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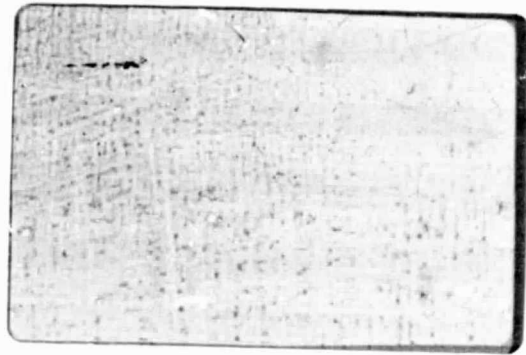
INTERGRAPH

Analysis of Spacecraft Data

Final Technical Report

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1. SPACECRAFT DATA ANALYSIS OVERVIEW

During the contract period support was provided for the maintenance and modifications of software for the production and detailed analysis of data from the DE-A spacecraft and new software developed for this end. Also a new task was undertaken to develop software for the analysis of the data from the Spacelab Experimental Particle Accelerator (SEPAC).

1.1 Software Modifications

Modifications were made to the following software:

ENSP3D - Incorporated the calibration options to allow plotting the data as either raw data numbers, differential phase space density, intensity, integral flux, or flux. Added the capability to the RPASGS portion to plot the data in a line contour format in cartesian coordinates, or to plot the data in a color contour or line contour format in polar coordinates. The capability was also implemented to plot the line contour format over the color contour format. Also included on the polar version is a line to indicate the direction of the B-field. Incorporated an aperture bias testing subroutine, to see if the data meets the aperture bias setting selected by the user.

IMSTGS - Modified to allow the user to select which contour table to use, and to select the angle range to process. Also, the size of the plot was changed to be the same as the other RIMS plots, and the call to ORBPLT was changed to ORBPL1 to allow for putting the orbital parameters on the plot in a different manner.

SFRANL - Modified to produce a smaller file for each set of data instead of one large file for all the data from a run.

MSSPEC - Removed the chi-squared option, cleaned up the way the lines and data are erased. Rewrote the overlay for the PDP.

CALMNMX- This subroutine was modified so that instead of asking for all the ranges of all the ways that the data can be plotted, it now only asks for the range of the data for the way you are currently plotting.

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FREQRG - Modified so that it is easier to enter in the range in either frequency or channel number that you want to process.

AMPTIM - Modified so that when the noise level is below range of the plot it would not draw it.

CTRSET - Modified so that when you entered the name of a non-existant file it would not cause the program to go to end-of-job, but would ask again for a file name.

1.2 New Software

STPPLR - This subroutine provides the capability to do color contour plotting in polar coordinates.

RIMCAL - This program reads a set of data and calculates multiplicative factors for each the high and low mass channels to be used as first order calibration of the RIMS data. Also calculated are factors used to partially eliminate the saturation effect of the instrument.

BASK - This subroutine echoes the previous value of a byte variable prior to asking for the new value but allows the retention of the old value by simply entering a <CR>.

CASK - This is a sister to BASK except that it accepts character variables.

HMSMSM - A simple subroutine to convert hours, minutes, seconds, and milliseconds to milliseconds.

CHKYD - A subroutine to check the value of a calculated YYDDD variable and to return the correct YYDDD if it crossed a year.

MF1TIM - This program reads the RIMS mission analysis files and updates a file of start and stop times of continuous data allowing for data gaps of up to 4 minutes and 16 seconds.

RIMREQ - Reads the start and stop times in the file created by MF1TIM and compares them to a file containing the start and stop times when the instrument is on and creates a file of the times when the instrument was on but for which there is no data.

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PWIPTAL - This program for the PWI data outputs the time, various flags, the B-field samples, and the 4 samples of PWI data plus the average of sample 2, 3, and 4, for both SFR-A and SFR-B over a specified frequency range and time period to a file.

SPNMAS - This subroutine sorts and collects the DE-A RIMS data with mass as a function of ram angle.

MASSPN - This program produces a color spectrogram of the DE-A RIMS data with the x-axis mass, the y-axis ram angle, and the color intensity.

CMSPEC - This program produces a line plot of the DE-A RIMS data over a selected ram angle range with the x-axis mass kinetic energy and the y-axis intensity.

