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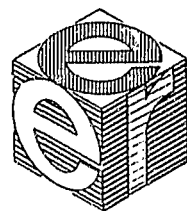
ENGINEERING & ECONOMICS RESEARCH, INC.

AN
ATTACHED PAYLOAD OPERATIONS CENTER (APOC)
AT THE
GODDARD SPACE FLIGHT CENTER (GSFC)

Volume II

Prepared for:

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

A functional design for an Attached Payload Operations Center (APOC) has been prepared and is documented in Volume I of this report. The APOC was designed to support both Spacelab and non-Spacelab payloads. Early consideration was given to the support of the Office of Space Science (OSS) -3 thru 7 missions, which were renamed ASTRO following the transfer of mission management responsibility to the Marshall Space Flight Center (MSFC). In addition, the requirements to support other attached payloads including several assigned Goddard Space Flight Center (GSFC) management responsibility were considered. These included the Solar Optical Telescope (SOT), OSS-2 (renamed Shuttle High Energy Astrophysical Laboratory (SHEAL)), Environmental Observation Mission (EOM) -A and Starlab.

The APOC concept as designed capitalized on existing and planned GSFC facilities and the remote Payload Operations Control Center (POCC) capability currently being brought to operational status to support free-flyer launch and retrieval from the Space Transportation System (STS). This latter capability is provided by the Shuttle/POCC Interface Facility (SPIF). The SPIF provides a centralized capability for supporting specific STS management functions thereby avoiding the need to duplicate these capabilities for each POCC interfacing with the STS. The SPIF is the first remote POCC to be interfaced with the Johnson Space Center (JSC) Mission Control Center (MCC), which is responsible for the command of Orbiter flight and flight safety and resources management for the STS. Utilization of this facility within the APOC is significant since its capability will be demonstrated shortly in the support of two free-flyer programs in 1984.

The Multi-Satellite Operations Control Center (MSOCC) facility was also included as an integral part of the APOC functional design. This facility undergoes continual upgrade to maintain operational capability for the various free-flyers supported out of the GSFC. It provides a multi-mission POCC environment for support of up to six simultaneous missions plus software development. Utilization of this facility provides a proven operational environment and a lower APOC sustaining cost as a result of a distribution of overhead functions.

Channel two (2) and three (3) data from the Spacelab for payloads utilizing this European Space Agency (ESA) system are input via the Spacelab Data Processing Facility (SLDPF). This facility was developed to provide the necessary data processing functions and data product generation capability for data received from Spacelab payloads. The facility is configured with a Spacelab Input Processing System (SIPS) providing necessary data capture, demultiplexing, Data Quality Monitoring (DQM) and data accounting functions; and a Spacelab Output Processing System (SOPS) providing editing/formatting, time ordering and overlap removal, input/output decommutation, ancillary processing, data accounting and data product generation. To support APOC additional SIPS capability was included to provide necessary capability for POCC functions.

Various other GSFC insititutional capabilities were utilized in the APOC design to provide required capability. These included the Flight Dynamics Facility (FDF) providing mission analysis and computational support, and operational and definitive attitude computation, the Command Management System (CMS) providing payload command management and a mission planning system providing the necessary tools and planning capability to support attached payloads with a link to the CMS.
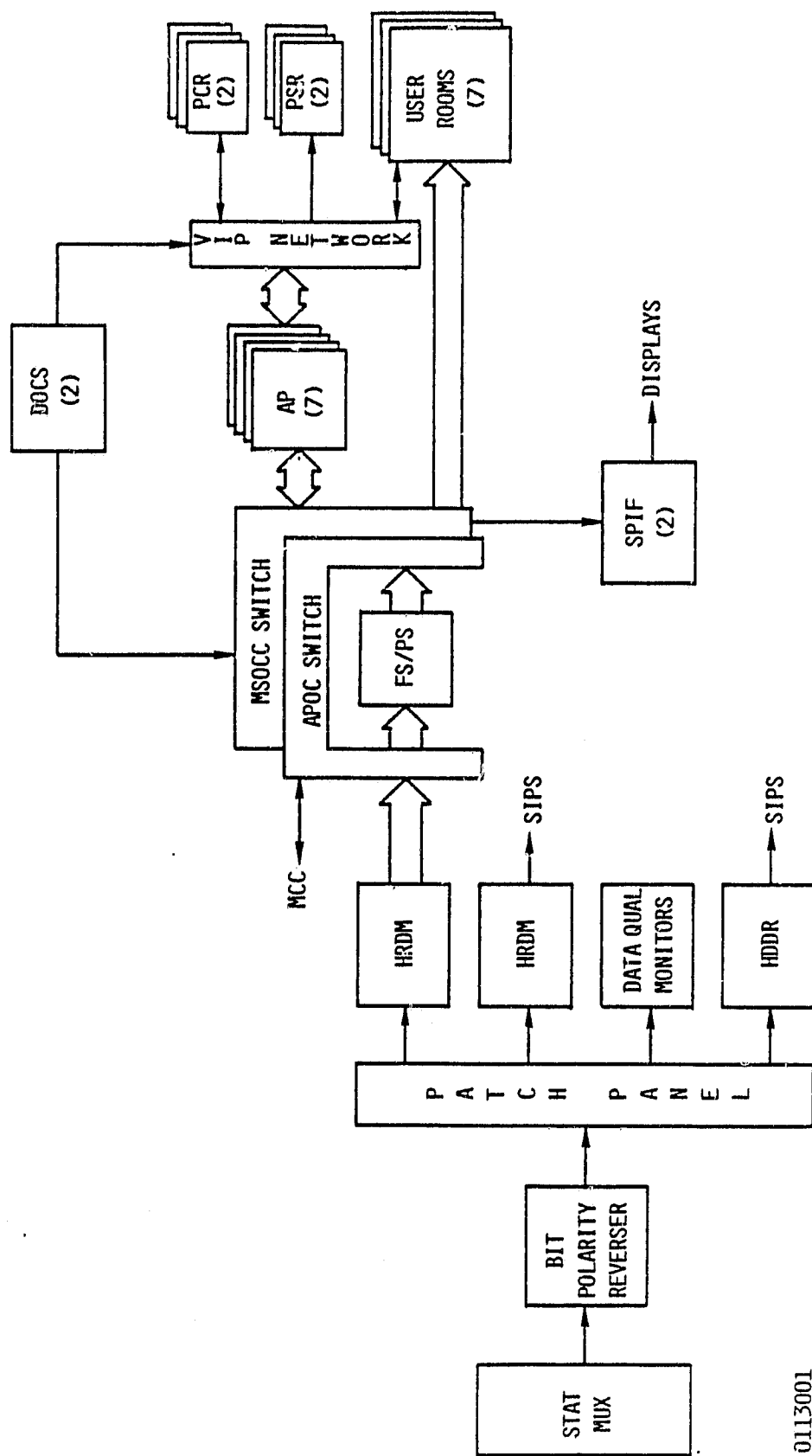
2.0 APOC OVERVIEW

An overview of the APOC is shown in Figure 2-1. For Spacelab payloads channel 2 and 3 data are input via a Statistical Multiplexer (SM) to the various SIPS functions. These include recording of the data on High Density Recorders (HDR), DQM and demultiplexing of the composite data stream by the High Rate Demultiplexer (HRDM). This system performs the inverse functions of the onboard Spacelab High Rate Multiplexer (HRM) enabling access to the data streams as multiplexed onboard the Spacelab. The contents and characteristics of channels one, two and three data as downlinked by the Tracking and Data Relay Satellite System (TDRSS) Ku-band are shown in Table 2-1.

