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NASCOM SYSTEM DEVELOPMENT PLAN

SYSTEM DESCRIPTION,

CAPABILITIES, AND PLANS

FY 94-2

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National Aeronautics and Space Administration

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

NASCOM SYSTEM DEVELOPMENT PLAN FOR NATIONAL AERONAUTICS AND SPACE ADMINISTRATION COMMUNICATIONS NETWORK

SYSTEM DESCRIPTION, CAPABILITIES, AND PLANS

FY 94-2

Approved by:

Vaughn E. Turner
Chief, NASA Communications Division

5/2/94
(Date)

The information in this document is intended for orientation and planning purposes only. It is not suitable for engineering design without effective coordination with appropriate Nascom personnel.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Goddard Space Flight Center
Greenbelt, Maryland

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FOREWORD

The Nascom System Development Plan (NSDP) provides information on the charter, organization, capabilities and future plans concerning the NASA Communications (Nascom) Network. The NASA Communications Division, Code 540 (GSFC), is responsible for the planning, engineering, and operation of the Nascom Network.

As implemented by GSFC management, the NSDP method of documentation serves several purposes. As a continuing document, revised and reissued annually, it is intended to serve as a communications medium for disseminating Nascom Network capabilities and development planning information. It is intended to promote organized, coordinated program planning and implementation. In addition, the NSDP facilitates management direction and control, and also provides a logical means for obtaining necessary approval of major Network changes from NASA Headquarters through interaction between updates. This document is intended to fulfill requirements of NASA Management Instruction 2520.1D and other NASA Headquarters instructions.

The NSDP consists of seventeen sections. Sections 1 through 14 comprise the basic document and contain a description of the present Nascom System's operational capabilities. Section 15 describes the support configurations provided to the various networks served by Nascom. Sections 16 and 17 summarize information concerning mission-unique support planning and 5-year Network development planning, respectively.

Detailed Network information on current circuit status, individual project support and various other NSDP backup data are maintained by the NASA Communications Division for internal use.

All Nascom Network users, mission and program planners, and managers are encouraged to provide comments relative to this document and mission support requirements to the NASA Communications Division, Code 540, Goddard Space Flight Center, Greenbelt, Maryland 20771. This organization will receive its formal requirements information through official documentation sources. Notification of program changes may be made at any time to the NASA Communications Division in accordance with prescribed procedures in order that these may be reflected in the NSDP and, where necessary, in Network implementation.

effective information transport services to meet the continuously evolving requirements of NASA's spaceflight projects.

1.5.3 OPERATIONS MANAGEMENT BRANCH

The Operations Management Branch (Code 542) is responsible for the overall technical and operational management of the NASA Communications Network. To execute these responsibilities, the Branch is comprised of three sections: Mission Planning, Communications Management, and Communications Services.

1.5.3.1 Mission Planning Section. The Mission Planning Section (Code 542.1), is tasked with reviewing all flight projects communications requirements to ensure that the telecommunications needs of the projects are met. It initiates actions to provide new communications services, if required, with due consideration given to the availability (or non-availability) of existing network resources. The section provides liaison between the technical implementation organizations and the flight projects while the service is being planned, engineered, and implemented. This section is also responsible for developing and publishing the Nascom System Development Plan (NSDP) for the Nascom Division.

1.5.3.2 Communications Management Section. The Communications Management Section (Code 542.2) provides operational management of the Nascom Network on a 24 hour per day schedule, ensuring that all supporting elements are available to meet project requirements. It provides liaison between Nascom and the commercial carriers supplying its circuits, thus ensuring the provision of reliable telecommunications services. It furnishes all the technical control functions required to maintain the network in a constant state of readiness to meet all telemetry, command, and other operational data and voice signal transport requirements. This section also has the responsibility for managing the GSFC Communications Security (COMSEC) Account.

1.5.3.3 Communications Services Section. The Communications Services Section (Code 542.3) provides technical contract management functions for leased telecommunications services and equipment, equipment purchases, and support service contracts. It provides guidance for the development of telecommunications performance standards and measurement techniques for Nascom Network circuitry. The section analyzes network performance and develops circuit performance data for use in the circuit procurement and rebate process.

1.5.4 TELECOMMUNICATIONS BRANCH

The Telecommunications Branch, Code 543, manages the requirements, system planning, design, maintenance and operation of the "GSFC Telecommunications Network." This network includes voice/data systems, local area communications networks, video systems, electronic mail facilities, office automation systems and cable plant facilities located at GSFC, NASA Headquarters, and the Wallops Flight Facility (WFF).

The Telecommunications Branch is organized functionally as indicated in the following paragraphs.

1.5.4.1 Closed Circuit Television (CCTV)/Datacom. The Closed Circuit Television (CCTV)/Datacom function provides continuous support for the GSFC control centers including the distribution of video, timing, and data. It maintains and operates TV Central and the centerwide GSFC RF video distribution network. Additionally, it provides TV engineering, transmission and production support for GSFC and NASA Headquarters.

1.5.4.2 NASA Select TV Network. The NASA Select TV Network function provides a maintenance and operation service for the NASA Select TV system. This service, provided five days per week, includes the production, scheduling and broadcasting of the Space Transportation System (STS) events, internal NASA educational and scientific projects, and other NASA sponsored video products.

1.5.4.3 Office of Space Communications (Headquarters Code O) Support. This function provides for the installation, maintenance, and operation of the audio/video distribution system at the new NASA Headquarters building.

1.5.4.4 GSFC Local Area Communications Network (LACN). This function provides for the overall maintenance and operation of the GSFC LACN. Additionally, it is significantly involved in assessing applications of new technology and evaluating systems for operational implementation at GSFC.

1.5.4.5 GSFC Institutional Support. This function provides for GSFCMail service support and maintains the extensive data base for the GSFC Interconnect Telecommunication System (ITS) (ROLM) telephone system. It also coordinates, with MSFC, all GSFC and Wallops requirements for PSCN service. It provides the technical support necessary to provide PSCN tail circuit extensions at GSFC and WFF. Related to this is the responsibility for installation and maintenance of cable plant facilities at GSFC, NASA Headquarters, and the WFF for support of institutional and scientific programs.

1.5.4.6 Public Affairs Office (PAO)/Visitor Center. This function provides repair and preventative maintenance for all the audio/visual equipment in the GSFC Visitors Center.

1.6 NASCOM SYSTEM DEVELOPMENT PLAN

1.6.1 CONCEPT, PHILOSOPHY, AND USE FOR NSDP DOCUMENTATION

The NSDP is a management document containing the approved plan for establishing and maintaining the Nascom Network System. Its preparation and maintenance is required by NMI 2520.1D. The concept in developing the NSDP is to provide a document concerning the Nascom Network that can be useful to a wide range of readers from NASA management to the various levels of Network users. Aside from serving as a technical reference, the NSDP can also serve as an introductory paper or tutorial for those who plan to use the Nascom Network. The NSDP reflects Nascom's interpretation of the communications services required to support NASA programs in existing and planned implementation. The NASA Communications Division does not evaluate program requirements, but provides for those validated requirements that have been funded by NASA Headquarters.

1.6.2 SCOPE

The NSDP covers the system description of Nascom systems, existing capabilities and requirements for these systems, plans and development activities during the fiscal year, plans for the ensuing fiscal year and the following five years, and descriptions of support provided to various NASA projects and missions.

1.6.3 CONTENT

Section 1 provides information on the Nascom charter and management, and Section 2 on procurement and resource planning. Sections 3 through 14 describe the various Nascom systems, circuit configurations, and arrangements. Section 15 provides information on NASA networks (other than the Nascom Network) and the extent of Nascom support. Section 16 describes Nascom planning for individual NASA missions. Section 17 provides information on development of Nascom systems that are planned or in the process of implementation to meet future program requirements.

1.6.4 RESPONSIBILITY

The Mission Planning Section of the NASA Communications Division is responsible for the publication, maintenance, and issuance of the NSDP. The Chief of the NASA Communications Division is, however, the signature authority for approving the NSDP, and the NASA authority responsible for the prompt issuance of revisions and necessary page changes to maintain the NSDP in an adequate and current status.

1.6.5 USE OF THE NSDP

As stated in the Foreword and in paragraph 1.6.1, the NSDP is a multipurpose document. It is used by Nascom management to meet a requirement of NMI 2520.1D, and as a medium for disseminating information to promote coordinated NASA networks and program planning. The NSDP is also used by NASA Headquarters in support of the budget presentation.

1.6.6 NSDP PREPARATION

Preparation of the NSDP necessitates that communications requirements from all programs be received and consolidated into an overall Nascom Network plan in a timely manner. Nascom development plans are coordinated with field installations and the NASA centers before implementation. Information is promulgated through publication and distribution of the NSDP.

1.6.7 NSDP PUBLICATION CYCLE

The NSDP production schedule has, to date, included the document being reissued on an annual basis during the first month of the fiscal year with a mid-year update (change pages) being provided as of the seventh month of the fiscal year. The FY 94-1 reissue and FY 94-2 mid-year update were the last to follow this schedule. Following this issuance, FY 94-2 update, the NSDP will be produced and reissued on an annual basis only, the next reissue being due as of April 1995.

1.7 NASCOM USER REQUIREMENTS PLANNING

1.7.1 SOURCE DOCUMENTATION

The following paragraphs identify the major source documents that are used to establish the requirements for support of spaceflight projects and missions. These documents will include operational ground communications support requirements, many of which may directly or indirectly specify Nascom systems support for the respective mission. Requirements are documented in two different ways: the Universal Documentation System (UDS) for manned flight missions and the Mission Requirements Request (MRR)/Detailed

Mission Requirements (DMR) Document for unmanned space projects and for suborbital and aeronautical flight projects. The operational communication requirements, originally documented, approved, and maintained in the UDS and MRR/DMR, are used by the Mission Planning Section, Code 542.1, for Nascom's mission-unique planning requirements activity.

1.7.1.1 Universal Documentation System. The following paragraphs describe the UDS.

a. UDS Basis Document. NMI 8610.10B, dated December 19, 1991, prescribes use of the UDS. The UDS provides a system for managing operational support requirements for manned flight missions including the requesting of support and the responding to those requests. The UDS is applicable to NASA Headquarters and the NASA field installations (including GSFC/Nascom) and DoD installations in accordance with the NASA/ DoD Memorandum of Understanding (MOU) on Management and Operation of the Space Transportation System and its subagreements

b. UDS Description. The UDS consists of three levels of documentation in six documents:

(1) Level 1: Program Introduction Document (PID)/Statement of Capability Document (SCD). The PID and SCD are the long-lead-time Level I Program requirements and response documents initiated at the start of a new program and signed by the cognizant Program Associate Administrators. These documents are generated and maintained for the Space Shuttle Program (SSP). They are revised as required according to approved Level I and Level II change procedures to reflect changes both in requirements and commitments.

(2) Level 2: Program Requirements Document (PRD)/Program Support Plan (PSP). Within the scope of the requirements and responses developed in the PID and the SCD, these program Level II documents define requirements and responses for prelaunch, launch, flight, landing and postlanding operations. These documents are used for direct support requests among NASA and DoD elements. The Space Shuttle requires launch and landing PRD's, prepared and approved by Kennedy Space Center (KSC), and flight PRD's, approved and maintained by Johnson Space Center (JSC) for flights launched from KSC. Each PRD consists of two volumes, Volume 1 containing Shuttle support requirements, and Volume 2 containing cargo/payload requirements, with separate annexes for each payload. The PSP is the support agency response commitment to PRD requirements.

There are also provisions for an Expedited Operations Requirements (EOR) system for unanticipated prelaunch test, launch, flight, and landing requirements to be requested and responded to in an expedited mode when essential to maintain continuing operations. These are known as Launch Support Requirements (LSR) and Flight Support Requirements (FSR) for the respective PRD's.

(3) Level 3: Operations Requirements (OR) and Operations Directives (OD). Within the scope of the requirements and responses developed in the PRD and PSP, these program Level III documents define requirements and responses in sufficient detail to be used for developing operational documentation for mission support. As the OR presents the detailed requirements of a mission or activity, the OD supplies the supporting agency's response commitment.

(4) OSC and GSFC Role: OSC is responsible for overall management and commitment for support of NASA's tracking and data acquisition, and communications and data systems. OSC responds to Level I Program support requirements for manned flight missions through the Associate Administrator for Space Communications. OSC responds to Level II and Level III program support requirements through the Goddard Space Flight Center.

c. UDS Requirements Control. All Space Shuttle requirements are documented in the UDS. Requirements control starts with JSC as the requestor for MO&DSD (Code 500) support services, which includes Nascom. The Flight Mission Support Office (Code 501) is responsible for preparing the UDS system OR document and their Mission Support Manager (MSM) or Mission Operations Manager (MOM), as applicable, coordinates with the Mission Planning Section (Code 542.1) for responses to requirements for Nascom Network services.

d. Automated Support Requirements System. An Automated Support Requirements System (ASRS) has been implemented for automated processing and electronic mailbox distribution of requirements. ASRS is mandated by the newly issued NMI 8610.10B except where classified requirements and responses in support of classified DoD payloads are concerned; in the latter case, manual documentation of requirements and responses employing UDS formats is used. This has been necessary to accommodate the large quantity of requirements and changes generated by multiple flight missions and payloads. Data bases for both launch and landing, and flight operations support requirements reside in host computers at KSC.

Compatible interacting terminals are located at various NASA centers and DoD locations.

e. UDS Handbook. The UDS Handbook, published in three volumes, describes the total UDS structure in Volume 1, Levels 2 and 3 sample formats in Volume 2, and Levels 2 and 3 response data in Volume 3. Handbook Supplement 2 describes the procedures for electronic processing of Levels 1, 2, and 3 documents.

1.7.1.2 Requirements Documentation Process for Unmanned Space, Suborbital, and Aeronautical Missions. The following paragraphs describe the process for obtaining use of OSC capabilities to support unmanned space missions, sub-orbital missions, and aeronautical missions.

NOTE

> The process herein described is that prescribed by NMI 8430.1C; it applies to missions for which planning commenced subsequent to the issuance of this NMI (December 31, 1991). Missions for which planning commenced under provisions of NMI 8430.1B (prior to 31 December 1991) will continue to use the procedures and documentation prescribed by that NMI.

a. General. This requirements process is both iterative and interactive, providing the mechanism for customers to obtain use of OSC capabilities throughout the mission life-cycle. The objective of the process is two fold: (1) attaining timely determination of the requirements for OSC support and (2) enabling OSC to develop cost and schedule baselines.

The customer is expected to initiate early coordination with OSC prior to the end of Phase A studies. This early interaction with OSC is intended to (1) provide the customer with knowledge of OSC capabilities, (2) identify requirement tradeoffs and alternatives, and (3) provide OSC with information that may influence its long-range planning. This early coordination activity precedes any formal requirements documentation from the customer to OSC.

b. Mission Requirements Request. The MRR is a concise summary document designed to identify the project's top-level requirements. The format to be used will be provided to the customer by OSC during the early coordination process. As its Phase A studies are concluding, a customer requiring OSC capabilities forwards its MRR, signed by the customer's Associate Administrator (or equivalent level if non-NASA) to the Associate Administrator/Space Communications. If new OSC capabilities are required, then the MRR must be submitted in sufficient time to allow for obtaining any budget authority necessary for implementation of the new capabilities. Whenever significant changes to customer requirements become known, the customer must update the MRR by submitting appropriate addenda to OSC.

c. MRR Acknowledgement Letter. In response to the MRR, OSC provides an Acknowledgement Letter in which are contained the following items: (1) confirmation of receipt of the MRR by OSC, (2) designation of the point-of-contact within OSC, (3) designation of OSC's Lead Center and direction to that Center to formally develop plans to meet the customer's requirements, and (4) designation of the Capacity Projection Plan (CPP) as the primary document summarizing how OSC's planned capability and capacity satisfies the customer's mission requirements.

d. Capacity Projection Plan. The CPP is the OSC document which presents to all customers a projection of their demands measured against the available supply of OSC capabilities and capacities. Issued semi-annually consistent with the NASA budget cycle, the CPP lists all projects for which MRRs have been received and indicates the extent to which each project's requirements may be satisfied. The CPP also identifies any capacity and capability shortfalls requiring resolution.

e. Detailed Mission Requirements Document. The DMR documents the customer's detailed requirements and includes the corresponding OSC plans for meeting those requirements. This document is the source of detailed requirements and plans needed by lower levels to guide their implementation activities. Requirements in the DMR are traceable to the MRR; whenever a requirement change impacts a planned OSC capability or capacity, an update is issued by the customer. The DMR is prepared and approved jointly by the customer's project manager and the OSC Lead Center's representative. Issued by the customer at the time of Phase C/D approval, the DMR is then used by OSC to baseline mission requirements and the corresponding cost and schedule for implementing any new capacity and/or capability required by the mission.

Where Goddard Space Flight Center is designated OSC's Lead Center, detailed requirements are processed by Code 501's applicable Mission Operations Manager (MOM) or Mission Support Manager (MSM). The MOM or MSM, in turn, formally coordinates any requirements for Nascom services with Nascom's Mission Planning Section. As a member of the MOM's or MSM's team, Nascom provides capability and capacity information to Code 501 for inclusion in Code 500's "responses" to the mission's requirements.

1.7.1.3 DELETED

1.7.1.4 Other Documentation. The other documents that specify the ground operational communication requirements for the Nascom Network to support a NASA project or mission include:

a. NMI 8410.3, Tracking and Data Relay Satellite System (TDRSS): Use and Reimbursement Policy for Non-U.S. Government Users, dated March 3, 1983.

b. GSFC-Level I Requirements, Code 500 Systems Management.

1.7.2 NASCOM PARTICIPATION

1.7.2.1 Nascom Inputs. The Mission Planning Section, Code 542.1, provides inputs to planned support for response documentation prepared by GSFC MO&DSD, Codes 501, 502, and 530. It also provides inputs to Jet Propulsion Laboratory's (JPL) managers for the various DSN-supported missions, via the DSN/Ground Communications Facility (GCF) Mission Coordination Group at JPL. The Mission Planning Section has varying degrees of participation in the drafting of the original Level 1 and 2 ground communications requirements section of the PRD's and MRR's, through participation in ad hoc support planning working groups. Nascom may also provide inputs concerning ground communications to the development of ancillary requirements documentation, such as the Payload Integration Plans (PIP) prepared by JSC, which are preliminary to PRD annex documentation for STS payload mission requirements.

1.7.2.2 NSDP Reportage. The requirements for approved or planned future NASA missions as reflected in GSFC MO&DSD level planning and NASA mission models, as well as future ongoing mission phase support requirements, are summarized in Sections 16 and 17 of this document.

1.7.3 INTEGRATION OF REQUIREMENTS

This paragraph describes the practices and procedures observed by Nascom in integrating the various communication requirements of the spaceflight missions during the planning and implementation phases. The manner in which the common-user Nascom Network is configured to meet necessary communication requirements for the various missions supported by the STDN and DSN stations is contained in Sections 3 through 14 of the NSDP. The integration of requirements for the communications channels and facilities is described in the following paragraphs.

1.7.3.1 Communication Channels. The actual number and type of communication channels required for a network station are determined largely through continuing consultation and review with the project and program planners, Ground Network (GN), SN and DSN GCF planners, and the NASA Communications Division, based on the validated, mission-related communication requirements.

1.7.3.2 Facilities. The number and type of facilities provided in the common-user portions of the network are ultimately determined by the NASA Communications Division, based upon the limitations of facilities actually available, budgetary constraints, carefully considered circuit sharing, mission traffic, and scheduling criteria, as provided by the program planners.

1.7.4 FUNDING

1.7.4.1 Recurring Charges. The major portion of Nascom Network operating costs consists of recurring charges for full-period (24 hour/day) lease of various types of point-to-point telecommunication services from domestic and foreign common carriers. These are carried in the operations budget. Also carried in the operations budget are operator, switching systems software, maintenance, engineering and operational support services.

1.7.4.2 Equipment Budget. An equipment budget provides for government-furnished voice, data modem, and TTY terminals, and switching, monitoring, and test facilities required for cost-effective use and operational control of the communication channels that cannot otherwise be provided through lease from the common carriers.

1.7.4.3 Variations. The fiscal year-to-year funding level changes projected in the overall operations budget for leased channels (domestic and overseas carriers) reflect the net effect of numerous anticipated circuit deletions, additions, or replacement actions, tariff revisions, monetary exchange rate variations, state-of-the-art developments, etc. Therefore, these overall budgetary year-to-year variations normally may not be correlated with particular project requirements or system changes.

1.7.4.4 Sources. Funding of the Nascom operational network is provided through the OSC, Code O, NASA Headquarters. In addition, some services are provided, on a reimbursable basis, to NASA projects; experimenter and commercial interests; and foreign governments and interests. This reimbursement is based on the actual cost of the service. Funding responsibility remains with the organization requiring the service on a continuing basis.

Additional information regarding OSC-funded categories for Nascom-obtained resources is contained in Section 2. Detailed Nascom budgetary information is contained in the GSFC Project Operating Plans (POP) and is supported by the current GSFC MO&DSD Work Authorization Documents (WAD). Information on network development related to the current Nascom portion of the WAD may be found in Section 17 of this document.

Deviation from the approved program as set forth in the Nascom WAD (exceeding $100,000 annual cost) must have concurrence of NASA Headquarters. All changes involving unique project communications will be coordinated with the cognizant field installation, regardless of size.

1.8 NASCOM POLICIES AND PRACTICES

1.8.1 MANPOWER

This paragraph describes the role of the NASA Communications Division and the contractor in providing manpower for implementing the various activities of the Nascom Network.

1.8.1.1 Government Role. The majority of NASA Communications Division government-employed personnel are located at GSFC engaged in the planning, engineering design, technical management, and operational direction of the Network.

1.8.1.2 Contractor Support. Government manpower is supplemented through contracts generally providing coordinated program support for engineering services, network planning and analysis, switching computer programming support, and communication controllers and operators at GSFC. The prime contracts for providing these services are described as follows:

a. The Systems, Engineering, and Analysis Support (SEAS) contractor is responsible for providing general systems engineering support services to Code 540 which include system engineering, installation monitoring, engineering, and Acceptance Test (AT) monitoring.

b. The Network Mission Operations Support (NMOS) contractor is responsible for providing general systems operations support services to Code 540 which include supervisors and operators to man positions on a 24-hour-per-day, 7-day-per-week basis to perform the day-to-day maintenance and operations (M&O) functions.

c. At overseas Nascom Interface Facilities, operations and maintenance personnel are provided through NASA contract arrangements with respective foreign governments or agencies.

d. The operationally oriented personnel are provided at the remote Nascom Interface Facilities and in the project control centers by the interfacing user organizations.

1.8.2 DELEGATION OF AUTHORITY

The Director, GSFC, for reasons of economy, workload, and responsiveness to project requirements, may request the cognizant field installation to implement the required operational long-line communications facilities and services. This may include provision for the applicable item in the appropriate program/project budget. It does not alter the requirement for the Director, GSFC, to concur in the technical adequacy of the planned facilities and services.

1.8.3 CONFIGURATION CONTROL MANAGEMENT

This paragraph describes the makeup and workings of the Configuration Control Board (CCB).

1.8.3.1 Configuration Control Board. The MO&DSD has delegated the authority for the management of the Nascom Network configuration control to the CCB, which reports to the NASA Communications Division. The CCB is chaired by the Associate Division Chief and is composed of the Branch and Section Heads of the Division. The purpose of the CCB is to ensure that all proposed configuration changes to the Nascom Network satisfy the system performance necessary to meet

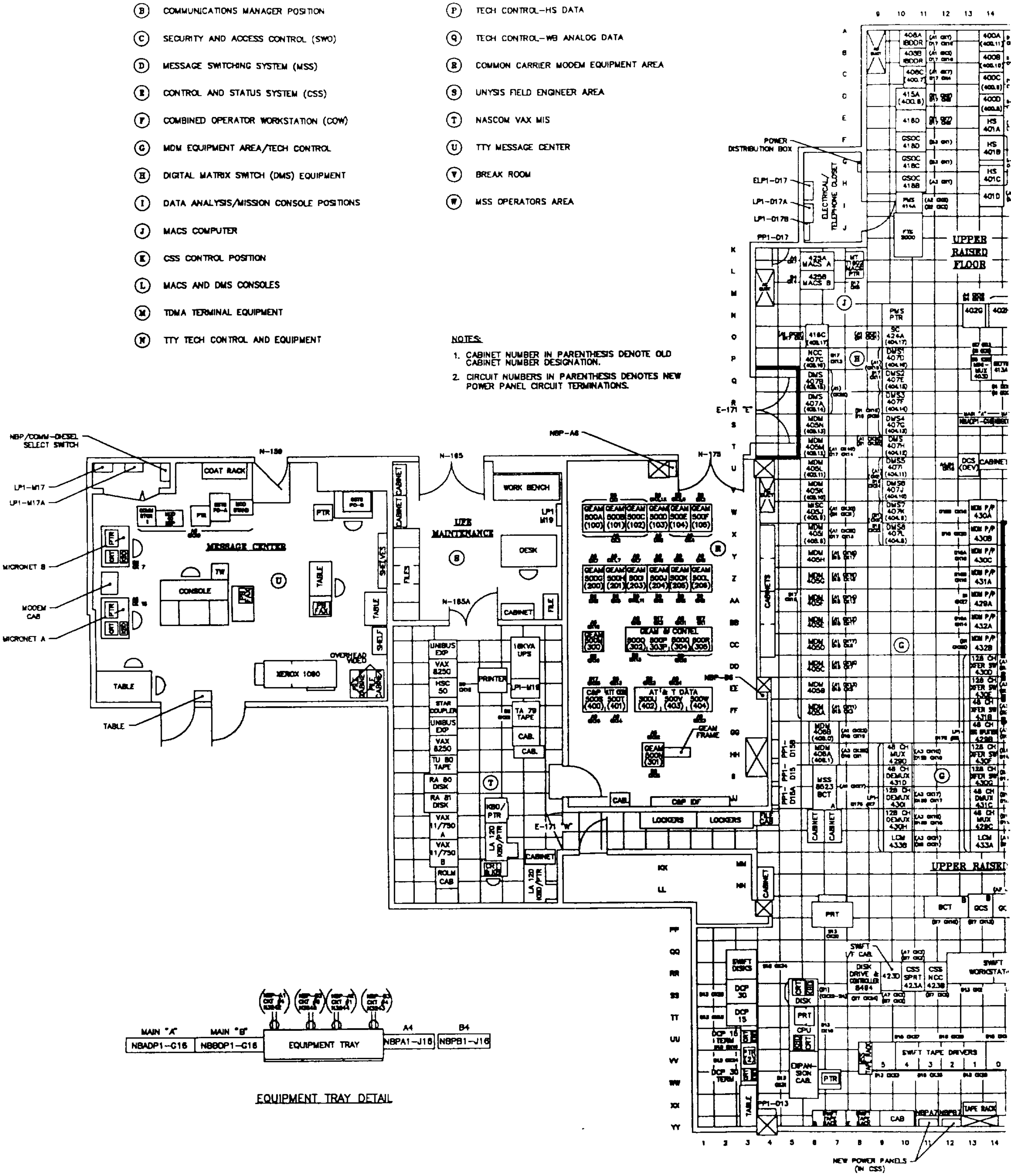
FOLDOUT FRAME

LEGEND

- (A) VOICE CONTROL
- (B) COMMUNICATIONS MANAGER POSITION
- (C) SECURITY AND ACCESS CONTROL (SWO)
- (D) MESSAGE SWITCHING SYSTEM (MSS)
- (E) CONTROL AND STATUS SYSTEM (CSS)
- (F) COMBINED OPERATOR WORKSTATION (COW)
- (G) MDM EQUIPMENT AREA/TECH CONTROL
- (H) DIGITAL MATRIX SWITCH (DMS) EQUIPMENT
- (I) DATA ANALYSIS/MISSION CONSOLE POSITIONS
- (J) MACS COMPUTER
- (K) CSS CONTROL POSITION
- (L) MACS AND DMS CONSOLES
- (M) TDMA TERMINAL EQUIPMENT
- (N) TTY TECH CONTROL AND EQUIPMENT
- (O) TECH CONTROL-WB DIGITAL DATA
- (P) TECH CONTROL-HS DATA
- (Q) TECH CONTROL-WB ANALOG DATA
- (R) COMMON CARRIER MODEM EQUIPMENT AREA
- (S) UNYSIS FIELD ENGINEER AREA
- (T) NASCOM VAX MIS
- (U) TTY MESSAGE CENTER
- (V) BREAK ROOM
- (W) MSS OPERATORS AREA

NOTES:

1. CABINET NUMBER IN PARENTHESIS DENOTE OLD CABINET NUMBER DESIGNATION.
2. CIRCUIT NUMBERS IN PARENTHESIS DENOTES NEW POWER PANEL CIRCUIT TERMINATIONS.



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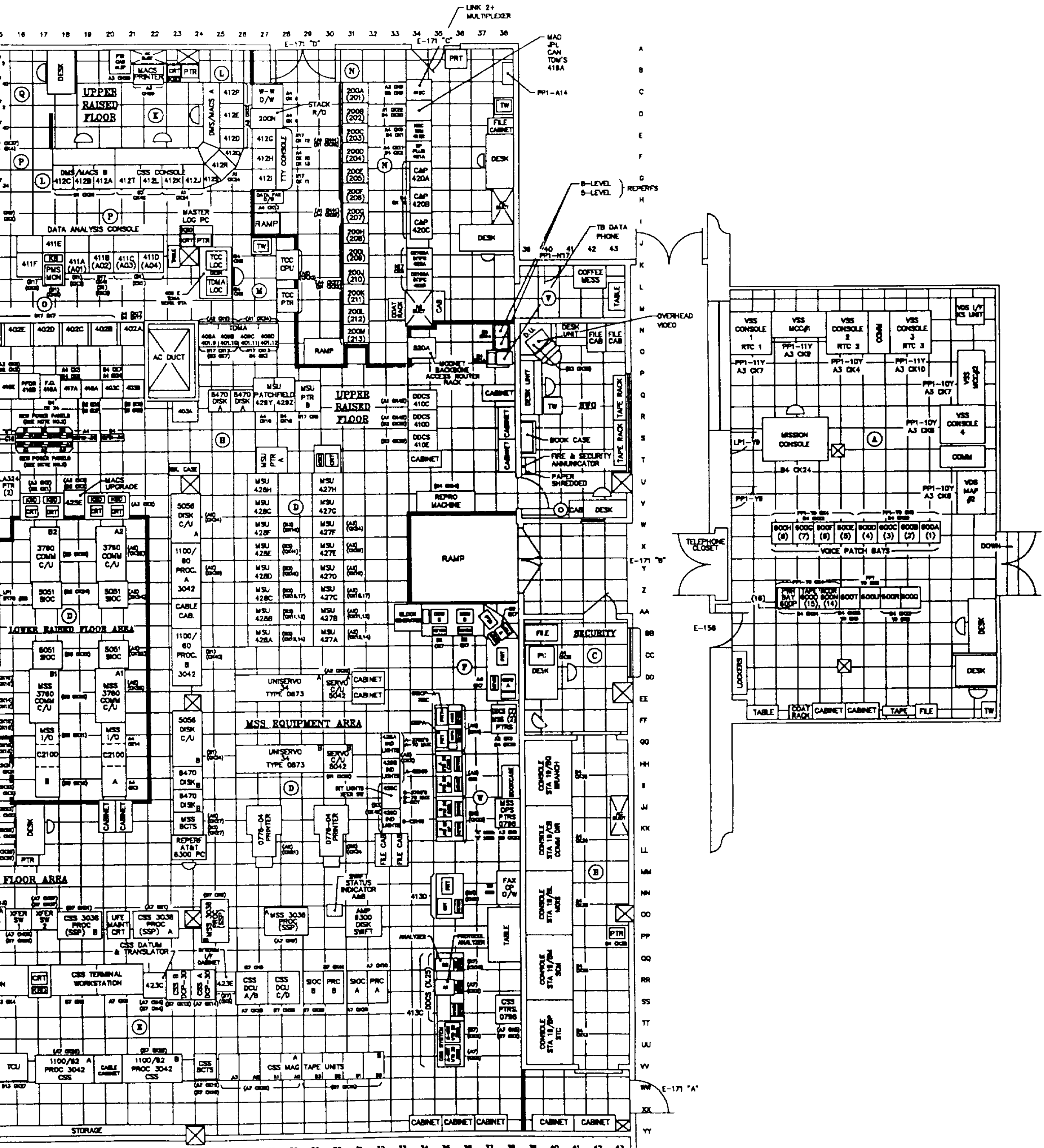


Figure 3-2. GSFC Nascom Switching Center Floor Plan

3.2.2 CIRCUIT SWITCHING SYSTEM

Circuit switching is the routine operational connection of one circuit to another performed by Nascom in response to schedules or real-time requests. It may be accomplished in several ways, depending on the circuits involved. It may be done manually, using the analog and digital high-speed and wideband patch panels in Technical Control to accomplish the direct interconnection (hardware) of long-haul point-to-point and/or local GSFC data channels. It may be accomplished semiautomatically via the Digital Matrix Switch (DMS), configurations being entered from local operator console positions. Or circuit switching may be accomplished automatically under the Control and Status System (CSS). This definition distinguishes circuit switching operations from message switching and those switching functions performed for trouble isolation, circuit testing, and restoration.

3.2.3 MESSAGE SWITCHING SYSTEM

The Message Switching System (MSS) is used to perform automatic message switching functions on wideband, high-speed, and low-speed digital data, and on TTY text and data messages.

3.3 WEST COAST (INTERMEDIATE) SWITCHING CENTER

The following paragraphs describe the West Coast Switching Center (WCSC) as an intermediate switching facility of the Nascom Network.

3.3.1 WCSC SYSTEM DESCRIPTION

3.3.1.1 WCSC/Nascom Facility Description. JPL operates both the GCF-20 communications center and the WCSC to support the communications requirements of the DSN as part of the Nascom Network, respectively. These centers, integral parts of the Central Communications Terminal (CCT) located in the Space Flight Operations Facility (SFOF) building at Pasadena, CA, share common equipment. They are separately budgeted and funded by JPL.

3.3.1.2 WCSC System Elements. Nascom uses the JPL-provided audio switch assembly, which has a capacity of 100 external line terminations. The 758A switchboard provides for switching, conferencing, and configuring voice and voice/data circuits. Nascom-supplied TDM terminals for a 50-channel, diversely routed TTY system between JPL and GSFC are included in the WCSC. Voice/data and TTY technical control and data terminal facilities for high-speed and wideband data are jointly provided by JPL and Nascom at JPL. This equipment is used to through-connect TTY, voice, and data circuits from sites in the west coast area to GSFC, as well as for local termination, distribution, facility control, test, and restoration operations.

3.3.1.3 JPL/GSOC Interface. In July, 1992 the German Space Operations Center (GSOC) located in Oberpfaffenhofen, Germany established a direct interface with JPL/DSN. To establish this interface GSOC leased a 64 kilobits per second (kb/s) data circuit and furnished GDC, Inc. MiniMux time division multiplexers for use on each end. Figure 3-3 depicts the multiplexer and circuit configuration.

3.3.2 NASCOM OPERATING ARRANGEMENTS

Both the GCF-20 communications center and the WCSC are operated 24 hours per day, 7 days per week by contractor personnel. The operation of both GCF-20 and the WCSC are subject to Nascom operating policies, procedures, and guidelines.

3.3.3 WCSC ENVIRONMENTAL SUPPORT FACILITIES

The environmental support facilities provided for the WCSC system include:

a. Power Facility. Normally, all loads are carried on commercial power. Three 1380 kVA auto-start diesel generators will assume the load within 20 seconds in the event of a commercial power failure. During critical mission periods, the generators are brought up in a standby mode. In the event of failure of both commercial power and diesel generators, an Uninterruptable Power Supply (UPS) will provide up to 30 minutes of power.

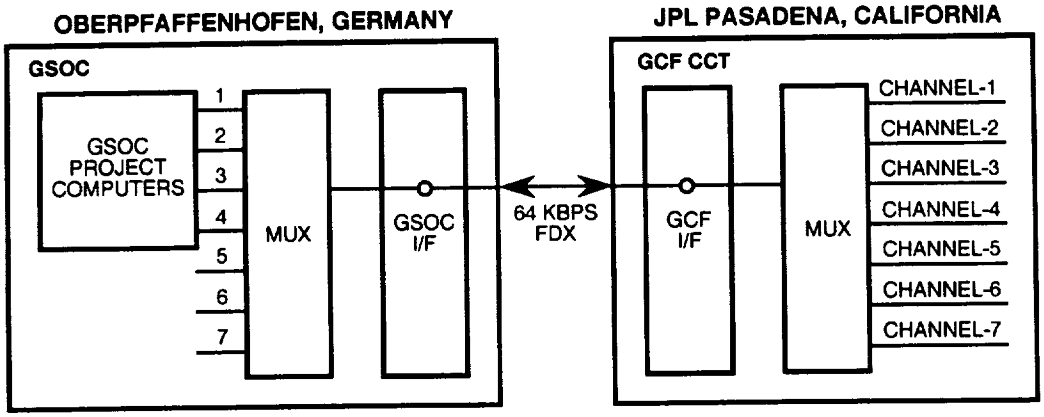
b. Air Conditioning Facility. The air conditioning system provided for the SFOF has a 1500-ton capacity.

3.4 MARSHALL SPACE FLIGHT CENTER NASCOM POINT-OF-PRESENCE

The following paragraphs describe the Nascom Point-of-Presence (POP) at MSFC as an extension of the Nascom network.

3.4.1 MSFC NASCOM POP DESCRIPTION

3.4.1.1 MSFC Nascom POP Configuration. The Nascom POP facility at MSFC is designed, managed, operated and maintained by Nascom. The Nascom POP is located in room 107, Building 4207, MSFC. This facility provides a Nascom interface



NOMINAL MUX CHANNEL DISTRIBUTION

CHANNEL	USE
1	9.6 KB/S FDX 4800-BIT BLOCK A1 ROSAT
2	9.6 KB/S FDX 1200-BIT BLOCK A7
3	9.6 KB/S FDX 4800-BIT BLOCK D2
4	9.6 KB/S FDX 4800-BIT BLOCK 51 SOE/ICV/ODF
5	VOICE - ROSAT COORD LOOP
6	VOICE -
7	ANTICIPATED TTY CHANNEL

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Figure 3-3. GSOC - JPL MUX Configuration

and demarcation point at MSFC where individual circuits and signals from user facilities may be interfaced to complex communications systems for transport between MSFC and other NASA Centers.

3.4.1.2 <u>MSFC Nascom POP Elements</u>. The communications systems in the POP consist of operations voice circuits, a Nascom 15 megabits per second (Mb/s) TDMA terminal, A and B system terminals for both JMRTS and KMRTS, DDCS nodes A and B, the associated patch panels and the interfacing equipment of Nascom's commercial carriers. It should be noted that even though there are A and B systems for both the JMRTS and the KMRTS, the systems are neither identical nor redundant. The Nascom MDM replacement project is installing MSFC's new MDM hardware in the POP thus completing the relocation of "Nascom facilities" that have been formerly identified for removal from the Huntsville Operations Support Center (HOSC).

NOTE

> There is as yet no project to relocate the high data rate system statistical multiplexer from the HOSC to the POP; should such a project materialize, it is to be expected that the existing hardware would be replaced with new equipment and that the replacement hardware would be installed in the POP. This would complete removal of "Nascom facilities" from the HOSC. Paragraph 17.4.8 discusses Nascom's goal for replacement of the HDRS.

Figure 3-4 depicts the floor plan of the Nascom POP as of January 1994.

3.4.2 NASCOM OPERATING ARRANGEMENTS

A preliminary Memorandum of Understanding (MOU) for Nascom POP at MSFC has been written and is in the review and signature cycle. This MOU, executed between Nascom (GSFC/540) and the Information Systems Office (MSFC/AI01), sets forth the following:

a. The MOU formally codifies accommodations and arrangements previously agreed upon. It defines major areas of responsibility for Nascom and for MSFC.

b. The Nascom POP is staffed by Nascom and reports operationally to the Communications Manager at Nascom, GSFC. Nascom provides specifications for hardware installation and determines requirements for the facility. Nascom provides operating and maintenance personnel sufficient to staff the facility on a single shift basis five days a week. This staff is also required to provide coverage on an extended basis as operational mission requirements may dictate.

SECTION 5
MAJOR GROUND COMMUNICATION SUPPORT SYSTEMS

5.1 GENERAL

This section describes the Nascom systems that are considered vital to the operation of the Nascom Network. These systems are within the scope of a major ground communication support system as defined in paragraph 4.1. They are introduced in the early part of this document to provide the reader an understanding of what they are first, and what they become as part of an integral or whole system.

5.2 VOICE SWITCHING SYSTEM (VSS)

5.2.1 SYSTEM DESCRIPTION

The VSS is a totally electronic digital switching system. The VSS currently has the capability to switch, conference, and monitor 2000 analog lines/circuits. The VSS is equipped to terminate 10 two-wire dial lines and 1990 four-wire private-line, long-haul or local circuits with manual "ringdown" signaling. The two-wire lines are incorporated into the system to provide emergency dial-up service in the event of four-wire private line failures. Two-wire dial-up services are not a standard offering for Nascom operational voice conferences. Conferencing capability is limited only by the number of circuits configured to the system. The system hardware design is modular thus enabling expansion to support future user requirements.

The VSS provides point-to-point and/or conference voice communications for project and operations support on a network of high-quality local and long-haul voice and voice/data circuits. The circuits radiate to the Nascom users either directly or through a Nascom remote switching center. Figure 7-1 shows the communications environment in which the VSS operates. [Note: Use of the term "SCAMA" is now limited to denote tail (local loop) circuits between the VSS and the POCCs located on Goddard Space Flight Center; any other use of the term is outmoded and discouraged.]

5.2.2 SYSTEM INTERFACES

The VSS is the focal interface for voice and voice/data circuits coming from the following:

a. Local GSFC facilities.

b. Domestic NASA switching center.

c. JSC Mission Control Center.

d. Overseas Network Stations.

e. KSC facilities and other U.S. terminals.

5.3 DIGITAL MATRIX SWITCH

This paragraph provides a standalone description of the DMS. Its role as a major support system of the BDS for SN is described in Section 11.

5.3.1 DMS DEFINITION

The DMS, located at GSFC, is a three-stage, solid-state circuit switch composed of a forward matrix and backup, return matrix and backup, and a control subsystem. The function of the DMS in the SN is to route TDRSS/NGT and JSC MDM traffic flows to/from users of the SN via GSFC. The DMS, when used as a generic system, can be defined as a computer-driven system that provides a circuit switching capability for the Nascom Network.

5.3.2 DMS SYSTEM DESCRIPTION

5.3.2.1 Brief Profile of DMS. The DMS was built by Applied Physics Laboratory (APL) of Johns Hopkins University. In August 1989 the PDP 11/03 was replaced by DEC MicroVAX II computers, which can be controlled by the CSS or an operator. The CSS at GSFC automatically controls and monitors the status of the DMS in accordance with the NCC schedule. Except for the computer terminals and printer, the DMS hardware is housed in nine racks.

5.3.2.2 DMS Configuration. A block diagram of the DMS is shown in Figure 5-1. The DMS is configured to employ full switching redundancy, where four switching systems (two forward and two reverse) utilize redundant power systems tied to "A" no break and "B" no break power grids.

5.3.2.3 System Elements. The DMS consists of circuit switches and a Digital Matrix Switch Control System (DCS). The DMS system consists of the following elements:

a. DCS hardware. The operational configuration is comprised of two systems, prime and backup. Each system consists of the following components; 1 DEC MicroVAX II CPU, 1 DEC Winchester disk, 1 DEC terminal, 1 DEC magnetic tape, and an AT&T printer.

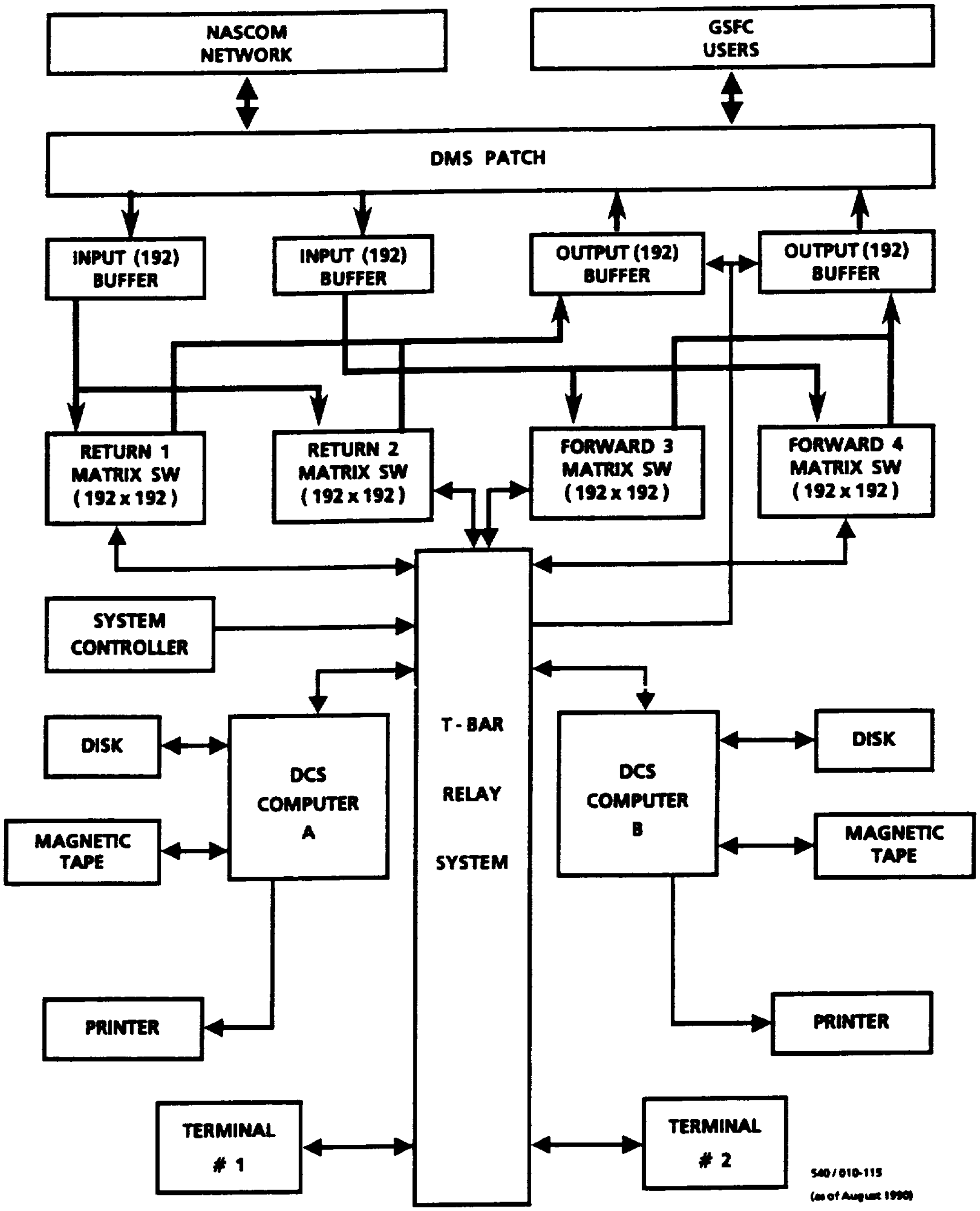


Figure 5-1. System Block Diagram of the Digital Matrix Switch

b. DCS software consisting of the DEC VMS Operating System and application software developed by Science Systems and Applications, Inc. (SSAI), and CSC in FORTRAN language.

c. DMS system controller based on a T-bar relay system panel featuring or using illuminated push-button switches.

d. Two input and two output buffers, where each buffer features a 192-port capability using an RS-422 interface.

e. Two forward and two return 3-stage switch matrices, where each switch matrix is capable of handling 192 input and 192 output lines.

f. A DMS patchfield to physically interface the Nascom Network and GSFC users with the DMS.

5.3.2.4 System Interfaces. The DMS was designed to provide the interface between the SN Type 1 forward return link services and local and remote POCC's.

5.3.3 SYSTEM OPERATION

5.3.3.1 DMS Data Flow. As indicated in Figure 5-1, all data flow through DMS is referenced to the GSFC users forward link as data-out from the user. The network return link is data-in from the network to the user. The data flow through the matrix switch is described in the following paragraphs:

a. DMS System Controller. This controller provides the mechanism for centralized control and configuration of the DMS. It operates through the T-bar relay system panel consisting of illuminated pushbutton switches. The online systems can be selected from this controller panel, where the select and control pushbuttons for the forward and return matrix switch arrays, associated output buffers, DEC MicroVAX computers, and the VT-220 terminals are featured. The controllers can also allow reconfiguration in the event of a system component failure or for normal maintenance and testing.

b. Matrix Switch Signal Flow. The matrix switch design employs a 3-stage switch array based on the theory developed by Charles Clos. A non-blocking design, which reduces the number of switch crosspoints from that of an X-Y equivalent array, was implemented. The switching algorithm follows the crosspoint equation: Number of crosspoints = 6(N exp(3/2))-3N, and with N = 192, the number of crosspoints = 15,387. The matrix switch arrays, consisting of the A-array, B-array, and C-array, are controlled via an IEEE-488 General Purpose Interface Board (GPIB). The computer is used to determine the path through the switch for a given input/output connection.

c. Ancillary Device Function. The Baseline Data System uses the DMS as an ancillary device to support the SN. MDM channels are terminated at the DMS. MDM channels that are scheduled to support the SN are configured by commands from the CSS or by technical control personnel using keyboard entries to make DMS Input/Output connections.

5.3.3.2 DMS Circuit Switching and Control. The DMS acts as the heart of the SN/Nascom Network for circuit switching. Network and user channels of the BDS are connected by the DMS. NCC schedule requests to Nascom are satisfied by circuit switching the network and user channels for forwarding and returning data through the DMS. Figure 5-2 depicts the Nascom Digital Matrix Switching System and Controls. Figure 5-3 depicts the DCS hardware configuration.

a. Return Link-DMS. The DMS for the return link has 192 input ports and 192 output ports. The switch is controlled by a MicroVAX II. Any input port from the network channels can be switched to any ten output ports (top user channels) for interfacing return link services to users. The first 100 input ports of the return link DMS represents the SN-Baseline Data Channels. The source channel identification number of the SN-service channel is used to identify the port to be switched. The output ports of the return link DMS are used to terminate users of the SN-BDS service channels and become the destination channel ID for data transferred to them.

b. Forward Link-DMS. The forward link DMS is identical to the return link DMS with 192 input and 192 output ports and a MicroVAX II as the controller. User source channels are connected to the input ports of the DMS. SN destination channels are connected to the output ports. The first 36 ports represent the SN destination channels in the forward link.

5.4 MESSAGE SWITCHING SYSTEM UPGRADE

This paragraph provides a standalone description of the MSU. Its role as a major support system of the other Nascom and NASA Network systems is described in later sections.

5.4.1 SYSTEM DEFINITION

Message switching is the general classification of a data driven, connectionless oriented switching system in which the destination address(es) of a given message are included as a portion (normally the leading characters or headers) of the message itself. The system handles data and message traffic through a switching center, either from local users or from other switching centers. Message switching operates in one of two ways: either a virtual real-time data path is established between the transmitting and receiving stations, or the message-type traffic is stored and forwarded through the system.

5.4.2 SYSTEM DESCRIPTION

5.4.2.1 Brief Profile of MSU. The Message Switching System (MSS) was established by Nascom early in the NASA program, to support the ground tracking networks long before the SN came into being. Nascom developed the MSS into a facility complex of communications processors and associated equipment (located at the GSFC primary Nascom switching center) to perform automatic message switching functions for the TTY, high-speed data, and wideband data systems.

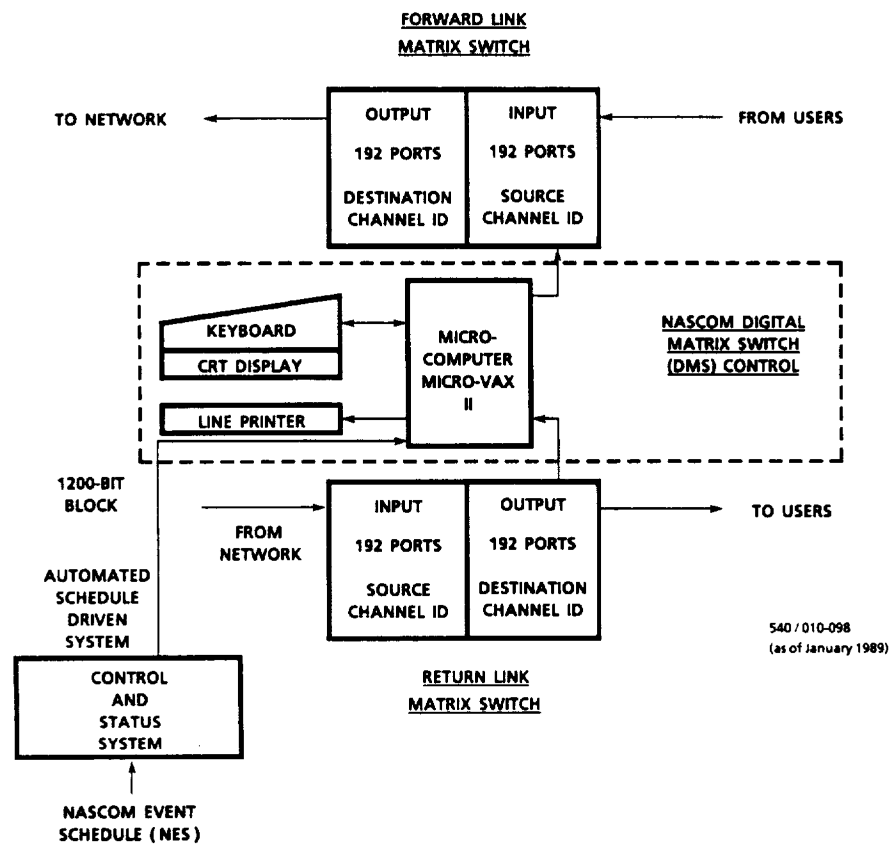


Figure 5-2. Nascom Digital Matrix Switching System and Controls

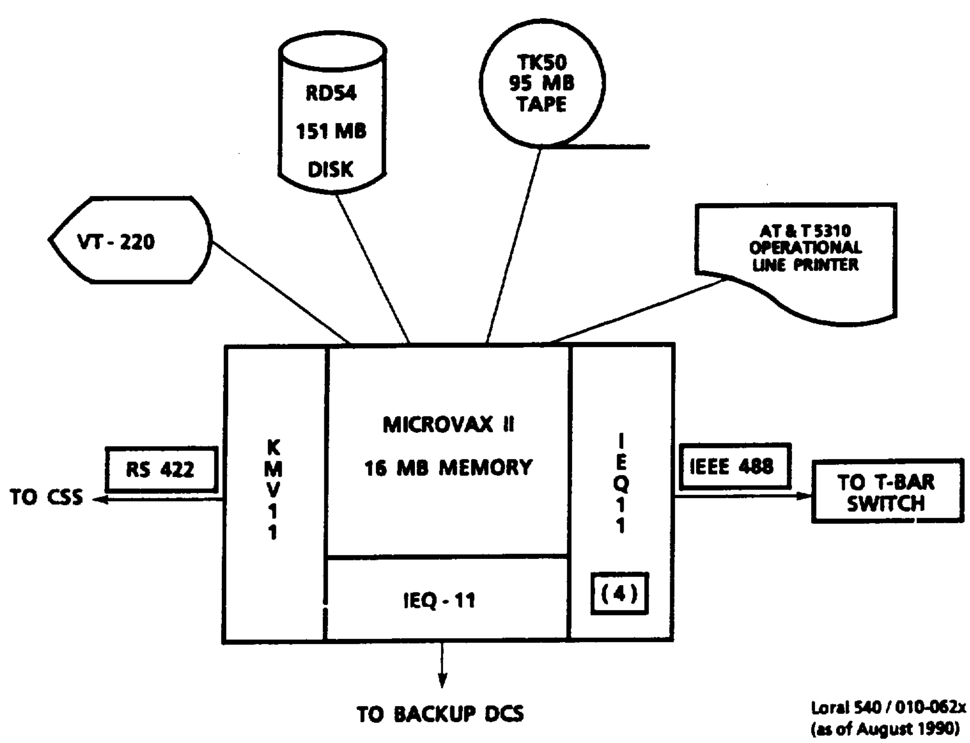


Figure 5-3. DCS Hardware Configuration

The hub of this complex was a dual complement of redundant computer systems, that were Nascom-designed, -implemented, and -programmed to provide a data-driven automatic switching function. The computer performed network traffic control functions in addition to its primary function of message switching data between the Nascom Network users. The MSS handled 4800 bit fixed format data block interchanges between users on high-speed and wideband data lines. It also handled variable sized text and fixed format data necessary on TTY and low-speed data lines. At more than 10 years old, the MSS equipment outlived its specified life expectancy. Since several items were special-engineered, one-of-a-kind communication peripherals, the performance of maintenance was restricted to only the few field engineers and the design engineer who had built them. Furthermore, age and increased demands on the system for more line terminations and overall higher line rates pushed the total throughput of the system past original limits. All these conditions contributed to the resultant decrease in MeanTime-Between-Failures (MTBF), increase in Mean-Time-To-Restore (MTTR), and an unacceptable restriction on those engineers responsible for equipment maintenance. The MSS Upgrade (MSU) project, initiated in 1989, was developed in order to rectify this situation. All three front-end units per MSS system (6 total) have been replaced with a single communications peripheral per system. Replacement included terminating all currently supported circuits, providing all presently supported high-speed functions, and yet still allowing future circuit terminations (expansion) and increased functionality (requirements). The Combined Operator Workstation (COW) was designed as the single point of control and operator interface for each of the switching computers. The system will be referred to as the Message Switching System Upgrade (MSU) until the completion of all planned upgrades, at which time the system name will revert to simply Message Switching System (MSS).

5.4.2.2 MSU Configuration. Since the MSU is a computer-driven system, the discussion of its configuration will include the hardware and the software elements. The hardware components are grouped into two separate but functionally identical systems. The MSU software is configured from the vendor-supplied system software, and from the in-house or Nascom developed software, commonly referred to as the applications software.

5.4.2.3 MSU Hardware Elements. The cluster of equipment for each group consists of the following elements:

a. MSU Switching Computer. The MSU switching computer hardware is a Concurrent Computer Corporation Series Micro 3200 Expanded System (Micro 5 ES). The system is enhanced by the addition of an integrated, highperformance, intelligent serial input/output (I/O) communications control system (ComPlus) supplied by Kardios Systems Corporation. The ComPlus system interfaces with the Concurrent host processor via direct memory access (DMA). The ComPlus supports dynamic port reconfiguration, and is programmed to the communication-line level to identify the 24-bit Nascom block synchronization code. The ComPlus supports the reception of bit-contiguous blocks with no idle time and buffers each Nascom 4800-bit block to the extent necessary to complete the application software processing of the block. Seven ComPlus port cluster units are configured with the Concurrent machine. Each cluster unit supports 32 ports for a total of 224 ports for each MSU Switching Computer. Additional MSU peripheral devices include a line printer, a system console, a mass-storage disk system, two cartridge tape units, and a ninetrack tape unit.

b. COW. The COW hardware is a SUN SPARCstation II that uses reduced instruction set (RISC) technology. The COW peripheral devices include a laser printer, a high-resolution color monitor, a mass-storage disk system, and CD-ROM unit, serial ports, and a cartridge tape unit.

c. X Terminals. The X terminal hardware is a nineteen inch color Tektronics XP337 with nine megabytes of memory and a trackball pointing device. The XP337 is capable of displaying 256 colors simultaneously and running both X windows and the Motif window manager locally. There is one X terminal associated with each COW. The X terminal supports some of the COW screen displays.

d. Hybrid PC. The hybrid PC hardware is an IBM PC compatible 80486 running at 33 Mhz. The hybrid PC provides a gateway between the TCP/IP LAN and the Nascom high-speed network. The PC includes 3Com network boards which provide the interface to the TCP/IP LAN. Nascom boards, developed by NASA, provide the interface to the high-speed network. The hybrid PC utilizes the UNIX operating system.

e. MSU Command LAN. An Ethernet LAN provides Institute of Electrical and Electronic Engineers (IEEE) 802.3 physical interface connections between all of the MSU and COW system. The two MSU and COW systems are configured on a single LAN trunk. This LAN trunk is comprised of two parallel LAN rails which are used as primary and backup LANs. By changing the machine plugs into the LAN, the operator can isolate a single machine or machine group on the backup LAN rail.

5.4.2.4 MSU Software Elements. Software for the MSU is best addressed in two categories: MSU system software, and COW software. The components for each category are delineated in the following paragraphs:

a. MSU System Software.

1. Vendor Software.

(a) OS/32 - Concurrent Computer Corporation multi-tasking real-time operating system.

(b) Utility and support programs.

(c) Editor programs.

2. Application Software.

(a) MBI - MSU backup operator interface task.

(b) MCMD - MSU console command task.

(c) MCU - MSU/COW common utility modules.

(d) MDD - MSU database distribution task.

(e) MDS - MSU data simulator task.

(f) MHL - MSU high-speed logging task.

(g) MHS - MSU high-speed switching task.

(h) MHU - MSU high-speed utility task.

(i) MHY - MSU hybrid data task.

(j) MIF - MSU/COW interface task.

(k) MIN - MSU initialization and recovery task.

(l) MMG - MSU message generator debug tool.

(m) MSU - MSU tools and utilities.

(n) MU - MSU common units.

(o) MUDUMP - MSU task dump utility.

b. COW Software.

1. Vendor Software.

(a) OS 4.1.3 - SUN SPARCstation operating system.

(b) Utility and support programs.

(1) X-Window

(2) Transportable Application Environment Plus (TAE Plus)

(3) Motif window manager

(4) C Language Integrated Production System (CLIPS)

(c) Editor programs.

2. Application Software.

(a) BOOTMSU - warm start of the MSU applications from the COW

(b) CAL - COW alert processing task

(c) CCM - COW baseline configuration change task

(d) CCQ - COW command and query task

(e) CDB - COW database manager task

(f) CDL - COW delogging task.

(g) CES - COW expert system task.

(h) CHC - COW checkpoint configuration change task

(i) CIF - COW-MSU interface task

(j) CIN - COW initialization and recovery task

(k) CLD - COW line indicator display task

(l) CLG - COW logging task

(m) CMG - COW message generator debug tool

(n) COA - COW operator assistance task

(o) CONVTXT - converts ASCII text files

(p) COS - COW operator stations task

(q) CTS - COW troubleshooting task

(r) CU - COW common units

(s) STARTCOW - warm start of the COW applications

5.4.2.5 System Interfaces. The MSU interfaces with the high-speed data and wideband network users. The principal user MSU interfaces are for GN-related operations. The users are required to generate compatible high-speed and wideband data message switching format. When the Nascom 4800-bit block format is used, the 48-bit network header is utilized for routing high-speed data.

5.4.3 SYSTEM OPERATION

5.4.3.1 Overview of MSU Operations. Two complete MSU hardware systems are configured to provide an online operational system and an offline hot-spare system. The hardware systems are designated as either the A or the B system; thus there is an MSU-A, an MSU-B, a COW-A and a COW-B. The two X terminals are designated as XTERM-A and XTERM-B. The systems communicate with each other across the LAN. Figure 5-4 illustrates the configuration of the MSU. Input from the network is sent to both systems. Output to the network is selected by the transfer switch. The transfer switch allows operations to select the online MSU. The output of the online MSU is sent to the network; the output of the offline MSU is discarded. The MSU switching computer and COW each perform a subset of the MSU functions as described in the following paragraphs.

a. The MSU switching computer is primarily responsible for switching the 4800-bit Nascom blocks. Other functions of the MSU switching computer include collecting historical archives of high-speed network activity, managing the high speed network configuration, interfacing with the operator workstation, and providing a backup operator interface.

b. The COW computer is the primary means of access for the MSU operator. It supports operator interfaces to display the network status and to change the network configuration.

