DSN Command System Tests

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The DSN Multiple-Mission Command System is continually being updated to support each successive flight project. DSN Command System tests are scheduled as each new model of Space Flight Operations Facility (SFOF) and Deep Space Instrumentation Facility Command System software is delivered. The DSN Command System test philosophy along with specific test results during the SFOF Mark III, Models 1 through 5 era, is described.

I. Introduction

The purpose of the DSN Command System tests is to verify that the DSN Command System meets the functional requirements specified in DSN System Requirements Document 820-8. The tests are supervised by DSN System Engineering and are performed after the appropriate facility has completed acceptance tests and delivered the system to the DSN. Following acceptance by the DSN based on the results of the DSN tests, the system is transferred to DSN Operations for flight project support.

DSN Command System Test Procedures or Test Sequence of Events (SOEs) are based on the DSN Standard Test Plan (DSN Document 851-1) and are updated to cover the capabilities of each new delivered system. The procedures are designed to test the Command System end-to-end, including all facilities necessary to operate the system, i.e., SFOF, GCF, DSIF, and Remote Information Center (RIC), if applicable.

DSN Command System tests are divided into two types: Single System and Combined System Tests. DSN Single System Tests are data flow and parameter tests of the Command System operating alone, except for support systems, such as Monitor and Operations Control, and are designed to exercise all of the Command System capabilities and interfaces. Combined System Tests are data flow and parameter tests for the Command System operating simultaneously with all other DSN systems (Telemetry, Tracking, Monitor, and Operations Control) and are designed to evaluate system performance and interaction between systems in a realistic operating environment.

Table 1 shows specific DSN Command System tests and their objectives.

II. Test Activity and Results

The first DSN tests of the Command System portion of SFOF Mark IIIA software (Model I) were conducted during December 1970 and January and February 1971. This test phase was reasonably successful considering the lack of familiarity and training of the test operators and the limited capabilities of the system. For example, Monitor

System display formats were not available and Command System linear display formats were not usable, standards and limits and configuration tables could not be sent to the Deep Space Station (DSS) via high-speed data lines (HSDL) so canned tables had to be entered at the DSS, and test commands were not being accepted by the Telemetry and Command Processor (TCP) at the DSS.

One of the major system problems encountered during the tests was in the HSD message verification cycle. HSD messages from SFOF to the DSS failed to verify at SFOF although they were correct when received by the TCP. A modification to the TCP software was made by DSIF System Engineering which corrected the problem. This was verified by a special test using CTA 21 to simulate a DSS. Another major problem was with erroneous system alarms and aborts generated by the TCP. Several special tests were run with CTA 21 to verify results of TCP software modifications in an attempt to solve the problem, and although the system was significantly improved, the problem still existed at the time the system was transferred to DSN Operations.

The second phase of DSN Command System testing started in March 1971 when the SFOF Mark IIIA, Model II, and DSIF Phase II systems were delivered to the DSN. Standards and limits messages were successfully sent to the TCP via HSDL but did not function properly, and configuration messages still could not be sent. Problems also continued to exist with system alarms and aborts, and destructive overlaying of system linear display formats. Attempts to send commands from a Command Generation Program (COMGEN) file resulted in the 360/75 system going down. This problem was corrected in the SFOF Model IV system. Similar problems were encountered when attempting to command from a file constructed from a card deck.

In August 1971, SFOF Mark IIIA, Model IV, and DSIF Phase IV systems were delivered to the DSN. Single System Tests indicated that configuration and standards and limits messages were now functioning properly, COMGEN and card file commanding was now working, destructive overlaying was still occurring on system linear displays, and many commands were erroneously being aborted for bit verify failure.

Combined System testing progressed very slowly at first, again due to a high percentage of 360/75 down time as a result of excessive backlogging of telemetry data; however, this problem decreased considerably in the latter portion of the test phase. System Data Record (SDR) validation and confirm/abort merge from an Original Data Record (ODR) playback was accomplished successfully for the first time. The system was transferred to DSN Operations and used to support *Mariner* Mars 1971 encounter.

The SFOF Mark IIIA, Model V System, which was designed to support *Pioneer F* launch together with *Mariner* Mars 1971 orbital operations, was delivered to the DSN in December 1971. Due to time constraints, no DSN Single System Tests were performed for the Command System; however, DSN System Engineering and Operations personnel participated in facility-level Command System Acceptance Tests. The DSN Combined System Tests were divided into two types: Level I tests were performed with a single DSS and used for engineering evaluation, and Level II tests were essentially Mission Operation Sequence tests performed with more than one DSS. All existing capabilities of the Command System together with unique *Pioneer F* command processing and multiple-mission capabilities (processing *Pioneer F* and *Mariner* Mars 1971 data together) were tested with no major problems. The linear display format problem was corrected, which greatly increased visibility into the system by the Command Analysis Group and Project Command. An attempt to operate the DSN Command System in the "hot backup mode" (prime and backup project command areas) under specific data priority and telemetry bit rate conditions resulted in bad data blocks being sent from the DSS. The problem was eventually solved by a hardware patch at the DSS. The system was delivered to DSN Operations in late February 1972, and was used successfully to support *Pioneer F* launch together with *Mariner* Mars 1971.

Table 1. DSN Command System tests and objectives

Test and objectives	Description	Prerequisites	Standards	Resources	Participants
DSN System Test Verifies system integrity, interfaces, data flow.	Commands (priorities and types) are generated by the SFOF command processor, routed via an HSDL to a DSS, modulated by RF and transmitted into dummy load. Verification, confirm abort messages and instructions are composed at the DSS, formatted and transmitted to the SFOF. The data are processed, routed and displayed by the 360/75 to the command analysis area, where the tests are conducted and results are analyzed.	1. Applicable facility systems have been tested and transferred to operations. 2. Test to be run concurrently with DSN Telemetry System Test.	820-8 Latest Edition, Section III	1 DSS: TCD, Receiver/Exciter, Transmitter GCF: 1 HSD, 1 TTY, 1 VOICE SFOF: 360/75, Command Analysis Area SOFTWARE: Multimission Command S/W (at DSS and SFOF); TCD/MMC diagnostics, command MDR/EDR S/W	Test Supervisor: DSN System Engineer Test Conductor: DSN Operations Chief Test Associate: Contemporary Project Engineer DSIF Facility Engineer SFOF Facility Engineer Command Analysis Supervisor Command Analysis Group and Supporting facility personnel
DSN System Multiple Mission Test Verifies multiple mission capability.	Following additions to test 1: Generation of standard and limits instruction by the Command Analysis Group relayed to and executed by the facilities. Periodic generation of command system status messages relayed to Operations control. Demonstration of generation within 24 h of command system data record.	Completion of DSN System Test (Command).	820-8 Latest Edition, Section IIB	Same as above.	Same as above.
DSN System Performance Test Measures system parameters (bit rates, subcarrier frequencies, power levels) and modes of operation.	Following addition to test 2: (a) Manual mode is exercised at the DSS. (b) With manual command input at the SFOF bit rates and power levels are varied and range of subcarrier frequency is checked. For these tests an abbreviated planetary mission profile is followed. Simultaneous sharing of processors with the other DSN systems on a non-interference basis is demonstrated. This includes real-time changes to the command system.	Completion of DSN Multiple-Mission Test (Command).	820-8 Latest Edition, Section IID	Same as above.	Same as above.