Channel one data is received by the MCC and processed with selected information provided to the APOC via the SPIF. This is received via the MSOCC switch. This includes Payload Data Interleaver (PDI) and Payload Parameter Frame (PPF) data from non-Spacelab payloads, which are input for processing by the SPIF or MSOCC as required. It should be noted that the SPIF is a separate facility, but utilizes several common systems capabilities with the MSOCC.

Output data from the HRDM are synchronized and input to the MSOCC via the APOC switch. The HRDM output data streams are shown in Table 2-2. The APOC switch has the capability for switching data streams up to 10 Mbps. Higher rate streams are patched on a mission-unique basis. Seven Frame Sync/Parameter Select (FS/PS) units are integral to the APOC switch and provide the capability to select subsets of required data streams. These streams can include selected experiment channels, the Experiment Computer Input/Output (ECIO) or Subsystems Computer Input/Output (SCIO) stream.

Figure 2-1. APOC Overview

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Table 2-1

TDRSS Ku-Band Downlink for Spacelab

MODE	CHANNEL		
	1	2	3
1 (PM)	DIGITAL 192 KBPS (64 KBPS FROM SPACELAB)	DIGITAL 0.016-2 MBPS	DIGITAL 2-50 MBPS
2 (FM)	DIGITAL 192 KBPS (64 KBPS FROM SPACELAB)	DIGITAL 0.016-2 MBPS	DIGITAL 0.016-4 MBPS OR ANALOG CCTV OR 4.5 MHZ CHANNEL
PRIME PAYLOAD DATA TRANSMITTED	STS ANCILLARY AND VOICE	ECIO AND HIGH RATE SCIENCE, SPACELAB VOICE	HIGH RATE SCIENCE AND/OR VIDEO OR ANALOG

Table 2-2

HRDM Output Data Streams

Data Stream	Number	Bit Rate
Experiment Channel	16	200 bps up to 16 Mbps
High Data Rate Recorder (HDRR)	1	2/4/8/12/16/24/32 Mbps
Payload Recorder (PR)	1	1 Mbps
Experiment Computer Input/Output	1	200 bps up to 0.5 Mbps[1]
Subsystem Computer Input/Output	1	200 bps up to 0.5 Mbps[1]
GMT	1	Retrieved from downlink status words

1   Maximum Input Rate 25.6 Kbps

Data streams may be input for processing by an Applications Processor (AP) or provided to a user room for processing by experimenter provided Electrical Ground Support Equipment (EGSE). The AP could typically provide simple processing such as limit checking of engineering data contained within the ECIO or arithmetic operations on a subset of an experiment channel to support an instrument monitoring function. In general processing of scientific data to support quicklook analysis would be provided by the EGSE. A maximum of 2000 parameters per second (16-bits per parameter) may be input to the AP for processing, although this capability is planned to be increased to 4000 parameters per second in January, 1986. A Near-Realtime (NRT) capability is provided, whereby STS and payload parameters are stored for on-demand access on a shared basis. This system has the capability to store 500 STS parameters per second (extracted from the STS data contained within Channel one and transferred from the MCC) and up to 9200 payload parameters, where these latter parameters are extracted from the various data streams and subsets provided from the APOC switch and/or the PDI and PPF.

Output of the results of the processing within the AP are transferred via a Virtual Interface Processor (VIP) to various peripherals contained within the Payload Control Rooms (PCR) and/or Payload Support Rooms (PSR) as required. These include terminal devices consisting of a Personal Computer (PC) with floppy disk and dot matrix printer, and/or a Strip Chart Recorder (SCR). Forty PC terminal systems are included in the APOC upgrade of the MSOCC facility, and a total of seven SCRs will be made available.

Commands may be input via the terminal devices and transferred to the AP for processing and uplink via the MCC. Other command modes supported include direct transfer of commands from EGSE to the AP and/or transfer

from a remote location to the AP. Command types include, realtime: time tagged, discrete (on/off), group, procedure, restricted and critical; and preprogrammed: command memory load, Dedicated Experiment Processor (DEP) and microprocessor loads, and Experiment Computer Operating System (ECOS) and/or Experiment Computer Applications System (ECAS) loads/ updates.

The APOC hardware and software processing resources are configured by the Data Operations Control System (DOCS). This system has the necessary switching and control capability to meet APOC scheduling requirements and configuration of required telemetry and command data formats. In addition the Data Operations Control (DOC) area has communications links (data lines, SCAMA [switching, conferencing, and monitoring arrangement], CCL [closed-conference loops] and PBX [private business exchange] telephone) to establish interfaces with other support facilities as required.

3.0 DATA FLOW

A detailed block diagram for the APOC functional design is shown in Figure 3-1. This diagram shows four SIPS processing lines. SIPS A&B are the present SIPS capability included within the SLDPF. SIPS C is a proposed augmentation of the SLDPF to provide capability to support the APOC operational requirements. SIPS D is a planned augmentation to provide additional SIPS capability to meet the increased SLDPF processing requirements of the projected flight manifest. SIPS C&D as proposed utilize the proven design of the current processing lines. The only difference being a reduction of the number of HDRs from 5 to 2 for the C and D processing lines. This reduced number was determined to be adequate to support the APOC operational requirements for data recording and playback. The SIPS A&B processing lines provide the NASA wide capability for Spacelab mission support and also support the SOPS.

