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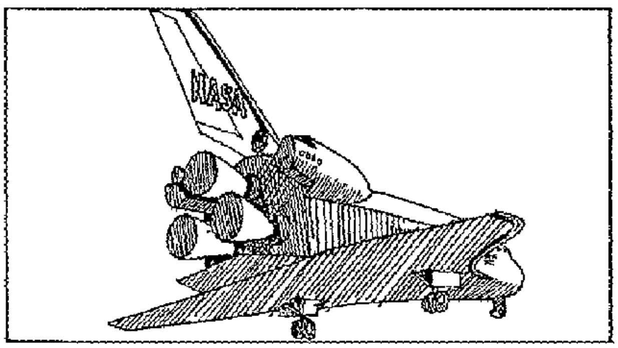
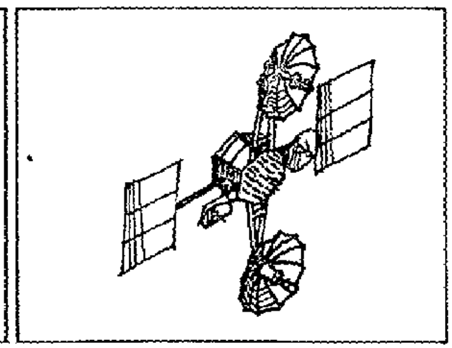
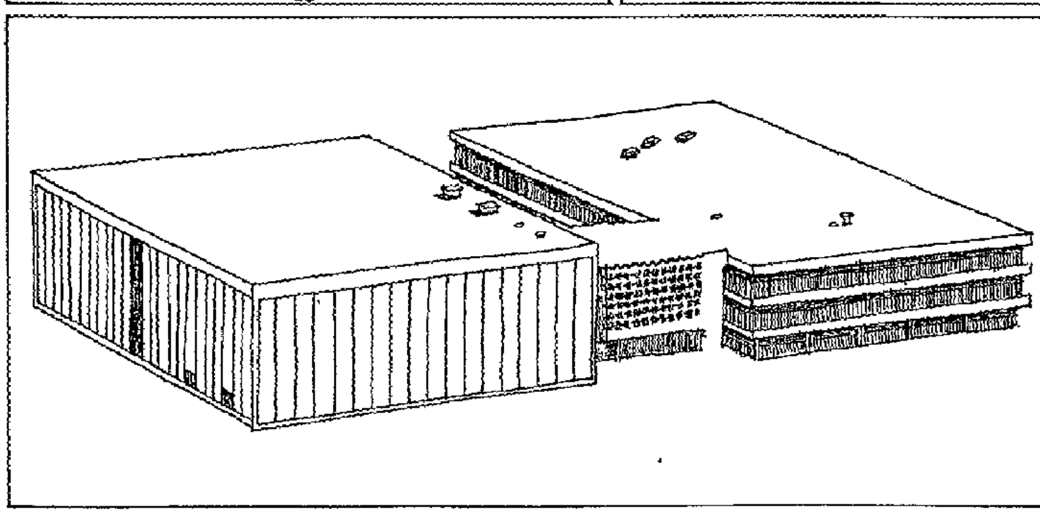
Mission Control Center (MCC) System Specification for the Shuttle Orbital Flight Test (OFT) Timeframe







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Houston Texas

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MISSION CONTROL CENTER (MCC) SYSTEM SPECIFICATION FOR THE SHUTTLE ORBITAL FLIGHT TEST (OFT) TIMEFRAME

Prepared for

GROUND DATA SYSTEMS DIVISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS

Jointly Prepared by

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FOREWORD

This document is developed jointly by the Lyndon B. Johnson Space Center, Houston, Texas, Ground Data Systems Division; Ford Aerospace & Communications Corporation, Space Information Systems Operation (SISO); and International Business Machines (IBM)/Houston, Ground Based Space Systems. It is published by Ford Aerospace & Communications Corporation in accordance with the requirements established under Task Order (TO) P-1B00 of Contract NAS 9-15014.

This document defines the current level of completion of the Orbital Flight Test Data System (OFTDS) design that is baselined. Items marked with a TBD (to be determined) shall be defined in a future revision of this document. Any information required pertaining to specification development may be acquired from the *MCC Shuttle Development Plan*, JSC-10001.

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MISSION CONTROL CENTER (MCC) SYSTEM SPECIFICATION FOR THE SHUTTLE ORBITAL FLIGHT TEST (OFT) TIMEFRAME

APPROVED BY
SISO

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1. SCOPE

1.1 General. This document specifies the Lyndon B. Johnson Space Center (JSC) Mission Control Center (MCC) systems required to command/control the Space Transportation System (STS) orbital test flights.

This document defines MCC systems, both hardware and software, their configurations, and the extent of their implementation to be accomplished for the Orbital Flight Test (OFT) timeframe. The OFT timeframe is considered to be through the sixth OFT flight. This specification, therefore, includes certain implementations and transition requirements that must occur to keep the MCC functionally ready for all phases of the STS Program.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed below were used as source material in the generation of this specification. These documents are listed only as references, and do not constitute a portion of the design contained within this document. Where discrepancies exist between this document and the references listed below, this document shall take precedence.

A. *Shuttle Telemetry Standards*, Vol. XIV, Appendix A-X, 18 March 1975, NASA JSC.

B. ALT OI Data, JSC Memorandum.

C. SI-25820, *Preliminary ALT Interface Control Document*, 10 November 1975, SISO.

D. SE-25818, *Preliminary ALTDS Hardware Performance Specification*, 4 September 1975, SISO.

E. SH-25819, *Preliminary ALTDS Software Design*, 7 August 1975, SISO.

F. "Network Interface Processor Study," SISO MCC Task 3 Study Report, 7 April 1975, SISO.

G. JSC-09337, *Space Shuttle Orbiter Approach and Landing Test-Flight Operations Facilities Requirements*, 7 March 1975, NASA JSC.

2.1 General. (Cont'd)

H. *Computer Program Development Specification (CPDS)*, Vol. 1, Book 1 (Hardware) and Book 2 (Software), February 1975, SDD, DSAD, NASA JSC.

I. MC615-0016, *Compiler-PCMMU Specification*, 15 February 1975.

J. MF0004-038, *Assembler-MDD Specification*, 22 January 1975.

K. MC476-1030A, *PCMMU Specification*, 12 November 1973.

L. MC615-004B, *MDM Specification*, 11 December 1974.

M. *Data Format Control Book(s)* (ALT, OFT, OPS), GDSD, NASA JSC.

N. SS-09605, *Skylab Display Control System Requirements and Specification*, 9 September 1972.

O. JSC-11028, Vol. VI, Part I, *Network Interface Processor Requirements*, 12 May 1976, NASA JSC.

P. *Shuttle Telemetry Data Format Control Book*, Rev. D, 10 March 1975, NASA JSC.

Q. *Level A Requirements for Shuttle*, Vol. I, OFT, 17 October 1975, NASA JSC.

R. *OFT Baseline Operations Plan*, NASA JSC.

S. PHO-TR388, *PHO Operations Quality/Reliability Plan*, 12 September 1968; Rev. 3, Ch. 1, 5 September 1975, SISO.

T. PHO-TR446, *DTE Background Disk Recording Program Requirements*, 6 May 1969, SISO.

U. PHO-TR576, *Study of Ground Data Handling Systems for Earth Resources Satellite*, 8 August 1974, SISO.

V. IS4000-00051, *SISO MCC Program General Requirements Specification*, SISO.

W. SE-09588, *DTE Cluster Control Unit Performance Specification*, 11 February 1971, SISO.

2.1 General. (Cont'd)

X. SU-25827, *Confidence Tape Hardware Subsystem Performance Specification*, 13 June 1975, SISO.

Y. SP-25838, *Network Interface Processor Telemetry Preprocessor Computer System Procurement Specification*, 8 August 1975; Rev. A, 13 October 1975, SISO.

Z. PHO-TN321, *Reliability Baseline Analysis of the Video Display String Equipment*, SISO.

AA. *Generalized Confidence Tape System User's Guide*, SISO.

AB. JSC-10309, *MCC/Shuttle Test Plan*, Vols. 1 through 6, 21 September 1976.

AC. JSC-11028, *Test and Checkout Software*, Vol. IV, Rev. B, March 1977.

AD. JSC-10382, *TPC Checkout Software System Specification*, 1 February 1977.

AE. JSC-10388, *TPC Checkout System (TCOS), Version A, Software Design Specification*, 13 June 1977.

AF. JSC-10081, *Shuttle Orbital Flight Test Data System (OFTDS) Interface Definition Document*, Ch. 5, 12 August 1977.

3. MCC SHUTTLE OFT SYSTEMS OVERVIEW

3.1 Introduction. The MCC Shuttle OFT Data System (OFTDS) shall provide facilities for flight control and data systems personnel to monitor and control the Shuttle flights from launch (tower clear) to rollout (wheels stopped on runway). It shall also support the preparation for flight (flight planning, flight controller and crew training, and integrated vehicle and network testing activities). The MCC Shuttle OFTDS shall provide for monitoring and control of specific payloads assigned to JSC. Emphasis during OFT shall be on the Shuttle system performance with extensive real-time system monitoring performed in the MCC to assure crew safety, mission success, and qualification of the Shuttle onboard systems. As the Shuttle becomes operational, the MCC support emphasis shall shift from basic systems monitoring to payload monitoring, data management, and multiple flight support.

The MCC Shuttle OFTDS shall also provide support for guidance; targeting; communication; trajectory determination, navigation, monitoring, and control; Orbiter systems command and monitoring; inflight payload data acquisition; and information extraction necessary for the execution of the above functions.

Figure 3-1 depicts the three major support systems of the OFTDS and the data types and sources of data entering or exiting the MCC. These systems are the Communication Interface System (CIS), the Data Computation Complex (DCC), and the Display and Control System (DCS). All of these systems may interface with, and share processing facilities with, other applications processing supporting current MCC programs. These programs include the 360/75 Computer Complex, Software Development Lab (SDL), Large Area Crop Inventory Experiment (LACIE), Production Processor System (PPS), Data Retrieval and Formatting Technique (DRAFT), and Medical Information Computer System (MEDICS).

3.1.1 Purpose of the MCC. The MCC shall provide centralized control of the NASA Space Shuttle OFT from launch through orbital flight, entry, and landing until the Orbiter comes to a stop on the runway. This control shall include the functions of vehicle management in the area of hardware configuration (verification), flight planning, communication and instrumentation configuration management, trajectory, software and consumables; payloads management; flight safety; and verification of test conditions/environment.

MCC EXTERNAL SYSTEMS	T/M	CMD	TRAJ	VOICE	FACS	TTY	VIDEO
GSFC	X	X	X	X	X	X	
TDRSS	X	X	X	X			X
KSC			X	X	X		X
SMS	X	X	X	X		X	X
JSC BLDGS				X			X
OTHER SITES				X	X		

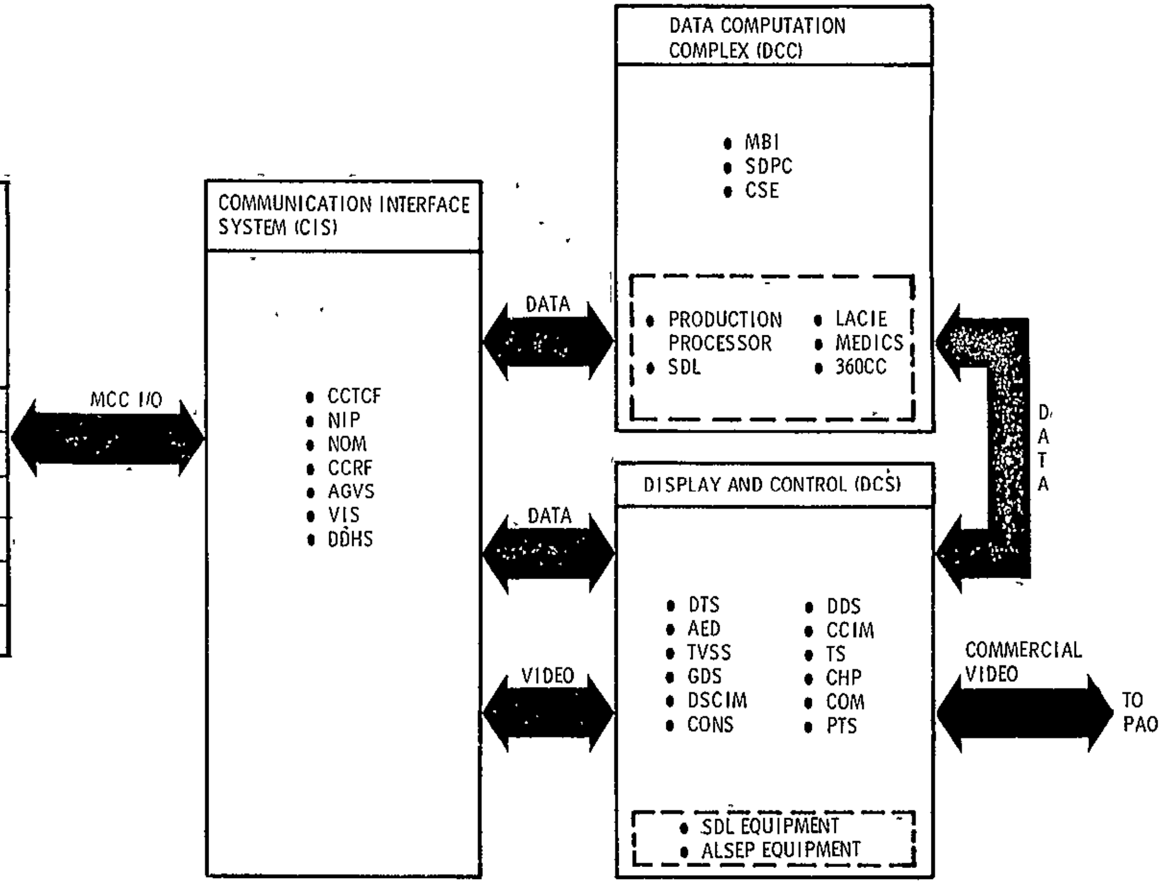

Figure 3-1 OFTDS System Overview

3.1.2 Operations. The MCC shall be supported by the John F. Kennedy Space Center (KSC) facilities and by the Spaceflight Tracking and Data Network (STDN). The STDN shall consist of a worldwide network of ground tracking and voice-data communication stations. The term STDN shall initially refer to the pre-Tracking and Data Relay Satellite System (TDRSS) network of ground stations and communication lines. After TDRSS becomes operational, the remaining ground stations shall be referred to as the Ground Spaceflight Tracking and Data Network (GSTDN). The term STDN shall then refer to the GSTDN plus the TDRSS. The TDRSS is expected to reduce the GSTDN support required for Shuttle as it becomes operational. It shall consist of two satellites placed in a geosynchronous equatorial orbit to give maximum earth orbit coverage to spacecrafts at orbital altitudes up to approximately 2700 nmi (5000 km), and one primary ground station, optimally located for viewing the two satellites.

3.2 OFTDS Data Flow. The major data flows within the MCC OFTDS are telemetry, command, and trajectory. Table 3-1 presents an overview of the OFTDS capabilities for these data flows. How the subsystems interface as the data flows through the system is described in the following sections.

3.2.1 Telemetry Data Flow. Figure 3-2 depicts the telemetry data flow for OFTDS as it progresses to/from the different subsystems. Telemetry data shall enter the OFTDS through the Communication Circuit Technical Control Facility (CCTCF) via GSTDN, TDRSS, or Shuttle Mission Simulator (SMS). The CCTCF shall establish the interface to the data stream and route the data to the appropriate subsystem. Recording of the incoming data shall be accomplished by the Consolidated Communications Recording Facility (CCRF). The data shall be forwarded to the Network Interface Processor (NIP) where network communications and telemetry preprocessing occur. The telemetry data stream shall be routed from the NIP to the Air-Ground Voice Subsystem (AGVS) for digital voice processing, and then to the Voice Intercom Subsystem (VIS) where voice distribution to the public address (PA) and console keysets occurs. Voice recordings shall be made in the CCRF. As a backup, the telemetry stream can be routed directly from the CCTCF to the AGVS. Analog/bilevel event data shall be forwarded to the Analog and Event Distribution (AED) Subsystem for stripchart recording or display. Dump and real-time telemetry data shall be routed to the Dump Data Handling Subsystem (DDHS) for data corrections and temporary storage (the DDHS shall be implemented for use during STS flight 8 and all subsequent TDRSS flights). Corrected data shall be output to the NIP for telemetry preprocessing, to the AGVS for digital voice processing, and to the CCRF for archive. Data quality messages for the dump data shall be forwarded to and configuration/control data received from the Shuttle Data Processing Complex (SDPC) via the Multibus Interface (MBI). The primary data flow shall progress from the NIP, via the MBI, to the SDPC for logging, limit sensing, conversion, and analysis processing. SDPC processing results shall be advanced to the Digital Television Subsystem (DTS) via the Configuration and Switching Equipment (CSE), where the DCC data shall be converted to dynamic video displays and forwarded to the Television and Video Switching Subsystem (TVSS) for switching to the Console Subsystem (CONS) for display. Event and timing data

TABLE 3-1

OFTDS CAPABILITIES

TELEMETRY	COMMAND	TRAJECTORY
• RECEIVE 2 SIMULTANEOUS ORBITER DOWNLINK PLUS SCIENCE DOWNLINK	• MAJOR COMMAND FUNCTIONS RESIDENT IN MCC	• TRAJECTORY PROCESSING FOR ORBIT DETERMINATION
• DOWNLINK RATES UP TO 1 Mb/s	• GENERATE RTC, SPC, COMPUTER LOADS, REMOTE SITE COMMANDS	• HIGH-SPEED TRAJECTORY - 1 USER
• GENERALIZED TLM DATA PROCESSING IN ACCORDANCE WITH NASA TLM STANDARDS	• GENERATE ENTIRE SHUTTLE UPLINK FOR TDRSS TRANSMISSION	• OPERATIONS - 2 SIMULTANEOUS USERS
• PROVIDE TLM DATA FOR STRIP-CHART, VIDEO, EVENT DISPLAYS	• INTERFACE GSFC POC FOR ORBITER-COMMANDED GSFC PAYLOADS	• SUPPORT 16 SIMULTANEOUS TRAJECTORY DISPLAY PROCESSING REQUESTS
• RECORDING OF TLM DATA RECEIVED AT MCC FOR FURTHER DATA REDUCTION	• COMMAND ONE ORBITER AND ANY ASSOCIATED PAYLOADS WHICH USE THE ORBITER COMMAND SYSTEM	• PROVIDE TRAJECTORY PLANNING SUPPORT CAPABILITY
		• SUPPORT MULTIPLE FLIGHT PROFILES
		• PROVIDE ACQUISITION DATA TO GSFC
		• VALIDATE ONBOARD NAVIGATION COMPUTATIONS
		• PROVIDE UPLINK COMMAND TRAJECTORY DATA

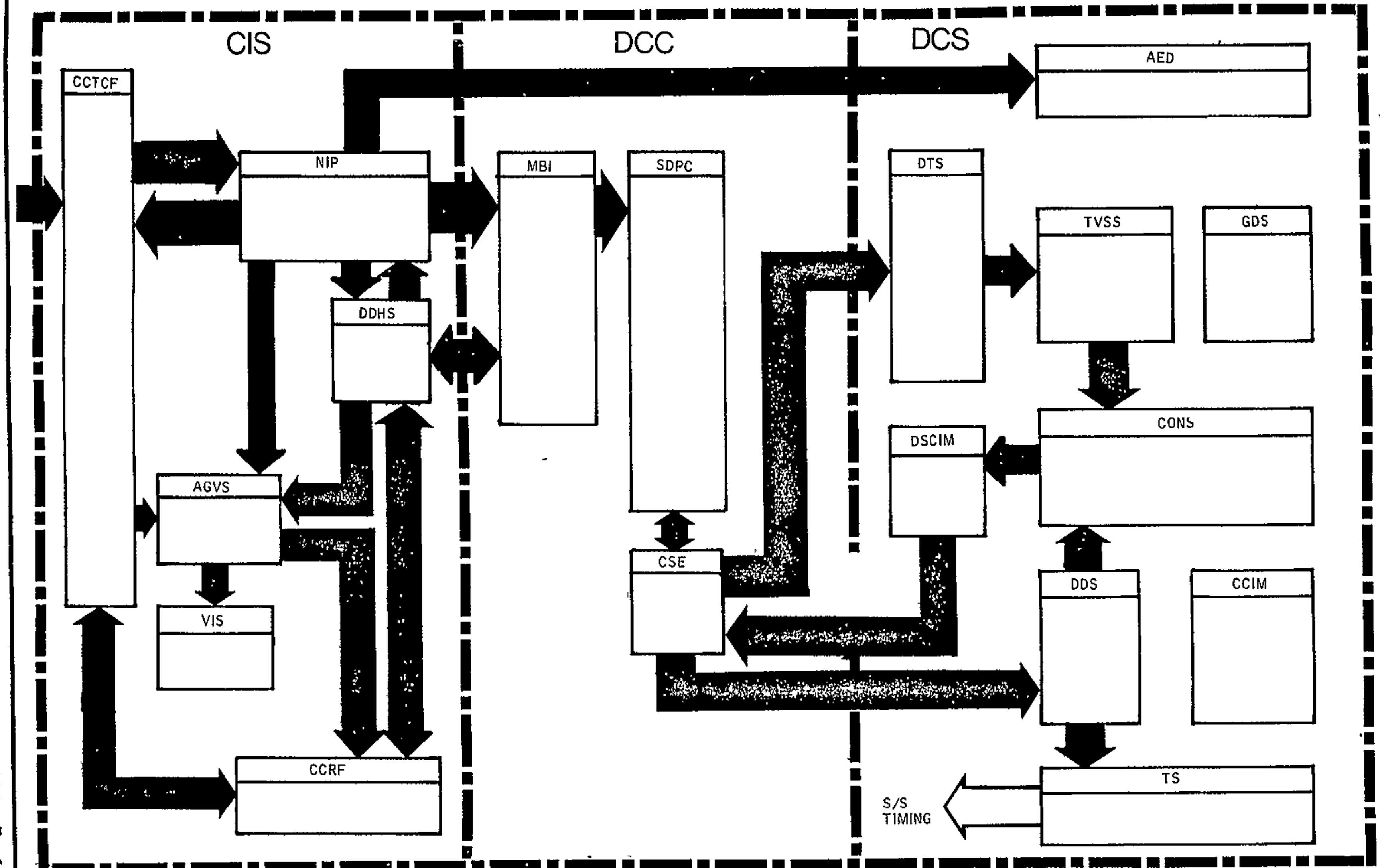

Figure 3-2 Telemetry Data Flow

3.2.1 Telemetry Data Flow. (Cont'd)

shall progress from the SDPC, through the CSE, to the Discrete Display Subsystem (DDS) where timing information shall be passed to the Timing Subsystem (TS) and event data shall be converted to lamp driver signals for indication at the consoles. The man/machine interface shall be established at the consoles where display requests can be made and forwarded to the Display Select Computer Input Multiplexer (DSCIM) for routing via the CSE to the SDPC for processing and response.

3.2.2 Command Data Flow. Commands shall originate and be verified at the MCC consoles. Command requests shall be forwarded to the Command Computer Input Multiplexer (CCIM) for routing through the CSE to the SDPC. The SDPC shall generate the command, respond with any displays associated with the command to the DTS via the CSE, where the data shall be converted to dynamic video displays and routed to the TVSS for switching into the CONS. Command and event verification data received in the telemetry data stream shall be passed to the CSE; it shall be advanced to the DDS where the event indicators shall be converted into lamp signals for relay to the console lamps. Real-time, stored program, computer load, and remote site commands shall be sent over the MBI to the Network Output Multiplexer (NOM). The NOM shall interleave the digital voice data from the AGVS with the command data from the SDPC for output to the network (TDRSS era only). The CCTCF shall receive data from the NOM for output to GSTDN, TDRSS, and SMS. See figure 3-3 for the command data stream as it flows through the OFTDS subsystems.

3.2.3 Trajectory Data Flow. Figure 3-4 depicts the trajectory flow for OFTDS. Trajectory data shall enter the MCC from the following sources: wideband data from GSFC, TDRSS, and SMS; and high-speed Launch and Landing Tracking Data (LLTD) from KSC and SMS. Tracking data (metric and TDRS vectors) from GSTDN shall be received over the 1.544 Mb/s wideband lines. Wideband data shall be received by the CCTCF and routed to the CCRF for recording and playback. It shall also be routed through the NIP where the primary communications management functions shall be performed before forwarding the data over the MBI to the SDPC for selective logging and processing. All trajectory processing shall be performed by the SDPC. The resultant displays shall be directed to the DTS via the CSE, converted to dynamic video displays, and routed through the TVSS. Large screen projection displays shall be forwarded to

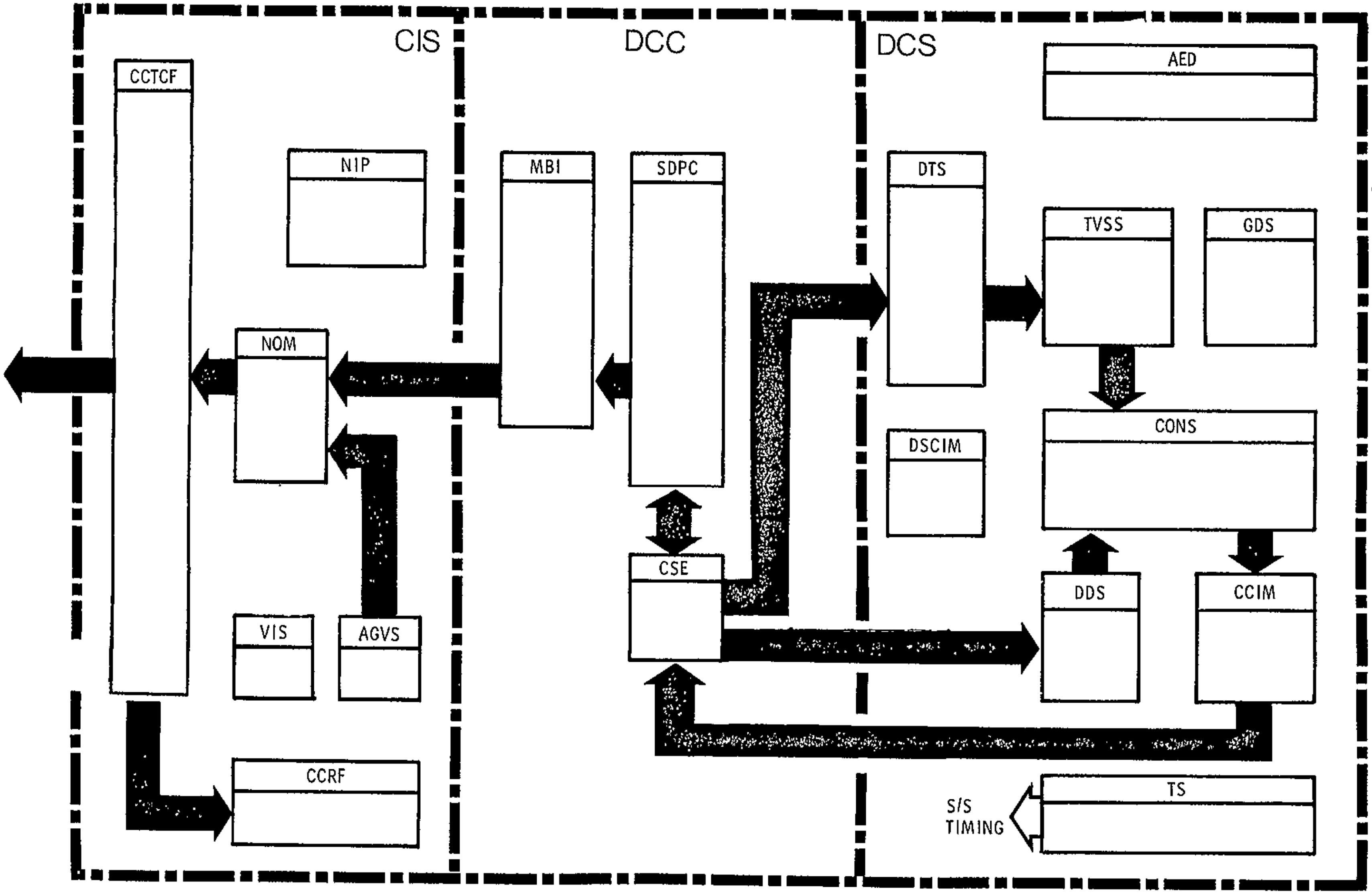

Figure 3-3 Command Data Flow

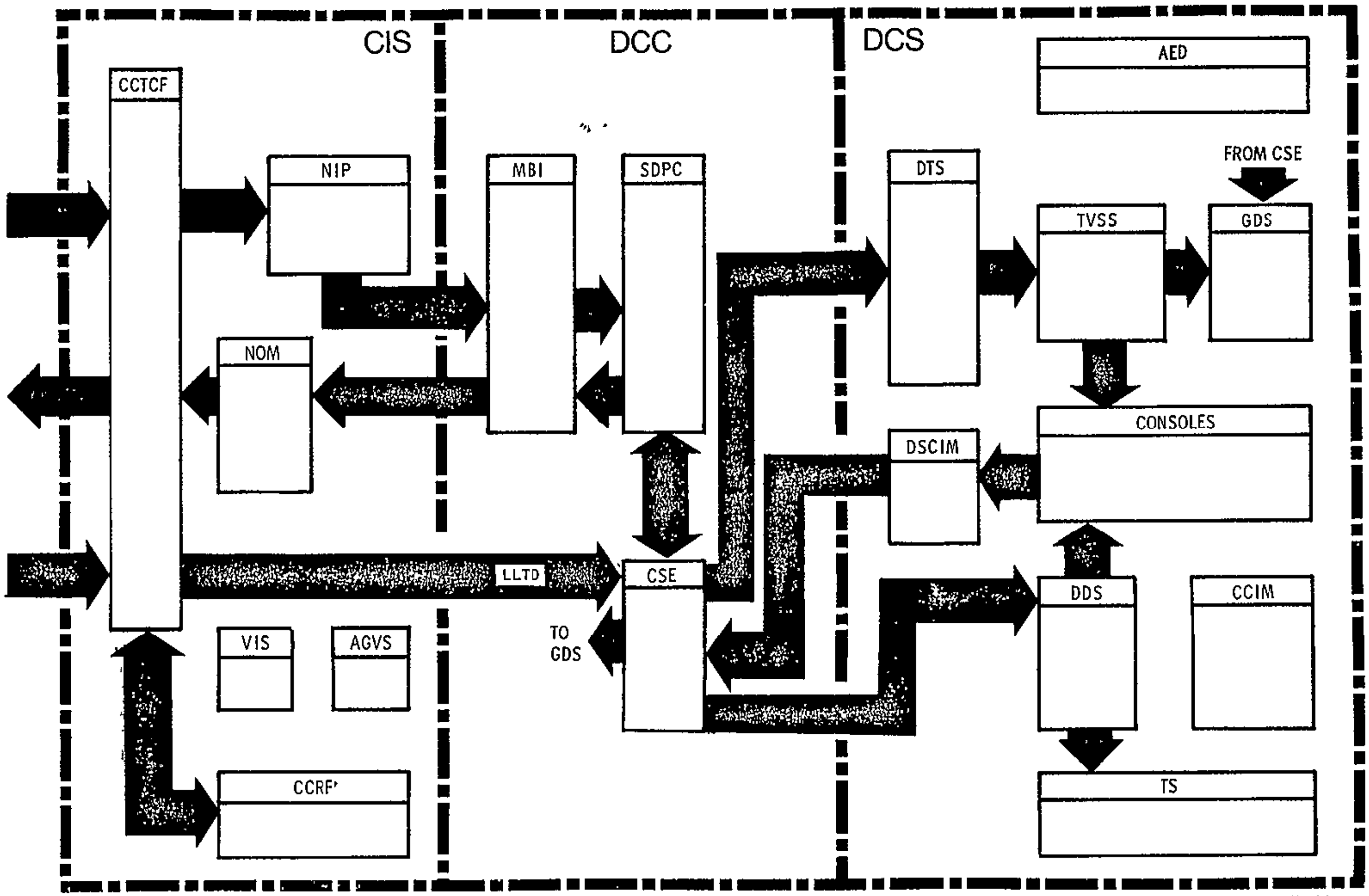

Figure 3-4 Trajectory Data Flow

3.2.3 Trajectory Data Flow. (Cont'd)

the Group Display Subsystem (GDS); other displays shall be routed to the consoles. Trajectory event data from the SDPC shall be routed through the CSE to the DDS where the digital data shall be converted to lamp drive signals at the consoles and relative time accumulator (RTA) control signals shall be routed to the TS. Acquisition data to the GSTDN shall be generated in the SDPC and routed through the NOM and CCTCF. High-speed launch and impact prediction data shall be processed by the SDPC after being received by the CCTCF and forwarded through the CSE. Console display requests received by the DSCIM and forwarded through the CSE to the SDPC shall result in generation of trajectory displays which shall be forwarded to the DTS.

3.2.4 Miscellaneous Data Flows. Figure 3-5 depicts the flow of data through the OFTDS subsystems for analog voice data, video, teletype data, time-share option (TSO) data, and facsimile data as they enter or exit the OFTDS through the CCTCF. Video data shall be received by the CCTCF and forwarded directly to the TVSS for display. TSO data shall enter the CCTCF and advance to the SDPC via the CSE for processing; the resultant output shall return through the CSE and CCTCF. Analog voice received shall be sent to the VIS (or AGVS, then to the VIS) for voice distribution to the PA and console keysets. Voice recordings shall be made in the CCRF. Teletype data shall be routed to the message center within the CCTCF. Remote Job Entry (RJE) data shall be routed directly from the IBM building to the SDPC for processing; the resultant output shall return directly to the IBM building.

3.3 Mission Phase Support Elements. The MCC shall be required to provide support to Shuttle in a variety of configurations in normal and contingency operations. Mission phases identified for support are launch, landing, abort/contingency, flight simulations, and nominal on-orbit operations. Each support area imposes operational restrictions upon the MCC and the needed tools must be available to meet these conditions. The following assumptions are made concerning MCC support for these mission phases: all MCC resources shall be available for support as needed; only one mission operation shall be conducted at one time; no routine simulation shall be conducted during critical phases; and those resources not committed to mission support shall be available on a 30-minute callup basis.

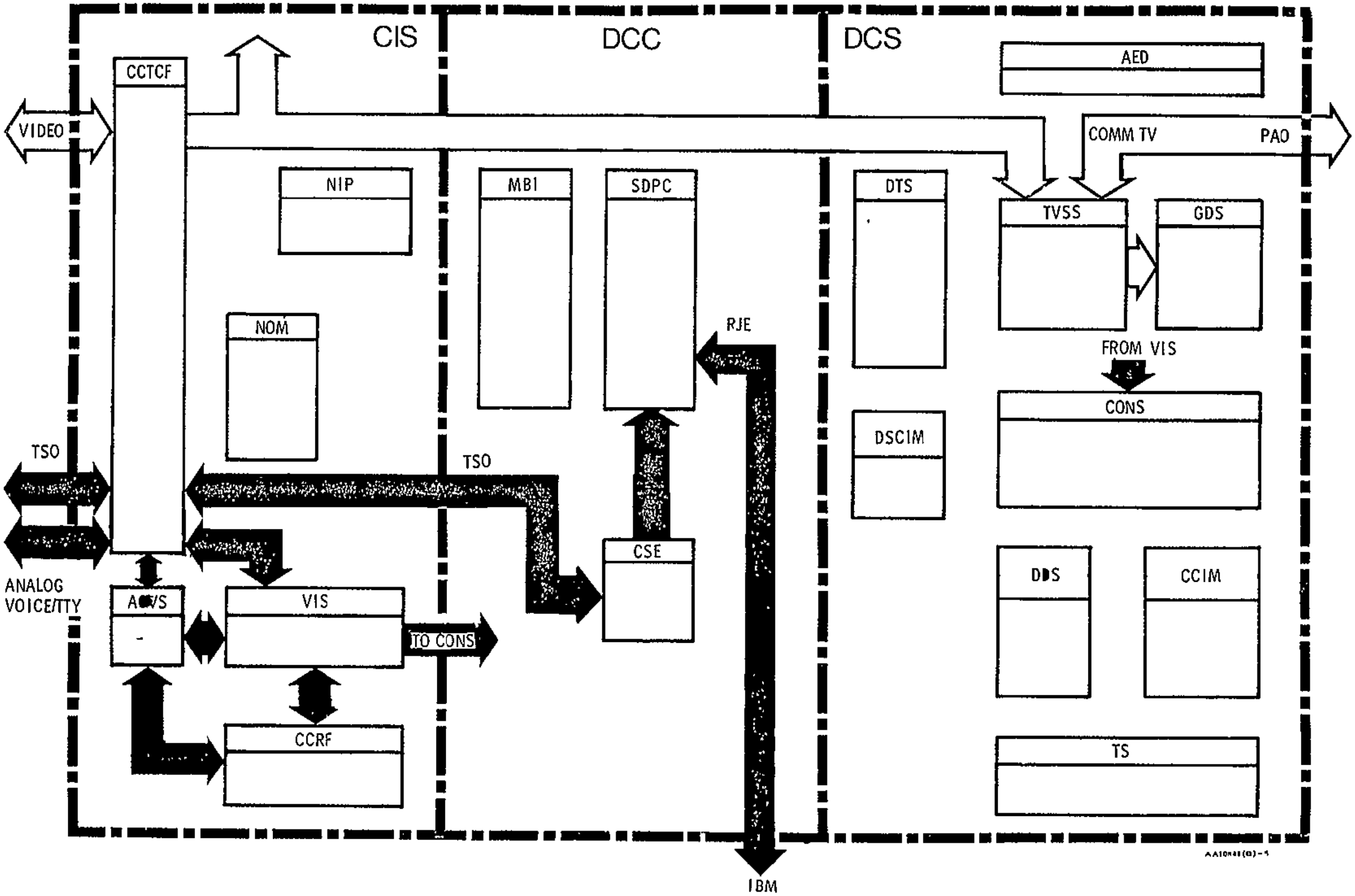

Figure 3-5 Miscellaneous Data Flow

3.4 MCC OFT Functional Allocations. The functional requirements for Shuttle OFT shall be allocated to three MCC systems; the CIS, DCC, and DCS. The basic MCC OFT functional allocations are presented in figure 3-6.

3.4.1 Communication Interface System (CIS). The CIS shall perform the functions of providing voice and data communications within the MCC, and between the MCC and external circuits. Functions allocated to CIS subsystems shall be as follows.

A. CCTCF. The CCTCF shall provide terminations and configuration for all external voice, data, TSO terminal and TTY circuits entering and leaving the MCC, and termination/configuration for all MCC systems requiring access to these external circuits. It shall include capability to interface and reconfigure the circuits and provide measurement of circuit performance.

B. NIP. The NIP shall provide processing of incoming network data to the extent of determining data validity and quality; extracting tracking, site-originated data [command history, Data Link Summary Message (DLSM), site status, etc.], and telemetry data; and preprocessing individual vehicle data for transmission to the SDPC and the AED.

C. NOM. The NOM shall provide the output function for transmission of SDPC data and digital voice data to the network. SDPC data shall be output in block format when transmitting to GSTDN. Digital voice and SDPC data interleaving shall be accomplished when outputting to TDRSS. Interleaving shall not be performed for network management commands which are output to GSTDN.

D. DDHS. The DDHS shall provide reverse-to-forward and rate correction for dump operational downlink data and temporary storage of dump and real-time operational downlink data for quick access playbacks.

E. AGVS. The AGVS shall provide air-ground communications with the Orbiter, both analog through GSTDN and digital through TDRSS.

3.4.1 Communication Interface System (CIS). (Cont'd)

F. VIS. The VIS shall provide voice communications among MCC operating positions, and between these operating positions and other external ground support locations. It shall also provide PA coverage in the MCC.

G. CCRF. The CCRF shall provide historical recording of all data and selected voice communications entering or leaving the MCC.

3.4.2 Data Computation Complex (DCC). The DCC shall provide computational, peripheral, and switching capability which will support the requirements derived from the *MCC Level A Requirements for the Shuttle, Vol. 1: OFT*. The DCC, a distributed processing complex, shall consist of the following elements.

A. MBI. The MBI shall provide a common data bus enabling multiple paths that can be established dynamically on a demand basis between the SDPC, Telemetry Preprocessing Computer (TPC), Network Communications Interface Common (NCIC), and NOM.

B. SDPC. The SDPC shall provide the processing of communication, command, trajectory, and telemetry functions.

C. CSE. The CSE shall provide interface equipment necessary to configure the DCC computer systems with communications, display and control systems, and selectover for Mission Operations Computer/Dynamic Standby Computer (MOC/DSC) computers.

3.4.3 Display and Control System (DCS). In conjunction with the DCC and CIS, the DCS shall provide OFT mission and support personnel the capability to request and monitor computer data in several media. In this capacity the system shall detect, encode, and transmit operator requests in the form of either display requests, configuration control messages, command requests, or data management information to the DCC. The DCC, in response to functional requests, shall provide the requested information in the proper

3.4.3 Display and Control System (DCS). (Cont'd)

media format to the DCS for utilization by such devices as SCR's, TV monitors, group displays, and event monitors, or send the information to its proper destination, network, or other JSC facilities. Other related DCS capabilities shall consist of providing the MCC with timing standards, hardcopy information in several media, switching and routing of display information, and conversion and taping of video information.

A. DTS. The DTS shall convert the Shuttle computer data into video displays selectable by the user.

B. TVSS. The TVSS shall provide video switching and sync for video distribution to 320 console monitors and group displays. The processing and distribution of onboard Shuttle television shall also be provided. In addition, the TVSS shall provide for PAO dissemination of video mission information as well as NASA intercenter video interfacing.

C. CHP Subsystem. The CHP Subsystem shall provide selectable hardcopy of messages routed to the SDPC from the DSCIM, CCIM, and Digital Display Driver/Subchannel Data Distributor (DDD/SDD).

D. GDS. The GDS shall provide large screen displays suitable for group viewing.

E. DDS. The DDS shall display event data from Orbiter data and DCC computer-generated data for 250-300 lamp driver events per console.

F. AED Subsystem. The AED Subsystem shall receive analog and bilevel event data from the NIP and distribute this data to SCR's.

G. CONS. The CONS shall provide the physical housing for the display and control devices required for operator interface with the DCC.

H. TS. The TS shall provide the master timing source for all OFTDS subsystems.

3.4.3 Display and Control System (DCS). (Cont'd)

I. DSCIM. The DSCIM shall allow access of display-related information from the DCC computers as a result of a user console request.

J. CCIM. The CCIM shall accept input data (pushbutton switch closures) from the CONS and convert this into binary codes for transfer to the SDPC command processor.

K. Computer Output Microfilm (COM). The COM shall provide offline generation of high resolution film images of alpha-numeric and graphic information for both mission-related data and earth resources data.

L. Pneumatic Tube Subsystem (PTS). The PTS shall provide hard-copy message transportation of video hardcopy to flight control from the various message centers located in Bldg. 30 Mission Operations Wing (MOW).

3.5 MCC OFT Software Allocations. MCC OFT software shall be divided between front end type data conditioning as provided in the NIP and data monitoring and display as provided by the SDPC. The exception is the display of analog and event recorder data from the NIP. Checkout software shall be provided by both the NIP and the SDPC. The NIP shall also provide Data Flow Engineer (DFE) logging software.

3.5.1 NIP Software. The NIP software shall consist of the following components.

A. Real-Time Operating Software. This software shall be TPC-resident and consist of systems software and applications software. The systems software shall include the operating system software and the system support software. The applications software shall incorporate all functions, which are assigned to individual modules, necessary to support the OFT/TPC telemetry processing requirements.

B. Checkout Software. This software shall be TPC-resident and form the basis for the TPC Checkout System (TCOS). It shall provide for the testing of elements of the CIS, DCC, and DCS; for confidence tape generation; and for scoring of the OFT TPC operational software outputs.

C. DFE Logging Software. This software shall reside in the PDP-11/45 and provide for the monitoring and analysis of live network data (as it progresses through the NIP) to verify proper operation of the NIP hardware or proper operational data flow.

3.5.2 SDPC Software. SDPC software elements shall consist of systems and applications software. The vendor-supplied systems software shall provide the basic capabilities needed to support hardware and applications software real-time data driven functions, response-critical interactive functions, and local and remote batch processing. Special applications software (developed by the associate contractor) shall be provided as required to support telemetry, display, command, trajectory, and message handling within the SDPC.

3.6 OFTDS Testing. The purpose of the OFTDS testing shall be to certify the OFTDS as capable of meeting the operational system needs. OFTDS testing objectives are to certify the complete OFTDS, verify reconfiguration and user operability, demonstrate the ability to support premission simulation and readiness to support external validation testing, and to verify MCC capability to interface with external systems such as KSC and GSFC. OFTDS testing shall occur in two major phases, development and operational.

3.6.1 Development Phase Testing. In the development phase, there shall be four significant categories of testing that occur.

A. Predelivery Testing. Predelivery testing shall include those tests that are performed at the contractor facility prior to installation on site.

B. Certification Testing. Hardware/software certification testing shall include those tests that are performed onsite to certify and selloff to NASA the deliverable hardware/software components.

C. Integration Testing. Integration testing shall include those tests that are performed to verify end-to-end application of all MCC/Shuttle hardware/software elements.

D. Recertification Testing. Recertification shall be that testing deemed necessary to re-establish the integrity of a component, subsystem, or system after a change (modification or addition) has been made to a previously certified element.

3.6.2 Operational Phase Testing. In the operational phase, the testing shall verify that the OFTDS as configured by mission requirements can support each mission. The operational phase can be divided into three categories.

A. Reconfiguration Testing. This category shall provide the mechanism which verifies that the reconfigurable elements of the OFTDS are correctly configured on a mission-to-mission basis. This testing shall address verification of the integration of the generalized software and configuration data that controls system data processing.

3.6.2 Operational Phase Testing. (Cont'd)

B. Validation Testing. This cateogry shall include verification of the operational capability of the MCC internal system, the MCC/simulation interface, and the MCC/STDN system interfaces. These tests shall also verify that configurations and procedures satisfy user requirements in a mission-specific atmosphere from the remote site to the user end instrument.

C. Maintenance Testing. This category shall ensure that the MCC/Shuttle hardware is in a state of readiness to support user requirements. This testing shall be accomplished by implementation of a preventive and corrective maintenance program that ensures equipment availability for operational support.

3.7 System Reliability. The OFT mission reliability goal for each mandatory subsystem shall be 0.9995. This means that, on the average, the subsystem is expected to experience 5 failures for each 10,000 missions supported. Reliability analysis for OFT shall be concerned with four data streams: command, telemetry, trajectory, and voice. Each unit of each subsystem involved in the data flow shall be analyzed to determine the necessary redundancy and reconfigurability required to guarantee the 0.9995 reliability of the subsystem. Reliability assessment for the command, telemetry, trajectory, and voice shall be 0.9965, 0.997, 0.997, and 0.9987, respectively.

3.8 Other MCC Support Functions. The MCC shall provide the capability to support other activities not considered Shuttle mission activities.

3.8.1 360/75 Computer Complex. The 360/75 computer complex shall provide for the testing of DCS interfaces in nonreal-time OFT mission support. It shall provide the capabilities for performing hardware certification and verification testing, and assist in hardware fault isolation and identification. It shall include functions for testing consoles, display devices, external interfaces, and special-purpose hardware and/or interfaces.

3.8.2 Other Programs. Programs in support of earth resources, medical record files, and software development are concurrent operations which shall be supported by the MCC. Operations in this category are the PPS, MEDICS, LACIE/Interactive Earth Observation Display/Control System (IEODCS), SDL, DRAFT, Natural Environment Support, and the Special-Purpose Processor (SPP).

3.9 OFT/OPS Transition. The transition period from Shuttle OFT to Shuttle OPS shall bring about major changes to MCC operations and resources. The time period from second quarter 1980 to fourth quarter 1981 is denoted as "Transition Period" for the Space Shuttle Program. It is noted, however, that the transition of the MCC to support Shuttle activities is currently in progress and shall continue to evolve until STS maturity. The MCC shall continue to support other programs while the development of Shuttle continues.

Changes which are expected to occur over the transition period are:

A. TDRSS Operational. TDRSS is expected to be launched in FY 1980. The initial system shall be limited to S-band capability. High-bit rate (HBR) Ku-band capability will not be available immediately. During first quarter FY 1981, full bit rate capability is expected to be implemented for operational support.

B. Shuttle Online Data Base. The MCC shall implement an online data base in support of Shuttle during the OFT/OPS transition period. The data base should be operational at the beginning of the OPS timeframe. The data base is projected to be part of the SDPC.

C. Multiple Vehicle Processing Capability. This capability shall be expanded to allow increased data loads imposed by multiple vehicle support. The following expansions may be required:

- Additional NCIC, NCIU, and TPC strings to handle multiple data sources from multiple vehicles
- Update and expansion of the DCS to include MCC control and support room reconfiguration to four Flight Control Rooms (FCR's), 12 Multipurpose Support Rooms (MPSR's), and one Mission Operations Planning Room (MOPR)
- Expansion of the MBI
- Expansion of the DDHS.

4. MCC SYSTEM CONFIGURATION

4.1 General. This section specifies the equipment configuration to be baselined for the MCC OFT System. Figure 4-1 depicts the overall system configuration, grouping the equipment into the three major systems (CIS, DCC, and DCS). Additionally, system interfaces external to the MCC are depicted on the far left of the diagram. The shaded parts of the figure represent equipment and interface lines that provide the capability to support other activities not considered Shuttle mission activities.

Paragraphs 4.2, 4.3, and 4.4 specify the equipment baselined for the CIS, DCC, and DCS respectively, including a discussion of the required transition from the OFT to the OPS phase. Paragraph 4.5 specifies the MCC building arrangement for OFT, paragraph 4.6 presents reliability specifications, and paragraph 4.7 presents availability specifications.

4.2 Communication Interface System (CIS). The CIS shall provide voice and data communications within the MCC, and voice, data, and TTY between the MCC and external circuits. Seven subsystems are defined to perform these functions.

A. Communication Circuit Technical Control Facility (CCTCF). The CCTCF shall provide terminations for all external voice, data, TSO terminal, and TTY circuits entering and leaving the MCC, and termination for all MCC systems requiring access to external circuits. It shall provide the capability to interface and reconfigure the circuits appearing in it, and shall permit measurement of circuit performance and evaluation of data quality.

B. Network Interface Processor (NIP) Subsystem. The NIP shall provide generalized communications interface and routing of incoming network data (both GSTDN and TDRSS) to the extent of determining data validity and quality; routing telemetry data containing digital voice to the AGVS; extracting non-telemetry data for transmission to the SDPC; extracting telemetry data; and preprocessing individual vehicle data for transmission to the SDPC, AED, and IDSD via CCT.

C. Network Output Multiplexer (NOM) Subsystem. The NOM shall accept outgoing network data from the SDPC, add digital voice when required, and interface the STDN (both GSTDN and TDRSS).

4.2 Communication Interface System (CIS). (Cont'd)

D. Dump Data Handling Subsystem (DDHS). The DDHS shall accept operational downlink telemetry dump and real-time data from the NIP or playback of site tapes from the CCRF and provide the required reverse-to-forward correction, rate correction, and temporary storage. Corrected data shall be output on command to the NIP, AGVS, and CCRF.

E. Air-Ground Voice Subsystem (AGVS). The AGVS shall provide air-ground communications with the Orbiter, both analog through GSTDN and digital through TDRSS.

F. Voice Intercom Subsystem (VIS). The VIS shall provide voice communications among MCC operating positions, and between these operating positions and external locations. It shall also provide PA coverage of the MCC.

G. Consolidated Communications Recording Facility (CCRF). The CCRF shall record all voice and data into and out of the MCC, and permit replaying the recorded data or externally-supplied tapes for MCC data evaluation.

Refer to figure 4-1 for a block diagram of the CIS. Each subsystem is specified in greater detail below.

4.2.1 Communication Circuit Technical Control Facility. The CCTCF shall consist of the following elements required to interface locations external to the MCC with complementary internal MCC systems. Types, quantities, and locations of interfaces shall be as shown in figure 4-1 and as described in the following paragraphs.

A. Audio Patch and Test Facility. This facility shall provide access to audio circuits for testing, monitoring, and restoration.

B. TTY Patch and Test Equipment. This equipment shall provide access to TTY circuits for testing, monitoring, and restoration.

4.2.1 Communication Circuit Technical Control Facility. (Cont'd)

C. HSD Patch and Test Facility. This facility shall provide access to HSD circuits for testing, monitoring, and restoration.

D. WBD Switching and Test Equipment. This equipment shall provide the capability for data routing, testing, monitoring, and restoration of the WBD circuits.

4.2.1.1 Audio Circuits

4.2.1.1.1 Functional Description. Audio circuits shall be provided between the MCC and locations external to the MCC. These circuits shall be 4-wire full-duplex circuits. The I/O signal levels shall be a nominal 0 dBm test tone level (TTL) and -8 dBm speech power level (SPL). The circuits shall be routed to and from the MCC through the Audio Patch and Test Facility located in the CCTCF. This facility shall provide capability for monitoring, testing, and crosspatching up to 260 4-wire circuits entering and leaving the MCC. The patch facility shall provide access to the external lines and the MCC audio systems; the test facility shall provide the capability to test circuit performance. Circuits routed through this facility shall be 4-wire voice communication circuits used for mission operations and support. These circuits shall provide all voice communications with locations external to the MCC, with the exception of Private Automatic Branch Exchange (PABX) telephone service.

4.2.1.1.2 Interfaces

A. Private Wire Telephone Service Interface (NASCOM Voice Circuits)

1. Operational Interface. The NASCOM voice lines shall be used as follows:

   - Point-to-point communications between the MCC and the NASCOM sites for operational messages such as status reports, equipment failures, etc.

4.2.1.1.2 Interfaces. (Cont'd)

- A/G control functions accompanying the voice to certain NASCOM sites for the purpose of controlling A/G transmitter keying circuits when in communication with the spacecraft.

2. Physical Interface. All NASCOM 4-wire lines shall be terminated by the common carrier on its main distribution frame (MDF), and cross-connected to a tie cable. The point of physical interface shall be the end of the tie cable which is terminated by NASA on a NASA frame located in the CCTCF.

3. Electrical Interface. The normal TTL (send and receive) measured at the physical interface shall be 0 dBm and adjustable within ±3 dB.

B. VIS Interface

1. Operational Interface. Same as NASCOM circuits.

2. Physical Interface. All NASCOM 4-wire voice circuits shall be cross-connected through normal-through jacksets to a Cable Termination Cabinet (CTC) in the CCTCF. From the CTC the circuits shall be cross-connected by a tie cable to the MDF in Room 127A. The end of the tie cable, terminated by NASA on the Room 127A MDF, shall be the point of physical interface.

3. Electrical Interface. Same as NASCOM circuits.

C. Timing Subsystem (TS) Interface

1. Operational Interface. Digital time-of-the day signals shall be distributed by the CCTCF to various internal components on two lines from the DCS.

2. Physical Interface. The two lines from the DCS shall be terminated on the distribution frame located in the CCTCF.

4.2.1.1.2 Interfaces. (Cont'd)

3. Electrical Interface. The signal at the point of physical interface shall be an IRIG-B modulated GMT signal, with a peak-to-peak amplitude of 4 volts [1.4 V root mean square (rms)] when terminated in 75 ohms. The impedance shall be 75 ohms, balanced to ground, in either direction.

D. IRIG-B Timing Distribution Interface

1. Operational Interface. Digital time-of-day signals shall be distributed by the CCTCF to various Bldg. 30 users and to outside users in various other JSC buildings.

2. Physical Interface. Fourteen signal outputs shall be terminated through normal-through jacksets in the audio patch bay and cabled to the CCTCF distribution frame.

3. Electrical Interface. The signal at the point of physical interface shall be an IRIG-B modulated GMT signal adjustable to +17 dBm. The output impedance of each circuit shall be 600 ohms and may be balanced or unbalanced to ground.

E. Voice Frequency Telegraph (VFTG) Interface

1. Operational Interface. The VFTG shall consist of an AN/FCC-25 which is an FDM providing transmission and reception of telegraph signals over VF transmission channels.

2. Physical Interface. Two 4-wire voice circuits shall be cross-connected through normal-through jacksets to a NASA frame located in the CCTCF. From the frame, the two circuits shall be cross-connected to the cable terminated in two sets of VFTG equipment.

3. Electrical Interface. Levels measured at the physical interface shall be nominally -8 dBm send and receive

4.2.1.1.2 Interfaces. (Cont'd)

TTL's, adjustable within ±3 dB. Impedance shall be 600 ohms balanced. Nominal frequency response shall be 3 kHz.

F. Central Power Interface

1. Operational Interface. The Room 127A central power supply shall provide negative 48 V dc signaling and lamp power.

2. Physical Interface. The Room 127A main distribution fuse panel shall provide a 2-wire connection to a CCTCF fuse distribution panel located in an audio patch bay.

3. Electrical Interface. The electrical interface shall consist of a negative 48 V dc feed capable of providing 30-amp service.

G. Communications Line Switch (CLS) Bad Lines Interface

1. Operational Interface. A bad line or out-of-service condition indication shall be provided to the CLS by switch closures on the audio patch panels.

2. Physical Interface. The CCTCF audio patch modules shall route 180 wires to the CCTCF frame. From the frame, the wires shall be cross-connected to a tie cable terminated on the Room 127A MDF. The wires shall then be cross-connected to a cable terminated at the CLS consoles.

3. Electrical Interface. The switch closures on the audio patch modules shall provide grounds to the CLS console causing lamps to be illuminated.

4.2.1.2 Teletype Circuits

4.2.1.2.1 Function Description. The TTY Test and Patch Equipment, including the TTY loop power supplies and VFTG equipment, shall provide monitoring and cross-patching for all internal and external MCC TTY circuits. TTY shall be 60 or 100 words per minute (WPM), 45.5 or 74.2 baud, 7.42-unit interval start-stop Baudot code. The equipment shall provide loop power and patching access for up to 200 TTY circuits and jack access for the following tests:

- Distortion measurements
- Distortion analysis
- Standard test messages.

The TTY loop power equipment shall consist of a 130 V dc, 25-amp power system. In addition, the TTY loop power equipment shall provide loop battery current for neutral operation of all NASCOM and internal TTY send/receive circuits. The VFTG terminal equipment shall provide the interface for all TTY circuits between the MCC and GSFC, via two 3-kHz duplex voice channels, and shall accommodate up to 16 full-duplex TTY circuits on a redundant basis.

