DSN Test Support System, Mark IV-85

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As part of the Network Consolidation Program, the present DSN Test and Training System, Mark III-77, will be upgraded during the Mark IVA implementation planned for 1984-85. This new upgraded system will be referred to as the DSN Test Support System, Mark IV-85. This article provides descriptions and functional capabilities that exist or will be implemented in the subsystems which comprise the DSN Test Support System.

I. System Definition

A. General

The DSN Test Support System, as part of the Network Consolidation Program (Ref. 1), provides support capabilities for testing the DSN data systems at each of the three Deep Space Communications Complexes (DSCC) (Goldstone, California; Canberra, Australia; Madrid, Spain) and at the Network Operations Control Center (NOCC). The system also provides support to flight projects for testing and training activities with the DSN facilities. The system includes capabilities for:

(1) Facility-level system performance testing of each DSN system.

(2) Maintenance and diagnostic testing for the DSCC subsystems.

(3) End-to-end testing of each DSN system, including related DSCC, Ground Communications Facility (GCF), and NOCC functions.

The system consists mainly of a number of hardware and software components that are normally parts of other DSN systems and subsystems. However, it includes two subsystems that are dedicated to the test support: DSCC Test Support Subsystem and NOCC Test Support Subsystem.

Figure 1 describes the system's functions and interfaces. This article updates the system description published in Ref. 2.

B. Key Characteristics

Design goal key characteristics of the DSN Test Support System are:

(1) Centralization of test support capabilities at each DSCC.

(2) Capability to support testing and maintenance activities concurrently with operational activities.

(3) Capability to function without alteration of DSN operational configurations.

(4) Accommodation of flight-project-supplied simulated data via GCF.

(5) Capability to support network loading tests with a combination of actual and simulated data streams.

(6) Testing functions to be controlled by Monitor and Control Subsystems.

(7) Accommodation of other data sources, as follows:

(a) Spacecraft test data via JPL Compatibility Test Area (CTA 21).

(b) Spacecraft prelaunch data via Merritt Island, Florida, Spacecraft Compatibility Monitor Station (STDN, MIL 71).

(8) DSCC Test Support Subsystem will use mission-independent hardware and software.

C. System Usage

Since the system capabilities can be used to support various DSN activities, the following are provided:

(1) Calibrations and prepass readiness verification.

(2) Real-time diagnostics and fault isolation.

(3) DSN implementation activities and performance testing of DSN systems, DSCC subsystems, and NOCC subsystems.

(4) DSN operational verification tests to prepare for mission support.

(5) Flight project ground data system tests, mission simulations, and operational readiness tests.

II. System Implementation

A. Description

The Mark IVA DSN plan establishes a Signal Processing Center (SPC) at each of the three Deep Space Communications Complexes. In each SPC, a new DSCC Test Support Subsystem will be implemented. Included within this subsystem are two assemblies, Telemetry Simulation Assembly (TSA) and Maintenance Support Assembly (MSA), that provide major support capabilities for the DSN Test Support System. Also, within the SPC, a new Monitor and Control Subsystem will be implemented that will provide control for operational activities. The backup Monitor and Control Subsystem will be used to support new system performance test programs.

In addition to the major implementation described in the above paragraph, additional changes will be implemented in other DSCC subsystems that support the DSN Test Support System. The test support functions provided by all DSCC subsystem are described in Section III.

B. New Capabilities

This paragraph lists some of the new support features that are different from those provided by the Mark III-77 Test and Training System as described in Ref. 2.

(1) DSCC Test Support Subsystem. In support of the telemetry simulation and conversions functions the DSCC Test Support Subsystem will:

(a) Provide status to Mission Control and Computing Centers (MCCC) during remote simulation tests.

(b) Provide capability to store and replay project-generated telemetry data.

(c) Provide project tables that contain the data parameters for establishing unique spacecraft telemetry test signals.

(d) Generate delayed-telemetry test signals.

(e) Generate telemetry test signals to support the High Earth Orbiters mission that will be tracked by the Mark IVA DSN.

(f) Provide test signal generation and distribution capability to support multiple telemetry equipment groups.

(2) Maintenance support. At the DSCCs, the Maintenance Support Assembly will provide maintenance support carts to interface with various subsystem controllers via maintenance interface connectors.

(3) System performance test support. With the implementation of a local area network as part of the DSCC Monitor and Control Subsystem, testing activities and operational activities can be supported concurrently. System performance test programs and procedures will be provided for each of the eight DSN systems, as part of the Mark IVA project.