The layout of the MSOCC including the MSOCC switch, Telemetry and Command (TAC), Recorder/Utility Processor/Simulator (RUPS) and AP units utilizes the current MSOCC system with planned upgrades. These include the AP, TAC and DOC processor upgrades shown in Table 3-1 and a local Area Network (LAN) and VIP switching capability. These upgrades are planned to maintain required capability to support future free-flyer spacecraft. The VIP is shown communicating to various terminal devices within the PCRs, PSRs, Mission Support Room (MSR) and/or user rooms. The layout of these rooms and the terminology correspond to a revised floor plan for the APOC within building 14 at the GSFC. Figure 3-2 shows the revised floor plan for the second floor. The noticeable difference from the current configuration is the inclusion of two PCRs for APOC support. With this layout inclusion of the adjacent Mission Operations Room (MOR) with the PCR may be undertaken
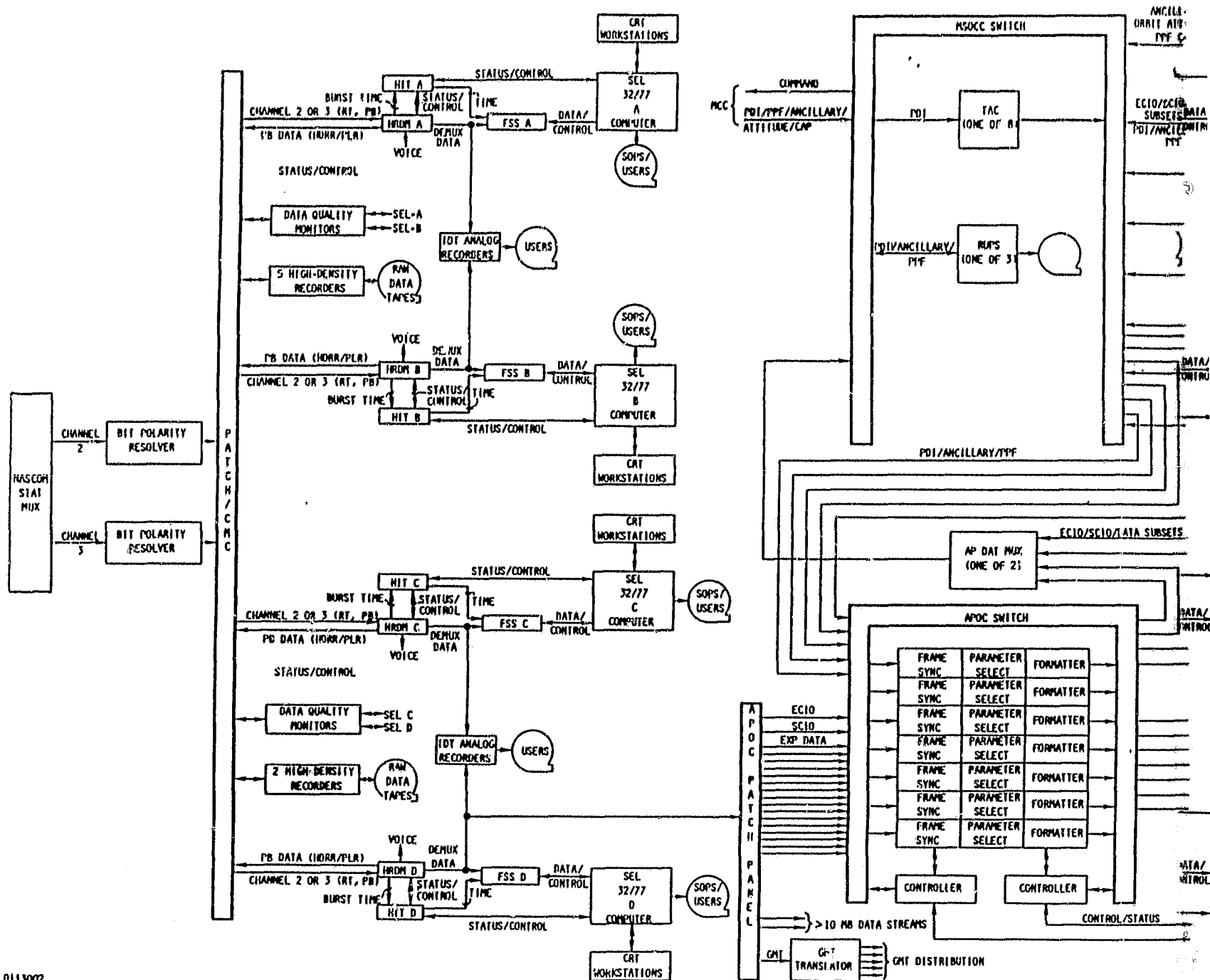
Figure 3-1. GSFC Attached Payload Operations Center (APOC) Block Diagram

x DiagFC Attached Payload Operations Center (APOC) Block Diagram

3-2
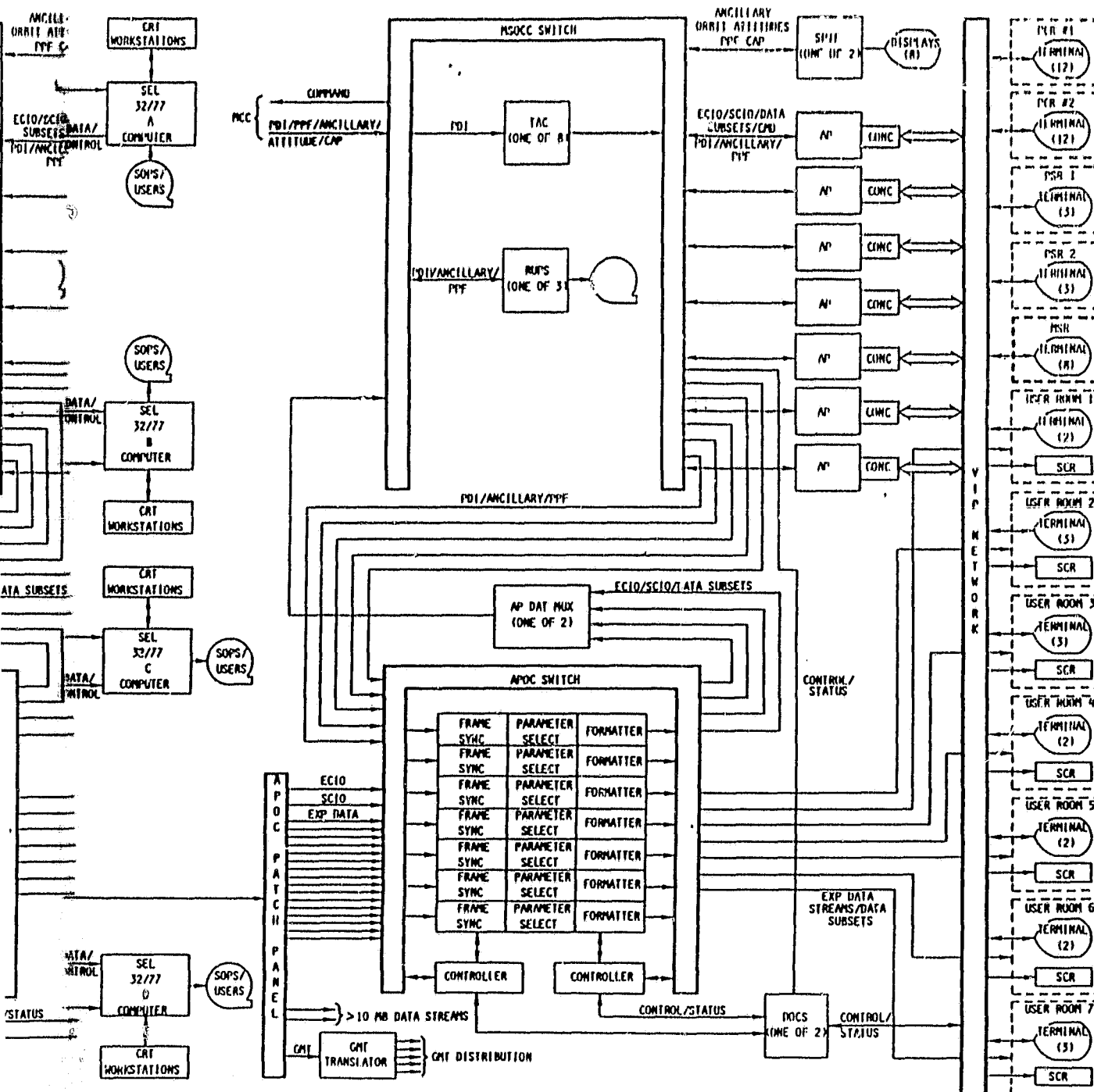
Table 3-1
Planned MSOCC Upgrades

ELEMENT	CY 1983	CY 1984	CY 1985	CY 1986	CY 1987
LAN					
System Operational	▽ 11/83				
AP Processor Upgrade					
RFP		▽ 1/84			
System Operational		▽ 6/84			
TAC Processor Upgrade (11/34 to 11/44)					
System Operational		▽ 10/84			
DOC (Two (2) VAX 11/780s)					
Installation			▽ 5/85		
System Operational				▽ 1/86	
VIP Switching (Display System Augmentation)					
RFP		▽ 5/84			
Initial System Operational			▽ 9/85		

