Tactical satellite communications

by SFC William E. Campbell

Satellite communications is already beginning to play a significant role in Army tactical operations...In the near future TACSAT will greatly increase the commander's ability to communicate over extended distances rapidly, reliably, and securely.

Since the early 1960s, the Army has been using satellite communications at fixed sites to pass various types of information. However, except for engineering development and low rate initial production (LRIP) models, the Army did not field a full-fledged tactical satellite (TACSAT) system until 1982. At present, the Army has two single channel TACSAT systems and is beginning to field a multichannel system. Unlike the Army's fixed station equipment, the TACSAT systems will use a number of different frequency ranges and satellites in order to communicate. The purpose of this article is to familiarize the reader with the composition, function, and capabilities of the satellites that will be used to support the Army's TACSAT systems.

There are three frequency ranges that Army TACSAT terminals will be operating in: 225-400 MHz, ultrahigh frequency (UHF); 7.25-8.4 GHz superhigh frequency (SHF); and 20/44 GHz, extremely high frequency (EHF). In some cases, there are a number of different satellites supporting each range.

In the UHF range, there are three different satellites supporting Army TACSAT terminals and operations, all of which are single channel oriented. It should be noted that the Air Force and the Navy, primary users of these satellites, have overall priority of use.

Fleet Satellite Communications (FLTSATCOM, FLTSAT) spacecraft (Fig. 1): The FLTSAT network, which consists of five satellites in geostationary orbit, provides worldwide coverage. The design life of each satellite is seven years, but most have exceeded their life expectancy. The first was launched in February 1978 and the last in 1980. Three further FLTSAT launches have been proposed for the late 1980s, two of which will carry EHF modules to test the new MILSTAR satellite components. Each FLTSAT provides ten 25 KHz channels, twelve Air Force narrow band 5 KHz channels, and one wideband 500 KHz channel. The

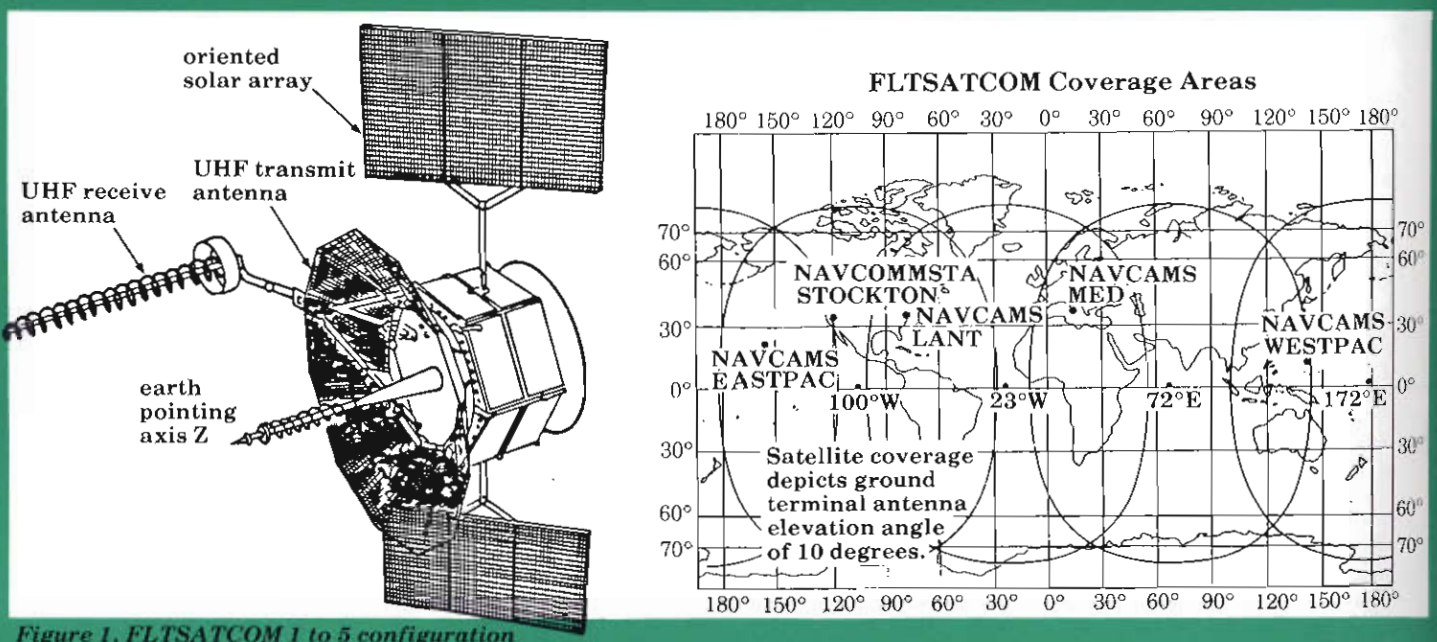
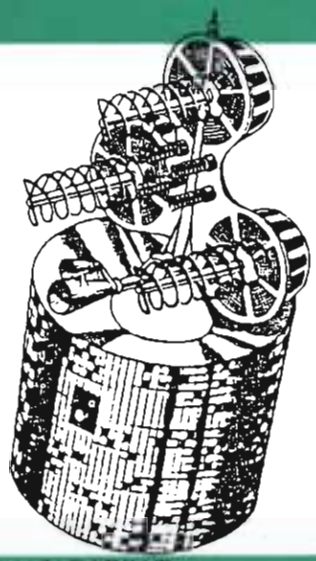


