Geostationary Operational Environmental Satellite/Data Collection System

A Description of its Architecture, Use, and Capacity

26 February 1982

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Environmental Satellite Service

Technical Report No. 1986

ORI
Silver Spring, Maryland 20910

GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE/DATA COLLECTION SYSTEM

A DESCRIPTION OF ITS ARCHITECTURE, USE, AND CAPACITY

FINAL REPORT

26 FEBRUARY 1982

Prepared by ORI in collaboration with
Executive Resource Associates (ERA), Inc.,
under ERA Subcontract 502 with ORI,
and ERA Contract NA-81-SAM-0054 with
The U.S. Dept. of Commerce

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

AMS	Automatic Monitoring System
ANSI	American National Standards Institute
CAT	Channel Activity Table
CCITT	Consultative Committee for International Telegraph and Telephone
CDA	Command and Data Acquisition
CDDF	Central Data Distribution Facility
CPUs	Central Processing Units
DAMS	Data Acquisition and Monitoring Subsystem
DCP	Data Collection Platform
DCPI	Data Collection Platform Interrogate
DCPRS	Data Collection Platform Radio Set
DCS	Data Collection System
DPS	Data Processing System
DRO	Direct Read Out
EIRP	Effective Isotropic Radiated Power
GOES	Geostationary Operational Environmental Satellite
ISO	International Standards Organization
LSB	Least Significant Bit
NASA	National Aeronautics and Space Administration
NBS	National Bureau of Standards
NESS	National Earth Satellite Service
NOAA	National Oceanic and Atmospheric Administration
O&M	Operations & Maintenance
PMH	Platform Message Handler
PSK	Phase Shift Keying
SMS	Synchronous Meteorological Satellite
TCT	Time Code Translator
VISSR	Visible and Infrared Spin-Scan Radiometer
WWB	World Weather Building

1.0 INTRODUCTION

1.1 BACKGROUND

The Geostationary Operational Environmental Satellite (GOES) service is an integrated system of Earth and space environmental sensors which provide nearly continuous observational information to ground-based user stations. The service is operated and controlled by the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce, and was developed at the National Earth Satellite Service (NESS) in conjunction with the Synchronous Meteorological Satellite (SMS) program of the National Aeronautics and Space Administration (NASA).

The GOES system performs four services. Each of the services is carried out by the following dedicated subsystems:

(a) Visible and Infrared Spin-Scan Radiometer (VISSR)
(b) Weather Data Relay (WEFAX)
(c) Space Environmental Monitoring (SEM)
(d) Data Collection System (DCS).

The DCS is the subject of this report.

1.2 PURPOSE

The purpose of this report is to document the description of the current DCS system in order to provide an accurate baseline of its use and capabilities. This baseline system description will be used in evaluating the impact of user growth and in various operational concepts and changes that could meet future projected requirements.

1.3 SCOPE

The overall DCS includes:

1. The users, their data collection platforms, application requirements, and interface capabilities

2. The GOES satellites

3. The DCS ground-based RF and demodulation facilities

4. The DCS computers and ground-based Communications facilities.

The information in this report is selected from a great quantity of documentation that is available as well as from interviews with system managers and operators.

1.4 SYSTEM OVERVIEW

The DCS is comprised of three basic elements: The GOES space segment, the GOES ground system, and the Data Collection Platforms (DCPs). The Data Collection platforms transmit information to the GOES which relay the signals to the ground system. The ground system acquires the information and disseminates it to specified users.

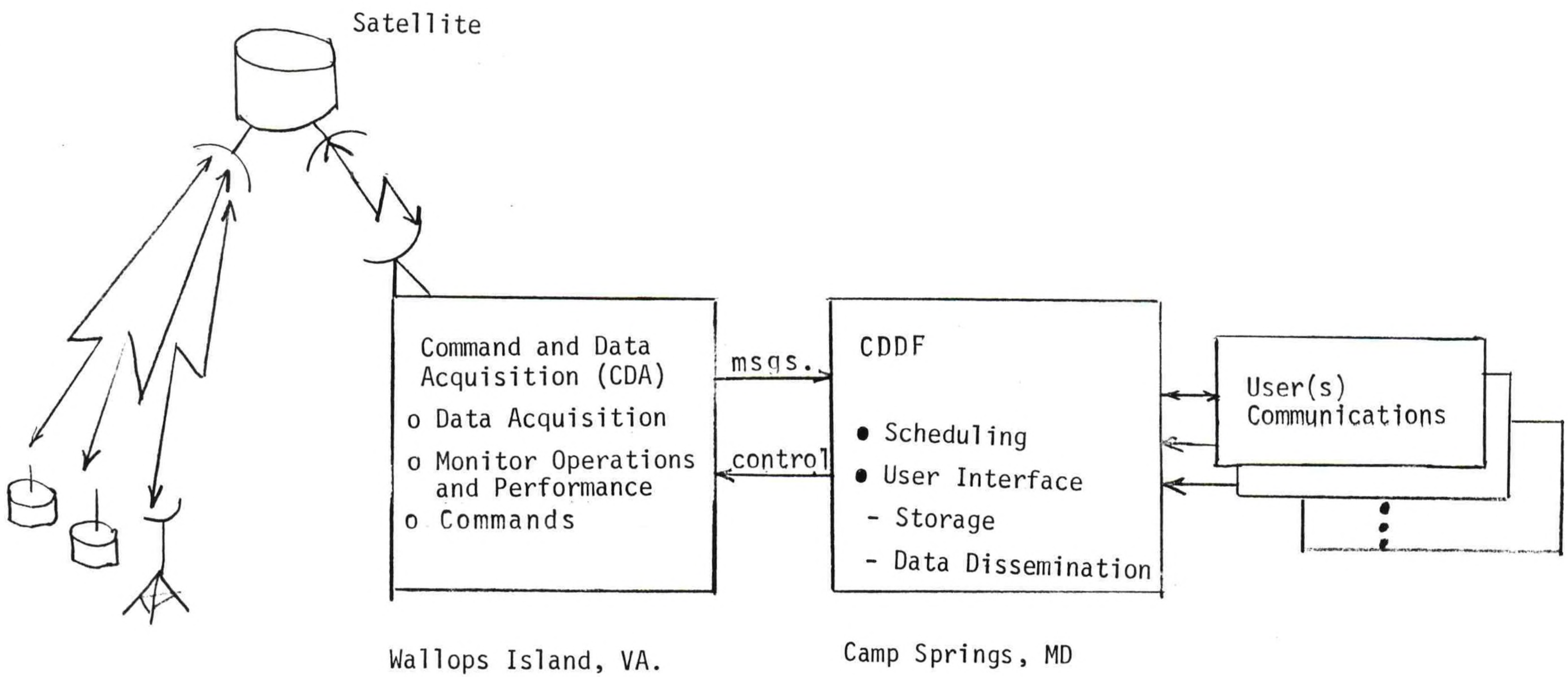


FIGURE 1.1. DCS CONFIGURATION OVERVIEW

By planning and design, the DCS accomodates three different types of platform access to the GOES satellite. A self-timed platform transmits at a fixed repeat interval. Interrogated DCPs transmit after receiving an interrogate signal from the GOES. Random Reporting platforms transmit at non-scheduled times.

The ground system, comprised of two interconnected major systems - the Command and Data Acquisition (CDA) at Wallops Island, Va., and the Central Data Distribution Facility (CDDF) at the World Weather Building (WWB) Camp Springs, Maryland, performs the prime functions of data acquisition, operations monitoring and control, and user interface (Figure 1.1). The data acquisition function is performed at the CDA where data is extracted from the signal downlinked from GOES. System monitoring is performed at the CDA for parameters directly derivable from the downlink signal (e.g., signal strength) or based on an expected event. System monitoring is also performed by the CDDF. Data acquired at the CDA is temporarily buffered and transmitted to the CDDF. The CDDF can relay the data in real-time to selected users or store the data until a user can dial-in to access the data. Users are agencies, organizations or companies that own DCPs and can access data from their own or other user DCPs.

1.5 ORGANIZATION OF THIS REPORT

The first portions of this report, Sections 2 and 3, present a functional description of the DCS system. Section 2 presents a description of the elements (i.e., spacecraft, platforms, ground systems) including hardware. Section 3 presents a detailed functional description of the operation of the ground systems. (Appendix A presents a detailed description for ground system operations with interrogated platforms.) Section 4 presents a description of software in the NOAA/NESS ground system. Section 5 describes the users of the system and their interfaces with the overall system. Section 6 presents the performance and limitations of the ground system. Section 7 presents information concerning the cost of the DCS.

2.0 SYSTEM ELEMENTS

The GOES DCS includes the space segment, CDA, CDDF, and the Data Collection Platforms. These elements are briefly characterized in this section. Certain aspects of the characterization, e.g., software, and performance parameters are described in greater detail in other sections.

2.1 SPACE SEGMENT

The GOES service currently operates two satellites located in Earth-synchronous orbits approximately 35,500 kilometers above the Equator at longitude 75°W and longitude 135°W. To serve as a backup in event of failure of either operational satellite, there is a third geostationary satellite in orbit at longitude 105°W (located midway between the other two). All satellites are controlled from the CDA Station at Wallops Station, Virginia. The backup satellite can be moved to either the east or west satellite position should such a need arise.

There will be service interruptions during the periods of solar eclipses. The GOES satellites undergo spring and autumn eclipses during a 46-day interval at the vernal and autumnal equinoxes. The eclipses vary from approximately 10 minutes at the beginning and end of eclipse periods to a maximum of approximately 72 minutes at the equinox. The eclipses begin 23 days prior to equinox and end 23 days after equinox; i.e., March 1 to April 15 and September 1 to October 15. Because of satellite power constraints DCS outages occur during local midnight for varying periods during the eclipse seasons.

2.1.1 Geometric Coverage

The DCS was based on the practicality of an Earth-sited transmitter operating with a suitable antenna to provide an Effective Isotropic Radiated Power (EIRP) of 50 dBm (max.) at a minimum antenna elevation angle of no less than 5°. The minimum antenna elevation angle defines the portions of the Earth's surface having geocentric angles up to approximately 77°, measured from the subsatellite point. Figure 2.1 presents the actual Earth surface coverage for the DCS of both GOES satellites for two different antenna elevation angles.

2.1.2 Satellite Access Scheme

Frequency division multiple access is the basic technique used to meet the data traffic requirements. Listed in Appendix B are 200 channels available for domestic user assignment with an additional 33 channels provided for cooperative requirements with international users. The channel spacing accommodates the 100-bits-per-second DCS message data rates. Additionally, the channels in the GOES are grouped by other satellite access methods as shown in Table 2.1. The DCPs use the assigned channel by having their transmit frequency set to the center of the specified channel.

Two selected channels are assigned for use by the CDA; one channel is assigned to each of the two operational GOES. These channels are used to relay the interrogate signal from the CDA to the DCPs.

2.1.3 System Capacity

The theoretical capacity of the space segment can be determined by assuming channelization and data rate as specified in 2.1.2 and assuming 180 DCPs per channel, for the Self-Timed (ST) and Random Reporting (RR). For ST, this is based on eight one minute messages per DCP per day. For the RR, it is based on 2 minutes per DCP per day with a probability of 0.66 of successfully receiving an uncorrupted message at the CDA. These assumptions concerning

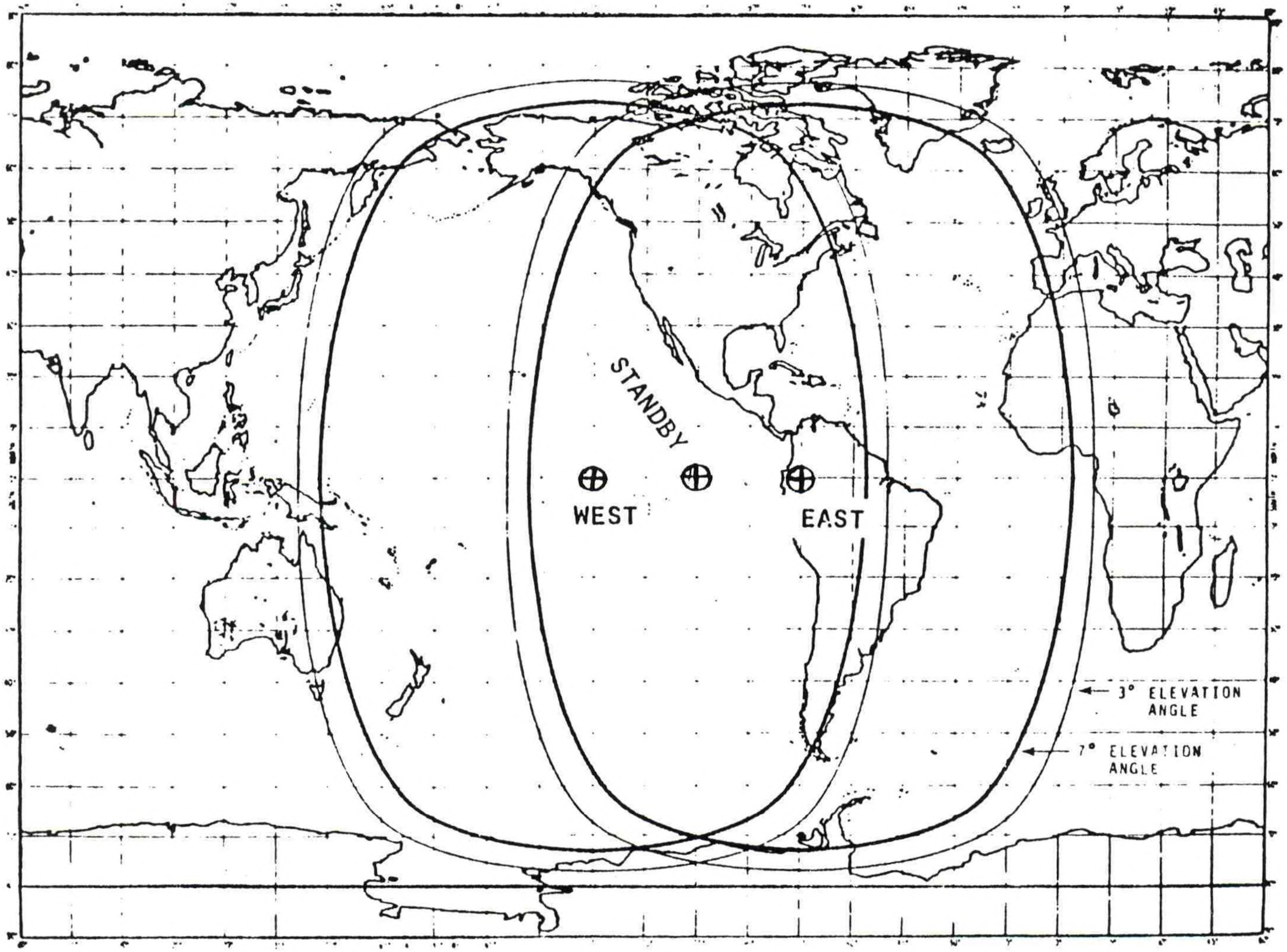


FIGURE 2.1 SMS/GOES COVERAGE

TABLE 2.1

GOES SATELLITE CHANNEL ASSIGNMENT CATEGORIES

	CHANNEL NUMBERS	ASSIGNED USE
	1-40	Self-Timed
	41-70	Self-Timed Direct Read Out
	71-94	Self-Timed
Domestic	95-111	Interrogated
Channels	112-145	Random Reporting
	146-165	Spare
	166-199	Lannion (NOAA Satellite Data)
International Channels	200-233	

Note: Odd numbers assigned to East satellites
Even numbers assigned to West satellites

the capacity of each channel are values that have been used by NOAA to plan future operations; these values also represent the desired standard or norm to which, NOAA would perfer, that users should conform.

Based on this space segment allocation and these assumptions, 180 DCP per channel capacities are calculated. For a two satellite system, each supporting 199 domestic channels (one channel for time code) the capacity is 35,820 DCPs per satellite. For the 120 channels specified for the DCS ground system, this capacity is 21,420 (119x180) per satellite. In practice, the actual capacities are not greater than one half of each of these values because the RF spectrum in each satellite is not reuseable (see Section 6.1).

2.2 DATA COLLECTION PLATFORM (DCP)

The DCP is an equipment that serves two primary functions. It contains sensors that gather information about the environment and it contains subsystems that enable it to transmit collected sensor information through the GOES to the CDA or to a Direct Read Out (DRO) user (this is a user who has an earth station that directly receives the downlink signal from the GOES). This latter function, the Data Collection Platform Radio Sets (DCPRS) interaction with the DCS, is controlled by requiring (by NOAA) that the DCPRS are certified or conform to specifications for the three major platform types: self-timed, interrogated and random reporting.

Two DCPRS requirements are summarized in the following paragraphs. First, the reporting or transmitting of information to the GOES has the same satellite access format for each of the three platform types. Secondly, the interrogated DCPRS has a receiver that receives signals transmitted by the CDA through interrogate channels in the GOES.

2.2.1 Sensor Platform Transmitter Response Format

The platform response format satisfies the CDA requirements for response signal acquisition, clock recovery, data bit synchronization, message synchronism, and optimum response channel utilization. The data are Manchester encoded to provide a self-clocking signal which is used to modulate the transmitted carrier by phase shift keying (PSK). Figure 2.2 defines the coding and modulation characteristics of the platform transmitter response signal.

A platform response transmission (Figure 2.3) begins with unmodulated carrier (0^{o} phase shift) for 0.5 seconds to allow the CDA data demodulator to acquire the signal and establish a phase reference. Next, the response signal is PSK'd with 0.48 seconds of alternate "one," "zero" data (Manchester coded) so the data demodulator may obtain the 100-Hz bit rate clock and data bit synchronization. Then the 46-bit preamble is sent, consisting of the 15-bit Maximum Length Sequence (MLS) message sync word (100010011010111) followed by the 31-bit sensor platform address identifier word with the most significant bit (MSB) of those sequences transmitted first. The sensor data in serial ASCII character (odd parity) format are sent immediately following the preamble with the least- significant bit of each character transmitted first. A postamble consisting of three 8-bit EOT characters marks the end of the response message.

2.2.2 Command/Interrogate Signal Format

The DCP's with receivers are designed to receive signals that have two types of information from the CDA via the interrogate channels:

1) Platform address identifier (or command word) which initiates the appropriate response activity from the platform to which it corresponds.

2) Coded time data, updated at 1/2-minute intervals, referred to an NBS source.

Details of the interrogated signal format are contained in Appendix C.

2.3 EQUIPMENT

A detailed diagram that shows the ground system, space segment, and DCP configuration is presented in Figure 2.4.

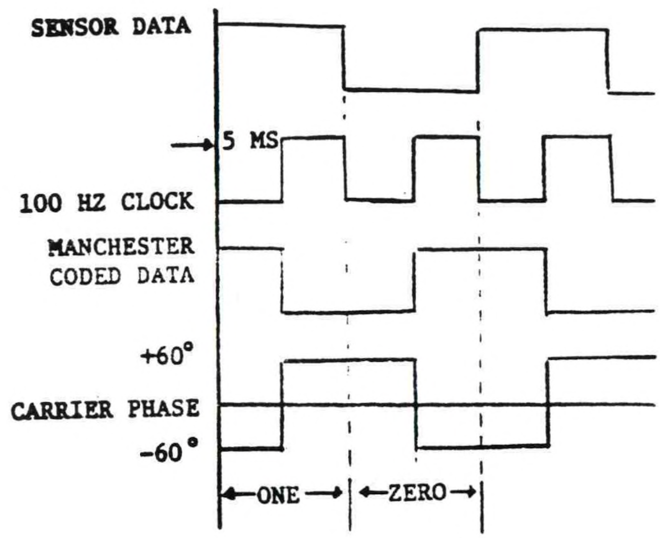
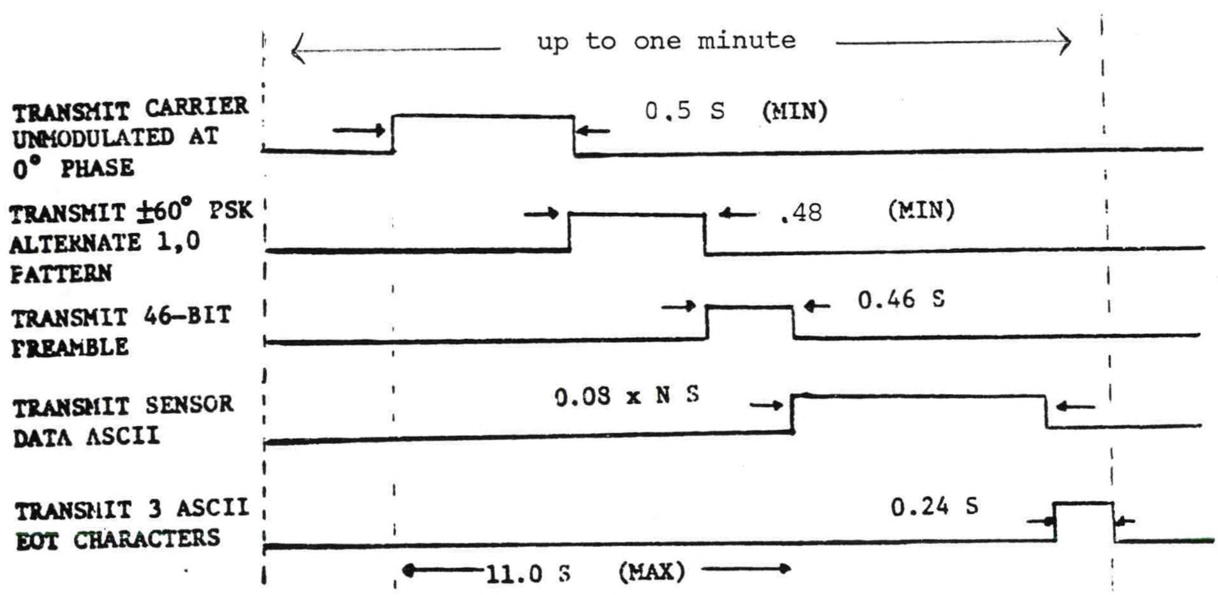


FIGURE 2.2 MODULATION DEFINITION



NOTE: N = NUMBER OF 8-BIT ASCII CHARACTERS OF SENSOR DATA

FIGURE 2.3 PLATFORM TRANSMITTER RESPONSE TIMING

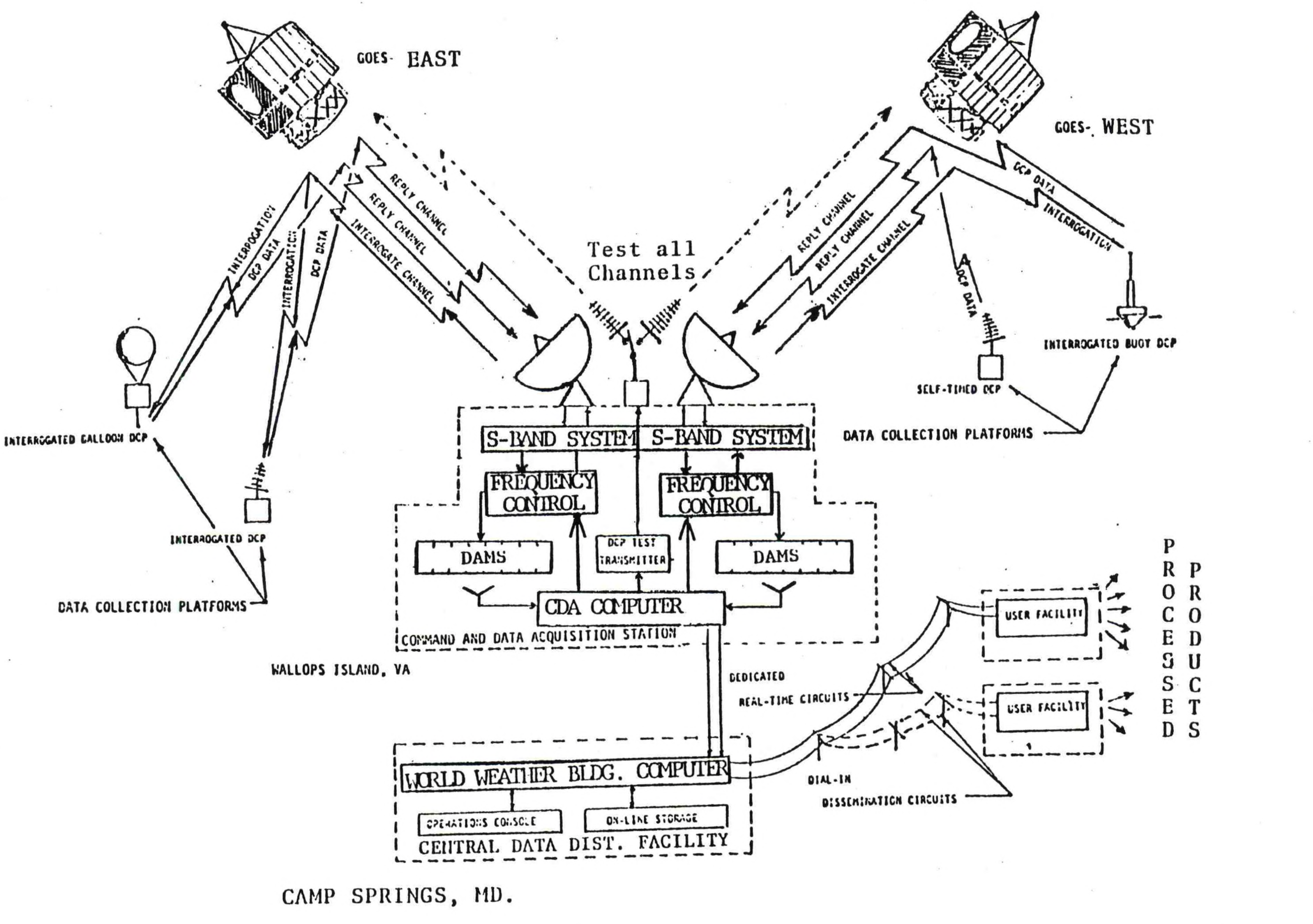


FIGURE 2.4 GOES DATA COLLECTION SYSTEM

The major equipments discussed in this section are the systems at the CDA, CDDF, and the ground system communications facilities in the DCS. All four computer systems in the DCS are models IS/1000 (previously GTE Tempo 1000) originally procured in 1975/1976.