4.2.1.2.2 Interfaces

A. Private Line Teletypewriter Service Interface

1. Operational Interface. These TTY lines shall be used to provide text message traffic between the MCC and all outside users (meteorology, defense communications agency, etc.) except the NASCOM, which interfaces through the VFTG equipment.

2. Physical Interface. The common carrier shall furnish, install, and terminate TTY circuits on the common carrier MDF, and cross-connect to a tie cable terminated on the CCTCF distribution frame. The common carrier shall provide NASA with the cable count and designate the circuits appearing on the pairs. NASA shall terminate the cable on the frame and make the necessary crossconnects.

4.2.1.2.2 Interfaces. (Cont'd)

3. Electrical Interface. The TTY lines shall meet the following electrical requirements:

- Operating Speeds: 60 or 100 WPM (45.5 or 74.2 baud)

- Signaling Levels: 60 mA neutral battery power externally furnished by CCTCF; full-duplex circuits shall appear as 4-wire dry lines, and half-duplex circuits shall appear as one 2-wire dry line

- Character Composition: 7-unit (5-level start/stop), 7.42-unit internal minimum length

- Line Resistance: Only inherent line and keying relay resistance, with a 200-ohm maximum total.

B. NASCOM Interface

1. Operational Interface. All NASCOM TTY circuits entering or leaving the MCC shall be routed through the TTY patch before being routed to their specific users.

2. Physical Interface. These TTY circuits shall be routed from the dc interface of the VFTG equipment by a cable terminated at the NASA frame located in the CCTCF. They shall be cross-connected through the appropriate TTY patch modules back to the frame, then cross-connected to leased TTY machines. All internal TTY machines and associated circuits required by the MCC shall be furnished, installed, and terminated by the common carrier on the common carrier MDF. The common carrier shall also provide a tie cable to the CCTCF NASA distribution frame. Cable count and designated pair assignments are provided to NASA by the common carrier. NASA shall furnish the terminal blocks, connect the common carrier tie cable to the NASA distribution frame, and make the necessary crossconnects.

4.2.1.2.2 Interfaces. (Cont'd)

3. Electrical Interface. Same as Private Line Service.

C. Central Power Interface

1. Operational Interface. The Room 127A central power supply shall provide negative 48 V dc for relay and lamp power.

2. Physical Interface. The Room 127A main distribution fuse panel shall provide a pair of wires to a Room 118 fuse distribution panel located in the TTY patch bay.

3. Electrical Interface. A negative 48 V dc feed shall be capable of providing 30-amp service.

4.2.1.3 HSD Circuits

4.2.1.3.1 Functional Description. HSD circuits at up to 9600 b/s shall be provided between the MCC and selected locations both internal and external to JSC. External lines with the exception of the TSO lines, in the form of MODEM VF data, shall be routed to and from the MCC through the data circuit VF patch facility located in the CCTCF. The TSO lines shall be input directly to the MODEM and line driver equipment. This facility shall provide capability for monitoring, testing, and crosspatching up to 52 full-duplex HSD circuits entering and leaving the MCC. The patch facility shall provide access to the interface between VF lines and the common carrier and GFE MODEM's. Onbase data circuits, not requiring MODEM's, shall appear directly on HSD patch bay jacks, as will the digital (drop) side of the MODEM's for external circuits.

Data routed through the HSD facility shall be in accordance with *EIA Standard RS-232* for data rates up to 9.6 kb/s. This data shall be:

- LLTD via KSC
- CASRS data
- TSO data.

4.2.1.3.1 Functional Description. (Cont'd)

High-speed data test equipment shall be provided for the following types of tests:

- Visual observation of signals on individual interface lines
- Test message generation and reception
- Error checking of the test messages on a bit-by-bit basis, either by the correlation or ready-line method.

4.2.1.3.2 Interfaces

A. Operational Interfaces. The HSD patch shall provide HSD switching and routing capability as follows:

1. Launch and Landing Tracking Data (LLTD). LLTD shall be switched and routed to the DCC. The MCC shall receive tracking data from KSC. The input data from the 7.2 kb/s MODEM interface shall be routed through the HSD patch to the DCC.

   Data interface logic levels and impedance shall be as stated in *Bell System Data Set 209 Interface Specification* and JSC-10081 for the HSD patch/Launch and Landing Interface Unit (LLIU) interface definition.

2. CASRS Data. This data shall be received from KSC via a 201 data MODEM and routed through the HSD patch to the CASRS (part of the DCS), where it shall be decoded and routed to appropriate display devices.

3. TSO Data. This data shall be received from offsite contractor terminals via TELCO 209 data MODEM circuits or equivalent GFE MODEM circuits. Two data circuits shall be routed through the HSD patch bay to the SCU for distribution to the SDP 3705's. Three additional circuits shall be routed directly from the HSD patch bay to the 360/75 Computer Complex. All circuits shall operate at 9600 b/s. Data interface logic levels and impedance shall be as stated in *Bell System Data Set 209 Interface Specification* and JSC-10081 for HSD patch/SCU interface definition.

4.2.1.3.2 Interfaces. (Cont'd)

B. Physical Interface. Terminations for the HSD lines shall be common carrier type 201, 203, 208, and 209 data MODEM's, as well as several types of GFE MODEM's and digital line drivers. The physical interface is described for the digital data side of the MODEM or the line drivers.

1. MODEM's. The data interface on each circuit shall be a 25-pin connector on the rear of each MODEM as specified in *Bell System, Data Set 201, 203, 208, and 209 Interface Specification*. The common carrier MODEM's shall be mounted by the common carrier in Room 127 in common carrier-supplied racks; GFE MODEM's shall be mounted in racks in the CCTCF.

2. Digital Line Drivers and Terminators. These interfaces are TBD.

C. Electrical Interface. Data interface logic levels and impedance shall be as stated in *Bell System, Data Set 201, 203, 208, and 209 Interface Specification*, and *EIA Standard RS-232*.

4.2.1.4 WBD Switching Circuits

4.2.1.4.1 Functional Description. WBD circuits at rates up to 7 Mb/s shall be provided between the MCC and selected locations both internal and external to JSC. External lines in the form of 1.544/6.314 Mb/s digital network data shall be routed through the GFE network MDM (hereafter called NASCOM) to and from the MCC through the Wideband Data Transfer Switch (WBDTS) located in the CCTCF.

The WBDTS shall provide capability for monitoring, testing, recording, and routing up to 24 full-duplex WBD circuits entering and leaving the MCC. Internal circuits used for internal MCC

4.2.1.4.1 Functional Description. (Cont'd)

testing, playback of recorded data, and circuit monitoring shall also be routed through the WBDTS. The WBDTS shall provide access to these interfaces at a common interface level in order to facilitate switching.

Data routed through the WBDTS shall be in accordance with *EIA Standard RS-422* or CCITT V.35. This data shall include: TDRSS, SIM TDRSS, GSFC, SIM GSFC, GSFC backup, and SIM GSFC backup data.

WBD test equipment shall be provided for the following types of tests:

- Visual observation of signals on individual interface lines
- Test message generation and reception
- Error checking of the test messages on a bit-by-bit basis using the correlation method.

4.2.1.4.2 Interfaces

A. Operational Interfaces. The WBDTS shall provide WBD switching and routing capability as follows:

1. Incoming Data to JSC. Incoming Orbiter data (telemetry/digital voice) from either 1) TDRSS or GSFC via the NASCOM or 2) SIM TDRSS or SIM GSFC from Bldg. 5 at rates from 30 b/s to 6.314 Mb/s shall be switched to the NIP, the AGVS, or the communications WBD test equipment. All incoming data shall be routed automatically to the CCRF for historical recording.

2. Outgoing Data from JSC. Outgoing commands/digital voice, serial telemetry, and test messages from the NOM, NIP, and communications WDB test equipment at rates from 30 b/s to 1.024 Mb/s shall be switched through the WBDTS to the TDRSS and GSFC via the NASCOM and to Bldg. 5 for the SIM TDRSS and SIM GSFC. All outgoing data shall be routed automatically to the CCRF for historical recording.

4.2.1.4.2 Interfaces. (Cont'd)

3. Miscellaneous Data. Miscellaneous data such as CCRF playback data and NIP BITE output data shall be provided to the WBDTS for historical playbacks and NIP testing.

B. Physical Interface. Refer to paragraph C below.

C. Electrical Interface. For physical and electrical interface details, refer to 1) JSC-10081, *Shuttle Orbital Flight Test Data System (OFTDS) Interface Definition Document* for WBDTS/MCC subsystem interfaces and 2) JSC-11534, *Shuttle Mission Control Center External Communications Interface Control Document* for WBDTS/NASCOM interfaces.

4.2.2 Network Interface Processor (NIP) Subsystem. The NIP shall perform a generalized communications interface and routing function, and generalized decommutation service for Orbiter and associated payload data. Prior to routing telemetry data, processing shall be performed to compensate for idiosyncracies in Orbiter-generated downlink data, permitting more conventional decommutation techniques to be utilized for subsequent processing of telemetry data by other MCC subsystems.

A block diagram of the OFT NIP Subsystem is presented in figure 4-2. Only those elements contained within the dashed boundary are part of the NIP Subsystem; the other elements are included to clarify the relationship of the NIP to other subsystems. Reference JSC-10081 for details of the NIP interfaces to these subsystems.

The major elements of the NIP and a summary of their functions are described below; these functions are described in greater detail in following paragraphs.

A. Network Communications Interface-Common (NCIC). The NCIC (figure 4-3) shall be the network input interface for the NIP Subsystem and shall perform the following major functions:

- Network block synchronization
- Block Buffering
- Polynomial encoding/checking
- BDF header validation
- Selected BDF message accounting
- Block data demultiplexing and routing according to SDPC-supplied routing parameters
- Configuration/reconfiguration/echo transmissions of routing parameters from/to the SDPC via the MBI.

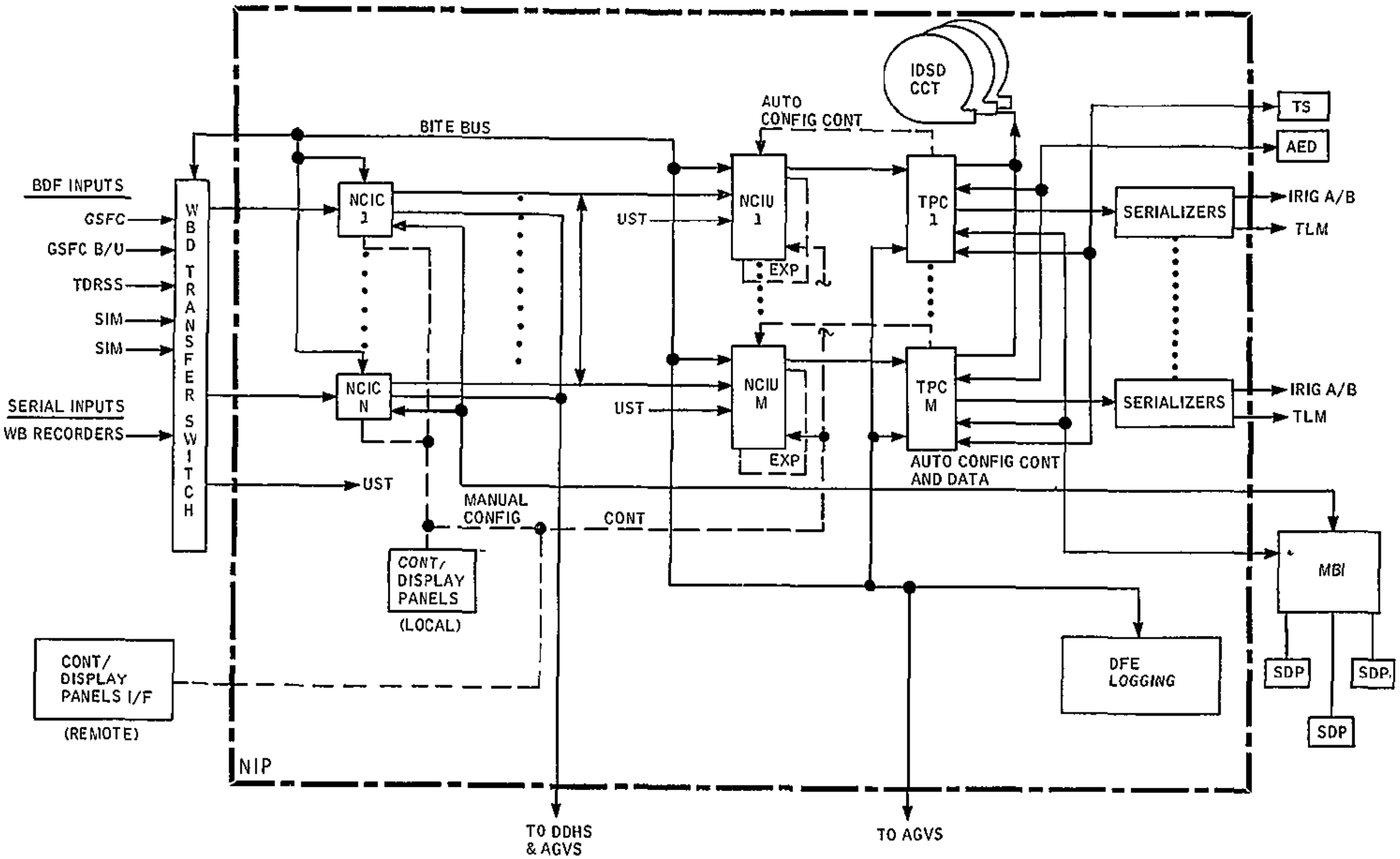

Figure 4-2 OFT NIP Subsystem Block Diagram

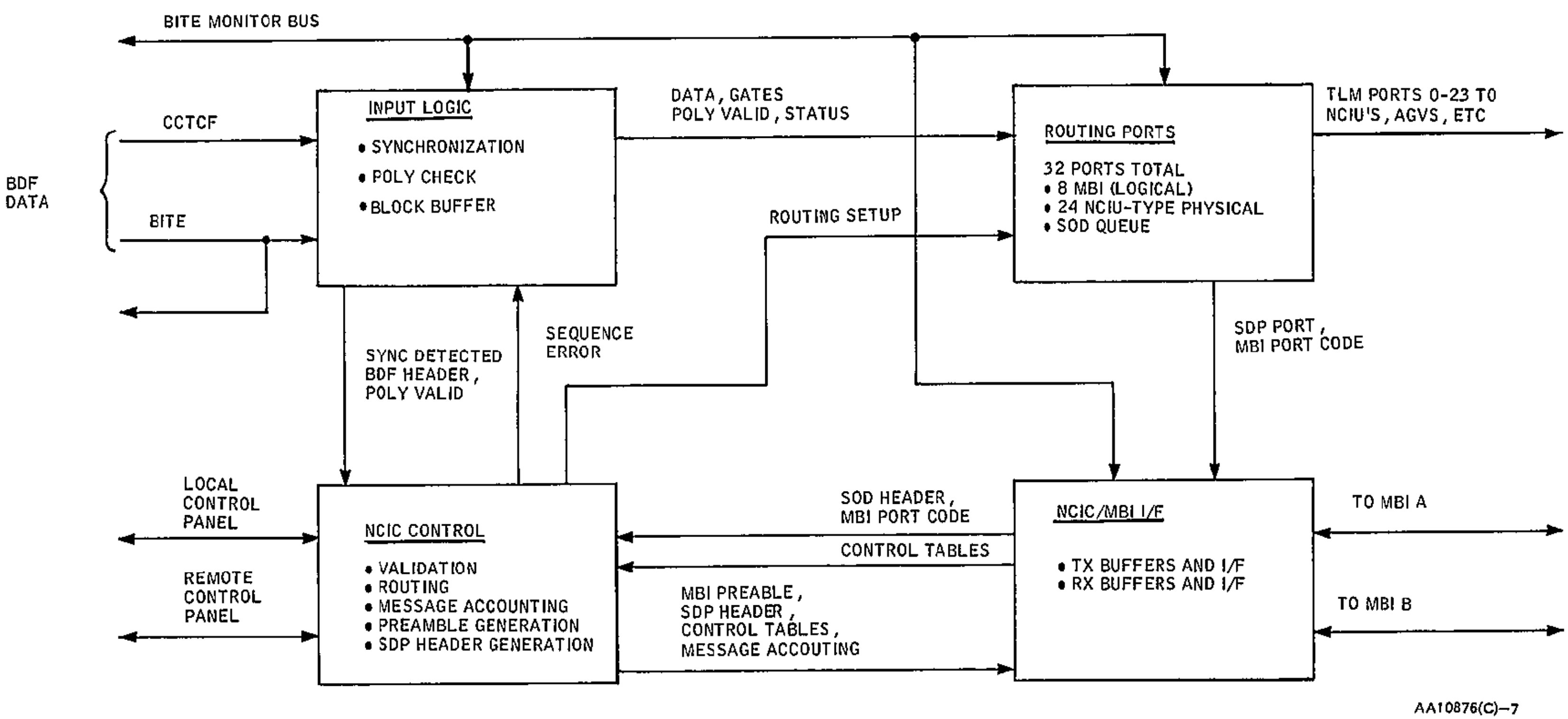

Figure 4-3 NCIC/OFT Functional Block Diagram

4.2.2 Network Interface Processor (NIP) Subsystem. (Cont'd)

B. Network Communication Interface Unique (NCIU). The NCIU (figure 4-4) shall handle a single telemetry data stream. The data may either be in a "clocked" format or in an unblocked serial telemetry (UST) format.

The following synchronization and data handling functions shall be performed by the NCIU:

- Reduce network BDF data rates to transfer rates compatible with TPC processing
- Perform A/G frame synchronization
- Determine delta time components for BDF and UST OD data
- Transfer A/G data buffers to TPC
- Transfer A/G frame synchronizer status to TPC
- Provide midframe sync detection of OD high/low bit rate telemetry data
- Detect the input telemetry data rate and provide this data to the TPC
- Configure/reconfigure input multiplexing (manual) and synchronization parameters (manual or via TPC).

C. Special NCIC Interfaces. Special NCIC interfaces indicated in figure 4-2 shall be considered special because they output to MCC subsystem elements other than a TPC and incorporate functions which differ from the standard NCIU functions. Each of the special interfaces shall incorporate buffering to reduce the network data to rates optimized for transfer to the using subsystem element.

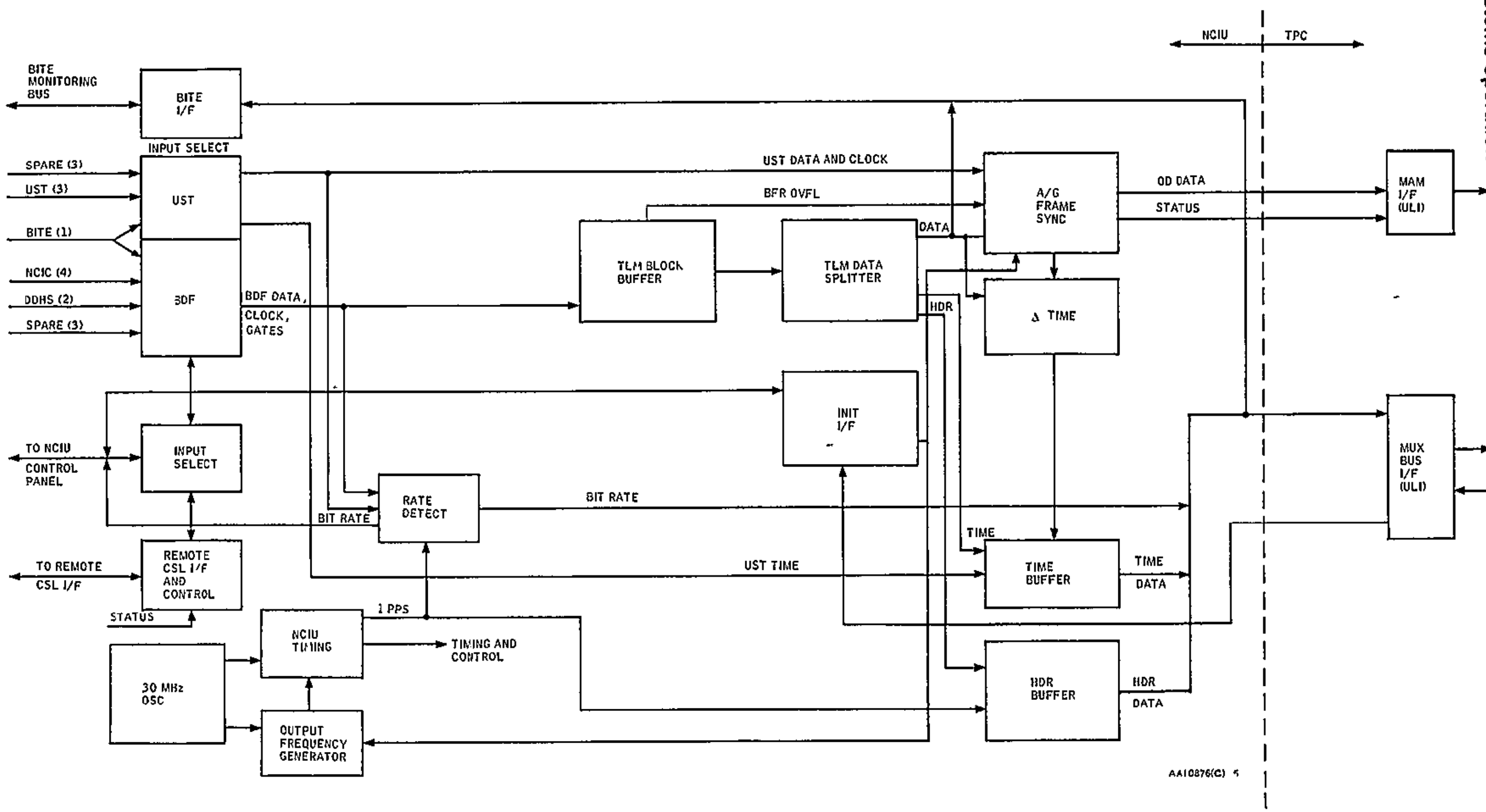

Figure 4-4 NCIU/OFT Detailed Block Diagram

4.2.2 Network Interface Processor (NIP) Subsystem. (Cont'd)

D. NIP BITE. The BITE shall provide test data generation, test data monitoring, and live network data monitoring capability to verify proper operation of the NIP hardware or proper operational data flow. The BITE shall be capable of generating test data in the format, type, and rates of OFT data streams normally applied to NIP equipment. Configuration messages shall be generated in the same format as the SDP/NETCOM. The BITE shall consist of the following components:

- BITE data generator
- BITE data monitor
- Data flow engineer (DFE) logging equipment.

Each TPC delivered for the initial OFT NIP configuration and each TPC added as an expansion shall incorporate BITE data generator and monitor functions. The DFE logging equipment shall utilize the PDP 11/45 based ALT NIP BITE with hardware and software upgrades to meet OFT NIP DFE logging requirements. A bus configuration shall enable any TPC (one at a time) to perform BITE data generation or monitoring functions or enable the DFE logging equipment to perform live network monitoring.

E. TPC Configuration. The TPC configuration is represented in figure 4-5. The major functions of the special I/O interfaces are described below.

1. TS/IRIG Interface. Data transfer to/from the TPC, all functions necessary to input time from the TS, and all functions necessary to generate an IRIG-A or -B formatted TPC time output shall be incorporated in this interface.

2. Memory Access Multiplexer (MAM). The MAM shall be an interface supplied by the computer manufacturer to

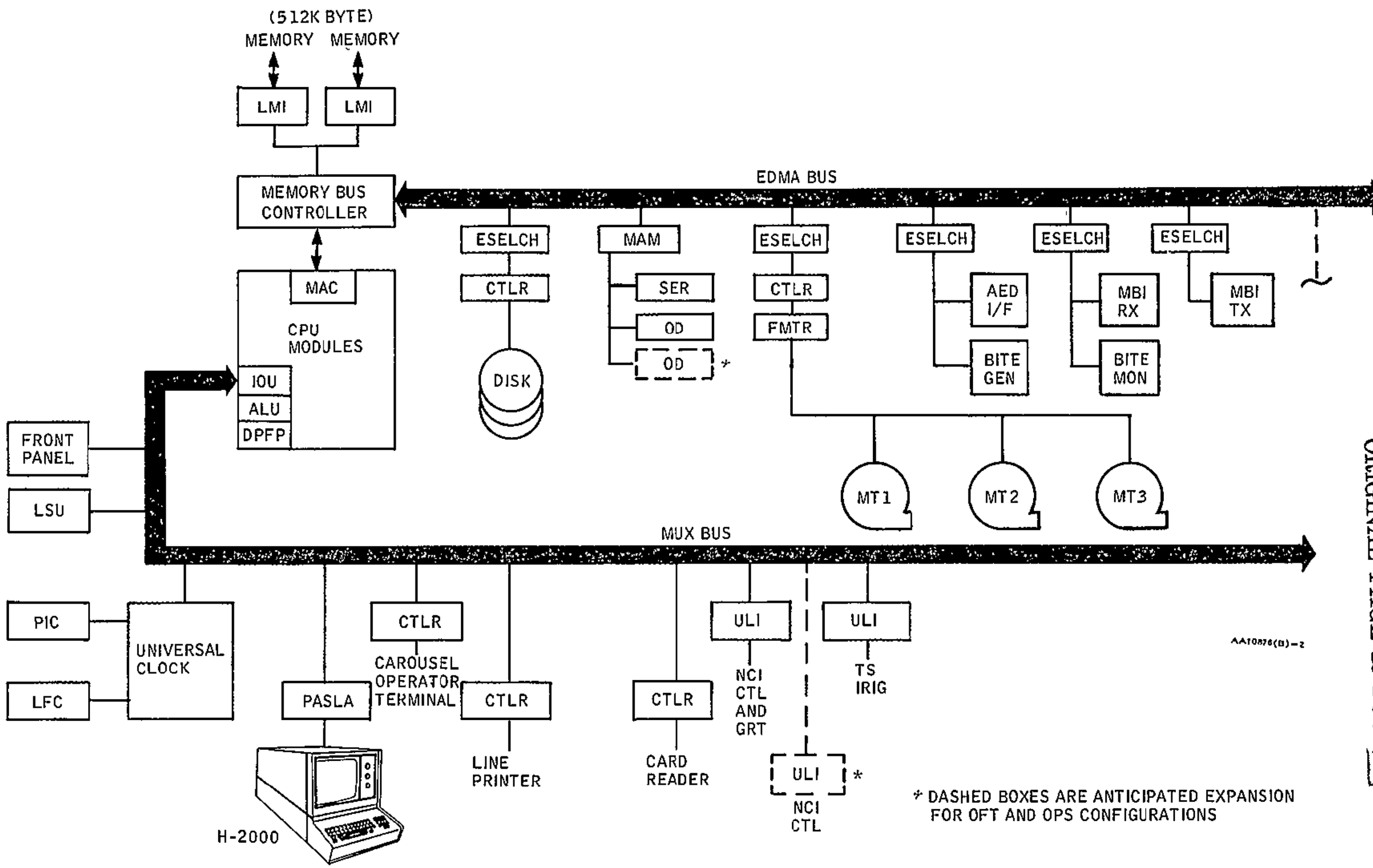

Figure 4-5 Telemetry Preprocessing Computer

4.2.2 Network Interface Processor (NIP) Subsystem. (Cont'd)

allow HS interleaving of external data into memory under direct memory access (DMA) control. The data to/from up to two NCIU's and a serializer shall be buffered in and out of memory via the MAM.

a. Serializer Interface. Serializer output of 30 b/s to 1 Mb/s shall be routed to the WBDTS for distribution.

b. NCIU Telemetry Interface. Telemetry data from an NCIU shall be input on a minor frame buffer basis. The last word of each buffer shall contain NCIC status, NCIU status, and A/G status information.

3. NCIU Control Interface. The TPC/NCIU control interface shall perform the following functions:

- Set up messages and control instructions for each NCIU
- Transfer delta time components, bit rate, and BDF header information from NCIU to the TPC.

4. MBI Interface. The TPC/MBI interface shall support the following data transfers between the TPC and the SDPC:

- Telemetry data from the TPC
- TPC status from the TPC
- Data link summary messages (DLSM's) from the TPC
- Configuration messages from the SDPC for the TPC and/or the NCIU and AED (via the TPC).

5. AED Interface. The TPC shall interface directly with the AED. The TPC shall format and drive analog, event, and timing data to the AED for display on recording

4.2.2 Network Interface Processor (NIP) Subsystem. (Cont'd)

devices. Parameter-to-pen configuration data shall be received by the AED via a separate interface from the central configurator.

6. IDSD High Rate Delog Interface. The TPC shall format and output asynchronously all data from two input links to a CCT for further processing by IDSD.

F. TPC Processing. The TPC software shall incorporate all functions necessary to meet the following general telemetry processing requirements.

1. Provide a generalized decommutation service for a wide variety of telemetry formats within the following limits:

   - Maximum bit rate - ≤1 Mb/s
   - Maximum frame length - 8192 bits/frame (per link)
   - Maximum frame rate - 200 frames/second (per link)
   - Maximum word size - 16 bits/word
   - Maximum number of subcoms - five per link.

2. Process the following data types:

   - Operations downlink (real-time, playback, and dump)
   - Interim upper stage (IUS) downlink
   - Development flight instrumentation (DFI) (playback, dump - UST input only, IDSD output only, OFT only)
   - Payloads
   - NCIU GRT and status.

4.2.2 Network Interface Processor (NIP) Subsystem. (Cont'd)

This data may be from the TDRSS, STDN, SAIL/ESTL, OAS/SMS or instrumentation tapes. TPC processing flow is shown in figure 4-6.

3. Output formatted data with the appropriate header information to:

- SDPC
- AED
- IDSD/High Rate Delog
- Serializer.

G. Configuration Control. The online configuration control function of the NIP is shown by dashed lines in figure 4-2. Regardless of which MCC subsystem is allocated the configuration management function, the interface with NIP shall be via the MBI. Manual override and offline maintenance controls shall be provided for selected configuration functions. Classes of NIP configuration control shall be as follows.

1. TPC-routed configuration functions shall provide the following:

- Tables defining processing and output formatting of telemetry data
- Tables of parameters to be output to the AED
- NCIU telemetry frame synchronization parameters
- Configuration status messages.

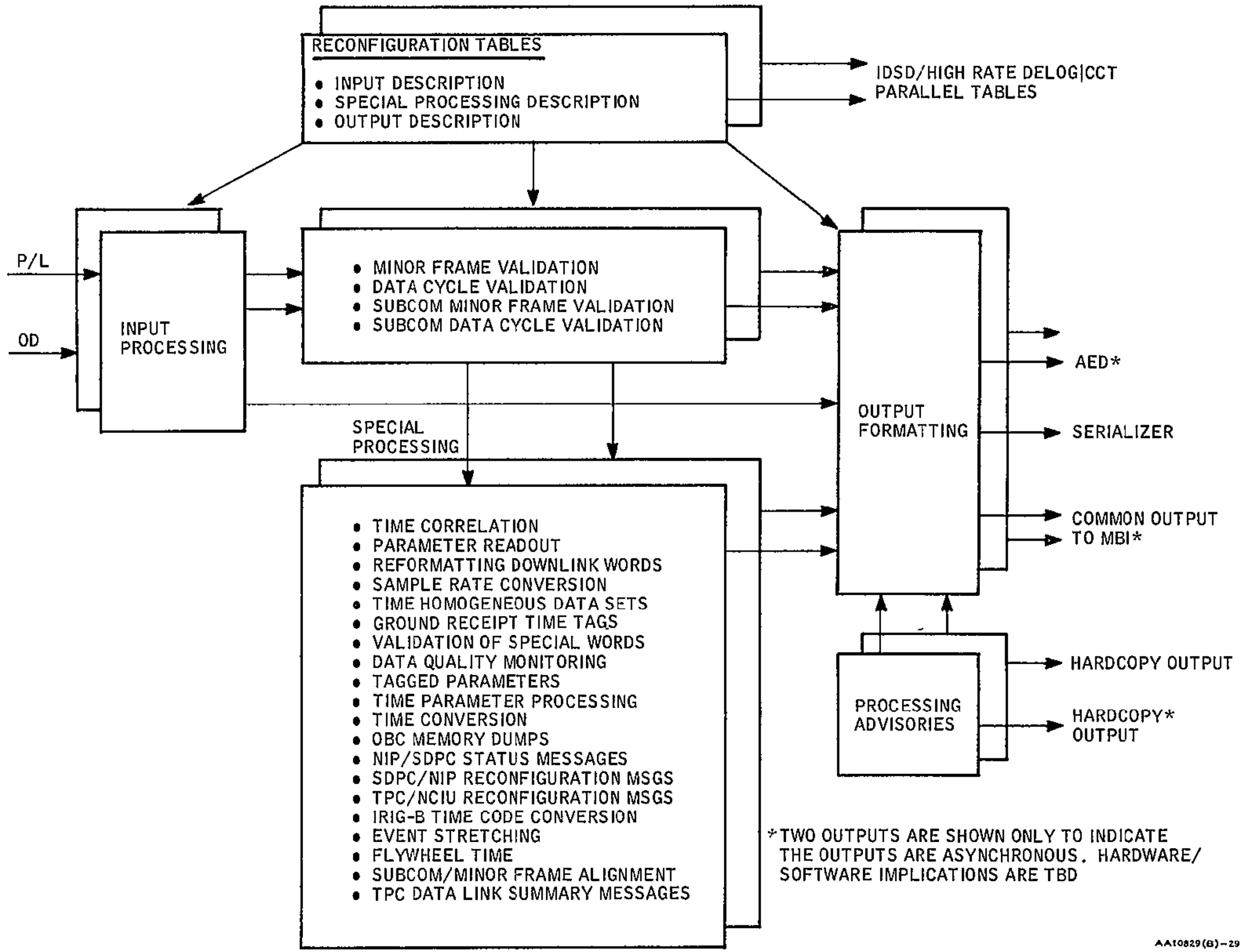

Figure 4-6 TPC Processing Flow

4.2.2 Network Interface Processor (NIP) Subsystem. (Cont'd)

2. NCIC configuration functions shall provide the following:

- Data routing
- NASCOM valid header ID fields (manual only)
- Poly-code check inhibit/enable (manual only).

4.2.3 Network Output Multiplexer (NOM). The NOM shall provide the output interface between the MCC and the STDN. The NOM shall accept data blocks containing Shuttle commands, acquisition/pointing data, remote site telemetry system management commands, remote site·status requests, network configuration requests, etc. from the SDPC via the MBI and shall transmit the data block serially in the NASCOM format to the selected port of the GSTDN Multiplexer (MUX). The NOM shall accept data blocks containing Orbiter command or computer load data from the SDPC via the MBI, and shall time-division multiplex the SDPC data with digital voice, and digital text and graphics data to provide continuous synchronous serial Shuttle uplink formats to the TDRSS MUX (see figure 4-7). MCC-generated site status requests and vehicle acquisition/pointing data messages for TDRSS shall be transmitted to the GSFC Network Operations Control Center (NOCC), via GSTDN, for response or retransmission to the TDRSS earth station.

4.2.3.1 GSTDN Block Transfers. The NOM shall accept output data blocks from the SDPC, provide buffering of the SDP blocks, and serialize the data for transmission to the GSTDN MUX. The NOM shall route data to one port (GSFC) of the GSTDN MUX for pre-TDRSS OFT and to six ports (GSFC, plus five sites) of the GSTDN MUX for post-TDRSS OFT and OPS. Expansion capability shall be provided for up to 64 output ports for Payload Operations Control Centers (POCC's) and future GSTDN users.

The SDP output block to the NOM shall contain only NASCOM header and output data. The NOM shall provide NASCOM sync and data fill required to complete a 4800-bit NASCOM block. The NOM shall format and output one NASCOM block for each SDP input block. The NOM shall provide GSTDN block data output hardware to support operations and simulations, and to back up the operational hardware, as a minimum. Routing of SDPC data to NOM internal functions shall be provided by an SDP routing field in the data block, designating the NOM output port (MUX input port) for the selected block.

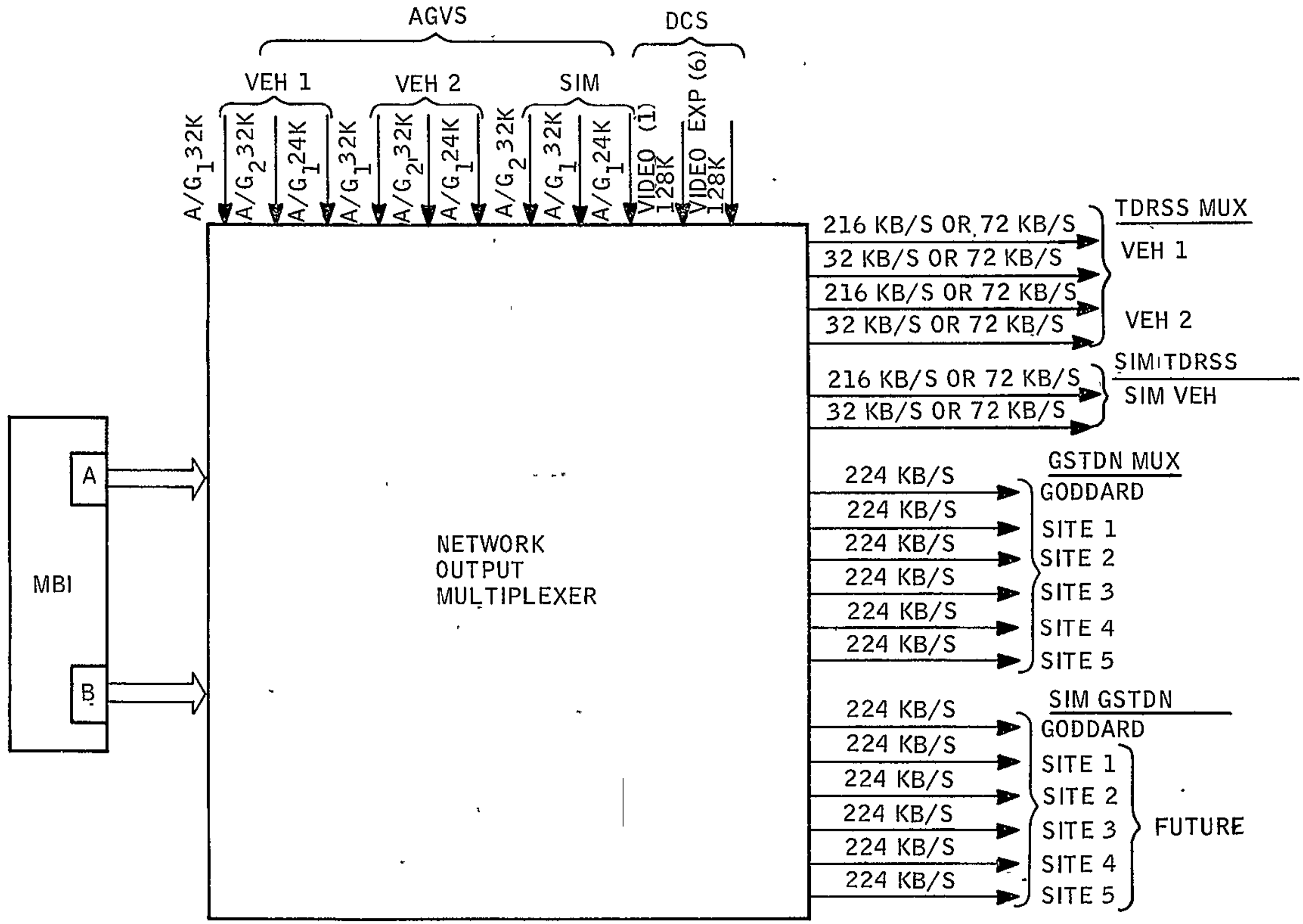

Figure 4-7 NOM Subsystem Interfaces

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4.2.3.1.1 Interfaces for GSTDN

A. SDPC Interface

1. Operational Interface. The NOM shall receive data from the SDPC for output to the GSTDN. The SDPC output block will be similar to that shown in figure 4-8. The NOM shall provide a status message to the SDPC upon request by the SDPC. The NOM shall provide error messages to the SDPC when error conditions are detected. SDPC/NOM message formats shall be as defined by the NOM/SDPC IDD, JSC-10081.

2. Physical Interface. The SDPC-to-NOM interface shall be via the MBI and shall provide access capability to each of the MBI systems. The MBI-to-NOM interface shall provide 8-bit parallel data transfer at rates up to 1.2M (8-bit) bytes/second.

3. Electrical Interface. The MBI-to-NOM electrical interface characteristics shall be as defined by the NOM/MBI IDD, JSC-10081.

B. GSTDN MUX Interface

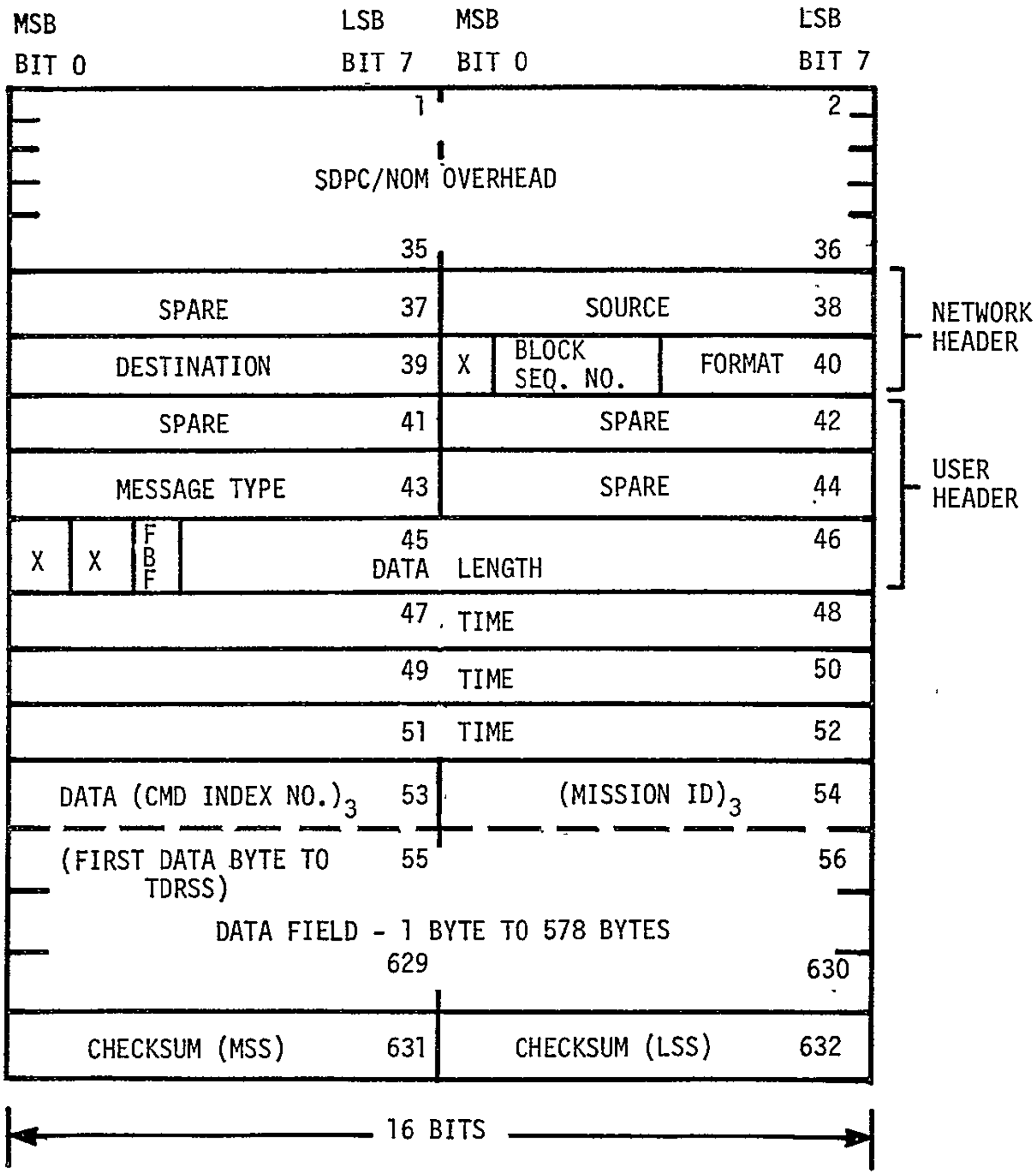
1. Operational Interface. The NOM shall provide outputs to the GSTDN MUX in the NASCOM block format. The NOM shall message-switch output blocks to six MUX ports (GSFC, plus five sites). Interfaces to individual MUX ports shall consist of serial data and clock signals at 224 kb/s supplied by the NOM.

2. Physical Interface. NOM output lines shall be routed through the WBDTS or Digital Data Line Switch (DDLS) (for OPS) to the GSTDN MUX.

3. Electrical Interface. The NOM-to-WBDTS electrical interface characteristics shall be as defined by the CCTCF/NOM IDD, JSC-10081.

C. Timing Interface

1. Operational Interface. The TS shall provide a 448 kHz square wave to the NOM for derivation of 224 kHz clock signals to the GSTDN MUX.



NOTE:
1. X - SPARE.
2. NASCOM FIELDS ARE REPRESENTATIVE ONLY, FORMATTING SHALL BE PROVIDED BY THE SDPC.
3. PARAMETERS DESIGNATED ARE FOR COMMAND BLOCKS ONLY.

Figure 4-8 SDPC/NOM Data Block Format

4.2.3.1.1 Interfaces for GSTDN. (Cont'd)

2. Physical Interface. The TS shall provide redundant 448 kHz signals on separate twisted-pair cables to the NOM with status lines for selection.

3. Electrical Interface. The TS-to-NOM electrical characteristics shall be as defined by the TS/NOM IDD, JSC-10081.

4.2.3.1.2 Simulation of the NOM/GSTDN Function. The NOM shall provide the block data output from the SDPC to the simulation GSTDN interface (Bldg. 5). All simulation I/O interfaces shall have characteristics identical to the operational NOM/GSTDN function. The data path through the NOM for simulations shall be separate from the operational NOM/GSTDN data path to preclude degradation of the operational NOM/GSTDN throughput rate of 224 kb/s. Selection of the simulation data path shall be accomplished by assignment of unique SDP routing identifiers (reference figure 4-8) to simulation ports.

4.2.3.2 TDRSS Uplink Formatting. The NOM shall provide time-division multiplexing of Orbiter uplink data transmitted via TDRSS. The NOM shall receive Shuttle command and computer load data from the SDPC and interleave this data with digital voice data, and digital text and graphics data to build the Shuttle Orbiter uplink formats. The NOM shall generate all uplink formats required for TDRSS support of Shuttle Orbiters. The NOM shall maintain continuous uplinks containing digital voice, text and graphics, and command fill when commanding is not required.

The NOM shall provide TDRSS formatters for two Orbiters and one simulation vehicle. The NOM shall provide expansion space for four simultaneous payload uplinks via TDRSS. Routing of SDPC data to NOM TDRSS formatters shall be provided by an SDP routing field in the data block, designating the vehicle for the command or computer load data.

4.2.3.2.1 Interfaces for TDRSS

A. SDPC Interface

1. Operational Interface. The NOM shall receive data from the SDPC for output to the TDRSS network. The SDPC output block shall be similar to figure 4-8. The network header, GMT, and user header fields shall not be required for TDRSS uplink formatting. The SDPC may insert fill in these fields. The NOM shall provide a status message to the SDPC upon SDPC request. The NOM shall provide error messages to the SDPC when detected error conditions occur. SDPC/NOM message formats shall be as defined by the NOM/SDPC IDD, JSC-10081.

2. Physical Interface. The SDPC-to-NOM interface shall be via the MBI. The NOM-to-MBI interface shall provide access capability to each of the MBI systems. The MBI-to-NOM interface shall provide 8-bit parallel data transfer at rates up to 1.2M bytes/second.

3. Electrical Interface. The MBI-to-NOM electrical interface characteristics shall be as defined by the NOM/MBI IDD, JSC-10081.

B. TDRSS MUX Interface

1. Operational Interface. The NOM shall provide outputs to the TDRSS MUX in the Orbiter uplink formats defined by the *Shuttle OFT Data Format Control Book*. The NOM shall output high-bit rate (HBR) and low-bit rate (LBR) Orbiter uplink formats continuously. The NOM shall insert command fill when SDP commands are not available. Interfaces to individual TDRSS MUX ports shall consist of serial synchronous data and clock signals provided by the NOM.

2. Physical Interface. NOM output lines shall be routed through the WBDTS or DDLS for OPS to the TDRSS MUX.

4.2.3.2.1 Interfaces for TDRSS. (Cont'd)

3. Electrical Interface. The NOM-to-WBDTS electrical interface characteristics shall be as defined by the CCTCF/NOM IDD, JSC-10081.

C. AGVS Interface

1. Operational Interface. The NOM shall receive digital voice data in continuous serial streams from the AGVS and shall time-division multiplex these inputs into the TDRSS Orbiter uplink formats. The AGVS shall supply two 32-kb/s and one 24-kb/s digital voice input for each Orbiter supported. Each digital voice input to the NOM shall consist of continuous serial delta-modulated voice data and clock signals provided by the AGVS. Data and clock rates shall be derived from an Atomic Frequency Standard (AFS) clock source.

2. Physical Interface. The AGVS shall provide differential data and clock signals on twisted-pair cables to the NOM.

3. Electrical Interface. The NOM-to-AGVS electrical interface characteristics shall be as defined by the NOM/AGVS IDD, JSC-10081.

D. Digital Video Interface

1. Operational Interface. The NOM shall provide capability to receive digital Test and Graphics (TAGS) data in a continuous serial format from the DCS and time-division multiplex the digital video inputs into the TDRSS Orbiter HBR uplink format. The NOM shall provide the capability to configure up to seven digital TAGS data inputs to the three available TDRSS formatters in the NOM. The DCS shall supply 128 kb/s digital video inputs to the NOM. Each input shall consist of continuous serial data and clock signals provided by the DCS or a remote POCC. Data and clock rates shall be derived from an AFS clock source.

4.2.3.2.1 Interfaces for TDRSS. (Cont'd)

2. Physical Interface. The DCS shall provide data and clock signals on twisted-pair cables to the NOM.

3. Electrical Interface. The TAGS-to-NOM electrical interface characteristics shall be as defined in the TAGS/NOM IDD, JSC-10081.

E. Timing Interface

1. Operational Interface. The TS shall provide clock rate inputs to the NOM for derivation of TDRSS Orbiter up-link data rates. The NOM timing input rates shall be derived from an AFS clock source. The NOM shall require one or more square wave source rates from which rates of 216 kHz, 72 kHz, and 32 kHz may be derived.

2. Physical Interface. The TS shall provide redundant clock signals on separate twisted-pair cables to the NOM with status lines for selection.

3. Electrical Interface. The TS-to-NOM electrical interface characteristics shall be as defined by the TS/NOM IDD, JSC-10081

4.2.3.2.2 Simulation of the NOM/TDRSS Functions. The NOM shall provide the time-division multiplexing function for SDP data, digital voice, and digital TAGS data output to the simulation TDRSS interface (Bldg. 5). All simulation I/O interfaces shall have characteristics identical to the operational NOM/TDRSS function. Selection of the simulation uplink formatter for SDP command and computer load outputs shall be accomplished by assignment of a unique SDP routing identifier (reference figure 4-8).

4.2.4 Dump Data Handling Subsystem (DDHS). The DDHS shall perform a generalized raw telemetry storage function for the Shuttle STS data and shall be required to process this data during the TDRSS era of the Shuttle OFT's. Prior to playback of telemetry data to other MCC subsystems for subsequent processing, the DDHS shall perform processing to compensate for idiosyncracies in the Shuttle STS downlinked data, permitting more conventional decommutation techniques to be utilized.

The DDHS shall receive dump and real-time telemetry data in blocked data format (BDF) at a block burst rate of 7.667 Mb/s from the NCIC elements of the NIP and unblocked serial telemetry (UST) at rates up to 1.024 Mb/s from the CCRF. The DDHS shall perform the following functions in support of the Shuttle OFTDS:

- Receive mixed direction dumps at accelerated A/G data rates up to 1.024 Mb/s
- Forward correct reversed data segments
- Rate-reduce dump data for playback to other MCC subsystems
- Provide up to 12 hours storage capability for telemetry data correlated with spacecraft time
- Generate, format, and output data quality messages to the SDPC via the MBI
- Provide capability to play back data received to the NIP and the AGVS for subsequent processing
- Provide capability to play back data received to the CCRF for storage of DDH processed data.

Figure 4-9 is a block diagram of the DDHS. Refer to JSC-10081, *Shuttle OFTDS IDD*, for details of the DDHS interfaces to other subsystems.

The major hardware elements of the DDHS and a summary of their functions are described below.

4.2.4.1 Frame Synchronizers. The frame synchronizer elements shall be the data input interfaces for the DDHS and perform the following major functions:

- Store four programmable frame formats and automatically select the appropriate format to achieve A/G frame lock

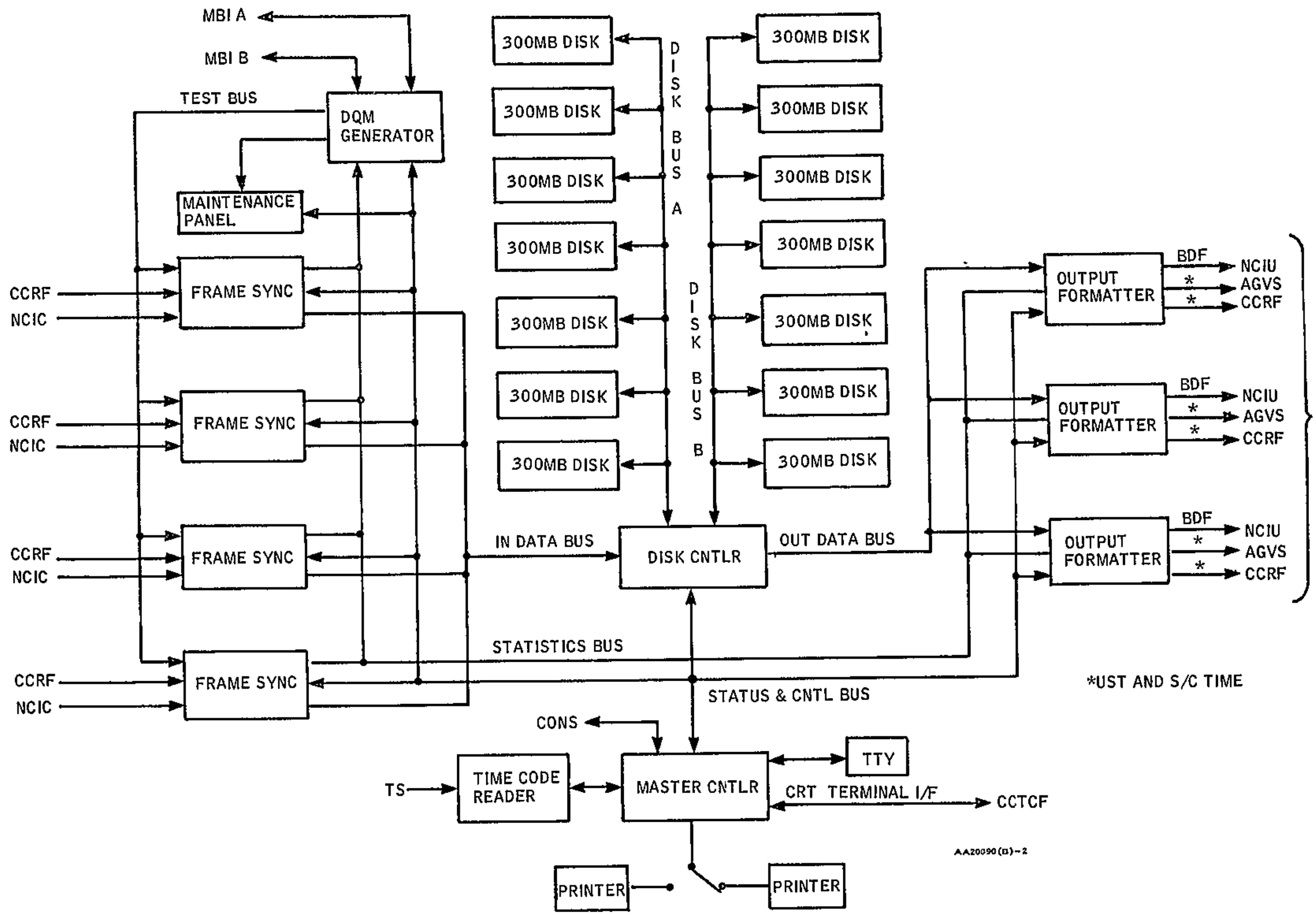


Figure 4-9 Dump Data Handling Subsystem

4.2.4.1 Frame Synchronizers. (Cont'd)

- Compile and transfer frame quality statistics to the DQM generator
- Format data into files; reverse data corrected to forward in the file buffer
- Provide storage for up to four files
- Generate file confidence number and tag files
- Notify Data Storage Facility when file is available for transfer
- Select any one of up to eight input data sources (four NCIC, three CCRF, and one TEST).

4.2.4.2 Data Quality Message (DQM) Generator. The primary function of the DQM generator element shall be to control the DDHS interface to the MBI. The DQM generator shall receive statistics from the DDHS I/O ports and perform the following functions:

- Format DDHS status messages and DLSM's and transmit to SDPC via the MBI
- Receive configuration/control data from SDPC via the MBI
- Format data for and drive the DDHS maintenance panel
- Provide online and offline testing of DQM generator and frame synchronizer functions from the test frame generator.

4.2.4.3 Data Storage Facility. The Data Storage Facility consists of the disk controller element and two totally redundant disk subsystems. Each disk subsystem comprises seven 300M byte disk drives and a disk data and control bus. The Data Storage Facility shall perform the following functions:

- Provide up to 12 hours storage for OD telemetry data plus 2-hour storage capability to facilitate restaging of DDHS processed data from CCRF storage
- Provide redundant storage
- Provide programmable disk allocation

4.2.4.3 Data Storage Facility. (Cont'd)

- Provide write decision logic (use confidence number)
- Provide file tag to physical disk address conversion
- Provide disk drive control and data formatting circuitry for dual disk subsystems
- Provide library flag RAM for data segments, stored calculations, and degap function
- Control multiplexing of files to/from disk
- Detect and report drive and controller errors.

4.2.4.4 Output Formatters. The output formatter elements shall be the data output interfaces for the DDHS and perform the following major functions:

- Accept output data request from the master controller
- Request and buffer files from the Data Storage Facility
- Provide DDHS data file spacecraft time tag in IRIG-B format to AGVS and CCRF
- Format data and output in BDF to NCIU and UST to AGVS and CCRF
- Provide output with data gaps or degaped
- Report error conditions to master controller
- Report status to the DQM generator.

