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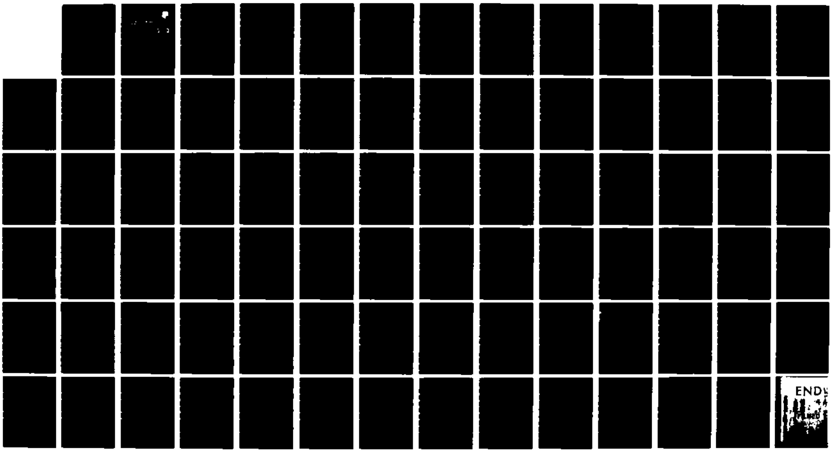

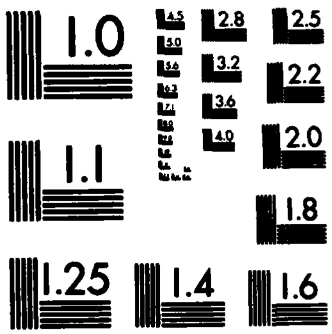

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Final Technical Report
July 1983

TACTICAL OPERATIONS ANALYSIS SUPPORT FACILITY

TRW Defense and Space Systems Group

Michael P. Murphey, Daniel E. Yuchnovicz and Roger W. Starr

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ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
Griffiss Air Force Base, NY 13441

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APPROVED: Paul E. Gwyther

PAUL E. GWYTHER
Project Engineer

APPROVED: Thadeus J. Domurat

THADEUS J. DOMURAT
Acting Technical Director
Intelligence & Reconnaissance Division

FOR THE COMMANDER: John P. Huss

JOHN P HUSS
Acting Chief, Plans Office

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes the current computer hardware and operating software configuration of the Tactical Operations Analysis Support (TOAS) Facility, formerly located at Langley AFB VA. It was transferred to Griffiss AFB NY and integrated into the Intelligence Information Processing Laboratory. ~~(IIPL)~~. The original purpose of the TOAS Facility was to provide a testbed for tactical intelligence system ideas and to provide user feedback within associated development programs. The major purpose cont

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~~of this report~~ is to present a brief description of some candidate software prototyping tools and hardware upgrades for a test and development facility.

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1. INTRODUCTION

The Tactical Operations Analysis Support (TOAS) Facility was an R&D initiative sponsored by the Rome Air Development Center (RADC). Originally part of Project 2315 - (a 6.3 advanced development effort), the TOAS Facility provided the computer hardware and system software to support this project and other data processing experiments/demonstrations. Located at an operational intelligence user's site (460 RTS - Langley AFB, VA), the TOAS Facility was envisioned to become the center of the Tactical Air Force's ADP R&D efforts to support intelligence.

As of late 1982, all other contracts associated with Project 2315 were cancelled (so that the Air Force could pursue their goals by other means). The equipment from the TOAS facility was scheduled to be moved to Griffiss AFB, NY as the nucleus of the Intelligence Information Processing Laboratory (IIPL), a new concept in R&D computer technology development, application, and validation to support the Air Force Intelligence Community.

1.1 PHILOSOPHY/CONCEPT TOAS FACILITY

The original purpose of the TOAS Facility was to provide a testbed for tactical intelligence system ideas and to provide user feedback in the several advanced development programs. The R&D managers at RADC saw the increasingly important need to demonstrate technology advances to the user and allowing him to experiment with <u>applications</u> of this technology to support a particular functional tasks. By having the Air Force user involved in the R&D process, the developer would be better able to evolve an understanding of the functional task and mission, and the user would have both insight into the utility of and have the opportunity to comment on current (and projected) capabilities and limitations of technology.

The current TOAS Facility concept provided the users with a baseline of technologically mature software and hardware.

Some problem areas limited the success of the TOAS Facility as follows:

- Five year LOE contracts.
- Long lead time, inflexible contracts.
- No integration entity (Government or contractor).
- Low level of involvement by user personnel.

Some of these drawbacks will be solved by the IIPL.

1.2 INTELLIGENCE INFORMATION PROCESSING LABORATORY (IIPL)

In concert with the TOAS Facility implementation, IIPL concept was developed at RADC. The objective of the IIPL to provide technology demonstrations addressing user defined problems. In order to better guide and manage these R&D efforts, this laboratory will be implemented at RADC (Building 240) and will support both government and contractor sponsored technology applications. This laboratory will be the hub for evolving intelligence technology demonstrations and experimentations for users and developers.

Advantages of the concept are:

- Better management of overall objectives.
- Optimized use of equipment/systems across many R&D projects.
- Hands-on experience for RADC Project Engineers.
- "System" Perspective Possible.
- Emphasis on rapid prototyping of hardware, software, systems, and MMI.
- Opportunity to influence user involvment in development /experimentation process.

Current plans will establish an interim IIPL at RADC using the TOAS equipment as a base line. Future experiments and technologically advanced equipment will replace the current computer hardware suite as funds are made available. Air Force operational requirements will influence equipment and software upgrades.

1.3 Final TOAS FACILITY Technical Report

The purpose of this report is to present a brief description of some candidate software prototyping tools (GIDS, FLAIR, and Chromatics Man Machine Interface), hardware upgrades, and the initial hardware available at the Interim ISL. For completeness, the base line hardware and software data for the current TOAS equipment has been updated and republished in this report. A section has been included on possible near-term hardware/software acquisitions that has immediate application in the intelligence community. An interesting performance experiment (SI 9775 Winchester disk technology verses the RP06 disk system) is detailed in Appendix A. Physical characteristics and system performance data on three color graphics terminals (Chromatics 7900, Ramtek 9400, and SU 1655) are included in Appendix B.

2. TOAS FACILITY SYSTEM ENVIRONMENT

This section provides the current TOAS Facility configuration as it existed prior to the move to RADC and technical descriptions of the hardware and system software resources. Project 2315 and other Air Force sponsored R&D projects used this facility to test and demonstrate software and hardware technologies to support the Tactical Intelligence arena. This section is provided as documentation of the hardware and software tools that will be available at the ISL, upon completion of the facility transfer to RADC (expected in early 1983). Additional technical data is available from the manufacturer's technical documentation (available at the IIPL).

The primary ADP equipment consists of dual PDP 11/70 computers, system support peripherals, and various user interface devices, that can operate in autonomous or networked modes to support functional demonstration/experimentation and/or software development. The overall Facility configuration (prior to move) is provided in Figure 2-1. Systems A and B are detailed in Figures 2-2 and 2-3 respectively. A Facility hardware list is in Table 2-1.

2.1 BASELINE HARDWARE DESCRIPTION

The major features of the computer hardware are documented in this section.

2.1.1 Central Processing Unit

The PDP-11/70 Central Processing Unit (CPU) is the KWB11-C 16 bit processor intended for high-speed, real time applications, and for large multi-user, multi-task, time sharing applications. Memory management allows 16, 18, and 22-bit addressing modes for operating systems and tasks requiring large amounts of addressable memory. Integral components of the CPU include: Cache Memory organization to provide a high-speed memory; FP11-C floating-point processor; and Memory Management for relocation and protection in multi-user, multi-task environments.

