

# **COMSAT SATELLITE CONTROL NETWORKS**

**Charles E. Johnson**  
**Manager Automated Test**  
**Spacecraft Engineering**  
**Communications Satellite Corporation**  
**Palo Alto, California**

## **INTRODUCTION**

The COMSAT family of companies is actively involved in the operation of the Intelsat, COMSAT General, and Satellite Business Systems (SBS) ground networks which currently control twenty-five communications satellites utilizing three control centers and thirteen ground stations with forty-five antennas. Satellites controlled include INTELSAT IV (7), INTELSAT IVA (5), INTELSAT V (4), COMSTAR (4), MARISAT (3), and SBS (2). COMSAT also operates a launch services network consisting of a COMSAT Launch Control Center and Intelsat ground stations, as required, to guide spacecraft to the proper orbit station. Intelsat V flight 4 was launched in March 1982. Two additional Intelsat V's and one SBS are scheduled for launch this year. The latter will be on the first commercial shuttle mission.

The ground control networks contain a commonality traceable to COMSAT's influence in the design of the satellites and experience in the control of communications satellites dating back to the launch of the Early Bird in 1965. This paper presents an overview of operational and planned networks in which COMSAT plays a significant role.

## **CONTROL OF THE SPACE SEGMENT**

The primary objective of each of these networks is to control the space segment of the satellite system so as to provide uninterrupted commercial communications service consistent with the requirements of the ground segment. All of the satellites controlled are in geostationary equatorial earth orbit at the nominal synchronous altitude of 35,780 km, positioned at various longitudes over the three ocean regions and the American continents.

Each network uses tracking, telemetry, command, and ranging facilities to control satellite parameters and functions including satellite orbit position, spacecraft attitude, and antenna pointing. Each network also performs housekeeping functions such as communications configuration, power management, fuel management, and redundant resource management.

## **COMMON NETWORK ELEMENTS**

Each network consists of a control center (all located in the Washington, D.C. general area) and from two to eight tracking, telemetry, command, and ranging ground stations located around the world. Most ground stations include at least one full motion tracking antenna but many utilize limited motion T&C antennas. Co-located communications antennas are sometimes used for telemetry and command. Some additional communications antennas are used to facilitate the transfer of telemetry data to the control center. There is always at least one antenna assigned to each satellite for full time telemetry monitoring, but the command and ranging carriers illuminate the spacecraft only as required.

Each ground station includes computerized telemetry processing, command generation, tracking, and ranging capability sufficient for the short term autonomous control of assigned satellites, but strict control is maintained from the control center except in the event of a communications outage. All telemetered data is transferred without modification to the control center using satellite links and leased telephone facilities. Although each network includes some form of computer aided command transmission capability, commands are normally transmitted manually from the ground stations under voice direction of the control center.

Each control center contains extensive computer processing equipment for real time telemetry display, limit checking, fault detection, and alarm generation. Historical telemetry data is available on all satellites at progressively less frequent sample rates from launch to the current date. An interactive plotting capability can provide access to every frame of data for several hours, and long term magnetic tape storage can provide every frame of data for longer periods.

Satellite orbital control and monitoring for all networks is provided by a single COMSAT group. Tracking and ranging data from all ground stations is returned to one of COMSAT's computers in the Washington, D.C. area for orbit determinations.

## **INTELSAT CONTROL NETWORK**

COMSAT's Intelsat Technical Services provides engineering and other technical support to the Intelsat satellite control network, and COMSAT owns and operates the two TT&C stations located in the United States at Andover, Maine and Paumalu, Hawaii.

The Intelsat network includes six additional TT&C stations located at Carnarvon, Australia; Fucino, Italy; Pleumeur-Bodou, France; Tangua, Brazil; Yamaguchi, Japan; and Zamengoe, Cameroon. These stations include thirteen TT&C antennas in addition to

fifteen communications antennas. The Intelsat Control Center is located in Washington, D.C. The Intelsat network now supports twelve INTELSAT IV's and IVA's, and four INTELSAT V's. An additional eleven INTELSAT V series spacecraft are scheduled to be launched through 1985. Recently, a contract was awarded for an initial order of five INTELSAT VI series spacecraft, scheduled for launch in 1986 and beyond.

## **COMSTAR AND MARISAT CONTROL NETWORK**

COMSAT General Corporation serves as the system manager for the COMSTAR and MARISAT systems. The COMSAT General satellite control network consists of three TT&C ground stations located at Fucino, Italy; Santa Paula, California; and Southbury, Connecticut; and a Systems Control Center (SCC) located in Washington, D.C. The Fucino, ground station has one auto tracking antenna. The Santa Paula and the Southbury earth stations each include two autotracking and one limited motion (non-autotracking) antennas.

The system supports a network of seven satellites consisting of three MARISAT satellites serving the Atlantic, Pacific, and Indian ocean regions, and four domestic COMSTAR satellites.

## **SATELLITE BUSINESS SYSTEMS CONTROL NETWORK**

The SBS Telemetry, Tracking, and Command (TT&C) network consists of one beacon earth station in Castle Rock, Colorado and a combined earth station and control center in Clarksburg, Maryland. The Castle Rock station includes two full function autotrack antennas, three limited motion T&C antennas, one limited motion Constant Reference Source (CRS) antenna, and a set of telemetry and command processing equipment. The Satellite Control Facility in Clarksburg, Maryland includes two limited motion T&C antennas, two limited motion CRS antennas which may be shared for T&C. It also has an extensive set of TT&C processing equipment, and additional equipment for monitoring and exercising direct control over the satellites and the beacon earth station.

The SBS series is unique in the current COMSAT family of satellites in that the primary means for spacecraft antenna pointing control is through tracking of a ground beacon. Current Intelsat and COMSAT General satellites use on-board earth or sun sensors for antenna pointing control. SBS uses both K-band and C-band telemetry and command frequencies, C-band for transfer orbit (for compatibility with the Intelsat network) and K-band for synchronous orbit operations. The SBS network currently controls two satellites in orbit. A third is scheduled for launch on the shuttle in November, 1982. A fourth is being assembled at the manufacturer's plant and a fifth is in the planning stages.

## **FUTURE PROGRAMS**

A COMSAT subsidiary, Satellite television Corporation (STC), plans to implement a network for controlling direct broadcast satellites, intended primarily for satellite-to-home pay television service. SIC is currently evaluating proposals for the construction of two satellites (one operating and one spare) which would be used to initiate service in the eastern United States, as well as options on additional satellites to extend the service nationwide. The ground facilities portion for control of the system will include a centralized Broadcast Center and System Control Facility near Las Vegas, Nevada, a backup ground station at Santa Paula, California, and an alternate monitoring facility in Washington, D.C.