GETDAT - This subroutine reads the SEPAC RSECT data tapes and puts the file header data in a file header data array, the record header in a record header array, and the data in a data array.

GETEPA - This subroutine extracts the electron particle analyzer data from the SEPAC data array, reformats it and puts it in an EPA data array.

GETLP - This is the same as GETEPA only it operates on the langmuir probe data.

GETFP - This is the same as GETEPA only it operates on the floating probe data.

EPACLT - This subroutine collects the EPA data and sums the counts and number of samples for each energy over a predetermined number of minor frames.

LPCLT - This is the same as EPACLT only it operates on the langmuir probe data.

FPCLT - This is the same as EPACLT only it operates on the floating probe data.

CLTEPA - This is the same as EPACLT only it sums over one complete data scan.

CLTLP - This is the same as CLTEPA only it operates on the langmuir probe data.

CALLPH - This function calibrates the high gain data of the langmuir probe.

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CALLPL - This function calibrates the low gain data of the langmuir probe.

LPBIN - This function converts the langmuir probe bias data, from raw counts to volts, and determines a bin number based on the voltage.

EPAVEW - This program outputs all the raw EPA data to the terminal to a formated screen.

LPVEW - This is the same as EPAVEW only it operates on the langmuir probe data.

FPVEW - This is the same as EPAVEW only it operates on the floating point data.

EPAPLT - This program produces a color spectrogram of the EPA data with the x-axis time, the y-axis energy and the color is particle intensity.

LPPLT -- This program produces a color spectrogram of the langmuir probe data with the x-axis time, the y-axis bias voltage and the color is the probe current.

1.3 Miscellaneous Software Tasks

Intergraph personnel worked with a visiting scientist from Belgium to alter the software he provided to be compatible with the software and hardware available here. Technical consultation was also provided relative to various aspects of the DE-A S/C data analysis effort and the maintenance of the O/A database.

2. SYSTEMS SUPPORT OVERVIEW

Intergraph personnel provided technical services in three main areas of systems support:

1) DSTP Support
2) VAX System Management
3) SPAN Management

2.1 DSTP Support

NASA's Data System Technology Program (DSTP)/Data Base Management System (DBMS) is a technology testbed used to procure, test, and evaluate state-of-the-art data systems hardware and software. The DBMS is composed of three superminicomputers, two minicomputers, and a Mass Memory Archive (MMA) tied together with a high speed fiber optics bus and custom systems software. At the beginning of the contract period, nearly all DBMS hardware and software had been delivered by NASA contractors, with the exception of the MMA and its associated hardware and software. Before the MMA was delivered, the DBMS was configured to utilize an emulated MMA so that other DBMS hardware and software checkout could be done in its absence. The MMA consists of an RCA video disk "jukebox" that con hold up to 125 14" video disk platters. It was delivered by RCA around September of 1984 with installation and low level checkout continuing for several months. Upon completion of MMA installation by RCA, OAO installed new software and additional hardware to integrate the MMA into the DMBS. From that point to the current time, the DMBS/MMA has been undergoing extensive debugging, testing, and performance analysis.

Intergraph personnel have been involved in the DSTP for the entire duration of the contract. At various times during the contract, Intergraph personnel have performed system management as well as hardware, software, and integration support for personnel of both RCA and OAO.

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2.2 VAX System Management

One of the superminicomputers associated with the DMBS differs from the rest of the DMBS computer systems in that it is used as a general purpose time sharing machine by a large community of NASA civil service and contractor personnel. For the duration of this contract, Intergraph personnel have acted as the "system manager" for the DIGITAL VAX 11/780 that is known as the Packet Management System (PMS) to the DBMS or NEEDS (NASA End to End Data System) to the network. Some of the regular duties performed include user consulting, interfacing with vendor field representatives for hardware support, installing new versions of the VAX/VMS operating system, installing new versions of layered software products such as VAX-11 FORTRAN, VAX-11 Pascal, DECnet-VAX, etc., maintaining the user authorization data base, monitoring and controlling the allocation and utilization of system resources such as disk space, CPU time, memory, etc., analyzing system accounting files to detect unauthorized system use, doing regular compressions of system disk packs, ensuring scheduled system backups are performed, etc.