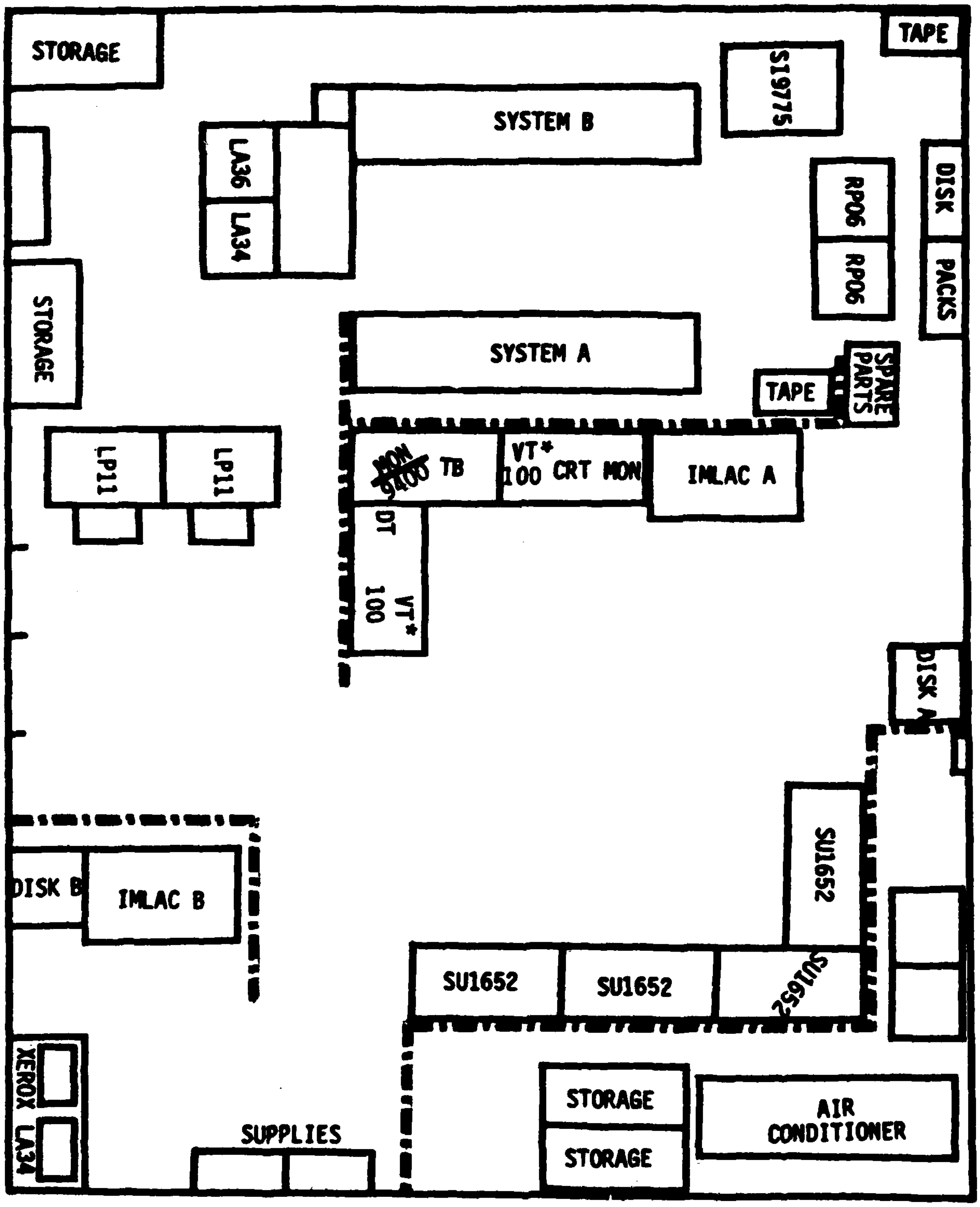
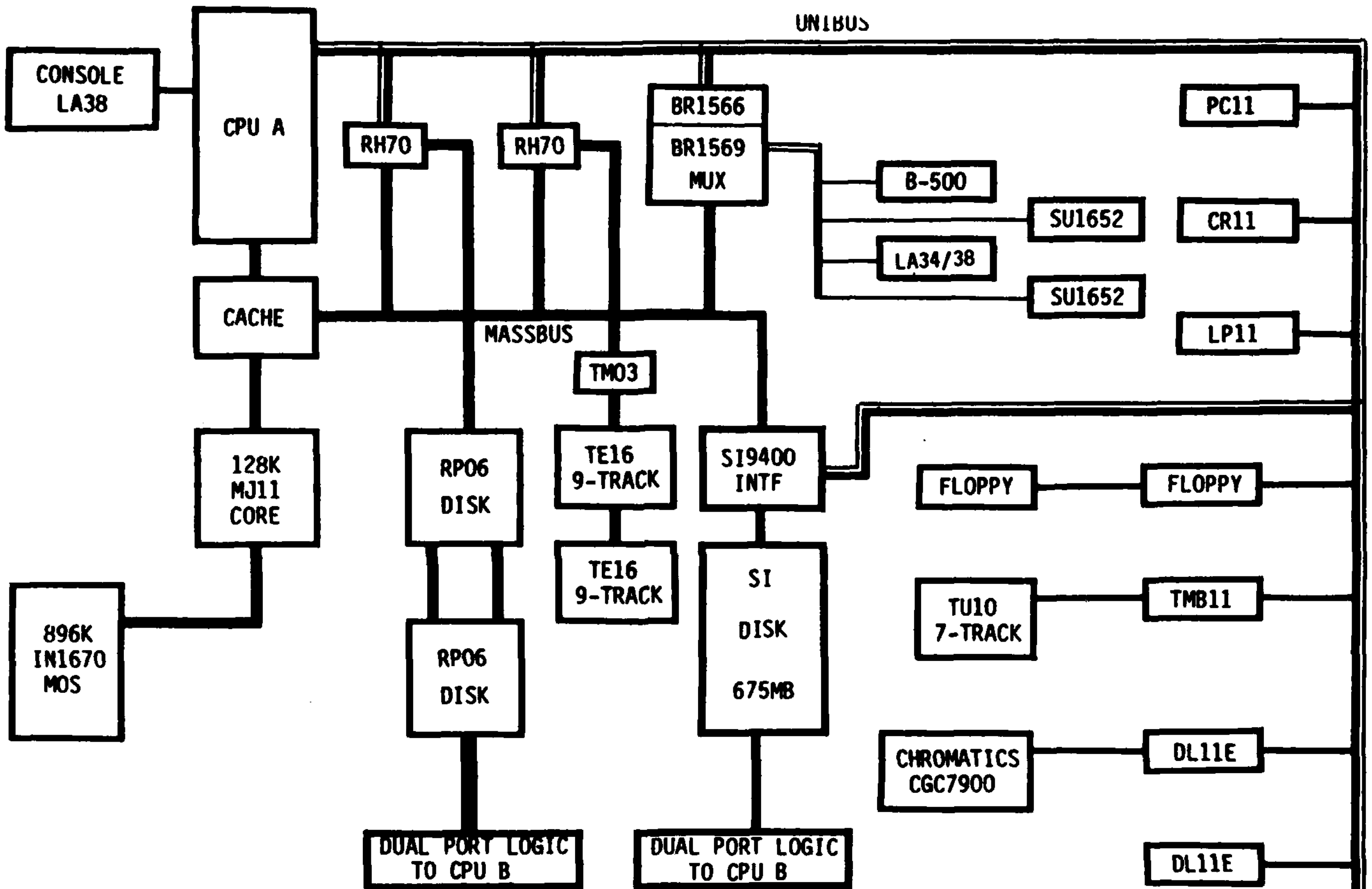
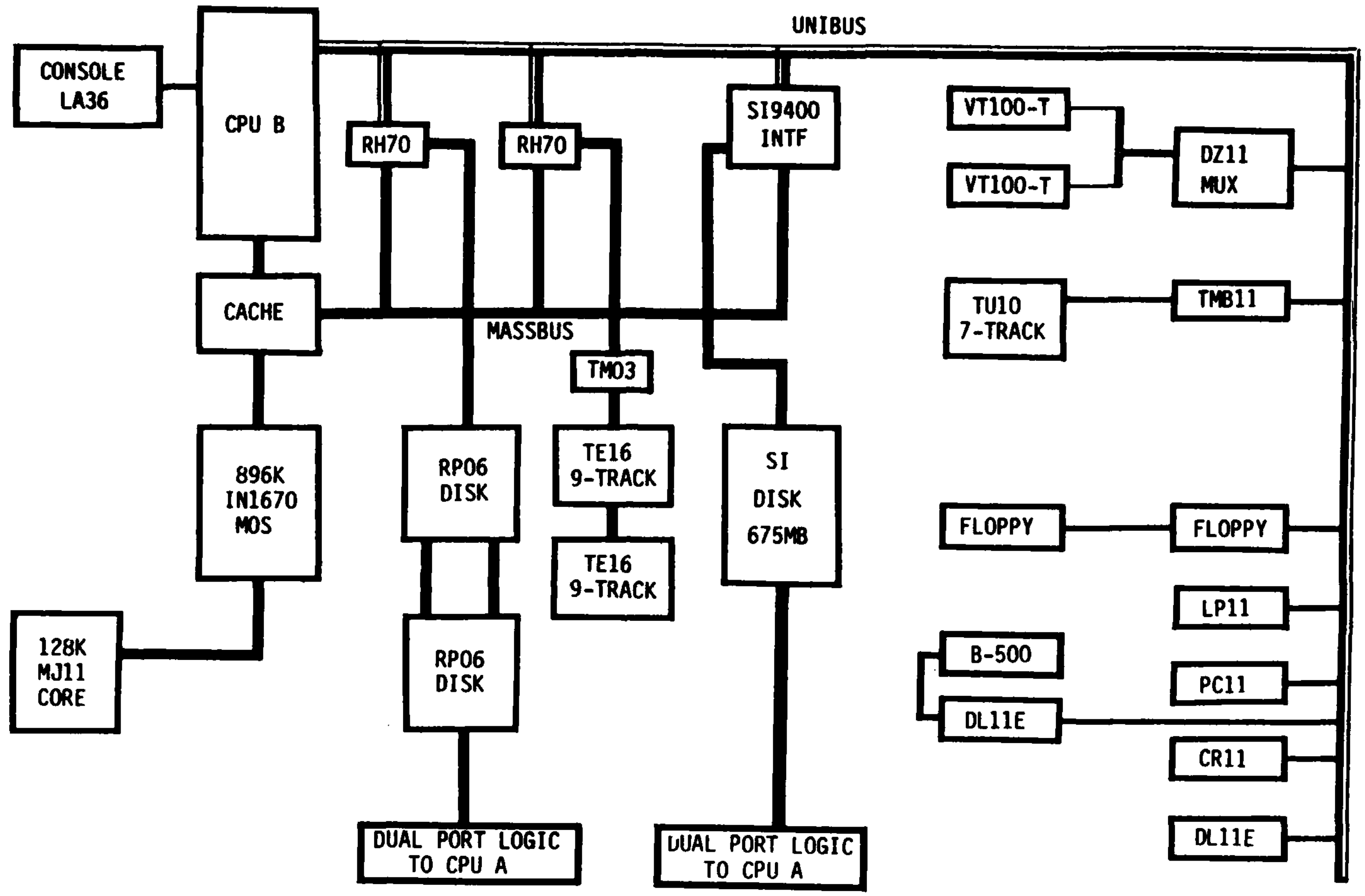


Figure 2-1. TOAS [illegible]ITY [illegible]ARDWARE CONFIGURATION



NOTE: Main memory upgraded to 1024K words, 512K of Intel IN-1670 MOS and 512K of Intel SY-1671 MOS.

Figure 2-2. Computer System A



NOTE: Main memory upgraded to 1088K words, 64K of DEC MJ11 core, 512K of Intel IN-1670 MOS and 512K of Intel SY-1671 MOS.

