Viking Mission Support

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DSN Support for Viking remains in the transitional phase between planning and commitment, and the early stages of implementation. Existing implementation schedules have been thoroughly reworked to reconcile desired operational readiness dates with anticipated DSN manpower and funding resources. Investigation of downlink interference effects in a dual-carrier environment continued to make progress at Deep Space Station (DSS) 13. The Network configuration for the DSN Test and Training System is described in this article.

I. Introduction

Over the past 2 months DSN support for Viking 1975 (VK75) has been concentrated in a substantial effort to reconcile the existing implementation plans with the operational readiness dates requested by the Project. This effort has taken longer than originally anticipated but is now complete with minor exceptions. As reported in Vol. XII of this series, the resolution of some of the conflicts is related to the definition of working relationships among DSN Operations, DSN Systems Engineering, and the Telecommunications Division.

Tracking and Data Acquisition documentation is also involved to the extent that it reflects the plans, procedures, schedules, and agreements that must be developed among the organizations concerned. This has been accomplished and will be reported in a later issue of the DSN Progress Report.

Investigation of the effects of the dual-carrier environment on DSN performance has made significant progress. The results of this work will be reviewed in mid-December.

II. DSN Test and Training System Configuration

The DSN Test and Training System (TTS), as configured to support Viking 1975, will accomplish the following functions:

(1) Generate and control simulated Deep Space Station (DSS) and spacecraft data streams to support development, testing, training, and fault isolation in the DSN.

(2) Participate in VK75 mission simulation exercises with the Project by controlling data flow within the DSN and generating simulated DSN data to supplement Project simulation data.

It will be possible to accomplish these functions in either the long-loop (via DSSs) or the short-loop [via Ground Communications Facility (GCF) Central Communications Terminal] configurations, as shown in Table 1.

The functional requirements of the DSN Test and Training System, as configured for VK75, are shown in Fig. 1. Unless otherwise stated, these requirements apply to both the 26- and 64-m subnetworks.

The functional capabilities of each of the three elements of the DSN are described below.

A. Deep Space Station Test and Training Functions

The DSSs will accept and process telemetry, command, and radio metric simulation data from the TTS or the Viking Simulation System (VSS) on High-Speed System (HSS) or Wideband System (WBS), as shown in the footnotes to Fig. 1. The capacity of each DSS to handle simulated data will be equivalent to its capacity to handle real-time data, as described in Refs. 1 and 2, except that the data originated in the TTS will be of a simple fixed pattern, whereas the VSS-originated data will be interactive with command and more representative of true flight data.

B. Ground Communications Facility Test and Training Functions

For test and training purposes, the GCF is required to accept simulated telemetry, command, and radio metric data from the TTS and VSS and transfer the data either short-loop or open-loop to the destinations shown in Fig. 1 by HSS and/or WBS as appropriate.

All simulated data will be formatted by the originator to exactly the same standards as for real-time data, as described in Refs. 1 and 2.

C. Network Control System Test and Training Functions

This System includes the Network Control (NC) Test and Training Subsystem, which, when configured for Viking, is required to perform the following functions in support of Project test and training exercises:

(1) Control data flow within the DSN.

(2) Generate simulated DSN data to supplement Project-supplied simulation data.

(3) Accept computer-generated telemetry data from the Viking Mission Control and Computing Center (VMCCC) for transmission to the DSSs.

(4) Accept simulated command data from the VMCCC that is interactive with the telemetry data in item (3).

(5) Provide simulated radio metric data to the VMCCC based on the predicts capability.

The NC Test and Training Subsystem will, in addition, perform the following functions in support of Deep Space Instrumentation Facility (DSIF) development, testing, training, and fault isolation.

(1) Generate DSIF data streams to exercise GCF and NC Subsystems.

(2) Generate fixed telemetry data patterns to exercise DSS subsystems.