The two online MSU computer systems are operated from no-break power. The no-break systems normally take power from the commercial feed, but have the capability to be transferred to local diesel power in case of loss of commercial service. The transfer to battery power is automatic. The diesel transfer can be automatic or manual. Where it is critical that hardware, such as disk memory, be protected from power spikes, peaks, and surges, their electric power circuits are buffered by means of motor-alternators. These motor-alternators are normally powered from the commercial source with diesel capability existing via the transfer switches.

5.4.3.2 MSU Communication Format. Users are required to generate a compatible high-speed and wideband data message switching format for use with the high-speed MSU. Appendix D describes the 4800-bit block structure which is the basic Nascom high-speed and wideband data message switching format. This format is generated by the GN and by all users of the system.

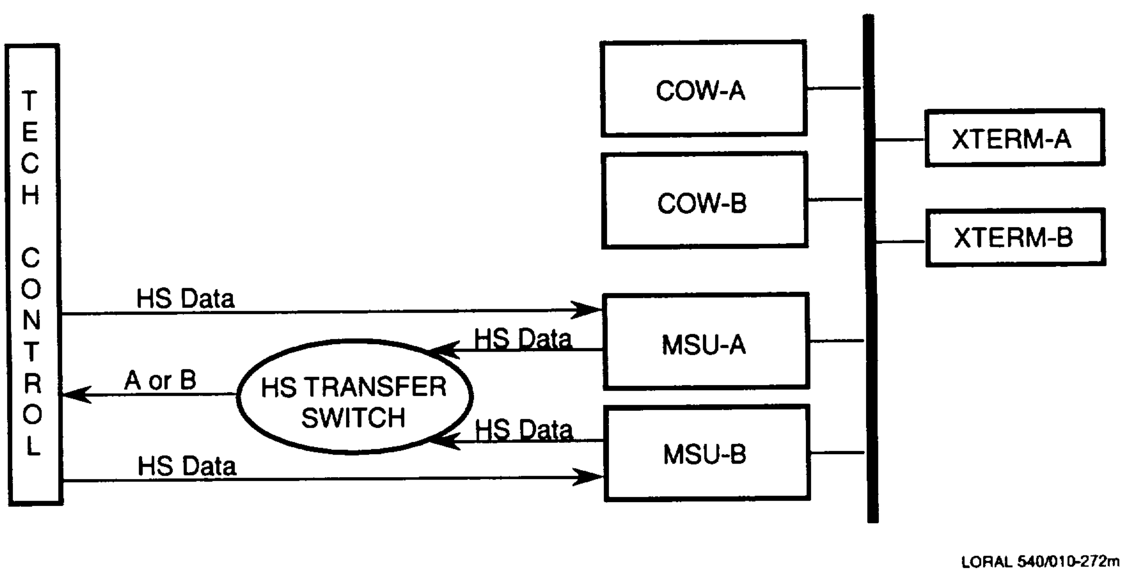


Figure 5-4. MSU System Configuration

Based on the current field size for source and destination codes in the Nascom 4800-bit block, all 256 MSU source and destination codes have been exhausted. In order to expand the number of valid source and destination codes from 256 codes to 512 codes, the sequence monitoring field is being eliminated from the Nascom 4800-bit block. The sequence monitoring bits, which currently identify the sequence of block transmission, are bits 41-43 of the Nascom network header. The following changes will be implemented for these bits:

Bit 41 - destination code expansion (this aligns with the current destination code bits 33 to 40)

Bit 42 - source code expansion (currently the source code occupies bits 25 to 32)

Bit 43 - spare

For both source and destination codes, a value of zero (0) in the new bit would use the current routing codes of 0 to 255. A value of one (1) would use routing codes 256 to 511.

The changes are currently scheduled for implementation in March 1995.

5.5 DATA DISTRIBUTION AND COMMAND SYSTEM (DDCS)

The DDCS derives its name from its original implementation role in supporting the packet switching requirements of the GRO project, as a dedicated system which is described in paragraph 16.2.7. The DDCS is intended, however, to be an institutional X.25 packet switching system for operational traffic requirements of Nascom users. The institutional, shared network resource nature of DDCS is demonstrated by its use in support of the EUVE and SAMPEX projects.

5.5.1 SYSTEM DEFINITION

The DDCS, as defined in Nascom Document No. 541-008, DDCS System and Functional Requirements, is the system which will provide the packet switching communications, via the X.25 protocol, to satisfy the command request, data base exchange requirements, and telemetry distribution for the various projects' principal scientific investigators. The X.25 protocol is an international, standardized data communications protocol which specifies the interface between DTE and DCE for terminals operating in the packet mode.

5.5.2 SYSTEM DESCRIPTION

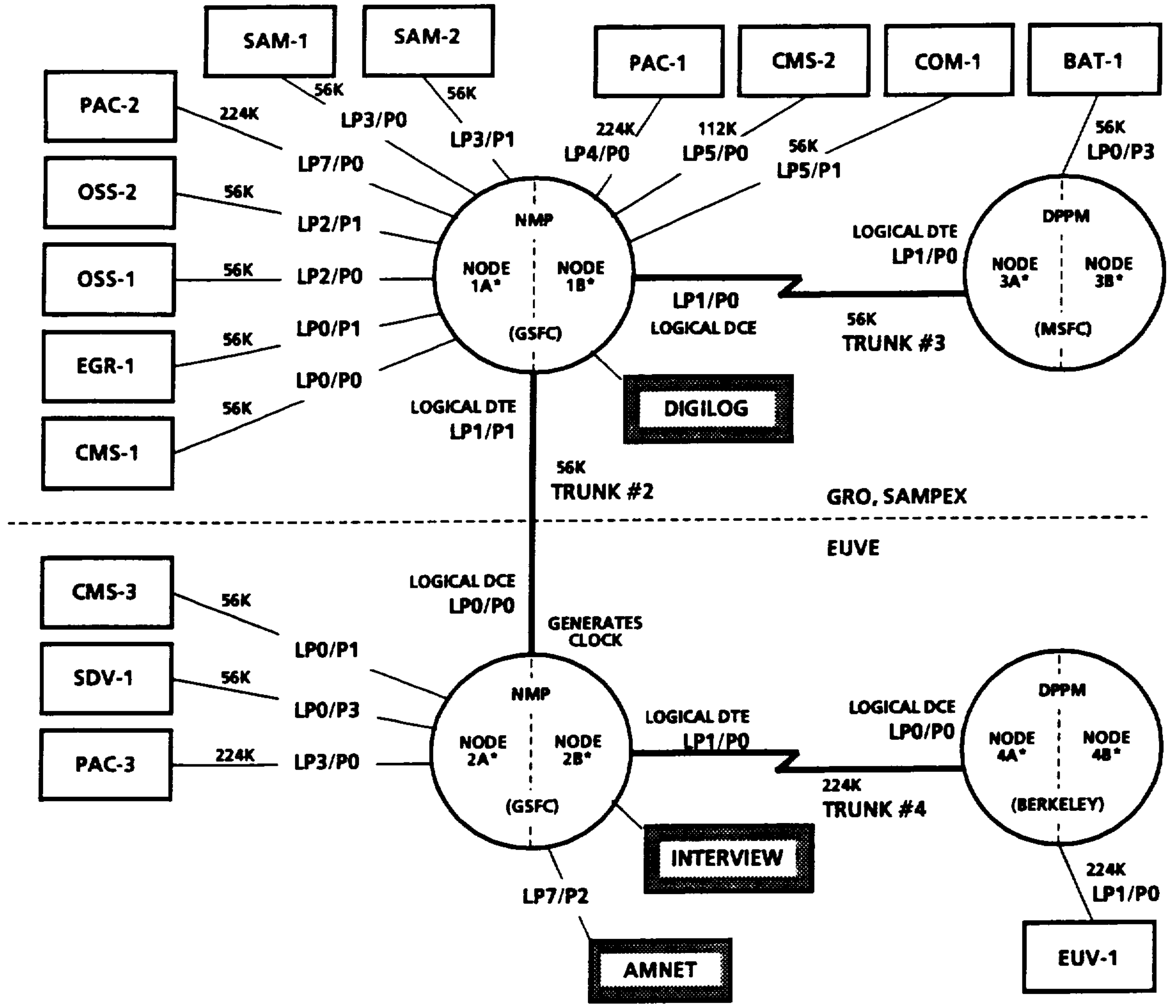
5.5.2.1 Brief Profile of DDCS. The DDCS will generally support ground data communications between the scientific experimenters whose instruments are aboard certain spacecraft, the ground support equipment at the experimenters location, and other GSFC systems necessary for operational support of the satellite experimenters operations and data distributions. These other systems and their roles are as follows: the Packet Processor (PACOR)/Code 560, which processes the telemetry data packets that are shipped to the experimenters; and the Command Management System (CMS)/Code 510, which receives and validates instrument command data from the experimenters; and the spacecraft contractors System Test Complex (STC) facility, which simulates the functions of the PACOR and the CMS for prelaunch integration, testing, and support. These are the end systems which presently use the DDCS packet switching network.

5.5.2.2 DDCS X.25 Configuration. The DDCS Packet Switching Network (PSN) consists of two main PSN's, located at GSFC Building 14, which include online and backup support for up to 40 trunks or X.25 subscriber ports, and switches up to 300 packets per second per PSN. Two remote PSN's are trunked to the main PSN's (see Figure 5-5).

5.5.2.3 System Elements

a. GSFC PSN's. The configuration of the GSFC PSN's consists of two AMNET Nucleus 7400 Network Management Processor (NMP) nodes, each with a hot backup. The AMNET N7400 is a mid-range performance packet switching system based on Line Processor (LP) boards using 80186 microprocessor chips. These LP's exist in an extended chassis with the 80386-based CPU. The N7400 contains a 1.2 MB floppy disk drive with a high density disk controller. The PSN is booted off the Disk Operating System (DOS) floppy disk containing AMNET software. Automatic failover switching occurs between node/primary and backup nodes through the HADAX switch/control unit. All user ports are connected through the HADAX. Through patching at the Nascom Technical Control area, an X.25 protocol analyzer can be used for circuit data monitoring. GRO and SAMPEX users are connected to Node 1; EUVE users are connected to Node 2.

b. NMP's. Two NMP's function as the operator control and status interface, providing a graphics display for troubleshooting, and manage



* Redundant User Ports

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(as of July 1992)

Figure 5-5. DDCS Network Configuration

the operational network database. NMP 1 is connected to Node 1, and NMP 2 is connected to Node 2 at the GSFC. The NMP is currently based on 80386 IBM Personal Computer Advanced Technology (PC/AT) hardware with a 100 MB hard disk. The NMP stores system software files for initial program load and selective program load. These software files have been programmed using the high-level "C" language, which is used under the UNIX operating system. The NMP is connected to the respective node through an AMNET custom-designed Primary Interface Adapter (PIA) cable and computer board.

c. Remote PSN's. The remote PSN's are located at MSFC in Huntsville, Alabama, and the University of California, Berkeley Campus. These remote PSN's are N7400 Packet Processor Modules (PPM) nodes, and do not have local NMP's attached. They communicate with the GSFC NMP's via the trunks. Each site has an N7400 PPM with a redundant backup node. HADAX automated failover units exist at each site. Each N7400 consists of an 80286 PC/AT compatible unit, 640K Random Access Memory (RAM) and a 1.2 MB floppy drive with high density disk controller. The nodes boot off of DOS system formatted floppies, with node boot floppy software downloaded from the GSFC NMP's. Each remote PSN contains two LP boards with 80186 microprocessors. Node 3, which supports GRO, and Node 4, which supports EUVE, are currently operational.

5.5.3 SYSTEM OPERATION

The DDCS Network was accepted by Nascom operations on 17 May 1990. DDCS operations are described in the following paragraphs.

5.5.3.1 DDCS System Capabilities. The DDCS provides the following capabilities:

a. Packet switching communications between the Principal Investigators Instrument Ground Support Equipments (IGSE), CMS, STC, and PACOR.

b. Monitoring the status of the network, and communication links.

c. Logging/delogging all alarms, status, and changes in the system configuration.

d. Operations from a local interactive terminal.

e. Printing information on traffic data and usage.

5.5.3.2 Details on Provision for X.25 Packet Switching Capability. The DDCS provides an X.25 packet switching (CCITT 1984 Recommendation) capability to distribute the packetized scientific data for the spacecraft missions and packetized command requests between the IGSE's, CMS, experimenter homesites, STC, and PACOR. The CCITT X.25 specified system supports the first three levels of the International Standard Organization (ISO) Open System Interconnection (OSI) architecture. The DDCS as a DCE was developed to interface the external equipment or DTE at the following levels:

a. Physical layer (Level 1). The required characteristics are as follows:

(1) Interface. The physical, electrical, and functional characteristics to establish, maintain, and disconnect the physical link between the DTE and the DCE shall conform to the Federal Standard 1020, EIA RS-422, and EIA RS-232C.

(2) Transmission rate. The DDCS supports 9.6, 56, 64 and 224 kb/s transmission rates between the DCE and DTE.

b. Link Layer (Level 2). The DDCS supports the LAPB procedure and all parameters specified by the users of each project.

c. Network Layer (Level 3). The DDCS supports the following communication features:

(1) Services: Virtual call and permanent virtual circuit.

(2) Packet types: All basic packets specified in CCITT X.25, 1984 Recommendation.

(3) User data field length: Maximum of 1024 octets/packet.

(4) Packet sequence numbering: Modulo 8.

(5) Frame sequence numbering: Modulo 8 and Modulo 128.

(6) X.25 Diagnostic code: Standard.

5.6 MDMR DATA SYSTEM

This paragraph provides a standalone description of the MDMR Data System. Its role as a major element of the BDS is described in Section 11.

5.6.1 SYSTEM DEFINITION

The MDMR Data System, when referred to as an integral part of the BDS, can be defined as a system featuring the following characteristics:

a. Two online full duplex terminals at each location: NGT, GSFC, and JSC.

b. Functionally consists of separate MDMR data terminal controlled by a collocated Multiplexer/Demultiplexer Automatic Control System Upgrade (MACSU) at each location. (The MACSU was developed as a separated project to upgrade the MACS in support of the MDMR Data System. See Paragraph 5.6.5 for more information on the MACSU.)

c. MDMR line interface channels designed for data rates between 10 b/s and 7 Mb/s.

d. A composite (common carrier interface) transmission rate capability of up to 20 Mb/s. (This is an upgrade from the original MDM Data System capability.)

e. Range of data format capabilities and operating features available as options to the users.

5.6.2 SYSTEM DESCRIPTION

5.6.2.1 Brief Profile of the MDMR Data System. The Nascom Network extends the TDRSS forward link and return link services by providing data transport systems between the NASA Ground Terminal at White Sands, NM; the NCC; and major user spacecraft control centers and data processing facilities. Both the TDRSS and Nascom Network are elements of the SN. Nascom has implemented two distinct multichannel transport systems to extend the TDRSS data transmission. One of these is the BDS which supports the Type I interfaces

(10 b/s to 2 Mb/s). An essential component of BDS is the MDMR Data System. An MDMR terminal is installed at MSFC to serve as the tandem link to GSFC, where NGT forward and return link SN user services are extended to MSFC. The Nascom replacement MDM Data System specification document (541-89-03) was developed in the early 1990's in accordance with the Project Management Plan (541-097). Installation of the MDMR was completed in late 1993.

5.6.2.2 MDMR Data System Configuration. Figure 5-6 illustrates the MDMR data flow block diagrams. The system configuration of the baseline MDMR data subsystem is shown in Figure 5-7. The MDMR data subsystem consists of separate data terminals at GSFC, NGT, and JSC. Operationally, the baseline MDM system had the capability of 100 return link channels from NGT to GSFC, and 36 forward link channels from GSFC to NGT. The JSC station in the baseline MDM system was operationally considered as a drop and insert station. JSC could insert up to 30 channels into the forward link and up to 20 channels into the return link to/from NGT and GSFC. When this occurred, the total number of channels available for scheduling between NGT and GSFC was reduced by an equivalent number. The MUX/DEMUX systems and channel capacities provided by the MDMR Data System at the respective locations are as follows:

a. GSFC:

MUX (Broadcast)	48 channels
DEMUX (NGT/STGT)	128 channels
DEMUX (JSC)	48 channels

b. JSC:

MUX (Broadcast)	48 channels
DEMUX (GSFC)	48 channels
DEMUX (NGT)	48 channels

c. GSFC/MSFC Trunk:

MUX/DEMUX	24 channels (duplex)

The above channelization represents an upgrade to the original MDM Data System capabilities. All indicated MUX/DEMUX equipment will be provided in redundancy. Connectivity is the same as per the original MDM Data System, except that spare DEMUX equipment lacking in the original MDM Data System has been added for each downlink at each location; also a connectivity change has been implemented at the GSFC location wherein all receive channels from WSGT and JSC have been extended to the DMS in lieu of a channel termination sharing arrangement.

5.6.2.3 System Elements. As indicated in Figure 5-6, the MDMR functional elements are as follows:

a. Interface equipment that includes patch panels, signal splitters, and channel select switches.

b. Multiplexer that includes Input Terminal Units (ITU) and Output Controller (OC).

c. Demultiplexer that includes Input Controller (IC) and Output Terminal Units (OTU).

d. MACSU that include Control Subsystem Transfer Switch (CSTS) computer system.

e. Local operator control console that provides manual configuration capability at individual ITU/OTU control panel.

f. Effective with the MDMR Data System, MDM control is entirely remoted to consoles (no front panel controls) and channel Port address is now remotely controllable.

5.6.2.4 System Interfaces. The system interfaces of the MDMR Data System are as follows:

a. At NGT, the MDMR interfaces with the TDRSS forward and return link user services.

b. At GSFC, the MDMR interfaces with the NCC via the CSS and with the SN users.

c. At JSC and MSFC, the MDMR interfaces with the SN users.

5.6.3 MDMR OPTIONS AND FEATURES

MDMR Data Systems users can select data processing options by specifying the options in configuration codes developed during mission planning and by including their options in their scheduling requests to the NCC. The MDMR Control Systems configure the MDMR in accordance with the user's scheduled request to the NCC. The following processing options and operating features are available to the users, and are described below:

5.6.3.1 Unblocked or Blocked Data. The user chooses to supply/receive data in either unblocked or blocked format. Unblocked data is defined as a serial bit-contiguous data stream with no header or routing information. When unblocked data is supplied, it is inserted in the data field of an MDMR Data System-generated 4800-bit data block, along with appropriate system-generated network header information and a polynomial code per data block. Users who elect to receive

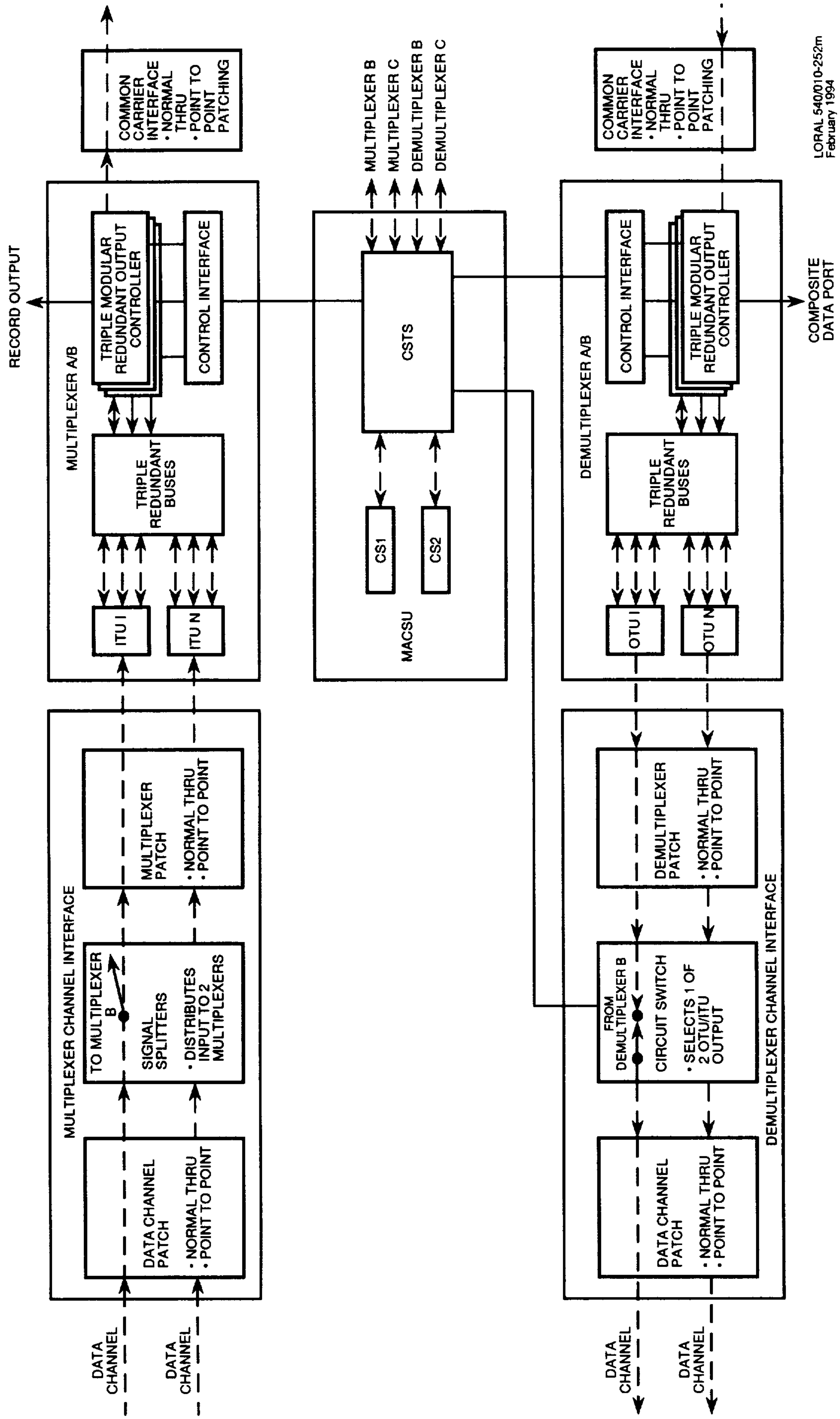

Figure 5-6. MDMR Data FLow Block Diagram

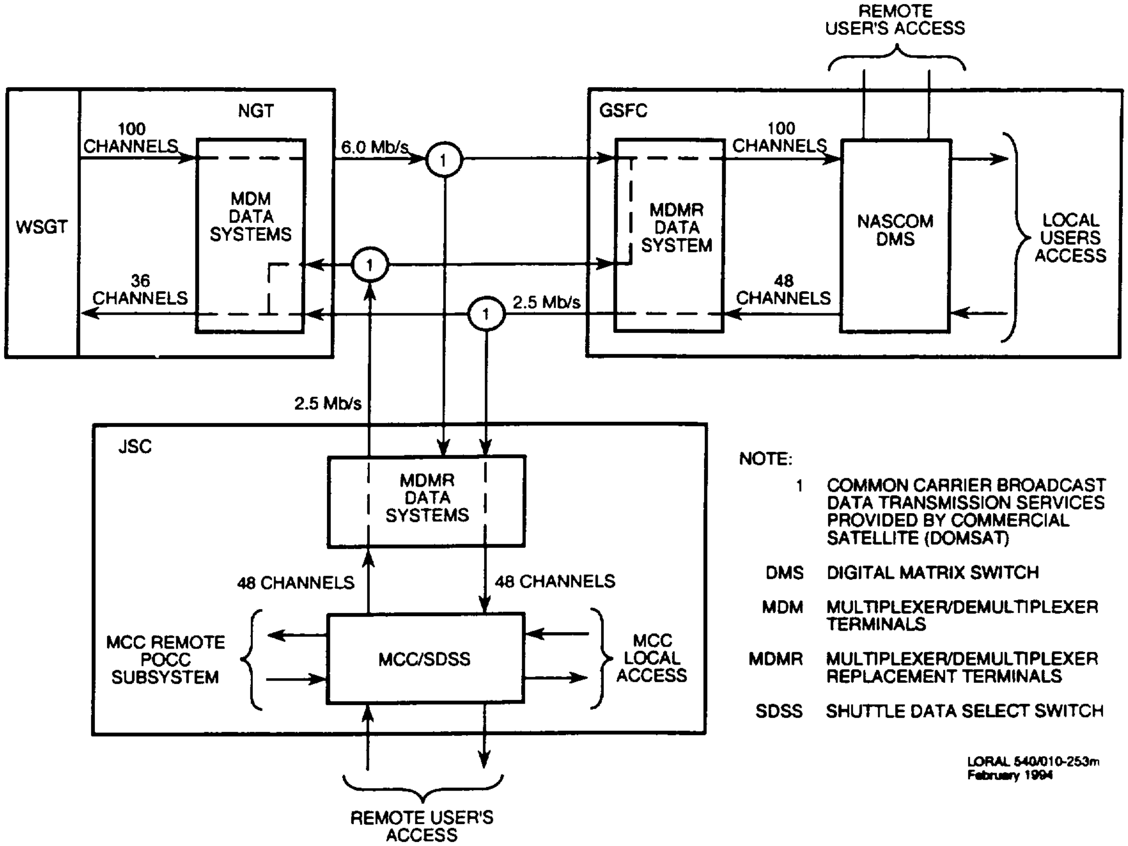

Figure 5-7. Configuration of the MDMR Data Subsystem in the Baseline Data System

unblocked data receive a serial stream of data from the data field of the block, after the system strips out the network header, user header, time block, and the block error control field.

Blocked data is defined as data that is supplied/ received in a 4800-bit block format, and that contains a network header, user header, time tag, and a block error control field. The user may insert the time tag.

If a user is remotely located from the MDMR and requires long-haul circuit facilities, Nascom can be consulted to determine the technical feasibility and cost effectiveness of selecting the unblocked serial data option. At rates above 1800 b/s, special payload block formatting equipment may be available from Nascom on a loan or reimbursable basis.

5.6.3.2 Selectable Data Rate. MDMR Data System users may choose supplying or receiving blocked or unblocked data at rates from 10 b/s to 7 Mb/s. The data rate selected must be approved by Nascom personnel due to the bandwidth limitations of the Common Carrier Broadcast Transmission Service (CCBTS) and the multiple user network channels serviced by the MDMR Data Systems. The exact data rate specified is selected by setting the most significant decimal digits and a single decimal digit exponent of the associated clock. In addition, when receiving blocked data, the option of supplying the clock externally or using the internal MDMR Data Systems clock exists.

5.6.3.3 Unmodified or Modified Network Header. This option is available only to users supplying data in a blocked data format. The MDMR Data System user may choose to have an unmodified or modified network header. If the user chooses the unmodified network header, the user inserts the network header information into the MDMR Data System, and the system transmits the 4800-bit block exactly as inserted by the user. If the user chooses the modified network header, the MDMR Data System will modify the network header by inserting a selected data stream ID and a sequential port sequence number. The MDMR Data System will also generate a new polynomial code at the end of the 4800-bit block.

5.6.3.4 Time Tagging. The time-tag option is available only when a user is transmitting blocked data to an MDMR Data System. When requested by a user, the time-tag option enables an MDMR Data System to write the time of year into the time field of the 4800-bit data block. The time of year is provided in the NASA PB-4 time format. (See

Figure 5-8.) This time is referenced to the time the MDMR Data System detects the last bit of the network header synchronization pattern. A new polycode is generated and inserted in each data block that is processed under the time-tag option. If the time-tag option is not selected, the MDMR Data System transmits the 4800-bit data block with the time field exactly as received. The GSFC system inserts a static pattern in the time-tag field when the time-tag option is not selected.

5.6.3.5 <u>One-second Timeout</u>. The one-second timeout option is useful to a user supplying unblocked data to an MDMR Data System at a low bit rate. The unblocked data is inserted into the data field of an MDMR Data System generated 4800-bit data block. With the timeout option selected, if the input data rate is such that the full block of 4624 data bits is not received in one second, the MDMR Data System will timeout, complete the data field with fill bits, generate a polynomial code, transmit the data block, and begin building a new data block. The timeout of the data block occurs only at the boundaries of 8-bit bytes as measured from the first bit inserted in the data field of the data block.

If the timeout option is not selected, the MDMR Data System continues to accumulate the incoming data and generate circuit assurance blocks at the rate of one per second until a full data field of incoming data is entered in the data block.

5.6.3.6 <u>Circuit Assurance Blocks</u>. This option is available only to users receiving blocked data. If the input data rate is such that the source MDMR Data System does not have a data block ready for transmission within one second, the source MDMR Data System generates and transmits Circuit Assurance Blocks (CAB) to the destination MDMR Data System at a one block-per-second rate. The CAB's are generated in the same data format as the Nascom/TDRSS 4800-bit block, but are uniquely identified (by setting the data length field to zero and filling the data field with a 11001001 bit pattern) to distinguish CAB's from data blocks.

The CAB's are generated for use within the MDMR Data System. When a user specifies the CAB option, the operation of the MDMR is not altered, but merely enables the user to receive the CAB's whenever they are generated. The CAB's provide the user with a confidence check on circuit operations.

5.6.3.7 <u>Unclamped or Clamped Clock</u>. The destination MDMR/OTU delivering unblocked data has the option to deliver an unclamped clock or clamped clock signal to the user interface. With the unclamped clock option, the destination user interface receives a continuous clock signal at the selected rate. The clock signal is uninterrupted as long as the user's channel is enabled, regardless of whether data is being processed or not. When the user selects the clamped clock option, the destination interface receives data and clock signals at the selected rate. During those periods when no data is being processed (OTU buffers depleted), the clock signal is clamped to a logic 1. When the next data block is available for transmission to the user, the clock signal resumes in synchronization with the data.

5.6.3.8 <u>Clock Tracking</u>. The clock tracking option is available when the destination MDMR Data System is supplying unblocked (serial bit contiguous) data to the user. This option prevents the data overflow/underflow condition that occurs from the inevitable variations between input clock and output clock frequencies, even when operated within specified tolerances. Data overflow occurs when the input clock runs faster than the output clock and an underflow condition occurs when the input clock runs slower than the output clock. The clock tracking option allows the destination MDMR output clock to track the source MDMR in-

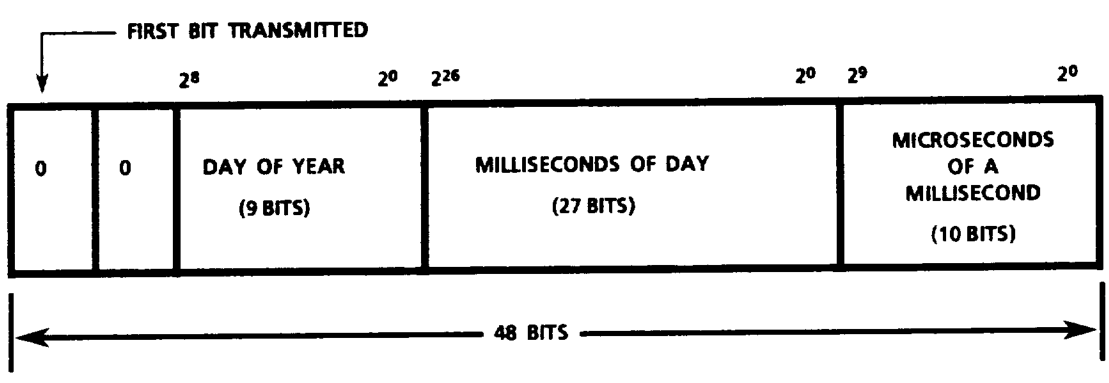

Figure 5-8. NASA PB-4 Time Code Format

put clock. The output clock tracks the input clock for variations of plus or minus .12 percent from the nominal input clock rate.

5.6.3.9 Internal/External Clock. An engineering option is available in the selection of a clock choice for data transfer of blocked data from an OTU to a user. The data transfer is synchronized to either an external clock, if a source is available, or an internally generated clock, at the specified rate.

5.6.3.10 Single Data Block Transfer. The single data block transfer feature of the MDMR Data System is an online operating option available to the user and does not require scheduling configuration of the MDMR. The feature is controlled by the user's software in real-time operations. It is principally intended to accommodate the POCC's preferred method of real-time throughput commanding of spacecraft through the MDMR/TDRSS. It is only available for user-generated blocked data being transmitted to the MDMR Data System at NGT. The NGT MDMR is normally operated in the unblocked smooth (contiguous) data mode.

The smooth data mode requires that the demultiplexer wait for the receipt of five data blocks, or for a maximum delay of 264 ms from receipt of the first data block (whichever occurs first) before beginning transmission. When the entire data transmission is a single data block, the single data block transfer option allows the user to bypass the smooth data mode delay (i.e., allows immediate uplinking). To single data block transfer, the user must generate blocked data and set the datagram bit to a logic 1. The logic 1 datagram bit flags the data block as a single block transmission and the demultiplexer begins transmission of unblocked data immediately upon receipt of the data block.

5.6.4 SYSTEM OPERATION

The 4800-bit block is the standard transmission format used in the MDMR system. Three block formats are described in Appendix D of this document. These are:

a. The GN block, also called the throughput block, is used to transmit digital data to and from GN sites for support of spacecraft that are TDRSS compatible; the GN block is also used for launch support of TDRSS compatible spacecraft.

b. The SN block is used to route digital data via the MDMR data system to and from the SN.

c. The DSN GSFC Interface Block, also called the DGIB, is used for transport of command and telemetry data to and from DSN stations in support of TDRSS compatible spacecraft that use the DSN for contingency or emergency support should TDRSS be unavailable (inoperable) for an extended period of time.

All data transferred between terminals of the MDMR Data System are in a 4880-bit block format This includes an 80-bit link control header added as a prefix by the MDMR systems. The 4800-bit block format portion is used for transport of user data. The 80-bit link control header is used exclusively by the MDMR data system for routing and message accounting purposes and is transparent to the user (the MDMR inserts and removes this link control header).

5.6.5 MACSU

The original Multiplexer/Demultiplexer Automatic Control System (MACS) provided the capability of computer-aided monitoring and configuration control of MDM system. MACS allowed control from local operator positions, or remote control by the CSS. The MACS Upgrade (MACSU) was developed to replace antiquated hardware and remove the memory constraints inherent in the present PDP 11/34 computers. The MACSU uses VAX 4000 series computers. The MACSU has enhanced monitoring capabilities that enable notification to the operator in the event of MACSU performance problems. The MACSU also provides the capability to archive operational changes to disk, and of generating alarm and configuration change history reports. MACSU was installed and operational in time to support MDMR project equipment as it was integrated into the network in late 1993.

5.7 STATISTICAL MULTIPLEXER DATA SYSTEM

This paragraph addresses the Statistical Multiplexer Data System (SMDS) in a standalone description. Its role as a major element of the HDRS is described in Section 12.

5.7.1 SYSTEM DEFINITION

The SMDS can be defined as a Nascom system that has the following capabilities:

a. Interfacing of return link services from NGT to JSC, JPL, MSFC, and GSFC for digital data.

b. A time division MDM system that creates four discrete digital channels to timeshare 50 Mb/s digital common carrier bandwidth.

c. Interfacing capability of up to four individual user data streams.

d. Individual user data rates range between 125 kb/s to 48 Mb/s.

5.7.2 SYSTEM DESCRIPTION

5.7.2.1 Brief Profile of SMDS. The HDRS consists of a Statistical Multiplexer (SM) system and a high data rate digital service (up to 50 Mb/s) in a full-period, protected, leased Domsat transponder broadcast configuration. The system provides a return link broadcast transmission capability from NGT to user's ground data capture and processing facilities at JSC, JPL, MSFC, and GSFC. The SM is designed to effectively utilize the leased digital transmission resource on the domestic communication satellite. The SMDS creates discrete channels that time-share the total bandwidth in the digital mode, with alternate analog and video services provided by the common carrier. The system is used to extend high data rate science and image data, Orbiter/ Spacelab high rate science, analog, and video data to GSFC, JSC, JPL, and MSFC. The SMDS was procured by Nascom from Aydin Monitor Systems.

5.7.2.2 SMDS System Configuration. The functional block diagram of the SM is shown in Figure 5-9. The SMDS configuration is based on the Aydin Model 781 Statistical Multiplexer.

5.7.2.3 System Elements. The Statistical Multiplexer principally consists of: transmit section (multiplexer), Receive Section (demultiplexer), control section, and clock generation section. These system elements are described in the following paragraphs:

a. Transmit Section. The transmit section accepts data from up to four input ports at frequencies from 125 kb/s to 48 Mb/s. The unit measures the input clock rate independently on each port, buffers the data at each port into separate storage queues, and formats the data for output based on rate-determined priority. The resultant multiplexed 50 Mb/s data stream is output to a modem. Pseudonoise (PN) is transmitted by a 2047-bit PN generator when no port is ready with buffered data.

b. Receive Section. The receive section accepts a 50-Mb/s data stream from the modem, obtains frame sync using the distributed sync patterns in the data, decodes the port address, and routes the data and frequency information to the addressed output section. The output sections buffer the data in independent storage queues and then output the data and clock from the ports at the nominal rate of the original data.

c. Control Section. The transmit and receive sections share a control section that is based on a type 6502 microprocessor. The control section performs the following functions:

(1) Provides control and display interface with the operator.

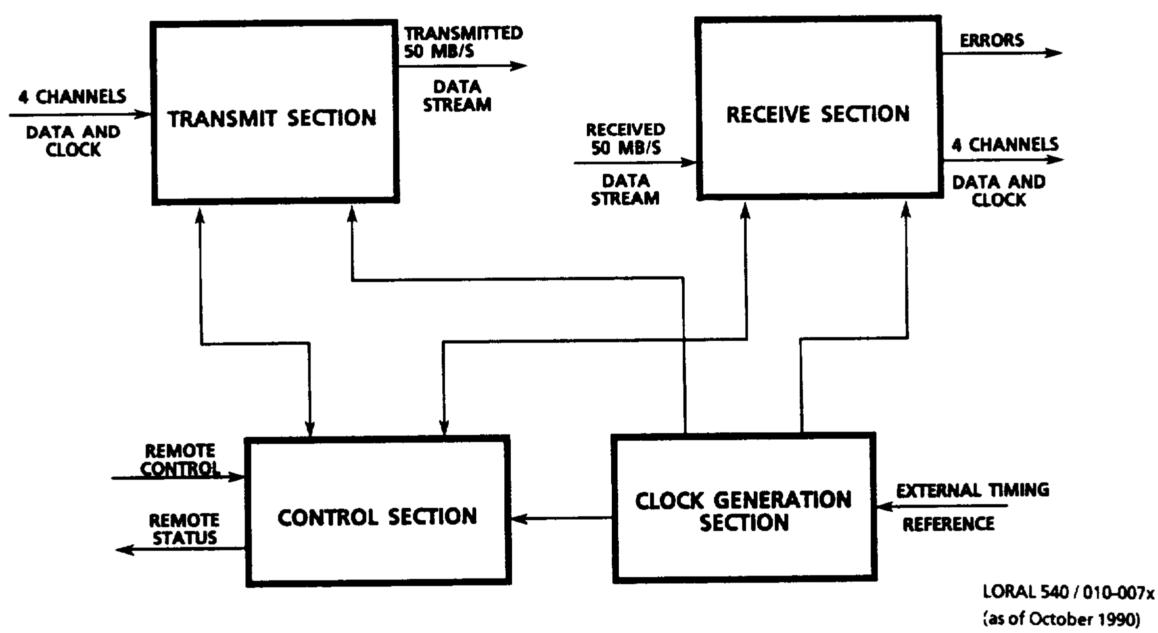

Figure 5-9. Simplified Functional Block Diagram of the Aydin Model 781 Statistical Multiplexer

(2) Calculates and displays input frequencies to six significant digits.

(3) Determines port input priority assignments based on rate measurements.

(4) Adjust receiver output rates to guard against output buffer underflow or overflow.

(5) Controls updating of the frequency synthesizer prescale divider so that there is no discontinuous change in output frequency when a synthesizer breakpoint is crossed.

d. Clock Generation Section. The clock generation section uses an external timing reference and two internal voltage-controlled oscillators to generate the clock signals used by the control, transmit, and receive sections.

5.7.2.4 System Interfaces. As illustrated in Figure 5-10, the SMDS interfaces with the systems at NGT, GSFC, JSC, and MSFC are as follows:

a. At NGT, the SMDS interfaces with the TDRSS KSA Type II return link channels using two SM's.

b. At GSFC, the SMDS interfaces with the following:

(1) Spacelab at Building 23 using two SM's.

(2) Landsat DAF near Building 25 using two SM's.

(3) Nascom Tech Control at Building 14 using one SM for monitoring of SM transmissions in Building 23 and DAF near Building 25.

c. At JSC, the SMDS interfaces with the JSC MCC at Building 30 using two SM's.

d. At MSFC, the SMDS interfaces with the MSFC Spacelab POCC at Building 4663 using two SM's.

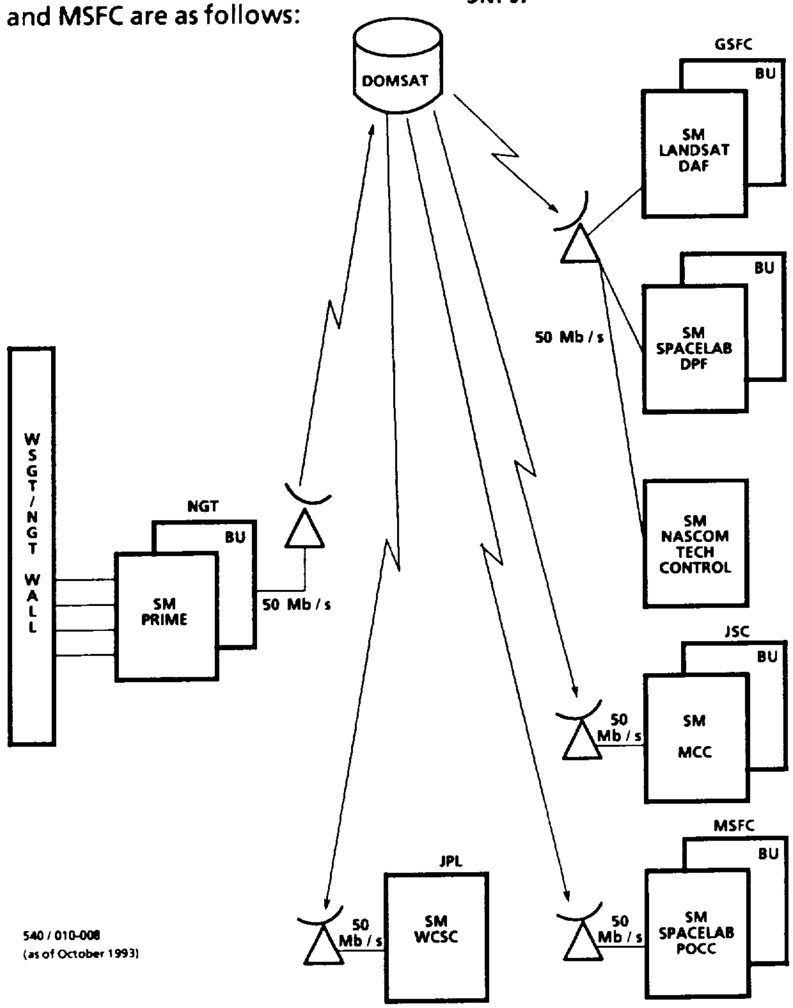

Figure 5-10. Location Diagram of the SMDS System Terminals

e. At JPL, the SMDS interfaces with the SRL/SIR-C Ground Processor System (GPS) at Building 300 using one SM.

5.7.3 SYSTEM OPERATION

5.7.3.1 SMDS Operation. The SMDS operates in the following manner:

a. For the high rate (50 Mb/s) synchronous digital data mode of the Common Carrier Domestic Satellite Transponder Service (CCDTS), Nascom provides a special four-channel SMDS capable of multiplexing individual user data streams (up to four) with individual user data rates between 125 kb/s - 48 Mb/s into a composite data rate of up to 48 Mb/s. The SM reserves 2.0 Mb/s of bandwidth for system overhead. The capacity of the system for user's data is constrained to 48.0 Mb/s. The system is designed to be adaptive to data rate changes and to track data rate variations from nominal rates indicated due to oscillator variation and system Doppler effects within specific tolerances, with the maximum increase above 48 Mb/s not exceeding 48.024 Mb/s.

b. The SN has provided cabling and a distribution switching system (DSS-II) at NGT to integrate the switching of the 14 KSA Type II return link channel interfaces. NCC-directed NGT operations configure the DSS-II to provide up to four digital signals from the Type IIB interfaces through the DSS-II to four input channels of the SM. The SM multiplexes the input channels and outputs a composite serial data stream for transmission to the 50 Mb/s data service. A service switch interfaces the digital modulator (see Figure 12-2), while the digital modulator interfaces a mode switch before the multiplexed data is uplinked to the domestic satellite.

c. Demultiplexers of the SM are installed at the Landsat DAF, Spacelab Data Processing Facility and Nascom Technical Control Facility at GSFC, the Spacelab POCC at MSFC, the West Coast Switching Center at JPL, and the MCC at JSC. The demultiplexers at these user locations demultiplex the composite data stream and deliver the data to each of its assigned channels. Each stream, at this point, is a synthesized replica of the bit synchronized clock and data stream originated at the input of the SM at the White Sands interface. The SM uses its own data formatting and multiplexing technique (that is germane to Nascom) and is transparent to the users of the system. Redundancy is provided in the system with a patchable backup SM at each location (except JPL). The SM equipment is provided in full duplex for local loopback test capabilities.

5.7.3.2 SM Frame Format. The SM is designed to accept and deliver user spacecraft raw bitstream data. The frame formatting of the bitstream data, as illustrated in Figure 5-11, is described in the following paragraphs:

a. At the transmit section, each of the four ports receives an ECL balanced channel of data and clock. The serial data is converted to 31-bit parallel words organized into 248-word frames. These frames are then formatted into 250 32-bit words that include distributed sync, frequency, and port address information. The sync information is attached, one bit per word, to the end of each of the first 248 words. The sync pattern in the last 31 words of the 248 provides end-of-frame information. Words 249 and 250 contain the port frequency and the frame sequence number. The formatted frames are passed to the communications link modem at 50 Mb/s. When no data is available from any of the input ports, PN data pattern 2047 is generated for transmission.

b. At the receive section, the 50 Mb/s data stream from the communications link modem is received in the rear panel. The frames are synchronized into 32-bit words and a clock pulse is developed to occur simultaneously with the distributed sync bits in the data stream. The port address and end of frame are determined from the distributed sync pattern. Each data frame is converted into 32-bit parallel words corresponding to the transmit section. The overhead information from the data frame is removed, and converts the data back into serial form.

5.8 CONTROL AND STATUS SYSTEM

This paragraph provides a standalone description of the CSS. Its role in supporting the scheduling and configuration function of the BDS and HRDS is discussed more comprehensively in Sections 11 and 12, respectively.

5.8.1 SYSTEM DEFINITION

The CSS, as a Nascom System, can be defined as the vehicle through which the communication resources of the Nascom Network supporting the SN will be scheduled and configured.

5.8.2 SYSTEM DESCRIPTION

5.8.2.1 Development History. The CSS was developed to provide the SN with a system apparatus needed to automate the schedule-driven data traffic control capability and network status information for the various Nascom Network elements supporting SN. The development history of

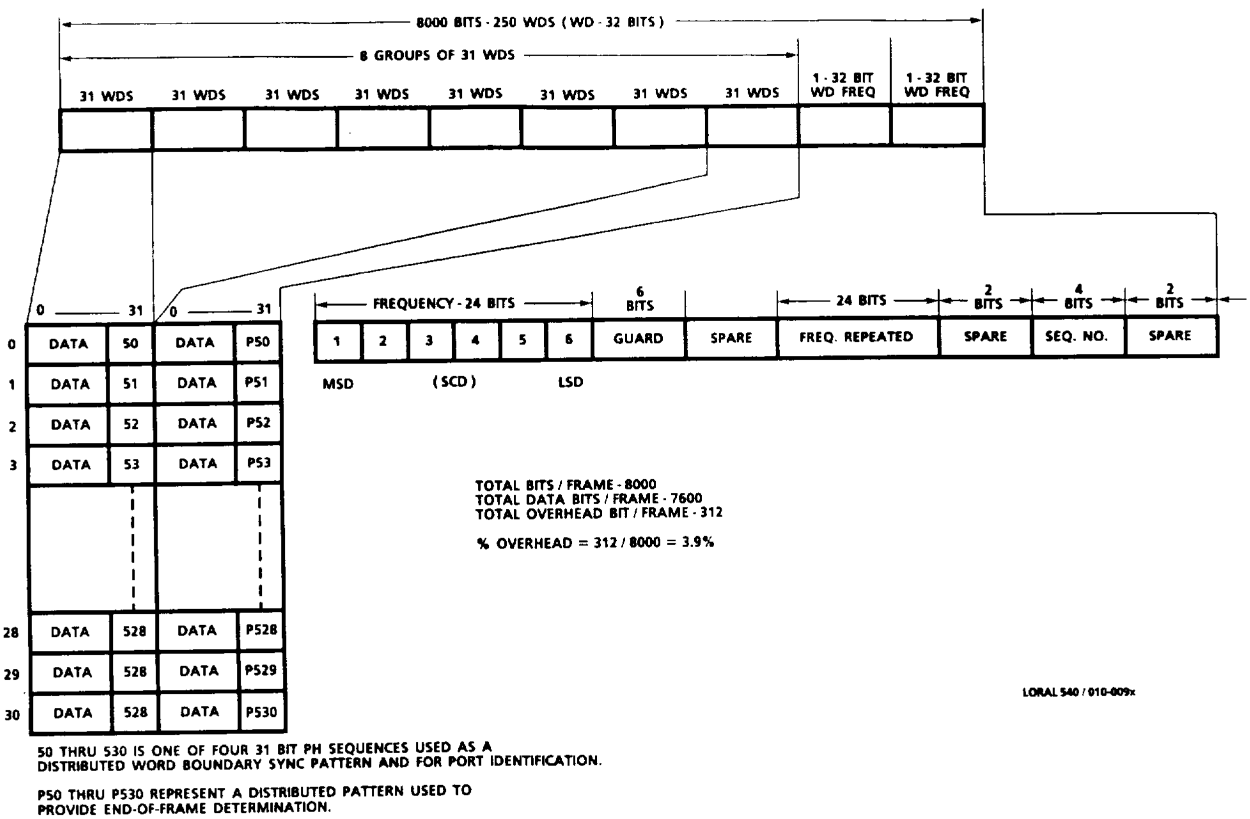

Figure 5-11. Frame Format of the SM Bit Stream Data

the CSS is summarized in the following paragraphs:

a. Control and Status System Development. The CSS has been a major augmentation for the Nascom/SN data transport system and has been beneficial in automating the prior manual configuration of ground communications equipment supporting TDRSS users. Having operated in a RED mode for several years, system changes enabled the CSS to be color changed in 1991 back to its original design: operating in a BLACK mode.

b. The CSS development has been implemented in two parts as follows:

(1) Acquisition of hardware through competitive procurement resulting in acquisition of a Sperry 1100/62 Federal Information Processing Standard (FIPS) compliant processing system.

(2) In-house development of software through task order via the Nascom Contractor Engineering Support Team.

c. Except for a recently initiated front end, mass storage and tape drive replacement project, the CSS acquisition is considered to be complete. Further enhancements in the form of a new host processor are being contemplated. Subsystem software requirements have recently been updated and are under review. A phased implementation plan was adopted, under which a minimum required operational capability was delivered at the end of the first quarter of 1987 (Phase I), and a more complete capability was delivered during the first three quarters of 1988 (Phase II).

d. In the first phase of implementation the CSS acquired the capability of accepting Nascom Event Scheduling (NES) messages from the NCC and from a local operator and controlling the MDM and SM.

e. Implementation of CSS Phase I also required delivery of a CSS Emulator, which is a primary test tool to be used in testing of CSS prior to online operation. The Emulator consists of software capable of limited emulation of all external interfaces of the CSS; i.e., the various subsystem interfaces described in paragraph 5.8.2.4 and the NCC interface.

f. Capabilities for processing status or alarm information for its subsystems, generating response messages to the NCC, controlling the

DMS, and generating and distributing the advance schedule via TTY messages were provided in Phase II.

g. Software acceptance testing of all CSS Phase II releases was successfully accomplished in September 1988.

h. The CSS was tested successfully with the DCS in July 1989. DCS is now online with the CSS.

i. An independent software development computer system with compatible software and interfaces (Swift 2200/200) permits software development activity to occur with minimum release time of CSS on-line assets.

j. Code 530 developed and installed a CSS at NGT to control the MDM and SM equipment. The CSS was modified to interface with the NGT CSS (NCSS) for status only.

k. Certain capabilities originally intended in Nascom CSS System Requirements Specification 541-001, were not accomplished in Phase I and II. A software enhancement effort was designed to complete certain system requirements and certain newly identified requirements that were deferred in the original implementation.

(1) Software Enhancements.

(a) Release 91.3 was developed to control the MACS, which control the old MDMs.

(b) Release 92.2 was developed to control the upgraded MACS, which control the new MDMs.

(c) Release 94.1, scheduled for delivery in the final quarter of FY 94, includes the ability to handle the 3-character TDRSS identifiers, as well as supporting the NCC Level 6 testing. Support for STGT and WSC are also included in this release. Following successful completion of ORR for Release 94.1, CSS software development enters the support and maintenance mode.

(2) Hardware upgrade. An upgrade of the processor has been procured: UNISYS model 2200/400 computers. The equipment is scheduled for installation and implementation in conjunction with Release 94.1 of the CSS software.

5.8.2.2 <u>CSS Configuration</u>. The CSS is a computer system that automates the scheduling and configuring of Nascom resources committed to support of the SN.

5.8.2.3 <u>System Elements</u>. The hardware system elements are the central complex cabinets housing the UNISYS 2200/400 processing systems, system support processors, system consoles, FEPs and assorted peripheral devices. The software system consists of the vendor and application software. The software system elements are briefly described in the following paragraphs:

a. <u>Vendor Software</u>. The vendor software shown in Figure 5-12, consisting of Unisys-supported products such as OS, utility programs, diagnostics, and other system programs required to operate the UNISYS 2200/400 computers and peripheral devices configured for the CSS. Vendor software includes system- or machine-specific programs that support a set of general functions for the CSS. The vendor software follows:

(1) <u>Transaction Interface Processor (TIP) System</u>. An extension of the Series 1100 EXEC OS that allows immediate execution of transaction programs.

(2) <u>Message Control Bank</u>. A general-purpose message-handling mechanism that provides the capabilities of controlling and recovering input and output messages.

(3) <u>Data Management System 1100 (DMS1100)</u>. A system that allows users to define the data base and the various user views of the data base.

(4) <u>Integrated Recovery Utility (IRU)</u>. A program that provides a set of language commands for the recovery and reconstruction of TIP/DMS files.

(5) <u>Command Management System 1100 (CMS1100)</u>. A system that provides a real-time interface for routing communications data from hardware devices to the 1100 EXEC OS.

(6) <u>DCP OS</u>. DCP OS handles information queries from its own application and provides boot capabilities and file services.

(7) <u>TELCON</u>. TELCON provides (1) data send and receive capability to the operator terminals, (2) Advance Schedule via the CMS1100, and (3) Nascom line modules to and from the host.

b. <u>Application Software</u>. Application software consisting of function-specific programs that enable the execution of application processes specified for the CSS. This software is developed in-house by a contractor according to Nascom specifications. Application software cannot be ex-

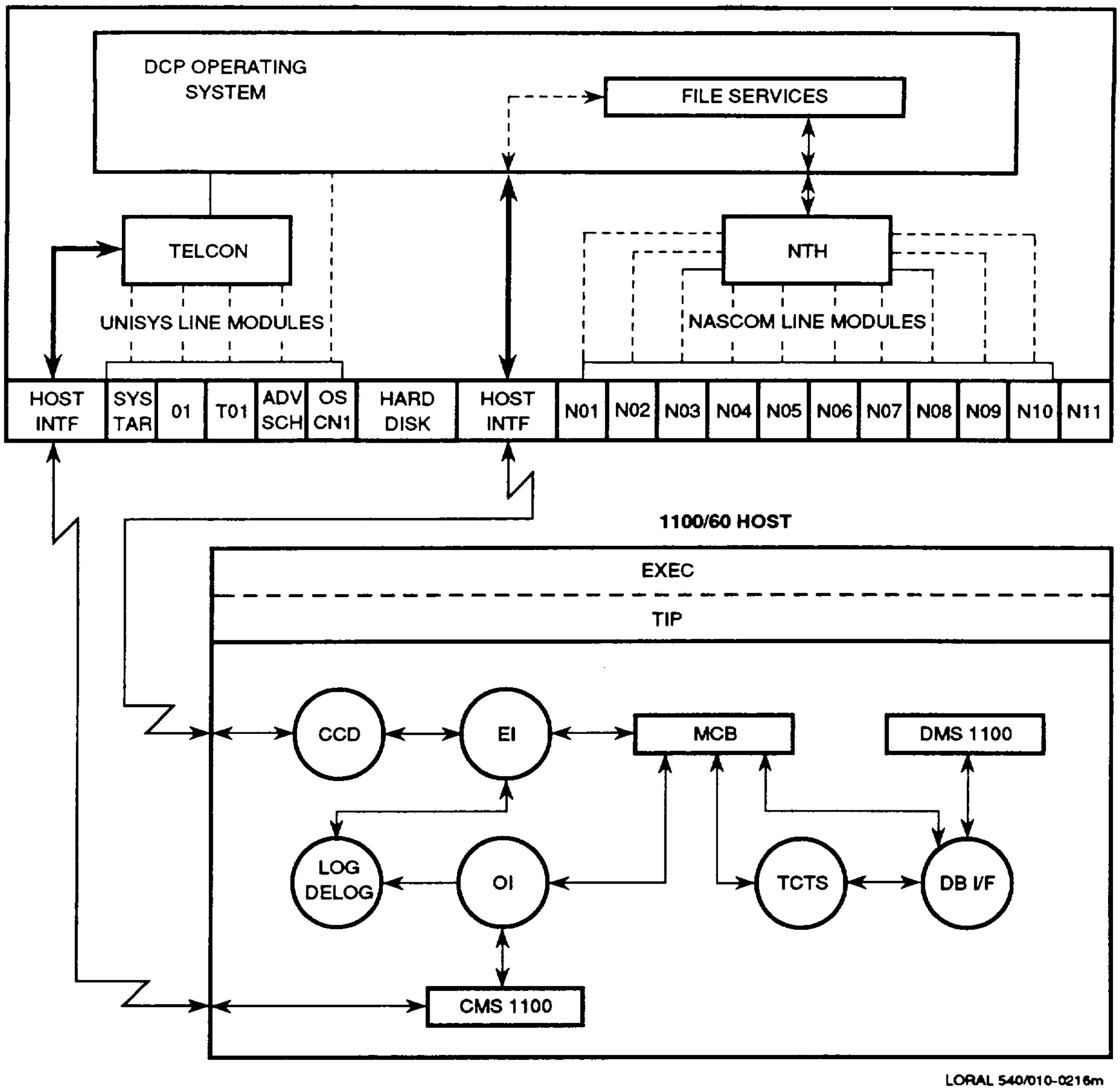

Figure 5-12. Vendor Software Configuration

ecuted in the computer by itself; it requires the operating system program provided by the vendor.

5.8.2.4 System Interfaces. The CSS system interface configuration is illustrated in Figure 5-13. All interfaces shown are Nascom internal control and status interfaces, except for the interfaces with the NCC. The CSS Systems interfaces are described as follows:

a. NCC Interface. The CSS interfaces the NCCDS with two 56 kb/s data lines routed via the Nascom MSS and the NCC Restricted Access Processor (RAP). (These 56 kb/s data lines are still routed via the PDS installed in the 1980s for support of classified DoD shuttle operations, an activity now discontinued.) Message interchange be-tween the NCC and the CSS are in standard 4800-bit blocks. The NCC is constrained by Interface Control Document (ICD) agreement to a maximum transmission rate of eight blocks per second. NES messages may be multiblock messages. The definition of messages by type, class, content, and protocol for interchange between the NCC and CSS is contained in STDN 220.9 "Interface Control Document between the Network Control Center and the Nascom Control and Status System."

b. Subsystem Interfaces. On the basis of the NES messages received from the NCC, the CSS performs a resource allocation, produces a Traffic and Configuration Time Schedule (TCTS), and issues TCTS time-driven command blocks to the subsystem control elements. The CSS also

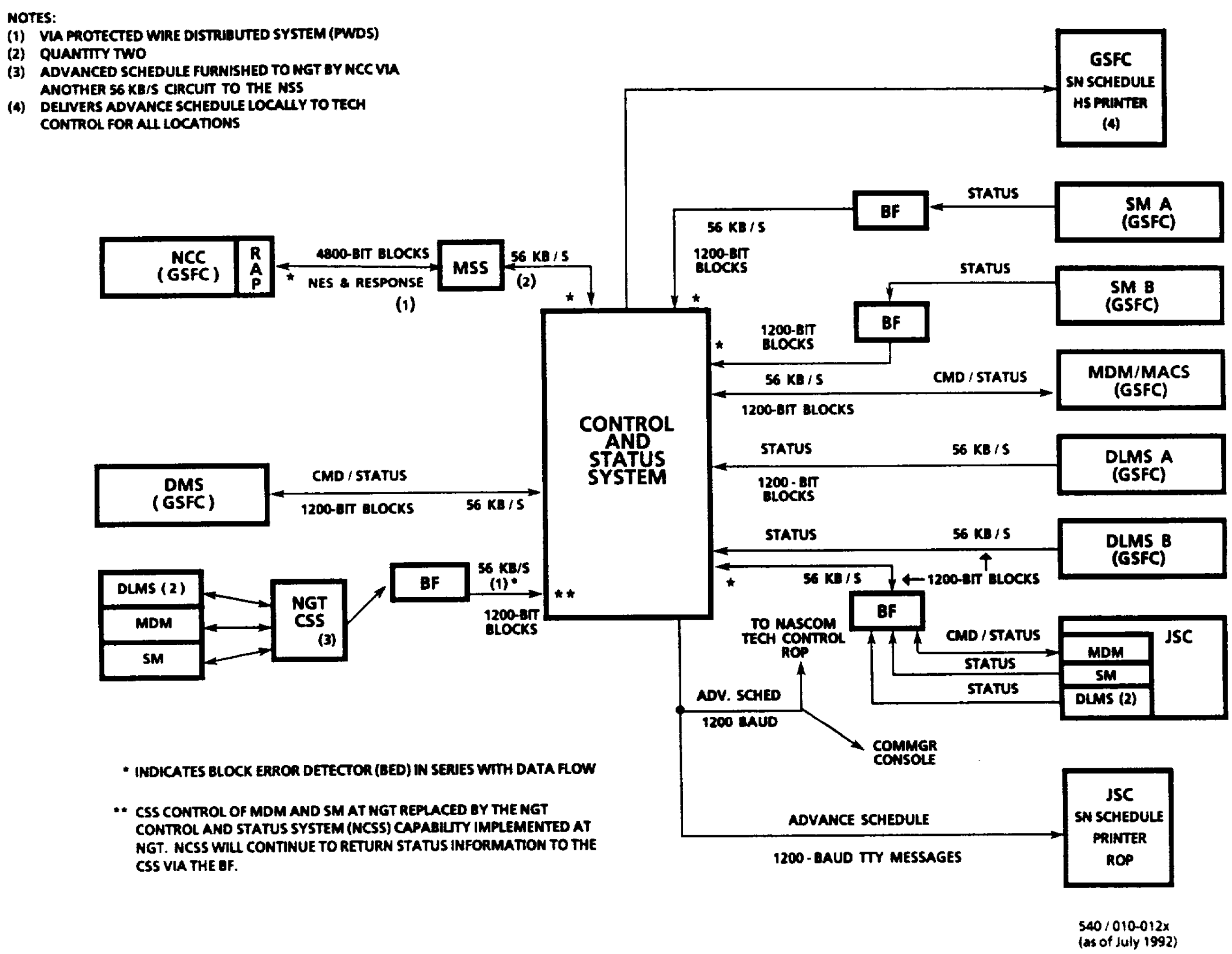

Figure 5-13. CSS Functional Interface Block Diagram

maintains a data base of available Nascom system resources and updates it based on status data received from subsystems.

c. NCSS Interface. Since the NGT CSS controls the NGT equipment, status information is sent to the CSS from the NCSS via the Block Formatter.

d. Block Formatter Interface. The Block Formatter (BF) is a Nascom subsystem element that was developed for each of the four installations (NGT, JSC, and two GSFC SM locations). It multiplexes block status information from the MDM, SM, and DLMS at NGT and JSC for transmission to the CSS, and distributes schedule-driven control messages from the CSS to the MDM. The SM's (and the Mode Switch at NGT) require external block formatting/deblocking capability, which is also furnished by the BF. The BF is capable of block multiplexing/demultiplexing 6 channels, and will handle 1200 bit blocks. The BF is required in conjunction with the CSS for implementation of automated scheduling and control of the Nascom SN elements. In-house fabrication, assembly, and testing were completed as of March 1985. Installations were completed in conjunction with CSS Phase I at the end of the second quarter 1987.