Several events of special interest occurred on the NEEDS VAX during this contract period. One was the purchase, delivery, and integration into the system of two new DIGITAL TU78 high speed tape drives. These drives replaced two older TU45 tape drives and have given the group much better use. Intergraph personnel assisted with the installation and testing of the new tape drives. Another point of special interest occurred when several local high school students targeted a large number of NASA computer systems for unauthorized penetration. After a very large amount of effort, these so call "hackers" were successful in logging onto the NEEDS VAX. Intergraph personnel quickly spotted this unauthorized activity and locked the breached accounts. This was immediately reported to the civil service personnel responsible for the NEEDS VAX. They reported it to Marshall security and communications, and then they reported it to the FBI. Intergraph personnel cooperated with security groups both on and off center. After a short investigation, the FBI placed tracers on both dialup lines to the NEEDS VAX so that all incoming calls could be traced. The parties responsible were soon located and their communications and computer equipment seized. (The justice department recently decided not to press charges against those responsible and their equipment was returned.)

Another activity associated with the management of the NEEDS VAX has been that of assisting Space Science Laboratory personnel prepare for the installation of their own VAX 11/780. Intergraph personnel assisted with specifying power and other site requirements, ordering special system hardware and software, helped with developing system management practices and procedures, installation of system software, etc.

2.3 SPAN Management

The final major area of Intergraph activity on this contract is concerned with the Space Physics Analysis Network (SPAN). SPAN is a wide-area DECnet network which links together DIGITAL computers used for spacecraft data analysis at universities, corporations, and national laboratories located across the country. Intergraph personnel are responsible for configuration, performance, and management of the SPAN.

During this contract period, the SPAN grew from a total of 15 nodes to over 30 nodes. A number of new institutions were brought on the network while a number of new machines were brought online on LAN's at existing SPAN sites. Some of the many interesting occurances during the contract period include:

- Installation of Equipment Racks - Intergraph personnel were responsible for reconfiguring all networking hardware associated with the SPAN at MSFC. Suitable AT&T hardware was chosen, NASA procured it, and Intergraph and Kentron personnel installed it. The resulting configuration is much cleaner and allows much easier access to both communications equipment and DBMS hardware.

- Router Server - During the contract period, NASA personnel procured a DECnet Router Server for use on SPAN. This piece of equipment acts as a dedicated routing node on a DECnet network, allowing routing overhead to be moved off heavily used timeshare systems. Intergraph personnel assisted DIGITAL field service in installing both the Router Server and the section of Ethernet cable that connects it with the NEEDS VAX. Intergraph personnel also installed all router software and integrated it into the SPAN.

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- UNIX Systems - Much time was spent during this contract searching for a method to allow non-DIGITAL machines and non-DIGITAL operating systems to join the SPAN. Several possible methods were identified and several methods are currently being tested with a connection between the NEEDS VAX (running under VMS) located at Marshall and a SUN workstation (running BSD 4.2 UNIX) located at the University of Washington at Seattle.

- Telenet - The SPAN project scientist decided that the SPAN needed to extend to DEC systems located in Europe. The only practical method of allowing such overseas connections is to use a commercial packet switch network which utilizes the X.25 communications protocol (such as Telenet). Intergraph personnel (working with DIGITAL sales) identified and wrote the requirements for what hardware and software would be needed to support such a connection. The required items have been procured and are ready to be installed on the new SSL VAX system.

- Node Numbers - One of the worst problems associated with the network at the beginning of this contract was that of duplicate node numbers. The SPAN has interconnects with another very large DECnet network located at Los Alamos National Laboratory (LANL) in New Mexico. At the beginning of the contract period there was no coordination between the management of the LANL network and the management of the SPAN. Intergraph personnel represented NASA in negotiations with LANL and a new cooperative node numbering agreement was created. Since that time there have been no SPAN/LANL problems as far as duplicate node numbers are concerned.

- DECnet Phase IV - A new release of DECnet software from DIGITAL, DECnet Phase IV, was delivered during the contract period. Intergraph personnel tested and evaluated new DECnet features such as Area Routing and Proxy Access in cooperation with several system managers on the network. A new master plan featuring Area Routing was created for the SPAN/LANL network that will hopefully be implemented in the near future.