ACRONYMS

AP   – Applications Processor
DOC   – Data Operations Control
LAN   – Local Area Network
MSOCC – Multi-Satellite Operations Control Center
TAC   – Telemetry and Command
VIP   – Virtual Interface Processor

MSR

PSR

MOR 6

MOR 7

SMM MOR

MSR

SPIF MOR

DOC

EQUIPMENT OPERATIONS AREA

PCR 1

MOR 1

MOR 2

MOR 3

EQUIPMENT ROOM

DOC

MOR 4

PCR 2 (MOR 5)

CMS EQUIPMENT AREA

MSR

OSC

SCHEDULING ROOM

XEROX

CMS MOR

ACRONYMS

CMS – Command Management System
DOC – Data Operations Control
MOR – Mission Operations Room
MSR – Mission Support Room
OSC – Operations Support Center
PCR – Payload Control Room
PSR – Payload Support Room
SMM – Solar Maximum Mission
SPIF – Shuttle/POCC Interface Facility

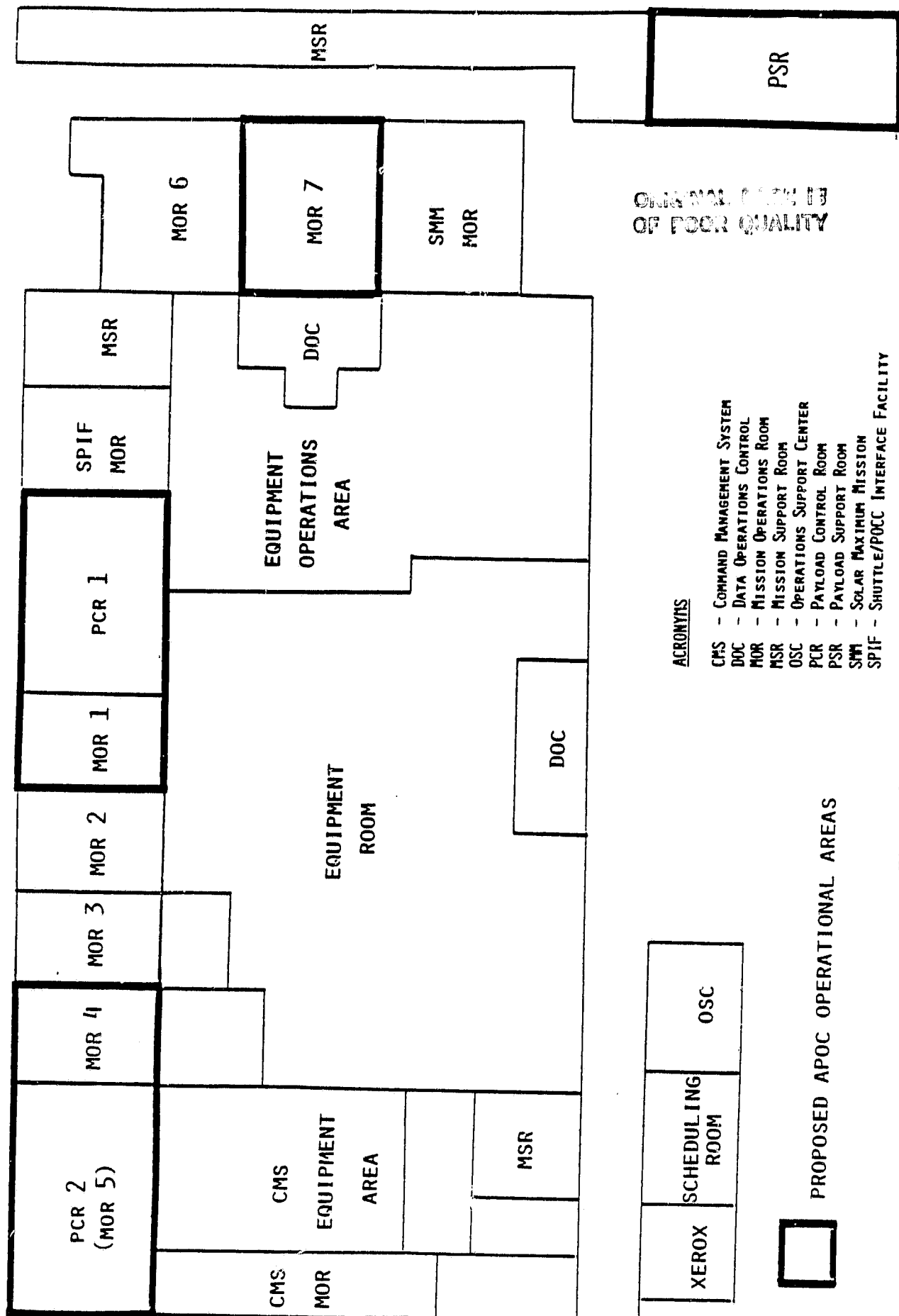☐ PROPOSED APOC OPERATIONAL AREAS

Figure 3-2. 2nd Floor Floor Plan

to provide increased operational space when required. Figure 3-3 shows the revised floor plan for the building 14 ground floor. An area is included for user space where EGSE will be configured for operational support. This user space may be configured into separate user rooms or areas as required to meet mission-unique requirements. An adjacent MSR area is included to provide office and conference space for the experimenters. Table 3-2 provides details of the floor space provided by this layout.

The APOC switch which is controlled from the DOCS was designed specifically to meet APOC requirements. This switch provides capability to switch specific incoming Spacelab data streams and also parameter select of specific subsets from up to seven data streams according to mission requirements. The maximum data stream rate which can be handled is 10 Mbps. Data streams of higher rate must be connected via patch panel capability.

The data flows within various parts of the APOC functional design are described in more detail in the following sub-sections.