4.2.4.5 Master Controller. The master controller element shall provide the central configuration control function for the DDHS. The major functions provided by the master controller shall be as follows:

- System statusing
- Status poll sequencing and response interpretation
- Advisory message generation

4.2.4.5 Master Controller. (Cont'd)

- Command interpretation
- Configuration controlling and report generation
- TTY, CRT, and printer handling
- Subsystem interface to TTY, printers, time code reader, remote CRT terminal, and CONS.

4.2.4.6 DDHS Maintenance Panel. The DDHS maintenance panel shall provide supplemental maintenance and test capabilities for the DDHS. The maintenance panel shall be divided into three functional sections which perform the following major functions:

A. I/O Port Status Section

- Provide manual selection of the DDHS I/O ports
- Provide monitoring of spacecraft time in I/O data
- Provide monitoring of I/O port rate in kHz
- Provide monitoring of input port frame type
- Provide monitoring of output port mode.

B. Status and Control Bus Section. Provide monitoring and manual control of DDHS elements via status and control bus.

C. Test Frame Generator Section

- Provide selection of frame type to be generated
- Provide selection of incrementing or decrementing time
- Provide selection of data pattern
- Provide selection of test frame generator output characteristics.

4.2.5 Air-Ground Voice Subsystem (AGVS). The AGVS shall include the following elements:

- Analog channel switch
- Digital output switch
- Digital input switch
- AGVS interface
- Voice/data processing equipment
- Conference equipment
- Record switch
- Comm Tech console.

A block diagram of the AGVS is shown in figure 4-1. The elements of this subsystem are discussed in the following paragraphs. Detailed interface characteristics for interfaces between the AGVS and other subsystems are presented in JSC-10081. Internal AGVS interface characteristics are presented in the *AGVS Performance Specification*.

4.2.5.1 Analog Channel Switch

4.2.5.1.1 Functional Description. The analog channel switch shall provide the capability for the Comm Tech controller to selectively connect analog voice channels (from locations external to the MCC) to voice conference (within the MCC).

4.2.5.1.2 Interfaces. The analog channel switch shall accept voice channels from the audio patch element of the CCTCF as inputs and voice channels to the AGVS voice processing equipment as outputs. Interconnection between an input and an output shall be on an individual channel basis. Unswitched input channels shall be terminated.

4.2.5.1.2 Interfaces. (Cont'd)

The audio patch/analog channel switch interface shall contain the following voice channels.

A. GSTDN Input Channels. These channels shall provide 2-way voice conversations between MCC flight controllers and the Shuttle crew when operating in a GSTDN RF support mode. They shall also provide tone keying to the supporting site for control of voice uplinks.

B. Simulated GSTDN Channels. These channels shall provide 2-way voice conversations between MCC flight controllers and flight crew simulation personnel in Bldg. 5. The channel shall also provide push-to-talk (PTT) tones to the simulated GSTDN site in Bldg. 5.

C. Merritt Island Launch Area (MILA) Channel. This channel shall provide 2-way voice communications between MCC flight controllers and the Shuttle crew during the launch phase. This communication shall be via the UHF RF link. In addition, the channel shall provide tone keying to the MILA site for control of the UHF transmitter.

D. POCC Channels. These channels shall permit the GSFC POCC to participate in MCC flight controllers' conversation with the Shuttle crew. The POCC-generated PTT keying tone shall be extracted from the channel and a PTT signal derived from this input tone. The PTT signal shall then be combined with the VIS keyset PTT signals to control AGVS processing.

The output voice channels of the analog channel switch shall interface with two types of analog voice processing equipment. This equipment shall be quindar tone transmitters and tone receivers. The transmitters shall connect to the GSTDN and MILA channels, and the receivers shall connect to the POCC channels.

4.2.5.2 Digital Output Switch

4.2.5.2.1 Functional Description. The digital output switch shall provide the capability for the Comm Tech controller to selectively route delta-modulated voice uplink data for support of a Shuttle vehicle to the appropriate NOM input port.

4.2.5.2.2 Interfaces. The digital output switch shall accept delta-modulated voice signals from the AGVS processing equipment as inputs and accept NOM input lines as outputs. The input signals shall consist of three data and three clock signals for support of one real-time or simulated Shuttle vehicle. Two of the data and clock signals shall be transmitted at a data rate of 32 kb/s and the third at a rate of 24 kb/s. The six clock and data signals shall be switched by the digital output switch. The switched TTL signals shall then be connected to differential drivers for routing to the NOM. When a connection is established, three interlock signals shall be generated and routed to the NOM.

4.2.5.3 Digital Input Switch

4.2.5.3.1 Functional Description. The digital input switch shall provide the Comm Tech controller the capability to select a digital input source and route the data to the desired data processing equipment for support of a real-time or simulated Shuttle vehicle, for support of a data playback, or to monitor an uplink.

4.2.5.3.2 Interfaces. The digital input switch shall accept digital inputs from the AGVS interface equipment, the WBDTS, and the DDHS and provide outputs to the AGVS processing equipment.

A. AGVS Interface Channels. Four input channels shall be received from the AGVS interface equipment. Each input channel shall contain a data and clock signal. The input data in a bit contiguous serial data stream shall be at a rate of 64 kb/s, 96 kb/s, 128 kb/s, or 192 kb/s.

B. WBDTS Input Channels. One set of WBDTS input channels shall provide real-time, simulated, or playback downlink telemetry data as a backup (or bypass) to the NIP data which is received via the AGVS interface equipment. A

4.2.5.3.2 Interfaces. (Cont'd)

second set of WBDTS input channels shall provide uplink monitor data. Each input shall be a clock and data signal. The NIP bypass data rates shall be 64 kb/s, 96 kb/s, 128 kb/s, or 192 kb/s. The uplink monitor input rates shall be 32 kb/s, 72 kb/s, or 216 kb/s.

C. DDHS Input Channels. Two input channels shall be received from the DDHS (one channel from each DDHS output formatter). Each channel shall contain a data and clock signal. The inputs to the digital input switch shall be forward mode bit contiguous serial data with clock at either 64 kb/s, 96 kb/s, 128 kb/s, or 192 kb/s.

D. AGVS Processing Equipment. One input data source shall be connected to the AGVS processing equipment for support of a vehicle. This input shall be used for:

- Extracting downlink voice signals; 96 kb/s or 192 kb/s
- Extracting onboard time; 64 kb/s, 96 kb/s, 128 kb/s, or 192 kb/s
- Monitoring uplink voice quality; 32 kb/s, 72 kb/s, or 216 kb/s.

4.2.5.4 AGVS Interface

4.2.5.4.1 Functional Description. The AGVS interface is composed of the following functional elements: an input selector with local and remote control, data buffers, and a BITE address decoder. This equipment shall perform the following functions:

- Accept 7.667 MHz telemetry data in a burst format along with gate signals
- Route the input data to a buffer
- Determine the downlink data rate
- Output the buffered data to the digital input switch in a bit contiguous serial data stream along with a clock signal at the detected rate
- Decode buffer address code and route the output to the NIP BITE when the buffer is addressed.

4.2.5.4.2 Interfaces. The AGVS shall accept inputs from three sources and provide outputs to the digital input switch and the NIP BITE. The sources are NCIC-1, NCIC-2, and NIP BITE. Up to three of these inputs may be handled simultaneously. The downlink data rate of an input shall be 64 kb/s, 92 kb/s, 128 kb/s, or 192 kb/s.

A. NCIC Inputs. The AGVS interface equipment shall receive three signals as an NCIC input. These are data, clock, and gate.

B. BITE Data Input. This input shall be for testing the AGVS interface equipment. The input signals shall be data, clock, and gate.

C. BITE Data Output. This output shall be provided to the BITE data channel when it has been addressed by the BITE address channel. The output shall be a data clock and data valid channel.

D. BITE Address Bus. The AGVS shall provide continuous monitoring of the BITE address bus to decode its address. When one of the four interface paths is addressed, the output of the addressed channel shall be routed to the BITE input. The address bus shall be 16 differential data channels.

E. Digital Input Switch Channels. Refer to paragraph 4.2.5.3.2,A.

4.2.5.5 Voice/Data Processing Equipment. The voice/data processing equipment shall provide the necessary functional processing to interconnect VIS keysets with other subsystems of the CIS. The processing equipment shall include the following elements.

A. MILA Tone Keying Equipment. The MILA tone keying equipment shall be a quindar type transmitter. The transmitter shall perform functions of generating mark and space keying tones, mixing these tones with uplink voice signals, and providing a composite uplink signal output to the analog channel switch.

4.2.5.5 Voice/Data Processing Equipment. (Cont'd)

B. GSTDN Tone Keying Equipment. A GSTDN tone keying equipment unit shall include two quindar type transmitters. Each unit shall provide voice communications to one vehicle via a TDRSS link. Three units are provided; one for real-time support, one for simulations, and the third as a backup. The functions performed by the transmitters are the same as described under paragraph 4.2.5.5,A.

C. POCC Tone Keying Equipment. A POCC tone keying equipment unit shall include two quindar receivers. Each unit shall provide POCC to Space Shuttle communication on up to two voice channels. The three units shall permit support of a real-time and simulated vehicle with one spare. The receivers shall perform the functions of removing the tone from the input composite signal and generating a PTT signal.

D. TDRSS Delta Modulation System (DMS) Equipment. The TDRSS equipment shall include frame synchronizers, demultiplexers, D/A and A/D converters, a time decoder, an idle code detector, and a bit rate detector. Three groups of this equipment shall be provided for voice communication to an operational and a simulated vehicle, with the third unit in reserve as a backup to either vehicle. This equipment shall perform the following functions:

- Derive one downlink voice signal from a 96 kb/s input and route to the conference equipment and the record switch
- Derive one uplink voice signal from a 32 kb/s input for Comm Tech monitoring
- Derive two downlink voice signals from a 192 kb/s input and route to the conference equipment and the record switch
- Derive two uplink voice signals from a 72 kb/s or 216 kb/s input for Comm Tech monitoring

4.2.5.5 Voice/Data Processing Equipment. (Cont'd)

- Derive an onboard time word from a 64 kb/s, 96 kb/s, 128 kb/s, or 192 kb/s downlink input; convert the word into a serial IRIG-B data signal; modulate a 1000 Hz carrier with the IRIG signal; and output the composite time signal to the record switch

- Generate two 32 kb/s and one 24 kb/s delta modulated uplink signals for support of a real-time or simulated vehicle.

E. Playback - Uplink Monitor DMS Equipment. This equipment shall include frame synchronizers, demultiplexers, D/A converters, an idle code detector, a time decoder, and a bit rate detector. Three groups of this equipment shall be provided for support of two playbacks and one uplink monitor. This equipment shall perform the same functions as the TDRSS DMS equipment except for the generation of uplink signals.

4.2.5.6 Conference Equipment

4.2.5.6.1 Functional Description. The conference equipment shall be existing intersite trunks in the MCC. This equipment shall be utilized for establishing three types of conferences; real-time, playback, and private.

4.2.5.6.2 Interfaces. Conference equipment shall perform the following functions:

- Establish a voice conference bus for VIS keyset access

- Accept voice playback from the CCRF

- Extend the conference to the voice/data processing equipment for connection to users outside the MCC.

4.2.5.7 Record Switch

4.2.5.7.1 Functional Description. The record switch shall permit the Comm Tech controller the capability to selectively route AGVS outputs to CCRF record channels.

4.2.5.7.2 Interfaces. The record switch shall accept up to two analog voice signals and a time signal input for support of a real-time or simulated Shuttle vehicle or playback of a vehicle downlink. These signals shall be connected to one of two record channels.

4.2.5.8 Comm Tech Console

4.2.5.8.1 Functional Description. The Comm Tech console shall provide the capability to monitor the performance of AGVS equipment, to establish or alter an AGVS support configuration, and to test and checkout a support configuration.

4.2.5.8.2 Interfaces. The Comm Tech console shall provide a central point of control of the following AGVS configuration switches:

- Analog
- Digital output
- Digital input
- Record.

The console shall also provide lamp indicators and light emitting diode (LED) display drivers for monitoring equipment performance and configuration status.

4.2.6 Voice Intercom Subsystem (VIS). The VIS shall consist of the following elements.

A. Console Communication Equipment (CCE). The CCE shall provide the following:

- Conferencing capability among various locations within the MCC
- Talk and/or monitor capability on conference circuits
- Access for certain specific conference circuits to external communications facilities
- Private communications capability among the various locations within the MCC
- Private communications capability between the locations within the MCC and the NASCOM voice network
- Access by certain specific positions to the Public Address (PA) System.

B. Communication Line Switch (CLS). The CLS shall consist of a 2-position manual, 4-wire switchboard and associated equipment necessary to interconnect on a direct (2-party) or conferencing (multiparty) basis. The following types of communications circuits shall be used.

- Single-party voice circuits within MCC
- Conference circuits within MCC
- Longline circuits from NASCOM stations
- Longline circuits direct from NASA sites (KSC, etc.)
- Local JSC circuits.

4.2.6 Voice Intercom Subsystem (VIS). (Cont'd)

C. Public Address (PA) Equipment. The PA equipment shall provide the distribution of information and paging messages to separate and independently accessible zones within MCC.

D. Central Power Equipment. The central power equipment shall provide 25 V ac, negative 24 V dc and negative 48 V dc operating and supervision power to the MCC VIS.

4.2.6.1 Console Communication Equipment (CCE). Voice communications shall be handled over numerous loops terminated on station keysets and jack stations located at MCC operating positions (see figure 4-10). The loops shall be independent, and each circuit shall be capable of servicing a maximum of 180 stations. The maximum number of stations can be increased by the addition of special extension loop amplifiers.

4.2.6.1.1 Voice Loops. There shall be five types of voice circuits as defined in the following paragraphs.

A. Local Conference Loops. These loops shall comprise 4-wire conference circuits providing 2-way communications and monitoring capability for all stations on the loop. Other CCE loops cannot be connected to the conference loop, nor shall this loop require signaling. There shall be a total of 204 local conference loops.

B. Intersite Conference Loops. These loops are similar to the local conference loops, but shall have the added capabilities to permit 2-way signaling between the MCC and remote location, and interconnection to a similar loop to a remote station by landline or common-carrier interface. There shall be a total of 200 intersite conference loops.

C. PA Loop. This loop shall be a 2-wire, talk-only circuit providing access to the PA equipment. There shall be a maximum of 16 PA loops.

D. Centrex Loops. These loops shall provide access to the commercial telephone network. Lamp signaling and optional ringing shall be provided for incoming calls, and specified stations shall have dial facilities for outgoing calls. There shall be a total of 112 Centrex loops.

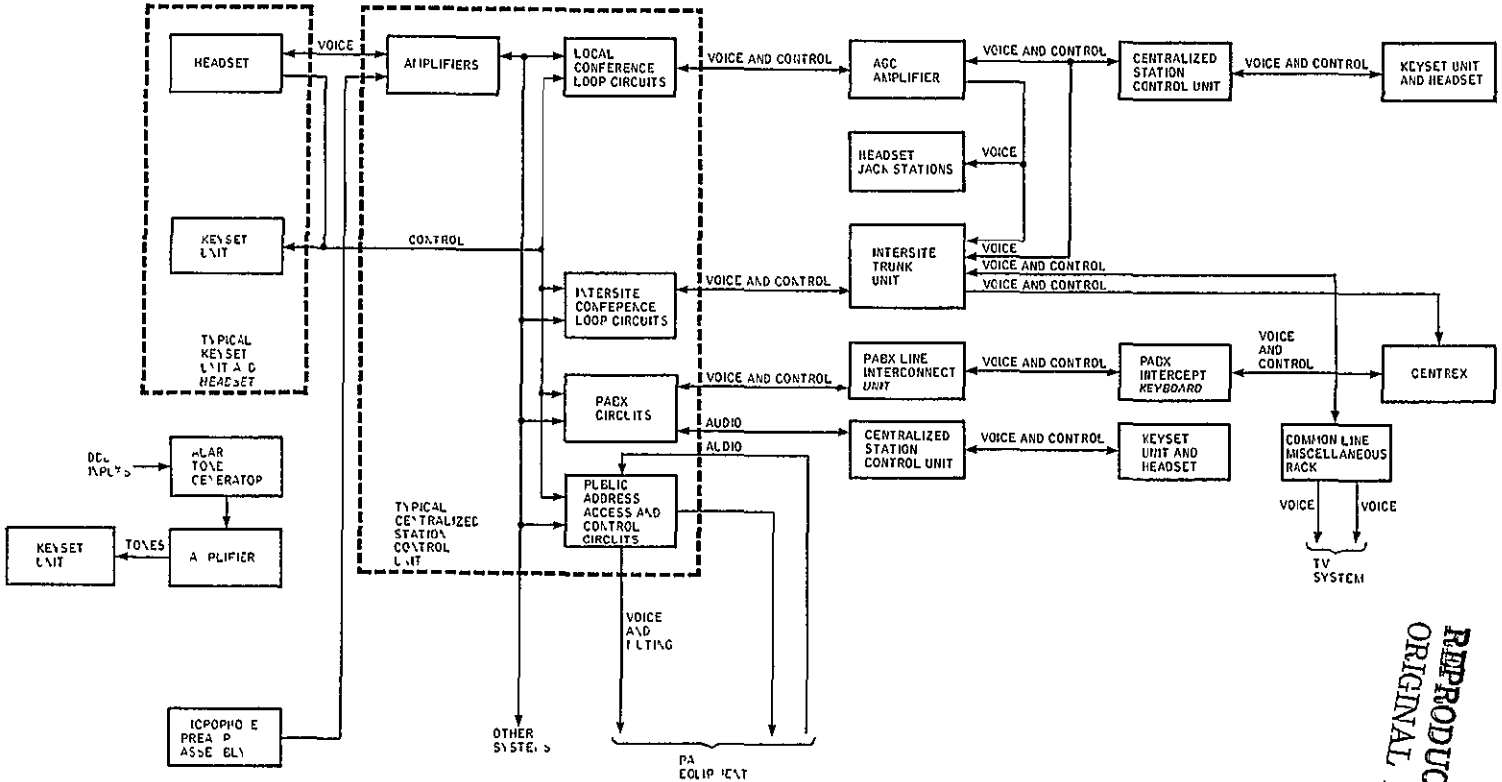


Figure 4-10 CCE Block Diagram

4.2.6.1.1 Voice Loops. (Cont'd)

E. Point-to-Point Loops. Local point-to-point and intersite point-to-point loops are similar to the local conference and intersite conference loops, respectively; however, both shall be wired for manual or automatic signaling.

4.2.6.1.2 Stations. CCE stations shall be defined as keyset stations, jack stations, and remote stations. They are defined in the following paragraphs.

A. Keyset Stations

1. Horizontal Console-Mounted. The horizontal console-mounted keyset shall be equipped to accommodate a maximum of 48 talk-listen (T/L), talk/listen-monitor (T/L-M), monitor, and transfer keys; 5 or 6 common keys (hold, ring, release, buzzer, multiaccess, and mode select on some), a dial device, and a volume control. Not all positions, however, shall accommodate T/L-M.

2. Vertical Console-Mounted. The vertical console-mounted keyset shall have capabilities identical to those of the horizontal-mounted keyset.

3. Rack-Mounted. The rack-mounted keyset shall be equipped to accommodate a maximum of 48 keys (T/L, T/L-M, monitor, and transfer), 5 or 6 common control keys, a dial device, a volume control, and 2 headset jacks. Not all positions, however, shall accommodate T/L-M.

4. Desk Top-Mounted. The desk top keyset shall be equipped to accommodate 48 keys or 36 keys (T/L, T/L-M, monitor, and transfer), 5 or 6 common control keys, a volume control, and 2 headset jacks.

5. Desk- or Pedestal-Mounted. The desk or pedestal keyset shall be equipped to accommodate 10 keys (T/L, monitor, and transfer), 2 control keys, a buzzer, a volume control, and 2 headset jacks.

4.2.6.1.2 Stations. (Cont'd)

B. Jack Stations

1. Single-Loop. Single-loop jack stations shall be wired for T/L or monitor on one loop. Approximately 240 single-loop jack stations shall be provided.

2. Three-Loop. Three-loop jack stations shall be wired for T/L or monitor on any one of three selectable loops. Approximately 140 3-loop jack stations shall be provided.

C. Remote Station. The remote station shall be designed to work at a remote location with the MCC VIS. The station shall be equipped with 10 or 36 keys providing T/L, T/L-M, or monitor access, and 6 common keys. The remote station shall be self-contained with power and necessary encoding and decoding logic to work on a MODEM or frequency-shift keyed (FSK) circuit to MCC. An interface unit shall be provided at MCC on the CCE to encode/decode signals to and from the remote station.

4.2.6.1.3 Interfaces

A. Operational Interface. Access to CCE voice loops shall be through PBI keys and jacks. All transmitters shall be PTT, and speakers associated with keysets shall be muted while the transmitters are keyed. Talk circuits shall be electrically interlocked, thus permitting access to one single loop at a time. Keysets with multiaccess capability, however, shall permit access of up to three talk circuits simultaneously (except the PABX line, which shall release all talk circuits when selected). Any number of monitor loops appearing on the keyset may be simultaneously selected. Lamp supervision (wink, flash, and flutter) shall indicate the status of PBI keyset operations. Audible signals shall provide for station calling. Operational configurations shall be handled in the centralized station control element (capable of accommodating a total of 351

4.2.6.1.3 Interfaces. (Cont'd)

keysets) by plug-in modules and cross-connecting on the combined distribution frame (CDF). Additional reconfiguration or circuit assignments may be handled by jacks and cut keys on the Test and Patch Bay Facility.

B. Physical Interface. CCE keyset stations, jack stations, and deskset stations shall be located throughout the MCC with a limited number of keysets located in other JSC buildings that support mission operations. All CCE equipment on the second and third floors of the MCC shall be cabled to intermediate distribution frames (IDF's) on the respective floors, and from there connected by tie cable to the CDF. Terminal equipment consisting of interrupter and transfer circuits, local conference loop circuits, intersite conference loop circuits, PABX circuits, control and access circuits, PA access and control circuits, selective ring circuits, single- and 3-jack access circuits, patch and switch circuits, and critical alarm circuits shall be located in the centralized station equipment. Operating and control circuits for this equipment shall be cabled to the CDF. For PABX access, the common carrier shall furnish a tie cable to the CDF permitting an interface to the commercial telephone network.

C. Electrical Interface. Local and intersite conference loop amplifiers shall accept signals with up to 20 dB input variation, and deliver a signal with a maximum ±3 dB variation when loaded with up to 180 circuits. PABX dialing shall provide pulse rates from 9.5 to 10.5 pulses per second (p/s), with a 58 to 64 percent break. The MCC shall accept 90-V, 20-Hz signaling from the commercial telephone network. Talk voltage for all voice communications shall be negative 48 V dc. Interrupter and transfer circuits shall apply flash, flutter, and wink lamp supervision to all keyset PBI's. The centralized station control units shall provide switching and signaling circuits (25 V ac) for each PBI, and voice amplification for headset common circuits.

4.2.6.2 Communications Line Switch (CLS). The CLS shall be a manually-controlled switchboard used to configure external lines to internal loops (intersite trunks), or to conference a number of lines and/or loops together. All operations shall be performed from either of two redundant operating consoles. These consoles shall be standard MCC consoles with two operator positions. The positions shall be wired with multiple lines to provide independent line access from either position to the common link equipment. Control and supervision of the lines shall be provided at each position by flush-mounted illuminated PBI keys. Additional keys at each position shall provide control of conference connections and common functions. The console equipment shall be limited to keys and to any switches which are an integral part of the key assembly. All relay circuitry, common equipment, etc. shall be mounted in centrally-located common equipment racks.

4.2.6.2.1 Switching and Conferencing Equipment

A. Switching Capability. The switching capability of the CLS shall provide for connection of the following:

- Any 4-wire line to another 4-wire line, or any line to a 10-party conference circuit

- Group switching to allow the connection of 10-party conference groups together for a 30-party conference.

B. Conference Connections. Conference capability shall be as follows:

1. Lines may be added or dropped from an established conference without affecting other lines on the conference circuit.

2. Identification of all lines associated with any one conference shall be provided at the operator's console.

4.2.6.2.1 Switching and Conferencing Equipment. (Cont'd)

C. Signaling and Supervision

1. Signaling. Incoming signals shall activate lamp supervision and audible alarms at the console operator's position. Ring-off shall be necessary, and the rering signal shall activate supervision as required.

2. Supervision. Line and link supervision shall be provided in the form of multicolor key lamp indications.

D. Functional Description

1. Line Capacity. The CLS shall have the capability to control and switch 230 4-wire circuits, with the capability to expand to 300 lines.

2. Link Capacity. A link shall be defined as the internal CLS circuitry which interconnects a line to any other line or lines. The CLS shall have the capability to control and switch all lines to configure any combination of 2-party or multiparty conferences, with full trunk capability.

3. Line Switching Matrix. A switching matrix shall be provided to perform switching functions as required. The number of 4-wire lines accommodated shall be 230, and the matrix design shall permit expansion without disruption of the existing capability. Links shall be switched to provide audio connections between 150 2-party lines, 10 10-party conference circuit links, or combinations of the two types.

4. Signal-Through Circuit. Provision shall exist for connecting the signaling circuits through additional connections in the 2-party link portion of the matrix so that dc signaling voltage received from either line causes dc signaling voltage to be sent to the other

4.2.6.2.1 Switching and Conferencing Equipment. (Cont'd)

line. Either operator may establish the connection by pressing the SIGNAL-THROUGH key immediately following normal 2-line connection and before the operator RELEASE key is pressed.

5. Two-Party Link. The 2-party link, when used as part of a line-to-line circuit, shall have the capability to allow the line-to-line circuit to equal or exceed the requirements specified in paragraph 4.2.1.2.

6. Automatic Link Selector. Operator access to a line not already connected to a link shall cause the automatic link selector to select the next idle link and provide control to devices that connect the accessed line to the selected link. In addition, the automatic link selector shall precondition connection of the link to additional idle lines. The automatic link selector shall not function when lines are being connected to conference circuits.

4.2.6.2.2 Transmission Requirements

A. Transmission Level. The TTL at the CLS 4-wire interface shall be 0 dBm.

B. Crosstalk Level. Crosstalk shall not exceed -50 dBm, measured on any unloaded receive line with all other lines test tone loaded.

C. Frequency Response. The frequency response of any normal voice path through the CLS shall be such that the net level change for any signal between 300 and 3000 Hz is within 3 dB of the level for a 1000-Hz signal.

D. Line Termination. Idle line terminations shall be provided for all lines.

E. Return Loss. Return loss for all lines under normal conditions of operation at any frequency of interest shall not be less than 40 dB.

4.2.6.2.2 Transmission Requirements. (Cont'd)

F. Longitudinal Balance. Longitudinal balance across lines terminated through a link shall equal or exceed 40 dB when measured according to *EIA Standard RS-210*.

G. Distortion. Distortion shall not exceed 5 percent.

H. Line Isolation Requirements. With three or more lines connected through a common link circuit, the isolation between lines shall be such that a short on either pair of lines does not cause the nominal TTL on either pair of remaining lines to change by more than 3 dB, providing the short occurs on the house side of the CLS 4-wire interface.

I. Impedance Characteristics. The terminating impedance shall be 600 ohms ±5 percent.

4.2.6.2.3 Interfaces

A. CCTCF (Audio) Interface

1. Operational Interface. Interface shall exist between the CLS and the CCTCF at the patch and test bay.

2. Physical Interface. The point of physical interface shall be the distribution frame.

3. Electrical Interface. TTL's measured at the physical interface nominally shall be 0 dBm send and receive, adjustable ±3 dB; operational (speech power) shall be -8 volume units (VU's); impedance shall be 600 ohms balanced. Signaling shall be negative 48 V dc, referred to ground, and introduced on the circuit at the end originating the ring. Bad line supervision shall consist of negative 48 V dc, referred to ground, applied through the CLS bad line lamp to CCTCF.

B. CCE (Audio) Interface

1. Operational Interface. Interface shall exist between CLS and CCE at the patch and test bay.

4.2.6.2.3 Interfaces. (Cont'd)

2. Physical Interface. The point of physical interface shall be the CDF.

C. Central Power Interface

1. Operational Interface. Interface for negative 24 and 48 V dc for CLS power shall exist at the CLS power bay. Lamp power (negative 24 V dc) fusing shall also be provided on this bay.

2. Physical Interface. The point of physical interface shall be the main power distribution fuses in negative 24 and 48 V dc distribution bays.

4.2.6.3 Public Address Equipment (PAE)

4.2.6.3.1 Functional Description. The PAE shall provide coverage of the Bldg. 30 MOW to permit announcements to be broadcast into all rooms. To permit announcements of interest to certain operational areas without disruption to other personnel, the MCC MOW shall be divided for coverage into common-interest zones. All loudspeakers in each zone shall be ganged to a power amplifier for that zone; by selectively accessing an amplifier or group of amplifiers, a single zone or group of zones may be selected for announcements. Provision shall be made for announcements by microphones located within each zone through use of a separate group of speakers at the microphone location; these speakers shall be muted during an announcement to prevent acoustical feedback. Figure 4-11 is a block diagram of the PAE for one zone.

4.2.6.3.2 Interfaces

A. Operational Interface. The PAE shall accept inputs from both the CCE (one input per zone up to 12 zones from any 48 PBI CCE keyset) and microphone direct input.

B. Electrical Interface. Average speech output level from the CCE operating positions into the PAE shall be -8 dBm into

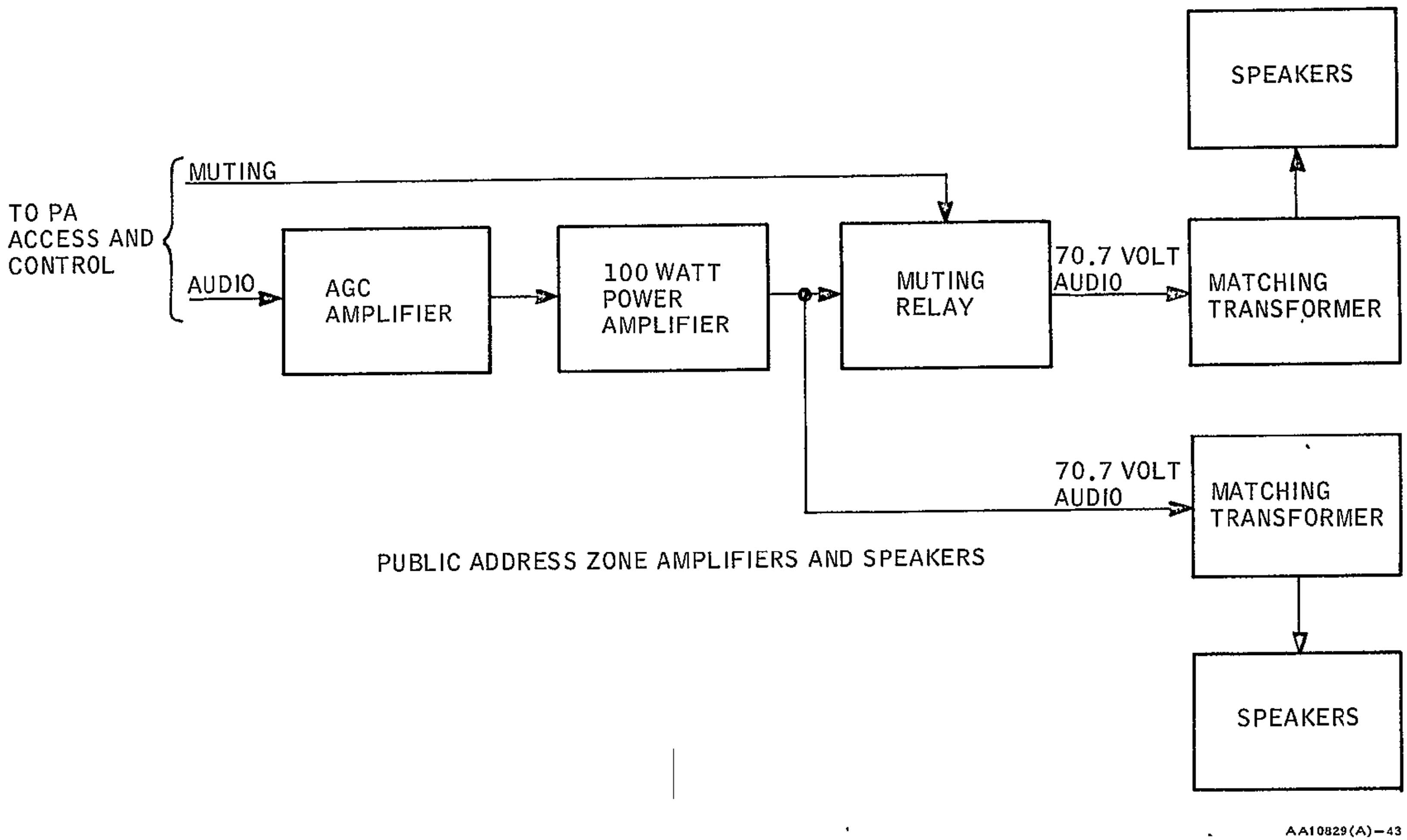


Figure 4-11 Public Address Circuits Block Diagram

4.2.6.3.2 Interfaces. (Cont'd)

a nominal 600-ohm load at 1000 Hz. Speech channel bandpass into the amplifiers shall be from 300 Hz to 3000 Hz from the CCE. Amplifiers shall be 70.7 V rms constant level, 35, 40, and 100 watts, with the higher power amplifiers used in the high density zones.

4.2.6.4 Central Power System

4.2.6.4.1 Functional Description. A central power supply shall provide operating and supervision power to all MCC voice communications equipment. This supply shall consist of a central dc power supply, dc-to-dc converters, and an ac lamp supply. The dc power supply shall consist of both 24 and 48 V storage batteries, battery chargers, power boards, and power distribution panels. The 24 and 48 V dc power supplies shall be connected to provide a negative potential with respect to their common return line. The ac lamp supply shall consist of a 25 V ac supply for signaling and supervisory lamps, and a 12 V ac supply for supervisory lamps. The dc-to-dc converters shall provide +12 V dc, -12 V dc, -26 V dc, and -24 V dc, all from the -48 V dc battery supply. A block diagram of the Central Power System is shown in figure 4-12.

4.2.6.4.2 Interfaces

A. Operational Interface. During normal operations, the -48 V dc battery chargers shall trickle-charge the 23-cell battery, trickle-charge a 3-cell end cell battery, and supply power to the equipment. The end cell battery shall be connected in series with the load when battery voltage drops below -46 V dc. As recharging raises the battery voltage above -53 V dc, the end cell shall be disconnected, and both the 23-cell battery and end cell battery shall resume trickle-charge. The -24 V dc battery chargers shall trickle-charge the 12-cell batteries and supply power to the equipment. The recharge scheme is similar to that of the -48 V dc system, except that no end cells shall be used. Battery capacity shall provide 6 hours of operation without commercial power.

B. Physical Interface. The 24-volt and three 48-volt rack-mounted battery charger/rectifiers connected in parallel

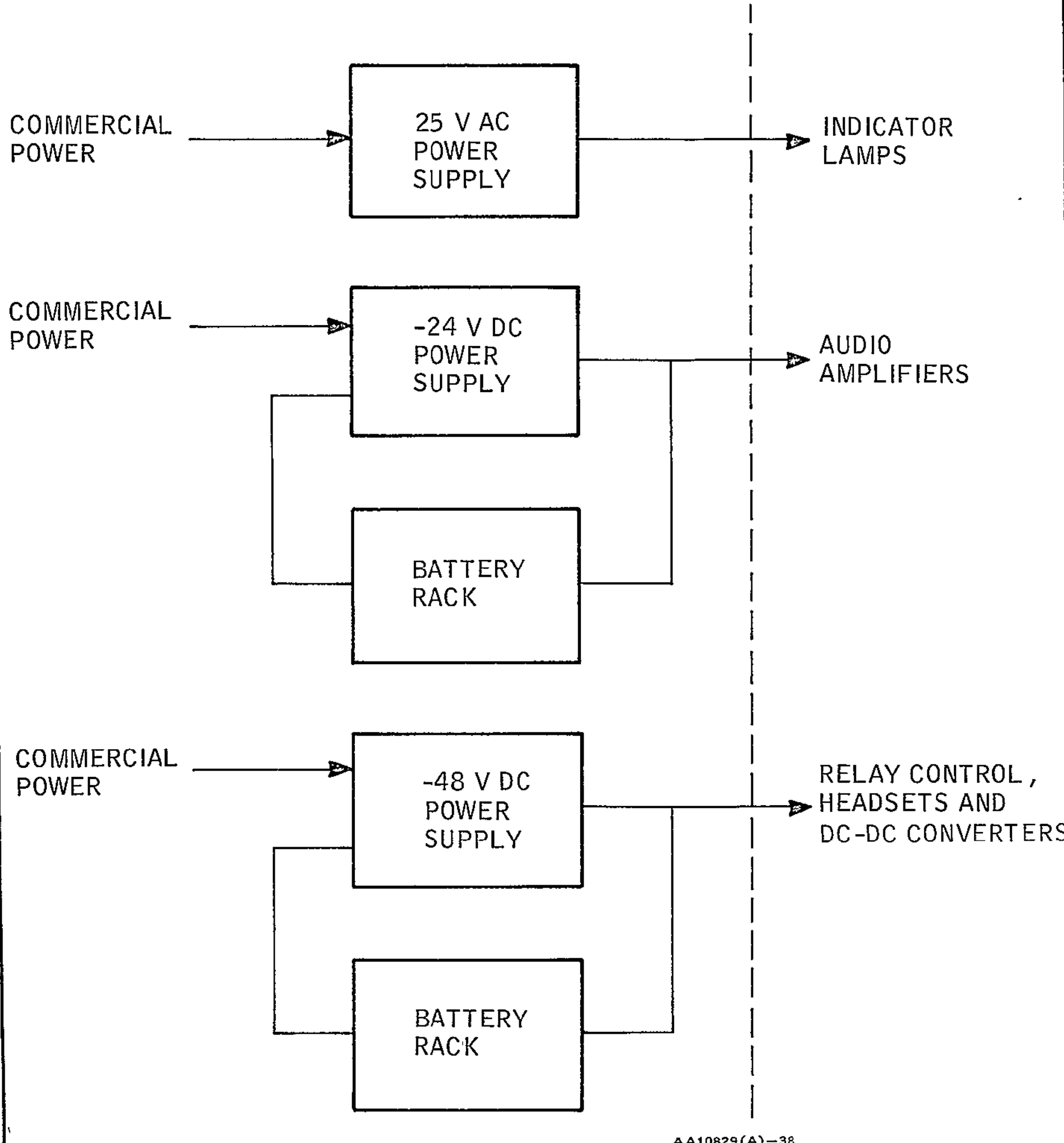


Figure 4-12 Central Power System Block Diagram

4.2.6.4.2 Interfaces. (Cont'd)

for maximum current shall supply dc power. The 12-cell and a 23-cell battery shall provide -24 V and -48 V emergency power when commercial technical power fails.

1. The 24 V dc power supply shall connect to a distribution fuse panel which shall supply -24 V dc fused power to the common equipment racks and to external areas requiring central power. Additionally, -26 V dc power shall be supplied from the power distribution racks by voltage reducers (batt-taps) to a separate dc lamp battery fuse distribution panel in the CLS power panel.

2. The -48 V dc power supply shall connect to a distribution fuse panel which shall supply -48 V dc fused power to external areas requiring power.

3. The ac power shall be supplied from rack-mounted 115 V ac stepdown transformers and rack-mounted distribution panels. The 25 V ac power shall be connected from terminal strips on the power supplies to the CDF, where it shall be cross-connected to the IDF's, and then to the CCE stations.

C. Electrical Interface. Single-phase 115 V ac and 3-phase 208 V ac technical power shall be supplied from the commercial source to power panels, where it is distributed to equipment systems and convenience outlets in the various areas. The two 100-amp, -24 V dc charger/rectifiers and the three 100-amp, -48 V dc charger/rectifiers shall be designed to handle peak loads of approximately 100 amps and 200 amps, respectively. The -24 V dc and -48 V dc distribution panels shall have a current capacity of 400 amps. The -26 V dc power supplies shall have a rated capacity of 15 amps, and the +12 V dc and -12 V dc power supplies shall have a rated capacity of 10 amps. The 25 V ac power supply shall have a rated peak load capacity of 1020 amps.

4.2.7 Consolidated Communications Recording Facility (CCRF). The CCRF shall provide recording, playback, and archival facilities necessary to accomplish the following functions:

- Record all data entering and leaving the MCC for historical purposes
- Play back previously recorded historical data and site-provided tapes for post-occurrence analysis
- Play back checkout and test tapes for testing and configuration verification purposes
- Record voice conversations or specific voice loops and at specific operating positions for historical purposes and also for quick retrieval
- Play back previously recorded voice conversations for post-occurrence analysis
- Provide multiple duplicates of selected voice tapes
- Provide GMT timing on an additional track on all recorders.

4.2.7.1 Data Recording. The data recording component of the CCRF shall be designed and equipped to provide the following capabilities:

- A record of all wideband data (WBD) and high-speed data (HSD) entering or leaving the MCC for post-mission analysis, equipment checkout, testing, and simulation training
- Record/playback of confidence tapes
- Playback of GSTDN/TDRSS and Shuttle Avionics Integration Lab (SAIL) generated instrumentation tapes
- Handling of serial pulse code modulation (PCM) of varying bit rates up to 6.3 MHz, nonreturn to zero (NRZ), multiplexed FM, IRIG pulse duration modulation (PDM), and pulse amplitude modulation (PAM)

4.2.7.1 Data Recording. (Cont'd)

- Interface between the CCRF and the WBDTS for WBD and the HSD patch for HSD
- Interface with the DDHS.

4.2.7.1.1 High-Density WBD Recorders. The capability to record and reproduce the prime WBD and HSD circuits entering and leaving the MCC and to record and playback high rate confidence tapes shall be provided by three high-density WBD recorder/reproducers.

A. Configuration. The three recorders shall be configured so that all inputs are parallel to the three machines. One machine shall be operational, the second offline/standby, and the third used for playback. The configuration shall provide for automatic online switchover of recorder/reproducers when tape runout approaches. All input/output to the recorders shall be by means of the wideband data patch and control interface bays.

B. Capabilities. Each recorder/reproducer shall be capable of:

- Recording/reproducing four channels of data of frequencies up to 6.3 MHz by parallel PCM record/reproduce techniques (1.5 MHz at 15 IPS and 6.3 MHz at 60 IPS)
- Recording/reproducing four channels of data at frequencies from 400 Hz to 50 kHz by direct record/reproduce techniques
- Recording/reproducing seven channels of data at frequencies from 128 kHz to 224 kHz by serial PCM record/reproduce techniques
- Accepting control signals from momentary relays in a remote tape control unit.

4.2.7.1.2 <u>WBD Recorders</u>. The capability to record and reproduce data for confidence and SAIL tape usage, reproduce payload and GSTDN/TDRSS tapes, and record miscellaneous data circuits shall be provided by four 14-track and three 7-track WBD recorders.

A. <u>Configuration</u>. The WBD recorders shall be configured so that all inputs/outputs are by means of the wideband data patch and control interface bays.

B. <u>Capabilities</u>

1. <u>14-Track Recorders/Reproducers</u>. Each 14-track recorder/reproducer shall be capable of:

- Recording/reproducing 14 channels of data of frequencies from 400 Hz to 1.5 MHz by direct record/reproduce techniques
- Utilizing 9 of the 14 channels to record/reproduce data of frequencies from dc to 400 kHz by use of optional FM record/reproduce amplifiers
- Maintaining tape speed control within ±0.02 percent by use of optional tape speed servo circuitry
- Accepting control signals from momentary relays in a remote tape control unit
- Being fully operational under local manual control.

2. <u>7-Track Recorders/Reproducers</u>. Each 7-track recorder/reproducer shall be capable of:

- Recording/reproducing seven channels of data of frequencies from 400 Hz to 1.5 MHz by direct record/reproduce techniques
- Utilizing three of the seven channels to record/reproduce data of frequencies from dc to 400 kHz by use of optional FM record/reproduce amplifiers.

4.2.7.1.3 WBD Patch and Control Interface Bays. This equipment shall provide the capability to patch record source lines to the various channels of the high-density and wideband recorders/ reproducers. It shall also provide the capability for patching data playbacks from the data recorders/reproducers. Signal conversion and interface shall be provided as necessary to ensure the following:

- Outputs to the recorder/reproducers are within the levels acceptable by the recording device input amplifiers
- Voltage levels appearing at all patch jacks are such that no damage will be caused to equipment by any patching combination
- Outputs to the WBD switch matrix are at the same levels as the inputs from the WBD switch matrix
- Outputs to the HSD patch bay (HSDPB) are at the same levels as the inputs from the HSDPB
- Reproduced IRIG-B signals to the tape control units are compatible with the time converter and tape search control unit inputs
- Inputs from the audio patch bay are terminated to a buffer circuit
- Biphase conversion for biphase recording is at the proper level required by the recorder/reproducer.

4.2.7.1.4 Signal Conditioners. Nine signal conditioners shall be provided to recover clock and data from reproduced biphase signals. The received digital signal may be positive or negative going with amplitudes from 0.5 V to 120 V peak-to-peak and may be pulse code modulated using NRZ (C, M, S, or L), RZ, split phase, Manchester I, or Manchester II codes.

4.2.7.1.5 Data Recording Interfaces. The data recording portion of the CCRF shall interface with the WBDTS, the HSDPB, and the DDHS. Refer to JSC-10081 for interface characteristics with the WBDTS and the DDHS. The interface with the HSDPB shall be in accordance with *EIA Standard RS-232*.

4.2.7.2 Voice Recording. Voice recording shall be designed and equipped to provide the following:

- A post-mission record of conversations which take place on selected loops or from selected positions of the CCE and crew conversations which have been extracted from the digital downlink data stream

- Equipment capable of reproducing any portion of this record during the mission

- Equipment to sufficiently delay release of A/G conversations to news media to allow deletion of portions of the text

- Equipment capable of producing multiple copies of selected recordings at a commercial standard speed

- Console equipment for remote control of recorders.

4.2.7.2.1 Historical Recording Facility (HRF). The HRF shall consist of multichannel tape recorders to provide historical records of conversations which take place on preselected voice circuits of the MCC VIS and AGVS. The equipment shall be designed so that addition of a recorder channel to any voice circuit does not deteriorate the performance of that circuit's voice performance.

Two historical recorders shall be provided to record 28 channels on each recorder at a speed of 15/16 inches per second (IPS). These recorders shall have redundant power supplies and tape transports with automatic switchover between transports. GMT timing shall be included on a separate track. Inputs to these recorders shall be routed through normal-through jacks of the voice patch and monitor cabinet.

4.2.7.2.2 Voice Historical Playback Consoles. Two historical playback consoles capable of playing back tapes recorded on historical recorders 1 and 2 shall be provided. These units are capable of selecting either normal speed (15/16 IPS) or four times normal speed (3-3/4 IPS). This equipment is capable of playback on three channels. Channel 1 is fixed, and channels 2 and 3 are switchable between channels 2 through 30. The three channels of playback from each console are jack-ended on the patch and monitor cabinet for patching to any of the tape copy recorders.

4.2.7.2.3 Tape Copy Recorders. Eighteen 2-channel recorder/reproducers shall be provided for the direct record and playback of selected voice circuits, or for record and playback of the historical playback consoles. The tape copy recorders shall be as follows:

- Six recorder/reproducers capable of 7-1/2 and 15 IPS speeds
- Two recorder/reproducers capable of 7-1/2 and 3-3/4 IPS speeds
- Two recorder/reproducers capable of 3-3/4 and 1-7/8 IPS speeds
- Eight recorder/reproducers capable of 1-7/8, 3-3/4, 7-1/2, and 15 IPS speeds.

Record and playback channels for each machine shall be terminated in jacks on the voice patch and monitor bay to allow any voice circuit appearing on the patch field to be patched to any of the eighteen recorders. The above recorders shall be provided with on-off remote control capability, controlled from the historical and WBD recording control consoles. One channel shall be used for voice, and the other channel shall provide GMT timing.

4.2.7.2.4 Delay Loop Recorders. Four delay loop recorders shall be provided to delay transmission of a conversation on a selected voice circuit, or on a selected playback from the tape copy recorder. The delay time capability of each recorder shall be 5 or 15 seconds at low speed and 2.5 or 7.5 seconds at high speed.

4.2.7.2.5 Patching Facilities. A patching and monitoring facility shall be provided with the following jack appearances:

A. Recording Equipment

- Recorder inputs - 88
- Input monitors - 88
- Reproduce outputs - 88.

B. Loops and Miscellaneous Circuits

- VIS-tie lines - 60
- CCTCF patch tie lines - 4
- Monitor amplifier inputs - 4
- Multiple recording circuit with eight outputs - 1
- Historical playback access to VIS patch and test bay - 1
- Tape copy playback access to VIS patch and test bay - 1
- CCE loop mixing circuit inputs and outputs - 2
- AGVS record and playback lines - 20.

C. Copy Equipment

- Recorder inputs - 32
- Recorder input monitors - 32
- Recorder outputs - 32
- Recorder output monitors - 32.

D. Delay Loop Recorders

- Delay loop inputs - 4

4.2.7.2.5 Patching Facilities. (Cont'd)

- Delay loop outputs - 14
- Voice-operated relay (VOX) inputs - 2.

E. Timing System. Two time distributers shall provide IRIG-B GMT to each voice recorder.

4.2.7.2.6 Miscellaneous Equipment. The following miscellaneous equipment shall be provided for support of the HRF.

A. Timing Distribution Units. Two timing distribution units shall provide proper levels and impedances to distribute IRIG-B time code to the various recorders of the facility.

B. Automatic Gain Control (AGC). A jack-ended AGC amplifier shall be provided to allow AGC amplification to be patched into any of the voice circuits appearing on the voice patch.

C. Bulk Tape Eraser. A bulk degausser (eraser) shall be provided for erasing entire reels of tape. This equipment shall be capable of accepting reels up to 10-1/2 inches in diameter.

4.2.7.3 CCRF Control Consoles. Two control consoles shall be provided.

A. Data Recorder Control Console. This 3-bay console shall provide the capability to allow an operator to remote-control (start, stop, record, and rewind) all data recorders (high-density and wideband). Two tape search units shall be provided in the console; one unit shall be switchable between the three high-density recorder/reproducers, and the other unit shall be switchable between all the WBD recorders. The inputs to the time code translater associated with each tape search shall be patchable on the WBD patch and control interface bay.

B. Voice Recorder Control Console. This 3-bay console shall provide the capability to allow an operator to remote-control (start, stop, record, and rewind) all voice recorder tape copy machines. A time code reader shall be provided to allow an operator to search for a time on a tape. The input to this reader shall be patchable on the voice patch and test bay.

4.2.8 OFT/OPS Transition. Changes which are expected to occur over the transition period are:

- Change out the historical voice recorders/reproducers
- Change out the WBD/confidence/range tape recorders/reproducers
- Change out the PAE
- Upgrade and replace all or portions of the VIS to handle the new quick reconfiguration Shuttle OPS requirements
- Change out the WBDTS to a larger, solid state switch to handle OPS requirements
- Increase the NOM output from one to six GSTDN MUX ports (with expansion capability to 64 GSTDN MUX ports) and from one to six simulated GSTDN MUX ports
- Provide NOM expansion for up to four GSTDN formatters to minimize NOM data throughput limitations to the GSTDN network
- Provide NOM expansion capability to output four serial telemetry uplink data streams to the TDRSS MUX for support of detached payloads controlled from JSC
- Provide NOM capability to multiplex command, digital voice, and TAGS data for support of two live Shuttle missions via TDRSS
- Increase the number of TPC's to six and the number of NCIC's to four.

4.3 Data Computation Complex (DCC). The DCC shall provide computational, peripheral, and switching capability which will support the requirements derived from the *OFT Level A Requirements for the Shuttle Ground Data System (SGDS)*.

The DCC shall be composed of the Multibus Interface (MBI), Shuttle Data Processing Complex (SDPC), and the Configuration and Switching Equipment (CSE).

4.3.1 Multibus Interface. The MBI shall consist of two redundant standalone units identified as MBI-A and MBI-B, which are a part of the DCC. Each MBI shall consist of up to 11 (expandable to 64) interface adapters, a configurator, a BITE, and five data buses. Each MBI shall have the capability of functioning independent of the other. The MBI shall provide a common data bus for multiple bidirectional data paths between the SDPC, the TPC, the NCIC, the NOM, and the MBI BITE.

The MBI hardware is divided functionally into four groups as follows (refer to figure 4-13):

- Interface adapters
- Configurator
- Data buses
- MBI BITE.

4.3.1.1 Interface Adapters. Each MBI (MBI-A and MBI-B) shall be designed to support up to 64 interface adapters. Each interface adapter shall consist of a Bus Adapter (BA) and an isolation relay within the MBI unit, and, if required, user unique interface logic located in or near the specific user. Current system definitions require that only the TPC and SDP have unique interface logic. To provide redundancy and ensure a data transfer capability if an MBI unit is taken offline, each user shall be assigned an interface adapter to each MBI (MBI-A and MBI-B). The interface adapters assigned to the user shall have the capability of functioning as source adapters (transmitting data to a data bus), or as destination adapters (receiving data from a data bus). Once a data path has been established, all demand signals shall be provided by the source adapters, and all response signals shall be provided by the destination adapters. Each interface adapter shall be capable of handling any data block size (message length) up to 4351 8-bit bytes. A message with a priority shall not exceed 1023 8-bit bytes in length.

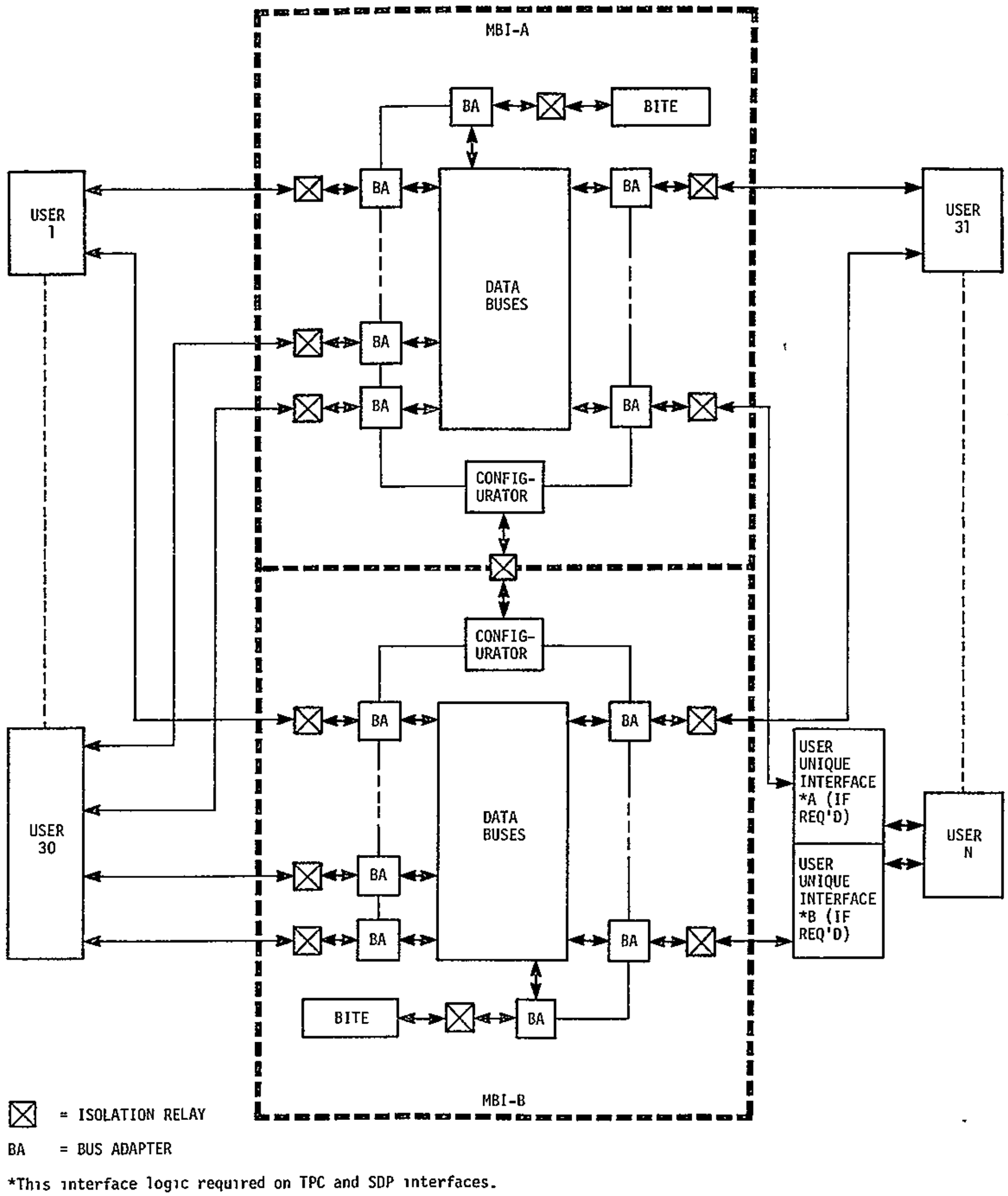


Figure 4-13 Multibus Interface

4.3.1.1 Interface Adapters. (Cont'd)

A. BA's. Each MBI BA shall be capable of supporting the following modes of operation: half-duplex, full-duplex, dedicated, and echo (offline test mode available only to the MBI BITE).

Each MBI BA shall interface with the five half-duplex data buses in its respective MBI, with the capability of transmitting data on one data bus while simultaneously receiving data on another bus. A single MBI BA failure shall not impact the operation of more than one data bus in that MBI. Provisions shall be made to prohibit access to any data bus by a BA until service has been granted as a result of a successful request/acknowledge exchange between the BA and the configurator. Each BA shall have as a minimum, the capability of detecting and/or indicating the following conditions:

- Data parity error
- Transmit/Receive Timeout Errors
- Preamble timeout
- Byte count error
- Destination unavailable
- Adapter disabled.

B. User Interface. Each MBI user shall be connected to an MBI BA. The requirements for interfacing the MBI shall be described for each user.

1. SDPC Interface. The SDP-to-MBI BA interface shall be implemented using unique interface logic to convert the IBM 2909 subchannel interface to the MBI BA interface. This interface shall:

   - Conform to the requirements described in IBM publication *SDPC Interface Description - MBI SDPC Interface Control Document*

4.3.1.1 Interface Adapters. (Cont'd)

- Operate in the full-duplex mode
- Provide relays to physically isolate the MBI BA from the SDP.