2.3.1 CDA Equipments

The overall equipment configuration at Wallops Island includes new Data Acquisition and Monitoring Subsystem (DAMS) demodulators each of which demodulates one channel from the satellite. This configuration will accommodate up to 80 online demodulators, 40 hot spares and 20 logistical spares, as shown in Figure 2.5. For the DAMS procurement online demodulators are implemented as shown in Table 2.2 and 20 demodulators are spare. Based on the assumptions in 2.1.3, the on-line demodulators will accomodate a total of 9600 platforms. Assigning the 40 spare demodulators to on-line status would allow an additional 7200 platforms (any mix of ST and RR) to be handled by the DCS.

The DAMS provides the capability to derive four signal quality measurements. These are received signal strength at CDA, DCP transmit frequency measurement, DCP modulation index, and modulation quality. These measurements are ingested by the CDA computer and used in several ways (see Section 3.2).

The computer configuration at CDA (see Figure 2.6 for configuration layout) consists of two central processing units (CPUs), associated memory, and peripheral devices. Manual switches are provided to enable the operator to switch the CDA communications lines from one CPU to another; and the Test Transmitter and Interrogate Modulators between CPUs as well. The reply multiplexer inputs are dually ingested by the online and offline CPUs, so they are never switched. Table 2.3 summarizes the computer system parameters for the CDA.

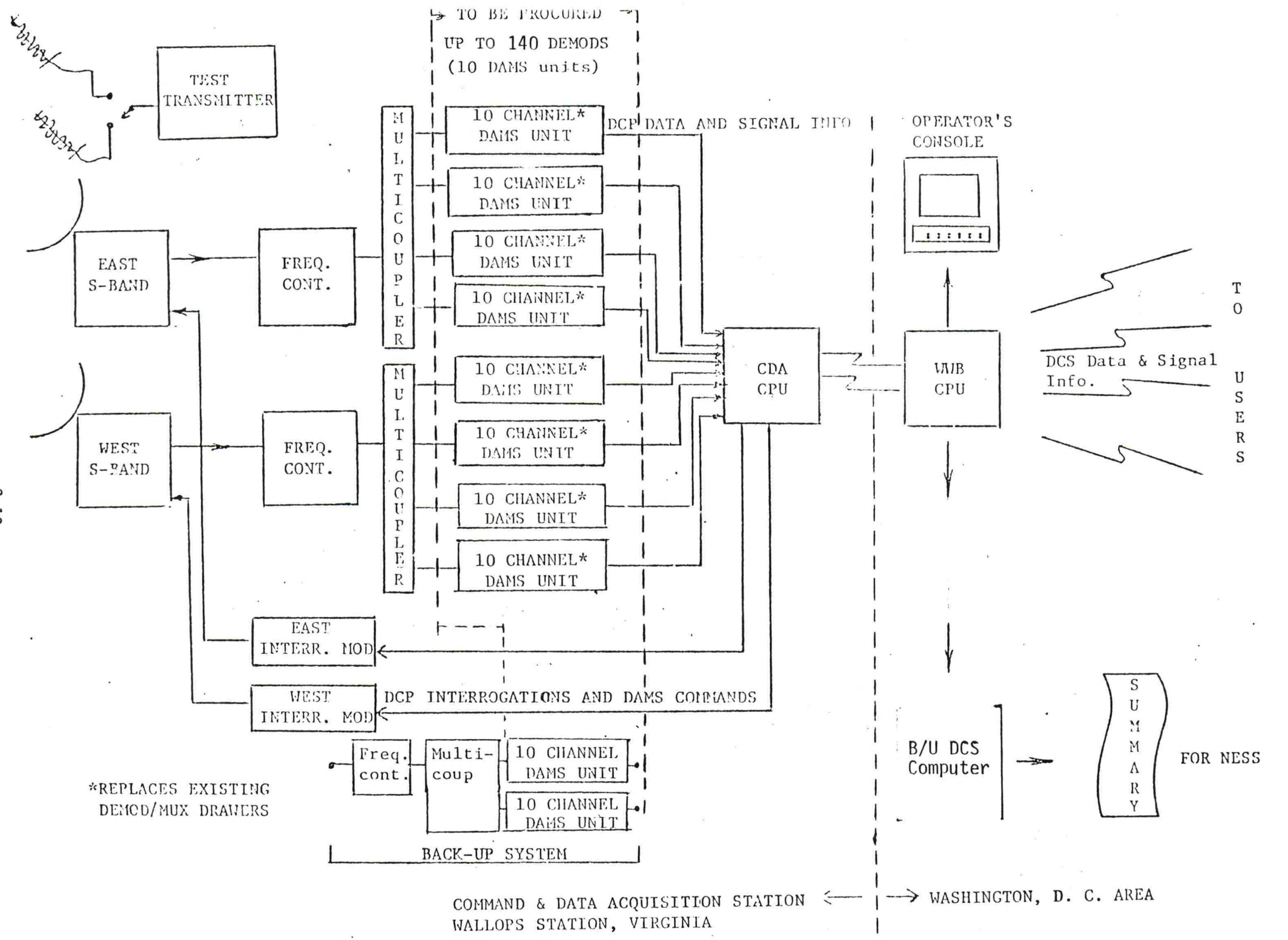


FIGURE 2.5. DAMS DATA FLOW

TABLE 2.2

CDA DEMODULATOR CHANNEL ASSIGNMENTS

GOES Satellite	Channel Number (1)
East	3, 5, 7, 13, 17, 19, 27, 33, (3) 43, 45, 47, 53, 55, 61, 67, 69, 77, (3) 79, 83, 91, 93, 95, 109, 111, 129, (3) 161, 165, 230, 232, 234 (2), (4)
West	2, 4, 6, 10, 22, 24, 28, 30, 38, (3) 40, 42, 44, 50, 52, 54, 56, 80, 96, (3) 98, 104, 106, 118, 124, 128, 130, 140, 146, (3) 156, 230, 232, 234 (2), (4)

(1) Each row represents the set of demodulators assigned to one drawer and sharing a common multiplexer. There are eight drawers. Two drawers holding a total of 20 demodulators are reserved as a back-up system.

(2) 230, 232, 234 are designated international for use both in East and West GOES.

(3) Each row of demodulators in a drawer has one spare.

(4) Six spares in the drawer allocated to international uses.

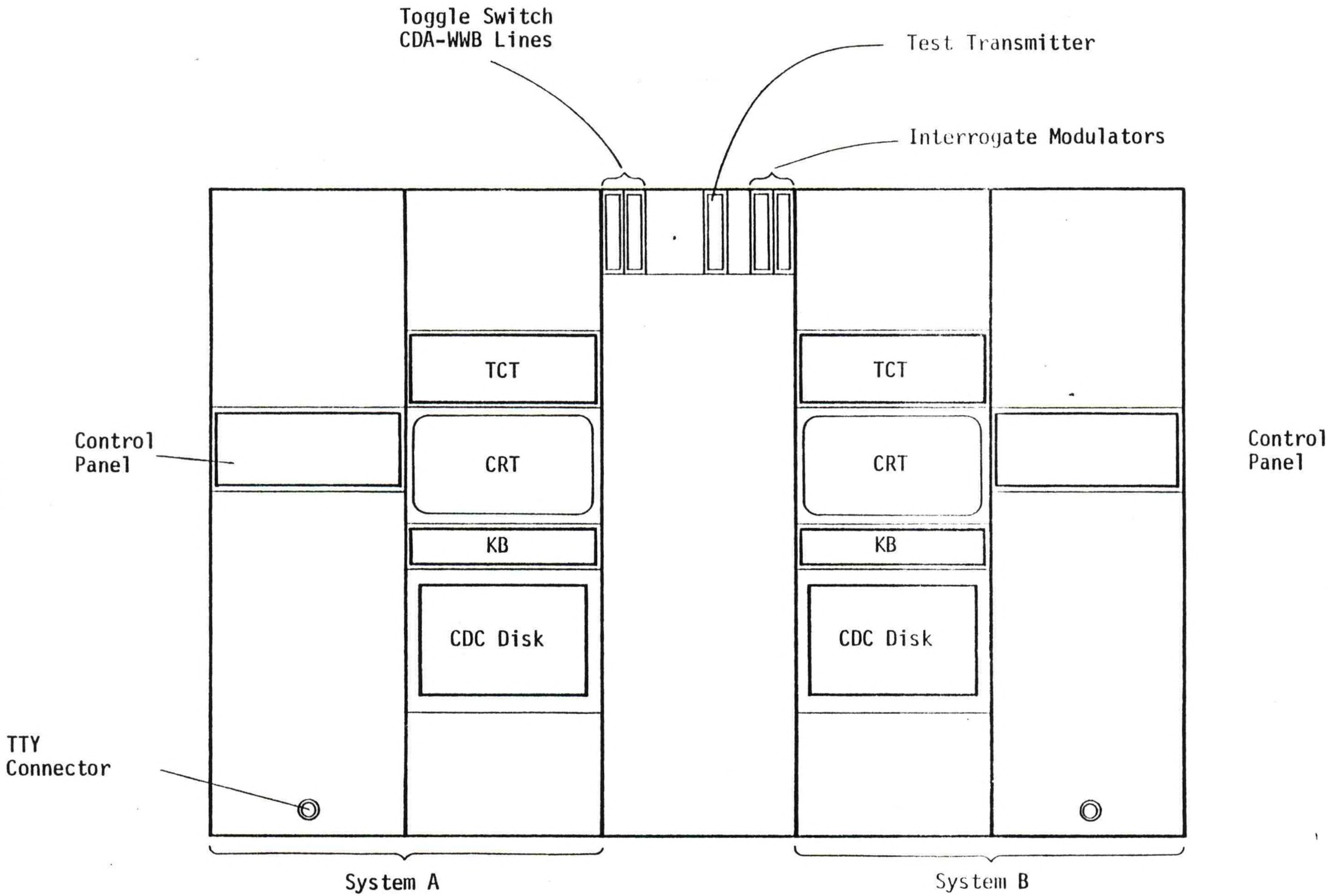


FIGURE 2.6 CDA SYSTEM LAYOUT

TABLE 2.3

CDA COMPUTER SYSTEM PARAMETERS

Parameter	Value
Main Memory	48K Words[1]
Disks[2]	
A. Fixed	5M Bytes
B. Removable	5M Bytes

---

[1]16 Bit words.

[2]Organization is 127 word sectors

2.3.2 CDDF Equipments

The CDDF computer system configuration at WWB consists of two CPUs, associated memory, peripheral devices, and control console. Manual switches are provided to enable the operator to switch the WWB/CDA communications lines and user dissemination lines from one CPU to another.

The duplex system layout at WWB is shown in Figure 2.7, and Figure 2.8 gives the layout of the CDDF console. The disk drives may be positioned elsewhere rather than in line with the cabinets.

Table 2.4 summarizes the computer system parameters for the CDDF. The memory size listed is for the upgrade system. This memory is organized into eight banks of 16K words each. All I/O for main memory must use only bank zero.

2.3.3 Ground System Communications

The ground system communications circuits all emanate from the IS/1000 computer system at the DPS in Camp Springs, Maryland. A switching system allows any circuit to be switched between the two computers in the CDDF. Table 2.5 shows the circuits and their assigned ports. The first 16 ports are used for synchronous communications; the remaining ports for asynchronous circuits. Ports one and two are dedicated to full-period use between the Wallops CDA and the CDDF; these circuits operate at 9600 bps using an IBM Bysynchronous communication procedure. The assigned usage of the ports is listed in Table 2.5.

Table 2.6 presents the circuits and their assigned ports for synchronous communications at the CDA and their assigned functions.

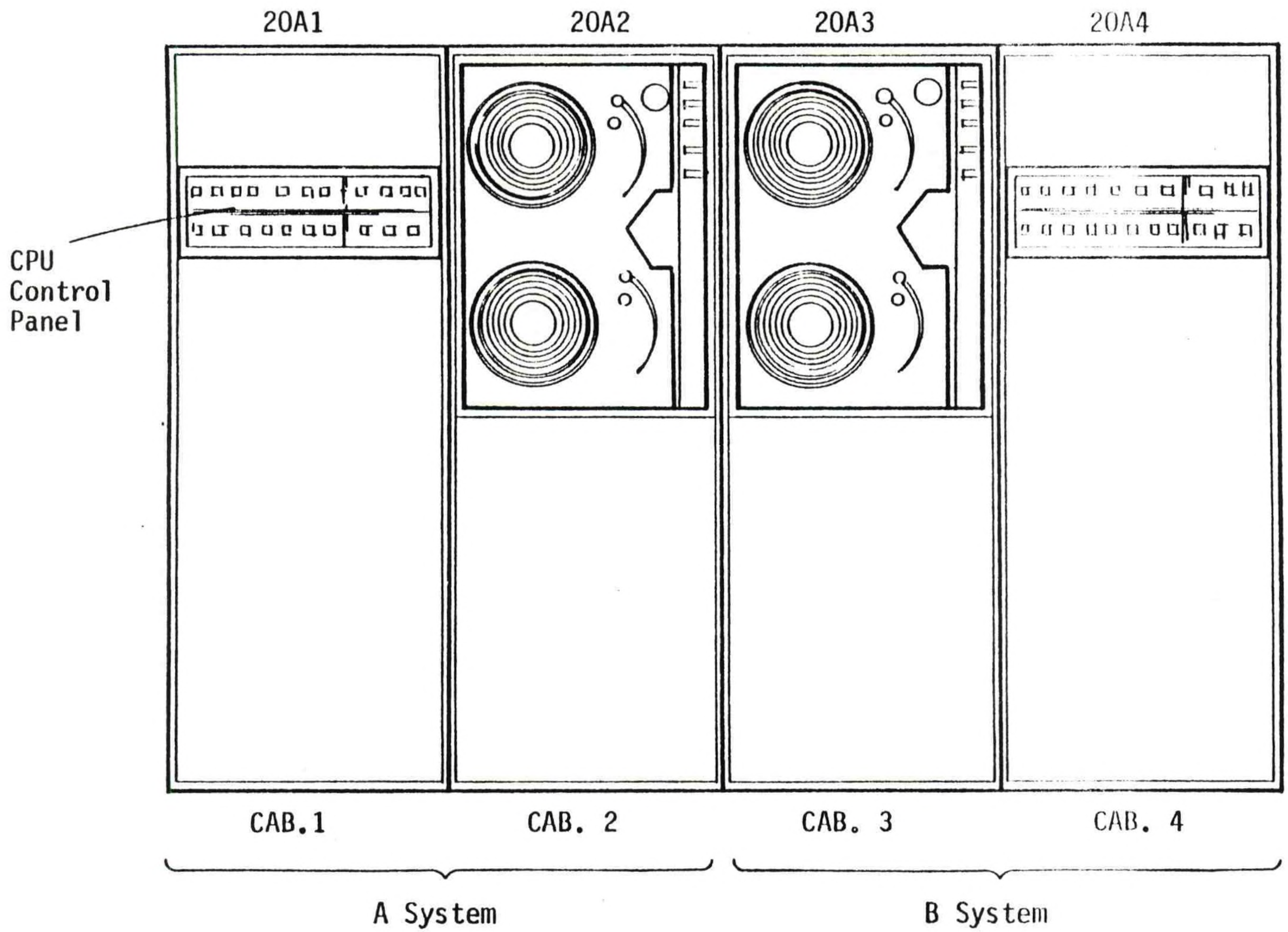


FIGURE 2.7 CDF WWB CPU CONFIGURATION

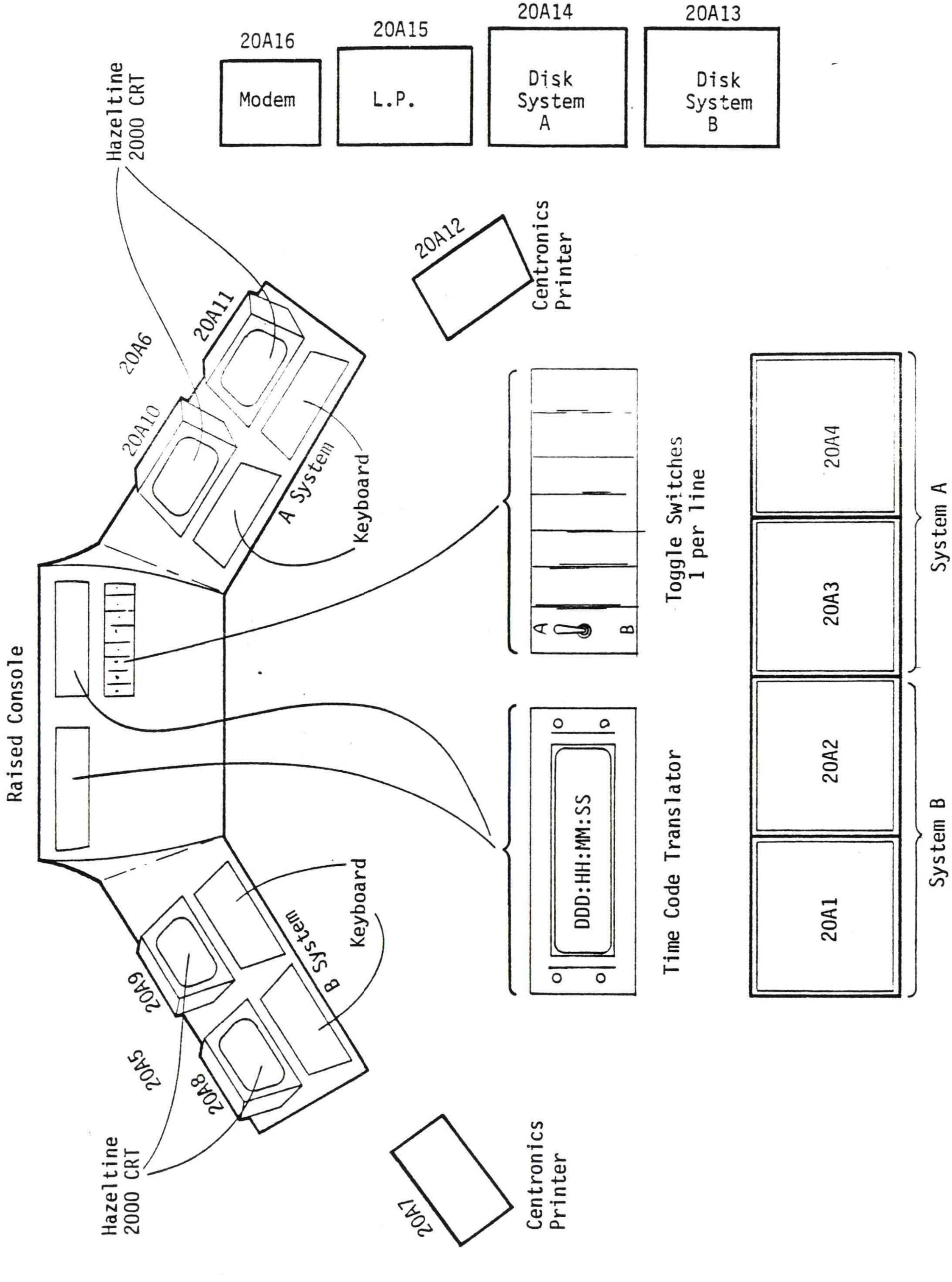


FIGURE 2.8 CDF WWB CONSOLE LAYOUT

TABLE 2.4

CDF COMPUTER SYSTEM PARAMETER

Parameter	Value
Main Memory	176K[1, 2]
Disks[3]	
A. System	22M Bytes
B. Message	22M Bytes

[1] 16 Bit words.