Figure 1. FLTSATCOM 1 to 5 configuration



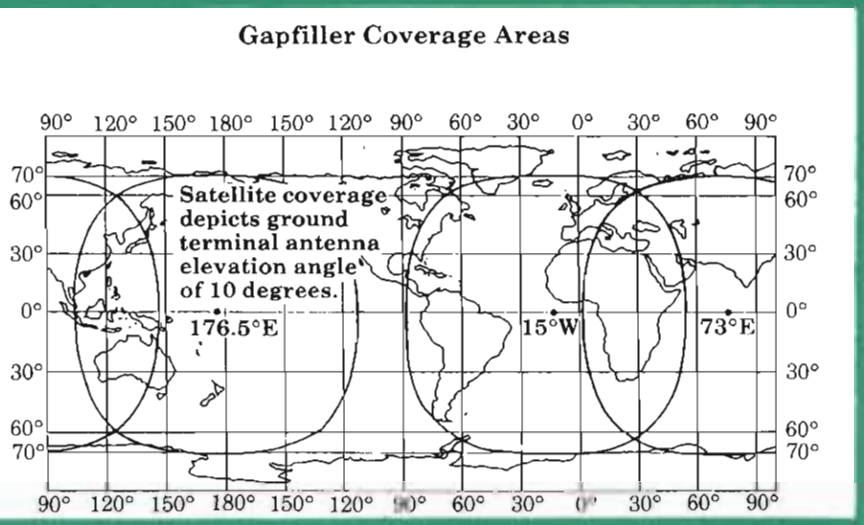


Figure 2. GAPSAT

antenna subsystem consists of two antennas, a 16-foot paraboloid transmit antenna, and an 18-turn helical receive antenna.

Gapfiller spacecraft: The Gapfiller network consists of three geostationary satellites positioned to provide worldwide coverage. The system is in operation and there are no further launches scheduled. The Gapfiller network was intended to supplement the FLTSAT network until the Lease Satellite (LEASAT) network became operational. Each satellite is designed to provide two 25 KHz channels and one 500 KHz wideband channel; however, only the 500 KHz channel is operational. The antenna subsystem is a three element helical array which provides the transmit and receive capability.

Lease Satellite (LEASAT) spacecraft: The LEASAT network consists of four satellites in geostationary orbits providing worldwide coverage. In the past year, all of these satellites have been placed into orbit by the space shuttle. You may remember one of them as the satellite which the shuttle crew unsuccessfully tried to start with a "flyswatter." Though this satellite was started on a later shuttle mission, the fourth LEASAT, which was launched at that time, lost its control link. Currently only two of the four LEASATs are operational. Each LEASAT provides seven 25 KHz channels, five 5 KHz channels, and one 500 KHz wideband channel. The antenna subsystem consists of two large helical antennas which provide the receive and transmit capability.

The 5 KHz channels on the UHF satellites can support 75 bps to 2.4 Kbps, and the 25 KHz channels can support 16 Kbps. (Normally the 500 KHz channels are subdivided into 5 or 25 KHz channels to allow more user networks to be established.) There is no way to predict how many users these satellites can support; the number will vary greatly depending on type of satellite, data rate, type of ground terminal, weather conditions, etc. Additionally, to increase the number of users that can access UHF satellites, the Joint Chiefs of Staff is requiring that all UHF TACSAT terminals be capable of operating on 5 KHz channels.

