NGT-NASCOM REQUIREMENTS/SUPPORT MATRIX

			TDRSS							(4)	DCF		(5)	OSCF (6)	
SUPPORT SYSTEMS	AVAIL DATE	TEST DATE	TRANSMITS GCMRs FROM NCC	RECEIVES HI-RATE (SSA) SCIENCE DATA	RECEIVES LO-RATE (I) SCIENCE DATA	RECEIVES 'Q' CHAN. ENGINEERING DATA	RECEIVES PERFORMANCE DATA	TRANSMITS COMMANDS FROM POCC	RECEIVES ST & TDRSS TRACKING DATA FOR OSCF		TRANSMITS HI-RATE SCIENCE DATA	TRANSMITS LO-RATE SCIENCE DATA		TRANSMITS TRACKING DATA FROM TDRSS	
POCC PORTS PASS (1)				*	*	*		*							
NCC (2)			*	*	*	*		*			*	*		*	
MPT (2)															
NGT-NASCOM (3)			*	*	*	*	*	*	*		*	*		*	
TDRSS (4)			*	*	*	*	*	*	*					*	
DCF (5)											*	*			
OSCF (6)														*	
ST (7)				*	*	*		*	*						
MSFC SIM (8)															
SOGS STScIF(9)															
SOGS SCC (9)															

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(NASA-CR-168587) SPACE TELESCOPE OBSERVATORY MANAGEMENT SYSTEM PRELIMINARY TEST AND VERIFICATION PLAN Final Report (Information Systems and Networks Corp.) 215 p HC A10/MF A01 CSCL 03A G3/89

N82-20090

Unclas
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ISN

Information Systems & Networks Corporation

ISN/TR-81/1079

SPACE TELESCOPE OBSERVATORY MANAGEMENT SYSTEM PRELIMINARY TEST AND VERIFICATION PLAN

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January 8,1982

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BIBLIOGRAPHIC DATA SHEET

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
ISN/TR-81/1079		

4. Title and Subtitle	5. Report Date
SPACE TELESCOPE OBSERVATORY MANAGEMENT SYSTEM PRELIMINARY TEST & VERIFICATION PLAN	January 8, 1982
	6. Performing Organization Code
7. Author(s) James S. Fritz, Charles F. Kaldenbach, Warren B. Williams	8. Performing Organization Report No.
9. Performing Organization Name and Address Information Systems & Networks Corporation 5454 Wisconsin Ave., Suite 920 Chevy Chase, MD 20815	10. Work Unit No.
	11. Contract or Grant No. NAS5-26624
12. Sponsoring Agency Name and Address C. Scaffidi, Code 503 Goddard Space Flight Center Greenbelt, MD 20771	13. Type of Report and Period Covered Final Report
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The Space Telescope Observatory Management System (STOMS) consists of the Payload Operations Control Center and the Data Capture Facility, both unique Space Telescope facilities provided under several contracts. This report encompasses the preliminary plan for STOMS Test and Verification (TAV) as developed by ISN in conjunction with NASA Code 500. The plan includes methodology, test scenarios, test plans and procedures formats, schedules and the TAV organization. Considerable supportive information is provided in the appendices.

17. Key Words (Selected by Author(s))	18. Distribution Statement
STOMS, SPACE TELESCOPE, TEST, VERIFICATION SIMULATION	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
None	None		

*For sale by the National Technical Information Service, Springfield, Virginia 22161

GSFC 25-44 (10/77)

PREFACE

This document represents a preliminary plan for the Space Telescope Observatory Management System (STOMS) Test and Verification (TAV). The objective of this effort is to provide a working model to be used by the TAV contractor in performing test and verification activity.

The scope of this document includes a definition of all the STOMS elements including organizations, support resources, interfaces and test tools. The methodology, including test conditions and scenarios, has been developed; outlines for test plans and procedures have been provided; and, a procedure for failure reporting and corrective action has been recommended. A test organization including detailed definitions of responsibilities summarizes the test plan.

A very preliminary schedule for the TAV has been developed being cognizant of the other test and simulation activities occurring in the same period and competing for support resources. The entire TAV plan has been developed with full awareness of other testing activities in order to reduce conflicts and to maintain continuity.

The appendices contain supportive information including a number of matrices showing the relationship between the various support elements and the functional requirements, descriptions of test systems, descriptions of test events and Controlled Test Data Set examples.

This document is a recommended TAV plan developed by ISN in conjunction with NASA Code 500. No specific points have been singled out as being a recommended approach over an alternative.

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During the course of this study some data was found to be not available or in conflict with previously published data. When data was missing the term TBD (To Be Determined) has been used in the test. If availalble data conflicted, the term TBR (To Be Resolved) has been used.

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ACRONYMS

AP	Actuator Control Subsystem
A&V	Assembly and Verification
BER	Bit Error Rate
CR	Command Request
CSC	Computer Sciences Corporation
CTA	Computer Technology Associates
CTDS	Controlled Test Data Sets
CTV	Compatability Test Van
DCF	Data Capture Facility
DDCMP	Digital Data Communication Message Protocol
FACC	Ford Aerospace and Communication Corporation
FGS	Fine Guidance Sensors
GCM	Ground Control Messages
GCMR	Ground Configuration Message Request
GSFC	Goddard Space Flight Center
GSSS	Guide Star Selection Software
GSTDN	Ground Spaceflight Tracking and Data Network
I&T	Integration and Testing
ICD	Interface Control Documents
IIRV	Improved Interchange Vector
JHU	Johns Hopkins University
LMSC	Lockheed Missile and Space Company, Inc.
LTU	Line Test Unit
MD&O	Mission and Data Operations Directorate
MOC	Missions Operation Contractor
MOGS	Mission Operation Ground System
MPT	Mission Planning Terminal
MSFC	Marshall Space Flight Center
NASA	National Aeronautical and Space Administration
NASCOM	NASA Communications Network
NCC	Network Control Center
NGT	NASA Ground Terminal
NGT-NASCOM	NASA Ground Terminal - NASA Communications Network

OBC	On-Board Computer
OD	Operation Directive
ODM	Operations Data Message
OFLS	Off-Line System
ONLS	On-Line System
OP	Operation Procedures
OSCF	Operation Support Computing Facility
PASS	POCC Application Software System
POCC	Payload Operations Control Center
PORTS	Preliminary Operation Requirements and Test Supports
PSAT	Predicted Site Acquisition Table
RS	Reed-Solomon
RSC	Resource Scheduling Chart
ScI	Science Institute
SI	Scientific Instrument
SIRD	Support Instrumentation Requirements Document
SOGS	Science Operations Ground System
SPC	Stored Program Commands
SSC	Science Support Center
SSM	Support System Module
ST	Space Telescope
ST ScIF	ST Science Institute Facility
STOCC	Space Telescope Operations Control Center
STOMS	Space Telescope Observatory Management System
TAC	Telemetry and Command
TAV	Test and Verification
TBD	To Be Determined
TBR	To Be Resolved
TDRSS	Tracking Data Relay Satellite System
VAP	Verification and Acceptance Program
VIP	Virtual Interface Processor

SECTION 1

INTRODUCTION

The Space Telescope (ST) Mission Operations Ground System (MOGS) is comprised of two major systems that will provide full ground support and data processing. These systems, the ST Observatory Management System (STOMS) and the Science Operations Ground System (SOGS), are comprised of a number of interconnecting facilities. To ensure that the MOGS will function smoothly, the STOMS and SOGS and their related elements and interfaces must be carefully integrated and tested. The MOGS Integration and Test (I&T) will encompass all I&T activities associated with combining the major ST ground system elements into the MOGS and with verifying MOGS operation.

This document pertains only to the STOMS Test and Verification (TAV) which will be performed prior to the MOGS I&T and will consist of testing and validating all of the STOMS facilities and their interfaces. The SOGS will undergo similar tests and validation followed by integration of STOMS and SOGS into the MOGS. To insure the STOMS TAV planning responds fully to the overall MOGS requirement, Section 2 provides an overview of the entire ST Ground System with special emphasis on the STOMS TAV and interfaces. Section 3 describes the STOMS TAV Methodology including test conditions and scenarios. The data transmitted across each of the STOMS interfaces are categorized in Section 4. For each data category, detailed descriptions of the individual data sets are also provided. Section 5 specifies the functional requirements of the individual interfaces which must be tested during the STOMS TAV. Section 6 identifies and describes the support elements for TAV. The interrelated testing activities for STOMS implementation are presented in Section 7 with an associated test schedule. Section 8 describes failure reporting and correction procedures appropriate for STOMS TAV. Section 9 identifies the format and content requirements for individual test plans and procedures to be furnished by the individual contractors/projects. Section 10 describes the test organization and responsibilities of the test personnel, configuration control procedures to be followed, and test evaluation activities. Documents used in the development of this plan are described in the Bibliography.

SECTION 2

OVERVIEW

The ST is a large, versatile, high resolution telescope with a complement of five scientific instruments including two cameras, two spectrographs, and a photometer. The extremely accurate and stable attitude control system which will point the ST will also be employed for making precise astrometric measurements. Operation of the ST in the absence of the atmosphere will allow observations in the visible region of the spectrum to be made at the full resolution of the telescope. In addition, the absence of atmosphere will permit observations to be made at wave lengths inaccessible to terrestrial observatories. The ST will be operated as an orbiting astromonical facility and will provide observational capabilities which greatly exceed those of any existing or planned ground based telescopes.

Due for launch in 1985, the ST will be inserted into a nominal 500 km altitude and 28.5 degree inclination orbit by a Space Shuttle launched from Kennedy Space Center. This will be the first free flying payload for the Space Shuttle and will be revisited by the Shuttle and be provided with on-orbit maintenance by astronauts. Spacecraft subsystem components and complete science instruments can be replaced during orbital maintenance. The ST will be retrieved periodically by the Space Shuttle and returned to the ground for major servicing, instrument updating, and telescope refurbishment. The operational life of the ST is at least 15 years.

The NASA Space Telescope ranks as one of the largest space programs undertaken by the U.S. It will be operated in a manner very similar to the world's major ground-based observatories, but will be capable of observing celestial bodies which are 50 times fainter and 7 times more distant than those visible to earth-based telescopes, possibly seeing as far as 14 billion light years.

2.1 ST GROUND SYSTEM

The ST will be controlled by the space telescope ground system shown in Figure 2-1. The various elements of this ground system, the functions performed by each element, related terminology and contractors are described in the following paragraphs.

2.1.1 STOMS. The STOMS consists of the Payload Operations Control Center (POCC) and the Data Capture Facility (DCF), both unique ST facilities provided under several contracts. The POCC will be located at the GSFC, and will direct, control, and monitor all spacecraft scheduling and operations. The DCF, also located GSFC, will record (capture) science data for retransmission to the SOGS.

The POCC is being developed under two separate contracts: Preliminary Operations Requirements and Test Support (PORTS) contract and the POCC Applications Software System (PASS) contract. The PORTS contract will provide for the complete hardware and systems level software implementation of the POCC, for execution of the mission control functions, including both an on-line command and control system and an off-line support computing system. The PASS

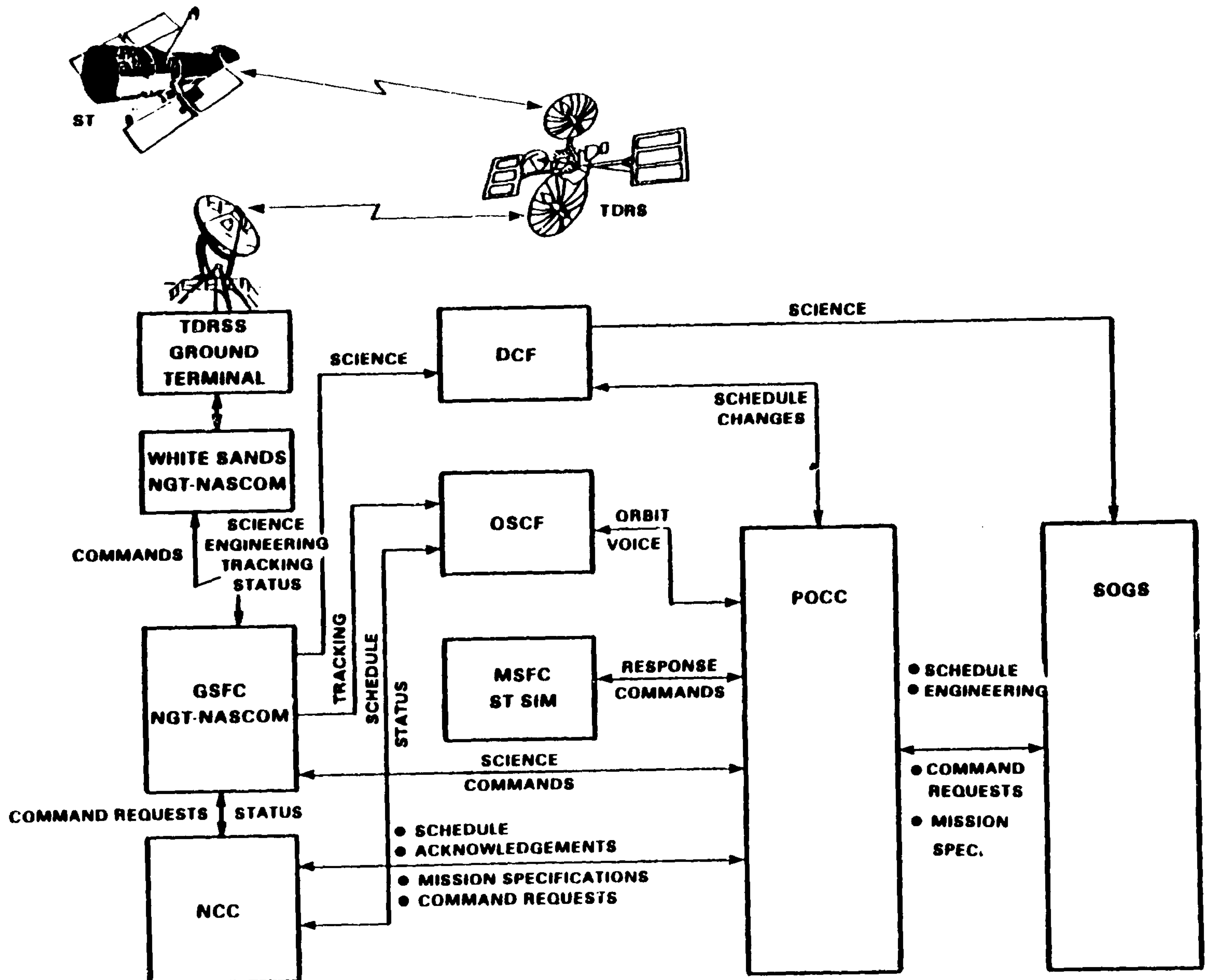

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FIGURE 2-1 SPACE TELESCOPE GROUND SYSTEM OVERVIEW

contract will contribute to support of the mission control function and provide the additional software necessary to provide the sub-functions of attitude determination, command management, subsystem management, target pointing support, and mission scheduling.

The various NASA institutional facilities included in the STOMS will provide the communications capability required for uplinking commands and receiving downlinked data, capture downlinked science data, and provide certain computational support for ST operations. These NASA facilities interfacing with the STOMS are the Network Control Center (NCC), the NASA Ground Terminal - NASA Communications Network (NGT-NASCOM), the Tracking Data Relay Satellite System (TDRSS), the Operations Support Computing Facility (OSCF) and the dedicated Marshall Space Flight Center (MSFC) supplied ST simulator.

2.1.2 SOGS. The SOGS is comprised of the Science Support Center (SSC), co-located with the POCC at the GSFC, and the hardware and software located at the ST Science Institute Facility (ST ScIF) at Johns Hopkins University. The combined SSC and ST ScIF hardware and software specified above will be developed under the SOGS contract. (The Guide Star Selection System (GSSS) and science data analysis software is an exception to this and will be developed under a separate contract.)

The SSC will perform detailed science scheduling, manage the transfer of real-time and near real-time data between the SSC and the ST ScIF, support the POCC in system anomaly investigation, and conduct limited real-time science operations. The ST ScIF will conduct the program to support scientific observations, including the selection of scientific programs, observation planning, science data analysis, and product generations.

2.1.3 Related Terminology. Some of the terms used in the ST project are further defined in the following paragraphs.

The construction of the building at Johns Hopkins University, Baltimore, housing the ST Science Institute (i.e., the ST ScIF), the development of the GSSS hardware and software, the development of the science data analysis software and the operation of the SOGS will be accomplished under the ST Science Institute (ST ScI) contract.

The ST ScIF hardware and software procurred under the SOGS contract, in combination with GSSS hardware and software, and the science data analysis software procurred under the the Science Institute contract are collectively referred to as the ST ScIF.

The combination of the POCC and the SSC is collectively referred to as the Space Telescope Operations Control Center (STOCC).

Figure 2-2 supports Figure 2-1 in defining these interrelationships of the MOGS elements.

2.1.4 <u>ST Ground System Contractors.</u> The contactors involved with the STOMS and SOGS are the Support System Module (SSM) contractor, Lockheed Missile and Space Company, Inc. (LMSC); the PORTS contractor, Ford Aerospace and Communications Corporation (FACC); the PASS contractor, Computer Sciences Corporation (CSC); the Mission Operations Contractor (MOC); LMSC; the ST ScI contractor, John Hopkins University (JHU); and the SOGS contractor, TRW Inc. The primary hardware and software development contractors for the STOMS are SSM, PORTS, and PASS. The SOGS contractor has responsibility for the SSC and ST ScIF systems interfacing to the STOMS. The MOC and the Mission and Data Operations Directorate (MD&O) personnel share operational responsibility for the POCC with the MOC having primary responsibility for ST flight operations.

The Networks Directorate has operational responsibility for the NCC and NGT-NASCOM. The development and operational responsibility for the ST Simulator is part of the Project Management (MSFC) responsibility. The ST ScI contractor will operate the SCC and ST ScIF interfacing the STOMS.

Institutional Support (NASA)

- o TDRSS
- o NGT-NASCOM
- o Network Control Center (NCC)
- o Operations Support Computing Facility (OSCF)

Space Telescope Observation Management System (STOMS)

- o Data Capture Facility (DCF)

Space Telescope Operations Control Center (STOCC)

- o Payload Operations Control Center (POCC)
  - Preliminary Operations Requirements and Test Support (PORTS)
  - Applications Software Support (PASS)
- o Science Support Center (SSC)

Science Institute Facility (ST ScIF)

Science Operations Ground System (SOGS)

- o Science Institute Facility (ST ScIF)
  - Operational Support System (OSS)
  - Post Operations Data Processing System (PODPS)
  - Science Planning and Scheduling System (SPSS)

Science Institute (ScI)

- o Space Institute Facility
  - Guide Star Selection System (GSSS)
  - Science Data Analysis Software

FIGURE 2-2 ELEMENTS OF ST MISSION OPERATIONS GROUND SYSTEM (MOGS)

2.2 STOMS TEST AND VERIFICATION (TAV)

The functional requirements to be met under the TAV are not only those imposed for each system element within STOMS, but also the requirement that these elements, when combined, function as a total system. The major element interfaces to be tested under the TAV event, are the POCC, DCF, NGT-NASCOM, NCC, OSCF, and the MFSC ST Simulator. Under the implementation effort, the POCC functional requirements are tested during the PORTS and PASS integration and test events. The DCF, MFSC ST Simulator and ST functional requirements are also tested under their specific integration and test events or, in the case of ST itself, during ST Assembly and Verification (A&V) at LMSC.

The NASA institutional elements, i.e., TDRSS, NGT-NASCOM, NCC and the OSCF are multimission support facilities and will have been tested as individual elements and exercised considerably by similar satellite projects prior to the TAV. However, these elements will be tested for ST unique functions during the TAV of other elements within the STOMS.

The functional requirements for the SOGS elements will be tested as part of the SOGS contract. STOMS TAV will concern itself with interface TAV as described in sub-section 2.2.2 of this section.

The STOMS TAV is part of the ST implementation effort and encompasses all activities associated with combining the major elements into the STOMS and with verifying STOMS operation. The TAV activities will be conducted in three phases. Phase I will consist of sequentially testing the interfacing hardware and software and verifying that the specific interface being tested complies with the related Interface Control Document (ICD). The use of both real and simulated Scientific Instrument (SI) data, spacecraft data, commands schedules and Controlled Test Data Sets (CTDS) will be required.

Phase II will be a systems engineering test to verify the various command, data and engineering strings as well as support functions. This will be a total test including verification of system reaction to anamolies. CTDS will include predefined error inducing data.

Phase III will be a mission oriented system performance test to verify full computer loading and timelines. All STOMS elements and interfaces will be exercised in a near normal operational environment. The ability of the STOMS to respond to element and sub-element failures will also be tested during this phase. Refer to Figure 2-3, STOMS Development and Implementation, as an illustration of the relationship between the TAV phases and other portions of the STOMS implementation. Although the TAV contractor Computer Technology Associates (CTA) will have full responsibility for the three phases of the TAV, the contractor will also be involved in the pre- and post-TAV activities. The contractor will be represented in the element testing and the establishment of CTDSs. The contractor will identify all CTDSs required and develop those not provided. The TAV contractor will also be representative in post-TAV which would include STOMS operational evaluation and the MOGS I&T.

SPACE TELESCOPE OBSERVATORY MANAGEMENT SYSTEM

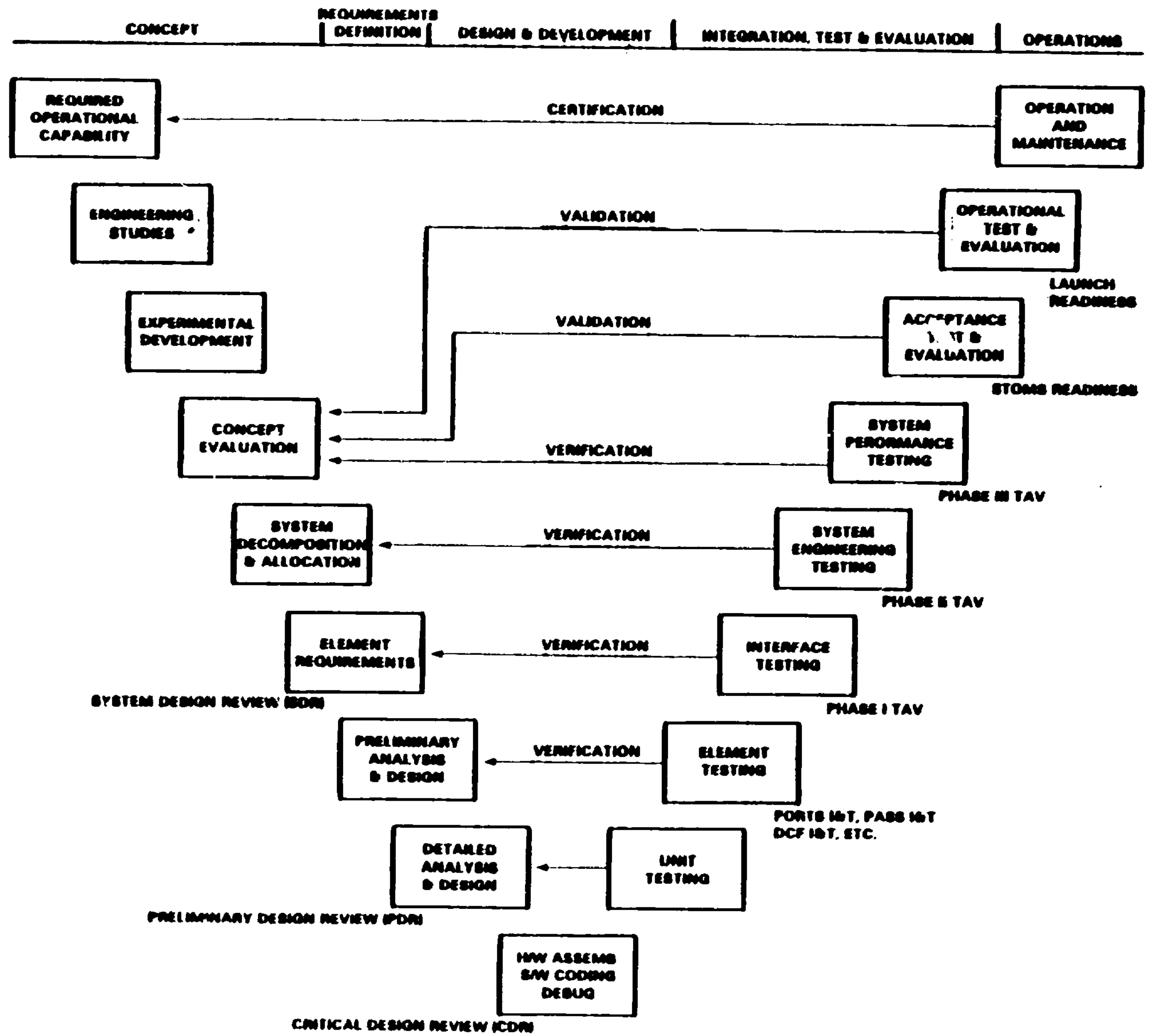

FIGURE 2-3. STOMS DEVELOPMENT AND IMPLEMENTATION PLAN

2.2.1 <u>STOMS Internal Interface TAV.</u> The data flows between the STOMS system elements are shown in Figure 2-4. As previously indicated, the STOMS TAV will be preceded by an extensive series of tests performed at the element level. The hardware and software provided under the PORTS contract and the software provided under the PASS contract will be separately integrated and tested by the respective contractors. The DCF and other institutional facilities which are a part of the STOMS, will undergo functional testing by the GSFC.

Other tests such as the Verification and Acceptance Program (VAP) and the A&V at LSMC, developed and to be exercised for specific purposes, will perform a secondary function of testing some interfaces. These tests are not part of the TAV; however, data developed during these tests could be used as TAV CTDS (TBD).

The test requirements, plans, and procedures for each interface test will be prepared by the same organization that has developed and maintained the related ICD. The PORTS contractor will develop and maintain the ICDs between the DCF and the On-Line System (ONLS), between the MSFC Simulator and the POCC ONLS, between NGT-NASCOM and the ONLS, between the SSC and the ONLS, between the NCC and the ONLS and between external telemetry users and the ONLS. The PORTS contractor will also develop and maintain the ICD between the SCC and the Off-Line System (OFLS). The PASS contractor will develop and maintain the ICDs between the SSC and the POCC, between the Mission Planning Terminal (MPT) and

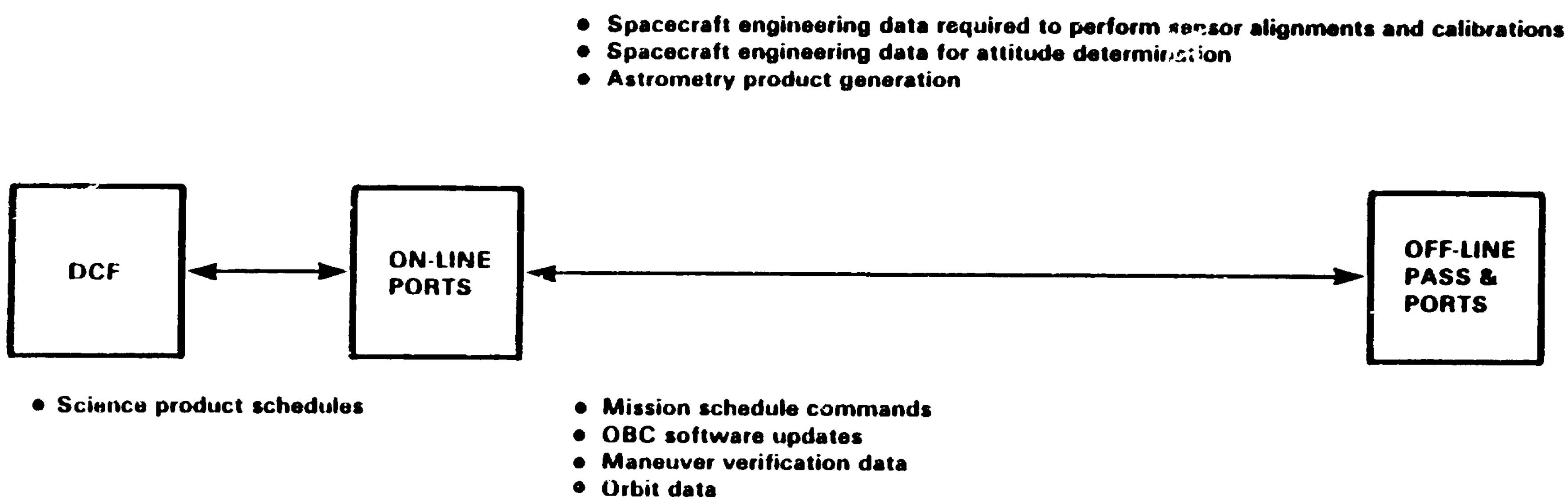

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FIGURE 2-4. STOMS INTERNAL INTERFACES

the OFLS, between the OSCF and the OFLS, and between the NCC and the MPT.

The character of the data transmitted across each of the interfaces involved is specified in detail in Sections 4 and 5.

2.2.2 <u>STOMS External Interface TAV.</u> Another function of the TAV is to test the interfaces external to the STOMS (Figure 2-5). The first STOMS external interface is between the DCF and the ST ScIF. All captured SI science data are transmitted across this interface from the DCF via NASCOM to the ST ScIF Post Observation Data Processing System. In the second STOMS external interface, SI engineering data are transmitted to the associate contractor from the POCC. The third STOMS external interface is with the SSC, and is comprised of two sub-interfaces: the SSC to POCC-ONLS interface and the science scheduling subsystem to POCC-OFLS interface. Four categories of data are transmitted over the SSC/ONLS interface: (1) data from at least 20 percent of all science observations transmitted from the ONLS to the SSC, (2) engineering data sets transmitted to the SSC, (3) real-time command requests transmitted by the SSC and (4) voice and video from the ONLS and the SSC. Four categories of data are transmitted over the SSC/OFLS interface: (1) program command requests to the OFLS, (2) iterative, two-way transmission of science mission specifications, (3) ephemeris data transmitted from the OFLS, and (4) spacecraft operations data transmitted from the OFLS.

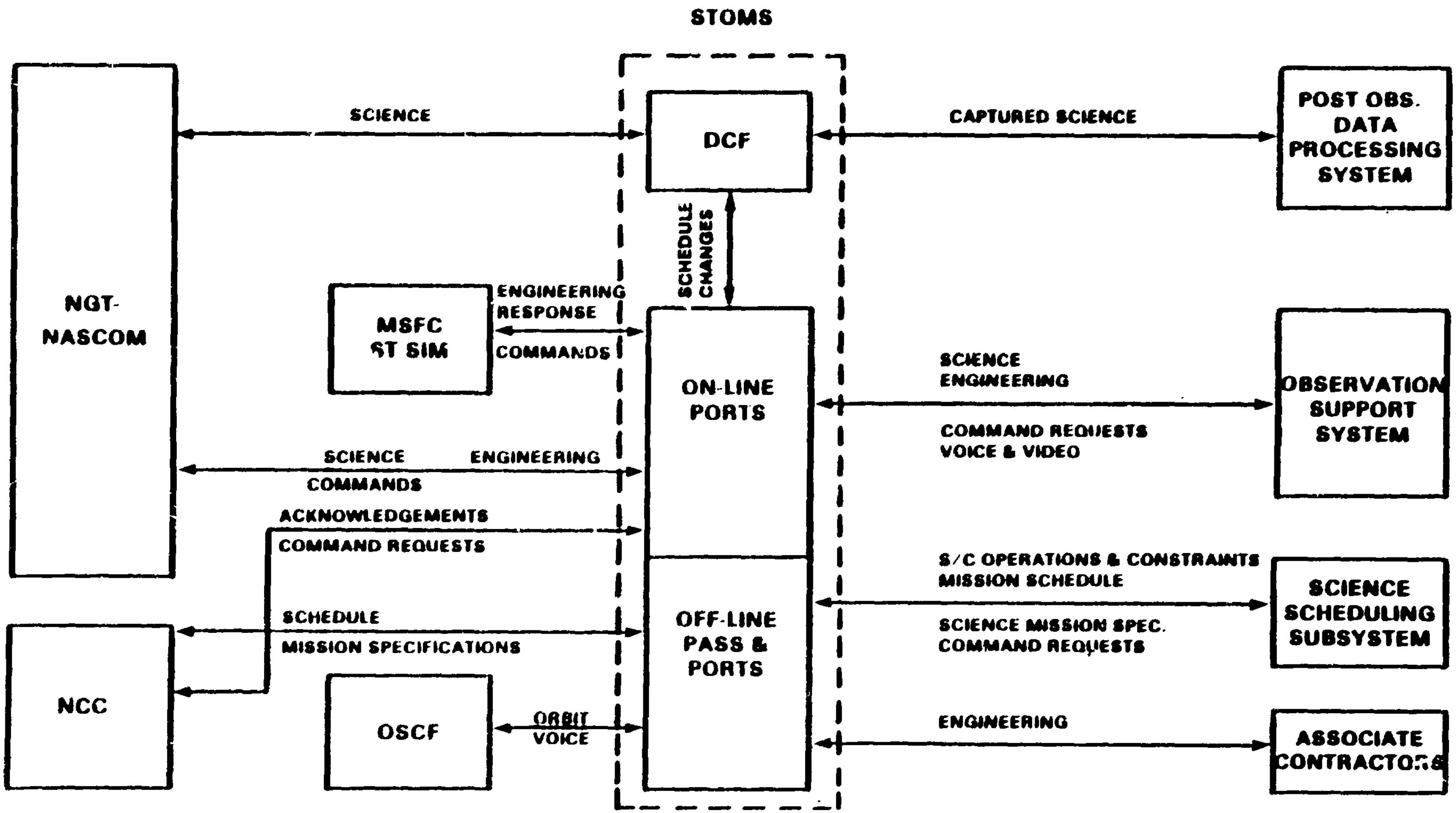

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FIGURE 2-5. STOMS EXTERNAL INTERFACES

More detail on the character of these data as well as the data between the NASA facilities and STOMS, is presented in Section 4 and 5.

SECTION 3

METHODOLOGY

The STOMS TAV methodology is a planned approach to testing the major elements comprising the STOMS, and performing such tests as are required to verify that the operation of the total systems satisfies all established requirements. Each of the major elements will be tested prior to the STOMS TAV.

The STOMS TAV activities will be performed in three phases. The interface hardware and software will be tested during Phase I. Phase II will consist of testing the various command, data, and engineering strings until a total test is completed. Phase III will be mission oriented and be a total system performance test. Testing in all three phases will verify compliance of the interfaces and elements to the applicable requirements documentation, specification, or ICD. Compliance verification is crucial to successful test plan development. This approach insures compliance through traceability from controlled document requirements to test procedure requirements. Figure 3-1, STOMS Requirements/Test Procedure Interrelationship, indicates how the STOMS requirements will be traceable to a test procedure.

3.1 PRE-TAV ACTIVITY

The TAV contractor will be represented in element testing prior to the actual TAV phases. This prephase activity will be of a TAV preparatory nature to ensure continuity between integration, testing and verification. The establishment of CTDS at this point will ensure the validity of test input data during TAV. Completion of TAV test execution procedures would also occur at this time.