- Distributed User Directories - One of the requests most often repeated by network users has been for the creation of some kind of SPAN "phonebook" where network users can locate other users' node and account names. Intergraph personnel devised a simple method to allow each network node to maintain their own "userlist" database that is accessible to any user on the network.

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This method was chosen over a centralized database to avoid the frustrations of frequent updates from incomplete remote node information, and also to move the responsibility for database maintenance from the network manager onto the individual system managers.

- Network Bulletin Board - Another frequent request of network users has been that the SPAN support a network wide bulletin board. As with a "real world" bulletin board, it would allow anyone on the network to post a notice, to read previously posted notes, etc. Intergraph personnel devised a method for implementing a very simple network bulletin board, but it was rendered unusable by a new release of the VAX/VMS operating system. DIGITAL, DECUS, and third party software vendors were contacted by Intergraph personnel in an attempt to locate an "off-the-shelf" bulletin board package with little success.

- Travel and Meetings - Intergraph personnel made several trips during the contract period to support the network. One trip was to the 1984 DECUS Spring Symposium held in Cincinatti where Intergraph personnel presented a paper for several civil service employees who were unable to attend. A number of DECUS Network Special Interest Group (SIG) sessions were chaired by Intergraph personnel. During the contract period, there were two meetings of the Data Systems Users Working Group (DSUWG), the group that is responsible for network oversight and direction. Intergraph personnel gave SPAN operations update talks at both meetings, one of which was held at Marshall, the other at Stanford University. After attending the DSUWG meeting at Stanford, Intergraph personnel then travel on to southern California to inspect the facilities of four institutions which had just joined the SPAN.

- SPAN Manual - During one of the DSUWG meetings, it was decided that the group should produce some kind of "manual" on what the SPAN is, how an institution can join it, some of the basic methods of using it, etc. Intergraph personnel proceeded to write several sections of the manual and then co-edited it along with the civil service SPAN project scientist. The "Introduction to SPAN" is currently in it's second revision and is being submitted to the proper NASA authorities so it can be issued as a Marshall Technical Report.
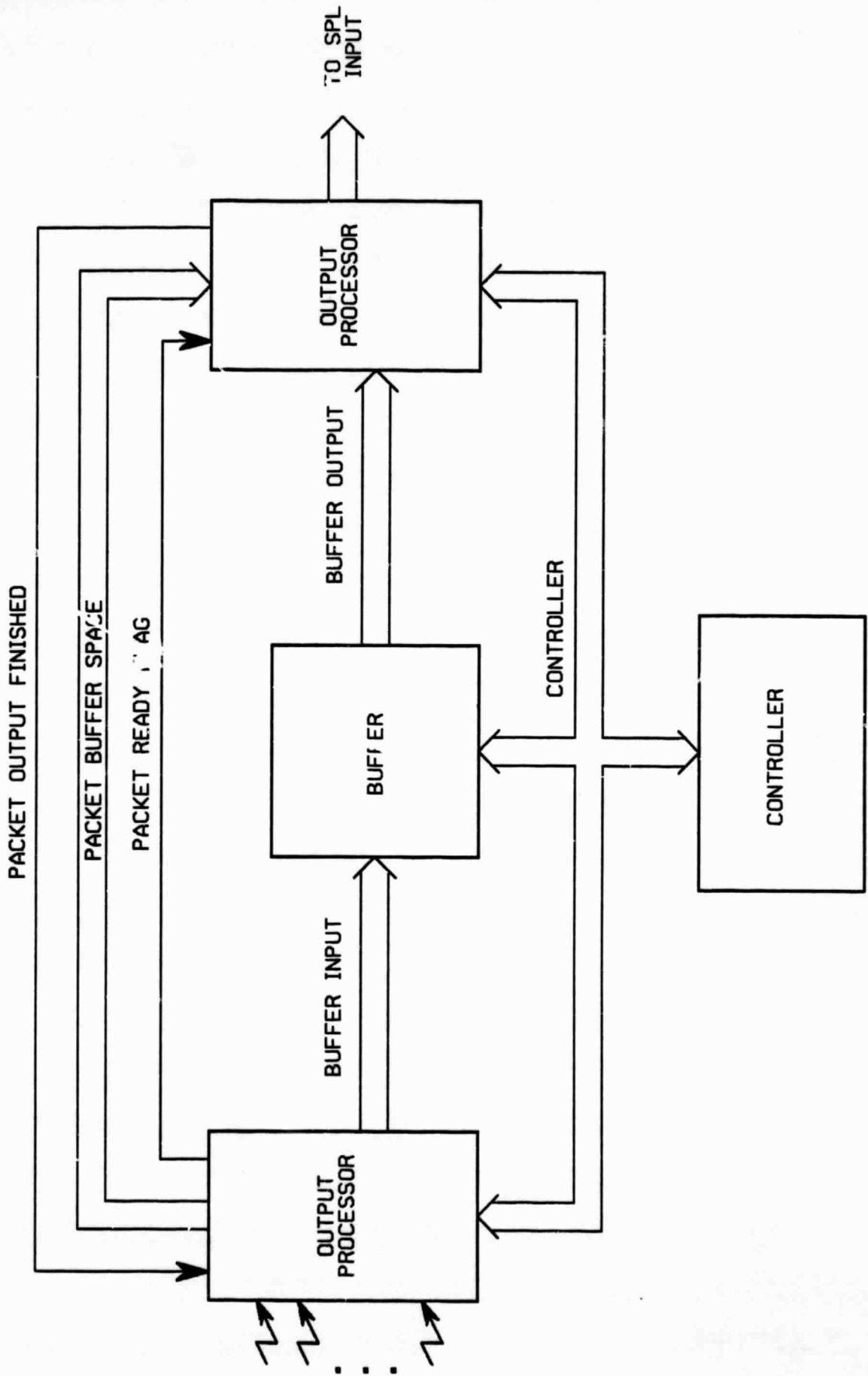
3. DATA COUPLER