3.1 SIPS.

The data flows to the HDTs, DQM and HRDMs are described in this subsection.

a) HDT

The SIPS provides recording of incoming channel 2 and 3 data on HDTs. The characteristics of the HDTs are presented in Table 3-3. The data streams are input to the HDTs via an HDT input switch. This system is essentially a patch panel. To ensure that the data are properly captured a
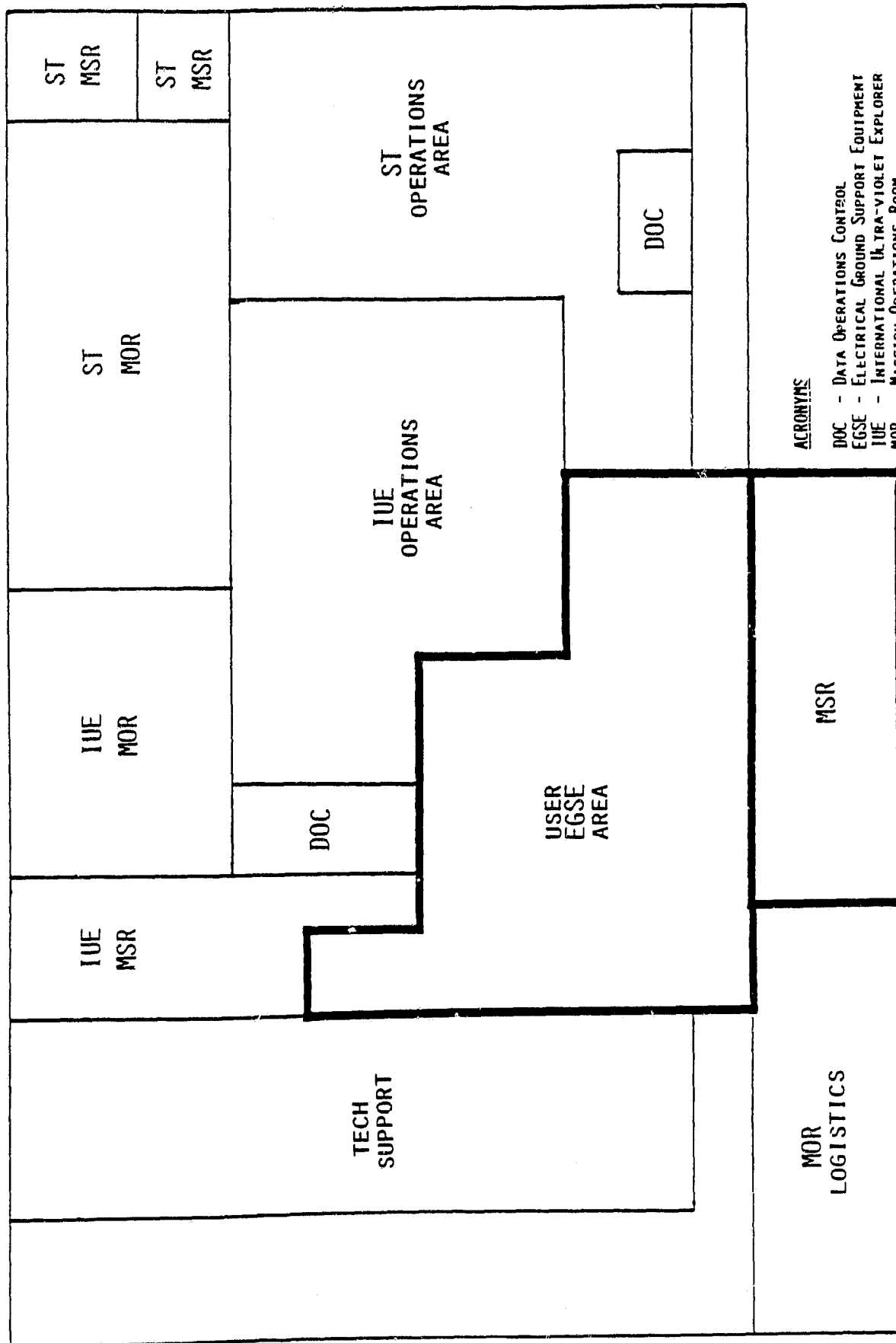
Figure 3-3. Ground Floor Floor Plan

ACRONYMS

DOC - Data Operations Control
EGSE - Electrical Ground Support Equipment
IUE - International Ultra-violet Explorer
MOR - Mission Operations Room
MSR - Mission Support Room
ST - Space Telescope

Table 3-2

Facility Floor Space (Sq. Ft.)

Room(s)	Operational	EGSE	Support
PCR 1	600		
PCR 2 (Expanded MOR 5)	700		
MOR 1	300		
MOR 4	300		
MOR 7	560.		
PSR			530
User EGSE area		2600	
MSR			1560
TOTAL	2460	2600	2090

Table 3-3
HDT Characteristics

Parameter	Value
Tape length – total	9200 feet
– usable (minus leading/ trailing)	8543 feet
Density	29 kbpi [kilobits per inch] with 22 tracks fan-out
Gross Capacity	65,405 Mbits
Useful Capacity (minus bits for synchronization and cyclic redundancy check)	59,459 Mbits or 7,400 Mbytes
Capacity [80 percent]	5920 Mbytes
Recording time supported	
At 32 Mbps	31 minutes [full]
	25 minutes [80 percent]
At 48 Mbps	21 minutes [full]
	16 minutes [80 percent]
Time to rewind	6 minutes

Frame Synchronizer Unit (FSU) is used with each HDT to monitor the quality of the data recorded.

The configuration utilized for both the SIPS A&B and SIPS C&D systems is a function of the operational requirements and input data rates of channel 2 and 3 utilized. With reference to Table 3-3, it can be seen that an HDT will support approximately 16-30 minutes depending on mode. In general, an HDT is started 3 minutes before the scheduled start of a transmission.

Various operational configurations have been developed for the HDT system. In general, proper operation is validated via monitoring of the FSU outputs by the appropriate Systems Engineering Laboratories (SEL) 32/7780 computer. For instance, if it was initially planned to record on HDT 1 on SIPS C&D, with changeover on to HDT 2 after 20 minutes for continuation purposes, then the HDT input switch would be patched accordingly. Following completion of this manual patch, the sequence would be performed in realtime under the control of the SEL. Providing all FSU outputs were normal the sequence would be completed properly. If the FSU for HDT 1 initially indicated an error, the system would transfer over to HDT 2 early, thereby ensuring data recording. In general, whenever the HDT availability changes, a message is provided by the SEL to an operator to take appropriate action. This could include patching an alternate HDT or changing the planned sequence. A feature is available to enable the FSUs to be monitored manually during periods, when the SEL is not available.

The SIPS system provides a number of FSUs for monitoring the HDTs and HRDMs. For SIPS A & B 23 FSUs are available within each Frame

Synchronizer Subsystem (FSS) [FSS A & B]. Eighteen of these are experiment FSUs and five monitor FSUs. Any monitor FSU may be selected by the operator to monitor the data quality recorded on any HDT via an HRDM and FSU input switch.

b) DQM

The SIPS monitors and reports the quality of all data received as a standard SLDPF function. Data streams reported on for data quality include the composite input data stream, the demultiplexed individual data streams following processing by an HRDM, and the Direct Access Channel (DAC). A number of devices are involved in the gathering of DQM statistics for the SIPS including the SEL, HRDM and FSU input switch, FSS, HRDM and the disk subsystem. The HDT input switch and HDTs are also required when processing data for DQM reporting post-transmission.