Figure 2-3. Computer System B

Table 2-1 TOAS Hardware List

Manufacturer	Model	Description	Quantity
DEC			
	PDP-11/70	Computer CPU, 128K core	2
	FC-11C	Floating Point Processor	2
	KW-11P	Programmable Real-time clock	2
	RWP-06BA	Dual Access Disk Controller	2
	RP-06	Dual Access Disk Drive	2
	TWE-16EA	9 Track Tape Controller/Drive	2
	TE-16EE	9 Track Tape Drives	2
	TME-11EA	7 Track Tape Drive	2
	LA-36	Decwriter	2
	LA-34/38	Decwriter IV	2
	LP-11VA	300 Ipm Printer	2
	CR-11	300 cpm Card Reader	2
	PC-11	Paper Tape Punch/Reader	2
	DMC-11AR	DDCMP Micro Processor	2
	DMC-11DA	Network Link Line Unit	2
	DL-11E	Async Serial Line Interface	5
	VT100-T	TEMPEST Video Terminals	2
	DZ-11-T	8-Channel Multiplexer with Fiber Optic Interface	1
Intel			
	IN-1670	512K Words MOS Memory	2
	IN-1671	512K Words MOS Memory	2
Bunker Ramo			
	BR-1569	8 Channel Multiplexer	1
	BR-1566	Memory Bus Interface	1
Univac	SU-1652	Dual Screen Monitor (Graphics)	2
Imlac	PDS-4	Graphic Display System	2

Table 2-1 TOAS Hardware List (cont.)

Manufacturer	Model	Description	Quantity
Chromatics			
	CGC 7900	Graphic Display System	1
Data Systems			
	DSD 210	Dual Floppy Disk Drives	2
Beehive Int'l			
	B500	Video Terminal	2
Summagraphics			
		ID Data Tablet/Digitizer	2
Conrac Monitors			
	SNA 15	15 Inch CRT Monitor	2
Genesco			
	CGT-3000	Graphic Display Processor	1
System Industries			
	SI-9400	Disk Controller	1
	SI-9775	Disk Drive	1

2.1.2 Memory

The TOAS computer system memories consist of factory installed DEC MJ11-A magnetic core memory and add-on Intel IN-1670 and IN-1671, semi-conductor memory. Each computer system memory consists of 64K words of MJ11-A core, 512K words of IN-1670 MOS and 512KB words of IN-1671 MOS. The memories are accessed via the Main Memory Bus or Massbus, with the MJ11 core occupying the lower addresses (0 -400,000) and the add-on IN-1670/1 occupying the upper addresses (400,000 - 4,000,000).

2.1.3 Magnetic Media Peripherals

Magnetic media peripherals of the removable media type are a means of off-line permanent data storage. This group of peripherals include disk drive (removable and Fixed Winchesters), magnetic tape drives, and floppy disk drives. High data transfer rate peripherals interface to the Massbus and communicate with the CPU over the Unibus while lower transfer rate peripherals interface and communicate over the Unibus. The TOAS Facility uses a combination of DEC and Non-DEC peripherals.

2.1.3.1 RP06 Disk Subsystem

The RP06 disk drive is a high speed, moving head, removable media storage device (unformatted capacity of 176 MB) designed to operate on-line with the PDP-11/70. Features include throughput of 806K bytes per second, dual access options that accommodate manual and CPU switching between controllers, and 30 ms average seek time. The RP06 is interfaced to the PDP 11/70 via the RH-70 Massbus controller.

2.1.3.2 TWE16/TME11-EA Magnetic Tape System

Magtape transports provide the TOAS Facility with mass, off-line data storage capabilities. The TWE16 is an industry-compatible 9 track magnetic tape transport system. The unit comprises a master transport with interface and control logic, and TE16-EA slave transport. The master transport interfaces to Main memory through a RH-70 Massbus controller. The TE16 is capable of reading and writing magnetic tape at 1600 bits per inch in Phase Encoding (PE) mode and 800 bits/inch in NRZ mode. Tape density and character format are program selectable.

The TME11-EA is a 9 track tape system (TMB11/TE10) mechanically modified to a 7 track format. The TMB11 controller interfaces the Unibus to one TE10 tape drive. Each computer system supports one TME11-EA. The TE10 has a read/write capability of 800 bits per inch in NRZ mode.

2.1.3.3 DSD 210 Diskette Memory System

Data Systems DSD 210 dual floppy disk memory system is a random access, mass storage subsystem utilizing two eight-inch single sided, single density, soft sectored floppy disks. This system interfaces to the PDP-11/70 via a SPC quad board placed in either the CPU cabinet or BA11 expander box. All data transfers between the PDP-11/70 and the DSD 210 are buffered in a 128 byte RAM. Data from the CPU is written to the RAM buffer where the data is then transferred to diskette. The CPU to RAM transfer is much faster than the RAM to diskette transfer.

A formatted diskette contains 493 blocks (252-bytes) of available storage space. This floppy disk system affords a fast and convenient method for the transfer of files between computer systems.

2.1.3.4 Series 9775 Winchester (System Industries)

The System Industries Series 9775 Winchester is a fixed media disk drive offering a storage capacity of 675 Mbytes. The 9975 in conjunction with the System Industries 9400 Disc Controller interfaces to the PDP 11/70 Mass Bus in an RH70 Controller slot and provides total RH70 emulation which is operating system software transparent.

The Series 9775 675MB disk drive comprises a cabinet and frame (36.0 x 23.0 x 38.0 inches) containing a sealed Head Disk Assembly (HDA), the drive motor and brake, a power supply, and an air circulating system. A logic chassis contains the electronics for read/write, I/O, fault, drive and control functions, plus a microprocessor controlled servo.

Components sealed within the HDA are a deck plate, spindle, disks, heads, and the linear motor voice coil. There are 40 heads of low mass that are lightly loaded to allow start/stop contact with the recording medium and low flying heights. Two heads per recording surface read/write 20 data surfaces at 6495 bpi (inner track). Recording medium is a coated, oriented magnetic oxide disk, which facilitates start/stop contact of the read/write data heads.

Included on the drive is a stand alone diagnostic panel that allows for execution of disk drive diagnostics from the control panel. Diagnostic tests are entered and initiated via the diagnostic panel by rotary dial selection of the desired test number. The panel will constantly display the current state of the drive, monitor all system voltage supplies, and display a hexadecimal error code for any hardware discrepancies found.

2.1.4 Hard Copy Peripherals

Hard copy peripherals provide Facility users with program listings and permanent non-magnetic media data storage. Multi-part line printer paper is available for long listings requiring more than one copy.

2.1.4.1 LP11/LP05 Line Printer

The LP05 free standing line printer is capable of hard copy output or multicopy output on multipart forms at 300 lines/minute with 132 columns and a 64 character print drum. The LP11-VA controller interfaces the LP05 to the Unibus. Output to the printer may be either program listings or text files processed by the DEC utility Runoff.

2.1.4.2 CR11 Card Reader

The CR11 is a 285 card/minute, standard 12-row, 80 column card reader with a hopper capacity of 550 cards. The cards are stacked in the output hopper in the same order as input. The reading cycle is under external off-line data and program storage capabilities.

2.1.4.3 PC11 Paper Tape Reader/Punch

The PC11 Reader/Punch and controller comprise a PC05 high-speed reader/punch and a PC11 controller capable of reading 8-hole tape at 300 characters/second and punching at 50 characters/second. The PC05 punch allows for off-line data and program storage capabilities.

2.1.4.4 LA-34 Decwriter IV

The LA-34 is a microprocessor driven hardcopy table top terminal capable of output at 30 characters/second. The printing mechanism features a 7x9 dot matrix impact print head and is capable of printing on plain tractor fed paper or preprinted forms in rolls or fanfolds. A non-detachable typewriter style keyboard contains the full ASCII upper/lower case character set.

Other features include variable vertical pitch (lines per inch), and variable horizontal pitch (characters per inch). Communications with the host CPU are full duplex serial asynchronous transmission format utilizing an EIA RS232-C or 20mA current loop interface.

2.1.4.5 Xerox 1750 Printer

The Xerox 1750 (Diablo 1650 RO) is a letter quality daisy wheel printer driven by an device capable of data output in an asynchronous serial format conforming to the RS232-C protocol. In its current configuration, the Xerox 1750 can receive characters at rates from 10 cps to 120 cps and output at 45 cps. To increase system throughput, the incoming characters are buffered in a 256 byte character buffer at a data transfer rate higher than the print rate. Status condition flags are used to halt data transfer from the host by implementing a printer ready signal which is sent to the host over pin-5 (clear to send) of the RS232 interface. When the status condition flag is cleared, the printer ready flag is again raised.

Standard status sensors include input buffer full, paper out, ribbon out, cover open, and parity error. Other features include self test diagnostics, bi-directional paper feed and carriage movement, adjustable forms width, margin control, and variable column spacing (130 or 155).

The Xerox 1750 printer is currently used as a hardcopy device for the Imlac PDS/4 terminals, the CGC 7900 display terminal, and also on BM:7 of the Bunker Ramo 1659 Multiplexer. The DEC utility, Runoff, is currently employed to output Files-11 text files from the PDP-11/70 to the 1750 via the BR 1569 multiplexer.

2.1.5 User Interfaces Devices

The TOAS Facility supports several hardcopy and video user terminals. These terminals include the LA36, PDS-4/L, SU1652 and the recently acquired B500, LA38, VT100's, Genesco System and Chormatics CGC 7900. LA36 system consoles allow direct manipulation of system functions and system configuration. The PDS-4/L is a stand-alone terminal that can be down-line loaded for use as a timesharing terminal, and the SU-1652M is a dedicated terminal supported by System A.

2.1.5.1 LA36 DEC writer

The Digital LA36 DECwriter is an interactive data communications terminal for use as a system console terminal. Hardware features include impact printer hardcopy output on variable width line printer paper, and a standard ASCII keyboard. The keyboard options include variable baud rates (110, 150, and 300 baud), cap locks, numeric keypad, and a line/local setting. Throughput is 30 characters/second via a 20 mA current loop DL11 asynchronous serial interface.