Performed an investigation to determine the performance requirements for a interface device that would allow coupling a Fiber Optic Data Bus Port/s in the DSTP facility to a data link that would carry Plasma Physics experiment data and other data sets that would be archived in the DSTP. In addition to the coupler device, Intergraph specified the interface/s that are required between data link, an HRDM, an MDM, and a general data packet source. Intergraph employed a methodology that considered the technical characteristics of the various data sets.
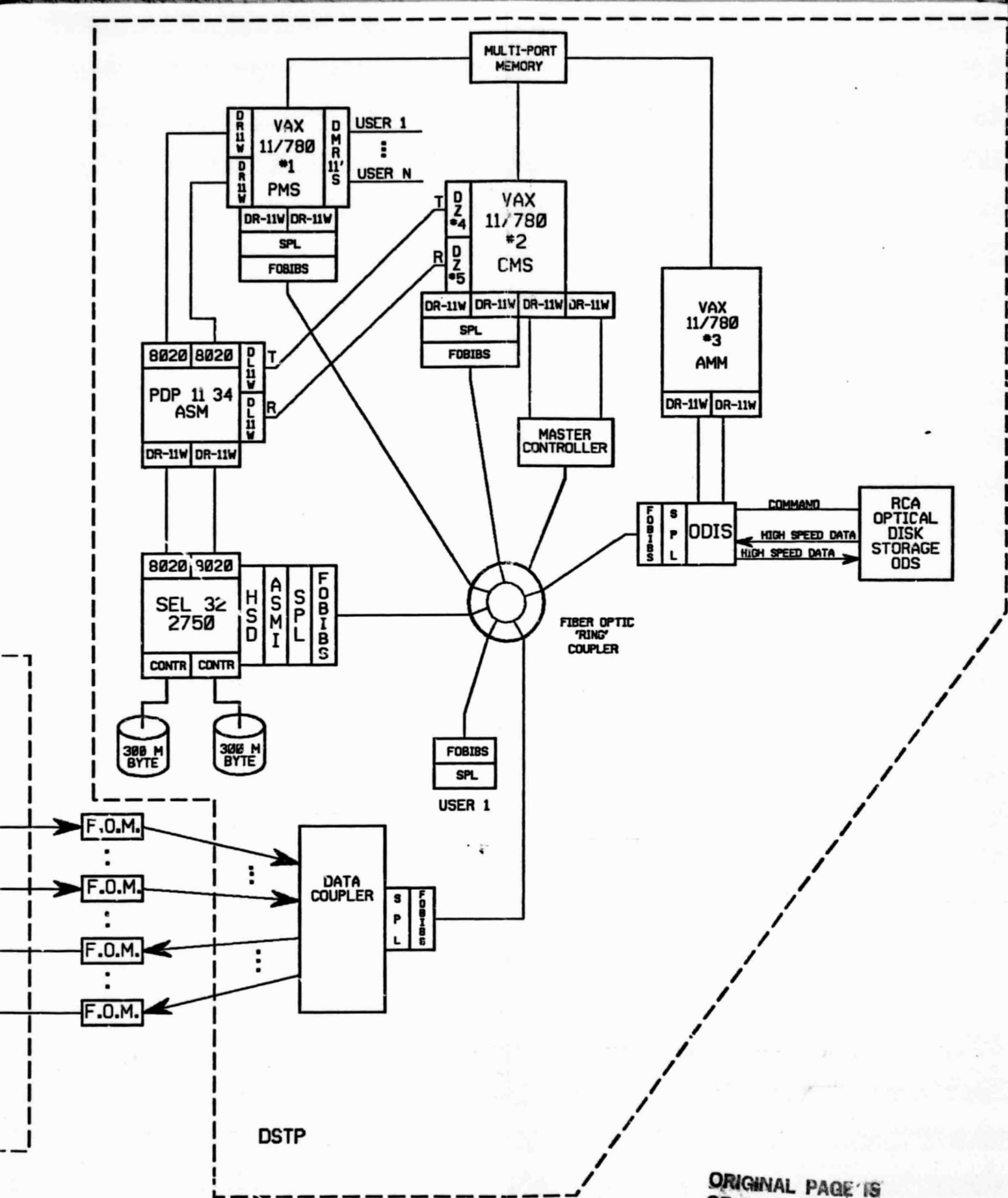
Intergraph utilized the data gathered in order to develop detailed technical specifications for the interfaces, handshaking, and throughput specifications. All interface buffering and storage requirements were specified.