[2] This amount of main memory is part of the DAMS upgrade. The initial amount of memory was 56K words

[3] Organized as sectors containing 173 words

TABLE 2.5

COMMUNICATION I/O PORTS

PORT (1) NUMBER	PORT USEAGE
1	Wallops/Marlow Heights; 9600 bps
2	Wallops/Marlow Heights; 9600 bps
3	Unused
4	Dedicated User full period connection
5	
6	
7	
8	
9	
10	Dial-up: 4800 bps, with modems
11	
12	Dial-up: 4800 bps, unused
13	System Displays
14	
15	Unused: assignable only to displays
16	
17	Dial-up: 300 bps
19	
18	Dial-up: 1200 bps
20	

(1) Ports 1 through 16 are on a synchronous I/O controller; the remaining ports are on an asychronous controller.

TABLE 2.6

COMMUNICATION PORTS AT CDA

PORT NUMBER	PORT USAGE
1	Wallops/Marlow Heights; 9600 bps
2	Wallops/Marlow Heights; 9600 bps
3	Unused
4	Multiplexer Inputs From Demodulators
5	
6	
7	
8	
9	
10	
11	Interrogate Modulators
12	
13*	Operators Console (1)
14*	
15*	Computer-to-computer link (1)
16*	

* Used with an synchronous to synchronous converter

(1) To use these channels for multiplex input (channels 3 through 10), the operators console can be connected to a special interface device and the computer-to-computer link can be handled as a COP-to-COP link.

3.0 GROUND COMPUTER SYSTEM FACILITY FUNCTIONS

This section describes the data acquisition, monitor and command function at the CDA and the CDDF. For emphasis, the DCS system capacity (discussed in Section 2.3) is 14,400 platforms based on 120 channels. In Section 6.0 the limitations on this capacity are discussed. The remainder of this section describes the CDA, CDDF and user interfaces.

3.1 CDA FUNCTIONS

The material in this section is primarily oriented to a description of data and control flow at the CDA as shown in figure 3.1. At the left is shown the hardware interfaces with the data demodulators and other I/O devices. Each data demodulator handles one satellite channel. The output data from up to ten demodulators are combined (MUX) for serial transmission via a synchronous interface (SMM) with the computer. The data is routed via the Communication On-line Processor (COP) which is a micro-processor based device providing control and buffer storage. The COP provides a Direct Memory Access (DMA) interface with the computer.

The data from a multiplex unit once placed in main memory will be handled in sequence by several programs. First the DEMUX program will separate individual DCP messages, detect the Start of Message (SOM), End of Message (EOM), check the MLS and check parity. The Message Processor (CDAMP) program validates the DCP address and generates abnormal response messages for

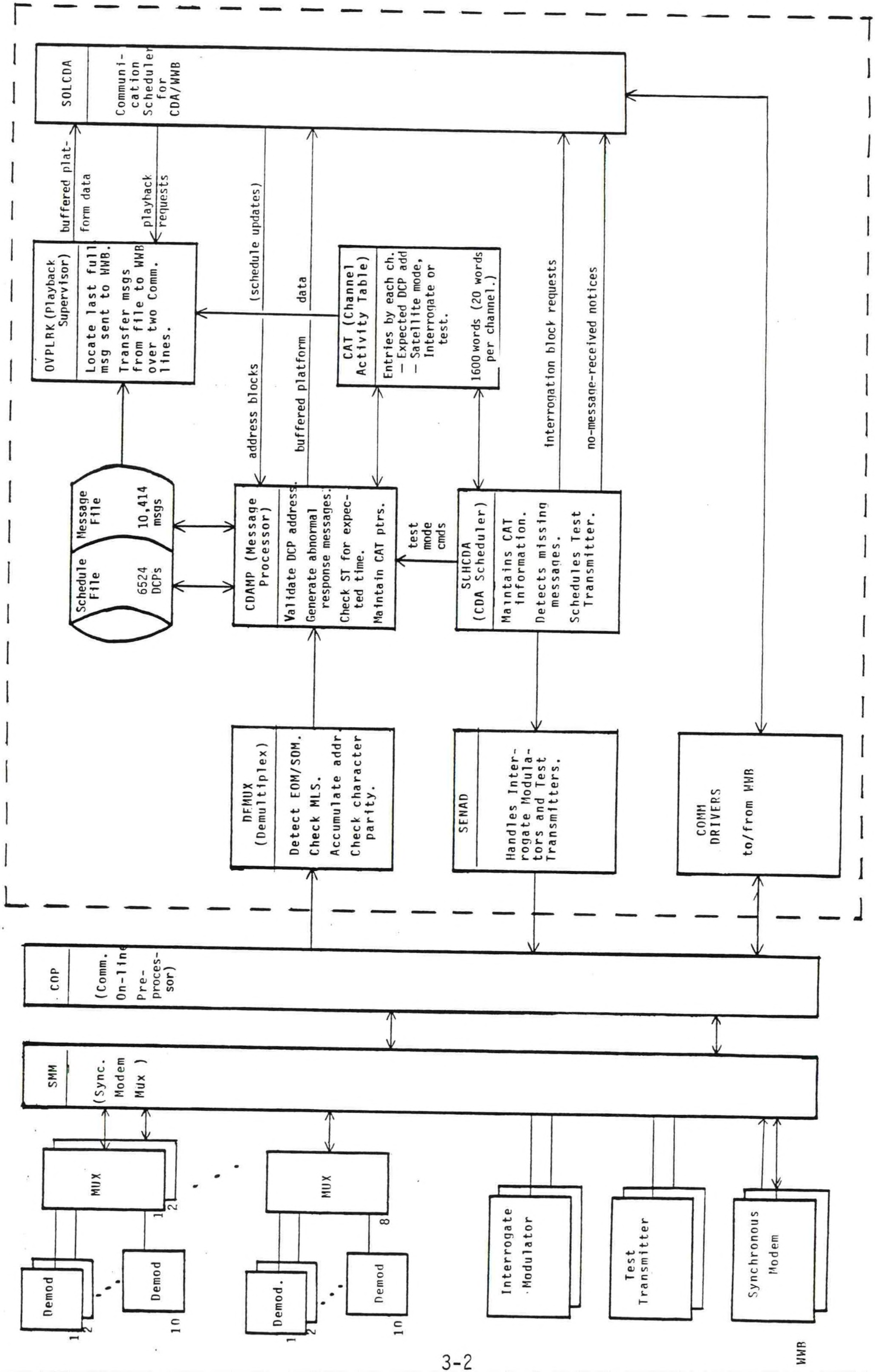


FIGURE 3.1. MESSAGE FLOW AND SCHEDULE OPERATION AT THE CDA

messages received but not expected as indicated in the Channel Activity Table (CAT). The CDAMP program stores the received messages in a message file contained on a disk. Also, messages are buffered and transmitted to the CDDF via the Communication Scheduler (SOLCDA). The CDA schedule program (SCHCDA) checks messages received and generates missing message notices and generates notices concerning on-receipt of messages.

The data received at the CDA from the CDDF includes address blocks that update the schedule file. These blocks are routed via SOLCDA to the CDAMP which then writes the blocks to the disk file (currently, the schedule file can support about 5400 DCPs).

The CDA scheduler program, SCHCDA, also functions to support the interrogation of DCPs. It outputs interrogation requests to the interrogation modulators via SENAD. It also requests additional interrogation blocks to be sent from the CDDF.

The remaining material in this section presents a detailed description of the data flow at CDA based on the documentation describing the existing system. Section 3.1.2 describes the new functions that are part of the baseline resulting from the procurement of hardware and some minor software modifications at the DAC. Section 3.1.7 describes operator functions.

3.1.1 Data Acquisition

The CDA equipment continuously receives all active reply channels simultaneously. Each channel is individually received and demodulated. The data from ten channels is then combined (multiplexed) and provided to the computer for processing and storage on the disk.

The CDA secondary system also demultiplexes and assembles the DCP data on disk as complete messages. Each message is time-stamped with its receipt time as provided by the time code translator (TCT) in each machine. Therefore, as long as the two TCTs are in sync, the messages in each machine can be correlated by time. Communication between the primary and secondary is via an intercomputer device which enables CDA secondary to recognize a failure of the primary and to signal the operator. Wallops secondary continues to demultiplex and store the data on disk and assumes all operational functions when the operator designates it as primary.

3.1.2. Data Quality Monitor

In the Data Acquisition and Monitor Subsystem (DAMS) the demodulators at the CDA will provide measurements of the four parameters listed in Section 2.3.1. Measurements will be made on each message as it is being received by the appropriate channel demodulator. The raw measurements available from the demodulators will be passed along with sensor data to the CDA computers. The quality information will be added to the end of each message. From the CDA, the primary path to the users will be the same as currently utilized for the DCP data i.e., from the CDA computer, to the CDDF, and finally disseminated over one or more communications circuits.

Another path is intended specifically for technicians who are actually in the field deploying the DCP. For such platforms undergoing tests, the CDA computer will transmit a special message over the Data Collection Platform Interrogate (DCPI) channel. This message will be in the form of a platform command and provide the DCP (or more likely the field technician using a separate special purpose receiver) with the salient measurement's made on the previous transmission.

3.1.3 Message Storage

The CDA System will store platform reply messages in the Message File, which is in disk storage. The CDA Message File is logically a single queue of messages, stored progressively along the file extent and then, when the end of the extent is reached, back to the beginning of the file. The storage will currently accommodate about 16 hours of messages.

3.1.4 Scheduled Operations

From a schedule stored (on disk) in the CDDF, messages are periodically transmitted to the Wallops system indicating the upcoming activity to be expected on each of 80 DCS channels. This schedule information transmitted to Wallops includes address of the platform, channel occupation time, whether it is a self-timed or interrogated-type radio set, and whether or not a response is expected. At Wallops it is maintained in a Channel Activity Table (CAT).

3.1.5 Interrogation Functions

With the schedule data, the CDA system sends interrogation addresses (via the two interrogation modulators) through each of the GOES (for interrogation-type DCPRS only). The interrogation rate is exactly 0.5 seconds for each GOES, and the addresses are sent in the order in which they were provided by the CDDF.

3.1.6 Error Monitoring

Once a message is received at the CDA in its entirety, it is checked for the correct address and examined for error conditions by the Message Processor. The message is then transmitted to the CDDF along with its error status. Platform transmissions received at the CDA, but not at an assigned time, can occur due to three reasons: 1) a platform failure has occurred, 2) an "emergency" situation has arisen triggering a spontaneous transmission, and 3) a platform is under test. A notification of these conditions is sent to CDDF along with the message.

3.1.7 Operator Intervention at CDA

Although the system design philosophy does not require operator intervention (except for CPU failures or catastrophic system failures), the operator can exercise total control and supervision.

The CDA system operator may:

1. Manually disable (close) or activate (open) individual communication lines or DCS channels.

2. Observe the status (open/closed channels, messages in progress, etc.) of any channel (or communications line) and change it from open and vice-versa as external situations require.

3. Initiate diagnostics on the off-line CPU or communications lines.

4. Perform tests on the system, such as sending interogations, receiving data, or using the test transmitter independent of the WWB system.

5. Change which CPU is online.

Also, the operator is informed of system status changes via messages on the CRT, and critical items sound an audio alarm.

3.2 CDDF FUNCTIONS

This section high-lights some of the more significant functions performed by the CDDF system at the WWB and its operator. These message storage and platform address validation functions are associated with the data flow shown in Figure 3.2. and scheduling functions shown in Figure 3.3. The description of each of these functions in this section is based on existing documentation (references R.1, R.6) of the CDDF and have been updated to reflect changes expected from the Automatic Monitoring System (AMS) enchancements (Reference R.2). Because of the importance of AMS, a separate section is devoted to its description. Scheduling and operator intervention are covered in separate sections as well as user interface with CDDF.

3.2.1 Message Data Flow

DCP messages are received from the CDA via synchronous modems and communication devices by the CDDF scheduler program, SOLWWB, which routes the messages to the Platform Message Handler (PMH). SOLWWB also routes interrogation buffer requests from the CDA to the WWB dispatcher. The PMH program stores the received messages and error notices in a message file on

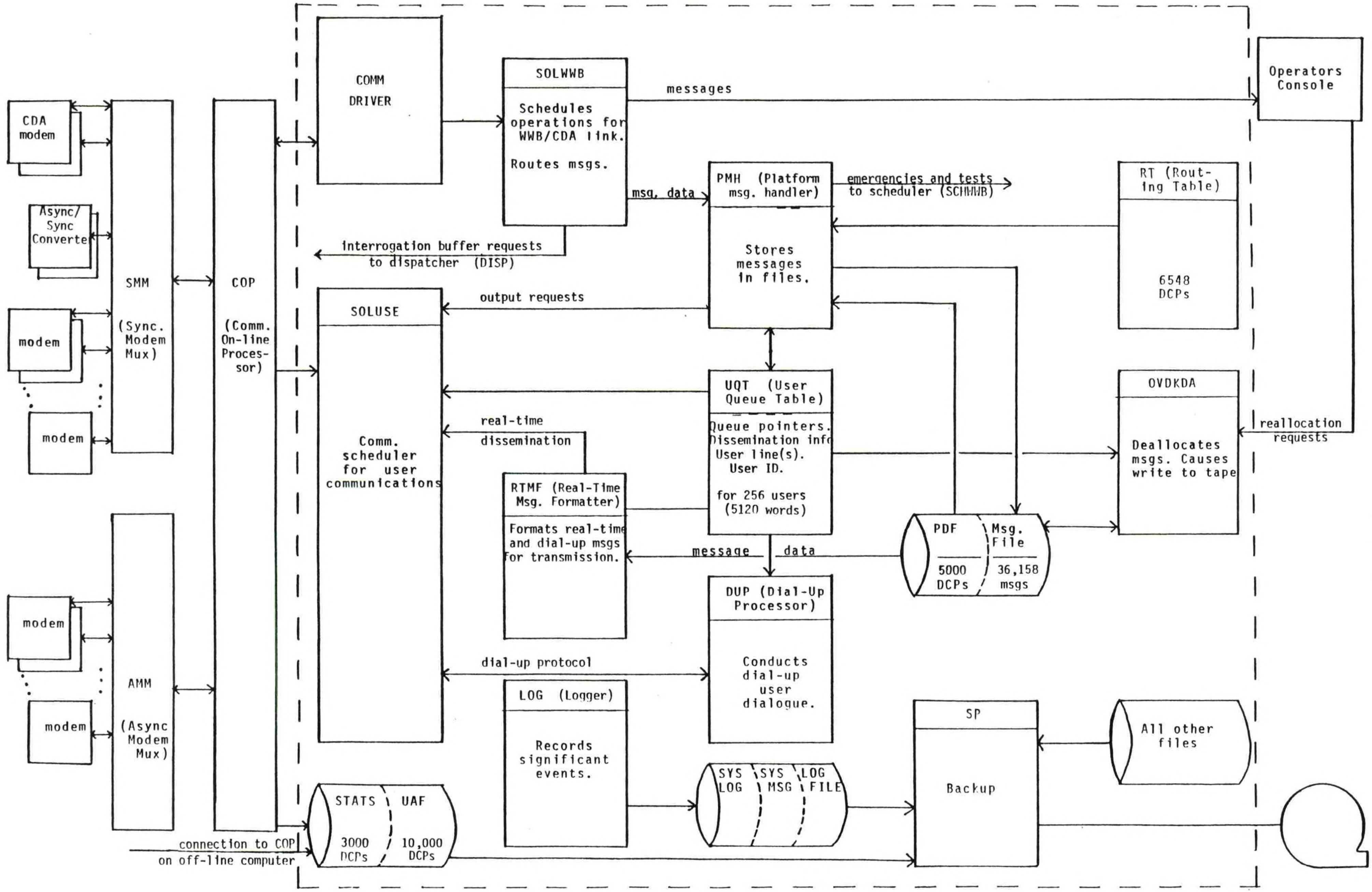


FIGURE 3.2. MESSAGE FLOW AT THE CDDF

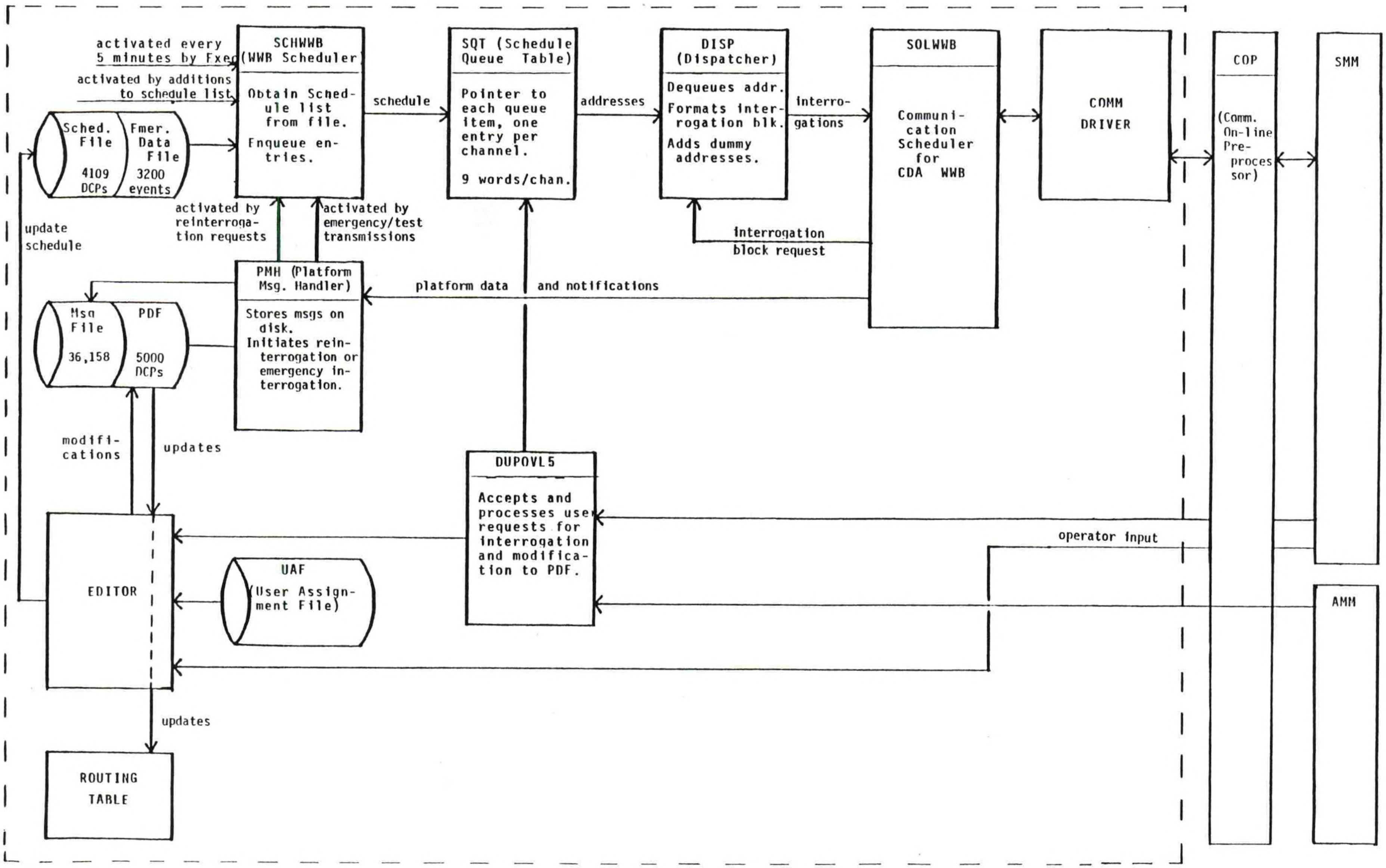


FIGURE 3.3. SCHEDULING OPERATIONS AT THE CDDF

disk; it also handles the generation of appropriate routing information using the routing table and the Platform Data File. The PMH also updates the User Queue Table (UQT) pointers when new messages are stored.

The messages to be transmitted via modems (synchronous or asynchronous) are handled by the CDDF communication scheduler (SOLUSE), the Real-Time Message Formatter (RTMF) and the Dial-up Processor (DUP). The SOLUSE program inspects the UQT table in order to sustain transmission of message blocks to users. The RTMP program receives information from SOLUSE that it uses to acquire messages from the file and to format these messages which are then handed-off to SOLUSE. The Dial-Up Processor (DUP) is a program that enables the CDDF system to respond to and enable circuits with dial-in users.

Other significant functions associated with message processing shown in Figure 3.2 are message deallocation (handled by OVDKA), file maintenance, Logging, and backup (handled by program SP). The deallocation function releases disk space for reuse after a pair of criteria based on storage time and dissemination have been checked. The file maintenance operation enables the up-dating of the Statistics File in the on-line computer via the COP to the off-line computer. The system logger (LOG) records all significant events in a log file on disk. The back-up program writes all files from disk to a tape for archive.

3.2.2 Message Storage

The DPS system stores platform reply messages in a file on disk storage. The file is logically 256 queues of messages, with each queue dedicated to a single User. This file is used in a "wraparound" manner and will hold 64,000 short platform messages in its disk file (about 32,000 average length messages). A message not yet recorded as having been disseminated by the DPS remains stored until it is disseminated unless the user indicates (via a parameter) that the data should be de-allocated after a specific interval regardless of dissemination.

The disk file in the DPS is currently copied to tape once each 8-hour shift. This provides a backup in case of failures at the WWB. The tape copy takes about 15-20 minutes to make.

3.2.3 Platform Address Validation

If two addresses (the expected address in the schedule and the received address) differ by more than two bits, the CDA sets an "unexpected-message" bit in the internal header of the message received, and generates an "incorrect-address-received" notice for the expected message as well as an "unexpected-message" notice for the received message (CDA corrects the received address if one or two bits are different). The CDDF will check in its files (a routing table is maintained in main memory listing each DCP to expedite message handling) for the received address, obtaining the "User queue" and setting up the message header if the address (including random reporting) is found, and storing the message in the "garbage queue" if it is not found.

3.2.4 Scheduling

The scheduling information supplied to CDA by the CDDF is stored in disk files (Schedule and Emergency Files). These schedule files contain separate schedule records which are similar but not identical for self-timed platforms and for interrogated platforms. There is a platform schedule of each type for every five-minute interval of the day. The Emergency File contains schedules for platforms to be interrogated as a result of an emergency trigger. Figure 3.3 represents an overview of the scheduling function at the WWB. If a channel, an interrogate modulator, or a satellite fails or is taken down for preventive maintenance, the CDDF operator can "close" the appropriate subsystem such that no scheduling takes place for it until it is "opened" again. This feature can also enable the operator to temporarily alter the scheduling for a particular channel by closing it and this is accomplished using the EDITOR program.

The following paragraphs discuss the scheduling for the various types of platforms and conditions in the DCS.

3.2.4.1 Scheduling of Self-Timed Platforms. The schedules for self-timed platforms are created and modified by the System Operator at CDDF, and transmitted to CDA by the scheduler programmer (SCHWWB in Figure 3.3) automatically after update. The CDDF will transmit the self-timed schedules to CDA only on creation and when modified; it may also be necessary to transmit the self-timed schedules to CDA after a failure of the CDA primary computer and consequent recovery by the CDA secondary computer.

The schedule file is used by CDA either for its scheduling or message processing activities. The user dissemination queue for each DCP in the schedule file is sent back to CDDF in the header of the platform message, to enable the CDDF to queue the message for dissemination without having to access the Platform Data File to determine the appropriate dissemination queue.