2.1.5.2 SU-1652M Dual Screen Monitor

The 1652 is a 15 inch dual screen micro-programmable terminal used to manually prepare, display, edit, and enter data/control signals to the PDP-11/70 via the BR1569 Communications Control Unit. In addition, the 1652 supports alphanumeric and/or graphic displays sent from the PDP-11/70.

The terminal is configured with a light pen, dual pads of variable function keys (60 keys), and interactive graphics options (joy stick). The Intel 8080 microprocessor provides terminal intelligence for remote processing. Down-line loading of complete programs is attained via the Program Load Module (PLM).

2.1.5.3 Imlac PDS-4/L Graphics Display System

The PDS-4/L in conjunction with the Pertec D3442 disk drive is a stand-alone, refreshed-graphics random stroke writer, interactive display system. Features include: a Display processor that is programmed in its own assembly language for generating displays; a Main processor for file I/O, field calculations, and other support functions. Hardware features include: a programmable asynchronous interface (75 - 19.2K baud), 67 key programmable alphanumeric keyboard, rapid refresh display (40/second), a random deflection 21-inch CRT, and complementary software. The Pertec disk drive supplies 10 Mbytes of mass rapid access memory. In addition, the PDS-4/L is utilized as a word processor with text output sent to a Xerox 1750 printer.

2.1.5.4 VT-100T Video Terminal (TEMPEST Approved)

DEC's VT-100-T is a TEMPEST modified version of the VT-100 video terminal and includes most functions of the VT-100 including identical internal electronics. Features include double width/size characters, up to 132 columns per line, detachable keyboard, smooth scrolling, split screen, and power-up self test diagnostics.

An internal terminal controller manages all displays and communications utilizing an Intel 8080 microprocessor. Functional components of the terminal controller include a video processor for data to video conversions, 3.072K bytes of RAM for screen data storage and a micro scratch memory. Micro instructions are stored in 8.192K bytes of ROM and user alterable features such as tabs, baud rate, type of cursor, reverse video, etc. are stored in nonvolatile RAM (NVR). Communication with a host processor via a UART (75-19.2K bps) in full duplex mode. An advanced video option board expands the CRT display from 14 to 24 lines and also extends character attributes.

To meet the TEMPEST requirements for electromagnetic emanations suppression from data transmission lines, the VT-100-T utilizes the EIA to fiber optics adaptor. Fiber optic transmission lines do not generate any electromagnetic fields and are therefore free of any electromagnetic emanations. This terminal is interfaced to the PDP-11/70 through a DZ11-T 8-line asynchronous multiplexer where the multiplexer inputs have been modified to accept fiber optic inputs. The Mil STD 188C interface is also available in addition to the fiber optics interface and also meets TEMPEST requirements.

2.1.5.5 Summagraphics ID Data Tablet/Digitizer

The Summagraphics Intelligent Digitizer will input graphics materials such as maps, diagrams, patterns, etc., in the form of binary or BCD code to a computer or data storage/retrieval device. Input to the host device such as disk, magtape, paper tape, or card punch is via a special interface or DL11-E interface with appropriate software.

Microprocessor control (Intel 8080) allows computing capability which yields high linearity and resolution (200 lines/inch) on a 17-inch square tablet. Microprocessor control implements operational features such as binary to BCD conversion, relocatable origin, output data formatting, and computational functions such as calculating volumes, areas, linear displacements, and perimeters.

A stylus incorporating a ball point tip has a built in pressure sensitive switch actuated by pressing the ball point against the tablet to begin digitizing in point or stream mode. Digitizing an image may be accomplished in point to point mode where various points are input, or in stream mode for continuous line input at 100 conversions per second maximum.

2.1.5.6 Beehive International B500 Video Terminal

The B500 video terminal is a self-contained programmable display device incorporating an Intel 8080A microprocessor, a two page (4K byte) display memory, and an expandable program memory. Operation may be in local text editing mode, or on-line mode over a RS-232C serial interface at speeds up to 19.2K bps.

Two basic units comprise the terminal system; a detachable keyboard assembly and a CRT monitor assembly. Other features include: 5x7 dot matrix characters at 25 lines x 80 characters, scroll up and down within a two page display memory (40 total lines in local mode) addressable cursor, keystroke programming, and composite video output.

2.1.5.7 Genisco CGT-3000 Graphics Display Generator

The CGT-3000 is a host driven programmable computer graphic raster scan display system. Basic system configuration consists of a 16-bit parallel DMA interface from the CGT-3000 to the PDP-11/70. Data and instructions are passed from the host to a programmable graphics processor that processes the information into a useable display and writes this information to the memory refresh planes. A video controller and monitor controller translate the information stored in the refresh memory planes into a video signal suitable to drive a CRT.

2.1.5.8 Conrac SNA/17 B&W Video Monitor

The Conrac SAN/17 is a 17-inch diagonal, monochrome, solid state monitor designed for continuous operation at a minimum of 800 TV lines center resolution, and is capable of displaying standard 625 horizontal scan lines. This unit may be operated either from a composite video and sync line or from separate video and mixed sync lines. A loop-through feature allows monitor chaining. Two Conrac monitors are available; applications include slave monitors driven by CRT terminals.

2.1.5.9 LA-34 Decwriter IV

The LA-34 is a microprocessor driven hardcopy table top terminal capable of output at 30 characters/second. The printing mechanism features a 7x9 dot matrix impct print head and is capable of printing on plain tractor fed paper or preprinted forms in rolls or fanfolds. A non-detachable typewriter style keyboard contains the full ASCII upper/lower case character set.

Other features include variable vertical pitch (lines per inch), and variable horizontal pitch (characters per inch). Communications with host CPU are full duplex serial asynchronous transmission format utilizing an EIA RS232-C or 20mA current loop interface.

2.1.5.10 Chromatics CGC-7900

The CGC-7900 is a color graphics terminal capable of displaying graphics sent from a host CPU or graphics that have been interactively created in stand alone mode and internally stored. Graphic displays are easily created in a stand alone interactive mode and stored on either a 10 Mbyte Winchester disk or on two double density floppy disk drives.

All graphics creating functions translate into a string of ASCII characters which are stored on disk media. The ASCII command string may be recalled and executed which results in the redrawing of the stored display. This method of storing only graphics command strings enable more displays to reside on a given storage medium rather than attempting to store an entire bit map display.

System features include a 16-bit microprocessor (Motorola MC68000) CPU, 10 Mbyte Winchester disk drive, dual double density floppy disks, and a high resolution raster scan 19-inch color CRT having 1024x768 viewable pixels at a 60 Hz refresh rate. Also included is a 151 key keyboard having the full ASCII character set, 24 programmable function key strokes, and eight programmable bezel keys located below the CRT face.

The MC68000 CPU executes all functions necessary for an operational system with the aid of the keyboard support processor. Upon keyboard input, the CPU will execute the proper instructions to draw a display into one or the other group of memory bit planes. Two complete graphic displays can be stored in two separate and complete groups of memory bit planes, with both groups alternately viewable.

Each display memory bit plane contains 1024x1024 addressable bits. If one group of bit planes is configured to the maximum of eight planes per group, one of 256 predetermined colors are displayable at each of the 1024x768 viewable CRT pixels. The CPU implements hardware pan and zoom that allows display of pixel information contained in bit map lines 769 to 1023, i.e., almost half of the display is not presented to the CRT at any given time. One bit plane can serve as an overlay which allows specific parts of a display to be masked or enhanced. Overlay capabilities include overlay on/off, alphanumerics of selectable size, shape, color, and variable angle character base line (charcters displayable at any angle diagonally across the CRT. A software/hardware modifiable video look up table is 24-bits wide at 8-bits per primary color. Each primary has 256 intensities allowing for a diverse color palette, from which 256 colors are selected.

Currently available software for the CGC-7900 is a disk operating system (DOS 1.6), IDRIS operating system, C, Pascal, and FORTRAN compilers. Also included are system hardware diagnostics on floppy disk media. In the near future, DOS 1.6A will be released which improves hard disk file access.

CGC 7900 Hardware/Software Configuration

Model 2	16 bit Processor, 19" CRT, Keyboard, eight color overlay, 128K RPM, 32K EPROM, 4 Refresh Memory Planes.
	128K Memory Module 512KB Memory Module.
7922-01	4K CMOS RAM and Real Time Clock.
7940/1-01	Dual Floppies, controller, and 10MB hard disk.
7970/1/2-01	Extended Plotting Software, Complex Fill, Faster Processing Options.
7980/2-01	Joystick and Light Pen.
796X-01	MC68000 Assembler and Text Editor (DOS); Pascal, FORTRAN, and C (IDRIS).

2.1.6 Hardware Controllers/Interface Devices

The PDP-11/70 supports two types of communications controllers. The RH70 Massbus controller interfaces high-speed peripherals such as disk and magtape. There are also slower Unibus DMA interfaces for peripherals such as floppy disks and host driven graphics generators. The PDP-11/70 supports up to four RH-70 Massbus controllers or similar high performance controllers.

An interface serves as the communications link between the computer and other devices. Interfaces serve to translate signals sent from one device into signals that the receiving device can interpret. Most interfaces serve to electrically link I/O terminals to the computer.

Each channel may be separately configured for data format and transfer rates of up to 9600 bps in full duplex mode. The terminal handler software polls each data channel and responds on a first come first served basis. Each DZ11 may be expanded to 16 channels by adding channels in groups of eight.

2.2 SYSTEM SOFTWARE DESCRIPTIONS

The baseline system software consists of commercial DEC operating systems and compilers, DI 3000 (a CORE Standard Graphics Processing System), the GRAPHELP graphics system (Harry Diamond Laboratories), Imlac and Sperry Univac Utilities. The baseline system software modules consist of:

- Interactive Applications System (IAS) Version 3.0.
- Data Base Management System (DBMS-11)
- DECnet-11
- COBOL-11
- FORTRAN IV PLUS
- DI 3000
- GRAPHELP
- IMLAC PDS-4 MODULES
- UNIVAC MICRO CODE

These software modules and documentation will be transported with the ADP equipment and installed in the ISL. The following sections provide a brief description of the system software capabilities.

