System Performance Tests for the Network Control System

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This article presents a description of the system performance tests executed during the implementation and transfer to Operations of the Network Control System, Block I, Phases 1 and 2.

I. Introduction

System Performance Tests (SPTs) are executed throughout the DSN whenever modifications that may affect system performance are made. Also, SPTs are required for the verification of performance of new equipment and capabilities.

The purpose of this article is to describe the effort that was undertaken in executing SPTs for the Block I Network Control System (NCS). The philosophy and the objectives of the SPTs will be discussed so as to demonstrate the benefits gained by performing these tests. A description of the NCS SPTs will be presented along with a description of the test procedure and test software.

The NCS is being implemented in three major steps defined as Block I, Block II, and Block III. Each of these Blocks is further broken down into phases. This article describes the SPTs performed for NCS Block I Phases 1 and 2.

II. Objectives of System Performance Testing

The development of test procedures and test software, and the execution of the NCS SPTs are performed to accomplish certain objectives. The overall objective is to guarantee that the NCS can meet specified operational capabilities. These capabilities are defined in various documents; those of particular importance are given in Refs. 1 through 3. The SPT must verify that the NCS configuration and interface requirements are satisfied. They also evaluate the ability of the NCS to meet data rate performance requirements.

An additional object of SPTs is to aid in the training of NCS and DSN Operations personnel. The SPTs are performed with configurations as near as possible to configurations utilized for real time tracking of spacecraft. By using the test procedures, NCS and DSN Operations personnel can gain experience in operating the NCS hardware and software.

One additional feature of the NCS SPT is that the test procedure may be used to isolate system problems. This capability may aid in the resolution of discrepancy reports written against the NCS during operational periods.

III. Test Configuration

Shown in Fig. 1 is the basic NCS Block I hardware configuration. The normal mode of operational support is as follows:

(1) One Sigma-5 on-line processing real-time data. This Sigma-5 is connected to the remote peripheral devices located in the Network Operations Control Area (NOCA).

(2) Off-line Sigma-5 processing and preparing data for transmission to the Network

(3) One PDP-8 computer operating as a real-time multiplexer and demultiplexer. The second PDP-8 operating as a hot-backup

The operational software required for the NCS Block I Phase 1 implementation consists of three computer programs. They are:

(1) DOI-5056-OP PDP-8 Real Time Program

(2) DOI-5057-OP Sigma-5 Real Time Program

(3) DOI-5058-OP Sigma-5 Off-Line Program

For Phase II, Items 2 and 3 above are replaced with:

(4) DOI-5059-OP Sigma-5 Real-Time Program

(5) DOI-5060-OP Sigma-5 Off-Line Program

The NCS SPT is divided into three basic tests. They will be explained in more detail later. The first portion of the SPT consists of a short loop configuration as shown in Fig. 2. The second portion is a long loop configuration with one DSS operating its Monitor, Tracking (TRK), Telemetry (TLM) and Command (CMD) Subsystems in a normal tracking mode. The Simulation Conversion Assembly (SCA) is used to generate fixed pattern telemetry data. The third and final portion of the SPT is a combination of the first two portions with multiple DSSs on-line as well as a short-loop link operating simultaneously.

The software required at the DSS to support the NCS SPT is:

(1) DOI-5046-OP Digital Instrumentation Subsystem (DIS) Monitor Program

(2) DOI-5035-OP-F Pioneer 10 Terminal Countdown Demonstration Test (TCD) Program

(3) DOI-5050-OP-A MVM'73 TCD Program

(4) DOI-5050-OP-B Pioneer and Helios TCD Program

(5) DOI-5089-OP-C SCA Program

IV. NCS SPT Test Software

SPTs for other systems such as CMD and TLM use test software in conjunction with the normal operational software for analytical purposes. This is possible since additional on-site computers are available for real-time testing.

Within NCS Block I, test software may not reside within the operational software. A limited self-test capability exists which consists of generation of HSD Blocks and transmission in a short loop mode. This capability simulates one Deep Space Station (DSS) and is primarily used for software development.

A computer program has been developed which allows the test personnel to formulate SPT procedures files. These files may then be transmitted to DSSs via high-speed data (HSD) and listed on high-speed printers. The general goal of this implementation was to provide a method for rapid update of SPT procedures and distribution to the Network Operations personnel.