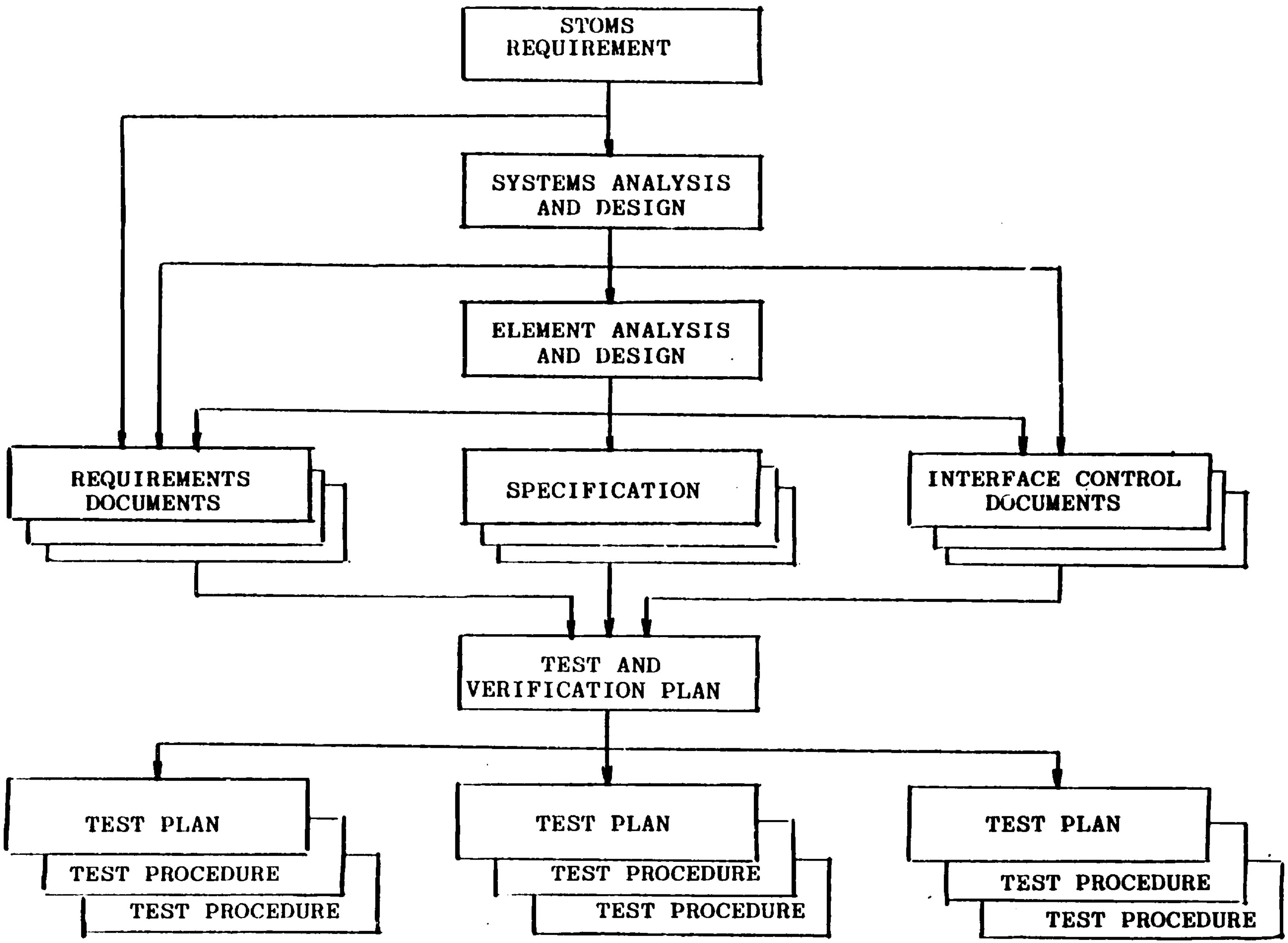

FIGURE 3-1 STOMS REQUIREMENTS/TEST PROCEDURE INTERRELATIONSHIP

3.2 TAV PHASE I, INTERFACE TEST

The internal and external interfaces of the STOMS were shown in Figures 2-4 and 2-5, respectively. During Phase I, compatibility across each individual interface will be verified by means of separate tests of the commands, data and acknowledgements specified for each interface. These tests will often require the use of CTDS, testing software, and hardware test units to simulate portions of ground system elements which may not be available.

As an example of the methodology of separately testing the individual STOMS interfaces, the NGT-NASCOM to POCC interface will be described. There will be a discrete channel for the spacecraft commands and for the telemetry stream. On the return channel, the data transfer will be non-contiguous burst-block transfer. The correct blocking, format, mode/flag/indicator setting, and bit error-rate (BER) will all be measured in the POCC and compared to the specifications. Command data originating at the POCC will be checked to verify format as well as correct block and bit transfer rate. Where possible multiple operational configurations will be simulated to provide a more comprehensive test.

3.3 TAV PHASE II, SYSTEM ENGINEERING TEST

Phase II will comprise a number of tests each designed to ensure the desired end product as well as to verify all elements and interfaces involved with the generation of that end product. As an example, the ST command function would involve a string of elements and their interfaces, from the SSC to the ST. Other strings would include science data flow, ST engineering data, SI engineering data, scheduling data, and support data. Each of these strings would include subsets, each tested in the same fashion. All data or commands will be traceable from origin to final termination through as many elements as possible.

The tests conducted during Phase II will include a comprehensive set of test cases and conditions intended to expose system, hardware, and software limitations. As an example, data with marginal signal levels would test the system's capability to recognize data errors and to recover properly.

The systems engineering attributes of reliability and maintainability will be determined and recorded during Phase II in conjunction with each test established.

3.4 TAV PHASE III, SYSTEM PERFORMANCE TEST

Tests will be performed during Phase III using all of the major STOMS elements with the objective of exercising and verifying the operation of the total STOMS. This phase will include testing across multiple interfaces and will involve the use of simulated data and CTDS. Tests will be comprehensive and will exercise as many hardware components and program statements as practicable. Timelines will be verified against mission requirements and under full load conditions.

Phase III is mission oriented with emphasis on exercising the total system in a closely simulated real time environment.

3.5 POST-TAV ACTIVITY

After completion of the TAV, the TAV contractor will assume a supportive role in the subsequent STOMS test and simulation events. These events include mission operations procedure development, MOGS I&T, training and simulation.

3.6 TEST CONDITIONS

The three phases of STOMS testing, in addition to the planning and execution of the required tests, must necessarily include the evaluation of test results, with such evaluation essentially required in real-time. The evaluation of test results will entail a comparison of the results actually obtained in a particular test with the anticipated results described in the test plan. The immediate detection of anomalous test results will enable any necessary regression testing to be performed, prior to a test configuration being torn down. Input data (e.g., magnetic tapes of simulated SI data) will be evaluated in terms of its usability (e.g., format, content, fidelity, and completeness) prior to their utilization for test purposes. This, along with control of the test data sets, will be a primary function of the TAV contractor.

3.7 TEST SCENARIOS

Test scenarios for Phase I and Phase II have been developed and are depicted in Tables 3-1 and 3-2. The Phase I scenario indicates a possible sequential order for verification of the STOMS interfaces. This sequence begins with supportive data being transmitted to the POCC and DCF, prior to the interface between the POCC and DCF being tested.

TABLE 3-1

Test 1. POCC-to-NCC

- o Schedule requests from the POCC.
- o Ground control messages requests from the POCC.
- o Acknowledgements by the NCC of data flow receipt.
- o Performance data transmittal to the POCC.

Test 2. POCC-to-MSFC/ST SIMULATOR

- o POCC commands to the MSFC ST Simulator.
- o Receipt of simulated engineering data from the MSFC ST Simulator.

Test 3. POCC-to-OSCF

- o ST orbit data to the POCC.
- o TDRSS orbit data to the POCC.
- o Major planet orbit data to the POCC.
- o Solar data to the POCC.
- o Lunar orbit data to the POCC.

Test 4. POCC-to-DCF

- o Science product schedules from the POCC.

Test 5. POCC-to-ASSOCIATED CONTRACTORS

- o ST engineering data to LMSC, IBM, etc.
- o SI engineering data to Perkin Elmer, IBM, etc.

Test 6. TDRSS-to-DCF

- o Science tape recorder playback.
- o Real-time science.
- o NSSC-1 dumps.
- o Status buffer readouts.
- o SI microprocessor dumps.

Test 7. DCF-toScIF

- o Transmission of captured science data to ST ScIF.
- o Transmission acknowledgement from ST ScIF.

Test 8. POCC-to-TDRSS

- o Science data.
- o Engineering data.
- o On-Board Computer (OBC) dumps.
- o St commands to TDRSS.

Test 9. PASS-to-PORTS

- o Spacecraft engineering data required to perform sensor alignments and calibrations from PORTS.
- o Spacecraft engineering data for attitude determination from PORTS.
- o Astrometry product generation from PORTS.
- o Mission schedule commands from PASS.
- o OBC software updates from PASS.
- o Maneuver verification data from PASS.
- o Orbit data from PASS.

Test 10. POCC-to-SSC

- o Operations and constraints data to the SSC.
- o POCC receipt of science mission specification from the SSC.
- o POCC transmission of mission schedule parameters and timelines to the SSC.
- o POCC transmission of science (including astrometry) and SI and SI C&DH engineering data to the SSC.
- o Receipt of command requests from the SSC.
- o ST status display to the SSC.

TABLE 3-2. PHASE II SYSTEMS ENGINEERING TEST SCENARIO

Test A. SCHEDULING

1. ST operations and constraint data are transmitted to Science Planning and Scheduling System in the SSC from the POCC-OFLS.
2. Science mission specifications data are transmitted to POCC-OFLS.
3. POCC and NCC resolve the TDRSS Schedule.
4. ST mission schedule is provided to the SSC from the POCC.
5. POCC sends mission schedule to the NCC.
6. NCC transmits the schedule to NASCOM, TDRSS and OSCF.
7. POCC transmits a product schedule to the DCF.

Test B. STORED PROGRAM COMMAND (SPC) LOADS

1. Stored Program Command (SPC) Loads are uplinked from the POCC to ST via TDRSS.
2. SPC loads are acknowledged from ST to POCC.
3. SPC loads are uplinked to MSFC Simulator.
4. SPC loads are acknowledged from MSCF Simulator to POCC.

Test C. COMMAND REQUESTS

1. Command requests from the SSC are transmitted to the POCC.
2. Command requests transmitted from the POCC to the ST via TDRSS.
3. Command requests acknowledged from the ST to the POCC via TDRSS.

4. Command requests transmitted from the POCC to the MSFC Simulator.
5. Command requests acknowledged from the MSFC Simulator to the POCC.

Test D. <u>SI ENGINEERING DATA</u>

1. SI Engineering data are transmitted from the ST via TDRSS to the POCC.
2. SI Engineering data are transmitted from the POCC to the SSC.
3. SI Engineering data are transmitted from ST via TDRSS to DCF. (TBR)
4. SI Engineering data transmitted from the MSFC Simulator to the POCC.

Test E. <u>ST ENGINEERING DATA</u>

1. ST Engineering data transmitted from the ST via TDRSS to the POCC.
2. ST Engineering data transmitted from the POCC to the SSC.
3. ST Engineering data transmitted from the MSFC Simulator to the POCC.

Test F. <u>SCIENCE DATA</u>

1. Science data are transmitted from the ST via TDRSS to the DCF.
2. Science data are transmitted from the ST via TDRSS to the POCC.
3. Science data are transmitted from the POCC to the SSC.
4. Recorded science data are transmitted from the MSFC Simulator within the POCC to the DCF.

5. Recorded data are transmitted from the MSFC Simulator within the POCC to the POCC.
6. Science data are transmitted from the DCF to the ST ScIF.

Thereafter other elements would be interfaced and tested within and to the STOMS in a modular fashion. When all internal interfaces are tested, then the external interfaces to the SOGS would be tested. Some SOGS elements may not be completed in time to conduct all STOMS/SOGS interface tests. The TAV contractor will develop the necessary drivers to complete the interface tests.

The test scenario for Phase II indicates the dependence on testing a string of data or commands beginning at the origin. The scenario illustrated begins with the scheduling of the science mission from the SOGS, then commanding the ST, next monitoring the ST, and ends with the transmittal of science data to the SOGS for processing.

A Phase III scenario would be a full operational simulation as described in detail in other documentation.

SECTION 4

INTERFACES

The specifications regarding each interface between major elements of the STOMS will be controlled by an appropriate ICD. In the case of the hardware and software within the POCC, this interface will also be controlled through ICDs as they relate to the PORTS and PASS contractors. The responsibility for the development of each ICD will be assigned to a specific contractor of GSFC organization. In addition to the internal interfaces within STOMS, there are external interfaces to the SOGS and NASA institutional facilities.

As indicated in Section 3, Methodology, the primary objective of the SOGS TAV is to verify the interface compatibility, both physically and operationally. Table 4-1 presents a summary of the STOMS interfaces to be verified during TAV. The data categories and characteristics are also summarized. As noted on the Table, a number of ICDs are currently unavailable. Appendix I contains a list of the current applicable ICDs.

TABLE 4-1. STOCS TAV INTERFACE SUMMARY

ELEMENT INTERFACE	INTERFACE REQUIREMENT	DATA CHARACTERISTICS	COMMUNICATION MEDIUM	ICD NUMBER	ICD RESP CNTR.	REQUIREMENTS DOCUMENT NUMBER	REQUIREMENTS DOCUMENT NASA CODE	STDN CKT NO.*
PASS - PORTS	• ST Engineering from PORTS • Sensor calibrations • Attitude • Astrometry from PORTS • Mission schedule CMD from PASS • OBC software updates from PASS • Maneuver verification from PASS • Orbit data from PASS	PASS/PORTS Hardware/Software dependent	PASS/PORTS hardware/ software interfaces	TBD	FACC/CSC			
POCC - NCC	• TDRSS schedule	56 Kbps, fixed format and content, NASCOM 4800-bit blocks, RT on-line and off-line (MPT)	56 Kbps NASCOM, full duplex serial and RS-422 (MPT)	TBD	PORTS	FACC-SH3800		13,14
	• LLMS	Same	Same	Same	Same	Same		
	• Ground Control Message Request from POCC	Same	Same	Same	Same	Same		13, 14
	• NCC Acknowledge data Receipt	Same	Same	Same	Same	Same		13, 14
	• Performance data to POCC	Same	56 Kbps NASCOM full duplex, serial	Same	Same	Same		13
POCC - MSFC	• ST Commands	.125 or 1.0 Kbps, NASCOM 4800-bit blocks	56 Kbps NASCOM Simplex, serial	ST-ICD-28	MSFC	FACC-SH3800		10.1 10
	• Simulated Engineering Data	.5, 4, 32 Kbps, NASCOM 4800-bit blocks	56 Kbps NASCOM, Simplex, serial	Same	Same	Same		
	• Control Data	56 Kbps	56 Kbps NASCOM, Full duplex DECNET compatible		Same	Same		26
POCC - OSCF	• ST, TDRSS, Planet, Lunar Orbit Data	56 Kbps, NASCOM format, RT	56 Kbps NASCOM, Full Duplex		PORTS	FACC-SH3800		23
	• Solar Data	Same	Same		Same	Same		23
POCC - UCF	• Science product schedules	56 Kbps, NASCOM format, non-RT	56 Kbps NASCOM, full duplex	TBD	PORTS	FACC-SH3800		25
	• Science Simulation (hi-rate)	1.024 Mbps, NASCOM 4800-bit blocks, SIM-RT	1.544 Mbps NASCOM full duplex SSA channel		Same	Same		27
	• Science Simulation (low-rate)	4 Kbps, NASCOM 4800-bit blocks, SIM RT	56 Kbps, NASCOM, full duplex, I channel		Same	Same		28

*Reference ST SIMD, pp 4100

TABLE 4-1. STOMS TAV INTERFACE SUMMARY (Continued)

ELEMENT INTERFACE	INTERFACE REQUIREMENT	DATA CHARACTERISTICS	COMMUNICATION MEDIUM	ICD NUMBER	ICD RESP CNTR.	REQUIREMENTS DOCUMENT NUMBER	REQUIREMENTS DOCUMENT NASA CODE	SIRD CKT NO.*
POCC - NGT-NASCOM	• Science Data (hi-rate)	1.024 Mbps, NASCOM 4800-bit blocks, RT, time division demand block multiplex	1.544 Mbps NASCOM, simplex, serial, SSA channel, RS-422		PORTS	FACC-SH3800		1
	• OBC dumps	Same as above	Same as above		Same	Same		1
	• Science Data (low-rate)	4 Kbps, NASCOM 4800-bit blocks, RT, time division demand block multiplex	56 Kbps NASCOM, simplex, serial, I channel, RS-422		Same	Same		2
	• Engineering Data	.5, 4, 32 Kbps, NASCOM 4800-bit blocks, RT, time division demand block multiplex	56 Kbps NASCOM, simplex, serial, I and Q channels, RS-422		Same	Same		2,3
	• ST Commands to TDRSS	.125 or 1.0 Kbps, NASCOM 4800-bit blocks, RT	56 Kbps NASCOM, simplex, serial		Same	Same		4
POCC - SSC	• Science link data to SSC	4 Kbps, 1.024 Mbps, NASCOM-like blocks (TBD), RT	1.544 Mbps Direct (DTS), simplex		PORTS	FACC-SH3800		7
	• OBC dumps to SSC	1.024 Mbps, NASCOM-like blocks (TBD), RT	Same as above		Same	Same		7
	• Science Engineering Data to SSC	1.0 Kbps, RT	56 Kbps, Direct (DTS), duplex, DMC-11 compatible	ST-ICD-12	Same	FACC-SH38		8
	• Astrometry to SSC	56 Kbps, RT	Same as above	Same	Same	Same		8
	• Command requests from SSC	56 Kbps, RT	Same as above	Same	Same	Same		8
	• Operations and Constraints to SSC	56 Kbps, non-RT	Same as Above	ST-ICD-12	SOGS	FACC-SH3800		9
	• Mission Schedule data to SSC	56 Kbps, non-RT	Same as Above	ST-ICD-11	Same	Same		9
	• ST Status Display to SSC	4 Kbps video, non-RT	Same as Above	ST-ICD-12	Same	Same		9
	• Science Mission Specifications from SSC	56 Kbps video, non-RT	Same as Above	ST-ICD-11	Same	Same		9
TDRSS - ST	• Science Data (hi-rate)	1.024 Mbps, NASCOM 4800-bit blocks, RT, time division demand block multiplex	1.544 Mbps NASCOM, simplex serial, SSA channel, RS-422	ST-ICD-06	LMSC			1
	• OBC dumps	Same as above	Same as above	Same	Same			1
	• Science Data (low-rate)	4 Kbps, NASCOM 4800-bit blocks, RT, time division demand block multiplex	56 Kbps NASCOM, simplex, serial, I channel, RS-422	Same	Same			2
	• Engineering Data	.5, 4, 32 Kbps, NASCOM 4800-bit blocks, RT, time division demand block multiplex	56 Kbps NASCOM, simplex, serial, I and Q channels, RS-422	Same	Same			2,3
	• ST Commands to TDRSS	.125 or 1.0 Kbps, NASCOM 4800-bit blocks, RT	56 Kbps NASCOM, simplex, serial	Same	Same			4

*Reference ST SIRD, pp 4100

TABLE 4-1. STDMS TAV INTERFACE SUMMARY (Continued)

ELEMENT INTERFACE	INTERFACE REQUIREMENT	DATA CHARACTERISTICS	COMMUNICATION MEDIUM	ICD NUMBER	ICD RESP CNTR.	REQUIREMENTS DOCUMENT NUMBER	REQUIREMENTS DOCUMENT NASA CODE	SIRD CKT NO.*
NGT - NASCOM - DCF	• Science data (hi-rate)	1.024 Mbps, NASCOM 4800-bit blocks, RT, time division demand block multiplex	1.544 Mbps NASCOM simplex, serial, SSA channel, RS-422	TBD	DCF			1
	• Science Tape Recorder playbacks	Same as Above	Same as Above	Same	Same			1
	• NSSC-I dumps	Same as Above	Same as Above	Same	Same			1
	• SI Microprocessor dumps (hi-rate)	Same as Above	Same as Above	Same	Same			1
	• Science data (low-rate)	4 Kbps, NASCOM 4800-bit blocks, RT, time division demand block multiplex	56 Kbps NASCOM, simplex, serial I channel, RS-422	Same	Same			2
	• Status Buffer Readouts	Same as Above		Same	Same			2
	• SI Microprocessor dumps (low-rate)	Same as Above		Same	Same			2
DCF - ScIF	• Captured Science Data	1.024 Mbps, 4 Kbps, TBD	1.54 Mbps NASCOM (switchable between DCF & SSC) Full duplex	ST-ICD-13	GSMO			5
POCC - Associated Contractors	• Telemetry subsets & command data	9600 bps, non-RT	9600 bps data phone, single modem dial-up		PORTS			12
NCC - OSCF	• Acquisition & Scheduling	56 Kbps, fixed format & content, NASCOM 4800-bit blocks, RT on-line & off-line (MPT)	Same as Below	ST-ICD-18	GSMO			24
NCC - NGT - NASCOM	• Resource Scheduling	56 Kbps, fixed format & content, NASCOM 4800-bit blocks, RT on-line & off-line (MPT)	56 Kbps NASCOM, full duplex, serial & RS-422 (MPT)	TBD	800 ND			13, 14
	• Performance Monitoring	56 Kbps (from POCC), .125 or 1.0 Kbps (TDRSS)	Same as Above plus 56 Kbps NASCOM, simplex serial	TBD	Same			13, 14
	• Performance Acquisition/Tracking	.125 or 1.0 Kbps, NASCOM 4800-bit blocks, RT	56 Kbps NASCOM, Simplex, serial	Same	Same			4
NCC - DCF	• TDRSS Schedule	56 Kbps, NASCOM format, RT	56 Kbps NASCOM Full duplex	TBD	GSMO			15
POCC - DATA CON	• Video	CCTV	Duplex Video, NASCOM					30
SPIF - DATA CON	• Video	CCTV	Simplex Video, NASCOM					32

*Reference ST SIRD, pp 4100

SECTION 5

FUNCTIONAL INTERFACE REQUIREMENTS

In the previous sections the major elements to be interfaced were defined. In this section the functional requirements for the interfaces of these elements are delineated. These requirements are not presented to the level of an ICD, but only to the level of better definition of the TAV event requirements.

5.1 POCC INTERFACE FUNCTIONAL REQUIREMENTS

The POCC interfaces directly with the SSC and the MPT, and through NGT-NASCOM to the OSCF, NCC, DCF, and MSFC ST Simulator. Only the SSC and NGT-NASCOM interfaces are presented here. The other interfaces are defined in their respective subsections.

5.1.1 POCC AND NGT-NASCOM INTERFACE

- o Receives three telemetry data streams simultaneously from the NGT-NASCOM. The three streams are:
  - o SSA channel (Hi-rate science, tape recorder NSSC-1 memory dumps),
  - o I channel real-time (RT) (Lo-rate science or engineering, DF 224 memory dump) and
  - o Q channel (RT) (Engineering DF 224 memory dump).
- o Transmits commands to the ST via the NGT-Nascom and TDRSS. The commands will be transmitted in 4800 bit blocks metered to be consistent with spacecraft command rates of 125 BPS or 1000 BPS.

5.1.2 POCC AND SSC INTERFACE

- Permits access by the SSC to the POCC mission planning and scheduling data base via scheduled transfers. The POCC will update this data base with current spacecraft and communication constraints and operational data for SSC;
- Receives science mission specifications from the SSC;
- Transmits mission schedule parameters and time lines from the POCC to the SSC;
- Transmits science (including astrometry), SI engineering data and SI C&DH engineering data from the POCC to the SSC;
- Receives SSC Command Requests (CRs). The CRs will be in a pre-described mnemonic format to change SI and astrometry Fine Guidance Sensor (FGS) parameters, making pointing correction and, where appropriate, to select among alternate preplanned paths in the observation sequence;
- Provides communications through control center lines, commercial telephone lines, and video lines between SSC and the POCC for effective control, liaison coordination, and data collection.

5.2 NCC INTERFACE FUNCTIONAL REQUIREMENTS

The NCC interfaces directly with the NGT-NASCOM, indirectly to the DCF, OSCF, and POCC through NGT-NASCOM and indirectly with the POCC through the MPT.

5.2.1 NCC AND POCC INTERFACE

- o Receives Ground Configuration Message Requests (GCMRs) from the POCC. These are requests to change the network or TDRSS ground support configuration;
- o Receives quality reports from the POCC;
- o Receives TDRSS service requirements via the MPT from the POCC;
- o Transmits TDRSS and network schedules via the MPT to the POCC;
- o Transmits TDRSS and network performance data to the POCC in the form of Operations Data Messages (ODMs);
- o Transmits and receives acknowledgement.

5.2.2 NCC AND NGT-NASCOM INTERFACE

- o Transmits GCMRs to TDRSS via NGT-NASCOM;
- o Receives TDRSS performance data from TDRSS via NGT-NASCOM;
- o Receives NGT-NASCOM performance data from NGT-NASCOM;
- o Provides system performance data to NGT-NASCOM.

5.2.3 NCC AND DCF INTERFACE

- o Transmits TDRSS schedules via TBR to the DCF.

5.2.4 NCC AND OSCF INTERFACE

- o Receives acquisition/scheduling data including Predicted Site Acquisition Tables (PSAT), Improved Interchange Vectors (IIRVs) and ephemerides from OSCF;

- o Transmits TDRSS schedules via the MPT to the OSCF;
- o Receives OSCF performance data from the OSCF.

5.3 NGT-NASCOM INTERFACE FUNCTIONAL REQUIREMENTS

The NGT-NASCOM interfaces directly with all of the STOMS elements and indirectly to the ST through the TDRSS Ground Terminal. All of these interfaces are described under their respective elements.

5.4 TDRSS INTERFACE FUNCTIONAL REQUIREMENTS

The TDRSS interfaces directly with the ST and the NGT-NASCOM. The NGT-NASCOM interface is presented here as well as a description of the Ground Spaceflight Tracking and Data Network (GSTDN) interface functional requirements.

5.4.1 <u>TDRSS AND NGT-NASCOM INTERFACE</u>

- o Receives GCMRs from the NGT-NASCOM;
- o Receives ST Command data from the NGT-NASCOM (See 5.1.2 POCC and NGT-NASCOM Interface);
- o Transmits Command data to the NGT-NASCOM (See 5.1.2 POCC and NGT-NASCOM Interface);
- o Transmits ST and TDRSS tracking data (Range and Doppler measurements) to the NGT-NASCOM;
- o Provide equipment status messages indicating the equipment availability and status, to the NGT-NASCOM;
- o Provide performance data indicating transmitter power, received signal strength, bit error rate estimates to the NGT-NASCOM.

5.4.2 GSTDN AND NGT-NASCOM INTERFACE

The GSTDN will be scheduled for contingency support in the event of a complete TDRSS outage. The GSTDN does not provide science data but does:

- o Provide ST tracking data for the OSCF;
- o Receive ST command data from the POCC and transmits to the ST;
- o Receive operational messages from the NGT-NASCOM;
- o Receive engineering/safe mode data tape recorder playback and SSM computer dump from the ST and transmit to the POCC and DCF.

5.5 DCF INTERFACE FUNCTIONAL REQUIREMENTS

- o Receives ST schedule from NCC;
- o Receives ST schedule change from the POCC;
- o Provides voice-grade phone lines for verbal coordination of data capture activities with the POCC;
- o Provides voice-grade phone lines with the ST Sci transmission requests and acknowledgement;
- o Receives real-time science data and science tape recorder playback data;
- o Provides a full duplex communication link with the ST Sci for transmission of captured science data.

5.6 OSCF INTERFACE FUNCTIONAL REQUIREMENTS

- o Receives ST and TDRSS tracking data from the NGT-NASCOM;
- o Provides ST, TDRSS, major planet, solar, and lunar orbit data to the POCC;

- o Provides acquisition scheduling data to the NCC;
- o Receives the ST and TDRSS schedule from the NCC via the MPT.

5.7 ST INTERFACE FUNCTIONAL REQUIREMENTS

- o Receives, via TDRS forward link, command sequences or individuals commands. The rate will be 125 bps for the short command sequence using MA or SSA service. Either rate could be used for either purpose.
- o Receives, via TDRS forward link, Stored Program Command loads. The rate will be 1000 bps using SSA service;
- o Transmits ST engineering, astrometry, and science data to TDRS on the MA and SSA channels at 4.0 or 32, 4.0 and 1024 K bps;
- o Transmits a coherent return PM code on the MA channel to TDRSS for ranging purposes.

5.8 MSFC ST SIMULATOR INTERFACE FUNCTIONAL REQUIREMENTS

The MSCF ST Simulator control and engineering portion will be resident in a host computer located at MSFC. The POCC will provide simulator support utilizing software provided by MSFC to supply the simulated science data stream from a POCC Applications Processor (AP). The MSFC ST Simulator interface requirements are:

- o Receive output command stream from the POCC;
- o Transmits the various engineering data streams applicable to the ST (including astrometry). These data streams will represent real-time simulation of specific subsystems residing within the ST;

- o Transmits data streams from POCC applications processor, in NGT-NASCOM format 4800-bit NASCOM blocks;
- o Simulates science and tape recorder data using predetermined information.

SECTION 6

SUPPORT ELEMENTS

In this section each of the support elements are identified to the level where they can be related to the functional interface requirements.

The support elements are categorized according to:

1. Systems and subsystems associated with each of the interface functional requirements;
2. Organizations supporting the development of test requirements, plans, procedures, tools and data bases;
3. Organizations supporting the test conduction, validation and reporting;
4. Test tools in the form of hardware, software and procedures; and
5. Controlled Test Data Sets.

These five categories of support elements are discussed in the following five subsections.

Matrices depicting the relationship between the support elements and the functional interface requirements are provided in the appendices.

Note that the interfaces and support elements are not limited to those elements within the STOMS but all elements directly and indirectly associated with STOMS TAV.

6.1 SUPPORT SYSTEMS AND SUBSYSTEMS

The systems associated with the STOMS interface functional requirements include the POCC, NCC, NGT-NASCOM, TDRSS, DCF, OSCF, ST, the MSFC ST Simulator, the SSC and ST ScIF. Each of these systems and subsystems have been described in previous sections and their interfaces summarized in Section 4, Interfaces.

The matrices depicting the system or subsystem required to support the test and verification of each individual interface functional requirement are presented in Appendix A. These matrices will be related to the Test Sequence and Schedules in Section 7, making them a useful planning tool in scheduling and in the development of test scenarios. As an example, a test of the POCC's requirement to receive TDRSS and Network schedules would be dependent upon availability of the POCC, MPT, NCC and the TDRSS as indicated on the matrix. These dates will be used to establish a test date, or window, for a test sequence.

6.2 TEST DEVELOPMENT ORGANIZATIONS

The test development organizations are those responsible for developing the requirements, plans, procedures, tools and data bases to test the individual interface functional requirement. These organizations include both the Government and the various ST contractors. The NASA organizations are: MD&O (Code 500); Flight Projects Directorate (Code 400); Networks Directorate (Code 800) and Project Managaement (MSFC). The NASA contractors are the SSM contractor, the PORTS contractor, and PASS contractor, the MOC contractor, the ScI contractor, and the SOGS contractor. The primary hardware and software development contractors for the STOMS are SSM, PORTS and PASS. The SOGS contractor has responsibility for the SSC and ST ScIF systems interfacing to the STOMS. The MOC and MD&O personnel share operational responsibility for the POCC with the MOC having primary responsibility for ST flight operations. The Networks Directorate has operational responsibility for the NCC and NGT-NASCOM. The development and operational responsibility for the ST Simulator is part of the MSFC responsibility. The ScI contractor will operate the SSC and ST ScIF interfacing the STOMS.

The matrices indicating the relationship between each interface functional requirement and the development organizations are presented in Appendix B. These organizations are responsible for test development and the support of test conduction as described in Section 10. If the organization is responsible for an ICD then this is also indicated. Organizations responsible for test conduction, validation and reporting are described in the next subsection.

6.3 TEST VALIDATION ORGANIZATIONS

The test validation organizations are those responsible for reviewing the test plans and procedures; conducting or monitoring the test performance; coordinating the resolution of problems; evaluating the test results; and, reporting on the results. These organizations include both the Government and various ST contractors as identified in Subsection 6.2, Test Development Organizations.

The primary organizations responsible for validation are the operational contractors and the designated NASA Code. In some cases, a development organization, which was not responsible for the development of the interface being tested, could perform as a validation organization. As an example, the PORTS contractor would perform test validation on PASS developed software to ensure compatability with the PORTS hardware and an operational POCC. As the emphasis changes from integration to validation, and then to training, the specific role of each contractor will change. The responsibilities of these organizations are described in Section 10. Matrices indicating the relationship between each interface functional requirement and the validation organization, are presented in Appendix C.

6.4 TEST/SIMULATION TOOLS

The test tools associated with the STOMS interface functional requirements include four hardware test systems, a TBD number of software test packages and seven test scenarios. The hardware test systems are:

- o MSFC ST Simulator;
- o POCC Line Test Unit (LTU);
- o NASA Compatability Test Van;
- o NCC Simulator.

The software test packages are the vendor supplied diagnostic and demonstration packages including:

- o Operating System Exercisers;
- o Peripheral Test Packages;
- o Data Base Management Testing Programs.

The PORTS and PASS contractors will also be developing software routines to provide internal testing. The seven test scenarios are those described in Section 3, Methodology.

6.4.1 <u>Hardware Test Tools.</u> The four hardware test systems are described in the following paragraphs.

MSFC ST SIMULATOR

The MSFC ST Simulator is the main test and simulation tool for STOMS implementation. A summary of its capabilities and functions is presented here; and, a detailed description is provided in Appendix F.

The ST Simulator, developed by MSFC, consists of three computers - two at MSFC and one at GSFC with an interface via NASCOM. (An AP in the ST Simulator mode will function as the GSFC computer.) The system serves as a functional ST, accepting and processing all ST commands and generating telemetry data streams. The ST Simulator can produce up to three programmable data streams simultaneously. Data stream can be either science data (pre-recorded), or engineering data, or both, and contain pre-programmed anomalies. The ST Simulator has the capability to respond to all St commands including memory loads for the on-board computers.

The functional aspects of the ST Simulator enable it to test many of the telemetry and command interfaces within the STOMS plus the interfaces to the SSC, ST ScIF and NGT-NASCOM.

As the ST Simulator is a viable test tool for the TAV, it is described in considerably more detail in Appendix F, Simulator and Test System.

LINE TEST UNIT

The POCC LTU, developed by the PORTS contractor, is a programmable, operator controlled, data generator/monitor used for fault isolation of the POCC interface. The LTU will be capable of simulating telemetry and command functions with static data as well as displaying selected data when received in the NASCOM format.

The LTU's capabilities as a test tool include the ability to monitor telemetry and commands being received by, and transmitted from, the POCC. This provides an interface check for the NCC, DCF, OSCF and MPT data transmitted in NASCOM format. Data transmitted to and from the POCC using Digital Data Communication Message Protocol (DDCMP) can also be verified. This provides a check for the SSC and MSFC Simulator interfaces using DECnet. DECnet is a hardware and software interface developed by Digital Equipment Company.

The LTU can simultaneously generate engineering and science telemetry data at selected rates. In a non-simultaneous mode it can play back DDCMP data blocks. This provides additional interface verification for the NCC, DCF, OSCF and MPT.

The LTU is described in more detail in Appendix F, Simulator and Test Systems.

COMPATABILITY TEST VAN

The CTV is a GSFC transportable system used to facilitate the compatability test between the ST and TDRSS/NGT-NASCOM. These tests verify that the tracking, telemetry and command equipment will meet the network requirements and that the mission can be supported. The CTV will be located at the A&V contractors facility during the STOCC compatability testing. During these tests the CTV will not only be used to verify performance and adherence to network standards but also to verify compatability to the POCC and DCF interfaces. Using the input provided by the ST, the POCC and DCF can perform verification of their respective interfaces to the SSC and ScIF.