2.2.1 Interactive Applications System (IAS)

IAS is DEC's general purpose operating system implemented on the PDP-11/70 processor. It is a multi-user timesharing system that supports concurrent interactive, real time, and batch applications. The System to be delivered to the ISL has IAS Version 3.0 generated as a timesharing system; the other operating system modes (Real-time and Multi-user) could be generated if required.

IAS can provide timesharing services for up to 32 simultaneous users and supports a variety of peripheral devices. The timesharing user/system interface is the Program Development System (PDS) which requests and processes passwords and user names to validate the users identity. PDS allows the user to create, edit, and execute user programs and data files. In addition, PDS allows interaction with some system peripherals and utilities.

The interactive applications facility is easily modified and additional applications can be added. As a generalized, flexible base for executing interactive applications, IAS provides support for application specific user/system interfaces where it is necessary to present a custom interface to terminal users. The special purpose interfaces can be written and checked using PDS and then installed in the system for use on specific terminals.

Tabulated below are the system features supported by the different operating modes.

	Real-Time	Multi-User	Timesharing
Priority Schedule	X	X	X
Heuristic Scheduler		X	X
General Purpose Timesharing			X
Volume Protection			X
Program and Data Protection			X
User Written CMD Language Interpreter			X
Concurrent Real-time, Multi-user Program Development		X	X
Program Development System (PDS) With System Control Interface (SCI)		X	X
Monitor Console Routine (MCR)	X	X	X
Print Spooling	X	X	X
Reentrant Code	X	X	X
Sharable Data Areas	X	X	X
Utilities	X	X	X
Multitasking	X	X	X

IAS was built from RSX-11D operating system with Version 3.0 enhancements in terms of flexibility and functionality over the predecessors IAS Version 2.0 and RSX-11D. The significant major features are:

- Enhancement to the IAS/RSX-11D Executive. The ability to include the IAS heuristic timesharing scheduler into the Executive is supported.
- Addition of subtasking support at the Kernel Executive level via the SPAWN system directive.
- Support for full complement of memory management directives (including dynamic creation, attach, and deletion of regions and inter-task transmission of region access).
- A new, easier system generation procedure which utilizes a question and answer dialogue for selection of major options.

2.2.1.1 User/System Interfaces

IAS supports the CDL (PDS) and MCR command syntax with almost every MCR command having a PDS analog. Real-time systems usually implement MCR as the user/system interface while multi-user systems utilize MCR or PDX. PDX is a special version of PDS; MCR is usually preferable to PDX due to space requirements for PDX. MCR has been changed to take advantage of the task spawning feature along with additional commands that have been added to enable users to access the new system features. The MCR indirect file processor allows the creation and use of interactive command files.

Full timesharing systems implement PDS and MCR "mode." A PDS user terminal supports the MCR mode which was included for those users more familiar with MCR commands than PDS commands. However, the MCR mode does not have all the capabilities of a true MCR user/system interface.

The MCR interface is present on the system console after the computer is bootstrapped. Timesharing is then set in operation by executing an indirect IAS command file that installs the timesharing facility. The system console is automatically renamed the SCITERMINAL and the SCI interface prompt is presented to the user. SCI commands are privileged operator commands used to manipulate/control the operating system. The SCI task runs at priority

220 (priority 250 being the highest) which allows the operator to intervene in lower priority user tasks when necessary. For example, the operator can abort a looped program via the SCITERMINAL. SCI recognizes the full set of PDS commands and also supports the MCR mode interface.

2.2.1.2 System Generation

System generation procedures for IAS Version 3 are easier than previous versions of IAS/RSX-11D. A question and answer dialogue prompts the user for inclusion of major options. The terminal handler building procedures and device configuration procedures have also been simplified. An indirect command file is provided for the building sequence.

2.2.2 Data Base Management System (DBMS-11)

DBMS-11 is an implementation of the CODASYL data base language specification. The DBMS provides data control and manipulation functions for application programs. The application programs can be written in COBOL, FORTRAN, or other languages using the CALL statement.

DBMS supports network and hierarchical type data structures and permits structure definition suitable to the applications. It also provides a separate language facility, Data Description Language (DDL), for description of the complete data base or portion of the data base. For a detailed discussion of the DBMS concept, refer to the Data Base Administrator's Guide.

2.2.3 DECnet-11

DECnet is a software package that extends the IAS operating system to form computer networks. The DECnet facilities provide for program sharing and intertask communication. Peripheral devices from a remote system may be connected to a host computer system and used via DECnet. The files from the remote system may be shared or new files opened for storage.

An executable program module may be transferred to a remote system for execution (down-line loading or specific tasks). Intertask communication is allowed between two tasks, either locally or remotely.

2.2.4 COBOL Compiler

The COBOL compiler translates ANS-74 COBOL source into relocatable object modules. The compiler runs under the supervision of the IAS operating system and conforms to all connections and restrictions of IAS. To run a COBOL program, a five step process is required:

- Prepare the source program.
- Compile the source program.
- Merge or prepare an overlay description file (optional).
- Task-build the object modules into an executable task.
- Execute the task.

For a detailed description of COBOL use, refer to the COBOL User's Guide.

2.2.5 FORTRAN Compiler

The FORTRAN-IV Plus compiler is supported at the TOAS; however, FORTRAN-IV with virtual data arrays can be installed if required. For a detailed description of compiler use, compiler diagnostic messages, and the run time diagnostic messages, refer to the FORTRAN-IV Plus User's Guide. For a more detailed description of specialized applications, an Object Time System Reference Manual is provided by the Facility.

2.2.6 DI-3000

DI-3000 is a graphics software package, commercially available from Precision Visuals, Inc., and purchased for the TOAS Facility. However, due to the Facility move schedule, DI3000 was not installed at the Facility at LAFB. Users of the ISL will have this tool available for experiments. Several device drivers were purchased with the system package (including one to support the CGC-7900).

DI-3000 has been implemented in 1966 ANSI FORTRAN as a library of FORTRAN callable subroutines. The design of DI-3000 is based upon the fundamental premise that computer graphics programs should be device independent. Through true device independence, an applications program will produce similar or even identical images on several different graphics devices. To achieve device independence, DI-3000 targets all graphics output commands and input requests to a virtual graphics device. A device driver is then used to translate virtual graphics device commands into device dependent commands. A device driver is a library of subroutines that interpret the device independent commands generated by the device independent routines, and converts these commands into the device dependent instructions required to drive specific graphics devices.

Some outstanding features of the DI-3000 graphics software package include:

- An application program may reference one or more virtual graphics devices. At run time there will be a one-to-one correspondence between the active virtual graphics devices and the active device drivers.
- For each physical display device there is a corresponding device driver. The device driver translates device independent commands into device dependent instructions. The device driver will always try to implement commands through the device's hardware or firmware first. If not possible, it will try to simulate it using software. If this fails, the command will be ignored.
- DI-3000 was modeled after a proposed graphics standard; therefore, it utilizes a world coordinate system which can be either two dimensional or three dimensional. This world coordinate system is used to define the orientation of primitives (e.g., moves, lines, characters, special symbols).
- Application programs define the mapping from a window in the world coordinate system to a viewport in the virtual coordinate system. This mapping is called a viewing transformation.
- Facilities are provided for applications programs to perform scaling, rotation, translation, and shearing.
- The DI-3000 metafile is a sequential file of pictures generated by a DI-3000 program. The metafile is in essence a "picture audit trail." Whenever a new picture is created, it will be written to device 0 (the metafile) simultaneously with being written to the user selected graphics device. By using the metafile translator, these pictures may be positioned, scaled, and superimposed on a selected graphics device.

The attributes for non-text primitives include:

- Color
- Intensity
- Linestyle (e.g., solid, dashed, or dotted)
- Pen (represents a composition of color, intensity, linestyle, and linewidth)
- Polygon Edge Style
- Polygon Interior Style
- Polygon Interior color and Intensity
- Marker Symbol (index number of symbol to be displayed)

DI-3000 also provides a set of attributes for text. These are:

- Character Path - determines the direction of the text
- Character Font - defines the typeface (e.g., simplex,complex, or italics)
- Character Justification (e.g., left, center, or right)
- Character Size
- Character Gap - determines intercharacter spacing
- Character Base - defines the orientation of the baseline of a string of characters in the world coordinate system.
- Character Plane - defines a plane in the world coordinate system in which characters will lie.

2.2.7 GRAPHELP

GRAPHELP is an interactive graphics FORTRAN-IV software package that runs on a PDP-11 commputer system. The GRAPHELP PACKAGE SUPPORTS all Tektronix 401X Graphic storage Tube Terminals and the Imlac PDS-4/L Refresh Graphics Display System. The software provides both absolute and relative vectors of four varying line textures, user definable scaling, windowing, clipping, terminal transparency, and 128 nested subpicture display files for refresh graphics. Routines are provided for interactive graphics crosshair input and screen erase control. The applications are oriented towards data plotting for both linear and logarithmic data, along with alphabetic and numeric symbol output. This software will be superceded by DI-3000.

2.2.8 Imlac Software

The Imlac PDS-4/L terminal system provides the user with powerful utility programs, editor, disk operation system, assembler, compiler, interface systems, emulator, and diagnostics that are used in the stand-alone mode. These software packages were delivered as part of the PDS-4/L system.

- Disk Operating System (DOS-4)
- System Editor (DFED)
- Program Assembler (Compiler) and Linker
- Editor Graphics (ED80)
- Compiler
- Tektronix Emulator

2.2.9 Univac Micro-Code

The SU 1652 Micro-code, supplied by the Univac Corporation, has been converted to Files 11 format and stored on the TOAS time sharing disk at UIC 210,11. The micro-code for the terminal maintenance has been modified to allow it to be assembled on the PDP-11.