2. TPC Interface. The TPC-to-MBI BA interface shall be implemented using an Interdata universal logic interface printed circuit board containing unique interface logic. The interface shall:

   - Conform to the requirements described in the following Interdata publications: 29-311, *Universal Logic Interface Instruction Manual*; 02-328A21, *M73-105 Extended Selector Channel Maintenance Specification*; and 02-328A20, *M73-105 Extended Selector Channel Installation Specification*.
   - Operate in the full-duplex mode
   - Allow the TPC to transmit/receive data and status information to/from the MBI in 8-bit bytes
   - Accommodate TPC transmission to either MBI on one ESELCH and reception from either MBI on a separate ESELCH for each TPC.

3. Other Interfaces. The interfaces between the MBI BA and the NOM, NCIC, and MBI BITE shall be a single design, common to all three. The interface requirements shall be as follows:

   - Provide for fully interlocked (demand/response) asynchronous data transfer
   - Operate in the full-duplex mode
   - Contain eight data lines, one parity (odd) line, and associated control lines for transmit
   - Contain eight data lines, one parity (odd) line, and associated control lines for receive

4.3.1.1 Interface Adapters. (Cont'd)

- Provide relays for physical isolation of the MBI from the user

- Provide for status data transfers from the MBI to the user

4.3.1.2 Configurator. Each MBI shall contain a configurator, keyboard, printer, and control panel. Each configurator shall perform all operational and centralized functions for that MBI, as well as providing an interface for the operator control panel and activity display. The configurator shall be capable of establishing a data path between any two BA's on any of the five MBI data buses, including a data path from the transmitter to the receiver in the same MBI BA (loop back).

A. Configurator Error Detection and Status Advisories. Each MBI configurator shall be capable of detecting preamble errors and generating status advisories for at least the following conditions:

- Unassigned function status
- Preamble error status
- Assignment status errors
- Excessive byte count errors
- Destination dedicated
- Path busy status
- Invalid sign-on, sign-off, selectover preambles

4.3.1.2 Configurator. (Cont'd)

The configurator shall provide status advisories to the appropriate user, i.e., the source and destination adapters, configurator control panel, printer, or MBI BITE.

B. Configuration Tables. The configurator shall be capable of receiving configuration data from any of the 64 users and assigning any number of unique function codes to that user's physical address, up to a maximum of 128 function codes per MBI. Each user shall be responsible for signing on to both MBI's with the same configuration information. Any attempt by a user to assign itself a function code currently assigned to another user shall result in a sign-on rejection and the configurator generating an error status message. The configurator shall also provide for manual configuration table modification, including override of a current function code assignment.

C. Configurator Request Wait Tables. Each MBI configurator shall provide a set of Request Wait tables for the data paths that cannot be established due to transient conditions. These Request Wait tables shall permit multiple requests to be stored (maximum of one request per user in the Wait Table at any time). The configurator shall examine the requests on a first-come first-serve basis, assuming destination and data bus availability, with the exception of specified short messages which shall have priority over long messages. The configurator shall have provisions to remove a request from the Request Wait Table as a result of a request timeout.

4.3.1.2 Configurator. (Cont'd)

D. Configurator Keyboard and Control/Display Panel. Each MBI configurator shall provide for the following local control and display panel functions:

- Configuration table modification
- BA disable and enable
- Configuration status request
- Manual transfer of its MBI to offline or online status
- Isolation of one or all MBI BA's from their respective users
- Activity statistics display request
- Dedicated path establishment
- Adapter status request.

E. Configurator Printer. Each MBI configurator shall include a printer capable of logging MBI advisories at a minimum rate of two lines per second (LPS). A typical MBI error message shall consist of one line of print. An error buffer shall be provided to enable buffering of up to 32 MBI detected errors. Conditions that cause printing loads to exceed the buffer capacity shall cause a printer buffer overflow indication to be generated.

The printer shall log all detected errors and provide outputs based on the various configuration changes. Each printer entry shall be accompanied by an event time tag accurate to within 100 ms. The printer shall log the following MBI information.

- MBI activity statistics
- Data bus dedicated or inhibited
- Function signon or signoff.

The printer shall also be capable of printing the configuration table, including function code, user address, online/standby, and standby function code (if applicable) for all active functions.

4.3.1.3 Data Buses. Each MBI shall contain five data buses interconnected to each of the BA's. Each data bus shall consist of eight data lines, one parity line, and associated control lines. Each data bus shall be capable of transferring data at any rate up to 1.2M bytes per second between the bus extremities.

4.3.1.4 MBI BITE. Each MBI shall contain manually-controlled BITE. The BITE shall permit the generation and checking of test messages and configurations via a BITE control panel and a GFE CRT terminal.

A. Data Bus Verification. Each MBI BITE shall provide all test control and status functions required to execute and monitor the data bus verification. The BITE shall also provide the capability of entering message errors to verify error detection features of the BA's and configurator. In order to verify the data bus path, the BITE shall be capable of the following:

- Data path setup and data transfer to any adapter for isolation of failures in the BA's, configurator, or data buses

- Providing a user interface test verification message where a predetermined user-originated message is received and verified by the BITE or vice versa

- Providing an online test of inactive MBI elements.

Each MBI BITE shall have the capability to change the data content and block size of the test message from zero data bytes to the maximum block size of 4352 bytes, then transmit and receive this data block at the maximum rate.

B. MBI BITE Logging. Each MBI BITE shall interface directly with a BITE CRT terminal. The terminal shall provide the results of the tests performed by the BITE.

4.3.1.5 Multibus Software. There shall be no software elements for the MBI.

4.3.2 Shuttle Data Processing Complex (SDPC). The SDPC shall provide for the processing of communication, command, trajectory, and telemetry functions. The SDPC computers shall support mission-critical events and provide a batch processing capability to support software development and checkout during nonreal-time support periods. In a critical mission configuration, the system shall require one of three processors for support of time-critical processing, one processor system to run as a dynamic standby, and one to serve as a backup with selectover and restart capability.

4.3.2.1 Functional Description. The SDPC shall perform the following functions in support of Shuttle data processing:

A. Network Communications. This function shall perform circuit monitoring, configuration control and management, and data formatting and routing.

B. Command. This function shall generate, format, transmit, and maintain a history of network management commands, Orbiter real-time commands (RTC's), stored program commands (SPC's), computer loads, and Display Electronics Unit (DEU) commands.

C. Trajectory. This function shall determine, predict, and plan the Orbiter trajectory, allowing the user to monitor and evaluate the trajectory and analyze alternatives during launch, abort, orbit, and entry phases.

D. Telemetry. This function shall validate, calibrate, and perform special computations on telemetry data, and perform real-time display, data retention, and data tracking and management functions.

E. Telemetry Data Reduction. This function shall obtain and reduce MCC-recorded historical telemetry data for inflight presentation of the Orbiter operational downlink.

4.3.2.1 Functional Description. (Cont'd)

F. Terminal Control Subsystem (TCS). This subsystem shall provide the man/machine interface for interactive users of data information, and provide data paths between the user and application functions.

G. Command and Control System (CCS) Control. This function shall perform mission initialization and control, logging, delogging, time and data routing, input decoding, display formatting and management, digital display driver (DDD) management, and simulated input processing.

H. Software Checkout System. This system shall provide the capabilities needed for software testing by performing test control, data generation, presentation and delivery, data scoring and comparison, automatic data response simulation, user output, and post-test analysis functions.

I. Hardware Checkout System. This system shall provide the capabilities for performing hardware certification and verification testing and assist in hardware fault isolation and identification; it includes functions for testing MCC hardware systems, subsystems, consoles, display devices, external interfaces, and special-purpose hardware and/or interfaces.

J. Configuration Requirements Processor (CRP). This function shall maintain files in which configuration requirements for MCC disciplines are collected, validated and retained, and produce tables for use by MCC applications based on these requirements.

K. Program Management Facility. This facility shall maintain program libraries, with extensive accounting, reporting and cross-referencing capabilities, and provide support for programming languages.

L. Advance Statistics Collector. This function shall collect detailed data relating to the utilization of Central Processing Unit (CPU), input/output (I/O), and memory, and provide extensive data reduction capabilities.

4.3.2.2 Shuttle Data Processor (SDP) Capability. The SDPC shall be an integral part of the Shuttle support system. The detailed capabilities of the SDP are defined in the *IBM 370/168 System Users Guide* (GC20-1787-0 and GA22-7010). Each SDP shall consist of a CPU, addressable memory, random access storage (RAS), and peripherals. The CPU shall have a processing capability of 3 million instructions per second (MIPS). Either one CPU or a maximum of three CPU's may be connected as a multiprocessor. A 7M byte main storage shall be implemented for each SDP.

4.3.2.2.1 Hardware Elements. SDPC hardware elements shall be as follows (refer to figure 4-1 for SDPC configuration).

A. SDP. Each SDP shall consist of:

- One IBM System 370, Model 168-1, with 7M bytes of main processor storage, 16K bytes of high-speed (cache) buffer storage, and high-speed multiply option
- One 2909-111 asynchronous data channel
- One 3705-11 communications controller, Model F05, with 163,840 bytes storage
- One 2870-byte multiplexer channel
- Two 2880 block multiplexer channels (two channels each)
- One 3830-2 direct access storage device (DASD) control unit
- Two 3340 disk storage units (two drives each)
- One 3066-2 system console.

B. Switching Units and Switched Paths. Equipment contained in this category shall provide for the manual switching between SDP's of the equipment contained in the peripheral and operations console categories and the equipment contained in the RJE work stations. This equipment shall consist of:

- Three 4 × 4 2914-1 switching units
- Four 3272-2 display control units
- One 2955 data adapter unit

4.3.2.2.1 Hardware Elements (Cont'd)

- Two 2701 data adapter units (one adapter per RJE work station).

Each RJE work station consists of an IBM S/360 Model 22 unit with 24,576 bytes of storage, a 1052-8 printer/keyboard, a 2701 data adapter unit, a 2501-B01 card reader, a 2821-2 control unit, a 1403-N1 printer, and a 3811/3211 printer.

C. Peripherals. Equipment contained in this category shall be manually switched between SDP's and shall consist of:

- Four 3811/3211 printers
- Three 3505-B2 card readers
- Two 7460/3525-P1 card punches.

D. SDP Operations Consoles. Equipment contained in this category shall be manually switched between SDP's and shall consist of:

- Ten 3277-2 display stations
- Three 3286-2 printers
- Two 3284-2 printers.

E. Shared Mass Storage. Mass storage shared by all SDP's shall be provided by the 3850 Mass Storage System which consists of:

- One 3851-B2 mass storage facility with 102 billion bytes capacity
- Two 3830-2 DASD control units
- Two 3333 disk storage units (two drives each)
- Two 3330-11 disk storage units (two drives each).

F. Shared Disk Storage. Disk storage shared by all SDP's shall be provided by the following equipment:

- Two 3830-2 DASD control units
- Five 3350 disk storage units (two drives each).

G. Shared Tape Storage. Tape storage shared by all SDP's shall be provided by two tape pools, independent of one another, containing a total of:

- Six 3803-2 tape control units

4.3.2.2.1 Hardware Elements (Cont'd)

- Eighteen 3420-4 magnetic tape units
- Three 3420-5 magnetic tape units
- Four 3420-8 magnetic tape units.

4.3.2.2.2 Software Elements. SDPC software elements shall be as follows:

A. Operating System (OS). An OS shall provide the basic capabilities needed to support the existing MCC hardware and application software in the following areas:

- Real-time data driven functions
- Response-critical interactive functions
- Local and remote batch processing.

B. Applications Software. Special applications software shall be provided as required to support telemetry, display, command, and message handling within the SDPC.

4.3.2.3 SDP Interface Capability. Each SDP shall be capable of interfacing with the CIS, the DCS, other DCC subsystems, other SDP's, and SDP peripherals. Refer to figure 4-1.

4.3.2.3.1 SDP/CIS Interface. The SDP/CIS interface capability shall consist of interfaces between each SDP and four TPC's, two NCIC's, and the NOM.

A. SDP/TPC. The SDPC shall interface with all TPC's via the MBI. The SDPC shall receive telemetry data and TPC status messages for real-time processing from up to three TPC's for Shuttle OFT. TPC configuration and control shall be provided by the SDPC. The interface between the TPC and the SDP shall have the following general characteristics:

- Rate - up to 1M bytes/second
- Width - parallel (eight bits or greater)
- Type - full-duplex
- Number - two interfaces per TPC.

4.3.2.3.1 SDP/CIS Interface. (Cont'd)

B. SDP/NCIC. The SDPC shall interface with the two NCIC's via the MBI. The interface shall allow the SDP to provide configuration commands to the NCI defining which TPC will process which telemetry stream. The NCI shall transmit site-originated data (SOD) and tracking data directly to an SDP. Each NCI shall also transmit configuration and error status and network message accounting statistics directly to the SDPC.

The basic interface characteristics shall be:

- Rate - up to 360K bytes/second
- Width - parallel (eight bits wide or greater)
- Type - full-duplex
- Number - two interfaces per NCI.

Refer to JSC-10081 for further details of this interface.

C. SDP/NOM. The NOM shall provide the MCC interface to the STDN command system for vehicle commands, site management commands, and acquisition data from the SDPC. The interface between the NOM and the SDP's shall be via the MBI's.

The MBI shall allow the data from the SDP to be transferred to any one of the two NOM internal units. The basic interface characteristics shall be:

- Rate - 230.4K bytes/second
- Width - parallel (eight bits wide or greater)
- Type - full-duplex
- Number - two interfaces per NOM unit.

4.3.2.3.2 SDP/DCS Interface. The SDP/DCS interface capability shall consist of interfaces between the SDP's and the Command Computer Input Multiplexer (CCIM), the Display Select Computer Input Multiplexer (DSCIM), Digital Television Equipment (DTE), the Digital Display Driver/Subchannel Data Distributor (DDD/SDD), the Plotting Display Subchannel Data Distributor (PDSDD), the Timing Subsystem (TS), and the SDPC control area. Refer to figure 4-1.

A. SDP/CCIM. The CCIM shall multiplex commands and requests onto separate input channels to each SDP. The serial input on each interface shall be assembled in 36-bit words. All words shall be transferred, starting with bit 0 and ending with bit 35. All characters comprising a word shall be transferred with the most significant bit (MSB) first. Some of the basic interface characteristics of this interface shall be:

- Rate - 2.4 kb/s ±10 percent
- Width - serial
- Type - simplex from the CCIM
- Number - three interfaces, one to each SDP.

B. SDP/DSCIM. The DSCIM shall multiplex and transfer a large number of request messages onto separate input channels to each SDP. These requests shall be initiated from special function keyboards [display request keyboards (DRK's), manual select keyboards (MSK's), summary message enable keyboards (SMEK's), etc.]. Encoders shall detect and encode data into 36-bit words and transfer it to the SDP. Some of the basic interface characteristics shall be:

- Rate - 2.4 kb/s ±10 percent
- Width - serial
- Type - simplex from the DSCIM
- Number - three interfaces, one to each SDP.

4.3.2.3.2 SDP/DCS Interface. (Cont'd)

C. SDP/DTE. Each SDP shall interface to the existing DTE; up to 10 DTE clusters shall be capable of being addressed and driven by each SDP. This interface shall allow CRT display data, TV channel configuration data, and TV channel saturation data to be displayed. Some of the basic interface characteristics for this interface shall be:

- Rate - 200K bytes/second
- Width - parallel (8-bit words)
- Type - simplex data to DTE interface cabinet
- Number - three, one interface per SDP.

D. SDP/(DDD/SDD). Each mission operations computer (MOC) and dynamic standby computer (DSC) SDP drives a DDD/SDD interface. The interfaces shall be identical and have the following general characteristics:

- Rate - 81.6 kb/s
- Width - serial
- Type - simplex from the SDP
- Number - one interface from each SDP to the SDPC Configuration and Selectover Unit (SCS) and interface from the SCS to each DDD/SDD (MOC and DSC).

This interface shall drive event lights and provide timing configuration data at various consoles.

E. SDP/PDSDD. Each MOC and DSC SDP shall drive a PDSDD interface. The interfaces shall be identical and shall have the following general characteristics:

- Rate - 40.8 kb/s

4.3.2.3.2 SDP/DCS Interface. (Cont'd)

- Width - serial
- Type - simplex from the SDP
- Number - one interface from each SDP to the SCS and interface from the SCS to the PDSDD.

F. SDP/TS. Each SDP shall be capable of accepting an existing external time input signal and external time pulse signal. The time and pulse signals shall originate in the TS and shall be transmitted to each SDP on separate lines via the DU. A 1 pulse per second timing pulse shall be provided to each SDP. The time input shall be GMT in an IRIG-B binary-coded decimal (BCD) format. Input shall be provided in serial. The GMT interface signals shall be updated at 1-second intervals and shall remain static between updates; i.e., NRZ. The basic characteristics of the GMT time base are:

- Rate - GMT updates once every second
- Width - serial
- Type - simplex from TS
- Number - three interfaces, one per SDP.

G. SDP/SDPC Control Area Interface. This interface shall provide the capability for Manual Entry Devices (MED's) and restart/selectover to interface with the SDP.

1. SDP/MED. In support of the real-time processing function, each SDP shall have the capability to interface a total of 24 Cathode Ray Tube (CRT) MED's, which shall be furnished by the Government. These CRT MED's shall be used for program control and for generation of the Shuttle vehicle commands. These interfaces shall not be shared or switched between the SDP's; however, the MED's will be switched. These interfaces shall support data rates of 9.6 kb/s per MED.

4.3.2.3.2 SDP/DCS Interface. (Cont'd)

The CRT MED's shall be used by flight control and data systems personnel for command control and by the computer controllers for program control. The CRT MED's shall be switched by MCC systems external to the SDPC; they shall be switched to each SDP as required during mission support, in an MOC/DSC environment, and during program development. The CRT MED's shall be located at cable distances of from 50 feet to 600 feet from any one SDP area. The following characteristics describe the CRT MED's:

- CRT screen display
- A/N display characters - approximately 4000
- Display characters - 96
- Display edit functions; such as cursor control, insert/delete character, insert/delete row, and clear screen
- A/N keyboard
- Program control function keys - 6 minimum
- Transmission capability - partial or full screen
- Error indications on data transfer
- CRT display hardcopy or parallel printout of CRT data
- Local display storage; tape cassette must be capable of specific block selection.

4.3.2.3.2 SDP/DCS Interface. (Cont'd)

2. SDP/(Restart/Selectover). When the SDP's are configured in a MOC/DSC configuration, a method shall be available to signal the two systems that a selectover will occur, i.e., the MOC shall become DSC and the DSC shall become MOC. This shall be accomplished by providing signals to the systems involved indicating selectover will occur and also indicating the status of the selectover. To indicate a selectover is to occur, a positive level (logical one) shall be sent to both the MOC and DSC. Once the SDP's receive this selectover interrupt, both systems must suspend their output operations until selectover has occurred, i.e., any message that has started from either computer shall be completed, but no new outputs shall be started. Under normal conditions, relays shall switch the outputs after 200.0 ms. In addition to the one interrupt line, each system shall be provided with one status line which will present the status (complete or incomplete) of the selectover. The status shall be presented by putting a one or zero on the line. Both lines and drivers shall be GFE, and the signals shall originate from GFE.

4.3.2.3.3 SDP/DCC Subsystem Interface. The SDP shall interface with other subsystems of the DCC. Interface capability shall exist between the SDP's and the two MBI's, and between the SDP's and the CSE. The interface capabilities for the interface between the SDP's and the Demarcation Unit (DU) element of the CSE are the same as presented in paragraphs 4.3.2.3.2.A through 4.3.2.3.2.F since these SDP/DCS interfaces are via the DU. The interface capabilities for the interface between the SDP's and the SCU element of the CSE for the MED, TASS, and TSO lines shall be as presented in paragraphs 4.3.2.3.2.G.1, 4.3.2.3.5.F, and 4.3.2.3.5.I, respectively. The SDP shall also provide an interface to the LLIU component of the CSE for the LLTD.

A. SDP/MBI. Each SDP shall interface the MBI via an interface adapter. There shall be two MBI's and therefore, two adapters per SDP to allow each SDP to communicate with either or both MBI's. The interface between the SDP and interface adapter shall be determined by the SDP. Some of the basic requirements for the MBI shall be:

- Rate - up to 1.0M bytes/second per MBI adapter (one adapter active), minimum rate of 250K bytes/second on SDP/MBI 2909 subchannel

4.3.2.3.3 SDP/DCC Subsystem Interface. (Cont'd)

- Width - parallel (32 bits)
- Type - full-duplex
- Number - two interfaces per SDP.

This interface shall allow the SDP's to communicate with the four TPC's, the NOM, and two NCIC's.

B. SDP/LLIU. The SDPC shall interface with the LLIU via the SCU. The LLIU shall transmit LLTD (operational, simulation, or test data) to the SCU where the data shall be switched to one or more SDP's. Each SDP (switchable at the SCU) shall be capable of transmitting test data to the LLIU over a separate interface. The SDP/LLIU interface shall provide the capability for simultaneous data transfer over two independent input data paths (LLIU-to-SDP) and one output data path (SDP-to-LLIU). Data shall be transferred in 1200-bit blocks.

The basic interface characteristics shall be:

- Rate - 81.6 kb/s burst
- Width - serial
- Type - simplex (nondemand response for LLIU-to-SDP input data; demand response for SDP-to-LLIU output test data)
- Number - two LLIU-to-SDP input interfaces (nominally one in operation and one spare); one SDP-to-LLIU output interface (test data).

4.3.2.3.4 SDP/SDP Interface. The SDP's shall be interconnected for transfer of data between the SDP's for support of the mission restart function, for load sharing in the software development environment configuration, and for intercommunication between programs residing in different SDP's. The interconnection shall be provided for the three SDP's.

4.3.2.3.5 SDP/SDP Peripheral Interface. The type of peripherals required and quantity are addressed in the following paragraphs.

A. SDP/MTU. A total of 21 pooled MTU's shall be available to the initial 3 SDP's. The MTU's shall be configured so that at least seven can be switched to each SDP. One of these seven (3 of 21) MTU's shall be capable of a read and write speed of 120 IPS for a 9-track, 1600-bpi tape density, and read and write of 800 bpi tape density.

B. SDP/RAS. This interface shall allow the SDP's to have access to a minimum of 1.6×10^9 bits. This storage shall be dedicated to each SDP. The average access time shall not be more than 40 ms.

C. SDP/Printer. Four printers shall be provided for support of the local SDPC programming and support activities. These printers shall have the capability of being assigned in sets of two to a single SDP. Each printer shall have a print capacity of approximately 1200 lines per minute (LPM) for a 96-character print set. Each line of print shall be at least 132 characters in length. Each printer shall be capable of being field-modified to a different print set of up to 128 characters.

D. SDP/Card Reader/Punch. The shared system shall provide a total of three card readers and two card punches. The reader shall be capable of reading approximately 1000 80-column cards per minute. The punch shall be capable of punching approximately 100 80-column cards per minute. The control system shall be capable of assigning all readers and punches to any one SDP.

E. SDP/RJE. The SDPC applications software development shall be conducted from an RJE facility located in the IBM Bldg. or by batch submitted in JSC Bldg. 30. The RJE facility shall interface directly to the SDPC via two 50 kb/s data lines.

F. SDP/TASS Network. The TASS network shall provide capability for 50 users, with growth capability to support up to 150 users. The interface users (terminals) shall be 100 percent clustered synchronous data link control (SDLC) compatible at 9.6 kb/s.

4.3.2.3.5 SDP/SDP Peripheral Interface. (Cont'd)

G. SDP/Peripheral Switch. The capability to allow for pooling of the various SDPC peripherals shall be provided using IBM 2914 switch equipment.

H. SDP/Main Memory. Each SDP shall provide as a minimum 40×10^6 bits of storage. This storage may be a combination of main and extended main storage provided that a minimum of 16×10^6 bits is main storage and the remaining memory is extended main storage.

I. SDP/TSO. A remote TSO facility shall be available for software development functions. The facility shall provide for up to 32 CRT terminals with keyboards and hardcopy capability to be located in the IBM building. Switchable configurations with redundant lines and controllers shall be provided as necessary to assure a 95 percent availability to the SDPC. The MCC operations MED/CRT's shall also be capable of accessing the SDPC/TSO function and be used as on-site terminals for software development when not used in a mission or operations configuration.

4.3.3 Configuration and Switching Equipment (CSE). In addition to the MBI specified in paragraph 4.3.1, the following equipment shall be used to interface and configure the DCC computer systems with MCC's communications, display, and control systems. This equipment shall be composed of three hardware elements: the System Configuration Unit (SCU), the Data Interface Unit (DIU) which contains the SDPC Configuration and Selectover Unit (SCS) and the Launch and Landing Interface Unit (LLIU), and the Demarcation Unit (DU). There are no software elements associated with the CSE.

4.3.3.1 System Configuration Unit (SCU). The SCU (refer to figure 4-14) is an existing piece of hardware which has been modified to provide the following capabilities to:

- Configure the SDPC CRT MED's to the MED 3705's
- Reallocate a group of CRT MED's from a failed MED 3705 to another MED 3705 within 200 ms
- Configure either of the two Launch and Landing Tracking Data (LLTD) interfaces which are received from the HSD patch via the LLIU to one or more of the SDP IBM 2909-3 Asynchronous Data Channels (ADC's)

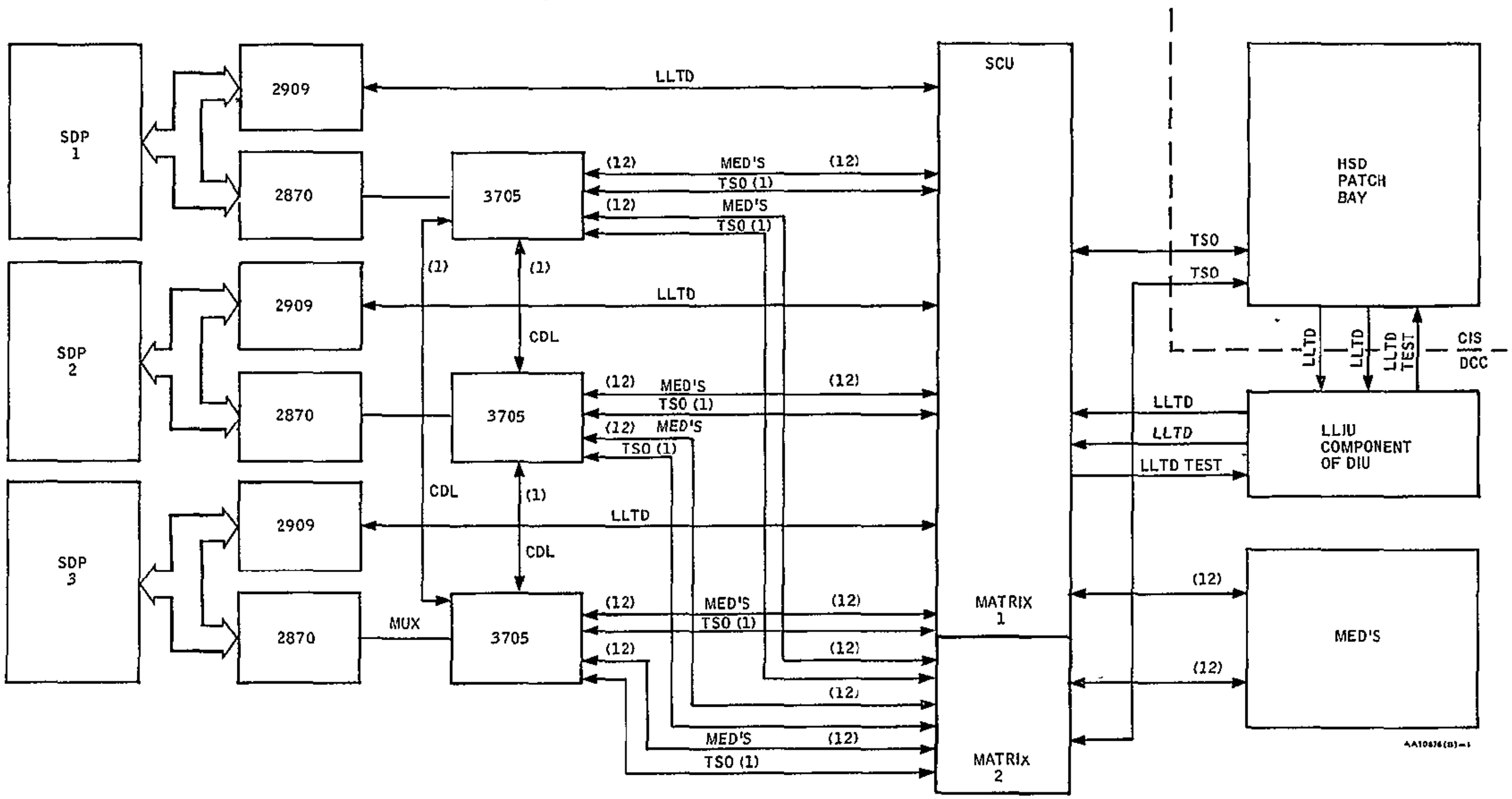


Figure 4-14 DCC MED, LLTD, and TSO Interfaces (OFT)

4.3.3.1 System Configuration Unit (SCU). (Cont'd)

- Configure the LLTD test and checkout data interface from any one SDP IBM 2909-3 ADC to any other SDP IBM 2909-3 ADC or to the high-speed patching facility via the LLIU

- Configure the TSO to the IBM 3705's.

The SCU performance requirements shall be fulfilled by the SCU using I/O interface and monitoring circuitry, predefined crosspoint configurations in the electronic switch matrices of the SCU, and online/standby inhibit functions associated with each of the MED 3705's. The predefined crosspoint configurations shall be loaded from the SCU console using either manual or paper tape loading facilities. The online/standby inhibit functions shall be activated from the SCU console using the system control facilities or the SDPC selectover module. The selectover input shall be backed up by local override capabilities. The operation of the SCU console facilities for crosspoint reconfiguration, online/standby control, and SCU diagnostics shall be as described in SISO EM-150. All performance characteristics of the SCU shall be as described in SISO Specification JSC-10391.

4.3.3.2 Data Interface Unit (DIU). The SCS component (refer to figure 4-15) of the DIU is a new piece of hardware which shall perform the following functions:

- Configure a single interface from each of three SDP IBM 2909-3 ADC's and one 360CC IBM 2902 Multiplexer Line Adapter (MLA) to either the MOC or DSC DDD/SDD

- Configure a single interface from each of three SDP IBM 2909-3 ADC's and one 360CC IBM 2902 MLA to the PDSDD

- Selectover between the defined MOC/DSC interfaces.

The LLIU component (refer to figure 4-14) of the DIU shall interface the LLTD between the SCU and the HSDPB.

The DIU performance requirements shall be fulfilled by the SCS component utilizing wideband I/O interface circuitry and electronic gate switching derived from a console switch module input for configuration, and an SDPC selectover module input for selectover. The selectover input shall be backed up by local override capabilities. The LLIU component shall convert the LLTD from a 7.2 kb/s rate to an 81.6 kb/s burst rate. It shall also convert the LLTD test and checkout data from a burst rate of 81.6 kb/s to a 7.2 kb/s rate.

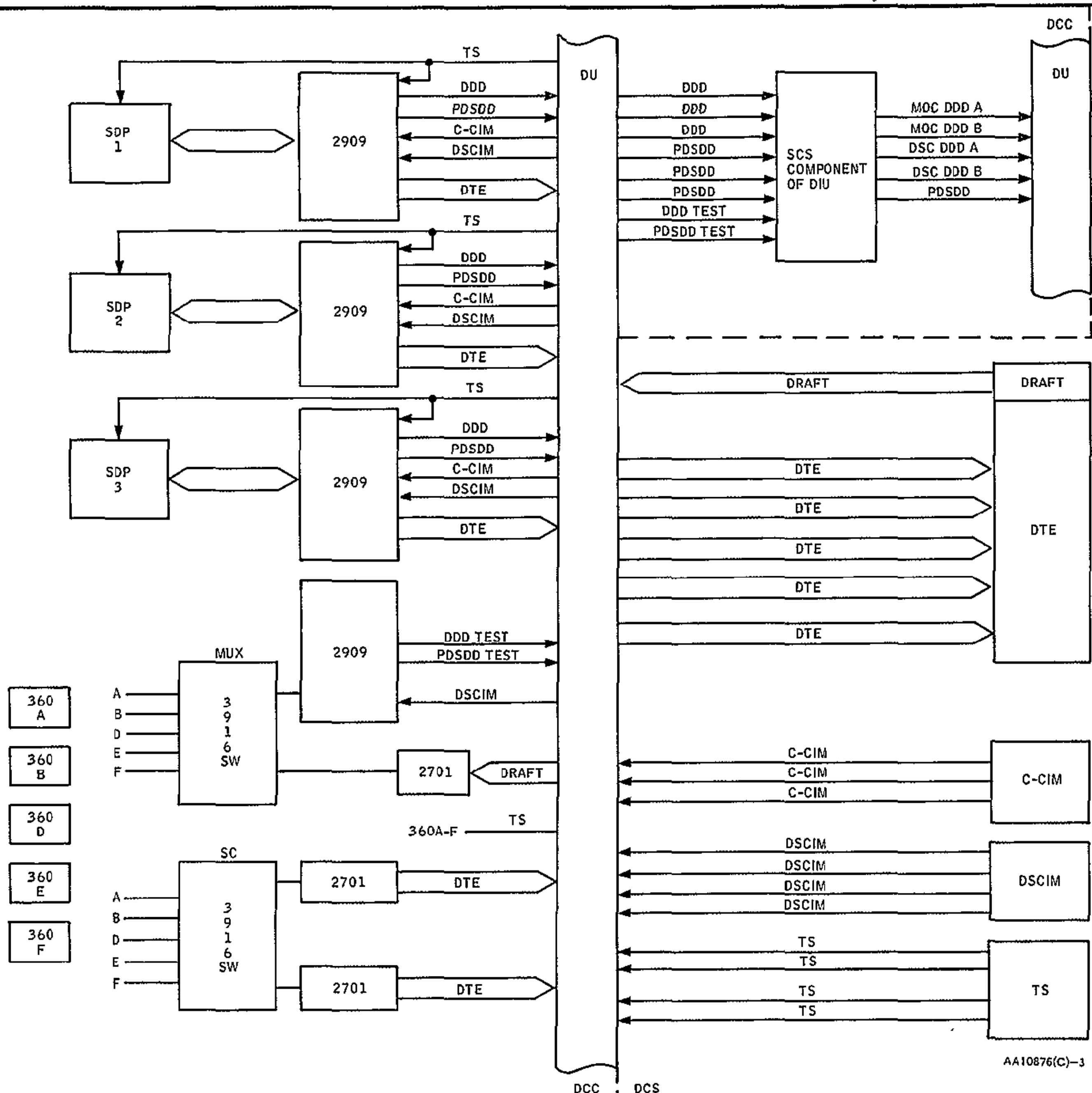


Figure 4-15 DCC SCS and DU Interfaces (OFT)

4.3.3.3 Demarcation Unit (DU). The DU (refer to figure 4-15) is an existing piece of hardware which shall provide monitoring and interface demarcation for all DCC-to-DCS interfaces except the SDPC control area interfaces. The DU performance requirements shall be fulfilled by using existing monitoring and demarcation facilities as described in IBM Technical Manual RTCC 117.

4.3.4 OFT-OPS Transition - DCC. Transition to the Space Shuttle OPS area shall introduce major modifications to DCC resources in order to meet expanded support requirements. These modifications are not firm at this time but the following paragraphs discuss the projected or anticipated changes.

4.3.4.1 Multibus Interface (MBI). The initial DCC configuration shall contain two MBI units. This configuration shall allocate a specific number of I/O ports for each SDPC, NOM, NCI, and TPC within the system. The increase in data loading, and addition of SDPC computers to accommodate this increased load, indicate necessary expanded capability within the MBI. The expansion shall be accomplished through the addition of new modules to add I/O ports; the number of ports to be added shall be dependent upon the increase in SDPC computers, etc. Typical expansion shall be:

New Equipment	Additional Costs
SDPC	2 ports each
NOM	0 ports each
NCI	2 ports each
TPC	2 ports each

4.3.4.2 Shuttle Data Processing Complex (SDPC). The transition from OFT to OPS support by the SDPC shall be accomplished in the 1980 timeframe. It shall provide for mission support of up to three simultaneous vehicles, each with multiple payloads for processing support of up to seven network sources. Present SDPC system planning shall also provide for the installation of a data base to optimize the SDPC utilization.

4.3.4.3 Configuration and Switching Equipment (CSE). The transition period for the CSE shall involve expansion in the SCU, DIU, and the DU areas.

A. SCU. The SCU must be expanded to accept additional SDP 2909-3 ADC's and MED 3705's as required during OPS.

B. DIU. During the transition period the SCS shall be expanded to support any additional SDP IBM 2909-3 ADC's and two sets of DDD/SDD's and PDSDD's. A set consists of two DDD/SDD's and one PDSDD.

C. DU. The DU shall be configured during the transition period to accept any additional SDP IBM 2909-3 ADC's and two sets of DDD/SDD's and PDSDD's. A set consists of two DDD/SDD's and one PDSDD.

4.4 Display and Control System (DCS). The Shuttle OFT DCS shall perform in conjunction with the DCC and the CIS to provide OFT mission and support personnel the capability of requesting and monitoring computer-generated display data. In this capacity, the system shall detect, encode, and transmit operator requests to the computer systems, generate displays in response to these requests, and distribute the display information to the display equipment. Related DCS capabilities shall include the generation and distribution of the primary MCC timing standard, interfaces to video sources external to the MCC, and support of MCC and POCC command systems.

4.4.1 DCS Capabilities. The DCS shall perform the following major functions:

- Convert computer-generated data into raster-type video displays suitable for distribution to console-mounted TV
- Convert computer-generated data into large screen plotting and X-Y plotboard type displays suitable for group viewing
- Convert computer-generated event data into discrete event data suitable for acceptance by console modules, the TS, and the plotting displays control logic
- Convert computer-generated data into analog and bilevel event data suitable for display on SCR's
- Offline convert computer-generated, mission-related data into high resolution film images
- Provide the physical housing for the majority of control and display end devices required for direct operator interface with the Shuttle DCC
- Provide switching and monitoring of the video subsystems
- Provide timing signals to other major systems and subsystems

4.4.1 DCS Capabilities. (Cont'd)

- Provide conversion of command panel switch inputs into data suitable for DCC input
- Provide hardcopy of TV displays
- Provide distribution of hardcopy material throughout the MCC.

4.4.2 DCS Major Components. The DCS shall comprise the following major subsystems:

- Digital Television Subsystem (DTS)
- Television and Video Switching Subsystem (TVSS)
- Command History Printer (CHP) Subsystem
- Group Display Subsystem (GDS)
- Discrete Display Subsystem (DDS)
- Analog and Event Distribution (AED) Subsystem
- Console Subsystem (CONS)
- Timing Subsystem (TS)
- Display Select Computer Input Multiplexer (DSCIM) Subsystem
- Command Computer Input Multiplexer (CCIM) Subsystem
- Computer Output Microfilm (COM) Subsystem
- Pneumatic Tube Subsystem (PTS).

4.4.2.1 Digital Television Subsystem (DTS). The DTS shall provide the capability to convert Shuttle DCC computer language data into dynamic raster-type video displays containing both alphanumeric and graphic information. The DTS shall continually refresh the last information received from the DCC until the display

4.4.2.1 Digital Television Subsystem (DTS). (Cont'd)

is either deselected by the user or updated by the DCC. The displays generated by the DTS shall be made available for viewing when selected by the user, within the MCC on console and/or overhead TV monitors. The DCS shall also provide the capability for the initial allocation of DTE resources to the DCC computers, and for the continuing near real-time reallocation of those resources in accordance with changing support requirements and priorities. The DTS shall consist of the following major components:

- Digital Television Equipment (DTE)
- Digital Television Equipment Cluster Control Unit (DCCU)
- Video Switching Matrix Buffer Multiplexer (VSMBM).

4.4.2.1.1 Digital Television Equipment. The total MCC DTE shall consist of 10 clusters of 8 DTE channels each. The 80 DTE channels shall be capable of interfacing up to 8 DCC computers as enabled by the DCCU. Under the present configuration, the DTE shall be interfaced to five DCC computers (three SDP's and two 360/75's). Eight clusters (64 television channels) shall provide video to the VSM for MCC distribution, and two clusters (16 channels) shall provide video to the auxiliary video switching matrix (AVSM) for special application use. For purposes of system definition, all capabilities of the DTE are discussed in the following paragraphs. It should be noted, however, that during the OFT timeframe the DTE shall not provide DTE-resident backgrounds or operate in the 48-bit mode. All DTE background displays shall be DCC-resident. The DTE disk shall be used exclusively for DTE diagnostic routines. Additionally, the DCC/DTE word format shall be 36-bit.

A. DTE Functions. Each DTE cluster shall accept computer language data from the DCC. This data, either dynamic or background, shall be converted to alphanumeric characters (five selectable sizes), symbols (five selectable sizes), and vectors as required to generate the requested video information contained in any selected display (video) format.

4.4.2.1.1 Digital Television Equipment. (Cont'd)

Each channel within a cluster shall be capable of the following throughput processing:

- Accepting DCC inputs and assembling them in a computer language memory (CLM) (including accessing a background storage device, when required)
- Scaling, translating, and reformatting the data from the DCC coordinate system (when required)
- Generating raster-type display data and assembling it in a display language memory (DLM)
- Transferring the display data from the DLM to the refresh memories (RM's)
- Transferring the display data from the RM's to the TVSS in a composite or noncomposite form
- Providing video outputs to the DRAFT video printer
- Transferring video switching data, received through the DCC interface, to the VSMBM for subsequent assignment of individual DTE channel video outputs to console monitors.

B. DTE Throughput Processing Requirements. The DTE shall be capable of updating all eight channels of a cluster a minimum of once each second. An update cycle for a channel shall be defined as the time required to extract data from the CLM, generate the corresponding vectors or characters, and display them on a CRT. Whenever less than worst-case conditions (type and volume of data) are encountered in the processing cycle for any channel, the processing time shall be the minimum required to generate that particular display; i.e., the processing cycle for any channel shall be initiated by completion of the processing cycle for the previous channel. Thus, the update rate shall increase as data volume decreases; if only one channel is active, it shall be

4.4.2.1.1 Digital Television Equipment. (Cont'd)

updated by every DCC input. Initialization time for the cluster shall be determined by the number of channels receiving simultaneous inputs, and the type of data input (one or a combination of the three types). Worst-case initialization times are required for Mode 1 (all backgrounds are DTE-resident) and Mode II (all backgrounds are DCC-resident). Analysis of the two modes shall assume the following:

1. A channel sequencer scans through the CLM on a channel-by-channel basis. A channel is processed only if it has been updated since the last DTE processing cycle.

2. A DTE-resident background display, if completely assembled in the background storage area of the CLM for a particular channel at the start of the scan cycle for the channel, shall have priority over any dynamic data that may also be available for that channel.

Throughput processing times shall be determined by combinations of input rates, data types, and data volume. Input rates for a cluster shall vary from those for single channel data up to eight simultaneous channel inputs, one for each channel. Data shall be one of three classes: dynamic data (character or vector), DTE-resident background data (character or vector) and DCC-resident background data (character or vector). The volume of data input for a single channel shall vary from a minimum of 1 word [a console select function (CSF) command] to a maximum of 1024 words for dynamic updates or DCC-resident background, or 1536 words for a DTE-resident background.

C. Dynamic Data Generation. The DTE shall be capable of generating characters and vectors at the rates specified in tables 4-1 and 4-2. Rates are shown in characters (or vectors) per second per cluster.

1. Character Generation. The DTE shall be capable of generating any of five character sizes at the rates

TABLE 4-1

CHARACTER GENERATION REQUIREMENTS

CHARACTER SIZE (BITS × LINE PAIRS)	GENERATION TIME (MICROSECONDS)	CHARACTERS PER SECOND PER CLUSTER
5 × 7	16.9	50.0×10^3
7 × 9	19.5	43.3×10^3
9 × 12	23.4	36.0×10^3
10 × 14	26.0	33.3×10^3
14 × 18	31.2	27.0×10^3

TABLE 4-2

VECTOR GENERATION REQUIREMENTS

VECTOR LENGTH (POINTS)	GENERATION TIME (MICROSECONDS)	VECTORS PER SECOND PER CLUSTER
100	86.0	10.00×10^3
200	169.2	5.12×10^3
300	255.2	3.38×10^3
400	331.2	2.60×10^3
500	406.2	2.12×10^3
600	492.2	1.75×10^3

4.4.2.1.1 Digital Television Equipment. (Cont'd)

specified in table 4-1. The characters per second per cluster calculations are based on the total available processing time per second per cluster; i.e., 1 second minus eight (one per channel) display language core-to-refresh memory transfer times.

2. Vector Generation. Vector generation capability shall be provided for either of two vector types, those with slopes less than 45 degrees, and those with slopes greater than or equal to 45 degrees. Based on the requirement that all eight channels be updated at least once per second, the DTE shall be capable of vector generation rates as shown in table 4-2. The vectors per second per cluster calculations are based on the total available processing time per second per cluster.

D. Cluster Identification. The DTE shall decode and examine the operation code of each word transmitted by the DCC. The first word in each message shall be a command word. If the command is a 36-bit dynamic command or background command, or a 48-bit dynamic control, background control or background request word, the DTE shall decode the cluster select code. Subsequent data in the message shall be accepted by the selected cluster until the message is terminated. If the command is a 36-bit CSF word, the DTE shall examine the TV channel ID and determine the intended cluster for the slide/MSK data. The VSM portion of a CSF word shall be passed on to the VSMBM by any cluster having its VSM ENABLE/DISABLE switch in the ENABLE position. The TV channel assignments for each cluster shall depend upon the cluster address that is manually selected at the cluster's diagnostic panel. The cluster channel assignments shall be sets of 8 consecutive TV channels, chosen from the following 12 sets.

4.4.2.1.1 Digital Television Equipment. (Cont'd)

Selected Cluster Address (Octal)	Channel Numbers
• 01	1 (1_8) - 8 (10_8) - VSM
• 02	9 (11_8) - 16 (20_8) - VSM
• 03	17 (21_8) - 24 (30_8) - VSM
• 04	25 (31_8) - 32 (40_8) - VSM
• 05	33 (41_8) - 40 (50_8) - VSM
• 06	41 (51_8) - 48 (60_8) - VSM
• 07	49 (61_8) - 56 (70_8) - VSM
• 10	57 (71_8) - 64 (100_8) - VSM
• 11	65 (101_8) - 72 (110_8) - Spare Addresses
• 12	73 (111_8) - 80 (120_8) - Spare Addresses
• 13	81 (121_8) - 88 (130_8) - AVSM
• 14	89 (131_8) - 96 (140_8) - AVSM.

E. Format Compatibility. Each DTE cluster shall operate in either 36- or 48-bit word format, selectable at the cluster's diagnostic panel. In 36-bit mode, the four MSB's of the first byte of each 5-byte/40-bit word received from the DCC shall be disregarded. The cluster hardware shall be completely reinitialized when switching modes. The DTE shall verify that the total number of bytes received from the DCC in a single message is divisible by five in the 36-bit mode, and is divisible by six in the 48-bit mode. A command error shall be sent to the DCC if the correct division is not verified.

4.4.2.1.1 Digital Television Equipment. (Cont'd)

F. DCC-DTE Data Transfer Rates. Each DCC-DTE interface shall be capable of accepting data at a total rate of up to 400 kb/s. Each cluster shall be capable of accepting data from one or more interfaces at a compound input rate no greater than 800 kb/s. The DCC may be prevented from inputting to a single channel for up to 2.66 ms if the DTE is involved with input buffer data management of the channel.

G. Error Detection. Several types of errors shall be detected by the DTE, including DCC-DTE parity errors, addressing errors, data content errors, internal processing errors, and background storage unit/display cluster transfer errors.

H. DTE Output Video Requirements. The DTE video output shall be a standard 945-line format with 2-to-1 interface, 3 × 4 aspect ratio, and having a field rate of 60 fields per second. It shall be compatible with standard 945-line U.S.A. commercial monitors.

I. DTE Cluster Functional Description. Each DTE cluster shall be divided into discrete areas that perform specific functions. These discrete areas shall be interconnected, combining the specific functions of each area into one overall function of converting computer-generated digital data into a TV display. The following are the major discrete areas of a DTE cluster:

- Input/Output Cabinet
- Data Processing Cabinet
- Refresh Memory Cabinet
- Display Cluster Diagnostic Unit (DCDU)
- Disk Drive Unit.

4.4.2.1.1 Digital Television Equipment. (Cont'd)

1. Input/Output Cabinet. The major components of the I/O cabinet are the Input Interface Module (IIM) drawer and the CLM drawer. The I/O cabinet shall contain the following functions:

   a. Input Interface Module (IIM). The IIM shall provide the DTE interface with the DCC (five computers), the DCCU, and the VSMBM.

   b. Memory Assignment Control (MAC). The MAC shall control access to the CLM.

   c. Channel Sequencer. The channel sequencer shall sequence the data processor to a channel containing new data.

   d. Editor. The editor shall edit and organize new data stored in the CLM while transferring it from the CLM input buffer to the CLM processing buffer.

   e. Computer Language Memory (CLM). The CLM shall store new data, the conversion and font tables, and shall provide working storage for the DCC. The CLM shall have a capacity of 16,384 words of 48 bits each with a memory full cycle time of 1.7 μs.

2. Data Processing Cabinet. The data processing cabinet shall contain the data processing logic (DPL) drawer and the DLM. The cabinet shall contain the following major logic functions:

   a. Character/Vector Generator. The character/vector generator shall convert CLM data into characters and vectors for storage in the DLM.

   b. Background Request Control Logic (BRCL). The BRCL shall cycle through the background buffer area of the CLM seeking background requests. If a request

4.4.2.1.1 Digital Television Equipment. (Cont'd)

is found, the BRCL shall initiate a transfer of the requested background data from the disk memory to the CLM. Once the transfer is completed, the character/vector generator shall convert the data and transfer it to the DLM for storage.

c. Display Language Memory. The DLM shall accept data from the character/vector generator for storage in display language for later transfer to the RM. The DLM shall have a capacity of 8192 words of 34 bits each with a memory full cycle time of 1.3 μs.

3. Refresh Memory Cabinet. The RM cabinet shall contain 16 RM's. Eight RM's shall contain the dynamic data for eight channels, and the other eight shall contain the background data for eight channels. The data generated by the character/vector generator and stored in the DLM shall be transferred to one of the channel memory modules in the RM cabinet. Video generation logic in the module shall provide a continuous refresh of this data to the video outputs 60 times a second. Each RM shall contain 4096 words of 68 bits each.

4. Display Cluster Diagnostic Unit. The DCDU shall contain the DCDU control logic drawer and the memory exerciser drawer. The cabinet shall contain the following major logic functions:

a. DCDU Control Logic. This circuit shall provide the interface between the DCDU and the display processor and the I/O cabinets, the disk control logic, and the disk drive unit.

b. Memory Exerciser Logic. This circuit shall provide the interface logic for the paper tape reader, and shall provide test patterns for testing all memories contained in the cluster. The test patterns shall originate from paper tape, the disk, or by manual entry from the operations panel.

4.4.2.1.1 Digital Television Equipment. (Cont'd)

c. Operations Panel. The operations panel shall provide control and status indication of all selectable cluster functions.

d. Tape Reader Panel. This panel shall provide the capability of entering data tables and test data into the CLM or into the IIM's through the DCC simulator.

e. TV Monitor Panel. The TV monitor panel shall provide capability for visual observation of the video output of any two RM's simultaneously.

5. Disk Drive Unit. One disk drive unit shall be provided for each DTE cluster. This unit shall function as a diagnostic data storage unit and shall be a movable head, removable disk pack disk file, electrically and physcially compatible with an IBM 2311 Disk Drive. The data recording formats on the disk shall be in accordance with SISO-TR446, *DTE Background Disk Programming Requirements*. The DCC shall have the capability to input background data to the background storage unit for disk storage via the normal IIM. The words per message to be input for storage on the disk shall be limited to 1.5K by the DTE.

4.4.2.1.2 DTE Cluster Control Unit (DCCU). The DCCU shall control the allocation of DTE resources to computer data sources in the MCC. The DCCU shall be capable of providing for allocation control of 80 DTE TV channels (10 8-channel clusters) and 5 computers. A detailed description of the DCCU equipment performance is provided in SISO Specification SE-09588, *DTE Cluster Control Unit Performance Specification*.

A. Functional Requirements. The DCCU shall provide functional configuration control of the DCC/DTE data interface. This interface shall comprise five independent data paths, each originating in a DCC computer and terminating in a dedicated

4.4.2.1.2 DTE Cluster Control Unit (DCCU). (Cont'd)

input port in every DTE cluster. It shall utilize a daisy-chain bus terminating technique to ensure that the data on any single DCC/DTE data path appears as an input to all clusters. The DCCU shall govern the acceptance or rejection of these inputs (by DTE) by issuance of enable or disable signals to each DTE cluster via DCCU/DTE control interfaces (see figure 4-16). The generation and issuance of these signals shall comprise the DCCU allocation function; the DCC/DTE interface configuration resulting from the status of these signals shall reflect one of the three basic allocation operations provided by the DCCU's primary cluster allocation, selectover allocation, and restart allocation.

B. DCCU Major Components. The DCCU shall comprise the following major components (see figure 4-17).

1. DCCU Control Console. Control and status indication of DTE cluster allocations shall be provided through the following:

   a. Cluster Allocation Panel. This panel shall contain pushbutton and indicator switches to indicate computer designation, cluster allocations and restrictions, status change, multiple computer restrictions, lamp test, and selectover test.

   b. Manual Allocation Panel. This panel shall provide separate toggle switches for enable/disable outputs to five computer interfaces in each DTE cluster. Each switch shall be operated independently of the others and shall provide a locking lever to prevent accidental selection. The panel shall be provided with a locking cover. The DCCU shall provide a backup manual allocation panel to perform allocation (or reallocation; if required to reflect restart or selectover) in the event of DCCU logic or circuit failure. This shall be provided in lieu of

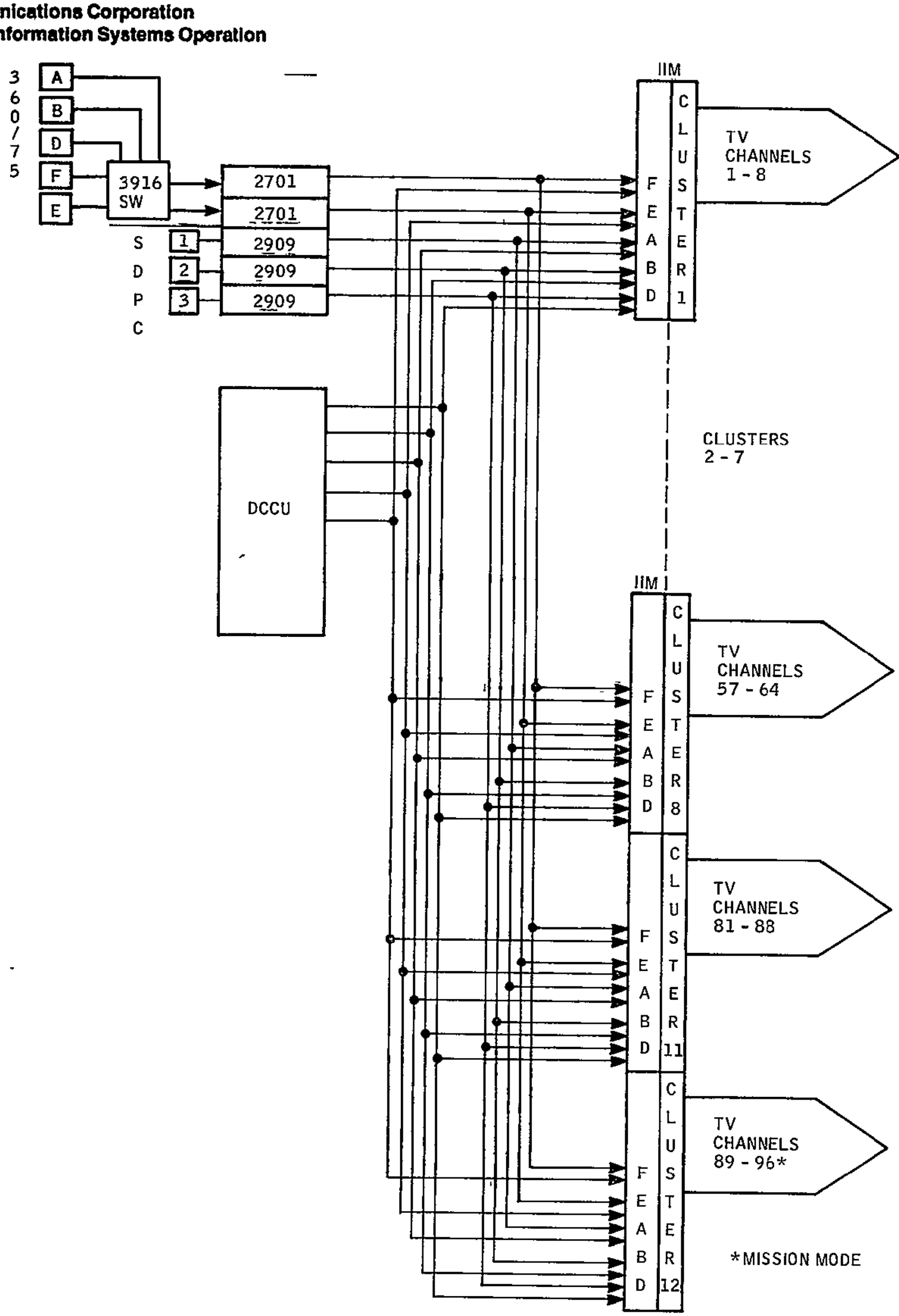


Figure 4-16 DCCU/DTE Control Block Diagram

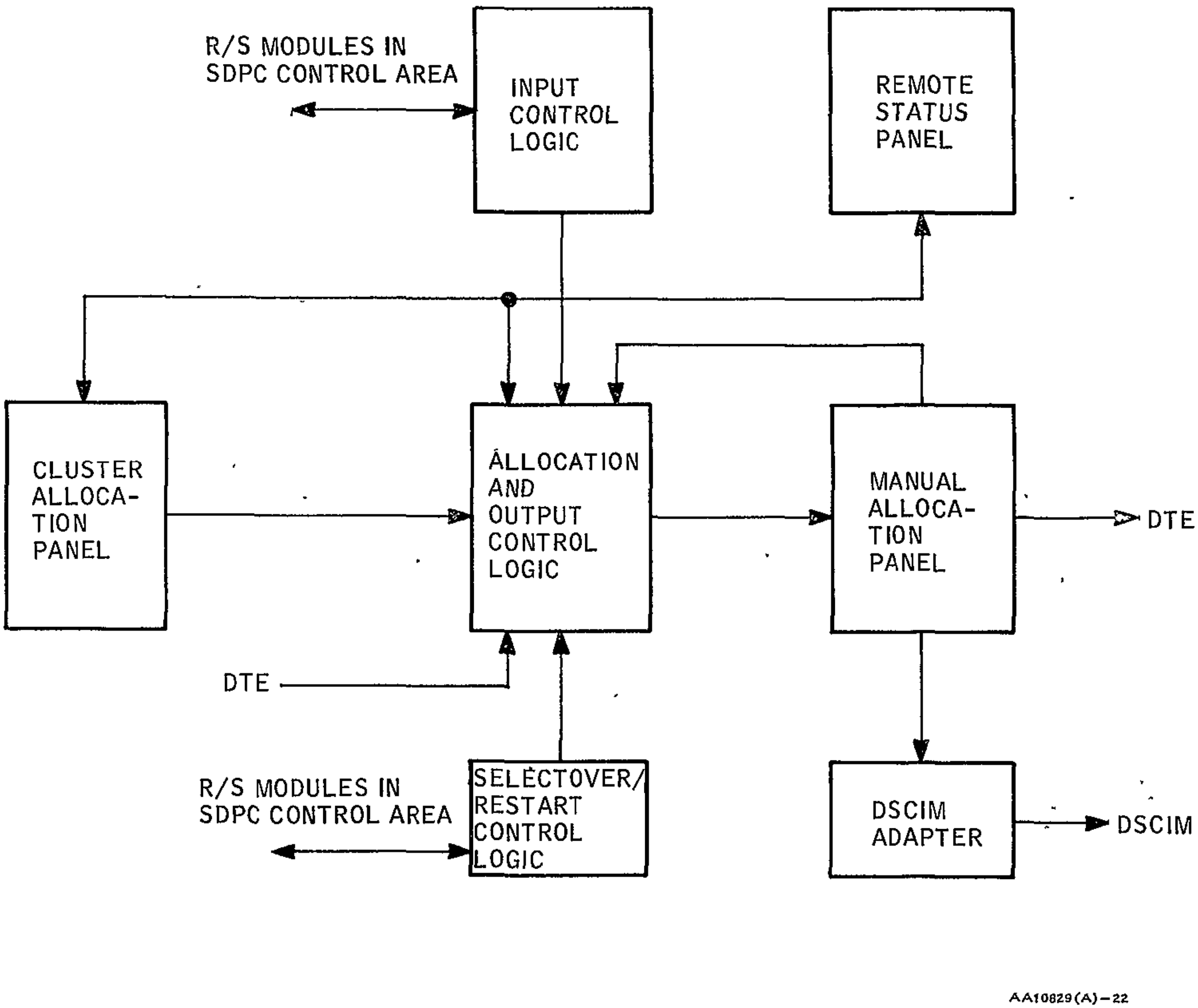


Figure 4-17 DCCU Functional Block Diagram

4.4.2.1.2 DTE Cluster Control Unit (DCCU). (Cont'd)

DCCU logic redundancy. Also parallel, diode-isolated, load-sharing power supplies shall be provided. Each shall be connected to a separate external source (A and B power buses), and each shall be capable of carrying full load requirements for the logic and manual allocation panel.