These latter functions are used for internal DSN purposes and are described in various DSN Standard Operating Procedures. Other elements of the NC Subsystem, such as the Real-Time Monitors (RTMs), are required for test and training support, but their role is identical to that performed under the real-time data environment.

The NC Test and Training Subsystem interfaces only with the VSS, as shown in Fig. 1, via the GCF Central Communications Terminal (CCT). All simulation data flowing in either direction across this interface will be formatted by the originator, according to the provisions of Ref. 3. Voice and administrative teletypewriter (TTY) circuits between the NC Test and Training Subsystem and the VSS will be provided for DSN/Project coordination of joint test and training exercises.

III. Interfaces

The telecommunication link interfaces between the DSN and the Viking Orbiter and Viking Lander have been fully defined in Refs. 4 and 5. In addition to defining all the telecommunication link parameters, these documents also contain all of the telecommunication link performance data. The documents are now in the formal sign-off process.

A preliminary copy of the DSN to VMCCC System interface agreement is completing its review cycle at present. This document will establish and control all interfaces between the DSSs and the VMCCC that are pertinent to Viking support. It is derived from and is consistent with the DSN System Requirements Document (820-13), Detailed Interface Design.*

IV. Schedules

The need for DSN schedule revisions and reconciliation with current implementation plans as constrained by anticipated budget and manpower resources was discussed in Vol. XII of this series. This work has now been accomplished, and a DSN Implementation Schedule, Level 5, has been released and will serve as the basis for all subsequent implementation planning and testing. The new agreements are depicted in Table 2.

*JPL internal document.

V. Problem Areas

Investigation of downlink interference effects in a dual-carrier environment continues to make good progress at DSS 13. After an extensive cleanup of all waveguide components and taping of all antenna surface joints, the interference effects were still found to be present. Removal of the quadripod and subreflector assemblies resulted in further test data, which suggested that RF leakage around the outer surfaces of the cone and feed horn contributed significantly to the generation of the interference.

These surfaces and the subreflector surfaces have now been welded and reassembled on the antenna, and a further series of test data is being collected. The data will be presented to the Viking Project in December, and will be a critical factor in determining the choice of implementation to be adopted for meeting the dual-carrier requirement.

Other options include the use of dual stations (one 64-, one 26-m) at a single location to provide one carrier each, operation at reduced power levels, and reduction of the available frequency channels from four to three. The conclusions and recommendations from the December review will be reported in the next issue.

References

1. Mudgway, D. J., "Viking Mission Support," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. XI, pp. 19–21, Jet Propulsion Laboratory, Pasadena, Calif., Oct. 15, 1972.

2. Mudgway, D. J., "Viking Mission Support," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. XII, pp. 14–15, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 15, 1972.

3. *Deep Space Network/Viking Mission Control and Computing Center Interface Requirements Document*, JPL Document 619-10, Jet Propulsion Laboratory, Pasadena, Calif. (JPL internal document).

4. *Viking 75 Project Orbiter System, Lander System and Launch and Flight Operations System to TDS Interface Requirements Document, Volume II, Viking Orbiter System to Deep Space Network*, Project Document ID 3703111, Jet Propulsion Laboratory, Pasadena, Calif. (JPL internal document).

5. *Viking 75 Project Orbiter System, Lander System and Launch and Flight Operations System to TDS Interface Requirements Document, Volume III, Viking Lander System to Deep Space Network*, Project Document ID 3703111, Jet Propulsion Laboratory, Pasadena, Calif. (JPL internal document).

Table 1. Deep Space Network Test and Training System configuration modes

Test mode	Data transfer			Flowpaths	
	From	To	Monitored by	HSS	WBS
DSN-long loop	TTS	DSS		1	3
	DSS	RTM		33	33
	DSS		TTS	9	11
	DSS		OCA	26	26
	DSS		VSS[a]	10	12
FOS[b]-long loop	VSS	DSS		2	4
	DSS	VMCCC		25	12
	DSS		VSS	10	12
	DSS		OCA	26	26
	DSS		TTS[a]	9	10
DSN-short loop	TTS	CCT		5	7
	CCT	RTM		33	33
	CCT		TTS	9	10
	CCT		VMCCC	25	12
FOS-short loop	VSS	CCT		6	8
	CCT	VMCCC		25	12
	CCT		VSS	10	12

[a]Desirable capability only.