Within the SHF range, two different satellites will support Army multichannel TACSAT operations. These two satellites belong to the Defense Satellite Communication System (DSCS) and are known as DSCS II and DSCS III (Fig. 4 and 5). There are currently seven DSCS II and three DSCS III satellites in orbit. DSCS II satellites have a design life of five years. Since the last one was launched in October 1982, some have now either exceeded their design life or developed degraded capabilities. The only DSCS III in orbit and operational was launched in October 1982. Two other DSCS III satellites were launched in 1985 by the space shuttle and are expected to be operational in mid-1986. The DSCS III satellites, which are replacing DSCS II, have a 7-10 year design life; ten more DSCS III satellites are scheduled to be launched.

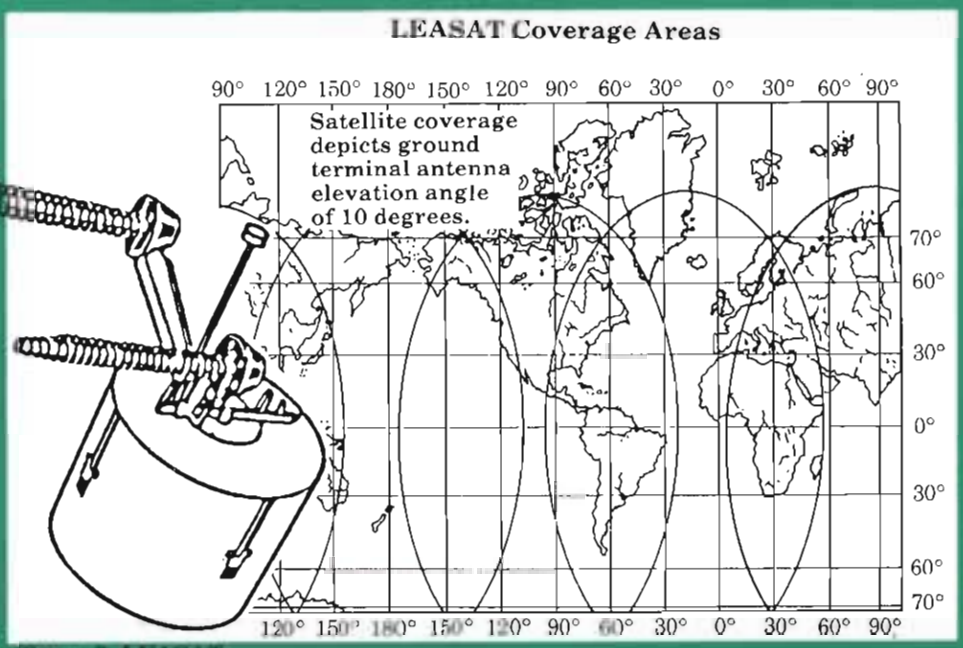


Figure 3. LEASAT

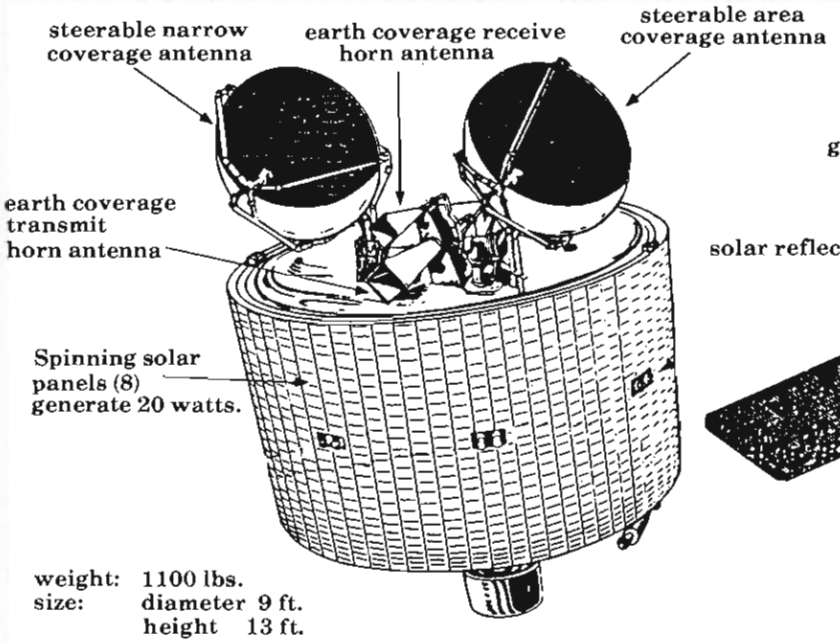


Figure 4. DSCS II satellite

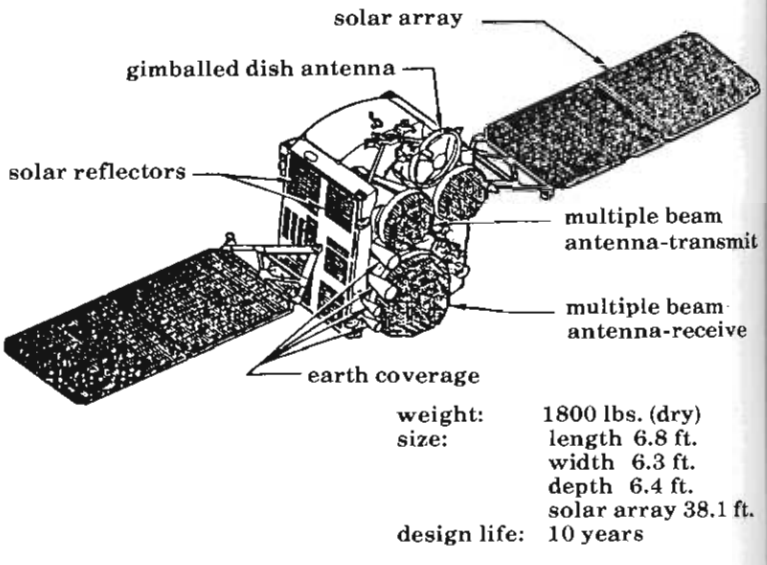


Figure 5. Fully extended view of DSCS III satellite

The DSCS II satellite consists of a multichannel repeater, a receive and transmit Earth coverage (EC) antenna, and two narrow coverage (NC) antennas. Each NC antenna is capable of receiving and transmitting simultaneously. These transponders have a bandwidth of 410 MHz, arranged in four channels, plus a total of 90 MHz of guard band between channels. Also capable of being independently steered, the two NC antennas cover an area approximately 750 miles