V. Test Descriptions

The NCS System Performance Test is divided into three basic tests. They are described below:

A. Short Loop Test

This test verifies the operation and capabilities of the NCS in a short loop mode. This test is executed as the first part of the SPT, in order to verify operation prior to scheduling HSD lines and DSS resources.

TRK, TLM, and CMD test data transmission files are generated by the off-line Sigma-5. These data types are transmitted and received by the NCS. Ground communications (GC) accountability is verified, as well as the capability of test data generation. The peripheral equipment control and capabilities are exercised; computer

system recovery is verified; and backup computer and communication configurations are also verified.

The time required to perform this portion of the SPT is twelve hours.

B. Long Loop Test

This test verifies the operation of the NCS in a long loop mode with one DSS at a time. The primary goal is to prove that the DSS interfaces are, indeed, correct.

Transmission files are created for sequence of events (SOE), schedule (SKED), tracking predicts, and commands (for Mark III-71 and Mark III-74 versions) by the off-line Sigma-5. These data types are transmitted to the DSS. Real TRK, TLM, CMD, and monitor data reception is validated for various data rates. GC data accountability is tested. Commands are transmitted to TCD A and TCD B for Pioneer, Mariner, and Helios configurations. The capability of transmitting command data simultaneously with other data types is exercised. The input/output portions of NCS software are tested thoroughly.

The time required to perform this part of the SPT is six hours for each DSS.

C. Full Load Test

The last test performed in the SPT is the full load test. The goal is to prove that the NCS can operate with multiple DSSs on-line in a normal Network configuration,

The test capabilities described above for the short and long loop tests are combined to exercise the NCS with multiple DSS, spacecraft, and data rate combinations. Excessive data rates and erroneous information are input to the NCS to determine error detection properties.

The time required to perform this test is twelve hours.

VI. Test Status and Results

NCS Block I Phase 1 SPTs were executed from Dec. 15, 1973 through Jan. 15, 1974. The Phase 2 SPTs were begun on Feb. 4, 1974 with Compatibility Test Area, CTA-21. Due to high activity within the Network, the complete NCS SPT has not been completed for the Phase 2 software.

The tests for Phase 1 were run by system support personnel from Network Operations. The Phase 2 tests were run by real-time operations analysis personnel under direction of the System Support Group.

In a number of cases the SPTs uncovered software anomalies. These have been reported to the software development organization. Also, a number of improvements have been suggested and are under consideration for future software releases.

Overall, the hardware and software performance as demonstrated by the NCS SPTs has been acceptable. The SPTs have proven to be a valuable tool in the performance evaluation of the Network Control System. In addition, training has been accomplished for numerous operating personnel.

As new versions of NCS software become available with new or revised capabilities, the SPTs will be updated accordingly and executed as required.

References

1. *Deep Space Network System Requirements Block I Network Control System*, Document No. 822-10, Jet Propulsion Laboratory, Pasadena, Calif., Oct. 15, 1973.
2. *Deep Space Network System Requirements Detailed Interface Design*, Document No. 820-13, Feb. 1, 1971 (JPL internal document).
3. Maclay, J., *Block I NCS Network SPT Requirements and Acceptance Criteria*, IOM NSE-74-2, Jet Propulsion Laboratory, Pasadena, Calif., Jan. 3, 1974 (JPL internal document).