(1) A total of eight BF's plus supporting equipment are installed, two each, at the following locations:

(a) Landsat Data Acquisition Facility (DAF) near Building 25 at GSFC.

(b) Spacelab Data Processing Facility in Building 23 at GSFC.

(c) Communications Circuit Technical Control Facility in Building 30 (Mission Operations Wing) at JSC.

(d) NGT at White Sands, New Mexico.

(2) The BF's are arranged in a hot-standby, redundant configuration. Each BF is capable of interfacing two SM's, one MDM MACS, and three DLMS units to the CSS. The BF select switch, which is part of the installation, provides switching functions of their BF serial, RS-422 interfaces. These functions include a 2 x 2 switch to route two communication links to/from the two BF's, as well as a 2 x 1 switch to route the MACS and DLMS to/from either of the two BF's. The SM switch switches the interface of two SM's to/from the two BF's.

The CSS communicates with Nascom subsystem control elements in 1200-bit blocks and 56-kb/s interfaces. The MDM, DLMS, SM, and DMS control subsystems are compatible with the 1200-bit block 56-kb/s interfaces. The 4800-bit block is used on the NOC interface. For CSS communications with the NGT and JSC locations, the BF also performs a block multiplexing function for efficient utilization of 56-kb/s circuits to be established between GSFC and remote locations for the CSS function. These 56-kb/s control circuits established external to the MDM systems for a normal operational diversity configuration, but may use channels within the MDM system (serial data mode) as an alternate path.

e. Statistical Multiplexer Interface. The SM A and B shown at GSFC represent the system controllers of separate SM equipment locations for the SLDPF and the Landsat DAF interfacing individually to the CSS via BF's.

f. DLMS Interface. Each of the three BDS locations (NGT, JSC, and GSFC) will have two DLMS, one for each alternate downlink (A and B system), which will periodically send link status to the CSS. The DLMS provides status only, and requires no CSS commanding function. At GSFC, the DLMS interfaces directly with the CSS to provide link status. At NGT and JSC, the DLMS interfaces via the BF and at NGT indirectly via the NCSS.

g. MDM Interface. The MDM system is interfaced directly to the CSS at GSFC, and via the BF at NGT and JSC for control and status functions.

h. TTY Interface. The CSS also interfaces with a 1200-baud TTY circuit for transmission of the 24-hour advance schedule, which is sent to a Receive-only Printer (ROP) at the local MDM operating positions at JSC and GSFC Nascom Tech Control for manual execution of the schedule (if needed) as a backup to the CSS. A translation of the 4800-bit block NES messages into identifiable instructions in TTY message form is accomplished in the CSS. The advance schedule for NGT is also transmitted by the NCC directly to the NGT Scheduling System (NSS) via a separate 56-kb/s channel.

i. DMS Control System Interface. The DMS, located at GSFC, is a three-stage, solid-state, circuit switch composed of a forward matrix and backup , return matrix and backup, and a control subsystem. Each of these four matrices is capable of handling 192 input and output lines. The function of the DMS in the SN is to route TDRSS/NGT/JSC MDM traffic flows to/from users and operators of the SN via GSFC. The CSS at GSFC will be used to automatically configure and monitor the status of the DMS, in accordance with the NCC schedule. The current DCS is a DEC MicroVAX II.

5.8.3 SYSTEM OPERATION

5.8.3.1 CSS Subsystem Operations. The CSS operation is premised on the functions specified for the system. The functions of CSS, as depicted in Figure 5-14, are grouped into three main subsystems. These are:

a. EI Subsystem. Manages the communications interfaces between the CSS and other network elements. As can be seen in Figure 5-13, the NCC is included as an element, in addition to the various network equipment at each of the sites.

b. TCTS Subsystem. Receives daily Nascom event schedules from the NCC via EI or from the local operator via OI, configures the network equipment in accordance with the schedule, and monitors the network status.

c. OI Subsystem. Provides for operator control of CSS and network activities.

5.8.3.2 Fundamental CSS Processes in Subsystems. There are seven identified fundamental processes operating in the subsystems to perform the functions. The acronym placed after a process indicates the subsystem where the process occurs:

a. Manage NCC/CSS interface communications (EI).

b. Manage Network/CSS interface communications (EI).

c. Manage JSC SN/CSS interface communications (EI).

d. Schedule Nascom events (TCTS).

e. Command network configuration (TCTS).

f. Monitor network status (TCTS).

g. Interact with operator (OI).

5.9 NASCOM ENVIRONMENTAL SUPPORT SYSTEM

5.9.1 SYSTEM DEFINITION

The Nascom Environmental Support System refers to the various systems that support the environ-

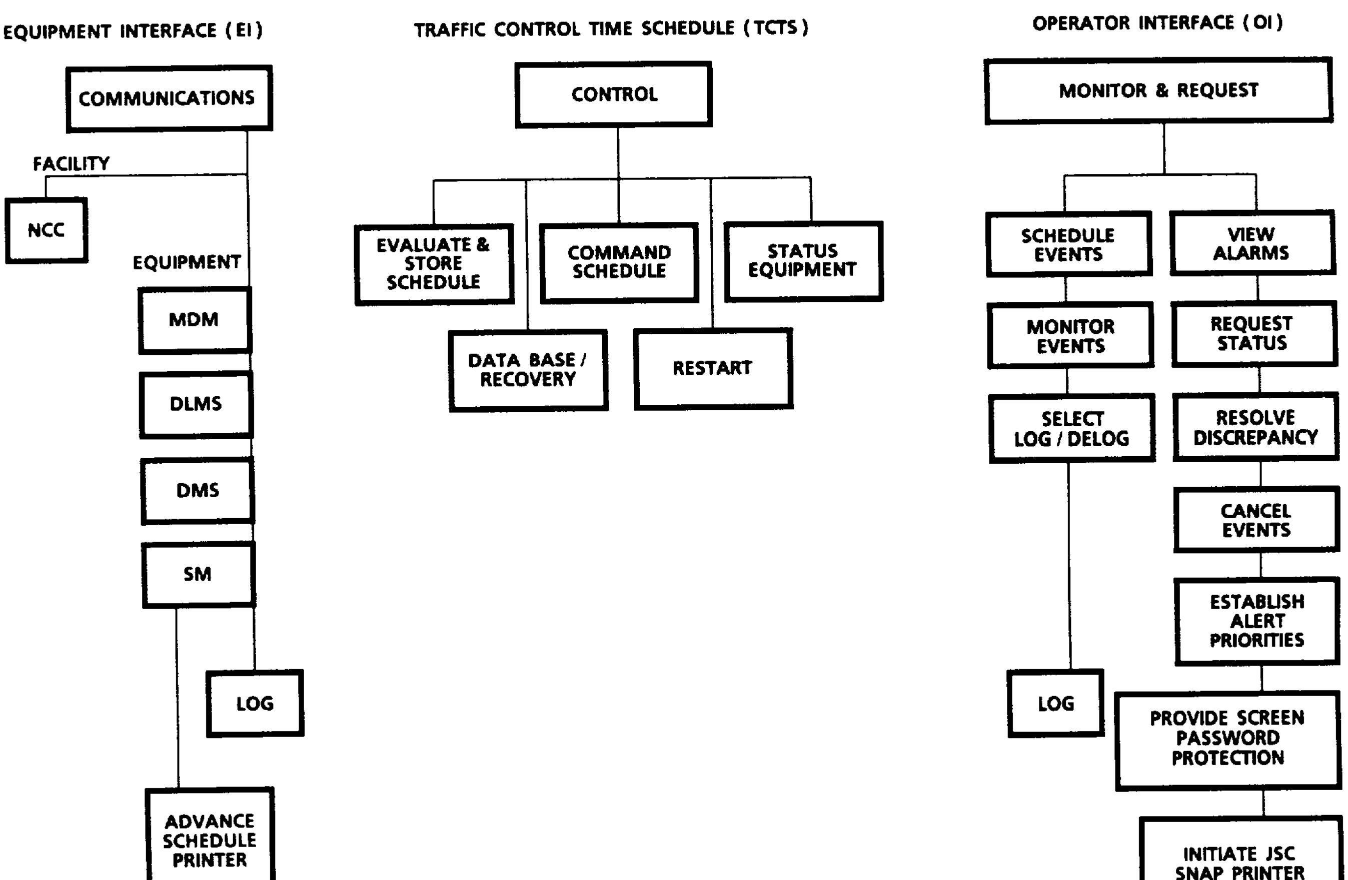

Figure 5-14. Categories of the Main CSS Subsystem

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mental requirements of the primary switching and technical control facilities at GSFC in the areas of electric power, emergency lighting, and air conditioning.

5.9.2 SYSTEM DESCRIPTION

5.9.2.1 Primary Power. Primary power to Buildings 3 and 14 is provided by two separate commercial feeders backed up by four 500-kVA diesel generators. During critical mission periods, the diesel generators are kept running continuously. Nascom does not utilize the diesel power source unless commercial power becomes unstable or fails. Special power switching arrangements are provided such that the Voice Switching System (VSS), Control and Status System, and Technical Control areas and their associated UPS's can be automatically supplied from either the commercial or diesel power sources. In the event of failure of either power source, these loads are automatically (or manually) switched to the remaining unfailed source.

5.9.2.2 Uninterruptible Power System. Three separate UPS's provide for a continuous power feed to Nascom's Voice Switching System, the Control and Status System, the Digital Matrix Switch, and the Technical Control area. The UPS's operate on a battery/converter principle with the battery system permanently floating on-line. When commercial power fails, no switching is required: the batteries assume the critical load instantaneously until commercial power is restored or the diesels are brought on-line. In this manner, critical systems and circuits which must be protected from power fluctuations are assured stable, reliable power.

5.9.2.2.1 Voice Switching System UPS. The Voice Switching System UPS consists of two identical battery chargers and four battery banks providing for a minimum of four hours operation without an external alternating current (AC) power source.

5.9.2.2.2 Technical Control System UPS. The Technical Control Area systems are supported by three identical UPS's. These UPS's provide an operating period on battery of about 15 minutes. Currently, these UPS's are loaded at about 70 percent of their rated capacity.

5.9.2.3 Emergency Lighting. Emergency lighting is provided by one 30-kVA no-break power systems which provide power to selected fluorescent fixtures in Building 14.

5.9.2.4 Air Conditioning. Air conditioning is provided by the GSFC chilled water supply. Two standby water chillers with 250-ton and 125-ton capacities (located in Building 3) can be arranged to supply air conditioning in the event of failure of the GSFC chilled water supply. Three separate air-handling units, located in Building 14, provide cooling for the equipment and afford approximately 50 percent redundant capacity. With this margin, any two of the three units are capable of handling the anticipated total heat load generated when all equipment is operated simultaneously.

5.10 NASCOM TECHNICAL CONTROL SYSTEM

5.10.1 SYSTEM DEFINITION

The Nascom Technical Control System refers to arrays of test, patch, monitoring and diagnostic capabilities arranged on a functional subsystem basis for support of Nascom TTY, Data, and Video services.

5.10.2 SYSTEM DESCRIPTION

5.10.2.1 TTY Tech Control. The TTY Tech Control, located in the Building 14 TTY operational area, consists of rack-housed jackfields and test equipment used for configuring, testing, and monitoring of the TTY circuits, including the restoration and/or replacement of TTY equipment.

5.10.2.2 Data Tech Control. The Data Tech Control, located in the Building 14 communications area, consists of an extensive array of bay racks housing the test and patch subsystems used for test access, reconfiguration and/or restoration, testing, and monitoring of data channels. From the High-speed Data Technical Control area, the capability to test and monitor analog [alternate voice/data (AVD) and TTY] as well as digital data channels, and order wires, is provided. Another area is called the Wideband Data Tech Control, which is used for the test and monitoring of wideband data circuits.

5.10.2.3 Video and Timing Tech Control. The Video and Timing Tech Control, (Tech Support) located in Building 14, consists of an extensive array of bay racks housing the video test and monitoring equipment, and test and patch facilities (including the video consoles for video signal control). Video Tech Control operates jointly with TV Central Control, located at Room N-2, Building 8, which is also operated by Nascom but under Code 543.

5.11 NASCOM DATACOM-TECHNICAL SUPPORT FACILITY AND INTER-BUILDING CABLE NETWORK

5.11.1 DATACOM-TECHNICAL SUPPORT FACILITY

Operated by Code 543, the DATACOM-Technical Support Facility is located in Room E-2, Building 14. It consists of the following equipment:

a. Remote-control POCC video switching and distribution matrix

b. Termination frame for the GSFC Inter-Building Cable Network

c. Time standards generator and distribution system

d. Interface for internal extension of commercial carrier supplied video and audio circuits

e. Audio terminal for Mission Operations audio and General audio

f. Main-frame for control of all remote-controlled cameras

5.11.2 GSFC INTER-BUILDING CABLE NETWORK

5.11.2.1 General. Managed and operated by Code 543, the GSFC Inter-Building Cable Network is comprised of twisted pair, coaxial and fiber optic cables. Over this cable network are transported television, audio, computer-to-computer data, data to and from interfaces external to GSFC, and spacecraft data for operational and testing support between Goddard control centers and their respective spacecraft. Each building connected to the cable network has cable-appropriate termination frames or racks on which the outside cables serving the building are terminated, including appropriate audio and video outlet boxes. Within each building are "house cables" that interface to the outside plant cables at these frames/racks used to extend circuit paths to the end user's facilities.

5.11.2.2 Obtaining Service. To obtain a cable circuit on GSFC, the requiring office submits its requirements in writing to Nascom's Telecommunications Branch, Code 543. Each request needs to contain the following information:

a. Types and quantities of circuits

b. Data rates to be transported

c. Period(s) of support

d. Building and room number where service is required

e. Name and phone number of person who will be point of contact to work with Code 543 to implement the requested service

Upon receipt of a service request, Code 543 determines the availability of appropriate cable(s) to the service location and identifies the routing and circuit configuration for the requested service. When the circuit is established, it is tested end-to-end (on-site) to demonstrate compliance with service requirements. If the on-site segment of a circuit is being implemented to meet a Nascom requirement, then Nascom may supply conditioning or line-driver equipment if necessary for the circuit to function properly.

If there is a circuit problem after activation of the on-site circuit, the user opens a trouble report with Nascom. The circuit is then turned over to Nascom for fault isolation and correction by CCTV-DATACOM personnel of Code 543. If the problem cannot be corrected, then the service will be restored on a similar cable, if one is available.

5.11.3 MISSION-ORIENTED FIBER OPTIC CABLE PLANT

5.11.3.1 General. To support the ever increasing requirement for extending digital circuits between buildings housing operational mission supporting facilities, the Nascom Telecommunications Branch maintains an extensive and growing fiber optic cable plant. This fiber optic cable plant centers on Building 14 (Nascom GSFC Switching Center's location) and provides connection to and between buildings housing operational, mission-oriented facilities.

5.11.3.2 Description. Nascom's fiber optic cable plant consists of fiber optic cables possessing the following characteristics:

Type: multimode
Size: 50/125/250 microns
Numerical Aperture: 0.20
Attenuation: 400/1000 Mhz @ 2.5/1.5 dB/km

Type: multimode
Size: 62.5/125/250 microns
Nmberical Aperture: 0.275
Attenuation: 1.5dB/km/500 Mhz@1300nm

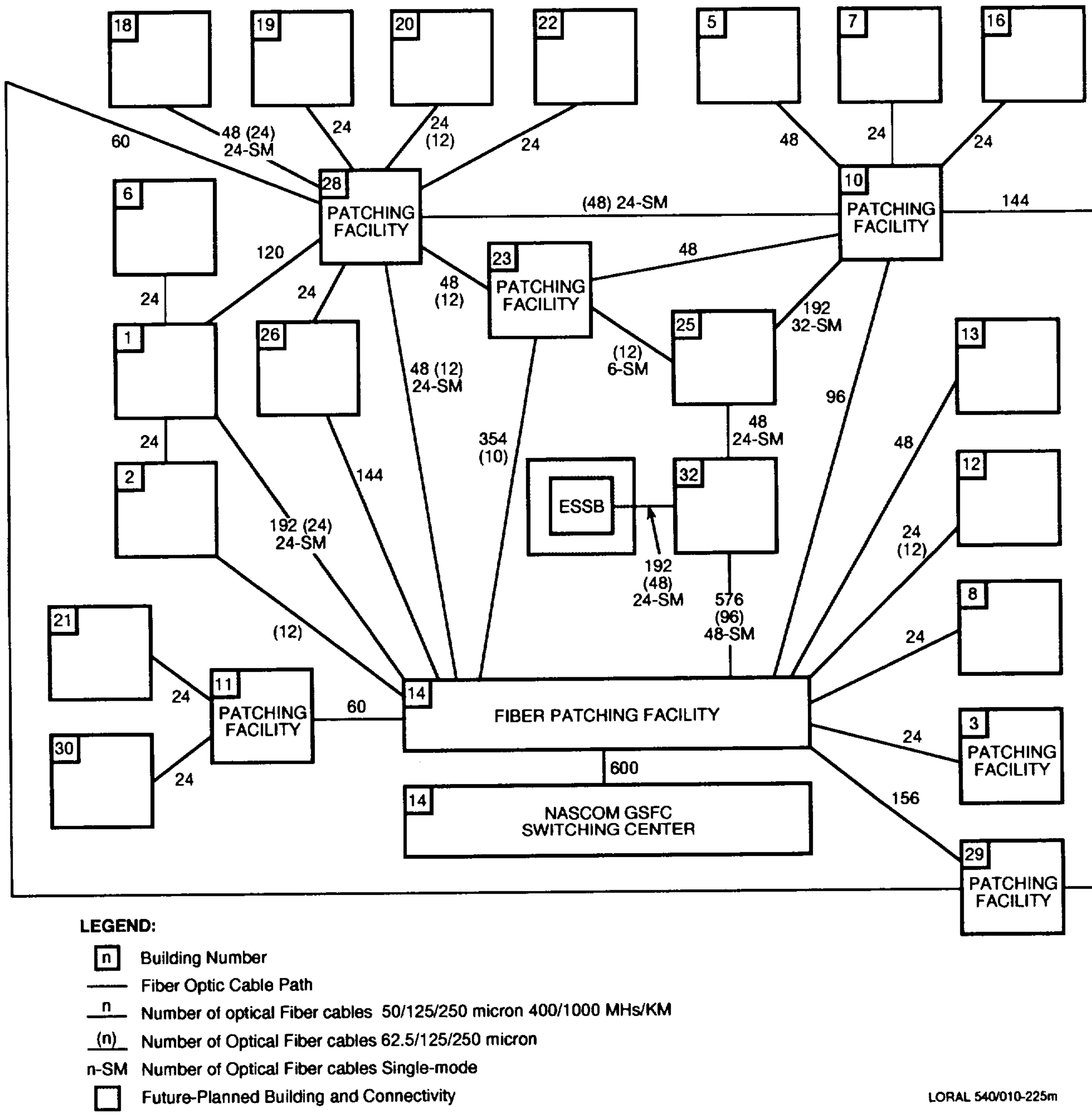


Figure 5-15. Operational, Mission-Oriented Nascom Interbuilding Fiber Optic Cable Plant on GSFC

Type: single-mode
Size: 8-9 micron
Attenuation: 0.4/1310-1550nm

From the principle node in Building 14, cables fan out across GSFC. Route diversity to selected buildings is achieved through intermediate patch facilities (nodes) in buildings 10, 11, 23, 28 and 29. Figure 5-15 portrays the operational, mission supporting fiber optic cable plant currently installed on GSFC. Cables for support of the ICLU project (paragraph 17.4.7) are shown on this drawing.

5.12 SECURITY OF NASCOM SYSTEMS

5.12.1 ADP SYSTEM RISK ANALYSIS

5.12.1.1 Background Information. The Nascom organization has been required to assess vulnerabilities and the feasibility of additional safeguards for its Automatic Data Processing (ADP) systems, where appropriate. These analyses are used by NASA/GSFC Computer Security Officials (CSO), in compliance with various directives on this general subject. Those directives include the Office of Management and Budget (OMB) Circular No. 130, the NASA Management Instruction (NMI) 2410.7, and the NASA Handbook (NHB) 2410.9.

5.12.1.2 Nascom Activities. The ADP Equipment (ADPE) risk analysis is a continuing activity that requires periodic reassessments. Accordingly, Nascom has tasked its Nascom Maintenance and Operations Support (NMOS) contractor to provide support to the Nascom Division CSO. Risk analyses have been performed for each of the following systems and reassessments are conducted on a continuing basis: Interconnect Telecommunications Systems (ITS), Goddard electronic mail system (GSFCMail), Nascom System Engineering Management System (SEMIS), and Nascom Operations System (a collective designator for the MSS, MACS, CSS, DCS, DDCS, VSS, and VDS).

5.12.2 NASCOM ACCESS CONTROL

5.12.2.1 Background Information. NASA Code O (OSC) has established a NASA-wide policy regarding Nascom access control [refer to Memorandum TS-88-246 (August 1, 1988)] and NMI 2520.1D. The policy requires that users of Nascom services survey their resources and determine the applicability of their Nascom interconnecting systems and compliance with policy. Purpose of the policy is to prevent unauthorized access and potential damage to Nascom operational systems and user Automated Information Systems (AIS).

5.12.2.2 Nascom Responsibility. Nascom has been given responsibility to verify compliance through unannounced audits at Network user sites. The SEAS contractor has been tasked to support the Nascom CSO by forming a security audit team to carry out this policy. The schedule and identity of installations are determined by Nascom. The contractor furnishes a detailed written report following each site visit. This is, and will be, an ongoing and continuing activity. Specific details are found in NASA Communications (Nascom) Access Protection Policy and Guidelines (541-107).

5.12.3 NASCOM PHYSICAL SECURITY ARRANGEMENT

The physical security system established for the Nascom Network consists of the following: coded lock access for operational areas, access procedures, and badge systems, earth station fencing, limited access area delineation, closed circuit TV surveillance, and contractor clearances.

5.12.4 SECURE NASCOM SYSTEMS

5.12.4.1 Multiplexed Circuits. The following wideband circuits/systems are encrypted at the aggregate interface of the multiplexer:

a. NCC/NGT (sole remaining link of the ISC).

b. CSTC/NCC.

5.12.4.2 Non-multiplexed Circuits. The 56 kb/s circuit for the NGT communications hardware configuration and status remains encrypted pending completion of the NGT guard processor project.

5.12.4.3 RED Information Transport Practice. For intercenter wideband trunks terminating in Nascom managed time division link multiplexer equipment, it is now the practice to implement the occasional requirement for classified voice and data signal transport with user supplied and installed RED sub-multiplexers, located in secure user facilities, the encrypted aggregates of which are interfaced as BLACK synchronous data signals to appropriately configured data channel cards of the link TDM's.

5.12.4.4 Historical Note. The multi-node secure network known as the Integrated Secure Communications System (ISC) has been deactivated as a result of changes in the Air Force program which originally generated the requirement for the ISC. ISC nodes at MSFC, JSC, GSFC (with extension to NASA Headquarters), MIL and CCAFS have now been deactivated; as indicated in paragraph 5.12.4.1, only the GSFC NCC/NGT link of the ISC remains active.

for interface with the voice system. All of these systems provide analog/digital conversion for integrated services transport, and some of them also provide data encryption for protection and/or security. These systems are briefly summarized in the following paragraphs.

7.5.1 TDMA

The Nascom/TDMA system provides the capability to establish point-to-point circuits between any combination of 14 TDMA installations at NASA and DOD locations. Each TDMA terminal is provided with at least one D-3 channel bank capable of terminating 24 local voice circuits. The D-3 channel bank equipment provides analog-to-digital conversion for integrated system digital transport compatible with T-1 multiplexing. The TDMA multiplexer equipment provides split channel operation, allowing the circuits to be individually assigned to communicate with any terminal in the TDMA Network. Authorized voice circuit connectivities established in the TDMA system are not considered to be dedicated full-period circuits, but are set up as required in accordance with daily schedules by the GSFC/NNSG. At GSFC, a 24-voice circuit interface is established between the local TDMA terminal and the voice control facility. Twenty-three voice circuits from GSFC to other locations are authorized in the TDMA system. These circuits are interfaced to the VSS and activated from an RTC when scheduled. Refer to Section 3 for a description of the Nascom TDMA Network.

Nascom plans to deactivate the TDMA network on or about October 1, 1994. Services formerly provided via the Nascom TDMA will be transitioned to the FTS2000, NSAP I. Currently these services will be limited to T-1 (1.544 MBS) rates. Requirements in excess of a T-1 rate must be reviewed, validated, and provided independently.

7.5.2 SECURE/PROTECTED VOICE SYSTEMS

7.5.2.1 General. Secure and/or protected voice systems use digitized voice and are encrypted for protected transmission.

These transmissions terminate in secure areas. Wideband digital data services provided by Nascom are utilized. Circuits are derived by digital TDM multiplexers which integrate voice and data channels for transport. Secure/protected voice channels are not terminated in the VSS.

7.5.2.2 ISC. The one remaining ISC trunk provides a capability for the secure transport of RED voice, data and facsimile signals between the NCC and the NGT/WSGT (to be followed by STGT when that facility is operational).

7.6 VOICE DISTRIBUTION SYSTEM (VDS)

7.6.1 BACKGROUND INFORMATION

To provide GSFC POCCs and other local users with a campus wide operational voice distribution capability that is reliable, flexible, and permits a high degree of user interaction with the system for control of each user's voice circuit/loop allocations, Nascom contracted with COMPUNETICS, Inc. to furnish and install a voice switching system to meet the GSFC requirements for on-campus operational voice switching and distribution. Two significant requirements met by the VDS are the incorporation of digital switching technology and compliance with applicable ISDN standards for 2B + D service.

The VDS system was installed in 1992 to provide operational voice communications between POCCs for scheduling, command and control, and element coordination. Users were cutover from the old voice intercom system to the VDS for operational support during the first half of FY 93. Acceptance testing was completed in October 1993.

7.6.2 SYSTEM HARDWARE AND CONFIGURATION

The VDS switch is installed in Building 14 and comprises 12 equipment bays allocated as follows:

a. 1 Switch Control Bay

b. 4 ISDN Bays

c. 1 Analog Line Interface Bay (2 & 4 Wire)

d. 1 Input Switch Bay

e. 2 Conference Bays

f. 1 Output Switch Bay

g. 2 TDM/OSS Bays

Also located in Building 14 is the Maintenance and Administration Position (MAP) for the VDS. The MAP resides on redundant PCs. The VDS UPS is colocated in Building 3 with the VSS UPS.

Power for the VDS bays is supplied as 208 VAC single phase from two 208 VAC inverters. The two MAPs are supplied 120 VAC single phase from one 120 VAC inverter. All three inverters are fed by four banks of 48 VDC lead-calcium batteries. These battery banks are supplied by six identical rectifier units which in turn are fed by 208 VAC three phase commercial power. The batteries also provide 48 VDC power to breaker panels located in the telephone closets where it is distributed to the individual instruments. The batteries are capable of providing 4 hours of backup power at full load without recharge. A power monitoring system displays voltage and current levels and alarm conditions.

Switch architecture supports path verification and an availability number that should approach 100%. Each circuit through the switch between any two ports is a physical path; TDM techniques whereby multiple ports time share a path are not employed. The system controller is triple redundant and performs Input/Output port path verification prior to establishing a connection; idle paths are periodically checked, and if a fault is found, that path is disabled and alarmed/reported at the MAP. Figure 7-3 depicts a functional representation of the VDS.

Allocated to users across the Goddard campus are 600 ISDN Instruments and 6 POCC Utilization Management Positions (PUMPs) the latter of which enable the POCC managers to prepare, store, and control the configuration of their allocated circuits and loops to their instruments. Table 7-1 summarizes the VDS system capability.

7.6.3 VDS INSTRUMENT FEATURES

There are four different types of instruments that the VDS offers to its users: keyset (KS), mechanical keyset (MKI) and single line instrument (SLI) and Digital Keyset (DKS). The following paragraphs describe each instrument type.

7.6.3.1 Keysets (KS). The KS provides a 28 key electroluminescent touchscreen, 12 elastomeric standard dial telephone keys, a 1.5 watt speaker and handset with a push-to-talk feature mounted on a 7 x 19 inch EIA standard panel. Electronically, the KS stores 10 touchscreen pages, each page with 28 keys, for a total capacity of 280 circuits.

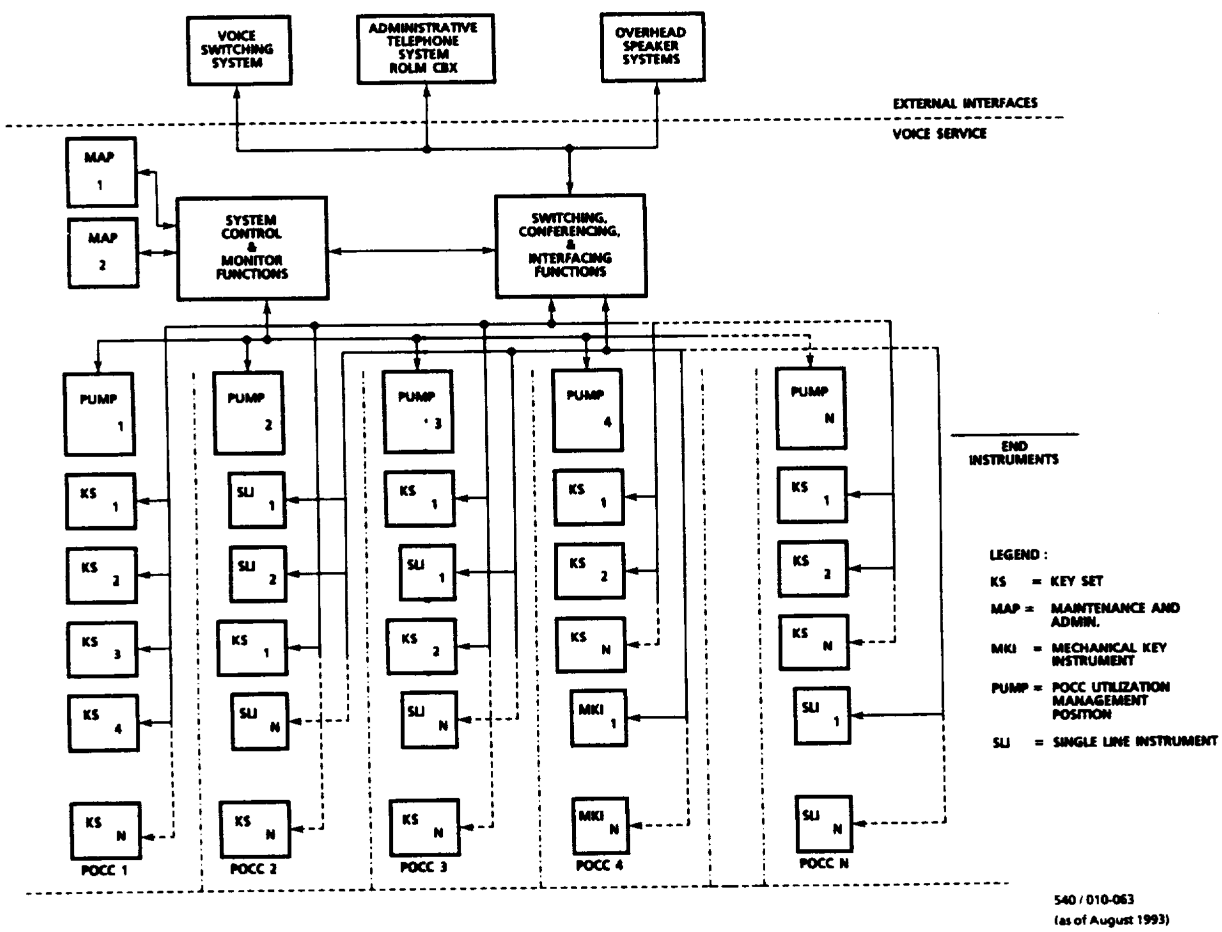


Figure 7-3. Voice Distribution System Operational Block Diagram

Table 7-1
Summary of VDS Capabilities

Communication Service Type	Installed	VDS Internal Wired	Additional Expandable
Overhead Speakers	456	-	500
VSS Interfaces- 4 wire	400	-	752
CBX	128	80	176
IDSN (User Instruments)	600	24	656
	ISDN units are composed of keysets, mechanical keysets, and single line instruments. The mix of these types is not fixed, but rather, depends on user needs.		
VDL Hotlines	100	-	20
Conference Ports	-	-	-
	Has no external significance in that conferencing has a different meaning inside VDS.		

The KS supports local SCAMA lines, CCLs, CBX, VDL and DI circuits. With the exception of the DI circuit which is talk/listen only, the KS may terminate these circuits in one of three selectable modes: talk/listen, loudspeaker monitor, handset monitor. Additionally, the KS is equipped with a HOLD and Active Circuit Indication features.

7.6.3.2 Mechanical Keyset (MKI). The MKI provides a desk-mounted (with reversible base for wall mounting) instrument equipped with hookswitch, elastomeric keypad, and push-to-talk handset. Electronically, the MKI has a page selector capability of two pages at ten circuits per page for a total capacity of 20 circuits. The MKI terminates the same kinds of circuits as the KS and in the same modes. Additionally, the MKI is equipped with HOLD and SIGNAL button features.

7.6.3.3 Single Line Instrument (SLI). The SLI provides a desk-mounted (with reversible base for wall mounting) instrument equipped with hookswitch, elastomeric keypad, and push-to-talk handset. Electronically, the SLI can terminate only one circuit at a time, and that circuit may be terminated in the same modes as the MKI or KS. The SLI also has Signal Button, Hold Button, and Busy Lamp features.

7.6.3.4 Digital Keyset (DKS). The DKS has been identified for use in accommodating the growing number of users. The primary use of the DKS will be to replace the MKI at NASA Headquarters. Specifics on the DKS were not available at the time of publication.

7.6.4 MAP FUNCTIONS

There are two MAP positions provided with the VDS. Both MAPs are online and function redundantly. The MAP positions are comprised of standard IBM PC-AT equivalent personal computers equipped with a color monitor and a 3 1/2" high density floppy disk drive. The MAP performs the following functions:

a. VDS system data base maintenance
b. POCC Utilization Management Position (PUMP) emulation
c. Report generation
d. User account maintenance
e. The MAP also comes with file transfer utilities

7.6.5 PUMP FUNCTIONS

Sixteen PUMPs are provided with the system capable of incrementing that number up to a total of 25. The PUMP platform is the same as that of the MAP. Each PUMP has the capability to perform the following POCC/user functions:

a. Configure the resources (circuits, loops, dial accesses), as allocated to the POCC by the master data base resident in the MAP, among the various instruments installed in the POCC or user facility.
b. Save/restore individual instrument configurations

c. Save/restore the master POCC configuration(s)

d. Download background configuration sets to instruments

e. Activate background configuration sets on instruments

f. Generate reports

7.6.6 SUPPORTED NASCOM AND USER ELEMENTS

VDS instruments serve the following Nascom and user elements on GSFC:

a. GSFC Technical Control/Comm Manager.

b. GSFC Voice Control.

c. Multi-Satellite Operation Control Center (MSOCC). All POCCs associated with the MSOCC are currently supported by all three types of VDS instruments. POCC managers determine the type(s) of instrument(s) best suited to their needs.

d. Other POCCs. The Hubble Space Telescope (HST) POCC is equipped with all three types of VDS instruments. The Extreme Ultraviolet Explorer (EUVE) is currently equipped with KS instruments.

e. Flight Dynamics Facility (FDF). The FDF is currently equipped with all three types of VDS instruments.

f. Network Control Center. Fourteen instrument terminal blocks and 14 instruments were provided to the NCC. The NCC is responsible for connection to the VDS switch.

g. Principal Investigators. The Information Processing Division (IPD), Building 23, is equipped with all three types of VDS instruments installed in the POCC Data Capture Rooms.

h. Other Facilities. Buildings 5, 6, 7, 8, 21, 29, and 88 are equipped with all three types of VDS instruments.

7.7 NASCOM POLICY ON DIGITAL VOICE TRANSMISSION

7.7.1 BACKGROUND

Over the years Nascom has developed an operational voice network renowned for the clarity of the delivered voice signal as heard in the listener's headset. Operationally, a principle feature of this high quality service is the near total absence of any "say again . . ." being heard on the net.

In 1991, Nascom conducted extensive testing of commercial off the shelf (COTS) multiplexers as part of its VAMS project (now canceled) and in preparation for a possible move of Nascom's voice service to the FTS2000 contract. Various algorithms (PCM, ADPCM, and proprietary) with A/D encoding for transmission at line rates from 64 kb/s to 9.6 kb/s were employed. A key result of this test was that participants judged the voice quality to be less than that normally provided over a Nascom circuit when listening to a voice signal encoded for transmission at a line rate less than 32 kb/s. As a result of this testing, the following policy has been established.

7.7.2 POLICY

Nascom is inclined not to subject its network voice quality standards to possible degradation attributable to voice signals that have been digitally encoded for transmission at a line rate less than 32 kb/s anywhere in their transmission path. Accordingly, it is Nascom policy that voice signals which are to be conferenced by Nascom systems should not have been digitally encoded for transmission at line rates less than 32 kb/s anywhere in their transmission path. Projects, programs or operations which plan to interface to a Nascom voice conference loop any voice signal which has been digitally encoded for transmission at a line rate less than 32 kb/s anywhere in its path should advise Nascom of all pertinent details as soon as such a plan becomes known. This advisory will enable Nascom to determine how best to deal with the proposed connection and to be ready with such measures as may be necessary to maintain the quality of the conference, inclusive of terminating service to the non-compliant interface.

b. Three-cabinet assemblies are provided at the Australian Earth Station, and the Buitrago Earth Station, Spain. A two-cabinet assembly is provided at the Cable & Wireless, Ltd. (CWL), Earth station on Bermuda.

9.3.2.4 Remote Nascom Interface Facilities. The wideband terminal configuration at the Madrid NIF includes group band analog equipment for extension of services to the DSCC as well as to the foreign-carrier Earth stations. This relay configuration provides regeneration at digital data interfaces. The wideband terminals include their own cordless patching arrangement (matrix switching) and test facilities. In addition, there is TDM equipment associated with the wideband terminal. The terminals at the remote switching centers and NIFs are engineered, fabricated, installed, and operated under NASA Communications Division contract arrangements.

9.3.3 WBDS INTERSWITCHING CENTER/NIF TRUNK AND STATION-UNIQUE CHANNEL CONFIGURATIONS

These paragraphs describe certain unique wideband channel configurations to individual GN and DSN complexes, and intercenter trunk channel configurations.

9.3.3.1 Canberra-JPL Trunk Configuration. Figure 9-4 illustrates the configuration of the Canberra NIF-JPL wideband data trunks. One full-duplex 1544-kb/s and one full-duplex 64-kb/s digital data trunk exist between Canberra NIF (located within the CDSCC) and JPL. The 1544-kb/s service is multiplexed as required by the DSN, using a TimePlex Link 2+ multiple aggregate multiplexer. Generally, there are three 32-kb/s voice, one 768-kb/s, one 256-kb/s, three 9.6-kb/s, one 1.2-kb/s, and seven 300-baud data channels configured.

9.3.3.2 Madrid-JPL Trunk Configuration. Figure 9-6 illustrates the Madrid NIF-JPL wideband data trunk configuration; this is similar in arrangement to the Canberra-JPL configuration, but the circuits are extended from the DSCC through the Madrid NIF, located a short distance away. The second wideband data trunk at Madrid is 56-kb/s, vice 64-kb/s (as at Canberra), and is routed through GSFC to JPL.

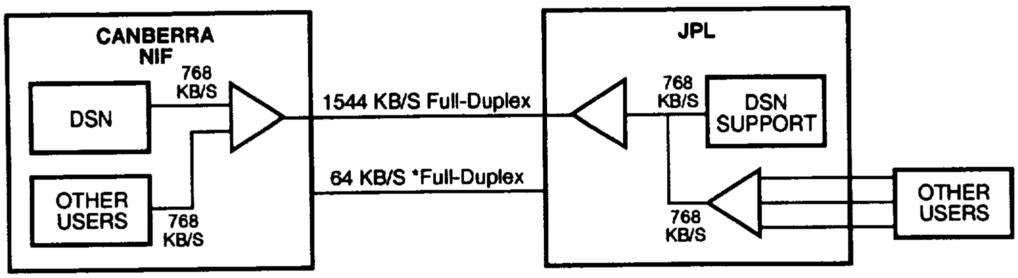
9.3.3.3 JPL-GSFC Trunk Configuration. Figure 9-7 illustrates the JPL-GSFC wideband data trunk configuration. Six 56-kb/s wideband services exist between GSFC and JPL. One is used to provide a Statistical Multiplexer system between GSFC and JPL, one is used to extend the MDSCC 56-kb/s wideband to JPL, one is dedicated to TOPEX, two are dedicated to MARS Observer, leaving one for various multi-mission uses. Two 224-kb/s circuits are also provided, one dedicated to TOPEX and one for multi-mission support, including extension to the DSCCs for STS support. A 512-kb/s circuit provides a full-duplex interface between the GSFC MSS and the JPL EUG.

9.3.3.4 GSFC-MIL/MIL-71. Figure 9-8 illustrates the wideband data trunk configuration between GSFC and both MIL/MIL-71 and CCAFS, Building AE. Two 224-kb/s services – one full-duplex, and one simplex (MIL-GSFC) and two 56-kb/s services - both full-duplex are provided between GSFC and MIL/MIL-71 joint stations for GN service and STS. MIL-71 is supported by 56-kb/s and 224-kb/s full-duplex TDMS interfaces configured directly to JPL for DSN support requirements. A full-duplex 56-kb/s channel links Building AE to MIL/MIL-71. This circuit is used for support of both Delta and Centaur inertial guidance data. It is switched to GSFC via the MIL/GSFC full-duplex, 56-kb/s service.

9.3.3.5 MIL-PDL Microwave Link. A government-furnished and installed microwave link is provided between the GN station on MIL and Ponce de Leon (PDL) for transmission of Shuttle launch phase data. The system requires repeaters at Shiloh and North Wilson. The system is designed to carry duplex 224/56-kb/s data and a six-channel duplex voice capability, plus a party line voice order wire.

9.3.3.6 GSFC-BLT Trunk Configuration. Figure 9-9 illustrates the wideband data trunk configuration between the Nascom Switching Center (Building 14) and the Greenbelt Ground Network Station (BLT), which is housed at the Network Test and Training Facility (NTTF), Building 25. There is a central communications center in Building 25 that serves the in-house Network Development Center (NDC) and Simulation Operations Center (SOC). All wideband circuits are routed over government-owned cables that also use line drivers provided by Nascom. The following paragraphs describe the wideband data configuration of NDC and SOC.

a. Network Development Center. All software programs are checked out at NDC. POCC programs are also checked out here. Three full-duplex, 56-kb/s circuits plus a full-duplex, 1.544-Mb/s, a full-duplex 224-kb/s, and two 7.2-kb/s high-speed data circuits are provided between NDC and Nascom. These circuits can be either circuit switched or message switched to the GSFC users network or to the STDN. (The full-duplex 224-kb/s and 1.544-Mb/s circuits are shared with SOC.)



NOTES:
The general channel configuration for the 512 KB/S data trunk is:
(3) 32 KB/S voice, (1) 56 KB/S, (1) 224 KB/S, (1) 9.6 KB/S, and (1) 112 KB/S

* The 64 KB/S data trunk is used as a backup for the 512 KB/S data trunk.

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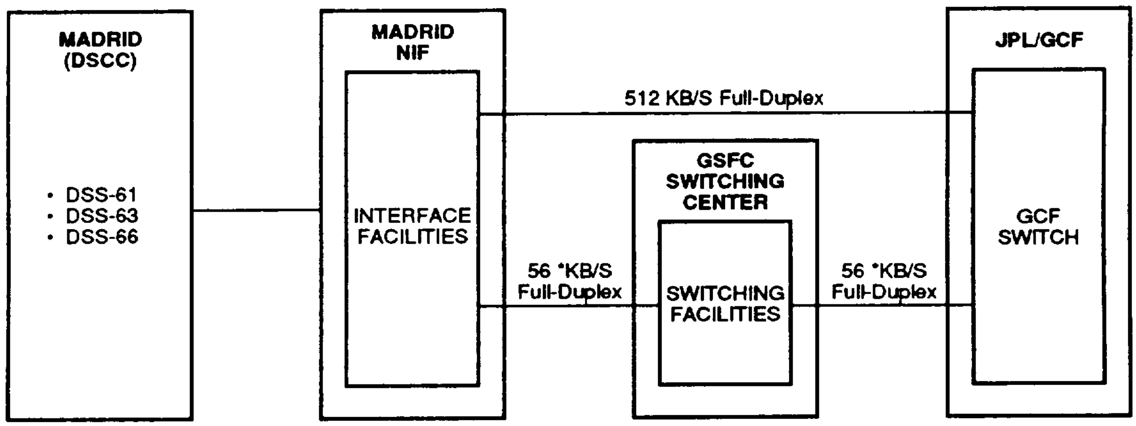
(as of February 1994)

Figure 9-4. Canberra NIF / JPL - Wideband Data Trunks

Figure 9-5. DELETED



NOTES:

The general channel configuration for the 512 KB/S data trunk is:
(3) 32 KB/S voice, (1) 56 KB/S, (1) 224 KB/S, (1) 9.6 KB/S, and (1) 112 KB/S

*The 56 KB/S data trunk is used as a backup for the 512 KB/S data trunk.

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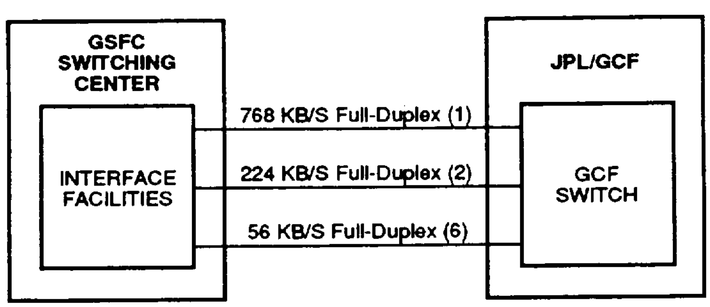
(as of September 1993)

Figure 9-6. Madrid NIF / GSFC Wideband Data Trunk Configuration



NOTES:

Numbers in parens (n) indicate quantity of channels

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(as of February 1994)

Figure 9-7. JPL / GSFC-Wideband Data Trunk Configuration

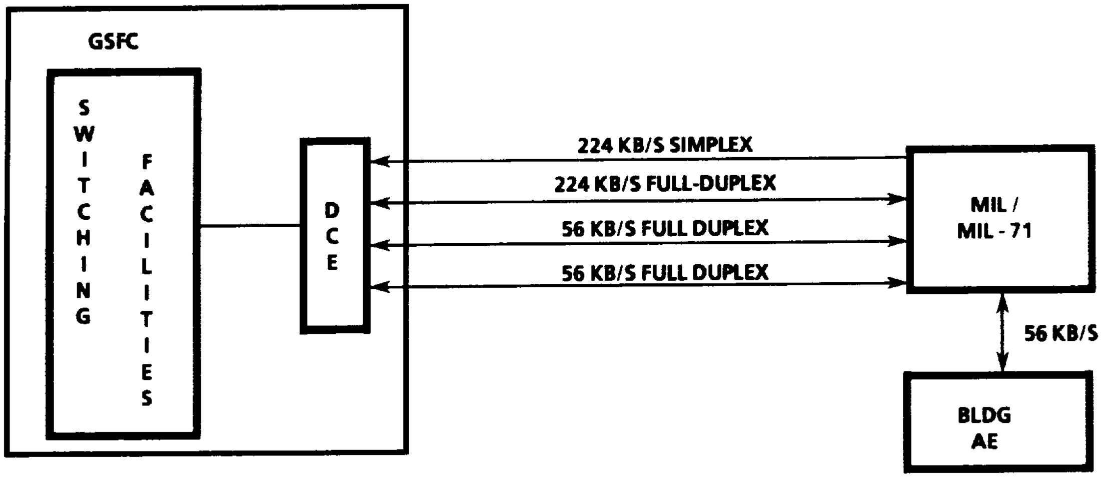

Figure 9-8. MIL / MIL-71 and CCAFS Building AE / GSFC - Wideband Data Trunks

b. Simulation Operations Center. The SOC is able to simulate either a spacecraft using the Radio Frequency Simulation Operations Center (RF SOC), or a control center operation. It provides Portable Spacecraft Simulators (PSS) to the network to check out projects in the prelaunch phase. There are two full-duplex 224-kb/s circuits, one full-duplex 1.544-Mb/s circuit, and six voice circuits between SOC and Nascom for switching to either STDN or GSFC users. The full-duplex 224-kb/s and 1.544-Mb/s circuits are shared with NDC.

9.4 WBDS SWITCHING CONFIGURATION AND INTERFACES AT GSFC

9.4.1 WIDEBAND SYSTEM SUPPORT TO STDN

9.4.1.1 GN Support Interfaces. The WBDS circuit support between the GN and its users is essentially an automated message-switched Nascom service to local wideband interfaces at GSFC to/from the GSFC POCC's, the GSFC IPD facilities, GSFC FDF and the GSFC SOC. A major GN user is the JSC/MCC for the Shuttle missions. The JSC/MCC is also provided with a message-switched, wideband interface at GSFC with the GN and user POCC's. Channels for this interface are derived on the MDM-equipped BDS. Other GN users remotely located from GSFC are also message switched at GSFC. Finally, the NCC at GSFC is provided with a wideband message switched local interface. All of these interfaces are considered a part of the overall wideband system configuration. These wideband configurations supporting GN and its users are described in paragraphs 15.2 and 15.5.

9.4.1.2 SN Support Interfaces. The WBDS circuit support between the SN and its users is principally provided via channels derived in the BDS and HDRS transport systems, direct to the SN major users at GSFC, JSC, and MSFC. The HDRS provides direct broadcast wideband channel interfaces to the SN high data rate users at these three locations. Likewise, the BDS provides a broadcast WBDS derived channel interface configuration direct to and from GSFC and JSC. Local users at these locations are provided with circuit-switched access to and from the SN. At GSFC, Nascom provides its own circuit-switched access via its DMS. These systems and wideband configurations are described in paragraphs 5.3, 5.6, 5.7, and 15.4.

9.4.2 WIDEBAND SYSTEM SUPPORT TO DSN

The WBDS circuit support provided by Nascom between the overseas DSN/DSCC's and its users are routed and circuit switched principally at JPL. These configurations are considered a part of the WBDS, and descriptions are provided in paragraph 15.2.

9.5 WBDS TIME DIVISION MULTIPLEXING APPLICATIONS

9.5.1 TDM SYSTEMS OVERVIEW

9.5.1.1 Definition. TDM is a means of deriving a number of channels over a single path (i.e., the common carrier-provided wideband circuit) by dividing the path into time slots and assigning each channel its own intermittently repeated time slot. At the receiving end, each time-separated channel is reassembled.

9.5.1.2 Nascom TDM Systems. In a technical sense, there are a number of Nascom systems that per-

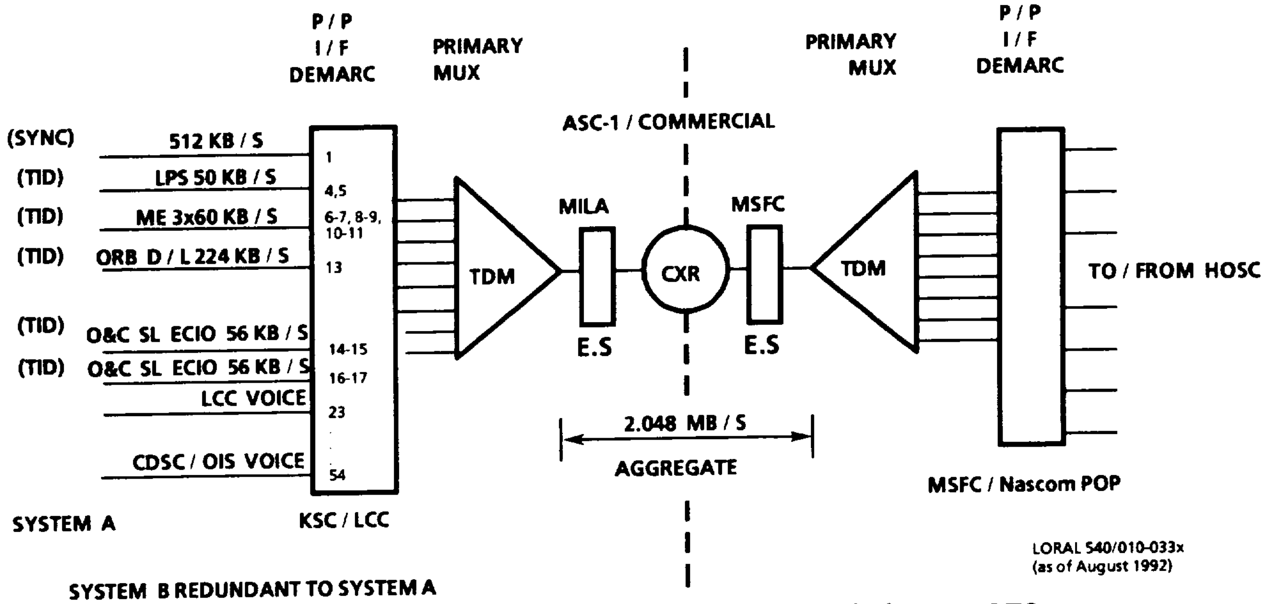

Figure 9-10. Redundant Configuration of the KMRTS

b. The digitized (32 kb/s) voice channels are transmitted as four-wire circuits E and M type 1 signaling interface.

c. An external, leased communications circuit is provided by Nascom as an orderwire with various drops at CD&SC, LCC, MIL, and MSFC buildings 4207/4663.

9.5.3.3 Nascom Support Arrangement. Nascom provides the following services to support KMRTS:

a. Design and engineering, demarcation to demarcation.

b. Implementation that includes circuit and equipment procurement.

c. Installation.

d. Testing.

e. Sustaining engineering, depot level maintenance, and system documentation.

9.5.3.4 Planned Changes. Nascom will be converting eligible existing circuits to GSA's FTS2000 Network A contractor starting in FY94. (See section 17 for a description of Nascom's implementation of FTS2000 services.) Nascom intends to transition the voice circuits now transported by KMRTS to FTS2000. This action will release 736 kb/s of bandwidth (plus associated overhead) and should enable a significant reduction to the circuit bandwidth that must be leased to transport these data links. By the end of FY94, Nascom plans to transition the data circuits supported by KMRTS to FTS2000, where possible, and deactivate the KMRTS system.

9.5.4 JSC-MSFC REDUNDANT TRANSMISSION SYSTEM

9.5.4.1 Background. For support of STARLAB, the Air Force tasked NASA to procure and install an Encrypt For Transmission Only (EFTO), redundant, clear channel, 1.544 Mb/s data link between JSC and MSFC. The STARLAB project was experiencing so many slippages that NASA offered to install the system early, channelized for 52 voice and data circuits to make maximum use of the bandwidth, and pay the difference between the STARLAB configuration and the NASA configuration. The request was approved, and the JMRTS was activated in June 1990. At the end of September 1990, the Air Force announced the cancellation of its STARLAB project. NASA was permitted to retain the JMRTS system as installed and configured. In view of STARLAB's cancellation, plans to provide for EFTO protection were terminated. JMRTS is now a Nascom system used for transport of operational voice, facsimile and data signals between JSC and MSFC. JMRTS is managed by Nascom in the same fashion in which similar systems wholly external to GSFC are managed by Nascom. A simplified block diagram of the JSC-MSFC Redundant Transmission System is shown in Figure 9-11.

9.5.4.2 Configuration. The JMRTS provides JSC and MSFC with flexibility, limited only by channel cards and aggregate bandwidth, to configure a

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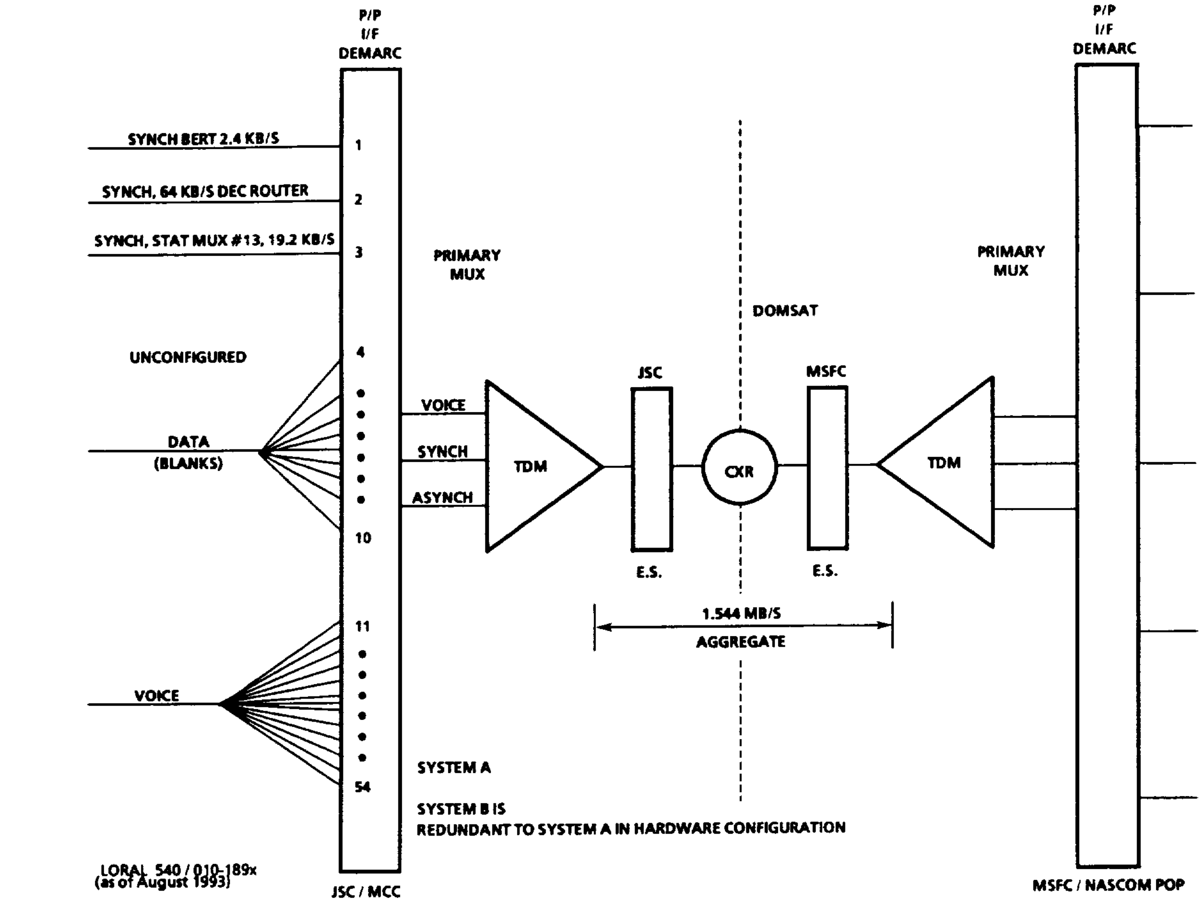

Figure 9-11. Simplified Block Diagram of the JSC-MSFC Redundant Transmission System

data transport system on a mission-by-mission basis without having to procure and turndown circuits each time a requirement change is made. Though Nascom maintains overall hardware configuration control and oversight of the signals transported by any given channel, the arrangement enables MSFC and JSC to respond rapidly and effectively to requirements that fit JMRTS. To provide this flexibility, the TDM's are channel-card configured to support the following:

a. Voice. Forty four channels are available, each digitally encoded for transmission at a line speed of 32 kb/s using the CVSD algorithm. Analog facsimile is not supported on these channels.

b. Asynchronous Data. None currently in use.

c. Synchronous Data. Three channels are currently configured and in use, one of which is allocated to the system diagnostics function. These channels are capable of supporting synchronous data and digital facsimile signals at clock rates up to 1154 kb/s. Currently, no facsimile signals are transported; the highest data rate used is 64 kb/s.

d. Redundancy. Though the JMRTS "A" and "B" systems are configured identically in hardware, channel utilization on the two systems may vary. For example, channel 3 on the "A" system is assigned to the MSFC Stat Mux 13 composite; on System "B," channel 3 is assigned to MSFC Stat Mux 14's.

9.5.4.3 Planned Changes. By the end of May, Nascom plans to transition all circuits currently transported by the JMRTS System to FTS2000. This will permit deactivation of two satellite 1.544 Mbps circuits and the associated TDM equipment.

9.5.5 LPS/KSC - MER/JSC - ROCKWELL/DOWNEY TRANSMISSION SYSTEM

9.5.5.1 General. Three distinct but closely integrated Nascom data links are employed to provide real-time transmission of Space Shuttle Orbiter launch operations information between the Launch Control Center/Launch Processing System

(LCC/LPS) at KSC, the Mission Evaluation Room (MER) at JSC, and the Rockwell International facility at Downey, California, responsible for manufacture and support of the Shuttle Orbiter Vehicle. Signals transported include synchronous and asynchronous data, isochronous (time independent) data, and voice. Functionally, these signals represent the wideband Launch Processing System, main engine and orbiter downlink data streams, other high speed sensor and processed data signals, and supporting operations voice loops and

audio circuits. This paragraph will describe the three data links in turn. An overview system diagram is provided in Figure 9-12.

9.5.5.2 LPS/KSC - MER/JSC Data Link. This link employs TDM-1258 time division multiplexers interfaced to a DOMSAT-carried 2.048 Mb/s clear channel data circuit; the link provides signal transport between KSC's Launch Control Center and JSC's Mission Evaluation Room. Primarily, LPS 772 kb/s data and shuttle related voice are transported via this link. Additionally, voice and data signals from Control Room 1 are handled. Voice and data signals are interfaced to appropriate channel cards on the TDM-1258. This link is shown in Figure 9-13.

9.5.5.3 KSC - Rockwell International Downey Data Link. Kennedy Space Center has established its Kennedy Integrated Data System (KIDS) using the Megamux Plus TDM and Megamux Transport Management System (MM/TMS) product line of General DataComm. This hardware provides KSC with the capability for easy integration and distribution of multiplexed signals at T-1 rates, and provides access to Nascom data links without requiring Nascom to engineer and supply a multiplexer each time a major data link is needed. Operating together, the MM/TMS and the Megamux Plus comprise an intelligent multiplexer node with automated network management features. Configuration management is under stored program control, but can be modified, within limits dictated by the aggregate bandwidth and the numbers and types of channel cards installed, by operator interaction with the system via a mouse or keyboard. (See Figure 9-14.)