3.2.4.2 Scheduling of Interrogated Platforms. The CDDF program (SCHWWB) reads a schedule for interrogated platforms from a disk file every five minutes. It processes each entry in the schedule using it to create a schedule queue item which is then queued to the bottom of a schedule queue for the appropriate channel in the Schedule Queue Table (SQT). If a channel or satellite is closed (or not available), an interrogation will not be scheduled for it until it is opened. The SQT is used by the Dispatcher program (DISP) which sustains the CDA/WWB Communications by sending interrogation blocks and receiving requests for interrogation blocks. The PMH program receives the messages and notification of missing or corrupted messages from CDA. The PMH can then initiate reinterrogation of the platform based on this information. These requests are presented to the WWB scheduler (SCHWWB). Another program, DUPOVLS, enables the user to access the SQT and initiate non-scheduled interrogation requests.

All of the schedule queue items are used by CDA either for its scheduling or message processing activities, with the exception of the user dissemination queue(s), the retry number, and the maximum number of retries. CDA sends these items back to the CDDF in the header of the platform message, to enable the DPS to queue the message for dissemination or schedule for reinterrogation without having to access the disk.

The first entry of each interrogated schedule is reserved for the name of an alternate list to be sent one time only. When the alternate list name is entered, the date on which it is to be sent is also entered. This list is then sent on that day only and the schedule subsequently reverts to the original list.

3.2.4.3 Reinterrogation Due to Error. When the CDDF software (PMH) receives from an interrogable platform a platform message that has been flagged in error by CDA, it examines the message header in order to compare "retry number" with "maximum number of retries". If the two are equal, then for those users who only want good data (a user option set in a disk file), the software allows this last version in error to stand; however, for other users, all messages will be sent whether in error or not. In both cases, reinterrogations will cease when the retry threshold is reached. If the retry number is less than the maximum number of retries for that platform, CDDF software will queue a request for a reinterrogation. The software system will increment the retry count.

When the CDDF receives an "expected-message-not-received" or "received-in- error" notice, it will check its records for that platform to determine whether it should reinterrogate the same address again or interrogate a different address. The latter will be the case for certain self-timed platforms, which, if they do not respond or if they respond in error, are then to be interrogated on a different channel with a different address.

3.2.4.4 Emergency Interrogations. When an unexpected transmission from a platform is recognized, it will be ascertained by the CDDF software (Platform Message Handler) whether the message was a test transmission, or a random reporting message. If it was not a test transmission or random reporting, and was received on the platform's secondary channel, it may be an emergency message. If further checking reveals it is an Emergency type platform, it will be determined whether the specific emergency is already active. If it is not recorded as active or it is but its count has gone to zero, it will be recorded by the CDDF software. If it is recorded that the count has not gone to zero, the Emergency will not be reinstated. For each platform address determined to be associated with an emergency, an interrogation will be scheduled at the top (highest priority) of the interrogation queue. In recovery, the emergency list will be cleared.

3.2.4.5 Automatic Scheduling Via Remote Input. The users may initiate platform interrogation/command requests by sending to the CDDF a message in a fixed format with the identifier "AS" in a fixed position. These messages may be sent via specific dedicated communication lines or via GOES as a platform message type transmission. The acceptance or rejection of this request will be logged and the operator will be notified with an appropriate alarm. This same notice is sent to the user also. If the request is received from a platform and accepted, a reply verify will be sent to the requesting platform on its secondary address.

3.2.5 The Automatic Monitoring System (AMS)

The Automatic Monitoring System (AMS) represents an upgrade to the GOES DCS system that includes hardware mostly at the CDA (see Section 2.2.1) and predomination software and installation of more main memory at the CDDF. The added software capabilities include the support of random reporting platforms; the generation of system performance statistics; the measurement of DCP signal characteristics and the communication of this data to the system users; and an enhanced capability for the computer operators to monitor the status of the real-time system, providing a data base on user assignments.

3.2.5.1 Random Reporting Upgrade. The upgrade to handle random reporting provided routing information for each DCP to be stored in main memory instead of on disk files. This improvement reduces the number of disk accesses required when much of the routing information was stored on disk. In addition to message routing, random reporting necessitates other changes in the way the system operates. For example, because such platforms are always unexpected, operator alarms and notices to users must be suppressed. Such alarms are currently utilized for evaluating system health, and policing channel assignments and utilization.

Because of the significant probability that random DCP's can interfere with each other (30% to 50%) a considerable number of garbled messages can be routinely expected. For most operational uses, such garbled messages are worthless and are not distributed. For test and evaluation purposes, however, they are useful and can be made available.

3.2.5.2 System Performance Statistics. When one considers there are thousands of platforms utilizing 80 or more channels involving dozens of users, each working with one or more computers, and generating hundreds of different products, the GOES-DCS is a relatively dynamic and complex system. The system has been designed to operate in spite of multiple hardware failures (including satellites). Being so dynamic, however, it is difficult to tell just how well it is operating. Further, isolation of problem areas can be complex. Because the system is divided into many individual components, each operating independently, it is necessary that each element be aware of how its performance affects that of the other elements.

The AMS upgrade at the CDDF will enable the WWB operators to generate routine reports on system performance and utilization for each of the operating elements. These reports will make the desired information readily accessible and accurate in spite of various failures or unusual operating modes within the system. Most of these reports will be generated on a line printer at WWB utilizing the computer resources of the standby computer.

3.2.5.3 Real-Time System Monitoring. The CDDF represents the operating hub of the system because it is the place where Wallops, and the users, routinely interface. As such, it becomes the "tech control" for the whole system. All elements of the system rely on WWB to observe the operation in real-time, initiate corrective action to problems as soon as possible, and provide supportive information when problems are detected elsewhere.

In an effort to make this overall responsibility more efficient and reliable, the AMS upgrade provides improvements in the areas of alarm generation, log display capabilities, failure identification, and on-line performance evaluation. A major effort will be made toward minimizing the amount of interaction that is necessary between the users and the operator for DCP scheduling.

3.2.6 CDDF Off-line System Operations

The Off-line system operations are illustrated in Figure 3.4. A back-up tape from the on-line system is used to generate and update statistics on the back-up disk. Simularly, the operator edits the user assignment file; the results are stored on a back-up disk. Both statistics and user assignment files are written to tape and are processed by a repot generator with printed output available. The back-up program also transmits information about the updated statistics file to the on-line system via the COP.

3.2.7 CDDF Operator Intervention

The CDDF system operator may do all of the functions listed in 3.1.7 and the following as well:

1. Inspect the current and future schedule and make modifications as required.

2. Review recent events occuring on the system.

3. Review and modify information contained within the system: platforms, users, etc.

4. Display individual platform messages.

5. Request removal of messages from disk, or route messages to different users.

6. Initiate any required disk clean-up procedure where deallocated areas may be recovered for use.

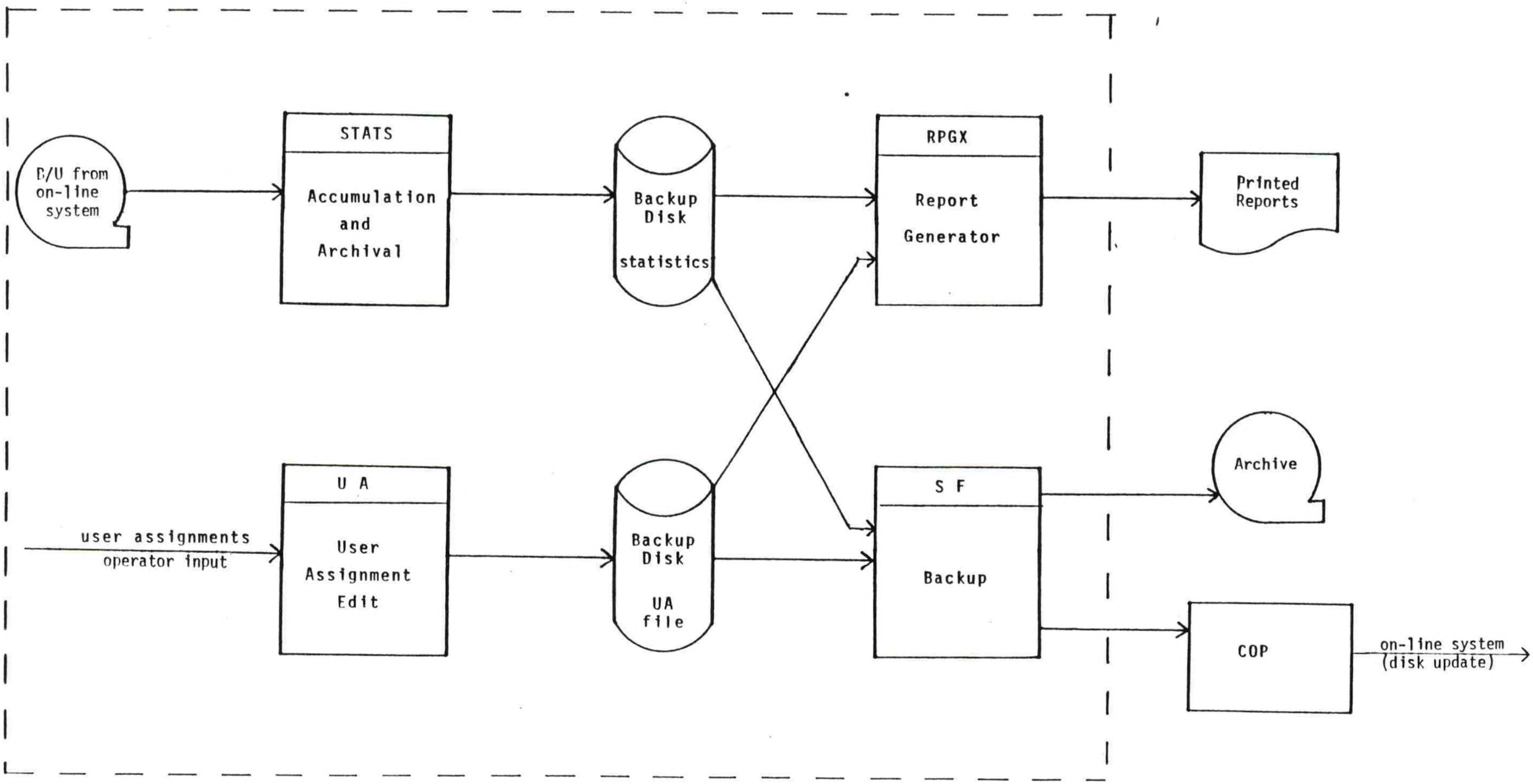


FIGURE 3.4. OFF-LINE OPERATIONS AT THE CDDF

7. Receive and display operator messages from users (from both dedicated and dial-in lines).

8. Make a permanent record on a console printer of anything observed on the console display.

9. Take a CPU off-line, if necessary, and generate new programs and assemble them. A programmer may also perform a new SYSGEN on the standby computer and place a new program into operation without complete system interruption.

3.2.8 CDDF User Interface Description

The DCS user interface is described in References 1 and 2 and summarized in Table 3.1. Each user interface is supported by the appropriate communication port/circuit identified in Section 2.3.3. The interface has the following elements:

1. A set of data communications protocols that are used to communicate between the user site equipments and the DCS. These protocols include variants of the binary synchronous communication protocol (BSC) described in IBM document and in ANSI X.3 2/A2. There is also an asynchronous protocol. Two of the protocols (the asynchronous and the TI 742 BSC) include option selections and features that are either peculiar to the DCS or are relatively unusual.

2. A set of user directives and commands. These include:

   DIS - which causes the users output file to be transmitted and deleted (after successful transmission).

   RLT - which allows the user to perform a simple selection (based on time) of items from the output file, and transmits the selected items without deletion.

TABLE 3.1

USER INTERFACE CHARACTERIZATION

LINE	PROTOCOL	FUNCTIONS PROVIDED (1)						REMARKS
		Op Mg	AS	FT	ED	DIS	RLT	
Synchronous, Dedicated (up to 9600)	IBM BSC	✓	✓	✓	✓			Automatic dis-semination
Synchronous, Dial-up (4800)	IBM BSC	✓	✓	✓	✓	✓	✓	
Synchronous, Dial-up (1200)	BSC-related (TI 742 version) ANSI X3.2 class A2/	✓	✓	✓	✓	✓	✓	Protocol allocates control character options for TI 742 cassette control
Asynchronous (300/1200)	Asynchronous, with some unused control characters transmitted	✓	✓	✓	X	✓	✓	

(1) A check indicates function is available

(2) Legend of terms in text

FT - which allows the user to receive a copy of a platform file record.

ED - which allows the user to enter a complete platform file (that had previously been copied by the user and edited in the user's equipment by means of a user-supplied editing capability).

User ID - which allows the user to send a message to the DCS operator.

AS - which allows the user to enter a platform "autoschedule" request for real-time platform interrogation/command.

STOP - which terminates user communication.

4.0 SOFTWARE SYSTEMS AND ARCHITECTURE

The operational DCS utilizes four distinct sets of software: DCS (CDA) which runs in both CDA computers; DCS (CDDF) and DCS2 (CDDF) which runs in the operational (real-time) computer at WWB; and STAT (statistics generation) and UA (user assignment) which are run in the off-line CDDF computer; LOADBK (CDDF) which generates a copy of the operational disk pack, from an on-line-produced tape, for back-up purposes. Table 4.1 summarizes the size of some of these programs.

This section describes selected characteristics of the software systems in the DCS and their architectures. The description includes architecture of the software, description and sizing of modules/programs, main memory and secondary memory organization. A preliminary assessment of selected features of the software is also presented. The emphasis in this section is on the CDDF software although some information is presented on the CDA.

4.1 SYSTEM ARCHITECTURE

The CDDF software system is implemented by using an overlay structure in the IS/1000 systems; that is, a root containing several modules is always memory resident, this root is used in conjunction with up to four overlay areas in which non-resident modules can be brought into memory.

TABLE 4.1

PROGRAMS SIZES* IN OPERATIONAL DCS

Program Name	Root	Overlays	Total
DCS (CDA)	15,045	23,958	39,003
DCS2 (WWB)	12,254	83,428	95,682
DCS (WWB)	20,650	-	20,650
RTBLD (WWB)	1,549	-	1,549
TOTALS	49,498	107,396	156,884

*Size in 16 bit words of storage

The CDDF system has two main operational programs. DCS2 is an initialization and clean-up program that is used after a failure or before a start-up. It recovers space on the disks. DCS is the normal operation program that supports all of the functions discussed in previous sections.

The total complement of software (modules, programs, routines) in the DCS (both the CDDF and CDA) are presented in Table 4.2. This table presents a brief description column labeled Definition in the table of each module function and its size (in 16 bit words of storage).

4.2 STORAGE ORGANIZATION

The storage of the CDDF includes two 22 M Bytes disks and the 178 K words of main memory in the IS/1000. The main memory which is comprised of 8 banks is organized as shown in Table 4.3. All I/O operations for the IS/1000 must be through bank zero (0). The disks are organized as indicated in Table 4.4 by sectors each of which contains 173 words.

The storage of the CDA includes two 5M Byte disks and 48K words of main memory in the IS 1000. The disks are organized as shown in Table 4.5 by sectors each of which contains 127 useable words.

4.3 PRELIMINARY SOFTWARE ANALYSIS

The software in the DCS system is comprised primarily of custom coded programs to support the applications. Some of this custom coded software provides program features/functions that are currently provided in the commercial area as a procureable product (e.g., operating system).

For the DCS, a preliminary assessment of the match between custom coded programs and commercially available software is provided in Table 4.2. Three categories have been established in the table: category 1, probably Operating System (OS); category 2, probably simplified by OS; category 3, probably special. The aggregate sizes (16 bit words) associated with each of these categories are respectively 12,331 words for category one 38,279 words for category 2, and 34,411 words for category three. The assessment was performed by a quick perusal of the functions of the programs and associating these functions with identifiable OS functions.

TABLE 4.2 DCS SOFTWARE

MODULE	LOC	CALLS TO:	CALLED BY:	DEFINITION	SIZE *	CLASS **
ACKNAK	WWB	XTIME, SOLUSE, LOG, DUP, GETCOR, RELEL	TAUODP	Performs cleanup tasks at WWB after a message has been successfully transmitted by TAM.	497	3
ADVAL	CDA	ERRNTE, GETCOR	CDAMP	Platform Address Validator compares expected address with received addressed.	169	3
ASGN	CDA/WWB		INITAL	Assigns devices at WWB; assigns files and devices at CDA.	114/100	1
AUTOSCHD	WWB	GETCOR, FRECOR, SCHWWB, DSA, LOG	DUPOVL5, PMH	Analyzes auto schedule messages from uses and accepts or rejects for interrogation.	5	3
B2HEX	CDA/WWB			Converts 16-bit positive binary integer into four ASCII hex chars.	38	1
BINASC	CDA/WWB		OVDOP	Converts 16-bit positive binary integer into ASCII coded decimal.	47	1
BLDUQT	WWB		INTDCS	Moves fixed user info. from Snapshop to User Queue Table to maintain number-ID correspondence.		3
BLDUQT	CDA		OFFSTAT	Recovers the UQT from the Snapshot File and builds a table of user ID's.		3
CDAMP	CDA	ADVAL, DSA, GETCOR, RELEL, STCHK, TTCOMP; SOL, SCHCDA, LOG (tasks)	DEMUX, ERRNTE	Stores platform data on disk and initiates sending it to WWB.	537	2
CHKCFE	WWB	GETCOR, LOG	INITAL	Check for recovery of cross-file edit.	15	2
CHKPRI	CDA		INITAL	Check CDA for primary/secondary.	60	3
CHKSPEC	WWB			Check NAK'd output buffers for control characters.	130	1
CKSTUP	CDA/WWB	GETCOR	INITAL	Check for update of self-timed schedules when starting up.	34/20	3
CMPRFIL	CDA/WWB	GAPCMPR	INITAL	Compress gap files.	76/111	1
COMTABS	CDA/WWB			Contains line vector, line, device, and controller tables required by TAM/TAMSUBS for communications interfaces.	699/1118	1
COTEND	CDA	XTIME	SENADD, OVSCTT	Adds Channel Occupation Time to current time to get time channel should be empty.	161	3
DCSCLK	CDA/WWB	OVIOQS		Compares TCT and GCE time, adjusting if necessary. If TCT fails, updates DCS time fields.	370/421	3
DCSREC	WWB	INTREC, RECOV		Provides entry point of recovery load module.	50	1
DEC2B	CDA/WWB			Converts up to six ASCII dec. chars. into 16-bit positive integer.	50	1

TABLE 4.2 DCS SOFTWARE (Cont.)

MODULE	LOC	CALLS TO:	CALLED BY:	DEFINITION	SIZE *	CLASS **
DELETE	WWB	DIRSRC, SCANPACK	GAPFIX, EDIT	Deletes a module from a file and updates directory.	468	1
DEMUX	CDA	GETCOR, RELEL	TAUIDS	Separates multiplexed data frames for each channel and transmits to CDA message processor.	1206	1
DIRCHK	CDA/WWB	DIRSRC	SRCWRT	Provides flexibility for file directories.	50/89	1
DISP	WWB	SOL		Buffers platform interrogation requests for transmission to CDA.	248	2
DLOG	WWB	DLOG,HEX2ACI, DTIM, BIN2ASCI	DLOG, SELECT, Operator Utilities	Outputs specified log file to specified device at specified time or page. Formats and prints log items.	855	1
DRVDDIO/DRVTCT	CDA/WWB		TTOUT	Services TCT interrupts generated by the DDIO.	145/89	1
DSA	CDA/WWB		CDAMP	Disk Sector Allocation of message files	13/751	1
DUP	WWB	LOG, SOLUSE	TAUIDS, ACKNAK	Processes dial-up user requests, and sets-up Line Table parameters to indicate appropriate dissemination formats.	426	2
DUPOVL1	WWB			Initiate request for ID; if valid, a log item is built to indicate that a user has signed on to a dial-up line.	286	1
DUPOVL2	WWB			Output routine for all text; builds output buffer and queues it to the line.	460	1
DUPOVL3	WWB			Validates parameters (DIS, RLT, MSG, etc.) and sets up for appropriate output.	788	2
DUPOVL4	WWB			Outputs time of last dissemination and the number of messages.	398	1
DUPOVL5	WWB			Processes all user messages. The first line of the message is queued to the logger.	1171	1
DUPOVL6	WWB			Sets up parameters for sending of data. For time searches, calls GETCLOSE, then initiates sending of message.	267	2
DUPOVL7	WWB			Does output cleanup; updates pointer, if required, and asks for more input if necessary, or exits.	397	2
ERRNTE	CDA	CDAMP, GETEL	SCHCDA, SENADD, CDAMP, ADVAL, STCHK	Generates standard error notices for scheduling and plaform message errors.	10	3
EXTBCH/EXTEND	CDA		OVIOEA, SCHCDA	Extends platform address from 24-bit to 31-bit representation.	91	3

TABLE 4.2 DCS SOFTWARE (Cont.)

MODULE	LOC	CALLS TO:	CALLED BY:	DEFINITION	SIZE *	CLASS **
FILEDIR				Lists directory of files from any operational disk on the off-line side of DCS.		1
GAPCMPR	CDA		INITAL, OVBK, LOADBK	Compresses a gap file from disk to tape, tape to disk, or disk to disk.	1796	1
GAPSQZ	CDA/WWB		INITAL, OVBK, LOADBK	Performs quick gap compress on files.	1029/1060	1
GCBS	CDA/WWB			Provides Group Control Block (one for each line type in system) for GCE/TSM with various line parameters.	52/79	1
GETCLOSE	WWB	GETCOR, HLTXIT	OVIOMF, DUPOVL6	Interprets QSNAP file to enable message searching programs to get within one hour of a message before starting the search.	192	3
GETCOR	CDA/WWB	GETEL			22/20	1
GETEL	CDA/WWB	GETCOR		Get free core via GCE Core mgmt.		1
HASR	WWB			Handles 110/300-baud line (no protocol).	436	1
HBSC	CDA/WWB			Handles BSC lines in ASCII format.	512/633	1
HIM	CDA	TAUODP		Handles Interrogate Modulators.	81	2
HLTXIT	CDA/WWB			Error exit subroutine.	55/56	1
HMVX	CDA			Handles Magnovox Multiplexer.	182	3
HTI742	WWB			Handles 1200-baud line, using a subset of BSC protocol.	494	1
INITAL	CDA/WWB	LEVST, ASGN, CMPRFIL, INTCT, INTMEM, SETUP, INTDSA, RECSNP, RECOVER, CHKPRI, TASKS, INTTAM, GETTIME, INTPBK, CKSTUP, INTPVT, INCAT, OVCG	INTCTRL	Performs and calls to perform all initialization for startup of DCS.	333/790	3
INTCAT	CDA		RECSNP	Initialize channel activity table.		3
INTCCB	WWB		INTDCS	Formats Cylinder Control Blocks in the message file.		1
INTCHN	WWB		TASKS	Initialize channel numbers and priorities at WWB.	141	3
INTCST	WWB		INTREC	Initialize channel status table.	17	3
INTCT	CDA/WWB		INITAL	Sets up interrupt address for DRVTCT/DRVDDIO and checks GCE time with TCT time.	267	3
INTCTRL	CDA/WWB	INITAL		Starts DCS initialization and control of the system.	8	3

[redacted]ABL[redacted].2 D[redacted]OF[redacted]E ([redacted].)