The composite data quality is monitored by the FSUs. The demultiplexed data streams output from the HRDM are monitored by eighteen experiment FSUs. The DAC data stream is monitored by a monitor FSU in realtime and directly by a monitor FSU during playback. The FSUs can be operated in a data mode or a monitor-only mode during DQM. During the data mode, the FSU transfers a block of data via a Fast Data Interface (FDI) to a designated buffer area and also transfers a status report concerning data quality when the buffer is full. The output of the buffer are transferred to an output tape by the SEL computer. The input data are triple-buffered to allow output tape error recovery. In the monitor-only mode, the FSU transfers a status report to the SEL

computer upon request. The history of all DQM statistics collected by the FSUs is stored for DQM report generation by the SEL.

Data quality information is sampled from each FSU once every 60 seconds and at Acquisition of Signal (AOS) and Loss of Signal (LOS) of a transmission. The DQM information is used to determine proper SLDPF operation and to support DQM reporting to the JSC. These latter reports are provided on JSC request. Information collected with each data quality sample includes:

i)   sample time

ii)   device functional assignment

iii)   device status

iv)   count of frames

v)   loss of lock count

vii)   missing sync count

vii)   count of frames with sync bit error

viii)   count of frames with sync bit error and bit slip

ix)   count of frames with bit slip

x)   count of frames with suspected time tag.

c) HRDM

Each SIPs system [A & B and C & D] has an HRDM and FSS input switch, which can route the channel 2 and 3 composite streams or the playback from the HDTs to both the HRDM and the FSS. Both systems have two each of these latter units to provide redundancy. Each FSS has eighteen FSUs which are used for receiving demultiplexed data from HRDMs. SIPS A & B has five remaining FSUs (monitoring FSUs) connected directly to

the output of the HRDM and FSU input switch. These are used for monitoring the data quality recorded by the HDTs. SIPS C & D has only 2 HDTs and therefore only requires 2 monitor FSUs on each FSS, however five may be included for consistency with the current SIPS A & B system.

The HRDMs demultiplex the composite input stream into the data streams shown in Table 2-1. HDRR and PR data are recorded on HDTs for subsequent playback as required. The double demultiplexing of the data is removed on the second transit through the HRDMs. Minor frame synchronization of individual data streams, formatting, data-quality flagging, and time tagging of minor frames as well as frame and data-flag counting is performed by experiment FSUs. Each of the sixteen experiment channel FSUs within each FSS is uniquely interconnected with one of 16 FDI units contained within its corresponding experiment channel Fast Multiplexer System (FMS). Each of the other seven FSUs of each FSS (SIPS A & B) is uniquely connected with one of seven FDIs contained within a corresponding master FMS.

The experiment channel FMSs and the master FMSs are connected to the SEL 32/7780 computer in such a way that either master FMS for SIPS A & B can be accessed by SEL A or B, but each experiment channel FMS can only be accessed by the corresponding SEL computer. A similar arrangement is proposed for SIPS C & D.

d) SEL 32/7780 Computers

Each SEL computer system is a dual processor processing unit consisting of a Central Processing Unit (CPU) and an Internal Processing Unit

(IPU). Two private disks are provided for each system, and two shared disks are provided that are accessible by each computer system and are used to store SIPS software, mission-related files, and a data base. The contents of these latter two disks are identical and data are written to both disks simultaneously. This applies to both SIPS A & B and C & D and therefore a single point failure is avoided.

3.2 APOC Switch

The APOC switch has been designed to distribute HRDM output data to an AP within the MSOCC, EGSE within the user area, and /or remote users from the GSFC. These data include the sixteen experiment channels, the ECIO and SCIO. The switch can handle data streams with data rates less than 10 Mbps. Higher rate streams must be connected via a patch panel type capability. The APOC switch provides the capability to select a subset of data from a given stream with the use of a FS/PS. Following extraction of the subset the resultant data can be distributed as before to an AP, EGSE and/or remote. Seven FS/PS units are planned for the APOC functional design, although the APOC switch design approach is modular and therefore additional units could be added as needed.

The APOC switch was designed to meet or exceed the Spacelab POCC functional requirements as initially provided to JSC for the JSC POCC and subsequently as modified by the MSFC. These requirements specified the need for a capability to extract from up to four streams a total of 2000 parameters a second for processing. A maximum of 9200 parameters a second could be extracted and provided to the NRT on-line data base for on-demand access. The maximum data stream input rate for subset extraction was 2 Mbps,

although this value was reduced by the MSFC to a maximum of 2 Mbps for three streams.

The subsets to be extracted from a given stream would normally be determined pre-mission and stored in a data base. During the mission the required format would be selected and used to configure the FS/PS accordingly. Other configuration information stored in the data base pre-mission includes the data stream switch connections and frame sync parameters. The APOC switch is contolled by two microcomputer based controllers, which report to the DOCS. The configuration data base resides on these controllers. A design requirement is that the switch can respond to a configuration and/or format change command is less than five seconds.

The DOCS controls the APOC switch configuration according to the requirements specified pre-mission or as modified during operational support. New configuration identifiers are transferred to the controller, which retrieve the required parameters from the configuration data base. The switch configuration and data quality status are reported back to the DOCS.

3.3 MSOCC Switch

STS ancillary and non-Spacelab data are input via the MSOCC switch. These data include Orbiter ancillary data, PDI and PPF extracted from the Operational Downlink (OD) on Channel 1; Orbiter ephemeris including trajectory, tracking data and Orbiter attitude information; and JSC status, Command Acceptance Patterns (CAP) generated in response to GSFC transmitted payload commands and command history information. These data are normally provided to the SPIF, but may be provided to other MSOCC systems as required. The

GSFC generated payload commands are transmitted to the MCC via the MSOCC switch. Other information available to the APOC via the SPIF interface include crew activity plans from the Crew Activity Planning System (CAPS), Orbiter voice and video and communications with the MCC via data facsimile and teletype. The SPIF also provides a Text and Graphics (TAGS) system for uplink facsimile type capability to the Orbiter crew.

Orbiter tracking data are received by the SPIF every three minutes under timeline control or by request. These data are provided to the FDF and processed to provide Closed Circuit Television (CCTV) displays for users within the MSOCC or user EGSE area. Two-hour projections are available containing all planned Orbiter maneuvers. Orbiter attitude data is received every twelve seconds under timeline control or by request. These data are provided to the FDF and formatted for user CCTV display. Projections covering the next forty-eight hours are provided.

Auditing of MSOCC generated payload commands transmitted via the MSOCC switch is provided by the SPIF. This audit ensures the APOC-to-payload command interface validity via receipt, identification and validation of MSOCC command blocks and decode and verification of responding MCC CAPs. A log of command validation and CAP processing results is maintained in the SPIF command data base. Command performance reports may be prepared from this data base and formatted for hardcopy and CCTV display for users. JSC realtime and off-line command history data are also received by the SPIF and formatted for hardcopy and CCTV display.

Payload telemetry data received by the SPIF via the MSOCC switch is validated for proper NASA Communications (NASCOM) header, user header and block error control fields to ensure proper block sequence and non-presence

of missing blocks and transmission errors. PDI and PPF data extracted from the OD may be processed, converted to engineering data and diplayed. In addition, STS ancillary data extracted from the OD and transferred to the SPIF may be processed to provide user CCTV displays. The received JSC status blocks containing Operational Instrumentation (OI) and PDI data quality and routing information may also be processed by the SPIF to provide user CCTV displays.