[b]Flight Operations System.

Table 2. DSN/Viking readiness dates

Facility	Implementation complete	DSN Systems and Operations testing, weeks	Commit to Project support
CTA 21	Feb. 1, 1974	16	June 1, 1974
DSS 71	Aug. 15, 1974	16	Dec. 15, 1974
DSS 11, 14	Aug. 1, 1974	22	Jan. 15, 1975[a]
DSS 12, 42, 61	Nov. 1, 1974	30	June 15, 1975[b] Feb. 1, 1976[a]
DSS 43, 63	Nov. 1, 1974	30	June 15, 1975[b] Feb. 1, 1976[a]
GCF to CTA 21	Feb. 1, 1974	16	June 1, 1974
to DSS 11, 14	Aug. 1, 1974	22	Jan. 15, 1975
to DSS 12, 42, 61, 43, 63	Nov. 1, 1974	24	May 1, 1975
to DSS 71	Aug. 15, 1974	16	Dec. 15, 1974
NC test and training only	Mar. 1, 1974	14	June 15, 1974
NC full system	Oct. 1, 1974	14	Jan. 15, 1975

[a]Full planetary operational configuration.

[b]Cruise configuration only.

Table 3. Telemetry data rates and channel requirements

Data rates			
Telemetry channel	Description	Bit rate	Subcarrier frequency, kHz
Orbiter[a]			
Low-rate	Uncoded engineering data	8⅓ or 33⅓ bps	24.0
High-rate	Coded (32,6) science data	1, 2, 4, 8, or 16 kbps	240.0
Lander[b]			
B	Uncoded data	8⅓ bps	23.3
A	Coded (32, 6) data	250, 500, or 1000 bps	72.0

Required combinations of channels		
Either Lander	Orbiter A	Orbiter B
A and B	Low-rate	Low-rate
A and B	Low-rate	Low- and high-rate (uncoded)
A and B	Low-rate	Low- and high-rate (coded)
A and B	Low- and high-rate (uncoded)	Low- and high-rate (uncoded)
A and B	Low- and high-rate (uncoded)	Low- and high-rate (coded)
A and B	Low- and high-rate (coded)	Low- and high-rate (coded)

[a]Each Orbiter may transmit low-rate only or low- and high-rate channels.

[b]Each Lander will transmit A and B simultaneously, except when ranging.

A. DATA FLOW PATHS

(1) SIMULATED DATA FROM TTS, FORMATTED FOR LONG-LOOP HSD TRANSMISSION TO ONE DSS:
- (a) LOW AND MEDIUM-RATE TELEMETRY STREAMS FROM TWO ORBITERS AND ONE LANDER (TABLE 3)
- (b) BIT-RATE SUBCARRIER FREQUENCY, ATTENUATION, AND MODULATION INDEX CONTROL INFORMATION FOR SIMULATION CONVERSION ASSEMBLY (SCA)
- (c) SIMULATION INSTRUCTIONS IN TEXT FOR SCA
- (d) FORMATTED RATIO METRIC DATA FOR DTS RETRANSMISSION FROM 64-m SUBNETWORK ONLY

(2) SAME AS (1) (a), EXCEPT TELEMETRY DATA ORIGINATES IN VSS

(3) SIMULATED DATA FROM TTS, FORMATTED FOR LONG-LOOP WBS TRANSMISSION TO DSSs 14, 43, AND 63:
- (a) HIGH-RATE TELEMETRY STREAMS FROM TWO ORBITERS (TABLE 3)
- (b) BIT-RATE SUBCARRIER FREQUENCY, ATTENUATION, AND MODULATION INDEX CONTROL INFORMATION FOR SCA
- (c) SIMULATION INSTRUCTIONS IN TEXT FOR SCA