MODULE	LOC	CALLS TO:	CALLED BY:	DEFINITION	SIZE *	CLASS **
INTDCS	WWB	BLDUQT, UPFILE, INTMSG, INTCCB, INTLOG		Clears message and snapshot files.		1
INTDSA	CDA/WWB		INITAL	Initialize in-core CCB's or file pointers.	51/71	1
INTLOG	WWB		INTDCS	Initializes log files.		1
INTMEM	CDA/WWB		INITAL	Finds total available free storage to initialize dynamic storage.	90	1
INTMSG	WWB		INTDCS	Clears entire message file.		1
INTREC	WWB	UPFILE, RECSNP, INTCST	DCSREC	Initializes files for a recovery.	89	1
INTTAM	CDA/WWB	TAMISU	INITAL	Initialize communication lines.	106/86	1
INTUQT	WWB	DSA	TASKS	Performs initialization UQT for PMH.	150	2
IOINT	CDA/WWB	GETCOR	UTILCT	I/O handler between operator and computer; controls 1st overlay area.	186/185	1
LOADBK		GAPCMPR, TPTOPK		Loads DCS application files from tape to disk.		1
LOG	CDA/WWB	UTILCT, SOL	PMH, DUP, ACKNAK, OVATS, TAMSUBS, DRVTCT, OVDKDA, OVOPCL, MBPROC	Records DBS events in the Log File; outputs real-time log information.	10/226	3
MBPROC	CDA/WWB	SOLUSE, DEMUX, GETEL, RELEL, TAMISU, LOG	TAMSUBS, OVOPCL	Processes Message Blocks for error conditions.	289/337	3
MODPACK	CDA/WWB			GCE sub. (modified) to locate/format a directory entry.	486/1010	2
MTERR	WWB		OVDKDA, DLOG	Calls OVIOMT when an I/O error occurs and queues item to OVCT.	42	2
OFFSTAT		INITAL, SELECT, BLDUQT, IOCOMM, TMREQ, ASC2HX		Performs initialization and requests desired stat. type from operator.		3
OVATS	WWB		AUTOSCHD	Overlay to AUTOSCHD.	1035	3
OVBK	WWB	GAPCMPR, OVPKTP	OVIOBK	Provides operator with facility to back-up real-time files on tape.	2264	1
OVCAND	CDA/WWB		OVCT	Provides operator interface for cancelling the current display.	16	1
OVCKSU	WWB	SOL; OVCKSU (recalled in 5 minutes)	CKSTUP	Overlay to check for self-timed schedule updates to CDA every 30 minutes.	48	3
OVCT	CDA/WWB	RELEL	UTILCT	Manages loading of programs into second overlay area	76/60	1
OVDEQ	WWB			Deq schedule items for channel QCBS.	70	3

TABLE 4.2 DCS SOFTWARE (Cont.)

MODULE	LOC	CALLS TO:	CALLED BY:	DEFINITION	SIZE *	CLASS **
OVDKDA	WWB		OVCT	Deallocates disk by checking each user queue.	1135	2
OVDLOG	CDA			Overlay to LOG; handles bulk of real-time log processing for CDA.	685	3
OVDOP	CDA/WWB	BINASC, GETCOR, RELEL	OVIODO	Interprets target display # to format CRT output buffer from specified file.	165/163	3
OVEDED	WWB	XTIME, MODLOK, BINASC, DEC2B, DIRSRC ISRCWI, SRCRNL, ISRCRD, SRCWRP, SRCDUM, SCRDIR, SRCRDE	OVFED	Perform cross-file editing of the emergency data file.	966	3
OVEDIS	WWB	XTIME, MODLOK, BINASC, DEC2B, DIRSRC ISRCWI, SRCRNL, ISRCRD, SRCWRP, SRCDUM, SCRDIR, SRCRDE	OVFED	Perform cross-file editing of the schedule file.	1407	3
OVEDPD	WWB	XTIME, MODLOK, BINASC, DEC2B, DIRSRC, GARDEL, ISRCWI, SRCRNL, ISRCRD, SRCWRP, SRCDUM, SCRDIR, SRCRDE	OVFED	Performs cross-file editing of the platform data file.	2209	3
OVEDSP	WWB	XTIME, MODLOK, BINASC, DEC2B, DIRSRC, GARDEL, ISRCWI, SRCRNL, ISRCRD, SRCWRP, SRCDUM, SCRDIR, SRCRDE	OVFED	Performs cross-file editing of the self-timed platform data file records.		3
OVEDTX	WWB	XTIME, GETCOR	OVIOED	Performs editing of the text file.	2378	1
OVEDUD	WWB	XTIME, MODLOK, BINASC, DEC2B, DIRSRC ISRCWI, SRCRNL, ISRCRD, SRCWRP, SRCDUM, SCRDIR, SRCRDE	OVFED	Performs cross-file editing of the user data file.	1088	3
OVENQP	WWB	HLTXIT	OVIOIN	Enqueues data to SCHWWB after reading platform data.	785	3
OVERR	CDA			Overlay to ERRNTE to generate messages; handles bulk of processing.	513	3
OVFDI	WWB		OVIOFD	Retrieves specified gap file.	1989	2
OVFED	WWB	DEC2B, GETCOR, ISRCRD, ISRCWT, SRCRNL, SRCDUM, SRCWRP, SRCRDP, SRCWRT, SRCDIR, OVEDPD, OVEDSP, OVEDUD, OVEDED, OVEDIS, OVDOP (tasks)	OVIOED	Process operator file modifications	1650	3

TABLE 4.2 DCS SOFTWARE (Cont.)

MODULE	LOC	CALLS TO:	CALLED BY:	DEFINITION	SIZE *	CLASS **
OVFTX	WWB		OVIOFD	Retrieves specified text file.	1081	1
OVINED	WWB	ISRCWT, SRCWRP, SRCDIR	OVCT	Provides operator interface for initiating emergency data file by creating a dummy emergency record and initiating the EID file.	254	3
OVINPD	WWB	ISRCWT, SRCWRP, SRCDIR	OVCT	Provides operator interface for initializing the platform file by creating a dummy platform record.	513	3
OVINSC	WWB	ISRCWT, SRCWRP, SRCDIR	OVCT	Provides operator interface for creating an interrogated schedule for each 5-minute period of the day.		3
OVINTX	WWB			Initiate text file and create TXDUMY.	894	2
OVINUD	WWB	ISRCWT, SRCWRP, SRCDIR	OVCT	Provides operator interface for creating a dummy user data file record.	155	3
OVIOAR	WWB	GETCOR, XTIME, LOG, DSA	IOINT	Moves a message from one user queue to another.	864	1
OVIOBK	WWB			Initialize backup of all files upon receipt of "BK" command.	57	1
OVIOCE	WWB		IOINT	Allows operator to terminate an emergency in case it doesn't clear normally.	107	2
OVIOCF	WWB	OVCT	IOINT	Check for recovery of cross-file edit-overlay.	310	2
OVIODK	WWB	HLTXIT, BINASC, XTIME, MTERR, LOG, DSA	IOINT	Calculates and prints percentage of message file allocated.	201	1
OVIODL	WWB			Initiate demand log.	357	2
OVIODO	CDA/WWB	OVDOP		Initiate display output.	377/666	2
OVIOEA	CDA/WWB		IOINT	Provides operator with 31-bit platform address as requested.	251	3
OVIOED	WWB	OVFED		Initiate cross-file edit.	945	2
OVSCAT	CDA			Overlay to SCAT.		3
OVIOFD	WWB	GETEL, OVDOP	IOINT	Receives parameters for calls to OVFDI and OVFTX.	97	2
OVIOIN	CDA/WWB	SCHWWB, MODPACK, GETCOR, DC2B, OVCT	IOINT	Allows operator to designate interrogation request for a single platform or a schedule list for sending to WWB scheduler.	639/326	3
OVIOMC	CDA	DEC2B, BINASC, SNAPER	IOINT	Provides interface to assign multiplexer/demodulator to specific input unit/channel at CDA.	483	3
OVIOMO	CDA/WWB	GETCOR, SOL	IOINT	Relays message to operator.	140	1

TABLE 4.2 DCS SOFTWARE (Cont.)

MODULE	LOC	CALLS TO:	CALLED BY:	DEFINITION	SIZE *	CLASS **
OVIOMT	WWB		IOINT	Initializes magnetic tape and its Device File Table entry.	442	1
OVIOMU	WWB	DSA	IOINT	Enters message into msg. file for the user.		2
OVIOPA	CDA/WWB		IOINT	Provides operator with utility to change printer for alarms.	51/46	1
OVIOPR	WWB	DEC2B, BINASC	IOINT	Provides operator interface to assign channel priorities for scheduling.		2
OVIOQS	WWB	XTIME	DCSCLK	Builds buffer with QTNXT value of each user queue and writes it to snapshot file.	351	3
OVIOSC	WWB	GETEL, MODID, OVDOP, RELEL	IOINT	Receives schedule parameters for calls to OVSCHD.	154	3
OVIOSD	WWB	GETCOR	IOINT	Signals CDA for shutdown, receives info for restart, and exists DCS.	369	3
OVIOST	WWB	XLINE, MODID, DIRSRC	IOINT	Provides operator inteface to acquire starts on Platform Data Msgs.	224	3
OVIOSW	CDA	GETCOR, TAMISU	IOINT	Switches computer status to close or open all lines; watchdog indicators are changed.	350	1
OVIOTT	CDA	DEC2B	IOINT	Communicates with operator for scheduling a test through the specified channel.	162	2
OVIOUD	WWB	T12TCT	IOINT	Updates dissemination pointers as specified by operators.	728	3
OVMSND	CDA	GETCOR, SOL	OVCT	Sends/receives Magnavox configuration for the other CPU.	336	3
OVOPCL	CDA/WWB	SOL, SOLUSE, DEMUX, RELEL, TAMISU, XTIME, DC2B, GETCOR, OVDEQ	IOINT	Allows operator to define status of device a table has open or closed.	636/601	3
OVPAGE	CDA/WWB	GETCOR, RELEL, OVDOP	OVCT	Provides oper. interface for paging to next page of the current display.	242/1173	1
OVPKTP	WWB			Copies non-gap files to tape (backup).		1
OVPLBK	CDA	GETCOR, XTIME		Governs startup and synchonization of the user communications between the CDA and WWB systems.	1081	1
OVPRINT	CDA/WWB		OVCT	Provides oper. interface for printing current display on Centronics.	32/41	1
OVSCHD	WWB		OVIOSC, OVCT	Reads schedule and queues each platform to a channel queue for interrogation.	1139	3

TABLE 4.2 DCS SOFTWARE (Cont.)

MODULE	LOC	CALLS TO:	CALLED BY:	DEFINITION	SIZE *	CLASS **
OVSCTT	CDA		SCHTT	SCHTT overlay checks Test Transmitter and activates if necessary; performs channel checks for next CAT entry.	1018	3
OVSCUF	CDA			Overlay to SCRUF.	190	3
OVSQZ	CDA/WWB			Initiate on-line quick gap file cleanup.	28/76	2
OVSTAT	WWB	BINASC	OVIOST	Calculates the Platform data Messages statistics.	788	3
OVTIME	CDA/WWB	OVDOP	OVCT, OVIOMK	Displays message from specified time range.	754/402	3
OVUP	CDA/WWB	GETCOR, OVDOP	OVCT	Provides operator interface for updating current page display.	125	2
PFH	WWB	MODID, DIRSRC	PMH	Reads specified Platform Data File record and returns list of important fields, converted from display format to internal format.		3
PMH	WWB	DSA, SCHWWB, GETCOR, FRECOR, SOLUSE, PFH, LOG	TAUIDS (CDS)	Stores platform messages; queues reinterrogation requests, and activates User Line Schedules when messages are ready for dissemination.	2464	3
RECOVER	CDA		INITAL	Scans message file to find the point at which to allocate next sector.	736	1
RECOVER	WWB		DCSREC	Validates msg. file queues, reconstructs CCB's, validates UQT, summarizes recovery stats and errors.	9149	2
RECSNP	CDA/WWB	RERROR, HLTXIT	INTREC (WWB); INITAL (CDA)	Locates latest snapshot on disk and reads it into core.	776/8857	2
RELEL	CDA/WWB			Releases free core via GCE Core mgmt.		2
RTMF	WWB	TAM, SOLUSE	SOLUSE	Handles formatting of user messages for real-time and dial-up dissemination.	2119	2
SCANPACK	CDA/WWB			GCE sub. containing utility subroutine for MODPACK.	65	2
SCAT		SCREW	IDS	Recognizes a Schedule File Status Request Message from other processor.		3
SCHCDA	CDA	GETEL, ERRNTE, SOL, RELEL, COTEND	TAUIDS	Manages interrogation and self-timed schedules for transmission to CDA.	965	3
SCHFH		MODID, DIRSRC, GETCOR	SCHWWB	Reads specified module from Schedule File and returns one schedule entry in transmission format.		3
SCHST	CDA	ERRNTE, LOG, GETEL, MODID, DIRSRC	every 5 min.	Manages self-timed schedules at CDA.	1400	3

MODULE	LOC	CALLS TO:	CALLED BY:	DEFINITION	SIZE *	CLASS**
SCHTT	CDA	ERRNTE, TTOUT	every 30 secs; OVIOTT	Triggers Test Transmitter to send over next unoccupied channel; scans for channels on which a reply was due but did not arrive.	125	3
SCHWWB	WWB	XXDATE, XTIME, DIRSRC, LOG GETEL, RELEL	every 5 mins., or emergency request	Reads and queues interrogation requests contained in schedule file module.	1480	3
SCRATCH	CDA/WWB	SCREW	TAUIDS	Check to see if WWB's and CDA's self-timed schedules are identical; if not, send to CDA latest versions of schedules out of date at DDA.	1188/1520	2
SCREW	CDA/WWB		OVSCAT, SCRATCH	Reads Schedule Directory File; creates list of self-timed schedule version numbers for transmission to another processor.	267/320	3
SCRUF	CDA		TAUIDS	Receives up-to-date self-timed schedules from other processor.	79	3
SEARCH		DOMTIO, TIMCHK	SELECT, SUMMARY	Searches log tape for item matching the search packet and is within the time range specified.		3
SELECT		BIN2ASCI, SEARCH, DLOG, BLDHDR,PRNTSU, B2HEX	OFFSTAT	Prints header, searches tape, and ouputs list of events or platform summaries.		3
SETUP	CDA/WWB			Starts TAM tasks.	325	3
SNAPER	CDA		OVIOMC, OVMSND	Formats and writes snapshot when Magnavox config. is updated.	200	3
SNAPER	WWB		PMH, OVSHDN	Writes snapshot to snapshot file when called or every 10 secs.	137	2
SOL	CDA/WWB	GETCOR, RELEL, LNCHCK, XTIME	OVIOMO, SCRATCH; DISP(WWB); CDAMP, SCHCDA, LOG, WATCHDO (CDA)	Schedules all activity on the CDA/WWB communication lines and initiates it.	429/50	2
SOLUSE	WWP	RTMF	PMH, ACKNAK, OVOPCL, RTMF, DUP	Reads in from disk the stored message buffers for RTMF.	515	2
SRCRD	WWB			GCE sub. reads a module.	281	2
SRCWRT	CDA/WWB			GCE sub. (modified) writes a module and updates a directory.	890/918	2
STCHK	CDA	ERRNTE, GETCOR	CDAMP	Compares the scheduled self-timed response received with the time expected.	119	3
SUMMARY		LOCATE, PUTER, CALC, SEARCH	SELECT	Generates in-core summary tables for up to 2000 platforms.		3
TAM	CDA/WWB			Subsystem for handling application I/O requests and performing protocol management.	1544	1

MODULE	LOC	CALLS TO:	CALLED BY:	DEFINITION	SIZE *	CLASS **
TAMSUBS	CDA/WWB	(CDA): SOL, SCRUF, SCHCDA, LOG, OVSCUP, OVSCAT, SENADD, LOG, SOLUSE, DISP, DUP, ACKNAK, PMH, SOL, OVSCUP, CHKSPEC (WWB);		Contains TAM interface subroutines: TAULSS, TAUODH, TAUODP, TAUIDS	992/1802	1
TASKS	CDA/WWB	INTDSA, INTSNP, INTUQT	INITAL	Task driver.	145/413	3
TAUIDS	CDA/WWB			Called once per completed input buffer. Stores buffer away and keeps track of it.		1
TAULSS	CDA/WWB			Called at "idle" conditions for a given line; the application specifies one of poll, select, or "sleep".		1
TAUODH	CDA/WWB			Called once per successful select sequence; provides a header buffer for transmission.		1
TAUODP	CDA/WWB			Prepares a page of text for transmission and, when appropriate, flags the last page.		1
TMCHCK	CDA/WWB		WATCHDO	Compares two TCT times for a difference of ten seconds.	139	3
TTCOMP	CDA	GETCOR	CDAMP	Compares test transmitter message with known messages and generates appropriate notice.	245	3
UPFILE	WWB		INTDCS, INTREC	Assigns files at WWB and sets up file sizes where necessary.	446	1
UTILCT		GETEL, RELEL		Provides operator interface to initiate utilities	527/483	1
WATCHDO		SOL	TAUIDS	Monitors the other CPU and signals any failure.	165/210	2
XTIME				Returns time of TCT format in BCD in first 2 words; 3rd word is year in bin.	64/79	2

SIZE: Program size in 16 bit words

CLASS: 1 - Probable OS;
2 - Possible OS, or simplified by OS;
3 - Probably Special.

TABLE 4.3

DCF MAIN MEMORY USEAGE

LOCATIONS (Hex)	USEAGE
0-20	GCE Vector
21-80	System boot
81-2k	DCS system tables
2K+ - 5K	DCS root
5K+ - 8K	Dynamic Storage
3K+ - CK	GCE operating system
MEMORY BANKS	**USEAGE**
0	DCS tasks and overlays
1,2,3	DCS tasks and expansions
4,5,6	In memory routing tables
7	reserved

TABLE 4.4

22 M BYTE DISK ORGANIZATION (1)

A. MESSAGE FILE DISK	
Size (2)	Assigned Useage
15	Volume Table of Contents (VTOC)
1	System Control
100	Queue Snaps
80	Snapshots
64,000	Message file
B. SYSTEM DISK	
5	VTOC
1	Control
1,794	Executive
1,280	Programs
10,500	Platform Data File (PDR) (for 5,000 platforms)
6,144	Schedule
236	Emergency file
1,280	User data file
1,280	Text file
20,480	Log file
4,096	User Assigned
10,240	System Statistics
973	Scratch
512	Spool

(1) Only significant items listed. This table does not account for every sector on each disk.

(2) Size in number of sectors; each sector has 173 16 bit words.

TABLE 4.5

DISK ORGANIZATION (CDA)

A. MESSAGE FILE DISK (5 Mbytes)	
Size (1)	Assigned Useage
18,432	Message
80	Snapshot
768	Temporary
B. SYSTEM FILES DISK (5 Mbytes)	
1,536	Executive
4,096	Program
12,880	Schedule
768	X-File

(1) in decimals

5.0 SYSTEM USAGE

This section of the report provides detailed information regarding the GOES DCS community, their unique requirements for data collection and distribution, and DCS operating procedures established to ensure a smooth working relationship between users and NESS. The user community is identified as to the organizations involved, their locations, and the types of data of interest. The scope of the data gathering operation is indicated by the number, type, and general location of the user Data Collection Platforms (DCP's); the number of DCP's, along with their transmission frequency and duration size the magnitude of the data collection and storage requirements. Data distribution from NESS to the various users is by phone lines whose bandwidth can be appropriately configured to meet the rate requirements.

5.1 DCS RULES AND PROCEDURES

Rules and procedures which govern DCS operations are formalized in Memoranda of Agreements (MOA) between NESS and each user organization. These agreements stipulate that data collected by the GOES DCS must be environmental in nature, and can consist of physical, chemical or biological property measurements of the oceans, lakes, rivers, solid earth, atmosphere, or space. Strict adherence is essential for compliance with the frequency allocation by the Interdepartmental Radio Advisory Committee for the GOES DCS data links. DCS operations are further guided by NESS policy which states that this system was developed to meet NOAA needs, but in the interest of efficiency, non-NOAA users are invited to participate. Accordingly, NESS is responsible for overall systems management, operations, and scheduling. NESS will assign user channels in the most efficient manner, and reserves the right to interrupt operations whenever there are sufficiently serious spacecraft or ground system problems. Priorities for data gathering purposes put disaster warning data first, operational requirements second, and experimental data last. User data requirements are negotiated between NESS and the individual organizations.

5.1.1 User and NESS Responsibilities

Responsibilities between users and NESS are quite straightforward. Users have responsibility for all aspects of DCP funding, procurement, installation, and maintenance. However, DCP's are subject to NESS certification. In addition, users are responsible for obtaining their data from NESS, and for its processing, analysis and reporting. NESS has responsibility for the GOES spacecraft and the DCS ground equipment, and for telemetry reduction needed to monitor DCP performance. As an added service in assisting users in their DCP checkout procedures, NESS has recently implemented the DATA Acquisition and Monitoring Subsystem (DAMS) whereby DCP transmission signal strength and quality can be monitored in the field during deployment or repair operations.

5.2 USER COMMUNITY

The user community consists preponderately of U.S. government agencies which comprise about 80% of the total. Foreign government and U.S. state and local government organizations comprise most of the remainder. The current GOES DCS user community is listed in Table 5.1 which identifies the user organization and its location.

5.2.1 DCP Summary

User data requirements generally can be estimated from the numbers and types of DCP's in operational use. For self-timed DCP's data flow reflects numbers of platforms and their transmission schedules. The standard requirements is for one minute of transmission every three hours. Some DCP's need only 30 seconds of transmission time, but these units require more precise

TABLE 5.1
GOES DATA COLLECTION SYSTEM USER SUMMARY

Nomenclature:

DCP's
ST - Self-timed
STI - Self-timed, with interrogate capability
STR - Self-timed, with pseudo-random capability
I - Interrogated
RR - Random reporting
A - Active
D - Deactivated
T - Total

UNIQUE NEEDS
DAT - Deallocation time

USERS	DCP'S								UNIQUE NEEDS	LOCATION	DATA LINK	SECONDARY USERS
	TYPE						STATUS					
	ST	STI	STR	I	RR	T	A	D				
1. ALBERT Alberta, Dept. of Environment	9					9	8	1		Edmonton/Alberta Canada	Dial-in	
2. AMSTST DAMS Test Queue			1			1	0	1				
3. BATELE Battelle Pacific Northwest Labs	3					3	1	2		Richland, Wash.	Dial-in	
4. BCHYPW British Columbia Hydro & Power Authority	45					45	14	31	Data on 1 & 2 hour schedule	Vancouver, Brit. Columbia, Canada	Dial-in	NWSESO NWSGSH
5. BLM001 Bureau of Land Management	57					57	12	45		Boise, Idaho	"	26. DAFS02 57. NWSBLM NWSAKB NWSGSH 91. USGS02
6. BNLASD Brookhaven National Labs				3		3		3	Data on 1 hour sched.	Upton, N.Y.	"	
7. BPOA01 Bonneville Power Administration	19					19	14	5		Portland, OR.	"	1. ALBERT NWSBPA 90. USGS01

TABLE 5.1 (cont.)