More detail on the CTV is provided in Appendix F, Simulator and Test Systems.

NCC SIMULATOR

The NCC Simulator will provide simulated real-time Ground Control Messages (GCM's) and ODM's to the POCC during training for POCC personnel. The NCC Simulator will be used to verify those interfaces.

6.4.2 Software Test Packages. The software packages associated with the LTU and ST Simulator are not part of this discussion.

In general, software test packages are developed to test operating systems, data base systems and system peripherals. Where these systems cross interfaces (such as one system providing data base data to another) then the software package could become a test tool for that interface.

The scripting and testing system developed by the PORTS and PASS contractor for system software testing of the POCC will provide interface testing in regard to the Telemetry and Command (TAC) input and Virtual Interface Processor (VIP) output. This will provide a partial test of the NGT-NASCOM/POCC and the POCC/SSC interfaces.

Additional study of software test packages, as information becomes available, may prove useful in this analysis. Also, the development of CTDSs may require development of software designed for the generation of specific data.

The matrices depicting the test tools required to support the test and verification of each individual interface functional requirements are presented in Appendix D. Individual software test packages were not delineated since their primary purpose is to provide internal rather than interface testing. Where the possibility exists that they could be used for an interface test, this has been indicated.

6.5 CONTROLLED TEST DATA SETS

The CTDS's required to support testing of the interface functional requirement are identified in the matrices and defined in general terms in this subsection. A detailed description of a CTDS for each individual functional requirement to be tested is a prerequisite for developing the test procedures. The complete CTDS identifies all input test material required, including data bases or data recorded on magnetic or other media. CTDS's describe drivers or stubs (dummy data or modules) which are required to simulate unavailable input data, and specify tape numbers, file names, and/or other means of uniquely identifying the input data.

In addition to science, engineering and astrometry data, CTDS's include schedules, missions specifications, requests, orbital data, operational instructions or any other data essential to performing the test. Other information pertinent to the test data would also be considered part of the CTDS. This includes, but is not limited to, a description of the volume of data and the frequency at which these data will be required. Examples of CTDS documents are included in Appendix H.

The term "Controlled" in CTDS indicates that the test data identified must be under the control of the Configuration Manager, Test Manager or some comparable authority. This control assures that the test input will not be a variable during an incremental approach to testing.

The matrices depicting the CTDS's required to support the test and verification for each individual interface functional requirement are presented in Appendix E. Each CTDS has been assigned a unique number for identification purposes. These numbers indicate (1) where the data originates and (2) the specific interfacing element involved. A correlation with the ST Support Instrumentation Requirements Document (SIRD) is also indicated.

SECTION 7

TEST SEQUENCE AND SCHEDULES

The development of a conflict free schedule for the TAV requires coordination of all support resources with the major test and simulation events competing for these resources. Space Telescope Observatory Management System Test Simulation Requirement, ISN GSFC, January 1982, describes in detail the support resources, the key test simulation events, and the tentative schedules for these events. This section identifies the support resources that must be scheduled, the key test/simulation event, and the TAV schedule in relation to these resource schedules and events.

7.1 SUPPORT RESOURCES

The resources required to support the STOMS TAV are the POCC, the DCF, the LTU, the MSFC ST Simulator, the CTV, and the SOGS. Those elements such as the NCC that are not ST unique are not included. These multisatellite support elements will be scheduled as part of each test/simulation event. The support resources have all been described in this document; however, a more detailed description of the MSFC ST Simulator and test systems is provided in Appendix F.

7.2 TEST/SIMULATION EVENTS

The test and simulation activity considered as major events for STOMS implementation are the VAP, the STOMS TAV, A&V, the SOGS I&T, the mission operations procedure development effort, the MOGS I&T, and Missions Simulation. These, as well as the training effort, are considered as the eight key events that will require sharing of the support resources and STOMS elements. These events are also placed in a relative order of priority according to requirements for support resources. Appendix G contains a summary description and tentative schedule of each test/simulation event as well as other activities concerning STOMS implementation.

7.3 RESOURCE SCHEDULING CHARTS

The STOMS Implementation Study has developed Resource Scheduling Charts (RSCs) for each support element identified in Section 7.1. (Reference charts 7-1 through 7-6). Each chart covers a two year period from 1983 to 1984 depicting the time element for each key event. The time element illustrates, as a minimum, a "window" for that event indicating when the event begins and ends. Within this window, time is scheduled for the indicated support resource. Additionally, the events are listed in a general order of priority as established by this study. The rationale for determining the indicated priority was based primarily on the dependency methodology i.e., STOMS TAV and SOGS I&T must occur prior to MOGS I&T. It must be emphasized that this is a general order of priority. As an example, although MOGS I&T has a higher priority, training in specific areas must occur prior to certain MOGS I&T events although the MOGS I&T would be the driving event.

Within each "window" the known and probable requirements for the appropriate resource are scheduled. As an example, in Chart 7-1, POCC Resource Scheduling Chart, the known schedule for the POCC during the VAP is the entire time period, or "window", for the VAP. This known schedule also has priority, as

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Chart 7-1. Payload Operations Control Center Resource Scheduling Chart

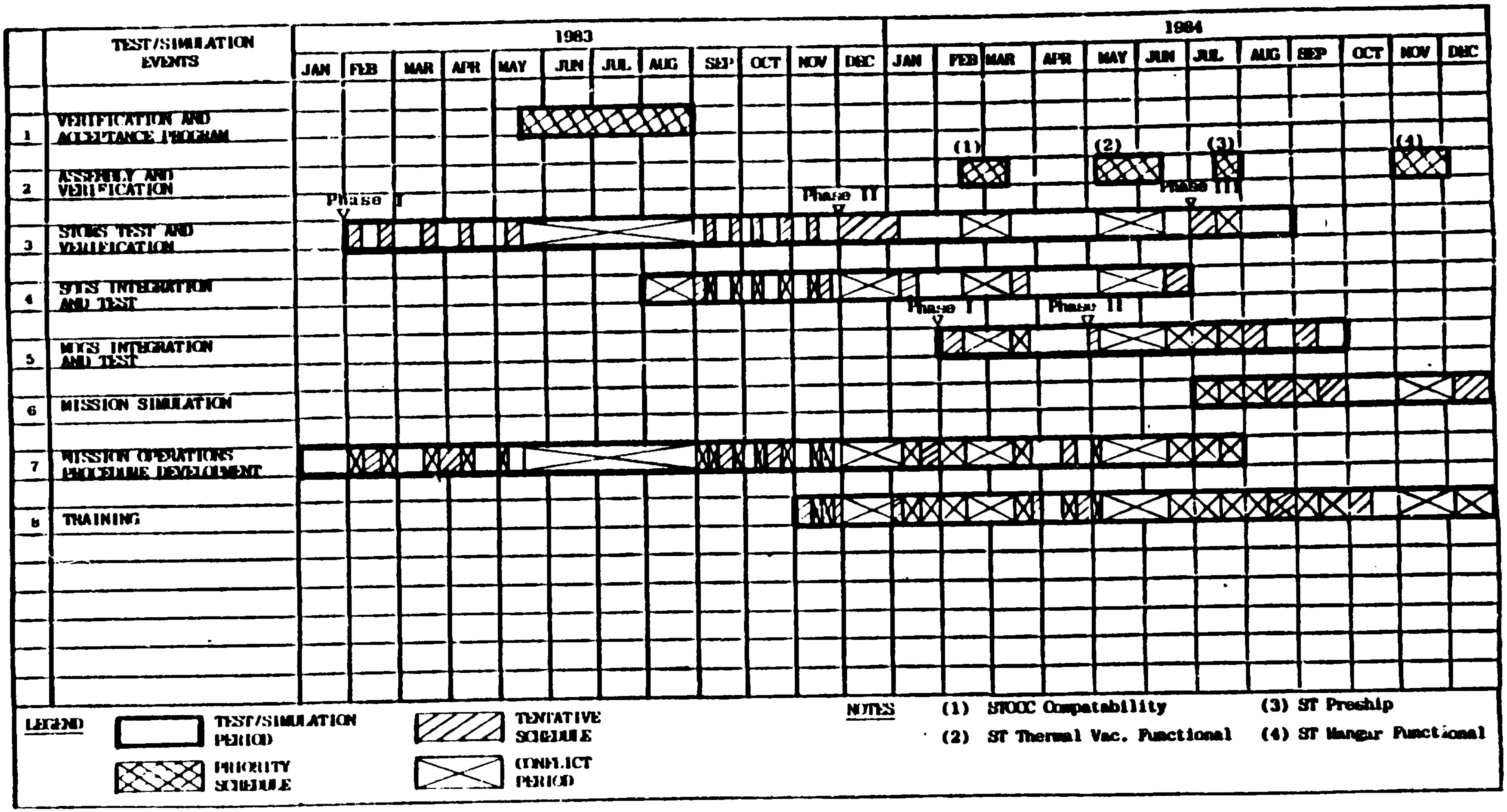

Chart 7-2. Data Capture Facility Resource Scheduling Chart

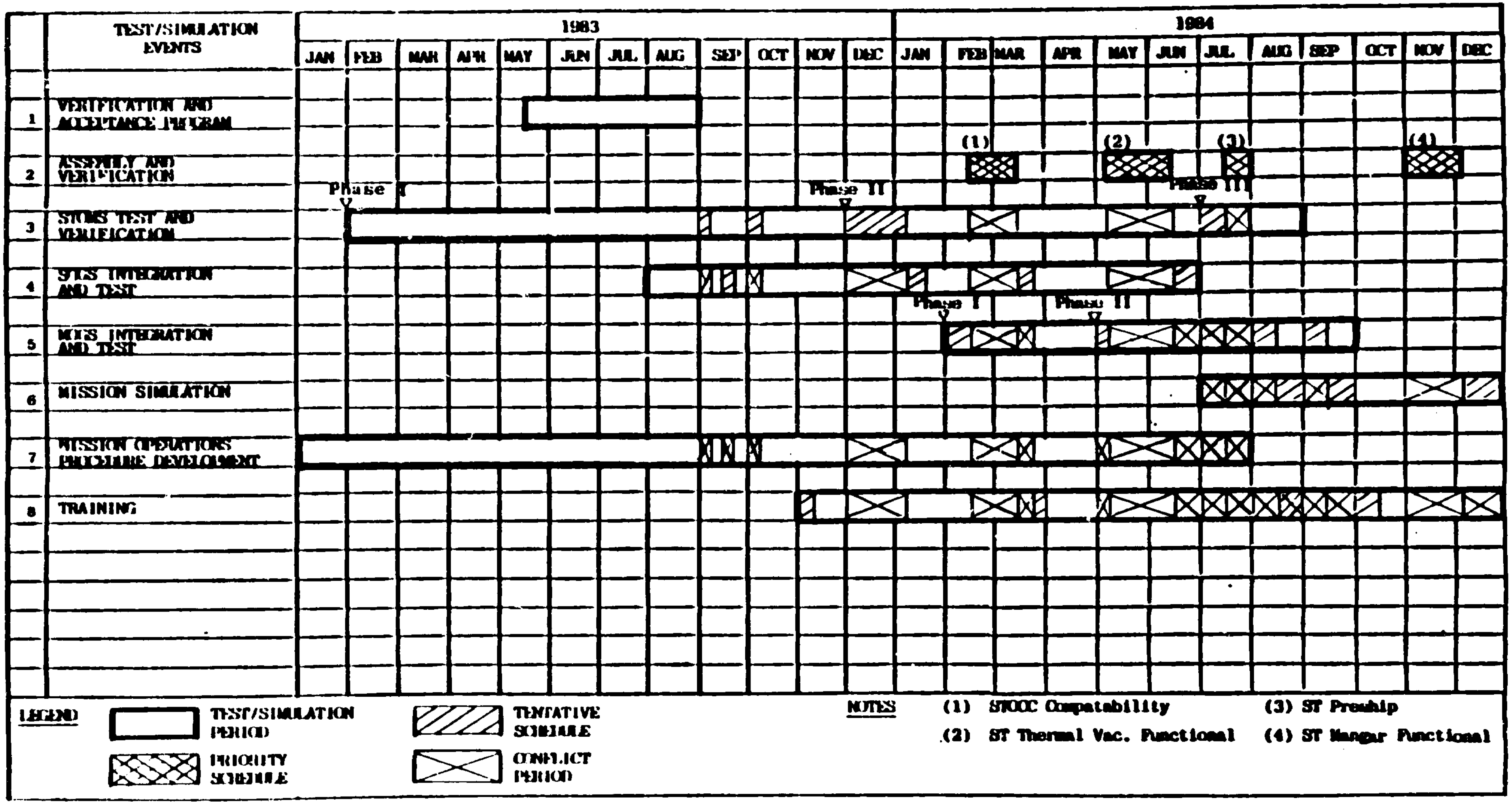

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Chart 7-3. Line Test Unit Resource Scheduling Chart

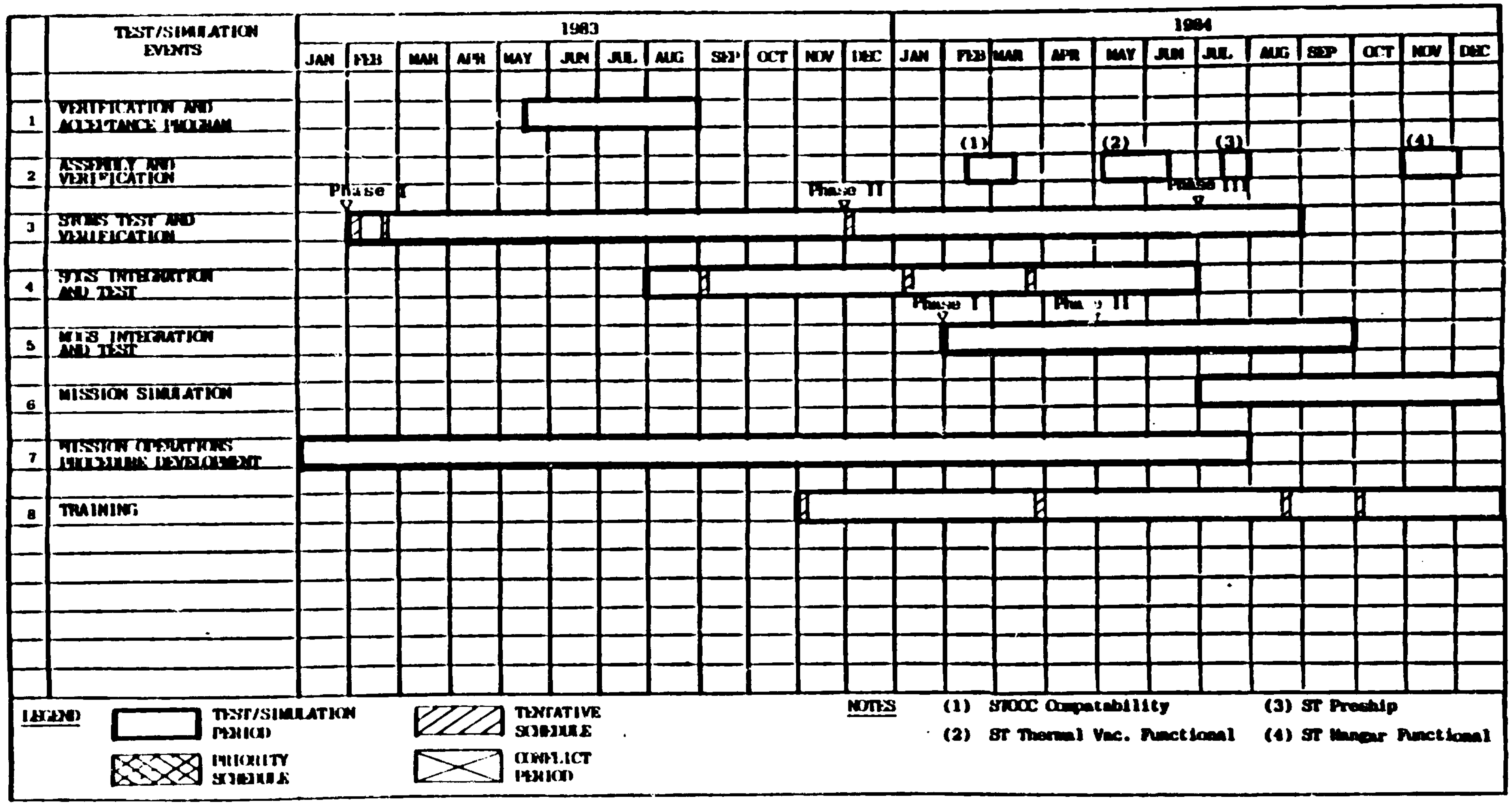


Chart 7-4. MSFC ST Simulator Resource Scheduling Chart

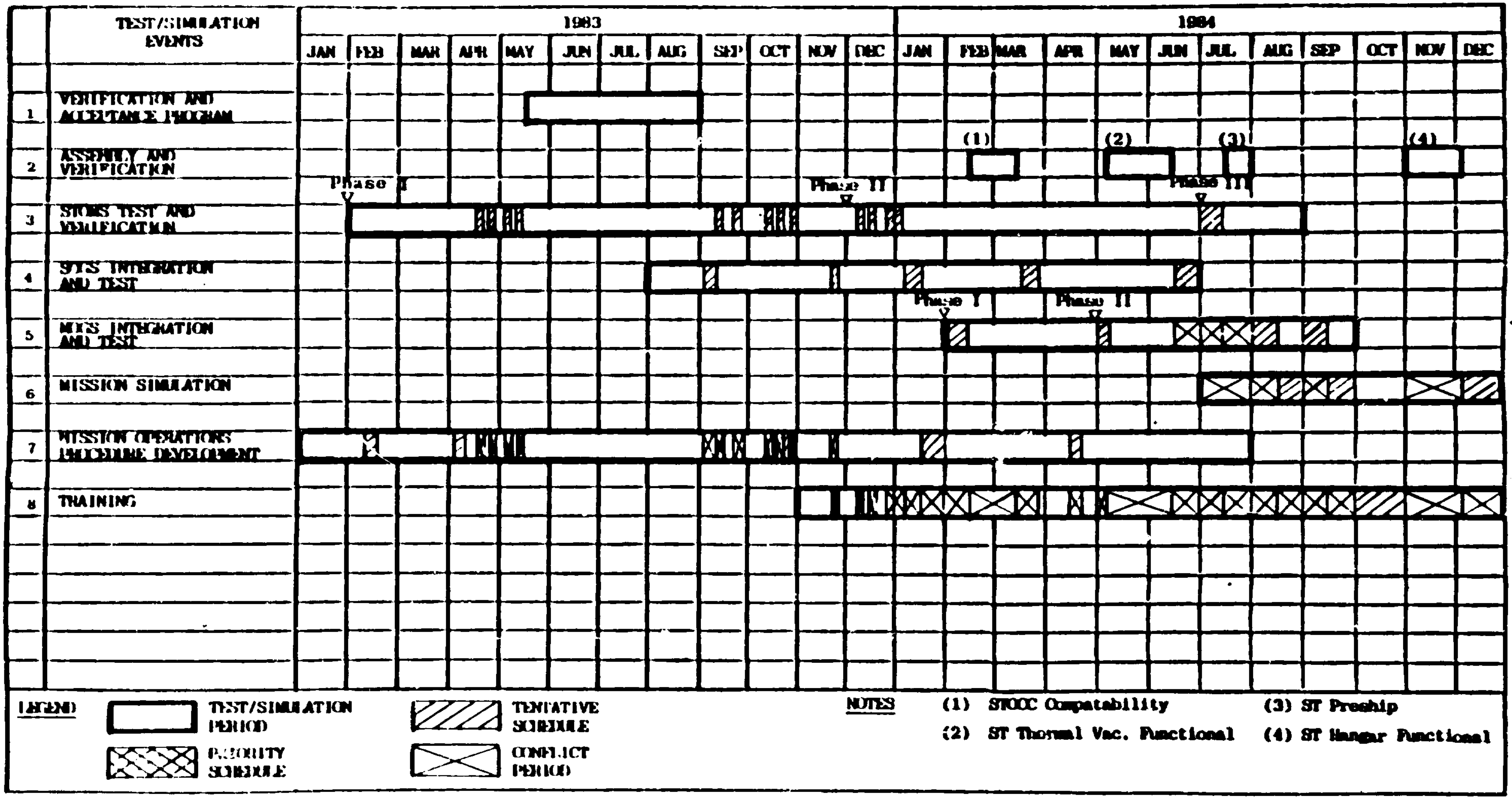


Chart 7-5. Compatability Test Van Resource Scheduling Chart

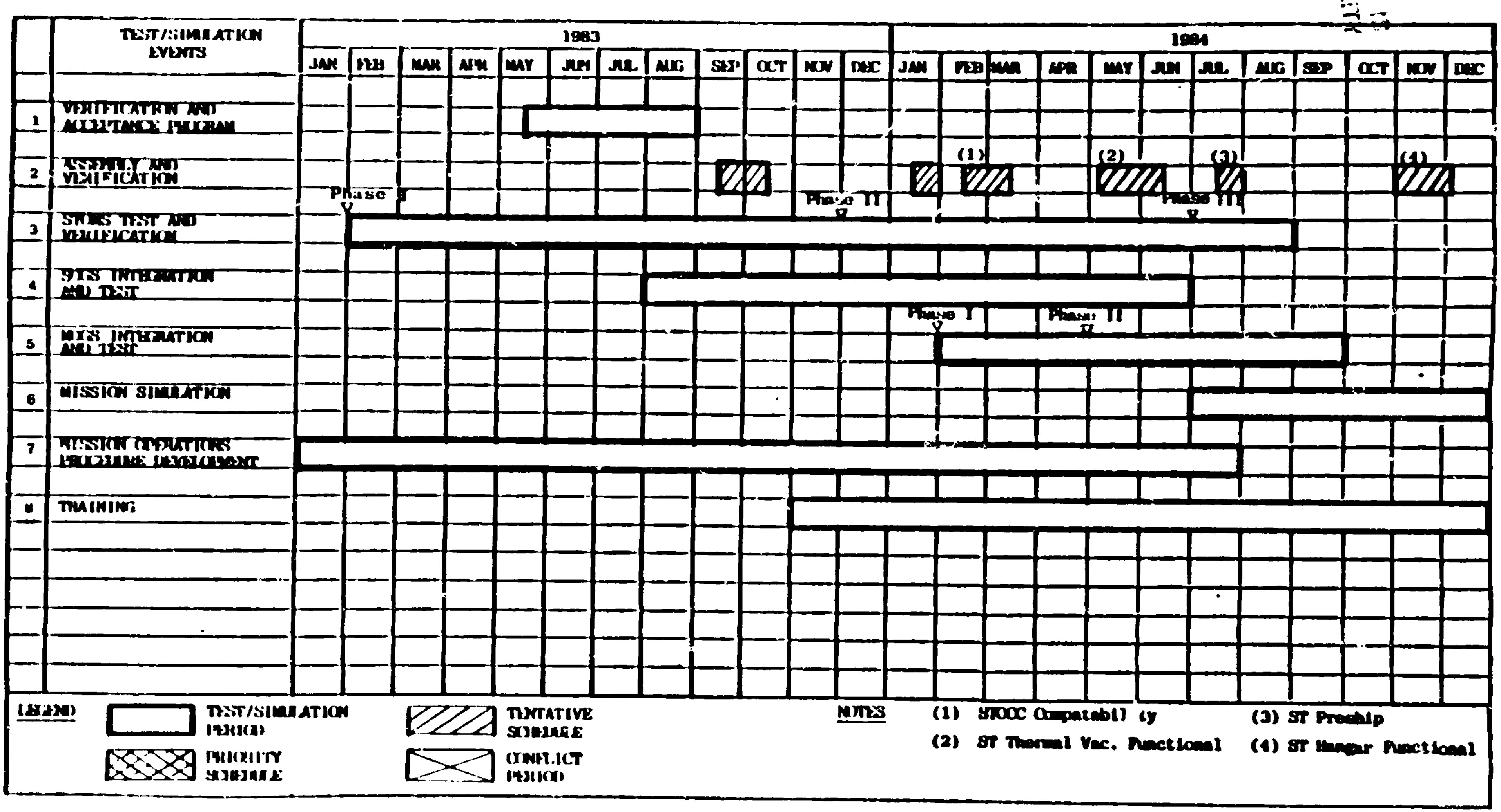
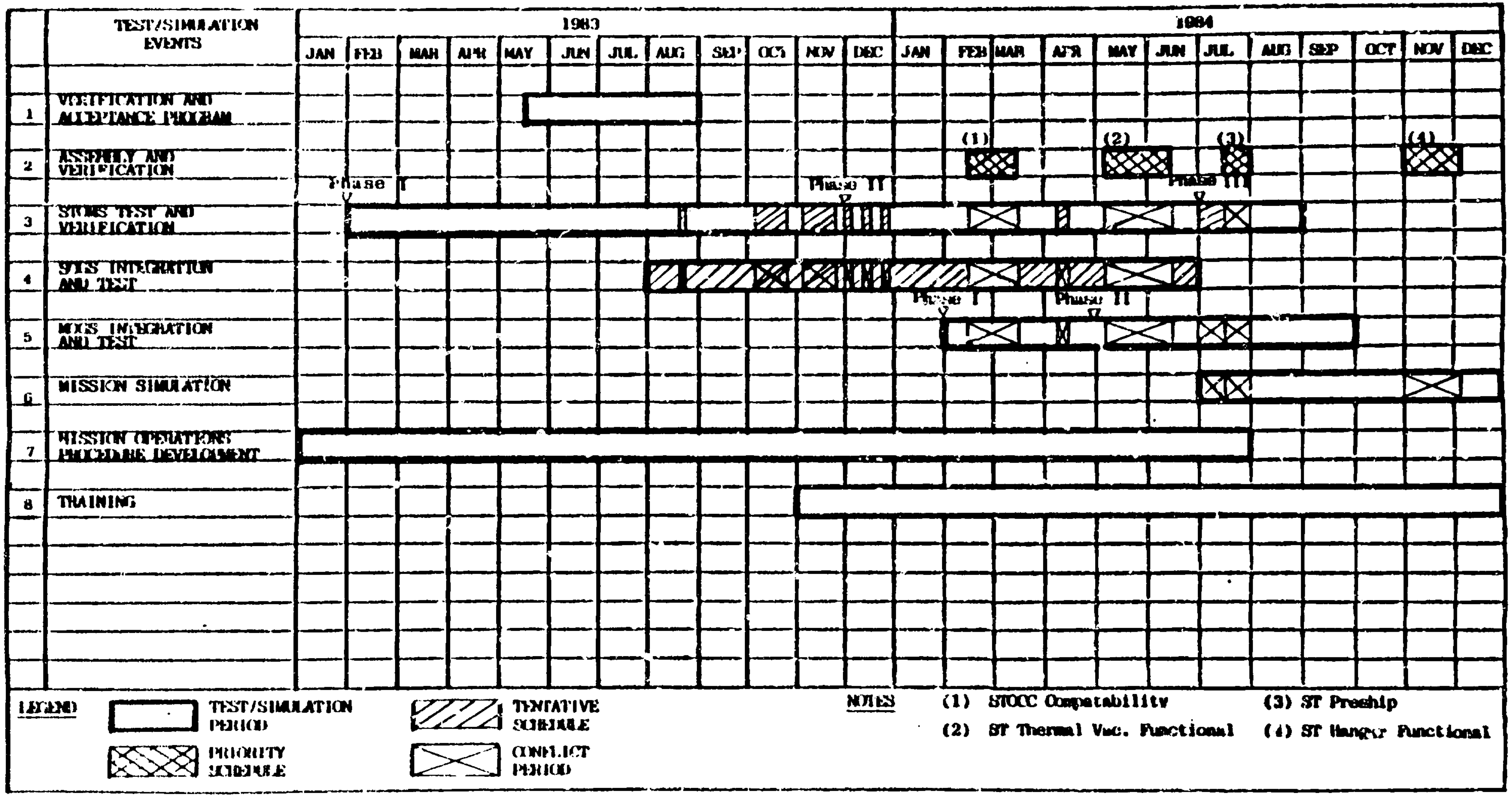


Chart 7-6. Science Operations Ground System Resource Scheduling Chart



indicated. Reference the legend on the chart. Note that priority schedule for the VAP, line 1, from mid May to the end of August 1983 has caused a scheduling conflict during this same period for STOMS TAV, line 3, and Mission Operations Procedure Development, line 7. Again, reference the legend. The SOGS I&T, line 4, only has a conflict for the month of August as it is not scheduled to begin testing until then.

A conflict does not mean that testing or training can not occur during this period but that a prior schedule creates a conflict in scheduling that particular resource. As shown, the SOGS I&T would have difficulty scheduling the POCC, but other testing can be done simultaneously utilizing other resources. A similar situation occurs for the A&V.

Testing during the four major A&V test periods, line 2, results in competition for the POCC by the other events during this time period. Tentative schedules create a similar situation. As an example, the first week of February 1983 for the STOMS TAV, line 3, causes a conflict period for the Mission Operations Procedure Development event, line 7.

The priority and tentative schedules do not preclude the scheduling of the POCC by another event during this conflict period. Reference Chart 7-1 again for an example of this. The training window, line 8, indicates that during the month of December 1983 and the first week of January 1984 the tentative schedule for STOMS TAV, line 3, has priority and this is a conflict period for training. However, the first week of January has been tentatively scheduled as a training period coinciding with the STOMS Phase II TAV. Both of these events could occur simultaneously with operations personnel conducting a portion of Phase II TAV.

7.4 STOMS TEST AND VERIFICATION SCHEDULE

Using the RSCs as working documents to determine resource availability and the test scenarios described in Section 3, a tentative schedule for the STOMS TAV has been developed.

The test scenarios presented in logical test order and in three phases were plotted in the TAV window. The schedules for the supporting resource elements were then checked to confirm if the resource was available for supporting the test. If the resource was not available, the test was rescheduled. Plotting the parts of the scenario across the window of the TAV and checking the time the supporting resources were available resulted in the tentative schedule for the TAV as illustrated in Chart 7-7, STOMS Test and Verification Schedule.

The STOMS TAV is divided into three phases. The first phase is constructed with sets of individual interface tests. The second phase is constructed of string tests. The third phase is the entire system test.

The durations of the tests were tentatively allocated equal amounts of time, although this will not be the case in real-time testing. As each test becomes more definitive then the scheduling can be adjusted accordingly. The RSCs will enable test schedulers to coordinate the sharing of support resources and to provide test completion in a timely manner.

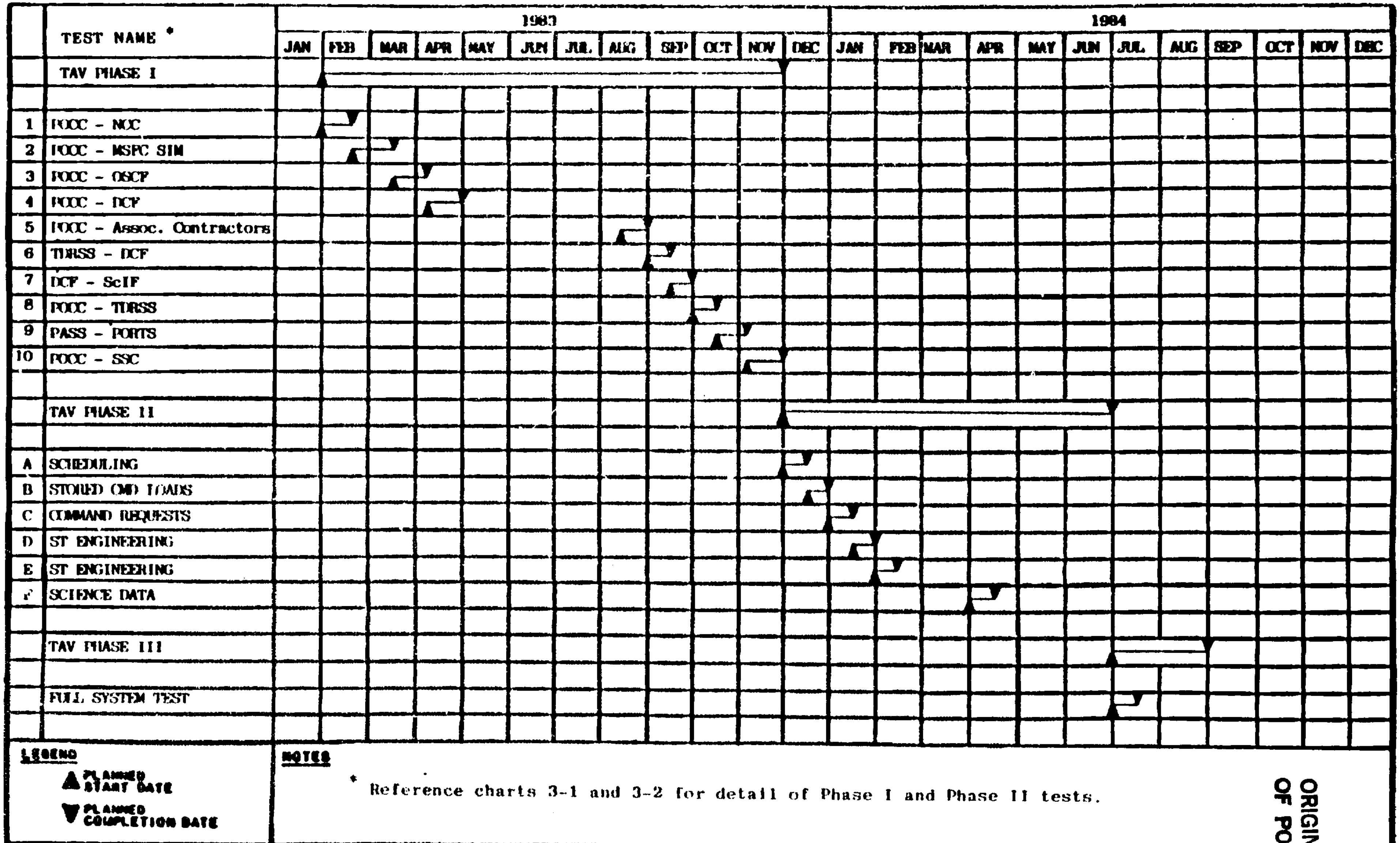


FIGURE 7-7 STOMS TEST & VERIFICATION SCHEDULE

SECTION 8

FAILURE REPORTING AND CORRECTION PROCEDURES

A mechanism for systematically reporting failures and initiating appropriate correction action will be required during the STOMS TAV. The failure reporting and correction procedures instituted by the GSFC for use on other programs will be used by the TAV contractor.

The Malfunction Report form, Figure 8-1, is a mechanism for failure reporting used at GSFC. (Reference GSFC Specifications for Contractor Malfunction Reporting, GSFC-S-312-P-1, March 1970 for additional information.) This form is used as a working document and also provides a means for recording information for storage and subsequent retrieval. The corresponding form to be designed for use during the STOMS TAV should provide the entry of similar information relevant to failures encountered during testing. Specifically, the malfunction report form should provide, as a minimum, designated spaces for the following information to be recorded:

1. Date and time of malfunction.
2. Date the malfunction report was originated.
3. Identification of the failed test item. A failed hardware item should be specified by level (e.g., system, subsystem, component), and the manufacturer's name and identification numbers (e.g., manufacturer's part number, item serial number) should be provided. A failed software item should also be specified by level (e.g., system, subsystem, module), and the software developer's name and appropriate identification numbers should be provided.
4. The type of test that was being conducted when the malfunction occurred (e.g., OSCF/POCC orbit data interface test).

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GSFC MALFUNCTION REPORT

NO.