(4) SAME AS (3), EXCEPT DATA ORIGINATES IN VSS FOR WBDL TRANSMISSION TO VMCCC

(5) SIMULATED DATA FROM TTS FORMATTED FOR SHORT-LOOP HSDL TRANSMISSION TO NC SUBSYSTEM RTMs AND OCAs
- (a) LOW AND MEDIUM-RATE TELEMETRY STREAMS FROM TWO ORBITERS AND ONE LANDER (TABLE 3); COMMAND VERIFICATION ALARM, CONFIRM/ABORT MESSAGES
- (b) FORMATTED RADIO METRIC DATA
- (c) PARTIAL STATUS AND SUPPLEMENTAL DATA
- (d) DSS MONITOR DATA

(6) SAME AS (5) (a), EXCEPT DATA ORIGINATE IN VSS FOR HSDL TRANSMISSION TO VMCCC

(7) SIMULATED DATA FROM TTS FORMATTED FOR SHORT-LOOP WBS TRANSMISSION TO RTM AND OCA; CONSISTING OF HIGH-RATE TELEMETRY STREAMS FROM TWO ORBITERS (TABLE 3)

(8) SAME AS (7), EXCEPT DATA ORIGINATES IN VSS FOR WBS TRANSMISSION TO VMCCC

(9) TELEMETRY, COMMAND, TRACKING, AND MONITOR DATA FROM LONG-LOOP CONFIGURATION IN (1) FOR TTS MONITORING

(10) TELEMETRY, COMMAND, TRACKING, AND MONITOR DATA FROM LONG-LOOP CONFIGURATION IN (2) FOR VSS MONITORING

(11) HIGH-RATE TELEMETRY FROM LONG-LOOP CONFIGURATION IN (3) (a) FOR VSS MONITORING

(12) HIGH-RATE TELEMETRY FROM LONG-LOOP CONFIGURATION IN (3) (b) FOR VSS MONITORING

(13) SIMULATED HIGH-RATE TELEMETRY DATA TO VMCCC VIA WBS

(14) VOICE TRAFFIC FOR TEST COORDINATION AND SIMULATION OF DSS OPERATING POSITIONS IN SHORT-LOOP MODE

(15) S-BAND CARRIER MODULATED WITH SIMULATED TELEMETRY

(16) ONE ENGINEERING LOW-RATE BIT STREAM

(17) ONE MEDIUM OR HIGH-RATE BIT STREAM

(18) SIMULATION INSTRUCTIONS AND SCA CONTROL

(19) MESSAGES FROM VMCCC AND TTS TO DSIF TRACKING, TELEMETRY, COMMAND, AND MONITOR SYSTEMS

(20) SIMULATED REAL-TIME RADIO METRIC DATA FOR DTS RETRANSMISSION VIA HSDL

(21) BINARY-CODED DECIMAL (BCD) TIME CODE FOR USE THROUGHOUT DSS

(22) EXTERNAL DATA SOURCES

(23) REAL OR SIMULATED COMMANDS FROM VMCCC TO DSSs

(24) NOT USED

(25) SIMULATED LOW AND MEDIUM-RATE TELEMETRY AND DIGITAL TRACKING DATA TO VMCCC VIA HSS; COMMAND CONFIRMATION AND VERIFICATION FROM DSS

(26) TELEMETRY, COMMAND, AND TRACKING REQUESTS TO NC SUBSYSTEM DATA PROCESSING FUNCTIONS; TELEMETRY, COMMAND, AND TRACKING DISPLAY FROM NC SUBSYSTEM DATA PROCESSING FUNCTION