2. DCCU Remote Status Console. This console shall provide an indication of DTE resource allocation and configuration selected by the DCCU control console. Its remote status panel shall be similar to cluster allocation panel, but shall be composed of remoted indicators only.

3. DCCU Equipment Cabinet. This cabinet shall contain input control logic, allocation and output control logic, selectover control logic, and DSCIM interface adapter logic.

C. Cluster Allocation Requirements. The DCCU shall control the acceptance or rejection of the computer data appearing at the DTE input interfaces by providing a cluster allocation function. This function shall be defined as the generation and issuance of enable (acceptance) or disable (rejection) control signals from the DCCU to the DTE clusters. Each signal shall govern the response of an associated IIM to its computer inputs. Cluster allocation shall permit assignment of single cluster to a single computer or, if required, assignment of a single cluster to multiple computers. Procedurally, however, those clusters assigned to a MOC or DSC in a mission environment shall not be shared by any other computer and shall require protection from such an occurrence; the DCCU shall provide this in the form of a selectable mode of operation in which any reallocation or deselection of mission-supporting clusters shall be inhibited.

4.4.2.1.2 DTE Cluster Control Unit (DCCU). (Cont'd)

D. Selectover Requirements. In a mission environment, a MOC/DSC pair shall supply DTE display data for the Mission Operations Control Room (MOCR) and Auxiliary Display Equipment Group (ADEG), respectively, on the mission floor to which the pair is assigned. Since both computers in the pair output identical data, these correlations must be established through cluster allocation by enabling those connected to the ADEG to accept only DSC data. To ensure the more critical MOCR users a valid data source in the event of MOC failure, the DCCU shall provide a selectover function, which when initiated, shall automatically recondition the MOCR clusters to accept data only from the original DSC, which shall then become the MOC, and conversely, permit the ADEG clusers to accept data only from the original MOC, which shall then become the DSC. The DCCU shall be capable of providing for selectover capability from the SDPC only. The selectover function is further defined for the MOC operational configurations as follows.

1. Single Mission Selectover. When conditioned for selectover by either of two Restart/Selectover (R/S) modules in the SDPC control area (CONS), the DCCU shall perform the selectover operation without affecting allocations to any existing nonmission applications.

2. Pseudo MOC/DSC Selectover. When supporting nonmission functions not requiring the MOCR/ADEG concept, any desired dynamic/standby computer pairs (pseudo MOC/DSC) in the SDPC shall be provided the selectover function if that function is requested from the R/S modules.

E. Restart Requirements. The nominal procedure following a selectover due to MOC failure is to designate a new DSC from the R/S modules. This consists of a normal entry procedure, which shall cause those clusters allocated to the previous DSC to automatically be reassigned to the new DSC.

4.4.2.1.3 Video Switching Matrix Buffer Multiplexer (VSMBM). The VSMBM shall accept video switching requests from the DTE and the DSCIM and shall control the transfer of these requests to both the VSM and the AVSM. In addition, the VSMBM shall accept function-oriented TV saturation data inputs from the DTE and provide outputs suitable for interface with the Telemetry Event Drivers (TED's) for driving the console-mounted amber or red TV saturation indicators, and also for driving LED readouts on the TV Channel Status Module (TCSM).

A. Functional Requirements. The VSMBM shall satisfy the following operational requirements.

1. The VSMBM shall provide 10 separate input interfaces. One serial interface shall be compatible with DSCIM requirements; eight parallel interfaces shall be compatible with the DTE requirements; and one (spare) shall be a parallel interface.

2. The VSMBM shall provide storage and gating for video switching requests from all 10 input interfaces.

3. The VSMBM shall provide four output interfaces including the VSM, AVSM, TED, and TCSM.

B. VSMBM Input/Output Requirements. The following paragraphs describe the VSMBM I/O characteristics.

1. DSCIM Interface. The DSCIM input to the VSMBM shall be a bit serial interface under the control of the DSCIM. The data transferred shall include TV channel ID, console ID, and monitor ID.

2. DTE Interface. Each DTE input to the VSMBM shall be a word parallel interface operating on a demand-response basis initiated by each individual DTE. Data transferred shall include TV channel ID, console address, and monitor ID. In addition, a TV saturation word shall be transferred to the VSMBM via the DTE. This

4.4.2.1.3 (Cont'd) Video Switching Matrix Buffer Multiplexer (VSMBM).

word shall include a function ID, the number of TV channels assigned or remaining (for the particular function), and amber or red saturation indicator illumination data.

3. VSMBM/(VSM/AVSM) Interfaces. The VSMBM (VSM/AVSM) interfaces each shall consist of 19 parallel data lines, 1 strobe line, and 2 return lines. Data transferred shall include TV channel ID, destination console ID, and monitor ID.

4. VSMBM/TED Interface. The VSMBM/TED interface shall consist of 126 parallel lines including 64 lines for red saturation (4 lines for each of the 16 Shuttle functions); 64 lines for amber saturation (4 lines for each of the 16 Shuttle functions), and 2 TED return lines (1 line for red saturation and 1 line for amber saturation). Although the VSMBM provides for the decode and drive capability for amber saturation, no OFT requirement exists to perform this function.

5. VSMBM/TCSM Interface. The VSMBM/TCSM interface shall consist of 40 parallel lines including 16 lines for (number of TV channels) assigned strobes (1 line per Shuttle function), 16 lines (number of TV channels) for remaining strobes (1 line per function), and 8 lines for assigned and remaining data.

4.4.2.2 Television and Video Switching Subsystem (TVSS). The TVSS shall be a multifunction information display and recording system. The TV equipment group shall be configured with two LSR systems. Standard resolution shall be 525 LSR and high resolution 945 LSR. Synchronizing pulses required for the 945 LSR shall be generated in the TS from an atomic standard. Distribution of synchronization pulses and video shall be provided by the TV equipment group. The 525-LSR synchronization pulse clock shall be generated from a rubidium standard within the 525-LSR system

4.4.2.2 Television and Video Switching Subsystem (TVSS). (Cont'd)

and with a 525-LSR video within the TV equipment group. In addition to MCC-generated video, the TVSS shall interface, process, and enhance spacecraft video signals and distribute them to external users (see figure 4-18).

4.4.2.2.1 Major TV Components. The TV equipment group shall perform the following.

- Video generation
- Standard conversion
- Pulse distribution
- Large screen TV projection
- Video distribution
- Sequential color conversion
- Video display
- Horizontal and subcarrier phaselocking
- Video recording
- Frame synchronization
- Video processing and enhancement
- Video switching
- Hardcopy generation.

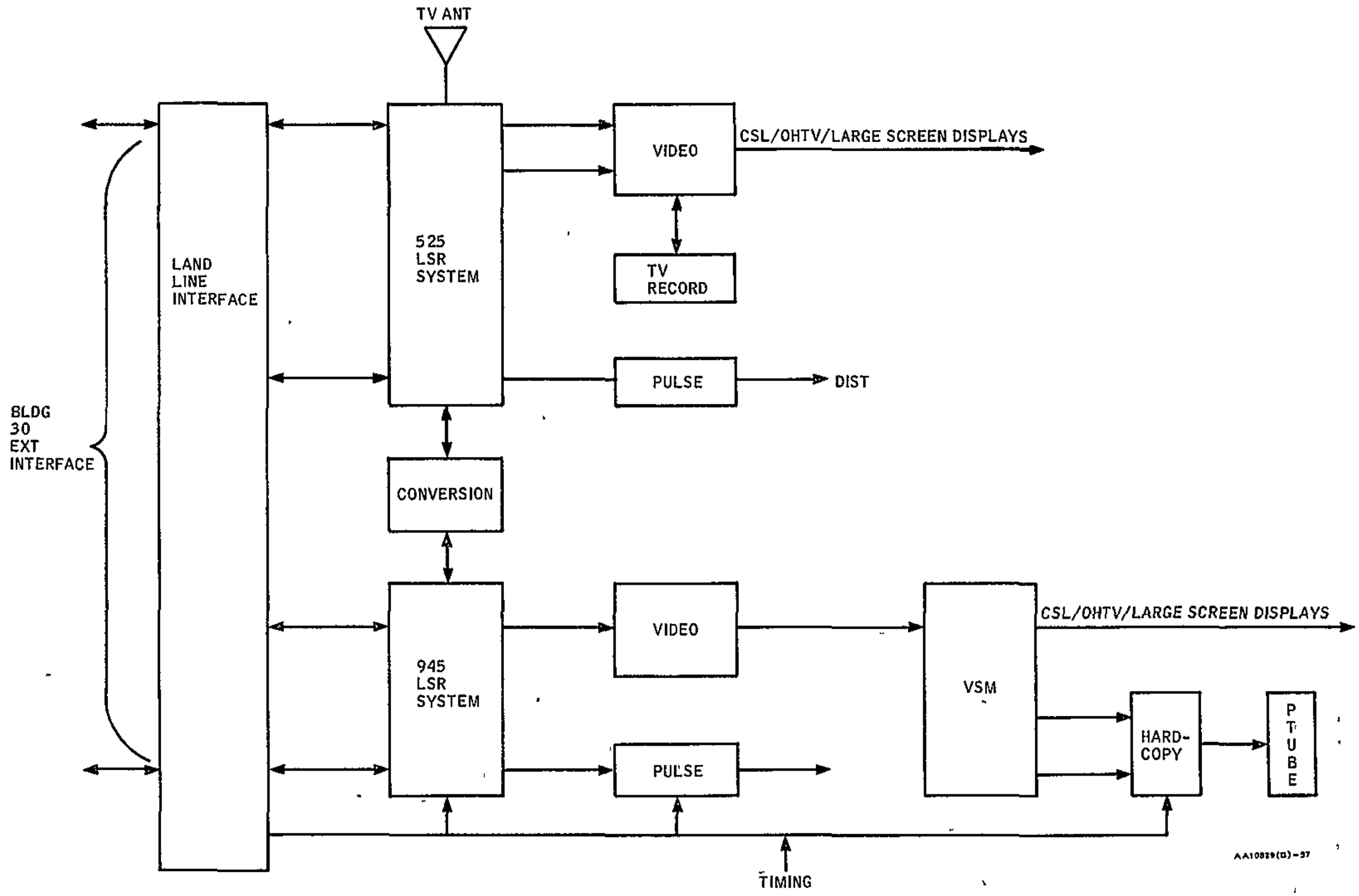


Figure 4-18 OFT DCS TVSS

4.4.2.2.2 Video Switching and Distribution. Video switching shall be accomplished using the existing switching system. Currently the number of accessible, switchable video sources and the number of discrete users is limited by the VSM to 80 inputs and 160 outputs per floor, with an additional 20 input by 20 output AVSM. An additional 160 outputs shall be obtained by paralleling the two VSM's. Distribution of video and timing pulses shall be accomplished by the use of video and pulse amplifiers that are designed to accept a single loop-through or terminated source and provide from one to three identical outputs at 75-ohm source impedance, with synchronization add capability provided.

4.4.2.2.3 TV Reception (RF System). The TV RF System shall be capable of accepting inputs "off-the-air" of local TV commercial broadcast stations. The amplifier system associated with this system shall be configured to accept commercial channels 2, 11, 13, and 8. In addition to the "off-the-air" signals the RF system shall have the capability of accepting locally (Bldg. 30) generated 525-LSR signals that are converted to RF and applied to the system as TV channels 4 and 6. Both video and audio shall be available on all channels (with the exception of 4 and 6), as output signals. The RF signals channels 2, 4, 6, 8, 11, and 13 shall be distributed throughout Bldg. 30 to specified areas via a coaxial transmission line with appropriate tap-offs at the designated locations. Standard commercial TV receivers shall be connected at these line drop taps for viewing by operational personnel.

4.4.2.2.4 TV Conversion Equipment. The TV conversion equipment shall include the LSR converter, field sequential (FS)-to-NTSC converter, and TV frame synchronizer [Digital Coherent Video Synchronizer (DCVS)].

A. LSR Converters. The LSR converters shall perform the change from one scan rate to another (945 to 525 or 525 to 945) through a camera and monitor combination for each converter. The video information shall be presented on a monitor at one scan rate and picked up by a camera operating at the scan rate of the display monitors. This arrangement provides an economical scan rate conversion with some loss in resolution.

4.4.2.2.4 TV Conversion Equipment. (Cont'd)

B. FS-to-NTSC Color Converter. The 525-LSR system shall provide for the conversion of spacecraft sequential color video to an NTSC format and simultaneously record this information for OFT editing, playback, and archive. The time base of the incoming FS signal shall be corrected to the Bldg. 30 sync standards by a Tape Loop or Solid State Memory Time Base System before processing into NTSC format. The basic hardware in the FS/NTSC converter shall be a rotating magnetic disk with three flying heads that input through switchable 1/2-line delay lines. The control logic shall be arranged so that recording and playback occur in an output sequence compatible with NTSC encoder requirements. The simultaneous red, green, blue (RGB) signal shall be routed to an encoder where chrominance and burst are added to provide the complete color encoded signal. The FS-to-NTSC color converter shall satisfactorily support all known OFT requirements.

C. TV Frame Synchronizer. The DCVS shall be a self-contained video processing unit consisting of analog and digital circuit assemblies and all necessary power supplies. The primary function of the DCVS is to accept any EIA, NTSC, or FS 525-LSR nonsynchronous video signal and output a compatible video signal which is synchronous and coherent with the building reference sync. The DCVS shall also provide video processing functions such as amplitude control, chrominance gain, sync reinsertion, burst reinsertion, and setup control. The asynchronous video signal shall be processed on input to recreate the sync pulses and subcarrier. Subsequently the signal shall be sampled three times per subcarrier cycle and converted to an 8-bit digital word format. The digital samples shall be stored in a full frame memory which is read out at the building sync rate. The analog output signal shall be filtered and reference sync, color burst, and output drive provided.

4.4.2.2.5 TV Camera, Operational TV, and Monitors. The cameras currently in use shall be used for OFT.

4.4.2.2.6 Video Hardcopy. The hardcopy equipment shall be a photo/mechanical-optical/electrical system that records and provides a permanent hardcopy and film record of operator-selected displays containing automatically annotated operator ID, time, and data. A full size image (the same as that on the console monitor, 9.5 × 7.3 inches) shall be provided on the hardcopy and delivered to the console operator by pneumatic tube. The film can be fixed and provides an archival record. There shall be three machines configured to provide for high mission activity times and redundancy to allow for the necessary routine maintenance.

Video information display (text) shall be projected onto the hardcopier film by a 10-inch flat face CRT with P11 phosophor. Annotation shall be provided by separate incandescent illuminated readouts that are optically mixed in the light path. Once the information display has exposed the film, the hardcopy system shall:

- Develop the film
- Fix the film
- Wash the film
- Project the contents of the film onto electrostatic paper
- Run the paper through toner for production of hardcopy output.

4.4.2.3 Command History Printer (CHP) Subsystem. The CHP equipment shall provide for buffering, time-indexing, reformatting, and transferring of selected DCS equipment data to two high-speed printers (HSP's).

The CHP shall receive serial data from 4 (expandable to 10) external sources. These sources are: 1) DSCIM, 2) CCIM, 3) MOC DDD/SDD, and 4) DSC DDD/SDD. In addition to the above inputs, the TS shall provide inputs (parallel BCD GMT) for time-tagging printer outputs.

4.4.2.3.1 Major Subsystem Components. The CHP shall comprise the following equipment:

- CHP buffer translator unit
- HSP units (two each).

4.4.2.3.2 CHP Functional Requirements. The CHP buffer translator shall contain a set of control PBI's associated with each of two HSP's. These controls shall enable the selection of data from any one of 4 (expandable to 10) sources for processing and print-out on the associated HSP. The controls shall enable the selection of data from the same source for both printers, or selection of a separate source for each printer. The selected data shall be processed on a time-shared, priority-controlled basis and printed out on the selected HSP. The CHP input data shall consist of either the computer-generated serial event data for processing by the DDS, or the CCIM or DSCIM serial output data. Figure 4-19 depicts the data flow for the CHP Subsystem.

4.4.2.4 Group Display Subsystem. The group display equipment shall interface with the PDSDD and the TVSS to provide large-screen displays suitable for group viewing to the MOCR and the NASA Bldg. 30 auditorium.

4.4.2.4.1 Group Display and Plotting Display Components. The group display equipment shall consist of the following major components:

- Projection plotting displays
- Projection TV displays
- Screens and mirrors.

4.4.2.4.2 Group Display Configuration and Operation

A. Projection Plotting Displays (Figure 4-20). These displays shall convert computer-generated data into alphanumeric symbols and vectors for display on large, rear projection

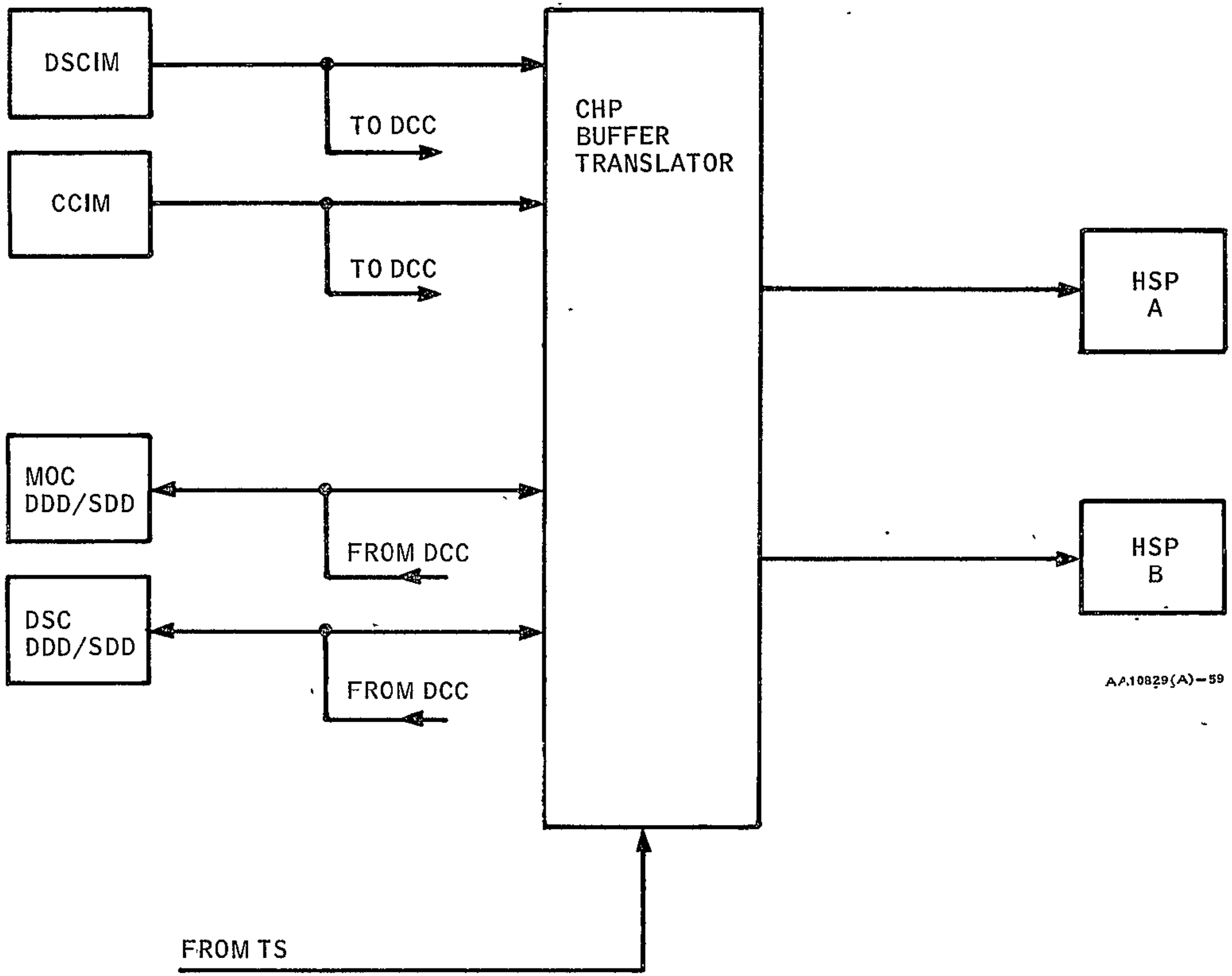


Figure 4-19 CHP Subsystem Data Flow

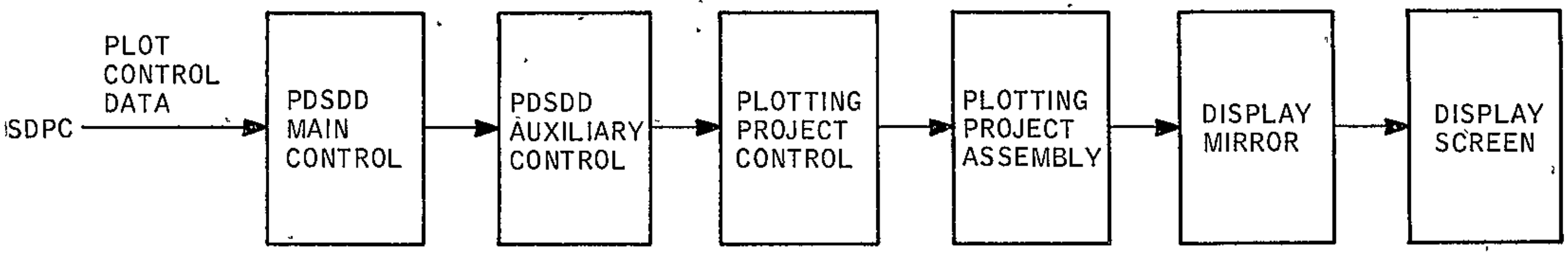


Figure 4-20 Plotting Projection Group Display

4.4.2.4.2 Group Display Configuration and Operation. (Cont'd)

group viewing screens. The displays shall be accomplished by the projection of data which shall be scribed on opaque slides by means of servo-controlled styli. There shall be one Projection Plotting Display Subsystem in the MOCR, a 10 × 20 foot array. The projection plotting displays shall include the following components:

- Four scribing (plotting) projectors
- One reference background projector
- Two spotting projectors
- One symbol generator
- Control electronics.

The projection plotting displays shall receive data from only the trajectory processor.

B. Projection TV Displays (Figure 4-21). The projection TV display equipment shall employ oil-film light modulation techniques to present high-brightness TV displays for projection to large viewing (group display) screens. The TV information displayed shall include:

- Monochrome alphanumeric data or computer-generated data that has been converted to TV signals
- Color TV signals generated by the FS-to-NTSC converter system
- Launch or conference data that is generated by remote TV cameras (MSC/national networks)
- Other RS170 or NTSC live signals as required.

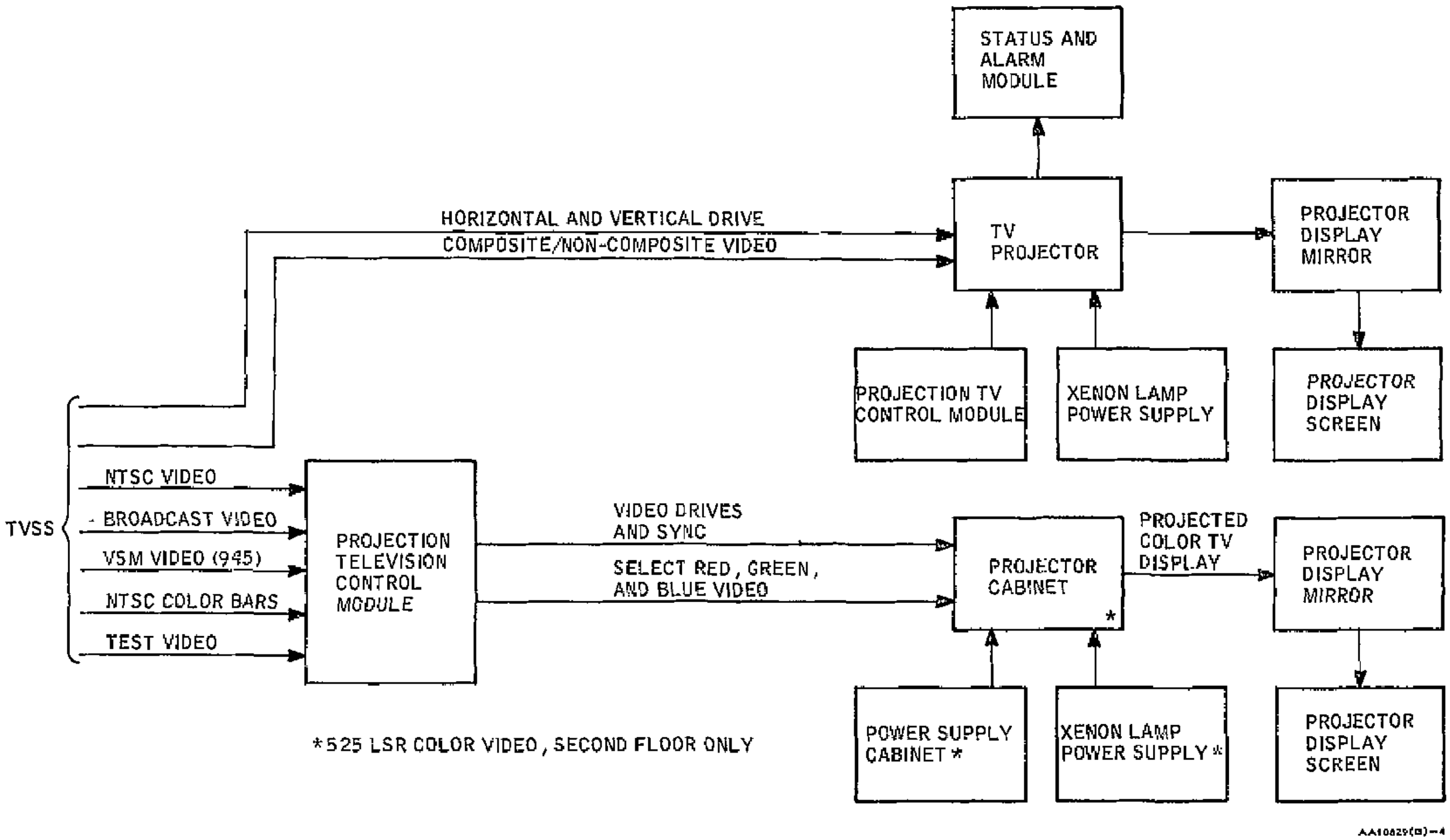


Figure 4-21 MOCR Projection TV Display Equipment

4.4.2.4.2 Group Display Configuration and Operation. (Cont'd)

There shall be four projection television displays in the MOCR, and one projection television display in the NASA Bldg. 30 auditorium. The MOCR images shall be cast on rear projection screens with a single optical fold in the horizontal plane. The projector in the Bldg. 30 auditorium shall be located in a conventional projection booth and the image shall be cast on a front projection screen. One MOCR projector shall selectively display 525-line color monochromatic video or 945-line monochromatic video. Three MOCR projectors are capable of displaying 945-line monochromatic video. The Bldg. 30 projector shall selectively display 525-line or 945-line monochromatic video.

C. Screens and Mirrors. Rear projection screens, on which images will be focused, shall be located on the forward wall of the MOCR. To reduce the space required behind the screens, each projection patch shall have an optical fold by means of a single mirror.

4.4.2.4.3 Group Display Interface. The PDSDD shall provide the interface for the transfer and distribution of control signals and plotting data from the DCC to the group display equipment. This data shall control the generation of large screen projection plotting displays.

4.4.2.4.4 PDSDD Functional Requirements. The PDSDD shall satisfy the following functional requirements.

A. An interface for data transfer and distribution shall be provided from the DCC to the group display equipment. The data transfer shall be bit serial at a nominal 40.8 kb/s rate.

B. Limited storage (for each plotting device) for alleviation of excessive delays in data transfer due to plotting device response time shall be provided.

4.4.2.4.4 PDSDD Functional Requirements. (Cont'd)

C. Redundancy for time-shared portions of the PDSDD shall be provided. Capability for selection of either one of the two PDSDD redundant channels shall be accomplished either locally (at the PDSDD) or from a remote configuration control console.

D. Automatic fault detection techniques shall be used to monitor the status of both the online and standby channels. Errors in either channel shall be indicated both locally and remotely.

E. Sufficient logic circuitry shall be provided to sense an out-of-order condition in any of the user equipment. In all cases, an out-of-order condition shall simulate an end-of-plot or ready-to-receive signal from the plotter to avoid suspending the portion of the unit that must be time-shared, and to facilitate the flow of data words to all user equipment at all times regardless of an out-of-order condition in any of the PDSDD new plotting device control sections.

4.4.2.5 Discrete Display Subsystem (DDS). The Shuttle DDS shall accept computer event display data from the DCC and output data in the proper form and levels to the CONS and TS. The DDS shall provide lamp driver signals to event indicators, timing and control data to the TS, and alarm control data to the CONS.

The DDS shall be composed of the following major equipment (refer to figure 4-22):

- DDD/SDD's
- DDD's.

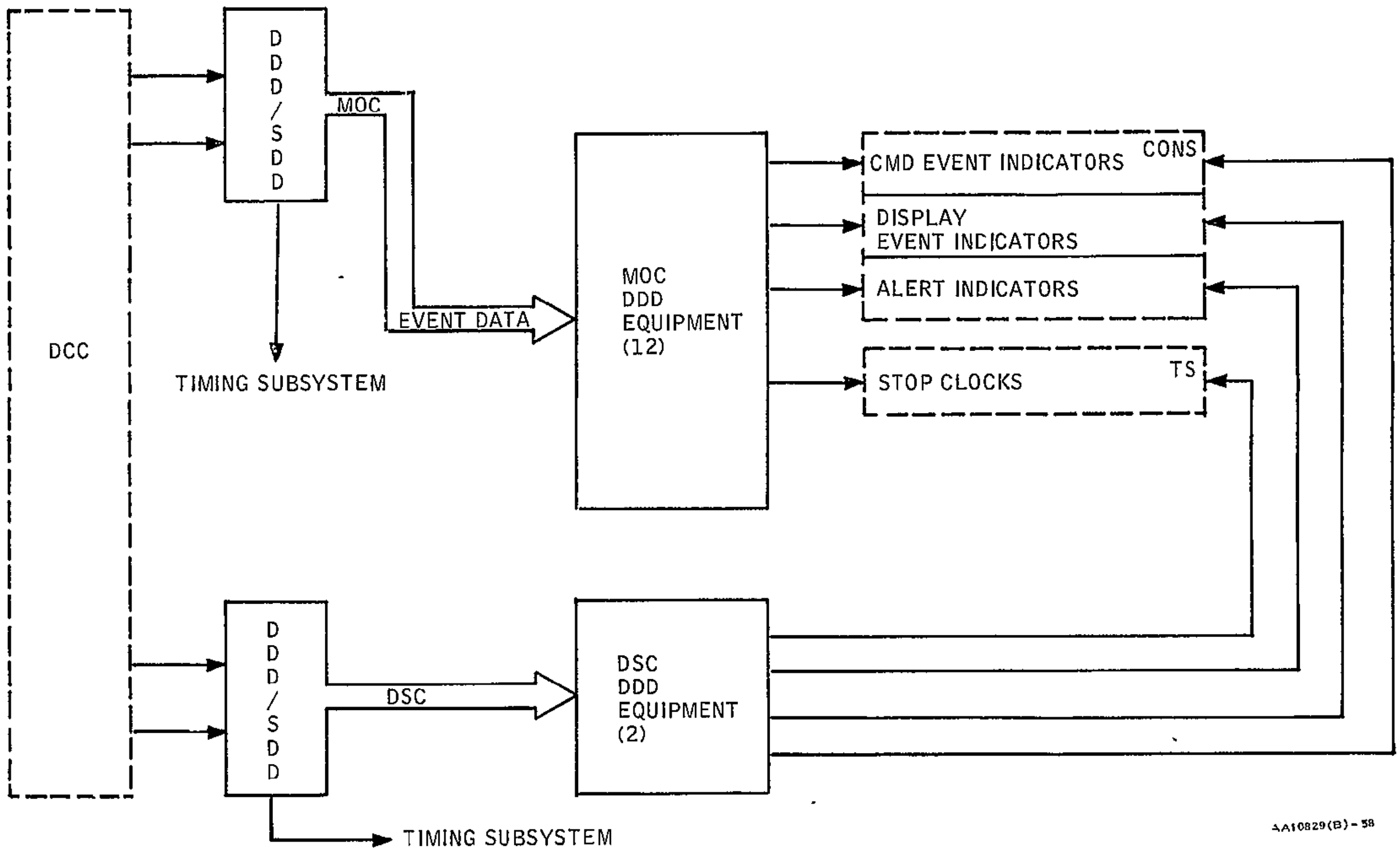


Figure 4-22 Discrete Display Subsystem Data Flow Diagram

4.4.2.5.1 DDD/SDD Functional Requirements. The DDD/SDD shall accept serial input data from the DCC via the SCS on parallel paths and output data in the proper form and levels to the DDD's and TS. Two DDD/SDD's shall be provided for the OFT-DDS, one designated for MOC data and one designated for DSC data. Each of the DDD/SDD's shall provide independent outputs to separately assigned DDD's. The input to the SDD shall be a parallel path demand response serial data transfer (clock, data and RTR) at a rate up to 81.6 kb/s, consisting of 36-bit words in a variable length block. Each 36-bit word shall contain address bits and data bits as a function of the intended destination or user as follows:

- SDD inputs for DDD's - 12-bit address, 24 bits data
- SDD inputs for TS (RTA's) - 6-bit address, 30 bits data.

The DDD/SDD shall route the data according to address designation, provide all control signals in the proper time sequence required to update the digital displays, and/or transfer information to the TS.

DDD/SDD outputs shall be patchable. The time update data shall be patched directly from the SDD' to user subsystems.

Circuits in the DDD/SDD shall be capable of decoding up to 4096 unique addresses (64X × 40Y). Of these possible 4096 decodable addresses, up to 1600 (40X × 40Y) may output at any one time. Each unique address shall determine the DDD/SDD output routing of data for the DDD's.

The DDD/SDD shall compare input data of the parallel online and standby channels and provide error detection and alarm indicators. Errors in either the online or standby channels shall cause the DDD/SDD to inhibit the input data and generate alarm signals. During error status, data may be processed by the selection of the test mode for the failed channel.

4.4.2.5.2 DDD Functional Requirements. The DDD's shall accept digital event data from the DDD/SDD and provide equivalent drive signal outputs to illuminate event indicators. The input to the DDD's from the DDD/SDD shall be parallel data transferred on an independent word-by-word basis consisting of 42 select lines, 24 data lines, and 1 strobe line. The maximum input data rate shall

4.4.2.5.2 DDD Functional Requirements. (Cont'd)

be 450 μseconds per word. The output from each DDD shall be multiple sets of 24 independent event driver lines capable of 100 mA lamp drive and 1 associated power supply line. Each of 12 micrologic DDD's shall provide 80 sets of 24 lamp drivers. Each of two micrologic DDD's shall provide 60 sets of 24 lamp drivers and 20 sets of event pen drivers.

The DDD's shall provide storage for event data between update cycles for all output data driver sets. The DDD's shall also provide event drive power for each event line of each data set. The DDD's shall provide the indicator driver capability for any console or display element within the per driver limits of 100 mA at 28 V dc. This shall be for only those console modules that are connected and addressed by computer control. For increased functional reliability, more than one lamp of a console element may be driven by separate addresses derived from the same functional source. This capability shall be under DCC computer control. Each driver may be required to drive parallel lamps within the driver's current capability. No other redundancy shall be provided. The DDD shall provide certain error indications such as offline/online, blower failure, and equipment alarm for voltage failures at monitored points. Fourteen DDD racks are presently assigned to the OFT-DDS.

4.4.2.6 Analog and Event Distribution (AED) Subsystem. The AED shall receive digital analog and bilevel event data from the TPC's and distribute this data to analog and event SCR's located throughout the MCC. The AED shall be capable of converting and distributing a minimum of 200 analog and 447 event parameters. In addition, it shall be capable of accepting spacecraft time from each TPC and performing a parallel-to-serial conversion on the timing data for output to the timing pens.

4.4.2.6.1 Functional Requirements. The AED shall provide the following minimum capabilities:

- Drive 200 analog pens
- Provide a resolution of analog parameters of 1 part in 256
- Drive 447 event pens

4.4.2.6.1 Functional Requirements. (Cont'd)

- Provide two spacecraft times to each analog recorder
- Provide one spacecraft time per group of 24 event pens on each event recorder
- Interface with existing recorders
- Be data cycle driven
- Maintain the time homogeneity between parameters of the same data cycle as provided by the TPC
- Provide data storage sufficient to double buffer up to 128 samples/data cycle for each pen
- Accept GMT, SGMT, PET, and pulse rates from the TS and output signals to the recorders
- Provide both local and remote capability to enable/disable each TPC to each SCR/pen group
- Provide the capability to mix a minimum of two data cycles on one SCR
- Provide an interface to each of the six TPC's (four existing, two for expansion)
- Provide timing in normal or expanded formats to the timing pens
- Interface with Third Order Polynomial D/A Converters (TOPDAC's)
- Provide a test module to aid in troubleshooting and check-out analysis
- Provide redundancy to the extent necessary to avoid catastrophic failure
- Drive other analog devices with interface characteristics similar to SCR's; such as contouroscopes, LBO's, etc.

4.4.2.6.2 Major Subsystem Elements. The AED shall consist of the following major elements (refer to figure 4-23):

- TPC interface logic modules
- Central scanner and router
- Analog/event pen memory and controller
- Analog pen, event pen, and TOPDAC drivers
- Synthesizer logic
- Timing pen memory, controller, and drivers
- Test module and maintenance panel.

4.4.2.6.2.1 TPC Interface Logic Modules. The AED shall contain one TPC interface logic module for each TPC. Each logic module shall contain an 8-kilobit × 18-bit buffer with the memory I/O control logic required to permit each TPC to transmit to the AED independent of the other TPC's.

4.4.2.6.2.2 Central Scanner and Router. The AED central scanner and router shall sequentially scan each interface logic module for a logic module service request. When a service request is detected, the central scanner shall stop, process the message from that logic module, then resume the scan operation. During the scanning and message routing operations, the central scanner and router shall maintain synchronization between the logic module and the pen buffer memories.

4.4.2.6.2.3 Analog/Event Pen Memory and Controllers. The analog and event pen memories shall be modular. Each memory module shall provide both storage and storage control for at least 100 pens. Therefore, the AED shall contain a minimum of six memory modules (two for analog pens and four for event pens). Each pen word shall contain the sample value, a new data flag, synthesizer address, and a parity bit. Each pen word shall be double buffered in the memory module, and each memory module shall have the capacity for 128 sample words per pen.

The pen memory controllers shall interleave the reading of the memory with the writing of new data into the memory by the central scanner and router. The pen memory controller shall check the parity and verify that the stored synthesizer address is the same

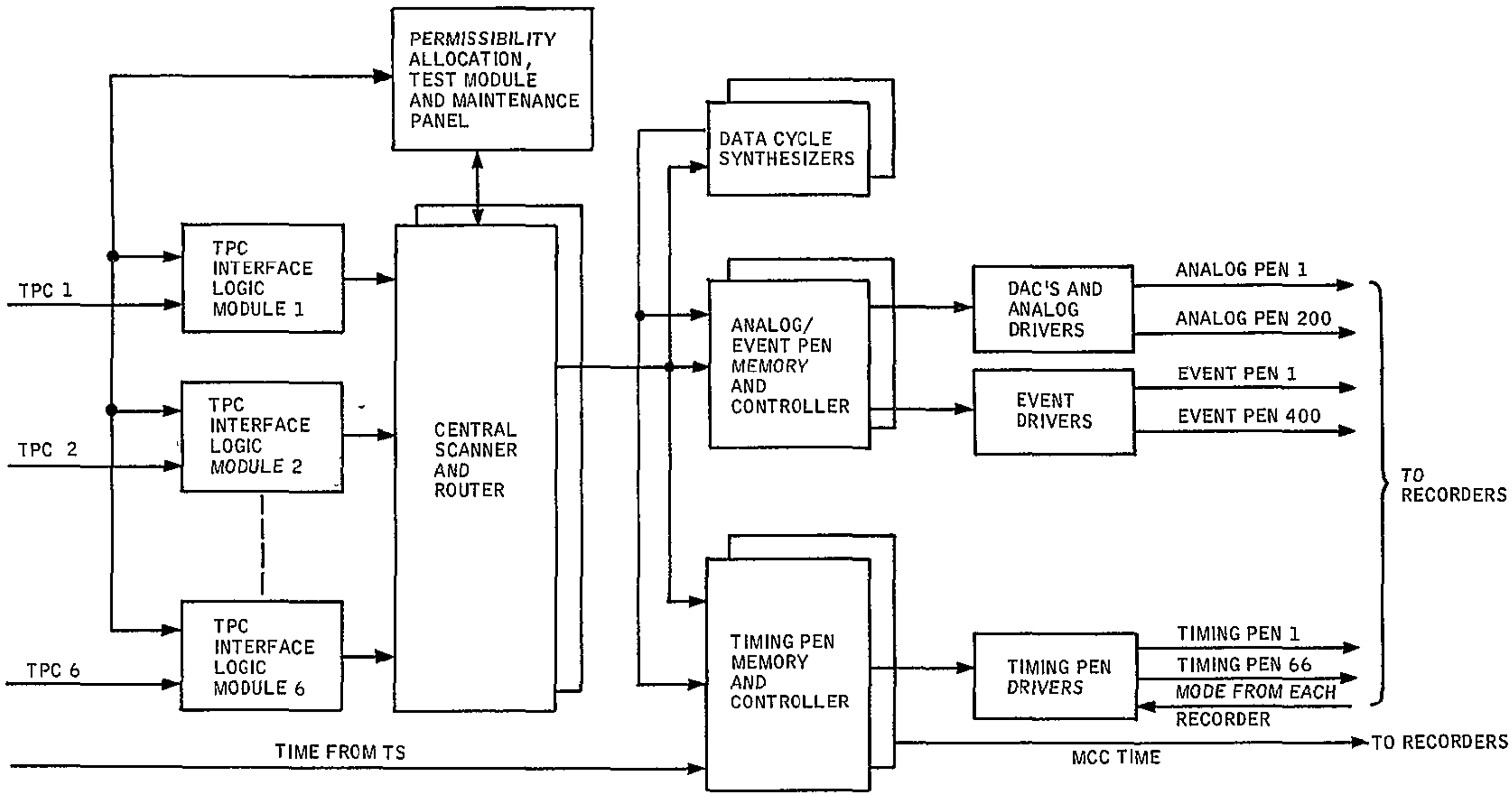


Figure 4-23 AED Subsystem Block Diagram

4.4.2.6.2.3 Analog/Event Pen Memory and Controllers. (Cont'd)

as the synthesizer providing the pen word. When an invalid parity is detected, the location of the bad cell shall be stored to aid fault isolation. If the synthesizer addresses compare, the pen memory controller shall check for the new data flag. If a new data flag is present, the pen memory controller shall output the sample value to the designated pen.

4.4.2.6.2.4 Analog Pen, Event Pen, and TOPDAC Drivers. The AED shall contain the analog/event pen drivers and TOPDAC drivers required to operate the various recorders. The requirements for the specific driver shall be as described in the following paragraphs.

A. Analog Pen Driver. The analog pen driver shall contain the pen address decode logic to route the sample value from the pen controller memory to the appropriate pen register. Each D/A shall contain its own data register to maintain previous sample values until new values are received. The D/A shall also convert the sample value to an analog voltage for output to the analog pens of the SCR.

B. Event Pen Driver. The event pen driver shall contain the pen address decode logic to route the event bit from the pen controller memory to the appropriate data register. Each data register shall maintain the previous event bit until a new event bit is received. The event pen driver shall be capable of driving event pens on the SCR.

C. TOPDAC Driver. The TOPDAC interface in the AED shall provide the interface for 1 MHz clock signals, pen address, sample value, and strobe to the TOPDAC control logic.

4.4.2.6.2.5 Synthesizer Logic. The synthesizer logic shall control the addressing of pen buffer memories during the read cycle to ensure that sample values are transferred to the analog and event pen drivers with the proper time correlation. The synthesizer logic shall be capable of providing sample value timing for up to 32 data cycles. System redundancy and an error monitoring scheme shall be provided to enhance system reliability. Operational tasks performed by the synthesizer logic are functionally divided into the following categories:

- Data cycle timing
- Synthesizer allocation/deallocation
- Pen buffer memory addressing.

4.4.2.6.2.6 Timing Pen Memory, Controller, and Drivers. The TPC shall transmit spacecraft time to the AED which shall drive the timing pens on the SCR's. The timing data received from a TPC shall correspond to relative address zero of a pen buffer. There shall be either one or two spacecraft times stored for each recorder/pen group. Each analog recorder shall have two timing pens. The event recorder shall contain one timing pen for each group of 24 events. The spacecraft times shall be double buffered.

In order to maintain time correlation between time and data, the timing data contained in the active buffer shall be incremented every 10 milliseconds and the value accumulated. Whenever the milliseconds portion of the time is between 0 and 10 milliseconds, the time shall be converted to a days, hours, minutes, and seconds format, then transferred to the appropriate timing pen driver logic. The timing pen driver logic shall be capable of driving the timing pens in a serial-decimal timing pen format in either a normal or expanded mode as selected by the normal/expanded mode switch on the SCR.

The AED shall receive GMT, SGMT, PET, and seven different pulse rates from both channels of the TS. The AED shall convert the times to a serial-decimal format and transmit them in either a normal or expanded mode to 25 analog recorders, 3 event recorders, and 2 trajectory recorders. The AED/TS interface shall conform to the requirements described in the JSC-10081, *Shuttle OFTDS IDD*.

4.4.2.6.2.7 Test Module and Maintenance Panel

A. Test Module. The test module shall provide for fault isolation, checkout, calibration, and maintenance of the AED. It shall be able to exercise the AED via any selected TPC input port or directly into either channel of the central scanner and router logic. The test module shall provide the capability to perform the following as a minimum:

- Exercise the AED using any legal message type via any selected TPC input port
- Generate predefined pen calibration patterns for any specified SCR address and pens on that recorder
- Accept sample data, pen number, SCR address, sample count, and strobe period from the maintenance panel

4.4.2.6.2.7 Test Module and Maintenance Panel. (Cont'd)

- Properly format and transmit a message in either a continuous or noncontinuous mode
- Provide diagnostic routines to perform fault isolation on the offline channel
- Perform error detection between the two redundant channels.

B. Maintenance Panel. The maintenance panel shall provide for the following:

- Operator-configured AED operations, such as online/offline, TPC/SCR enable-disable, etc.
- Location indications for input interface, memory errors, and errors between channels
- Test module diagnostic routine initiation and termination
- AED synthesizer and memory status
- AED synthesizer release when the TPC is unable to do so
- Local/Remote switch.

4.4.2.6.3 AED/TPC Universal Logic Interface (ULI). Each TPC shall provide an Interdata 02-304 ULI printed wiring board connected to the ESELCH and shall interface with the TPC interface logic modules in the AED. This interface shall be a demand-response type and shall be capable of a minimum data rate of at least 250K bytes per second. The AED/TPC interface shall conform to the requirements described in JSC-10081. The AED shall provide the interface unique logic located on the wirewrap portion of the ULI printed wiring board.

4.4.2.7 Console Subsystem (CONS). The CONS shall provide the physical housing for the majority of display and control end devices required for direct operator interface with the DCC. It shall consist of functionally-grouped keyboards, digital/event indicators, and TV monitors mounted in mechanically interlocked multiples of a modular 1-bay console.

4.4.2.7.1 Functional Requirements. The CONS shall provide the link between the operator and computer I/O automatic processing equipment, transforming human action into basic encoded messages, and computer output words into lamp indications and video displays. The input group shall input to the computer via the DSCIM and CCIM. The output group shall be exercised from the computer via DDD/SDD, DTS, and the TS.

4.4.2.7.2 Computer Input Group Functional Requirements. The following is a list of the minimum requirements for the CONS computer input group:

- TV channel selection
- Display request selection
- Discrete display format request
- Function code selection and display (live, simulation, playback 1, playback 2 mode selection)
- Hardcopy request
- System switching (MOC/DSC)
- Mission-oriented command generation
- DTE status and cluster allocation data
- DCC subrouting selection (computer selection)
- Event sequence override
- Other special control modules.

4.4.2.7.3 Computer Output Group Functional Requirements. The following is a list of the minimum requirements for the CONS output group functional requirements.

- Console/site indication
- TV channel indication
- Telemetry input select indication
- Time displays
- Load number indication
- Telemetry, command, tracking, and trajectory event indication
- Biomedical displays
- CRT displays
- TV saturation and status indications
- Other special control modules.

4.4.2.8 Timing Subsystem (TS). The Shuttle DCS TS shall function as the timing standard for the MCC Shuttle Program. From either actual or simulated sources, the subsystem shall be capable of generating and distributing GMT in various formats and timing pulses at numerous pulse rates. These timing signals shall be used for synchronization and time correlation by other DCS subsystems and MCC systems external to the DCS. In addition to generating timing signals, the TS shall accept either live or simulated launch countdown data and supply this data as countdown timing signals to various display devices during the countdown phase of a mission (or simulation). At countdown conclusion, the TS shall supply a mission or phase-elapsed time (PET) to the same display devices that previously displayed countdown time. The TS shall accept inputs from the DCC or remote control modules to control time word accumulation functions. The TS shall also provide stopclock and time coincidence displays on console-mounted equipment and control GMT displays on wall clocks throughout the MCC.

4.4.2.8.1 Major Equipment Areas. The timing equipment shall consist of the following:

- Master Timing Unit (MTU)
- Frequency Standards Unit (FSU)
- Countdown and Status Receiver System (CASRS)
- Time display/control modules
- Wall clock equipment.

4.4.2.8.2 Functional Requirements. Both external (to MCC) and internal (within MCC but external to TS) time data sources shall be available to the TS (see figure 4-24). External sources shall provide live reference time control and real-time vehicle-related time words. Internal sources shall provide real-time, general-purpose time words and operator controls. In addition, internal sources shall provide the TS with time data equivalent to any live or real-time data.

4.4.2.8.3 Data Sources

A. External Sources

1. National Bureau of Standards (NBS). The NBS, through its low frequency radio station WWVB, shall provide the TS with a universal coordinated time (UCT) standard reference which shall serve as reference for all internal signal generation within the TS.

2. U.S. Naval Observatory (USNO). The LORAN-C Navigation System which is closely synchronized with the USNO shall, through its low frequency transmissions, provide the TS with reference for time and frequency transfer.

3. Launch, Countdown, and Status Source. KSC shall provide real-time launch pad-related parameters, including launch countdown time, hold, and liftoff events. The simulation complex shall provide simulated parameters in support of nonreal-time MCC training.

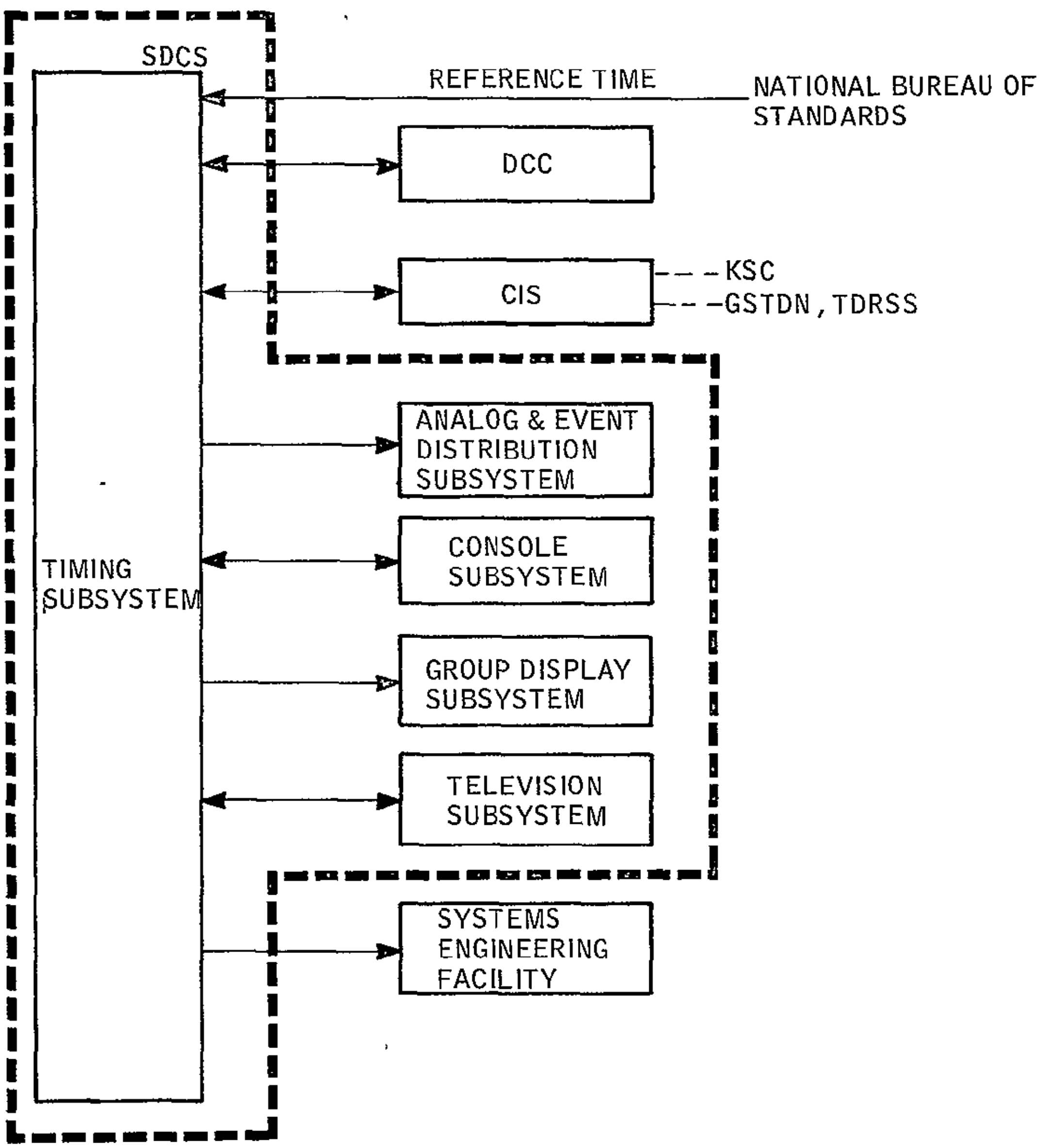


Figure 4-24 Timing Subsystem Interface Data Flow

4.4.2.8.3 Data Sources. (Cont'd)

B. MCC Data/Control Sources

1. DCC. The DCC shall provide the TS with time control words in real-time for general-purpose accumulation functions. This control shall be via the DDD/SDD interface.

2. Console Circuit Inputs. Operator control of various TS outputs (refer to paragraph 4.4.2.8.4.2) shall be provided from the CONS.

4.4.2.8.4 Output Signal Generation/Distribution. Thirteen general categories of time signals and parameters shall be provided as outputs of the TS.

- Pulse rates
- Status signals
- GMT and Simulated GMT (SGMT)
- General-Purpose Time (GPT)
- Mission-Elapsed Time (MET)
- Phase-Elapsed Time (PET)
- Spacecraft time words
- Secondary clock (wall clock) supervisory signals
- Accumulated time remote control
- 1 kHz reference time
- Time coincidence signals
- Interrange Instrumentation Group (IRIG) time codes A and B, NASA 28- and 36-bit codes
- TV time display video.

4.4.2.8.4.1 Signal Definition. Each of the 12 general time categories shall contain subgroups of timing parameters as defined in the following paragraphs. Their distribution and utilization is provided in paragraph 4.4.2.8.4.2.

A. Pulse Rates. Pulse rate generation shall be derived from a Cesium (atomic) standard for stability and reliability and shall consist of redundant pulse rate dividers. Three subgroups shall comprise the pulse rate output capability of the TS: display rates, 945-line video rates, and transmission rates.