(1) Project: SUBMIN		(2) Spacecraft: A	(3) Operation: 11263	(4) Units: 1 [X] Hrs 2 [ ] Cys
(5) System or Experiment: COMMUNICATIONS	(6) Date & Time of Malfunction: Yr 67, Mo 09, Day 13, Time 1500	(7) Date of Report: Mo 09, Day 14		(8) Critical: 1 Yes 2 [X] No

	NAME	IDENTIFICATION NUMBER	SERIAL NUMBER	MANUFACTURER
(9) Component	TRANSMITTER	624A32564	3	SMITH ELEC.
(10) Assembly	POWER SUPPLY	624C63524	12	SMITH ELEC.
(11) Sub-Assembly	REGULATOR	BR63241-11	A6423	BROWN ELEC.
(12) Part	RESISTOR	Manufacturers Part Number: 47K6324	Circuit Des.: R-63	U.S. RESISTOR

(13) Malfunction Occurred During: 1 [X] Qualification Test; 2 [ ] Acceptance Test; 3 [ ] Integration Test; 4 [ ] Pre Launch; 5 [ ] Launch Operations; 6 [ ] System Test; 7 [ ] Bench Test; 8 [ ] Post Launch

(14) Environment When Failed: 1 [ ] Acceleration; 2 [ ] Shock; 3 [ ] Thermal-Vacuum; 4 [ ] Temperature; 5 [ ] Humidity; 6 [X] Vibration; 7 [ ] Ambient; 8 [ ] Acoustic

(15) Action to be Taken on Failed Unit: UNIT TO BE RETURNED TO CLEAN ROOM FOR FURTHER INVESTIGATION. Document Number that Authorized Failure Analysis: FAA-632

(16) REFERENCE: Spacecraft Log Book # A-1 Page 63 Test Procedure QTP 604-1 Para 3.2.1

(17) Description of the Malfunction: OUTPUT OF TRANSMITTER SHIFTED TO 256.3 MC DURING 'X' AXIS OF VIBRATION TEST AT 12.2 GRMS - OUTPUT SHOULD BE 230 MC ±1% - IT WAS NOTED THAT THE POWER SUPPLY OUTPUT WAS 32.6 VDC - SHOULD BE 28 ±1% - IT APPEARS THAT THE REGULATION IS BAD -

(18) Originator: BILL JONES Phone: 516-324-8400 Organization: SMITH ELECTRONICS, INC.

(19) Cause of the Malfunction: RESISTOR R-63 WAS FOUND TO HAVE VOIDS - THESE VOIDS CAUSED THE RESISTOR TO FAIL DURING VIBRATION TEST -

(20) Corrective Action Taken: ALL 47K6324 RESISTORS HAVE BEEN X-RAYED TO DETERMINE WHICH PARTS HAVE VOIDS - ALL REGULATOR SUBASSEMBLIES HAVE BEEN REWORKED WITH PARTS THAT DO NOT CONTAIN VOIDS - QUALITY INCOMING ACCEPTANCE PROCEDURE HAS BEEN REVISED TO REQUIRE X-RAY INSPECTION ON ALL 47K6324 PARTS BY U.S. RESISTOR.

If Corrective Action is Required on Other Units, List Units: NONE -

(21) Failure Analysis Performed? 1 [X] Yes 2 [ ] No. Organization That Performed Failure Analysis: BROWN ELECTRONICS, INC. Failure Analysis Report Number: FAR 67-34 Date 9-27-67

(22) Rework of Unit: 1 [X] Repaired 2 [ ] Modified 3 [ ] Discarded. Date 10-2-67. Organization that Performed Rework: BROWN ELECTRONICS INC

(23) Is Retest Required? 1 [X] Yes 2 [ ] No. If Yes, State Retest Requirements: RERUN VIBRATION TEST DEFINED IN QTP 604-1 PARA 3.2

(24) Retest Results: 1 [X] Satisfactory 2 [ ] Unsatisfactory. Remarks:

(25) Unit May Be Used For: 1 [X] Flight 2 [ ] Test Only

GSFC Project Approval	GSFC MRRT Approval	Date	Contractor Approval	Date
			Jim White	10-12-67

FIGURE 8-1 GSFC MALFUNCTION REPORT

5. Specification of the actual environment that the test unit was being subjected to when the malfunction occurred.
6. All details of the malfunction such as inputs, outputs, tolerances, etc.
7. A detailed, concise narrative defining the direct cause of the malfunction.
8. A detailed, concise narrative specifying the corrective action taken, including a list of other hardware or software units affected by the corrective action.
9. Indication of whether a failure analysis was conducted. If affirmative, specify the organization which conducted the analysis, and give the number and date of the corresponding report prepared.
10. Indication of rework of a failed item, identifying the organization that performed the rework and its completion date.
11. Indication of, and restrictions on, the future use of a reworked item.
12. Indication of whether the retest of a failed item is required. If retest is required, state the test requirements.
13. Indication of the results of any retest.
14. Approval signatures certifying completion of corrective actions taken.

The initiation of corrective procedures during the STOMS TAV may be modeled after other GSFC corresponding systems. Corrective procedures are initiated at the request of the equipment operator, or in the absence of the operator, by the individual identifying the malfunction. The equipment operator notified the shift supervisor of the malfunction who, in turn, notifies the maintenance staff. The shift supervisor initiates the malfunction report, indicating the time of failure and the symptoms observed.

If the malfunction is not corrected within a specified mean time to repair (time would be dependent upon system), then a Corrective Maintenance Work Plan, (Figure 8-2) to undertake necessary corrective action will be required. This work plan is to be prepared by the responsible maintenance staff, subject to approval by NASA. The operation supervisor will be responsible for ensuring that preparation of the work plan is accomplished. The primary purpose of the work plan is to ensure an organized, controlled, and coordinated approach to troubleshooting a problem that may encompass several disciplines, development contractors, maintenance contractors, operation personnel and NASA.

After a malfunction is corrected, the malfunction report is completed by the responsible engineer or technician, and signed by him and the shift supervisor. The shift supervisor will determine if a line test is required, and will notify affected parties of the system status.

The equipment operator is responsible for logging the time reqired for malfunction, correction time and the malfunction report numbers into the Equipment Operator's Log and into the Malfunction Report Log.

CORRECTIVE MAINTENANCE WORK PLAN

SYSTEM	DATE	ORIGINATOR	EXT.
REQ'D SYSTEM TIME	SCHEDULED SYSTEM TIME		PROD. CONTROL APPROVAL
PURPOSE			
APPROACH (LIST PROPOSED STEPS)			MAINT. SUPV. APPROVAL
REQUIREMENTS (SYSTEMS, CONTRACTOR SUPPORT, DEPT. SUPPORT)			NASA APPROVAL
RESULTS			
THE SYSTEM HAS BEEN RETURNED TO A NORMAL OPERATING MODE		RESP. ENG.	

FIGURE 8-2 CORRECTIVE MAINTENANCE WORK PLAN

SECTION 9

TEST PLANS AND PROCEDURES

Descriptions of the numerous tests which are required during the two phases of the STOMS TAV were presented in Section 3. In order to achieve maximum effectiveness in their performance, each of the required tests must be conducted in accordance with an established test plan. A test plan may consist of a group of individual tests designed to assure verification of a particular system or subsystem, or it may be comprised of a sequence of tests required to validate a particular function. Reference Figure 3-1, STOMS Requirements/Test Procedure Interrelationships.

Each test to be conducted should follow a detailed procedure. The test procedures will be prepared by the development contractor or TAV contractor, as appropriate, and will be approved by NASA. This section provides outlines of the formats applicable to the preparation of test plans and procedures. Uniform test plans and procedures from each contractor will expedite review of such plans and aid in maintaining traceability of test procedures.

9.1 TEST PLAN OUTLINE

An outline of the format to be used for the preparation of test plans, and description of the contents of each section, are provided below in the following pages.

TEST PLAN OUTLINE

A. TEST PLAN DESCRIPTION

1. Objectives

   The functions of the interface/elements are summarized and the objectives of the tests are defined in this section. This section will also include a summary of the specific project, the organizations involved, the location of the test, and reference to any prior testing.

2. Description

   Each test included in this plan, will be described in detail and the individual test procedures referenced.

3. Environment

   The test personnel, documentation, hardware, software interfaces, physical location, inputs, test materials, data handling support, data bases, and all other support material and/or services required to perform each test are identified in this section.

4. Requirements To Be Verified

   The requirements to be verified by each test are specified in this section. The requirements specified should correlate with the Integration Test Plan and the most recent design review or other relevant documentation. The hardware and software functions to be exercised are listed in this section in relation to the test identified.

B. EVALUATION PLAN

The measurements to be taken and the method to record the test results during each test are specified in this section. Other pertinent information about the tests, such as the expected results, are provided.

The pass/fail acceptance criteria and any limitations due to the test environment are specified in this section.

The test evaluation techniques, methods of measurement, equipment, personnel, reporting, and any additional unique requirements are also described, with references being made to specific test plans.

C. TEST TEAM MEMBERS

The functions of each member of the test team are described in this section, and the organizational affiliation of each team member indicated. This section specifieS training required by each operation and test team member. The procedures for assuring the qualification of these personnel to conduct the required tests are also described.

D. SCHEDULE

The sequence of the tests included in the plan are described in this section, and the rationale for the sequence established provided. The schedule for performing these tests, based upon known prerequisites of other deliverables or upon any other prevailing constraints, are also indicated.

E. ANOMALY PROCEDURES

The procedures to be invoked in the event of contingencies are specified in this section. If applicable, alternate sequences to be followed in the test progression in the event the occurrence of unexpected anomalies are described. As appropriate, reference is made to other applicable procedures.

F. CONFIGURATION MANAGEMENT

The Configuration Management Plan will be described or referenced in this section. Procedures for partial retesting while maintaining configuration control will be defined.

G. DEBRIEFING

The particular format for reporting on the test results will be defined in this section. This would include the form of written, verbal or visual presentation, method of managing action items, attendance, plus schedules for debriefing, followup and other actions.

9.2 TEST PROCEDURE OUTLINE

An outline of the format to be used for the preparation of test procedures and description of the contents of each section, are provided in the following pages.

TEST PROCEDURE OUTLINE

A. TEST SEQUENCE

The steps necessary to accomplish each test will be specified in this section in the precise sequential order in which they are to be conducted. The specified steps include: receiving the test article; reviewing all applicable documentation; providing orientation to test team members; gathering required test support materials; scheduling required test support services; performing the individual tests, analyzing and reporting the results of each test; and, acceptance of the test article. The individual steps involved in the performance of each test will be listed in this section.

B. CONTROLLED TEST DATA SET

All CTDS required to support each test are specified in this section. This specification defines all test materials required, identifies access which is required to specific data bases, and defines all drivers or stubs which are required to simulate unavailable components. These input requirements specify tape numbers, file names, or other means of uniquely identifying the supporting data required. The volume of input data and the frequency at which these data will be required are specified to the extent feasible.

C. CONFIGURATION

The hardware and software configuration required for the performance of each test (e.g., number of tape drives and operating system) are specified in this section.

D. REPORTING FORMAT

The particular formats to be used for reporting problems, specifying test results, and summarizing the execution of each test are indicated in this section.

E. OUTPUT

The output products required in connection with each test are fully described in this section. The labeling, routing, and storage requirements of all hard copy, magnetic media, and other output products are indicated. The requirements for recording video messages or other data are also specified in this section. When the output product is to become part of a CTDS then the procedures required to control this data will be referenced or included.

SECTION 10

TEST ORGANIZATION

The TAV contractor will have full responsibility for the development, conduction, and completion of the TAV activities; however, specific functions within the TAV will be the responsibility of individual GSFC or contractor organizations. This assignment of responsibility and composition of test groups is depicted in Figure 10-1, STOMS Test and Verification Organization. The TAV program aspects will consist of test development, test conduction, test support and test reporting as illustrated in the organization chart.

10.1 TEST MANAGER

The test manager has overall responsibilities for the test groups. These responsibilities include, but are not necessarily limited to: reviewing test plans and procedures; coordinating the activities of contractors; monitoring the performance of tests; coordinating the resolution of problems; analyzing test results; and preparing and reviewing test reports.

10.2 TEST DEVELOPMENT GROUP

The Test Development Group is headed by the TAV contractor who h general responsibilities for developing all tes plans and procedures. Procedures previously developed by the development contractor will be used where applicable. The same organization that has developed and maintained the ICD related to each interface will be responsible for the preparation of the test requirements, plans, procedures, and test report for each Phase I test. The other interfacing

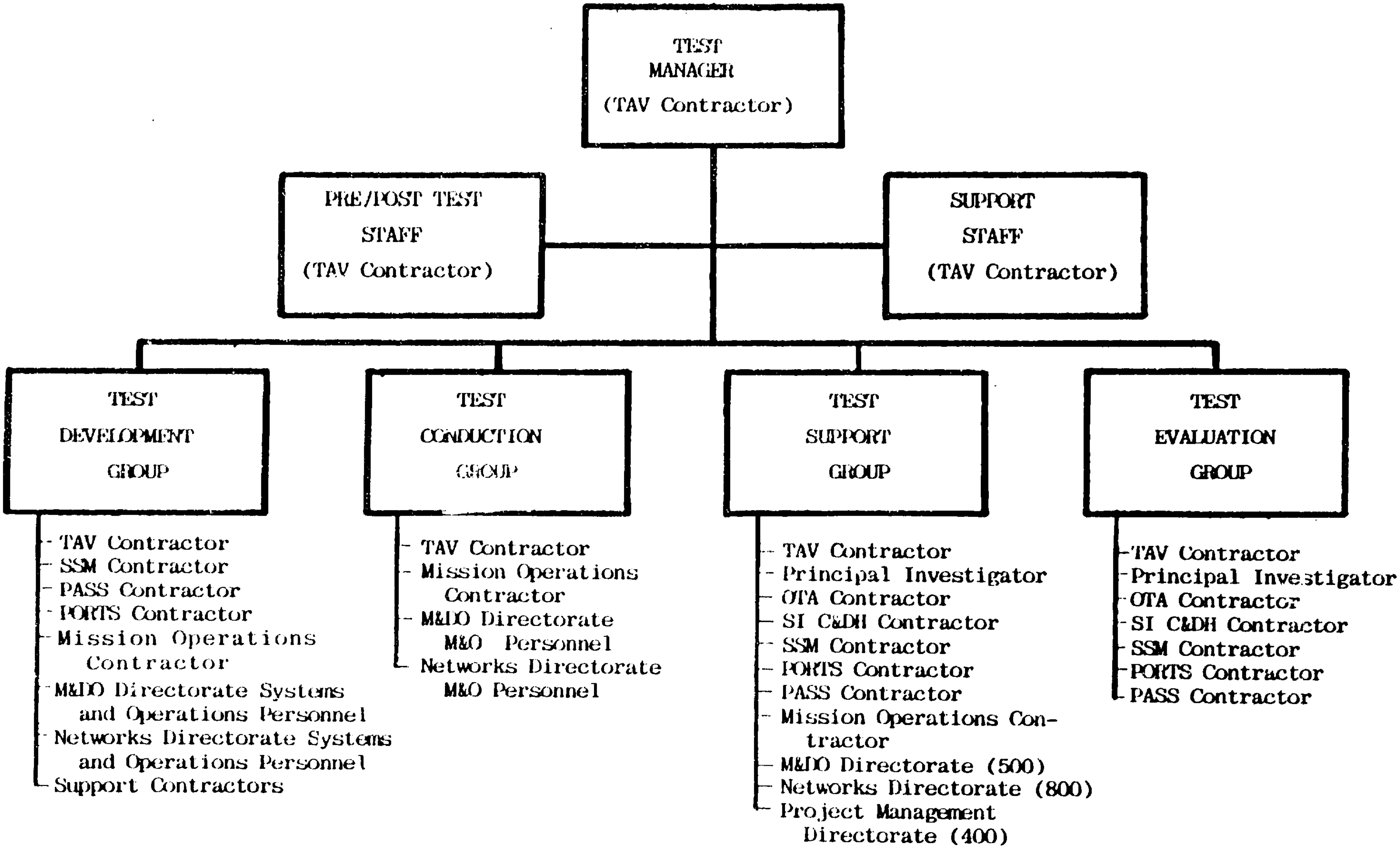

FIGURE 10-1 STOMS TEST & VERIFICATION (TAV) ORGANIZATION

entity will review these documents for accuracy and completeness, and will provide inputs related to its unique responsibilities, as required. The MOC will prepare Phase II test requirements, plans, procedures and reports as required. The TAV contractor will coordinate their effort and develop those items not under the responsibility of another contractor or GSFC directorate. All test documents will be approved and controlled by the GSFC.

10.3 TEST CONDUCTION GROUP

Each development contractor organization involved in a Phase I test will supply the test and operations personnel required to support the test.

Phase II tests will be performed by operations personnel provided by the Mission Operations contractor. During both phases, NASA M&O personnel will be responsible for the operations of the NASA facilities.

TAV contractor personnel will be responsible for coordinating all test conduction efforts including the scheduling of activities, monitoring the performance of the tests and ensuring configuration control.

Configuration control will be exercised in accordance with contractor-developed, and NASA-approved, Configuration Management Plans. Each such plan shall meet the requirements of the GSFC Space Telescope Project Configuration Management Plan, GSFC-ST-CMP, Revision A. Space Telescope (ST) Scientific Instruments and Mission Operations Configuration Management Plan, February 1980. All Class One changes to the configuration baselines shall be approved by NASA, and shall be properly documented by the cognizant contractors. This document also describes the specific functional and physical audits which are to be performed in connection with configuration control.

The ST Project will maintain configuration control over the various STOMS-to-SOGS interfaces as well as the STOMS to NASA facility interfaces. The participating ground system and TAV contractors will appoint representatives as required to provide representation at the board controlling these interfaces.

The TAV contractor shall review and analyze the following functions both during and after the execution of each test: volume of input data ingested; volume of data having conversions properly performed; output data volume; proper handling of anomalies; system throughput capabilities; and out-of-limits function execution times.

10.4 TEST SUPPORT GROUP

Prior to testing, the development contractors will provide the TAV contractor and MOC with such technical support as is required to ensure that the training of all test personnel is phased to adequately support their roles in the TAV.

During testing, the Test Support Group will provide maintenance, operational and management support as required. The TAV contractor will be responsible for coordinating this activity.

10.5 TEST EVALUATION GROUP

The Test Evaluation Group will report in detail on each test conducted; determine the need for additional testing to correct deficiencies; recommend contractual acceptance of tested elements; and, make recommendations for system implementation. The group will provide reports containing the comparison of the recorded test measurements, or results, with those results which are anticipated or specified in the test plan. Any requirements which were not verified will be identified, and the probable cause of the failure to verify a requirement will be cited in each instance.

Specific recommendations regarding the measures necessary to correct any failures or limitations encountered during testing will be provided in their report. These recommendations will include estimates of the expenditure of time and resources required to implement the suggestions. The test evaluation report will include recommendations regarding the readiness for implementation of each element tested.

APPENDIX A
REQUIREMENT/SUPPORT SYSTEMS MATRICES

The following matrices depict the relationship between the STOMS interface functional requirements (along the top of the page) and the support systems (along the side of the page). The interfacing elements are numbered 1 through 9 and correspond to the support systems. The MPT for the purposes of this matrix is considered part of the NCC (2); and, the ST ScIF and SSC are both part of the SOGS (9).

As an aid in reading these matrices, the 'from' and 'to' can be read into each interface description. As an example, the first three pages illustrate the POCC interfaces grouped according to the element being interfaced. The first group of interface functional requirements are those that pertain to the POCC and the NCC. The first interface requirement within this block is 'TRANSMITS GCMRS'. This is read as "the POCC transmitts GCMRs to the NCC". The systems required to support this interface test are (those asterisked) the POCC, NCC and NGT-NASCOM.

The 'AVAIL DATE' indicates the date the support system is to be available for integration. The 'TEST DATE' will be the earliest date that the system is required for testing the interfaces indicated. These dates will be completed as data becomes available.

POCC REQUIREMENTS/SUPPORT MATRIX

SUPPORT SYSTEMS	AVAIL DATE	TEST DATE	NCC (2)								NGT-NASCOM (3)				
			TRANSMITS GCMRS	TRANSMITS POST EVENT (QUALITY) REPORTS	TRANSMITS TDRSS SERVICE R'QMTS VIA MPT	RECEIVES TDRSS PERFORMANCE DATA	RECEIVES TDRSS & NETWORK SCHEDULES VIA MPT	PERFORMS DATA BASE INQUIRY	RECEIVES & TRANS-MITS ACKNOWLDGMT		RECEIVE HI-RATE SCIENCE DATA (SSA)	RECEIVE LO-RATE SCIENCE DATA (I)	RECEIVE ENGINEER-ING DATA (Q)	TRANSMIT COMMANDS	
C PORTS PASS (1)			*	*	*	*	*	*	*		*	*	*	*	
NCC (2)			*	*		*	*	*	*		*	*	*	*	
MPT (2)					*		*								
NGT-NASCOM (3)			*	*		*			*		*	*	*	*	
TDRSS (4)											*	*	*	*	
DCF (5)															
OSCF (6)															
ST (7)											*	*	*	*	
MSFC-SIM (8)											*	*	*	*	
SOGS STScIF (9)															
SOGS SCC (9)															

POCC REQUIREMENTS/SUPPORT MATRIX

SUPPORT SYSTEMS	AVAIL DATE	TEST DATE	DCF (5): TRANSMITS ST SCHEDULE	DCF (5): TRANSMITS SIM. HI-RATE SCIENCE DATA (SSA)	DCF (5): TRANSMITS SIM. LO-RATE SCIENCE DATA (I)	DCF (5)	OSCF (6): RECEIVE ORBIT DATA	OSCF (6)	MSFC ST SIM. (8): RECEIVES ENGINEER-ING DATA STREAM (Q'CHAN.)	MSFC ST SIM. (8): RECEIVES DATA STREAM VIA DECNET	MSFC ST SIM. (8): TRANSMITS COMMANDS	MSFC ST SIM. (8)			
POCC PORTS PASS (1			*	*	*		*		*	*	*				
NCC (2									*	*	*				
MPT (2															
NGT-NASCOM (3			*	*	*				*	*	*				
TDRSS (4															
DCF (5			*	*	*										
OSCF (6							*								
ST (7															
MSFC SIM (8				*	*				*	*	*				
SOGS STScIF(9)															
SOGS SCC (9)															

POCC REQUIREMENTS/SUPPORT MATRIX

			SSC								(9)	MISC			
SUPPORT SYSTEMS	AVAIL DATE	TEST DATE	PROVIDES COMMUNICATION CONSTRAINTS & OPERATIONS DATA	RECEIVES SCIENCE MISSION SPECIFICATION	TRANSMITS MISSION SCHEDULE PARAMETERS AND TIMELINES	RECEIVES COMMAND REQUESTS	TRANSMITS REAL-TIME SCIENCE LINK DATA	TRANSMITS SCIENCE TAPE RECORDER DUMPS	TRANSMITS SCIENCE ENGINEERING DATA	TRANSMITS ASTROMETRY DATA		TRANSFERS SELECTED TELEMETRY FILES TO LMSC, P-E, BENDIX			
POCC PORTS PASS (1)			*	*	*	*	*	*	*	*		*			
NCC (2)															
MPT (2)															
NGT - NASCOM (3)															
TDRSS (4)															
DCF (5)															
OSCF (6)															
ST (7)															
MSFC - SIM (8)															
SOGS STScIF(9)															
SOGS SCC (9)			*	*	*	*	*	*	*	*					

NCC REQUIREMENTS/SUPPORT MATRIX

SUPPORT SYSTEMS	AVAIL. DATE	TEST DATE	POCC (1)									NGT-NASCOM (3)			
			RECEIVE GCMRs	RECEIVE POST EVENT QUALITY REPORTS	RECEIVE TDRSS SERVICE REQUIREMENTS	TRANSMIT TDRSS NETWORK PERFORMANCE	TRANSMIT TDRSS SCHEDULE VIA MPT	RESPOND TO DATA BASE INQUIRY	TRANSMITS ACKNOWLEDGEMENTS			TRANSMIT GCMRS TO TDRSS	RECEIVE TDRSS/NGT PERFORMANCE DATA	PROVIDE SYSTEM PERFORMANCE DATA	
POCC PORTS PASS (1)			*	*	*	*	*	*	*						
NCC (2)			*	*	*	*	*	*	*			*	*	*	
MPT (2)							*								
NGT-NASCOM (3)			*	*	*	*			*			*	*	*	
TDRSS (4)												*	*		
DCF (5)															
OSCF (6)															
ST (7)															
MSFC-SIM (8)															
SOGS STScIF (9)															
SOGS SCC (9)															

NCC REQUIREMENTS/SUPPORT MATRIX

SUPPORT SYSTEMS	AVAIL DATE	TEST DATE	DCF (5)		OSCF (6)										
			TRANSMIT TDRSS SCHEDULE		RECEIVE PSATs IIRVs & EPHEMERIDES	TRANSMIT TDRSS SCHEDULE VIA MPT	RECEIVE OSCF PERFORMANCE DATA								
POCC PORTS PASS (1)															
NCC (2)			*		*	*	*								
MPT (2)						*									
NGT-NASCOM (3)			*		*		*								
TDRSS (4)															
DCF (5)			*												
OSCF (6)					*	*	*								
ST (7)															
MSFC SIM (8)															
SOGS STScIF (9)															
SOGS SCC (9)															

NGT-NASCOM REQUIREMENTS/SUPPORT MATRIX

			POCC (1)					NCC (2)				MSFC-SIM(8)			
SUPPORT SYSTEMS	AVAIL DATE	TEST DATE	TRANSMITS HI-RATE (SSA) SCIENCE DATA	TRANSMITS LO-RATE (I) SCIENCE DATA	TRANSMITS ENGINEERING DATA	RECEIVES ST COMMANDS		RECEIVES COMRS FOR TDRSS	TRANSMITS TDRSS & NGT PERFORMANCE DATA	RECEIVES SYSTEM PERFORMANCE DATA				TRANSMITS ST ENGINEERING DATA	
POCC PORTS PASS (1)			*	*	*	*			*						
NCC (2)			*	*	*	*		*	*	*					
MPT (2)															
NGT-NASCOM (3)			*	*	*	*		*	*	*				*	
TDRSS (4)			*	*	*	*								*	
DCF (5)															
OSCF (6)															
ST (7)			*	*	*	*								*	
MSFC SIM (8)														*	
SOGS STScIF(9)															
SOGS SCC (9)															

C-2

NGT-NASCOM REQUIREMENTS/SUPPORT MATRIX

SUPPORT SYSTEMS	AVAIL DATE	TEST DATE	TDRSS: TRANSMITS GCMRs FROM NCC	TDRSS: RECEIVES HI-RATE (SSA) SCIENCE DATA	TDRSS: RECEIVES LO-RATE (I) SCIENCE DATA	TDRSS: RECEIVES 'Q' CHAN. ENGINEERING DATA	TDRSS: RECEIVES PERFORMANCE DATA	TDRSS: TRANSMITS COMMANDS FROM POCC	TDRSS: RECEIVES ST & TDRSS TRACKING DATA FOR OSCF	TDRSS (4)	DCF: TRANSMITS HI-RATE SCIENCE DATA	DCF: TRANSMITS LO-RATE SCIENCE DATA	DCF (5)	OSCF: TRANSMITS TRACKING DATA FROM TDRSS	OSCF (6)
POCC PORTS PASS (1)				*	*	*		*							
NCC (2)			*	*	*	*		*			*	*		*	
MPT (2)															
NGT-NASCOM (3)			*	*	*	*	*	*	*		*	*		*	
TDRSS (4)			*	*	*	*	*	*	*					*	
DCF (5)											*	*			
OSCF (6)															
ST (7)				*	*	*		*	*					*	
MSFC SIM (8)															
SOGS STScIF (9)															
SOGS SCC (9)															

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TDRSS REQUIREMENTS/SUPPORT MATRIX

SUPPORT SYSTEMS	AVAIL DATE	TEST DATE	NGT-NASCOM (3): RECEIVES GCMRs FROM NCC	NGT-NASCOM (3): TRANSMITS HI-RATE SCIENCE DATA TO POCC/DCF	NGT-NASCOM (3): TRANSMITS LO-RATE SCIENCE DATA TO POCC/DCF	NGT-NASCOM (3): TRANSMITS 'Q' CHAN. RT ENGINEERING DATA TO POCC	NGT-NASCOM (3): TRANSMITS PERFORMANCE DATA TO NCC	NGT-NASCOM (3): RECEIVES COMMAND DATA FROM POCC	NGT-NASCOM (3): TRANSMITS ST & TDRSS TRACKING DATA TO OSCF	NGT-NASCOM (3)	ST (7): TRANSMITS COMMANDS USING MA OR SSA	ST (7): TRANSMITS STORED PROGRAM COMMAND LOADS USING SSA	ST (7): RECEIVES ST ENG., ASTROMETRY & SCIENCE ON MA & SSA	ST (7): RECEIVES PN CODE ON MA FOR TRACKING	ST (7)
POCC (1)				*	*	*		*			*	*	*		
NCC (2)			*	*	*	*	*	*	*		*	*	*		
MPT (2)															
NGT-NASCOM (3)			*	*	*	*	*	*	*		*	*	*	*	
TDRSS (4)			*	*	*	*	*	*	*		*	*	*	*	
DCF (5)				*	*										
OSCF (6)									*						
ST (7)											*	*	*	*	
MSFC SIM (8)															
SOGS STScIF (9)															
SOGS SCC (9)															

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DCF REQUIREMENTS/SUPPORT MATRIX

SUPPORT SYSTEMS	AVAIL DATE	TEST DATE	POCC (1)				NCC (2)		NGT-NASCOM (3)			SCI (9)			
			RECEIVES ST SCHEDULE CHANGES	RECEIVES SIMULATED HI-RATE SCIENCE DATA	RECEIVES SIMULATED LO-RATE SCIENCE DATA		RECEIVES ST & TDRSS SCHEDULE		RECEIVES HI-RATE SCIENCE DATA	RECEIVES LO-RATE SCIENCE DATA		TRANSMITS SCIENCE DATA			
POCC PORTS PASS (1)			*	*	*										
NCC (2)							*								
MPT (2)															
NGT-NASCOM (3)				*	*				*	*		*			
TDRSS (4)									*	*					
DCF (5)			*	*	*		*		*	*		*			
OSCF (6)															
ST (7)									*	*					
MSFC SIM (8)				*	*										
SOGS STScIF (9)												*			
SOGS SCC (9)															

OSCF REQUIREMENTS/SUPPORT MATRIX

SUPPORT SYSTEMS	AVAIL DATE	TEST DATE	POCC (1)		NCC (2)				NGT (3)						
			TRANSMITS ORBIT DATA		TRANSMITS ACQUISITION DATA	RECEIVES ST & TDRS SCHEDULE VIA MPT	TRANSMITS PERFORMANCE DATA		RECEIVES TRACKING DATA FROM TDRSS						
POCC PORTS PASS (1)			*												
NCC (2)					*	*	*								
MPT (2)						*									
NGT-NASCOM (3)					*		*		*						
TDRSS (4)									*						
DCF (5)															
OSCF (6)			*		*	*	*		*						
ST (7)															
MSFC SIM (8)															
SOGS STScIF(9)															
SOGS SCC (9)															

ST REQUIREMENTS/SUPPORT MATRIX

SUPPORT SYSTEMS			AVAIL DATE	TEST DATE	TDRSS (4)												
					RECEIVES COMMAND SEQUENCES	RECEIVES COMMAND LOADS	TRANSMITS ST ENGINEERING & SCIENCE DATA	TRANSMITS PN CODING FOR RANGING									
POCC	PORTS PASS	(1)			*	*	*										
NCC		(2)			*	*	*										
	MPT	(2)															
NGT-NASCOM		(3)			*	*	*										
TDRSS		(4)			*	*	*	*									
DCF		(5)					*										
OSCF		(6)															
ST		(7)			*	*	*	*									
MSFC SIM		(8															
SOGS	STScIF	(9															
SOGS	SCC	(9															

MSFC ST SIMULATOR REQUIREMENTS/SUPPORT MATRIX

			POCC (1)				NGT (3)								
SUPPORT SYSTEMS	AVAIL DATE	TEST DATE	TRANSMITS SIM. ENGINEERING DATA STREAM	ORIGINATES DATA STREAM VIA DECNET	RECEIVES OUTPUT COMMANDS		RECEIVES ST ENGINEERING DATA								
POCC PORTS PASS (1)			*	*	*		*								
NCC (2)							*								
MPT (2)															
NGT-NASCOM (3)							*								
TDRSS (4)							*								
DCF (5)															
OSCF (6)															
ST (7)							*								
MSFC SIM (8)			*	*	*		*								
SOGS STScIF (9)															
SOGS SCC (9)															

APPENDIX B

REQUIRMENT/TEST DEVELOPMENT ORGANIZATIONS MATRICES

APPENDIX B

REQUIREMENTS/TEST DEVELOPMENT ORGANIZATIONS MATRICES

The following matrices depict the relationship between the STOMS interface functional requirements (along the top of the page) and the test development organization (along the side of the page). The interfacing elements are numbered 1 through 9 and correspond to the support systems (see Appendix A). The MPT for the purposes of this matrix is considered part of the NCC (2); and, the ST ScIF and SSC are both part of the SOGS (9).

As an aid in reading these matrices, the 'from' and 'to' can be read into each interface description. As an example, the first three pages illustrate the POCC interfaces grouped according to the element being interfaced. The first group of interface functional requirements are those that pertain to the POCC and the NCC. The first interface requirement within this block is 'TRANSMITS GCMRS'. This is read as "the POCC transmits GCMRs to the NCC". The test development organization to support this interface test is the PORTS contractor.

