar regions. A fifth satellite is planned as a contingency spare. Each will have a seven-year design lifetime.

FLTSATCOM will operate primarily as a tactical communications relay between shipboard, airborne, and vehicular terminals. Within the allocated spectrum covering 225-400 MHz, 24 separate communication channels will be shared by a number of terminals, using either push-to-talk or broadcast operation. When the system is fully operational, fleet broadcast by satellite can be received by every U.S. Navy ship simultaneously. The Strategic Air Command and the Presidential Aircraft also will have two-way capability for air-ground communications.

FLTSATCOM ground terminals are small and inexpensive relative to the DSCS-2 terminals. Large parabolic dishes are not required. A typical shipboard antenna contains a single or multiple crossed-dipole arrangement, manually positioned by the operator. The transmitter power rarely exceeds 1 Kw for a UHF terminal, even in an airborne installation with low antenna gain.

The DSCS-2 and FLTSATCOM systems collectively provide the United States with a world-wide tactical and operational communications network. The satellite segments for both systems will be fully deployed within the next few years. The ground segments will be expanded and upgraded throughout the next decade to take full advantage of the satellite capability.

FUTURE TRENDS

Improvements in system capability over the next few years will be principally in the ground processing area. Communication capacity within existing military bands can be greatly increased by transitioning from analog to all-digital modulation. The present frequency division multiplex techniques will gradually be replaced by digital, time division multiplexing. This trend will be forced by the need for handling more and more traffic with the existing frequency bands. Satellite designs are already compatible with this upgrading of earth terminal capability.

Another trend toward better frequency utilization is improvement in demand assignment techniques. Demand assignment is a system whereby a user requests use of a satellite link when required and releases the link for others immediately upon completion of his call. Improved techniques are particularly important for low duty-cycle users.

Eventually, the present UHF and SHF bands will no longer be able to handle the growth in military traffic. The trend for satellites as well as for terrestrial links will be toward higher frequencies. Development work is already underway in the 11 to 15 GHz and the 30 to 35 GHz regions.

Another trend for the future is the use of multibeam antennas with RF switching capability within the satellite. Steerable beams with small footprints on the earth allow multiple use of the same frequency by different earth stations. On-board switching networks are then used to interconnect the appropriate receive and transmit antennas. Varying traffic loads will be accommodated through rapid reconfiguration of the satellite switching network by ground command.

The speed at which presently planned systems transition to more advanced capability will be determined by counteracting forces. Need for increased capacity and mobility will serve as a catalyst for improvement and expansion. Costs for equipping and modifying ground terminals will inhibit the transition.

One thing is clear. Our military space communications capability will continue to grow, replacing much of today's dependence on terrestrial links. Economies of operation and the need for a more effective command and control posture will force the transition.

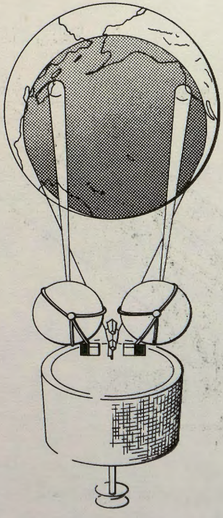

Figure 1. DSCS-2 Satellite System

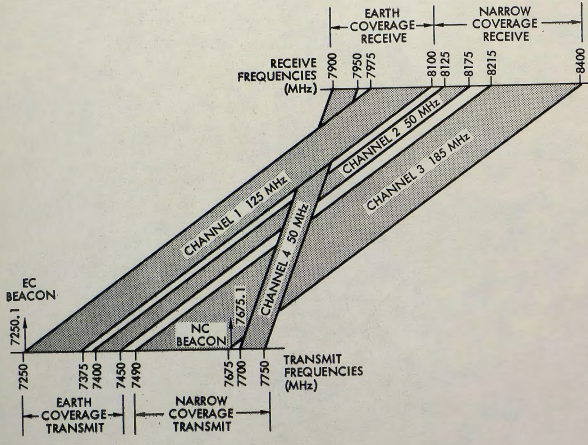

Figure 2. DSCS-2 Frequency Plan

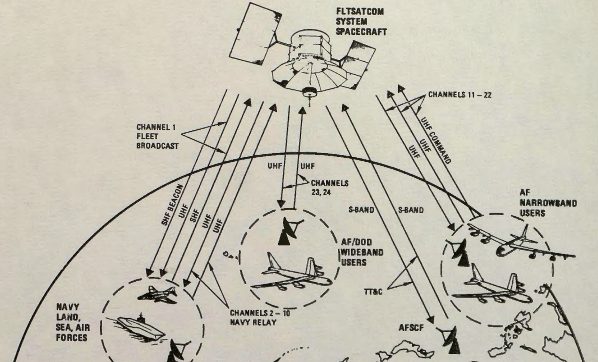

Figure 3. FLTSATCOM Communication Links