C. Schedule

The Mark IVA Network implementation plan is phased with the Goldstone facility, being completed in February 1985, followed by Canberra in May 1985 and Madrid in August 1985.

III. Deep Space Communication Complex Functions

A. DSCC Test Support Subsystem (DTS)

As a major subsystem of the Test Support System, the following functions are provided:

(1) Telemetry simulation and conversion functions are shown in Fig. 2. The Telemetry Simulation Assembly (TSA) provides the functions that include the various digital and analog capabilities as itemized in Table 1.

(2) Maintenance Support functions include the following:

(a) Accept equipment assignments for maintenance.

(b) Maintain status of all equipment assigned for maintenance.

(c) Provide portable maintenance support equipment.

(d) Interface with subsystem-supplied diagnostics.

B. Receiver-Exciter Subsystem (RCV)

The RCV provides the following test support functions:

(1) Generation of simulated S-band and X-band downlink test carriers. Specific capabilities are as follows:

(a) 64-meter and 34-meter transmit-receive stations provide one X-band carrier and one S-band carrier.

(b) 34-meter receive-only stations provide a single X-band test carrier.

(c) CTA-21 and MIL-71 provide the same capability as the 64-meter stations.

(2) Modulation of telemetry subcarriers and data streams from the TDA onto simulated test carriers.

(3) Variable attenuation of each test carrier signal level.

(4) Translation of S-band exciter uplink frequencies to S- and X-band downlink frequencies.

(5) Measurement of carrier power levels and modulation levels.

C. Antenna Microwave Subsystem

The Antenna Microwave Subsystem provides the following test support functions:

(1) Routing of simulated downlink carriers to masers and/or receivers

(2) Mixing of simulated S-band downlink carriers.

D. Transmitter Subsystem

The Transmitter Subsystem includes provision for feeding the transmitter output into a dummy load to support Command System and Tracking System test operations.

E. Frequency and Timing Subsystem

The Frequency and Timing Subsystem provides the following support functions:

(1) Time code and reference frequencies.

(2) Generation and distribution of a simulated time signal which can be substituted for the true GMT input to the various DSCC subsystems. This capability is provided to support realistic mission simulations in flight project testing and training activities.

F. DSCC Digital Communication Subsystem

The Digital Communications subsystem provides the following test support functions:

(1) Transmission of data blocks of simulated telemetry data and DTS control messages from the NOCC or MOC.

(2) Transmission of status and alarm messages from the DTS to NOCC and/or MOC.

(3) Transmission of system performance test data blocks and simulated response data to the NOCC for DSN systems testing and project testing and training.

(4) Provision of on-site loop-back of data blocks for testing.

G. DSCC Monitor and Control Subsystem

The Monitor and Control Subsystem (DMC) provides the following test support functions:

(1) Generating and transmitting control messages to the DTS and to all subsystem controllers during system performance testing and flight project training activities.

(2) Displaying DTS alarm and status information for DSCC operations personnel.

(3) Supporting system performance test programs for DSCC operations personnel.

(4) Providing DSCC subsystem status data to DTS upon request.

(5) Transferring control of DSCC subsystem controllers to DTS for maintenance support activities.

H. DSCC Subsystem/Assembly Controllers

All DSCC subsystem controllers and/or assembly controllers provide the following functions in support of the DSCC maintenance support capability:

(1) Diagnostics and test procedures to support the DSN maintenance program.

(2) Standard maintenance interface connector.

IV. Ground Communications Facility Functions

The DSN Test Support System utilizes the Ground Communications Facility Subsystems for communicating data and information between Network Operations Control Center (NOCC) or any Mission Operations Center (MOC) and the

Deep Space Communications Complexes, CTA-21, and MIL-71. The following capabilities are supported:

(1) Transmission of control messages, simulated telemetry, and simulated command data to any DSCC from NOCC or from any MOC. Simulated telemetry data rates will be less than 30 kbps.

(2) On-site loop-back of test data for system performance testing.

(3) Voice communications for purpose of test coordination and training.

V. Network Operations Control Center Functions

Test support capabilities presently implemented in NOCC are as follows:

(1) Off-line generation of recordings of high-speed data blocks for testing of the real-time monitors in the NOCC Tracking, Telemetry, Command, Radio Science, and Monitor and Control Subsystems

(2) Selection of stored data blocks and output of the data to the DSS for system readiness verification.