In addition to the maintenance micro-code, the Program Load Module (PLM) contains a number of different micro-code packages that can be down loaded using the PLM routines.

2.1.6.3 DL11-E Asynchronous Line Interface

The DL11-E is an asynchronous serial line character-buffered data communications interface designed to assemble or disassemble the serial bit stream required by data terminal I/O devices. Parallel character data can be disassembled sent serially to be reassembled at the receiving terminal and vice versa.

The unit consists of a single quad module that can be mounted in either a Small Peripheral Controller (SPC) slot or in one of the DD11-DK Peripheral Mounting Panel slots.

2.1.6.4 DMC11 Network Microprocessor

The DMC11 network is a high performance interconnection that links two Unibus computers for intercommunications between processors. Communications between computers is accomplished by a DMC-AR/AL microprocessor module that processes and executes commands sent from the local processor to remote processor, or from the remote processor to the local processor. A DMC-AR/AL microprocessor module is required in each processor in the communications network. DMC11 communications format utilizes the DDCMP protocol. The DMC11 software is completely isolated from the host processor software with software communications implemented through hardware status and control registers.

Data transmission is locally implemented via coaxial or triaxial cable in half or full duplex mode. Local processor to processor data transfer rates are available at 56K-bits/second. Remote data communications can be implemented by synchronous modems and common carrier facilities, with transfer rates at 19.2K-bits/second (CCITT V.35/DDS compatible).

2.1.6.5 DZ11-T 8-Line Asynchronous Multiplexer

The DZ11-T is an 8-line asynchronous multiplexer supporting an interface that translates fiber optic input signal to the RS232C protocol. This fiber optics to EIA RS232C translation is necessary to support the fiber optic outputs from the VT-100-T video terminal. The DZ11 meets the electromagnetic emanations suppression requirements of TEMPEST.

2.1.6.1 RH-70 Massbus Controller

The RH-70 is the Massbus I/O controller interfaced to Cache memory for data transfers and the Unibus for control signal transfer. Major functions of the RH-70 include: communications with Main memory via Cache in order to store and fetch large amounts of data; communications with the CPU via the Unibus to receive commands, provide error and status information, and to generate interrupts; and interface with one to eight compatible mass storage disk drives via the Massbus.

2.1.6.2 BR-1566 Controller/Multiplexer

The BR-1566 is a high-speed Massbus interface similar to the RH-70 and occupies the RH-70 #C slots in computer system A. This device is used in conjunction with the BR-1569 Communications Control Unit (CCU). The CCU is a 32 channel I/O multiplexer designed to interface a variety of local serial and remote peripherals to the PDP-11/70 via the BR-1566. The BR-1566 can interface up to four BR-1569 CCUs.

The TOAS Facility supports a BR Controller/Multiplexer on computer System A. The BR-1569 supports the necessary hardware to realize eight active channels designated as BM channels. The BM software channels are numbered BM0: through BM7: while the actual hardware channels are numbered J1 through J8. The BM handler is the software routine utilizing the SU CRC protocol that services BM channels one, three, five, and seven while the TYCRT handler services BM channels two, four, six, and eight.

Available protocols on the 8 active channels are given below.

Channel	Protocol	Baud Rate
J1-BM:0	SU-CRC	9600
J2-BM:1	Interactive TTY	9600
J3-BM:2	SU-CRC	9600
J4-BM:3	Interactive TTY	9600
J5-BM:4	SU-CRC	9600
J6-BM:5	Interactive TTY	9600
J7-BM:6	SU-CRC	9600
J8-BM:7	Interactive TTY	1200

3. IIPL CANDIDATE TOOLS

The IIPL concept emphasizes flexibility in the hardware and software tools presented to the investigator. In order to enhance current capabilities, the following hardware and software should be considered for inclusion in the laboratory environment. Of special note is the Local Area Network (LAN) implementation with Bus Interface Units BIUs.

3.1 HARDWARE

The current mainframe and peripheral equipment should be upgraded to a more advanced technology. Proof of principal and concept demonstrations using the PDP 11/70 architecture will have little impressions on a user who routinely uses more advanced equipment (e.g., a VAX).

For minimum cost DEC will replace the current hardware CPU with VAX hardware and software. This alternative is strongly recommended as soon as possible.

The following paragraphs provide a brief description of three hardware tools suggested for inclusion in the ISL.

3.1.1 The DEC VAX

VAX is an acronym for Virtual Address Extension and is characteristic of Digital Equipment Corporation's (DEC) family of 32 bit mini-computers. DEC currently manufactures the following VAX models:

- 11/730
- 11/750
- 11/780
- 11/782

The VAX 11/730 the least expensive and powerful member of the group incorporates bit-slice and Programmed Array Logic (PAL) technology. Primarily used to support a small section or project, the 11/730 is also used to interconnect to DECnet to access a more powerful CPU. The 11/730 does not support the MASSBUS options.

The mid-range (price and performance) device is the VAX 11/750. Incorporating custom bipolar LSI Schottky logic, this system can support UNIBUS and MASSBUS peripherals.

The VAX 11/780 and 11/782 are the top end systems in the VAX family and provide high speed performance in processing and I/O transfers. The 11/782 consists of two CPUs interconnected via shared memory. The 11/782 is used to support computation-intensive applications.

All VAX hardware is compatible with the VMS operating system. VMS and the VAX hardware architecture combine to provide users a 4GB address space. This "virtual" memory is provided via memory mapping hardware; the actual (physical) memory size is limited to 8MB.

The VAX family is more advanced than the current ISL equipment and should be upgraded as soon as possible. Upgrade to the VAX via another computer type will help migration problems associated with PDP 11 software and keep RADC compatible with other Intelligence areas.

3.1.2 Intelligent Data Base Machine (IDM-500)

Currently the trend in data processing is to segment specialized ADP functions into hardware/firmware "machines." Smart terminals, I/O controllers, and unique peripheral processors are examples of this process. Briton Lee, Inc., has implemented a relational data base management type of system in their IDM series (200 & 500) processors. These devices off-load data base I/O processing to maximize total system performance.

3.1.2.1 IDM 500 Hardware Description

The basic IDM is a rack mounted device (17.5" high, 19" wide, and 24.75" deep, weight 170 lbs) with the following capabilities:

- Data Base Processor
- Storage Module Device (SMD) Disk Controller (support up to 4 SMD Disks with a total of 8 billion bytes)
- Parallel/Serial I/O
- Memory (up to 3 megabytes)

Options include:

- Data Base Accelerator (improves performance by a factor of 10)
- Expanded I/O capability: 64 serial or 8 GPIB lines
- Additional disk controllers: 4 total (maximum of 16 disks)

3.1.2.2 IDM-500 DBMS Description

The IDM-500 provides the user with a Relational DBMS capability. The IDM can manage up to 50 different data bases (each of which can contain up to 32K relations); relation size is limited to 250 different attributes (fields); tuples are limited to 2K bytes in length. As are the primary characteristics of relational DBMS, the IDM-500 provides the user and applications programmer with data structure/storage independence.

3.1.2.2.1 Overall Capabilities

In order to easily interact with the IDM-500, the following basic data base commands are provided:

- Create (Destroy) a Data base
- Create (Destroy) a Relation
- Retrieve Data
- Change Data
- Add (Delete) a Tuple
- Create (Destroy) an Index

Other DBMS management functions/utilities include:

- Logging
- Load and Dump Utility
- Data base Protection
- Data base "views"
- Multiple thread data base and system control
- Stored query for process optimization

3.1.2.2.2 DBMS Commands and Capabilities

- Create Data base - this command sets up the physical data base characteristics

- Open Data base - allows access by users to a data base
- Create Relation - creates the format for the relation/table defines data type and size
- Retrieve Into - allows data to be put into the data base relation
- Range - defines limits for a data search
- Retrieve - display data
- Create Index - data is sorted on a "key" and that "key" is stored
- Create View - allows access to only a portion of the data base
- Change Data Commands

  Replace - values in data base are changed

  Delete - tuples are deleted

  Destroy - relation is removed
- Protection Commands

  Deny - locks out unauthorized users from the relation

  Permit - gives user access to a relation
- Dump disk device - allows saving of entire data base efficiently
- Load disk - converse of dump disk
- Dump/load Data base - allows selective saving and loading of logical data bases
- Dump transaction Log - saves the transaction accounting data
- Rollforward - based on the transaction; data base is restored to a certain point in time
- Create/destroy File - creates/destroys a file
- Open/close File - access to file is granted/released
- Read/write File - allow direct read/write access

3.1.2.3 User Interface

The IDM-500 system is complete unto itself; however, the user must supply the interface between the host computer and the IDM hardware. This interface can be further broken down into two parts: a user command language and a hardware device driver.

The interface functions to be developed include:

- Provide user/terminal interface language
- Transmit user commands to the IDM (device driver function)
- Receive IDM processed data and pass to user
- Format data for display to user

3.2 SOFTWARE

This section provides a description of candidate software for immediate use in the ISL. These three systems were chosen due to their flexibility and responsiveness to provide a fast prototyping capability. ORACLE, a relational DBMS, is operational/planned for several IDHS sites and provides the ISL with an efficient DBMS. The other two system prototyping tools to support man machine interface concept development and demonstration.

3.2.1 ORACLE

The relational data base model implemented by ORACLE is well suited for use in R&D test beds due to the increased speed (query dependent) and versatility over more traditional data base models. ORACLE is capable of searching large tables of data at very rapid rates. Search times can be favorably reduced by carefully building tables and selecting indexed fields.

ORACLE can be called from applications programs or can be used interactively to support ad hoc queries. This flexibility, when combined with large amounts of intelligence data, provides a solution to data management problems. ORACLE provides all of the features necessary for data security and data recovery. If a data base is defined as secure, that data base's dictionary contains information about the users of the data base in addition to a description of data stored within the data base. This allows ORACLE to control access to the data base by a user on an access privilege basis.