Intergraph identified the components required to build the coupler device. Once identified, Intergraph compiled a list of those standard components that are critical and/or would have a long-lead time procurement.

The details of the Data Coupler design was delivered to NASA in the form of briefing charts and engineering mates. Figure 3a shows the general block diagram of the Data Coupler. Figure 3b identifies all the major interfaces between the Data Coupler, the DSTP and the HOSC.

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FIGURE 3A   DATA COUPLER-DSTP INPUT

GROUND STATION
Kb/s
Kb/s

TDRSS
96 Kb/s
192 Kb/s

NASCOM NETWORK

GSFC

HOSC

MDM

8

8

8

PSCN

SSME
960 Kb/s

POCC

PE

HRDM

EC10
SS10
OPT.

DIGITAL SWITCH

KSC

EC10 (56 Kb/s)
SS10 (56 Kb/s)
LPS (50 Kb/s)

FIGURE 3b   INTERFAC
HOSC, AN

MULTI-PORT MEMORY

VAX 11/780 #1 PMS
DR11W
DR11W
DMR11'S — USER 1 ⋮ USER N
DR-11W DR-11W
SPL
FOBIBS

VAX 11/780 #2 CMS
DZ #4 T
DZ #5 R
DR-11W DR-11W DR-11W DR-11W
SPL
FOBIBS

VAX 11/780 #3 AMM
DR-11W DR-11W

PDP 11 34 ASM
8020 8020
DL11W T
DL11W R
DR-11W DR-11W

MASTER CONTROLLER

SEL 32 2750
8020 9020
HSD ASMI SPL FOBIBS
CONTR CONTR

300 M BYTE
300 M BYTE

FIBER OPTIC 'RING' COUPLER

FOBIBS SPL ODIS

COMMAND
HIGH SPEED DATA
HIGH SPEED DATA

RCA OPTICAL DISK STORAGE ODS

FOBIBS
SPL
USER 1

F.O.M.
⋮
F.O.M.
⋮
F.O.M.
⋮
F.O.M.

DATA COUPLER
SPL FOBIBS

DSTP

RFACES BETWEEN DATA COUPLER, ⎰ FOLDOUT FRAME
C, AND DSTP.