References

1. Yeater, M. L., and Herrman, D. T., "Networks Consolidation Program," *TDA Progress Report 42-65*, pp. 19-24, Jet Propulsion Laboratory, Pasadena, Calif., Oct. 15, 1981.

2. Herrman, D. T., "DSN Test and Training System, Mark III-77," *DSN Progress Report 42-50*, pp. 7-13, Jet Propulsion Laboratory, Pasadena, Calif., Feb. 15, 1979.

Table 1. DSCC Test Support Subsystem digital telemetry simulation capabilities

Functional capability	Description
Real-time data streams	6 independent channels
Variable data rates	6 SPS to 4 MSPS without subcarrier 6 SPS to 2 MSPS with subcarrier
Block-to-serial conversion	2 remote streams; combined rate 30 kbps
Block coding	1 channel; biorthogonal (32, 6)
Long constraint length convolutional codes	6 channels; K=32, r=1/2, 1/3 K=24, r=1/2, 1/3
Short constraint length convolutional codes	6 channels; K=7, r=1/2, 1/3
Selectable frame sizes	
Insert frame sync codes	Up to 48 bits
Increment data fields	Maximum of 3 fields per frame
Data patterns	Selectable per channel: PN sequence, fixed formats, or project provided
Pulse coded modulation	Non-return-to-zero level (NRZL) or non-return-to-mark (NRZM) or bi-phase-L
Subcarrier frequency output	100 Hz to 2 MHz, 1/4 Hz resolution
Modulation index control	0 to 89 deg on each subcarrier
Subcarrier mixing	Maximum of two telemetry subcarriers
Delayed test signals	Five channels can be delayed from a reference channel; delays are selectable from 0 to 128 microsec