- DEFINE USER - The creator of a secure data base can authorize additional users by means of this command.
- User Name and Password - A secure data base requires an authorized user to supply his predefined User Name and his Password.

- GRANT Privilege - This command allows users to control access to their data by other users. Once granted, these privileges may be rescinded by using the REVOKE command.

Data recovery is almost as important as data security; therefore, ORACLE provides a complete journaling utility. The following journal (JNL) commands are available:

- JNL START - starts the ORACLE journal (if journaling is to be used, this should be part of the start up procedure).
- JNL STOP - stops the ORACLE journal.
- JNL DBSTART - starts journal activity for a particular data base. Once this command is given, journal activity will begin in future sessions unless specifically instructed to stop (see JNL DBSTOP).
- JNL DBSTOP - stops journal activity until restarted.
- JNL APPLY - used to recover a data base by applying the journal to the last saved copy of the data base.
- JNL STATUS - used to display the journal activity within the ORACLE environment.

The only data base not journaled is the ORACLE system data base. If a failure occurs on it, the Data base File Utility (DBF) must be used to recreate the system data base and enter the user data bases. Journaling is an absolute necessity in maintaining data integrity.

3.2.2 Prototyping Tools

The ISL concept is to provide an ADP hardware/software environment to experiment with and apply advanced technology to support the intelligence mission. Prototyping software tools and the required hardware testbed will allow rapid prototyping of individual modules on entire intelligence systems for concept validation, refinement, or demonstration. This section outlines two systems specifically tailored to the C^3 function.

3.2.2.1 General Purpose Interactive Display System (GIDS)

GIDS is an IR&D project sponsored by TRW Defense & Space Systems Group. GIDS was developed to provide a device independent graphics system. This goal is accomplished by using hardware dependent display drivers and a universal display language.

The design concepts of GIDS are firmly based on accepted programming techniques. Since graphics display technology is rapidly changing, the need to write transportable applications software is emphasized. By using a universal display language and display drivers, applications software can be transported from one hardware system to another without modification. Thus "throw away" software is kept to a minimum. GIDS is an exceptionally flexible man-machine interface (MMI) evaluation tool. GIDS can be used on the IMLAC, the Ramtek 9400, and Chromatics CGC 7900 display devices.

The GIDS Executive was designed to support he addition of new functional capabilities with minimal impact on overall system operations. The GIDS architecture provides for functional expansion on three levels:

- The development of additional device drivers for adding new display devices to the system.
- The development of additional functional display elements.
- The development of special user oriented man-machine interface modules.

The GIDS system consists of six display processors. The six are:

- Briefing Processor - used to display flow, network, or any symbol oriented diagrams using standard flow charting symbols.
- Graph Plotting Processor - used to display statistical data in pictorial form.
- Geographic Processor - used to:
  - Display charts showing land masses and political boundaries
  - Display platform movement histories
  - Display platform location characteristics
  - Display tactical situations
  - Calculate distances, travel times, and routes
- Geographic Overlay Processor - used to:
  - Develop command and control scenarios and simulations
  - Display platform movement histories and the current location of platforms of interest
  - Perform intelligence gathering functions
  - Display tactical/potential combatant situations.

- Analysis Processor - used to perform calculations on user supplied information, i.e., "What is the travel time, course, and distance between two points on the Earth's surface?"
- Status Processor - used to display the contents of a file and to create one or more lines of text.

3.2.2.2 FLAIR

FLAIR (Functional Language Articulated Interactive Resource) is a voice/menu-driven design language developed and implemented by TRW. Using a variety of input devices (such as graphics tablet for cursor control, light pen, trackball, keyboard for text entries, and voice recognition for commands) FLAIR controls a hierarch of user command menus to build displays and display scenarios. FLAIR capabilities are described in Table 3-1.

HIGH LEVEL FEATURES

- Allows user to define and control a menu hierarchy of his own design in his operator's dialog.
- Provides access to a worldwide geographic database. A geographic outline on the area can be displayed with progressive levels of detail.
- Generates full-color, dynamic bar and pie charts.
- Contructs new symbols from stored building blocks.
- Computes arithmetic expressions using a built-in, voice-actuated calculator that includes six registers.
- Accesses the relational data base for symbol attributes and data retrievals.
- Generates a grid system for precise cursor positioning for lines, charts, and characters.
- Accesses the voice synthesizer unit.

GRAPHIC OBJECT MANIPULATIONS AND PRIMITIVES

- Draws lines, boxes or circles
- Writes text in stroke or hardware character sets in any size or orientation.
- Selects colors
- Fills any selected enclosed area with a color
- Pans and zooms the screen.
- Displays and reads pixel images from the color monitors.
- Displays predefined symbols.
- Erases display.
- Draws lines as input by free-hand.

Table 3.1 FLAIR CAPABILITIES

In addition to the capabilities outlined in Table 3.1, FLAIR contains a number of features, conventions, and utilities as follows:

- A "save" mode that enables the operator to construct a dynamic scenario that includes all FLAIR commands and indicator inputs, stored in that operator's own file. The scenario can be played back by a "display file" command.
- Provision for the operator to define and use menu-based hierarchies, with the capability to transfer control, change hierarchy levels, and exit.
- A set of self-contained, self-prompting utilities that enable th user to use the language in a standalone mode or create programs from the subroutines developed for FLAIR.
- Default options for all graphical attributes, so that the user need not define them unless he wishes to.
- A menu to access 30 basic symbols, plus an additional 120 symbols available through an off-line process.
- Binding of any symbol to a string of text in the data base; when the symbol is picked on the primary display window, the string of text is displayed in the message area.
- A set of three utilities for use with the voice recognition module to aid in the training process and to demonstrate the module.
- A set of image processing utilities to support FLAIR control of the RAMTEK 9400.
- A set of three routines to interface the Summagraphics Intelligent Digitizer with the RAMTEK 9400 via the VAX computer.
- Miscellaneous test and demonstration tools and utilities for the RAMTEK 9400, and the Interstate Electronics Voice Recognition units.

3.1.3 Local Area Network (LAN)

Originally developed as part of the SAFE Project, TRW is currently marketing a local area network to support large and small data transmission systems. This tree-like network structure provides flexibility to users in a multi-terminal, - CPU, and - system environment such as exists at the ISL. A secure (TEMPEST) approved version has also been developed.

The network is characterized as a low cost, high performance, reliable system. The network consists of three major components.

- The communication medium or Bus (CAT V coaxial cable and related components).
- Network interface devices called Standard Bus Interface Units (BIU).
- Network enhancements (BIU Expansions).

System capabilities include:

- Full device connectivity i.e., any device can communicate with any other device.
- Standard interface supported - RS232, DEC DRV11 and DRVII-B, IBM, IEEE - 488.
- Carrier Sense Multiple Access (CSMA) Bus access schema allows high throughput.
- Transmission speeds: 110 - 19.2KB Serial, 250KB.
- Electronic Mail.
- Computer-to-computer high speed file tranfer.
- Telephone interface for non-secure data networks.
- Multi-frequency channel expansion.

3.3 MMI Design Methodology

Military Command, control, communications and Intelligence (C^3I) Systems have increased in capability as technological advances allow more data to be collected, processed and presented to the user. Based on this data the operator makes decisions and provides further instruction to an automated system to accomplish a task. The I/O interface between this C^3I System and the operator is an important factor in the overall visibility of this system. Unfortunately, MMI design is often a neglected part of the overall system design methodology.

These are three essential elements for successful prototyping of MMI:

- Methodology for customizing/testing MMI.
- Flexible Testbed Facility (ISL).
- Rapid Prototyping Software Tool (e.g., FLAIR).

As MMI Prototyping is accomplished at the ISL, the following ideas are suggested.

3.3.1 Optimization of Human Preference Vice Hardware/Software Optimization

As technology increases computer speed and capability, the employment of redundant operations, reasonableness checking, and "help" functions may enhance human performance. The needs of the operator should be foremost in software/hardware designs philosophies.

3.3.2 MMI Characteristics

Well designed MMI will provide the following:

- Consistency - menu formats, system prompts, and error display should be consistent and should appear in the same region of the screen.
- Continuous Information - the screen should never be blank; if busy, a wait message should be displayed.
- Feedback - the status of the system should be displayed via information messages.
- HELP Function - the HELP Function should always be available to the user.

3.3.3 Techniques

- Context Switching - enabling the operator to use a function in the course of a sequence without losing his place in the sequence.
- Menu Design - menu items should be self-explanatory and items that are not valid in the context should be inhibited; it is also useful to permit selection of a menu item through a choice of devices (keyboard, joy stick, tablet, voice, etc.) default options should also be provided.
- Clutter Control- removes or reduces the number of items of low interest under the operator control.
- Edit Capability - handles cases of a single erroneous character without making the operator repeat the entire input.
- Highlighting - reverse video, blinking, or other mean to call the operator's attention to an item on the display.

- Interactive Device Selection - the operator can choose his means of interacting with the machine -- keyboard, joy stick, trackball, light pen, etc.
- Flexibility of Input - so that any entry that is both unique and meaningful will evoke the desired action; for example, the operator should not have to supply leading zeros or enter a complete keyword when an abbreviation will serve.
- Ease of Startup and Restart - requiring a minimum of operator actions to start or restart the system and a message to inform him of whether the action has been completed.
- Error Trapping - detects errors that could crash the system or entries that are outside specified limits.
- Safeguards - protects the system from access by unauthorized persons.
- Message Removal - deletes a message when no longer needed.

APPENDIX A

APPENDIX A

A. SYSTEM INDUSTRIES 9775 675M BYTE WINCHESTER DISK DRIVE EVALUATION

This section documents the evaluation and test procedures of the SI 9775 disk drive. The evaluation consisted of a benchmark test series executed on the SI drive and on a control disk drive, Digital Equipment Corporation's (DEC) RP06 200M Byte (176M Byte formatted) disk drive. Benchmark tests performed on the evaluation drive and control drive were selected to compare the following:

- Installation/integration into current PDP-11/70 hardware configuration.
- Ease of operation/maintenance.
- System through-put for tests consisting of varied amounts of disk I/O.
- A disk to magtape back-up of a full disk volume.
- Reliability.