USERS	DCP'S								UNIQUE NEEDS	LOCATION	DATA LINK	SECONDARY USERS
	TYPE						STATUS					
	ST	STI	STR	I	RR	T	A	D				
8. BROKHN Brookhaven National Labs				7		7		7	DAT 50 hours. Message length 6400 bits. Data on 1 hour schedule.	Upton, N.Y.	Dial-in	
9. CALENS Engineering Science	1					1	1			Arcadia, Ca.	"	
10. CMEDSP Marine Environmental DATA Services	2					2	1	1		Ottawa, Canada	"	
11. COE003 Dept. of Army Corps of Engineers	6					6	1	5	DAT 50 hours. Data on 1 hour schedule.	Vicksburg, MS	"	NWSGSH 24. COEVIC
12. COE004 "	122					122	99	23	Data on 2 hour schedule.	Huntington, WV	Ded. Line 7	90. USGS01 NWSGSH
13. COE005 "	17					17	14	3		Memphis, TN	Dial-in	19. COELOU 24. COEVIC NWSGSH
14. COE007 "	6					6	3	3	Data on 2 hour schedule.	Wilmington, NC	"	NWSGSH 90. USGS01
15. COE008 "	4					4	4			Kansas City, MO	"	63. NWSCOE NWSGSH
16. COE010 "	4					4	2	2		Jacksonville, FL	"	NWSGSH
17. COEFT1 "	2					2	2			Fort Worth, TX	"	NWSGSH
18. COEFTW "	4			2		6	5	1	Emergency alert.	"	"	NWSGSH

TABLE 5.1 (cont.)

USERS	DCP'S TYPE ST	STI	STR	I	RR	T	STATUS A	D	UNIQUE NEEDS	LOCATION	DATA LINK	SECONDARY USERS
19. COELOU Dept. of Army Corps of Eng.	23					23	22	1		St. Louis, MO	Dial-in	NWSGSH
20. COENAS "	15					15	12	3	Data on 2 hour schedule.	Nashville, TN	"	NWSGSH 90. USGS01
21. COEOMA "			3			3	2	1		Omaha, NE	"	NWSGSH
22. COEPIT "	12					12	10	2		Pittsburg, PA	"	NWSGSH
23. COETUL "	8					8	5	3		Tulsa, OK	"	NWSGSH 90. USGS01
24. COEVIC "	17					17	10	7	Data on 1 hour schedule.	Vicksburg, MS	"	11. COE003 23. COETUL NWSGSH 63. NWSCOE
25. DAFS01 Dept. of Agriculture	7					7	3	4		Riverside, Ca.	Dial-in	26. DAFS02
26. DAFS02 U.S. Dept. of Agriculture	122					122	47	75	Data on 1 hour sched.	Boise, Idaho	"	90. USGS01
27. DAFS03 "	4					4	4			Denver, Col	"	26.DAFS02
28. DAWREG "	1					1	1			Riverside, Ca.		
29. DCSTST NESS-TEST Queue	2			7		9		9	Data on 1 hour sched.	Camp Springs, Md.	"	
30. ECPCRC Nat. Research Council of Canada	5					5	1	4		Ottawa, Canada	"	
31. EPA001 Environmental Mon. Systems Lab.	6					6	6		Data on 1 hour schedule.	Las Vegas, Nev.	"	

TABLE 5.1 (cont.)

	USERS	DCP'S TYPE 'ST	STI	STR	I	RR	T	STATUS ' A	D '	UNIQUE NEEDS	LOCATION	DATA LINK	SECONDARY USERS
32.	ERL001 U.S. Dept. of Com. NOAA/ERL	21			1		22	15	7	Message length 8448 bits. Store Data on tape occasionally. Data on 12 min. sched.	Boulder, Col.	Ded. Line 6	
33.	ERL002 "	6					6	3	3	Data on 12 min. sched. Message length 8448 bits. Store data on tape occasionally.	"	"	
34.	ES017E ESSO Resources Canada, Ltd.	7					7	2	5	DAT 50 hours. Data on 1 hour schedule.	Edmonton Alberta Canada	Dial-in	NWSESO NDBOTE
35.	EXXONT EXXON Production Research Co.	18					18	10	8		Houston, Tx.	"	NWSEXX 46. NDBOTW NDBOOP
36.	HANDAR	1					1		1		Sunnyvale, Ca.	"	
37.	HIGUOH Univ. of Hawaii	5					5		5	DAT 50 hours.	Honolulu, Ha.	"	
38.	HOUETD-NESS Text Exercise	1					1	1					
39.	KETKAN Ketchikan Public Utilities	1					1	1		DAT 50 hours.	Ketchikan, Alaska	"	
40.	LABARG Labarge, Inc.	1			1		2	1	1	Emergency alert Data on 30 min. schedule.	Tulsa, Ok.		

TABLE 5.1 (cont.)

USERS		DCP'S								UNIQUE NEEDS	LOCATION	DATA LINK	SECONDARY USERS
		TYPE						STATUS					
		ST	STI	STR	I	RR	T	A	D				
41.	LADAMO L.C. Adamo, Inc.	2					2		2	DAT 50 hours. Message length 12,000 bits.	Solano Beach, Ca.	Dial-in	
42.	LDGOCU Lamont Doherty Geological Obsv.	6					6	3	3		Palisades, NY		
43.	LLL18W Lawrence Livermore Labs	2					2	1	1	DAT 36 hours.	Livermore, Ca.	"	NWSLLL
44.	NCAR01 National Center for Atmospheric Res.	3					3		3	DAT 72 hours. Data on 5 min. & 1 hour sched., Message length 26,000 bits.	Palestine, Tx.	"	
45.	NCARBL "	4					4		4	Data on 1 hour sched.	Boulder, Col.	"	
46.	NDBOTW NOAA Data Buoy Ofc.	46	46		63		155	76	79	Data on 1 hour sched. Store data on tape occasionally. Message lengths 7,000 and 10,000 bits	NSTL Station Mississippi	Ded. Line 8	NBOOP 41. LADAMO NDBODG
47.	NDBTDC "	1					1	1		DAT 50 hours. Data on 1 hour schedule.	"	Dial-in	46. NDBOTW
48.	NES17W NESS	1					1		1	DAT 72 hours.	WWB. Camp Springs Maryland		
49.	NOANOS National Ocean Sur.				6		6		6	Emergency alert. Message length 9,999 bits. Data on 1 hour schedule.	Rockville, Md.	Dial-in	

TABLE 5.1 (cont.)

USERS	DCP'S TYPE ST	STI	STR	I	RR	STATUS T	A	D	UNIQUE NEEDS	LOCATION	DATA LINK	SECONDARY USERS
50. NPS001 Office of R & D Env. Monitor Syst. Labs.	1					1		1	Data on 1 hour sched.	Las Vegas, Nev.	Dial-in	
51. NWCAEI Atmospheric Env. Services	48					48	12	36	Data on 1 hour sched.	Downview, Ontario Canada	Ded. Line 5	
52. NWCWR1 Environment Canada	8					8		8		Ottawa Canada	Dial-in	
53. NWCWR2 "	3					3	2	1	DAT 50 hours.	"	"	
54. NWSAKA Nat. Weather Service, Alaska	2			11		13	5	8	Message length 11,000 bits. Data on 1 hour schedule.	Anchorage Alaska	Ded. Line 5	90. USGS01
55. NWSARD Nat. Weather Svc.	7					7		7	Data on 1 hour sched.	Suitland Maryland	"	
56. NWSARG C.I.D.E.M.	13					13		13		Argentina	"	
57. NWSBLM Nat. Weather Svc.	5			8		13	10	3	Data on 1 hour sched. Emergency alert.	Suitland Maryland	" "	
58. NWSBOL Servicio Geological Bolivia	3					3		3		La Paz, Bolivia	"	90. USGS01 91. USGS02
59. NWSBR1 Bureau of Reclamation	3					153	33	120	Data on 1 hour sched.	Denver Co.	"	27. DAFS03
60. NWSBR2 "	10					10	2	8	Data on 1 hour sched.	"	"	
61. NWSCDF Calif. Dept. of Forestry	22					22		22		Sacramento, Ca.	"	

TABLE 5.1 (cont.)

USERS	DCP'S								UNIQUE NEEDS	LOCATION	DATA LINK	SECONDARY USERS
	TYPE					STATUS						
	'ST	STI	STR	I	RR	T	'A	D '				
62. NWSCHL Landsat Proj. Coord.	10					10	6	4		Santiago, Chile	Ded. Line 5	
63. NWSCOE U.S. Army Corps of Engineers	80		1			81	40	41		Ft. Belvior, Va.	"	
64. NWSDEN Nat. Weather Svc. Denver	10			6		16	10	6	Data on 1 hour schedule. Emergency AHOS interrogation upon request.	Aurora, Col.	"	NWSCAS
65. NWSECU Nat. Weather Svc.				2		2	1	1		Suitland, Maryland	"	78. NWSTSU
66. NWSGAT "	1					1	1		Data on 1 hour sched.	"	"	
67. NWSHUR NOAA Research Facility Center	6					6	1	5	Message length 8,200 bits. Data on 1 hour schedule.	Miami, FL.	"	
68. NWSIHA Nat. Weather Svc.				4		4	2	2		Suitland, Maryland	"	78. NWSTSU
69. NWSKNT "				1		1		1	Emergency alert. Data on 1 hour schedule.	Lexington, KY	"	
70. NWSMAI Nat. Weather Svc., Maine	2			2		4	2	2		Portland, Maine	"	86. QMRCAN 96. WSCFTN
71. NWSNOS NOAA	7					7		7	Data on 1 hour sched.	Riverdale, Md.	"	
72. NWSPOR Nat. Weather Svc., Portland, Oregon	12			7		19	18	1	Emergency interrogation upon request.	Salt Lake City Utah	"	

TABLE 5.1 (cont.)

USERS	DCP'S								UNIQUE NEEDS	LOCATION	DATA LINK	SECONDARY USERS
	TYPE					STATUS						
	ST	STI	STR	I	RR	T	A	D				
73. NWSPRU Nat. Weather Svc.				2		2	1	1		Suitland, Maryland	Ded. Line 5	78. NWSTSU
74. NWSRAM "	2			10		12	5	7	Data on 1 hour sched. Emergency alert.	"	"	NWSRFF
75. NWSSEI "				5		5	1	4	DAT 36 hours. Message length 8,700 bits.	"	"	
76. NWSTED Nat. Weather Svc., T & E	7					7	4	3	Data on 1 hour sched.	Sterling, Va.	Dial-In	
77. NWSTEX Nat. Weather Svc., Texas	9			6		15	13	2	Emergency interrogation upon request.	Suitland, Maryland	Ded. Line 5	90. USGS01 NWSCAS
78. NWSTSU Nat. Weather Svc.				6		6	2	4	DAT 36 hours.	"	"	
79. NZMETS New Zealand Meterological Svc.	2					2		2		Wellington New Zealand	Dial-In	
80. NZMWD1 Ministry of Works & Development	2					2	2		DAT 50 hours.	Christchurch, New Zealand	"	
81. ONTHYD ONTARIO HYDRO	10					10	2	8		Toronto, Ontario Canada	"	
82. ONTMNR Ministry of Natural Resources	13					13	8	5		"	"	
83. PEXCAN PETRO-CANADA	6					6	3	3	DAT 36 hours.	Calgary, Alberta Canada	"	NWSPEX

TABLE 5.1 (cont.)

USERS	DCP'S TYPE ST	STI	STR	I	RR	T	STATUS A	D	UNIQUE NEEDS	LOCATION	DATA LINK	SECONDARY USERS
84. PMELWA NOAA/Pacific Marine Env. Lab.	8					8	2	6		Seattle, WA	Dial-in	
85. PHFIWX Water Survey of Canada	1					1		1	DAT 50 hours	Ottawa, Ontario Canada	"	
86. QNRCAN Direction des Inventaires	66					66	57	9		Quebec City Quebec, Canada	"	
87. SASREC Saskatchewan Res. Council	5					5	2	3		Saskatoon, Sask. Canada	"	
88. SEAEDL Nat. Weather Svc.	4					4		4	DAT 50 hours. Message lentgh 15,000 bits.	Suitland, Maryland	"	
89. UCALIF Univ. of California	1					1		1	DAT 36 hours.	Santa Barbara, Ca.	"	
90. USGS01 U.S. Dept. of Int. Geological Survey	361					361	147	214	Store data on tape occasionally. Data on 1 and 2 hour schedule.	Reston, VA	Ded. Line 4	NWSGSH NWSCAS NWSHGS 99. WSCOTT COE002 16. COE010 20. COENAS 14. COE007 23. COETUL 91. USGS02 100.WSCREG 62. NWSCHL
91. USGS02 "	12					12	5	7		"	Dial-in	NWSGSH

TABLE 5.1 (cont.)

USERS		DCP'S								UNIQUE NEEDS	LOCATION	DATA LINK	SECONDARY USERS
		TYPE					STATUS						
		ST	STI	STR	I	RR	T	A	D				
92.	USGS04 U.S. Dept. of Int. Geological Survey	33					33	24	9		Reston, VA	Dial-in	
93.	USGS05 "	6		105			111	104	7		"	"	NWSGSH 18. COEFTW
94.	USGS06 "	15					15	3	12	DAT 50 hours. Data on 1 hour sched.	"	"	NWSGSH 90. USSS01
95.	WASDNR Dept. of Natural Resources, Wash. State	10					10		10	DAT 50 hours.	Olympia, Wash.	"	26. DAFS02
96.	WSCFTN Water Survey of Canada	5			1		6	3	3		Ottawa, Ontario Canada	"	NWSGSH 70. NWSMAI NWSCAS 90. USGS01
97.	WSCGUE "	2					2	1	1		Guelph, Ontario Canada	"	
98.	WSCHAL "	2					2	1	1	DAT 50 hours.	Darthmouth, N.S. Canada	"	
99.	WSCOTT "	1					1		1		Ottawa, Ontario Canada	"	
100.	WSCREG "	7					7	4	3		Regina, Sask. Canada	"	NWSGSH 90. USGS01
101.	WSCVAN "	2					2	2			"	"	NWSESO 4. BCHYPW
102.	WSCWPG "	3					3	2	1		Winnipeg, Man. Canada	"	99. WSCOTT NWSGSH

TABLE 5.1 (cont.)

USERS	DCP'S								UNIQUE NEEDS	LOCATION	DATA LINK	SECONDARY USERS
	TYPE					STATUS						
	ST	STI	STR	I	RR	T	A	D				
103. WSMR01 U.S. Army Electronic Command				11		11	8	3	Data on 15 min. sched.	White Sands Missile Range New Mexico	Dial-in	
SUB-TOTALS:	1647	46	110	172	0	1975	967	1008				
DIRECT READOUT (DRO) USERS OUTSIDE OF NESS DATA BASE												
CALIF. DEPT. OF GEN. SERV.	120					120	60	60		Sacramento, CA	DRO	
U.S. BUR. OF RECL.	170					170	55	115		Boise, ID	"	
U.S. BUR. OF RECL.	160					160	35	125		Denver, CO	"	
SUB-TOTALS:	450					450	150	300				
SECONDARY DATA USERS WITHOUT THEIR OWN DCP's												
NWSESO									Data Monitor Only	Suitland, MD	Ded. Line 5	
NWSGSH									"	"	"	
NWSAKB									"	"	"	
NWSBPA									"	"	"	
NWSEXX									"	"	"	
NWSLLL									"	"	"	
NWSCAS									"	"	"	
NWSRFF									"	"	"	
NWSPEX									"	"	"	
NWSHGS									"	"	"	
NDBOTE									"	NSTL Station, MI	Ded. Line 8	
NDBOOP									"	"	Ded. Line 5	
NDBODG									"	"	Line 17	
COE002									"	Suitland, MD	Ded. Line 5	
TOTALS:	2097	46	110	172	0	2425	1117	1308				
Percent:							46	54				

timers and are not considered the standard units. In Table 5.1, this requirement would be listed under Unique Needs. Data requirements for the Integrated and Random Reporting DCP's are more difficult to evaluate, but generally they do not exceed the self-timed unit data rate requirements. These more sophisticated units provide the flexibility for data reporting on an unscheduled or event basis. The numbers and types of DCP's associated with each user are shown in Table 5.1. There are two variations of self-timed units indicated, one with Interrogate (STI), and the other with Random Reporting (STR) capability. The latter is considered to be pseudo-random since an event can trigger its reporting at a more frequent, but not strictly a random rate. At present, there are no Random Reporting DCP's in the system. Since experience with the DCS has shown that about 50% of the DCP's are deactivated at any given time, the deactivated number is also shown.

5.2.2 Data Requirements

Deviations from the standard three-hour frequency of reporting and one minute (6000 bits) message length are indicated as Unique Needs. Others in this category are requirements for data deallocation times in excess of one day, and tape storage of data for extended periods of time in the event of a User data handling system failure. Priority message handling is also considered a Unique Need, and the types noted are Emergency Alerts which could result in a Disaster Warning.

5.2.3 Data Links

GOES DCS data may be obtained directly from the satellites, from the various users, or from the DCS control center. The last case is the usual situation for most of the user community, but several organizations have their own ground stations for direct data reception from GOES. Data from the DCS control center flows by commercial phone lines to the individual users, and these lines can be dedicated or dialed-in, depending on the traffic volume. There is also flexibility in the line bandwidth, which can vary according to individual needs from low speed (300-1200 bps) to medium speed (2400-4800 bps).

5.2.4 User Queues

Table 5.2 summarizes the assignment of storage queues to current users (see Section 3.2.1). As indicated, major assignments are to U.S. Federal agencies and to the Canadian Water Survey Department. The remainder, listed as "other" are generally assigned as single queues to individual users.

5.3 DCP GROWTH RATE

As has been mentioned previously, the GOES DCS has experienced a rapid increase in use since it became operational in 1974. This growth reflects user confidence in the system and appreciation for the cost-effectiveness potential for conducting a data gathering operation from remote or not easily accessible locations. Cost effectiveness to the user has probably been unduly enhanced by the free operational service provided by NESS. For these and possible other reasons, growth in the DCS over the past few years has been specular, as shown in Figure 5.1. From this historical experience, one could infer an annual growth rate of about 60%. Whether this growth will continue is very difficult to estimate. On the one hand, the effect of Presidential Directive PD54 which gave NOAA responsibility for operating a National satellite data collection system was predicted to result in a five-fold increase in DCP's in five years. A more conservative expectation would be that after some initial period, a constant number of platform will be added each year. This latter scenario could reflect a new policy statement by NESS that user resources will be required to fund the expansion of the DCS ground system to meet future user needs. Nevertheless, past growth rate is probably the best indication of future trends. On this basis the GOES spacecraft limit of 20,000 DCP's would be reached in 1986. For planning purposes, this appears to be a reasonable probability.

TABLE 5.2
USER QUEUES

Agency	Number
U.S. Department of Army Corps of Engineers	15
U.S. Department of Agriculture	4
U.S. Department of Commerce	49
NOAA NWS - 35	
NOAA other - 14	
U.S. Department of Interior, Geological Survey	5
Water Survey of Canada	8
Other	36
Total	117

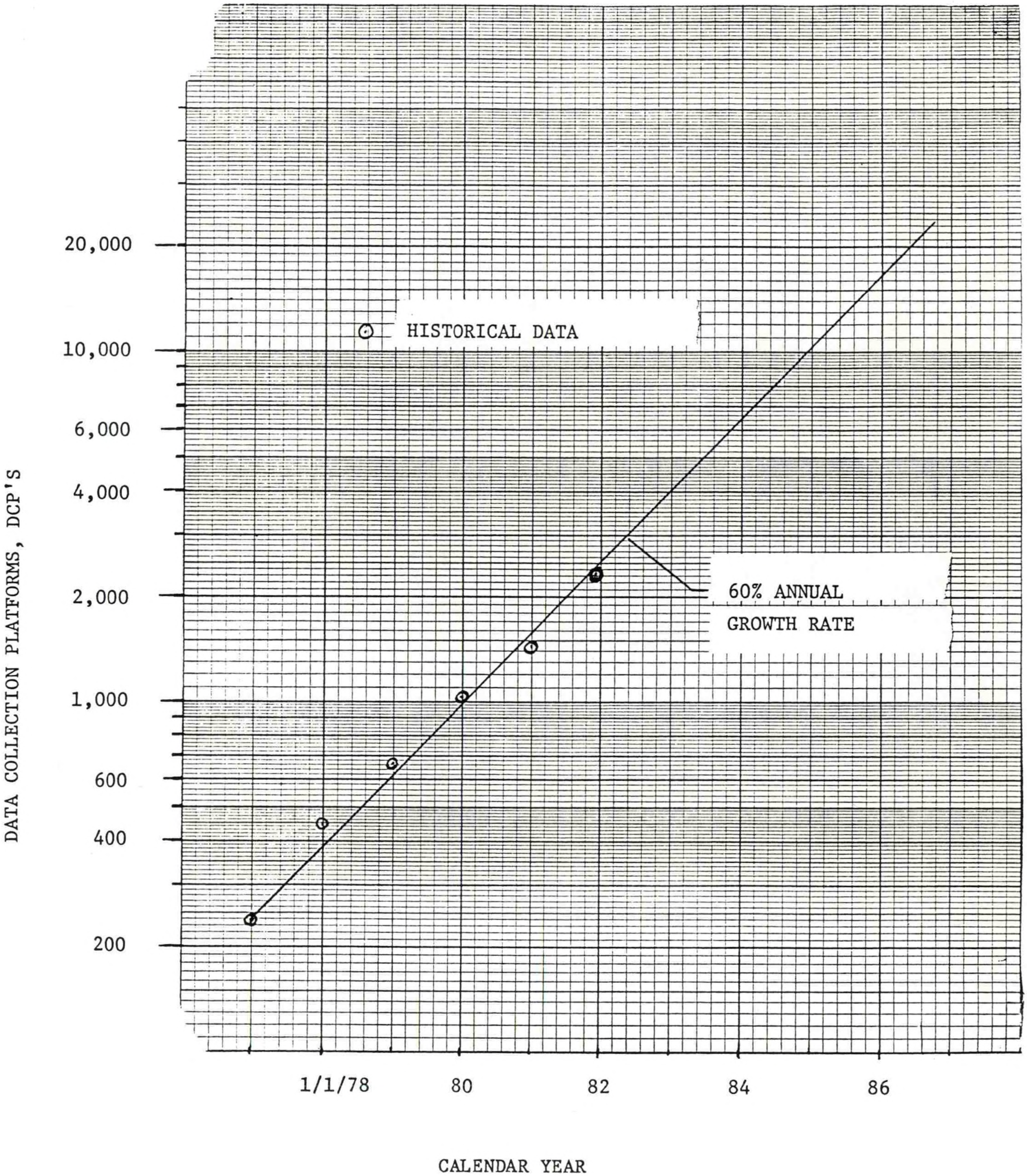


Fig. 5.1 Historical growth of DCP's

6.0 PERFORMANCE/LIMITATIONS

The performance of the DCS can be measured by its ability to handle the actual workload and its ability to handle the expected workload; workload can be considered the capacity of the DCS in terms on the number and type of DCP, and the number of users. Also, part of the workload would be the ability to transmit the captured message to the users. In this section, the performance of the DCS will be analyzed and factors that limit the performance will be identified and quantified. The specific areas of performance and limitations discussed are operational procedures and policies regarding the space segment, ground system equipment limitations, and ground segment software limitations.