POCC REQUIREMENTS/TEST DEVELOPMENT ORGANIZATIONS MATRIX

			NCC							(2)	NGT-NASCOM				(3)
TEST DEVELOPMENT ORGANIZATION	ICD RESP		TRANSMITS GCMRS	TRANSMITS POST EVENT (QUALITY) REPORTS	TRANSMITS TDRSS SERVICE R'QMTS VIA MPT	RECEIVES TDRSS PERFORMANCE DATA	RECEIVES TDRSS & NETWORK SCHEDULES VIA MPT	PERFORMS DATA BASE INQUIRY	RECEIVES & TRANS-MITS ACKNOWLDGMT		RECEIVE HI-RATE SCIENCE DATA (SSA)	RECEIVE LO-RATE SCIENCE DATA (I)	RECEIVE ENGINEER-ING DATA (Q)	TRANSMIT COMMANDS	
SSM (LMSC)															
PORTS (FACC)			*	*		*	*	*	*		*	*	*	*	
PASS (CSC)					*										
SOGS (TRW)															
MOC (LMSC)															
ScI (JHU)															
M&DO (500)															
NETWORKS (800)															
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)															

POCC REQUIREMENTS/TEST DEVELOPMENT ORGANIZATIONS MATRIX

			DCF (5)				OSCF (6)		MSFC ST SIM. (8)						
TEST DEVELOPMENT ORGANIZATION	ICD RESP		TRANSMITS ST SCHEDULE	TRANSMITS SIM. HI-RATE SCIENCE DATA (SSA)	TRANSMITS SIM. LO-RATE SCIENCE DATA (I)		RECEIVE ORBIT DATA		RECEIVES ENGINEER-ING DATA STREAM (Q'CHAN.)	RECEIVES DATA STREAM VIA DECNET	TRANSMITS COMMANDS				
SSM (LSMC)															
PORTS (FACC)			*	*	*										
PASS (CSC)							*								
SOGS (TRW)															
MOC (LMSC)															
ScI (JHU)															
M&DO (500)															
NETWORKS (800)															
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)									*	*	*				

POCC REQUIREMENTS/TEST DEVELOPMENT ORGANIZATIONS MATRIX

			SSC								(9)	MISC			
TEST DEVELOPMENT ORGANIZATION	ICD RESP		PROVIDES COMMUNICATION CONSTRAINTS & OPERATIONS DATA	RECEIVES SCIENCE MISSION SPECIFICATION	TRANSMITS MISSION SCHEDULE PARAMETERS AND TIMELINES	RECEIVES COMMAND REQUESTS	TRANSMITS REAL-TIME SCIENCE LINK DATA	TRANSMITS SCIENCE TAPE RECORDER DUMPS	TRANSMITS SCIENCE ENGINEERING DATA	TRANSMITS ASTROMETRY DATA		TRANSFERS SELECTED TELEMETRY FILES TO LMSC, P-E, HENDIX			
SSM (LSMC)															
PORTS (FACC)						*	*	*	*	*		*			
PASS (CSC)															
SOGS (TRW)			*	*	*										
MOC (LMSC)															
ScI (JHU)															
M&DO (500)															
NETWORKS (800)															
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)															

NCC REQUIREMENTS/TEST DEVELOPMENT ORGANIZATIONS MATRIX

			POCC								(1)	NGT-NASCOM			(3)
TEST DEVELOPMENT ORGANIZATION	ICD RESP		RECEIVE GCMRs	RECEIVE POST EVENT QUALITY REPORTS	RECEIVE TDRSS SERVICE REQUIREMENTS	TRANSMIT TDRSS NETWORK PERFORMANCE	TRANSMIT TDRSS SCHEDULE VIA MPT	RESPOND TO DATA BASE INQUIRY	TRANSMITS ACKNOWLEDGEMENTS			TRANSMIT GCMRS TO TDRSS	RECEIVE TDRSS/NGT PERFORMANCE DATA	PROVIDE SYSTEM PERFORMANCE DATA	
SSM (LSMC)															
PORTS (FACC)			*	*		*	*	*	*						
PASS (CSC)					*										
SOGS (TRW)															
MOC (LMSC)															
ScI (JHU)															
M&DO (500)															
NETWORKS (800)												*	*	*	
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)															

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NCC REQUIREMENTS/TEST DEVELOPMENT ORGANIZATIONS MATRIX

			DCF (5)		OSCF (6)										
TEST DEVELOPMENT ORGANIZATION	ICD RESP		TRANSMIT TDRSS SCHEDULE		RECEIVE PSATs IIRVs & EPHEMERIDES	TRANSMIT TDRSS SCHEDULE VIA MPT	RECEIVE OSCF PERFORMANCE DATA								
SSh (LSMC)															
PORTS (FACC)															
PASS (CSC)															
SOGS (TRW)															
MOC (LMSC)															
ScI (JHU)															
M&DO (500)			*		*	*	*								
NETWORKS (800)															
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)															

NGT-NASCOM REQUIREMENTS/TEST DEVELOPMENT ORGANIZATIONS MATRIX

			POCC (1)					NCC (2)				MSFC-SIM(8)			
TEST DEVELOPMENT ORGANIZATION	ICD RESP		TRANSMITS HI-RATE (SSA) SCIENCE DATA	TRANSMITS LO-RATE (I) SCIENCE DATA	TRANSMITS ENGINEERING DATA	RECEIVES ST COMMANDS		RECEIVES GCMRS FOR TDRSS	TRANSMITS TDRSS & NGT PERFORMANCE DATA	RECEIVES SYSTEM PERFORMANCE DATA				TRANSMITS ST ENGINEERING DATA	
SSM (LSMC)															
PORTS (FACC)			*	*	*	*									
PASS (CSC)															
SOGS (TRW)															
MOC (LMSC)															
ScI (JHU)															
M&DO (500)															
NETWORKS (800)								*	*	*					
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)														*	

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NGT-NASCOM REQUIREMENTS/TEST DEVELOPMENT ORGANIZATIONS MATRIX

			TDRSS							(4)	DCF		(5)	OSCF (6)	
TEST DEVELOPMENT ORGANIZATION	ICD RESP		TRANSMITS GCMRs FROM NCC	RECEIVES HI-RATE (SSA) SCIENCE DATA	RECEIVES LO-RATE (I) SCIENCE DATA	RECEIVES 'Q' CHAN. ENGINEERING DATA	RECEIVES PERFORMANCE DATA	TRANSMITS COMMANDS FROM POCC	RECEIVES ST & TDRSS TRACKING DATA FOR OSCF		TRANSMITS HI-RATE SCIENCE DATA	TRANSMITS LO-RATE SCIENCE DATA		TRANSMITS TRACKING DATA FROM TDRSS	
SSM (LMSC)															
PORTS (FACC)															
PASS (CSC)															
SOGS (TRW)															
MOC (LMSC)															
ScI (JHU)															
M&DO (500)											*	*	*	*	
NETWORKS (800)			*	*	*	*	*	*	*						
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)															

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TDRSS REQUIREMENTS/TEST DEVELOPMENT ORGANIZATIONS MATRIX

			NGT-NASCOM							(3)	ST				(7)
TEST DEVELOPMENT ORGANIZATION	ICD RESP		RECEIVES GCMRs FROM NCC	TRANSMITS HI-RATE SCIENCE DATA TO POCC/DCF	TRANSMITS LO-RATE SCIENCE DATA TO POCC/DCF	TRANSMITS 'Q' CHAN. RT ENGINEERING DATA TO POCC	TRANSMITS PERFORMANCE DATA TO NCC	RECEIVES COMMAND DATA FROM POCC	TRANSMITS ST & TDRSS TRACKING DATA TO OSCF		TRANSMITS COMMANDS USING MA OR SSA	TRANSMITS STORED PROGRAM COMMAND LOADS USING SSA	RECEIVES ST ENG., ASTROMETRY & SCIENCE ON MA & SSA	RECEIVES PM CODE ON MA FOR TRACKING	
S SM (LMSC)															
PORTS (FACC)															
PASS (CSC)															
SOGS (TRW)															
MOC (LMSC)															
ScI (JHU)															
M&DO (500)															
NETWORKS (800)			*	*	*	*	*	*	*		*	*	*		
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)															

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DCF REQUIREMENTS/TEST DEVELOPMENT ORGANIZATIONS MATRIX

			POCC (1)				NCC (2)		NGT-NASCOM (3)			SCI (9)			
TEST DEVELOPMENT ORGANIZATION	ICD RESP		RECEIVES ST SCHEDULE CHANGES	RECEIVES SIMULATED HI-RATE SCIENCE DATA	RECEIVES SIMULATED LO-RATE SCIENCE DATA		RECEIVES ST & TDRSS SCHEDULE		RECEIVES HI-RATE SCIENCE DATA	RECEIVES LO-RATE SCIENCE DATA		TRANSMITS SCIENCE DATA			
SSM (LMSC)															
PORTS (FACC)				*	*										
PASS (CSC)															
SOGS (TRW)															
MOC (LMSC)			*												
ScI (JHU)															
M&DO (500)							*		*	*		*			
NETWORKS (800)															
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)															

OSCF REQUIREMENTS/TEST DEVELOPMENT ORGANIZATIONS MATRIX

			POCC (1)		NCC			(2)	NGT (3)						
TEST DEVELOPMENT ORGANIZATION	ICD RESP		TRANSMITS ORBIT DATA		TRANSMITS ACQUISITION DATA	RECEIVES ST & TDRS SCHEDULE VIA MPT	TRANSMITS PERFORMANCE DATA		RECEIVES TRACKING DATA FROM TDRSS						
SSM (LMSC)															
PORTS (FACC)															
PASS (CSC)			*												
SOGS (TRW)															
MOC (LMSC)															
ScI (JHU)															
M&DO (500)					*	*	*		*						
NETWORKS (800)															
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)															

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ST REQUIREMENTS/TEST DEVELOPMENT ORGANIZATIONS MATRIX

			TDRSS (4)												
TEST DEVELOPMENT ORGANIZATION	ICD RESP		RECEIVES COMMAND SEQUENCES	RECEIVES COMMAND LOADS	TRANSMITS ST ENGINEERING & SCIENCE DATA	TRANSMITS PN CODING FOR RANGING									
SSM (LMSC)															
PORTS (FACC)															
PASS (CSC)															
SOGS (TRW)															
MOC (LMSC)															
ScI (JHU)															
M&DO (500)															
NETWORKS (800)			*	*	*	*									
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)															

MSCF ST SIMULATOR REQUIREMENTS/TEST DEVELOPMENT ORGANIZATIONS MATRIX

TEST DEVELOPMENT ORGANIZATION	ICD RESP		POCC (1)				NGT (3)								
			TRANSMITS SIM. ENGINEERING DATA STREAM	ORIGINATES DATA STREAM VIA DECNET	RECEIVES OUTPUT COMMANDS		RECEIVES ST ENGINEERING DATA								
SSW (LMSC)															
PORTS (FACC)															
PASS (CSC)															
SOGS (TRW)															
MOC (LMSC)															
ScI (JHU)															
M&DO (500)															
NETWORKS (800)															
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)			*	*	*		*								

APPENDIX C

REQUIREMENTS/TEST VALIDATION ORGANIZATIONS MATRICES

APPENDIX C

REQUIREMENTS/TEST VALIDATION ORGANIZATIONS MATRICES

The following matrices depict the relationship between the STOMS interface functional requirements (along the top of the page) and the test validation organization (along the side of the page). The interfacing elements are numbered 1 through 9 and correspond to the support systems (see Appendix A). The MPT for the purposes of this matrix is considered part of the NCC (2); and, the ST ScIF and SSC are both part of the SOGS (9).

As an aid in reading these matrices, the 'from' and 'to' can be read into each interface description. As an example, the first three pages illustrate the POCC interfaces grouped according to the element being interfaced. The first group of interface functional requirements are those that pertain to the POCC and the NCC. The first interface requirement within this block is 'TRANSMITS GCMRS'. This is read as "the POCC transmits GCMRs to the NCC". The test validation organization to support this interface test are (those asterisked) the MOC, M&DO, and Networks.

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POCC/TEST VALIDATION ORGANIZATION MATRIX

			NCC							(2)	NGT-NASCOM				(3)
TEST VALIDATION ORGANIZATION			TRANSMITS GCMRS	TRANSMITS POST EVENT (QUALITY) REPORTS	TRANSMITS TDRSS SERVICE R'QMTS VIA MPT	RECEIVES TDRSS PERFORMANCE DATA	RECEIVES TDRSS & NETWORK SCHEDULES VIA MPT	PERFORMS DATA BASE INQUIRY	RECEIVES & TRANS-MITS ACKNOWLDGMT		RECEIVE HI-RATE SCIENCE DATA (SSA)	RECEIVE LO-RATE SCIENCE DATA (I)	RECEIVE ENGINEER-ING DATA (Q)	TRANSMIT COMMANDS	
SSM (LMSC)															
PORTS (FACC)															
PASS (LSC)							*								
SOGS (TRW)															
MOC (LMSC)			*	*	*	*		*	*		*	*	*	*	
ScI (JHU)															
M&DO (500)			*	*	*	*	*	*	*		*	*	*	*	
NETWORKS (800)			*	*	*	*	*	*	*		*	*	*	*	
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)															

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POCC/TEST VALIDATION ORGANIZATION MATRIX

			DCF (5)				OSCF (6)		MSFC ST SIM. (8)						
TEST VALIDATION ORGANIZATION			TRANSMITS ST SCHEDULE	TRANSMITS SIM. HI-RATE SCIENCE DATA (SSA)	TRANSMITS SIM. LO-RATE SCIENCE DATA (I)		RECEIVE ORBIT DATA		RECEIVES ENGINEERING DATA STREAM (Q.CHAN.)	RECEIVES DATA STREAM VIA DECNET	TRANSMITS COMMANDS				
SSM (LMSC)															
PORTS (FACC)				*	*				*	*	*				
PASS (LSC)							*								
SOGS (TRW)															
MOC (LMSC)			*						*	*	*				
ScI (JHU)															
M&DO (500)			*	*	*		*		*	*	*				
NETWORKS (800)															
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)									*	*	*				

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POCC/TEST VALIDATION ORGANIZATION MATRIX

			SSC								(9)	MISC			
TEST VALIDATION ORGANIZATION			PROVIDES COMMUNICATION CONSTRAINTS & OPERATIONS DATA	RECEIVES SCIENCE MISSION SPECIFICATION	TRANSMITS MISSION SCHEDULE PARAMETERS AND TIMELINES	RECEIVES COMMAND REQUESTS	TRANSMITS REAL-TIME SCIENCE LINK DATA	TRANSMITS SCIENCE TAPE RECORDER DUMPS	TRANSMITS SCIENCE ENGINEERING DATA	TRANSMITS ASTROMETRY DATA		TRANSFERS SELECTED TELEMETRY FILES TO LMSC, P-E, BENDIX			
SSM (LMSC)															
PORTS (FACC)															
PASS (CSC)			*	*	*										
SOGS (TRW)															
MOC (LMSC).						*	*	*	*	*		*			
ScI(JHU)															
M&DO (500)			*	*	*	*	*	*	*	*		*			
NETWORKS (800)															
MISSION OPERATION MANAGEMENT (400)			*	*	*	*	*	*	*	*					
PROJECT MANAGEMENT (MSFC)															

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NCC/TEST VALIDATION ORGANIZATION MATRIX

			POCC								(1)	NGT-NASCOM			(3)
TEST VALIDATION ORGANIZATION			RECEIVE GCMRs	RECEIVE POST EVENT QUALITY REPORTS	RECEIVE TDRSS SERVICE REQUIREMENTS	TRANSMIT TDRSS NETWORK PERFORMANCE	TRANSMIT TDRSS SCHEDULE VIA MPT	RESPOND TO DATA BASE INQUIRY	TRANSMITS ACKNOWLEDGEMENTS			TRANSMIT GCMRS TO TDRSS	RECEIVE TDRSS/NGT PERFORMANCE DATA	PROVIDE SYSTEM PERFORMANCE DATA	
SSM (LMSC)															
PORTS (FACC)															
PASS (CSC)															
SOGS (TRW)															
MOC (LMSC)			*	*	*	*	*	*	*						
ScI (JHU)															
M&DO (500)			*	*	*	*	*	*	*						
NETWORKS (800)												*	*	*	
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)															

NCC/TEST VALIDATION ORGANIZATION MATRIX

			DCF (5)		OSCF (6)										
TEST VALIDATION ORGANIZATION			TRANSMIT TDRSS SCHEDULE		RECEIVE PSATs IIRVs & EPHEMERIDES	TRANSMIT TDRSS SCHEDULE VIA MPT	RECEIVE OSCF PERFORMANCE DATA								
SSM (LMSC)															
PORTS (FACC)															
PASS (CSC)															
SOGS TRW															
MOC (LMSC)															
ScI (JHU)															
M&DO (500)			*		*	*	*								
NETWORKS (800)					*		*								
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)															

NGT-NASCOM/TEST VALIDATION ORGANIZATION MATRIX

			POCC (1)					NCC (2)				MSFC-SIM(8)			
TEST VALIDATION ORGANIZATION			TRANSMITS HI-RATE (SSA) SCIENCE DATA	TRANSMITS LO-RATE (I) SCIENCE DATA	TRANSMITS ENGINEERING DATA	RECEIVES ST COMMANDS		RECEIVES COMRS FOR TDRSS	TRANSMITS TDRSS & NGT PERFORMANCE DATA	RECEIVES SYSTEM PERFORMANCE DATA				TRANSMITS ST ENGINEERING DATA	
SSM (LMSC)															
PORTS (FACC)															
PASS (CSC)															
SOGS (TRW)															
MOC (LMSC)			*	*	*	*									
Sci (JHU)															
M&DO (500)			*	*	*	*								*	
NETWORKS (800)								*	*	*					
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT														*	

NGT-NASCOM/TEST VALIDATION ORGANIZATION MATRIX

TEST VALIDATION ORGANIZATION			TDRSS (4)								DCF (5)			OSCF (6)	
			TRANSMITS GCMRs FROM NCC	RECEIVES HI-RATE (SSA) SCIENCE DATA	RECEIVES LO-RATE (I) SCIENCE DATA	RECEIVES 'Q' CHAN. ENGINEERING DATA	RECEIVES PERFORMANCE DATA	TRANSMITS COMMANDS FROM POCC	RECEIVES ST & TDRSS TRACKING DATA FOR OSCF		TRANSMITS HI-RATE SCIENCE DATA	TRANSMITS LO-RATE SCIENCE DATA		TRANSMITS TRACKING DATA FROM TDRSS	
SSM (LMSC)															
PORTS (FACC)															
PASS (CSC)															
SOGS (TRW)															
MOC (LMSC)															
ScI JHU															
M&DO (500)											*	*		*	
NETWORKS (800)			*	*	*	*	*	*	*						
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)															

TDRSS/TEST VALIDATION ORGANIZATION MATRIX

TEST VALIDATION ORGANIZATION			NGT-NASCOM							(3)	ST				(7)
			RECEIVES GCMRs FROM NCC	TRANSMITS HI-RATE SCIENCE DATA TO POCC/DCF	TRANSMITS LO-RATE SCIENCE DATA TO POCC/DCF	TRANSMITS 'Q' CHAN. RT ENGINEERING DATA TO POCC	TRANSMITS PERFORMANCE DATA TO NCC	RECEIVES COMMAND DATA FROM POCC	TRANSMITS ST & TDRSS TRACKING DATA TO OSCF		TRANSMITS COMMANDS USING MA OR SSA	TRANSMITS STORED PROGRAM COMMAND LOADS USING SSA	RECEIVES ST ENG., ASTROMETRY & SCIENCE ON MA & SSA	RECEIVES PM CODE ON MA FOR TRACKING	
SSM (LMSC)											*	*			
PORTS (FACC)															
PASS (CSC)															
SOGS (TRW)															
MOC (LMSC)															
ScI (JHU)															
M & DO (500)															
NETWORKS (800)			*	*	*	*	*	*	*				*	*	
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)															

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DCF/TEST VALIDATION ORGANIZATION MATRIX

			POCC (1)				NCC (2)		NGT-NASCOM (3)			SCI (9)			
TEST VALIDATION ORGANIZATION			RECEIVES ST SCHEDULE CHANGES	RECEIVES SIMULATED HI-RATE SCIENCE DATA	RECEIVES SIMULATED LO-RATE SCIENCE DATA		RECEIVES ST & TDRSS SCHEDULE		RECEIVES HI-RATE SCIENCE DATA	RECEIVES LO-RATE SCIENCE DATA		TRANSMITS SCIENCE DATA			
SSM (LMSC)															
PORTS (FACC)															
PASS (CSC)															
SOGS (TRW)															
MOC (LMSC)															
ScI (JHU)												*			
M&DO (500)			*	*	*		*		*	*		*			
NETWORKS (800)															
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)															

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TEST VALIDATION ORGANIZATION MATRIX

			POCC (1)		NCC			(2)	NGT (3)						
TEST VALIDATION ORGANIZATION			TRANSMITS ORBIT DATA		TRANSMITS ACQUISITION DATA	RECEIVES ST & TDRS SCHEDULE VIA MPT	TRANSMITS PERFORMANCE DATA		RECEIVES TRACKING DATA FROM TDRSS						
SSM (LMSC)															
PORTS (FACC)															
PASS (CSC)			*												
SOGS (TRW)															
MOC (LMSC)															
ScI (JHU)															
M&DO (500)			*		*	*	*		*						
NETWORKS (800)					*		*		*						
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)															

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ST/TEST VALIDATION ORGANIZATION MATRIX

			TDRSS (4)												
TEST VALIDATION ORGANIZATION			RECEIVES COMMAND SEQUENCES	RECEIVES COMMAND LOADS	TRANSMITS ST ENGINEERING & SCIENCE DATA	TRANSMITS PN CODING FOR RANGING									
SSM (LMSC)			*	*											
PORTS (FACC)															
PASS (CSC)															
SOGS (TRW)															
MOC (LMSC)															
ScI (JHU)															
M&DO (500)															
NETWORKS (800)					*	*									
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)															

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MSFC SIMULATOR/TEST VALIDATION ORGANIZATION MATRIX

			POCC (1)				NGT (3)								
TEST VALIDATION ORGANIZATION			TRANSMITS SIM. ENGINEERING DATA STREAM	ORIGINATES DATA STREAM VIA DECNET	RECEIVES OUTPUT COMMANDS		RECEIVES ST ENGINEERING DATA								
SSM (LMSC)															
PORTS (FACC)			*												
PASS (CSC)															
SOGS (TRW)															
MOC (LMSC)			*												
ScI (JHU)															
M&DO (500)			*	*	*										
NETWORKS (800)															
MISSION OPERATION MANAGEMENT (400)															
PROJECT MANAGEMENT (MSFC)				*	*		*								

APPENDIX D
REQUIREMENTS/TEST TOOLS MATRICES

APPENDIX D

REQUIREMENTS/TEST TOOLS MATRICES

The following matrices depict the relationship between the STOMS interface functional requirements (along the top of the page) and the test tools (along the side of the page). The interfacing elements are numbered 1 through 9 and correspond to the support systems (see Appendix A). The MPT for the purposes of this matrix is considered part of the NCC (2); and, the ST ScIF and SSC are both part of the SOGS (9).

As an aid in reading these matrices, the 'from' and 'to' can be read into each interface description. As an example, the first three pages illustrate the POCC interfaces grouped according to the element being interfaced. The first group of interface functional requirements are those that pertain to the POCC and the NCC. The first interface requirement within this block is 'TRANSMITS GCMRS'. This is read as "the POCC transmits GCMRs to the NCC". The test tools required to support this interface test are (those asterisked) the LTU, NCCS Simulator, vendor software, TAV, and mission simulation.

POCC REQUIREMENTS/TEST TOOLS MATRIX

			NCC							(2)	NGT-NASCOM				(3)
TEST TOOLS			TRANSMITS GCMRS	TRANSMITS POST EVENT (QUALITY) REPORTS	TRANSMITS TDRSS SERVICE R'QMTS VIA MPT	RECEIVES TDRSS PERFORMANCE DATA	RECEIVES TDRSS & NETWORK SCHEDULES VIA MPT	PERFORMS DATA BASE INQUIRY	RECEIVES & TRANSMITS ACKNOWLDGMT		RECEIVE HI-RATE SCIENCE DATA (SSA)	RECEIVE LO-RATE SCIENCE DATA (I)	RECEIVE ENGINEERING DATA (Q)	TRANSMIT COMMANDS	
LTU			*	*	*		*		*		*	*	*	*	
CTV															
NCC SIM			*												
MSFC SIM											*	*	*	*	
VENDOR SOFTWARE			*											*	
VAP											*	*	*	*	
TAV			*	*	*		*	*	*		*	*	*	*	
LMSC A&V											*	*	*	*	
SOGS I&T															
MOPD											*	*	*	*	
MOGS															
MISSION SIM			*	*	*		*	*	*		*	*	*	*	

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POCC REQUIREMENTS/TEST TOOLS MATRIX

			DCF (5)				OSCF (6)		MSFC ST SIM. (8)						
TEST TOOLS			TRANSMITS ST SCHEDULE	TRANSMITS SIM. HI-RATE SCIENCE DATA (SSA)	TRANSMITS SIM. LO-RATE SCIENCE DATA (I)		RECEIVE ORBIT DATA		RECEIVES ENGINEER-ING DATA STREAM (O'CHAN.)	RECEIVES DATA STREAM VIA DECNET	TRANSMITS COMMANDS				
LTU			*	*	*		*		*	*	*				
CTV															
NCC SIM															
MSFC SIM									*	*	*				
VENDOR SOFTWARE				*	*						*				
VAP															
TAV			*	*	*		*		*	*	*				
LMSC A&V															
SOGS I&T															
MOPD									*	*	*				
MOGS															
MISSION SIM			*	*	*		*	*	*	*	*				

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POCC REQUIREMENTS/TEST TOOLS MATRIX

			SSC								(9)	MISC			
TEST TOOLS			PROVIDES COMMUNICATION CONSTRAINTS & OPERATIONS DATA	RECEIVES SCIENCE MISSION SPECIFICATION	TRANSMITS MISSION SCHEDULE PARAMETERS AND TIMELINES	RECEIVES COMMAND REQUESTS	TRANSMITS REAL-TIME SCIENCE LINK DATA	TRANSMITS SCIENCE TAPE RECORDER DUMPS	TRANSMITS SCIENCE ENGINEERING DATA	TRANSMITS ASTROMETRY DATA		TRANSFERS SELECTED TELEMETRY FILES TO LMSC, P-E, BENDIX			
LTU			*	*	*	*	*	*	*	*					
CTV															
NCC SIM															
MSFC SIM															
VENDOR SOFTWARE			*		*		*	*	*	*					
VAP															
TAV			*	*	*	*	*	*	*	*		*			
LMSC A&V															
SOGS I&T			*	*	*	*	*	*	*	*					
MOPD															
MOGS			*	*	*	*	*	*	*	*					
MISSION SIM			*	*	*	*	*	*	*	*		*			

NCC REQUIREMENTS/TEST TOOLS MATRIX

			POCC (1)									NGT-NASCOM (3)			
TEST TOOLS			RECEIVE GCMRs	RECEIVE POST EVENT QUALITY REPORTS	RECEIVE TDRSS SERVICE REQUIREMENTS	TRANSMIT TDRSS NETWORK PERFORMANCE	TRANSMIT TDRSS SCHEDULE VIA MPT	RESPOND TO DATA BASE INQUIRY	TRANSMITS ACKNOWLEDGEMENTS			TRANSMIT GCMRS TO TDRSS	RECEIVE TDRSS/NGT PERFORMANCE DATA	PROVIDE SYSTEM PERFORMANCE DATA	
LTU			*	*	*	*	*		*						
CTV															
NCC SIM			*			*									
MSFC SIM															
VENDOR SOFTWARE															
VAP															
TAV			*	*	*	*	*	*	*			*	*	*	*
LMSC A&V															
SOGS I&T															
MOPD															
MOGS															
MISSION SIM			*	*	*	*	*	*	*			*	*	*	

NCC REQUIREMENTS/TEST TOOLS MATRIX

			DCF (5)		OSCF			(6)							
TEST TOOLS			TRANSMIT TDRSS SCHEDULE		RECEIVE PSATs IIRVs & EPHEMERIDES	TRANSMIT TDRSS SCHEDULE VIA MPT	RECEIVE OSCF PERFORMANCE DATA								
LTU															
CTV															
NCC SIM															
MSFC SIM															
VENDOR SOFTWARE															
VAP															
TAV			*		*	*	*								
LMSC A&V															
SOGS I&T															
MOPD															
MOGS															
MISSION SIM			*	*	*	*	*								

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NGT-NASCOM REQUIREMENTS/TEST TOOLS MATRIX

			TDRSS							(4)	DCF		(5)	OSCF	(6)
TEST TOOLS			TRANSMITS GCMRs FROM NCC	RECEIVES HI-RATE (SSA) SCIENCE DATA	RECEIVES LO-RATE (I) SCIENCE DATA	RECEIVES 'Q' CHAN. ENGINEERING DATA	RECEIVES PERFORMANCE DATA	TRANSMITS COMMANDS FROM POCC	RECEIVES ST & TDRSS TRACKING DATA FOR OSCF		TRANSMITS HI-RATE SCIENCE DATA	TRANSMITS LO-RATE SCIENCE DATA		TRANSMITS TRACKING DATA FROM TDRSS	
LTU															
CTV				*	*	*		*			*				
NCC SIM															
MSFC SIM															
VENDOR SOFTWARE															
VAP															
TAV											*	*		*	
LMSC A&V				*	*	*		*	*		*				
SOGS I&T															
MOPD															
MOGS															
MISSION SIM											*	*			

NGT-NASCOM REQUIREMENTS/TEST TOOLS MATRIX

			POCC (1)					NCC (2)				MSFC-SIM(8)			
TEST TOOLS			TRANSMITS HI-RATE (SSA) SCIENCE DATA	TRANSMITS LO-RATE (I) SCIENCE DATA	TRANSMITS ENGINEERING DATA	RECEIVES ST COMMANDS		RECEIVES GCMRS FOR TDRSS	TRANSMITS TDRSS & NGT PERFORMANCE DATA	RECEIVES SYSTEM PERFORMANCE DATA				TRANSMITS ST ENGINEERING DATA	
LTU			*	*	*	*									
CTV															
NCC SIM															
MSFC SIM															
VENDOR SOFTWARE															
VAP															
TAV			*	*	*	*		*	*	*				*	
LMSC A&V			*	*	*	*								*	
SOGS I&T															
MOPD															
MOGS															
MISSION SIM			*	*	*	*		*	*	*				*	

TDRSS REQUIREMENTS/TEST TOOLS MATRIX

			NGT-NASCOM							(3)	ST				(7)
TEST TOOLS			RECEIVES GCMRs FROM NCC	TRANSMITS HI-RATE SCIENCE DATA TO POCC/DCF	TRANSMITS LO-RATE SCIENCE DATA TO POCC/DCF	TRANSMITS 'Q' CHAN. RT ENGINEERING DATA TO POCC	TRANSMITS PERFORMANCE DATA TO NCC	RECEIVES COMMAND DATA FROM POCC	TRANSMITS ST & TDRSS TRACKING DATA TO OSCF		TRANSMITS COMMANDS USING MA OR SSA	TRANSMITS STORED PROGRAM COMMAND LOADS USING SSA	RECEIVES ST ENG., ASTROMETRY & SCIENCE ON MA & SSA	RECEIVES PM CODE ON MA FOR TRACKING	
LTU															
CTV				*	*	*		*			*	*	*	*	
NCC SIM															
MSFC SIM															
VENDOR SOFTWARE															
VAP															
TAV															
LMSC A&V				*	*	*		*			*	*	*	*	
SOGS I&T															
MOPD															
MOGS															
MISSION SIM															

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DCF REQUIREMENTS/TEST TOOLS MATRIX

			POCC (1)				NCC (2)		NGT-NASCOM (3)			SCI (9)			
TEST TOOLS			RECEIVES ST SCHEDULE CHANGES	RECEIVES SIMULATED HI-RATE SCIENCE DATA	RECEIVES SIMULATED LO-RATE SCIENCE DATA		RECEIVES ST & TDRSS SCHEDULE		RECEIVES HI-RATE SCIENCE DATA	RECEIVES LO-RATE SCIENCE DATA		TRANSMITS SCIENCE DATA			
LTU			*	*	*										
CTV															
NCC SIM															
MSFC SIM															
VENDOR SOFTWARE															
VAP															
TAV			*	*	*		*		*	*		*			
LMSC A&V									*	*					
SOGS I&T															
MOPD															
MOGS												*			
MISSION SIM			*	*	*		*		*	*		*			

OSCF REQUIREMENTS/TEST TOOLS MATRIX

			RCC (1)		NCC		(2)		NGT (3)						
TEST TOOLS			TRANSMITS ORBIT DATA		TRANSMITS ACQUISITION DATA	RECEIVES ST & TDRS SCHEDULE VIA MPT	TRANSMITS PERFORMANCE DATA		RECEIVES TRACKING DATA FROM TDRSS						
LTU			*												
CTV															
NCC SIM															
MSFC SIM															
VENDOR SOFTWARE															
VAP															
TAV			*		*	*	*		*						
LMSC A&V															
SOGS I&T															
MOPD															
MOGS															
MISSION SIM			*		*	*	*								

ST REQUIREMENTS/TEST TOOLS MATRIX

			TDRSS (4)													
TEST TOOLS			RECEIVES COMAND SEQUENCES	RECEIVES COMAND LOADS	TRANSMITS ST ENGINEERING & SCIENCE DATA	TRANSMITS PN CODING FOR RANGING										
LTU																
CTV			*	*	*	*										
NCC SIM																
MSFC SIM																
VENDOR SOFTWARE																
VAP																
TAV																
LMSC A&V			*	*	*	*										
SOGS I&T																
MOPD																
MOGS																
MISSION SIM																

MSCF ST SIMULATOR REQUIREMENTS/TEST TOOLS MATRIX

			POCC (1)				NGT (3)								
TEST TOOLS			TRANSMITS SIM. ENGINEERING DATA STREAM	ORIGINATES DATA STREAM VIA DECNET	RECEIVES OUTPUT COMMANDS		RECEIVES ST ENGINEERING DATA								
LTU			*	*	*										
CTV															
NCC SIM															
MSFC SIM															
VENDOR SOFTWARE					*										
VAP															
TAV			*	*	*		*								
LMSC A&V							*								
SOGS I&T															
MOPD															
MOGS															
MISSION SIM			*	*	*										

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APPENDIX E

REQUIREMENTS/CTDSs MATRICES

APPENDIX E
REQUIREMENTS/CTDSs MATRICES

The following matrices depict the relationship between the STOMS interface functional requirements (along the top of the page) and the test CTDSs (along the side of the page). The interfacing elements are numbered 1 through 9 and correspond to the support systems (see Appendix A). The MPT for the purposes of this matrix is considered part of the NCC (2); and, the ST ScIF and SSC are both part of the SOGS (9).

As an aid in reading these matrices, the 'from' and 'to' can be read into each interface description. As an example, the first three pages illustrate the POCC interfaces grouped according to the element being interfaced. The first group of interface functional requirements are those that pertain to the POCC and the NCC. The first interface requirement within this block is 'TRANSMITS GCMRS'. This is read as "the POCC transmits GCMRs to the NCC". The CTDS required to support this interface is the GCMR CTDS.

A control number (CTDS NO.) for each Control Test Data Set uniquely identifies that data set plus indicates the particular system element and interface. The following list indicates the code used for labeling the CTDS. The alpha character indicates the system originating the data (the 'from' element). The numeric code indicates where this data terminates (the 'to' element).

	SOURCE	TERM	NUMBER IN SERIES
POCC	P	1	n
NCC	N	2	n
NGT	G	3	n
TDRSS	T	4	n
DCF	D	5	n
OSCF	C	6	n
ST	S	7	n
SIM	M	8	n
SSC/ST ScIF	X	9	n

As an example, CTDS, number N14, would indicate that this CTDS (Performance Data) originates in the NCC (N), terminates with the POCC (1), and is number 4 in that series.

Where applicable the Support Instrumentation Requirements Document (SIRD) number has also been indicated.