1. Display Rates. A total of 19 separate pulse rate outputs shall comprise this group: 5M p/s, 1M p/s, 100K p/s, 50K p/s, 10K p/s, 5K p/s, 2.5K p/s, 2.0K p/s, 1K p/s, 200 p/s, 100 p/s, 50 p/s, 10 p/s, 2 p/s, 1 p/s, 12 p/m, 6 p/m, and 1 p/m.

2. 945-Line Video Rates. This subgroup shall comprise the following: clock (21.7728M p/s), horizontal drive, vertical drive, mixed blanking, and composite sync.

3. Transmission Rates. The TS shall be capable of outputting standard transmission rates upon request. A total of three separate pulse rate outputs shall comprise this group: 3.456M p/s, 768K p/s, and 448K p/s.

B. Status Signals. The TS shall provide (to external systems) status signals to indicate the proper interval generation of prime pulse rates.

C. GMT and SGMT. The TS shall provide GMT outputs in binary and BCD format. BCD outputs shall be in both parallel and serial form, including SGMT.

1. Parallel BCD GMT. Parallel BCD GMT outputs shall contain BCD characters provided on interface lines, one bit per line.

2. Display GMT/SGMT. Display-oriented GMT/SGMT outputs shall be provided by the TS via parallel lines.

3. NASA Code 2. 28-bit BCD.

4.4.2.8.4.1 Signal Definition. (Cont'd)

4. NASA Code 1. 36-bit BCD.

D. Relative Time Outputs. The TS shall output BCD coded GPT in serial form on interface lines.

E. Launch Countdown Time. Launch countdown time (LCT), consisting of countdown time, hold, and liftoff signals, shall be provided as an output of the TS. Countdown time shall become MET or PET following liftoff. All outputs shall be provided on serial output lines.

F. Spacecraft Time Words. The TS shall have the capability to output 32 spacecraft time words in BCD, serial form. The spacecraft time words for OFT support are TBD.

G. Secondary Clock (Wall Clock) Supervisory Signals. A TS master clock, synchronized to the NBS reference time, shall output at 12-hour intervals (2 minutes before 0600 and 1800 hours) a supervisory signal which shall cause receiving wall-mounted secondary clocks to self-regulate to the master clock setting.

H. Relative Time Accumulator (RTA) Remote Control Signals. Remote control panels in the CONS shall provide control for the RTA's during maintenance or simulation periods. These signals shall be provided in the form of active static logic level changes.

I. Time Coincidence Control Signals. A logic module in the CONS shall receive GMT and PET from the TS, compare them with preset times in the module, and output start-stop time signals to stop-clocks when a comparison occurs.

J. IRIG Time. The TS shall output IRIG time in IRIG-A and IRIG-B formats and provide these formats in a modulated output form.

4.4.2.8.4.2 Signal Distribution/Utilization. All external interfaces to the TS shall either terminate or originate in one of these equipment groups. Data flows to other systems or subsystems on these interfaces are defined in the following paragraphs.

A. TS/CONS Data Flow. The time display/control modules, listed as a major equipment group in the TS, shall be physically located in the CONS equipment. The CONS shall contain the following time display/control modules: time display modules and clocks control modules.

1. Time Display Modules. The time display modules shall be defined as the console mounted assemblies that accept inputs from the TS and applications of which are directed toward timekeeping.

a. Six-Digit Clocks. These clocks shall accept parallel decimal GMT or SGMT from the TS in a truncated Type I (HH:MM:SS) format for display.

b. Seven-Digit Clocks. These clocks shall accept parallel decimal PET from the TS in a truncated Type I or a Type II (HHH:MM:SS) format for display.

c. Time Coincidence Module. The module shall accept parallel BCD PET in a truncated Type I or Type II format and GMT or SGMT in a truncated Type I format. These time words shall be selectively compared, bit-by-bit, to a preset time entered by the operator. When the selected time word coincides with the preset time, either a start or a stop (operator selectable) signal shall be internally generated and routed to an external dual stop clock for event timing applications.

d. Dual Stop Clocks. These clocks shall accept a 1 p/s pulse rate from the TS and remote start-stop signals from either a DDD input or a time coincidence module.

e. Single Stop Clock. This clock shall accept a 10 p/s pulse rate from the TS for event timing applications.

4.4.2.8.4.2 Signal Distribution/Utilization. (Cont'd)

2. Time Entry Control Module (TECM). A TECM in the FCR console shall provide the following inputs to the TS:

- Accumulator control for all RTA's in the TS
- SGMT initiate to the SGMT accumulators to cause the interval generation of SGMT
- Simulated launch countdown time to the RTA's in the TS.

B. TS/Group Display Subsystem (GDS) Data Flow. The TS shall provide interfaces to the GDS. TS/group display interfaces shall consist of pulse rates and display time-word outputs. The pulse rates shall be supplied to the SCR's via the AED; display time-words shall be supplied to the group display units.

Accumulator outputs to the GDS shall consist of LCT, MET, GPT, hold signals, and PET. The LCT data shall be routed to the RTA's for output to the group time displays.

LCT data shall become an incremental count (MET or mission time) following liftoff, and shall be provided to the GDS on the same interface and in the same format as the time signals prior to liftoff. Hold signals shall also be received in the RTA's, and shall be output to the group time displays, where they will be indicated on the large-screen time projections.

C. TS/TVSS Data Flow. The TS shall provide interfaces to the TVSS, consisting of video display formats containing GMT/SGMT and RTA, and these formats shall be supplied to TV monitors in the CONS and overhead monitors.

4.4.2.8.4.2 Signal Distribution/Utilization. (Cont'd)

D. TS/(CCTCF and CCRF) Data Flow. The TS shall supply modulated IRIG-A and B and NASA 28 to an IRIG distribution unit in the CCTCF. Data routed to the audio patch bay in the CCTCF shall be patchable to users in institutional JSC facilities. Data routed to time display units (in the CCTCF) shall be displayed on digital readout devices, and either be direct displays (from TS) or historical playback from HSD recorders which shall also receive IRIG-B from the TS.

The voice communications equipment in the CCRF shall receive and record modulated IRIG-A, IRIG-B, NASA 28, and NASA 36 on audio tapes. It shall also send IRIG-B to the video tape recorder in the TVSS. This data shall ultimately be displayed on time display units in the voice communications equipment.

E. TS/DCC Data Flow. The TS shall interface the DCC. TS interfaces shall include distribution of pulse rates and parallel or serial BCD GMT to computers, as required.

F. TS/Simulator (SIM) Data Flow. The TS shall provide interfaces to the SIM. The TS shall accept an initial SGMT signal from the TECM on the simulation supervisor console which shall cause the appropriate SGMT accumulator to begin in the TS. The same module shall provide an operator-initiated accumulator control signal to the RTA's to control conditions of time accumulators in the TS during simulations.

G. TS/Systems Engineering Facility (SEF) Data Flow. The SEF shall receive the signal pulse rates listed in paragraph 4.4.2.8.4.1. These signals shall be available for laboratory research and development as timing sources and references.

4.4.2.9 Display Select Computer Input Multiplexer (DSCIM) Subsystem. The DSCIM shall be capable of detecting, formatting, and multiplexing large numbers of data entries onto single subchannels to the DCC computers. Data entries shall be accepted as switch closures from DCS console keyboards and reassembled into computer language words for transfer to the DCC in serial form.

4.4.2.9 Display Select Computer Input Multiplexer (DSCIM) Subsystem. (Cont'd)

The DSCIM shall consist of the multiplexer, input data encoders, and interface circuits. The DSCIM shall accept input data originating as switch closures from console devices and output the data in computer language format to three SDP's and one of five 360/75 DCC computers and to the VSMBM on five identical serial, simplex 2500 b/s interfaces (see figure 4-25). The DSCIM shall support the multifunction environment in that it shall be capable of recognizing certain console input devices by their function, which may be variable (under operator control), and outputting their inputs to the DCC computers with the appropriate function identification. Two multiplexers shall be provided in the DSCIM, one on-line and one standby. The output of the multiplexers shall be serial, binary 36-bit words to five DCC computers.

Devices inputting to the DSCIM shall be one of the keyboard modules such as MSK, DRK, PCK, SMEK, ESO, PCL, FDK, ESW, CAW, etc. Each console-mounted module type shall have a corresponding encoder with the same functional designation (e.g., MSK encoder). Each of the module types shall interface a single associated encoder. The DSCIM shall continually scan the encoders in a preassigned sequential order for up to 1023 separate encoder scan addresses, accept format, and process the encoder data. All the keyboards except the MSK shall present straight binary-coded or bit-correlated data on their interfaces to the DSCIM encoders. The DSCIM shall reformat the data, insert a scanning (console) address, and transmit it to the DCC. BCD data, received from the MSK only, shall be converted to straight binary data and processed by the DSCIM to the DCC as above.

The DSCIM shall provide ESW and CAW processing to inform four DCC computers of the status of each of the DTE clusters and channels.

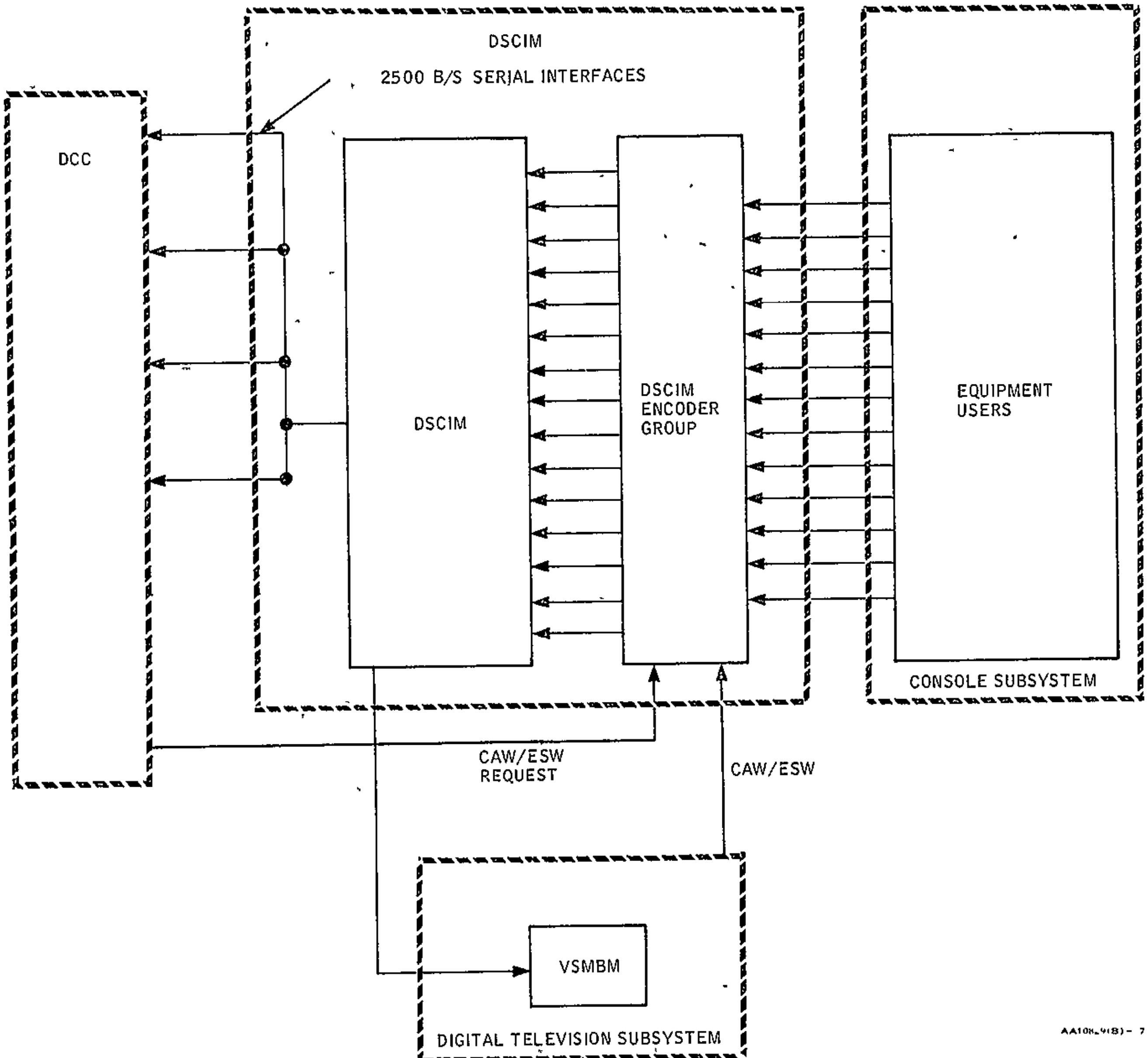


Figure 4-25 DSCIM Interface Data Flow Diagram

4.4.2.9 Display Select Computer Input Multiplexer (DSCIM) Subsystem. (Cont'd)

For the ESW encoder, the DSCIM shall provide 6 ESW encoders for accepting 80 individual static level GO/NO GO status indications. Each of the 6 encoders shall accept 16 inputs. The DSCIM shall process all 6 encoder contents and output 5 words in a sequential order to the DCC. These words shall be output when initiated by a status change on any 1 of the 80 ESW inputs or when any of the 5 DCC computers provides an ESW request via its DTE interface unit. (1 of the 6 ESW encoders has been inhibited resulting in only 5 being active).

For CAW encoders, the DSCIM shall provide 8 CAW encoders, each capable of accepting 20 parallel input lines from the DCCU. These inputs shall contain representations of DCCU allocations of DTE equipment. The DSCIM shall output an 8-word (one per CAW encoder) sequence to the DCC when initiated by any actual DCCU-DTE allocation change occurring in the DCCU or the occurrence of the ESW request. This shall cause all eight CAW's to be output, immediately preceding the five (six capable) ESW's. Both the CAW's and ESW's shall be output when the DCC initiates a send allocation status request. The multiplexer shall service inputs one at a time (i.e., upon completion of processing one input, it shall proceed to the next position).

The DSCIM shall be capable of supporting a multifunction environment utilizing up to three SDP's and one of five 360/75 DCC computers, while accepting inputs from the various input devices. In this environment, the DSCIM shall receive and output a function code to the DCC computers. Each computer shall receive all DSCIM output words.

4.4.2.10 Command Computer Input Multiplexer (CCIM) Subsystem. The CCIM shall accept input data (in the form of PBI switch closures) from CONS and convert this data into a unique binary code for subsequent transfer to the command processor(s) (SDPC).

4.4.2.10.1 CCIM Functional Requirements. The CCIM equipment shall comprise two major hardware functions, an encoding function and a multiplexing function. These CONS command-type modules are discussed in the following paragraphs.

A. Encoder Equipment Requirements. The CCIM encoder equipment shall detect, encode, and provide temporary storage for console module initiated requests. Each of the CONS command modules shall be provided with its own encoder.

B. Multiplexer Equipment Requirements. The CCIM equipment shall scan the encoders sequentially for detection of a console input. Upon receipt of a console input (to the encoders), the multiplexer shall halt the scan and transfer the encoded data (from the encoders) into the multiplexer section for further formatting and subsequent transfer to the command processor. Upon completion of data transfer, the scanning sequence shall resume. The CCIM output word transfer (to the command processor) shall be bit serial at a rate of 2.5 kb/s. Each word shall be 36 bits in length. Two redundant multiplexer channels shall be provided in the CCIM.

4.4.2.10.2 Hardware Integrity and Safing. In order to maintain the integrity of the CCIM hardware and to ensure the receipt of error-free, switch encoded command data by the command processor, the following CCIM hardware functions shall exist.

A. The "true" and "complement" side of each command module switch shall be sent to its respective encoder.

B. Switch closure data shall be routed directly from each console module on two separate cables. These cables shall not go through any console wiring distribution module or CTC. One cable shall contain the PBI true data; the other cable shall contain the PBI complement data.

4.4.2.10.2 Hardware Integrity and Safing. (Cont'd)

C. The true and complement PBI data shall be compared by the CCIM encoders, and by the command processor. The CCIM shall not output switch data nor shall the command processor output commands unless a comparison between the true and complement is detected. (The complement PBI switch data that shall be transferred to the computer shall be inverted in the encoder and sent in the true state; i.e., the PBI data fields of the command words are identical.)

D. In order to prevent address skewing, a minimum of two bits shall separate each encoder address.

E. An even parity bit shall be generated internal to the CCIM for each data word transferred to the command processor.

F. An HSP shall be provided for monitoring the CCIM output to DCC.

4.4.2.10.3 Command Module Types. The following is a minimum listing of the different types of command modules and their functions.

A. Multifunction Command Module. The multifunction command module shall contain a 4 × 8 matrix of projection readout PBI's; each PBI shall be capable of displaying 12 discrete captions. In addition, the module shall contain 12 field select PBI's for selecting the desired projection readout caption. The module shall have the capability for selecting a total of 384 discrete commands. A depression of the FIELD CLEAR PBI shall disable the module and cause the associated CCIM encoder to reject all commands generated from the module.

B. D9/40E Module. This module shall be a 3 × 6 matrix of double pole double throw (DPDT) switch momentary action PBI's. The DPDT contacts on the 18 switches shall be wired in such a manner as to create an octal code output for each depression. Each depression shall also provide a true and complement output to its respective encoder for generation of the dual data field for transfer to the command processor via the CCIM.

4.4.2.11 Computer Output Microfilm (COM) Subsystem. COM shall provide the capability for the offline generation of alphanumeric and graphic mission-related information contained on DCC or RTCC output tapes. Capability shall be provided for rapid processing, duplication, and display of high resolution 16 mm and 105 mm film images. See figure 4-26.

Associated with the COM is the Production Film Converter (PFC). The PFC shall provide high volume conversion of Shuttle Earth Resources Experiment Package (EREP), Earth Observations Aircraft Program (EOAP), and LACIE sensor data from digital format to finished film. The film used shall be 70 mm and 5-inch film.

4.4.2.11.1 Major Components. The COM Subsystem shall include the following major components:

- COM equipment group (located in the OSW)
- PFC equipment group (located in the OSW)
- Film processing equipment group (located in the OSW)
- Film display equipment group (located in the MOW).

4.4.2.11.2 Subsystem Functional Requirements

A. COM Equipment Functional Requirements. The COM must perform the following functions:

- Provide high resolution 16 mm and 105 mm microfilm outputs identical to all existing formats and displays.
- Accept intermixed alphanumeric and graphic inputs
- Accept input tapes provided by existing IBM print software
- Accept input tape provided by existing DTE software

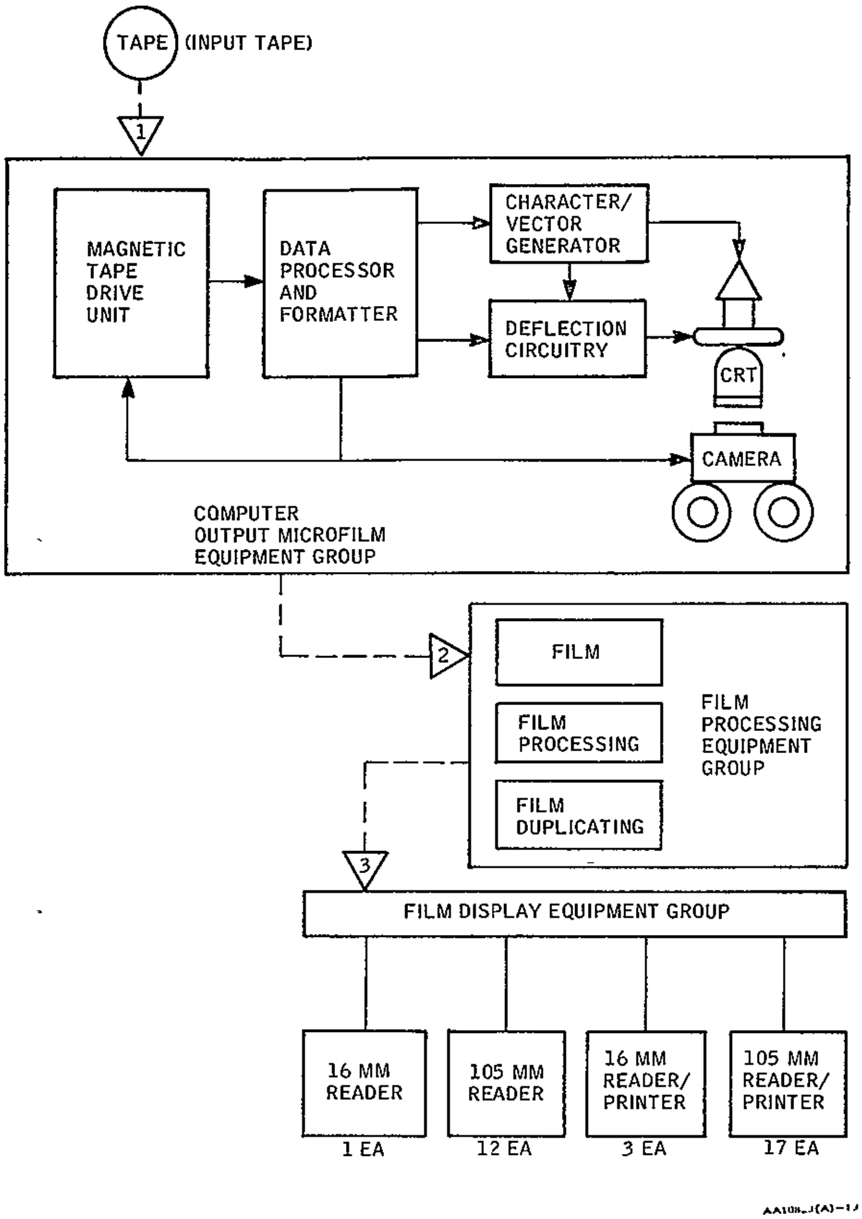


Figure 4-26 COM Subsystem Block Diagram

4.4.2.11.2 Subsystem Functional Requirements. (Cont'd)

- Provide a minimum of 64 character sizes and accommodate future changes in character repetoire without hardware modification or replacement

- Operate without realignment or maintenance throughout an 8-hour shift

- Accommodate software changes required for specific Shuttle missions without hardware modification or replacement.

B. PFC Equipment Functional Requirements. The PFC must perform the following functions:

- Provide high resolution 70 mm and 5-inch film images identical to all existing formats and displays

- Provide the capability of recording images on black-and-white film as well as color film

- Accept intermixed alphanumeric and graphic inputs

- Accept input tapes provided by existing IBM print software

- Accept input tape provided by existing DTE software

- Provide a minimum of 32 character sizes and accommodate future changes in character repetoire without hardware modification or replacement

- Operate without realignment or maintenance throughout an 8-hour shift

- Accommodate software changes required for specific Shuttle missions without hardware modification or replacement.

4.4.2.11.2 Subsystem Functional Requirements. (Cont'd)

C. Interface Requirements. The COM and PFC shall operate in a totally offline environment and shall have no external interfaces with online equipment.

4.4.2.11.3 Subsystem Description and Specifications

4.4.2.11.3.1 COM Equipment Group. The COM equipment group shall be capable of transforming digital data from magnetic tape into alphanumeric characters or graphic plots on the face of a CRT, and shall record this information on microfilm for subsequent display on a film reader.

A. Magnetic Tape Unit. The MTU shall accept 1/2-inch wide, NRZ 9-track computer tapes recorded with an 800 PBI density at 37.5 IPS. The tape unit shall accept both 8-1/2-inch and 10-1/2-inch reels.

B. Computer Format. The unit shall be capable of accepting data assembled in IBM 360 SYS OUT, UNIVAC 494, and 370/168 computer print formats and DTE output formats without reformatting by the host computer.

C. Error Detection. The unit shall provide the capability of detecting tape read errors and shall mark the frame or page containing erroneous data with a discrete symbol(s).

D. Alphanumeric Requirements

1. Character Set. The unit shall provide programmable sets of up to 256 characters consisting of upper case and lower case letters, numerics, and special symbols as required by the various print tape processor programs.

2. Character Size. A total of 64 programmable character sizes shall be provided. The character sizes shall vary over a nominal range of 21 to 1, with the largest size being approximately 277 addressable units and the

4.4.2.11.3.1 COM Equipment Group. (Cont'd)

smallest approximately 13 units. The smallest size, as measured on film, shall be equal to approximately 0.0005 inch on the 16 mm camera and 0.0006 inch on the 105 mm microfiche camera.

3. Orientation. The unit shall provide a minimum of eight software programmable character rotations. The rotations shall be at 45 degree intervals beginning at 0 degree.

4. Printing Speed. The unit shall be capable of printing alphanumeric characters at speeds of at least 10,000 characters per second.

E. Graphic Requirements. The unit shall be capable of generating graphs by plotting dots, lines, and alphanumeric characters, and of superimposing several plots on one graph under software control.

1. Dot Graphics. The unit shall be capable of generating graphs by plotting dots in eight programmable dot sizes. The dot sizes shall vary over a nominal range of 4 to 1, with the smallest size (as measured on film) being equal to approximately 0.0005 inch or 12 addressable units on the 16 mm camera and 0.0005 inch or 10 addressable units on the 105 mm microfiche camera.

2. Vector Generation. The unit shall be capable of drawing line segments from X, Y origins to X, Y end points anywhere on the addressable raster in eight programmable line widths. The line widths shall vary over a nominal range of 4 to 1, with the smallest size (as measured on film) being equal to approximately 0.0005 inch or 12 addressable units on the 16 mm camera and 0.0005 inch or 10 addressable units on the 105 mm microfiche camera.

4.4.2.11.3.1 COM Equipment Group. (Cont'd)

3. Intensity Levels. The unit shall be capable of plotting dots or lines in a minimum of 64 programmable gray scale intensities.

4. Plotting Speed. The unit shall be capable of plotting adjacent points at speeds of at least 40,000 points per second.

5. Line Drawing Speed. The unit shall be capable of drawing 10,000 vectors, up to one half the image width, in 15 seconds or less.

F. Film Output and Camera Requirements

1. Cameras. The unit shall be capable of producing images on 16 mm and 105 mm film.

2. Microfilm Magazines. The cameras shall be equipped with supply and take-up magazines, each having a capacity of at least 200 feet for 105 mm film and 16 mm film. The reloadable magazines shall be equipped with footage indicators. A separate footage or frame indicator shall be provided for use with preloaded disposable cartridges.

3. Page Format. The unit shall provide at least 132 characters per line and 64 lines per page for print simulators.

4. Page Recording Rate. The unit shall record at least 160 full pages per minute on 16 mm film and one 105 mm fiche in 1-1/2 minutes with 200 pages per fiche at 50 percent print density.

5. Reduction Ratio. The unit shall be capable of recording at reduction ratios 20X and 24X on 16 mm film and at a 42X reduction ratio on 105 mm film. The system shall provide software programmable reduction ratios for all film sizes.

4.4.2.11.3.1 COM Equipment Group. (Cont'd)

6. Image Orientation. The unit shall be capable of recording both cine and comic strip-oriented images.

7. Forms Overlay. The unit shall be capable of recording static form data in superposition with dynamic data from tape.

8. Fiche Titling. Fiche titling shall be provided on 105 mm film. This feature shall be software controlled.

9. Stripcharting. The system shall be capable of generating stripcharts on 16 mm film by butting frames. The frame butting accuracy shall be within ±0.005 inch.

10. Cut Marks. Fiche cut marks shall be provided on 105 mm film for automatic film cutting. Cut marks, consisting of three vertical lines in the upper left corner of each film frame outside the data area, shall be placed on 16 mm film.

11. Image Retrieval. Image count retrieval marks shall be provided on 16 mm film. MIRACODE and codeline or alternate retrieval systems shall be available as options.

G. Operational Requirements

1. Addressability. The unit shall have a positioning capability of 16,384 × 16,384 locations.

2. Resolvable Elements. The unit shall contain a minimum of 1024 × 1024 resolvable elements.

3. Linearity. The maximum deviation of alphanumeric characters or vectors from an ideal straight base line shall not exceed 0.1 percent of the maximum addressable image width.

4.4.2.11.3.1 COM Equipment Group. (Cont'd)

4. Repeatability. Repeatability of the unit shall be within ±0.05 percent of the maximum addressable image width.

5. Stability. Long term positional stability shall be within ±0.05 percent of the maximum addressable image width after 8 hours of operation.

6. Monitor Display. The capability to monitor the image being generated on a CRT display monitor shall be provided. The monitor shall also verify operator communication with the system for maintenance and program development.

7. Hardware Diagnostics. Hardware diagnostics, as a minimum, shall be provided for the CPU and associated core memory, character and vector generating elements, the disk storage system, and the MTU's.

8. Optical Alignment. Alignment of the camera and image generating elements shall be a nominal operator function that shall require no more than 5 minutes to complete.

9. Ambient Conditions. The unit shall perform as specified when operated over the ambient temperature range of +68 to +78 degrees Fahrenheit at 40 to 60 percent relative humidity.

10. Power. The unit shall operate as specified with a single phase primary power input of 120 V ac ±10 percent at 60 Hz, ±5 percent.

4.4.2.11.3.2 PFC Equipment Group. The PFC shall be capable of transforming digital data from magnetic tapes into alphanumeric characters, graphic plots, or sensor images on the face of a CRT, and shall record this information on microfilm for subsequent display on a film reader.

4.4.2.11.3.2 PFC Equipment Group. (Cont'd)

A. Input Requirements

1. Magnetic Tape Units. The MTU's shall accept 1/2-inch wide, NRZ, 9-track, CCT's recorded with a density of 800 bytes per inch. The tape units shall accept 8-1/2 and 10-1/2 inch reels and shall read at a speed of 75 IPS or greater. Interfaces shall be provided for the addition of up to two additional 800-byte-per-inch MTU's.

2. MED. The MED shall provide input capability for initialization and modification of internal software. The device shall be logically equivalent to an ASR 35 TTY and shall include paper tape read and punch capabilities.

3. Buffer Storage. The unit shall provide sufficient buffer storage to maintain maximum throughput.

4. Disk Storage Device. A disk file with storage for at least 250,000 18-bit words shall be provided for storage of internal preformatted instructions.

5. Input Formats. Input formats shall be compatible with the basic requirements as defined in the specific software requirements document. Input data shall consist of 8-bit bytes assembled into 16-bit words in records of up to 3060 bytes.

6. Error Detection. The unit shall provide the capability of detecting tape read errors and shall mark the image area containing erroneous data with a discrete symbol.

4.4.2.11.3.2 PFC Equipment Group. (Cont'd)

B. Film Output Requirements

1. Film Size. The unit shall record data on continuous rolls of either 5-inch film or 70 mm film as selected by the operator.

2. Film Type. The capability for recording images on black-and-white film or color film shall be provided. Both positive and negative film types shall be accommodated.

3. Film Quality. The recording film selected for operational use shall be compatible with the operating parameters of the film converter and the film processor and shall be readily available, off-the-shelf types. Black-and-white film shall allow image recording with a nominally straight line response of 64 equal density steps of 0.025D, or less, above gross film fog which shall not exceed 0.3D when processed to gammas up to 2.0. Color film shall provide a straight line response of 16 equal density steps of 0.1D, or less, above gross film fog with gammas up to 2.0.

4. Image Format. Sensor image data shall be recorded in the continuous and framed image formats. The image width across 70 mm film shall not exceed the nominal allowable image width of 2.295 inches. Continuous imagery shall occupy up to 1.955 inch and annotation up to 0.340 inch. All dimensions shall be within ±0.025 inch. The image width across 5-inch film shall be a nominal 2X expansion of the 70 mm image size, (4.59-inch maximum, 3.91-inch continuous image width, and 0.68-inch annotation). Output formats and annotation required are specified in the appropriate experiment software requirements document.

5. Print-Plot Formats. Output formats for tabular listings and plots of sensor nonimage data shall be provided full frame in cine or comic mode and shall be as specified in the appropriate experiment software requirements document.

4.4.2.11.3.2 PFC Equipment Group. (Cont'd)

C. Alphanumeric Capability

1. Character Set. The unit shall provide complete sets of 128 characters consisting of upper case letters; lower case letters; numerics; and special symbols in ASCII, EBCDIC, and BCD codes.

2. Character Sizes. The unit shall provide at least 32 software programmable character sizes and shall permit recording of up to 355 characters per line as a maximum.

3. Orientation. The unit shall provide a minimum of four software programmable character rotations: 0, 90, 180, and 270 degrees.

4. Print Speed. The unit shall be capable of printing alphanumeric characters at speeds of at least 10,000 characters per second.

D. Graphic Capability

1. Dot Graphics. The unit shall be capable of generating image data by plotting dots in eight programmable dot sizes.

2. Vector Generation. The unit shall be capable of drawing line segments from X,Y origins to X,Y end points in eight programmable line widths.

3. Scan Generation. The unit shall be capable of plotting dots, line segments, or lines along precalculated linear or conical paths up to 180 degrees.

4. Intensity Levels. The unit shall be capable of generating image data by plotting dots or lines in a minimum of 64 programmable gray scale intensities. Capability of 128 intensities shall be available as an option.

4.4.2.11.3.2 PFC Equipment Group. (Cont'd)

5. Plotting Speed. The unit shall be capable of plotting adjacent points at speeds of at least 40,000 points per second.

6. Line Drawing Speed. The unit shall be capable of drawing 10,000 vectors, up to 1/2 the maximum image width, in 15 seconds or less.

E. Operational Requirements

1. Addressability. Each element shall be addressable to 16,384 × 16,384 locations.

2. Resolvable Elements. The unit shall provide a minimum of 4096 × 4096 resolvable picture elements at a minimum of 64 programmable gray scale intensities and 16 color intensities.

3. Positional Accuracy. The deviation from the absolute value between centers of any two adjacent picture elements (pixels) shall not exceed plus or minus one part in 16,384 in the horizontal and vertical directions. Accumulated deviation of pixels in a scan line from the ideal straight or conical scan line shall not exceed 0.05 percent of maximum image width. Accumulated deviation of vertically aligned elements from an ideal straight vertical line of one image length shall not exceed 0.05 percent of maximum image width.

4. Camera Accuracy. Image alignment and frame butting accuracies shall not exceed the minimum thickness of one image scan line or one part in 4096.

5. Repeatability. Repeatability of the unit shall be within plus or minus one part in 32,768 when a given point or character is repeated up to 20 times.

4.4.2.11.3.2 PFC Equipment Group. (Cont'd)

6. Stability. Long term positional stability shall be within 0.05 percent of the maximum image area after 8 hours. Densitometric stability shall be within ±0.025D.

7. Intensity Variation. Density changes for a given intensity value shall not vary more than 2 percent of D maximum over the entire image area.

8. Film Cut Marks. Film cut marks for automatic cutting of the frame images shall be provided.

9. Film Capacity. The unit shall utilize reloadable film cartridges having a minimum capacity of 200 feet of 70 mm or 5-inch film. The cartridges shall be equipped with footage indicators, and shall be daylight replaceable.

10. Spare Cartridges. Spare film cartridges shall be provided for each film size and type.

11. Process Monitor Display. A process monitor display shall be provided to verify data processing and shall be used interactively with the MED for modification of internal software.

F. Throughput Requirements. The unit shall be capable of processing image, plot, and print data in the times specified. Throughput times for image processing shall be within ±10 percent of the specified values with input data tapes formatted for one channel of black-and-white imagery data, or three channels of color data, and a maximum pixel word length of eight bits. The image processing time shall include film annotation and frame advance times, but does not include the process initialization time; i.e., the time required to read the header, generate image correction tables, and record the job descriptor frame on film.

4.4.2.11.3.2 PFC Equipment Group. (Cont'd)

1. Continuous Image Mode. Minimum throughput times for exposing black-and-white continuous images shall be:

   - 1000 pixels per scan line at 13 lines per second
   - 2000 pixels per scan line at 6 lines per second
   - 4000 pixels per scan line at 3 lines per second.

2. Framed Image Mode. Minimum throughput times for exposing black-and-white framed images shall be:

   - 1000 × 1000 pixels at 75 seconds per image
   - 2000 × 2000 pixels at 300 seconds per image
   - 4000 × 4000 pixels at 1200 seconds per image [Earth Resources Technology Satellite (ERTS) type of data].

3. Color Throughput Times. Throughput times for color imagery shall not exceed four times the basic black-and-white time.

4. Plot Data. Adjacent points shall be plotted at speeds of at least 40,000 points per second.

5. Print Data. Characters shall be recorded on film at speeds of at least 10,000 characters per second.

4.4.2.11.3.3 Film Processing Equipment Group

A. Film Processing. The film processor unit shall perform in accordance with the following specifications.

   1. Capacity. The system shall have the capacity to process up to 400 feet of 16 mm film or 200 feet of 105 mm, 70 mm, and 5-inch magazine film continuously.

4.4.2.11.3.3 Film Processing Equipment Group. (Cont'd)

2. Processing Speed. The unit shall process 16 mm film at 20 feet per minute, 70 mm and 5-inch film at 15 feet per minute, and 105 mm film at 5 feet per minute.

3. Film Processing. The unit shall permit random daylight loading and processing of positive or negative film.

4. Film Output. The unit shall provide, by selection of chemicals, either positive or negative silver microfilm output of archival quality (10-year storage).

5. Chemical Replenishment. The unit shall use containers of premixed chemicals completely contained in the processor enclosure. Space for reversal chemicals shall also be provided.

6. Ventilation. The unit shall produce no discernible odor under nonvented conditions.

B. Film Duplicator. The film duplicator unit shall perform in accordance with the following specifications.

1. Capacity. The unit shall provide the capability to duplicate up to 400 feet of 16 mm or 200 feet of 105 mm film.

2. Copying Speed. The unit shall provide variable speeds up to 100 feet per minute.

3. Film Duplication. The unit shall provide random daylight loading and copying.

4. Film Output. The unit shall accept silver microfilm inputs and provide diazo duplicate negatives as an output.

4.4.2.11.3.3 Film Processing Equipment Group. (Cont'd)

5. Motor Control. The unit shall provide features which automatically stop the process if the original or copy film breaks.

6. Footage Indicator. An indicator shall be provided to monitor the film supply.

4.4.2.11.3.4 Film Display Equipment Group

A. Reader and Reader/Printers (16 mm). The 16 mm film readers and reader/printers shall perform in accordance with the following specifications.

1. Film Accepted. The unit shall accept 16 mm nonsprocketed silver microfilm in preloaded 16 mm cartridges.

2. Magnification. The magnification ratio shall be at least 24X.

3. Screen. The screen shall not be less than 11 × 14 inches with a nonglare, white, gray, blue, or brown surface.

4. Film Threading. The unit shall provide automatic film threading capability for preloaded 16 mm cartridges.

5. Controls. The unit shall provide on-off, focus, motorized forward and reverse drive, image rotation and illumination controls as a minimum.

6. Hardcopy. The microfilm reader/printers shall provide the capability to produce black-on-white, permanent, dry, 11 × 14-inch hardcopies.

B. Fiche Reader and Reader/Printers. The fiche readers and reader/printers shall perform in accordance with the following specifications.

4.4.2.11.3.4 Film Display Equipment Group. (Cont'd)

1. Film Accepted. The unit shall accept 105 mm microfilm.

2. Magnification. The magnification ratio shall be at least 42X.

3. Screen. The reader screen shall not be less than 11 × 14-inches with a nonglare, white, gray, blue, or brown surface. The reader/printer screen shall not be less than 8-1/2 × 11 inches with a nonglare, white, gray, blue, or brown surface.

4. Controls. The unit shall provide on-off, focus, and illumination controls as a minimum.

5. Hardcopy. The microfiche reader/printer shall provide the capability to produce black-on-white, permanent dry, 8-1/2 × 11-inch hardcopies.

4.4.2.12 Pneumatic Tube Subsystem (PTS). The PTS shall provide a means for dispatching hardcopy material within the MCC. The PTS shall consist of one manual p-tube network and two independent automatic p-tube networks.

4.4.2.12.1 Major Subsystem Components. The PTS shall comprise the following major equipment groups:

- P-tube transmission tubing
- Turbocompressor
- Central exchanger
- Automatic console stations
- Control assembly.

4.4.2.12.2 Subsystem Functional Requirements

A. P-Tube Transmission Tubing. The tubing of the PTS shall transport p-tube carriers between stations. Air lines, automatically operated sidegates and windgates, and manually-operated windgates shall control the flow of pressurized air into the main transmission tubing for dispatching and receiving p-tube carriers. The p-tube carriers shall be mechanically deflected into the selected receive station by the use of deflector switches. These deflector switches shall be welded into the transmission tubing to deflect carriers into loop-end stations.

B. Turbocompressor. Three of the four PTS turbocompressors shall provide air for impelling carriers in both the manual and automatic networks of the PTS. The fourth turbocompressor is a standby compressor which shall be parallel-piped to each of the three online compressors.

C. Central Exchanger. The central exchanger shall process dispatched p-tube carriers from various MCC dispatch stations and route the carriers to the selected receiving station. Each of the two central exchangers shall receive p-tube carriers from five incoming transmission tubes and route the carrier to the selected outgoing transmission tube (five network loops and one reject-to-message center tube) for subsequent receipt by the selected station. The central exchanger framework shall house all electrical, mechanical, and pneumatic components necessary for processing carriers through the central exchange.

D. Automatic Console Stations. The automatic console stations shall be used in each MOCR. Each automatic console station shall be a down-dispatch, up-receive, air cushion-type p-tube station. Carriers shall be loaded into the automatic console stations for subsequent routing to another p-tube station. The receiving station shall be selected by depression of a PBI on the station select control panel (located on the automatic console station).

4.4.2.12.2 Subsystem Functional Requirements. (Cont'd)

Other types of p-tube stations include the Recessed Select-omatic Terminal (RST) stations. These stations shall be located throughout the MCC. Each RST station shall be an up-dispatch, down-receive, recessed cabinet-mounted p-tube station consisting of manually operated dispatch and receive chamber doors and a control panel.

E. Control Assembly. The control assembly of each p-tube network shall provide dc operating power, loop control circuitry, station control circuitry, and readout and central exchanger control circuitry. This circuitry shall synchronize the processing of carriers from the dispatch chambers in automatic console or RST stations through the central exchanger to the receive chamber of the receiving stations.

4.4.2.13 OPS Transition. The transition period from Shuttle OFT to Shuttle OPS shall bring about major changes to the DCS. The philosophy of OFT system operation is operational support of one mission and a simultaneous, limited simulation. In the OPS era, the DCS shall be required to provide full support for multiple, simultaneous missions and full simulations.

The DCS shall provide centralized functional control. However, this control does not facilitate rapid reconfiguration or multiprocessor operation support in the areas of event display distribution and command multiplexing. During the OPS timeframe, all major subsystems, with the possible exceptions of DTE, AED, and TS shall require major changes.

The time period from second quarter of 1980 to fourth quarter of 1981 is presently denoted as "Transition Period" for the Space Shuttle Program. Prior to this time period, as OPS requirements become firm, required changes to the DCS shall be performed. This time period shall be utilized for implementation and checkout of the major affected subsystems.

4.5 Building Arrangements. The Bldg. 30 MOW for Shuttle OFT, functional areas, and equipment arrangements are defined in the following paragraphs. Detailed information pertaining to cabinet or console configurations can be obtained in the individual equipment specifications or SISO-TR155.

4.5.1 MOW First Floor. The MOW first floor shall be configured as shown in figure 4-27. The major functional responsibilities of the MOW first floor shall consist of:

- Incoming/outgoing MCC data processing
- Communications switching/routing
- SDL
- Pneumatic tube control
- Storage of processing resources
- Equipment/software monitoring and control (360/75, SDP).

4.5.2 MOW Second Floor. The MOW second floor shall be configured as shown in figure 4-28. The major functional responsibilities of the MOW second floor shall consist of:

- OFT mission monitoring and control
- CCRF
- OFT simulations monitoring
- Message center
- RJE control.

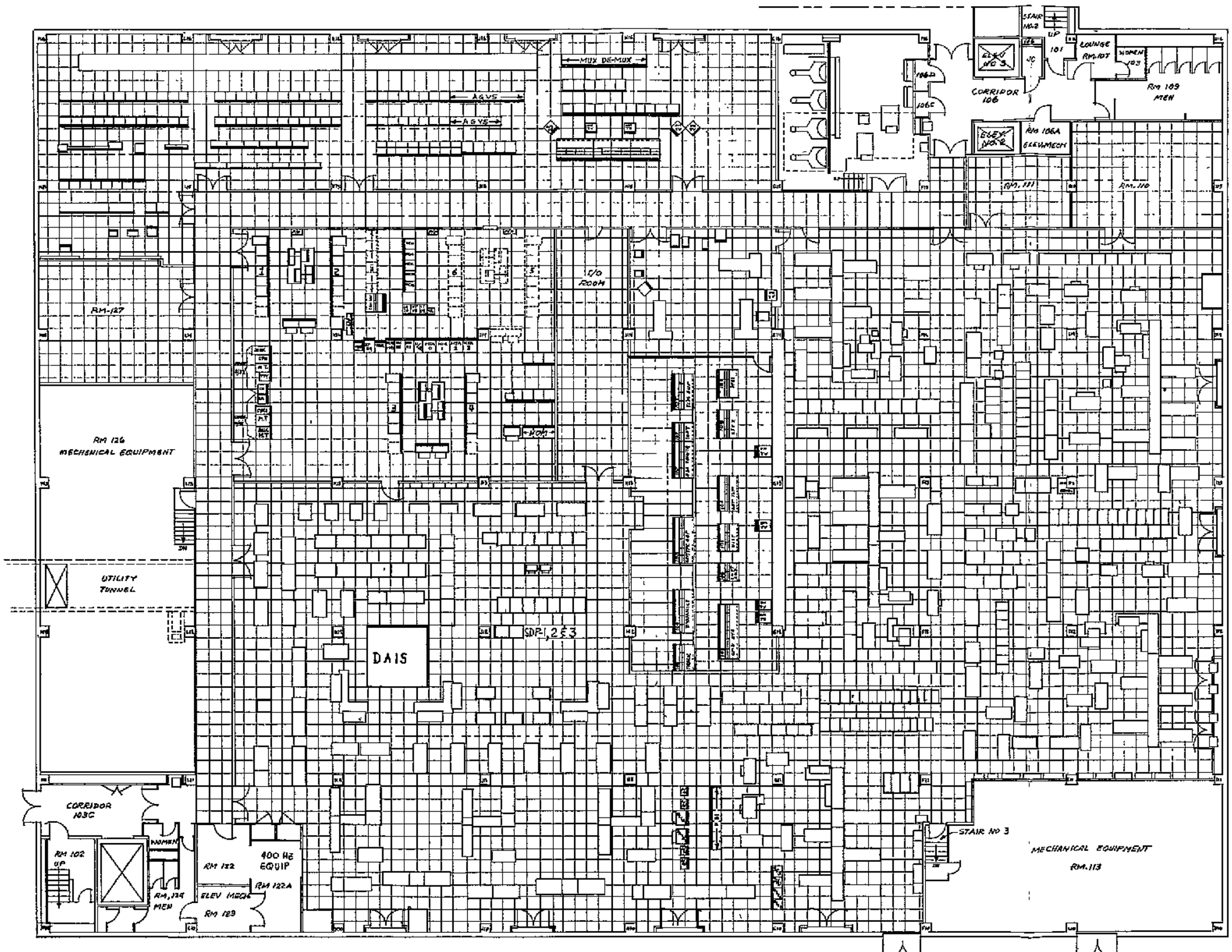


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Figure 4-27 MOW Equipment Arrangement, Bldg. 30 (First Floor)

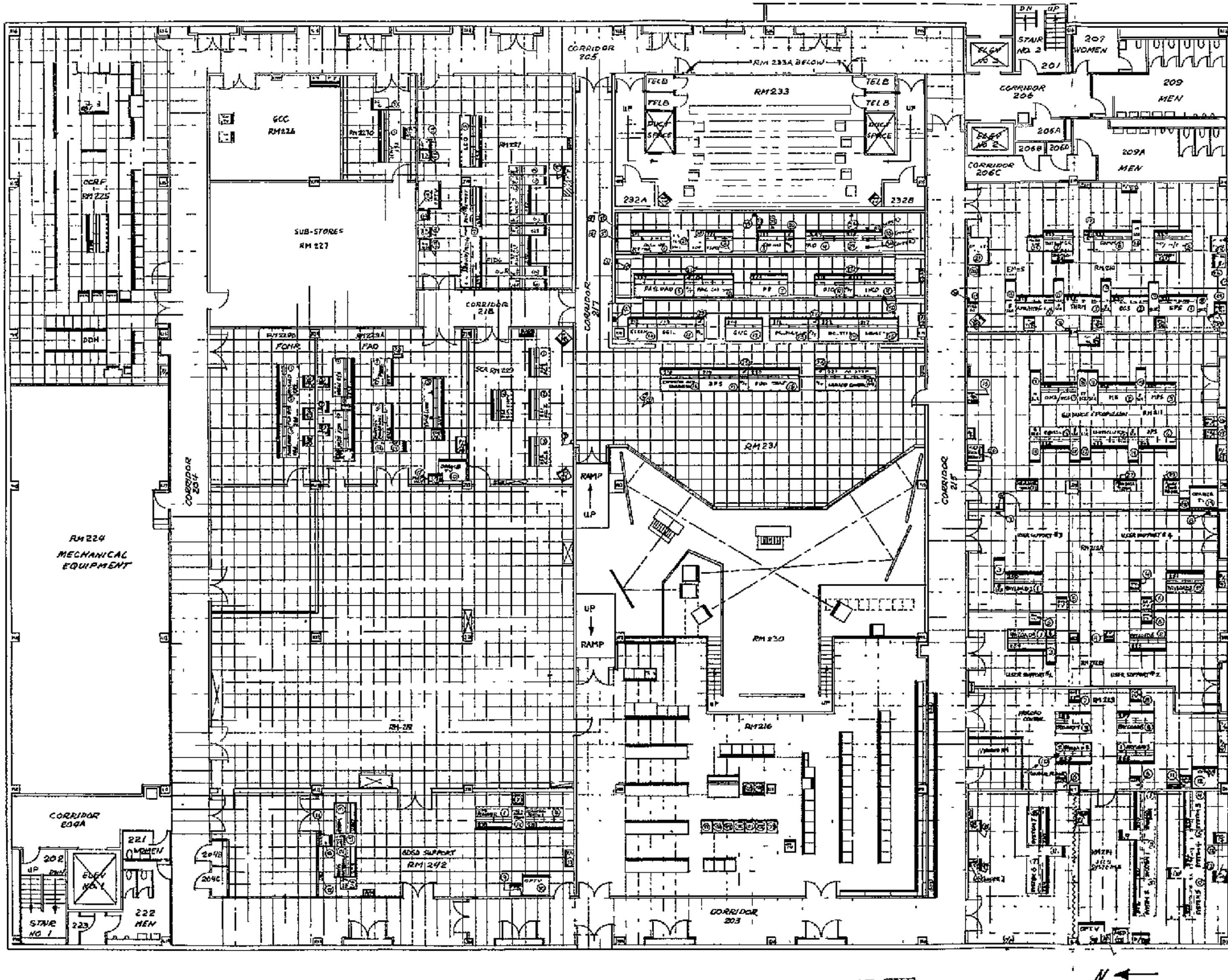

Figure 4-28 MOW Equipment Arrangement, Bldg. 30 (Second Floor)

4.5.3 MOW Third Floor. The MOW third floor shall be configured as shown in figure 4-29. The major functional responsibilities of the MOW third floor shall consist of:

- TS
- Display Evaluation Lab
- MEDICS
- National Bureau of Weather Service
- Earth resources
- Housing for equipment supporting second floor operations.

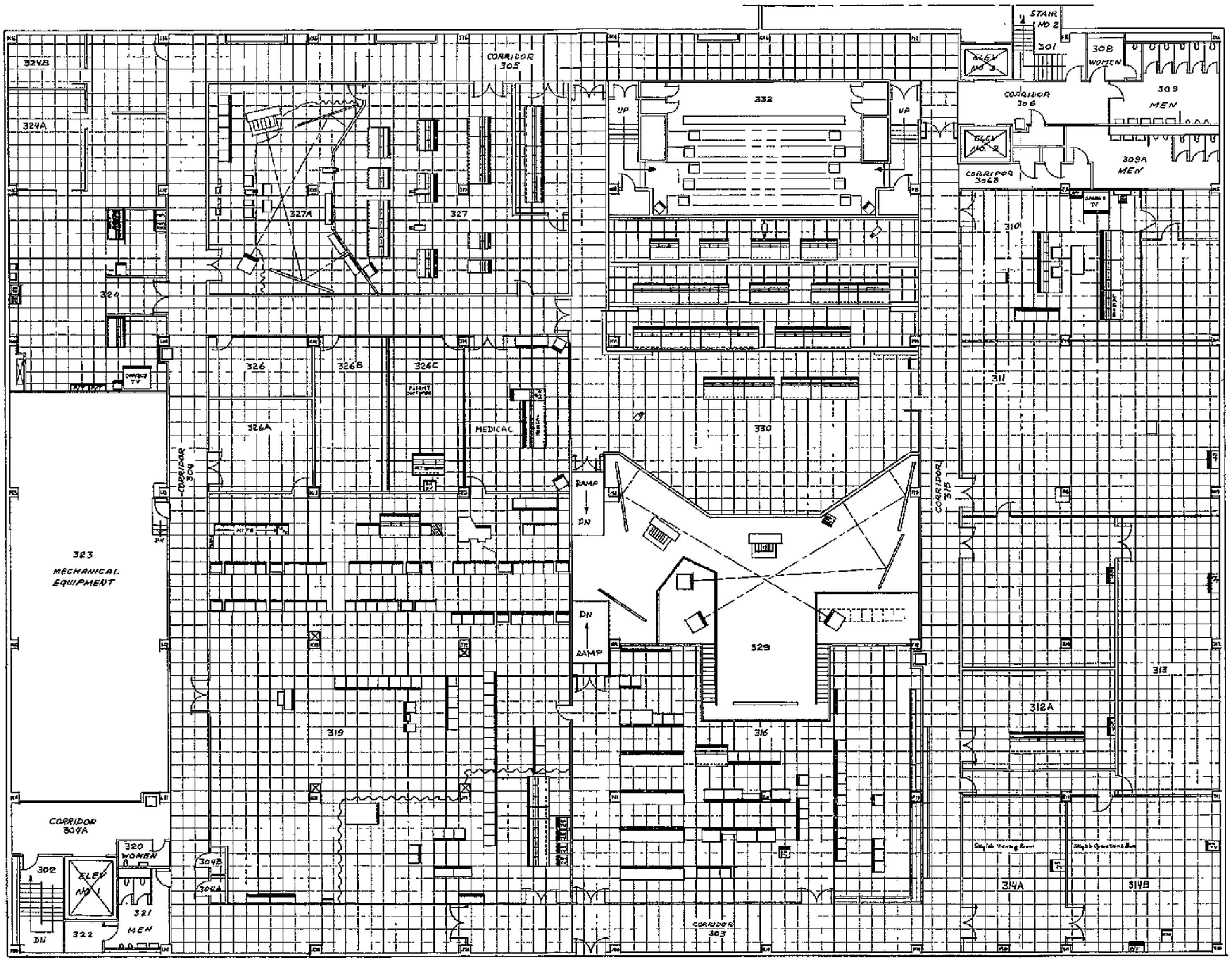

Figure 4-29 MOW Equipment Arrangement, Bldg. 30 (Third Floor)

4.6 Reliability. Reliability (R) is defined as the probability that an equipment system can meet an operational objective during a finite interval of time.

The following paragraphs specify a numerical reliability requirement for the mandatory equipment strings, enumerate such equipment strings necessary for the successful support of the Shuttle Orbiter, and identify fixed redundancies that are independent of mission requirements. The reliability estimates obtained from equipment and system evaluations are dependent on groundrules and operational philosophy developed on a mission-to-mission basis.

4.6.1 Reliability Requirements. The reliability of each string shall be R = 0.9995 for a time interval equal to the sum of the critical mission periods occurring at commencement of countdown for Orbiter launch, continuing through the orbital test flight, and ending at the termination of the flight test. During critical phases, prolonged periods of interrupted control cannot be tolerated. While failure criteria vary among various subsystems, it is generally accepted that failures which can be remedied by immediate switchover to standby equipment are not considered system failures. Conversely, failures which require repair of failed components or necessitate reinitialization of the system are considered system failures.

4.6.2 Configuration Identification. The reliability requirements shall apply to functional strings of mission critical equipment. The function of the string shall be identifiable and specified. The accomplishment of this function shall be critical for measuring successful mission support.

Critical equipment shall be identified as the equipment mandatory for the successful support of the OFT missions. These equipment strings are identified as follows:

- CCTCF
- NIP
- SDPC

4.6.2 Configuration Identification. (Cont'd)

- Video display
- DDS
- AED
- TS
- Display select
- Command select
- MBI
- NOM
- SCS component of DIU
- AGVS and VIS.

4.6.2.1 CCTCF

4.6.2.1.1 Boundaries. The analysis of the CCTCF Subsystem string shall be limited to the portion of the string which provides terminations for external WBD, HSD, and TTY circuits entering and leaving the MCC.

A. WBD String. The WBD string shall comprise the following equipment:

- MODEM and line driver termination equipment
- MODEM switch
- WBD crossbar switch
- Multiplexer/demultiplexer.

4.6.2.1.1 Boundaries. (Cont'd)

B. HSD String. Functioning separately, but utilizing some equipment common to the WBD string, the HSD string shall comprise the following elements:

- VF data patch
- MODEM and line driver/termination equipment
- WBD transfer switch
- HSD patch
- MODEM switch
- LLTD DCU-R
- Terminate Patch and Test.

C. TTY String. The TTY string shall encompass the following elements:

- TTY patch
- Audio patch
- VFTG.

The analyses that shall be performed on the WBD string elements, the HSD string elements, and the TTY string elements shall be limited to the elements that handle external telemetry data for the Orbiter vehicle.

4.6.2.1.2 Criticality. Critical elements within the CCTCF can be categorized into critical WBD, HSD, and TTY functions. The WBD functions shall include the processing of all external WBD (except digital voice) received from the STDN. However, HSD functions are only defined as the processing of the LLTD from either of two IBM DCU's.

4.6.2.1.2 Criticality. (Cont'd)

A loss of critical function within the WBD, HSD, or TTY requiring the repair of a failed element to restore system support shall be defined as a system failure.

4.6.2.1.3 Special Considerations

A. Hardware Redundancy. Nonreconfigurable fixed hardware redundancy shall exist for those WBD, HSD, and TTY functions that are constant for mission-to-mission operation requirements. All equipment implementation, augmentation, or modification shall be reviewed from mission-to-mission to ensure that the necessary redundancy is present so the system performance does not degrade below the levels attained for previous missions.

B. Operational Redundancy. Since the HSD is considered mandatory only during the launch phase and hardware redundancy shall exist within the string, no requirement for operational redundancy for the HSD elements exist. However, critical WBD and TTY data shall be routed along independent paths to multiple users. Sufficient operational redundancy, therefore, shall be required so that the system performance does not degrade below the levels attained for previous missions.