in diameter. The newer DSCS II satellites have the capability to defocus one NC antenna, thus creating an "area coverage" (AC) antenna which can cover a 1500-mile wide area. The EC antennas (transmit and receive horns) provide coverage to approximately one-third of the Earth's surface. The transmitting TACSAT terminal sends the signal to the satellite, where it is amplified, frequency translated (by 725 MHz), and retransmitted to the receiving terminal. Because of their low gain antennas and low power output, the TACSAT terminals must operate in the NC/AC coverage areas. There are four spacecraft locations to provide worldwide coverage. Figure 6 shows the satellite coverage area for the Atlantic DSCS II. The large oval contour shows the maximum coverage area for each satellite (EC antenna), while the smaller contours show the NC/AC antenna coverage areas.

DSCS III has three uplink antennas (one 61-element multiple beam, two EC horns) to receive signals from the earth terminals, and five downlink antennas (two 19-element multiple beams, two EC horns, one NC gimballed dish), which retransmit the signals to the receiving terminals. The DSCS III has a bandwidth of 375 MHz, arranged in six channels, plus a total of 125 MHz of guard band. The DSCS III has increased hardening, or resistance to potential enemy attacks, as well as the ability to operate in high jamming levels. There are four spacecraft locations to provide worldwide coverage. Figure 7 shows the satellite coverage area for the