9.5.5.3.1 Configuration. The KIDS provides the KSC-Rockwell Downey 1.544 Mb/s data link with flexibility, limited only by channel cards and aggregate bandwidth, to configure a data transport system on a mission-by-mission basis without having to procure and turndown circuits each time a requirement change is made. Though Nascom maintains overall hardware configuration control and oversight of the signals transported by any given channel, the arrangement enables KSC and

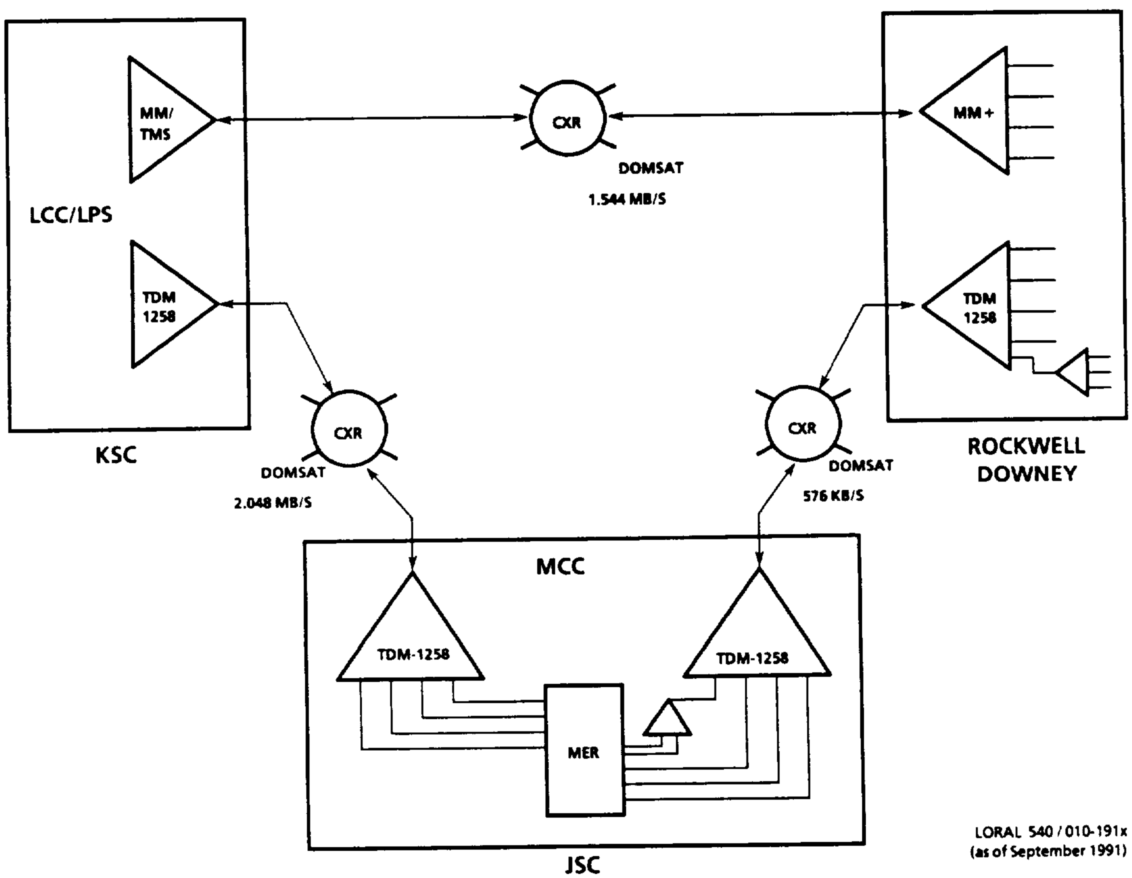

Figure 9-12. LPS - MER - Downey Wideband System

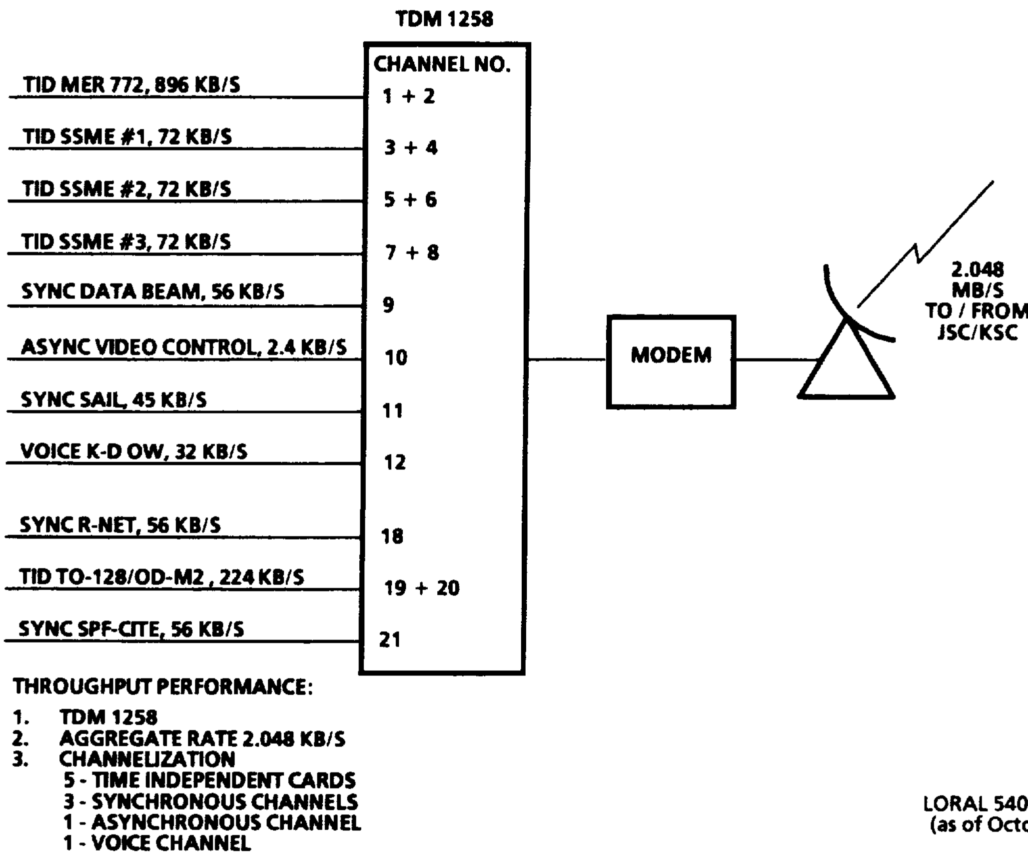

Figure 9-13. Data Flow Routing KSC LCC/LPS - JSC MCC/MER

Downey to respond rapidly and effectively to requirements that fit within KIDS. To provide this flexibility, the MM/TMS and MM/TDM's are channel-card configured to support the following:

a. Voice. Five channels are available, each digitally encoded for transmission at a line rate of 32 kb/s using the ADPCM algorithm.

b. Time Independent Data. Two channels are allocated for TID applications, one at 896 kb/s for transport of the same LPS data signal that JSC gets on its MER data link, and one at 224 kb/s to transport the 128/192 kb/s OD data stream. The TID channel provides a bandwidth-effective means of transporting isochronous data signals and other signals that are not synchronous with one of the standard clock rates supplied by the TDM.

c. Synchronous and asynchronous data channels are not currently configured on this link.

9.5.5.4 JSC-Rockwell International Downey Data Link. This link employs TDM-1258 time division multiplex equipment interfaced to a DOMSAT-transported 576 kb/s clear channel data circuit between JSC and Downey. The link currently provides eight active channels for operations voice loops and circuits, and one asynchronous 19.2 kb/s data beam circuit. Inactive, but still "in place", is a RED submultiplexer and associated encryption equipment that could interface to a 224 kb/s synchronous channel on the link. Figure 9-15 presents the configuration of this link.

9.5.5.5 Planned Changes. Nascom plans to transition the circuits on these systems to the FTS2000 backbone by October 1994. Whether the circuits between the Cape and Rockwell Downey are to be routed directly or through JSC remains to be determined.

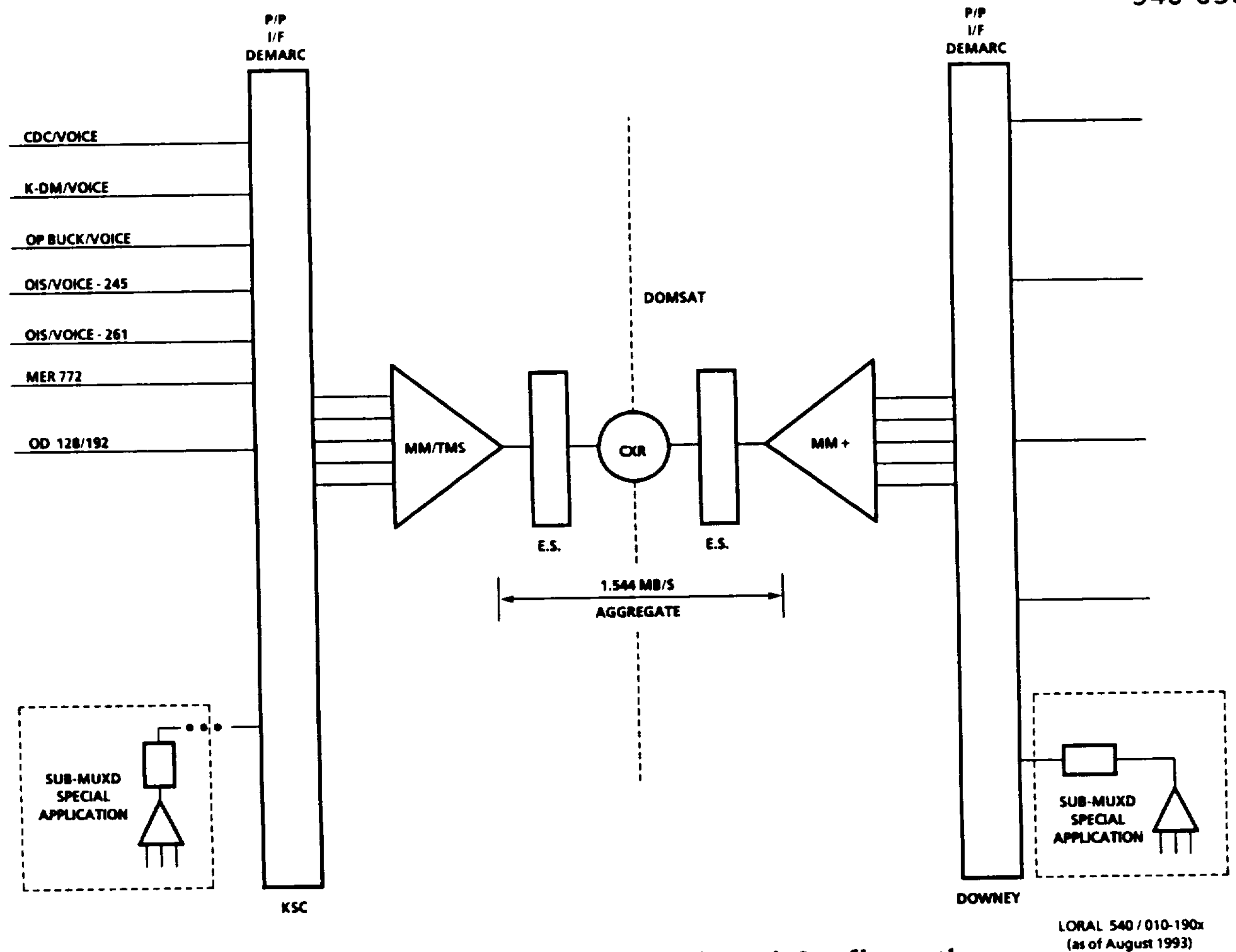

Figure 9-14. Kennedy - Downey (KIDS) Configuration

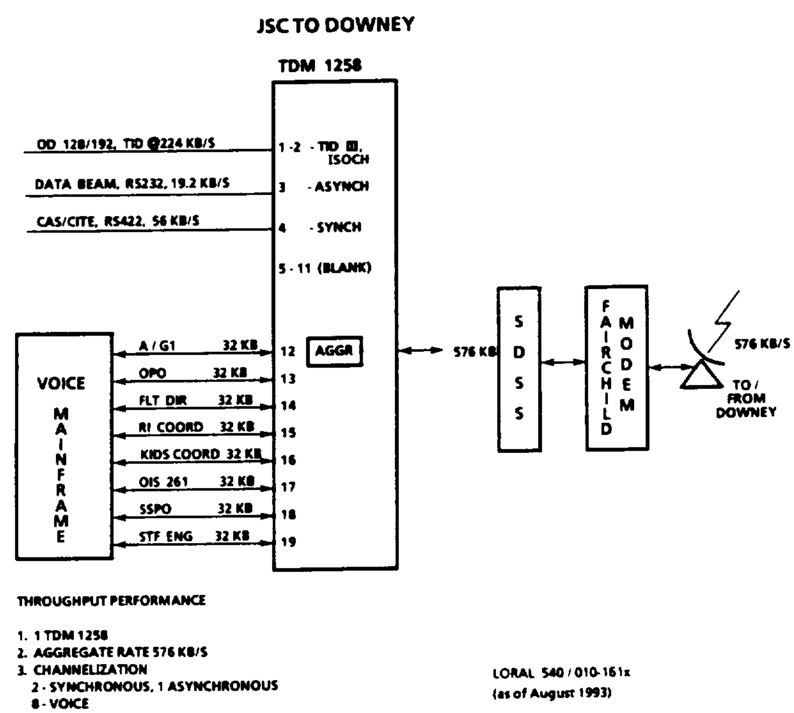

Figure 9-15. Data Flow Routing of the JSC / Downey Data Link

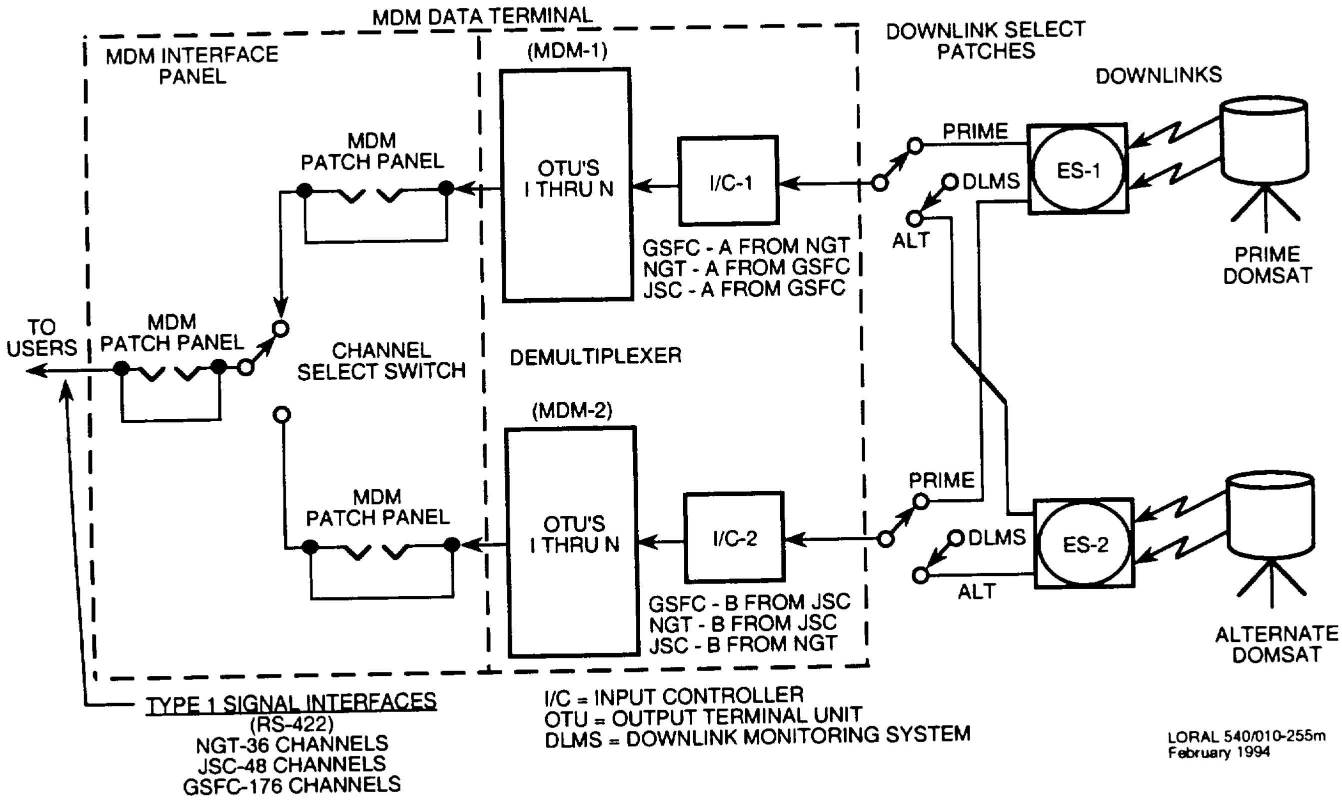

Figure 11-5. MDM - Common Carrier Configuration for Downlinking Data (Typical Site)

11.4 MDM DATA SYSTEM

Since the MDM Data System is provided with a detailed standalone description in paragraph 5.6, this section focuses on its role and capability in the BDS.

11.4.1 ROLE OF THE BASELINE MDM DATA SUBSYSTEM

The Baseline MDM Data Subsystem is designed to effectively use the low rate wideband (up to 10 Mb/s) digital transmission resource leased from the common carrier. The system creates discrete digital channels that time-share the total available digital bandwidth for high efficiency utilization of the system. The Baseline MDM Data System interfaces the CCBTS at three separate locations. These locations are the NGT, GSFC, and JSC. The prime purpose of the NGT's MDM data system is to interface the CCBTS with the TDRSS ground terminal. The prime purpose of the GSFC and JSC MDM data systems is to interface the CCBTS with associated SN user spacecraft control centers and user data capture/processing facilities.

11.4.2 BASELINE MDM DATA SUBSYSTEM CAPABILITY

The Baseline MDM Data Subsystem consists of separate data terminals at GSFC, NGT, and JSC. (See Figure 11-2.) Operationally, the baseline MDM system has the capability of 100 return link channels from NGT to GSFC, and 36 forward link channels from GSFC to NGT. The JSC station in the baseline MDM system may be operationally considered a "drop and insert" station. JSC can insert up to 30 channels into the forward link and extract up to 20 channels from the return link from NGT and GSFC. When this occurs, the total number of channels available for scheduling between NGT and GSFC is reduced by an equivalent number.

The MUX/DEMUX systems and channel capacities provided by the MDMR Data System at the respective locations are as follows:

a. GSFC:

MUX (Broadcast)	48 channels
DEMUX (NGT/STGT)	128 channels
DEMUX (JSC)	48 channels

b. JSC:

MUX (Broadcast)	48 channels
DEMUX (GSFC)	48 channels
DEMUX (NGT)	48 channels

c. GSFC/MSFC Trunk:

MUX/DEMUX	24 channels (duplex)

The above channelization represents an upgrade to the original MDM Data System capabilities. All indicated MUX/DEMUX equipment will be provided in redundancy. Connectivity is the same as per the original MDM Data System, except that spare DEMUX equipment lacking in the original MDM Data System has been added for each downlink at each location; also, a connectivity change has been implemented at the GSFC location wherein all receive channels from WSGT and JSC have been extended to the DMS in lieu of a channel termination sharing arrangement.

11.4.2.1 Data Handling. At a functional level, the baseline MDM data system consists of separately located data terminals, each controlled by a collocated common control subsystem. The data termi-

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nal controls the processing and distribution of data signals to and from multiple user or network channels. Each data terminal consists of interfaces, multiplexers, and demultiplexer equipment. The multiplexer equipment (see Figure 11-6) includes an OC rack and multiple ITU racks. The OC performs the multiplexing of individual channels into a composite serial data stream for distribution to the CCBTS. The other features of the data handling operation are described in the following paragraphs:

a. The demultiplexer equipment (see Figure 11-7) includes an IC rack and multiple OTU racks. The IC performs the demultiplexing of the composite serial data streams from the CCBTS to individual data channels for the distribution of data to the appropriate user or network channel.

b. Two sets of multiplexer and demultiplexer equipment are required for each data terminal. Each data terminal communicates with two separate distant-end data terminals. In addition to the two data terminals at NGT, there exists a third 10-channel data terminal to interface the NGT contingency, Line Outage Recording (LOR) playback equipment for discrete OTU channel playback to individual users. Additionally, the third data terminal provides a source of local test and spare equipment functions.

c. A complete data string requires the mux of a source MDM data terminal and the demux of a destination MDM data terminal. Data is input to an ITU of a source multiplexer. On a time-division basis, the ITU output is transmitted to the OC and multiplexed into a composite data stream. The composite data is routed through the CCBTS to the demultiplexer of the destination MDM data terminal. The demultiplexer's IC time division demultiplexes the composite data stream and routes the data to an associated demultiplexer OTU. The OTU distributes the data to a specific user or network channel, completing the data string. IC and OC equipment are provided with triple modular redundancy and two out of three Majority Voting Logic (MVL). ITU and OTU channel equipments are all similar modular units provided in a quantity that allows sufficient units to function as spares. IC and OC equipment are provided with common carrier modem clock and data, and are designed to operate at rates up to 10.0 Mb/s. The demultiplexer provides a decoded composite data signal available on a patch basis to users who may wish to perform the demultiplexing function internally (e.g., JSC). ITU and OTU equipment are designed to operate at data rates up to 7 Mb/s. ITU's re-

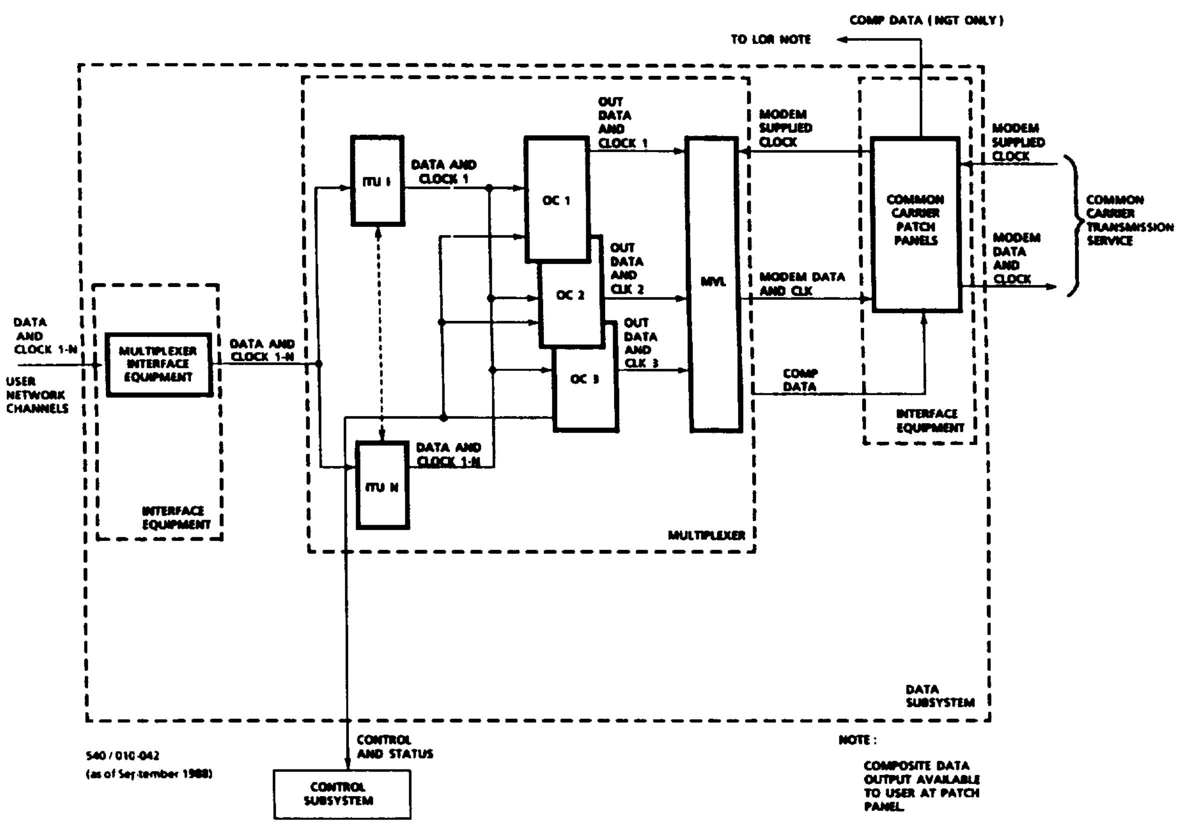

Figure 11-6. MDM Data System Multiplexer Data Flow (Typical Site)

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point-to-point or broadcast basis. The number and type of service capabilities available for each node is dependent on the quantity and type of line terminating equipment provided at the node. Data service terminating equipment is referred to as Group Interface Boards (GIB), and voice termination services are referred to as D-3 channel banks (provided in 24-channel groups). A two-way point-to-point voice circuit occupies 128 kb/s of the throughput capacity. A two-way video conference occupies 3.088 Mb/s or 1.544 Mb/s of this capacity. Wideband services of 56-, 112-, 224-, 448-, and 1,544-kb/s standard rates and variable rates between 56 kb/s and 15 Mb/s can be provided with different types of data GIB's. Lower speed digital data (up to 9.6 kb/s) can be provided on TDMA voice channels which are comparable to leased alternate voice/data (AVD) services. Figure 13-2 illustrates the nominal TDMA terminal configuration and interface capability. Each terminal is provided with patch panel facilities on both the common carrier and user interface sides. System users are responsible for the extension of circuits from their terminating facilities to the TDMA terminal back panel connectors. This link is the defined TDMA system interface.

13.2 TDMA SYSTEM DESCRIPTION

13.2.1 SYSTEM OVERVIEW

The nucleus of the TDMA system is manufactured by Commercial Telecommunications Corporation (COMTEL), Santa Maria, CA. The TDMA Network services 13 locations in the continental U.S. with a mixture of voice, data, and compressed digitized video communication circuits described in paragraph 10.2.2.2. The TDMA station at the GSFC Nascom facility in Building 14, functions as the TCC. The TCC uses a computerized network control facility manufactured by COMTEL to monitor and control the Nascom/TDMA system. This system is capable of supporting many traditional and advanced services. Nascom will operate and configure the TDMA system to fit current traffic demands until approximately 10/94.

13.2.2 SYSTEM CONFIGURATION

This paragraph describes the system configuration as a network structure of TDMA stations referred to as nodes. The configuration is illustrated in Figure 13-3.

13.2.2.1 Network Structure. The Nascom/TDMA Network System is a 15-node, fully interconnected satellite communications network that operates primarily in preassigned and dynamically reassigned modes. The system is designed to be operated and managed by a central network control computer, the TCC. Inherent capabilities of the TDMA system terminals permit distributed control in the absence of the TCC. The Nascom implementation of the COMTEL TDMA system predominantly puts to use its preassigned and reassigned Voice Frequency (VF) split-channel group interface capabilities through the addition of a Lynch model B325 type PCM channel bank. These same facilities are also used to implement high-speed (up to 9600 b/s) data service when used with an external data modem. Also available are wideband group interfaces that provide digital data services from 56 kb/s to 15 Mb/s. Video services use a standard 1.544-Mb/s wideband data channel for each video link and require the use of an externally supplied, compressed-video CODEC.

13.2.2.2 Terminal Locations. Figure 13-4 shows the location of the fifteen system terminals or nodes and system node designations. The locations of the GFE terminals and the establishment of common carrier owned and operated Earth stations in proximity, dedicated to the Nascom/TDMA Network are as follows:

a. NASA Field Centers:

(1) Goddard Space Flight Center (GSFC) (Two Nodes).

(2) Johnson Space Center (JSC).

(3) Merritt Island Tracking Station (MIL) (two nodes)

(4) Marshall Space Flight Center (MSFC).

(5) Jet Propulsion Laboratory (JPL).

(6) Ames Research Center (ARC).

(7) Langley Research Center (LaRC).

b. Other Stations/Facilities:

(1) Dryden Flight Research Facility (DFRF).

(2) Goldstone DSCC (DSS-14).

(3) Wallops Flight Facility (WFF).

(4) Vandenberg AFB (VAFB).

(5) White Sands NASA Ground Terminal (NGT).

(6) Naval Auxiliary Landing Field (NALF).

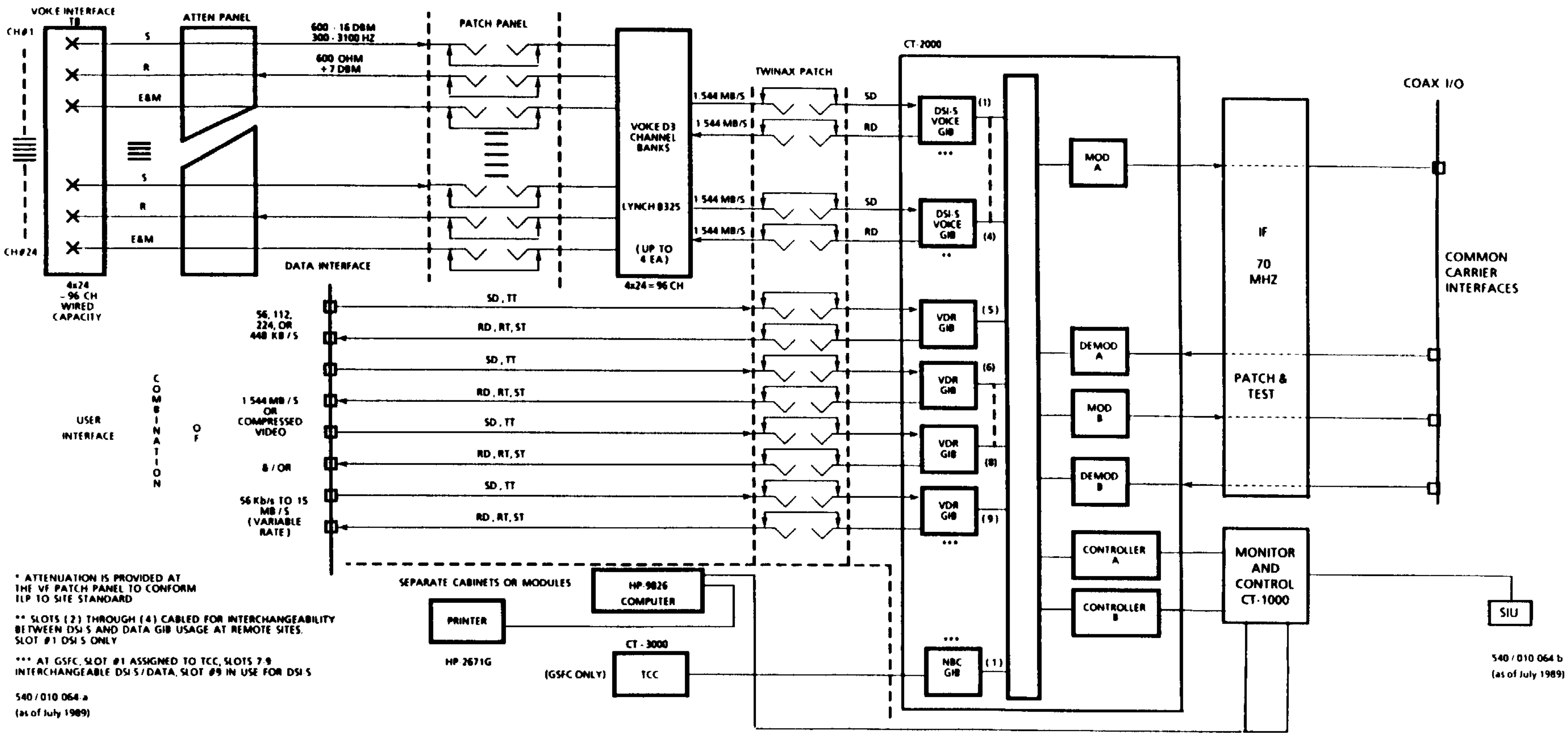

Figure 13-2. Nominal TDMA Terminal and User Interface Configuration

total of 9 GIB slots at remote sites. At the remote sites, GIB slot #1 is dedicated to a DS1S-24 GIB/voice channel bank. Slots 2 and 3 are arranged for interchangeability between DS1S or VDR GIB. Slots 4-9 are normally assigned to data GIB's. The present GSFC GIB slot capacity is also nine. At GSFC, GIB slot #1 is assigned to the TCC, referred to as the NBC GIB. Slots 7 through 9 are arranged for interchangeability between DS1S or Data GIB's, with slot #9 currently dedicated to a DS1S/voice channel bank. Slots 2 through 6 are dedicated to data GIB's.

13.2.3.2 Common Carrier Facilities. Implementation of the common carrier facilities for the TDMA Network provides a full-period lease of a GTE 36-MHz, C-band, full-transponder service. Also provided by GTE and dedicated to this network, are 14 Earth stations collocated at the 14 designated TDMA nodes. An intermediate frequency (IF at 70 MHz) interconnect facility extends to each TDMA terminal location. The common carrier facility is specified to support at 15.556-Mb/s burst data service with a 1×10^{-7} BER performance and a link availability of 99.5 percent or greater.

13.2.3.3 User Interface. The Nascom-provided TDMA terminal is considered the demarcation point for all communications services furnished by this system. Unless otherwise provided by special exception or authorization, each local site in the TDMA Network is responsible for cabling and interconnection, and maintenance of such cabling and interconnecting facilities and customer equipment that are located on the customer side of the TDMA terminal demarcation point.

13.3 TDMA SYSTEM OPERATION

TDMA system operation is fully described in NASCOP, Volume III. Excerpts from this document are included here to round out the description of TDMA as a Nascom system.

13.3.1 OVERVIEW OF TDMA SYSTEM OPERATION

The Nascom/TDMA system consists of communications equipment that accepts continuous voice, data, facsimile, and digitized compressed video signals from the end user terminal. The system converts signals into high-speed burst transmissions to the satellite. The system also receives burst signals from the satellite, converts these signals to the user's format, and delivers continuous data and voice channels to the local terrestrial interfaces. The other aspects of the system operation are described in the following paragraphs:

a. To accommodate the wide range of voice, data, facsimile, and video transmissions, modular GIB's are used in the system. The GIB's process the user signals as digital information and then, by means of a modulator, convert the digital signals into analog signals suitable for transmission in the satellite. Conversion is accomplished by modulating a 70-MHz baseband signal (which then becomes the output of the TDMA system) to the Domsat upconverter equipment.

b. Signals received from the satellite are fed from the downconverter to the system's demodulator. This signal is converted into digital information, which is then transferred to the voice and data GIB's.

c. The TDMA system is provided with test panels and patching capabilities necessary to substitute for malfunctioning components. Test and monitoring equipment is also provided to check for proper operating parameters and to allow isolation of malfunctions within the system.

d. A monitor and control subsystem consisting of an HP-9826 desktop computer and a thermal printer, provides the operator with the capability to define and monitor various analog and digital points within the TDMA system.

e. The TCC software provides ready access and displays for an operator to enter, edit, and store selected network parameters. The software performs limit checks and requires operator acknowledgment on selected operations to eliminate the possibility of inappropriate network and node parameters and improper network operations. The software also provides the capability to systematically distribute and command the execution of network parameters and BTP's generated from circuit connectivity plans.

13.3.2 AUTHORIZED CONNECTIVITY SERVICES

Services accommodated on the TDMA Network are termed "authorized connectivity," which are those service requirements approved through formalized internal Nascom procedures and selectively assigned to this element of Nascom transport resource and unique capability. It is intended that services on this system not be "dedicated," but preassigned and dynamically reassigned through scheduling using TCC capabilities. The system is scheduled for a weekly period no less than 48 hours in advance, and updated daily as needed, by the Nascom Network Scheduling Group (NNSG), based on requests from the NCC and/or other designated sources authorized to schedule the approved services. (Refer to NASCOP Volume III.)

13.3.3 TDMA SYSTEM MANAGEMENT

The TDMA Network is governed by a multi-faceted management system. Each level of management has separate and distinct responsibilities that follow the flow from review of communications requirements to implementation of circuit connectivity.

13.3.3.1 Configuration Control. Configuration changes in the TDMA Network that affect the systems of other organizations are to be processed through the CCB. Each proposed configuration change is evaluated in reference to: design, performance, cost, schedule, operational effectiveness, logistics, training, maintenance, and interfaces with associated systems. Configuration responsibility assumed by Nascom Code 542 includes all logical circuit connectivities as well as the physical GIB population and assigned addresses.

13.3.3.2 Communications Manager. The NASA Communications Manager (COMMGR), Head, Operations Management Branch, or his designated representative, is responsible for management of the operation, maintenance, and scheduling of the TDMA Network system. The Head, Operations Management Branch is the authority for assignment of services on the TDMA Network.

13.3.3.3 TDMA Control Center. All TDMA operational activities are normally monitored and controlled by the TDMA control center, which is the Nascom/TDMA equipment at GSFC. The TCC provides the following operational capabilities:

a. Network and nodal parameters entry and editing.

b. Network and nodal reconfiguration.

c. Network connectivity planning.

d. Network connectivity reconfiguration.

e. Network troubleshooting and fault isolation.

13.3.4 SYSTEM CAPACITY

The modular architecture of the Nascom TDMA terminal permits each service center or node to be configured according to individual communications needs. The TDMA system capacity is divided into three categories as follows:

a. Design Capacity. This is established primarily by the COMTEL TDMA system architecture.

b. Wired Capacity. The TDMA terminals are prewired for a fixed channel capacity, which establishes the extent to which the terminal hardware may be expanded without radical engineering change.

c. Authorized Capacity. This is the capacity authorized by Nascom based on user requirements, requests, and other considerations.

13.3.5 TDMA PERFORMANCE STANDARDS

Nascom/TDMA transmission parameters and interface considerations parallel those previously established and accepted by Nascom for its existing voice and data transmission facilities. Similarly, system service performance and availability should meet or exceed established Nascom parameters for comparable services as provided by traditional means.

13.3.6 TDMA TRANSITION

As the TDMA project draws to a close, a plan is being developed for transitioning the connectivity provided by the TDMA system to new carriers. FTS2000 services provided by AT&T, under three contract modifications, have been contracted to meet the telecommunications requirements of Nascom. FTS2000 will be utilized to the degree possible to meet the requirements currently satisfied by the Nascom TDMA system. Reference Section 17.4.9 for additional information in the FTS2000 implementation project.

Table 15-1
DSN Station List

LOCATION	IDENTIFICATION / DSS		ANTENNA DIAMETERS (meters)	REMARKS
GOLDSTONE, CA (GDSCC)		GCF-10	---	AREA COMM CENTER
		SPC-10	---	SIGNAL PROCESSING CENTER
	ECHO	DSS-12	34	
	VENUS	DSS-13	34	R&D STATION
	MARS	DSS-14	70	
		DSS-15	34	
		DSS-16	26	
		DSS-17	9	
		DSS-24	34	FUTURE BWG (1993)
CANBERRA, AUSTRALIA (CDSCC)		SPC-40	---	PROCESSING CENTER
	WEEMALA	DSS-42	34	
	BALLIMA	DSS-43	70	
		DSS-45	34	
	TIDBINBILLA	DSS-46	26	
		DSS-34	34	FUTURE BWG (1994)
MADRID, SPAIN (MDSCC)		SPC-60	---	PROCESSING CENTER
	ROBLEDO	DSS-61	34	
	ROBLEDO	DSS-63	70	
		DSS-65	34	
		DSS-66	26	
		DSS-54	34	FUTURE BWG (1994)
MERRITT ISLAND, FL		MIL-71	9	PRELAUNCH STATION
PASADENA, CA	NOCC		---	NETWORK OPERATIONS CONTROL CENTER
		GCF-20	---	
		CTA-21	---	

(as of September 1992)

BWG = Beam Waveguide

DSCCs are located within latitudes of 45 degrees north or south of the equator. All DSCCs operate at S-band frequencies: 2110-2120 MHz for Earth-to-spacecraft transmission and 2290-2300 MHz for spacecraft-to-Earth transmission. All DSCCs are equipped with X-band downlink capability.

b. Compatibility Test Area. CTA-21 at JPL has all the essential characteristics of the standard deep space stations adaptable to a 34- or 70-meter configuration except that CTA-21 has no tracking antenna. CTA-21 is used during spacecraft system tests to establish compatibility with the DSN of the proof test model and development models. CTA-21 has real-time data interfaces with the GCF-20 communications center via voice and data communications. CTA-21 is also used by mission operations for DSN ground data system compatibility testing and training. Also available for use in ground data system compatibility testing is the Goddard Compatibility Test Van.

c. Merritt Island Station. The DSN facility at STDN MIL is identified as MIL-71. This station provides selected spacecraft telemetry and command capability during certain preflight testing at KSC. In addition, the facility is used for DSN compatibility testing with the spacecraft to be supported by the DSN.

15.2.1.2 Network Operations Control Center. The NOCC provides centralized operational and configuration control of the DSN and monitors and analyzes DSN real-time performance. The NOCC interfaces operationally with various deep space projects and their respective mission control and computing centers at JPL and Remote Mission Operations Centers (RMOC) located elsewhere. The Network Operations Control Area (NOCA), Network Data Processing Area (NDPA) and GCF-20 of the NOCC are located in Building 230. The NOCC computers are not in series with the flow of data between the DSS and the JPL Mission Control and Computing Center (MCCC)/ RMOC, but rather the NOCC accepts a parallel feed of the DSS data. The NOCC electrical interface is with the GCF-20 Central Communications Terminal (CCT).

15.2.1.3 Ground Communications Facility. The following paragraphs describe the GCF.

a. GCF Capability. The GCF of the DSN provides ground communications capabilities necessary for support of spaceflight operations. The GCF consists of long-haul leased circuits; terminal equipments; switching facilities; and personnel required for the ground transmission, reception of data, recording, and control signals between the DSCCs, the NOCC, and the project mission control and data analysis locations (POCCs/RMOCs).

b. GCF Design and Engineering. The GCF is designed and engineered to function as a multimission entity and is configured and operated to meet DSN and mission-dependent requirements. The DSN arranges with Nascom to provide all operational long-haul circuits and associated switching and data transmission facilities (refer to paragraph 15.2.5). The GCF is controlled by the GCF-20 CCT, a portion of which is allocated to, and functions as, the Nascom West Coast Switching Center (WCSC). The CCT is located at JPL in Building 230 and includes communications terminal equipment, technical control, patch, test, switching, and monitoring capabilities.

c. Digital Communications Subsystem. This system in the JPL/GCF performs internal routing of data blocks in the CCT at JPL via the Error Correction and Switching (ECS) computer and/or the CCP/EUG computers.

15.2.2 JPL FLIGHT PROJECT SUPPORT OFFICE/ MCCC INTERFACE

Using the MCCC at JPL, project personnel command and control spacecraft in deep space and receive telemetry and radio metric data via the DSN GCF. The facilities of the MCCC are organizationally under the Flight Project Support Office (FPSO). Data flow interfaces also exist between MCCC and the TDRSS at White Sands, as well as between JSC and MCCC. TDRSS and STS interfaces will nominally be via the Nascom WCSC at JPL. JPL also provides management and support (tracking and data acquisition) for non-DSN space flight projects. This support is accomplished by the DSN 26-meter station or the TDRSS. The CCT accommodates both the DSN interface (GCF-20) and the Nascom WCSC interface to the MCCC, RMOCs, and RICs – as well as the WCSC interface with the WR launch facilities at VAFB.

15.2.3 MISSIONS SUPPORTED ON THE DSN/GCF

The DSN currently supports tracking and data acquisition operations related to Earth orbiting and deep space satellites. Table 15-2, SN Emergency Support Mission Set, Table 15-3, Deep Space Missions, and Table 15-4, Cooperative and Near-Earth Mission Set summarize DSN support to these spacecraft. Task RTOP-60, Very Long Baseline Interferometry (VLBI) is also being supported. The DSN/GCF and its Nascom-furnished ground communications facility elements, described later in this document, have an ongoing support requirement for these missions. Future DSN mission support commitments and requirements are summarized in Appendix C.

15.2.4 DEEP SPACE MISSION LOW RATE DIGITAL TELEVISION COVERAGE

During the periods of encounter, landing, and on-surface activities, images are transmitted digitally on a real-time or delayed basis from the planetary spacecraft to the DSCCs. It is anticipated that during these periods, as was done for the Viking and Voyager-Jupiter/Saturn and other missions, Nascom will provide slow-scan TV channels (9.6 k/bs) from JPL to NASA HQ, GSFC, and the cognizant research center for relay and distribution of processed image material to meet the high interest in events at that time. Requirements will be established for TV coverage of these phases during Mission encounters.

15.2.5 NASCOM SUPPORT FOR DSN

Nascom supports the DSN by providing dedicated circuits from each DSCC to the JPL GCF. In addition to the Nascom support services described in paragraph 15.1.2, other Nascom-provided support services are described in the following subparagraphs.

15.2.5.1 Support for DSS's. DSCCs at Canberra, Australia, and Madrid, Spain, have real-time data interfaces with the Nascom Network and are connected with JPL's GCF-20 CCT via voice, TTY, and data communications facilities. The Goldstone GCF-10 communications center has TTY, voice, high-speed data, and wideband ties with GCF-20 via two GEAM 1.544 MB/s T-1 systems, and one backup alternate voice/data circuit via Continental Telephone of California Company (CTCC) and PT&T facilities. From the GCF-10 communications center, the circuits are switched to the DSS's. The Goldstone communications capabilities are shown in Figure 15-2. Communications capabilities to Europe and Australia are shown in Figures 15-3 and 15-4 respectively.

15.2.5.2 DSN Circuit-switched Network. All Nascom-provided data circuits used to support the DSN are circuit switched. Wideband and high-speed data channels are switched at Nascom switching centers and GSFC technical control by

Table 15-2
SN Emergency Support Mission Set

SPACECRAFT	COMMAND RATE (kb/s)	TELEMETRY RATE (kb/s)
Landsat - 4 and 5	.125	1.0 Real -time 24.0 Playback
Shuttle	32 or 72	96, 192, 1024
TDRS-1, 3, 4, 5, and 6	.125	2.0
ERBS	1.0	1, 1.6, 12.8, 32, 128
HST	1.0	.5, 4, 32, 1024
GRO	.125 or 1.0	1, 32, 512
UARS	.125 or 1.0	1, 32, 512
EUVE	2.0	1, 32, 256, 512, 1024
TOPEX/Poseidon	2.0	16, 512, 768, 1024

(as of February 1994)

Table 15-3
Deep Space Missions

SPACECRAFT	COMMAND RATE	TELEMETRY RATE
International Cometary Explorer (ICE)	256 b/s	16, 32, 64, 128, 256 b/s
Pioneer 6, 7, 8	1b/s	8, 16, 64, 256, 512 b/s
Pioneer 10, 11	1b/s	16 to 1024 b/s
Voyager 1, 2	16 b/s	40 b/s to 7.2 kb/s
Magellan	7.8125 or 62.5 b/s	40, 1200 b/s; 115.2, 268.8 kb/s
Galileo	32 b/s	10 b/s to 134.4 kb/s
Ulysses	15.6 b/s	64 b/s to 8.1 kb/s

(as of February 1994)

Table 15-4
Cooperative and Near-Earth Mission Set

SPACECRAFT	COMMAND RATE (kb/s)	TELEMETRY RATE (kb/s)
Astro-D	N/A	1.024, 4.096, 32.768 Real-time 262.144 Playback
DSPSE	1.0	.125, .250, .5, 1, 2, 8, 64, 128
GEOTAIL	N/A	16.4 or 65.5 Real-time 65.5 or 131 Playback
NIMBUS-7	1.0	4, 800
SAMPEX	2.0	4, 16, 900
Solar-A	N/A	1.024, 4.096, 32.768 Real-time 131.072, 262.144 Playback

(as of February 1994)

patch panel facilities. JPL schedules Nascom circuitry directly with Nascom on a weekly basis. There are limited message-switching requirements for DSN data routed through GSFC technical control. The central communications terminal operated by the DSN/GCF at JPL extends and distributes channels locally at JPL. The wideband data circuits are configured as shown in Figures 9-7 and 15-3.

15.2.5.3 Nascom Monitoring Support. The data monitoring support provided by Nascom to DSN

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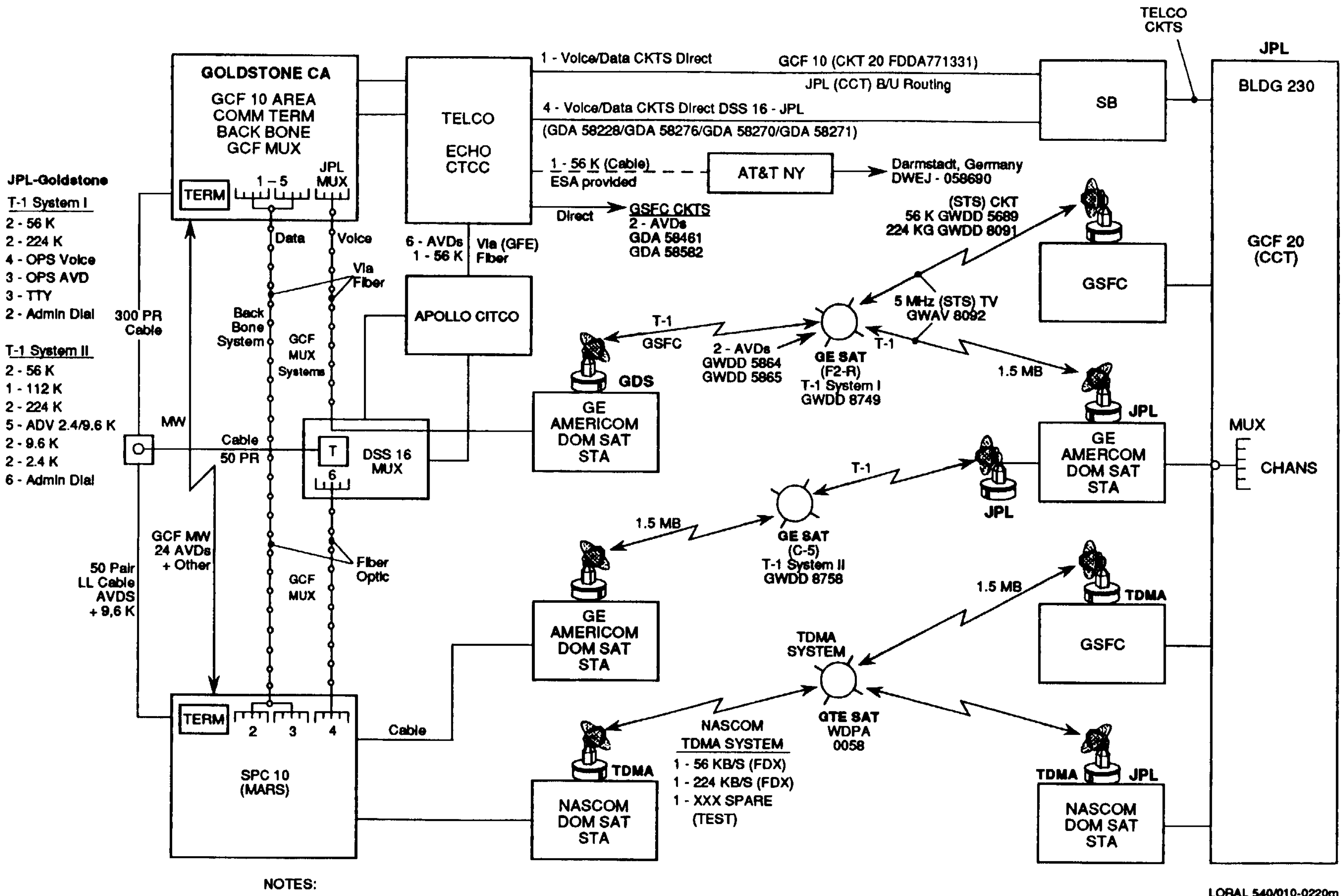

NOTES:

⚠1 During critical support periods, current DSN-Nascom planning calls for the (Goldstone-GSFC-JPL) Nascom TDMA system to provide JPL-Goldstone failure mode B/U, 1-56 K and 1-224 K WBD CKT ALT route on R/T callup basis.

Figure 15-2. GDSCC Communications Capabilities

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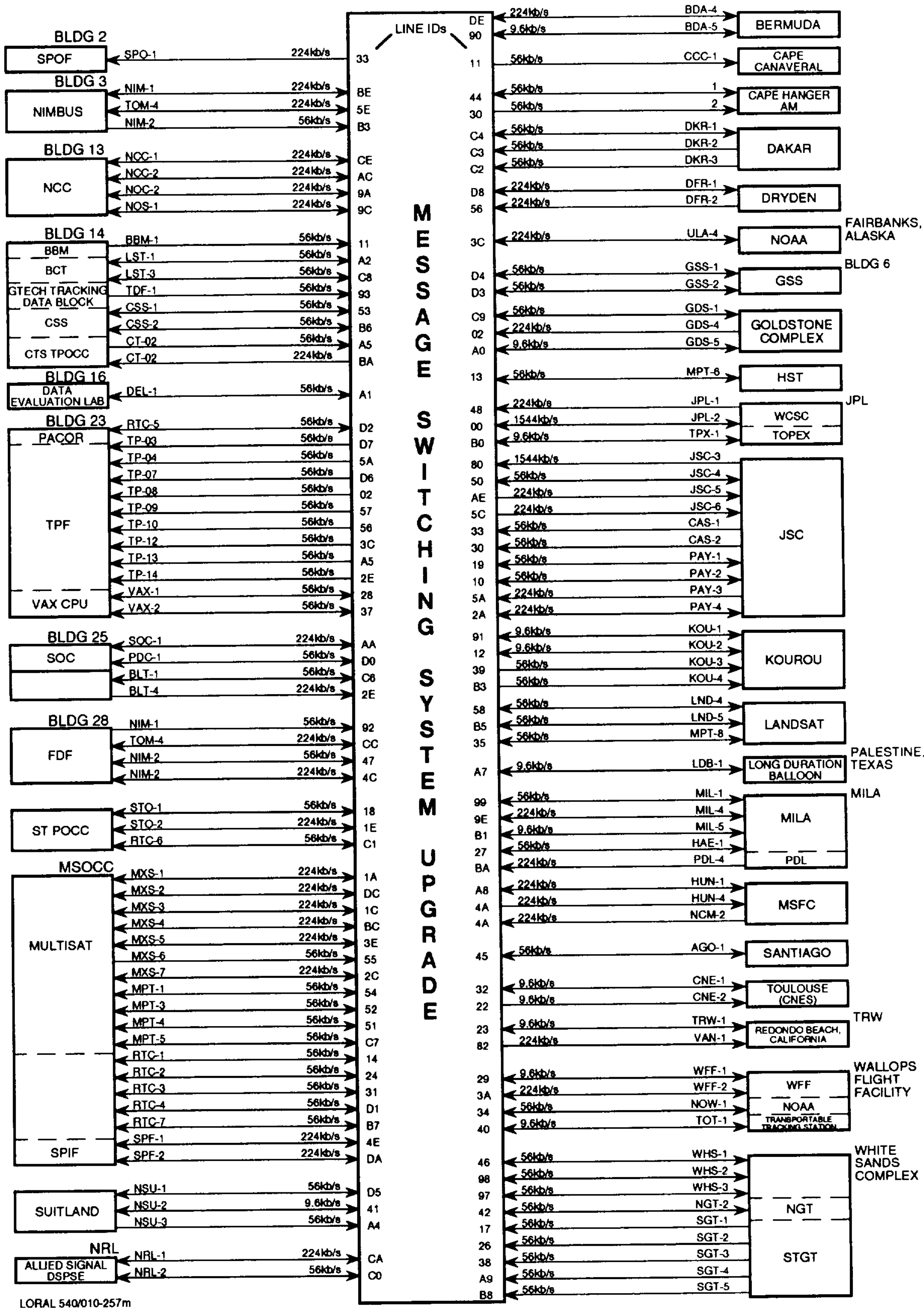

Figure 15-20. GSFC Local and Remote User MSU Interface for GN/NCP-related Operations

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multiple sources and this has conserved the number of interfaces required in the MSU.

f. Throughput Data Interfaces. With the advent of throughput (4800 A block) data handling from the GN and the 26-meter sites, there has been a move away from multiplexed data interfaces, to a greater number of discrete interfaces capable of handling only single-stream (non interleaved, single source at a time) data. Such interfaces are usually dedicated to a respective mission and data type. The use of throughput data interfaces has increased the required number of MSU dedicated interface requirements into the Control Centers (e.g., Multisat) and into the Sensor Data Processing Facility (e.g., the Telemetry Interface Preprocessor-into-TELOPS, or TIPIT), a throughput data handling facility.

g. GN/SN Throughput Data Time-sharing of Interfaces. Certain user throughput interfaces are time shared between the GN message switched sources and the SN source (i.e., the NGT/MDM system). The user interfaces are manually switched in the DMS [i.e., shifted between the MSU source, or an SN (MDM channel) source]. These transferable interfaces are identified in Figure 15-20. This transfer of sources is required for missions that are currently supported in a transition period, on both the GN (including the 26-meter Subnet) and the SN.

15.5.6 OTHER MAJOR STDN USER INTERFACES AT GSFC

Various other major STDN user and network support facilities route their data via the MSU. This includes the network scheduling and status data for the NCC, network and spacecraft checkout data to and from simulators, contractor locations, etc. However, the GSFC Flight Dynamics Facility interface with the MSU designed for handling metric data is unique.

15.5.6.1 Flight Dynamics Facility Interface. The FDF interface (see Figure 15-21) is described in the following paragraphs:

a. Data Received. The FDF receives orbital tracking data for spacecraft supported by the GN. The FDF also receives data from other NASA and DoD-ER and -WR trackers to provide launch and landing trajectory data for the STS and other missions. FDF also receives Delta and Centaur launch vehicle guidance data from the GN and vectors from orbit computation facilities at other centers (i.e., JSC and JPL). Tracking data from the SN for spacecraft supported by the SN and for TDRSS spacecraft from the BRTS, are also received in the FDF. Additionally, the FDF receives BRTS telemetry data from WSGT, as it performs a housekeeping function for the BRTS.

b. Data Generated and Transmitted. FDF functions include the generation and transmission of acquisition data to the GN and SN – and also the supply of scheduling aids to STDN controllers and the payload controllers using the GN and SN. It also transmits ephemeris data to its correspondents, vector data to other centers and networks, and BRTS scheduling requests and acquisition status data to the SN/NCC.

c. Received Data Interface. Figure 15-21 illustrates the complex interface that exists between the Nascom MSU and interfacing elements of the FDF, for the receipt and transmission of the various types of data. The following describes each FDF/Nascom element interface.

High-speed launch and landing trajectory data received on 2.4 kb/s circuits is routed through a Tracking Data Blocker, then to the MSU, and to the FDF over 224 and 56 kb/s lines for real-time processing. All data received by the Nascom MSS in 4800-bit blocks is delivered via the MSU 3760 224-kb/s interface to the Nascom Interface Systems (NIS) elements of the FDF. These include high-speed Tracking Data Processor System (TDPS) data, launch vehicle guidance data, TDRS/BRTS tracking data, BRTS telemetry data, Intercenter Vector (ICV) data, and NCC scheduling data.

d. Transmit Data Interface. On the transmit side (Figure 15-21), the FDF transmits acquisition data for the following:

(1) Nonreal-time operations via 300-baud ASCII and TTY interfaces to the Nascom C-2100 system for store and forward distribution.

(2) For real-time operations, the FDF interface also includes transmission of FDF-generated 4800-bit blocks with implanted ASCII Coded TTY acquisition data messages, via 56 kb/s interfaces directly to the 3760 system from the NIS system.

(3) FDF – generated 4800-bit blocks for SN operations are transferred via these same interfaces to the MSU 3760 system , for routing to FDF correspondents. These include SN scheduling aids, SN acquisition data, BRTS scheduling requests, payload state vectors, and ICVs.

15.5.6.2 Interbuilding Data Transmission System (IBDTS). The IBDTS extends the Nascom wideband data systems locally at GSFC to major STDN data users.

Figure 15-22 illustrates the IBDTS configuration.

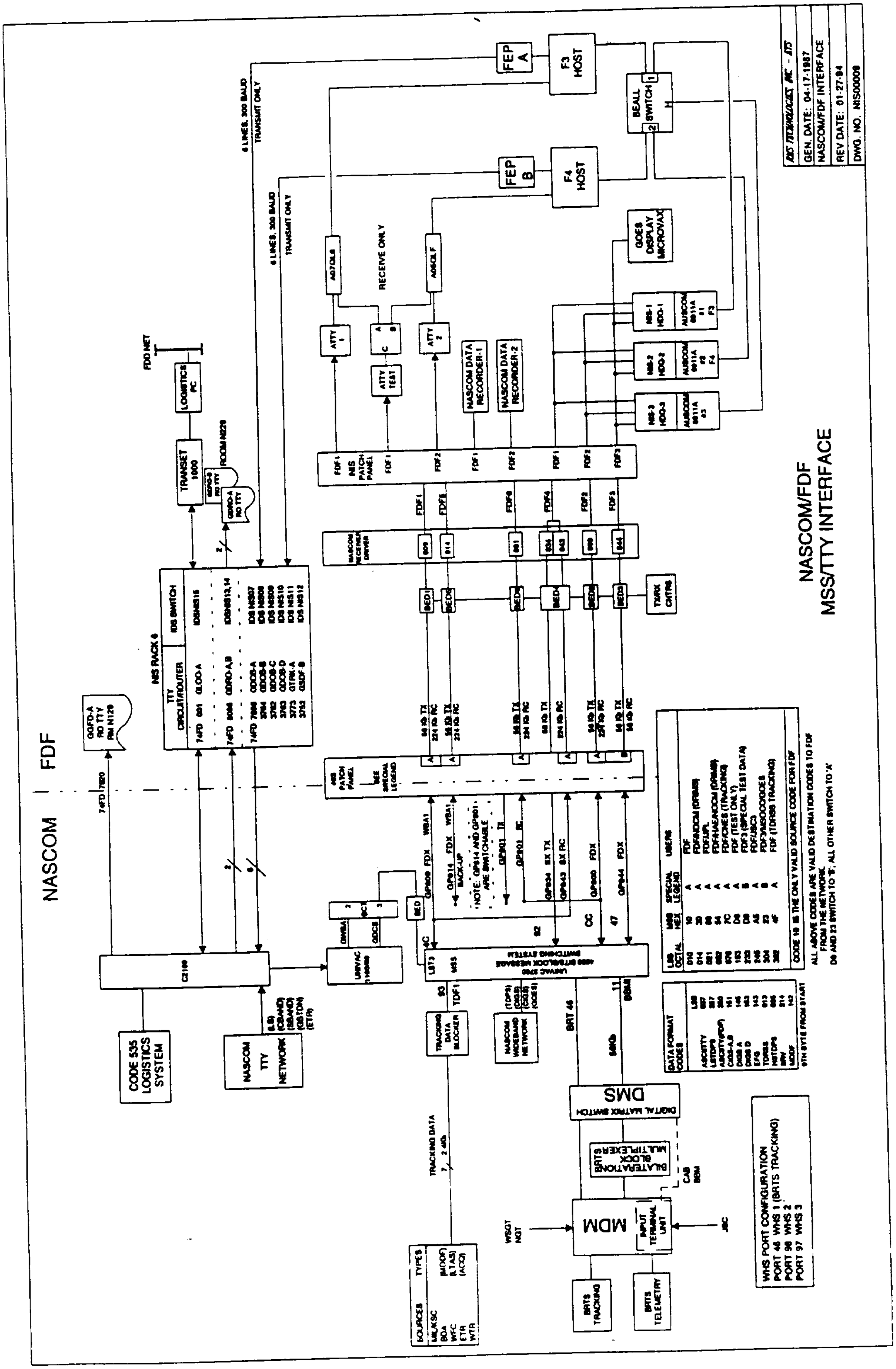

Figure 15-21. Nascom / FDF Functional Interface

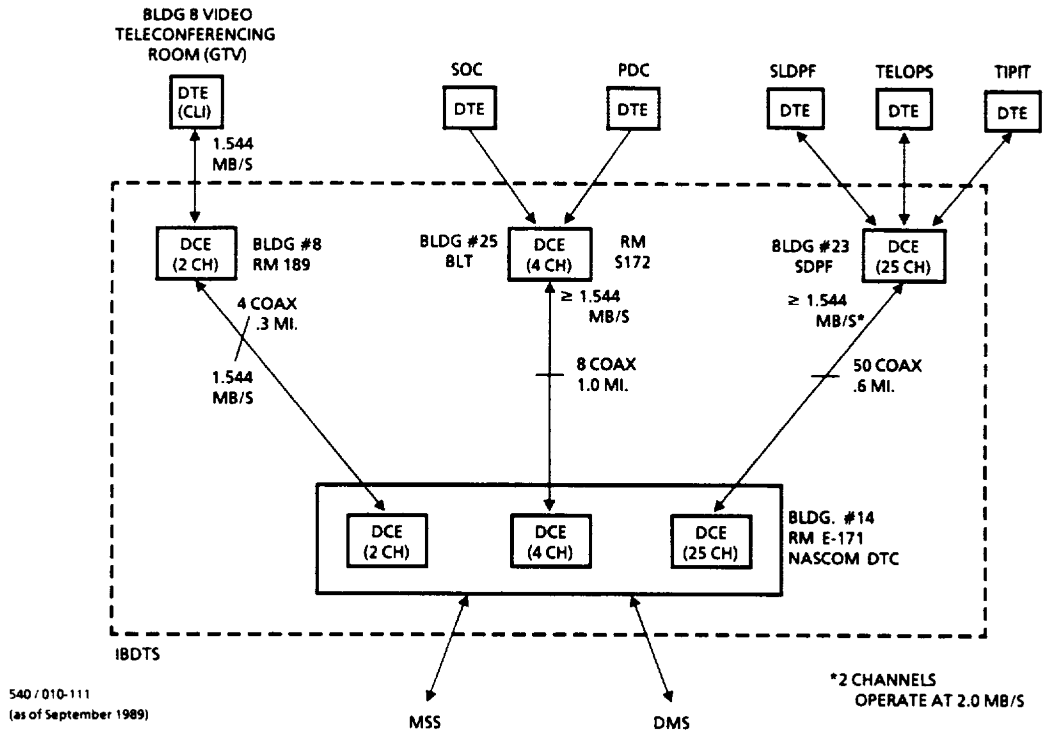

Figure 15-22. Interbuilding Digital Transmission System Configuration (IBDTS)

a. Original Building 23 System. The IBDTS #1 is an original Nascom-provided GSFC local wideband data transport system installed in 1977 to extend spacecraft sensor data, principally from the Nascom Wideband Data Tech Control Facility, in Building 14 to the SDPFs of the Information Processing Division (IPD) in Building 23. This system provides a DCE installation at each location capable of operating 25 channels in each direction. The DCE equipment chassis were designed and furnished by Computrol Corporation. The transmission medium for this system consists of 50 coaxial cables running 0.6 miles between the two buildings. As designed, each channel is capable of independently transmitting NRZ-L data and external clock signals at any rate up to 1.544 Mb/s. These are distributed at the distant end to local DTE designed to RS422/449 interface specifications. The DCE for each channel uses FM modulation of an 8.5-MHz RF carrier to transmit simultaneous clock and data signals over a single interbuilding coaxial cable. The DCE can also supply internally generated clock signals at standard rates of 7.2, 9.6, 56, 224, 1344, and 1544 kb/s, when required, to user's DTE.

b. Upgraded System. From 1983 to 1984, a number of original Computrol channel cards were replaced with new channel cards built by Astrotronic. Two of the channel cards and coaxial cables (selected for optimum characteristics), are used to support 2.0-Mb/s Spacelab data for extension into the SLDPF in Building 23. Most channels of this system terminate spacecraft sensor telemetry data into the TELOPS and TIPIT systems in Building 23. In Building 14, Room E171, the TELOPS channels are extended to the MSU and the TIPIT channels are extended to the DMS for network routing and configuration.

c. Added Systems. Two additional IBDTS systems have been provided by Nascom:

(1) IBDTS #2, a four-channel system installed in 1985 to Building 25, extends the SOC and the NDC over eight coaxial cables running approximately 1 mile to Building 14.

