JPL Emergency Support of TDRSS and Compatible Satellites

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The Tracking and Data Relay Satellite System (TDRSS) will consist of three identical satellites in geosynchronous orbits and a dedicated ground receiving station. The first two satellites (TDRS East and TDRS West) will form the operational TDRS service network providing near-global real-time user satellite coverage. The third TDRS satellite will act as an in-orbit spare. Since the TDRSS satellites are supported by a single ground station, a method of providing emergency support for TDRS and user satellites is needed. This article describes the support to be provided by JPL's Deep Space Network.

I. Background

With the concept of an orbiting Tracking and Data Relay Satellite System (TDRSS), NASA's Office of Space Tracking and Data Systems (OSTDS) adopted a policy of discontinuing the support of low earth orbiting satellites with a ground based network of tracking stations.

Goddard Space Flight Centers (GSFC), Flight Projects Directorate, requested a reconsideration of this policy in 1983. The Jet Propulsion Laboratory (JPL) was requested to assess the impact of providing support for a limited number of projects under emergency conditions.

JPL's study showed that for a nominal cost, the 26-meter subnetwork of antennas could provide the requested support. OSTDS then approved the concept and assigned JPL the responsibility of providing this support.

II. Support Conditions

Low earth orbiting satellites will normally be supported by the TDRSS and the White Sands, New Mexico, receiving station. In the event of a failure, either ground station or satellite, which would prevent or limit the normal communications functions, JPL may be requested to provide emergency support. GSFC is responsible for the JPL notification that an emergency exists.

III. Supported Projects

The following satellites will be supported.

A. Solar Maximum Mission (SMM)

This satellite studies solar activity occurring in active regions of the sun, sunspots, and solar flares. Observations are conducted in the ultraviolet, X-Ray, and Gamma-Ray regions of the spectrum with earth based instruments providing coverage at radio and optical wavelengths.

B. Land Satellite 4 and 5 (Landsat 4 and 5)

Landsat provides data continuity of earth resources information for worldwide users. Each satellite contains a thematic mapper and a multispectral scanner imaging device plus mission unique hardware.

C. Earth Radiation Budget Satellite (ERBS)

ERBS studies the earth's interaction with solar energy, a critical factor in predicting the earth's climate.

D. Space Telescope (ST)

The Space Telescope is planned as a national facility. It will consist of a 2.4-meter aperture Ritchery-Chretein cassegrainian telescope weighing approximately 9525 kilograms with various energy detectors designed for observations of infrared, visible, and ultraviolet wavelengths.

E. Gamma Ray Observatory (GRO)

GRO is an earth orbiting satellite that will study sources of localized, galactic, and extragalactic gamma radiation.

F. Upper Atmosphere Research Satellite (UARS)

UARS is designed to study the radiation, chemistry and dynamics of the upper atmosphere at low, middle, and moderately high altitudes and the coupling between these properties in order to determine the seasonal correlations.

G. Space Transportation System (STS)

The Space Transportation System is the manned reusable launch vehicle (Shuttle) used to carry into space nearly all of the nation's payloads for military, private industry, universities, research organizations, and foreign governments and organizations.

H. Tracking and Data Relay Satellite (TDRS)

The payload of each TDRS provides a Telecommunications service system which relays communications signals between low earth orbiting user spacecraft and the TDRS ground terminal. The service is provided by two types of links: (1) a multi-access system, with one 30-element S-Band phased array antenna system; and (2) a single-access system, either S-Band or K-Band, using two 4.8-meter parabolic antennas.

IV. Support Requirements

A. Initial Action

Upon initial notification of a declared satellite emergency requiring JPL support, JPL will take the steps necessary to provide station support. The DSN stations will acquire real-time engineering telemetry so that the project may assess the satellite health. They will also acquire high rate telemetry data recorded on the satellite's magnetic tape recorder. The recorder playback will be activated by ground command. The supporting DSN stations will generate and transmit radio metric data. All data will be provided to GSFC in real time or near real time.

B. Subsequent Passes

For subsequent passes, JPL will acquire real time engineering telemetry data, transmit ground commands to reload the spacecraft memory, if requested, acquire spacecraft memory dumps of telemetry data, acquire radio metric data, and provide data to GSFC in real time.

C. Prolonged Support

For prolonged emergency situations, reduced mission objectives will be pursued. Telemetry data will be acquired in real time, science data will be acquired via spacecraft recorder playbacks lasting from six to eight minutes, commands will be transmitted on a scheduled basis, radio metric data will be acquired, data rates exceeding the line capacity will be recorded on-station and played back during the post-pass period, and spacecraft coverage will be provided as defined in a negotiated schedule.