6.1 LIMITATION ON OPERATIONAL PROCEDURES AND POLICY REGARDING SPACE SEGMENT

When the initial ground system supporting the DCS was conceived, it was believed the space segment would need to support not more than 10,000 DCPs at some remote time in the future. The ground system for the initial procurement (1975/1976) was specified to handle only 1,200 platforms, and was considered to be a limited operation. The policies and procedures regarding the operation of the space segment are limited also by the inherent design conceived for this ground system.

First, the system capacity is halved by the method of assigning satellite channels to ground support equipment. As shown in table 2-6, the even DCS channels are assigned to the east NOAA spacecraft and the odd channels to the west spacecraft. This is partly a result of the type of DCPRS that most DCS users own and would consider purchasing. Most platforms broadcast omnidirectionally and none broadcast different polarizations. Thus, because of the proximity of the satellites, the DCPRS design and the relatively broad antenna patterns, most DCPs do illuminate both satellites and diversity for reuse of the satellite spectrum is not possible.

Secondly, the system capacity is less than the desired 180 platform per channel for the self-timed DCPs. A computed value for the actual capacity is 126 DCPs per channel. This reduction of capacity is a direct result of the diversity of user requirements that NOAA has had to satisfy. An inspection of table 5.1 will reveal that the repetition rate for ST platforms varies significantly from the desired 8 repetitions per day. This accommodation of various rates has resulted in the reduced number of platforms per channel.

The last limitation is due to scheduling inefficiencies that are estimated to reduce the available time by 50 percent per channel. This limitation is not having any significance on current operations because only about 2,400 platforms are now supported by the system. As the number of users grows, the limitations will become more evident.

6.2 GROUND SYSTEM EQUIPMENT LIMITATIONS

The ground system equipment affect the performance of the DCS by limiting the capacity to support the entire 200 channels of the satellite bandwidth. The ground system has been specified to support 120 channels but the current implementation is limited by the 80 demodulators in use at the CDA. Other ground system equipments that would limit the ability to support the 120 channels are the storage and communication equipment (both main memory and secondary disk), at the CDA and the CDDF. The number of DCPs that would be supported by the 120 channels and 80 channels are 7,528 and 5,052 respectively, assuming 126.3 DCPs per channel and a 50 percent scheduling efficiency. The precise way the hardware limits the ground performance is described in section 6.3.

6.3 SOFTWARE LIMITATIONS

Two aspects of the DCS operation are limited by software characteristics. These are monitor and control capability and message handling capability.

The monitor and control capability encompassed all the functions that enable the DCS to identify DCPs a prioria, to predict their transmissions, to check their operation and to notify owners of abnormal operation. A significant limitation of this function is caused by the software architecture at the CDDF which limits the number of users (i.e., an entity, organization, or agency, who has a specific ID associated with the platforms he owns) to 256. To overcome this limitation, either significant modification could be performed on the software or NOAA policy could limit the number of user IDs in the system; this latter procedure could be applied to agencies who have several user IDs.

Two other aspects of software that limit the performance of the DCS are table size(s), file size including organization. Both of these are discussed in subsequent paragraphs.

6.3.1 Table Size

The two tables that limit the capacity of the DCS are the Channel Activity Table (CAT) at the CDA and the Routing Table (RT) at the CDDF. The CAT is currently configured for 80 channels and can only be expanded to 120 channels after the main memory at the CDA has been expanded by at least 800 words. The RT at the CDDF is currently configured for 6,548 DCPs and probably cannot be expanded without the addition of a semiconductor drum emulator that can be used as RAM.

6.3.2 File Limitations

The system files contained on the existing disks at the CDA and the CDDF limit the number of DCPs that can be recognized within the DCS and are listed in Table 6.1. This table is based on the current file sizes at the CDA and CDDF and on the system as designed. In this paragraph, the analysis will cover the system files at the CDDF. The message files are handled in subsequent paragraphs. The limiting factor is seen to have been the CDDF system files; the CDA schedule file appears to have more capacity than do files at the CDDF.

For files at the CDDF, an inspection of the table shows that the total number of DCPs (third column) varies from 3,000 to 29,946. To optimize these files for holding additional DCPs, the spare space (7,252) at the CDDF can be distributed among the CDDF system files as follows: (a) to add 2,000 DCPs allocate 4,000 sectors to statistics; (b) to add 891 DCPs to schedule file, add 1.43 x 891 sectors = 1,274 sectors; (c) leaving the spare space at the CDDF as 1,977 sectors; (d) to allocate this space among the PDF, schedule file, and statistics file, divide by $2+2+.125N+.14N = 7.03$ ($N=11.4$) $1977 \div 7.03 = 281$; (e) total DCPs that can be supported: 5,000+281 = 5,281.

These system files at the CDDF could be extended to support additional (beyond 5,281) platforms by the use of larger disk storage systems with the existing IS 1000 computer. It is believed that 80M bytes as well as 300M bytes disk packs are available to overcome this limitation. The extension with any disk pack however, would be limited to 16,000 platforms based on using the current software because of indexing in 16 bits.

6.3.3 Message Files and Back-up Operations

The messages received at the CDA are stored on two separate disk systems in order to provide backup. These disks provide buffering in case of a failure at the CDA, a failure of communication circuits, or a failure at the CDDF. In practice, these disks function as a wrap around or circular file for message storage on a continuing basis. When playback of data from the CDA to the CDDF is necessary, the software will read the data out in increasing time sequence.

TABLE 6.1

DCS FILE CHARACTERISTICS

Name/Location	File Size (Sectors)	Space (Sectors) per DCP	Total Number of DCPs Based on File Size (8)	
Platform Data File (PDF) (CDDF)	10,500	2	5,000	
Schedule (CDDF)	6,144	0.125N (1.43)	4,109	(1),(2),(4)
Log (CDDF)	20,480	0.14N (1.60)	12,832	(3),(4)
Statistics (CDDF)	10,240	2	3,000	
User Data File (CDDF)	1,280	0.04	29,946	
User Assignment File (UAF) (CDDF)			10,000	(5)
Space (CDDF)	7,252			
Schedule (CDA)	12,880	0.2N (2.28)	6,524	(1),(4),(6)
Message (CDDF)	64,000	1.77	36,158	(7)
Message (CDA)	18,432	1.77	10,413	(7)

1) Subtract from file size 18 sector directory & 288 (truncation due to 288 five-minute segments).
2) 9 words per sector header, 20 words per schedule entry; 8 entries per 173 word sector; 1/8 = 0.125 sectors per event.
3) Based on design of 5,000 DCPs and 30 messages per day = 150,000 messages per day; 150,000÷20,480 = 7.32 messages/sectprs; N (average number of messages per DCP per day) ÷ 7.32 = 0.14N.
4) N = 11.4 messages per DCP per day based on PDF statistics.
5) Holds 2,000 address blocks identifying first and last DCP address belonging to a user. 10,000 based on estimate of 5 DCPs per user.
6) 9 words per sector header; 20 words per schedule entry; 5 entries per 127 word sectors; 1/5 = 0.2 sectors per event.
7) 1.77 sectors per message based on 9 different measurements obtained in DCS. The last column lists the number of messages.
8) The files include other information than DCP data; e.g., file directory.

Normally, the CDDF will continuously receive this data from the CDA via a 9600 bps dedicated circuit. To provide for backup in case of failure a copy of the message file and other files are periodically written to magnetic tape; currently the period is about eight hours. During the copy process, which takes about one-half hour, messages are still being received by the CDDF and written to the disk. Subsequent to certain failures, this tape is used to restore the disk to its state at the time of the tape creation. Then, all messages younger than the tape creation time are played back from the CDA to update the CDDF disks. After a period of update, the CDA and CDDF systems will achieve a steady state where the backlog at CDA has been eliminated.

One situation that is useful to analyze is when a disk failure occurs at the CDDF just before the archive process has been completed. This will result in a large backlog of messages to be transmitted from the CDA. First, an interval is necessary at the CDDF to copy the archive back-up tape to disk; then the following two expressions can be used to analyze this case.

$$R_o = R_i = 4800 - .474N_A \geq 0 \qquad (6.1)$$

and $18{,}432 \geq 0.84 N_A T_1$ (from Appendix D)

$$\text{Where } R_i = \frac{11.4 \text{ message}}{24 \text{ hours}} \times \frac{1 \text{ hour}}{3600 \text{ sec}} \times N_A \times \frac{127 \times 16 \text{ bits}}{\text{sector}} \times \frac{1.77 \text{ sectors}}{\text{message}}$$

R_o = effective data output rate from the CDA; assume 4800 bps.

T_1 = the interval of time from just after last tape back-up to completion of tape restore at CDDF.

N_A = active number of DCPs in the DCS.

Solving the first inequality the value of N_A is

$$N_A \leq 10{,}126 \qquad (6.2)$$

For the second expression, the number of messages during T_1 must not exceed the storage capacity at the CDA; otherwise messages will be overwritten because the message file is circular:

$$N_A T_1 \leq 21,943 \qquad (6.3)$$

To establish a range for the interval (T_1) of tape backup, two conditions are of interest: First, the number of platforms that can be supported by the DCS using the current 8-hour back-up interval; second; based on the current number of active platforms, the oldest messages that can be stored at the CDA before it is overwritten. Evaluating expression 6.3 for these two conditions yield respectively 2742 active (5484 total) platforms and 22.7 hours. This latter value has been checked against one test case at the CDA and the values agreed to within 21 percent.

6.3.4 Message File at the CDDF

The messages received from the CDA are stored in the message file. Some messages are stored more than once because of a feature of the DCS service called secondary user: i.e., an entity (user) that can request that the DCS automatically provide the entity with a copy of another entities' messages. The messages are stored in the file for various lengths of time depending on parameters (specified by the entity, within NOAA guidelines) maintained in the DCS. For users with dedicated communication circuit connections with the DCS, their data is stored for a short period of time (e.g., one hour) after which the space allocated for the messages can be reused. For other uses, primarily dial-in users, their data is stored for a period of time that is dependent on two factors: (a) has the data been disseminated, (b) has it been stored beyond a specified time interval These two criteria are used to determine if the space for these messages can be used. An analysis of the factors affecting the storage at the CDDF can be performed using the inequality, D-9, from Appendix D:

$$64,000 \geq N_A(1.53+0.54T)$$

In the use of this expression, it is assumed that dissemination for dial-in users is instaneous at the given time parameters. Particular cases of interest are 24-hour, and 72-hour week-end storage periods. For 24 hour and 72 hours, with operations supporting all users (as today), the computed values are respectively 4417 and 1584 active DCPs. Based on active platforms being 50 percent of all DCPs in the DCS, the total numbers of DCP's supportable by the system are 8834 and 3168 respectively.

7.0 COST SUMMARY

The available information concerning the cost associated with the DCS are presented in this section. Table 7.1 presents an estimate of the total cost for the GOES DCS to NESS. The second, third and fourth items in the table are associated with the ground system computer systems - the CDA and CDDF. Table 7.2 lists the costs associated with the initial acquisition of the ground system hardware and software.

The cost of operating the DCS is comprised of factors that include personnel, maintenance, energy, expendable supplies, communication circuits, and other factors. Of these items, costs have been determined and are listed in Table 7.2 for the operations and maintenance (O&M) staffing of the DCS in the CDDF at the WWB and for the lease of three full-period 9600 bps circuits between the CDDA and CDF.

TABLE 7.1

CAPITAL COST OF THE NESS GOES-DCS

GROUND SYSTEM	NESS COST	USER COST
DCS Unique RF Equipment and Spare Parts	$ 861K	0
DCS Computer System	806K	0
DAMS	426K	0
Software Enhancements to date (including Random Reporting and AMS)	158K	$ 145K
DCS System and S/C Testing	60K	0
DCPRS Certification Program Establishment	25K	0
TOTAL	$2,336K	$ 145K
Spacecraft Transponder Costs		
Six transponders (SMS-1 & 2, GOES 1-4) at $1.5M ea.*	$9M	

* Rationale:
1) Average cost of each satellite (less launch vehicle) has been about $15M.
2) DCS utilized 11% of the on-board power and 10% of the command repertoire, (a measure of complexity).
3) On a pro-rated basis, DCS is about 10% of the spacecraft.

TABLE 7.2

CDA AND CDDF PROCUREMENT AND OPERATIONS COSTS

	Description	Cost
Initial Purchase (CY 1975/ 1976)	System Software, Program Management Documentation, Training and Installation	$310,400
	Wallops Hardware	161,100
	Suitland Hardware	221,780
	Wallops Spares	30,780
	Suitland Spares	45,605
	Total	$769,665
Yearly Operations (CY 1981)	Operations and Maintenance (O&M)[1]	$345,000
	Communications Circuits [2]	43,938
	Total	$388,939

1. The O&M operations are for CDDF only and include costs for one full time programmer.
2. Three (3) circuits between the CDDF and CDA.

APPENDIX A
DCS INTERROGATION OPERATIONS

APPENDIX A

DCS INTERROGATION OPERATIONS

This appendix describes the detailed functions performed at the WWB and the CDA for interrogation operations.

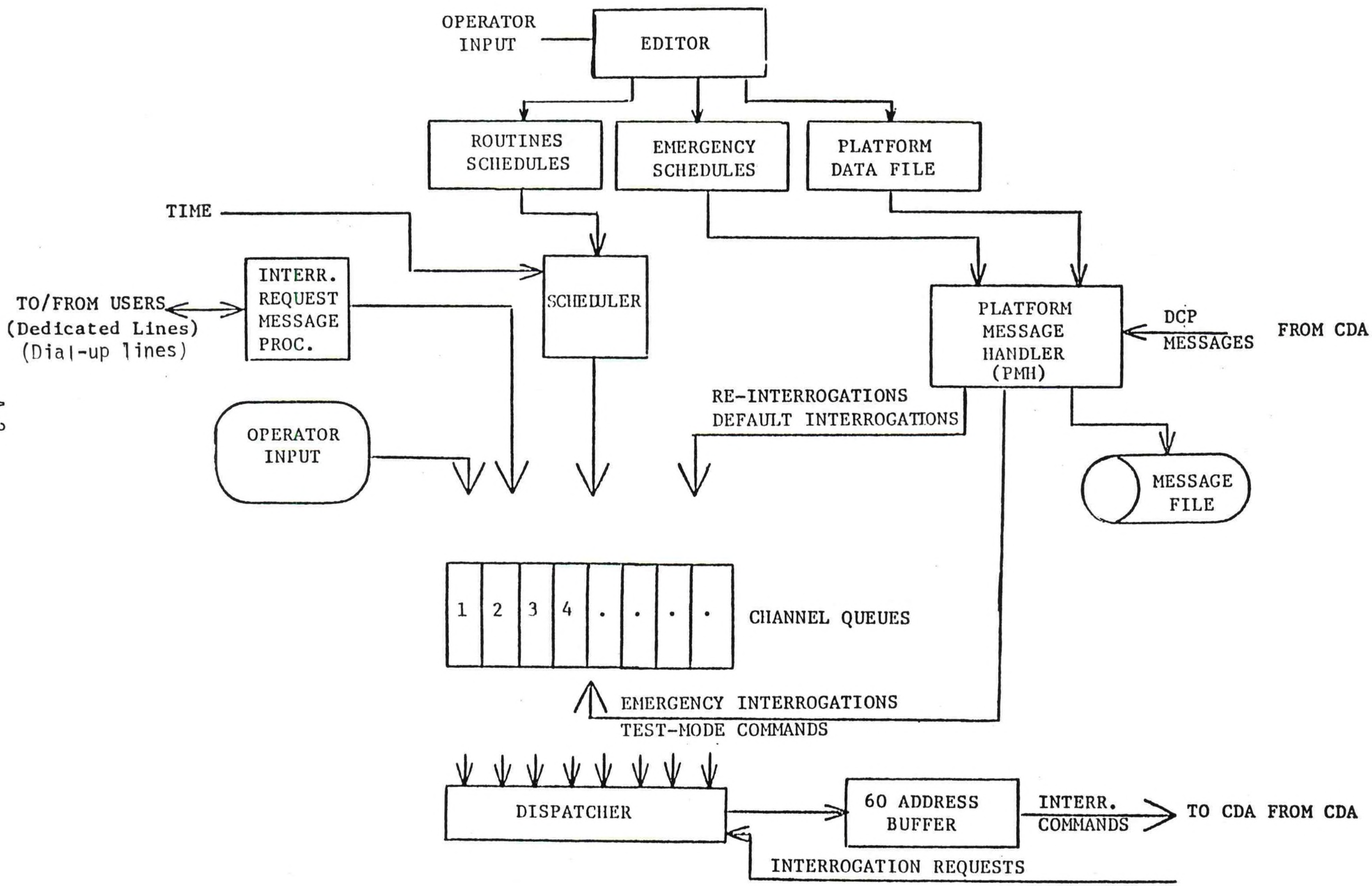
A.1 WORLD WEATHER BUILDING INTERROGATION OPERATIONS

Figure A.1 diagrams the methods by which interrogations are scheduled and sent to Wallops.

The primary method for sending interrogations utilizes a schedule which is stored on disk. The schedule file is organized by time and accessed in five-minute blocks. The block size is strictly a human engineering factor and does not limit the number of interrogations or the placement of the interrogations in any one block. Each schedule is a list of all interrogations to be sent during that five-minute period and with each is the address, the channel number, satellite, message length, test-mode flag, and the user(s) which are to get the resultant message.

The scheduler is a program which is activated by time and retrieves the appropriate schedule. The scheduler divides the interrogations by reply channel and stores them in individual channel queues. The channel queues represent a list of all upcoming interrogations.

FIGURE A.1. WWB INTERROGATION AND COMMAND GENERATION



Every 30 seconds (or more often) an interrogation request message is sent to the WWB system from Wallops. This request activates a dispatch program which scans the channel queues for interrogations to send. The dispatcher removes the interrogations from the channel queues and places them in a buffer which can accommodate up to 60 interrogations per satellite. Since interrogations are sent from Wallops at the rate of every half second, this buffer can accommodate 30 seconds of interrogation. Every time an interrogation is removed from a channel queue, the dispatcher notes the length of the message expected to result from that interrogation. The dispatcher takes care to ensure that another interrogation for that channel will not be sent until the preceding message has concluded. If the dispatcher scans all the channel queues and finds there are none to be sent (none in the queues or all the channels busy) it inserts a "dummy address" (3485763E) in the buffer. This dummy acts as a half-second delay. The dispatcher continues transferring interrogations from the channel queues to the output buffer, one by one, until it is full at which time it is sent to Wallops. In this manner, the reply channels are kept as busy as possible.

In an analogous manner, interrogations initiated by the operator or requested by users are placed in the appropriate channel queue and transmitted to Wallops on a first-in-first-out basis.

All other interrogations are initiated as the result of DCP messages being received from Wallops. All DCP reply messages received from Wallops pass through a Platform Message Handler (PMH). PMH stores these messages in the appropriate area on disk for eventual dissemination to users. For messages resulting from previous interrogations and having one or more errors, another interrogation is composed and put into the appropriate channel queue. "Message-not-received notices" generated from Wallops are handled the same way. With every interrogation sent to Wallops two numbers are also sent: the number of re-tries permitted (Rmax--zero to 15) and the number of re-tries currently in progress (Rcurr). Rcurr is initially zero when loaded into the channel queue by the scheduler or other inputs. The PMH increments Rcurr every time it puts an interrogation in a channel queue. When Rcurr equals Rmax, PMH stops generating re-interrogations. For messages received from Wallops with Rcurr=0 and Rmax >0, a special processing step is employed. Such messages cause the PMH to access the appropriate DCP's Platform Data File to see if a "default platform" is on record. If a default address (and channel) is on file for the original DCP, this new address is used for the remaining re-tries. This mechanism permits the system to interrogate alternative DCPs or interrogate a combined self-timed/interrogate DCP when its self-timed message was not received properly.

In the case of unexpected messages (i.e., not resulting from an interrogation or not scheduled if on a self-timed channel), the PMH tries to determine if special action is required. For every unexpected message that is received, the platform data file is accessed. In addition to finding who the message should be sent to, the PMH checks to see if it came in on an assigned channel. Every DCP can be assigned to two channels: a primary channel and a secondary. If an unexpected message is received on a DCP's secondary channel, it is considered an "alert." In this case, the PMH checks to see if an emergency interrogation list name is also in that DCP's platform file. If so, the PMH locates the emergency schedule list from the name given and puts these interrogations into the schedule queue. Emergency interrogations are added to the schedule queue on a last-in-first-out basis so that they take priority over routine traffic. In this manner, emergency interrogations only delay (not replace) scheduled interrogations. Further, many different emergencies may be active at the same time and will not appreciably interact with each other unless the reply channels are common. Flags accompany each emergency interrogation when it is sent to Wallops, and they also accompany the reply messages sent back from Wallops. The PMH keeps track of outstanding emergency interrogations and determines when the emergency is complete (all replies received). Emergency interrogation lists can contain as many interrogations as required. They are, however, used in a one-shot fashion. If a user requires repeats of the list (every few hours for example), this procedure must be repeated manually by operator command. The operator can trigger an emergency list (or a regular one for that matter) at any time in response to a phone call or other notification.

Emergency lists are given names to which both the user and NESS can relate. For example, list named EMDENV contains interrogations for hydrologic platforms in the Denver, Colorado, area.

One name, EMSELF, is unique and is not a list at all. A DCP triggering an EMSELF emergency causes the NESS computer to actually read its message. Such a DCP's message will contain sufficient information to interrogate or command one other platform. This feature allows a user in a remote location to command a DCP in near real-time, without depending on land-based communication with the NESS system. This capability is particularly useful in testing interrogated DCPs as they are being deployed.

The format for this trigger DCP message is virtually identical to the interrogate request messages received by the system over dedicated communication lines.