(27) REAL-TIME TELEMETRY, TRACKING, COMMAND DATA TO RTMs. REQUESTS FROM AND DISPLAYS TO DSN OPERATIONS AREA

(28) REQUESTS FROM DSN OPERATIONS FOR STANDARDS AND LIMITS

(29) DISPLAYS OF STANDARDS AND LIMITS TO DSN OPERATIONS

(30) RECALL REQUESTS FROM DSN OPERATIONS

(31) DISPLAYS TO DSN OPERATIONS OF RECALL DATA

(32) NOT USED

(33) WBDLs AND HSDLs AS REQUIRED TO SERVICE NC SUBSYSTEM VIA CCT

(34) MODULATION INDEX CONTROL

(35) S-BAND ATTENUATOR CONTROL

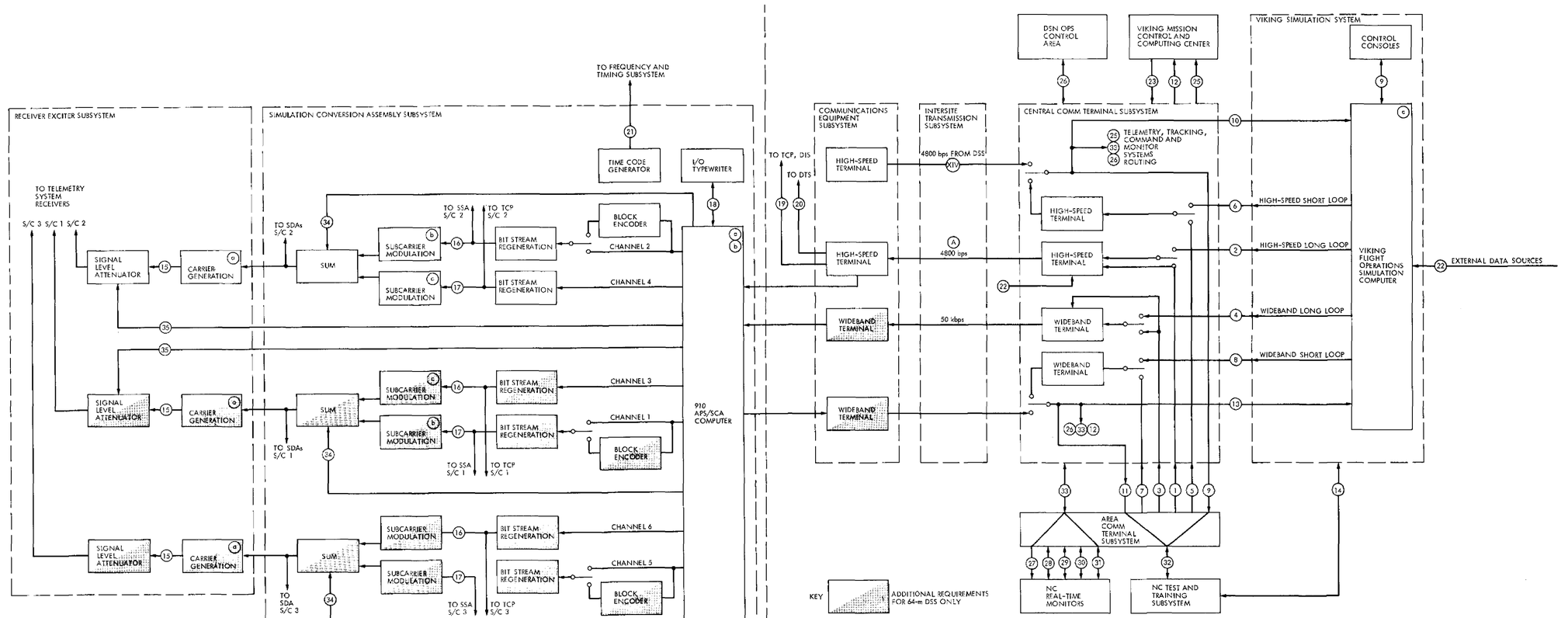

Fig. 1. DSN/VK75 Test and Training System baseline functional requirements