Several testing and simulations functions validating the MSOCC switch interface to the MCC are also provided by the SPIF. These include coordination scheduling and support of MSOCC/MCC interface testing, monitoring of the MSOCC/MCC interface during pre-mission testing and flight operations and simulation of the MCC communications interface for APOC checkout. Data flow fault analyses may be conducted to report monitored information. These are conducted following error recognition.

The TAC subsystems support preprocessing both of telemetry and command data going to and from selected APs and the NASCOM lines via the MSOCC switch. These subsystems provide a flexible routing capability for incoming data. In addition to bounding the frame sync, the TAC may perform polynomial error checking and has a complete set of routing parameters that allow definition of the type'of data to be passed to an AP. Tolerance on bit errors in the sync patterns can be set to allows restrictive or general passing of data of questionable quality. The TAC system also performs output format and labelling of MSOCC-transmitted commands and acknowledgements. NASCOM line monitoring and recording functions for all data entering and for scheduled data leaving the MSOCC may be provided by the RUPS subsystems. These subsystems produce an inventory record of all data blocks and a history tape of all data received in the MSOCC.

3.4 AP

Selected data may be provided to the APs for various types of processing. These include ECIO, SCIO and/or experiment channel data or subsets extracted by the APOC switch and transferred via the AP data mux, STS ancillary data, and PDI and PPF data. In addition, the APs provide various command processing functions. The processing conducted includes telemetry processing, command generation, display page generation, history tape generation, command verification and telemetry limit checking.

The APs provide extensive standard command and telemetry functions, which may be readily augmented with mission-unique software as required. This capability has been proven in the support of many free-flyer programs within the MSOCC multi-mission environment. The various standard functions may be simply tailored to meet defined mission requirements via input of appropriate data base information. This concept is used extensively within the MSOCC.

An NRT data archival capability consisting of a 1.2 GB disk system has been added to support the APOC. This system was sized to provide on-line storage and access for the 500 STS parameters and 9200 payload parameters received over a twenty-four hour period. The system provides on-demand access on a shared basis for recall and processing of telemetry and history data. Processing is provided via access to the standard APOC realtime processing capabilities. Output utilizes the APOC terminals and associated peripherals.

3.5 Operational and Support Rooms

As described in Section 3.0, the various MSOCC facilities have been redesigned and upgraded in the APOC functional design. Two PCRs, two PSRs, an MSR and a user EGSE area are provided. These areas are equipped with upgraded consoles and terminal capabilities including 40 PC systems with associated peripherals. The VIP network interfaces these capabilities with the overall APOC system. The VIP network allows a device-independent interface from the APs, DOCS and APOC switch to the various displays, printers, graphics terminals, SCRs and other special peripherals.

3.6 Access

The access to the various data types within the APOC are summarized below.

a) Realtime

Realtime channel 2 and 3 data from Spacelab are input through the SIPS C & D system via the APOC switch to appropriate APs and/or user EGSE. These data include the ECIO, SCIO, experiment channel data and/or subsets and GMT. Non-Spacelab data, STS ancillary and various JSC planning, operational and history data are received via the MSOCC and SPIF. Payload commands generated within the CMS or MSOCC are transmitted to the MCC via the MSOCC switch.

b) NRT

Data may be accessed in non-realtime via the NRT system. This system stores the 500 S'S parameters and 9200 payload parameters for

subsequent recall and processing. In addition, the Spacelab channel 2 and 3 composite streams may be accessed from the SIPS HDTs, demultiplexed within the redundant HRDM and processed via the standard APOC realtime capabilities and/or EGSE on a shared basis. Other history data may be accessed from the SPIF and MSOCC data bases.

c) HDRR and PR

HDRR and PR data within the incoming Spacelab composite stream have been multiplexed on-board twice by the HRM. On processing by the HRDMs in realtime or on playback from an HDT the data are demultiplexed once. The singly multiplexed data streams from the HRDM output are recorded on the HDTs. On subsequent playback from the HDT through the HRDM the demultiplexed HDRR and PR data are obtained. These data may be processed through the standard APOC processing capability on a shared basis.

d) Commands

Commands originating from an APOC terminal, the CMS, EGSE or remote are input to an AP for processing prior to transfer to the JSC MCC via the MSOCC switch.

4.0 TIMELINE CONTROL

The current SLDPF is configured for mission support based on a timeline generated by the center assigned mission management responsibility. This timeline is supplied in the form of a Computer Compatible Tape (CCT) for input to the SLDPF system. The MSOCC and SPIF are controlled by the DOCS. In developing the APOC concept these control modes were retained. In the case of GSFC assigned missions the SLDPF timeline information would be generated by the mission planning system. The DOCS would also configure the remainder of the APOC based on timeline data obtained from the mission planning system. The APOC switch was placed under the control of the DOCS.

4.1 SIPS

Three types of timelines are used to satisfy the SIPS requirements:

o Premission timeline

o Operational timeline

o As-flown timeline.

The premission timeline defines all experiments to be processed by the SIPS during each mission and is developed and delivered to the SLDPF prior to launch. The operational timeline consists of updates to the premission timeline. It is provided at periodic intervals of approximately twelve hours, prior to specific upcoming 12-hour mission segments. Currently these updates are provided by the JSC Payload Data Manager. The as-flown timeline consists of annotated versions of the operational timeline. It is the final record of actual experiment activity, including exceptions to preplanned data contained in either the operational or premission

timelines. The as-flown timelines are currently provided by the JSC Pay-
load Data Manager at periodic intervals of twelve hours and record the
actual activity during the immediately preceding 12-hour period.

a) Premission Timeline

There are two types of Premission Timeline Tape (PTT); a downlink configu-
ration PTT and an Experiment/TDRS PTT. The downlink configuration PTT
contains the date of tape creation, a single header record, and one or more
HRM format and downlink schedule records. The HRM format and downlink
schedule record defines a unique HRM format and the associated start and
stop times. One of these records exists for every unique period during the
mission during which the Ku-band channel configuration does not change and
within this configuration, the HRM format does not change.

> The experiment/TDRS PTT contains the date of tape creation, a single
> header record and one or more of each of experiment on-off records and
> TDRS records. The experiment on-off record appears once for every
> start-stop operation of an experiment (format change or rate change)
> and defines the start and stop times and associated experiment/format
> identifiers. The TDRS record appears once for every TDRS contact/sup-
> port period and defines the start and stop times and associated TDRS
> characteristics.

b) Operational Timeline

> Updates to the premission timeline are provided by the JSC Payload Data
> Manager via facsimile and voice link.

c) As-flown Timeline

The as-flown timeline consisting of annotated versions of the operational timeline are transmitted by facsimile by the JSC Payload Data Manager. In general, only pages reflecting actual changes or optionally a small number of changes within a single datafax transmission are provided

d) Operational Usage

The premission timeline is processed by the SIPS to define the patch panel configurations needed to support the mission. Providing these patch panel configurations are manually performed in proper sequence, the SIPS can support the mission under the control of the SEL according to the timeline. In instances where a patch panel connection is incorrect or there is an equipment malfunction or loss of recording various operator managers are provided by the system. For instance, in cases of improper HDT recording, the continuation tape could be put in operation early as described previously. In general, operator interaction is required to repatch various switches, configure redundant systems or change various configuration data within the SEL depending on the problem in question.