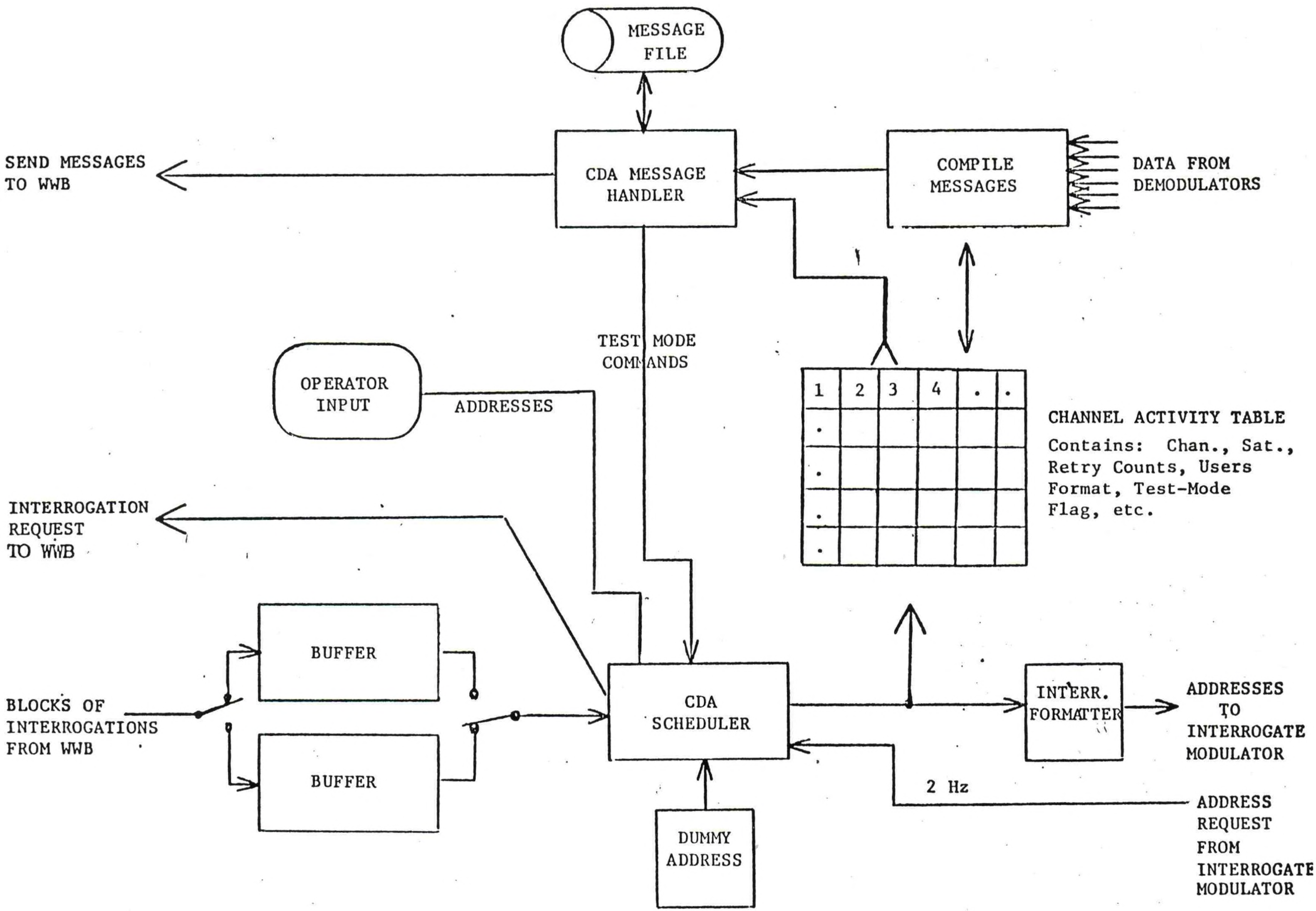
If an unexpected message does not trigger an emergency, the PMH checks the platform's file to see if it is in the "test mode." If so, the PMH composes a command containing Automated Monitoring System (AMS) performance data and puts it into the appropriate channel queue. Since such commands do not elicit a DCP transmission (they merely communicate the data to the field) they do not cause a channel to become busy. Therefore, such commands are queued as emergencies (last-in, first-out) so that the information gets out to the field as soon as possible. Such a command would delay other interrogations by only one second.

A.2 CDA INTERROGATION OPERATIONS

The CDA computers relay interrogations from the WWB to the GOES spacecraft and DCP messages from the GOES spacecraft to the WWB in a somewhat transparent fashion. As shown in Figure A.2, the CDA computers receive the 30-second blocks of interrogations from the WWB. The system attempts to keep two buffers on hand by sending an interrogation request message to the WWB any time one of the two buffers becomes empty.

The CDA scheduler provides addresses to the Interrogate Modulator (CDA hardware) in response to a 2-pulse per second input. For every non-dummy address sent to the Interrogate Modulator, all of the information associated with it (channel, satellite users, re-try counts, data format, test-mode flag, emergency flags, etc.) is stored in a table in a location reserved for that

FIGURE A.2. CDA COMPUTER DATA FLOW



particular channel. This table is the channel Activity Table (CAT) and contains the system's real-time understanding of what is happening on each channel. As a message is being received, a routine compares the address of the received message with that of the one in the CAT for that channel. If the address is different than that expected by only one or two bits, an "address received in error notice" message is sent to the WWB so the user can be notified. The address of the message being received is then "corrected" by the information in the CAT.

If the address of the received message differs by more than two bits, the entry in the CAT is replaced by the new address. An "address received in error" notice is also sent to the user whose message was expected. The new address (which differs by more than two bits) is assumed to be a different DCP which, of course, was unexpected. Once complete, the DCP message and an "unexpected message received notice" are sent to the WWB. The WWB uses the address (PMH) to find out where these two messages should be routed.

If a message is received and no entry exists in the CAT, the CDA computer assumes this is also unexpected. The appropriate notice and the data are sent to the WWB.

If no message arrives when expected, a routine which periodically scans the CAT will discover that fact. Once the message is declared "overdue" the CAT entry is removed and the user is sent an "expected message not received notice."

All message data sent to the WWB is buffered on a wrap-around disk file. Whenever a scheduled entry in the CAT is removed, all of the information in the table is appended to the message that is sent to the WWB. Also, at this time, the entry is examined to see if that DCP was in the test-mode. If it was, the system generates an AMS data command and transmits it over the interrogation link. Since this command will not generate a DCP response, it is inserted in the place of the next two consecutive dummy addresses that would be sent.

In the event communications with the WWB are lost, the CDA computer generates special dummy addresses to replace those that would have been sent. This dummy address is different (34858EC) and signifies to field technicians monitoring the DCPI link that real-time communication with the WWB has been lost.

APPENDIX B

SATELLITE FREQUENCY PLAN FOR DCP ACCESS

TABLE B.1

DCPRS TRANSMIT FREQUENCIES

CHANNEL	FREQUENCY
1	401.7010
2	401.7025
3	401.7040
4	401.7055
5	401.7070
6	401.7085
7	401.7100
8	401.7115
9	401.7130
10	401.7145
11	401.7160
12	401.7175
13	401.7190
14	401.7205
15	401.7220
16	401.7235
17	401.7250
18	401.7265
19	401.7280
20	401.7295
21	401.7310
22	401.7325
23	401.7340
24	401.7355
25	401.7370
26	401.7385
27	401.7400
28	401.7415
29	401.7430
30	401.7445
31	401.7460
32	401.7475
33	401.7490
34	401.7505
35	401.7520
36	401.7535
37	401.7550
38	401.7565
39	401.7580
40	401.7595
41	401.7610
42	401.7625
43	401.7640
44	401.7655
45	401.7670
46	401.7685
47	401.7700
48	401.7715
49	401.7730

CHANNEL	FREQUENCY
50	401.7745
51	401.7760
52	401.7775
53	401.7790
54	401.7805
55	401.7820
56	401.7835
57	401.7850
58	401.7865
59	401.7880
60	401.7895
61	401.7910
62	401.7925
63	401.7940
64	401.7955
65	401.7970
66	401.7985
67	401.8000
68	401.8015
69	401.8030
70	401.8045
71	401.8060
72	401.8075
73	401.8090
74	401.8105
75	401.8120
76	401.8135
77	401.8150
78	401.8165
79	401.8180
80	401.8195
81	401.8210
82	401.8225
83	401.8240
84	401.8255
85	401.8270
86	401.8285
87	401.8300
88	401.8315
89	401.8330
90	401.8345
91	401.8360
92	401.8375
93	401.8390
94	401.8405
95	401.8420
96	401.8435
97	401.8450
98	401.8465
99	401.8480

CHANNEL	FREQUENCY
100	401.8495
101	401.8510
102	401.8525
103	401.8540
104	401.8555
105	401.8570
106	401.8585
107	401.8600
108	401.8615
109	401.8630
110	401.8645
111	401.8660
112	401.8675
113	401.8690
114	401.8705
115	401.8720
116	401.8735
117	401.8750
118	401.8765
119	401.8780
120	401.8795
121	401.8810
122	401.8825
123	401.8840
124	401.8855
125	401.8870
126	401.8885
127	401.8900
128	401.8915
129	401.8930
130	401.8945
131	401.8960
132	401.8975
133	401.8990
134	401.9005
135	401.9020
136	401.9035
137	401.9050
138	401.9065
139	401.9080
140	401.9095
141	401.9110
142	401.9125
143	401.9140
144	401.9155
145	401.9170
146	401.9185
147	401.9200
148	401.9215
149	401.9230
150	401.9245
151	401.9260
152	401.9275
153	401.9290
154	401.9305
155	401.9320
156	401.9335
157	401.9350
158	401.9365
159	401.9380
160	401.9395
161	401.9410
162	401.9425
163	401.9440
164	401.9455
165	401.9470
166	401.9485
167	401.9500
168	401.9515
169	401.9530
170	401.9545
171	401.9560
172	401.9575
173	401.9590
174	401.9605
175	401.9620
176	401.9635
177	401.9650
178	401.9665
179	401.9680
180	401.9695
181	401.9710
182	401.9725
183	401.9740
184	401.9755
185	401.9770
186	401.9785
187	401.9800
188	401.9815
189	401.9830
190	401.9845
191	401.9860
192	401.9875
193	401.9890
194	401.9905
195	401.9920
196	401.9935
197	401.9950
198	401.9965
199	401.9980

TABLE B.2

FREQUENCY ALLOCATION FOR INTERNATIONAL
DCP RESPONSE CHANNEL

No. of Channel	Frequency MHz	Remarks
1	402.002577	
2	402.005577	
3	402.008577	
4	402.011577	
5	402.014577	
6	402.017578	
7	402.020578	
8	402.023578	
9	402.026578	
10	402.029578	
11	402.032578	
12	402.035579	
13	402.038579	
14	402.041579	
15	402.044579	
16	402.047579	
17	402.050579	
18	402.053579	
19	402.056580	
20	402.059580	
21	402.062580	
22	402.065580	
23	402.068580	
24	402.071580	
25	402.074581	
26	402.077581	
27	402.080581	
28	402.083581	

No. of Channel	Frequency MHz	Remarks
29	402.086581	
30	402.089581	
31	402.092581	
32	402.095582	
33	402.098582	

APPENDIX C
INTERROGATE SIGNAL FORMAT

The CDA equipment which generates the Interrogate signal transmits a different frequency for each spacecraft; a sensor platform receiver must be equipped to receive the specific signal frequency transmitted via the spacecraft serving its site. Currently, both spacecraft transmit identical address identifiers. The Interrogate signal modulation characteristics are those shown previously in Figure C.1.

The Interrogate message is formatted into blocks of 50 bits, as follows:

(1) 4 bits of time-code data.

(2) 15-bit MLS for message sync; same as used in platform reply (paragraph 2.2.2).

(3) 31-bit address identifier.

Message timing is derived from the CDA station atomic clocks which are maintained by NBS to within a few microseconds of the master NBS clock in Boulder, Colorado. As an approximate accomodation of the satellite transmission path time delay, the time signals as provided to the CDA Interrogate signal generating equipment are advanced 260,000 microseconds. The leading edge of the first bit of each message block coincides with the CDA station standard's 1/2 second mark.

A complete time-of-year data record is transmitted piecemeal in the time code bits every 30 seconds, beginning on the minute-and 1/2 minute marks. Figure C.1 shows the format of the Interrogate message block and the time code record.

The serial bit transmission sequence is shown in real-time reading from left to right. In all message segments the LSB is sent first.

The format of the time-of-year data record is as follows:

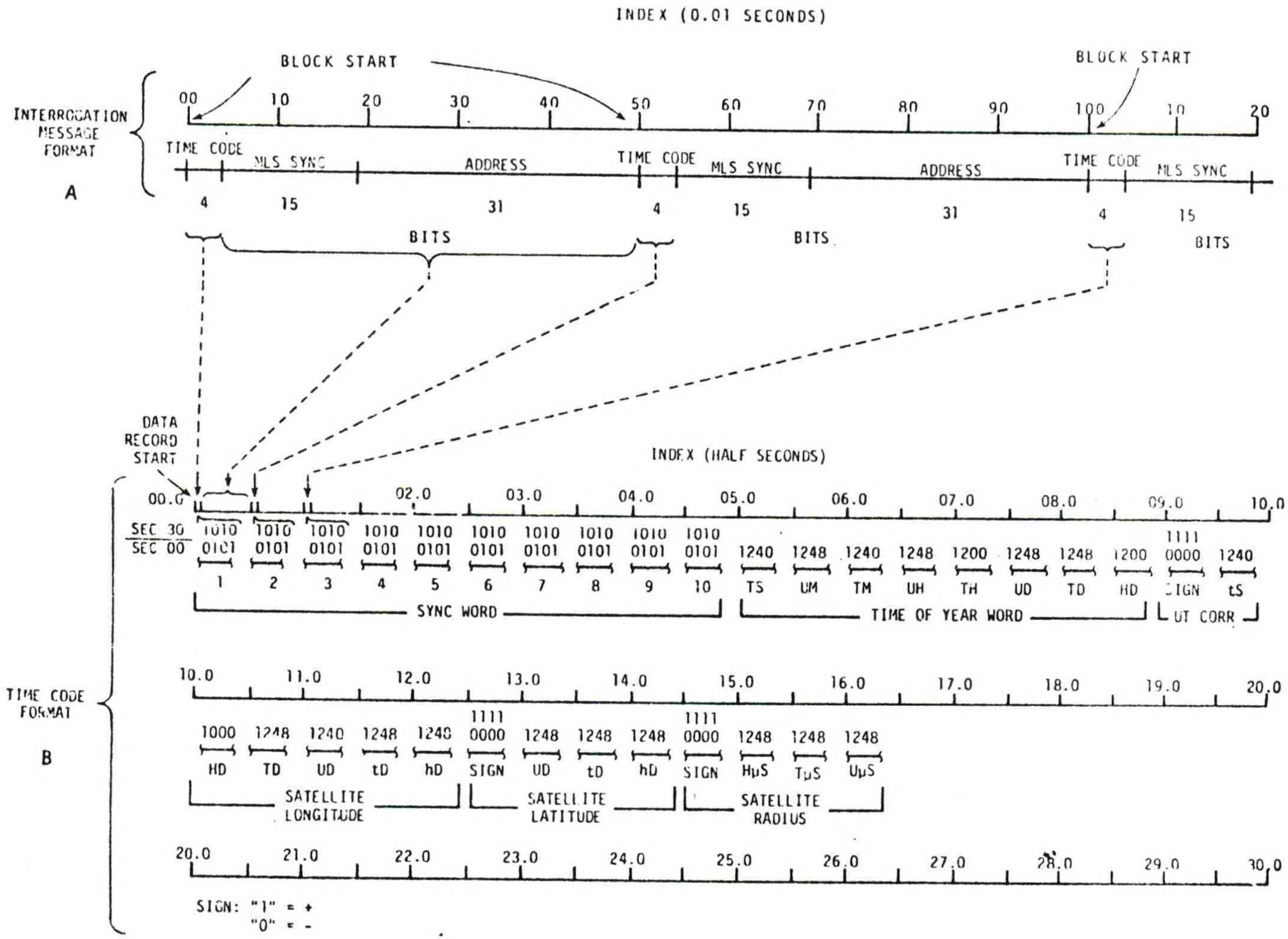


FIGURE C.1. INTERROGATION MESSAGE AND TIME CODE FORMATS

(1) Sync word, 40 bits in length, consisting of ten 4-bit time code characters which designate whether the transmission began on the minute-or 1/2 minute mark. (1010 character for 1-minute records, 0101 for 1/2 minute records; LSB sent first).

(2) Time-of-year word as eight 4-bit time code characters with the hexadecimal value of each character representing a decimal digit of the sequence ; seconds (tens); minutes (units), (tens); hours (units), (tens); days (units), (tens), (hundreds), of Coordinated Universal Time (UTC).

(3) Correction to universal time as 2 time code characters; sign of correction (1111 = +, 000 = -), and tenths of seconds corrected.

(4) Satellite ephemeris in geocentric measure as thirteen 4-bit time code characters; longitude in degrees (hundreds), (tens), (units), (1/10's), (1/100's); latitude in degrees (sign), (units), (1/10's), (1/100's), orbital radius correction in microseconds (sign), (hundreds), (tens), (units).

NBS Technical Note 681, "A Satellite-Controlled Digital Clock," describes use of the time code data transmitted via the DCS Interrogate signal to obtain continuously updated time-of-year data at a sensor platform site to an accuracy of about 100 micro-seconds with ± 20-microsecond precision.

APPENDIX D

EXPRESSIONS FOR MESSAGE STORAGE PERFORMANCE/LIMITATIONS

The analysis of message storage capacity in this report is based on the baseline system as currently designed and configured (i.e., one disk with fixed number of sectors for message storage respectively at the CDA and CDDF). The following equation which gives the rate of utilization of disk storage at the CDDF was derived for use in this analysis in Section 5:

$$S = N_A \times (A_1 + A_2 + A_3 + A_4 + A_5) \times \frac{11.4 \text{ messages}}{24 \text{ hour}} \times 1.77 \text{ sectors} =$$

$$N_A \times (A_1 + A_2 + A_3 + A_4 + A_5) \times \frac{.84 \text{ sectors}}{\text{hour}} \qquad \text{(D-1)}$$

where $A_1 = \frac{462}{967}$, Number of DCPs owned by dial-in users.

$A_2 = \frac{155}{967}$, Number of secondary DCPs inputing messages to dial-up user queues.

$A_3 = \frac{505}{967}$, Number of DCPs owned by users with dedicated circuits.

$A_4 = \frac{579}{967}$, Number of secondary DCPs inputing messages into queues of users who don't own DCPs and use dedicated circuits.

$A_5 = \frac{48}{967}$, Number of secondary DCPs inputing messages to dedicated circuit user queues.

S = Storage utilized in sectors per hour.

N_A = The total number of active DCPs in the DCS.

The equation expresses the rate at which disk sectors are used to store messages in the queues for the five categories (A_1 through A_5) of users. By setting certain values of A to zero, the equation can be used to express the rate of sector utilization at the CDA. Using the two forms of the equations, a comparison was performed of values computed from each equation with a respective measurement (see Table D.1) obtained at the CDA or CDDF. In both cases the computed and measured values agreed to within 18 percent.

The values used in this equation were derived from several different sources. The value of 11.4 messages per day per DCP was derived from a report on the platform data file obtained from the CDDF in December 1981. The value of 1.77 sectors per message is based on six different deallocation processes performed at the WWB and three tests at CDA. This value applies also to the CDA because of the implementation of the message files (i.e., the sectors are not repacked at the CDDF). The values for A_1 through A_5 were established by counting DCPs in Table 5.1 and a Platform Data File Report.

To use the equation for CDA operations, the values of A_2, A_4, and A_5 are set to zero. The value of A_1 plus A_3 becomes one (1) yielding:

$$S_1 = 0.84NT \qquad \text{(D-2)}$$

where
S_1 - the number of sectors storage
N - the number of active DCPs in the DCS
T - the time span in hours the received messages are stored.

To make sure the storage is adequate, the equation is converted to an inequality using the amount of storage (18,432 sectors) available at the CDA.

$$18{,}432 \geq 0.84NT \qquad \text{(D-3)}$$

To derive a similar expression for storage at the CDDF, it is assumed that one hour of all platform data in the DCS must be kept as backup for both dial-in users and users with dedicated circuits. Only messages destined for dial-up circuits are kept beyond one hour.

For the one hour total storage all values (A_1 through A_5) are used and T is one hour:

$$S_2 = N(1 + 0.81) \times 0.84 \times 1 \text{ hour} \qquad \text{(D-4)}$$

$$= 1.53N \qquad \text{(D-5)}$$

S_2 = the number of sectors to hold one hour of all DCP data in the system.

For the period of time after the one hour, the values A_1 and A_2 for dial-in users are used

$$S_3 = N(0.64) \times .84 \times T \qquad \text{(D-6)}$$

$$= 0.54\ NT \qquad \text{(D-7)}$$

where

S_3 = the number of sectors to hold messages for dial-in users for a period of time - T.

By summing the two values S_2 and S_3, the total amount of storage necessary for one hour of backup and dial-in users is computed for a period T+1 hours. This aggregate storage must be less than or equal to the amount available on the disk (64,000 sectors) at the CDDF as shown in the following inequality:

$$64{,}000 \geq S_2 + S_3 \qquad \text{(D-8)}$$

$$64{,}000 \geq N(1.53 + 0.54T) \qquad \text{(D-9)}$$

TABLE D-1
MEASUREMENTS OF PARAMETERS[1] IN THE DCS

PARAMETER	Test Results (sectors/minute)		
	A	B	C
Input Message Rate at CDA	8.2	7.9	8.2
Sector Allocation Rate at CDA	15.5	15.2	15.5
Sector Allocation[2] Rate at CDDF	23.1	21.1	—

1 Performed by inserting counters in software ; A, B, C are three measurement sets.

2 Over the interval including these two measurements, the deallocation rate at the CDDF was completed as 22.2 sectors/minutes.

LIST OF REFERENCES

R.1 Sigma Data Computing Corporation, GOES Data Collection System/Data Processing System Reference Manual, U.S. Department of Commerce National Oceanic and Atmospheric Administration National Environmental Satellite Service, January 1979.

R.2 Mazur, Wilfred E., Software for the GOES-DCS Automated Monitoring System, Spec. No. S25.033, U.S. Department of Commerce National Oceanic and Atmospheric Administration National Environmental Satellite Service, March 17, 1980.

R.3 Seman, Edward C. and Mazur, Wilfred E., Data Acquisition and Monitoring Subsystem, Spec. No. S25.032, U.S. Department of Commerce National Oceanic and Atmospheric Administration National Environmental Satellite Service, May 15, 1979.

R.4 Users Guide for Random Reporting: An Introduction to GOES Random Reporting Services, U.S. Department of Commerce National Oceanic and Atmospheric Administration National Earth Satellite Service, May 1981.

R.5 Geostationary Operational Environmental Satellite/Data Collection System, NOAA Technical Report NESS 78, U.S. Department of Commerce National Oceanic and Atmospheric Administration National Environmental Satellite Service, July 1979.

R.6 Sigma Data Computing Corporation, NOAA Data Collection System/Data Processing, System Operator's Manual, U.S. Department of Commerce National Oceanic and Atmospheric Administration National Environmental Satellite Service, May 1981. (revision)

R.7 Letter. Subject: A DCS Policy Question, dated August 21, 1981, from Faris T. Kahwajy to Diana Josephson.

R.8 DCS User Interface Manual, Draft, June 1981, Produced by Data System Collection Coordinator, S/OP31, WWB, Washington, D.C. 20233.

R.9 Report. Continued Use of Costly, Outmoded Computers In Federal Agencies Can Be Avoided, United States General Accounting Office, December 15, 1980.