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POCC REQUIREMENTS/CTDS MATRIX

			NCC							(2)	NGT-NASCOM				(3)
CDTS	CDTS NO.	SIRD NO.	TRANSMITS GCMRS	TRANSMITS POST EVENT (QUALITY) REPORTS	TRANSMITS TDRSS SERVICE R'QMTS VIA MPT	RECEIVES TDRSS PERFORMANCE DATA	RECEIVES TDRSS & NETWORK SCHEDULES VIA MPT	PERFORMS DATA BASE INQUIRY	RECEIVES & TRANS-MITS ACKNOWLDGMT		RECEIVE HI-RATE SCIENCE DATA (SSA)	RECEIVE LO-RATE SCIENCE DATA (I)	RECEIVE ENGINEER-ING DATA (Q)	TRANSMIT COMMANDS	
PERFORMANCE DATA	N14					R									
GCMR ACKNOWLEDGE	N12	13							R						
NCC DATA BASE	N13							R							
SCHEDULING MESSAGES	N11	14					R								
GCMR	P21	13	T												
POST EVENT REPORT	P22			T											
TDRSS SERVICE REQUIREMENT	P23	14			T										
HI-RATE SCIENCE	T31	1									R				
LO-RATE SCIENCE	T31	1										R			
ENGINEERING	T33	3											R		
RT COMMANDS	P21	4												T	

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PCCC REQUIREMENTS/CTDS MATRIX

			DCF (5)				OSCF (6)		MSFC ST SIM. (8)						
CTDS	CTDS NO.	SIRD NO.	TRANSMITS ST SCHEDULE	TRANSMITS SIM. HI-RATE SCIENCE DATA (SSA)	TRANSMITS SIM. LO-RATE SCIENCE DATA (I)		RECEIVE ORBIT DATA		RECEIVES ENGINEERING DATA STREAM (Q'CHAN.)	RECEIVES DATA STREAM VIA DECNET	TRANSMITS COMMANDS				
SCHEDULE MESSAGES	P51	25	T												
ORBIT DATA	C11	23					R								
COMMANDS	P81	10.1									T				
DECNET SERVICES	M12	26								R					
SIM ENGINEERING	M11	10							R						
SIM HI-RATE SCIENCE	P52	27		T											
SIM LO-RATE SCIENCE	P53	28			T										

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POCC REQUIREMENTS/CTDS MATRIX

			SSC								(9)	MISC			
CTDS	CTDS NO.	SIRI NO.	PROVIDES COMMUNICATION CONSTRAINTS & OPERATIONS DATA	RECEIVES SCIENCE MISSION SPECIFICATION	TRANSMITS MISSION SCHEDULE PARAMETERS AND TIMELINES	RECEIVES COMMAND REQUESTS	TRANSMITS REAL-TIME SCIENCE LINK DATA	TRANSMITS SCIENCE TAPE RECORDER DUMPS	TRANSMITS SCIENCE ENGINEERING DATA	TRANSMITS ASTROMETRY DATA		TRANSFERS SELECTED TELEMETRY FILES TO LMSC, P-E, BENDIX			
SPACECRAFT DATA BASE	P91.1	9	T												
CONSTRAINTS AND RESTRICTIONS DATA	P91.2	9	T												
COMMUNICATIONS DATA	P91.3	9	T												
SCHEDULE DATA	P 93	6			T										
SCIENCE MISSION SPECIFICATION	P 94	6		R											
SCIENCE DATA	P 95	7					T								
ENGINEERING DATA	P96.1	8							T						
ASTROMETRY DATA	P96.2	8								T					
ANCILLARY DATA	P96.3	8													
COMMAND REQUESTS	P96.4	8				R									
DIAL UP	P 0.1	12													
HIGH RATE SCIENCE	T 31	1						T				T			

NCC REQUIREMENTS/CDTS MATRIX

CTDS	CTDS NO.	SIRD NO.	POCC: RECEIVE GCMRs	POCC: RECEIVE POST EVENT QUALITY REPORTS	POCC: RECEIVE TDRSS SERVICE REQUIREMENTS	POCC: TRANSMIT TDRSS NETWORK PERFORMANCE	POCC: TRANSMIT TDRSS SCHEDULE VIA MPT	POCC: RESPOND TO DATA BASE INQUIRY	POCC: TRANSMITS ACKNOWLEDGEMENTS	POCC (1)	POCC (1)	NGT-NASCOM: TRANSMIT GCMRS TO TDRSS	NGT-NASCOM: RECEIVE TDRSS/NGT PERFORMANCE DATA	NGT-NASCOM: PROVIDE SYSTEM PERFORMANCE DATA	NGT-NASCOM (3)
OPERATIONS DATA MESSAGES	N14														
GCMR	N12	13							T						
NCC DATA BASE	N13							T							
SCHEDULING MESSAGES	N11	14					T								
GCMR	P21	13	R												
POST EVENT REPORT	P22			R											
TDRSS SERVICE REPORT	P23	14			R										
GCMR	N31											T			
PERFORMANCE DATA (ODM)	T34												R		

NCC REQUIREMENTS/CDTS MATRIX

			DCF (5)		OSCF (6)										
CTDS	CTDS NO.	STRD NO.	TRANSMIT TDRSS SCHEDULE		RECEIVE PSATs IIRVs & EPHEMERIDES	TRANSMIT TDRSS SCHEDULE VIA MPT	RECEIVE OSCF PERFORMANCE DATA								
TDRSS SCHEDULE	N51	15	T												
PSATS	C21.1	23			R										
IIRVs	C21.2	23			R										
EPHEMERIDES	C21.3	23			R										
TDRSS SCHEDULE	N61	24				T									
PERFORMANCE DATA	C22						R								

NGT-NASCOM REQUIREMENTS/CDTS MATRIX

CTDS	CTDS NO.	SIRD NO.	POCC (1)					NOC (2)				MSPC-SIM(8)			
			TRANSMITS HI-RATE (SSA) SCIENCE DATA	TRANSMITS LO-RATE (I) SCIENCE DATA	TRANSMITS ENGINEERING DATA	RECEIVES ST COMMANDS		RECEIVES GCMRS FOR TDRSS	TRANSMITS TDRSS & NGT PERFORMANCE DATA	RECEIVES SYSTEM PERFORMANCE DATA				TRANSMITS ST ENGINEERING DATA	
HI-RATE SCIENCE		1	T												
LO-RATE SCIENCE	T32	2		T											
ENGINEERING DATA	T33	3			T										
RT COMMANDS	P21	4 4				R									
GCMR	N31							R							
PERFORMANCE DATA	T34								R						
OPERATIONS DATA MESSAGES	N14									R					
RT ENGINEERING	T33	11												T	

NGT-NASCOM REQUIREMENTS/CDTS MATRIX

CIDS	CIDS NO.	STRD NO.	TDRSS							(4)	DCF		(5)	OSCF (6)	
			TRANSMITS GCMRs FROM NCC	RECEIVES HI-RATE (SSA) SCIENCE DATA	RECEIVES LO-RATE (I) SCIENCE DATA	RECEIVES 'Q' CHAN. ENGINEERING DATA	RECEIVES PERFORMANCE DATA	TRANSMITS COMMANDS FROM POCC	RECEIVES ST & TDRSS TRACKING DATA FOR OSCF		TRANSMITS HI-RATE SCIENCE DATA	TRANSMITS LO-RATE SCIENCE DATA		TRANSMITS TRACKING DATA FROM TDRSS	
GCMR	N31		T												
HI-RATE SCIENCE	T31	1		R							T				
LO-RATE SCIENCE	T32	2			R							T			
ENGINEERING	T33	3				R									
PERFORMANCE DATA	T34						R								
COMMANDS	T71							T							
TRACKING DATA	T35								R					T	

TDRSS REQUIREMENTS/CDTS MATRIX

			NGT-NASCOM							(3)	ST				(7)
CTDS	CTDS NO.	SIRD NO.	RECEIVES GCMRs FROM NCC	TRANSMITS HI-RATE SCIENCE DATA TO POCC/DCF	TRANSMITS LO-RATE SCIENCE DATA TO POCC/DCF	TRANSMITS 'Q' CHAN. RT ENGINEERING DATA TO POCC	TRANSMITS PERFORMANCE DATA TO NCC	RECEIVES COMMAND DATA FROM POCC	TRANSMITS ST & TDRSS TRACKING DATA TO OSCF		TRANSMITS COMMANDS USING MA OR SSA	TRANSMITS STORED PROGRAM COMMAND LOADS USING SSA	RECEIVES ST ENG., ASTROMETRY & SCIENCE ON MA & SSA	RECEIVES PM CODE ON MA FOR TRACKING	
GCMR	N31		R												
PERFORMANCE DATA	T34						T								
RT COMMANDS	P21	4						R							
HI-RATE SCIENCE	T31	1		T											
LO-RATE SCIENCE	T32	2			T										
ENGINEERING DATA	T33	3				T									
TRACKING DATA	T35								T						
COMMAND DATA	T71										T				
STORED PROGRAM COMMAND LOAD	T72											T			
TELEMETRY	S41												R		
ST TRACKING	S42													R	

DCF REQUIREMENTS/CDTS MATRIX

CTDS	CTDS NO.	SIRD NO.	POCC (1)				NCC (2)		NGT-NASCOM (3)			SCI (9)			
			RECEIVES ST SCHEDULE CHANGES	RECEIVES SIMULATED HI-RATE SCIENCE DATA	RECEIVES SIMULATED LO-RATE SCIENCE DATA		RECEIVES ST & TDRSS SCHEDULE		RECEIVES HI-RATE SCIENCE DATA	RECEIVES LO-RATE SCIENCE DATA		TRANSMITS SCIENCE DATA			
MISSION SCHEDULE	P51	25	R												
SIMULATED HI-RATE SCIENCE	P52	27		R											
SIMULATED LO-RATE SCIENCE	P53	28			R					R					
HI-RATE SCIENCE	T31	1							R						
LO-RATE SCIENCE	T32	2										T			
SCIENCE DATA	D91	5					R								
SCHEDULING MESSAGES	N51	15													

OSCF REQUIREMENTS/CDTS MATRIX

			POCC (1)		NCC			(2)	NGT (3)						
CDTS	CDTS NO.	STRD NO.	TRANSMITS ORBIT DATA		TRANSMITS ACQUISITION DATA	RECEIVES ST & TDRS SCHEDULE VIA MPT	TRANSMITS PERFORMANCE DATA		RECEIVES TRACKING DATA FROM TDRSS						
ORBIT DATA	C11	23	T												
PSATS	C21.1				T										
IIRVS	C21.2				T										
EPHEMERIDES	C21.3				T										
PERFORMANCE DATA	C22						T								
TDRSS SCHEDULE	N61					R									
TRACKING DATA									R						

ST REQUIREMENTS/CDTS MATRIX

CIDS	CIDS NO.	SIRD NO.	TDRSS (4)												
			RECEIVES COMMAND SEQUENCES	RECEIVES COMMAND LOADS	TRANSMITS ST ENGINEERING & SCIENCE DATA	TRANSMITS PN CODING FOR RANGING									
COMMANDS	T71		R												
STORED PROGRAM COMMAND LOAD	T72			R											
TELEMETRY	S41				T										
RANGING	S42					T									

MSCF ST SIMULATOR REQUIREMENTS/CTDS MATRIX

			POCC (1)				NGT (3)								
CTDS	CTDS NO.	SIRD NO.	TRANSMITS SIM. ENGINEERING DATA STREAM	ORIGINATES DATA STREAM VIA DECNET	RECEIVES OUTPUT COMMANDS		RECEIVES ST ENGINEERING DATA								
SIMULATED ENGINEERING DATA	M11	10	T												
DECNET SCIENCE	M12	26		T											
COMMANDS	P31	10.1			R										
RT ENGINEERING	T33	11					R								

APPENDIX F

ST SIMULATOR AND TEST SYSTEMS

APPENDIX F

ST SIMULATOR AND TEST SYSTEMS

This appendix provides more detail on the MSFC ST Simulator, the LTU and CTV as introduced in Section 2, Support Elements.

Several documents used as source material for the preparation of this report and are listed in the Bibliography. Some portions of these source documents have been included in the Appendices for reference purposes.

1. MSFC ST SIMULATOR

An overview of the ST Simulator is shown in Figure -1, ST Simulator Configuration. The primary elements, which simulate engineering data and respond to received command data are located at MSFC. The elements which are located in the STOCC at GSFC are used primarily to insert pre-recorded science data into the telemetry data stream and feed it to the POCC TAC subsystem. The computer used at GSFC is the VAX 11/780 which functions as the on-line system backup and simulator support.

The two basic applications for which the ST Simulator is intended are verification and personnel training. These applications are defined in the following paragraphs followed by a detailed description of the ST Simulator interface, functions, and applications.

1.1 VERIFICATION

The ST Simulator will verify the ability of the STOMS systems to perform their online and offline functions in accordance with design requirements. The ST Simulator

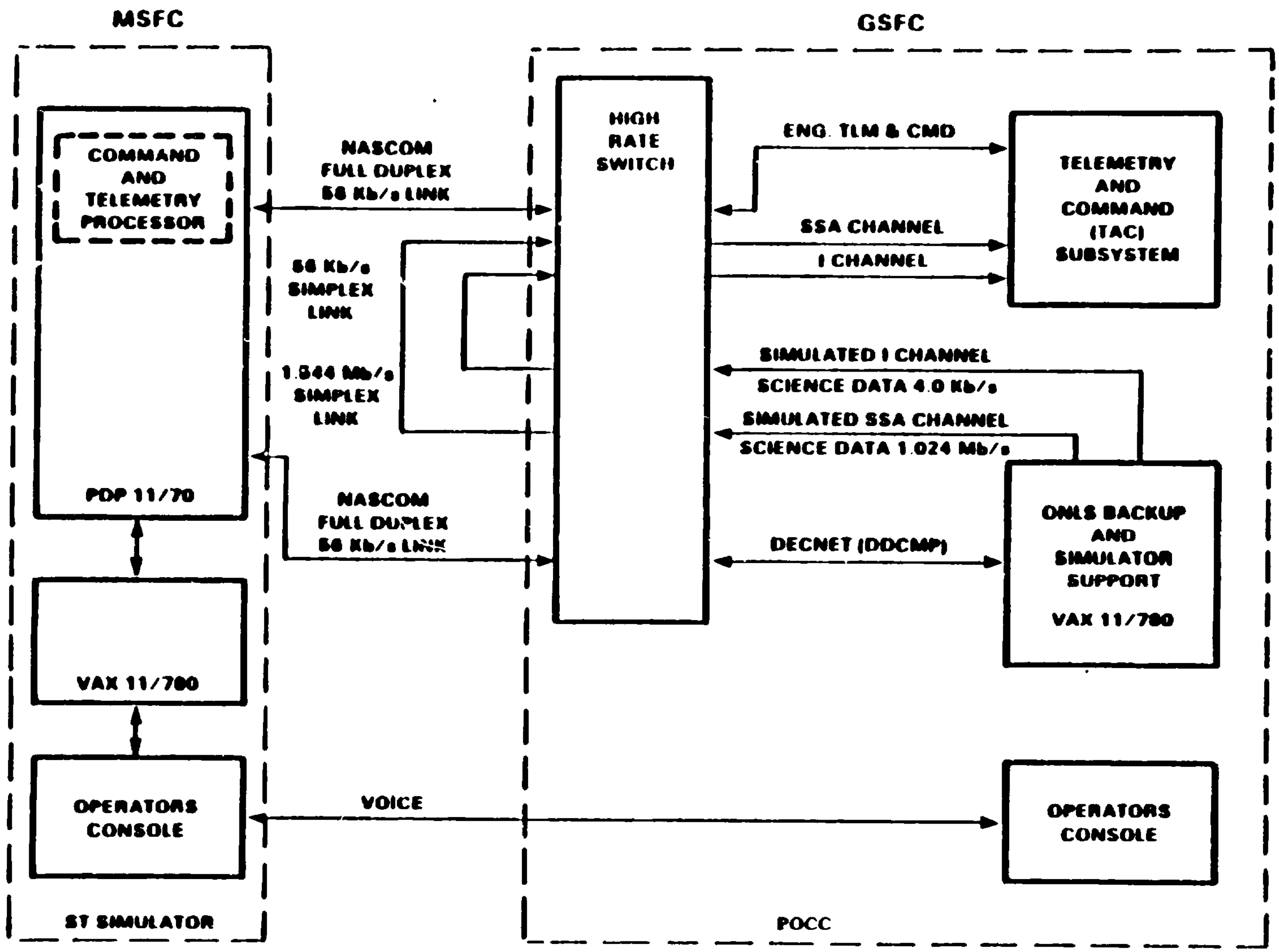

FIGURE F-1 ST SIMULATOR CONFIGURATION

serves as a functional Space Telescope interfacing with NASCOM, and exhibits the same data interface to the STOMS as the ST itself. It serves as an engineering and science data source to fully exercise the operation's ground system to help validate the system's ability to process ST data. The ST Simulator accepts and processes all valid ST commands, reflecting command effects in telemetry to validate the ground control capability over the ST. A detailed description of the STOCC functions to be verified is presented in the following subsections and Appendix H.

The simulator may be used to produce up to three telemetry data streams simultaneously. It is programmable to all ST data rates and formats. Data anamolies, such as dropouts and noise, may be either operator induced or pre-programmed. The data may represent engineering data which is generated within the St Simulator or science data which has been pre-recorded. Also, both science and engineering data streams may be output simultaneously. The engineering data stream will be altered by the software models.

The software models developed for the ST Simulator are:

- Systems Support Module (SSM) subsystems;
- Science Instruments (SI);
- Optical Telescope Assembly (OTA) components;
- Science Instrument Control and Data Handling (SI C&DH) subsystems.

The response of these models may be effected by the receipt of ST commands, the simulation of environmental stimuli, or the generation of On Board Computer (OBC) commands. The characteristics of sensor misalignments, drift, and null offsets may be exhibited by attitude sensor models, and these characteristics may be altered by an operators input. All modes of the Safing System are modeled including initiation by operator or conditions which would normally result in entry into such modes in the ST itself. The return to normal operations from safing modes is brought about by the receipt of applicable commands.

The ST Simulator has the capability to detect and respond to all valid ST commands. It will detect and reject invalid commands. It receives and responds to commands to the DF224 and NSSC-1 computers including memory loads. Delayed mode commands are stored and executed at the proper time and are time tagged accordingly.

1.2 PERSONNEL TRAINING

The ST Simulator provides the facility to train operations personnel in the conduct of Orbital Verification and normal Mission Operations. Using this training tool, operations personnel will verify operations procedures and proficiency for both spacecraft and science activities under both nominal and exception conditions. This training activity will involve the following:

a. Validation of the launch script through simulations;

b. Validation of the orbital verification script through simulations;

c. Validation of normal mission control through simulations;

d. Validation of preplanned recovery procedures from abnormal conditions including safing entry, loss of attitude control, etc.;

e. Certification of operator control position assignments.

The ST Simulator will realistically portray nominal operations, including Observatory on-orbit activation and verification, as well as a limited number of specific off-nominal conditions.

The command responses and other data generated by the ST Simulator are of sufficient realism to provide positive training in all on-line and critical off-line operations functions. The ST Simulator is also capable of being configured to match specific planned orbital conditions, systems configurations, and event sequences specified by STOMS personnel.

The ST Simulator supports simulations of limited duration to train in specific operations tasks, as well as all-up mission simulations with a possible duration of several days.

1.3 ST SIMULATOR INTERFACES

The engineering telemetry and command interface between the St Simulator and the STOCC is through NASCOM. On the STOCC end, the interface with NASCOM is the TAC. At the ST Simulator end the NASCOM interface is the Command and Telemetry Processor. An additional interface exists between the ST Simulator and STOCC for communication of instructions and information between the computers at each location. The high rate science telemetry data interface with the ST Simulator is accomplished via the Simulator Support VAX at Goddard and the TAC using a NASCOM simplex link. The characteristics of the interfaces mentioned above are given in the following paragraphs.

Telemetry and Command Interface

The ST Simulator generates ST engineering telemetry data in all formats and at all rates. This data is formatted into 4800 bit NASCOM blocks and transmitted to the STOCC over a 56 Kb/s full duplex NASCOM link. Data rates transmitted are 32 Kb/s, 4 Kb/s or 0.5 Kb/ps. The rate and format of engineering data generation are selectable by STOCC command, automatic safe mode initiation or ST Simulator operator control.

Command Interface

Command messages are generated in the STOCC and transmitted to the ST Simulator at data rates of 1.0 Kb/s or 125 b/s via the 56 Kb/s duplex NASCOM link. Command messages are transmitted in NASCOM 4800 bit blocks, received and decoded into 48 bit command words in the ST Simulator.

Science Data Interface

The ST Simulator does not generate science data. The science data interface is established through playback of pre-recorded science data by the Simulator Support VAX located at GSFC. The data is encoded and packetized at a 4.0 Kb/s or 1024 Kb/s rate and transmitted to the TAC in 4800 bit blocks, via NASCOM simplex low or high rate data link and the PORTS high rate switch. Control of the data formatting and transmission is via ST command or ST Simulator operator actions. The science data stream may be optionally Reed-Solomon (RS) or psuedo-noise (PN) encoded. Another option is the transmission of spacecraft computer memory dump information. The low data rate link may be used by SSM computers (DF-224) memory dump data. The high data rate link may be used for SI C&DH computer (NSSC-1) memory dump data.

Control DECNet Interface

The transfer of control instructions and information between the Simulator Support VAX 11/780 computer at GSFC and the computers in the ST Simulator at MSFC utilizes a full duplex 56 Kb/s NASCOM link. The communications network is supported by DECNet.

Voice Interface

There will be four voice links between STOCC and MSFC available for use during the testing activities of the ST.

1.4 SIMULATOR FUNCTIONS

The functional breakdown of the ST Simulator is shown in Figure F-2, ST Simulator Functional Breakdown Structure. A discussion of the functions of the major elements is given in the following paragraphs.

Simulator Control

The simulations will require a simulation director/team. This team will assemble/enter initialization data, monitor the performance of the simulation, change ST Simulator control values during simulations, capture required data and otherwise interact with the ST Simulator as the simulation progresses.

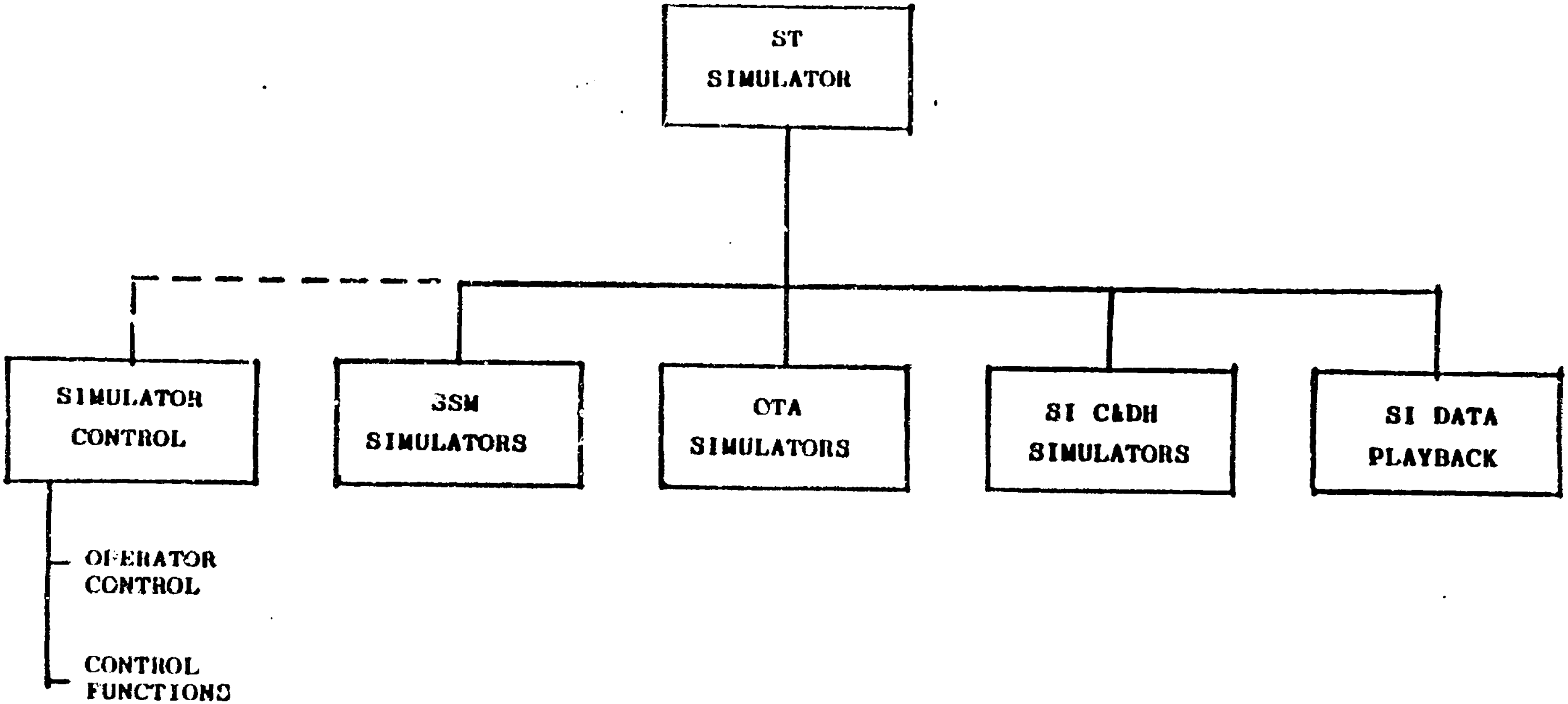

FIGURE F-2 ST SIMULATOR FUNCTIONAL BREAKDOWN STRUCTURE

Support Systems Module

The SSM consists of the Pointing Control Subsystem, the Electrical Power Subsystem, the Instrumentation and Communication Subsystem, the Data Management Subsystem, the Thermal Control Subsystem, the Safing System, and Structures and Mechanical Subsystem under control of the DF 224 computer. Each of these may be functionally modeled in the ST Simulator.

Optical Telescope Assembly

The OTA is a 2.4m f24 Cassegrain telescope consisting of two elements, a primary and secondary mirror. The focal plane of the telescope is divided among eleven sensing devices: four axial and one radial scientific instruments, three Optical Control Sensors, and three Fine Guidance Sensors. Other components include an Actuator Control Subsystem, Elecrical Power Subsystem, and Thermal Control Subsystem.

Each of these will be functionally modeled in the ST Simulator to meet requirements to support the STOCC verification and personnel training.

Scientific Instruments Control and Data Handling

The SI C&DH provides a unified command, data and telemetry interface between the five scientific instruments and the SSM Data Management System.

The SI C&DH system consists of three basic components, the Control Unit/Science Data Formatter (CU/SDF), Standard Interface for Computer (STINT) and NASA Standard Spacecraft Computer, Model 1 (NSSC-1).

The ST Simulator is designed to model: the CU/SDF control logic for science data stream output, using standard header data, unique logs, status buffer, and canned SI data as data sources; the CU/SDF capability for programmable science formats; and, the CU/SDF capability for receiving, decoding, storing and properly executing commands.

Science Instruments

There are five science instruments on the ST. These are: Faint Object Camera, Faint Object Spectograph, High Resolution Spectograph, High Speed Photometer, and the Wide Field/Planetary Camera.

The ST Simulator will not simulate science data. The St Simulator functions are to: accept commands from the SI C&DH and respond through the SI engineering data; provide the capability to feed pre-recorded science data through the science data stream for each instrument; provide capability to accept data loads to the SI microprocessors and OBCs; and provide the capability to dump maps of the SI microprocessor and OBC memories.

1.5 SIMULATOR APPLICATION

The capabilities of the ST Simulator which are necessary to support test activities may be developed in stages based upon the planned test activities. The following paragraphs describe the use of the St Simulator during these events.

Verification and Acceptance Program

The ST Simulator must initially support verification of the PORTS hardware and software capabilities. The

ST Simulator will accept and process SI and SI-C&DH real time and stored commands; generate SI and SI C&DH engineering data which has reasonable values for STOCC processing and is properly formatted; simulate the SSM DMS system to the extent necessary to flow SI data; support a 4 Kb/s rate science engineering telemetry format; support a science data stream of predefined fixed content; and, support SI C&DH memory load and dump.

Assembly and Verification

During the A&V tests all STOCC interfaces with the ST will be compatiblity tested using the NASCOM facilities for communications. There will also be a mission simulation conducted. The ST Simulator must be available with full data and command processing capability to verify the STOCC capabilities prior to STOCC participation in these tests.

STOMS Test and Verification

The ST Simulator will be a primary tool in the completion of TAV activities. The completion of verification activities prior to VAP and A&V constitute a part of the TAV but there are additional interfaces and functions within the STOMS which will be tested by use of the ST Simulator. The operations between PORTS, PASS and the DCF must be tested. The ST Simulator may be used as the source of data in any tests which include an exchange of data and or commands. This description fits many TAV activities including those in Phase I, Interface Test.

2. LINE TEST UNIT

An overview of the LTU is shown in Figure F-3, Line Test Unit. The primary elements are a Test Data Monitor,

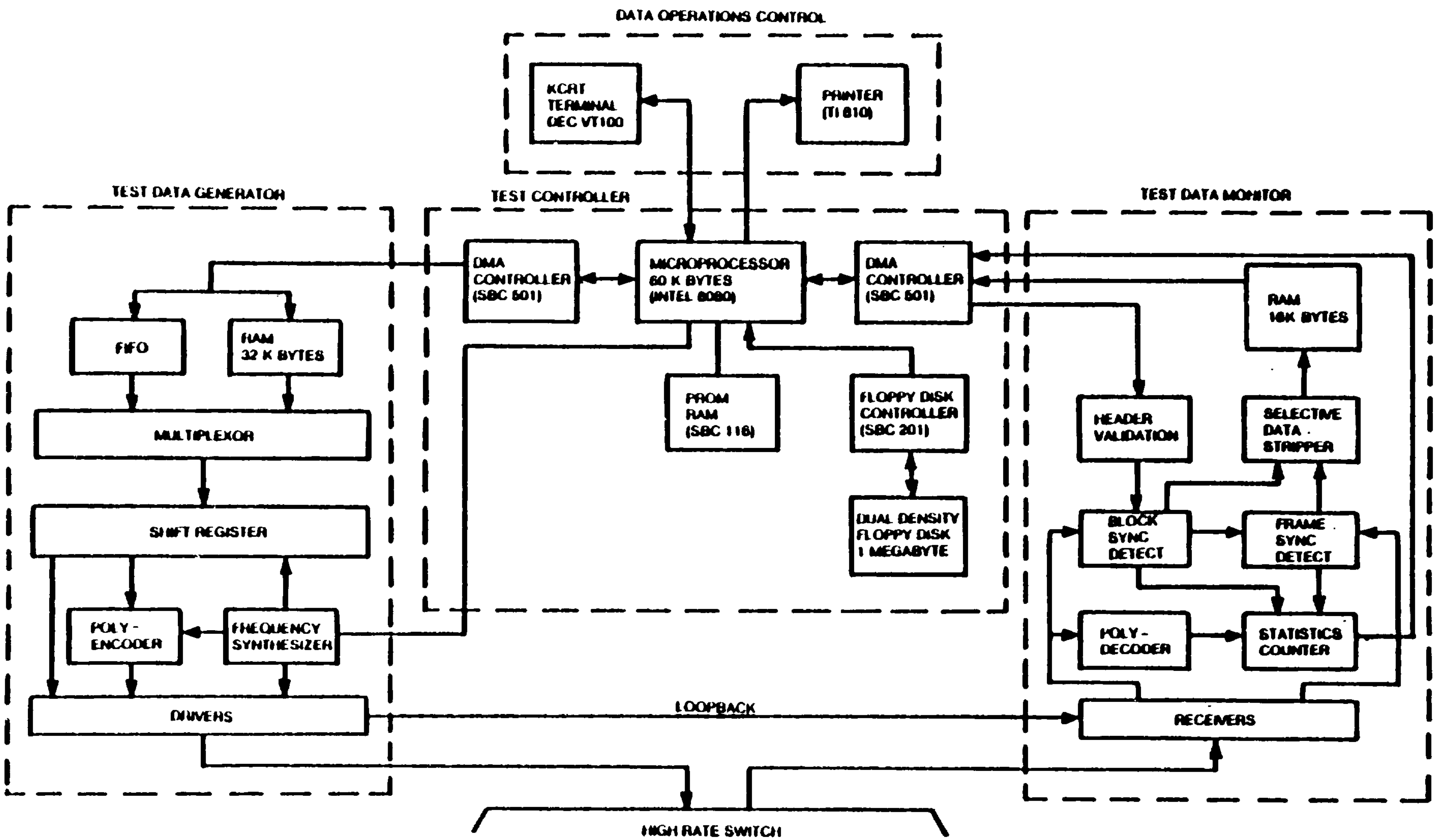

FIGURE F-3 LINE TEST UNIT

Test Data Generator, Test Controller and Data Operations Control all within one unit located at the POCC. Its primary purpose will be to function as a hardware checkout tool by monitoring data sources, generating test data and simulating specific ST command/telemetry interactions.

The Test Data Monitor will allow the extraction of selected data for display. Certain parameters can be selected to validate the header when NASCOM format is used.

The Test Data Generator portion of the LTU will permit the insertion of known data patterns selected from predefined formats into a serial communication interface.

The Data Operations Control and Test Controller provide the control, display and self testing functions of the LTU.

2.1 MONITORING

Monitoring Data Sources

The LTU will be capable of monitoring external data lines to and from PORTS. The monitored data sources are as follows:

- NASCOM telemetry on a 56 Kb/s or 1.544 Mb/s, line;
- TAC B channel command output on a 56 Kb/s, NASCOM format line;
- TAC B channel SSC output on a 1.544 Mb/s line, NASCOM-like blocks;
- AP DDCMP channel output to, or input from, the SSC on a 56 Kb/s line;
- AP NASCOM channel output and input for NCC, DCF, OSCF, and MPT interfaces;
- AP DDCMP channel output or input from MSFC ST Simulator control line on a 56 Kb/s line.

Monitoring Functions

The monitoring functions of the LTU consist of displaying, collecting statistics and recording data blocks. The formatted display in hexadecimal of the contents of data blocks or block header are as follows:

- NASCOM telemetry and command blocks;
- TAC data blocks output to SSC;
- DDCMP blocks transmitted or received;
- PORTS AP NASCOM blocks transmitted or received.

The collection of statistics on data blocks are as follows:

- Number of blocks;
- Number of blocks with poly errors;
- Number of block sequences errors as applicable;
- Number of blocks with selected header fields in error;
- Number of command words in command blocks.

The collection of statistics on spacecraft telemetry synchronization status are as follows:

- Number of sync search operations;
- Number of bit-slipped frames;
- Number of frames without frame sync error;
- Number of drop lock occurrences;
- Number of frames with errors in synchronization pattern.

The recording of incoming NASCOM blocks and DDCMP blocks (not concurrent with NASCOM blocks) on a magnetic tape from a single incoming line are also part of the monitoring functions of the LTU.

2.2 DATA GENERATION

The three simultaneous telemetry test streams that can be generated by the LTU are as follows:

- Engineering telemetry at 0.5, 4, or 32 Kb/s;
- DF-244 dump or science telemetry stream at 4 Kb/s;
- Science telemetry or tape recorder playback at 1024 Kb/s, except that science shall not be concurrently output at both 4 and 1024 Kb/s.

The LTU will additionally generate the following:

- Playback of DDCMP blocks at a line rate of 56 Kb/s for the online system or offline system message transfer in either direction;
- NASCOM AP test traffic for DCF, NCC, OSCF, or MPT message traffic in either direction.

2.3 TELEMETRY GENERATION

The LTU telemetry generation is divided into static and dynamic telemetry functions.

Static Telemetry

The LTU static telemetry generation will be divided in four parts. The generation of static engineering telemetry will provide:

- Generation of predefined and fixed sync patterns;
- Incrementation of frame counters;
- Generation of data formats by simple algorithms;
- Predefined and repeated faulting of parameters.

The generation of static science telemetry will provide:

- 1024-bits/segment with segments packetized and having a fixed sync pattern;
- Incrementation of packet count and segment numbers;

- Valid combination of Rs segments and PN encoding;
- Insertion of source ID and Packet Format Code.

The static telemetry generation will provide for generation of DF-224 dump data; and also Engineering Tape Recorder (ETR) and Science Tape Recorder (STR) dump data at 1 Mb/s with bit to byte expansion and data reversal.

Dynamic Telemetry

The dynamic telemetry generation function is as follows:

- Dynamic responses to interpretations of commands such as command counter incrementation and setting checksum flags;
- Dynamic update of command verification bi-levels in telemetry due to interpretation of commands;
- OBC memory maps maintained based on load received;
- Variable faulting at operator's request.