D. Support Configuration

TDRSS spacecraft emergency support will be provided by JPL's Deep Space Network (DSN) 26-meter subnetwork of stations located at Goldstone, California, Deep Space Station 16 (DSS 16); Canberra, Australia, (DSS 46); and Madrid, Spain, (DSS 66). The configuration delivered by the networks consolidation program will be used and will have the capability of supporting the data rates listed in Table 1. Real time transmissions will normally be limited to data rates which can be accommodated by a 56-kilobit transmission line rate. Under certain emergencies this capability will be increased to a transmission rate of 112 kilobits. Figure 1 shows a typical support configuration. Documentation will consist of a network operations plan (NOP) for each mission to be supported. This plan will document the plans, procedures, and configurations to be followed by the DSN stations, the DSN operations control team, and the DSN ground communications facility following the declaration of an emergency. The data interface for each mission to be supported will be documented in the interface control document (ICD) for GSFC and JPL. The ICD will describe the operational, technical and communications aspects of the data transfer between centers and projects using the DSN.

E. Support Scenario

When an emergency situation develops, GSFC will notify the DSN operations chief using the coordination voice network. This voice network is active 24 hours per day, seven days per week and connects the GSFC network control center to the DSN network control center. GSFC will inform the DSN of the circumstances for declaring the emergency, the parameters needed to acquire the spacecraft such as downlink frequency or channel, telemetry data rate and coding, uplink frequency or channel, last received uplink and downlink signal levels, etc. Arrangements will also be made for the transmission of vectors needed to point the 26-meter antenna at the spacecraft.

The operations chief will assess the request and negotiate and schedule station support. A network controller will be assigned to monitor the station to project interface; when necessary, communications lines will be activated between the assigned station and the project's operations control center at GSFC. The station will be notified by the DSN controller of the declared spacecraft emergency and will be asked to terminate the activity in progress and prepare for the emergency support situation. The controller will brief the station on the nature of the emergency and provide the parameters needed for spacecraft acquisition.

The GSFC Flight Dynamics Facility will provide state vectors to JPL or transmit an improved interrange vector (IIRV) directly to the station. These vectors will be used for antenna pointing. The station will use the NOP to configure the station for support. Following the completion of the preacquisition checklist the station will point the antenna at the spacecraft and acquire the downlink signal. At this point the station will notify the DSN controller of the acquisition of signal (AOS).

The project will instruct the DSN Controller on requirements for recordings, ranging, and command. During the pass, the DSN controller will monitor the net and provide assistance to the project or station. Upon completion of the pass, the station will be released for the next scheduled activity. The project will determine if continued emergency support is required and provide the DSN scheduling office with the requirements.

Table 1. Emergency satellite data rates

Mission	Initial R/T Telemetry, kbps	Contact Rates: Recorder Dumps, kbps	Subsequent R/T Telemetry, kbps	Contact Rates: Memory Dump, kbps
LANDSAT	8	256	8	32
SMM	16	512	16	32
ERBS	1.6	32	1.6	–
ST	0.5	1024	4	–
GRO	32	512	1	32
UARS	32	512	1	32
STS	128	128	128	128
TDRS	1	–	1	–

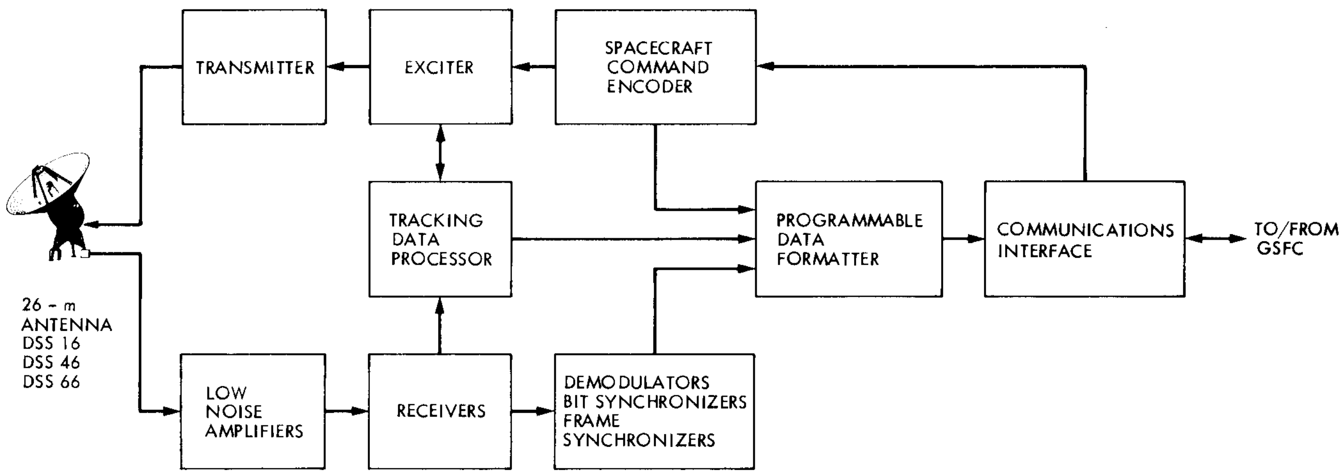

Fig. 1. A typical support configuration