(2) IBDTS #3, a two-channel system installed in 1986 to extend 1.544 Mb/s compressed video digital signals between the Nascom Building 14 facility and the GSFC TV (video teleconferencing) Center in Building 8, over four coaxial cables running approximately 0.3 miles.

d. Transition of Channels. All IBDTS channels are expected to be transitioned to the Interbuilding Communication Link Upgrade (ICLU) by the end of calendar year 1994.

15.5.7 INTERBUILDING FIBER-OPTIC TRANSMISSION SYSTEMS AT GSFC

15.5.7.1 Overview. Fiber-optic facilities support independent projects and systems requiring intra- and interbuilding transport fiber optics, which may be grouped and considered in two areas of distribution:

a. Facilities linking systems in the complex of Buildings 23 and/or 25 with Building 3/14. The link from Buildings 25 to 14 is approximately 6000 ft.

b. Facilities linking systems within the Buildings 13, 13A, and 13B complex and Building 14, which are related to ground system security enhancements.

The following identifies, in the order presented, these fiber optic-supported systems, their purpose, capabilities, and status.

15.5.7.2 Interbuilding Fiber-Optic Facilities, Building 14 to Buildings 23 and 25. An optical fiber system has been implemented between Buildings 14 (Nascom Tech Control area) and 23 (Room C110) and between Building 14 and 25 (Comm Center, Room S172). Interbuilding ten-fiber cables support two independent systems. Two of the 10 fibers are allocated in each cable to the Interbuilding Data Dissemination Resource (IBDDR) System, and eight fibers in each cable are allocated to a McDonnell Douglas (MDAC) fiber-optic system. The FO configuration is illustrated in Figure 15-23.

15.5.7.3 Interbuilding Data Dissemination Resource (IBDDR) System. This system was implemented to augment the IBDTS. Some existing and planned local GSFC wideband user interfaces have been transferred from the IBDTS to the IBDDR system. The IBDDR also anticipates future requirements as they are being defined. The FO configuration is described as follows:

a. For the IBDDR, Northern Telecom DMT-300 fiber-optic terminals provide a T3 (44.736 Mb/s) digital transmission system, full duplex, using a fiber-optic FMT-45 transceiver over a cable pair between Building 14 and each of the two other building locations. This system provides 28 T1 (1.544-Mb/s) channels to each of these locations. Two T1 channels in each of these systems are in use and are provided with Avanti Ultramux terminals, each of which submux 14 user channels that provide an aggregate composite at the T1 rate. The Ultra Mux channels provide RS-442/449 interfaces for synchronous data rates from 2.4 kb/s to 512 kb/s in 800 b/s steps. Each system is also capable of 26 additional T1 bipolar user channels. When and if equipped with Avanti 2439H Local Area Data Distribution (LADD), each channel will support a 1.544-Mb/s RS-422/449 user interface.

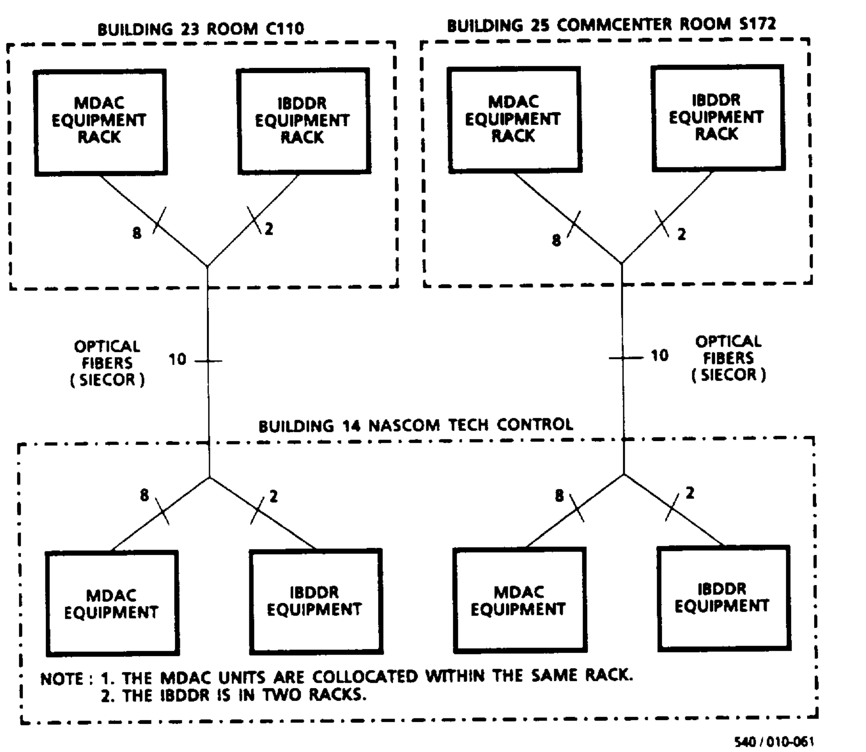

Figure 15-23. Interbuilding Fiber Optic Facility Configuration

These configurations therefore are capable of up to 54 possible user channels.

b. Overall system configuration (data rates, number of channels, and channel connections) is controlled and monitored by the Building 14 Nascom technical control operator, who controls channel assignments from a local control terminal. Once the system configuration is established, data transfers between users are processed and routed automatically. During normal operation, system status messages and modification commands are exchanged among the terminals in a manner completely transparent to the users. For maintenance purposes, the fiber-optic terminals at Buildings 23 and 25 may be configured locally by connecting a terminal directly to the equipment cabinet.

c. All channels of the IBDDR system are currently assigned. Any changes in requirements for IBDDR service are coordinated through Code 542.1.

d. Transition of Channels. All IBDDR channels are expected to be transitioned to the Interbuilding Communication Link Upgrade (ICLU) by the end of calendar year 1994.

15.5.7.4 McDonnell Douglas (MDAC) Fiber Optic System. The MDAC fiber-optic communications system also connects Buildings 25 and 23 with Building 14. The system provides four full-duplex fiber-optic paths: one prime, one backup, and two unused. The implemented link is capable of operating at up to 100 Mb/s. The system has been reconfigured by adjusting two links to operate at 96 Mb/s. The system has been provided for test and development purposes and for possible application for high data rate requirements leading into the Space Station era. One utilization transmits HDDR data tapes electronically from Building 25 via Building 14 to the SLDPF in Building 23 at 48 Mb/s. The user has implemented a Model 736 Rate Converter Unit necessary for this application. Although in use, the 96-Mb/s link has not yet been fully accepted as operational.

15.5.7.5 MODNET System. Fiber optic cables are installed within and between Buildings 3/14, 23, and 28 to support a backbone (interbuilding) FDDI ring, a local (intrabuilding) FDDI ring, and four interbuilding HYPERchannel trunks.

Fiber optic connectivity will soon be provided to Building 2 in support of Code 510's SPOF and XTE, to Building 25 in support of Code 510's Simulation Operations Center (SOC), and to Buildings 20 and 29 in support of XTE.

15.5.7.6 Buildings 13 and 14 Complex Fiber Optics. Several systems are related to the enhanced security development in the Building 13/13A/13B/14 complex serving the NCC and Nascom systems. Elements of these systems include the following:

a. MSU/CSS-Related Security Enhancement. This system provides a fiber-optic link at 56 kb/s between the NCC (Building 13, Room 141) and the MSU/CSS Distribution Bay (Building 14, Room E-171). Presently established and operational are fiber-optic multiplexed TTY links between the MSU/CSS rack and the Building 13B cryptographic area, for transmission of advanced schedules for the Space Network (TDRSS) ground systems. Also implemented are internal CSS-related Nascom links between: (1) the Communications Terminal Modular Controller (CTMC) interface and the Operator Interface Console, (2) the MSU/CSS and the DMS Control System, and (3) the MSU/CSS and the MACS. In addition, secured voice links have been implemented between the technical control group (Room E-171) and the Building 13 complex.

b. Building 13 Complex Fiber Optic Distribution System. This system provides a fiber-optic distribution system between Building 14 and the Building 13 complex, and distribution within the Building 13 complex. The FO configuration is illustrated in Figure 15-24. The system was implemented in two parts: part one for the installation of the fiber-optic cables; part two for the installation of the fiber-optic/copper conversion, patch, test, and interface systems. Passive Fiber-Optic Racks (PFOR) and the interconnecting fiber-optic cables between the PFORs are included in the baseline system. The installation specifies the use of 50/125 µm fiber cable type with bulkhead feed through SMA-type connector termination. In the fiber-optic link between Buildings 14 and 13, transmit/receive circuits are implemented using duplex fiber cables. Forty-eight duplex cables are provided for interbuilding service. The RS-422 copper-to-optical receiver/driver units (0-5 Mb/s) are used for the interface to user equipment, if required.

c. Building 13 PFOR Installation. Additional PFORs in Buildings 13A and 13B and the Building 13 PFOR form a three-node configuration interconnected by 12-fiber cable links. Each PFOR is provided with both Black and Red separate user interfaces.

15.5.8 MODNET AND NOLAN

15.5.8.1 Background. The MO&DSD Operational/Development Network (MODNET) provides a unified Directorate-wide operational network linking various operational MO&DSD computers using Transmission Control Protocol/Internet Protocol (TCP/IP) and HYPERchannel protocol. Nascom Code 541.2 is responsible for

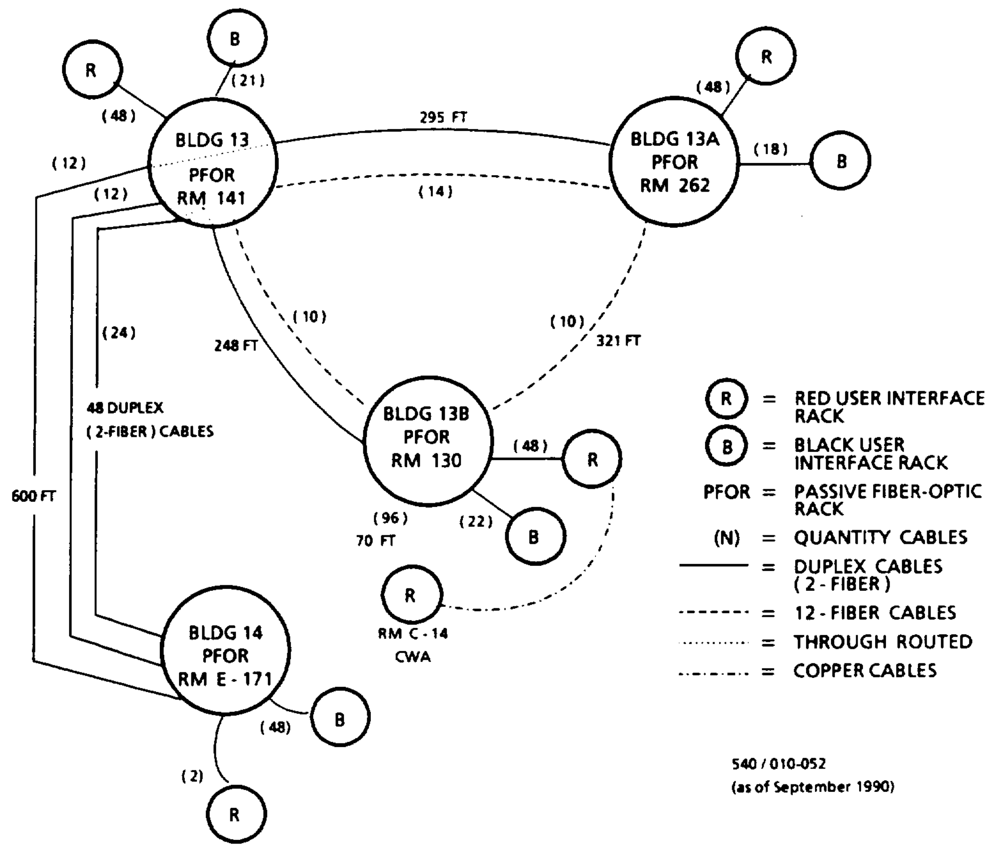

Figure 15-24. Building 13 Complex Fiber Optic Distribution System Configuration

network expansion, network security, continuing engineering, maintenance and operation of MODNET.

MODNET has been an operational network since 1988. Various processed orbit, attitude, and telemetry data are transported between more than 50 host computer systems via MODNET. There is no direct interface between MODNET and any other Nascom Network.

15.5.8.2 NOLAN, Expanding MODNET Beyond Code 500 Systems. MODNET is being expanded to connect non-MO&DSD computers through the Nascom Operational LAN (NOLAN). NOLAN provides an operational FDDI LAN on-center and a wide area network (WAN) capability for off-center data transport. Given formal requests for service, expansion of connectivity to new or additional buildings on GSFC for support of non-MO&DSD host systems will be considered for implementation through NOLAN. Formal requests for connection have been received from the projects listed in Table 15-5.

15.5.8.3 System Configuration. The HYPERchannel portion of MODNET is shown in Figure 15-25. The IP portion of MODNET/NOLAN is shown in Figure 15-25a. MODNET consists of a Backbone FDDI ring connecting Buildings 23, 28, and 3/14. Redundant concentrators connect dual homed IP and HYPERchannel routers to the FDDI Backbone. The IP routers provide an interface to local ethernets, local FDDI rings, and serial links to WAN connections. The HYPERchannel routers provide a proprietary interface to hosts utilizing NETEX/BFX. Though the IP and HYPERchannel networks both utilize the same FDDI Backbone, there is no gateway connection between the two networks.

The HYPERchannel network also consists of coaxial cable that supports 50 Mbps trunks connecting the HYPERchannel-DX adapters and the older A-series HYPERchannel adapters. There are two Highway trunks that run between and within Buildings 3/14 and 23, two Highway trunks that run between and within Buildings 3/14 and 28, two local trunks in Building 3/14 (MODLAN) that serve Code 510 hosts, and two local trunks in Building 23 (InfoLAN) that serve Code 560 hosts.

Two real-time network monitoring systems support MODNET. The HYPERchannel NMS4, running proprietary NSC software, is located in Building 23

Room E314 in the DDF area. The IP NMS, running HP OpenView, is located in Building 14 Room E171 in the Technical Control area. Both monitors provide a graphical and analytical indication of the health of MODNET.

15.5.8.4 MODNET HYPERchannel Connections. Network Systems Corporation Network Executive (NETEX) is the common network operating system for the MODNET. Bulk File Transfer (BFX) software and User Access software are utilities that allow file transfers between hosts. They are not Government Open System Interconnection Profile (GOSIP)-compliant protocols.

The following systems are connected to the MODNET:

Code 510	CMS 1, 2	Command Management System
Code 510	DOCS 1, 2	Data Operations Control System
Code 510	MODGW 1, 2	MODLAN Gateway provides isolation to the MSOCC MODLAN trunks
Code 510	SPIF 1, 2	Shuttle/POCC Interface Facility
Code 510	AP 1-8	Applications Processor
Code 520	DSTL 85, 86	Data Systems Technology Laboratory
Code 520	ALF	MicroVAX II Research Workstation
Code 550	FDF 3, 4,	Flight Dynamics Facility
Code 560	IPDGW1, 2	InfoLAN Gateway
Code 560	IPDOMS 1&2	Mass Storage System
Code 560	SIPS A, B, C	Spacelab Data Processing Facility, Input Processor System
Code 560	UNIS 2200	Telemetry Facility
Code 560	UARS 1, 2	Upper Atmosphere Research Satellite Central Data Handling Facility
Code 560	TDMLZP 1&2	Time Division Multiplex Level Zero Processor. Upgrade to Telemetry Online Processing System
Code 560	ISTP 1-4	International Solar Terrestrial Physics Program

15.5.8.5 MODNET IP Connections. TCP/IP has been selected for use as users migrate to GOSIP-compliant protocols. TCP/IP is used on both MODNET and NOLAN. As there is currently no requirement for a gateway between TCP/IP and NETEX, none will be provided.

The following systems are connected to MODNET using IP:

Code 510	TPOCC LAN	Transportable Payload Operations Control Center Local Area Network
Code 513	TOMS-EP	Total Ozone Mapping Spectrometer - Earth Probe
Code 520	FAST LZP	Level Zero Processor
Code 550	FDF	Flight Dynamics Facility
Code 560	PACOR II	Packet Processor
Code 560	DDF II	Data Distribution Facility

15.6 SPACE SHUTTLE PROGRAM NETWORK SUPPORT

15.6.1 SPACE SHUTTLE PROGRAM SUPPORT OVERVIEW

The forms of support provided by the STDN Ground and Space Networks and by many other special Space Shuttle supporting ground stations, including the Nascom special support arrangement with the Space Shuttle Program (SSP), are described in this paragraph. It should be mentioned that GSFC, Code 500 has the responsibility to act as the "lead range" for the SSP, i.e., to arrange all of the T&DA support required by JSC for the SSP. Nascom provides most of the operational communication interconnections as part of that responsibility. The Space Shuttle Program is conducted by JSC using the launch facilities at KSC. Tracking stations operated by ER, VAFB, WR, WSMR, United States Army Electronic Proving Ground (USAEPG), DFRF, GSFC managed ground stations, and JPL DSN provide T&DA functions to the Shuttle. In addition, several stations and facilities of the DOD, various off-net remote sites and contractor locations are used.

15.6.2 STDN GN SUPPORT FOR SSP

The communications support provided or sponsored by GSFC via the STDN/ground stations for Space Shuttle operations is described in the following paragraphs:

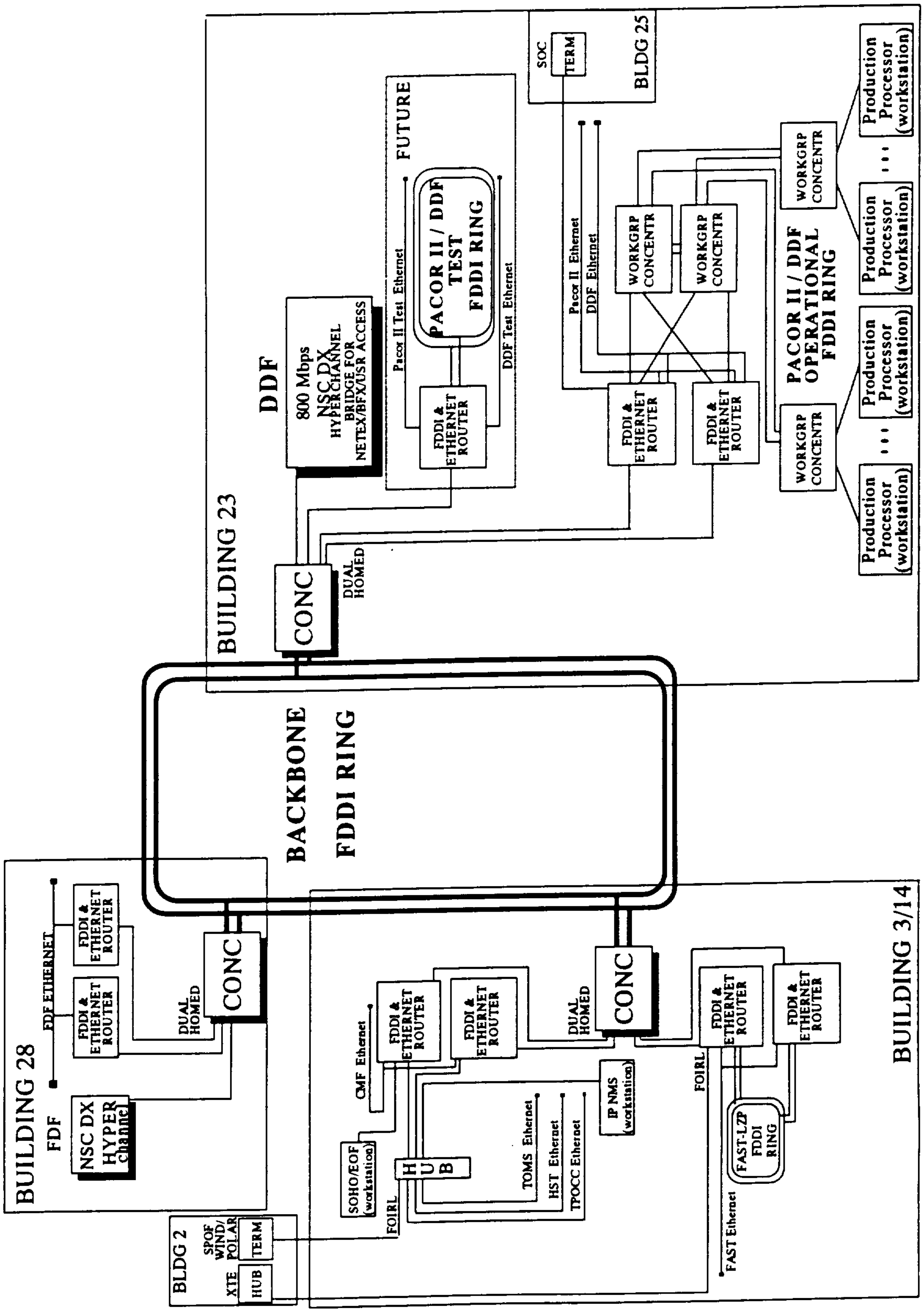

Figure 15-25a. MODNET/NOLAN System Diagram

Table 15-5. NOLAN Connections

Requirements Source	Data Link	Protocol	Bandwidth (Mbps, Maximum)	Number of Hosts of Workstations	Location of Hosts or Workstations	Connect Date	Data Volume (Maximum)
FAST/ Berkeley, CA	Berkeley: V.35 GSFC: RS422	TCP/IP	1.536	2	Berkeley, CA	November 1993	5 Gbits/day
SOHO ECS	Ethernet	TCP/IP	10	2	Building 3	November 1993	TBD
SOHO	Ethernet	TCP/IP	10	3-4	Building 25, Room N171	February 1994	TBD
XTE	Ethernet	TCP/IP	10	1	Building 29, Room 150	February 1994	38 Kbps
XTE	Ethernet	TCP/IP	10	2	Building 20, Room 80	February 1994	9.6 Kbps
XTE	3 Ethernets	TCP/IP	10	10-20	Building 2, Room W20	March 1994	Real-time: 1 Kbps Production: 5 Mbps Opns control: 1 Mbps
FAST/Poker Flats, Alaska	RS-232	TCP/IP	.0096	2	Poker Flats, Alaska	April 1994	TBD
XTE	RS422	TCP/IP	.056	TBD	San Diego, CA	May 1994	TBD
XTE	RS422	TCP/IP	.056	TBD	Boston, MA	May 1994	TBD
Nascom	Ethernet	TCP/IP	10	TBD	Building 7/10 Building 5 Building 12	May 1994	TBD
SWAS	RS422	TBD	.224	TBD	Boston, MA	June 1994	80 Mbps per day
HST	RS422 (multiple)	TCP/IP	1.536	TBD	Baltimore, MD	TBD	TBD
Clementine	Ethernet	TCP/IP	10	TBD	Building 22, Room TBD	TBD	TBD
Landsat 7	TBD	TBD	TBD	TBD	TBD	TBD	TBD
TRMM	TBD	TBD	TBD	TBD	TBD	TBD	TBD

LAS 540/010-0011

Table 16-1. TDRSS - Supported Missions Planned (Note 1)

MISSION (ACRONYM)	MISSION TITLE (APPROVAL STATUS) DOCUMENTATION	LAUNCH VEHICLE/ SITE/DATE/ LANDING SITE	SUPPORT PERIOD/ ORBIT	ON-ORBIT MAXIMUM DATA RATES (KB/S) BY SERVICE TYPE: SMA FWD I	SMA FWD Q	SSA/KSA FWD I	SSA/KSA FWD Q	MA RTN I	MA RTN Q	SSA RTN I	SSA RTN Q	KSA RTN (Note 2) I	KSA RTN (Note 2) Q
ASTRO-2 (SPACELAB)	ASTRONOMY-2 STS ASTRO PIP JSC-14065 (6/89)	STS-66 KSC 12/94	14 DAYS 28.5 DEG 350 KM			[5] MSFC POCC	[5] MSFC POCC					[3] 2,32,48 MB/s or [4]	[1] & [2] 125, 250, 500, 1000, or 2000
ATLAS-3, -4, -5 (SPACELAB PALLET AND IGLOO)	ATMOSPHERIC LABORATORY FOR APPLICATIONS AND SCIENCE-3 STS ATLAS-3 PIP NSTS 21158 EOM-1/2 PIP JSC-18446 (8/91)	STS-66 KSC 10/94 STS-79 KSC 7/96 STS-85 KSC 3/97	10 DAYS 57.0 DEG 296 KM			[5] MSFC POCC	[5] MSFC POCC					[3] 4,16, 24 MB/s or [4]	[1] & [2] 125, 250, 500, 1000, or 2000
AXAF-S	ADVANCED X-RAY ASTROPHYSICS FACILITY SPECTROSCOPY (APPROVED) AXAF AMO-2000 REQUIREMENTS FOR THE MRR AND DMR AXAF-101 PROGRAM REQUIREMENTS DOCUMENT (10/92) AXAF OPERATIONS PANEL MEETING MINUTES NASA/MSFC (6/22-23/93)	STS-98 KSC 10/98 DELTA II VAFB 10/98	3 YEARS 97.9 DEG 650 KM CIRCULAR			.125, 1.0				.5, 4.0 (RT)			
EOS	EARTH OBSERVING SYSTEM (MULTI-MISSION OBSERVING SYSTEM) PROJECT PLAN FOR THE EOS (7/93) EOS MISSION OPERATIONS CONCEPT DOCUMENT (3/93) EOS AM1 MRR (11/92)												
AM1, 2, 3		ATLAS II VAFB 6/98 ATLAS II VAFB 6/03 ATLAS II VAFB 6/08	5 YEARS (EACH) 98.2 DEG 705x708 KM CIRCULAR	1.0	RNG	.125, 1.0, 10		16 (RT)	16 (RT)	1.0, 16 (RT) {OMNI}	1.0, 16, 256 (PB)	Up to 150 MB/s	Up to 150 MB/s
PM1, 2, 3		TBD VAFB 12/00 TBD VAFB 12/03 TBD VAFB 12/10	5 YEARS (EACH) 98.2 DEG 705/708 KM CIRCULAR	1.0	RNG	.125, 10		16 (RT)	16 (RT)	1.0, 16 (RT) {OMNI}	1.0, 16, 512 (PB)	Up to 16 MB/s (R/T) Up to 150 MB/s (P/B)	Up to 16 MB/s (R/T) Up to 150 MB/s (P/B)
AERO1, 2, 3, 4, 5		TBD TBD 6/00 TBD TBD 6/03 TBD TBD 6/06 TBD TBD 6/09 TBD TBD 6/12	3 YEARS (EACH) ORBIT TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
ALT1, 2, 3		TBD TBD 6/02 TBD TBD 6/07 TBD TBD 6/12	5 YEARS (EACH) ORBIT TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
CHEM1, 2, 3		TBD TBD 6/02 TBD TBD 6/07 TBD TBD 6/12	5 YEARS (EACH) ORBIT TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
EURECA (UP TO 5 MISSIONS)	EUROPEAN RETRIEVABLE CARRIER (LAUNCH/ RETRIEVE) NSTS EURECA PIP JSC-14089, REV D		10 YEARS (PROGRAM)	LAUNCH AND RETRIEVAL COMMUNICATION VIA STS ORBITER LINKS									
2L		STS-77 KSC 3/96 EAFB	10 DAYS 28.5 DEG 426 KM										
2R		STS-81 KSC 9/96 EAFB	10 DAYS 28.5 DEG 296 KM										

Note 1: Source documents STDN 803 Dec 1993/Jan 1994
Note 2: Orbiter/Spacelab Capabilities - Rates on Ch. 2- .25, .50, 1.0, or 2.0 Mb/s (HRM), or 960/1024 orbiter recorder dumps.
Rates on Ch. 3 mode 1-2, 16, 32 Mb/s (HRM), or 48 Mb/s (direct access channel)

Notes for shuttle unique service for spacelab or attached payloads data
[1] PL data via STS KSA RET link Chan 1 (192 Kb/s) via JSC/MCC PDIS
[2] PL data via STS KSA RET link Chan 2 (up to 2.0 Mb/s) via HRM or orbiter recorder (1024 Kb/s)
[3] PL data via STS KSA RET link Chan 3 (up to 48.0 Mb/s) via HRM mode 1
[4] PL video or analog data via STS KSA RET link Chan 3 mode 2
[5] POCC CMDS via JSC/MCC via SSA forward service, 32 or 72 Kb/s

LEGEND:
{ } Contingency

LORAL 540/010-258(a)m
(as of February 1994)

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Table 16-1. TDRSS - Supported Missions Planned (Note 1) (Cont'd)

MISSION (ACRONYM)	MISSION TITLE (APPROVAL STATUS) DOCUMENTATION	LAUNCH VEHICLE/ SITE/DATE LANDING SITE	SUPPORT PERIOD/ ORBIT	ON-ORBIT MAXIMUM DATA RATES (KB/S) BY SERVICE TYPE									
				SMA FWD		SSA/KSA FWD		MA RTN		SSA RTN		KSA RTN (Note 2)	
				I	Q	I	Q	I	Q	I	Q	I	Q
IML-2 (SPACELAB)	SPACELAB INTERNATIONAL MICROGRAVITY LABORATORY MISSION - 2 STS IML-2 PIP NSTS-(TBS)	STS-65 KSC 7/94	14 DAYS 28.5 DEG 296 KM			[5] MSFC POCC	[5] MSFC POCC					[3] 2, 4, 32, 48 MB/s or [4]	[1] & [2] 250, 500, 1000, or 2000
LANDSAT-7	LANDSAT-7 (APPROVED) LANDSAT-7 DMR, SDR DRAFT, 11/93	DELTA II VAFB 1/98	5 YEARS 705+/-5 KM	1.2		11.5 {1.44 OMNI}		11.5	11.5	6.0 (RT) 300 (PB)	6.0 (RT) 300 (PB) {1.2 OMNI}		300 MB/s
LDBP (SERIES)	LONG DURATION BALLOON PROGRAM (APPROVED) LDB SIRD, REV 1 (5/91)	BALLOONS FROM MCMURDO 12/94	10-90 DAYS (EACH) 78 DEG SOUTH (+/-5) 40 KM	TBD	TBD	TBD	TBD	1-10 (2 BALLOONS)	1-10	TBD	TBD		
SLS-3	SPACELAB LIFE SCIENCES - 3 SLS-3 (TBD) PIP	STS-76 KSC 2/96 TBD	16 DAYS ORBIT TBD			[5] 1.6 MSFC POCC	[5] 1.6 MSFC POCC					[3] 2, 16, 32, 48 MB/s or [4]	[1] & [2] 250, 1000, or 2000
SS (ALPHA)	SPACE STATION (ALPHA) ALPHA STATION - ADDENDUM TO PIP (11/93)	(LAUNCH VEHICLE, LAUNCH SITE, AND LANDING SITE - TBD FOR ALL LAUNCHES	TBD 51.6 DEG 352-407 KM CIRCULAR			72 {6}				192 {12}	192 {12}	50 MB/s	
1R, 2R, 3R, 4R, 5R, 6R, 7R, 8R, 9R, 10R, 11R, 12R	RUSSIA AS THE PRIMARY DEVELOPER	5/97, 6/97, 7/97, 8/97, 10/97, 1/98, 6/99, 2/1, 5/1, 8/1, 9/1, 10/1											
1A, 2A, 3A, 4A, 5A, 6A, 7A, 8A, 9A, 10A, 11A, 12A, 13A, 14A	U.S. AS THE PRIMARY DEVELOPER	7/97, 9/97, 10/97, 11/97, 12/97, 4/98, 7/98, 10/98, 1/99, 4/99, 7/99, 1/1, 4/1, 7/1											
1J, 2J, 3J	JAPAN AS THE PRIMARY DEVELOPER	10/99, 1/00, 10/00											
1E, 2E	EUROPEAN SPACE AGENCY AS THE PRIMARY DEVELOPER	4/00, 7/00											
TRMM	TROPICAL RAINFALL MEASURING MISSION TRMM MRR (1/93) TRMM DMR (12/93)	H-II TANEGESHIMA, JPN 8/97	3 YEARS 35 DEG 350 KM CIRCULAR			.5, 1.0	RNG			32 (RT)	128 (PB) or 2 MB/s (PB) {1.0 (RT)}		
USML-2 (SPACELAB)	SPACELAB UNITED STATES MICROGRAVITY LABORATORY (APPROVED) STS USML-2 PIP JSC-21115, BASIC (9/91) THRU CHANGE NO. 13	STS-73 KSC 9/95 EAFB	16 DAYS 28.5 DEG 296 KM			[5] MSFC POCC	[5] MSFC POCC					[4] VIDEO	[1] & [2] 125, 250, 500, or 1000
USMP-2, -3, -4, -5 (SPACELAB)	SPACELAB UNITED STATES MICROGRAVITY PAYLOAD (APPROVED) STS USMP-2 PIP NSTS-21182, BASIC (6/93) THRU CHANGE NO. 1	STS-62 KSC 3/94 STS-75 KSC 12/95 STS-81 KSC 9/96 STS-88 KSC 7/97	14 DAYS 28.5 DEG 296 KM			[5] MSFC POCC	[5] MSFC POCC						
XTE	X-RAY TIMING EXPLORER XTE DMR (9/93)	DELTA II ER 8/95	2-5 YEARS 23 DEG 600 KM	1.0 {.125}	RNG	1.0 {.125}	RNG	32 (RT) {2}	32,48 or 64 (PB)	32 (RT) {2}	512, 1024 (PB)		

Note 1: Source documents STDN 803 Dec 1993/Jan 1994
Note 2: Orbiter/Spacelab Capabilities - Rates on Ch. 2- .25, .50, 1.0, or 2.0 Mb/s (HRM), or 960/1024 orbiter recorder dumps.
Rates on Ch. 3 mode 1-2, 16, 32 Mb/s (HRM), or 48 Mb/s (direct access channel)

LEGEND:
{ } Contingency

Notes for shuttle unique service for spacelab or attached payloads data
[1] PL data via STS KSA RET link Chan 1 (192 Kb/s) via JSC/MCC PDIS
[2] PL data via STS KSA RET link Chan 2 (up to 2.0 Mb/s) via HRM or orbiter recorder (1024 Kb/s)
[3] PL data via STS KSA RET link Chan 3 (up to 48.0 Mb/s) via HRM mode 1
[4] PL video or analog data via STS KSA RET link Chan 3 mode 2
[5] POCC CMDS via JSC/MCC via SSA forward service, 32 or 72 Kb/s

LORAL 540/010-258(b)m
(as of February 1994)

Table 16-2
TDRSS-supported On-Orbit Missions

(as of February 1994)

MISSION (ACRONYM)	MISSION TITLE DOCUMENTATION	LAUNCH DATE ORBIT INCLINATION (I)	SUPPORT PERIOD	MAXIMUM DATA RATES (KB/S) BY SERVICE TYPE									
				MA FWD		SSA/KSA FWD		MA RTN		SSA RTN		KSA RTN	
				I	Q	I	Q	I	Q	I	Q	I	Q
BRTS	BILATERATION RANGING TRANSPONDER SYSTEM, 6 TRANSPONDERS (GSFC/FDF BRTS MOC) (NOTE 9)	NA	LIFE OF TDRSS	-	RNG	-	RNG	.64	.64	.64	.64	-	-
ERBS	EARTH RADIATION BUDGET SATELLITE SIRD 5/82	10/05/84 575 X 592 KM I=57	THRU 9/30/94, 9/30/95 POTENTIAL	1.0	RNG			1.6	12.8 / 32	1.6	32/128		
EUVE/EP	EXTREME ULTRAVIOLET EXPLORER ON EXPLORER PLATFORM (NEW MMS) (GSFC MOC/PACOR) (SIRD REVISION 10/88/SORD 08/89)	6/07/92 514 X 528 KM I=28	THRU 6/30/96	1.0	RNG	1.0/ .125	RNG	1.0/32	1.0/32	1/32	1/32/ 512	-	-
GRO	GAMMA RAY OBSERVATORY SIRD 7/93 (GSFC MOC)	4/05/91 387 X 408 KM I=28	THRU 4/30/99, 4/30/01 POTENTIAL	1.0	RNG	1.0 .125	RNG	1.0 32	1.0 32	1.0 32	1.0 32 512	N/A	N/A
HST NOTE 1	HUBBLE SPACE TELESCOPE SERVICING MISSIONS BASELINE SORD 3/90 SM-2 10/96 STS-82	4/24/90 584 X 607 I=28	THRU 4/30/05	.125	RNG	1.0 (SSA)	RNG	4.0 500	4.0 OR 32 500 MA/SSA CONTINGENCY	1.024 MB/S	N/A	N/A	N/A
LANDSAT	LAND SATELLITE - 4 LAND SATELLITE - 5	7/16/82 697 X 708 I=98 3/01/84 699 X 706 I=98	THRU 10/31/92 RELEASE FROM CONTIGENCY SPT = TBD THRU 10/31/92 RELEASE FROM CONTINGENCY SPT = TBD	1.0	RNG	1.0	RNG	8	32	8	32/128	15 & 84.9 MB/S	

NOTE 1: REQUIREMENTS INDICATED ARE FOR ORBITAL SUPPORT

NOTE 2: ORBITER NO. 102 COLUMBIA
ORBITER NO. 103 DISCOVERY
ORBITER NO. 104 ATLANTIS
ORBITER NO. 105 ENDEAVOR

NOTE 3: SSA LOW RATE TDM 8 KB/S PLUS 1 VOICE DIGITAL 24 KB/S (32 KB/S)
SSA HIGH RATE TDM AND 8 KB/S CMD PLUS 2 VOICE DIGITAL 32 KB/S EACH (72 KB/S)

NOTE 4: KSA LOW RATE TDM AND 8 KB/S CMD PLUS 2 VOICE DIGITAL 32 KB/S EACH (72 KB/S)
KSA HIGH RATE TDM 72 KB/S CMD/VOICE PLUS 144 KB/S TEST AND GRAPHICS (216 KB/S)

NOTE 5: (1 OR 2) 32 KB/S DIGITAL VOICE CKTS PLUS ORBITER AND PAYLOAD TLM (TDM)

NOTE 6: 2 - 32 KB/S DIGITAL VOICE CKTS PLUS ORBITER AND PAYLOAD TLM (TDM)

NOTE 7: STS OPS RECORDER, TIME SHARED WITH PAYLOAD DATA

NOTE 8: STS VIDEO TIME SHARED WITH PAYLOAD VIDEO, ANALOG, OR DIGITAL DATA

NOTE 9: TRANSPONDER LOCATIONS: ALICE SPRINGS (1) TDRSW
ASCENSION (2) TDRSE
AMERICAN SAMOA (1) TDRSW
WHITE SANDS (2) TDRS E/W

Table 16-2
TDRSS-supported On-Orbit Missions (Cont'd)

(as of February 1994)

MISSION (ACRONYM)	MISSION TITLE DOCUMENTATION	LAUNCH DATE ORBIT INCLINATION (I)	SUPPORT PERIOD	MAXIMUM DATA RATES (KB/S) BY SERVICE TYPE									
				MA FWD		SSA/KSA FWD		MA RTN		SSA RTN		KSA RTN	
				I	Q	I	Q	I	Q	I	Q	I	Q
TOPEX/POSEIDON	OCEAN TOPOGRAPHY EXPERIMENT JOINT US/FRENCH MISSION (JPL POCC) JPL D - 601 REV. B 12/85 PREL. SIRD 5/92	8/10/92 1336 X 1336 I=66	THRU 8/31/95, 7/31/97 POTENTIAL	1.0	RNG	1.0/ .125 (SSA)	RNG	1.0 or 16.0 RT	32 or 48.0 PB	16.0 RT	512 PB	NA	NA
STS NOTE 2	SPACE TRANSPORTATION SYTEM LAUNCH AND LANDING AND FLIGHT OPERATIONS PRD'S, ON FILE IN ASRS, PERIODICALLY UPDATED	SEE STDN 803	UP TO 13 DAYS PER FLIGHT			SSA 32 or 72 (NOTE 3 KSA 72 or 216 (NOTE 4)					96 or 192 NOTE 5	4.2 MHZ VIDEO (CH. 3) NOTE 8	192 (CH. 1) NOTE 6 960/ 1024 (CH. 2) NOTE 7
UARS	UPPER ATMOSPHERE RESEARCH SATELLITE (APPROVED) SIRD 2/85 (GSFC MOC / DCF / CDHF)	9/12/91 575 X 591 KM I=57	THRU 9/30/94, 9/30/95 POTENTIAL	1.0	RNG	1.0 .250	RNG	32 or 1.0	32	32 or 1.0	1.0 or 32 or 512	NA	NA

NOTE 1: REQUIREMENTS INDICATED ARE FOR ORBITAL SUPPORT
SM REQUIREMENTS ARE TBS

NOTE 2: ORBITER NO. 102 COLUMBIA
ORBITER NO. 103 DISCOVERY
ORBITER NO. 104 ATLANTIS
ORBITER NO. 105 ENDEAVOR

NOTE 3: SSA LOW RATE TDM 8 KB/S PLUS 1 VOICE DIGITAL 24 KB/S (32 KB/S)
SSA HIGH RATE TDM AND 8 KB/S CMD PLUS 2 VOICE DIGITAL 32 KB/S EACH (72 KB/S)

NOTE 4: KSA LOW RATE TDM AND 8 KB/S CMD PLUS 2 VOICE DIGITAL 32 KB/S EACH (72 KB/S)
KSA HIGH RATE TDM 72 KB/S CMD/VOICE PLUS 144 KB/S TEST AND GRAPHICS (216 KB/S)

NOTE 5: (1 OR 2) 32 KB/S DIGITAL VOICE CKTS PLUS ORBITER AND PAYLOAD TLM (TDM)

NOTE 6: 2 - 32 KB/S DIGITAL VOICE CKTS PLUS ORBITER AND PAYLOAD TLM (TDM)

NOTE 7: STS OPS RECORDER, TIME SHARED WITH PAYLOAD DATA

NOTE 8: STS VIDEO TIME SHARED WITH PAYLOAD VIDEO, ANALOG, OR DIGITAL DATA

NOTE 9: TRANSPONDER LOCATIONS: ALICE SPRINGS (1) TDRSW
ASCENSION (2) TDRSE
AMERICAN SAMOA (1) TDRSW
WHITE SANDS (2) TDRS E/W

b. Video/Analog Service Support. As indicated in Figure 16-4, the Spacelab video and analog signals are backfed to Nascom technical control at GSFC, Building 14, for fault isolation purposes. The video is also monitored, quality checked, and distributed locally in the Building 8 Nascom TV control facility.

c. MDM and SM Support. Nascom is responsible for MDM and SM equipment engineering, configuration, control, and logistics support, and for assuring that the equipment is operated in a manner that meets all performance specifications.

16.2.5 DELETED

16.2.5.1 DELETED

16.2.5.2 DELETED

Figure 16-7. DELETED

16.2.6 HUBBLE SPACE TELESCOPE

16.2.6.1 HST Mission Description. Hubble Space Telescope (HST) is a high-resolution optical telescope operated as a national facility. It consists of a 2.4-meter aperture Ritchey-Chretien cassegrain telescope weighing approximately 9525 kg – with various energy detectors designed for the observation of infrared, visible, and ultraviolet wavelengths (0.12 to 1000 microns). HST was launched by the Space Shuttle from KSC on 24 April 1990, and deployed into a 28.5-degree inclination, circular orbit that permits an HST orbit lifetime of 15 years. HST is projected for 15 years in-orbit operation. HST servicing/maintenance missions are manifested on the Space Transportation System (STS) every 3 years (approximate) after launch.

a. Spacecraft Data Flow. The data flow between the HST spacecraft and the HST ground facilities is described in the following paragraphs:

(1) All of the HST observatory science and engineering data received via TDRSS/Nascom is routed to the POCC and the GSFC Data Capture Facility. The DCF records all of the science data. This data is forwarded to the Science Institute Space Telescope (ScI) within 1 day.

(2) The POCC receives, records, processes, and displays all HST engineering data to monitor the health and safety of the science instruments and support systems. It also receives and transmits the science data to the Science Support Center (SSC) and the ScI for quicklook evaluation and target acquisition support. The POCC also generates, transmits, verifies, and records all commands to the HST and produces the daily mission schedule. Either the SSC or the ScI may transmit (not simultaneously) real-time HST command requests, as scheduled to the POCC via the SSC command interface.

b. TDRSS Support Services. The TDRSS provides approximately 320 minutes-per-day support on the SSA return link and 100 percent in-view support on the MA return link. All HST support is provided by TDRSS. DSN/GN is responsible for providing contingency support for the HST if TDRSS or SC failure prevents communications via that link. MA return services provides real-time science or engineering data at up to 4 kb/s on I-channel, and real-time engineering data up to 32 kb/s on Q-channel (on MA/SSA cross support when needed). SSA return link service on I-channel provides data at 1.024 Mb/s for real-time science, or engineering and science data playbacks, or for Onboard Computer (OBC) memory dumps.

16.2.6.2 Space Telescope Observatory Management System. The HST Observatory Management System (STOMS) consists of the HST Operations Control Center (STOCC), and the Data Capture Facility (DCF).

a. HST Operations Control Center. The STOCC located in Building 3/14 areas at GSFC, and composed of the POCC and the Science Support Center (SSC), serves as the focal point of all orbital operations, including the monitoring and support of the spacecraft. The following describes the components of STOCC:

(1) The HST POCC performs all real-time health and status functions and offline spacecraft support functions for the HST mission. The HST POCC is composed of the Preliminary Operations Requirements and Test Support Section (PORTS), the POCC Applications Software Support (PASS), and the UPS.

(2) PORTS is that part of the HST POCC responsible for engineering design, hardware, online computer system payload operations, telemetry processing, and supporting functions. Included are a High Rate Switch, two Telemetry and Command Processors (TAC), three Applications Processors (AP), and two Virtual Interface Processors (VIP). The TAC's and VIP's are DEC PDP-11/44's. The AP's are DEC VAX 4000 computers. All external communications are through the high rate switch.

(3) PASS is a collection of software systems responsible for implementing capabilities in the POCC offline computer system as provided through PORTS. PASS responsibilities include areas of mission scheduling, command loading, attitude and calibration computation, spacecraft subsystem monitoring, PASS data management, and PASS operations support.

(4) Support and Maintenance System (SAMS) is a separate facility located in Building 1 that provides resources for the development and staging of hardware, software, and network changes on a non-interference basis with the HST POCC. SAMS will also have the capability to serve as an emergency backup control center in the event of a requirement to evacuate the POCC facilities in Building 3/14.

(5) UPS is an intelligent terminal in the POCC that provides an NCC interface for scheduling tracking, telemetry, and command support via the TDRSS.

b. Data Capture Facility. The DCF is a GSFC-managed and -operated element responsible for the capture and quality accounting of all received HST science data. It is a dedicated element of the

(b) The DDCS at GSFC is required to support:

1. A peak throughput of 107 packets per second from the PACOR to the IGSE's.

2. A peak throughput of 65 packets per second between the CMS and the IGSE's.

3. Variable packet sizes: 16, 32, 64, 128, and 256 octets/packet. Packet size for the GRO project is 256 octets/packet.

16.2.8 UPPER ATMOSPHERE RESEARCH SATELLITE

16.2.8.1 UARS Mission Description. The Upper Atmosphere Research Satellite (UARS) project is directed toward the study of the middle and upper atmosphere through the use of an Earth-orbiting observatory that operates at an altitude of 600 km and an inclination of 57 degrees. The observatory was launched in the fall of 1991 from KSC, using the STS. Operational life of the satellite will be 18 months, with the coverage of two Northern Hemisphere winters a major objective. The configuration of the UARS mission, including the supporting space and ground system elements, is illustrated in Figure 16-12. The following items a through c describe the primary system support elements.

a. GSFC Institutional Support. Flight operations are performed with the use of GSFC institutional mission support systems. These facilities provide for satellite command and control, definitive orbit and attitude computation, command management, and data capture (MSOCC, FDF, and DCF).

b. GSFC Central Data Handling Facility. Instrument data processing is accomplished in the CDHF at GSFC. Data analysis and theoretical studies are conducted by members of the UARS science team through the use of remote analysis computers located at the PI's facilities.

c. TDRSS Support. Communications between the observatory and ground facilities are provided by the TDRSS SSA system. The UARS is also compatible with the GN and the DSN. A 10-minute contact every orbit is baselined for tape recorder playbacks at 512 kb/s and real-time data transmission at 32 kb/s. These contacts are normally sufficient for ranging, command, OBC memory dumping, and monitoring the performance of the observatory. The forward SSA system is normally used for commanding at 1 kb/s. When SSA service is not available, command, real-time telemetry, and OBC dumping will be through the MA system. In addition, an SSA emergency mode and a ground station mode will be available.

16.2.8.2 Nascom Support for UARS Mission. As illustrated in Figure 16-12, the primary support provided by Nascom for the UARS mission is the extension of the UARS-TDRSS transmission channels to GSFC UARS facilities via the BDS.

16.2.8.3 Remote Experimenter Network. Nineteen Remote Analysis Computer (RAC) locations are being served by the GSFC CDHF for data processing and analysis activities. The following table lists the location and type of service to be provided to these RAC's. Secondary data distribution is via

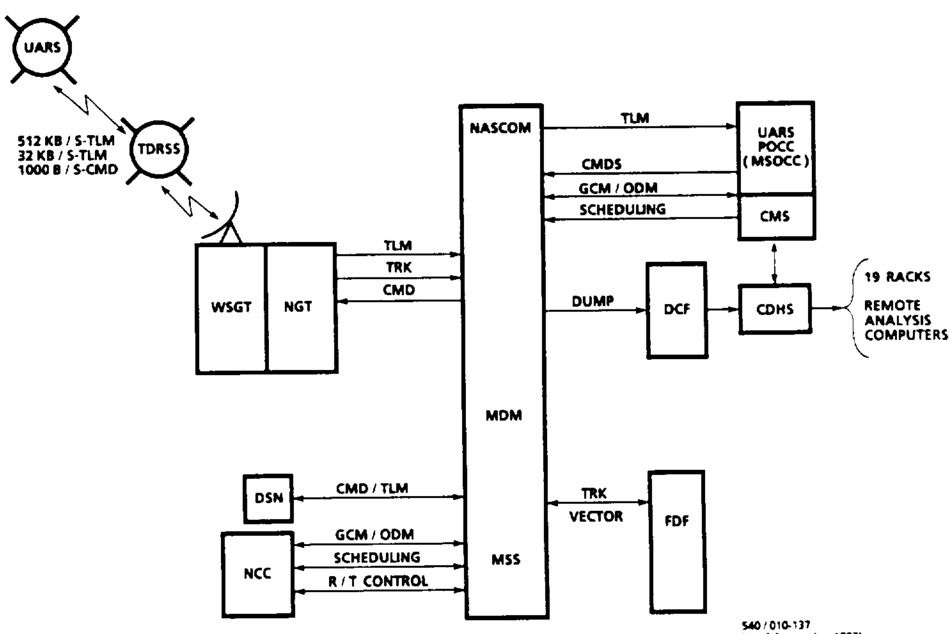

Figure 16-12. UARS Ground System Data Flow Interfaces

the Project Support Communications Network (PSCN).

CONTINENTAL LOCATIONS

Ann Arbor, MI	*9.6 kb/s
Atlanta, GA	9.6 kb/s
Boulder, CO (NCAR)	*9.6 kb/s
Boulder, CO (U of CO)	9.6 kb/s
Greenbelt, MD #1	56.0 kb/s
Greenbelt, MD #2	56.0 kb/s
Hampton, VA	*9.6 kb/s
Livermore, CA	9.6 kb/s
Palo Alto, CA	*9.6 kb/s 2 experimenters to share one line
Pasadena, CA	*9.6 kb/s
San Antonio, TX	*9.6 kb/s
Seattle, WA	9.6 kb/s
Suitland, MD	9.6 kb/s
Toronto, Canada	*9.6 kb/s
Washington, DC	*9.6 kb/s

OVERSEAS LOCATIONS

Bracknell, England	*9.6 kb/s 2 experimenters to share one line
Paris, France	9.6 kb/s

* Requires connection with the GSFC CMS

16.2.9 SPACE STATION (ALPHA)PROGRAM

NASA Deputy Administrator Decision Memorandum #25 transferred responsibility for "all forward and return link services that were to have been provided by CDOS, including Nascom II" [the Customer Data Operations System (CDOS) and Nascom II projects were canceled subsequent to the issuance of NASA Deputy Administrator Decision Memorandum #25] to the respective flight program office(s). Nascom has not received requirements for Space Station (Alpha) support. Until such requirements are received and responded to, this section cannot be further developed with respect to Nascom's role in support of ground data transport. However, using the Mission Requirements and Data Systems Support Forecast (501-803), December 1993/January 1994, as a guide, the following general comments and observations can be made:

16.2.9.1 Early Phase Requirements. This information is presented to illuminate some aspects of the current Space Station (Alpha) from which Nascom support requirements may be expected:

a. Space Station (Alpha) Space-Ground Data Rates. The intended Space Station (Alpha) C&T data rates planned to be transmitted on the SN (TDRSS) Space-ground link user services are:

(1) S-band (SSA): 192 kb/s, return link, normal; or 12 kb/s, return link, contingency.

(2) S-band (SSA): 72 kb/s, return link, normal; or 6 kb/s, return link, contingency.

(3) Ku-band (KSA): 50 Mb/s, return link only.

16.2.9.2 Space Station (Alpha) Preliminary Assembly Sequence. The new concept for the Space Station includes three distinct phases. Phase One expands upon previously planned joint participation by U.S. and Russian crews in Mir and Shuttle operations. Phase Two combines previously planned Station and Russian hardware to create an advanced orbital research facility with a human tended capability. Phase Three completes construction of this research facility to support a permanent human presence. Table 16-2a depicts a preliminary assembly sequence and schedule for Phases Two and Three of the Space Station (Alpha).

16.2.9.3 DELETED

16.2.9.4 DELETED

Figure 16-13. DELETED

Figure 16-14. DELETED

16.2.10 EARTH OBSERVING SYSTEM (EOS)

16.2.10.1 EOS Mission Description. The EOS is a multi-flight mission with the objective of acquiring geophysical, chemical, and biological information necessary for intense study of planet Earth. The EOS information system will build up over 10 years and then function at least 15 more years to accurately model processes that control the environment. The program involves operation of numerous instruments on multiple spacecraft in both polar and non-polar orbit to support a large international user/scientific community. The U.S. is developing multiple series of spacecraft, beginning with the EOS-AM series in 1998. Other EOS series include EOS-PM, EOS-Chemistry, EOS-Aerosols, and EOS-Altimetry. Each spacecraft has a projected operational lifetime of 5 years, except for EOS-Aerosols which have an operational life of 3 years, with respective replacement spacecraft to provide observations of the Earth for not less than 15 years. Both ESA and NASDA are planning Earth observing missions which complement the NASA flights; both will also have instruments on selected EOS flights. The CSA is providing one of the instruments on EOS-AM1 and is sponsoring two interdisciplinary investigators. EOS will also encompass data from designated Earth Science Missions

Figure 16-15. DELETED

Figure 16-16. DELETED

Table 16-2a. Space Station (Alpha) Preliminary Assembly Sequence and Schedule

Assembly Flight		Launch Designator	Developer	Element	Launch Date
PHASE TWO	1	1R	Russia/U.S.	FGB Energy Block	05/97
	2	2R	Russia/U.S.	Airlock/STS Docking Adapter	06/97
	3	1A	U.S.	Node 1	07/97
	4	3R	Russia	Service Module	07/97
	5	4R	U.S.	Docking Node	08/97
	6	2A	Russia/U.S.	Truss 1, Gyrodynes	09/97
	7	5R	Russia/U.S.	Truss 2, PV Array	10/97
	8	3A	U.S.	US Lab (3 System + 2 ISPR)	10/97
	9	4A	U.S.	Lab Outfitting, MBS	11/97
	10	5A	U.S.	SO Truss, MBSU, MT, TUS	12/97
PHASE THREE	11	6R	Russia	Soyuz ACRV	01/98
	12	6A	U.S./Canada	P1 Truss, TCS, SSRMS, S-	04/98
	13	7A	U.S.	Node 2, Cupola, S5, SPDM	07/98
	14	8A	U.S.	S1 Truss, TCS, S-band, UHF	10/98
	15	9A	U.S.	P3/P4 Truss, PV Array	01/99
	16	10A	U.S.	S3/S4 Truss, PV Array	04/99
	17	7R	Russia	Service Module LSS	06/99
	18	11A	U.S.	S6 Truss, PV Array	07/99
	19	1J	Japan	JEM	10/99
	20	2J	Japan	Outfitting Flight	01/00
	21	1E	Europe	APM	04/00
	22	2E	Europe	Outfitting Flight	07/00
	23	3J	Japan	JEM EF	10/00
	24	12A	U.S.	US Hab	01/01
	25	8R	Russia	Research Module 1	02/01
	26	13A	U.S.	Hab Outfitting	04/01
	27	9R	Russia	Soyuz ACRV 2	05/01
	28	14A	U.S.	Outfitting Flight	07/01
	29	10R	Russia	Research Module 2	08/01
	30	11R	Russia	Research Module 3	09/01
	31	12R	Russia/U.S.	Solar Dynamic Element	10/01

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under the broad umbrella of "Mission to Planet Earth".

16.2.10.2 Flight Profile. EOS spacecraft are self contained free-flyers, operating in sun-synchronous polar orbits. EOS-AM and -PM series will be launched from Vandenberg AFB, CA by the ATLAS II launch vehicle into 705 km near circular orbits with 100 minute periods. The launch vehicles for the EOS-Aerosol, -Chemistry and -Altimetry series are still TBD. The mission flight schedule for EOS is depicted in Table 16-3.

16.2.10.3 SN/DSN/GN Support. The EOS mission requires support equivalent to one TDRS/TDRSII KSA channel. During normal operations, each EOS flight will utilize a TDRS KSA channel for approximately 20 minutes per orbit for return link transmission of recorded science and engineering data. In addition, the capability exists for the spacecraft to transmit both real-time and recorded science and engineering data (selected data sets) via KSA. Real-time engineering and housekeeping data, and optionally dump data, will be transmitted via the corresponding SSA channel. Forward link command requirements include real-time commands and spacecraft loads for handling by the spacecraft onboard computer. Normal operations will consist of scheduled daily command loads. A number of contingency modes involving KSA, SSA and SMA services will exist. Tracking services will be required during orbit acquisition and for verification of the TDRSS Onboard Navigation System (TONS). Specific forward and return link services are depicted in Tables 16-4 and 16-5.

16.2.10.4 Earth Science and Data Information System (ESDIS) Project Elements. The EOC at GSFC is responsible for mission control, mission planning and scheduling, instrument command support, and mission operations. All communications with the platforms and instruments go through the EOC. The EOC will interface with Instrument Control Centers (ICC) and their Instrument Support Terminals (IST). The ICCs are responsible for health and safety monitoring of the instrument and observatory, planning and scheduling instrument operations, generating, validating, forwarding or storing command sequences, and providing instrument controllers with status for their instruments. ESDIS elements also include Distributed Active Archive Centers (DAAC).

16.3 GROUND NETWORK SUPPORTED MISSIONS

This paragraph provides a description of selected missions or mission categories involving principally ground network tracking and data acquisition support and related unique Nascom ground communications support planning.

16.3.1 INTERNATIONAL SOLAR TERRESTRIAL PHYSICS PROGRAM (ISTP)

16.3.1.1 ISTP Mission Description. ISTP is a joint cooperative effort undertaken to study the solar-terrestrial physics of the near-earth space environment or the Geosphere. This effort involves the spacecraft of three international agencies: The National Aeronautic and Space Administration (NASA), The Japanese Institute of Space and Astronautical Science (ISAS), and The European Space Agency (ESA). It also includes one Russian experiment, KONUS, on the US spacecraft "WIND". The US program is further subdivided into two programs, 1) The Global Geospace Science project which is the NASA portion with two spacecraft, WIND and POLAR; and 2) The Collaborative Solar-Terrestrial Research Initiative (COSTR) that provides for the development and operation of US experiments on the ISAS spacecraft, GEOTAIL and the ESA spacecraft, SOHO and CLUSTER. CLUSTER is a group of four satellites that orbit together in a predetermined pattern within the geosphere. The spacecraft will be launched over a period of three and a half years and during the latter part of the

Table 16-3
Schedule of EOS Missions

MISSION	LAUNCH	MISSION	LAUNCH	MISSION	LAUNCH	MISSION	LAUNCH	MISSION	LAUNCH
EOS-AM1	JUN 1998	EOS-PM1	DEC 2000	EOS-AERO1	JUN 2000	EOS-CHEM1	DEC 2002	EOS-ALT1	JUN 2002
EOS-AM2	JUN 2003	EOS-PM2	DEC 2005	EOS-AERO2	JUN 2003	EOS-CHEM2	DEC 2007	EOS-ALT2	JUN 2007
EOS-AM3	JUN 2008	EOS-PM3	DEC 2010	EOS-AERO3	JUN 2016	EOS-CHEM3	DEC 2012	EOS-ALT3	JUN 2012
				EOS-AERO4	JUN 2009				
				EOS-AERO5	JUN 2012				

POCC payload operations voice coordination may accommodate up to nine voice loops provided by Nascom for this function between GSFC and JSC. Data services between JSC and GSFC that can be accommodated on the current in-place MDM system are regarded as STS standard service. JSC/MCC Remote POCC Capabilities Document, latest revision, provides detailed information on its remote POCC payload services.