When changes to the premission timeline are received in the form of operational timeline updates an update timeline data base is generated by merging the appropriate data. In all cases, this updated timeline data base which consists of the downlink configuration PTT and experiment/TDRS PTT information is validated prior to use.

The various formats capable of being demultiplexed by the HRDMs are defined pre-mission. Sixteen formats are resident and 64 are available within an HRDM. The appropriate format is selected by the SEL during the mission via its corresponding identifiers.

The SIPS has an automated test mode for problem resolution. This mode, the SIPS Automated Test System (SIPSATS) supports many SIPS functions, but does not provide the standard data qulaity accounting.

4.2 DOCS

Various hardware and software upgrades to the DOCS are planned as part of current MSOCC developments. These upgrades are designed to implement an automated DOCS capable of configuring and monitoring the MSOCC resources. These upgrades will be available to support APOC. The upgrades include automatic allocation of MSOCC resources, monitoring of MSOCC host computers attached to the LAN, internal (and in some cases external) configuration control of the LAN host computers, monitoring and control of the automated MSOCC switches, providing the System Test Operations Language (STOL) for operator control, AP downline loading capability, inclusion of Mission Planning Terminal (MPT) schedule interfaces, DOC display enhancements, STOL procedural capability, history event recording, AP history recording and playback capabilities, error detection and fault isolation capabilities within MSOCC and increased operational manageability.

5.0 OPERATIONS PERSONNEL

The APOC operations management structure was configured to support all APOC operational requirements, provide required interfaces to the standard JSC operations structure and provide the necessary environment for the investigators for payload operations. The APOC operations management structure is shown in figure 5-1. Several features of this management structure are significant including.

o The presence of a GSFC Payload Operations Coordinator at the JSC to enhance payload operations coordination. The Payload Operations Coordinator interfaces with the JSC Payload Officer and reports to the GSFC Payload Operations Director. The Payload Operations Coordinator is familiar with GSFC payload operations requirements and practices and provides face-to-face contact with JSC payload operations personnel as required thus minimizing any problems associated with remote POCC operations.

o A Crew Interface Coordinator at the APOC providing coordination of all crew/APOC communications and interfacing with the JSC CAPCOM.

o A Data Management Coordinator coordinating with the JSC INCO and the Payload Data Manager and ensuring that the various APOC systems are configured for proper operational support of incoming data streams.
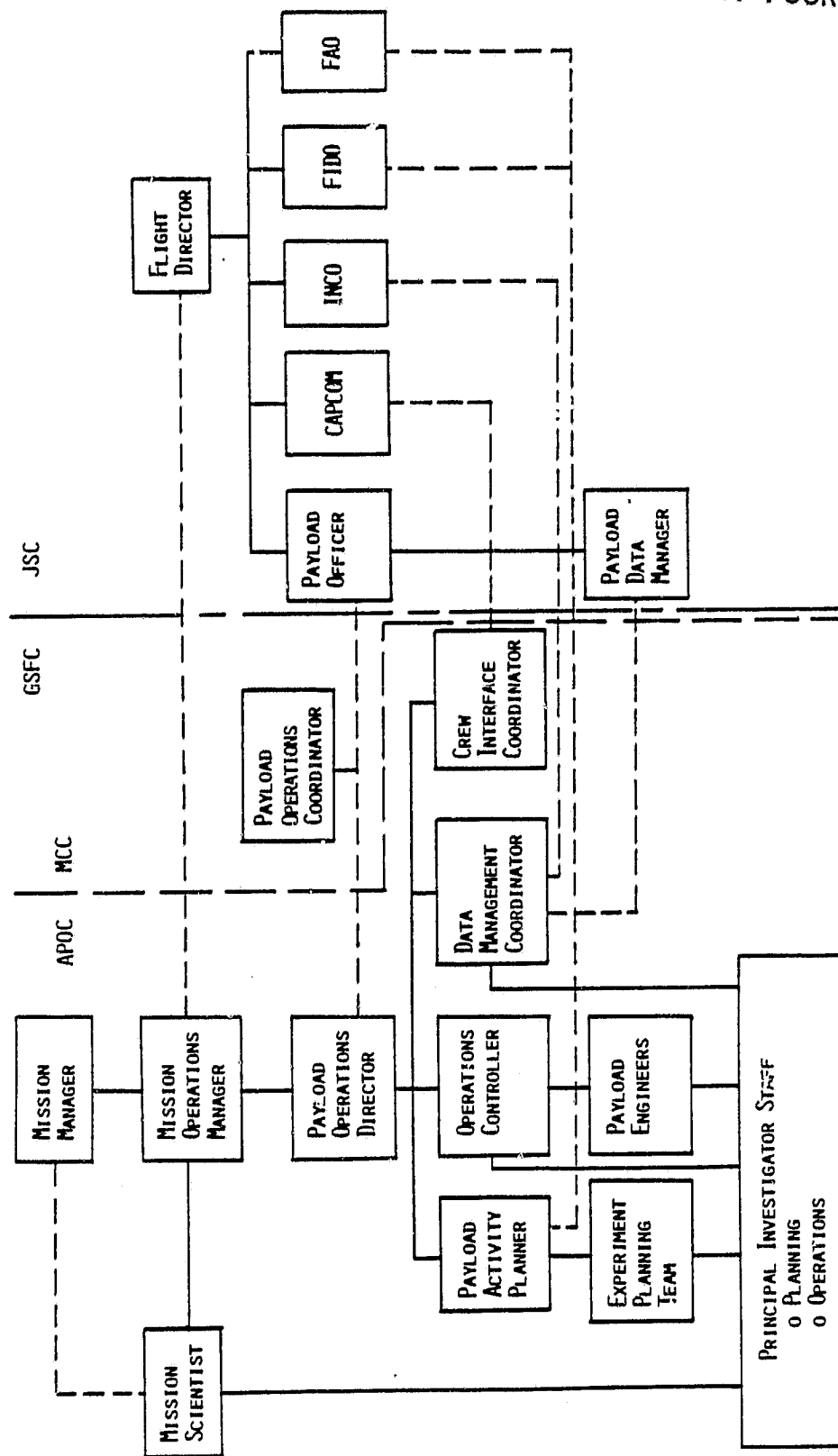
Figure 5-1. APOC Operations Management Structure

o A Payload Activity Planner coordinating all premission payload planning and operational payload plan updates. This individual interfaces with the JSC FIDO and Flight Activity Officer (FAO)

o The Mission Scientist interfacing directly with the GSFC Mission Operations Manager (MOM). The mission scientist has responsibility for providing coordination of Principal Investigator (PI) requirements.

o PIs and their staff responsible directly for the formulation of payload planning inputs and payload operations. Operational support would be provided out of the user EGSE area.