3. COMPATABILITY TEST VAN

The Multimission Unique Ground Support Equipment (MUGSE), Figure 3-4, is the planned CTV system for the TDRSS mode of operation. The MUGSE system includes a KU- and S-band relay, S-band Transponder Test Set (STTS), S-band Spread Spectrum Transponder (SSST), and peripheral equipment consisting of ranging, command, and data handling subsystems. The MUGSE system will be capable of the following:

- Act as a RF relay;
- Act as a test set for fault isolation;
- Act as ST Simulator to verify the integrity of the RF link;
- Communicate with the ST;
- Provide self testing of STTS;

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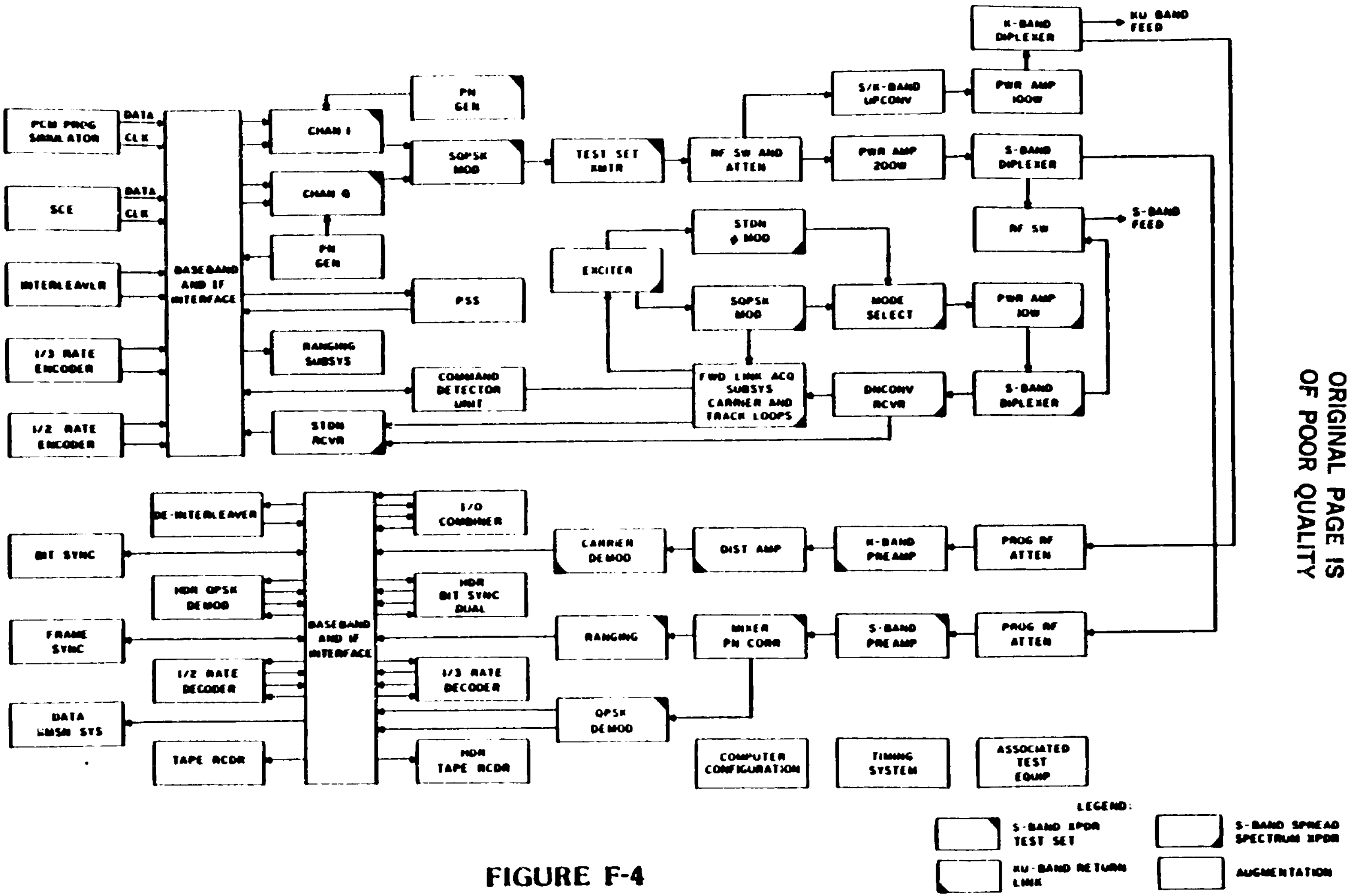


FIGURE F-4

CTV MULTIMISSION UNIQUE GROUND SUPPORT EQUIPMENT

- Communicate with TDRSS to emulate the ST under test;
- Act as an independent test bed for ST verification;
- Provide the capability for telemetry spread spectrum demodulation;
- Allow for data flows between the ST at manufacturer's site during A&V and the POCC NCC.

3.1 RELAY MODE

In the relay mode the van will serve as a throughput amplification system to interface the St communication systems via TDRSS and ground system. The CTV relays forward commands and ranging signals from TDRSS to the Satellite Under Test (SUT), in this case the ST, and the return telemetry from the ST to TDRSS. The typical interface between the CTV and satellite is via a coaxal cable. Reference Figure 3-5, TDRSS Compatability Test Configuration.

3.2 S-BAND TRANSPONDER TEST SET

The STTS consists of five major assemblies: test transmitter, test receiver, RF distribution, ranging subsystems, and command source/bit error test. Figure 3-6, S-band Transponder Test Set, is a functional block diagram of the system. The RF chassis assemblies generate the forward link (FT) in the 2025- to 2120-MHz frequency range. In the TDRSS mode, Quadriphase-Shift-Keying (QPSK) modulation by selectable PN codes clocked at 31/96 (FT/221) is provided. The return link signal is in the 2200 to 2300 MHz frequency range. The demodulation of the QPSK return link consisting of the in-phase (I-channel) and the quadriphase

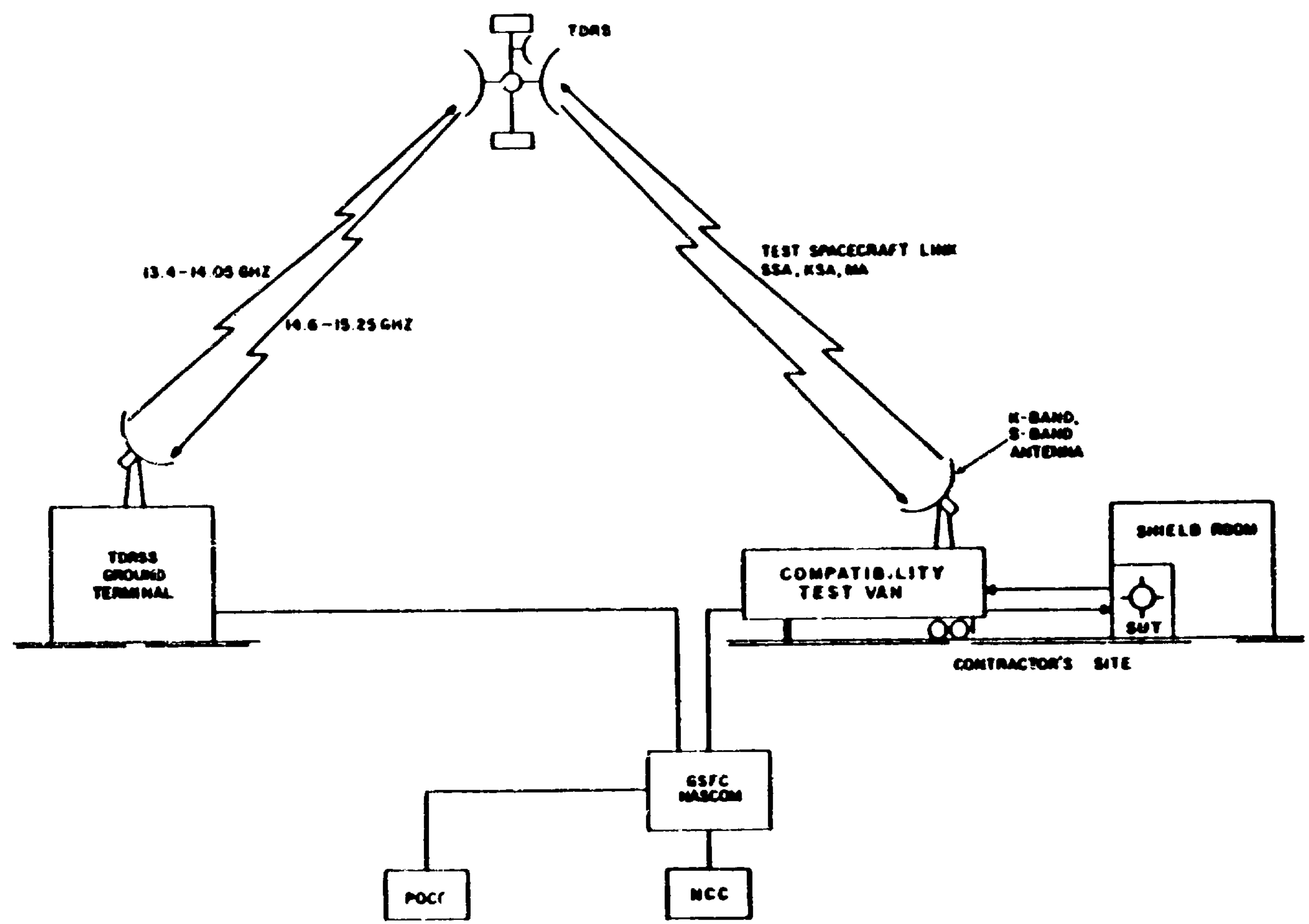


FIGURE F-5 TDRSS COMPATABILITY TEST CONFIGURATION

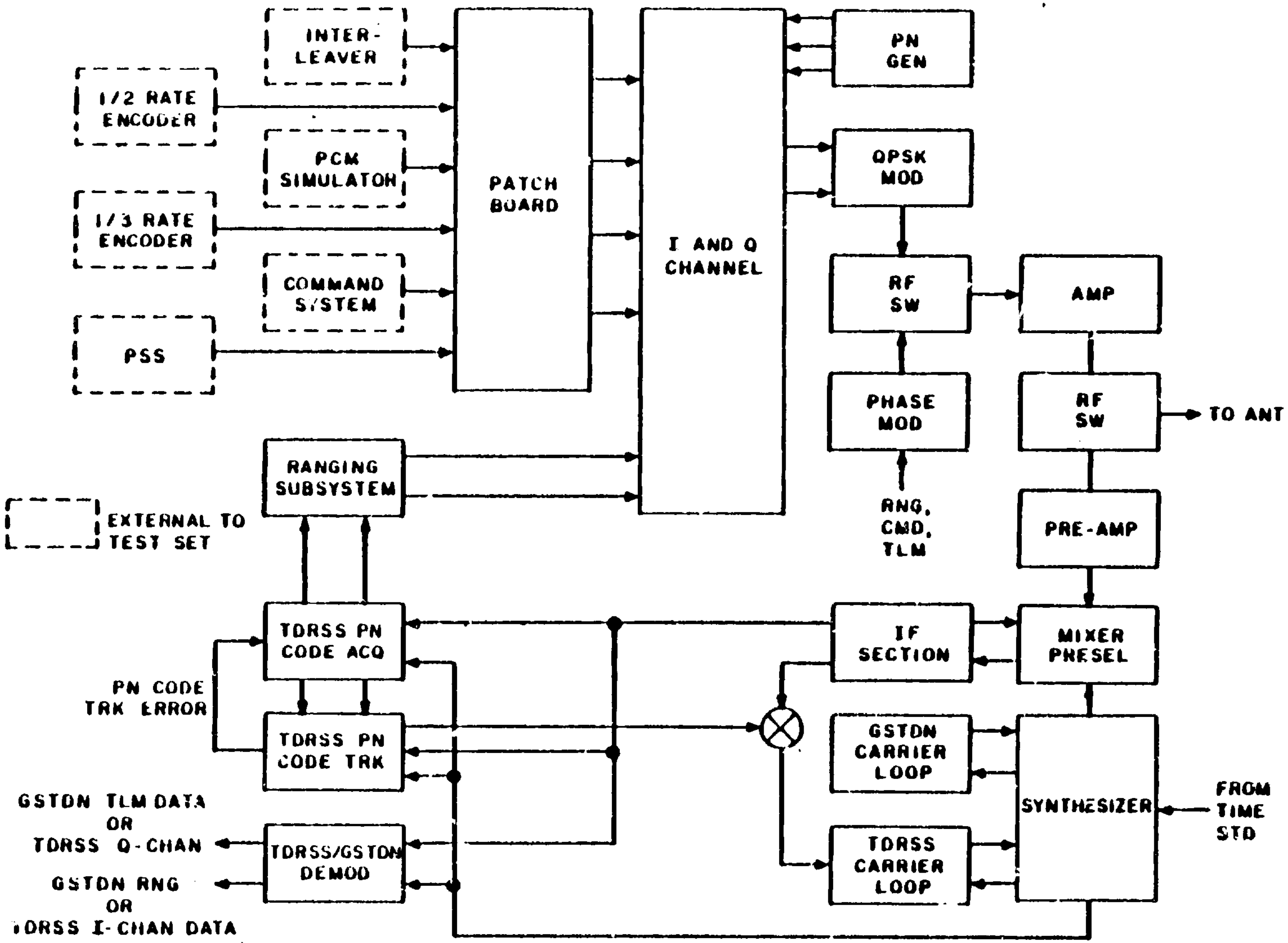


FIGURE F-6 S-BAND TRANSPONDER TEST SET

(Q-channel) signals is provided. It has the capability of high-accuracy group delay measurements of the transponder under test (the ST) in the TDRSS modes. The STTS, and the peripheral equipment, provide similar information in the TDRSS mode as that presently provided by the CTV's in the GSTDN modes of operation. Some of the operating parameters to be tested are the following:

a. RF link thresholds and margin;

b. Frequency and phase stabilities;

c. Signal spectrum analysis;

d. Modulation characteristics;

e. Command and ranging verification;

f. Telemetry decoding verification.

3.3 S-BAND SPREAD SPECTRUM TRANSPONDER

The SSST is a NASA standard multiple access TDRSS user satellite transponder. Its main functions in the CTV's are to check the operability of the STTS, and to emulate a SUT as a means of fault isolation should a problem in the relay mode occur. To enable the SSST to operate on other frequencies in the single access mode in the TDRSS-assigned spectrum, an external modification to the system is being developed. To the full extent of its designed capability, the SSST will be used in the Ku-band range by the use of appropriate up and down converters. A command detector unit external to the transponder will be provided.

3.4 COMPATABILITY TEST VAN APPLICATIONS

At present, due to the time frame and TDRSS schedule, the functional uses of the CTV are still under question. It is known however that the CTV will be used in the A&V tests.

The CTV will be required for the following tests at the SSM Contractors integration facilities during the A&V test:

- SSM Subsystem Functional and I/F Verification tests;
- ST Functional test;
- Electromagnetic Compatibility test;
- ST Thermal Vacuum/Thermal Balance test;
- ST Pre-ship Functional test/Launch and Orbital Verification Dress Rehearsal.

ST/TDRSS compatibility will be demonstrated during the above tests. The CTV will also be required for ground system checkout, STOCC compatability, and fault isolation during pre-launch and launch support at KSC.

APPENDIX G

TEST/SIMULATION EVENTS

APPENDIX G

TEST/SIMULATION EVENTS

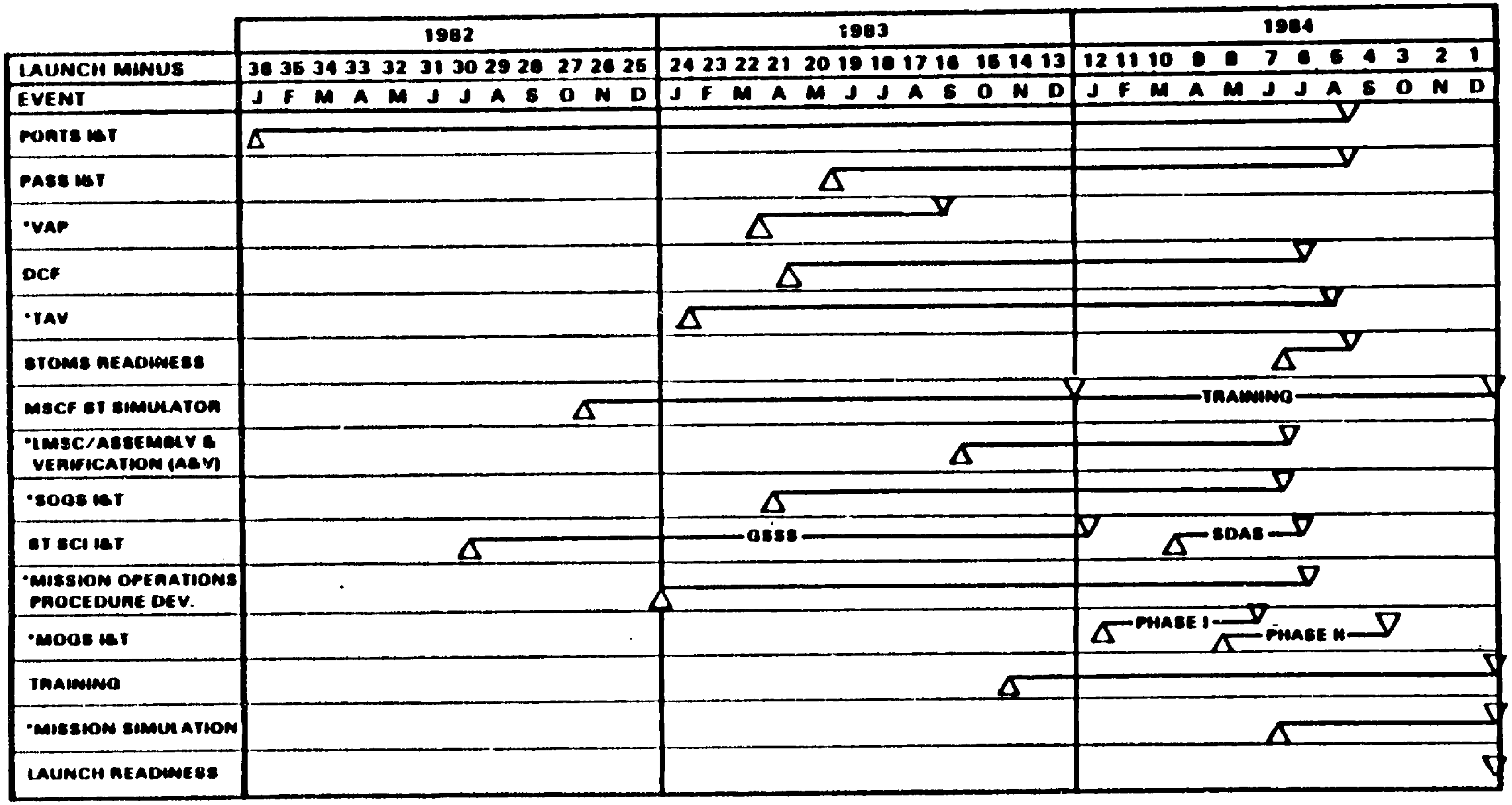
NASA documentation concerning the implementation of the entire ST ground system indicated a number of significant test and simulation events. Table G-1, ST Test/Simulation Schedule, represents these events depicting the relative time frame of their occurances. Four of these events have been identified by NASA (code 500) as key to the implementation of the STOMS. These are the Verification and Acceptance Program (VAP), STOMS Readiness, ST Mission Operations procedure development, and Mission Simulation. The STOMS Test and Verification (TAV) has been substituted for the STOMS Readiness as a key event, with the assumption that the STOMS Readiness will be primarily an analysis and review of the TAV. Three other key events were identified: Lockheed Missile and Space Company, Inc. (LMSC) Assembly and Verification (A&V): Science Operations Ground System (SOGS) Integration and Test (I&T); and Mission Operations Ground System (MOGS) I&T. All of these have been identified in various NASA documents as key test and simulation events.

The seven major test and simulation events (VAP, TAV, A&V, SOGS I&T, Mission Operation procedure development, MOGS I&T, and Mission Simulation) and their interface functional requirements are described in the following subsections.

1. VERIFICATION AND ACCEPTANCE PROGRAM (VAP)

The primary objective of the VAP is to verify the mechanical, electrical, and operational aspects of the

CHART G-1 ST TEST/SIMULATION SCHEDULE



*KEY EVENTS

NOTE: ABOVE TABLE SHOWS RELATIVE TIME SCHEDULES ONLY AND DOES NOT REFLECT DEFINITE DATES.

SI's and to ensure compatibility with the other SI and the SI C&DH interface. The VAP test will consist of utilizing a flight SI C&DH system, supplied by International Business Machines, for control command and data processing. A VAP Ground System Computer and SSM simulator will be used to interface the SI C&DH, and the POCC. The simulator will be connected via NASCOM from the VAP testing area in GSFC building 7 to the POCC area in GSFC building 14. The VAP Configuration is shown in Figure G-1.

The VAP testing will provide information for preliminary validation of the SI's loads and responses to finalize the SI designs.

VAP testing will also verify the compatibility of the SI's with the SI C&DH interfaces.

The purpose of the POCC participation is to:

- Demonstrate POCC compatibility with the SI C&DH and SI operation;
- Verify POCC command generation for SI C&DH and SI operation as early as possible;
- Verify POCC science and SI engineering data handling, processing and display capability to the POCC;
- Record real science data for later use in system development activities.

A partially operational POCC will be implemented with all support capabilities necessary for VAP testing. This support will be available prior to the scheduled start of VAP testing. The items listed below must be operational for POCC VAP test participation:

- Display Capability for Engineering Telemetry

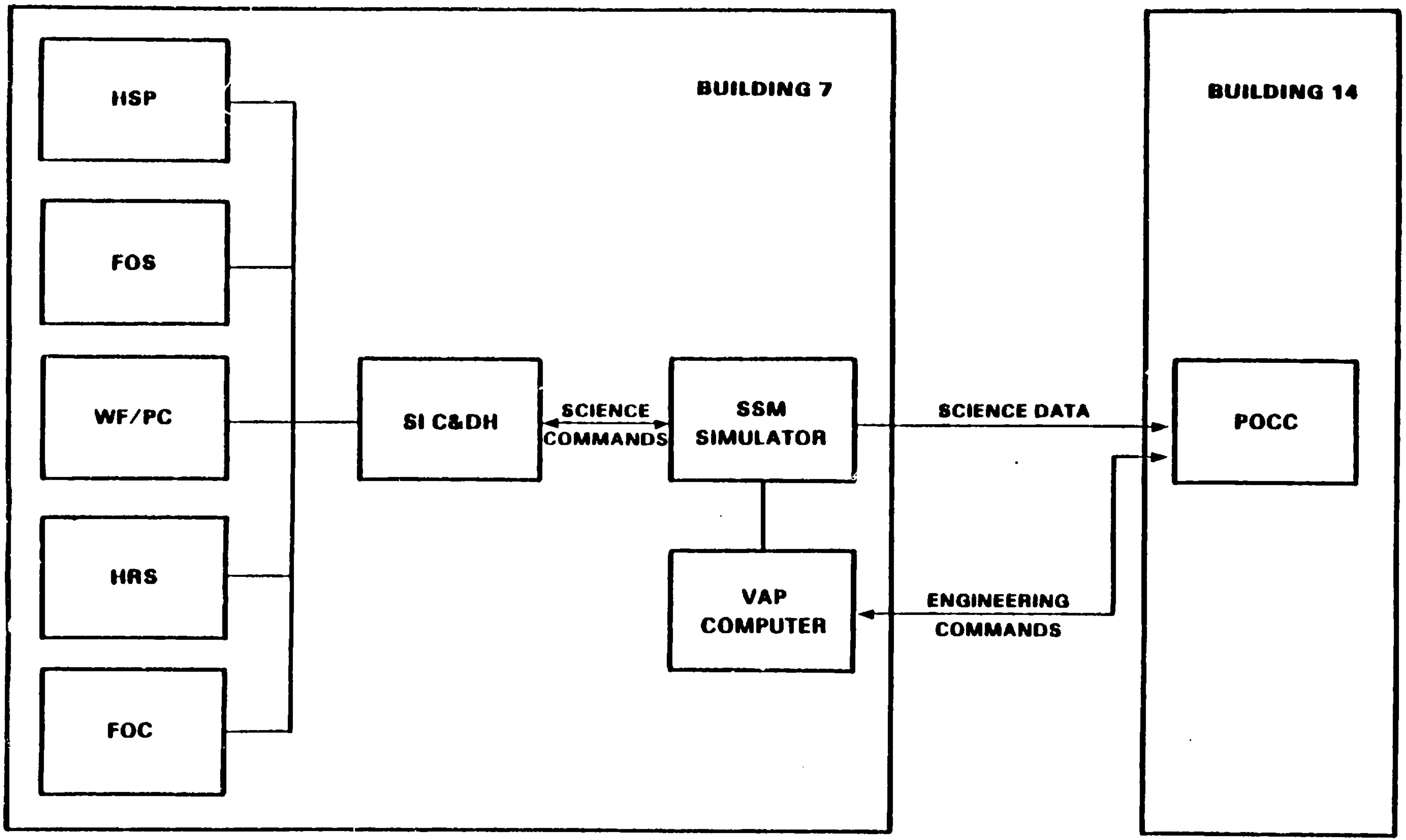


FIGURE G-1 VERIFICATION AND ACCEPTANCE PROGRAM

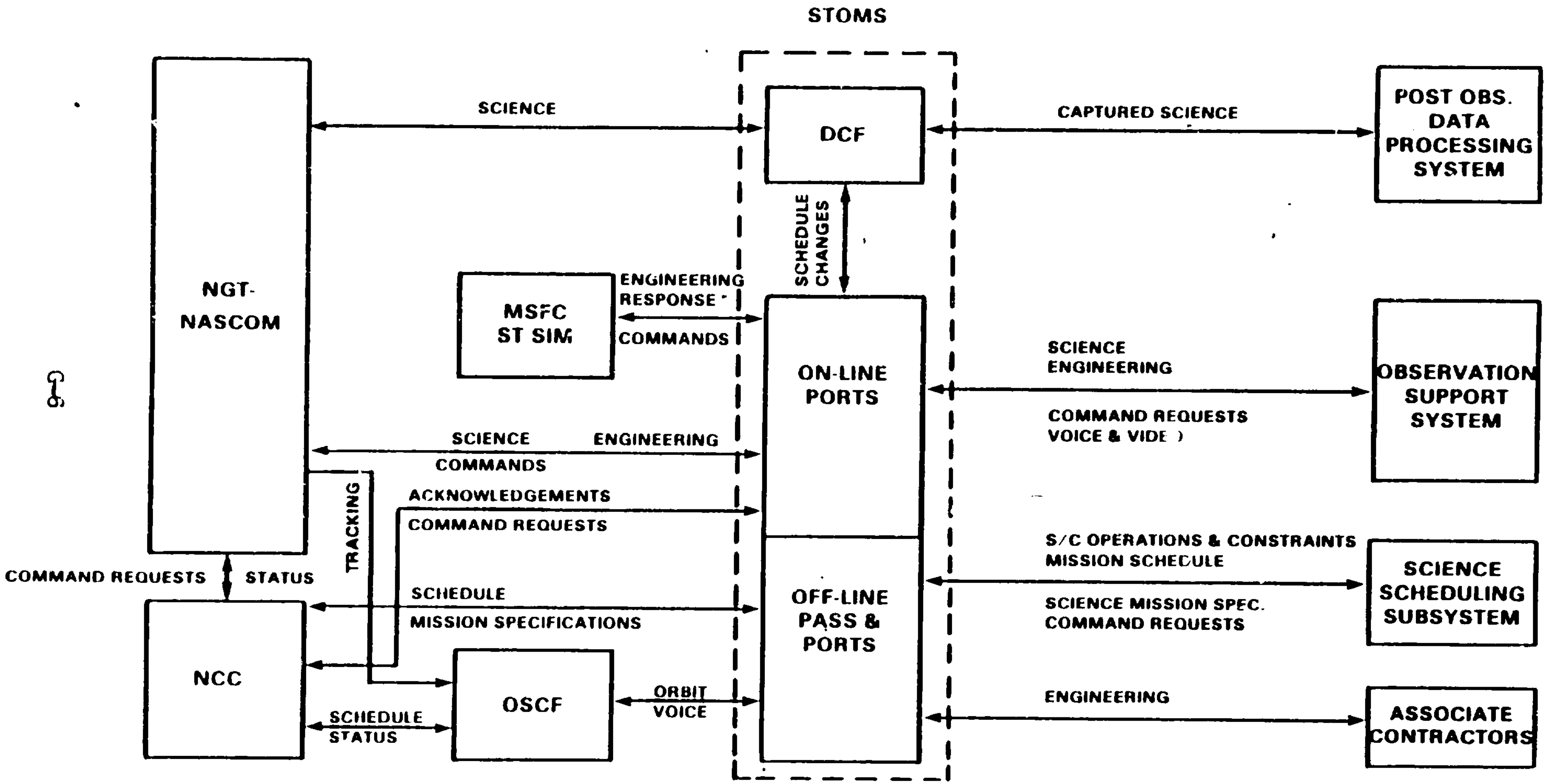
- Telemetry Data Processing for both Engineering and Science Data
- Command Data Processing including On-Board Computer Load Transmission Software
- PORTS Systems Test and Operation Language (PSTOL) Capability

The functional requirements of the element interface relative to VAP testing are discussed under Section 5, Functional Interface Requirements. The VAP testing comprises only a portion of the requirements for the ST and the POCC.

2. STOMS TEST AND VERIFICATION

The functional requirements to be met under the Test and verification (TAV) are not only those imposed for each system element within STOMS, but also the requirement that these elements, when combined, function as a total system. The major element interfaces to be tested under the TAV event, are the NCC, NGT-NASCOM, TDRSS, OSCF, DCF, MSFC Simulator, and the POCC (see Figure G-2). Under the STOMS implementation effort the POCC functional requirements are tested during the PORTS and PASS integration and test events. The DCF, MSFC Simulator and ST functional requirements are also tested under their specific integration and test events or, in the case of ST itself, during ST Assembly and Verification (A&V) at LMSC.

The NASA institutional elements, i.e., NCC, NGT-NASCOM, TDRSS, and the OSFC are multimission support facilities and will have been tested as individual elements and exercised considerably by similar satellite projects prior to the TAV. However, these elements will be tested for ST unique func-



NOTE DATA DESCRIPTION WRITTEN ABOVE THE LINE FLOWS TO THE RIGHT AND VICE VERSA

FIGURE G-2 SPACE TELESCOPE OBSERVATORY MANAGEMENT SYSTEM

tions during the verification of other elements within the STOMS.

The STOMS TAV encompasses all activities associated with combining the major elements into the STOMS and with verifying STOMS operation. The TAV activities will be conducted in three phases. Phase I will consist of sequentially testing the interfacing hardware and software and verifying that the specific interface being tested complies with the related ICD. The use of both real and simulated SI data, spacecraft data, commands, schedules and Controlled Test Data Sets (CTDS) will be required.

Phase II will be a systems engineering test to verify the various command, data and engineering strings as well as support functions. This will be a total test including verification of system reaction to anomalies. Controlled Test Data Sets will include predefined error inducing data.

Phase III will be a mission oriented system performance test to verify full computer loading and timelines. All STOMS elements and interfaces will be exercised in a near normal operational environment. The ability of the STOMS to respond to element and sub-element failure will also be tested during this phase.

Relative to the element interfaces previously defined under Section 5, Functional Interface Requirements, the STOMS TAV will test all of the element interfaces.

3. ASSEMBLY AND VERIFICATION

ST integration testing of the flight hardware is accomplished at the LMSC, Sunnyvale, California. This integration test set leads to ST interface verification and consists of several carefully planned and integrated test sequences performed to demonstrate the integrity and capability of an integrated ST. The configuration for Assembly and Verification is shown in Figure G-3.

The integration site (LMSC) test are as follows:

1. SSM Subsystem Functional and Interface Verification Tests.

   This test is the initial ambient functional system test which permits early verification of the SI's and major interfaces.

2. ST Functional Test.

   This test will be designed to verify the functional performance parameters of the ST.

3. Electromagnetic Compatibility Tests.

   The tests will monitor the predetermined critical interface circuits and power paths, and verify safety margins, sensitivity and interference on these circuits.

4. ST Mission Simulation and STOCC Compatibility Tests.

   (The ST Mission Simulation is not to be confused with the Mission Simulation for the ground support system.) The objectives of these tests are: (1) verification of satisfactory ST operation during simulated mission sequences; (2) verification of the compatibility of the deployment support equipment; and, (3) verification of the compatibility of the ST with the STOCC/TDRSS/NASCOM.

5. ST Thermal Vacuum/Thermal Balance Tests.

   The objectives of these tests are: (1) to detect latent material and workmanship defects under

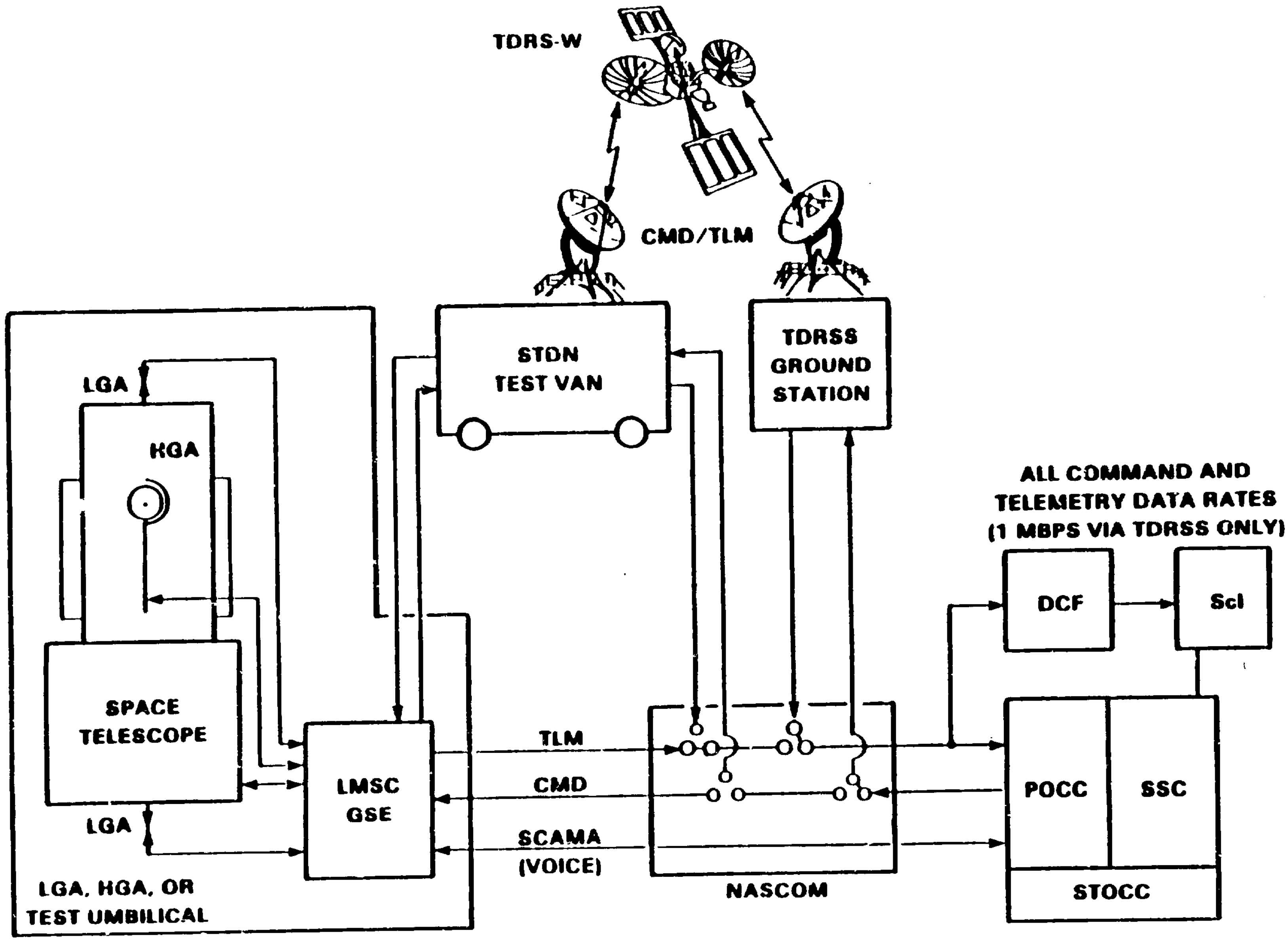


FIGURE G-3 ASSEMBLY AND VERIFICATION CONFIGURATION thermal vacuum stress that are not evident in ambient testing; (2) to demonstrate ST thermal control system ability to control temperature excursions within mission thermal limits; and (3) to confirm the analytical model prediction capability.