16.3.4.5 User-Nascom Interface. Remote POCC mission planners desiring access to the JSC/MCC payload services must plan and arrange interfaces with the Nascom System at GSFC. POCC's at GSFC are interfaced directly via the MSS for access to JSC remote POCC services. POCC's remotely located from GSFC must receive their payload data in 4800-bit blocked form, if so originated in JSC. If originated as serial data, Nascom will deliver serial data to the GSFC interface to the user. Nascom will extend serial data via asynchronous modem services if rates are 1800 b/s or lower, or via synchronous data services equipped with Nascom-provided payload data deblockers for higher data rates. Such unique service to remote POCC's from GSFC may be provided on a reimbursable basis.

16.4 DSN-SUPPORTED MISSIONS

16.4.1 GENERAL INFORMATION

Missions currently supported by DSN are listed and summarized in the "Deep Space Network Mission Support Requirements Document, JPL 870-14, Rev AH, April 1992," a quarterly publication similar to the 501-803.

16.4.2 CURRENT ONGOING DSN MISSION SUPPORT

Section 15, Tables 15-2, 15-3, and 15-4 briefly describe each DSN current mission, including data rates.

16.4.3 FUTURE DSN MISSION SUPPORT

Appendix C contains a brief description and approximate launch date of each project included in the future DSN mission set.

SECTION 17

NETWORK UPGRADE AND ADVANCED SYSTEMS DEVELOPMENTS AND PLANS

17.1 PURPOSE

This section reports current activities of Nascom and its supporting contractors in the area of Network Upgrade (NU) and Network Advanced Systems development. More specifically, this section encompasses the Nascom upgrades and projects scheduled or being planned for implementation over the next five years in support of Nascom's strategic planning activity.

17.2 LONG RANGE PLANNING

17.2.1 HISTORY

a. Nascom 1986 Long-term Plan. Contained in a two-volume briefing book, the Nascom Long-term Plan (LTP) was developed in 1986 as an internal document. Development of the LTP did two vital things: (1) it made visible and thus provided recognition for some very significant change drivers to the Nascom System and (2) it demonstrated the need for a methodology for long-range planning, including establishing a system baseline, high-level goals and objectives, plan strategies, elements of the plan itself, and a mechanism for its update. See paragraph 17.2.3 for a discussion of the Nascom Long Range Plan (LRP).

b. Drivers for Change. Drivers for change are both internal and external, and they include environmental factors. Examples of principal external drivers include future network user requirements and new interfaces associated therewith [EOS/EOS Data and Operations System (EDOS) program] and the requirement for data rates and volumes an order of magnitude higher than those supported during the 1980s decade; the fact that technology advancements drive paradigm shift changes in the telecommunications industry; the SN has planned significant changes resulting from the advent of the STGT, the WSC, a larger TDRS constellation and the follow-on TDRSS-II; planned changes in user operations (e.g., telescience); requirements for interoperability with the space networks of other countries' space agencies (ESA and NASDA); budgetary pressures; and resource limitations. Internal drivers characterized as being principally of a management nature, e.g. becoming more proactive in the planning and implementation of telecommunications services in the decade of the 90s and further, thereby asserting its leadership and fostering high-visibility participation in interagency planning and coordination activities. There are also the technology-based drivers that require internal Nascom R&D and study and analysis activities. In support of the foregoing, there are the planning and management actions necessary not only to maintain but also to expand the range and depth of skills available to Nascom both from its Civil Service staff and from its supporting contractor sources. Of particular impact are the Open Systems Interconnection (OSI) networking standards and protocols and the Federal policy mandating use of a selected set of these protocols in future Government networking systems (Government OSI Protocol Suite or GOSIP).

c. Nascom Planning Council. The LTP also established a Nascom Planning Council chaired by the Division Chief and composed of Nascom Division management at the branch level and above, and including a research and planning manager. The primary focus is to provide coordinated planning direction to Division elements. The Planning Council conducts periodic planning activities and provides planning strategies, sets objectives, and allocates and assigns responsibilities and tasks.

17.2.2 LTP/LRP GOALS AND OBJECTIVES

At the highest level, Nascom goals and objectives may be summarized as follows:

a. Provide efficient and effective institutional Nascom operational communications services that meet the requirements of the 1990s and beyond.

b. Develop and maintain in-house management skills sufficient to meet these requirements for Nascom communications services.

c. Develop the management, engineering, and operations plans necessary for effecting the necessary enhancements within the Nascom network and the development of "new" networks as required to meet the need of major flight programs, e.g., EOS.

17.2.3 LRP SCOPE AND CONTENT

A Nascom Long Range Plan (540-007, issued in January 1991) was developed in 1990 as a separate top-down mandated document prepared in accordance with guidelines and requirements promulgated by the GSFC Mission Operations and Data Systems Directorate (MO&DSD). The LRP was prepared in a form similar to that of the MO&DSD LRP; its content was coordinated with the that of the MO&DSD LRP in a manner showing how Nascom plans and projects supported those of the Directorate.

The Nascom 1990 LRP in effect captured in high level summary form the material contained in the NSDP of that year. One of the value added functions provided by the LRP was the establishment of a set of key service objectives and the description of how these objectives relate to the MO&DSD Directorate's service objectives as identified in the Directorate's LRP. The 1990 LRP further summarized near-term and long-term Nascom capabilities, and provided a look at Nascom's strategic plan for transition to the networks of the future.

17.2.4 NEW DIRECTIONS

At its inception, Nascom quickly discovered that it was not only operating at the forefront of technology but was significantly instrumental in pushing forward the technological developments necessary to fulfill its commitments to the space program. As a result, Nascom fielded a significant percentage of its infrastructure in the form of development items: proprietary and/or built for Nascom. The 4800-bit block was developed before there were international standards for data transmission in packetized form. Today, there are mature (and maturing) international and government standards for data communication (ISO, CCITT, CCSDS, GOSIP, TCP/IP, etc.), and vendors are offering standards based equipment and software on a commercial, off-the-shelf (COTS) basis. Space and earth science programs are now employing these standards based COTS offerings.

With the emphasis on doing NASA's business in ways which are "better, cheaper, faster," there is an opportunity now to develop a program for delivery of even more efficient and effective telecommunication network services with emphasis on customer satisfaction, quality, technical excellence, and cost effectiveness. There is now an opportunity to provide networking solutions adaptable to all projects rather than developing separate and distinct solutions for each project. Standards based COTS technologies, common to both the data user and data transport functions, allow this to happen. At the same time, there are opportunities to attain economies of scale and shared resources by carefully bringing the communication networks resources under single management.

With these strategic visions in mind, Nascom is an active participant in the MO&DSD's RENAISSANCE (Reusable Network Architecture for Interoperable Space Science Analysis, Navigation, and Control Environment) initiative. Nascom is also a leading player in the development of the NASA Office of Space Communications Strategic Plan. Internally, Nascom has developed an Evolution Action Plan (NEAP) with the following objectives in mind:

a. Review development plans for current and future systems to discover opportunities for insertion of standards based COTS products which offer opportunities to simplify operations, maintenance, and sustaining engineering support and thus reduce life-cycle costs.

b. Review the necessity for Nascom-specific protocols and identify (industry) standards based protocols that can be used to guide COTS insertion.

c. Review the Nascom-wide system engineering practices to take advantage of the flexibility of COTS packages to reduce the number of systems and their operational complexity.

d. Combine the results of these reviews into an Action Plan to chart the future of Nascom.

17.3 <u>CURRENT LRP STRATEGIC PLAN</u>

Present Nascom long-range planning strategy has separated advanced systems development activities, which include a major EOS Communications (Ecom) project from specific and current NU activities. Ecom draws upon work done for Nascom II before termination of NII procurement authority in FY92-1. These two activity areas are conducted concurrently. The following is a definition and expanded explanation of these terms and strategies.

17.3.1 DEFINITION OF NETWORK UPGRADING

17.3.1.1 <u>High-level Definition</u>. NU consists of any additions, modifications or enhancements, or replacements needed for existing Nascom systems, in order to continue to reliably support NASA missions using current aerospace data standards and practices.

17.3.1.2 <u>Scope of NU Activities</u>. NU activities sustain the major Nascom ground network systems currently supporting the STS/Orbiter/Spacelab/ Attached Payloads, Missions and Programs, and the life expectancy of the present on-orbit near-Earth and deep space missions that are supported by the GN, SN, and DSN networks. Additionally, NU upgrades these systems to provide support to the missions already planned for these existing ground network systems; e.g., HST, GRO, UARS (near-Earth missions), ISTP (high-Earth orbital missions), and Magellan, Galileo, Ulysses, and MARS Global Surveyor (MGS) (deep space missions).

17.3.1.3 NU for 4800-bit Block-based Systems. The requirement for continued use and sustaining engineering support of the present 4800-bit block format-based ground transport and switching system is included in the NU. Mission requirements for the SN/BDS system are expected to expire within 10 years as a result of expiration of existing and planned missions.

17.3.1.4 NU Relationship to LRP. The Nascom LRP recognizes the continued need for planning modifications, upgrades, and subsystem replacements because of aging or obsolescence. Technology advancements and the continued ability to provide near-term planning for, and relatively quick-response to, new or changing requirements for these missions are important elements of the Nascom LRP-NU commitment.

17.3.2 DEFINITION OF ADVANCED NETWORK SYSTEMS DEVELOPMENT ACTIVITIES

17.3.2.1 High-level Definition. These activities encompass the entire spectrum required, directly or indirectly, to meet the requirements of flight projects employing advanced orbital systems communication methods. Entirely new Nascom systems are under consideration with the focus being on CCSDS packet data transmission. These new systems will be data driven rather than schedule driven. An example is Ecom which is now being designed by Nascom for the exclusive support of EOS. As other flight projects formally establish their requirements, it would not be unreasonable to assume that additional Nascom projects could be initiated to provide a similar type of system/service for them. In this respect, the Ecom project serves as both a benchmark and a point of departure for evolving to the Nascom of the first decade of the twenty-first century.

17.3.2.2 Scope of Activities. These activities include: Nascom Advanced System Program technology studies and assessments particularly in the area of OSI Networking; participation in the ESDIS project initiatives at GSFC including certain R&D prototype developments in cooperation with GSFC Code 520 and the EOS project; continuing investigation and information gathering of missions and users support requirements; inter-agency systems planning and integration/coordination; development of architectural concepts, operations concepts, trade/feasibility studies and documented system design requirements leading to and including the various phases of procurement and implementation of Ecom; the development of interface agreements, control documentation, element and user interface compatibility, acceptance testing and full system documentation.

17.4 NETWORK UPGRADING ACTIVITIES AND PROJECTS

In the following paragraphs, NU activity/project descriptions are each identified as: recently completed, approved and undergoing implementation, or proposed and under evaluation. Projects or activities reported as completed will be removed from Section 17 in subsequent updates. Results will be integrated into system descriptions in Sections 3 through 15, if system modifications have been completed; results may be reflected in follow-on projects or plans, if applicable.

17.4.1 LOW SPEED NETWORK

As noted in the introduction of the Low Speed Network (LSN) System Requirements Document (541-200), budgetary constraints have led Nascom to the decision to discontinue operation of the existing MSS Low Speed System, commonly known as the teletype (TTY) network, as of October 1, 1994. But recognizing that requirements still remain for transport of tracking data and administrative message traffic, Nascom is implementing, separately from the MSS, a Low Speed Network.

The LSN is being designed as two separate systems. For the administrative message traffic, Nascom plans to implement a standards based, COTS Administrative Message System (AMS) using a TBD electronic mail system as its core (see Figure 17-1). Using this system, users will be able to send their messages directly to the recipients' mailboxes. The Nascom operated message center will no longer be required and can be closed. Users will be responsible for coordination of their communication with other system users, e.g., telephonically contacting the recipients of urgent messages to let them know an URGENT message has been placed in their mail box. As system administrator, Nascom will operate what might be called a "Help Desk" for the electronic mail system. For users, this means that electronic mail standards and protocols will be utilized. No longer available will be the 5-level Baudot coded TTY messages, the NASCOP message standards will no longer apply, and message retransmission will be a function of the end users.

For tracking data (non-human readable information), a LSN Tracking Data System (TDS) will be put in place with the switching/network management function at GSFC (see Figures 17-2 and 17-3). The TDS will support both ASCII and 4800-bit block. Baudot (5-level) code will not be supported. The TDS will provide interfaces for transport tracking

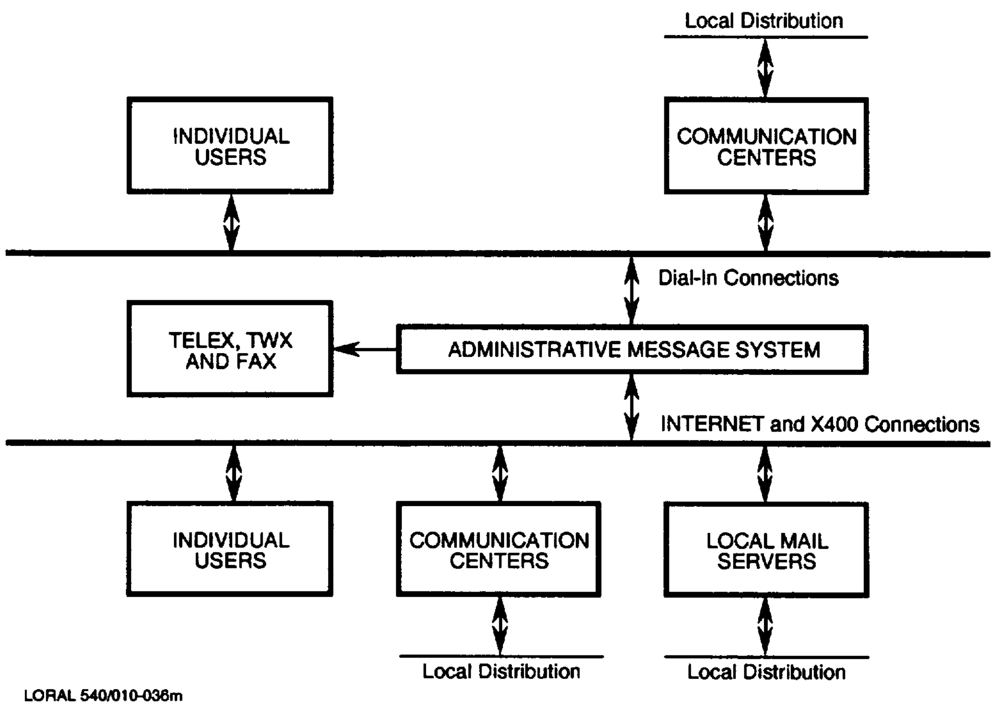

Figure 17-1. Proposed LAN Administrative Message System

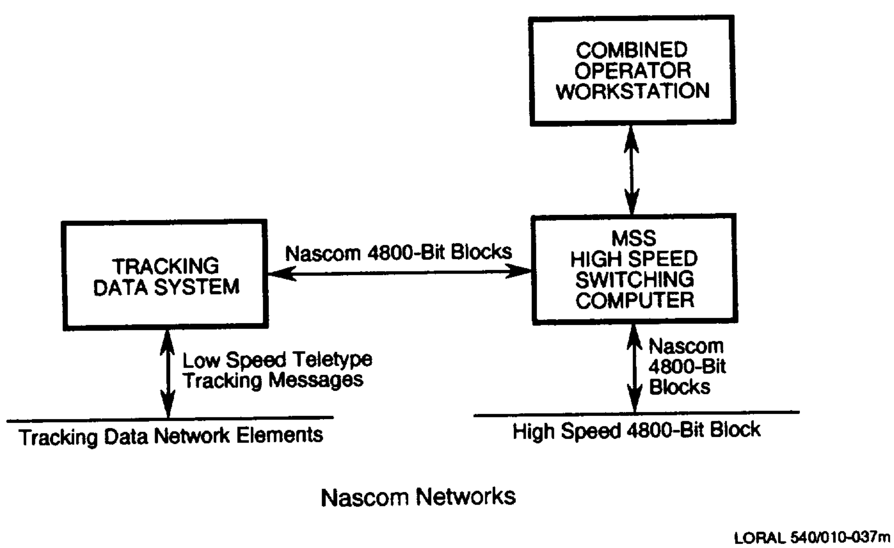

Figure 17-2. Proposed LSN Tracking Data System

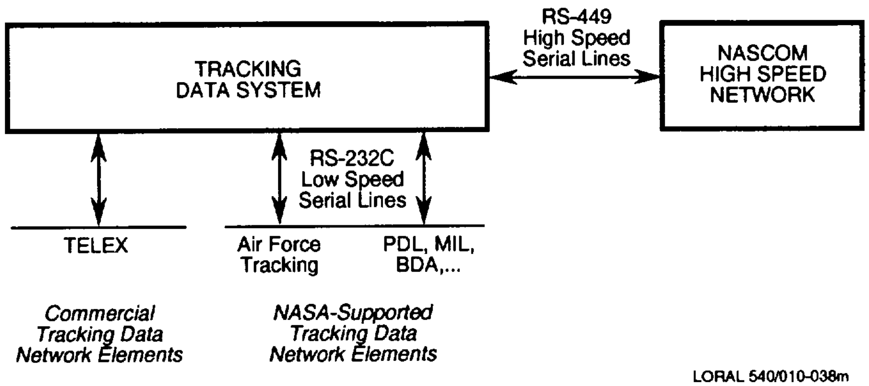

Figure 17-3. Detail of Tracking Data System

data: C-band, S-band and Improved Interrange, Vectors (IIRV). The functionalities that currently send and receive tracking data should not have to change, except to accommodate the discontinuance of Baudot code. Again the objective is to maximize use of COTS products, while recognizing that some software development will be required.

Figure 17-4 is a high level portrayal of Nascom message switching as planned for October 1994.

The schedule for the Low Speed Network (reflects acquisition occurring March and August 1994 and transition from the old system to the new occurring between August and October.

17.4.2 DIGITAL MATRIX SWITCH SYSTEM REPLACEMENT (DMSSR) PROJECT

17.4.2.1 Project Objectives. A Digital Matrix Switch Replacement Project has been established to meet the expanding needs of Nascom users for circuit switched services. The capacity of the current DMS, 192 input and 192 output channels, has been exceeded as more GSFC users have been added to the Nascom network. The existing matrix switch cannot be economically expanded.

The primary objective of the DMSR project is to develop a replacement system to meet the current and future circuit switching requirements of the GSFC user community. The chosen approach is a single switch with capability to interconnect at least 512 input ports and 512 output ports. Each port shall be simplex and consist of two signals (data and clock) at any rate from 100 bps to at least 2.048 Mbps, which shall be switched simultaneously. The second objective is to provide for a diagnostics capability that will perform the fault isolation function down to the single board level.

17.4.2.2 Background. In order to support the revised termination requirements for the MDM replacement system, and the growing pool of GSFC users, a replacement DMS is urgently required. The existing DMS, a one-of-a-kind product developed for Nascom by the Applied Physics Laboratory, implements Clos non-blocking switch theory and consists of input buffers, a matrix switch, output buffers and a DMS Control System. Figure 5-2 in Section 5 presents a simplified block diagram of the current DMS, and paragraph 5.3 provides a description of the existing system. Figure 17-5 represents one possible architecture of the replacement system. The DMSR will be procured using a modular implementation approach and commercial off-the-shelf (COTS) hardware and software to the maximum extent possible.

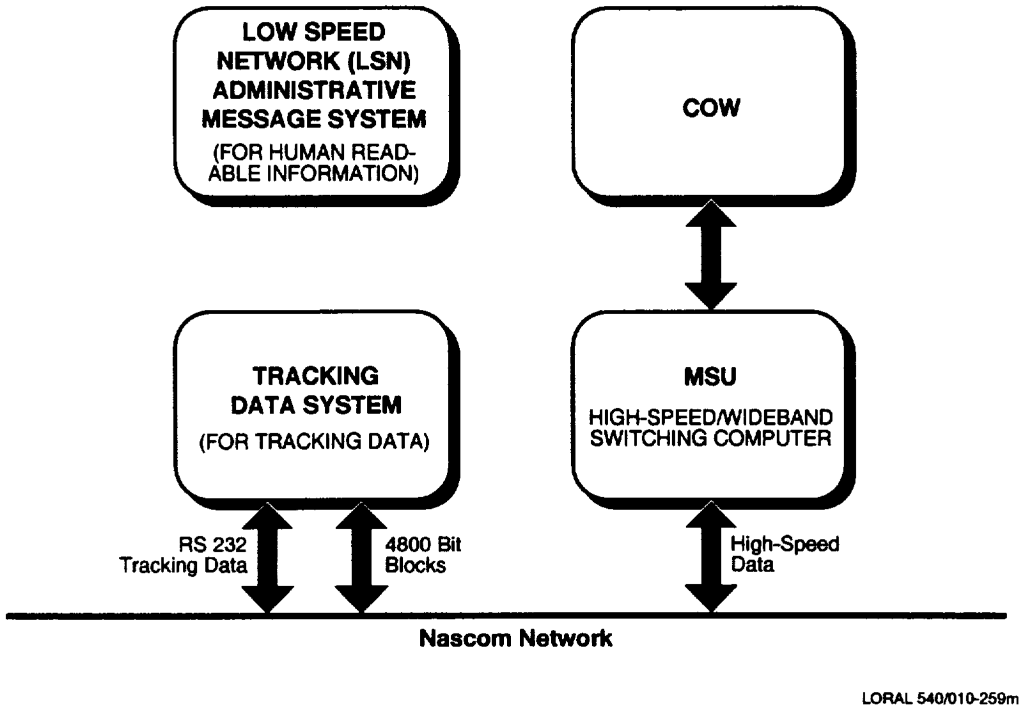

Figure 17-4. Nascom Message Switching as Planned for October 1994

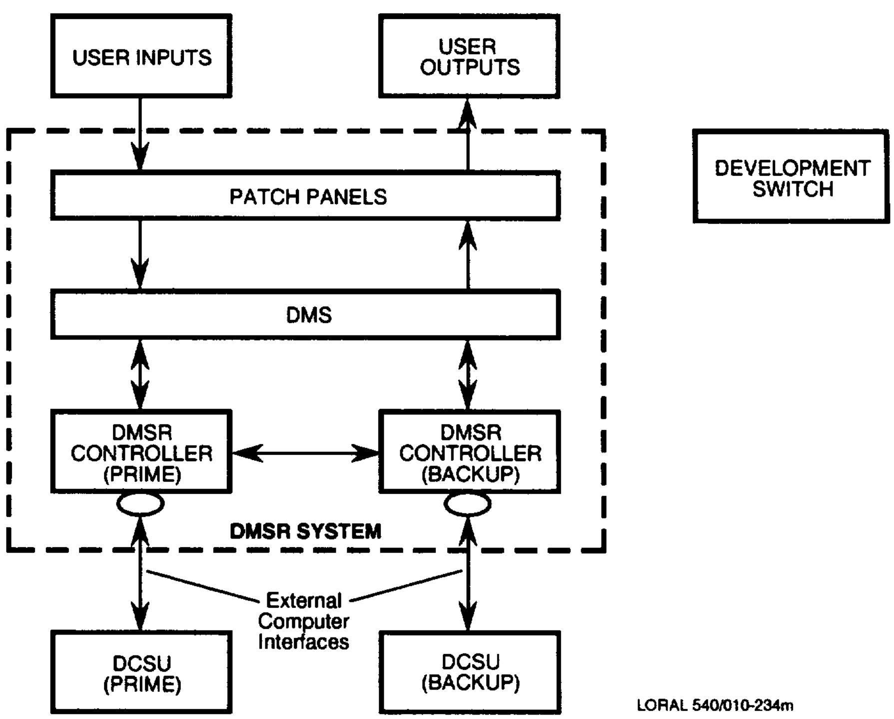

Figure 17-5. Proposed DMSR Architecture

17.4.2.3 Project Management Plan (PMP). A preliminary PMP document has been developed for the Level II DMSR project. As a Level II project, the document identifies the organizational relationships and responsibilities for the management and technical support throughout all phases of the DMS life cycle. This plan covers management approach, technical approach, system transition, operations, support and logistics.

17.4.2.4 Management Approach. The management approach for the DMSR Project is based on the MO&DSD System Management Plan (SMP) which outlines the documents and reviews needed. This ensures that all requirements for the DMS are identified and trace throughout each phase of the DMSR Project. The DMSR Project organizational interfaces include: the NASA Communications Division; the Systems Engineering Branch; the Communications Engineering Section; the Systems, Engineering, and Analysis Support (SEAS) contractor; the Computer Systems Section; the Operations Management Branch; the Communications Management Section; the Network and Mission Processing Equipment (ADPE) Procurement Branch; and the Logistics Supply Depot (LSD).

a. NASA Communications Division. The NASA Communications Division (Code 540), in fulfilling its responsibility for ensuring that Nascom's present and future requirements are met, has the overall system responsibility for the DMS replacement project.

b. System Engineering Branch. The Systems Engineering Branch (Code 541) has the overall responsibility for the procurement of the DMS replacement. The Communications Engineering Section, within the Systems Engineering Branch, is the project office for the DMS replacement project and has the responsibility for developing the requirements, procuring the DMSR, and implementing the DMSR into the Nascom network.

c. Communications Engineering Section. The Communications Engineering Section (Code 541.1) has assigned a DMSR Project Manager (PM). The PM is responsible for the day-to-day activities of the DMSR Project which will culminate in the successful procurement of a DMSR. In addition, the DMSR PM has the overall responsibility of ensuring the DMSR is tested by both the engineering and operations teams before it is accepted from the DMSR vendor by NASA. The PM, as part of the Communications Engineering Section, is responsible for the following activities:

(1) Interface with and solicit support from the Computer Systems Section, the Operations Management Branch, the Communications Management Section, the Quality Assurance office, the Logistics Supply Depot, the SEAS contractor, and the ADPE Procurement Branch.

(2) Develop the requirements for the DMSR specifications.

(3) Procure the DMS replacement system, to include: performing an industry survey of possible switch vendors, writing a sources sought synopsis to solicit vendor's inputs, providing technical documents and technical inputs to the ADPE procurement personnel for inclusion into the Request for Proposal (RFP) package, assembling a Source Evaluation Board (SEB) and subsequent evaluation criteria, coordinating with the chosen DMSR vendor the schedule and content of required meetings and reviews, overseeing the progress of the DMSR vendor during switch fabrication, and ensuring DMSR requirements are tested at the factory and on-site.

d. SEAS Contractor. The SEAS contractor, as the engineering support contractor, supports both the Communications Engineering Section and the Computer Systems Section.

(1) The SEAS contractor is responsible for the following activities, as requested by the Communications Engineering Section:

(a) Provide documentation support to include review of system documents, as required.

(b) Support acceptance testing efforts, as required, both at the factory and at GSFC. This may include testing of patch panels, to be provided by the DMSR vendor.

(c) Support the transition from the existing DMS to the DMSR. This includes preparing the facilities (HVAC, power, etc.) for the installation of the DMSR.

(d) Provide sustaining engineering support for the DMSR.

(2) The SEAS contractor is responsible for the following activities, as requested by the Computer Systems Section:

(a) Development of the Interface Requirements Document (IRD) and the Interface Control Document (ICD) between the DMSR controller and the DCSU.

(b) Negotiations with the DMSR vendor regarding the best approach for providing the DMSR controller / DCSU interface.

(c) Development of software needed for the DMSR controller / DCSU interface.

(d) Maintenance of and upgrades to the DMSR controller / DCSU interface. Also, if the DMSR controller source code is obtained, the maintenance of the DMSR controller software will be necessary.

e. Computer Systems Section. The Computer Systems Section (Code 541.2) will be responsible for the development of both the IRD and the ICD, which describe the interface formats needed between the DMSR controller and the DCSU. Code 541.2 will develop the IRD for inclusion in the RFP package. After vendor selection, Code 541.2 will negotiate the details of the external computer interfaces with the DMSR vendor, and subsequently develop and ICD. Code 541.2 will also ensure that software revisions received from the DMSR vendor for the DMSR controller and/or the external computer interfaces are satisfactory for the environment the DMSR will be in. In general, Code 541.2 is responsible for all matters relating to the software of the DMSR controller and its external computer interfaces.

f. Operations Management Branch/ Communications Management Section. The Operations Management Branch (Code 542) and in particular, the Communications Management Section (Code 542.2), is responsible for coordinating the transition from the existing DMS to the DMSR. Also, Code 542.2 is responsible for the operations portion of the overall engineering/operations testing. In addition, Code 542.2 will be overseeing the operations and maintenance (O&M) of the DMSR after is has been installed and tested. O&M support will be supplemented by the Network and Mission Operations Support (NMOS) contractor. Code 542.2 will also answer questions and provide support to the PM when operations issues arise.

g. NMOS Contractor. The NMOS contractor will be responsible for preparing the DMSR transition plan under the direction of Code 542.2. They will also support the operational testing portion of the DMSR acceptance testing.

h. Quality Assurance. The Quality Assurance office, Code 303, is responsible for all quality assurance issues associated with the DMSR Project. This will be done in accordance with the Nascom QA Plan and includes reviewing the System Design Specifications (SDS) and the Statement of Work (SOW) before they are part of the RFP package and, once a vendor is selected, ensuring the vendor is following proper QA procedures. Also, Code 303 will obtain Defense Contract Management Support (DCMS) as appropriate.

i. ADPE Procurement Branch. The ADPE Procurement Branch, Code 243, is responsible for the preparation of the RFP package an all contract activities.

j. Logistics Supply Depot (LSD). The LSD, Code 535, will be responsible for all logistics issues associated with the DMSR Project. This includes the overall spares provisioning and the repair process. In addition, the LSD and Code 535 will review DMSR documentation, develop a sparing analysis, track card-level maintenance failures once the DMSR is delivered, provide repair support when the DMSR vendor warranty has expired, and administer sustaining logistics following operational acceptance (unless the option in the DMSR contract for DMSR vendor-provided sustaining logistics is exercised).

17.4.2.5 Technical Approach

a. General. The DMSR will use commercial off-the-shelf hardware and software to the maximum extent feasible. Detailed system functions and performance are to be described in DMSR System Requirements Document and DMSR Specification (documentation under development).

b. Hardware and Interface Configuration. The DMSR will support the capability to compare the input and output of any configured channel, and to alert the operator in the event errors are detected. The DMSR will not provide storage of the throughput data.

The DMSR will possess its own internal control system. External control of the DMSR is via the DCS Upgrade (DCS/U); the DMSR vendor must demonstrate that its system will successfully interface with the DCS/U for external control and management activity.

The DMSR will be packaged in standard equipment racks. The capability to manually configure each channel is required and shall be implemented during the installation.

c. System Implementation Strategy. The DMSR implementation strategy contains four stages: a procurement phase, an installation phase, a testing phase, and a transition phase.

(1) Procurement. The training, system documentation, logistics support, and O&M procedures will be developed during the procurement phase.

(a) Training. Training includes the planning and conduct of the training program for the DMSR. This element includes developing and presenting the appropriate courses covering operations, maintenance, engineering, and follow-on support. This work will initially be performed by the vendor. The vendor's training will educate staff from the Networks Technical Training Facility (NTTF), the SEAS contractor, and the NMOS contractor. Subsequent training will be performed by NTTF personnel. This includes classes and materials needed by the operations personnel throughout the life of the DMSR. As recommended by Code 535, the format of the training classes and materials will follow standard 535-TIPCPT-001.

(b) Documentation. The following categories of project and system related documentation will be provided as part of the DMSR project: project management, system definition, system design, testing, training, logistics, maintenance, and operations. The schematics, catalogs, and manuals delivered with the DMSR will be provided by the vendor. Documents delivered with the DMSR and subsequent updates to the documentation will be brought under Configuration Management (CM) control. The CM of these documents throughout the life of the DMSR will be provided by the SEAS contractor.

(c) Logistics. Code 535 will be responsible for logistic support of the DMSR. Code 541 will establish the appropriate interfaces with Code 535 to assist in planning logistics support and in ensuring that initial spares and follow-on spare parts provisioning are accounted for in the procurement process.

(d) Facilities. No major revision will be required to the facilities that house and support the current system in order to accommodate the DMSR. Depending upon the software maintenance approach selected (in-house versus DMSR vendor), additional facilities may be required to support a DMSR development system.

(e) DMSR Development Facility. The DMSR contractor will be required to provide a scaled down DMSR system for the development and testing (verification and validation) of DMSR hardware and software, including the DCS/U interface.

(2) Installation. Installation includes the preparation of Building 3/14 Room E171 and the facilities needed to install the DMSR. Prior to delivery, Room E171 must be prepared to accept the DMSR; the preparation involves floor location, HVAC, power, lighting, and cooling. Also, cabling and other ancillary equipment may need to be provided and installed as well as preliminary check-outs of the DMSR before testing begins. The SEAS contractor will be responsible for this effort.

(3) Testing. Two phases of testing are planned for the DMSR: at the factory, and on-site.

(a) Factory Acceptance Testing. For factory acceptance testing, a vendor-provided Acceptance Test Plan (ATP) and Acceptance Test Procedures (ATPr) (to include a maintainability demo) will be followed. This will be provided to NASA for approval prior to the beginning of any acceptance testing.

(b) On-site Testing. For the on-site testing of the DMSR before government acceptance, a System Test Plan (STP) will be generated to describe the tests to be performed. The details of the test to be performed prior to acceptance are documented in the System Test Procedures (STPr). This activity will be a coordinated effort between Code 541 and Code 542, with oversight provided by the PM.

(4) Transition. The transition phase involves the changeover from the current DMS to the new DMSR. These efforts will be documented in a Transition Plan, to be developed by Code 542.2. Engineering support (engineering changes, material requisitions, etc.) will also be provided as needed.

(a) Hardware Maintenance. Hardware maintenance includes the maintenance of the delivered DMSR throughout its lifetime. During the first two years of its operational life, the DMSR maintenance is planned to be provided by the vendor via an extended warranty. After the first two years, maintenance will be provided by the NMOS contractor, with repair and spare parts support from the LSD and Code 535 (or the vendor, if the continued maintenance option on the contract is exercised).

(b) Software Maintenance. Software maintenance includes the maintenance of all system software, including:

1. Commercial Software in the DMSR Controller. Maintenance and upgrades for the DMSR controller software will be provided by the vendor; this software is proprietary (unless NASA received the source code, as asked for in the RFP package). Nonetheless, if the vendor goes out of business, NASA will receive the source code to provide maintenance.

2. Developed Software for the DMSR Controller/DCSU Interface. This software is planned to be developed, as much as possible, by SEAS via Code 541.2 direction. This includes the maintenance of the software. However, the details of this interface are yet to be determined, pending vendor selection.

(c) Operations Plan. The DMSR should perform the same generic circuit switching functions as the current DMS. Procedural revisions, as required, will be accomplished by Code 542.

d. Security. The DMSR is an unclassified system and is part of the NASA Operational System (NOS). The sensitivity level of the data is 3. The computer system, will adhere to NASA guidelines for Automated Data Processing Equipment (ADPE).

17.4.2.6 Status. The DMSR project is undergoing a thorough requirements review in conjunction with a comprehensive survey of the market for COTS vendors whose system(s) might, with minor modification, be adapted to meet Nascom requirements.

17.4.2.7 Schedule. Some tentative major milestones for the DMS replacement project are:

a.	RFP Release	03/94
b.	Contract Award	07/94
c.	Installation Complete	05/95
d.	Acceptance Testing Complete and Turn-over to Operations/ ORR	03/97

17.4.3 STGT-DIS RELATED ACTIVITIES

17.4.3.1 STGT-DIS Overview. The establishment of the Second TDRSS Ground Terminal (STGT) is a major goal of the planned augmentation of SN in accordance with the approved NASA 10-year plan for SN. It is a level 1 project of the MO&DSD. The STGT is an additional element of the SN. The STGT will be established as an enhancement of the TDRSS ground segment, which is currently defined as the WSGT and the collocated NGT. Figure 17-6 illustrates the relationship of the STGT to the TDRSS and to other elements of the SN. The functional features of STGT and its Data Interface System (DIS) are summarized in the following paragraphs:

a. The STGT is to provide, in conjunction with the TDRSS, forward (ground-to-space) and return (space-to-ground) communication and tracking services for TDRSS user satellites, as well as to perform tracking, telemetry, and command functions for the TDRS.

b. The STGT is required initially to function in an operationally ready standby capacity in the event of failure or performance degradation of existing WSGT facilities.

c. The STGT is being established in a facility provided by the Government at the NASA White Sands Test Facility (WSTF), NM, approximately 3 miles north of WSGT/NGT.

d. The STGT is also required to process and provide the required levels of protection for national security classified information. In addition to its other functions, the DIS will also provide support for classified information by receiving, processing, storing, transmitting and otherwise handling it in a secure manner.

e. The DIS is presently being implemented, and includes MDM and SM equivalent subsystems for interface with the Nascom-provided Common Carrier Interface (CCI), at WSGT, via the Interfacility Link (IFL). The DIS includes matrix switching for routing of user service interfaces and a defined set of interfaces allocated to both the local GTE CCI and the IFL. MDM channels must be reterminated and reassigned for these interfaces which will be controlled through NCC, DIS, and ADPE software.

f. The Interfacility Link (IFL) between WSGT/NGT and STGT provides for the exchange of user data between the NGT and the STGT-DIS. In addition it provides for the baseband data cross-strapping and interconnection for access to diversely routed Nascom common carrier data throughput systems and the single 50 Mb/s service at WSGT.

g. STGT follow-on plans call for refurbishment and replacement of the WSGT/NGT with a WSGT Upgrade (WSGT/U) after the STGT is operational. The WSGT/U will be functionally identical to the STGT. While the WSGT will be down for refurbishment, the STGT will assume the primary TDRS support role. When the WSGT/U returns to service, both ground stations will transition to a joint support role for the expanded TDRS constellation planned for the Space Station era.

h. STGT/WSGT/U Phasing Schedules. The STGT is scheduled to come online starting 4/1/94 , and will operate in parallel with the WSGT/NGT for 6 months until 10/1/94, with a gradual shift of operational services to the STGT. Standalone STGT service starts in 10/31/94 when WSGT/NGT will go

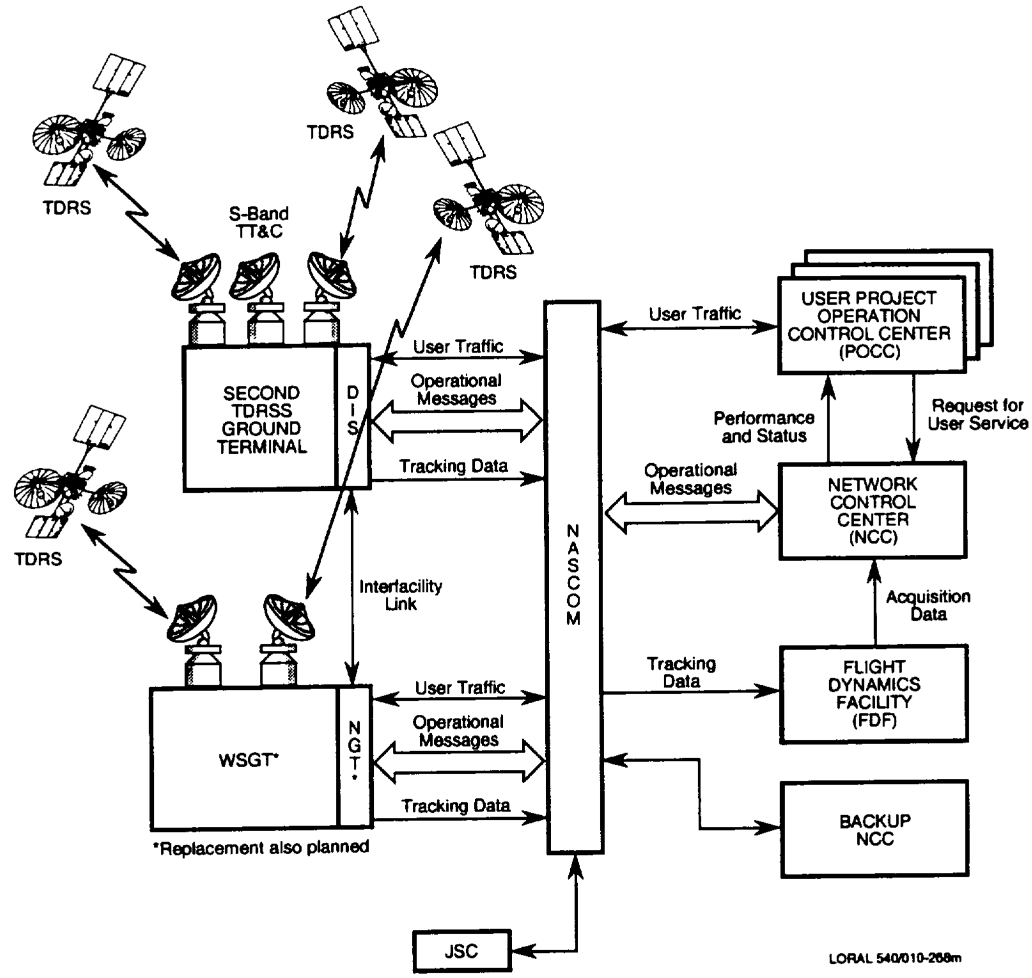

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Figure 17-6. The NASA Space Network Configuration with the STGT

down for its refurbishment. Final configuration will be achieved when WSGT/U returns to service, 12/15/95.

17.4.3.2 Nascom Support. Nascom will provide the communications services between the WSGT/STGT-DIS ground system baseband interfaces and corresponding SN user elements. New configuration requirements are being identified and Nascom/SEAS support studies are in progress as a continuing effort for both near-term (pre-Space Station) and Space Station era planning. Establishment of the initial STGT-DIS facility along with the other new SN-related requirements has a significant impact on the existing Nascom System architecture (i.e., MDM, DMS, and MACS equipment, and CSS software). Nascom support for the STGT/WSGT/U consists of the following activities:

a. Assume an active role in the development of the DIS.

b. Design and construction/implementation of the IFL fiber-optic cables and transmission systems, including the cross-strapping designs for access to/from the CCIs. Figures 17-7a, b, and c provide an IFL configuration overview for forward and return link baseband interface systems respectively. Note in Figure 17-7(a) that each site's return link includes a two-channel cross-strapping multiplexer which aggregates the MDM composite outputs of both sites. Thus, the return common carrier transport links become redundant, each carrying the same (both sites) data; one will be designated as prime link, the other will be an alternate (or backup) link as in the present BDS. Also note in Figure 17-7(b) that the forward link uses a similar prime and alternate arrangement; both links are bridged into WSC carrying the same forward data, but only one transport system is terminated at the destination at both sites through an A/B switch selection arrangement. Figure 17-7(c) shows that the 50 Mb/s service is available to only one return link at any given time. However, each site will have non-simultaneous, schedulable access to the SM.

c. Implementation of the new CCI for STGT/WSGT/U, and the attendant upgrade of the redundant long-haul transport system architecture; one of the two existing BDS Earth Stations will be relocated to the STGT location in April 1994.

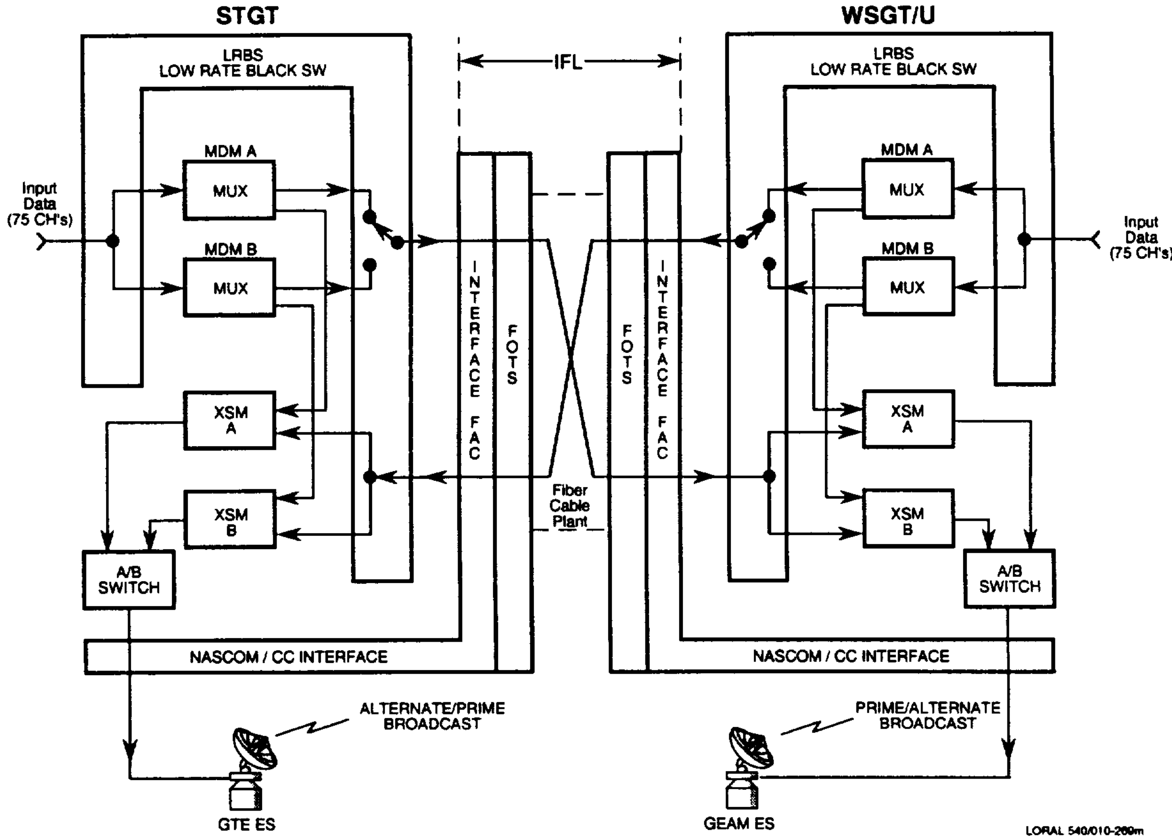

Figure 17-7(a). IFL and Associated Systems Overview Showing MDM Forward Link Interface

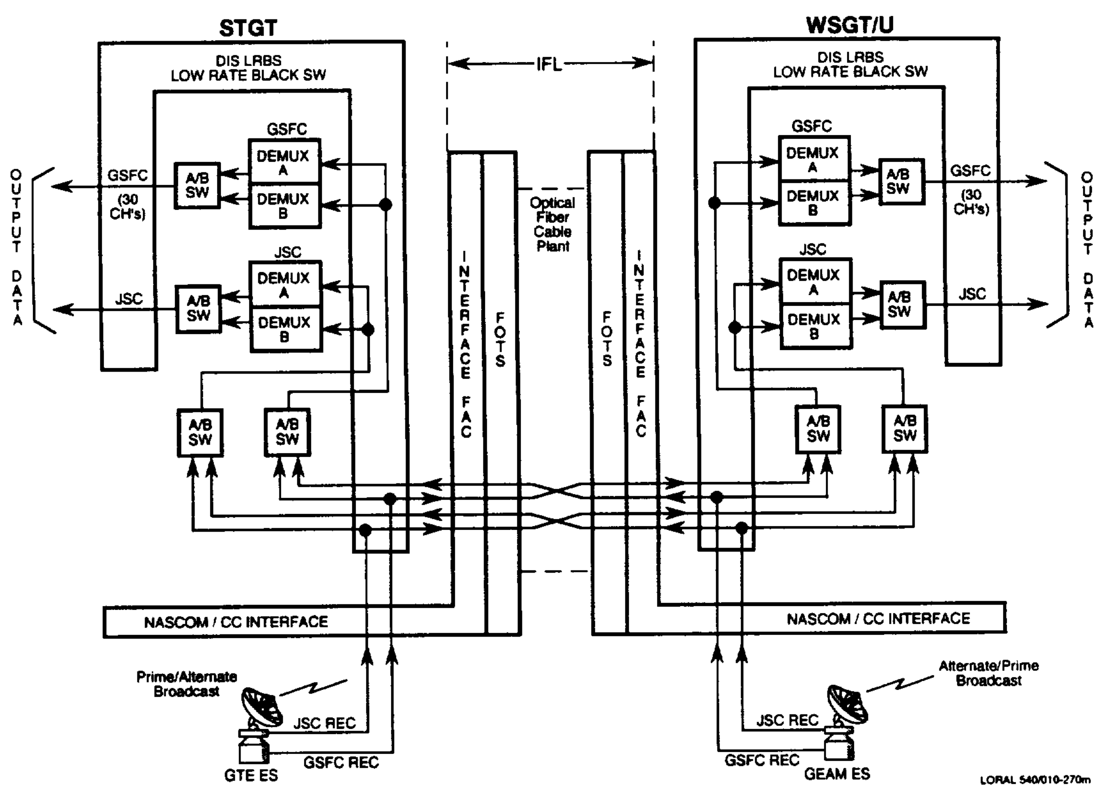

Figure 17-7(b). IFL and Associated Systems Overview Showing MDM Return Link Interface

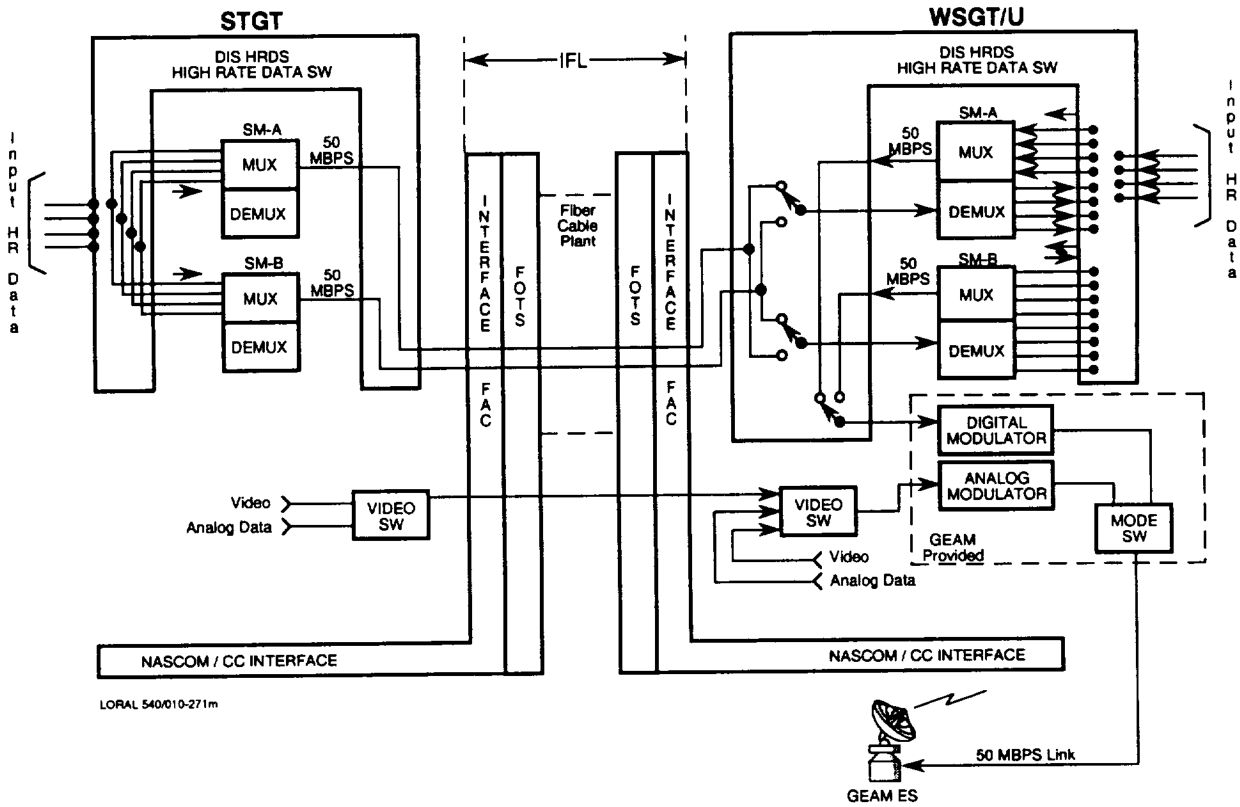

Figure 17-7(c). IFL and Associated Systems Overview Showing High Rate Data/Video Return Link Interface

d. Attendant upgrades of CSS/DMS systems, and NCC interface as required.

e. Implementation of the local administrative telephone service.

17.4.3.3 Status of Nascom Support. Items b and d of paragraph 17.4.3.2 are the major Nascom support efforts underway at this time:

a. IFL Implementation. The IFL implementation is complete and fully operational.

b. Nascom Interface Integration. Interface integration plans for the new DIS/Nascom MDM channel interface for NCC/CSS scheduling control, including port address assignments, has been the subject of close Code 530/540 coordination. Presently, Nascom MDM channels are hardwired to TDRSS interface channels. This will change: the new STGT/WSGT/U complex will provide baseband switching functions between TDRSS user services and the ground transport interface via the Low Rate Black Switch (LRBS). Nascom has negotiated a series of port addresses for the MDM system which reassigns and dedicates MDM channels to generic TDRSS user service types and to specific user data streams to and from control center (MOCC) interfaces. These assignments are documented in the Nascom Space Network Systems Upgrade (MDMR/MACSU) Operations Transition Plan, 542-045, dated September 1992. This document is configuration controlled by the Nascom Division CCB. These ITU/OTU assignments will also be incorporated in the Nascom SN Data Book, 542-016. FTS2000 may also play a role in the interface integration plans by supporting a portion of the voice/data links into STGT.

17.4.4 INTERBUILDING COMMUNICATION LINK UPGRADE (ICLU)

17.4.4.1 Background. The ICLU is a Level 3 project that will provide for the bandwidth and access requirements between the Nascom facility in Building 14 and the various other buildings on GSFC that house or will house Nascom service users. A review of major projects such as Second TDRSS Ground Terminal, the Space Station Freedom, EOS, and other projects indicates an expanded requirement for communications between Nascom and GSFC POCC's and data processing centers. The ICLU will provide the link bandwidth and channels, using fiber optic cables, between each user facility and Nascom to meet these future needs and in the process will replace existing systems designed for requirements and technologies (copper cables) of the 70's (IBDTS) and 80's (IBDDR).

17.4.4.2 Description. Individual circuit fiber optic cables have been or will be installed between Nascom and the various GSFC buildings that house facilities requiring this wideband service. The ICLU will utilize fibers provided by the Operational Mission-Oriented Nascom Interbuilding Fiber Optic Cable Plant (Figure 5-16). Interfacing the fiber optic cables are Fiber Optic Transceivers (FOT). Connections on the FOTs will be an RS-422 and BNC connectors. The ICLU design is a channel dedicated facility wherein every channel to and from entities is preassigned; a patchable, common redundant path feature is incorporated into the design to provide for a make good capability in the event of a hardware or fiber cable failure. Individual channel data rates of up to 10 Mb/s are to be supported, thus maintaining consistency with the replacement MDMs.

17.4.4.3 Schedule. The implementation schedule contains the following major milestones:

a. Prototype submittal 05/94.

b. FOT Contract Award 07/94.

c. Phased delivery of FOTs 08/94-11/94.

d. On-going integration and test 08/94-11/94.

e. Acceptance testing 09/94-12/94.

17.4.5 HIGH DATA RATE SYSTEM STATISTICAL MULTIPLEXER REPLACEMENT (SMR)

17.4.5.1 Concept. The present 50 Mb/s statistical multiplexer hardware transporting the Spacelab high rate multiplexer aggregate signal between the White Sands Complex and the receiving stations at GSFC, JPL, JSC, and MSFC is approaching the end of its economic life. A continuing requirement for the data rates and services it supports necessitates that the hardware be replaced maintaining current functionality in design but incorporating new technology that will enhance its reliability and supportability throughout the decade of the 90's and into the next century. A formal system requirements review has been conducted by Nascom, some of the main features of which are summarized in the following paragraphs. {Note: Though funds are not now available to implement this project, Nascom intends to have documentation completed to the point where a Request for Proposal could be released on relatively short notice in the event that funds became available.}

17.4.5.2 Requirements. The SRR for the SMR was conducted in November, 1993. It envisaged a system capable of transporting an 85 Mb/s aggregate at the carrier interface and providing at least four (modularly expandable to eight) user channel interfaces, each of which could accept user data rates from approximately 2 Mb/s up to 85 Mb/s, less SMR overhead. The system would be capable of being remotely controlled via a Simple Network Management Protocol (SNMP) interface. For local monitoring purposes, a local control and monitoring capability is intended. Additionally, at the WSC, the equipment would be required to maintain the integrity of the current interfaces at the WSC as set forth in the HRDLM ICD, dated June 25, 1992, and with paragraph 4.2.1.9 of STGT document STGT-HE-06-01.

Differing from today's system, there would be one terminal per NASA site: WSC (broadcast), and GSFC, JSC, JPL, and MSFC (receiving). Redundancy, sufficient to allow for automated failover between prime and redundant system elements to provide data path availability of at least 0.999975 over any continuous 10,000 hour operating period. Additional receiving terminals, e.g., at the EROS Data Center in Sioux Falls, SD, could be added modularly to the system if and as requirements warranted. The SMR would maintain the capability for dynamic clock tracking of user data, adjusting the output at the user interface.

Another differentiating point between the current SM and the SMR is that the data rates supported by the SMR will require fiber optic cables for on-site transmission of user data at the higher rates.

17.4.6 WBDS INTERSWITCHING CENTER - 64K OVERSEAS MULTIPLEXER CIRCUITS

An ongoing effort is underway to procure a 64-kb/s trunk line between GSFC and each of its foreign space agency counterparts. The goal is to provide a vehicle to support existing and planned project requirements and to reduce costs incurred by leasing individual voice and 9.6-kb/s circuits. Seven overseas centers have been identified to receive these services.

17.4.6.1 European Space Operations Center (ESOC) at Darmstadt, Germany. One full-duplex 64-kb/s data trunk is to be installed. The 64-kb/s service is to be multiplexed using a TimePlex Link/2+ multiple aggregate multiplexer. The trunk is to be configured for two 16-kb/s voice, one 8-kb/s voice, one 9.6 sync, and one 1200-baud teletype (riding on a 9.6 sync) channels.

17.4.6.2 European Space Operations Center (ESOC) at Vilspa, Spain. One full-duplex 64kb/s data trunk is to be installed. The 64-kb/s service is to be multiplexed using a TimePlex Link/2+ multiple aggregate multiplexer. The trunk is to be configured for one 8-kb/s voice, one 9.6 sync, and one 40.8-kb/s sync channels.

17.4.6.3 German Space Operations Center (GSOC) at Ober Pfaffenhofen, Germany. Existing services are to be reconfigured to add a 64-kb/s aggregate capability. The 64-kb/s service is to be multiplexed using existing General DataComm equipment. The aggregate service is to be configured for two 16-kb/s voice, three 9.6 sync, and one 300-baud async channels.

17.4.6.4 Centre National D'Etudes Spatiales (CNES) at Toulouse, France. One full-duplex 64-kb/s data trunk is to be installed. The 64-kb/s service is to be multiplexed using a TimePlex Link/2+ multiple aggregate multiplexer. The trunk is to be configured for two 16-kb/s voice, one 8-kb/s voice, one 9.6 sync, and one 1200-baud teletype (riding on a 9.6 sync) channels.

17.4.6.5 National Space Development Agency (NASDA) at Tokyo/Ibariki, Japan. One fullduplex 64-kb/s data trunk is to be installed. The 64-kb/s service is to be multiplexed using a TimePlex Link/2+ multiple aggregate multiplexer. One 32-kb/s voice, one 9.6-kb/s, and one 1200-baud async channels is the initial proposed configuration for the trunk.

17.4.6.6 Institute of Space and Astronautical Science (ISAS) at Sagamihara, Japan. One full-duplex 64-kb/s data trunk is to be installed. The 64-kb/s service is to be multiplexed using a TimePlex Link/2+ multiple aggregate multiplexer. One 32-kb/s voice, one 9.6-kb/s, and one 1200-baud async channels is the initial proposed configuration for the trunk.

17.4.6.7 Ground Network (GN) Station at Bermuda. One full-duplex 64-kb/s data trunk is to be installed. The 64-kb/s service is to be multiplexed using a TimePlex Link/2+ multiple aggregate multiplexer. The trunk is to be configured to support current project requirements.

17.4.6.8 Schedule. The schedule for overseas installations is as follows:

ESOC at Darmstadt, Germany	February 1994
ESOC at Vilspa, Spain	March 1994
GSOC at Ober Pfaffenhofen, Germany	March 1994
CNES at Toulouse, France	April 1994
NASDA at Tokyo, Ibariki, Japan	Late Summer 1994
ISAS at Sagamihara, Japan	Late Summer 1994
Bermuda GN	Late Winter 1994

17.4.7 FTS2000 IMPLEMENTATION PROJECT

17.4.7.1 Background. Public Law 100-440 imposes a requirement that all government agencies use GSA's FTS2000 contract to meet their network telecommunications requirements. In order for the FTS2000 to meet Nascom performance requirements, significant contract modifications needed to be made. In early 1991, the GSA, in conjunction with Nascom and AT&T (NASA is assigned to Network A for FTS2000 services; the vendor for Network A is AT&T), undertook to define the contract modifications that would be needed if FTS2000 were to provide the required services and meet Nascom's performance requirements. Three contract modifications were identified: Network Service Assurance Plan (NSAP), Special Routing (SR), and Alternate Network Connectivity (ANC).

a. Network Service Assurance Plan. The NSAP contract modification was awarded in April 1993. Basically, the NSAP provides for flagging and tagging of FTS2000 Network A assets supporting Nascom, maintains Nascom's position within the National Security Emergency Preparedness program, provides for enhanced maintenance response and special coverage, implements automatic restoration and reconfiguration within Nascom's allocation of Network A resources, and provides for site visits by the vendor.

b. Special Routing. The SR contract modification is anticipated to be awarded by December 1993. It provides for the establishment of a totally diverse terrestrial route, on an end-to-end basis, between any two points supported by Nascom where such route diversity is a requirement.

c. Alternate Network Connectivity. The ANC contract modification is anticipated to be awarded by September 1993. It makes provision for use of domestic satellite services between given locations, e.g., by making use of GTE Americom earth stations currently contracted for by Nascom.

17.4.7.2 Network Site Types. The NSAP contract modification makes provision for five different site types, i.e., node configurations. A center's complement of NSAP provided equipment may be comprised of multiple site types. Each site type will be briefly described in the following paragraphs.

a. Primary Site. The distinguishing feature of the primary site is the network management capability. Nascom will perform the network management function, remotely from GSFC, of the FTS2000 resources allocated for Nascom support. Network management functions may be extensively automated; however, human interaction with the network via remote terminal or workstation interfaces is standard. As is the case today, network access protection is assured. The primary site is equipped with the network management system, a digital cross connect device (DCCD) with five ports, a fully equipped enhanced (intelligent) multiplexer, and provisioned with spare circuit cards. (Figure 17-8)

b. Site A. An "A" site is similar to a Primary site with the exception that it does not have a capability to monitor or control the network. Otherwise, it is equipped the same as a Primary site. (Figure 17-9).

c. Site B. A "B" site is configured with an intelligent multiplexer terminating an FTS2000 T-1 line. The multiplexer is fully equipped and spared, but there is no DCCD. (Figure 17-10)

d. Site C. At a "C" site, there is a fully equipped and spared intelligent multiplexer which is interfaced to the FTS2000 network via a DCCD configured with two port cards. (Figure 17-11)

e. Site D. A "D" site interfaces the FTS2000 network via a DCCD configured for 3 ports. Each T-1 terminates in customer provided enhanced multiplexer equipment. To be connected to the NSAP T-1, the customer provided multiplexer must be approved by the FTS2000 vendor. In effect, this means using equipment designated by AT&T. (Figure 17-12)

f. Site T-1. A "T-1" site is equipped with an NSAP provided CSU (and spare). On the customer side of the CSU is customer terminating equipment, for example, the communications front end of a data processing facility, but with no NSAP provided nor NSAP approved multiplexer. (Figure 17-13)

17.4.7.3 Architecture and Topology. There are two intelligent multiplexers approved for use under the NSAP contract modification: the ACCULINK 740 and ACCULINK 745 ("ACCULINK" is a registered trademark of AT&T). The 740 is a programmable, time division, point-to-point, T-1 multiplexer capable of combining analog, voice, and digital data (both synchronous and asynchronous) into a single composite data stream with T-1 framing. The 745 is a T-1 switching multiplexer, which, along with the 740, is installed on the customer's premises by the FTS2000 vendor. The 745 supports the following network configurations: multipoint, drop and insert, and channel group bypass.