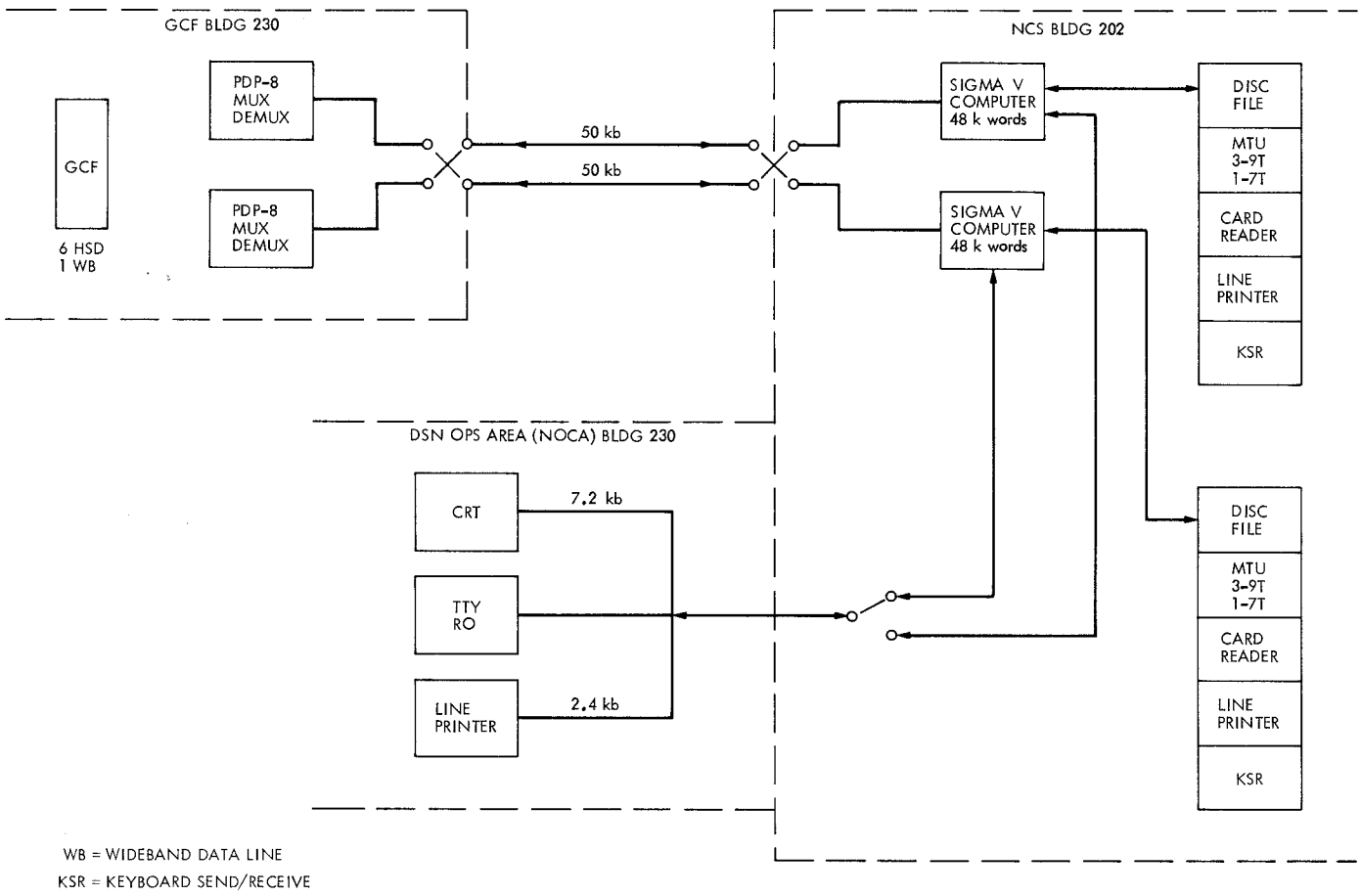

Fig. 1. NCS Block I configuration

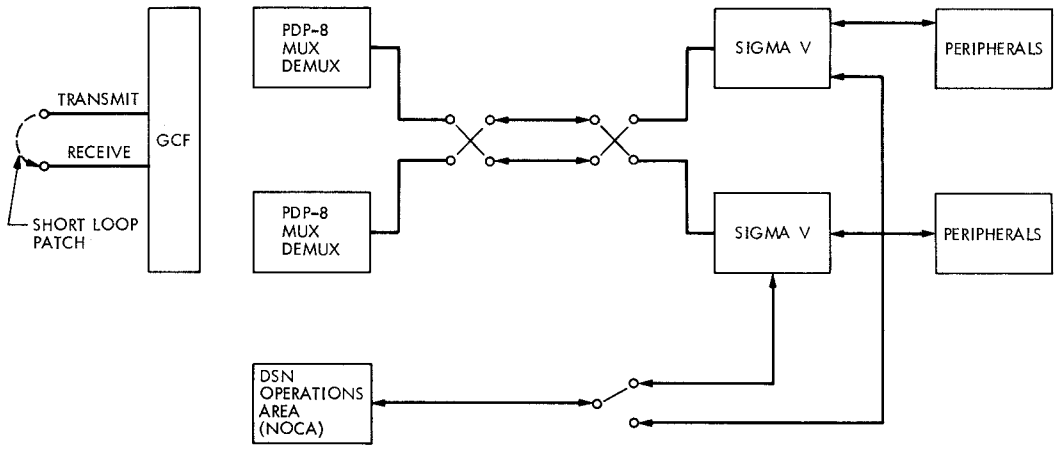

Fig. 2. NCS Block I short-loop test configuration