6. ST Pre-Ship Function Test/Launch and Orbital Verification Dress Rehearsal.

This functional test will contain representative sequences that will be used by the STOCC (in Launch Site Operations and Orbital Verification). The subsequent dress rehearsal sequences will be designed around environmental constraints and planned ST configuration at Launch Site.

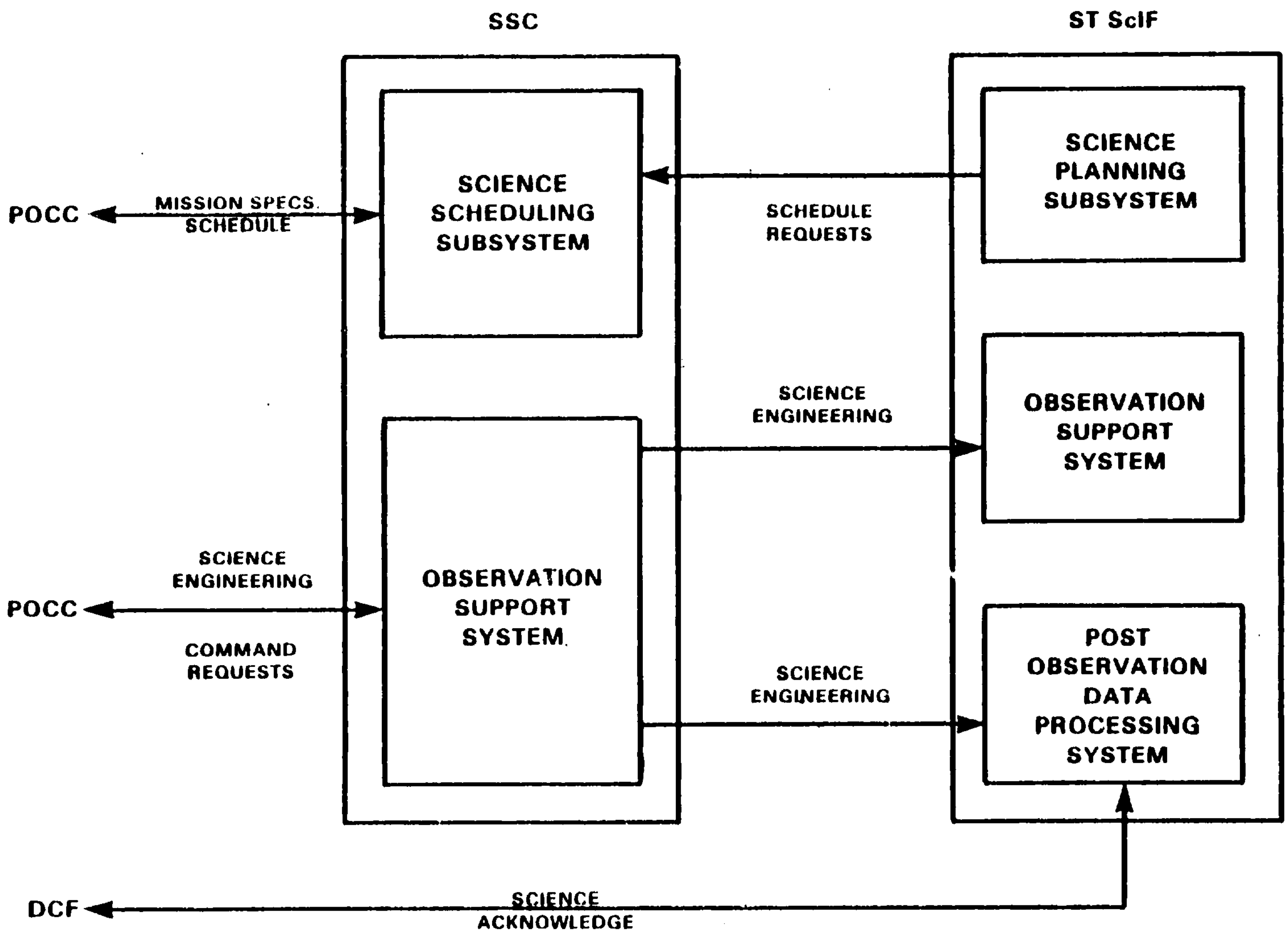
Relative to the element interfaces previously defined under Section 5, Functional Interface Requirements, A&V will test all of the POCC interfaces.

4. SCIENCE OPERATIONS GROUND SYSTEM INTEGRATION AND TEST

The SOGS is comprised of the hardware and software* located at the Science Support Center (SSC) and the ST Science Institute Facility (ST ScIF). The combined SSC and ST ScIF hardware and software specified above will be developed under the SOGS contract. Figure G-4 illustrates the SOGS configuration.

The SSC will be co-located with the POCC at the GSFC, and perform detailed science scheduling, manage the transfer of data between the SSC and the ST ScIF, support the POCC in system anomaly investigation, and conduct limited real-time science operations. The ST ScIF will conduct the program to

*NOTE: Not included is the Guide Star Selection Software (GSSS) and the SI analysis software developed by the ScI.



NOTE: DATA DESCRIPTION ABOVE LINE INDICATES FLOW TO RIGHT AND VICE VERSA

FIGURE G-4 SCIENCE OPERATION GROUND SYSTEM

support scientific observations, including the selection of scientific programs, observation planning, primary real-time science operations, science data processing and archiving, Scientific Instrument (SI) trend analysis, science data analysis, and product generation.

The SOGS I&T Plan and Procedure have not been developed as of this report time. However, the assumption is made that the I&T will be similar in nature to the STOMS TAV and MOGS I&T. The exception to both of these examples is that the SOGS will be developed by one contractor with all internal interfaces being the responsibility of that contractor. The SOGS contractor will integrate the hardware and software, develop the test plans and procedures, demonstrate the system, and provide the reports.

The SOGS external interfaces are those interfaces with the STOMS, as defined under the POCC and DCF Interface Functional Requirements (see Section 3, Functional Requirements for Element Interface), and with the Science Institute software. What is referred to in this document as the Science Institute software is the Guide Star Selection Software and science data analysis software under the responsibility of the ScI contractor.

The overall objective of the SOGS I&T will be to demonstrate the system's capability to perform all functions as defined in the specifications.

Relative to the element interfaces previously defined under Section 3, Functional Requirements for Element Interfaces, the SOGS will test a partial subset of the POCC and DCF element interfaces.

5. ST MISSION OPERATIONS PROCEDURE DEVELOPMENT

The ST Mission Operations will be conducted by using procedures developed primarily by the MOC contractor through liaison with the SOGS, ScI, other ST contractors and NASA. These procedures are divided into three categories: (1) operations procedures (OPs) for the ST; (2) machine-executable procedures which will run on the POCC equipment; and (3) non-machine executable procedures called Operations Directives (ODs) which define action to be taken by the operations staff.

The OPs are English language procedures written from the operations rather than the design point of view.

All machine executable procedures will be in PSTOL, a PORTS version of the System Test and Operations Language (STOL). These procedures shall normally be used by MOC and ScI personnel for all ST command generation, ST fault isolation, ST activation/deactivation, ST performance monitoring, acquisition of data, and ST contingency operations.

Operational Data (OD) will include procedures for reporting of spacecraft problems, malfunctions, or failures, and their solutions or corrections; analyses and projections which may indicate failure-prone components or equipment, or their long-term degradation; spacecraft failure analysis and malfunction diagnosis procedures which will isolate and identify end-point failures, degradations leading to failures, and probable propagation routes of failures through components or subsystems; and routine operations. The ODs will specify roles and responsibilities, functions, interfaces and schedules, and detail the step-by-step tests necessary to accomplish ST mission operations.

Mission Operations Procedure Development is not a test of the interfaces of STOMS although some of the procedures will be used in interface testing. Procedures may be developed by using input from the VAP, A&V and other test and simulation events.

6. MISSION OPERATIONS GROUND SYSTEM INTEGRATION AND TEST

The MOGS I&T encompasses all I&T activities associated with uniting the ST ground system elements into MOGS and verifying MOGS operation. MOGS is comprised of two major elements, the Space Telescope Observatory Managements System (STOMS) and the Science Operations Ground System (SOGS) plus the Space Telescope Science Institute (ST ScI) developed software. The MOGS is illustrated in Figure G-5. MOGS I&T is to be accomplished in two phases. Phase I includes the integration and test of the interfacing hardware and software and the testing and verification that the interface complies with the related ICD. The second phase is the operational verification of the MOGS.

Phase I will use relatively small components of each of the major elements to verify the compatibility across the specific interfaces being tested. Preparation of the test requirements, plans and procedures for each Phase I test will be done by the same organization that has maintained and developed the related ICDs. Each organization shall support the test with the necessary materials, test reports and test and operations personnel.

Phase II will be conducted using large components of each of the major elements to verify the operation of the MOGS. The operation personnel to perform these tests will be provided by the Missions Operations contractor and the ScI Contractor. The above contractors will provide test requirements plans, procedures, and reports. This phase will include multiple interface testing with the use of

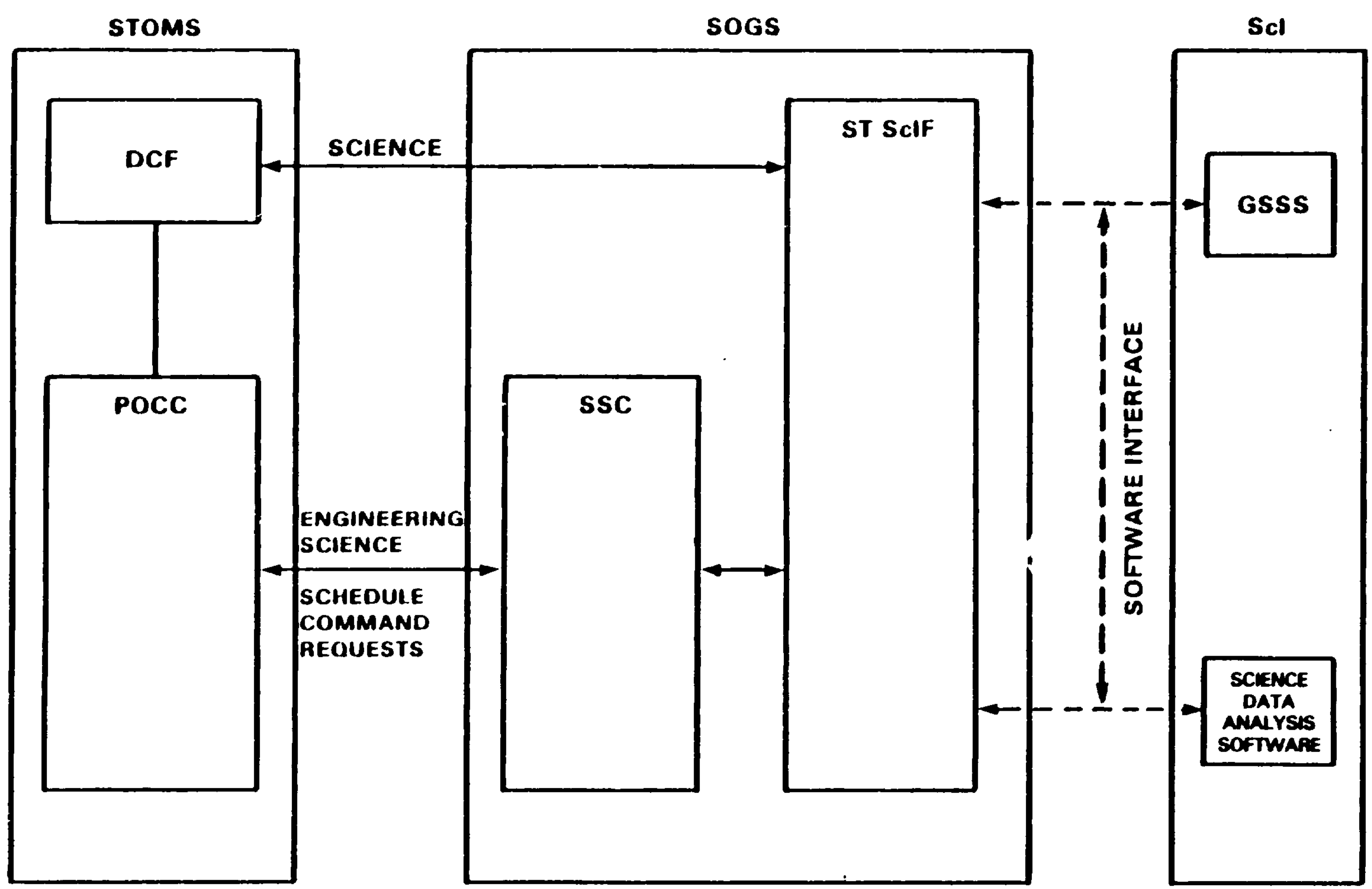


FIGURE G-5 MISSION OPERATIONS GROUND SYSTEM simulated and real ST data. MOGS data handling capacity and the ability of the MOGS to respond to system failures will also be tested.

The STOMS interfaces of concern are the interfaces between STOMS and SOGS. The functional requirements of these interfaces are listed below:

- Spacecraft operations and constraint data from STOMS to SOGS;
- STOMS receipt of science mission specifications from SOGS to STOMS;
- STOMS transmission of mission schedule parameters and timelines to SOGS;
- STOMS transmission of science (including astrometry) and SI and SI C&DH engineering data to SOGS;
- STOMS receipt of command requests from SOGS;
- ST Status display from STOMS to SOGS via CCTV;
- Transmission of captured Science data from STOMS to SOGS.

The MOGS I&T will test only a partial subset of the POCC and DCF element interfaces.

7. MISSION SIMULATION

The Mission Simulation is a functional test of the total ground system and will involve both the MOC and the ScI. Scenarios that will simulate "real time" operations will be developed to provide for rehearsal of prelaunch operations, deployment, orbit verification, routine operations and contingency operations.

All POCC related mission simulation procedures will be developed by the MOC. SOGS related mission simulation procedures will be developed by the ScI.

Maximum use will be made of the ST simulator and recorded ST data. Fault data shall be used to simulate contingency operations. During the actual simulations, the MOC and ScI provide all personnel for those functions which are routinely staffed by the MOC and ScI during normal operations.

The Mission Simulation is not to be confused with the ST Simulation at the LMSC for the A and V. The operational use of all the element interfaces will be used as defined under Section 5, Functional Interface Requirements.

APPENDIX H

CONTROL TEST DATA SET EXAMPLES

APPENDIX H

CONTROL TEST DATA SET EXAMPLES

The following pages represent examples of three CTDSs for the STOMS TAV. Reference Appendix E, Requirements/CTDS Matrices, for the correlation between these and other CTDSs and the origination of the CTDS number.

CONTROLLED TEST DATA SET - CTDS
NO. M11 - ENGINEERING DATA FROM ST SIMULATOR

1.0 INTRODUCTION

This interface is a simulated "Q" channel which supplies simulated engineering data from the ST Simulator at MSFC to the POCC. This is a test data stream which is used for verification of the POCC capabilities to receive and process ST engineering data.

2.0 CONTENT

The data stream contains engineering telemetry information which represents all systems of the ST and its payload. Space Telescope Health and Status Monitor Listings are given in Appendix B of Space Telescope Mission Operations Requirements OP-01 Volume III, document no. 4171847F LMSC. The telemetry data stream generated by the ST Simulator is developed to contain data from all of the monitored points listed in that document.

3.0 FORMAT

There are three programmable and two fixed formats which may be used for transmission of telemetry data from the ST. The ST Simulator data stream may be formatted according to any of these formats. A brief description of each of the formats is given below:

a. Deployment Format. The deployment format is a 500 bps, software controlled, programmable format designed to be used during deployment operations when only the LCAs are available. The format structure provides 125 eight-bit words per minor frame and 20 minor frames per major frame.

b. Basic Format. The basic format is a 4.0 kbps, software controlled, programmable format designed to be used during normal day-to-day ST operations. The format structure provides 250 eight-bit words per minor frame and 120 minor frames per major frame.

c. Diagnostic Format. The diagnostic format is a 32.0 kbps, software controlled, programmable format designed to provide data at a faster rate for OTA and SSM performance diagnosis or evaluation. The format structure provides 200 eight-bit words per minor frame and 1200 minor frames per major frame.

d. 4.0 kbps Fixed Format. This is a fixed format stored in DMS read-only memory (ROM) that is autonomously selected by the DMS in the event of a DF 224 computer failure. The format structure provides 125 eight-bit words per minor frame and 20 minor frames per major frame.

e. 500 bps Fixed Format. This is a fixed format stored in DMS ROM that is selected by ground command if for any reason the other formats are not available. The format is designed to provide the "bare bones" information necessary to evaluate essential SSM functions, and to identify critical ST modes and problem areas during severe contingency conditions. The format structure provides 125 eight-bit words per minor frame and 20 minor frames per major frame.

4.0 PHYSICAL INTERFACE REQUIREMENTS

Simulated telemetry data is received at the POCC on the return path of the 56 Kb/s full duplex NASCOM channel which is used for transmitting command data to the ST Simulator. The telemetry data rates are 0.5, 4.0 and 32.0 Kb/s.

5.0 VOLUME/SCHEDULING (TBD)

Volume and scheduling of simulated telemetry data is dependent upon the level of testing to be accomplished.

6.0 SPECIFICATIONS (TBD)

The exact measurements to be used for ST Health and Status monitoring in the POCC will be selected by POCC operations personnel. The specifics of the simulated telemetry data stream will necessarily be derived from the POCC requirements.

7.0 IMPLEMENTATION (TBR)

The implementation of the test telemetry data flow will be initiated by the issuance of a simulation test order. This order will list all required hardware, software and procedures giving the version/revision levels applicable to the test to be performed.

CONTROL TEST DATA SET (CTDS)

1. NO. M11

2. TITLE: ENGINEERING DATA FROM ST SIMULATOR

3. SYSTEMS/SUBSYSTEMS:

1. POCC
2. ST SIMULATOR

4. PRIMARY PURPOSE OF INTERFACE:

VERIFY THE CAPABILITY OF THE POCC TO RECEIVE AND PROCESS TELEMETRY ENGINEERING DATA

5. PHYSICAL INTERFACE REQUIREMENTS:

56 K b/s NASCOM FULL DUPLEX LINK
DATA RATES - 0.5, 4.0, and 32.0 K b/s

6. CONTENT:

ENGINEERING TELEMETRY INFORMATION WHICH REPRESENTS ALL SYSTEMS OF THE ST AND ITS PAYLOAD.

REF: OP-01 VOLUME III DOC 4171847F LSMC

7. FORMAT: THERE ARE 5 POSSIBLE FORMATS AS FOLLOWS:

1. DEPLOYMENT - 500 b/s, 8 b/w, 125 WORDS/MINOR FRAME, 20 MIN. FR/MAJOR FRAME.
2. BASIC - 4.0 K b/s, 8 b/w, 250 WORDS/MINOR FRAME, 120 MIN. FR/MAJOR FRAME.
3. DIAGNOSTIC - 32.0 K b/s, 8 b/w, 200 WORDS/MINOR FRAME, 1200 MIN. FR/MAJOR FRAME.
4. 4 K b/s FIXED FORMAT - 4.0 K b/s, 8 b/w, 125 WORDS/MINOR FRAME, 20 MIN. FR/MAJOR FRAME.
5. 500 b/s FIXED FORMAT - 500 b/s, 8 b/w, 125 WORDS/MINOR FRAME, 20 MIN. FR/MAJOR FRAME.

8. SPECIFICATIONS:

FACC - X X X X X X

MSFC - X X X X X X

9. FREQUENCY OF TRANSMISSION:

AS REQUIRED DURING SIMULATION OPERATIONS.

10. TRANSMISSION DURATION:

0.15 SECONDS PER BLOCK TO 9.6 SECONDS PER BLOCK — WITH MAXIMUM LENGTH BLOCK, DEPENDENT UPON DATA RATE.

9. LIST ALL DOCUMENTS, CONTROLLED STORAGE MEDIA, ETC. REQUIRED TO COMPLETE DATA SET.

TITLE	NUMBER	REVISION
ST SIMULATOR OPERATORS PROCEDURE	TBD	
PORTS SIMULATION SUPPORT OPERATORS PROCEDURE	TBD	

SHEET 2 of 2

CONTROLLED TEST DATA SET - CTDS
NO. M12 - DECnet SERVICES, ST SIMULATOR

1.0 INTRODUCTION

Communications between the two computers at NSFC and the Simulator Support Computer at the POCC take place via this interface. The DECnet family consists of hardware and software which provides networking capability between Digital Equipment Corporation (DEC) computers. In this particular application the VAX 11/780 Simulator Support Computer at the POCC receives commands and instructions via the DEC net link with the PDP 11/70 in the ST Simulator at MSFC. The facility supports the generation of science data streams and simulated memory dumps.

2.0 CONTENT

The data stream contains program information which controls the playback of pre-recorded science data and reformats it into NASCOM 4800 bit block format. The instructions and commands are transmitted according to the protocol of the Digital Data Communications Message Protocol (DDCMP).

3.0 FORMAT

The data transferred via this interface is formatted according to the VAX/VMS command language or any VAX-11 programming language. Communications may take place via direct commands from terminals at either end of the network or between processes of the applications program.

4.0 PHYSICAL INTERFACE REQUIREMENTS

The physical interface takes place between Network Controllers (DMC-11). These devices respond to program and operating system commands and automatically synchronize on the data, error check it and reformat it for communications using DDCMP rules. Transmission of data may occur at up to 19,200 b/s using EIA RS 232C standard interface.

5.0 VOLUME/SCHEDULING

TBD

6.0 SPECIFICATIONS

Specifications for the generation of the programs which control the playback of science data will be developed by MSFC.

7.0 IMPLEMENTATION

The implementation of the DECnet data flow will be initiated by the issuance of a simulation test order. This order will list all required osftware and procedures given the version/revision levels applicable to the test to be performed.

CONTROL TEST DATA SET (CTDS)

1. NO. M12

2. TITLE: DECNET SERVICES, ST. SIMULATOR

3. SYSTEMS/SUBSYSTEMS:
   1. ST SIMULATOR
   2. POCC

4. PRIMARY PURPOSE OF INTERFACE:

COMMUNICATIONS OF COMMANDS AND INSTRUCTIONS BETWEEN PDP11/70 IN ST SIMULATOR AND VAX 11/780 SIMULATION SUPPORT COMPUTER IN POCC

5. PHYSICAL INTERFACE REQUIREMENTS:

DMC11 NETWORK CONTROLLERS IN EACH SYSTEM.

TRANSMISSION OF DATA UP TO 19,200 b/s USING EIA RS 232C STANDARD LEVELS.

6. CONTENT:

PROGRAM INFORMATION TO CONTROL PLAYBACK OF PRE-RECORDED SCIENCE DATA AND REFORMAT IT INTO NASCOM 4800 BIT BLOCK FORMAT.

7. FORMAT:

DATA IS FORMATTED ACCORDING TO THE VAX/VMS COMMAND LANGUAGE OR ANY VAX 11 LANGUAGE.

8. SPECIFICATIONS:

MSFC - XXXXXX

9. FREQUENCY OF TRANSMISSION:

AS REQUIRED DURING SIMULATION OPERATIONS.

10. TRANSMISSION DURATION:

DETERMINED BY PROGRAM CONTENT, .CATED LINE REQUIRED DURING SIMULATION OPERATIONS.

SHEET 1 of 2

9. LIST ALL DOCUMENTS, CONTROLLED STORAGE MEDIA, ETC. REQUIRED TO COMPLETE DATA SET.

TITLE	NUMBER	REVISION
ST SIMULATOR OPERATORS PROCEDURE	TBD	
PORTS SIMULATION SUPPORT OPERATORS PROCEDURE	TBD	

CONTROLLED TEST DATA SET - CTDS
NO. P81 - COMMAND DATA TO ST SIMULATOR

1.0 INTRODUCTION

The purpose of this interface is to verify the capability of the POCC to generate and correctly format commands to the ST. These commands control the spacecraft as well as the instruments on-board. The command data stream sent to the ST Simulator at MSFC is generated by the PORTS using software which has been developed off-line. This software produces commands in sufficient variety and quantity to extensively test the PORTS command generation capabilities.

2.0 CONTENT

The command data stream contains both STORED PROGRAM COMMAND (SPC) blocks and REAL TIME COMMAND (RTC). The SPC blocks contain data for loading into either the DF224 or the NSSC-1. These commands are time tagged for execution at a later time. The SPC for the two computers (DF224 and NSSC-1) are not intermixed in any one data block.

Categories of commands intended for execution by the on-board subsystems are listed below, with the items effected by the commands.

- o All Support System Module (SSM) subsystems which includes:

  1. Instrumentation and Communications - commands for control of HGA and switches which select communications systems elements.

2. Pointing Control Subsystem (PCS) - commands control the attitude changes of on-board instruments.

3. Electricl Power Subsystem (EPS) - commands control the selection and deployment of solar arrays for battery charging; also change trip points of charge control relays.

4. Safing System - commands which cause the entry into, or deactivation of the Safing System.

5. Data Management Subsystem (DMS) - commands which control the DMS in its operation with other sub-systems or the acceptance and loading of computer load data.

- Optical Telescope Assembly (OTA) - discrete commands which directly or indirectly activate relays, or serial multi-bit commands, used to input engineering values.

- Scientific Instruments Control and Data Handling (SIC & DH) commands which are required in the operational use of the scientific instruments.

3.0 FORMAT

All ST commands are formatted into 48 bit command words. The first seven bits are the spacecraft address; the last seven bits an error protection Hamming Code.

The DF224, SPC and software updates are assembled with the first word in each block providing memory starting address and block length. The NSSC-1 has the block length in the first word and the starting address in the second word. The last word in each block is a ground computed checksum. For the DF224 (but not the NSSC-1) memory locations are replaced with data block or table number in data updates. All command words are formatted into 4800 bit NASCOM blocks and each block is preceded by a 48 bit synchronization word.

4.0 PHYSICAL INTERFACE REQUIREMENTS

Command data is transmitted to the simulator via the forward path of a full duplex 56 Kb/s NASCOM channel at data rates of 0.125 and 1.0 Kb/s. The electrical characteristics of the line meet E1A RS-422.

5.0 VOLUME/SCHEDULING

Volume and scheduling of simulated command data is dependent upon the level of testing to be accomplished.

6.0 SPECIFICATIONS

Specifications for the generation of command data to be used in verification of the PORTS system will be developed by the PORTS contractor. Commands shall be produced for all ST subsystems as well as memory load blocks for both DF224 and NSSC-1 computers.

7.0 IMPLEMENTATION

The implementation of the test command data flow will be initiated by the issuance of a simulation test order. This order will list all required software and procedures giving the version/revision levels applicable to the test to be performed.

CONTROL TEST DATA SET (CTDS)

1. NO. P81

2. TITLE:

COMMAND DATA TO ST SIMULATOR

3. SYSTEMS/SUBSYSTEMS:

1. POCC
2. ST SIMULATOR

4. PRIMARY PURPOSE OF INTERFACE:

VERIFY THE CAPABILITY OF POCC TO GENERATE AND CORRECTLY FORMAT COMMANDS TO THE ST.

5. PHYSICAL INTERFACE REQUIREMENTS:

56 K b/s NASCOM FULL DUPLEX LINK

DATA RATES - 0.125, 1.0K b/s

EIA RS422 LINE

6. CONTENT:

COMMANDS FOR EXECUTION BY ST ON BOARD SYSTEMS -

1. ALL SSM SUBSYS - HC, PCS, EPS, DMS, SAFING SYSTEM
2. OTA
3. SI

7. FORMAT:

NASCOM 4800 BIT BLOCKS

SYNC WORD 48 BITS

ALL COMMANDS 48 BITS/WORD

(REF. ICD - MSFC - DOC - 665)

8. SPECIFICATIONS:

FACC - XXXXXX

MSFC - XXXXXX

9. FREQUENCY OF TRANSMISSION: AS REQUIRED DURING SIMULATION OPERATIONS.

10. TRANSMISSION DURATION:

4.8 SECONDS PER BLOCK OR 38.4 SECONDS PER BLOCK — MAXIMUM LENGTH BLOCK, DEPENDENT UPON DATA RATE.

SHEET 1 of 2

C T D S

9. LIST ALL DOCUMENTS, CONTROLLED STORAGE MEDIA, ETC. REQUIRED TO COMPLETE DATA SET.

TITLE	NUMBER	REVISION
ST SIMULATOR OPERATORS PROCEDURE	TBD	
PORTS SIMULATION SUPPORT OPERATORS PROCEDURE	TBD	

SHEET 2 of 2

APPENDIX I

INTERFACE CONTROL DOCUMENTS

APPENDIX I

INTERFACE CONTROL DOCUMENT

DOCUMENT TITLE	DOCUMENT NUMBER	DEVELOPER	SUPPORT	STATUS
PORTS to NGT NASCOM		PORTS	840	N/A
PORTS to NCC		PORTS	850	N/A
PORTS to VAP	SF-ICD-20	PORTS	440	N/A
PORTS to A&V	ST-ICD-24	PORTS	MSFC	N/A
PORTS to Simulator	ST-ICD-28	PORTS	PORTS	N/A
PORTS to DCF		PORTS	DCF	N/A
PORTS to SSC (OLS)		PORTS	SOGS	N/A
PORTS to MPT		PORTS	MPT	N/A
PORTS to PE	ST-ICD-25	PORTS	MSFC	N/A
PORTS to LMSC	ST-ICD-25	PORTS	MSFC	N/A
PORTS to BFEC	ST-ICP-25	PORTS	MSFC	N/A
PORTS to Project Data Base	ST-ICD-26	PORTS	440	N/A
PORTS to CTV	ST-ICD-23	PORTS	860	N/A
PORTS to OSCF		PORTS	OSCF	N/A
PORTS to PASS	ST-ICD-11	PORTS	PASS	N/A
PORTS to CCTV/Data Comm		PORTS	513	N/A
PORTS to GSTDN		PORTS	800	N/A
PASS to SSC		SOGS	PASS	N/A
PASS to MPT		PASS	MPT	N/A
PASS to OSCF		PASS	OSCF	N/A
PASS to Project Data Base		PASS	MSFC	N/A
PASS to DCF		DCF	PASS	N/A
PASS to External VF224 Loads		PASS	MSFC	N/A

DOCUMENT TITLE	DOCUMENT NUMBER	DEVELOPER	SUPPORT	STATUS
PASS to External NSSC-1 Loads		PASS	MSFC	N/A
DCF to NCC		DCF	850	N/A
DCF to NGT-NASCOM		DCF	840	N/A
DCF to ScIF	ST-ICD-13	DCF	SOGS	N/A
POCC to SCC-Communicator	ST-ICD-12	PORTS	SOGS	N/A
POCC to VAP Data Base	ST-ICD-21	PORTS	IBM	N/A
POCC to VAP Telemetry Magnetic Tape	ST-ICD-22	PORTS	IBM	N/A
POCC to LMSC A&V Test Telemetry Magnetic Tape	ST-ICD-27	PORTS	LMSC	N/A
Ground Communications	ST-ICD-18	GSFC/ST Project	Code 800	N/A

NOTE: N/A indicates not available.

ICD

OUTLINE

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APPENDICES

GLOSSARY

Ancillary Data - Additional, "non-Scientific Instrument (SI)" data which are required to facilitate the analysis and reduction of science data and SI engineering data. These data include: time data, programmatic data, attitude data, ephemeris data, and non-SI engineering data obtained on special request.

Astrometry Science Data - Data derived from the Support System Module (SSM) engineering data stream, combined with appropriate header data, formatted into a science data stream, and delivered as science data. The bit error rate and data accountability standards normally applied to the SSM engineering data are applied even when this data stream is used to derive astrometry science data.

Constraint - An operational limitation imposed on the use of the hardware that must not be violated in either planning or operations. This includes features or characteristics of the hardware inherent to the design which, if violated, could cause physical damage.

DDCMP - (Digital Data Communications Message Protocols) These protocols control message transmission over a physical communications link by using: (1) Cyclic Redundance Check (CRC) for error detecting, (2) retransmission for error corrections; and (3) numbered data messages to ensure sequential transfer of data. DDCMP is a Digital Equipment Corporation development used exclusively with DECnet implementation.

DECnet - A family of network products developed by Digital Equipment Corporation that adds networking capability to DIGITAL's computer families and operating systems. Using DECnet, various kinds of computer system networks can be constructed to facilitate remote communications, resource sharing, and distributed computation DECnet is highly modular and flexible. It can be viewed as a set of tools or services from which a user selects those appropriate to build a network to satisfy the requirements of a particular application.

Ground Control Message Requests - A request transmitted to TDRSS via NCC from the POCC for the control and administration of site support ground functions, initiates reconfiguration of scheduled services or activates speacial procedures at the TDRSS ground terminal.

Mission Planning Terminal - The primary function of the Mission Planning Terminal (MPT) is to act as the interface for the POCC in obtaining STDN support from the NCC. The MPT provides POCC users with the capability to communicate with the Network Control Center Data Systems (NCCDS) in the TDRSS era.

This function provides the POCCs with the capability to convert their mission planning requirements into STDN service requirements, to communicate these requirements to the NCC, to view, confirm and modify the resultant STDN schedule, to receive and distribute schedules to the mission users, to alert POCCs service impacts from NCC, and to exchange portions of the planning/scheduling data bases.

Mission Schedule - The composite of all science and spacecraft operational elements, orbital events, data link opportunities, etc., which govern ST operations. The ST mission schedule is the master schedule from which ST commands are derived and generated.

Mission Timeline - The listing, in hardcopy and/or machine readable media, of the specifications of the sequence of events contained in the mission schedule.

NGT-NASCOM - The component of the NASA Ground Terminal (NGT) that provides TDRSS communication transport services between the NGT at White Sands and the POCCs.

Operation Data Messages - Enables administrative communication between the NCC and its external interfaces; provides information and direction or requests information and direction.

Performance Data - Provides link status information which indicates how well the system is supporting an event.

Science Data Streams - Data originating in the ST that contain the observational output of one or more of the five SIs, SI-unique data logs generated in the SIs or in the NSSC-1, the Standard Header Packet, the NSSC-1 Status Buffer contents, or NSSC-1 memory dumps. These data are transmitted in real-time at either 4 kbps or 1 Mbps or stored on a tape recorder for later transmission. When recorded, the 4 kbps stream is upconverted; a 32 kbps stream, capable of being recorded but not available in real-time, is not upconverted. Playback of recorded data occurs at a 1 Mbps rate.

Science Mission Specification - The detailed specification of science observations giving the particulars of all science-related functions, the sequence of observations and the command requests and parameters describing each observation. Each element of the science mission specifications is time-tagged in correspondence with its anticipated position in the ST mission timeline.

Spaceflight Tracking and Data Network (STDN) - The Tracking and Data Relay Satellite System (TDRSS), the Ground Spaceflight Tracking and Data Network (GSTDN), the Network Control Center (NCC) and the NASA Communications Network.

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