The FTS2000 transition plan as currently envisioned is for Nascom to cutover its existing voice and data circuits at each location where the criteria for using FTS2000 services (not less than six DS0s to or from any one location). Figure 17-14 represents a candidate architecture and topology for Nascom's FTS2000 network. (Again, this architecture is based on the transition of existing eligible circuits.) The figure portrays which FTS2000 contract modifications are used on any given link and provides a representation of each node's architecture [site type(s)]. Note that NSAP, as implemented by Nascom, is limited to the 48 contiguous states of the Continental United States. International circuits, circuits to Hawaii, Alaska, and the off-shore territories and possessions of the United States are not included.

17.4.9.4 Schedule. Table 17-1 depicts the most current schedule for FTS2000 implementation. It should be noted that this schedule is subject to change as Engineering Changes and detailed center/site implementation plans are developed.

17.5 ADVANCED NETWORK SYSTEMS DEVELOPMENT ACTIVITIES

17.5.1 ACTIVITIES OVERVIEW

As indicated in paragraph 17.3.2, these include activities directly or indirectly related to the development and implementation of new Nascom data transport system(s) for the mid-1990's. These activities also include a variety of ongoing research and development projects, and SEAS contractor-tasked analysis studies. The following is a topical summary of advanced development-related activities that are addressed in paragraph 17.5:

a. EOS Communications (Ecom)

b. GSFC FDDI LAN Development

17.5.2 EOS COMMUNICATIONS (Ecom) PROJECT

17.5.2.1 General. The Ecom project provides a unique ground-to-ground data transport system

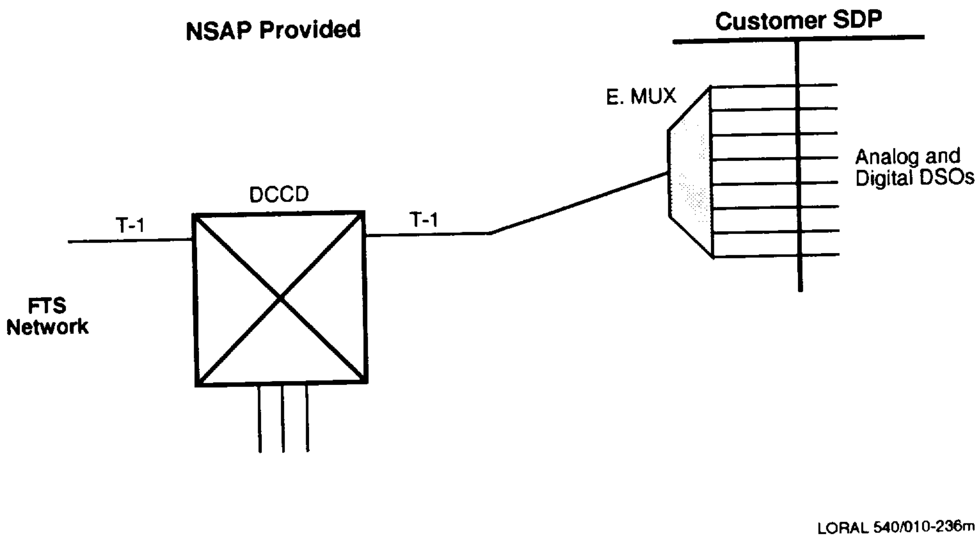

Figure 17-8. Typical of Primary Site

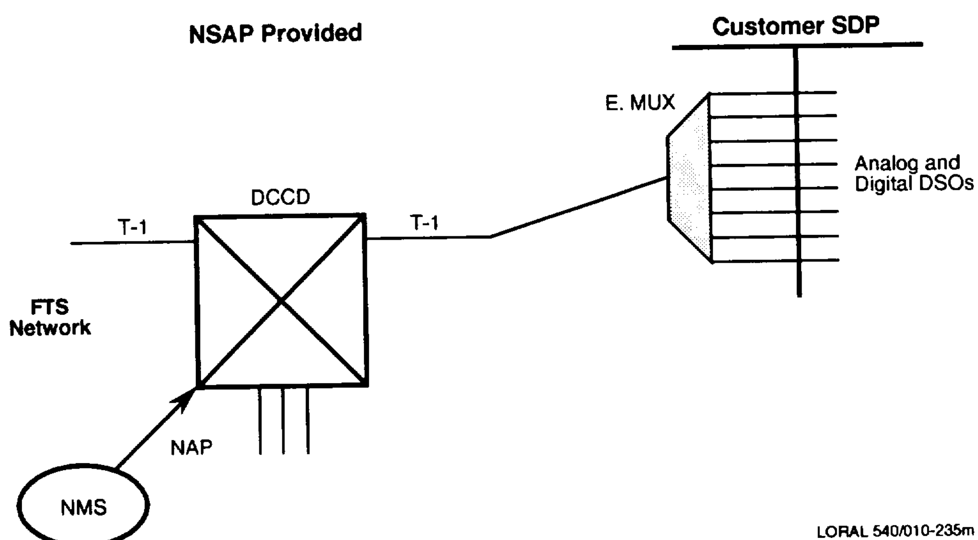

Figure 17-9. Typical of Site A

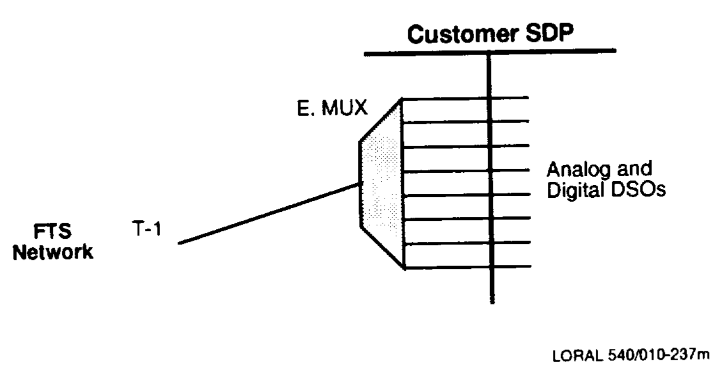

Figure 17-10. Typical of Site B

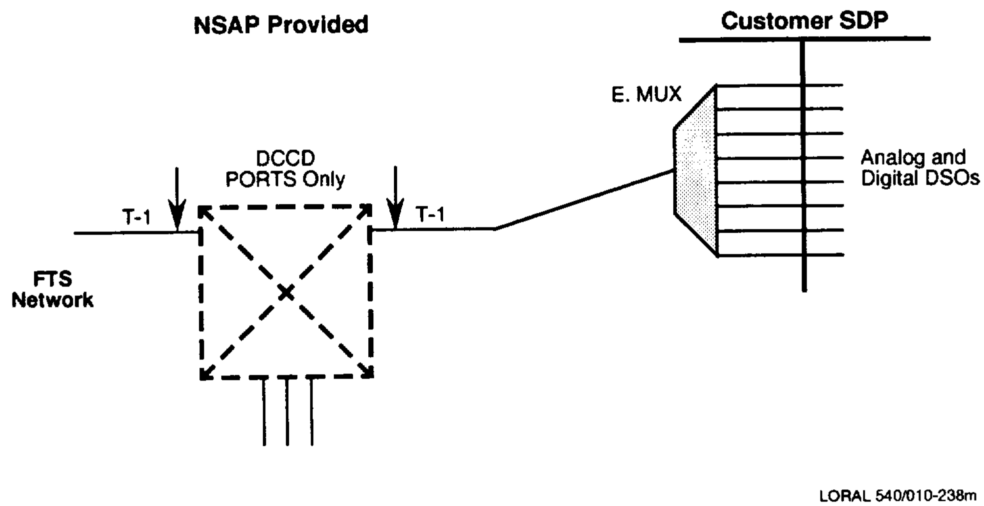

Figure 17-11. Typical of Site C

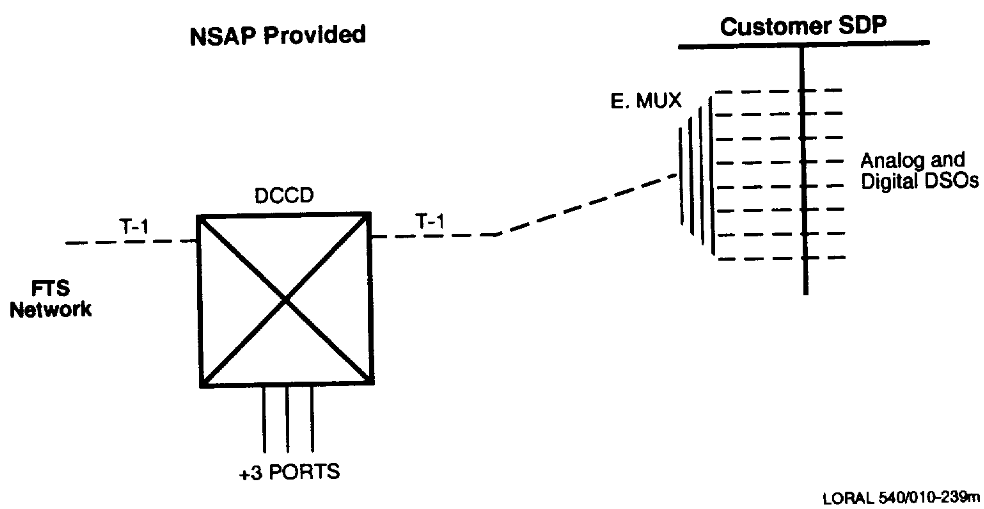

Figure 17-12. Typical of Site D

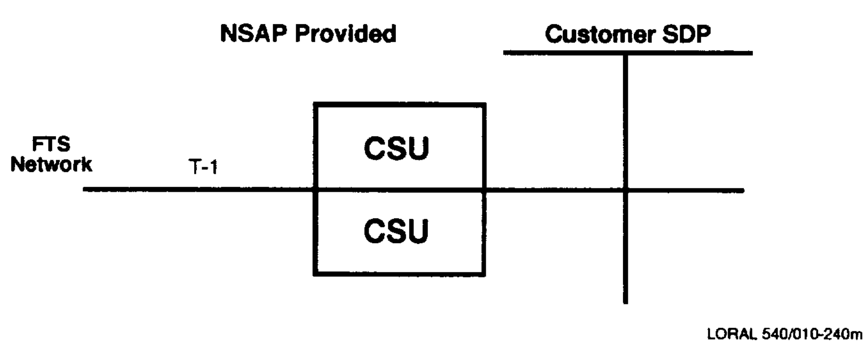

Figure 17-13. Typical of Site T-1

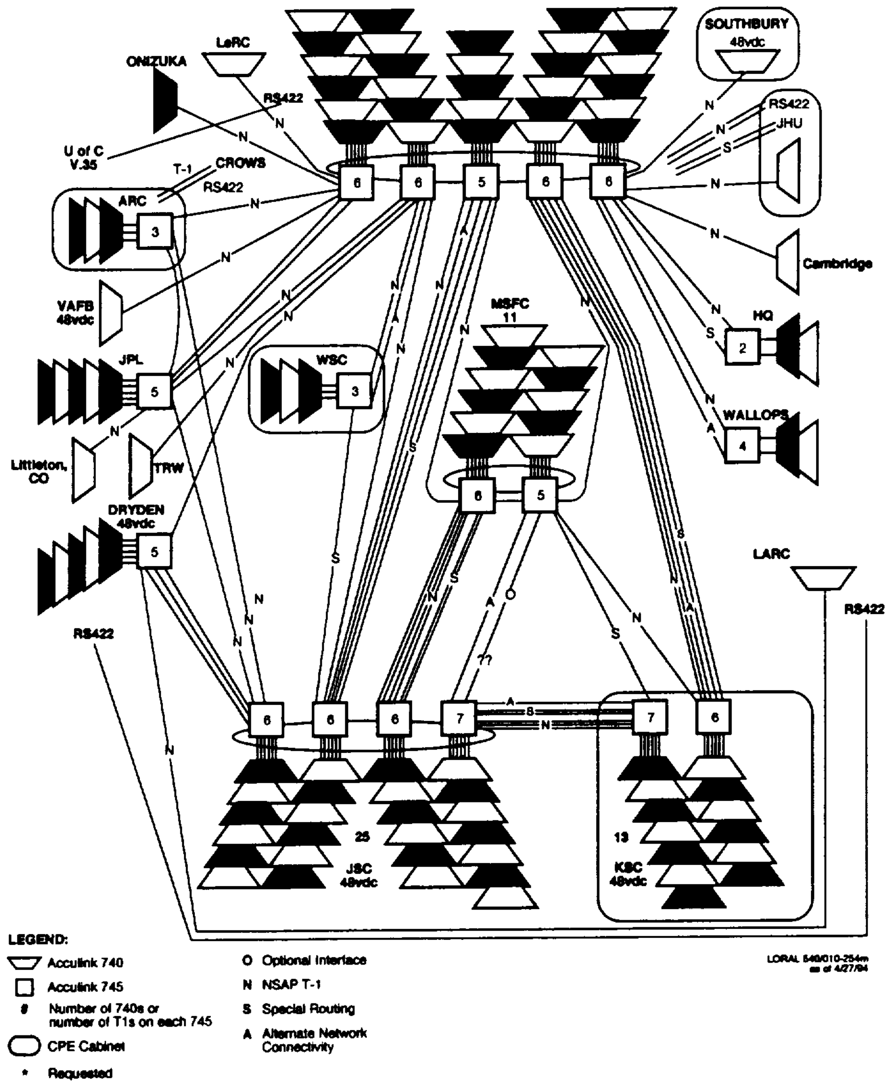

Figure 17-14. Nascom FTS2000 Network Topology

for operational EOS communications; Ecom is being built to address EOS-specific requirements. (A high level summary of the EOS project is presented in paragraph 16.2.10.) The system provided by Ecom will transport forward link commands, return link telemetry and payload science data, and operational data flowing between EDOS elements and between EDOS and the Distributed Active Archive Centers (DAAC). Additionally, Ecom/Nascom will provide the communications between the EOS Operations Center (EOC) and the MO&DSD institutional systems (1) controlling and scheduling Space Network resources (the NCC) and (2) determining spacecraft orbit and attitude (the FDF) as well as the contingency support communications interfaces with the GN, Wallops Orbital Tracking Station (WOTS), and the DSN.

17.5.2.2 Goals and Requirements. The goals of Ecom are to:

a. Implement an automated system maximizing use of Commercial-Off-The-Shelf (COTS) equipment.

b. Maintain compatibility with existing and enhanced versions of NASA institutional systems as needed to meet EOS requirements.

c. Minimize life-cycle costs for implementation, operation, and maintenance of the network.

d. Allow for growth, adaptability to changing requirements, infusion of new technology, and upgrading interfaces throughout its life cycle.

e. Prevent the unauthorized use of Ecom resources.

f. Operate with a minimum of human intervention.

In embracing these goals, some of the requirements that Ecom will support are as follows:

a. Transport traffic in a data driven mode between specified locations.

Table 17-1. Nascom FTS2000 Project Schedule

DATE	LOCATION 1	LOCATION 2	NUMBER OF T1 CIRCUITS	STATUS
1993				
09/09	GSFC	JHU	(4) O	Completed
11/03-08	GSFC	JSC	(2) Equipment Upgrade and Transition	Completed
11/16	GSFC	Berkeley, CA	(1) O	Completed
12/20	GSFC	JPL	(1) N	Completed
1994				
01/10	GSFC	JSC	(1) N, (1) S	Completed
01/13	GSFC	JHU	(1) N	Completed
02/07	PASADENA**		SDIS PIPE	
02/14	JPL**	San Diego, CA	(1) 9.6 Digital	Service Request Received
02/14	JPL**	Palo Alto, CA	(1) 9.6 Digital	Service Request Received
02/15	GSFC	JHU	(4) O, Change to Multimount	Completed
02/16	GSFC	Southbury*	(1) N	Completed
02/18	GSFC	MSFC*	(1) N	Completed
02/21	GSFC	LeRC	(1) N	Completed
02/23	GSFC	ARC (Moffett)	(1) N	Completed
02/25	GSFC	Headquarters	(1) N	Completed
03/17	ARC	NALF	(1) N	Service Request Received
03/25	JPL	ARC (Moffett)	(1) N	Service Request Recieved
03/29	GSFC	Berkeley, CA	(1) Change to Multimount	Completed
03/29	GSFC	MSFC	(1) N	Completed
04/19	ARC	NALF	(1) O	SRR
04/25	GSFC	JPL	(1) A	SRR
04/28	LaRC	DFRF*	(1) N	SRR
04/28	LaRC	DFRF*	(1) O	SRR
05/02	GSFC	TRW (Redondo)	(1) N	SRR
05/04	GSFC	Headquarters	(1) S	SRR
05/05	GSFC	VAFB*	(1) N	SRR
05/11	JSC*	MSFC	(3) N	
05/12	GSFC	WLPS	(1) N	
05/12	GSFC	WLPS	(1) A	
05/17	JSC*	MSFC	(1) S	
05/17	GSFC	JSC*	(1) A	
05/23	JSC	MSFC	(1) S	
05/25	JSC	MSFC	(1) A	
05/27	GSFC	Cambridge	(1) N	
05/31	JSC*	DFRF*	(1) N	
06/02	JSC*	DFRF*	(1) A	
06/06	JSC*	JPL	(1) N	
06/06	JSC*	ARC	(1) N	
06/08	GSFC	DFRF*	(1) N	
06/13	GSFC	JPL	(1) S	
06/15	GSFC	OAFB	(1) N	
TBD	JSC	WSC-STGT	(1) N	
TBD	GSFC	WSC-STGT	(1) N	
TBD	GSFC	WSC-STGT	(1) A	
TDB	GSFC	KSC	(1) N	
TBD	GSFC	KSC	(1) A	
TBD	GSFC	KSC	(1) S	
TBD	GSFC	KSC	(1) S	
TBD	JPL	Littleton CO	(1) N	
TBD	JSC*	KSC	(1) N	
TBD	JSC*	KSC	(1) N	
TBD	JSC*	KSC	(1) N	
TBD	JSC*	KSC	(1) S	
TBD	JSC*	KSC	(1) S	
TBD	JSC*	KSC	(1) A	
TBD	MSFC	KSC	(1) N	
TBD	MSFC	KSC	(1) S	
TBD	GSFC	KSC	(1) N	

LEGEND:
- **N** NSAP
- **S** Special Routed
- **A** Alternate Network Connectivity
- **O** Optional Interface
- * Locations that Require -48 Volt Power
- ** SDIS Access

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(as of 4/27/94)

b. Accommodate operations, simulations and testing on a concurrent basis.

c. Comply with a standard addressing convention per Open Systems Interconnection (OSI) Network Service Access Point addressing and Internet Protocol (IP).

d. Route on Government Open System Interconnection Profile (GOSIP) and IP.

e. Perform protocol and address mapping.

f. Expand to add new nodes.

g. Expand modularly the number of physical interfaces and/or the aggregate throughput rate of any node.

h. Provide network monitoring and control capabilities to manage network topology and resource allocation with display of same.

i. Manage network operations, administration, planning and security functions.

j. Perform fault management functions inclusive of fault detection, isolation and resolution.

k. Collect and report accounting and network utilization information.

l. Ensure users comply with NASA Communications Access Protection Policy and Guidelines and provide user authorization.

17.5.2.3 Design Assumptions. Ecom makes certain assumptions relative to network design. Some of these are stated in the following paragraphs:

a. Science users will interface Ecom via Asynchronous Transfer Mode (ATM) via 100 Mbps multi-mode fiber, User-Network Interfaces (100UNIs), or Synchronous Optical Network (SONET) Optical Carrier (OC) 3c interfaces. For permanent virtual circuits, the maximum single user rate is 28 Mbps.

b. Real-time users will interface Ecom via Fiber Distributed Data Interface (FDDI), Ethernet II, or 802.3 local area networks.

c. The common carrier subsystem will use only full period, dedicated, leased common carrier services. DS3 service (44.736 Mbps) is the highest-rate tarriffed service available currently, and, consequently, is the highest-rate that is now used in the Ecom design.

17.5.2.4 Topology and Architecture. A high level view of end-to-end data flows is depicted in Figure 17-15. Figure 17-16 provides a conceptual architecture representation for Ecom, its Node structure, and the relationship of Ecom network management functions to the EDOS management system. Ecom's design concept incorporates different subsystems for transport, network management, common carrier circuits, and engineering support. Using projected traffic data supplied by the EOS project, and after subjecting that data to network modeling and analysis, Ecom has developed candidate topologies for support of the AM-1 mission (1998) and for the year 2002. These are depicted in Figures 17-17 and 17-18 respectively. These topologies incorporate the following design rules:

a. The primary path between any two points is one hop. The secondary path is not more than two hops.

b. Design utilization of available bandwidth is less than 80 per cent.

c. Each location will be supported by two diverse physical paths. Sufficient redundancy is provided in each path to enable recovery from a total path failure on one of the two paths.

17.5.2.4.1 Transport Subsystem. The transport subsystem (TS) provides realtime, science, and frame encapsulator/decapsulator (FED) services. It also provide diagnostics equipment. The TS is based on a backbone of ATM switches. Each of the three services utilizes this ATM backbone.

a. Science users interface with Ecom through a fiber protect switch (FPS). The FPS enables Ecom to manually switch a science user from its primary ATM switch to a backup whenever the ATM interface (or entire switch) fails. Configuration items used to provide the science service are fiber protect switch, ATM switch, and DS1 and DS3 patch panels. The architecture of the science service is depicted in Figure 17-19.

b. Realtime users, given their more stringent availability and service restoral time requirements, must have automated recovery from all failures. Therefore, they interface with Ecom via Ethernet II/802.3 or FDDI LAN wiring hubs. The wiring hubs connect to routers which select the data path based on the layer 3 packets. ATM switches, in turn, combine the realtime with the science traffic, giving priority to router traffic. Configuration items used to provide the realtime service are the wiring hub, router, ATM switch (shared with science and FED services), and DS1 and DS3 patch panels (shared with other services). The architec-

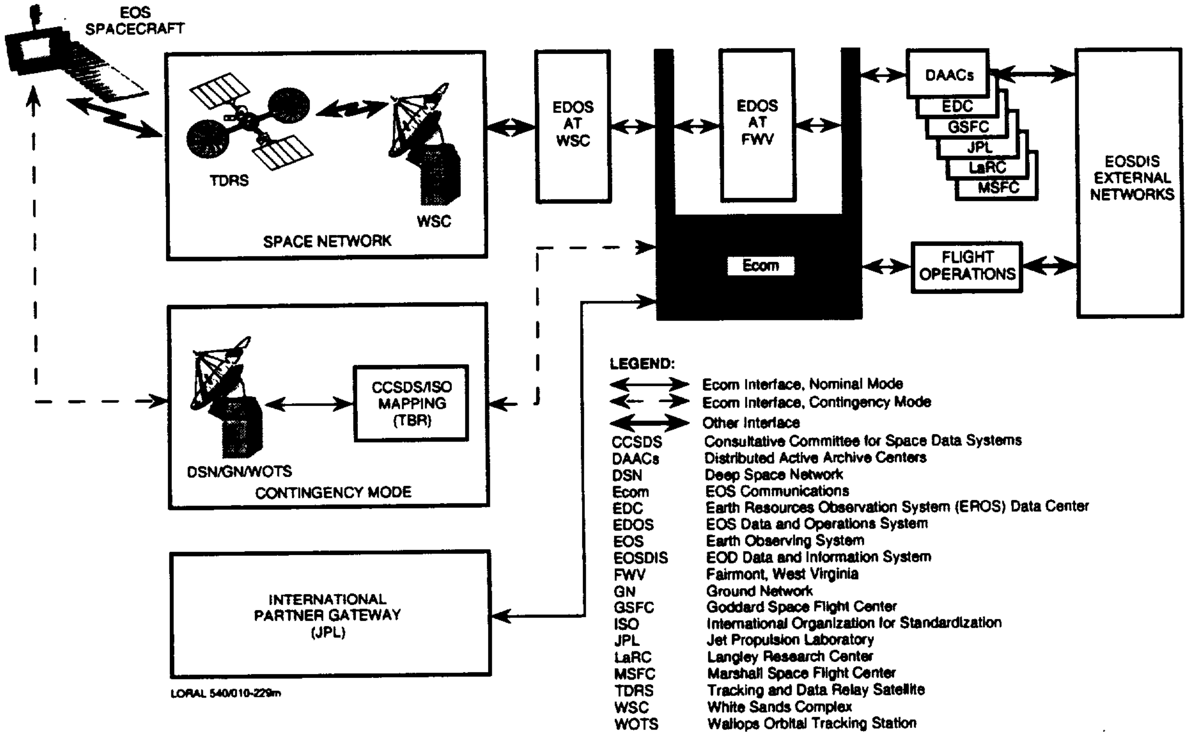

Figure 17-15. End-to-End Data Flow

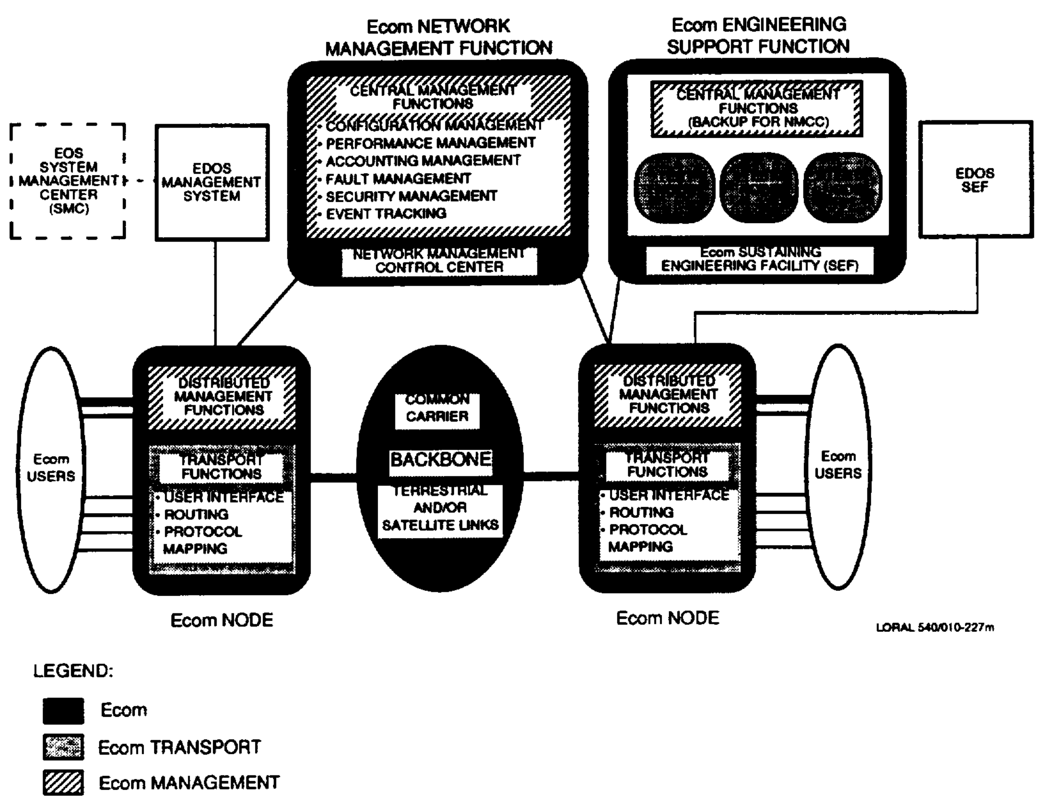

Figure 17-16. Ecom Conceptual Architecture

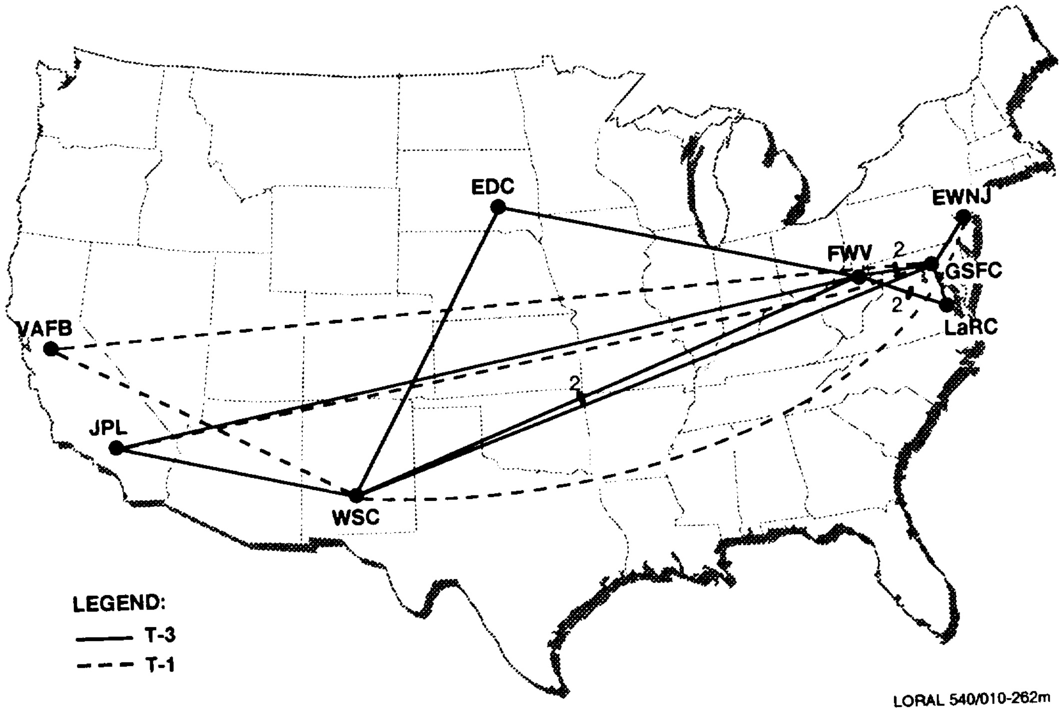

Figure 17-17. Candidate AM-1 Topology

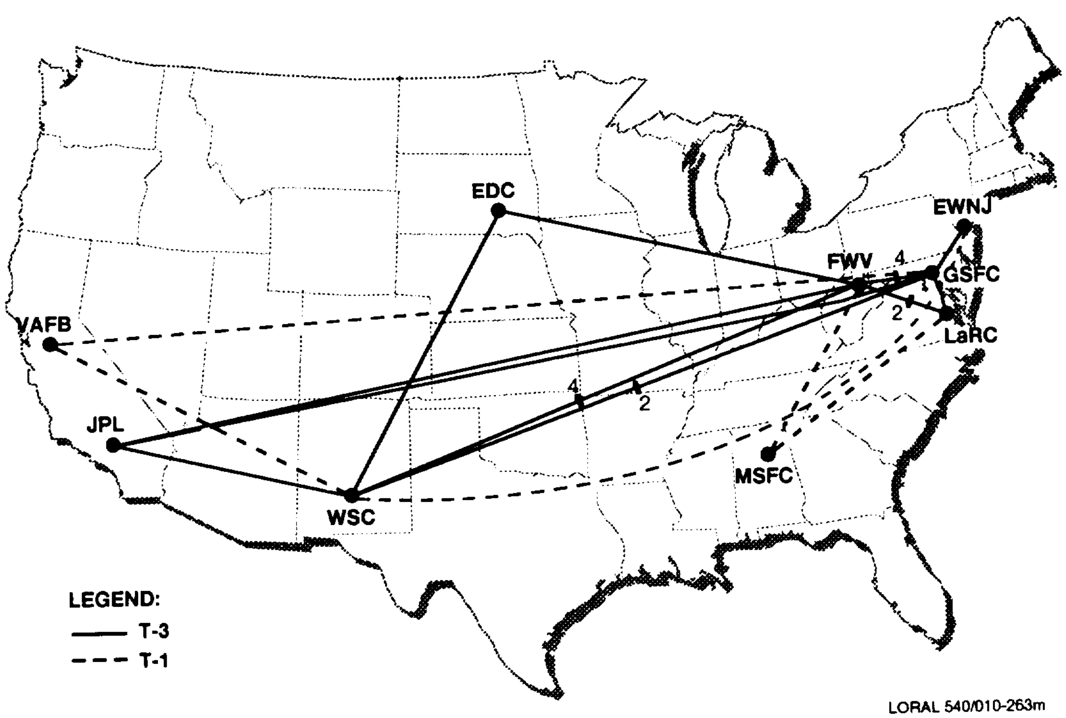

Figure 17-18. Candidate 2002 Topology

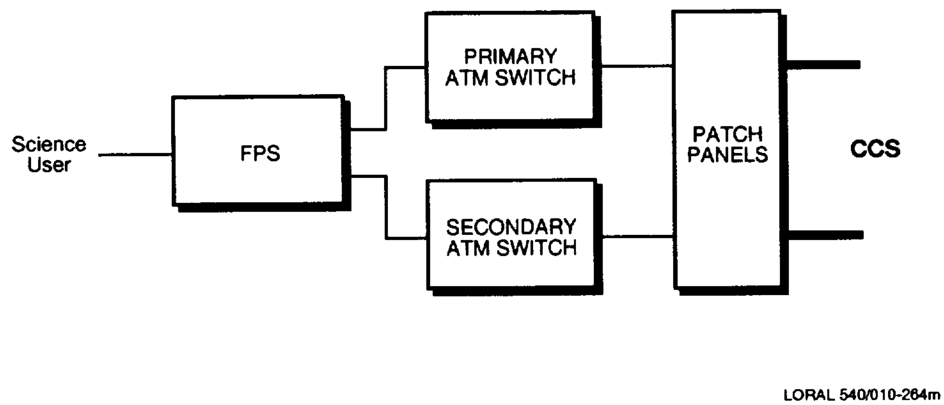

Figure 17-19. Science Transport Architecture

ture of the realtime service is depicted in Figure 17-20.

c. Frame encapsulator/decapsulator services are used to provide 4800-bit block data transfers with designated NASA institutional systems, e.g., the NCC, and CCSDS formatted data during prelaunch testing activities. The FED device is a development item for the Ecom project. It shares the following CIs with science and realtime services: wiring hub, router, ATM switch, and DS1 and DS3 patch panels.

17.5.2.4.2 Common Carrier Subsystem. The common carrier subsystem (CCS) connects the elements of the TS together using leased circuits and services. The candidate topologies, depicted in Figures 17-17 and 17-18, are simply candidates at this time. As the design matures, these topologies will be optimized. Baselining of the topology is scheduled to occur at CDR, with refinement and optimization occurring thereafter, if required. In addition, Ecom will support 9.6 kbps dial-up circuits from the NMCC and SEF out to each of the TS nodes.

17.5.2.4.3 Network Management Subsystem. The network management subsystem (NMS) is comprised of central management equipment (CME), located at GSFC, and nodal network management equipment. The CME monitors, manages, and controls the TS. It also monitors the CCS

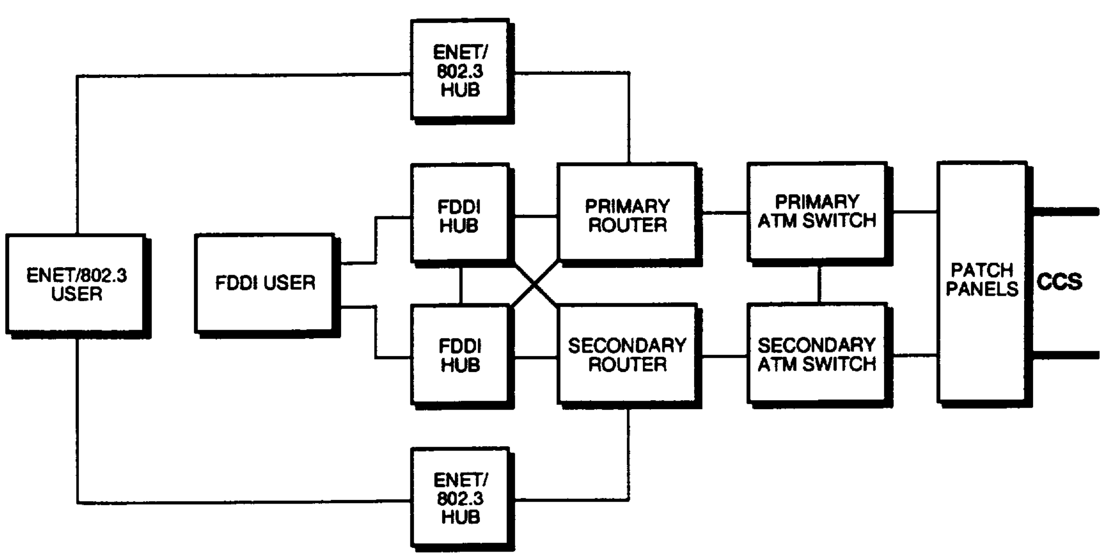

Figure 17-20. Realtime Transport Architecture

via the TS using standard NM protocols and COTS software to the maximum extent possible. The CME performs these functions from the NMCC in Bldg 3/14. The CME is comprised of four operator stations (OS) and four laser printers. The CME interfaces with the EDOS Operations Management Function through the TS, with the NMCC console operators through the OSs, and with the M&O technicians through a human-machine interface (HMI) at each node. Communication between the CME and the TS uses the SNMP protocol to the maximum allowable extent. The CME will support Management Information Base (MIB) II as a minimum. The network management functions, listed in paragraph 17.5.2.2, are performed by the NMS. The CI architecture of the NM is depicted in Figure 17-21; the functions allocated to each OS are listed as part of the different CIs associated with each numbered OS.

17.5.2.4.4 Engineering Support Subsystem. The engineering support subsystem (ESS) will be located in the Ecom Sustaining Engineering Facility, Building 28, GSFC. Though it is comprised mainly of CIs common to the TS and NMS, it is designated as a separate subsystem because it contains some additional CIs that are specific to engineering support. The ESS includes three test nodes (test nodes are non-operational and do not interface the TS) which, taken together, contain at least one piece of every kind of equipment found in the TS. Sufficient equipment is provided to enable two of the test nodes to be configured to support the maximum single stream data rate supported by the network, and so that alternate routing, switchover (failover), and service restoral scenarios can be tested. The ESS also supports the NMS function, and is to be equipped with one OS-1 or OS-2, one OS-3 or OS-4, one each high and low speed laser printers, two nodal human-machine interfaces, a maintenance terminal, two dial modems, one asynchronous data switch, and two modeling and development workstations. So equipped, the ESS can function as an emergency network control center in the event of a catastrophic failure of the NMCC. A functional depiction of the ESS equipment and its relationship to the TS is presented in Figure 17-22.

17.5.2.5 Implementation Approach. Implementation of the Ecom project is a responsibility of the NASA Communications Division, GSFC Code 540. To lead the project, Nascom has assigned a full time project manager at the "Assistant Chief for" level. The project is being implemented in-house and lead by civil servant employees, predominantly from the Advanced Development Section, Code 541.3, augmented by existing support contractor vehicles [Systems, Engineering, and Analysis Support (SEAS) and Network and Mission Operations Support (NMOS) contracts] for engineering, project management, and Independent Test and Verification/Acceptance Testing (IT&V/AT) support. Also assigned to the implementation management team are civil servant and contract personnel from Data Systems Assurance, Code 303, and the Logistics Management Section, Code 535.3.

Two in-house options for procurement of Ecom Configuration Items (CI) (equipment and software) are under consideration: (1) use of the FTS 2000 contract Network A (AT&T) service, if available, and (2) competitive procurement through GSFC ADPE Procurement Branch, Code 243. COTS equipment and software are to be well defined by system PDR (early 1994) after which time procurement packages will be prepared in support of Request for Proposal releases, if competitively procured, or service orders placed under the FTS2000 contract under provisions of Network A's Network Service Assurance Plan (NSAP), Level 2, if available. Where Development Configuration Items (DCI) may be required (e.g., equipment for encapsulation/decapsulation of the Nascom 4800-bit block and software implementing the NMCC/EDOS report generation function), the Ecom project will manage that development. The results of DCI PDRs and CDRs will be presented at the corresponding system level design review. Commercial communications carrier services in support of Ecom will be obtained using the approach described in Section 2 and Appendix F of the NSDP.

17.5.2.6 Facilities. Nascom Interface Facilities (NIF) (see paragraph 3.1.2.5) will be established at each location supporting an Ecom network node. Remote nodes will be provided staffing by Nascom, except for the East Windsor spacecraft integration and test facility node which will be operated and maintained by the spacecraft contractor. As Nascom attended facilities, they also meet the criteria of a Nascom Point of Presence facility (see paragraph 3.1.2.4). To house the NIFs, physical facilities are required at each location where an Ecom node will be activated. The Ecom Facility Plan and Utilization document, at this stage in the project, provides only "typical" requirements information for an Ecom facility: 1050 square feet for Ecom equipment, common carrier interface equipment, and a maintenance and operations work area. "Candidate" floor plans for a network node and the Ecom SEF are depicted in Figures 17-23 and 17-24, respectively. Figure 17-25 depicts the NMCC as currently planned. NIFs, the NMCC, and the SEF will be established and tested for acceptance into the network as indicated in Table 17-2.

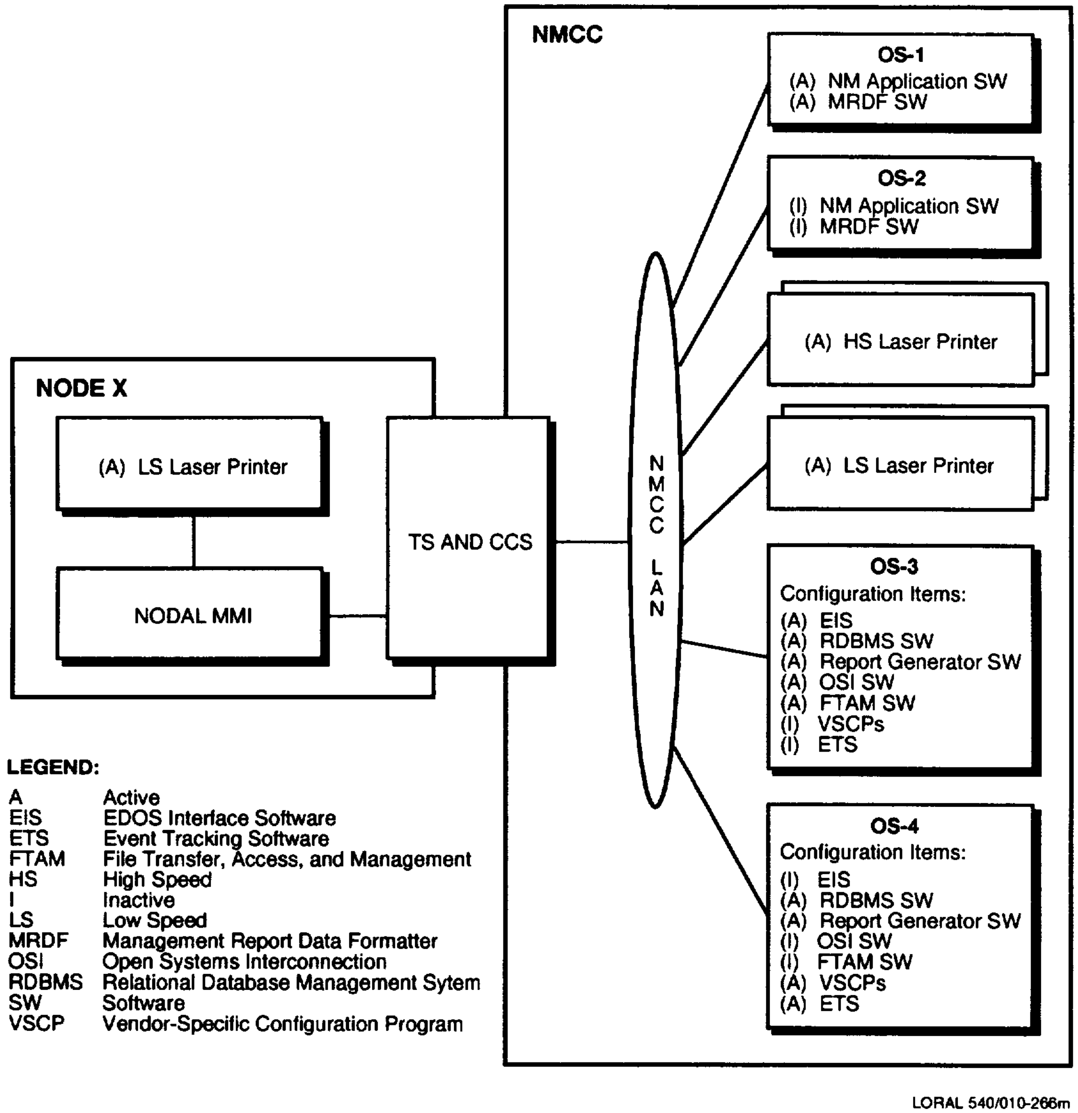

Figure 17-21. NM CI Architecture

Table 17-2. Ecom Nodes and Activation Schedule

NODE	SYSTEM TEST SCHEDULE
Install I	
GSFC/NMCC	3rd Quarter, FY96
GSFC/EOC	3rd Quarter, FY96
WSC/EDOS DIF	3rd Quarter, FY96
Fairmont, WV/EDOS DPF	3rd Quarter, FY96
East Windsor, NJ/S/C ITF	3rd Quarter, FY96
VAFB, CA/LF	3rd Quarter, FY96
Install II	
GSFC/SEF	1st Quarter, FY97
Sioux Falls, SD/EDC	1st Quarter, FY97
JPL,DAAC & IP GW	1st Quarter, FY97
LaRC/DAAC	1st Quarter, FY97
Install III	
MSFC/DAAC	4th Quarter, FY97

17.5.2.7 Staffing. The Ecom Maintenance and Operations Management Plan indicates that Nascom currently intends to provide sufficient maintenance and operations (M&O) technicians at each of the remote nodes, except for the EWNJ node which will be supported by Martin Marietta Corporation, to provide round the clock coverage, 365 days a year. At GSFC, sufficient M&O technicians will be added to the NMOS contractor's authorized staffing level to provide NMCC console operations personnel on a full period basis and to provide M&O technicians to cover the EOC node, NMCC, and SEF on a dispatch basis. For the Install I and II facilities, staffing will be phased in over two cycles, i.e., about half of the Install I M&O staff will be hired, trained, and assigned to their respective duty locations during the Install I period; the remaining M&O technicians for Install I sites will be supplied during the Install II period. In a similar

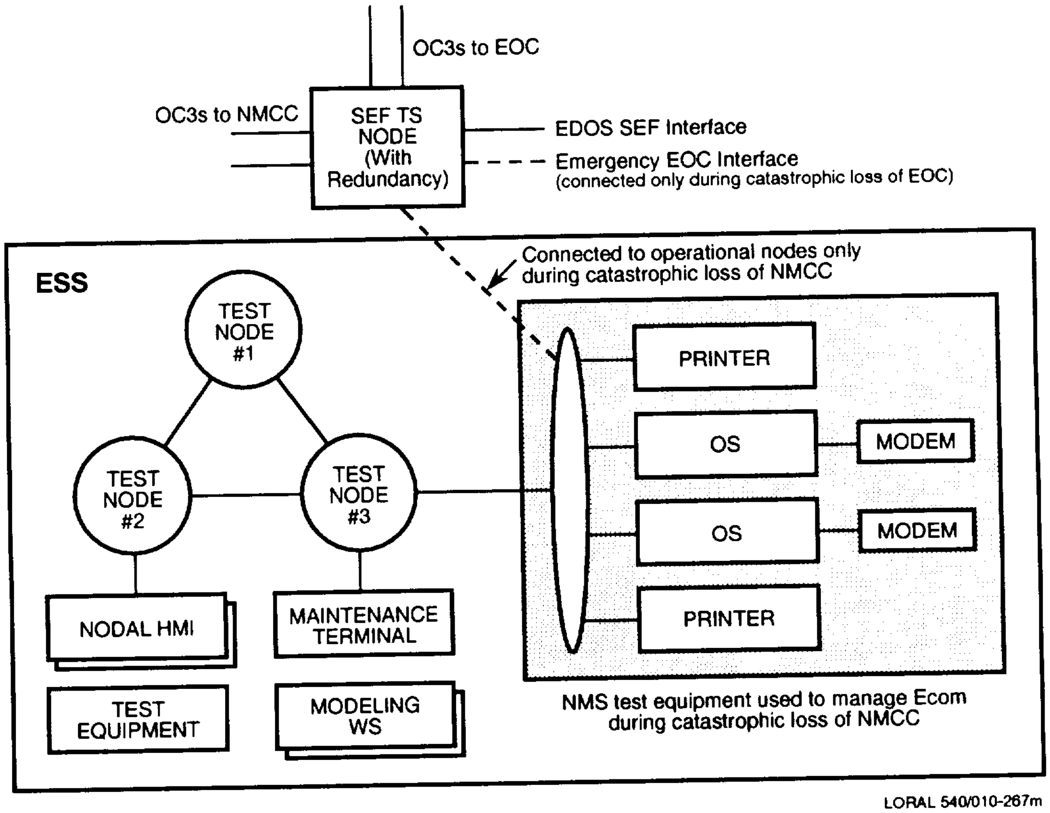

Figure 17-22. ESS Equipment and Relationship to TS

fashion, Install II site personnel will be phased in during the periods of Installs II and III. Install III M&O staff will be provided during the Install III period.

17.5.2.8 Training. The Ecom Training Plan indicates that the initial formal training will be provided to the M&O staff, the installation contractor's installation team (for the direct procurement through Code 243 option only), the IT&V/AT team, and to persons from the Network Test and Training Facility (NTTF) who will be responsible for follow-on training. For the M&O staff, initial formal training is followed by a period of On-the-Job Training (OJT) conducted by members of the engineering/installation team.

17.5.2.9 Schedule. The Ecom project completed the System Requirements Review phase on February 26, 1993, when the Nascom Project Review Board Chairman issued a formal authorization to proceed with the design phase. The Project presented is System Design Review on February 7, 1994. Information from the Ecom master schedule with EOS and EDOS major milestones shown for correlation purposes, is depicted in Figure 17-26.

17.5.2.10 Observation. Ecom represents a paradigm shift in the way Nascom provides operational communication services to flight missions and other users. The network will be data driven, i.e., will transport data from (ground data system) source to (ground data system) sink, using information contained in the header of the data packet. There will be no need to externally schedule and configure the network resources required for support of each service. The network will be comprised of COTS equipment and software in so far as possible. Standard protocols, e.g., ones selected from the GOSIP suite and IP, will be employed. The network will be highly automated, performing routine network management functions without need of human intervention. Also of significance, Ecom is Nascom's first new network to be implemented under the guidelines established in NASA's Decision Memorandum No. 25: the network is funded by, designed to the requirements of, and dedicated in providing its communications services to the EOS program.

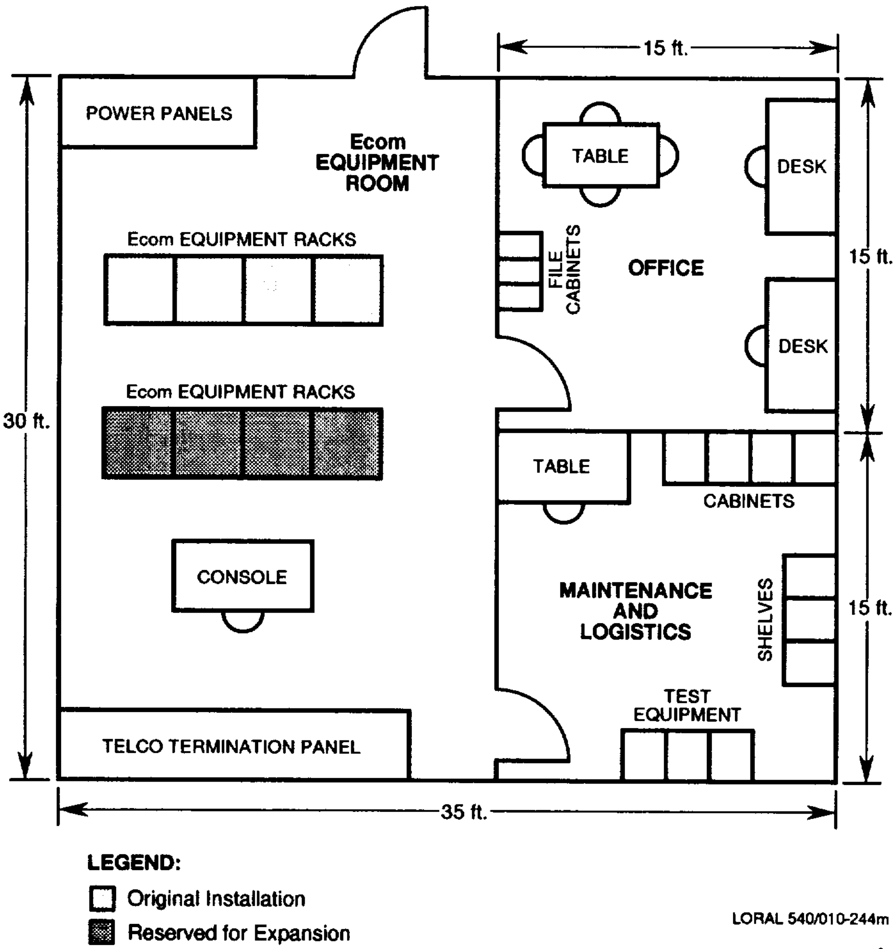

Figure 17-23. Conceptual Layout of an Ecom Network Node

17.5.3 FACILITY AND RESOURCE MANAGER (FARM)

The Facility and Resource Manager (FARM) Project has been formed with the goal to provide automated network management of the NASA Communications (Nascom) Division (Code 540) worldwide network. The FARM project will functionally re-engineer the automated control and status capabilities to provide automated command, monitor and management interface capabilities of all Nascom communication equipment located at GSFC, JSC, MSFC, and NGT. All functions of the Nascom Network will be investigated for possible inclusion in the command architecture design.

The FARM will emphasize utilization of COTS Network Management Systems, State-of-the-art Technology and Standards. The project, initiated in December 1993, will begin with a functional requirements analysis and continue through operational acceptance at the Nascom Operational Readiness Review (ORR).

The FARM will utilize a phased implementation approach. Phase I will concentrate on interfacing to and controlling the new Digital Matrix Switch (DMSR). The remaining content of Phase I and the follow-on phases will be determined by the results of the initial requirements analysis and prototyping efforts. Phase I is scheduled for completion in March 1995.