4.6.2.2 NIP

4.6.2.2.1 Boundaries. Analysis of the NIP string shall be limited to the portions of the CIS containing the following elements:

- NCIC, providing for interface with network WBD links and performing communication management type functions
- NCIU, providing A/G frame synchronization, validation, minor frame building, and frame time correlation
- TPC, providing preprocessing and data output to the SDPC.

4.6.2.2.2 Criticality. Critical functions of the NIP, as described above, shall be supported by an equipment string composed of an NCIC and NCIU/TPC. Loss of a critical function requiring repair of a failed element for support restoration shall be defined as a system failure. Data loss due to reconfiguration of the WBDTS, NCIC, or MBI is not considered a system failure.

4.6.2.2.3 Special Considerations. Minimum equipment redundancy shall be provided in the NIP subsystem elements where sufficient operational redundancy exists to assure system success. Failover to the 224 kb/s path shall be permitted to overcome failures in the 1.54 Mb/s path. Handover in the primary line (1.54 Mb/s) can be performed by reconfiguration of the NCIC while GSFC provides handover switching on the secondary (224 kb/s) line.

4.6.2.3 SDPC

4.6.2.3.1 Boundaries. The SDPC vendor shall provide a reliability analysis of the system configuration that involves creation of graphical reliability models, conversion of the graphical models into mathematical models, and the solving of the mathematical models to provide the reliability prediction.

4.6.2.3.2 Criticality. A system string capable of providing support shall be composed of a central processor with 3.2 Mb of addressable memory and direct access storage with a minimum storage capacity of 100 Mb. The direct access storage device shall be equipped with a removal storage pack easily replaced. A computer restart/selectover module shall be considered critical in the sense that it provides resource allocation, initialization, failover, and restart function for the SDPC.

4.6.2.3.3 Special Considerations. The SDPC shall provide uninterrupted support for data transfers on the input interface. Output interfaces shall be allowed a 200 ms interruption in the event that selectover is required. During the selectover interval, each output interface shall assume a quiescent state at the end of each respective message transfer and remain in that state

4.6.2.3.3 Special Considerations. (Cont'd)

throughout the switching period. Switching shall not be initiated until all output interfaces are in a quiescent state and the DTE signals that selectover is required.

In addition, the system shall receive restart signals from a remote PBI module when a dynamic standby mode is used. Restart shall require a dump of all addressable memory of the online central processor.

Fault detection, prediction, and isolation shall be automated by the use of built-in test equipment (BITE) and maintenance computer programs. Where possible, built-in diagnostics shall be used to the maximum extent; otherwise, facilities for offline diagnostics shall be modular so that additional routines may be incorporated to test growth items as they are added. Diagnostic programs shall be in a language compatible with the operational program.

4.6.2.4 Video Display

4.6.2.4.1 Boundaries. Analysis of the video display string shall be limited to the portion of the equipment used for conversion of computer-generated digital data into raster-type video and equipment that controls computer allocation of these resources by providing TV address data and video switching of these resources to selected output channels for distribution to various users. Equipment in this string shall comprise the following:

- Computer Restart/Selectover Module
- DTE
- DCCU
- DTE Interface Cabinet (DTEIC)

4.6.2.4.1 Boundaries. (Cont'd)

- VSM
- VSMBM.

The analysis that will be performed on each equipment group of the video display string shall be inclusive only to the extent of the impact on the acceptance of computer derived data, reformatting of this data, and transmission of the data to a CRT monitor for operator viewing.

4.6.2.4.2 Critical Functions. Each equipment component shall be an integral part of the overall video display system. The functions performed by these components shall be essential to the following extent.

A. Computer Restart/Selectover Module. Originates a selectover function that conditions the DCCU to reallocate the DTE clusters from an online computer to a designated backup computer.

B. DTE. Performs conversion of digital data from designated computers into raster-type video for display on CRT screens. In addition ESW's shall be provided to signify the operational status of each video channel.

C. DTE Cluster Control Unit. Provides cluster/computer allocation, allocation exchange, and allocation reassignment controls to the DTE clusters; also provides allocation status information to the DSCIM.

D. DTE Interface Unit. Functions as an intermediate termination point for signals passing between the DCC and the IIM's of the DTE.

E. VSM. Provides high resolution switching from a number of video sources to selected output channels for distribution to various TV viewers, TV projectors, and recording equipment.

4.6.2.4.2 Critical Functions. (Cont'd)

F. VSMBM. Multiplexes the address data from the DSCIM and DTE to the VSM on a priority basis to provide the TV channel, console, and monitor address for VSM control of its input to output designations.

System failure shall be defined as any anomaly that will cause the critical functions to degrade below mission requirements.

4.6.2.4.3 Special Considerations

A. Hardware Redundancy. Fixed channel, nonreconfigurable redundancy shall be an integral part of the hardware for functions that are independent of mission-to-mission operational requirements. This type of redundancy, identified in PHO-TN321, *Reliability Baseline Analysis of the Video Display String Equipment*, exists in the following video display string equipment:

- Computer Restart/Selectover Module
- DTE Cluster Control Unit
- VSMBM
- DSCIM (multiplexer cabinet only).

Subsequent equipment modifications shall be reviewed to ensure that sufficient redundancy is retained to prohibit system performance from degrading below that experienced for previous missions.

B. Operational Redundancy. Data distribution of critical events shall be routed on independent paths to multiple users. Viewer assignments made on a mission-to-mission reconfiguration basis shall provide sufficient operational redundancy so system performance is not degraded below that experienced for previous mission support (reference PHO-TN321).

4.6.2.5 DDS

4.6.2.5.1 Boundaries. Analysis of the DDS shall be limited to the portion of the DCS which receives computer-generated event data from the DCC and distributes the data for display on console event module indicators and to the TS. The DDS shall comprise the DDD/SDD and the DDD's. The analysis that shall be performed on the DDS shall be limited to those elements that handle lamp driver signals to the digital event indicators in CONS.

4.6.2.5.2 Critical Functions. Critical functions within the DDS shall be defined as that processing associated with driving the variable event modules within the consoles. If a loss of a critical function occurs within the DDS requiring the repair of a failed element to restore system support, the failure shall be defined as a system failure.

4.6.2.5.3 Special Considerations

A. Hardware Redundancy. Nonreconfigurable fixed hardware redundancy shall exist for those discrete display functions that are constant for mission-to-mission operational requirements. Redundancy shall be required insofar as the system performance does not degrade below the levels attained for previous missions.

B. Operational Redundancy. Critical data shall be routed along independent paths to multiple users to ensure operational redundancy. Sufficient operational redundancy is required so that the system performance does not degrade below the levels attained for previous missions.

C. Failover. Failover capability to redundancy hardware channels shall be required only for the DDD/SDD. The switchover to a standby SDD channel shall be accomplished by a manual replacement of the DDD/SDD output patch panel with a prepatched output panel configured for operation with the standby channel.

4.6.2.6 AED

4.6.2.6.1 Boundaries. Analysis of the AED Subsystem shall be limited to the portion of the subsystem which receives digital, analog, and bilevel event data from the TPC and converts and distributes a minimum of 200 analog and 400 bilevel event parameters to analog and event SCR's located throughout the MCC.

4.6.2.6.2 Critical Functions. Critical functions of the AED Subsystem shall be limited to the processing (excluding TPC) and distributing of both analog and bilevel event data as defined in paragraph 4.4.2.6.1. Loss of a critical function requiring the repair of a string element to restore system support shall be defined as a system failure.

4.6.2.6.3 Special Considerations

A. Hardware Redundancy. Sufficient nonreconfigurable hardware redundancy shall exist in the receiving, processing, and distributing portions of the AED Subsystem to minimize the probability of system failure.

B. Operational Redundancy. Hardware redundancy shall not be required for the AED Subsystem analog and bilevel event SCR's; however, the AED Subsystem design shall provide capability for sufficient operational and/or functional redundancy at the end-item devices.

C. Failover Considerations. Failover to redundant channels shall be accomplished without loss of data displayed on analog and bilevel event recorders. There shall be sufficient reconfiguration capability in the MCC configuration control computer for reallocating selected analog and bilevel event parameters for subsequent display on SCR pens.

4.6.2.7 TS String

4.6.2.7.1 Boundaries. Analysis of the TS string shall be limited to the portion of the subsystem which generates and distributes time reference signals for use by select MCC subsystems.

4.6.2.7.2 Critical Functions. Critical functions within the TS shall be as defined in paragraph 4.4.2.8.4. Critical distribution and utilization shall be as defined in paragraph 4.4.2.8.4.2 with the exception of the following which shall not be considered as critical within the TS:

- SIM
- SEF.

Subsystem failure shall be defined as degradation that will cause loss of a critical function or distribution which requires repair of a failed element prior to support restoration.

4.6.2.7.3 Special Considerations

A. Hardware Redundancy. Hardware redundancy shall exist for the portion of the TS which generates and divides the time reference signals. This portion shall include standards, synchronizers, synthesizers, and pulse rate dividers.

B. Operational Redundancy. Reconfigurable operational redundancy shall exist for signal drivers and TS interfaces.

C. Failover Considerations. Failover capability to redundancy channels shall be provided. This capability shall include switchover of offline redundant channels to the online mode without loss of TS support to the subsystem interfaces.

4.6.2.8 DSCIM

4.6.2.8.1 Boundaries. Analysis of the DSCIM shall be limited to the portion of the DCS that receives its inputs from PBI depressions in CONS, encodes or formats the inputs into 36-bit words, and outputs the words to the SDPC's. End-item keyboard devices shall be included in the analysis for critical path determinations.

4.6.2.8.2 Critical Functions. The functions critical to the DSCIM are contained in paragraph 4.4.2.9.1. System failure shall be defined as any failure which causes the loss of a flight controller's (FC's) display select capability in support of a critical FC position.

4.6.2.8.3 Special Considerations

A. Hardware Redundancy. Sufficient hardware redundancy exists for the DSCIM to meet reliability requirements. At the encoder level, hardware redundancy presently exists for all modules except for the following:

- Program control logic
- Forced display keyboard
- ESW module.

Configuration shall be established to make these encoders redundant.

B. Functional Redundancy. Functional redundancy for the DSCIM may be implemented using a MED; i.e., a teletype physically mounted on individual consoles. The MED shall be capable of communicating with both the dynamic and standby processors.

C. Operational Redundancy. Operational redundancy shall be implemented for the encoders whenever possible. Redundant encoders shall be configured so that they reside in the same logic drawer of a cabinet, rather than different logic drawers of different cabinets. Operational redundancy presently exists for all devices except for the modules contained in paragraph 4.6.2.8.3,A. Operational redundancy may also be accomplished by the assignment of various console keyboard inputs to the encoders on a mission-to-mission basis.

4.6.2.8.3 Special Considerations. (Cont'd)

D. Failover Considerations. Switchover to a redundant multiplexer in the DSCIM shall be accomplished manually. The time required to switchover from the active online multiplexer to the standby multiplexer shall be less than 200 ms.

4.6.2.9 CCIM

4.6.2.9.1 Boundaries. Analysis of the command select string shall be limited to the part of the system originating computer input data from console-mounted switches on command consoles. Command consoles shall be defined as having the capability to initiate a request for transmission of essential data from the MCC to the Orbiter and for transferring data between ground computers.

4.6.2.9.2 Critical Functions. The following CCIM functions shall be necessary for Shuttle support during critical mission periods:

- Initiation of real-time commands emanating from the command modules listed in paragraph 4.4.2.10.3
- Selection of desired command mode; i.e., abort, enable/disable, etc.
- Verification of commands received by the spacecraft
- Proper encoding of command words as they are initiated by the command consoles and received by the encoder circuits
- Verification of a proper command word
- Transfers to command words from the encoders to the CCIM
- Scanning of encoders to detect command console inputs.

4.6.2.9.2 Critical Functions. (Cont'd)

The success criteria for equipment contained in the CCIM string shall be defined as the capability to provide uninterruptible execution of the functions listed above.

4.6.2.9.3 Special Considerations

A. Equipment Redundancy. Sufficient equipment redundancy shall exist in the CCIM control cabinet to meet reliability requirements.

B. Functional Redundancy. Functional redundancy may be implemented for command console initiated inputs in lieu of equipment redundancy specified in paragraph 4.6.2.9.3,A. This could be accomplished by using the TTY as backup for command inputs to CCIM.

C. Operational Redundancy. Operational redundancy shall be implemented in the encoder circuits (as listed in paragraph 4.4.2.10.1 of the CCIM subsystem). This involves consideration of the interfaces between command consoles and encoder circuits, and shall be used whenever possible.

D. Failover Considerations. Switchover to a redundant channel in the CCIM control cabinet shall be implemented on a manual basis. Appropriate failure detection and subsequent switchover circuitry shall be retained for the CCIM. The internal circuitry of the CCIM control cabinet shall be configured so that effective switchover can be accomplished in 200 ms or less. At the encoder level, switchover from a failed encoder shall be accomplished by reinitiating the command from a different console.

4.6.2.10 MBI

4.6.2.10.1 Boundaries. Analysis of the MBI Subsystem string shall include but not be limited to the portion of the equipment that provides for a common data bus between the NIP and SDPC.

4.6.2.10.1 Boundaries. (Cont'd)

An equipment string providing mission support capability is composed of redundant MBI's, each of which includes the following:

- Bus configurator
- IA's
- Data bus drivers and receivers.

4.6.2.10.2 Critical Functions. Critical functions performed by the MBI Subsystem string shall include but not be limited to transfer of real-time command and telemetry data between the NIP and SDPC in support of Shuttle data processing.

4.6.2.10.3 Special Considerations

A. Hardware Redundancy. Fixed channel, nonreconfigurable redundancy shall be an integral part of the subsystem hardware for functions that are independent of mission-to-mission operational requirements. The redundant MBI's shall be configured such that 10 buses are online for data transfers, and that each bus configurator controls data transfers through its five data buses.

B. Operational Redundancy. Sufficient operational redundancy shall be required so that subsystem performance does not degrade below that necessary for minimum support. For minimum support, three buses with the respective configurator and BA's shall be required for peak periods. When dedicated buses are not required, degradation to 5 of 10 online buses shall be allowed prior to corrective repair action. There shall be sufficient control capability within the MBI configurators to disable, in the event of a bus failure, a single bus and assign alternate data paths.

4.6.2.10.3 Special Considerations. (Cont'd)

C. Failover. The MBI Subsystem shall be configured such that a maximum of 10 data buses are available for message transfers. The conventional dynamic/standby failover philosophy shall not apply. In the event of failure within the MBI Subsystem, status messages shall be transmitted via a control bus to disable that portion of the MBI which fails. Maximum degradation to 5 of 10 nondedicated data buses shall be allowed prior to necessary repair action. When a maximum of five buses is disabled, the MBI containing the majority of the disabled buses shall be taken offline for corrective repair action.

4.6.2.11 NOM

4.6.2.11.1 Boundaries. Analysis of the NOM shall be limited to the portion of the equipment that receives and time-division multiplexes SDP data, digital voice data, and digital video text and graphics data into Shuttle Orbiter uplink formats.

4.6.2.11.2 Critical Functions. Critical functions within the NOM shall be defined as the portion of the equipment that formats data into a NASCOM block and provides configuration control and routing of all inputs and outputs.

4.6.2.11.3 Special Considerations

A. Hardware Redundancy. The NOM shall utilize hardware redundancy.

B. Operational Redundancy. Reconfigurable internal redundancy shall exist for the TDRSS and GSTDN formatter functions.

C. Failover Coniderations. Automatic failover of the redundant MBI adapters is an integral part of the MBI Subsystem design. Failover of internal redundancy shall be under manual control from a PBI panel.

4.6.2.12 SCS Component of DIU

4.6.2.12.1 Boundaries. Analysis of the SCS component of the DIU shall be limited to that portion of the equipment necessary to provide the switching and control to reconfigure the interconnections of the DCS's data lines and the DCC's I/O elements. The analysis shall apply only to the subsystem used in conjunction with the SCS. The SCS hardware shall comprise the following functional elements:

- Power
- Configuration and selectover
- Data throughput.

4.6.2.12.2 Criticality. SCS operations shall be classified in two categories: those associated with enabling data transfers; and those associated with reconfiguration of the switch elements. Each must be evaluated independently taking into consideration the functions which the equipment must perform.

4.6.2.12.3 Special Considerations. Manual backup for the logic associated with the configuration/selectover function shall be provided by the override switch panel. This panel shall have the capability to perform any allocation selections that can be made from the SCS configuration panel as well as override the selectover initiated by the restart/selectover panel.

4.6.2.13 AGVS and VIS

4.6.2.13.1 Boundaries. Analysis of the AGVS shall be limited to the portion of the CIS which provides functional processing of the uplink and downlink voice communications for the TDRSS. The processing shall include analog-to-digital and digital-to-analog conversion control, status, and configuration of voice communication data. Analysis of the VIS shall be limited to that portion of the CIS which provides functional processing and distribution of analog voice communications.

4.6.2.13.2 Criticality. Critical functions of the AGVS and VIS shall be limited to the stripping of digital voice data from the downlink and the conversions from both digital-to-analog, analog-to-digital, and the distribution of voice data to specified users. These conversions shall include both the uplink and downlink data streams. Loss of a critical function requiring the repair of a string element to restore system support shall be defined as a system failure.

4.6.2.13.3 Special Considerations

A. Hardware Redundancy. Sufficient hardware redundancy shall exist for those voice communication functions that are constant for mission-to-mission operational requirements. Redundancy shall be required insofar as the system performance does not degrade below the levels attained for previous missions.

B. Operational Redundancy. Critical voice communications data shall be routed along independent paths to multiple users to ensure operational redundancy.

C. Failover Considerations. Where applicable, the components of the AGVS and VIS shall be grouped such that redundant elements are available for selectover in the event of failures. Failure detection logic shall be provided for both online and offline units to ensure that the offline units are not in a failed mode when switchover occurs. Additionally, the removal of a failed channel shall not interrupt support on the remaining channels. The dc power may be removed from a failed function for maintenance purposes while normal mission support is maintained.

4.7 Availability. Availability (A) is defined as the fraction of time that an equipment system will be meeting an operational objective. The following paragraphs specify numerical availability requirements for the following subsystems considered highly desirable for mission support.

- DDHS
- CCRF.

Also included are the identification of the configurations against which the requirements apply, the fixed redundancies which are independent of mission requirements, and operational redundancy considerations which are dependent on mission support groundrules and philosophy.

4.7.1 DDHS. The availability of the DDHS shall be ≥0.997 for each of the following operational configurations:

- Storage of dump or real-time data
- Playback of dump or real-time data including playback of data from archival storage.

Fixed hardware redundancies for the DDHS are TBD. Multiple I/O ports and multiple storage devices shall be considered operationally redundant to the extent that degraded support is deemed acceptable.

4.7.2 CCRF. The availability of the CCRF shall be ≥0.997 for each of the following major operational configurations:

- 1.544 Mb/s Recording
- 1.544 Mb/s Playback
- 224 kb/s Recording
- 224 kb/s Playback

4.7.2 CCRF. (Cont'd)

- Historical Voice Recording
- Historical Voice Playback.

The following hardware redundancy shall exist for the above configurations in order to minimize the probability of failure: 1) redundant recorders for the data and voice recording functions, and 2) redundant historical voice playback equipment.

5. NETWORK INTERFACE PROCESSOR (NIP) SOFTWARE

5.1 Introduction. The NIP software components shall consist of real-time operating software and checkout software which shall be TPC-resident, and Data Flow Engineer (DFE) logging software which shall reside in the PDP-11/45. The design objectives for NIP software systems are:

- Reliability
- Minimum impact to support mission-to-mission reconfigurations
- Maximum use of existing ALT design with required modifications and new builds
- Expandability
- Flexibility
- Online reconfiguration of hardware and software
- Online data quality monitoring and notification
- Maintainability.

5.2 TPC Real-Time Operating Software. The ALT TPC software design shall be used as the baseline for OFT implementation (see JSC-10441, *ALT TPC Detailed Software Design Document*). The software logic shall be table-driven to assure maximum flexibility and allow mission-to-mission reconfiguration to occur with minimum software impact. The software architecture shall be designed to be compatible with expansion requirements to handle two telemetry links.

5.2.1 TPC System Software. Application software shall use the OS/32 MT supplied by the Interdata 8/32 vendor. Modifications have been made to OS/32 MT to ensure more efficient dispatching from the systems queue, and to provide drivers for the unique

5.2.1 TPC System Software. (Cont'd)

TPC interfaces. The standard vendor-supplied systems software includes:

- Assembler
- FORTRAN
- Debug Package
- Text Editor
- OS/32 MT Configuration Utility Program.

5.2.2 TPC Application Software. The functions required to support the OFT/TPC telemetry preprocessing requirements are allocated to individual modules that shall operate as basically asynchronous tasks.

The application tasks shall communicate with each other, as required, through the task common area and service calls to the operating system (OS) as shown in figure 5-1.

Figure 5-2 illustrates the functional relationship of the application modules relative to the input validation of telemetry data links and the generation of output products. The telemetry processing shall be under the control of tables selected by the reconfiguration task. Table selection and other parameters can be reconfigured as a result of manual inputs, central configurator messages, or data driven by format changes detected in the Orbiter downlink (OD). The figure illustrates the basic architecture to support processing of dual telemetry links.

5.2.2.1 Initialization Processor. Two methods of TPC initialization selection are provided:

- Coldstart - complete system initialization, independent of the previous system state
- Restart - reinitialization of the system to its previous state with options to change selected conditions, such as link ID's, format ID's and NCI options.

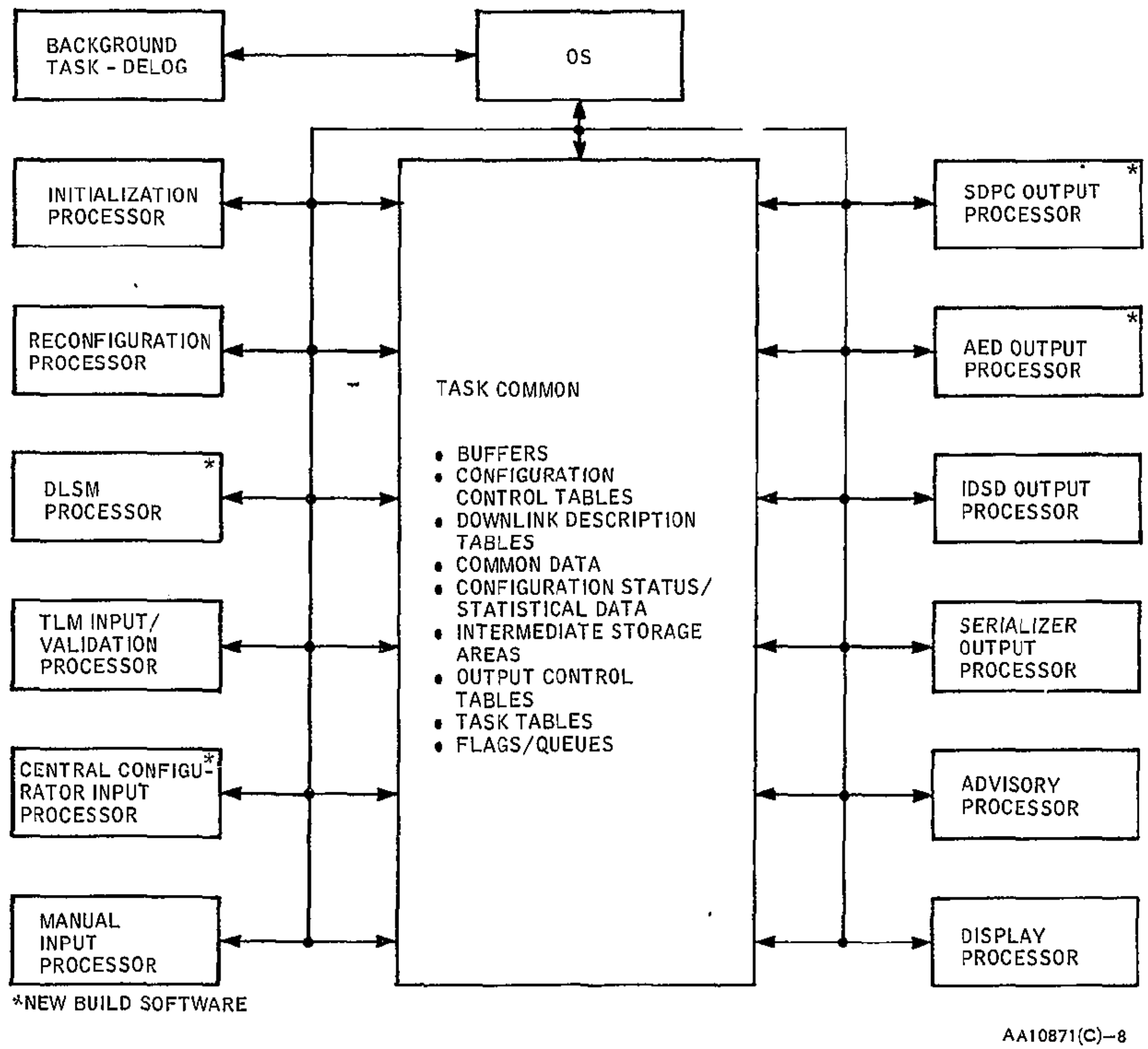

Figure 5-1 Application Software System Structure

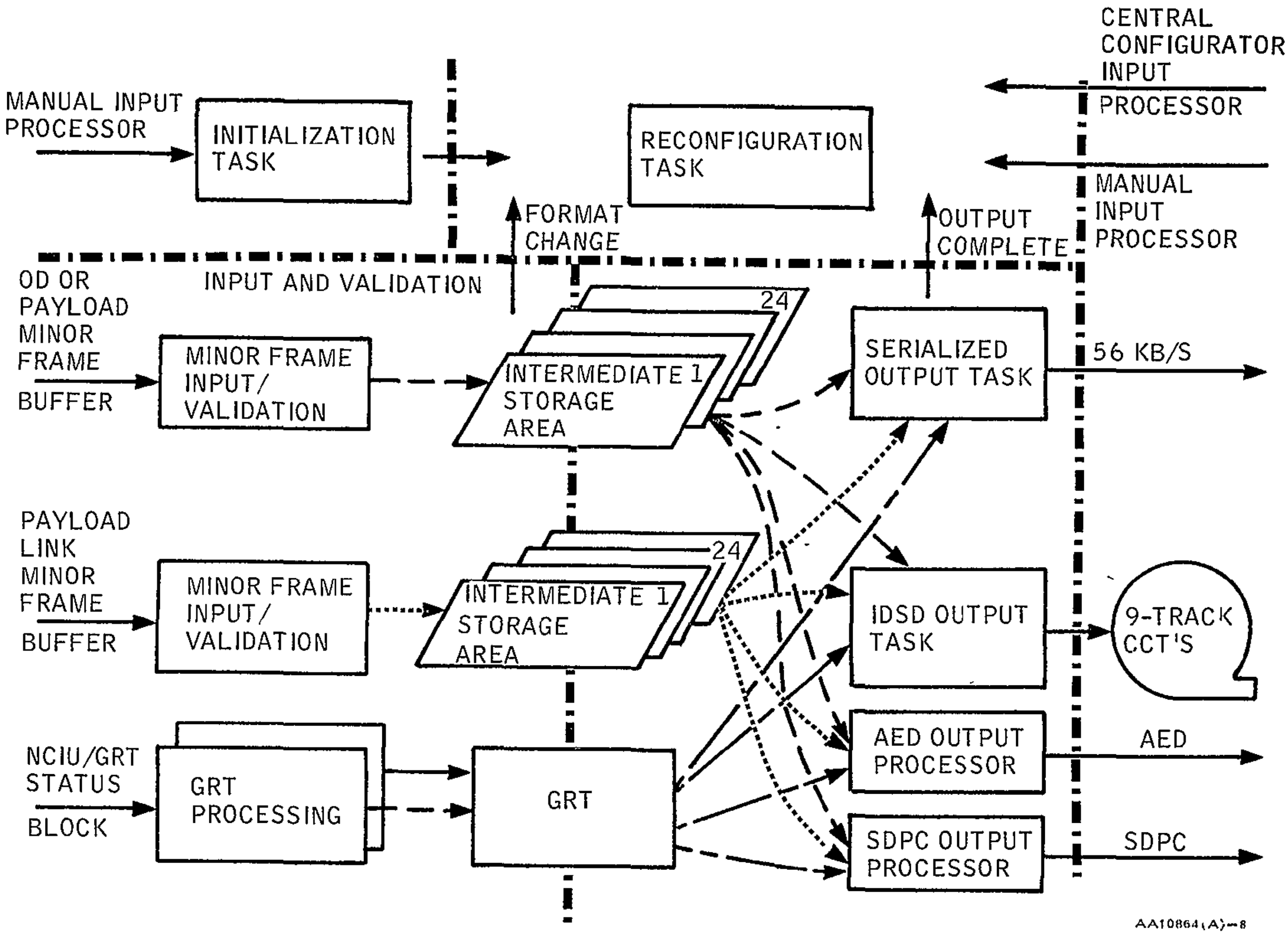

Figure 5-2 Telemetry Overview

5.2.2.2 Real-Time Reconfiguration Processor. The reconfiguration processor shall be responsible for completing system initialization and for processing real-time reconfiguration changes. This processor shall load the processing format tables, initialize the interfaces, and update the configuration control block and save it on disk for restart.

Real-time reconfiguration shall be required to support Orbiter format changes. The TPC shall maintain two sets of core-resident format tables for operational instrumentation and each subcom. In a dual link configuration, the TPC shall maintain one format table for a payload link and two format tables for the Orbiter link. Reconfiguration from one core-resident format table to another shall be accomplished with minimum (≤ 3 seconds) loss of data. For format changes using tables from disk, the reconfiguration shall be accomplished within 15 seconds of receipt of commands or downlink selection.

Configuration requests shall be received as manual entries or entries from the MBI. The TPC shall provide for routing configuration information to the NCIU.

5.2.2.3 Central Configurator Input Processor. This processor shall be responsible for processing configuration messages received from the SDP or via a MED. It shall validate each entry and initiate the action required by valid entries. Types of messages shall include:

- TPC format selection
- Output product selection
- AED control inputs
- Network configuration information.

5.2.2.4 Manual Input Processor (MIP). The TPC man-machine interface shall be provided to accept control requests from the H-2000 terminal, the operator's console, or the card reader. MIP shall validate each entry before initiating system action and inform the terminal operator of acceptance or rejection of the request. Manual entries shall be recorded on the hardcopy printer for future reference.

5.2.2.5 TLM Input/Validation Processor. This processor shall receive telemetry data buffers on a minor frame basis with associated hardware status and/or time tag components. The following major functions shall be performed to validate the input telemetry data link.

A. Minor Frame Validation. A frame shall be discarded if flagged as invalid during:

- A/G status word check
- Sequential frame counter validation
- OD minor frame format ID verification.

B. Subcom Validation. Once a minor frame has been declared valid, data from each subcom window shall be processed by the subcom validation routine. The following parameters shall be validated independently for each subcom.

- All minor frames containing subcom frame
- Subcom sync
- Subcom frame counter
- Subcom format ID.

C. Data Cycle Validation. The data cycle validation routine shall perform the following major functions:

- Validate data cycles based on minor frame validity
- Validate onboard time tags
- Monitor flywheel timers for onboard time or Ground Receipt Time (GRT) validation
- Set data and time status flags in the intermediate storage area (ISA) for use by output processors.

5.2.2.5 TLM Input/Validation Processor. (Cont'd)

D. Time Processing. The time processing task shall include the following major functions:

- Adjust current GRT and delta bit count to an adjusted GRT

- Reformat time sources to show total seconds and milliseconds

- Adjust flywheel timers.

E. Format Processing. The format processing task shall include the following functions:

1. Format Verification. Processing shall not be started until receipt of a valid minor frame zero. Manual entry shall provide the capability to start processing on the first valid frame.

2. Format Changes. Core-resident changes shall be made after one indication and noncore-resident changes shall be made after two successive indications have been detected.

5.2.2.6 IDSD Output Processor. The TPC shall be required to generate CCT's for use by the IDSD. The TPC software structure shall be expandable to format and asynchronously output the data from two input links to a CCT.

A. Physical Files. The IDSD Output Processor shall generate 9-track tapes, each consisting of two physical files as follows. Each record written to the CCT shall contain standard overhead information.

- Index file - comprises eight index records terminated by a single end-of-file (EOF) mark

- Data file - consists of a variable number of data records terminated by two EOF marks.

5.2.2.6 IDSD Output Processor. (Cont'd)

B. Index Records. These records shall describe the time-continuous data segments (CDS's) that are contained on the tape. All data which is contained on the CCT shall be described in the index file. Each index record shall contain:

- Standard overhead
- CDS counter
- Tape number
- CDS descriptors
- Fill pattern and/or end sentinel.

C. Data Records. The data records shall contain the telemetry data that has been frame- and time-validated. Each record shall contain standard overhead, followed by segments of data overhead and data. The number of data overhead and data segments shall vary.

5.2.2.7 AED Output Processor. The TPC shall interface directly with the AED by formatting and transmitting analog, event, and timing for driving the displays on the recording device. The AED shall send the TPC a status message on the transmission quality and AED hardware status pertinent to the maintenance of the interface.

A. AED and Timing Data Criteria. The analog, event, and timing data transferred to the AED shall be organized on a recorder basis and shall meet the following criteria:

1. Two types of data, [e.g., operational instrumentation (OI) and GPC subcom] shall be supplied to a single recorder.

2. Each data type time shall be correlated to a separate timing pen.

5.2.2.7 AED Output Processor. (Cont'd)

3. Different data types appearing on the same recorder shall not be required to be time-correlated to each other.

B. Message Types. The transfer of parameter and data cycle timing information from the TPC to the AED shall be via the following three message types:

1. Initialization Message. This message type shall be required to initialize a unique data cycle synthesizer with the proper data cycle length and strobe period. When this message is sent, the AED shall preset the assigned data cycle synthesizer.

2. Termination Message. This message type shall be required to release an assigned data cycle synthesizer.

3. Stripchart Recorder (SCR) Message. An SCR message shall be addressed to a particular SCR and contain data for the specified analog or event pens. It shall also contain values for two spacecraft times. A separate SCR message shall be transmitted for each data type.

C. TPC AED Processing Tasks. TPC AED processing shall include three major tasks: the AED configurator, the telemetry output, and the spare pen formatter.

1. AED Configurator Task. This task shall process MED or SDP configuration inputs to route selected parameters to pens specified on SCR's.

2. AED Telemetry Output Task. This task shall be active only when the AED output is enabled. The task shall be driven on a data-cycle basis; it shall process parameters on a data-type basis, and build and queue pen formats for output.

5.2.2.7 AED Output Processor. (Cont'd)

3. Spare Pen Formatter Task. This task shall be activated to process a card deck or MED input which defines a spare pen format for a specific downlink/downlist format combination.

5.2.2.8 SDPC Output Processor. The SDPC Output Processor shall output three basic types of messages to the SDP. The real-time data message shall be used to transmit all vehicle telemetry data with its associated status from the TPC to the SDPC. The Data Link Summary Message (DLSM) shall provide a tape index of all telemetry data processed by a given TPC. The TPC/NCIU configuration status message shall provide the current configuration and status.

The SDPC output processing shall be controlled by the reconfiguration task, which specifies whether the SDPC output is enabled or disabled, which link it is to process, whether MOC output only or MOC and DSC output is expected, and which format or formats are to be used on the data. This information shall be derived by the real-time configurator via the MBI.

A. Real-Time Data Message. The basic format convention shall be that of selecting required parameters from the downlink and transferring a fixed-format message to the SDPC at a variable output rate.

The data handling and data cycle validation for the 1-second data cycles shall match the required output rate of once per second. Output to the SDPC shall be started following the receipt of the first complete downlink data cycle in which all frames are valid. After the initial output, each succeeding message output shall reflect the data cycle validity from which it was built.

For data cycles (or subcoms) greater than one per second the output rate shall approximate one per second. One sample (or multisamples) of each parameter shall be output each second in a fixed format. A set of status bits

5.2.2.8 SDPC Output Processor. (Cont'd)

(one for each 8-bit byte) shall be output, indicating whether or not a valid sample has been received for the data set.

There are two interfaces to the SDPC, one to the MOC and one to the DSC. This shall require the same message buffer to be transmitted twice. The only difference in the total message shall be the TPC-to-SDP header.

B. Data Link Summary Message. DLSM's shall be output periodically as each IDSD CCT is completed. The DLSM shall provide a summary of all data processed by the TPC, along with associated IDSD/CCT tape numbers.

C. TPC/NCIU Configuration Status Message. The TPC/NCIU configuration message shall provide for the transfer of TPC/NCIU processing and configuration status to the SDP configuration control function on a link basis. The messages shall be output at a nominal once-per-second rate.

5.2.2.9 Serializer Output Processor. The OFT serializer processing requirements have been baselined as identical to the 56 kb/s ALT serial output format. Refer to the *ALT TPC Software Design Specification* for a detailed definition. Serializer formats to be utilized for payload or other OFT telemetry processing are TBD.

5.2.2.10 Display Processor. Multiple display formats shall be provided for status monitoring on the H-2000 terminal. The CRT general format is shown in figure 5-3. The following functions shall be available to the operator:

- Configuration status
- Parameter readouts
- TPC processing status
- NCI status

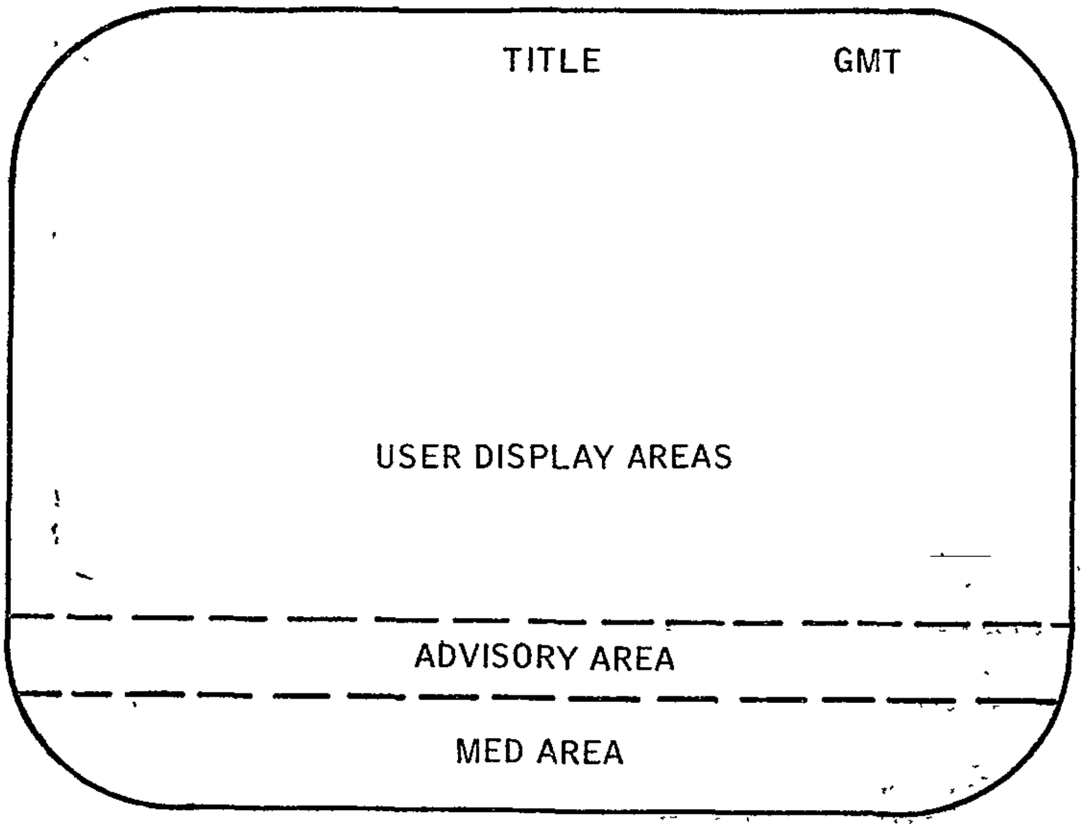

Figure 5-3 CRT Display Format

5.2.2.10 Display Processor. (Cont'd)

- Dynamic advisory history
- RADIX conversion (octal, decimal, hexadecimal)
- Discrete-to-English conversion
- Special conversions.

5.2.2.11 Advisory Processor. TPC advisories shall be output to the H-2000 terminal in a standard 5-line scrolled advisory area. Advisories shall be time-tagged with GMT occurrence and a hard-copy record provided. The following types of advisories shall be provided:

- Error messages and I/O messages from the OS
- Error messages and advisories generated by the assembler, compiler, load module generator, and utility software
- Error messages to aid in fault isolation and recovery mode selection
- MED entry errors
- Online reconfiguration advisories
- Status messages from the AED
- Error messages relating to errors detected during telemetry data validation
- SDPC/TPC configuration status and message validation
- Error messages and advisories resulting from special OD data processing
- Central configurator/TPC status advisories.

5.2.2.12 DLSM Processor. The DLSM output processor shall monitor the quality of the OD telemetry data stream which has been time- and frame-validated by the telemetry input/validation task. DLSM's shall be continuously compiled by the task and transmitted to the SDPC via the MBI when any of the following conditions are satisfied.

A. Total valid data frames = 999,999.

B. Total data dropouts = 9,999.

C. Change in any of the following:

- Site ID
- Orbit number
- Flight ID
- Vehicle ID
- DLSM data type
- IDSD CCT end.

D. Manual request for DLSM transmission.

E. System halt.

5.3 TPC Checkout System (TCOS). The following paragraphs establish the functional design structure for the OFT TCOS. The TCOS shall be used for testing elements of the CIS, DCC, and DCS as shown in figure 5-4. The TCOS shall provide confidence data generation and scoring of the OFT TPC operational software outputs. In addition, the TCOS shall be used for acceptance and/or qualification, and maintenance testing of the following MCC Shuttle OFT system hardware components:

- NCI
- MBI
- AED
- Wideband serializer (WBS)
- TS
- IRIG converter.

The TCOS shall reside in a TPC and execute under the standard OFT TPC OS. The specific test requisites shall be designed and developed as modules to form an integrated checkout system that maximizes the use of common functional capabilities. The system design concept shall not preclude any of the tests from executing concurrently; the limiting constraint shall be available resources, both internal and external. Internal resources may dictate the need for multiple software system configurations. Multiple system configurations, if necessary, shall be handled by system generation procedures.

5.3.1 Hardware Definition. The TCOS shall reside in an Interdata 8/32 small-scale computer system. The TPC configuration, as shown in figure 4-5, shall be utilized. The interfaces shall be identical to those used by the operational NIP TPC software system, with the exception of the BITE data generator and BITE data monitor, which shall be provided specifically for checkout purposes. The confidence data generation configuration for UST and BDF shall be as illustrated in figure 5-5. The detailed specifications of the required elements of the CCTCF and the CCRF are contained in paragraph 4.2 of this specification. Refer to JSC-10388 for detailed specifications of the confidence data configurations. The basic elements required are specified in the following paragraphs.

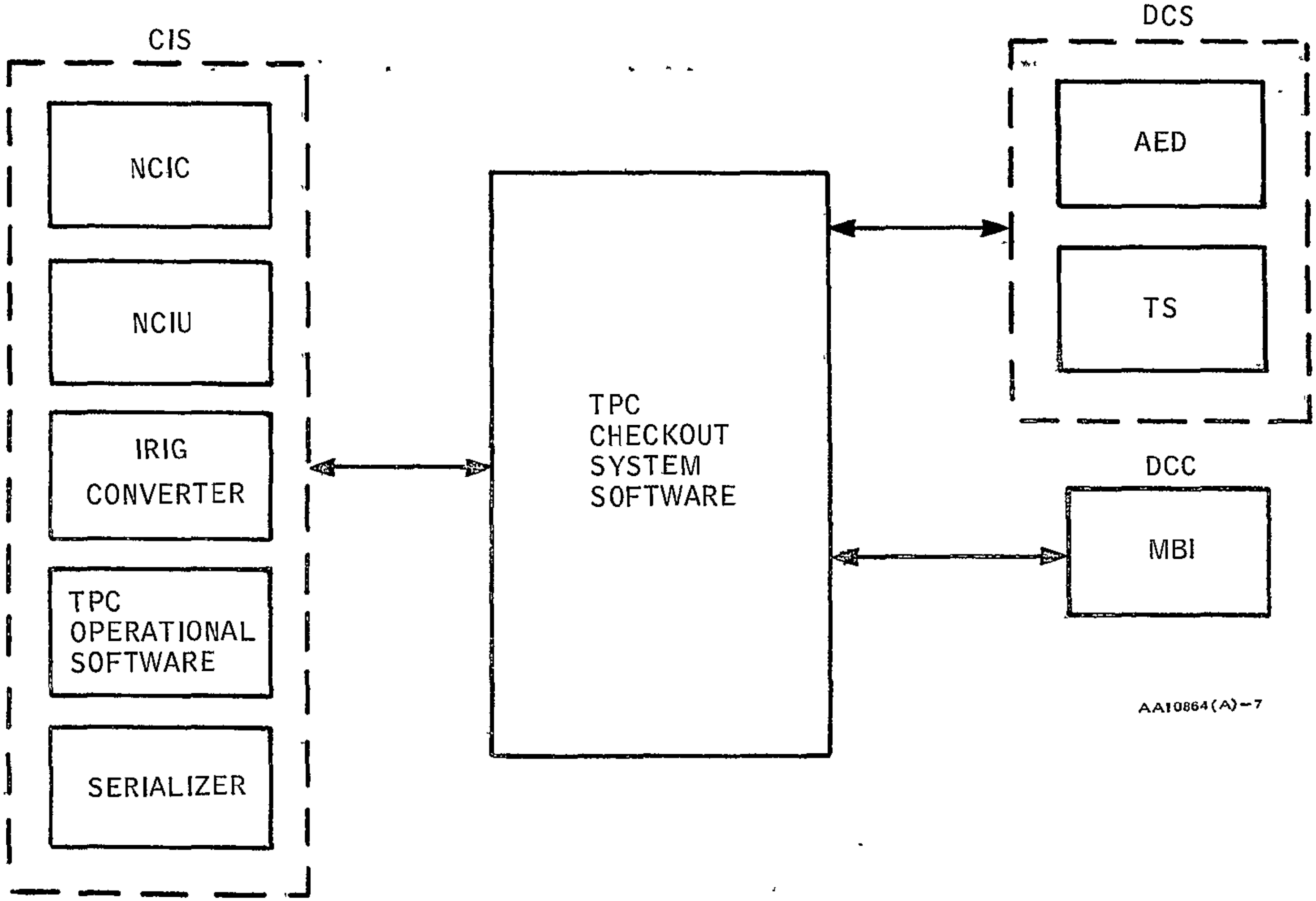

Figure 5-4 TPC Checkout System/MCC Shuttle Interfaces

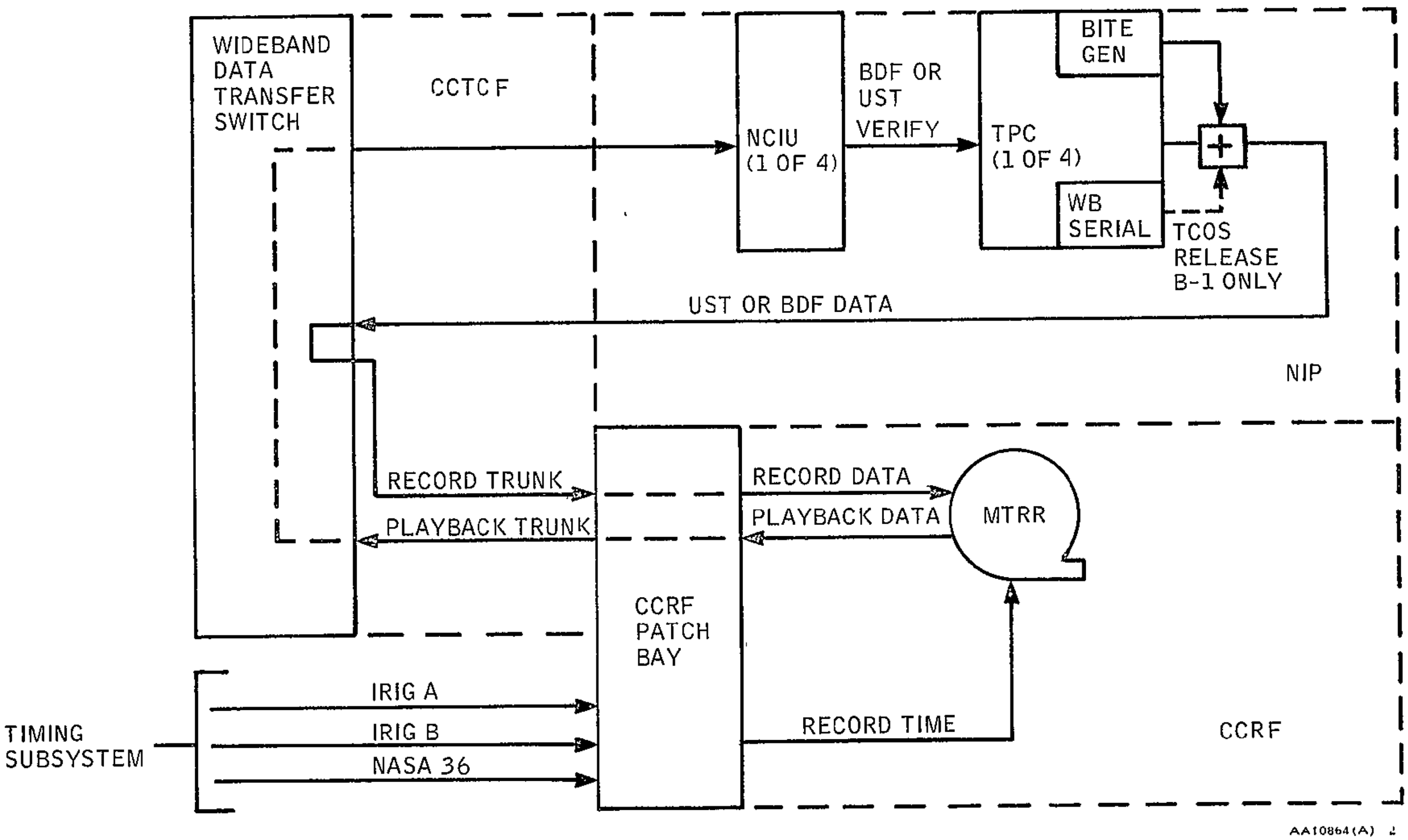

Figure 5-5 Confidence Data Configuration

5.3.1.1 Interdata 8/32 Configuration. The Interdata 8/32 Computer System is a 32-bit minicomputer with the capability addressing up to 1M byte of core memory without resorting to virtual memory mapping schemes. The essential features of the TPC are described in paragraph 4.2.2 of this specification.

5.3.1.2 Special Interfaces. The detailed subsystem-to-subsystem interfaces shall be as specified in JSC-10081. Internal interfaces shall be as specified in the appropriate subsystem performance specification(s). The special interfaces for the TPC configuration are as follows:

A. WBS. The TCOS shall provide A/G telemetry confidence data to the WBS for routing to the CCRF. The WBS interface tests shall provide setup data words and simulated telemetry data to verify the capability to output data buffers from the TPC for parallel-to-serial conversion.

B. NCIU. The TCOS shall support testing of the NCIU interface.

C. BITE Data Generator. The BITE data generator/TPC interface shall be used for hardware checkout of the NCI and for blocked data format (BDF) confidence data generation with distribution to the CCRF via the WBDTS.

D. BITE Data Monitor. The BITE data monitor interface shall provide a monitoring capability to verify proper operation of the NCI.

E. MBI. The TCOS shall use the MBI interface for hardware checkout of the MBI and the NCIC.

F. TS. The TS interface test shall be used to verify the capability to receive time-of-year data.

5.3.2 Software Definition. The checkout system software shall be comprised of the systems software and the applications software as shown in figure 5-6. The checkout system shall execute under the

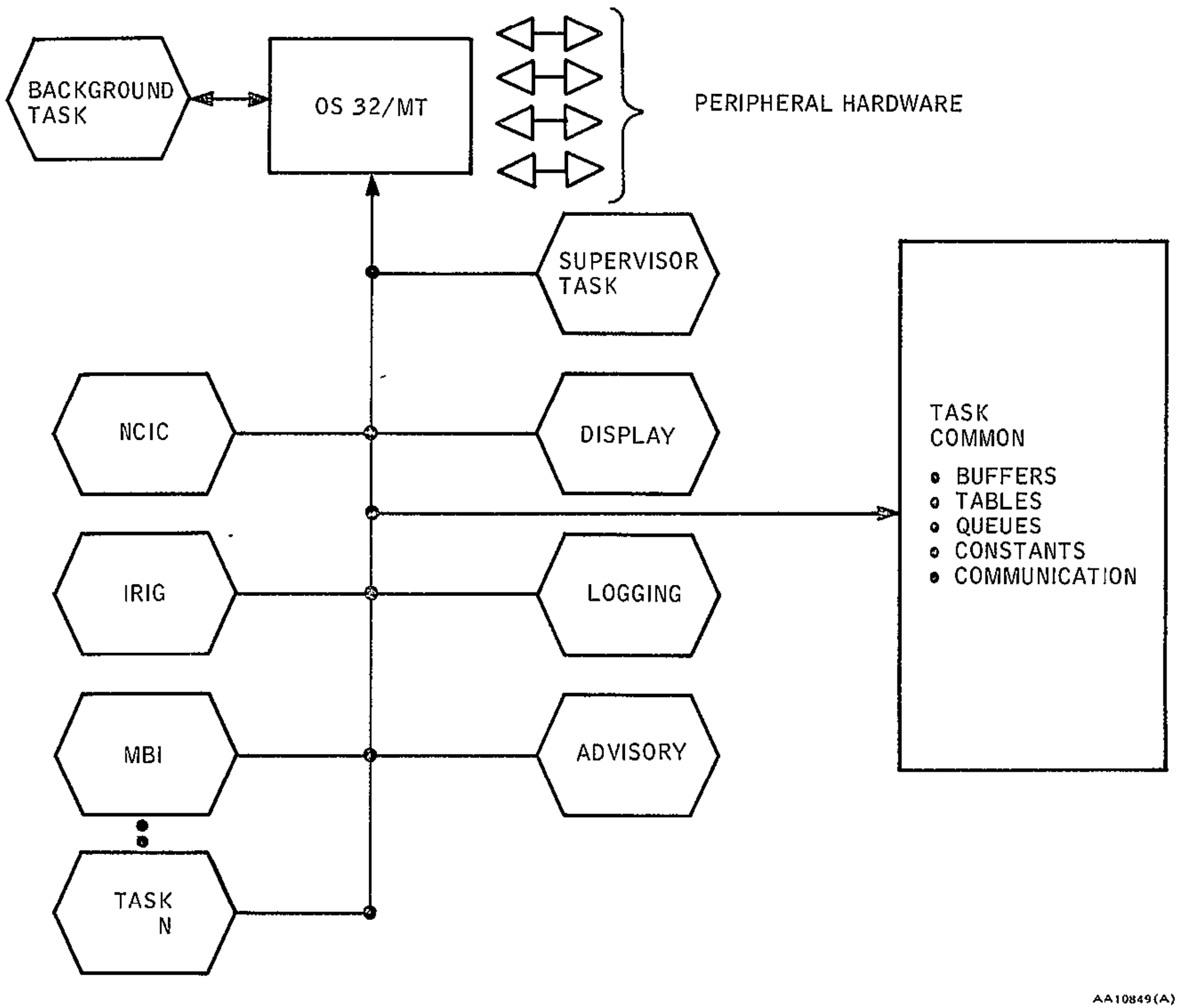

Figure 5-6 Software Structure

5.3.2 Software Definition. (Cont'd)

same OS as the OFT TPC operational system utilizing as many of the operational application modules as is feasible. The TCOS shall incorporate functions necessary to satisfy the following test requirements:

- NIP hardware checkout
- MBI hardware checkout
- AED hardware checkout
- Confidence data generation
- NIP TPC software checkout, including IDSD scoring, AED output scoring, and SDP output scoring.

The functions required to support the checkout requirements shall be allocated to individual modules that are then collected into asynchronous tasks. The application tasks shall communicate with each other, as required, through the task common area, shared disk files, and service calls to the OS.

5.3.2.1 TPC Operating System. The TCOS shall use the OS/32 MT supplied by the Interdata 8/32 vendor. Modifications have been made to OS/32 MT to ensure more efficient dispatching from the systems queue, and to provide drivers for the unique TPC interfaces. OS/32 MT vendor-supplied software is described in paragraph 5.2.1 of this specification.

5.3.2.2 TCOS Application Software. The checkout application software shall be modularized to reflect logical structures rather than actual external physical configurations as defined in JSC-11028, Vol. IV. The checkout application software shall incorporate all functions necessary to provide the following general testing requirements:

- Test control and prompting via manual inputs and selection displays

5.3.2.2 TCOS Application Software. (Cont'd)

- Test monitoring via real-time displays, advisories, and printer outputs

- Generation of A/G telemetry data, BDF data, predefined pattern data, algorithmic data, and manually defined data

- Real-time scoring and offline scoring of log tapes.

The software units necessary to support these functions shall be allocated to individual tasks. The primary communication between tasks shall be through the task common area. Task communication may also be accomplished by service calls to the OS. Tasks in the TCOS shall reside in an individual partition. A task may consist of several routines or software modules. Individual task functions are shown in figure 5-7 and described in the following paragraphs.

5.3.2.2.1 Supervisor. The Supervisor task shall be responsible for establishing and maintaining the system environment, accepting and processing manual entries, and controlling test sequencing. These functions shall be allocated to the following modules.

A. Initialization Processor. The Initialization Processor shall provide for system initialization.

B. Configuration Processor. The Configuration Processor shall be responsible for completing the system initialization.

C. MIP. The TPC man-machine interface shall be provided to accept control requests from the H-2000 terminal, the card reader, and the carousel.

D. Test Control. The test control module shall be responsible for maintaining application processing integrity. This module shall perform the controlling and sequencing functions for the various types of tests.