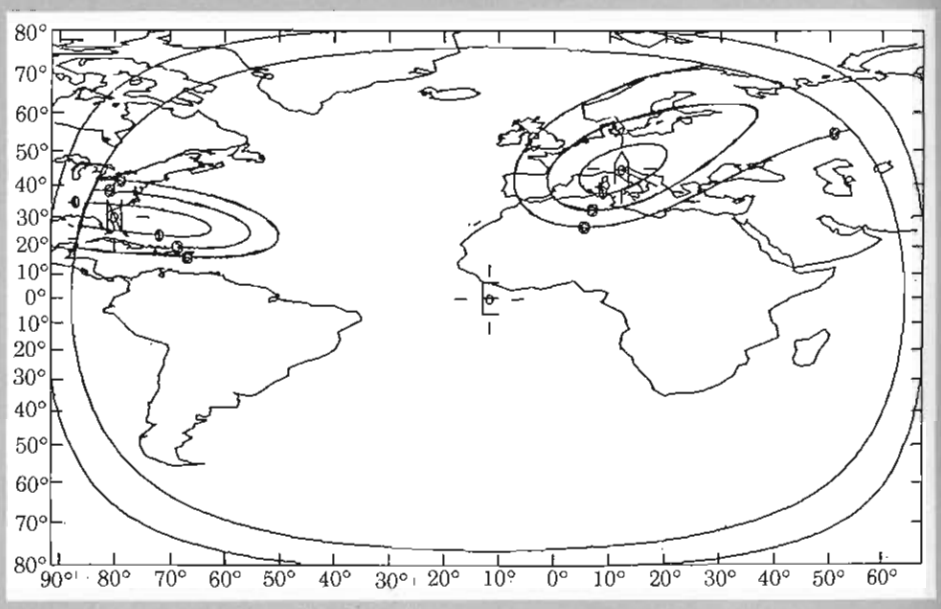


Figure 6. Typical NC andAC footprint for Atlantic satellite area

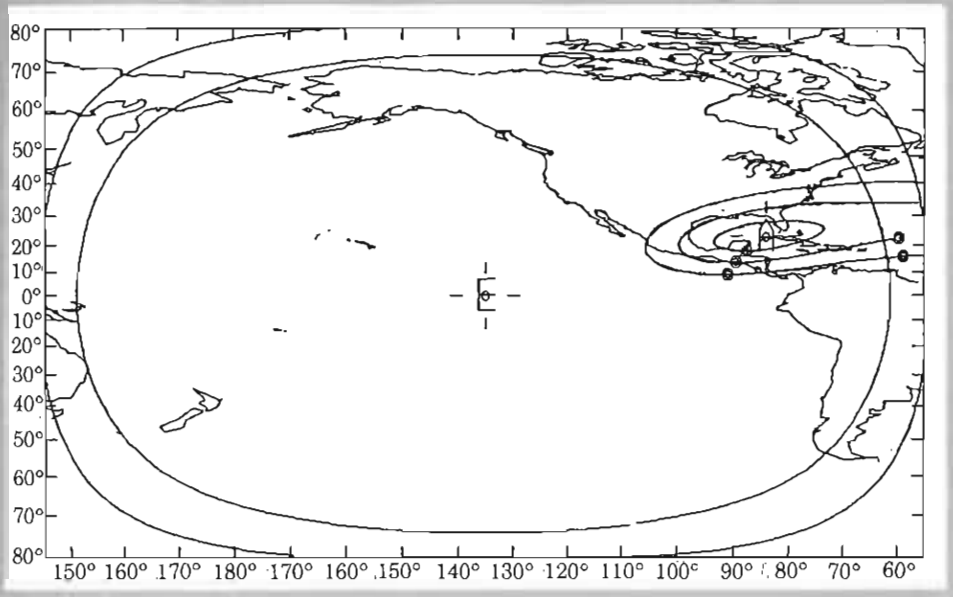


Figure 7. Pacific satellite area

DSCS III over the East Pacific. The large oval contour in the figure shows the EC coverage, while the smaller contour shows the NC coverage. As with DSCS II, TACSAT terminals must be in the NC coverage area to operate.

Channel capacity on DSCS satellites limits the number of TACSAT terminals that can simultaneously operate. This number will vary depending on type of terminal, number of channels, weather conditions, where in the satellite footprint the terminals are operating, etc. All these factors will, in some way or another, affect how many terminals can be placed on any given satellite. The Army is currently developing a number of product improvements to the terminals that will increase their efficiency and allow more terminals access to the satellite.

In the EHF frequency range, there is only one satellite currently projected. This satellite, MILSTAR, is under development, with its first launch planned for the late 1980s. The Single Channel Objective Tactical Terminal (SCOTT) is the Army's ground terminal currently being developed to operate with MILSTAR. The satellite and ground systems will utilize techniques such as Demand Assigned Multiple Access (DAMA) for improved connectivity and efficiency. They will also use techniques designed to improve their resistance to jamming and interception. MILSTAR is the first Army satellite which has a ground terminal being concurrently developed in order to support tactical as well as strategic requirements. MILSTAR will support user data rates from 75 bps to 2.4 Kbps.

Satellite communications is beginning to play a significant role in Army tactical operations. We used single channel and multichannel TACSAT terminals during the Grenada operation as well as in other contingency operations, such as responding to natural disasters. In the near future, TACSAT will greatly increase the commander's ability to communicate over extended distances rapidly, reliably, and securely.

(The following article, "The Army's use of space," outlines some of these communications improvements and their implications for the battlefield of the future.)

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