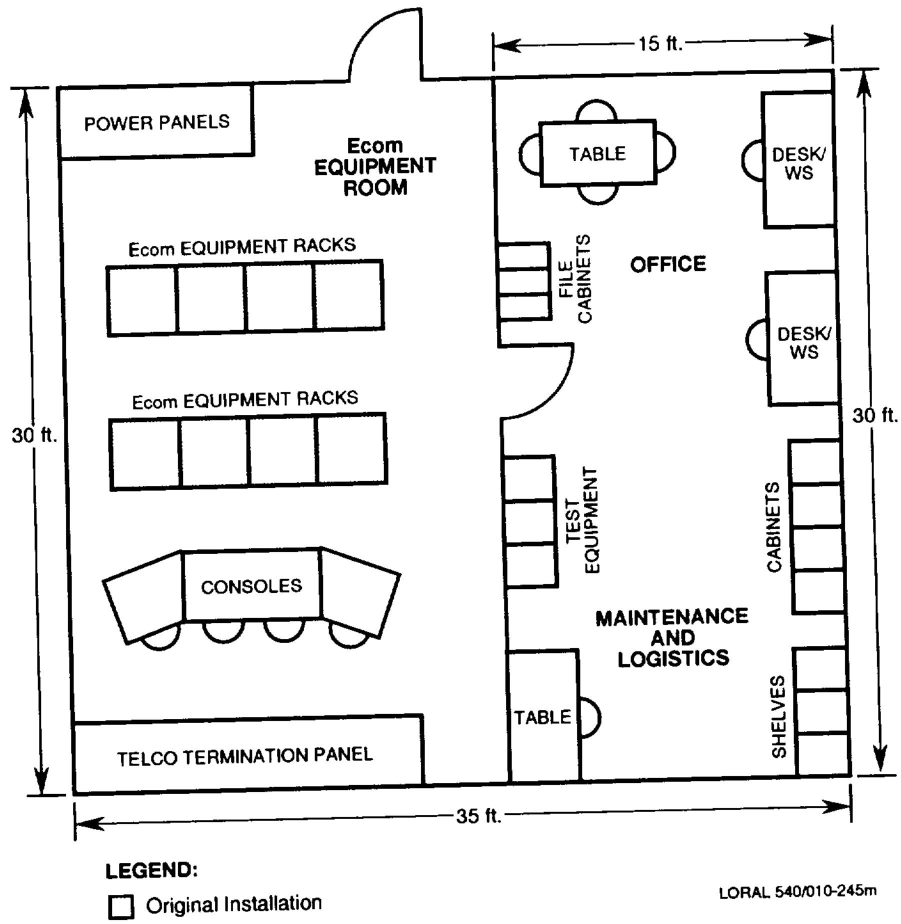

Figure 17-24. Conceptual Layout of Ecom SEF

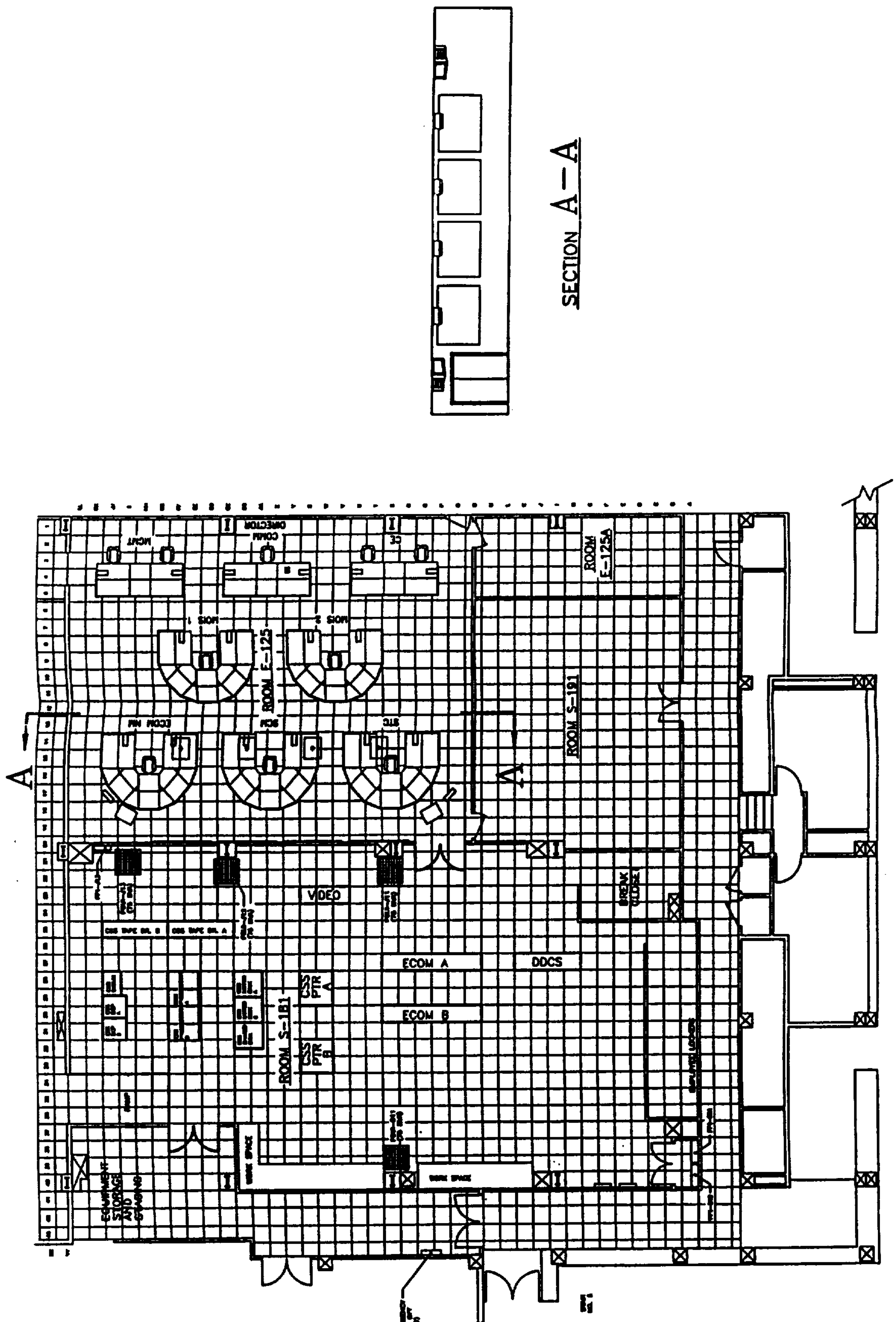

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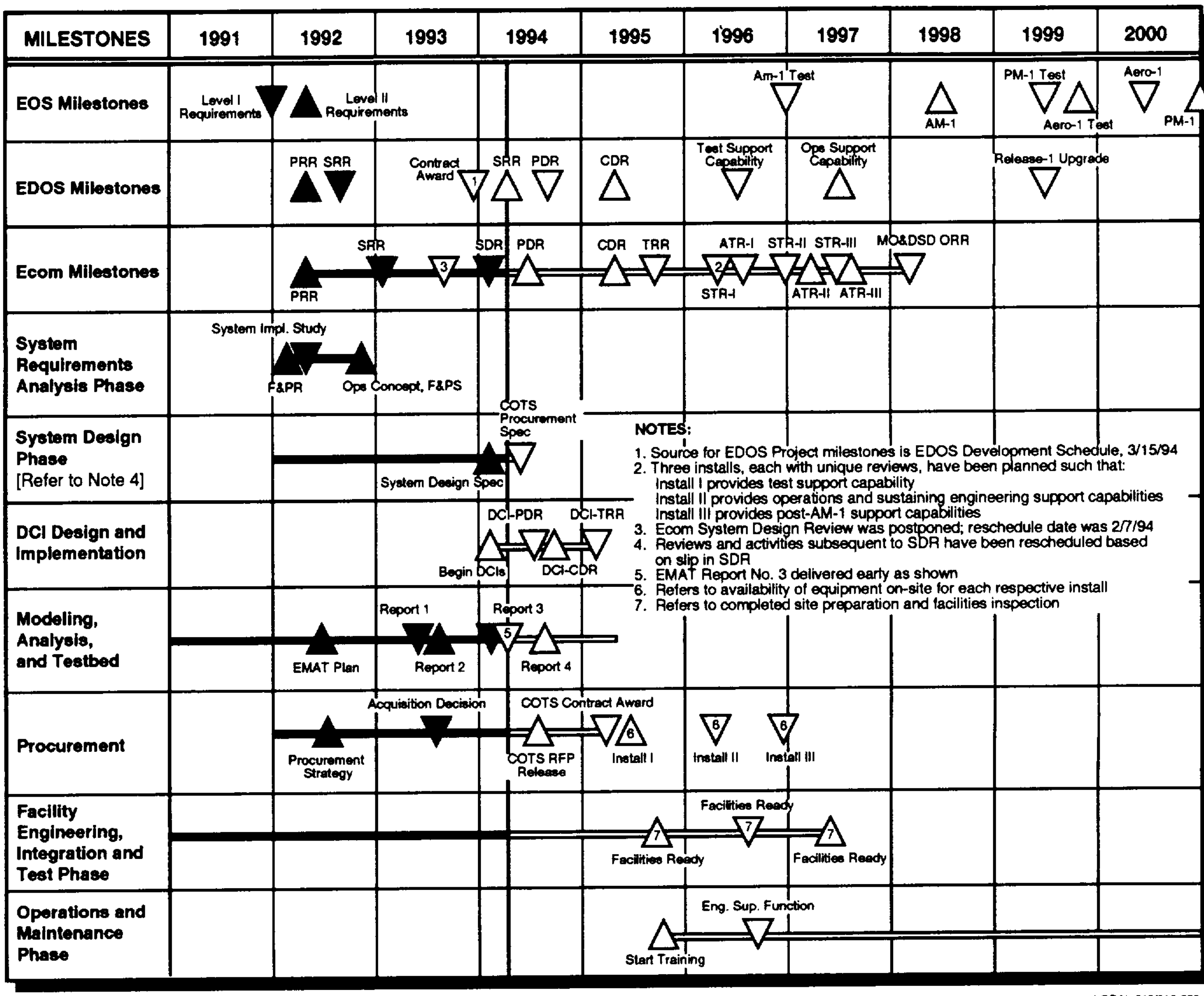
Figure 17-25. Layout of the NMCC



NOTES:
1. Source for EDOS Project milestones is EDOS Development Schedule, 3/15/94
2. Three installs, each with unique reviews, have been planned such that:
   Install I provides test support capability
   Install II provides operations and sustaining engineering support capabilities
   Install III provides post-AM-1 support capabilities
3. Ecom System Design Review was postponed; reschedule date was 2/7/94
4. Reviews and activities subsequent to SDR have been rescheduled based on slip in SDR
5. EMAT Report No. 3 delivered early as shown
6. Refers to availability of equipment on-site for each respective install
7. Refers to completed site preparation and facilities inspection

Figure 17-26. Ecom Master Milestone Schedule

APPENDIX B

GLOSSARY

ACRONYM	DEFINITION
A-G	Air-to-Ground
AC	Alternating Current
ACA	Canadian Space Agency, Alberta
ACAN	Army Command and Administrative Network
ACRV	Assured Crew Return Vehicle
ACT	Australian Capital Territory
ADPE	Automatic Data Processing Equipment
AE	Building Designator at Cape Canaveral Air Force Station
AED	Analog Event Distribution Subsystem
AERO	Aerosols
AFB	Air Force Base
AFSC	Air Force Systems Command
AFSD	Air Force Space Division
AGO	Santiago (3-letter Designator)
AGVS	Air-ground Voice Subsystem
AIS	Automated Information Systems
AL	Alabama
ALT	Altimetry
AMS	Administrative Message System
ANC	Alternate Network Connectivity
ANT	Antigua Island, Eastern Range Station (3-letter Designator)
ANZCAN	Australia, New Zealand, Canada Subcable
AOA	Abort-Once-Around
AP	Applications Processor
APLS	ATDRS Position Location System
APM	Attached Pressurized Module
ARA	Area Routing Assembly
ARC	Ames Research Center
APL	Applied Physics Laboratory
ART	Advanced Research Technology
ASC	American Satellite Corporation

ACRONYM	DEFINITION
ASCII	American Standard Code for Information Interchange
ASCR	Ames Stripchart Recorder
ASO	Application Services Objects
ASRS	Automated Support Requirements System
AT	Acceptance Test
AT&T	American Telephone and Telegraph
ATC	Australian Telecommunication Commission
ATDRSS	Advanced Tracking and Data Relay Satellite System
ATM	Asynchronous Transfer Mode
ATP	Acceptance Test Plan; Acceptance Test Procedures
AVD	Alternate Voice/Data
AXAF	Advanced X-Ray Astrophysics Facility
AXAF-S	AXAF Spectroscopy
AZ	Arizona
b/s	Bits per Second
BALUN	Balanced to Unbalanced
BATSE	Burst and Transient Source Experiment (Gamma Ray Observatory)
BCT	Buffered Communications Terminal
BDA	Bermuda GN Station (3-letter Designator)
BDS	Baseline Data System
BED	Block Error Detector
BER	Bit Error Rate
BF	Block Formatter
BFX	Bulk File Exchange
BISDN	Broadband Integrated Services Digital Network
BLT	Greenbelt Ground Network Station (3-letter Designator)
BOA	Basic Ordering Agreement
BOOTMSU	warm start of the MSU applications from the COW
bps	Bits per second
BRTS	Bilateration Ranging Transponder System
BSCD	Baseline System Concept Document
BWG	Beam Wave Guide
C&P	Chesapeake and Potomac Telephone Company
C&T	Communications and Tracking
C&W	Cable and Wireless (Bermuda)

ACRONYM	DEFINITION
CA	California
CAB	Circuit Assurance Block
CADH	Command and Data Handling
CAL	COW Alert Processing Task
CAN	Canberra 26-meter Deep Space Network Station (3-letter Designator)
CANBER	Canada Bermuda Cable Designator
CAP	Command Acceptance Pattern
CBD	Commerce Business Daily
CCAFS	Cape Canaveral Air Force Station
CCB	Configuration Control Board
CCBTS	Common Carrier Broadcast Data Transmission Service
CCC	Cape Communications Control; Central Computer Complex (Eastern Range)
CCDTS	Common Carrier Domestic Satellite Transponder Service
CCI	Commercial Carrier Interface
CCIM	Command Computer Input Multiplexer
CCITT	International Telegraph and Telephone Consultative Committee
CCM	COW Baseline Configuration Change Task
CCNIF	Cape Canaveral Nascom Interface Facility
CCQ	COW Command and Query Task
CCRF	Consolidated Communications Recording Facility
CCS	Common Carrier Subsystem
CCSDS	Consultative Committee for Space Data Systems
CCT	Central Communications Terminal (Jet Propulsion Laboratory)
CCTCF	Communications Circuit Technical Control Facility
CCTV	Closed-circuit Television
CD&SC	Communication Distribution & Switching Center
CDA	Command and Data Acquisition
CDB	COW Database Manager Task
CDF	Communications Data Formatter
CDHF	Central Data Handling Facility (Upper Atmosphere Research Satellite)
CDL	COW Delogging Task
CDMA	Code Division Multiple Access
CDOS	Customer Data Operations System
CDR	Critical Design Review
CDSCC	Canberra Deep Space Communications Complex

ACRONYM	DEFINITION
CES	Control Electronics System; COW Expert System Task
CFR	Concept Feasibility Report
CFS	Continental Telephone's Federal Services Division
CGS	CCSDS Ground Subnetwork
CHC	COW Checkpoint Configuration Change Task
CHEM	Chemistry
CHP	Command History Printer
CI	Configuration Items
CIF	COW/MSU Interface Task
CIN	COW Initialization and Recovery Task
CIS	Communications Interface System
CITF	CDOS Integration and Test Facility
CLD	COW Line Indicator Display Task
CLG	COW Logging Task
CLS	Communications Line Switching
CLUSTER	Plasma Turbulence Laboratory (ISTP Spacecraft)
CME	Central Management Equipment
CMG	COW Message Generator Debug Tool
CMS	Command Management System; Consolidated Management System
CNES	Centre National D'Etudes Spatiales (National Center for Space Studies, France)
CNIF	Canberra Nascom Interface Facility
CNV	Cape Canaveral (Eastern Range) Station (3-letter Designator)
CO	Central Office; Colorado
COA	COW Operator Assistance Task
COBE	Cosmic Background Explorer
Codec	Coder/Decoder
COM	Computer Output Microfilm
COMMGR	Communications Manager
ComPlus	Communications Control System
COMPTEL	Compton Telescope (Gamma Ray Observatory)
COMS	CDOS Operations Management System
COMSAT	Communications Satellite Corporation
COMSEC	Communications Security
COMSTAR	Communications Satellite

ACRONYM	DEFINITION
COMTEL	Manufacturer of Nascom Integrated Services Digital Network Time Division Multiple Access Systems
CONS	Console Subsystem
CONVTXT	Converts ASCII Text Files
COP	Co-orbiting Platform
COR	Contracting Officer's Representative
COS	COW Operator Stations Task
COSTR	Collaborative Solar-Terrestrial Research
COTS	Commercial Off-The-Shelf
COW	Combined Operator Workstation
CPE	Customer Provided Equipment
CPP	Capacity Projection Plan
CPU	Central Processing Unit
CRAF	Comet Rendezvous Asteroid Flyby
CRT	Cathode Ray Tube
CSA	Communications Service Authorization
CSAM	Carrier Services Advisory Message
CSB	Carrier Selection Board, Circuit Selection Board
CSE	Configuration and Switching Equipment
CSF	Control and Simulation Facility
CSO	Computer Security Officials
CSR	Communications Service Request
CSS	Communications Services Section; Control and Status System
CSTC	Consolidated Space Test Center
CSTS	Control Subsystem Transfer Switch
CT of CC	Continental Telephone of California Company
CTA	Compatibility Test Area
CTC Co	Continental Telephone of California Company
CTMC	Communications Terminal Modular Controller
CTNE	Compania Telefonica Nacional De Espana
CTO	Carrier Terminal Office
CTP	Circuit Terminating Package
CTS	COW Troubleshooting Task
CTV	Compatibility Test Van
CU	COW Common Units
CWA	Cryptographic Work Area
CWG	Communications Working Group

ACRONYM	DEFINITION
CWL	Cable and Wireless, Ltd.
CXR	Commercial Carrier
DAA	DoD Approving Authority
DAAC	Distributed Active Archive Centers
DAF	Data Acquisition Facility
DAVID	Digital Above Video
DBCI	Data Base Change Instruction
DC	Destination Channel
DC	Direct Current; District of Columbia
DCA	Defense Communications Agency
DCC	Data Computation Complex
DCCD	Digital Cross Connect Device
DCE	Data Circuit Terminating Equipment
DCF	Data Capture Facility (Goddard Space Flight Center)
DCI	Development Configuration Items
DCMS	Defense Contract Management Support
DCR	Daily Communications Reports
DCS	Digital Matrix Switch Control System; Display and Control System
DCS/U	DCS Upgrade
DCSU	DCS Upgrade
DDCS	Data Distribution and Command System
DDD/SDD	Digital Display Driver/Subchannel Data Distributor
DDGT	Digital Data Group Terminals
DDHS	Dump Data Handling Subsystem
DDPS	Digital Data Processing System
DDS	Dataphone Digital Service; Digital Data Service; Discrete Display Subsystem
DEC	Digital Equipment Corporation
DEMUX	Demultiplexer
DFRF	Dryden Flight Research Facility
DGIB	DSN/GSFC Interface Block
DHC	Data Handling Center
DHE	Data Handling Equipment
DIF	Data Interface Facility
DIF	Domsat Interface Facility (Goddard Space Flight Center)
DIS	Data Interface System
DITAC	Department of Industry, Technology, and Commerce

ACRONYM	DEFINITION
DKR	Dakar GN Station (3-letter Designator)
DKS	Digital Keyset
DLMS	Data Link Monitoring System; Downlink Monitoring System
DLR	Deutsche Forschungs und Versuchsanstalt fuer Luft und Raumfahrt (Research Agency for Aerospace Technology, Germany)
DLSM	Data Link Summary Message
DMA	Direct Memory Access
DMF	Distributed Management Function
DMR	Detailed Mission Requirements
DMS	Digital Matrix Switch
DMSR	Digital Matrix Switch Replacement
DoD	Department of Defense
Domsat	Domestic Satellite
DOS	Disk Operating System
DPF	Data Production Facility
DRRTS	Digital Receive, Record, and Transmit System
DSC	Data Switching Center (Western Range, VAFB)
DSCC	Deep Space Communications Complex
DSCIM	Display Select Computer Input Multiplexer
DSM	Data Support Manager; Data Systems Manager
DSN	Deep Space Network
DSS	Deep Space Station
DSS	Digital Switching System; Distribution Switching System
DSTL	Data Systems Technology Laboratory
DSU	Data Service Unit
DTE	Data Terminal Equipment
DTI	Data Transmission Interface
DTS	Digital Television Subsystem; Digital Transmission System
DTTS	Data Transmission Test Set
E	Electronics
E&O	Building Designator at Cape Canaveral Air Force Station
E-BUSS	Electronics Buss
EAFB	Edwards Air Force Base
ECC	Emergency Communications Center (Goddard Space Flight Center)
ECIO	Experiment Computer Input Output (Spacelab)

ACRONYM	DEFINITION
Ecom	EOS Data Operations System Communications
ECOS	Engineering Channel Operating System
ECS	Error Correction and Switching System
EDC	Earth Resources Observation Satellite Data Center
EDOS	EOS Data and Operations System
EER	Engineering Economics Research, Inc.
EFTO	Encrypt For Transmission Only
EGRET	Energetic Gamma Ray Experiment Telescope (Gamma Ray Observatory)
EI	Equipment Interface
EIA	Electronic Industries Association
ELV	Expendable Launch Vehicle
EMAIL	Electronic Mail
EMAT	Ecom Modeling, Analysis, and Testbed
ENTEL	Empresa Nacional de Telecommunications (Chile)
EOC	EOS Operations Center
EOM	End of Message; End-of-Mission
EOR	Expedited Operations Requirements
EOS	Earth Observing System
EPS	Energetic Particle Sensor
ER	Eastern Range
ERBS	Earth Radiation Budget Satellite
EROS	Earth Resources Observation Satellite
ES	Earth Station
ES-1	Earth Station One
ES-2	Earth Station Two
ESA	European Space Agency
ESC	Engineering Support Center
ESDIS	Earth Science and Data Information System
ESF	Enhanced Standard Format
ESMC	Eastern Space and Missile Center
ESOC	Earth Station Owners Consortium; European Space Operations Center
ESP	Equatorial Science Phase
ESS	Engineering Support Subsystem
ESTL	Electronic Systems Test Laboratory at JSC
ETS-VI	Engineering Test Satellite-VI

ACRONYM	DEFINITION
EURECA	European Retrievable Carrier
EUTELSAT II	European Telecommunications Satellite II
EUVE	Extreme Ultra Violet Explorer
EWNJ	East Windsor, New Jersey
F/L	Forward Link
FAA	Federal Aviation Administration
FAR	Federal Acquisition Regulations
FARM	Facility and Resource Manager
FAST	Fast Auroral Snapshot Explorer
FCC	Federal Communications Commission
FDDI	Fiber Distributed Data Interface
FDF	Flight Dynamics Facility
FDM	Frequency Division Multiplex
FDX	Full Duplex
FE	Front End
FEC	Federal Electric Corporation
FED	Frame Encapsulator/Decapsulator
FEL	First-element Launch (Space Station Freedom)
FES	Front End Support
FGB	Functional Energy Block (English translation of Russian Term)
FIFO	First-in-First-out
FIMS	Fault Isolation Monitoring System
FIPS	Federal Information Processing Standard
FIRMR	Federal Information Resources Management Regulations
FL	Florida
FM	Frequency Modulation
FOLAN	Fiber Optic Local Area Network
FOT	Fiber Optic Transceiver; Flight Operations Team
FPS	Fiber Protect Switch
F&PR	Functional and Performance Requirement
FPS	Flight Planning System
FPSO	Flight Project Support Office
FRF	Flight Research Facility (3-letter Designator) at Dryden
FSG	Future Service Growth
FSR	Flight Support Request

ACRONYM	DEFINITION
FTAM	File Transfer, Access, and Management
FTGT	First TDRSS Ground Terminal
FTH	Fort Huachuca Station (3-letter Designator)
FTS	Federal Telecommunications System
FWV	Fairmont, West Virginia
FY	Fiscal Year
GA	Georgia
GAO	General Accounting Office
GCF	Ground Communications Facility
GDS	Goldstone Deep Space Network Station (3-letter Designator); Group Display Subsystem
GDSCC	Goldstone Deep Space Communications Complex
GEAM	GE American Communications, Inc.
GE Americom	GE American Communications, Inc.
GEOTAIL	Geomagnetic Tail Laboratory
GFE	Government Furnished Equipment
GGS	Global Geospace Science
GGTS	Ground-to-ground Transport System
GHB	Goddard Handbook
GHIT	Goddard Space Flight Center High Density Inventory Tape
GHz	Gigahertz
GIB	Group Interface Board
GMI	Goddard Space Flight Center Management Instruction
GMS-5	Geostationary Meteorological Satellite-5
GN	Ground Network
GOES	Geosynchronous Operational Environmental Satellite
GOSIP	Government Open System Interconnect Profiles
GPIB	General Purpose Interface Board
GOSA	Ground Data System Assurance
GPOC	German Payload Operations Center
GPS	Global Positioning Satellite
GRO	Gamma Ray Observatory
GRTS	Goddard Space Flight Center Real-time Computing System (4-letter Designator); GRO Remote Terminal System
GSA	General Services Administration
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center

ACRONYM	DEFINITION
GSOC	German Space Operations Center
GSSR	Goldstone Solar System Radar
GSTS	Goddard Space Flight Center Message Center (4-letter Designator)
GTC	General Telephone Company
GTNDP	GSFC Telecommunications Network Development Plan
GW	Gateway
HAWTELCO	Hawaiian Telephone Company
HDDR	High Density Data Recorders
HDQ	High-speed Data Queue
HDR	High-data Rate
HDRR	High-data Rate Recorder
HDRS	High-data Rate System
HDX	Half-duplex
HEAO	High Energy Astrophysics Observatory
HEO	High-earth Orbiter
HEPAD	High-Energy Proton and Alpha Detector
HI	Hawaii
HMI	Human-Machine Interface
HOSC	Huntsville Operations Support Center
HP	Hewlett-Packard
HQ	Headquarters
HRDLM	High-Rate Data Link Monitor
HRDM	High-rate Demultiplexer
HRFL	High-rate Forward Link
HRM	High-rate Multiplexer
HS	High-Speed
HSD	High-speed Data
HSDS	High-speed Data System
HSSI	High Speed Serial Interface
HVAC	Heating, Ventilation, and Air Conditioning
Hz	Hertz
I	Incident (signal)
I/O	Input/Output
IBDDR	Interbuilding Data Dissemination Resource
IBDTS	Interbuilding Data Transfer System

ACRONYM	DEFINITION
IBS	International Business Service
IC	Input Controller
ICC	Institutional Communications Company; Instrument Control Center; Inter-Center Communications, Inc.
ICCWG	Intercenter Communications Working Group
ICD	Interface Control Document
ICE	International Cometary Explorer
ICF	Instrument Control Facilities
ICLU	Interbuilding Communication Link Upgrade
ICV	Intercenter Vector
ID	Identifier
I-DIF	Interim Data Interface Facility
IF	Intermediate Frequency
IFL	Interfacility Link (between WSGT/NGT and STGT)
IGF	Image Generation Facility
IGSE	Instrument Ground Support Equipment (Gamma Ray Observatory)
IGY	International Geophysical Year
ILS	Integrated Logistics Support
ILSP	Integrated Logistics Support Plan
ILT	Interface Level Translator
IMP	International Monitoring Platform
INPE	Intituto de Pequisas Espacias-Brazil
INSF	International Network Support Forum
INTA	Instituto Nacional de Tecnica Aerospacial
INTELSAT	International Telecommunications Satellite Consortium
IOU	Input-Output Unit
IP	International Partner; Internet Protocol
IPD	Information Processing Division (Goddard Space Flight Center)
IRC	International Record Carrier
IRD	Interface Requirements Document
IRIG	Interrange Instrument Group
IRIS	Italian Research Interim Stage
IRU	Integrated Recovery Utility
ISAS	Institute of Space and Astronautical Science
ISC	Integrated Secure Communications

ACRONYM	DEFINITION
ISCS	Integrated Secure Communication System
ISDN	Integrated Services Digital Network
ISI	Information Services, Incorporated
ISO	International Standard Organization
ISPR	International Standard Payload Rack
IST	Instrument Support Terminals
ISTP	International Solar-Terrestrial Physics
IT&V/AT	Independent Test and Verification/Acceptance Testing
ITP	Integration and Test Plan
ITS	Intelligent Terminal System
ITT	International Telephone and Telegraph
ITTC	International Telegraph and Telephone Consultative Committee
ITU	Input Terminal Unit
IUE	International Ultraviolet Explorer
IUS	Inertial Upper Stage
JEM	Japanese Experiment Module
JEM EF	Japanese Experiment Module Exposed Facility
JHU	John Hopkins University
JMRTS	JSC-MSFC Redundant Transmission System
JOI	Jovian Orbit Insertion
JOP	Joint Operations Procedure
JNOC	JPL Network Operational Control
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
K	Kilo (thousand)
CaSA	Ka-band Single Access
kb/s	Kilobits per Second
kbps	Kilobits per Second
KDP	Keyboard Display Printer
KEE	Knowledge Engineering Environment
kg	Kilogram
kHz	Kilohertz
KIDS	Kennedy Integrated Data System
km	Kilometer
KMRTS	Kennedy-Marshall Redundant Transmission System
KPT	Kanea Point Station (3-letter Designator)
KSA	Ku-band Single Access

ACRONYM	DEFINITION
KSC	Kagoshima Space Center; Kennedy Space Center
KuSA	Ku-band Single Access
KuSP	Ku-band Signal Processor
kva	Kilovolt Ampere
KWJ	Kwajalein Island Station (3-letter Designator)
LACN	Local Area Communications Network
LAGEOS	Laser Geodynamic Satellite
LAN	Local Area Network
LaRC	Langley Research Center
LCC	Launch Control Center (Kennedy Space Center)
LDR	Low-data Rate
LED	Light-emitting Diode
LeRC	Lewis Research Center
LF	Launch Facility
LISP	List Processing
LLTDS	Launch and Landing Trajectory Data System
LMSC	Lockheed Missiles and Space Company
LOR	Line Outage Recorder
LP	Line Processor
LPS	Launch Processing System
LRBS	Low Rate Black Switch
LRP	Long-range Plan
LRU	Line Replaceable Unit
LSD	Logistics Supply Depot
LSDS	Low-speed Data System
LSR	Launch Support Request; Launch Support Requirements
LSS	Launch Support Structure, Service Module (English translation of Russian Term)
LTAS	Launch Tracking and Acquisition System; Launch Trajectory Acquisition System
LTP	Long Term Plan
M&O	Maintenance and Operations
MA	Multiple Access
MACC	Multiple Application Control Center
MACS	Multiplexer/Demultiplexer Automatic Control System
MACSU	Multiplexer/Demultiplexer Automatic Control System Upgrade
MAD	Madrid 26-meter Deep Space Network Station (3-letter Designator)
MAF	Multiple Access, Forward Link
MAN	Metropolitan Area Network
MAP	Maintenance Administration Position

ACRONYM	DEFINITION
MASM	Macro Assembler
MB	Manned Base
Mb/s	Megabits per Second
MBI	Multibus Interface; MSU Backup Operator Interface Task
Mbps	Megabits per second
MBS	Mobile Base System
MBSU	Main Bus Switching Unit
MCC	Mission Control Center; Mission Control Consoles
MCCC	Mission Control and Computing Center (Jet Propulsion Laboratory)
MCI	Microwave Communications, Incorporated
MCMD	MSU Console Command Task
MCS	Microprocessor System
MCU	MSU/COW Common Utility Modules
MD	Maryland
MDAC	McDonnell Douglas
MDD	MSU Database Distribution Task
MDDF	Minimum Delay Data Format
MDM	Multiplexer/Demultiplexer
MDMR	Multiplexer/Demultiplexer Replacement
MDS	MSU Data Simulator Task
MDSCC	Madrid Deep Space Communications Complex
ME	Maine
MER	Mission Evaluation Room
MeV	Million Electron Volt
MGS	Mars Global Surveyor
MHL	MSU High-speed Logging Task
MHS	MSU High-speed Switching Task
MHU	MSU High-speed Utility Task
MHY	MSU Hybrid Data Task
MHz	Megahertz
MI	Michigan
MIB	Management Information Base
MIDDS	Meteorological Interactive Data Display System
MIF	MSU/COW Interface Task
MIL	Merritt Island Ground Network Station (3-letter Designator)

ACRONYM	DEFINITION
MIL-71	Deep Space Network Test Facility at Kennedy Space Center
MIN	MSU Initialization and Recovery Task
MLA	Merritt Island Station (3-letter Designator)
MMG	MSU Message Generator Debug Tool
MMI	Man Machine Interface
MMS	Multimission Modular Spacecraft
MM/TMS	Megamux Plus TDM and Megamux Transport Management System
MNIF	Madrid Nascom Interface Facility
MOAA	MSS Operator's Advisor and Assistant
MO&DS	Mission Operations and Data Systems
MO&DSD	Mission Operations and Data Systems Directorate
MOC/DSC	Mission Operations Computer/Dynamic Standby Computer
MODEM	Modulator/Demodulator
MODLAN	Mission Operations Division Local Area Network
MODNET	MO&DSD Operational/Development Network
MODSIN	Mission Operations and Data Systems Network
MOI	Mars Orbit Insertion
MOM	Missions Operation Manager
MOSP	Mission Operations Support Plan
MOU	Memorandum of Understanding
MOW	Mission Operations Wing
MPC	Mission Planning Center
MPT	Mission Planning Terminal
MRR	Mission Requirements Request
MSCC	Manned Space Control Center
MSCN	Manned Space Communications Network
MSFC	Marshall Space Flight Center
MSFN	Manned Space Flight Network
MSM	Mission Support Manager
MSOCC	Multisatellite Operations Control Center (Goddard Space Flight Center)
MSO	Management System Operation
MSP	Modular Switching Program
MSS	Message Switching System; Multispectral Scanner (Landsat Experiment)
MSU	Main Storage Unit; Message Switching System Upgrade
MT	Mobile Transponder

ACRONYM	DEFINITION
MTBF	Mean-Time-Between-Failures
MTC	Man-Tended Capability
MTL	Mount Lemmon Station (3-letter Designator)
MTTR	Mean-Time-To-Restore
MU	MSU Common Units
MUDUMP	MSU Task Dump Utility
MUX	Multiplexer
MVL	Majority Voting Logic
N^2	NASA Communications System for the Space Station Freedom Era (Nascom II)
NA	Network Adapters
NALF	Naval Auxiliary Landing Field (Crows Landing, CA)
NAS	Flight Dynamics Facility Computer
NASA	National Aeronautics and Space Administration
NASA HQ	NASA Headquarters
Nascom	NASA Communications
Nascom II	NASA Communications System for the Space Station Freedom Era
NASCOP	NASA Communications Operating Procedures
NASDA	National Space Development Agency (Japan)
NAUG	Nascom Augmentation
NBS	National Bureau of Standards
NCC	Network Control Center
NCIC	Networks Communications Interface Common
NCG	Network Control Group
NCP	Network Consolidation Program
NCPS	Network Command Process System
NCS	National Communications System
NDC	Network Development Center (Goddard Space Flight Center)
NDEEC	Nascom II Development, Engineering, and Emergency Support Center
NDI	Nondevelopment Item
NEAP	Nascom Evolution Action Plan
NED	Network Encoder/Decoder
NES	Nascom Event Schedule/Scheduling
NESDIS	National Environmental Satellite Data and Information Service
NESS	National Environmental Satellite Service
NEST	Network Engineering Support Team

ACRONYM	DEFINITION
NETEX	Network Executive
NGT	NASA Ground Terminal (White Sands)
NGTC	National Gateway Telecom
NII	Nascom II
NIF	Nascom Interface Facility
NIM	Network Integration Manager
NIP	Network Interface Processor
NIS	Nascom Interface System
NISDN	Nascom Integrated Services Digital Network
NISI	Network and Information Systems
NJ	New Jersey
NLV	Nippon Launch Vehicle
NM	Network Management; New Mexico
NMCC	Nascom II Network Management; Network Management Control Center
NMI	NASA Management Instruction
NMOS	Network and Mission Operations Support
NMP	Network Management Processor
NMS	Network Management Service; Network Management Subsystem
NMSS	Nascom Manual Scheduling System
NNMS	Nascom Network Management System
NNSG	Nascom Network Scheduling Group
NOAA	National Oceanic and Atmospheric Administration
NOCC	Network Operations Control Center
NOM	Network Output Multiplexer
NOS	Nascom Operations System
NOSIP	Nascom Open Systems Interconnection Protocol
NOSP	Network Operations Support Plan
NPR	NASA Procurement Regulation
NPRD	Network Program Requirements Document
NPSNET	Nascom Packet Subnetwork
NS	Northrop Strip (2-letter Designator)
NSA	National Security Agency
NSAP	Network Service Assurance Plan
NSDP	Nascom System Development Plan
NSGW	Nascom Services Gateway

ACRONYM	DEFINITION
NTTF	Network Training and Test Facility
NU	Network Upgrade
NVTS	NASA Video Transponder Service
OAFB	Onizuka Air Force Base
OBC	Onboard Computer
OC	Optical Carrier; Output Controller
OCA	Canadian Space Agency, Ottawa
OCD	Operations Concept Document
OD	Operations Directives
OFTDS	Orbital Flight Test Data System
OH	Ohio
OI	Operational Instrumentation; Operator Interface
OIS	Operations Intercommunications System
OJT	On-the-Job Training
OMB	Office of Management and Budget
OMF	Operations Management Function
OR	Operations Requirements
ORR	Operations Readiness Review
OS	Operator Station
OSC	Office of Space Communications
OSI	Open Systems Interconnection
OSSE	Oriented Scintillation Spectrometer Experiment (Gamma Ray Observatory)
OSTDS	Office of Space Tracking and Data Systems
OTDA	Office of Tracking and Data Acquisition
OTU	Output Terminal Unit
PA	Pennsylvania; Public Affairs
PABX	Private Automatic Branch Exchange
PACOR	Packet Data Processor
PAD	Packet Assembly/Disassembly
PAL	Programmable Array Logic
PAO	Public Affairs Office
PAR	Project Authorization Review
PASS	Project Operations Control Center Applications Software Support
PAT	Patrick Air Force Base Station (3-letter Designator)
PB	Playback

ACRONYM	DEFINITION
PBF	Payload Block Formatter
PBX	Private Branch Exchange
PC/AT	Personal Computer/Advanced Technology
PCM	Pulse Code Modulation
PDF	Payload Data Formatter; Programmable Data Formatter
PDFE	Prototype DIF Front End
PDIS	Payload Data Interleaver Subsystem
PDL	Ponce de Leon Station (3-letter Designator)
PDN	Public Data Network
PDP	Computer Designator
PDPF	Packet Data Processing Facility
PDR	Preliminary Design Review
PDRD	Program Definition and Requirements Document
PDSS	Payload Data Services System
PFOR	Passive Fiber Optic Rack
PIA	Primary Interface Adapter
PID	Program Introduction Document
PIOC	Parallel Input/Output Channel
PIP	Payload Integration Plan; Project Implementation Plan
PKM	Perigee Kick Motor
PM	Phase Modulated
PMI	Programmable Modem Interface
PMP	Project Management Plan
PMS	Performance Monitoring System
PMTC	Pacific Missile Test Center
PO	Purchase Order
POCC	Project/Payload Operations Control Center
POIC	Payload Operations Integration Center
POLAR	Polar Plasma Laboratory
POP	Point-of-Presence; Polar Orbiting Platform; Project Operating Plan
PORTS	POCC Operations Real-time Support
PPF	Payload Parameter Frame
PPM	Passes Per Month
PR	Procurement Request
PRD	Program Requirements Document

ACRONYM	DEFINITION
PSC	Platform Support Center
PSCN	Program Support Communications Network
PSDR	Preliminary System Design Review
PSN	Packet Switch Node; Packet Switching Network
PSP	Program Support Plan
PSS	Portable Spacecraft Simulator
PT&T	Pacific Telephone and Telegraph
PTF	Payload Test Facility (Space Telescope)
PTP	Point Pillar Station (3-letter Designator)
PTS	Pneumatic Tube Subsystem
PUMP	POCC Management Utilization Prositions
PV	Photovoltaic
PWDS	Protected Wire Distribution System
Q	Quadrature (Signal)
QA	Quality Assurance
QAF	Quick Access Facility (Western Range, VAFB)
QAM	Quadrature Amplitude Modulation
R&D	Research and Development
R/L	Return Link
RAC	Remote Analysis Computer (Upper Atmosphere Research Satellite)
RAM	Random Access Memory
RAP	Restricted Access Processor
RO	Receive Only
RCA	Radio Corporation of America
RCC	Range Control Center
RD	Receive Data
RENAISSANCE	Reusable Network Architecture for Interoperable Space Science Analysis, Navigation, and Control Environment initiative.
RFP	Request for Proposal
RF SOC	Radio Frequency Simulation Operations Center
RGCS	Request for Ground Communications Service
RIC	Remote Information Center
RIDS	Rockwell Integrated Data System
RMOC	Remote Mission Operations Center
ROP	Receive-only Printer
RSO	Range Safety Officer

ACRONYM	DEFINITION
RSS	Rotating Service Structure
RT	Real Time
RTC	Real-time Clock
RTOP	Research Technology Objectives and Plans
RTVE	Radio Television Espanola
S/C ITF	Spacecraft Integration and Test Facility
S/N	Signal-to-Noise
SAMPEX	Solar Anomalous and Magnetospheric Particle Explorer
SAR	Search and Rescue; Synthetic Aperture Radar
SATCOM	Satellite Communications
SC	Switching Computer
SCAMA	Switching, Conferencing, and Monitoring Arrangement
SCE	Spacecraft Command Encoder
SCE MUX	Spacecraft Command Encoder Multiplexer
ScI	Science Institute (Space Telescope)
SCM	Shift Communications Manager
SCPC	Single-Channel-per-Carrier
SCR	Serial Receive Clock; Strip Chart Recorder
SCTE	Serial Clock Transmit External
SCVM	Shuttle Command and Voice Multiplexer
SD	Send Data; South Dakota
SDP	System Development Plan
SDPC	Shuttle Data Processing Complex
SDPF	Sensor Data Processing Facility
SDR	System Design Review
SDS	System Design Specifications
SDSS	Shuttle Data Select Switch
SEAS	Systems, Engineering, and Analysis Support
SEB	Source Evaluation Board
SEE	Sustaining Engineering Element
SEF	Sustaining Engineering Facility
SELV	Small Expendable Launch Vehicle
SEM	Space Environment Monitoring
SEMIS	System Engineering Management Information System
SESNET	Space Earth Sciences Network
SF	Single Frequency

ACRONYM	DEFINITION
SFDU	Standard Format Data Units
SFOF	Space Flight Operations Facility (Jet Propulsion Laboratory)
SFU	Space Flyer Unit
SGL	Space-to-Ground Link
SHO	Schedule Orders
SIOC	Serial Input/Output Controller
SIP	Systems Implementation Plan
SIPS	Signal Input Processor System
SKR	Serial KG Recombiner
SL	Spacelab
SLDPF	Spacelab Data Processing Facility (Goddard Space Flight Center)
SLPO	Spacelab Program Office
SM	Statistical Multiplexer
SMA	S-band Multiple Access
SMCC	Shuttle Mission Control Center
SMDS	Statistical Multiplexer Data System
SMEX	Small Explorer
SMP	System Management Plan
SN	Space Network
SNI	San Nicholas Island (3-letter Designator)
SNIP	Space Network Interoperability Panel
SNMP	Simple Network Management Protocol
SNR	Signal-to-Noise Ratio
SOC	Simulation Operations Center (Goddard Space Flight Center)
SOCC	Satellite Operations Control Center (NOAA Suitland, MD)
SOGS	Science Operations Ground System (Space Telescope)
SOHO	Solar Heliospheric Observatory
SOM	Start of Message
SONET	Synchronous Optical Network
SOW	Statement of Work
SPADE	Single Channel per Carrier Pulse Code Modulation Multiple Access
SPC	Signal Processing Center
SPDM	Special Purpose Dexterous Manipulator
SPIF	Shuttle/POCC Interface Facility
SPK	Scott Peak Station (3-letter Designator)

ACRONYM	DEFINITION
SPOT-C	System Probatoire d'Observation de la Terra-C
SPPO	Spacelab Payload Project Office
SPX	Simplex
SR	Special Routing
SRB	System Review Board
SRR	System Requirements Review
SRT	Supporting Research Technology
SS	Space Shuttle
SSA	S-band Single Access
SSAI	Science Systems and Applications, Inc.
SSC	Science Support Center
SSCC	Space Station Control Center
SSCN	Scientific Satellite Communications Network
SSG	System Support Group
SSIO	Spacelab Engineering Data Designator
SSP	Space Shuttle Program
SSRMS	Space Station Remote Manipulator System
ST	Space Telescope
STADAN	Satellite Tracking and Data Acquisition
STARTCOW	Warm Start of the COW Applications
STC	System Test Complex
STD	Standard
STDN	Spaceflight Tracking and Data Network
STGT	Second TDRSS Ground Terminal
STOCC	Space Telescope Operations Control Center
STOMS	Space Telescope Observatory Management System
STPr	System Test Procedures
STR	System Test Review
STS	Space Transportation System
SUE	Shuttle-unique Echo-Equipment; System Utilization Enhancement
SUSTS	SN User Simulation and Test System
SWAS	Submillimeter Wave Astronomy Satellite
T&DA	Tracking and Data Acquisition
TAC	Telemetry and Command Processor
TAGS	Text and Graphics System

ACRONYM	DEFINITION
TAL	Transoceanic Abort Landing
TaSC	Tanegashima Space Center
TAT-5	Trans-Atlantic Submarine Cable - 5
TAT-6	Trans-Atlantic Submarine Cable - 6
TAV	Test and Verification
TBD	To Be Determined
TBS	To Be Supplied
TCC	Time Division Multiple Access Network Control Center
TCF	Technical Control Facility
TCI	Tracking and Data Relay Satellite System Command Interface
TCOPS	Trajectory Computation and Orbital Products System
TCS	Technical Control Systems; Oak Hanger Tracking Station (DoD Facility)
TCTS	Traffic and Configuration Time Schedule
TDM	Time Division Multiplex
TDMA	Time Division Multiple Access
TDPS	Tracking Data Processor System
TDRS	Tracking and Data Relay Satellite
TDRS II	Tracking and Data Relay Satellite II
TDRSS	Tracking and Data Relay Satellite System
TDS	Tracking Data System
TELCO	Telephone Company
TELECOM	Goddard Space Flight Center Telecommunications Network
TELECOM(A)	Australian Telephone Company
TELOPS	Telemetry Online Processing System
TGS	Transportable Ground Station
TI	Texas Instruments
TID	Time Independent Data
TIMED	Thermosphere, Ionosphere, Mesophere Energetics and Dynamics
TIMED-H	TIMED High Inclination
TIMED-L	TIMED Low Inclination
TIP	Transaction Interface Processor
TIPIT	Telemetry Input Processing into Telemetry Online Processing System
TM	Thematic Mapper
TMIS	Technical Management Information System
TOCC T&C	TDRSS Operations Control Center Tracking and Command

ACRONYM	DEFINITION
TOMS-EP	Total Ozone Mapping Spectrometer-Earth Probe
TPC	Telemetry Preprocessing Computer
TRANSPAC	Trans-Pacific Submarine Cable
TRW	Thompson Ramo Wolridge
TS	Timing Subsystem; Transport Subsystem
TSC	Technical Subcommittees
TT&C	Tracking, Telemetry, and Command
TTC&M	Tracking, Telemetry Control and Monitoring
TTY	Teletype
TV	Television
TVOC	Television Operations Center
TVSS	Television and Video Switching Subsystem
TX	Texas
U	Univac; Utilities
U-BUSS	Utilities Buss
U.S.	United States
UAF	University of Alaska at Fairbanks
UARS	Upper Atmosphere Research Satellite
UDS	Universal Documentation System
UHF	Ultra-high Frequency
UK	United Kingdom
UK/OCC	United Kingdom/Operational Control Center
UMSOC	University of Maryland Science Operations Center
UNH	University of New Hampshire
UPS	Uninterruptable Power Supply; User Planning System
USAEPG	United States Army Electronic Proving Ground
USAF	United States Air Force
USAF/SD	United States Air Force/Space Division
USN	United States Navy
V/D	Voice/Data
VA	Virginia
VAFB	Vandenberg Air Force Base
VANS	VAFB 9-meter System
VC	Video Conferencing
VCDU	Virtual Channel Data Unit

ACRONYM	DEFINITION
VCSM	Virtual Channel Sorter Multiplexer
VDS	Voice Distribution System
VEEGA	Venus Earth Gravity Assist
VF	Voice Frequency
VFI	Verification Flight Instrumentation; VCSM/FDDI Interface
VFTG	Voice Frequency Telegraph
VHF	Very-high Frequency
VIP	Virtual Interface Processor
VIS	Voice Intercom Subsystem
VLBI	Very Long Baseline Interferometry
VLSI	Very Large Scale Integration
VNB	Vandenberg Air Force Base (3-letter Designator)
VPF	Vertical Processing Facility (Eastern Range)
VSB	Vestigial Sideband
VSS	Voice Switching System
WA	Washington
WAD	Work Authorization Document
WAN	Wide Area Network
WBA	Wideband Adaptor
WBDS	Wideband Data System
WCSC	West Coast Switching Center (Jet Propulsion Laboratory)
WECO	Western Electric Company
WESTAR	Western Union Domestic Satellite
WFF	Wallops Flight Facility
WHS	White Sands Missile Range (3-letter Designator)
WIND	Interplanetary Physics Laboratory
WLPS	Wallops Flight Facility
WLR	Wideband Loop Repeater
WOTS	Wallops Orbital Tracking Station
WPM	Words per Minute
WPS	Wallops S-band Station (3-letter Designator)
WR	Western Range
WSC	White Sands Complex
WSGT	White Sands Ground Terminal
WSGT-U	WSGT Upgrade

ACRONYM	DEFINITION
WSMR	White Sands Missile Range
WSNS	WTR Shuttle Network System
WSTF	White Sands Test Facility
WU	Western Union
WUI	Western Union International
WV	West Virginia
XRI	X-Ray Imager
XRS	X-Ray Solar; X-Ray Spectrometer
XTERM	X Terminal
XY	Building Designator at Cape Canaveral Air Force Station
ZOE	Zone of Exclusion
100UNIs	User-Network Interfaces

APPENDIX C

DSN FUTURE MISSION SUPPORT REQUIREMENTS

The information contained in this appendix has been extracted from the July 1993 edition of JPL's "Deep Space Network Mission Support Requirements" (870-14) Rev. AM.

This appendix presents a brief description of specific support requirements for each of the following missions (the alpha-numeric entries in the left-hand column refer to the paragraph in Appendix C where the mission is described:

DESCRIPTIONS OF PLANNED MISSIONS

C.1 ADVANCED X-RAY ASTROPHYSICS FACILITY

Launch: December 1999

MISSION DESCRIPTION

The Advanced X-Ray Astrophysics Facility (AXAF) missions will consist of two free-flying observatory spacecraft that will perform x-ray astronomy research. AXAF is a follow-on project to the High Energy Astrophysics Observatory (HEAO) program that will provide about 10 times the resolution and 100 times the sensitivity of HEAO missions. AXAF-S (Spectroscopy) is the second of the two missions and will contain one instrument, the X-Ray Spectrometer (XRS).

FLIGHT PROFILE

The AXAF-S will be launched by a Delta II launch vehicle from VAFB into a 650 km circular sun synchronous orbit, with an inclination of 97.9 degrees.

COVERAGE GOALS

The AXAF spacecraft will be TDRSS compatible and be supported by the Space Network. The DSN 26-meter antennas at each complex will provide emergency support, as requested by GSFC.

DATA RATES

Telemetry	1, 4, or 32 kb/s realtime 256 or 512 kb/s playback
Command	2.0 kb/s

C.2 CASSINI

Launch: October 06, 1997

MISSION DESCRIPTION

Cassini is a deep space mission planned for launch in October 1997 to arrive at Saturn in June 2004. After arrival at Saturn, Cassini will send a probe into the Titan atmosphere, then continue on a 4-year satellite tour, using repeated gravity assists of Titan to shape the trajectory to satisfy science objectives.

FLIGHT PROFILE

The spacecraft will be launched from Cape Canaveral as a single payload using a Titan IV and Centaur upper stage as the launch vehicle. The Centaur second burn will inject Cassini into the interplanetary trajectory.

Cassini will use gravity assists with Venus, Earth, and Jupiter to provide the required energy to arrive at Saturn. Trajectory correction maneuvers and calibration activities will be performed during the interplanetary cruise, as well as limited science data collection.

Event	Date
Launch	06 Oct 1997
Venus Flyby	21 Apr 1998
Venus Flyby	20 Jun 1999
Earth Flyby	16 Aug 1999
Enter Asteroid Belt	12 Dec 1999
Jupiter Flyby	30 Dec 2000
Saturn Orbit Insertion	25 Jun 2004
Probe Separation	09 Jan 2005
Probe Entry	03 Jan 2005
End of Mission	25 Jun 2008

COVERAGE GOALS

The spacecraft will operate on the Low Gain Antenna during most of the first 2 years of cruise requiring 70-meter antenna support. If the 70-meter antennas are not implemented with X-band uplink capability, simultaneous 34-meter coverage will be required to meet the command and navigation requirements.

The 34-meter HEF antennas will provide one tracking pass plus one Delta VLBI pass per week during cruise operations, and continuous coverage around gravity assists and maneuvers.

During Saturn orbital operations, one 34-meter BWG pass per day for the 24 days of cruise-like activities, and continuous array 34-meter BWG support during the 6 days of high-level activities for each 30-day orbit.

DATA RATES

Telemetry	X-band	5 b/s to 285 kb/s
	Ka-band	Carrier only
	S-band	Carrier only
Command	X-band	7.8125 to 500 b/s

C.3 EARTH OBSERVING SYSTEM

Launch:	AM1	June 1998
	AERO1	June 2000
	PM1	December 2000
	ALT1	June 2002
	CHEM1	December 2002

MISSION DESCRIPTION

The Earth Observing System (EOS) program involves the operation of numerous instruments on multiple spacecraft placed in polar and midinclination orbits in support of multiple disciplines within the Earth science user community. The EOS mission is composed of several series of flights beginning with the EOS-AM1 flight in 1998. The other EOS series include PM, AERO (Aerosols), ALT (Altimetry), and CHEM (Chemistry) flights. Each spacecraft has a projected lifetime of 5 years with replacement spacecraft to provide a total series lifetime of 15 years. AERO flights are an exception with a 3 year projected lifetime and additional replacements to support the 15 year objective.

FLIGHT PROFILE

The EOS-AM and PM series missions will be launched from VAFB by Atlas II AS launch vehicles into 705 km sun-synchronous circular orbits with 98.2 degree inclinations. AERO, ALT, and CHEM series missions are under study to determine launch vehicle and orbit requirements.

COVERAGE GOALS

Primary mission support will be provided by the TDRSS. The DSN will be available for emergency support, if required.

DATA RATES

Telemetry	16 kb/s realtime 512 kb/s playback
Command	2.0 kb/s

C.4 ENGINEERING TEST SATELLITE VI (ETS-VI)

Launch: August, 1994

MISSION DESCRIPTION

The ETS-VI is being developed by the National Development Agency of Japan (NASDA) as the third Japanese three-axis stabilized engineering test satellite to establish the 2-ton geostationary operational satellite bus system. High performance satellite communications technology for future operational satellites will be demonstrated. Mission life expectancy is 10 years.

FLIGHT PROFILE

The ETS-VI satellite will be launched by a H-II launch vehicle from Tanegashima Space Center (TaSC) in southern Japan. The mission design follows the conventional injection sequence into synchronous orbit via parking, transfer, and drift orbits. The satellite is to be located at 154 degrees east longitude.

COVERAGE GOALS

Coverage will consist of all the 26-meter antennas with 34-meter antennas at Madrid and Canberra as backup. Maximum support will consist of two 8-hour tracks per station for the first 7 days, plus contingency support, if required.

DATA RATES

Telemetry	512, 2048 b/s
Command	1000 b/s

C.5 EUROPEAN TELECOMMUNICATIONS SATELLITE II (EUTELSAT II)

Launch: F-6 December 1994

MISSION DESCRIPTION

EUTELSAT II is a regional public telecommunications system for Europe. The services to be provided are telephone and television. Each satellite lifetime is expected to be 7 years.

FLIGHT PROFILE

EUTELSAT II satellites are launched using the Ariane 4 launch vehicle from Kourou, French Guiana. The satellites will be placed at a geostationary orbit within the arcs 6 to 19 degrees east, or 26 to 36 degrees east.

COVERAGE GOALS

The DSN 26-meter antennas at Goldstone and Canberra will support the transfer and drift orbits. Maximum support will consist of a 7-day period following launch, plus 14 days contingency support.

DATA RATES

Telemetry	512 b/s
Command	500 b/s

C.6 FAST AURORAL SNAPSHOT EXPLORER (FAST)

Launch: August 1994

MISSION DESCRIPTION

FAST is the second explorer of the Small Explorer multi-mission program. Its primary objective is to investigate the plasma physics of the low-altitude auroral zone.

FLIGHT PROFILE

FAST will be launched on a Pegasus Small Expendable Launch Vehicle (SELV) from the West Coast. The spacecraft will be launched into a nominal elliptical orbit of 350 km by 4200 km with an inclination of 83 degrees.

COVERAGE GOALS

The DSN 26-meter antennas will support three to six 30-minute contacts per day during launch and early orbit phase. WFF and the DSN will be backup to Poker Flats, Alaska and Kiruna, Sweden when apogee is in the northern hemisphere. When apogee is in the southern hemisphere, WFF and the DSN are prime support stations.

DATA RATES

Telemetry	4.0 kb/s Real-time 900 kb/s or 1.5 Mb/s Playback
Command	2.0 kb/s

C.7 GEOSTATIONARY METEOROLOGICAL SATELLITE-5 (GMS-5)

Launch: February 1995

MISSION DESCRIPTION

NASDA is developing GMS-5 as a continuation of their geostationary, spin stabilized, weather satellite program. The mission is to observe cataclysmic events such as hurricanes, typhoons and regional weather phenomena; day and night observations of regional weather; relay of meteorological observation data from surface collection points (ships, buoys and weather stations) to data processing center in Japan; and transmission of processed image data for facsimile distribution to western Pacific areas.

FLIGHT PROFILE

GMS-5 will be launched from TaSC in southern Japan by a H-II launch vehicle. Apogee Kick Motor (AKM) firing will occur at the 2nd (nominal) or 4th (contingency) apogee. After AKM firing, drift phase orbital and attitude maneuvers will be performed to place the spacecraft at its final geostationary position.

COVERAGE GOALS

The coverage will consist of the 26-meter antennas as prime and the Madrid 34-meter antenna as backup support for launch through drift orbit. Maximum support will be two 8-hour tracks per station for a 7-day period plus 23 days of contingency support from all complexes.

DATA RATES

Telemetry	250 b/s
Command	128 b/s

C.8 GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE (GOES)

Launch:	GOES-I	April 1994
	GOES-J	March 1995
	GOES-K	December 1998
	GOES-L	December 1999
	GOES-M	December 2003

MISSION DESCRIPTION

The objectives of the GOES program are to provide a satellite system that meets the National Environmental Satellite Data and Information Service (NESDIS) requirements specified by NOAA. These requirements include an Imager and Sounder system, a Space Environment Monitoring (SEM) System, a Data Collection System, and a Search and Rescue (SAR) monitoring system. The SEM subsystems include a Solar X-Ray Sensor (XRS), an Energetic Particle Sensor (EPS), a High-Energy Proton and Alpha Detector (HEPAD), a Magnetometer, and an X-Ray Imager (XRI). Each spacecraft will be designed to meet specified performance requirements for a 5 year period.

FLIGHT PROFILE

GOES satellites will be launched from the CCAFS using Atlas Centaur expendable launch vehicles. The satellites have been designed for shuttle retrieval in the event of a Perigee Kick Motor (PKM) or similar failure that would prevent the spacecraft from leaving low Earth orbit.

After Atlas/Centaur separation, the Centaur upper stage performs two main engine burns to place the satellite into an elliptical orbit with the apogee close to geosynchronous altitude. NOAA will perform control maneuvers to circularize the orbit and drift the satellites into the operational geostationary locations.

COVERAGE GOALS

The DSN 26-meter stations at all complexes will provide telemetry, command and tracking support following launch through completion of transfer and drift orbits. Contingency support will be provided while the spacecraft undergoes on-station checkout. After the initial 30-45 days, the DSN is committed for emergency support. Contingency and emergency support will be provided by Goldstone only.

DATA RATES

Telemetry	2.0 kb/s
Command	250 b/s

C.9 HELIOS-1 AND -2 (REIMBURSABLE)

Launch:	Helios-1	December 1994
	Helios-2	September 1999

MISSION DESCRIPTION

The Helios program will provide Italian, Spanish and French defense systems with remote sensing data. Each satellite will have one high-resolution instrument and two tape recorders that will be used to obtain constant data under optimal illumination conditions.

FLIGHT PROFILE

Both satellites will be launched from the Centre Spatial Guyanis in French Guiana on Ariane-4 launch vehicles. The satellites will be injected into the same near-circular orbits separated by 180-degrees.

COVERAGE GOALS

The Goldstone 26-meter station may provide telemetry, command and tracking support on revolutions 2 and 3 only.

DATA RATES

Telemetry	4.096 kb/s
Command	2.0 kb/s

C.10 INTERNATIONAL SOLAR TERRESTRIAL PHYSICS PROGRAM (ISTP) COLLABORATIVE SOLAR TERRESTRIAL RESEARCH (COSTR) INITIATIVE (SOHO AND CLUSTER MISSIONS)

Launch: SOHO July 1995
CLUSTER December 1995

MISSION DESCRIPTION

The COSTR initiative will combine resources and scientific communities on an international scale to undertake the development of instruments and their appropriate support elements, along with ground based theory investigations in the context of a comprehensive program of solar-terrestrial physics. The Geomagnetic Tail Laboratory (GEOTAIL) furnished by ISAS and launched by NASA in July 1992 was the first spacecraft of the ISTP program. The Solar and Heliospheric Observatory (SOHO) and the Plasma Turbulence Laboratories (CLUSTER) will be furnished by ESA. This program will study the overall balance and the nature of solar-terrestrial interaction of the Geospace region.

FLIGHT PROFILE

SOHO will be launched from CCAFS on a Atlas II launch vehicle and placed into a large Halo orbit about the L1 libration point. The CLUSTER spacecraft will be launched by an Ariane from Kourou, French Guiana into a four-spacecraft formation in a polar orbit 4 x 22 Earth Radii, with apogee near the Equator.

COVERAGE GOALS

Data acquisition from SOHO will consist of one eight hour contact per day for real-time data, and three 1.3 hour contacts for acquisition of tape recorder data. This mode of operation will be in effect approximately ten months per year. The remaining two months require continuous real-time data acquisition. The CLUSTER support will be limited to acquisition of plasma wave wideband data, two hours per orbit from three or four spacecraft. The DSN 26-meter antennas will be the prime support facilities with 34-meter antennas as backup.

DATA RATES

SOHO

Telemetry	245.7 kb/s real-time 245.7 kb/s playback
Command	2.0 kb/s

CLUSTER

Telemetry	240 kb/s playback
Command	N/A

C.11 INTERNATIONAL SOLAR TERRESTRIAL PHYSICS PROGRAM (ISTP) GLOBAL GEOSPACE SCIENCE (GGS) INITIATIVE (WIND AND POLAR MISSIONS)

Launch: WIND April 1994
POLAR June 1994

MISSION DESCRIPTION

The WIND and POLAR satellites are being developed by NASA as components of the ISTP program. These two spacecraft will be launched as the second and third missions in the program. The GGS objectives are to quantitatively assess the processes in the Sun-Earth interaction chain by the use of simultaneous instrument measurements from spacecraft placed in complementary orbits.

FLIGHT PROFILE

Both spacecraft will be launched on Delta II 7925 expendable launch vehicles. WIND will be launched from CCAFS into a sun-side apogee double-lunar swing-by orbit for a period of one year, after which the spacecraft may be transferred to a Sun-Earth L-1 Halo orbit. POLAR will be launched from VAFB into a 2 earth radii by 9 earth radii Polar orbit, with apogee near the North Pole.

COVERAGE GOALS

The WIND spacecraft will carry a NASA standard S-band transponder. One 2.08-hour support interval each day will be required for receiving tape recorder playback data. Real-time telemetry for spacecraft and instrument-performance monitoring will be received on a subcarrier simultaneous with the tape recorder playback. The spacecraft requires that command support periods be no more than 36 hours apart during the prime mission. The DSN 26-meter antennas are prime support with the 34-meter antennas used for backup support, or when insufficient link margins require their use.

The POLAR spacecraft will also carry a NASA standard S-band transponder. Four support intervals per day of approximately 45 minutes in duration will be required for receiving tape recorder playback data. Up to 12 hours per day for the first month and 3.6 hours daily thereafter will be needed for receiving real-time wide-band data. Real-time telemetry for spacecraft and instrument performance monitoring will be received on a subcarrier simultaneous with either the tape recorder playback or wideband data on the main carrier. The 26-meter antennas are prime for support with the 34-meter antennas used for backup support.

DATA RATES

WIND

Telemetry	5.565 or 11.3 kb/s real-time 32, 64 or 128 kb/s playback
Command	250 b/s

POLAR

Telemetry	55.65 kb/s real-time 256 or 512 kb/s playback
Command	1.0 kb/s

C.12 NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION-K, -L, -M, -N (NOAA-K, -L, -M, -N)

Launch: NOAA-K May 1995
NOAA-L August 1996
NOAA-M November 1997
NOAA-N May 2000

MISSION DESCRIPTION

This third-generation series of NOAA missions will provide advanced operational satellites and sensors for use in the National Environmental Satellite Data and Information Service (NESDIS).

FLIGHT PROFILE

All satellites will be launched from VAFB on Titan II expendable launch vehicles. The spacecraft will be launched into near-polar, circular, sun-synchronous orbits.

COVERAGE GOALS

The DSN 26-meter stations will support approximately six 12-minute contacts per day during launch and early orbit phase. The operational mission phase will be supported by NOAA stations with possible DSN backup support requirements.

DATA RATES

Telemetry	8.32 and 16.64 kb/s
Command	2.0 kb/s

C.13 SPACE FLYER UNIT (SFU) (REIMBURSABLE)

Launch: February 1, 1995

MISSION DESCRIPTION

The SFU is an unmanned, reusable, and retrievable free-flying platform for multipurpose use. The spacecraft will carry seven individual experiments to be completed during its mission period. Upon completion, the SFU spacecraft is to be recovered by the space shuttle.

FLIGHT PROFILE

The SFU spacecraft will be launched on an H-II launch vehicle from Tanegashima Space Center (TASC) in southern Japan into a low-Earth orbit of 400 km perigee and 500 km apogee.

COVERAGE GOALS

The DSN 26-meter stations will support the early orbit mission phase and SFU retrieval by the shuttle.

DATA RATES

Telemetry	1.0, 4.0, 8.0, and 128 kb/s
Command	1.0 kb/s

C.14 SUBMILLIMETER WAVE ASTRONOMY SATELLITE (SWAS)

Launch: June 29, 1995

MISSION DESCRIPTION

SWAS is a Small Explorer mission designed to study molecular clouds in the galactic plane, providing a mini and full survey of the clouds, leading towards the development of maps.

FLIGHT PROFILE

SWAS will be launched on a Pegasus Small Expendable Launch Vehicle (SELV) from Wallops Flight Facility (WFF).

COVERAGE GOALS

The DSN may support two to four 10-minute contacts per day as a backup to Wallops Flight Facility or Poker Flats.

DATA RATES

Telemetry	9 or 18 kb/s real-time 1.8 or 900 kb/s playback
Command	2.0 kb/s

C.15 TELECOM 2-C

Launch: January 1996

MISSION DESCRIPTION

The Telecom 2-C mission will provide high-speed data link applications, telephone, and television service between France and overseas territories as a follow-on to earlier spacecraft.

FLIGHT PROFILE

Telecom 2-C will be launched by an Ariane-4 from the Centre Spatial Guyanis in French Guiana. After the final Apogee Kick Motor firing, the spacecraft will be in a geostationary orbit.

COVERAGE GOALS

The Goldstone and Canberra stations will provide coverage during the transfer and drift orbits consisting of two 8-hour tracks per station for a 7-day period, plus 14 days of contingency support.

DATA RATES

Telemetry	320 b/s
Command	1.0 kb/s

C.16 TOTAL OZONE MAPPING SPECTROMETER/ EARTH PROBE

Launch: May 1994

MISSION DESCRIPTION

The Total Ozone Mapping Spectrometer/Earth Probe (TOMS/EP) mission will accomplish a contiguous survey of the Earth's global ozone layer each day. The spacecraft will be capable of autonomous operation for at least 24 hours without ground contact. Two contingency modes (safety-hold and sun pointing) will maintain the spacecraft in power- and thermal-safe conditions.

FLIGHT PROFILE

The TOMS/EP will be launched by a Pegasus launch vehicle from the West Coast into a 235 km orbit, with an inclination of 99.3 degrees. The TOMS/EP Orbit Adjust Subsystem will be used to lift the spacecraft into a 955 km operational orbit.

COVERAGE GOALS

The DSN 26-meter antennas at each complex will provide primary mission support, as requested by GSFC.

DATA RATES

Telemetry	1.125 kb/s real-time 50.625 or 202.5 kb/s playback
Command	2.0 kb/s

C.17 TRACKING AND DATA RELAY SATELLITE (TDRS-G)

Launch: June 29, 1995

MISSION DESCRIPTION

The Tracking and Data Relay Satellites relay communication signals between low Earth-orbiting spacecraft and the ground terminal at White Sands, New Mexico. This relay is accomplished through two types of communications links: (1) a multiple-access system with one 30-element S-band phased-array antenna system; and (2) two 4.8-meter single-access parabolic antennas operating at S- and Ku-band.

FLIGHT PROFILE

TDRS-G will be launched by the shuttle and deployed into a low Earth-orbit. Following deployment, the Inertial Upper Stage (IUS) will inject the satellite into an elliptical orbit that will be circularized to place the satellite into a geostationary position. Depending upon operational needs, the satellite will be drifted into the final operational location between 41 and 174 degrees west longitude.

COVERAGE GOALS

The DSN supports launch and transfer orbit plus emergency support from Canberra, Goldstone and Madrid. The 26- and 34-meter antennas at each complex are scheduled according to the specific flight profile for placing the spacecraft into the operational geostationary location.

DATA RATES

Telemetry	250 b/s or 1.0 kb/s
Command	2.0 kb/s

C.18 TROPICAL RAINFALL MEASURING MISSION

Launch: August 1997

MISSION DESCRIPTION

The Tropical Rainfall Measuring Mission (TRMM) is an integral part of the NASA Mission to Planet Earth Program. The mission is to study the distribution and variability of precipitation and latent heat release over a multi-year data set. TRMM is a climate mission designed to determine the rate of rainfall and the total rainfall between the North and South latitudes of 35 degrees. The primary data set is the monthly average rainfall with a spatial resolution of 500 km.

FLIGHT PROFILE

TRMM will be launched from Tanegashima, Japan on a H-II launch vehicle. The spacecraft will be placed into a 380 km orbit and maneuvered to its operational altitude of 350 km approximately one month after launch.

COVERAGE GOALS

TRMM is a TDRSS compatible mission and will receive all primary support through the TDRSS. The DSN 26-meter antennas at each complex will provide contingency support when requested by GSFC.

DATA RATES

Telemetry	1 or 32 kb/s
Command	2.0 kb/s

C.19 X-RAY TIMING EXPLORER

Launch: August 1995

MISSION DESCRIPTION

The X-Ray Timing Explorer (XTE) observatory will study a variety of x-ray sources including white dwarfs, accreting neutron stars, black holes, and active galactic nuclei. Measurements will be made over a wide range of photon energies from 2 to 200 keV. The spacecraft will carry three instruments: the Proportional Counter Array (PCA), the All Sky Monitor (ASM), and the High Energy X-Ray Timing Experiment.

FLIGHT PROFILE

XTE will be placed into a 600 km circular orbit with a 23 degree inclination by a Delta 7920 vehicle launched from CCAFS.

COVERAGE GOALS

Primary mission support will be provided by the TDRSS. The DSN will be available for emergency support, if required.

DATA RATES

Telemetry	32 and 1024 kb/s
Command	2.0 kb/s

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