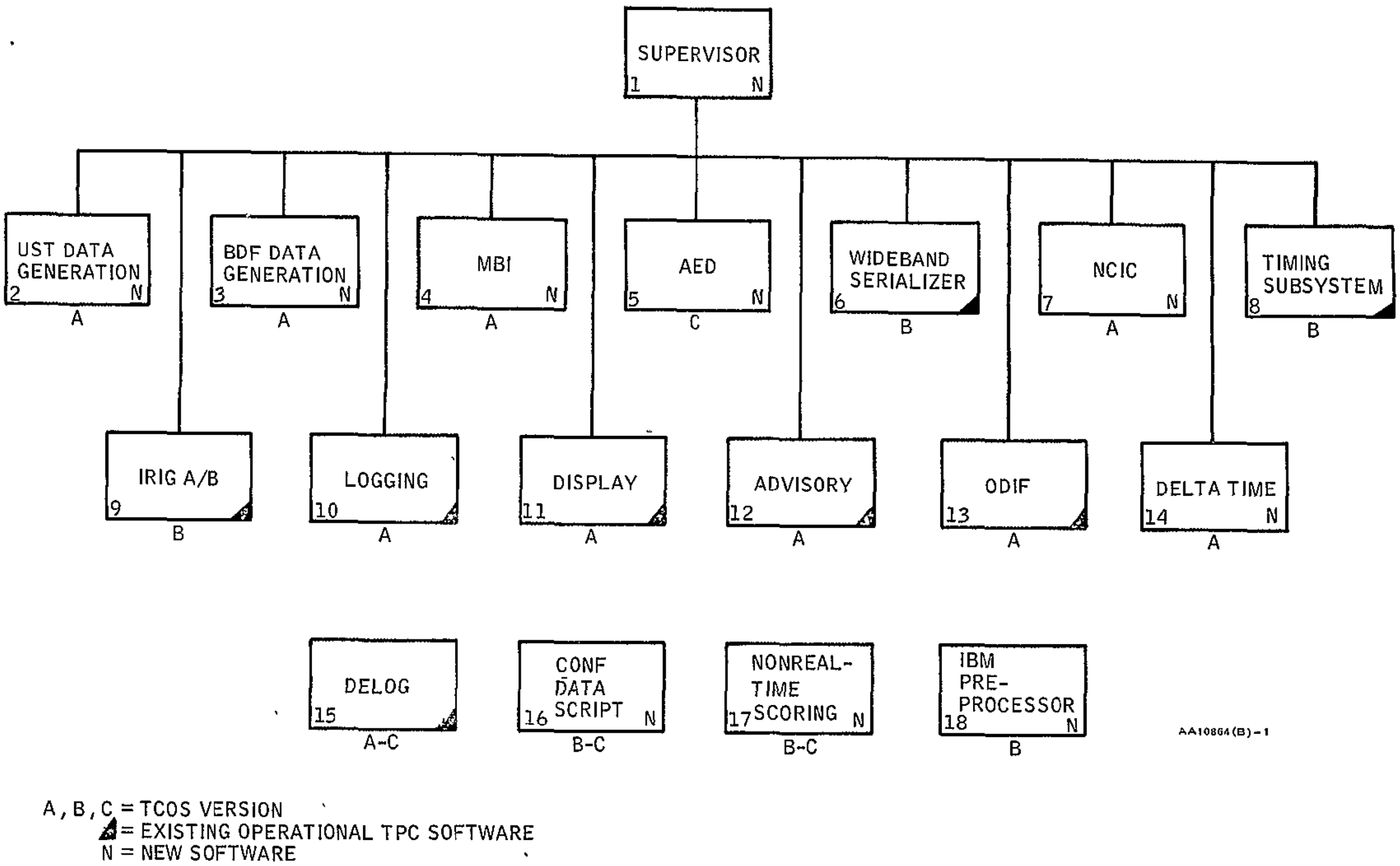

Figure 5-7 TCOS Task Definition

5.3.2.2.2 UST Data Generation. This task shall provide the capability for generating bit-contiguous UST data to support NIP hardware checkout and confidence data generation. Default values shall be provided unless overridden by manual intervention. All overhead parameters shall be subject to faulting with the exception of mission elapsed time (MET). The MET words are dedicated as Master Test Clock (MTC) in confidence data generation.

For hardware checkout, A/G data shall be output via the BITE data generator or WBS interface. Hardware checkout data shall consist of pattern and simple algorithmic data that is concerned with data cycle functions without regard to subcoms.

Confidence data generation shall be output to the WBS interface for routing to the CCRF via the WBDTS (see figure 5-5). The capability shall be provided to output A/G data to a storage media for merging into the BDF. Confidence data generation shall include, in addition to the hardware checkout functions, complex algorithmic data and parameter-specific data values in response to a predefined script. Subcom insertion and manipulation capabilities shall be provided. CRP products shall be utilized to define A/G format structures and parameter-specific definitions.

5.3.2.2.3 BDF Data Generation. This task shall provide for the generation of data to support both hardware checkout and confidence data. All BDF data output shall be via the BITE data generator interface.

Data generation for hardware checkout support shall provide the capability to initialize and provide error simulation control for all BDF header parameters, including control for hardware inserted polycode errors. The BDF data types shall include telemetry, tracking, and Site Originated Data (SOD). Error simulation control shall include "line faulting" (GSTDN telemetry) and back-to-back block insertion. The data content shall consist of transparent pattern data only. Hardware checkout BDF data shall be routed to a specified NCIC input port.

Data generation for confidence data shall include all of the above, plus the capability to insert prescripted individual data links (A/G telemetry, tracking, and/or SOD) into the data content

5.3.2.2.3 BDF Data Generation. (Cont'd)

section of the appropriate BDF block sequence(s) (see figure 5-5). BDF control functions shall be prescripted with special emphasis on time correlation with the prescripted data links to preclude undesirable multiple faulting of the overall data stream. The confidence data BDF generation shall be routed via the WBDTS to the CCRF for recording.

5.3.2.2.4 MBI. This task shall be responsible for supporting the testing and maintenance of the TPC/MBI interface. The MBI task shall be capable of operating in the transmit only, transmit/receive, and receive only modes. The MBI task shall perform the following functions under operator control, via the MIP interface:

A. Data Transmission. Operator commands shall specify data generation control functions.

B. Data Reception and Comparison. The MBI task shall provide the capability to receive and compare messages from the TPC/MBI interface. Operator commands shall be utilized to specify the receive and comparison mode options. In addition, the MBI task shall be capable of receiving and comparing messages to a default pattern, without prior operator command. The MBI task shall maintain message statistics and test summary results which will be available to the display, logging, and printer output tasks for subsequent processing.

C. Data Display/Dump. The MBI task shall provide the capability to display preamble, transmit, and receive buffers to the CRT and/or line printer. Operator notification of error and contingency situations shall be provided through the advisory generation task.

5.3.2.2.5 AED. This task shall provide the capability for testing and maintenance of the TPC/AED interface and the functions performed by the AED. The AED task shall provide operator-controlled functions which shall allow the generation and

5.3.2.2.5 AED. (Cont'd)

modification of AED test messages output to 41 unique AED devices, utilizing a maximum of 12 unique data cycles. The following functions shall be performed by the AED task.

A. Message Generation. The AED task shall provide the capability to generate the following four AED message types: 1) initialization, 2) termination, 3) SCR, and 4) last SCR message in a data cycle. Messages shall be generated from a canned test message library containing up to 10 unique test message patterns of up to 1000 samples per pattern.

B. Test Summary. The AED task shall maintain test summary statistics resulting from the generation of rate test and error test messages. These statistics shall be available for subsequent processing by the display, logging, and printer output tasks. In addition, the AED task shall provide operator notification of AED equipment discrepancies and contingency situations through the use of calls to the advisory generation task.

5.3.2.2.6 Wideband Serializer. The WBS module was developed for ALT hardware checkout. During the initial testing phase of the OFT hardware, the WBS module shall be upgraded in the ALT package and then added later to the TCOS. The module shall provide the capability to perform initialization of the WBS by outputting operator selectable setup words in a single step or continuous mode, and provides the capability to output test data buffers at a rate up to 1.67 Mb/s.

5.3.2.2.7 NCIC Control. The NCIC task shall provide the capability to generate NCIC configuration messages as well as a means to score various types of data that are transferred back to the task after it has been processed by the NCIC. This task shall operate with either the data generator/monitor or the operational TPC MBI transmit/receive adapters and shall coexist with BDF data generation. All results and/or errors shall be reported to the test operator via the CRT and/or line printer.

5.3.2.2.8 Timing Subsystem. The TS module was developed for ALT hardware checkout. During the initial testing phase of the OFT hardware, this module shall be upgraded in the ALT package and then added later to the TCOS. The capability shall be provided to read the time of year data in a single cycle mode or a continuous mode. In the continuous mode, the task shall read the time of year data at a 1, 10, 100, or 1000 sample per second rate. The time of year data shall be output to the line printer or CRT.

5.3.2.2.9 IRIG A/B Converter. This module was developed for ALT hardware checkout. During the initial testing phase of the OFT hardware, this module shall be upgraded in the ALT package and then added later to the TCOS. This module shall verify the capability of the TPC to output time words to the IRIG A/B converter at a rate of 1 or 10 times per second.

5.3.2.2.10 Logging. The checkout software logging function shall provide the capability for recording data on magnetic tape for historical and/or analytical purposes. This function shall provide a means for selectively logging data at each of the data monitoring points within the checkout system. Logging shall be selective in nature; such that hardware interface, data flow (input and/or output), and data type parameters may be specified. Application tasks shall initiate data logging requests to the logging task to perform the required logging functions. All tape control and data blocking functions shall be performed by the logging task, while all logging control and data building functions shall be performed by the applications tasks. The checkout system shall use the ALT NIP TPC logging software.

5.3.2.2.11 Display Processing. The checkout system shall use the OFT operational TPC system display software module. The general CRT screen layout is depicted in figure 5-3. Existing operational displays that are applicable shall be retained. Displays are activated upon operator request, and only one display can be active at a time. Displays shall be used for prompting and for status monitoring. The display task shall use tables that contain the information required to build the display background, to access the dynamic data, and to build the display foreground. Dynamic data shall be provided by the various processing tasks in the task common.

5.3.2.2.12 Advisory Generation. Advisories shall be output to the H-2000 terminal in a standard scrolled advisory area. Advisories shall be timed tagged with GMT occurrence and a hardcopy record provided. The Advisory Processor shall generate advisories on request from any foreground application task in the system.

5.3.2.2.13 OD Data Interface. The OD Data Interface (ODIF) task shall be used to verify the correct transfer of command words and OD data between the TPC and NCIU. The format and control of the test A/G data that is input to the NCIU shall be controlled by operator-selected options.

5.3.2.2.14 Delta Time and BDF Header/Bit Rate Interface. This task shall verify the capability of the TPC to receive the delta time tag, BDF header, and incoming telemetry data rate from the NCIU. Test results and status shall be displayed on the CRT and/or line printer.

5.3.2.2.15 Delogging. The checkout software delogging function shall provide the capability to selectively delog the contents of checkout system log tapes that have been created as described in paragraph 5.3.2.2.10. This function shall be performed as a background delogging task and requires no application software interaction. Delogging shall be selective in nature, such that data type, data format, and start/end time parameters may be specified to control the format and content of the delog line printer output. The TCOS shall use the NIP operational delog software.

5.3.2.2.16 Confidence Tape Scripting. The checkout software scripting function shall provide the capability for a high level of specific script control to be utilized in the generation of Shuttle A/G, non-A/G, and BDF data to support hardware checkout and confidence tape production. The scripting function shall allow user specification of macro type scripting instructions which control the format, content, behavior, and duration of the generated data. The scripting instructions shall be "free form" statements containing variable fields and multiple level field descriptions. All time-oriented scripted functions shall be in relation to the MTC, a 1-second/cycle clock which controls the

5.3.2.2.16 Confidence Tape Scripting. (Cont'd)

timing and sequencing of all generated data. Scripted events requiring a resolution greater than the 1-second MTC shall be addressable by location within the 1-second window. The following paragraphs describe the major functional elements of the scripting function.

A. Input. The scripting input task shall be responsible for controlling the input process required by the scripting function.

B. Validation. The scripting validation task shall provide the capability to validate script control sequences and initialization parameters prior to their execution.

C. Synopsis Generation. The scripting synopsis generation task shall provide the capability to create a synopsis or summary of the scripted input sequence. Synopsis generation and output device selection shall be operator-controlled functions.

D. Activation File Creation. This scripting task shall provide the capability for the creation of activation files which control the data generation processes as described in paragraphs 5.3.2.2.2 and 5.3.2.2.3. The activation file(s) shall contain the necessary control and sequencing parameters required to properly stimulate the data generation task(s). Four basic categories of data sequence shall be controlled by the activation file(s):

- Data faulting
- Data control
- Data insertion
- Format/subcom change.

5.3.2.2.16 Confidence Tape Scripting. (Cont'd)

E. Utility Support. The scripting utility support task(s) shall provide those functions necessary for creating, updating, and manipulating script control and data files. Utility functions provided by the OS shall be utilized to the maximum extent possible. Application tasks (utilizing the I/O functions provided by the OS) shall provide any special utility functions required for script control data file maintenance.

5.3.2.2.17 Nonreal-Time Scoring. The TCOS shall be used to generate confidence data to provide data inputs for the NIP software checkout. Offline scoring shall be via TPC output log tapes created during confidence tape input sequences. The TPC output functions validated are IDSD/high rate delog tape, AED, and SDPC. Scoring shall be performed and results shall be output to the CRT and/or line printer as specified in the various test requirements. Options provided include:

- Output errors as they are detected, showing both expected and received values
- Summary of errors detected.

5.3.2.2.18 IBM Preprocessor. This task shall provide the capability for converting the IBM preprocessor tape into a format that can be used by the confidence data scripting task. The major functions that this task will perform shall include:

- Editing tape for telemetry log buffers
- Converting data position in log buffer to A/G position
- Validating and reformatting (as required) MET code
- Formatting data for use by the confidence data scripting task.

5.3.2.3 TCOS Task Interfaces. The TCOS task shall communicate by the following methods:

A. Shared Disk/Tape Files. This is the only scheme by which a background task can communicate with a foreground task.

B. Service Calls. The SVC method enables a calling task to activate another task and to optionally pass an address to "variable data."

C. Task Common. The primary method of data exchange shall be to share areas of task common.

The specific task interfaces for the required test sequences are specified in JSC-10382 and JSC-10388.

5.4 PDP 11/45 Software. The PDP 11/45 shall be strategically positioned in the NIP to be capable of analyzing live network data as it progresses through the NIP. As an aid in diagnosing problems in the data stream, the PDP 11/45 shall be capable of capturing and logging all or part of the data stream. This log, and its accompanying delog, shall be used as an operational tool to support each OFT flight.

5.4.1 DFE Logging/Delogging. This capability shall include the following logging and delogging functions.

A. Logging. This function shall consist of:

1. Selection for logging by specification of one or more of the following:

   - Source code
   - Destination code
   - Message type
   - Port ID
   - Logging of either entire network blocks, or headers and trailers only.

2. Logging of any NCIC router outputs, including specification of NCIC port ID. Two NCIC ports shall be designated logging ports.

3. Logging of NCIU frame-synchronized outputs. When the data source is a magnetic tape and the data rate exceeds the CCT transfer rate, the tape shall be played back at a slower rate.

B. Delogging. This function shall consist of:

1. Selection for delogging on the basis of data type, time interval, or specification of one or more of the following:

   - Source code

5.4.1 DFE Logging/Delogging. (Cont'd)

- Destination code
- Message type
- Channel number ID.

2. The capability to display the logged data on a CRT to facilitate selection of data for delog.

6. DCC APPLICATION SOFTWARE

The DCC application software writeup is provided by IBM under separate cover titled *Mission Control Center (MCC) System Specification for the Shuttle Orbital Flight Test (OFT) Timeframe, Section 6.*

7. TESTING AND CHECKOUT

7.1 General. This section describes the hardware and software testing which shall be utilized to test and check out MCC functions. Included are definition of terms used as well as how the various test and checkout requirements shall be met.

JSC-10309, *MCC/Shuttle Test Plan*, Volumes 1 through 6 defines the entire MCC/Shuttle testing activity from development through operations to a level of detail which will support NASA and contractor management in the following areas.

A. Test Management. The definition and guidelines that will ensure all systems are tested to the proper level throughout the development and operations phases shall be provided. The test plan shall provide the planning tool to ensure that the test program is conducted in a consistent manner.

B. Test Tool Development. Planning and definition shall be provided at an early date to ensure that the test tools being developed will support the required tests, that redundant tools are not being developed by the different contractors, and that commonality between tests through various stages of the development and operations phases is maximized to minimize test tool costs.

C. Resource and Schedule Planning. A projection of required resources and schedules which lead to a feasible MCC/Shuttle test program shall be provided.

7.2 Testing Philosophy. The basic philosophy for the MCC/Shuttle testing shall be to establish an integrated test program for all system and subsystem level testing required during the MCC/Shuttle timeframe. The goal of this program shall be to provide effective and timely testing to demonstrate compliance to hardware/software specifications and mission support requirements.

MCC/Shuttle testing shall consist of two phases: 1) development testing which includes predelivery testing, onsite hardware/software certification, and integration testing, and 2) operational testing which includes reconfiguration testing, validation testing, and maintenance testing. Detailed descriptions of these tests and test phases are provided in JSC-10309.

The following groundrules and guidelines shall be adhered to throughout the development of the test plan and testing of the MCC Shuttle System.

A. Hardware. Qualification testing of hardware shall include certification of all interfaces in addition to certification of all required functions. Interfaces shall be tested as a part of these qualification tests (QT's).

B. Computer Systems (Hardware and Operating Systems). Acceptance testing shall include all interfaces and drive end items through the operating systems access methods.

C. Applications Programs. Applications programs shall interface with logical end items as a part of their test plans. An example is the SDPC driving the NOM as a part of development testing.

D. String Testing. Minimum string buildup shall be based upon the preceding guidelines. String tests are related to major functions (i.e., telemetry data flow) and shall essentially be a data flow test with predefined data sources. The primary objectives shall be to assemble large elements of the MCC into a system level flow and exercise specific data flow functions.

7.2 Testing Philosophy. (Cont'd)

E. Validation Testing. This test phase shall be primarily for operations familiarization and confidence. Minimum internal validation testing should be planned. Advantage should be taken of other testing activities going on within the MCC to assure that minimum system time is required for this activity.

F. External Validation. External validation shall be essentially the classical approach but shall include an increased emphasis on integration of the mission simulations into the MCC.

7.3 Development Testing. Development testing shall encompass all testing performed during the MCC/Shuttle implementation. This shall include predelivery testing, onsite hardware/software certification or recertification testing, and onsite integration testing. Figure 7-1 illustrates the development testing process.

7.3.1 Predelivery Testing. Predelivery testing shall include those tests that are performed at the contractor facility prior to installation onsite. The testing that shall be performed includes:

- SISO, hardware acceptance tests (AT's)
- SISO, software development testing
- IBM/SDPC, software operating system development and predelivery testing
- IBM/SDPC, hardware predelivery testing.

Software tests may be performed at the factory or onsite depending on computer availability.

7.3.2 Certification Testing. Hardware/software certification testing shall include those tests that are performed onsite to certify and sell off to NASA the deliverable hardware/software components. The testing that shall be performed includes:

- SISO, hardware QT's
- SISO, hardware modification requalification tests (RT's)
- SISO, software QT and RT's
- SISO, subsystem QT
- IBM/SDPC, hardware/operating system software onsite AT
- IBM/SDPC, subsystem integration testing
- IBM/SDPC, performance testing
- IBM/Ground-Based Space System (GBSS) application software development testing
- IBM/GBSS, software independent verification (IV) testing.

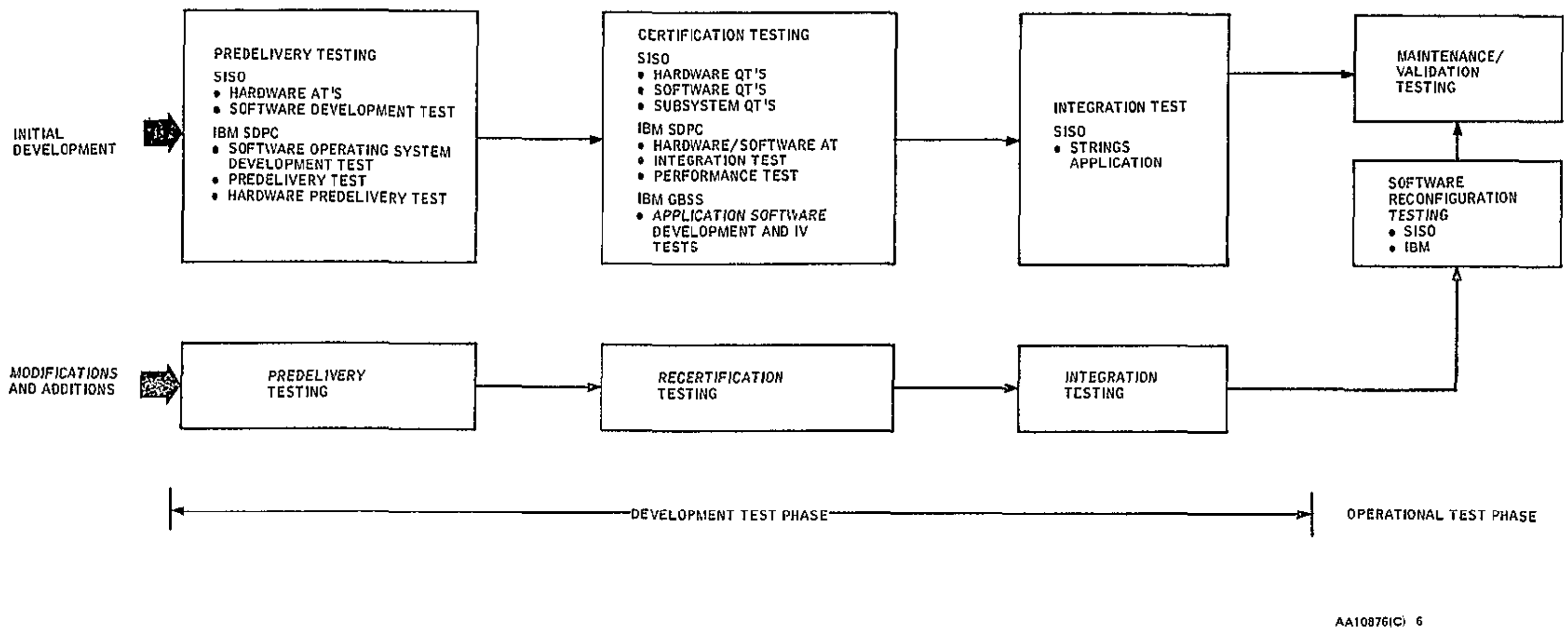

Figure 7-1 MCC Test Flow Diagram

7.3.3 Integration Testing. Integration testing shall encompass system level testing performed during the initial development phase and the modification/change phase.

A. Initial Development Phase. Integration testing shall include those tests that are performed to verify end-to-end application of all MCC/Shuttle hardware/software elements. The primary objectives shall be to assemble large elements of the MCC into application strings such as telemetry and command, and verify end-to-end data flow paths through the system.

B. Modification/Change Phase. The basic philosophy for the integration testing process shall provide for the following two test steps:

- Verify that the modified element as it exists in the system performs its function as a system element
- Verify that there is no degradation of system performance as a result of inserting the modified element into the system (regression testing).

7.3.4 Recertification Testing. Recertification testing shall be necessary when a previously certified element (hardware, software, system configuration data - CRP products) has been modified to expand, reduce, or improve capacity/capabilities or match approved requirements (see figure 7-1). Since the scope of modifications is varied, recertification testing shall be varied in scope and may be satisfied by performing one or more of the following:

- Inspection
- Continuity checks
- Specialized test sets
- Requalification tests to demonstrate change meets performance specifications.

The tests shall be performed using an RTP (Level 1 documentation) or a test preparation sheet (TPS).

7.3.5 Test Responsibility. Predelivery testing and onsite hardware/software QT and RT testing shall be the responsibility of the SISO system manager or IBM manager responsible for designing and implementing the hardware and/or software. These tests shall include the testing of the particular deliverable hardware and its immediate interfaces. Integration testing shall be the responsibility of the Test and Checkout Section of SISO Engineering Integration Department.

7.4 Operational Testing. Operational testing shall be performed to demonstrate the operational readiness of the MCC to support specified missions. These tests shall include reconfiguration, validation, and maintenance.

7.4.1 Reconfiguration Testing. Reconfiguration testing shall be defined as the verification process and testing performed on reconfiguration data and the resulting system when the reconfiguration data is merged with the generalized software to make up a mission-unique system. Reconfiguration tests shall be designed to certify that reconfigurable software tables are configured to appropriate user requirements. Examples of these tests are Telemetry Preprocessing Computer (TPC) tables that define telemetry downlink formats, Institutional Data Systems Division (IDSD) computer-compatible tape (CCT), Analog and Event Distribution (AED) output buffers, SDPC output buffers, etc. IBM shall be responsible for reconfiguration testing of the SDPC subsystem. SISO shall be responsible for reconfiguration testing of the TPC and TPC/SDPC compatibility tests.

Prior to using the application software for validation testing, it shall be necessary to verify that software tables have been configured to requirements. These tests shall be performed on an as necessary basis dependent upon the number/degree of changes to the software tables required to support mission operations. The test plan necessary to satisfy these goals shall be the responsibility of the SISO Test and Checkout Section with the support of the IBM Independent Verification Group.

7.4.2 Validation Testing. Validation testing shall include verifying the operational capability of the MCC internal system, the MCC/Simulation (SIM) interface, and the MCC/Spaceflight Tracking and Data Network (STDN) systems interfaces. These tests shall also verify that configurations and procedures satisfy user requirements in a mission-specific atmosphere from the remote site to the user end instrument. Operational validation testing shall be accomplished as follows.

A. Internal validation tests shall be performed to test internal functions and provide operations familiarization and confidence.

B. MCC/Shuttle Mission Simulator (SMS) validation tests shall be accomplished using the SMS and SIM computers. All

7.4.2 Validation Testing. (Cont'd)

defined mission configurations shall be tested. This shall demonstrate the ability to support premission simulated flights and establish the readiness of the MCC systems to support external validation testing.

C. External validation shall provide the testing of MCC systems with external systems at White Sands (WHS)/Tracking and Data Relay Satellite System (TDRSS), Western Test Range (WTR), John F. Kennedy Space Center (KSC), Goddard Space Flight Center (GSFC), the Ground Spaceflight Tracking and Data Network (GSTDN) stations, landing sites, and remote Payload Operations Control Centers (POCC's). In application, these interfaces shall be proven incrementally with the major tasks being the data acquisition, recovery, and processing involving the GSTDN and the MCC interface.

The overall configurations for MCC/Shuttle shall require extensive testing and verification subsequent to respective deliveries. After initial validation, only abbreviated tests shall be required for flights which follow.

Validation tests shall be performed in an operational configuration to demonstrate the operational readiness of the complete system for a specified mission. The test plan for validation testing shall be the responsibility of the SISO Operations Support Department.

7.4.3 Maintenance Testing. The maintenance testing shall ensure the MCC/Shuttle is in a state of operational readiness to support scheduled user requirements. This shall be accomplished by implementation of a preventive and corrective maintenance program that ensures equipment availability for operational support. The maintenance program shall be followed with internal Maintenance and Operations (M&O) validation tests to verify that the MCC Shuttle is configured to the current released version of JSC-10106, *Mission Control Center Operational Configuration Document*. These tests shall also verify that each unit, subsystem, and system is in a state of operational readiness. Maintenance testing shall consist of the maintenance program and maintenance validation testing. These activities shall be performed by the SISO M&O Department.

7.4.3.1 Maintenance Program. The maintenance program is established by JSC-10099, *Mission Control Center Shuttle Maintenance Plan*. This maintenance plan identifies equipment to be maintained, establishes a preventive and corrective maintenance program, provides levels of maintenance coverage, and defines reporting procedures. The plan also establishes standard maintenance procedures outlining policy and guidelines for all maintenance activities.

7.4.3.2 Maintenance Validation Testing. Maintenance validation testing performed by M&O personnel is directed by JSC-10105, *M&O Standard Operating Procedure*, established by JSC-10102, *M&O Operations Plan*. The validation test procedures are developed by M&O and compiled into the *MCC Validation and Test Manual*, Volume II. The internal M&O validation tests shall be conducted in accordance with standard operating guidelines, MCC reconfiguration schedules, and support count sequences directing specific validation tests.

7.5 Definition of Terms. Terms applicable to the overall MCC/ Shuttle testing are defined in the following paragraphs.

7.5.1 Development Testing Phase. The development testing phase of software or hardware testing shall be performed during MCC/ Shuttle development beginning with factory testing of discrete hardware/software modules, progressing through specification-oriented testing,e.g., AT's, QT's, RT's, and ending with the final MCC/Shuttle integration test.

7.5.2 Software Development Test (SISO). Development testing shall encompass all testing performed during an application's development phase. Beginning with the testing of the application control type programs, the procedure shall follow requirements-oriented testing of each function before and after it is incorporated into the current version of the subsystem.

7.5.3 Software Development Test (IBM). Development testing, shall encompass all testing performed during an application's development phase. Beginning with the testing of the application control type programs, the procedure shall follow requirements-oriented testing of each function before and after it is incorporated into the current version of the subsystem. This procedure shall continue until all elements of the application software are tested together, then it shall be delivered to the IBM IV Group as the final system release.

7.5.4 Software Acceptance Test (SISO)

A. Purpose. The AT shall comprise tests which verify a software entity has been constructed and implemented in accordance with applicable design specifications. A software entity may be a unit (one program), a module or subsystem (a collection of programs), or a complete software system (all programs in all modules). The AT shall demonstrate that all elements of the software satisfy the performance criteria as specified by an approved AT procedure. An AT shall be used with vendor-supplied software, software developed at other than the using facility prior to shipment, and software which cannot be tested in its operational environment due to factors such as phased delivery schedule.

7.5.4 Software Acceptance Test (SISO). (Cont'd)

B. Test Procedure. An AT procedure (ATP) shall specify the inspections, tests, and criteria to ensure that the design requirements for the configuration change or product to be delivered have been fulfilled. The criteria should consist of acceptable test results and include measurement and tolerance values. An AT procedure may be prepared for a single equipment component/computer program item, a subsystem, or a system.

Software ATP's shall be prepared in accordance with the applicable SISO standard and approved by the applicable SISO engineering department, Quality Assurance, and the Program Management Office. The ATP shall then be submitted to NASA for review at least 30 days prior to the scheduled test.

7.5.5 Hardware Acceptance Test (SISO)

A. Purpose. Hardware acceptance testing shall certify the equipment has been manufactured according to applicable documents and the equipment meets major performance requirements per applicable specifications. Successful completion of the AT and associated signatures shall constitute authorization to ship elements to the designated location.

B. Scope. Hardware acceptance testing is normally conducted upon completion of manufacturing and assembly of the hardware and prior to site delivery. The AT shall be performed at the manufacturing facility on a hardware element that is generally defined as a module, unit, subsystem component, or subsystem. The AT shall demonstrate that all elements of the hardware satisfy:

1. Manufacturing and assembly standards in accordance with applicable engineering documentation and standards:

   - QA inspection of workmanship of each manufactured item and of related documentation

   - Engineering verification that the manufactured item is in accordance with applicable documentation.

7.5.5 Hardware Acceptance Test (SISO). (Cont'd)

2. Functional performance specifications to the extent of the reasonable testing capabilities available in the manufacturing facility. This testing should include the following:

   - Verification of internal functions
   - Verification of data throughput
   - Verification of interface control logic levels and timing including interface connector pin assignments
   - Power requirements
   - Verification that design implementation is in accordance with applicable specifications.

C. Test Procedure. The AT shall be conducted according to an approved ATP. The ATP shall contain, as a minimum, the following (reference SISO Standards, Volume III, Part 5.1):

- Identification of the item to be tested
- Test objectives
- Specification of required test resources (test equipment/software) and calibration reference
- Identification of testing tools/methods such as: BITE, test software (when the element has a computer interface), and other test equipment to simulate an interface
- Step-by-step test procedures including initial setup
- Pass or fail criteria for the test
- Specified operational tolerances

7.5.5 Hardware Acceptance Test (SISO). (Cont'd)

- Data sheets that record specific values
- Signoff forms.

ATP's are type 1 documentation. The ATP shall be approved by the applicable SISO engineering department, Quality Assurance Department, and the Program Management Office, as specified in the SISO Standards (Volume III, part 5.4). The ATP shall be submitted to NASA for review at least 30 days prior to the scheduled AT.

7.5.6 Predelivery Test (IBM). Predelivery testing shall be defined as that testing to be conducted at the IBM facility in Nassau Bay on SDP2 to demonstrate the capabilities of each hardware element type, and the capabilities of the operating systems software and support software.

7.5.7 Software Qualification Test (SISO)

A. Purpose. A QT shall verify the functional capability of new equipment computer programs following onsite development or installation. The test shall comprise a series of tests that combine the various elements of a software system into a complete operational entity and verify performance against established requirements as delineated in the design specification. Successful completion of the QT shall constitute delivery and acceptance of the software product by the customer.

B. Test Procedure. The QT shall be conducted according to an approved qualification test procedure (QTP). The QTP shall provide detailed documentation of all testing required to demonstrate the software is in compliance with all applicable specification requirements. The procedures shall contain, as a minimum, the following:

- Identification of system element to be tested
- Test objective

7.5.7 Software Qualification Test (SISO). (Cont'd)

- Resources required for the test
- Step-by-step procedure for accomplishing the test, including the initial settings for all manually controlled parameters
- Specification of testing tools/methods such as test software
- Criteria for passing or failing the test
- Specified tolerance of operation.

The software QTP is Type 1 documentation and shall be approved by the applicable SISO engineering department, Quality Assurance, and Program Management Office. The QTP shall be submitted to NASA for review at least 30 days prior to the scheduled test.

7.5.8 Hardware Qualification Test (SISO)

A. Purpose. The QT shall certify the equipment performs in its operational environment as required by the applicable specification. Successful completion of the QT shall constitute delivery and acceptance of the element tested.

B. Scope. Hardware qualification testing shall be conducted to verify the functional capability of an element (unit, subsystem, or system) which may consist of any combination of hardware and software components. The QT shall also demonstrate to the customer that the element performs to specification. Successful completion of QT and associated customer signoff shall constitute acceptance by the customer. The QT (which may be a series of tests) shall evaluate the complete element (including interfaces) as an entity in its operational environment. The QT shall normally be performed at the delivery site to verify:

1. Operational Capabilities

   - All internal functions perform to specification

7.5.8 Hardware Qualification Test (SISO). (Cont'd)

- Required data throughput can be accomplished
- Interfaces with external equipment are operational
- Operator interface controls
- System response time meets operational requirements.

2. Onsite Workmanship

- Installation inspection by QA
- Inspection of cable routing and connectors
- Installation integration (equipment interface inspection, etc.).

3. External Equipment Interfaces

- Compliance with appropriate specification
- Identification of interface tests which are being waived (and/or allocated to other system element tests).

4. System Integrity

- Error rates within specified limits
- Operation during failure mode conditions
- Ability to function properly with other interfaced systems.

C. Test Procedure. The QT shall be conducted according to an approved QTP. The QTP shall provide detailed documentation of all testing required to demonstrate that the equipment

7.5.8 Hardware Qualification Test (SISO). (Cont'd)

is in compliance with all applicable specification requirements. The procedures shall contain, as a minimum, the following:

- Identification of system element to be tested
- Test objective
- Resources required for the test (e.g., test equipment for software test tapes, etc.)
- Step-by-step procedure for accomplishing the test, including the initial settings for all controls, power supply voltages, etc.
- Specification of testing tools/methods such as BITE and test software (when the element has a computer interface)
- Criteria for passing or failing the test
- Specified tolerance of operation.

QTP's are type 1 documentation and shall be prepared in accordance with SISO Standards (Volume III, Part 5.1). The QTP shall be approved by the applicable SISO engineering department, Quality Assurance Department, and Program Management Office, as specified in the SISO Standards (Volume III, Part 5.4). The QTP shall be submitted to NASA for review at least 30 days prior to the scheduled QT.

7.5.9 Hardware Requalification Test (SISO)

A. Purpose. An RT shall be used to verify the functional capability of a previously certified equipment item following the incorporation of a modification which expands or reduces the capacity/capability of the existing design or system. Depending on the equipment involved, the RT requirement

7.5.9 Hardware Requalification Test (SISO). (Cont'd)

may be satisfied by Preventive Maintenance Instructions (PMI's), continuity checks, tests using specialized test sets, or by an operational demonstration with associated subsystem elements. An RT may or may not require onsite computer support.

B. Test Procedure. The writing of requalification test procedures (RTP's) shall be the responsibility of the SISO engineering organization that performed the system design. RTP's may, depending on test requirements, consist of a detailed test procedure or simplified test procedure. RTP's are considered type 2 documentation, and as a minimum shall be approved by the applicable SISO engineering, Program Management Office, and Quality Assurance organizations. All RTP's shall be submitted to NASA for review at least 1 week prior to the scheduled test. Concurrently, copies shall be given to M&O for their review and familiarization prior to the scheduled test.

7.5.10 Test Preparation Sheet (SISO). When an equipment modification is installed which is relatively minor in nature, a test preparation sheet (TPS) may be used. SISO shall have the prerogative of describing the simplified tests for a minor modification required for QA and customer approval on a TPS. The TPS is a NASA form, MSC Form 1225. These forms can be used with SISO QA concurrence to cover minor testing efforts such as:

- Workmanship inspection
- Referencing M&O PMI checks which will suffice for checkout
- Simple cable or circuit continuity checks
- Simple type test procedures requiring a minimal number of steps and observations.

7.5.11 Software Requalification Test (SISO)

A. Purpose. An RT shall be used to verify the functional capability of a computer program following the incorporation of a modification. The RT requirement may be satisfied by tests using specialized test data sets or by an operational demonstration with associated subsystem elements.

B. Test Procedure. As with the QTP, the RTP shall describe the goals of the tests, the resources necessary to test the changes, the detailed test procedures, the responsible organizations, and the success criteria for the test. All RTP's shall be submitted to NASA for review at least 30 days prior to the scheduled test.

7.5.12 Onsite Acceptance Test (IBM). Onsite acceptance testing shall be conducted at JSC to demonstrate the capabilities of hardware elements delivered by IBM and to prove the software deliverables perform to contract specifications. The software testing shall demonstrate the SDPC Benchmark Program Test on each of the computer systems to be delivered.

7.5.13 System Integration Test (IBM). System integration testing shall be conducted at JSC to demonstrate the capability of the SDPC to communicate with the MCC support systems through the SDPC to MCC equipment interfaces.

7.5.14 Performance Test (IBM). Performance testing shall be conducted after system integration testing to demonstrate the opperational speeds and data handling capabilities of the SDPC while interfaced to the MCC equipment in the operational configuration.

7.5.15 Integration Test (SISO). Integration testing shall be performed with each application string such as telemetry, command, trajectory, etc., to verify that the application string meets system performance requirements. Integration testing shall also be performed to verify the integrity of the system after changes have been incorporated.

7.5.16 Independent Verification (IBM). Independent verification (IV) testing is defined as an independent, requirements-oriented approach to testing in a complete system environment (all software components have been incorporated into the system). IV shall perform detailed software interface tests between the various applications as well as MOC/DSC interface tests, timing interference tests, final performance measurement tests, and independently defined requirements-oriented system level functional tests. Complete control of software modifications shall be an integral part of the IV process. The software configuration management shall continue into the post-delivery timeframe with detailed testing of modifications and extensive regression testing.

7.5.17 Operational Testing Phase. The operational testing shall be performed with the complete end-to-end system in an operational configuration. The testing shall be performed with and by users of the system using tests based upon operational functions.

7.5.18 Reconfiguration Test. Reconfiguration testing shall consist of a test or a series of tests which are performed to verify a hardware/software reconfiguration. These tests shall be performed to determine the integrity of the system prior to the release of the system to operations. The major milestone that initiates these tests is the release of CRP configuration data products which are used to configure the TPC and SDP data processing.

7.5.19 Validation Testing. Validation testing shall verify mission configurations. Validation test configurations shall be divided into three integrated hardware/software systems categories:

- MCC
- MCC/SMS
- MCC/STDN.

7.5.19 Validation Testing. (Cont'd)

The tests shall be perfomed in an operational configuration to demonstrate the operational readiness of the complete system for a specified mission.

7.5.20 Maintenance Testing. Maintenance testing and checkout shall consist of a continuous testing phase to start after qualification and/or requalification of hardware/software units, subsystems, or systems. Categories of maintenance testing shall be as follows:

A. Preventive Maintenance (PM) Testing. PM testing and checkout is based on the requirement to test hardware for both electrical and mechanical performance in order to detect substandard conditions prior to failure. This testing shall require special test software checkout hardware packages.

B. Hardware Functional Unit Level Testing. Hardware unit level testing shall be test and checkout of a single functional unit to specification. A functional unit may be one or more collective functions of a subsystem or a standalone unit of hardware. Testing at this level shall require special software checkout hardware or hardware test equipment.

C. Hardware Subsystem Level Testing. Hardware subsystem level testing shall consist of test and checkout to measure collective performance of a subsystem. Testing at this level shall require special software checkout hardware or hardware test equipment.

D. Hardware System Level Testing. Hardware system level testing shall consist of test and checkout to measure performance of all hardware within a system. This may be a sequence of tests using special software and/or hardware test equipment.

8. QUALITY ASSURANCE

8.1 General. Quality assurance provisions for equipment, subsystems, or systems manufactured by SISO shall be in accordance with NASA publication NHB 5300.4(1D-1). Quality assurance provisions for equipment, subsystems, or systems procured as "off-the-shelf" or "modified-off-the-shelf" shall be as specified in NASA publications NHB 5300.4(1C) and NHB 5300.4(1D-1) respectively, as amended by SISO's TR388.

8.2 Workmanship. Workmanship shall be in accordance with Volume II of the SISO Standards, or SISO Quality Assurance approved equivalent vendor standards.

8.3 System Hardware Acceptance. Individual equipment acceptance shall be in accordance with an Acceptance Test Procedure (ATP), Qualification Test Procedure (QTP), or Requalification Test Procedure (RTP) prepared by SISO to demonstrate compliance of the equipment with the requirements of the specification. Testing of the OFTDS as an operational system shall be performed as a series of string tests after completion of individual ATP's, QTP's, and/or RTP's of the hardware components comprising the string. Subsystem strings that are directly interactive shall require concurrent testing, while other noninteractive strings shall require individual testing as defined in the following paragraphs. Further testing details are contained in SISO publication JSC-10309.

8.3.1 Interactive Testing. This testing is also referred to as string testing and shall consist of the following type tests.

A. Analog Instrumentation. Analogs representing downlinked onboard parameters shall be simulated on magnetic tape and sent to analog meters and SCR channels in the DCS and Mission Evaluation Room Subsystem (MERS).

B. Bilevel Instrumentation. Bilevel events shall be simulated and routed to event recorders and event indicators in the DCS. The TS shall provide the required event timing inputs.

8.3.1 Interactive Testing. (Cont'd)

C. Plotboard Tests. Software-generated, simulated coordinate data shall be provided to the plotboards in the DCS.

D. Timing. Timing signals shall be provided from magnetic tape and the TS for display in the MERS, DCS, and TVSS.

E. Video Tests. Video display of CRT characters and DTE video shall be provided by software-generated data. Video shall be simulated by video tape recorders and shall test the RF distribution circuits. Hardware requests shall be tested.

8.3.2 Individual Testing. Testing of the AGVS and VIS shall be performed at the time of installation and in conjunction with recording facilities of the AGVS and VIS.

Testing shall be provided by processing inputs from Bldg. 5 simulated data. The NIP shall eventually provide an alternate testing input data source.

8.4 System Software Acceptance. The OFTDS shall be developed and tested prior to implementation of the NIP. Therefore, all testing shall be accomplished with simulated data from confidence tapes. The system tests shall be divided into areas compatible with the partitioning of the software. The tests shall provide testing of OFTDS real-time functions, tabulation, hardware, and telemetry network.

8.4.1 OFTDS Real-Time Testing. Software testing of the OFTDS real-time function shall require the Confidence Tape System. Reconfiguration tables for the current system configuration shall be compared with those for the previous system by the comparative software developed for system validation. Specific confidence tapes shall be prepared for DTE format testing, limit sensing, event processing, logic processing, event latching, navigation data, plotboard testing, and MDD tests.

8.4.2 Tabulation. Items that shall be tested include: data selection, EU conversion, listing options, and listing control language capabilities.

8.4.3 Hardware Testing. Individual hardware testing shall precede a total system test. Total system testing shall verify all interfaces.

8.4.4 Telemetry Network. The system testing for the telemetry network test software shall require the same confidence tape used to validate the OFTDS real-time functions. The data shall be logged and the log tape compared with the binary associated with the confidence tape.

9. PREPARATION FOR DELIVERY

9.1 Preparation and Packaging. Preparation and packaging of hardware deliverable from SISO to JSC shall be in accordance with NASA publication NHB 5300.4(1D-1) as amended by SISO-TR388. Packaging of "off-the-shelf" or "modified-off-the-shelf" equipment shall be to previously approved commercial standards.

9.2 Receipt at Destination. The subcontractor shall be responsible for assuring that equipment, upon receipt at destination, is free of damage and operative within the performance requirements of this specification.

9.3 Marking and Labeling for Shipment and Storage. Equipment marking and labeling of hardware deliverable from SISO to JSC shall be in accordance with NASA publication NHB 5300.4(1D-1) as amended by SISO-TR388. Marking and labeling of "off-the-shelf" or "modified-off-the-shelf" equipment shall be to previously approved commercial standards.

APPENDIX A

LIST OF ACRONYMS AND ABBREVIATIONS

APPENDIX A

LIST OF ACRONYMS AND ABBREVIATIONS

A	Availability
ADC	Asynchronous Data Channel
ADEG	Auxiliary Display Equipment Group
AED	Analog and Event Distribution
AFS	Atomic Frequency Standard
A/G	Air-to-Ground
AGC	Automatic Gain Control
AGVS	Air-Ground Voice Subsystem
AIRP	Aircraft Instrumentation Research Program
ALT	Approach and Landing Test
ALTDS	ALT Data System
A/N	Alphanumeric
ANSI	American National Standards Institute
AOS	Acquisition of Signal
ASCII	American Standard Code for Information Exchange
ASTP	Apollo Soyuz Test Program
AT	Acceptance Test
ATP	Acceptance Test Procedure
AVSM	Auxiliary Video Switch Matrix
AWG	American Wire Gauge
AWS	Air Weather Service
BA	Bus Adapter
BCD	Binary-Coded Decimal
BDF	Blocked Data Format
BFCS	Backup Flight Control System
BITE	Built-In Test Equipment
bpi	Bits per Inch

LIST OF ACRONYMS AND ABBREVIATIONS (CONT'D)

BRCL	Background Request Control Logic
b/s	Bits per Second
B/U	Backup
CASRS	Countdown and Status Receiver System
CAW	Cluster Allocation Word
CCA	Channel-to-Channel Adapter
CCATS	Command, Control, and Telemetry System
CCE	Console Communication Equipment
CCIM	Command Computer Input Multiplexer
CCRF	Consolidated Communications Recording Facility
CCS	Command and Control System
CCT	Computer-Compatible Tape
CCTCF	Communication Circuit Technical Control Facility
CDF	Combined Distribution Frame
CDL	Cross Domain Link
CDS	Continuous Data Segments
CHP	Command History Printer
CIM	Computer Input Multiplexer
CIS	Communication Interface System
CLM	Computer Language Memory
CLS	Communications Line Switch
CMD	Command
CNTLR	Controller
COHART	Combined Operational Hardware and Readiness Testing
COM	Computer Output Microfilm
COMM	Communication
CONS	Console Subsystem
CP	Communication Processor
CPDS	Computer Program Development Specification

LIST OF ACRONYMS AND ABBREVIATIONS (CONT'D)

CPU	Central Processing Unit
CRP	Configuration Requirements Processor
CRT	Cathode Ray Tube
CSE	Configuration and Switching Equipment
CSF	Console Select Function
CSL	Console
CTC	Cable Termination Cabinet
CTMC	Communication Terminal Multiplexer Cabinet
D/A	Digital-to-Analog
DAC	Digital-to-Analog Converter
DASD	Direct Access Storage Device
dB	Decibel
D/C	Display/Control
DCC	Data Computation Complex
DCCU	Digital Television Equipment Cluster Control Unit
DCDU	Display Cluster Diagnostic Unit
DCS	Display and Control System
DCU-R	Data Control Unit Receiver
DCU-T	Data Control Unit Transmitter
DCVS	Digital Coherent Video Synchronizer
DDD	Digital Display Driver
DDHS	Dump Data Handling Subsystem
DDLS	Digital Data Line Switch
DDD/SDD	DDD Subchannel Data Distributor
DDS	Discrete Display Subsystem
DEC	Digital Electronics Corporation
DEMOD	Demodulator

LIST OF ACRONYMS AND ABBREVIATIONS (CONT'D)

DEMUX	Demultiplexer
DEU	Display Electronics Unit
DFE	Data Flow Engineer
DFI	Development Flight Instrumentation
DIU	Data Interface Unit
D/L	Downlink
DLM	Display Language Memory
DLSM	Data Link Summary Message
DMA	Direct Memory Access
DMS	Delta Modulation System
DPDT	Double Pole Double Throw
DPL	Data Processing Logic
DQM	Data Quality Message
DRAFT	Data Retrieval and Formatting Technique
DRK	Display Request Keyboard
DSC	Dynamic Standby Computer
DSCIM	Display Select Computer Input Multiplexer
DTE	Digital Television Equipment
DTEIC	DTE Interface Cabinet
DTS	Digital Television Subsystem
DU	Demarcation Unit
EBCDIC	Extended Binary Coded Decimal Interchange Code
EIA	Electronic Industries Association
EOAP	Earth Observations Aircraft Program
EOF	End-of-File
EREP	Earth Resources Experiment Package
ERIPS	Earth Resources Interactive Processing System

LIST OF ACRONYMS AND ABBREVIATIONS (CONT'D)

ERTS	Earth Resources Technology Satellite
ESO	Event Sequence Override
ESTL	Electronic Systems Test Lab
ESW	Equipment Status Word
ETR	Eastern Test Range
EU	Engineering Unit
FACS	Facility Control Subsystem
FC	Flight Controller
FCR	Flight Control Room
FDM	Frequency Division Multiplexer
FM	Frequency Modulation
FOD	Flight Operations Directorate
FODA	FOD Auditorium
FS	Field Sequential
FSK	Frequency-Shift Keyed
FSU	Frequency Standards Unit
FWTS	4-Way Transfer Switch
GBSS	Ground-Based Space System
GCTS	Generalized Confidence Tape System
GDS	Group Display Subsystem
GDSD	Ground Data Systems Division
GET	Ground-Elapsed Time
GFE	Government-Furnished Equipment
GMT	Greenwich Mean Time
GPC	General-Purpose Computer
GPT	General-Purpose Time
GRT	Ground Receipt Time

LIST OF ACRONYMS AND ABBREVIATIONS (CONT'D)

GSFC	Goddard Space Flight Center
GSSC	Ground Support Simulation Computer
GSTDN	Ground Spaceflight Tracking and Data Network
HBR	High Bit Rate
HRF	Historical Recording Facility
HS	High Speed
HSD	High-Speed Data
HSDPB	High-Speed Data Patch Bay
HSP	High-Speed Printer
HSR	High Sample Rate
IBM	International Business Machines
ICU	Interface Control Unit
ID	Identification
IDD	Interface Definition Document
IDF	Intermediate Distribution Frame
IDSD	Institutional Data Systems Division
IEODCS	Interactive Earth Observation Display/Control System
I/F	Interface
IIM	Input Interface Module
I/O	Input/Output
IPS	Inches per Second
IRIG	Interrange Instrumentation Group
ISA	Intermediate Storage Area
IUS	Interim Upper Stage
IV	Independent Verification
JSC	Lyndon B. Johnson Space Center
kb	Kilobit

LIST OF ACRONYMS AND ABBREVIATIONS (CONT'D)

kb/s	Kilobits per Second
km	Kilometer
KSC	John F. Kennedy Space Center
LACIE	Large Area Crop Inventory Experiment
LBR	Low Bit Rate
LCT	Launch Countdown Time
LED	Light Emitting Diode
LLIU	Launch and Landing Interface Unit
LLTD	Launch and Landing Tracking Data
LOS	Loss of Signal
LPM	Lines per Minute
LS	Low Speed
LSB	Least Significant Bit
LSR	Line Scan Rate
LSS	Least Significant Syllable
MAC	Memory Assignment Control
MAM	Memory Access Multiplexer
MBI	Multibus Interface
Mb/s	Megabits per Second
MCC	Mission Control Center
MDD	Multichannel Data Demultiplexer
MDF	Main Distribution Frame
MDM	Multiplexer/Demultiplexer
MED	Manual Entry Device
MEDICS	Medical Information Computer System
MERS	Mission Evaluation Room Subsystem
MET	Mission Elapsed Time

LIST OF ACRONYMS AND ABBREVIATIONS (CONT'D)

MILA	Merritt Island Launch Area
MIP	Manual Input Processor
MIPS	Million Instructions per Second
MLA	Multiplexer Line Adapter
M&O	Maintenance and Operations
MOC	Mission Operations Computer
MOCR	Mission Operations Control Room
MOD	Modulator
MODEM	Modulator/Demodulator
MOPR	Mission Operations Planning Room
MOW	Mission Operations Wing
MPSR	Multipurpose Support Room
MSB	Most Significant Bit
MSK	Manual Select Keyboard
MSS	Multispectral Scanner; Most Significant Syllable
MTC	Master Test Clock
MTU	Magnetic Tape Unit; Master Timing Unit
MUX	Multiplexer
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications Network
NBS	National Bureau of Standards
NCI	Network Communications Interface
NCIC	Network Communications Interface Common
NCIU	Network Communications Interface Unique
NETCOM	Network Communications
NIP	Network Interface Processor
nmi	Nautical Miles

LIST OF ACRONYMS AND ABBREVIATIONS (CONT'D)

NOAA	National Oceanic and Atmospheric Administration
NOCC	Network Operations Control Center
NOM	Network Output Multiplexer
NRZ	Nonreturn-to-Zero
NTSC	National Television Standards Committee
NWS	National Weather Service
OAS	Orbiter Aeroflight Simulator
OD	Orbiter Downlink
ODIF	OD Data Interface
OFT	Orbital Flight Test
OFTDS	OFT Data System
OI	Operational Instrumentation
OPS	Operations
OS	Operating System
OSW	Operations Support Wing
PA	Public Address
PABX	Private Automatic Branch Exchange
PAE	Public Address Equipment
PAM	Pulse Amplitude Modulation
PBI	Pushbutton Indicator
PCD	Pulse-Coded-Decimal
PCK	Program Control Keyboard
PCM	Pulse Code Modulation
PCMMU	PCM Master Unit
PDM	Pulse Duration Modulation
PDSDD	Plotting Display Subchannel Data Distributor
PET	Phase Elapsed Time

LIST OF ACRONYMS AND ABBREVIATIONS (CONT'D)

PFC	Production Film Converter
PHO	Philco Houston Operations (now SISO)
PIXEL	Picture Element
PM	Phase Modulation; Preventive Maintenance
PMI	Preventive Maintenance Instructions
POC	Processor-Oriented Circuit
POCC	Payload Operations Control Center
PPS	Production Processor System
PRESIM	Presimulation Program
PRNT	Printer
p/s	Pulses per Second
PSK	Phase-Shift-Keyed
PTS	Pneumatic Tube Subsystem
PTT	Push-to-Talk
QT	Qualification Test
QTP	Qualification Test Procedure
R	Reliability
RAS	Random Access Storage
RF	Radio Frequency
RGB	Red, Green, Blue
RJE	Remote Job Entry
RM	Refresh Memory
rms	Root Mean Square
R/S	Restart/Selectover
RST	Recessed Selectomatic Terminal
RT	Requalification Test
RTP	Requalification Test Procedure

LIST OF ACRONYMS AND ABBREVIATIONS (CONT'D)

RTA	Real-Time (or Relative-Time) Accumulator
RTC	Real-Time Command
RTCC	Real-Time Computer Complex
RTR	Ready-to-Receive
RTT	Ready-to-Transmit
RZ	Return-to-Zero
SAIL	Shuttle Avionics Integration Lab
SC	Selector Channel
S/C	Spacecraft
SCATS	Simulation, Checkout, and Training System
SCR	Stripchart Recorder
SCS	SDPC Configuration and Selectover Unit
SCU	System Configuration Unit
SDD	Subchannel Data Distributor
SDL	Software Development Lab
SDLC	Synchronous Data Link Control
SDP	Shuttle Data Processor
SDPC	Shuttle Data Processing Complex
SEF	Systems Engineering Facility
SGDS	Shuttle Ground Data System
SGMT	Simulated Greenwich Mean Time
SIM	Simulations; Simulator
SMEK	Summary Message Enable Keyboard
SMS	Shuttle Mission Simulator
SOD	Site-Originated Data
SPC	Stored Program Command
SPL	Speech Power Level
SPP	Special-Purpose Processor

LIST OF ACRONYMS AND ABBREVIATIONS (CONT'D)

S/S	Samples per Second; Subsystem
STDN	Spaceflight Tracking and Data Network
STS	Space Transportation System
SVC	Service Call
TAEM	Terminal Area Energy Management
TAGS	Test and Graphics
TASS	Terminal Applications Support System
TBD	To Be Determined
TBS	To Be Supplied
TCCE	Terminal Communication Control Element
TCOS	TPC Checkout System
TCS	Terminal Control Subsystem
TCSM	TV Channel Status Module
TDRSS	Tracking and Data Relay Satellite System
TECM	Time Entry Control Module
TED	Telemetry Event Driver
T/L	Talk/Listen
T/L-M	Talk/Listen-Monitor
TLM	Telemetry
TOPDAC	Third Order Polynomial D/A Converters
TPC	Telemetry Preprocessing Computer
TPS	Test Preparation Sheet
TRK	Tracking
TS	Timing Subsystem
TSO	Time-Share Option
TTL	Test Tone Level
TTY	Teletype

LIST OF ACRONYMS AND ABBREVIATIONS (CONT'D)

TV	Television
TVSS	Television and Video Switching Subsystem
UA	User Adapter
UAR	Unload Address Register
UCT	Universal Coordinated Time
UHF	Ultra-High Frequency
ULI	Universal Logic Interface
USNO	U.S. Naval Observatory
UST	Unblocked Serial Telemetry
V ac	Volts, Alternating Current
V dc	Volts, Direct Current
VF	Voice Frequency
VFTG	Voice Frequency Telegraph
VIS	Voice Intercom Subsystem
VOX	Voice-Operated Relay
V rms	Volts, Root-Mean-Square
VSM	Video Switching Matrix
VSMBM	VSM Buffer Multiplexer
VU	Volume Unit
WB	Wideband
WBD	Wideband Data
WBDTS	Wideband Data Transfer Switch
WBS	Wideband Serializer
WHS	White Sands, New Mexico
WINDS	Weather Information Network Data System
WPM	Words per Minute
WTR	Western Test Range

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