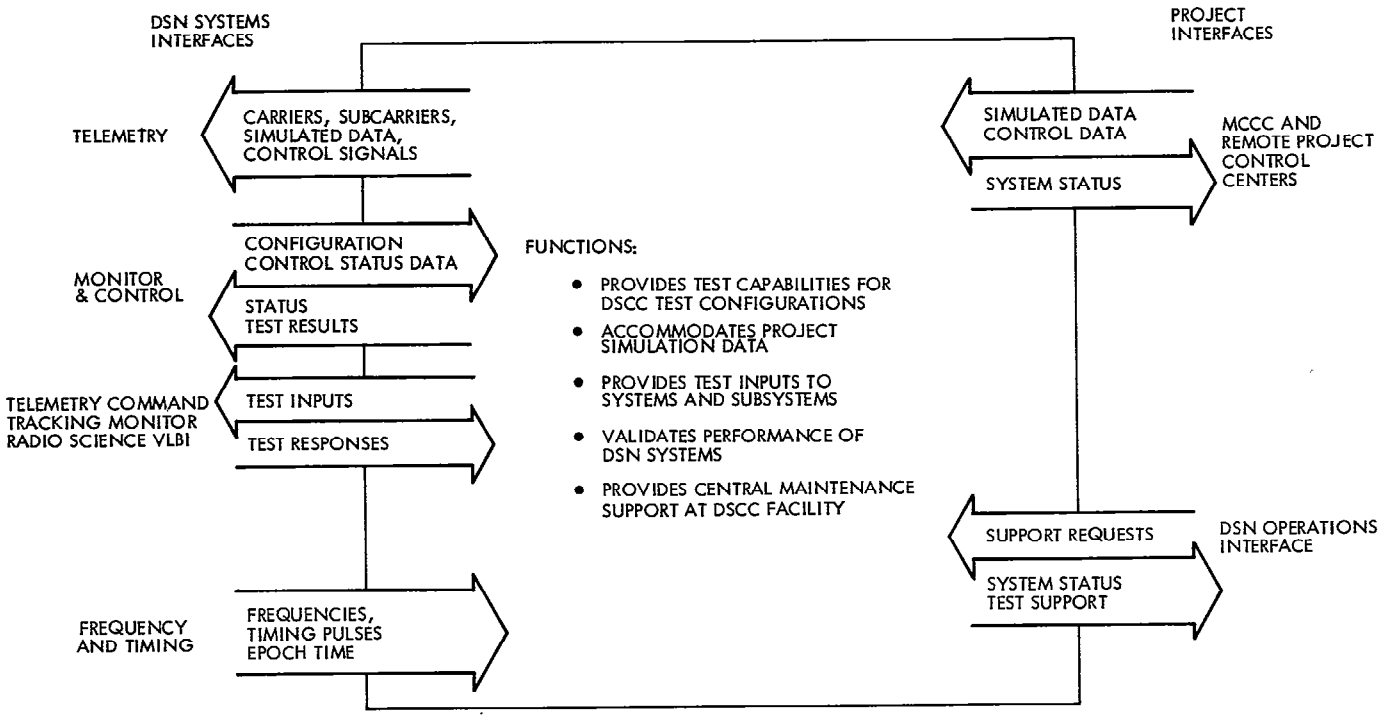

Fig. 1. Test Support System, functiona and interfaces

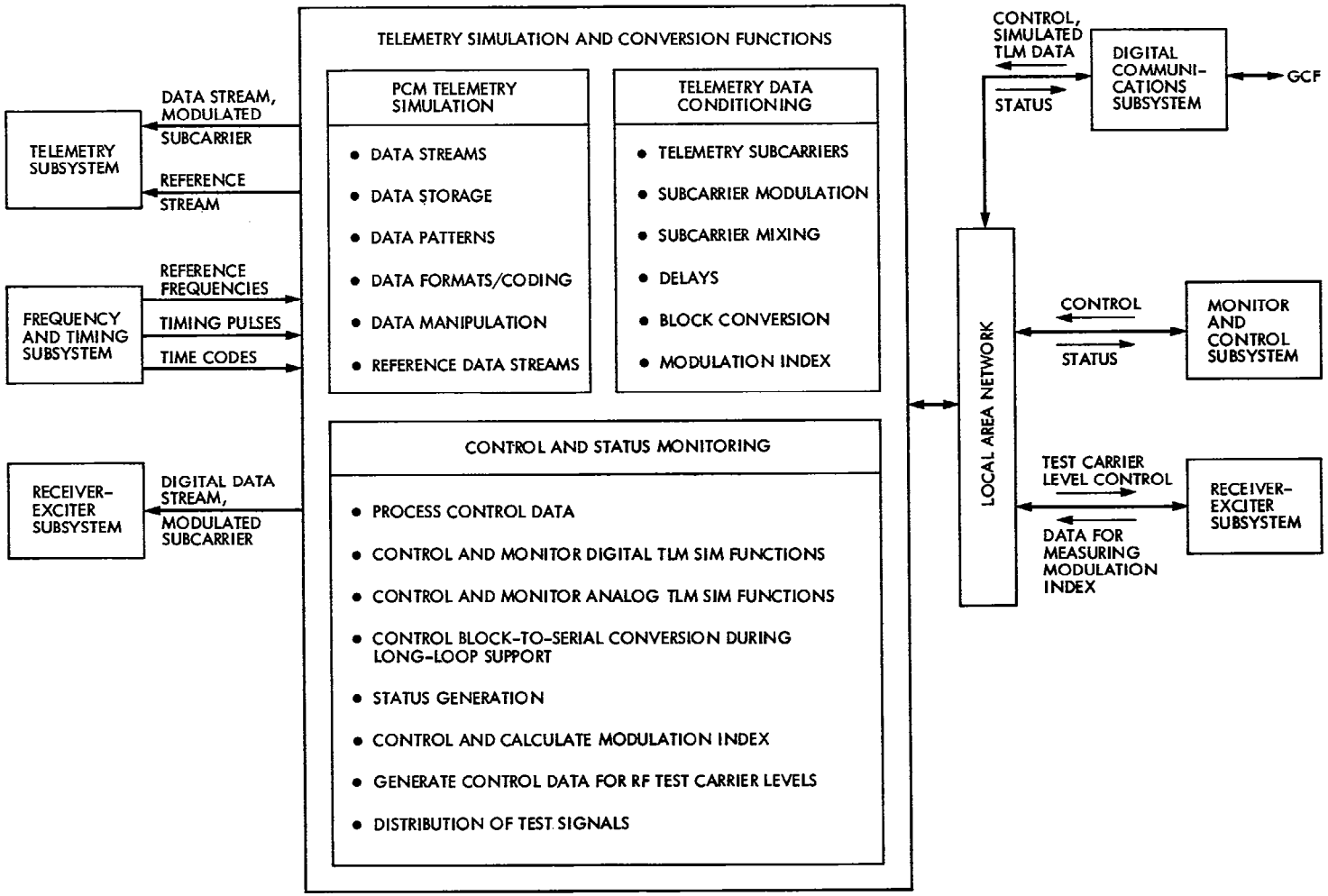

Fig. 2. Telemetry functions, interfaces, and data flow