Identical benchmarks were executed on both disk drives with the RP06 benchmark results utilized as a control baseline to which all SI9775 test results were compared.

A.1 Hardware Description

Complete hardware descriptions and installation procedures of the SI and DEC disk drives are given in 1981, and 1980 TOAS Facility annual reports to the Rome Air Development Center (RADC).

Volumous storage, speed, reliability, data integrity, and a 6000 hour mean time between failure (MTBF) were the primary factors that brought this evaluation into existence. While the RP06 is still an excellent disk drive possessing advantages such as removable recording media, the SI9775 (manufactured by Control Data Corporation - CDC) contains state-of-the-art technology that contributes to the large MTBF and small MTTR (1.5 hours) to change the head-disk assembly. Both the SI and DEC drives have extensive diagnostic programs that are run on the host CPU to aid in isolating drive hardware problems. The SI drive also contains on board hardware monitoring equipment and power-up diagnostics in addition to a controllable diagnostic panel for off-line testing.

The system diagram as connected to the A and B PDP 11/70s is given in Figure A-1. Total installation time of the dual channel option and controller installation in both systems, including site preparation, was about two days. System software changes were necessary since the SI 9400 controller emulates two large (300M byte) DEC RM03 80M byte drives. The software modifications occurred in the RM03 device handler and system utilities such as Disk Save and Compress (DSC).

A.2 Hardware Preparation

Preventive maintenance inspections were performed on each disk drive to insure the best possible performance in any hardware configuration. Several disk drive/CPU configurations were tested and documented. The drive/CPU configurations for the SI and DEC drives were the same as far as the CPU was concerned. Both drives were accessable by either CPU since both drives possessed dual port capabilities.

A.3 Operating System Preparation

The operating system configuration selected for the benchmark tests was first built on a RP06 disk pack, then transferred to a second RP06 disk pack via the DEC utility Disk Save and Compress (DSC). The operating system resident on the newly DSCed RP06 disk was then transferred via DSC to the SI9775 disk drive. To recap the action taken above, an IAS operating system and all resident user files were transferred onto the two target disk drives via the same transfer method. This transfer method (DSC) places all data in contiguous blocks and leaves the remaining unused disk space in contiguous blocks. This procedure was necessary to insure equality of the operating systems resident on the test and control drives.

The final operating system built for the evaluation was bootable from a RP06 disk but not from a SI9775 disk. A target system generation was performed on the SI9775 disk to create a hardware bootable system device so that each CPU could hardware boot from either drive.

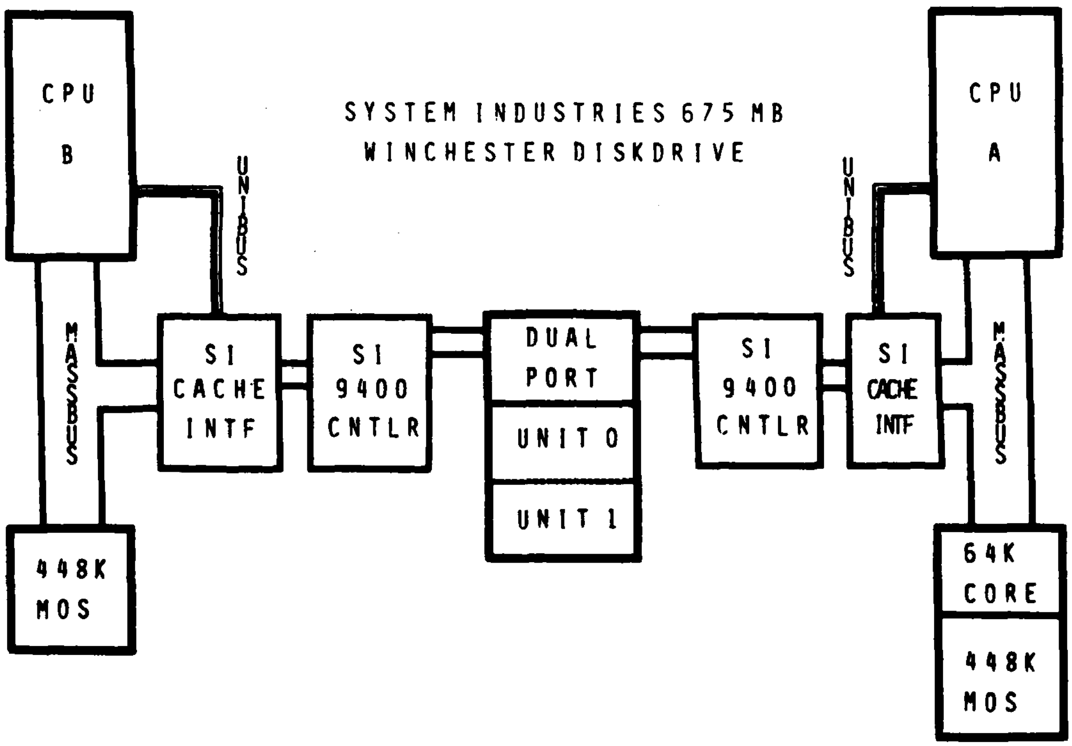


Figure A-1. SI 9775 System as Connected to the A&B PDP 11/70s

A.3.1 Operating System

Examination of the number of blocks, (512 bytes per disk block), utilized on each disk for identical operating systems revealed that the SI disk required 76 more blocks than the RP06 drive. The RP06 disk contained 242,471 occuppied disk blocks out of 340,670 useable blocks and was filled to 71.2% of total capacity. The SI9775 contained 242,547 occuppied disk blocks out of 500,384 usable blocks and was filled to 48.3% of total capacity. The 76 additional blocks occuppied on the SI drive amount to only 0.03% more occuppied blocks. This size difference was expected however since the operating system must keep track of 159,714 more blocks on the SI9775 disk than on the RP06 disk.

IAS system files sensitive to the total number of usable disk blocks are BITMAP.SYS and BADBLK.SYS. BITMAP.SYS is a file where the operating system keeps track of allocated (written) disk blocks and therefore must have a bitmap of sufficient size to describe each usable disk block whether the block is allocated or not. The RP06 requires 85 disk blocks to hold a bitmap of sufficient size while the SI9775 requires 124 disk blocks to contain a bitmap of sufficient size. BADBLK.SYS contains information pertaining to the physical addresses of defective disk blocks found by a bad blocks utility, (BAD), that writes and reads worst case data patterns on every addressable disk block. All disk media contains an inherent amount of manufacturer defects and since the SI9775 contains more disk media, a larger number of defective disk blocks are to be expected. BADBLK.SYS varies in size depending upon the number of bad blocks found. BADBLK.SYS was six blocks in size for the RP06 disk that contained 5 bad blocks, and was 46 blocks in size for the SI9775 disk that contained 12 bad blocks.

A.4 Benchmark Evaluation Procedures

Identical benchmarks were executed on both disk drives with the RP06 benchmark results utilized as a control baseline against which all SI9775 test results were compared.

All benchmarks were executed and timed via command files where each command file contained three system commands that would give the start time, system command for current benchmark test, and the end of execution time. The IAS V3.0 command language interpreter is the monitor control routine (MCR). The MCR command "TIME" was the first and last instruction in the benchmark command files, which enabled the operating system to output the time at the beginning and end of benchmark command file execution. This procedure was selected to eliminate timing errors introduced by hand-held stop watches. The difference between start and finish times was found and taken as total execution time.

A.5 Benchmark Tests

Benchmark tests were constructed to test both drives in various hardware configurations and over a wide range of I/O conditions. These I/O conditions ranged from mostly compute bound to heavily I/O bound. The six major tests constructed are given below.

1) Task build of the terminal handler "TT.TSK".

2) ORACLE database querries.

3) Purge of 2182 files in 16 user file directories (UFDs).

4) Full disk directory.

5) Partial disk directory in several hardware configurations.

6) Full disk backup to magtape.

Tests one through four are self-explanatory and some of the command files are given in Table A-1. Benchmark five is perhaps the most significant because each logical unit in the SI drive is accessed by one CPU. Eight hardware configurations were devised in order to fully test data integrity and operational reliability. The benchmark consisted of a command file designed to print a full directory of five UFDs from the SI drive only. The DEC drive is not separable into two logical units and is not applicable for comparison. However, the DEC drive is utilized in the seventh and eight configurations as the system disk with the benchmark being performed on one mounted logical unit in the SI drive.

A.6 Benchmark Test Results

As expected, the SI drive out performed the DEC drive when speed of execution times were compared. The DEC drive was not expected to perform as well because of the improved disk technology incorporated into the SI drive.

A.6.1 Results - Benchmarks One through Four

Test results for the first four benchmarks are given in Table A-1. Note that progressively more I/O commands are issued as the test numbers increase, therefore under increasing I/O conditions additonal time savings become apparent for the SI drive.

The task build of the terminal handler and the ORACLE querries exhibit less execution time improvement because both tasks are rather CPU intensive and require less I/O than the disk purge of benchmark three.

The greatest reduction of execution time was found in the I/O bound full disk direcory of benchmark four. This improvement is due to the 1.2 Mbyte transfer rate and 25 ms average access time for the SI drive as compared to the 0.806 Mbyte transfer rate and 28.5 ms average access time for the DEC drive. The SI drive average access time is 12.3% less when compared to the DEC baseline access time. An even more significant speed improvement is the 48.8% greater transfer rate of the SI drive. Higher transfer rates are accomplished on the SI drive due to a 60.7% greater inner track density. Both drives utilize the modified frequency modulation (MFM) recording technique with an inner track density of 6495 bits-per-inch on the SI drive and 4040 bits-per-inch on the DEC drive.

A.6.2 Results - Benchmark Five

Data taken during this benchmark revealed that the SI drive could operate reliably while being accessed by two CPUs (Tabel A-2). Even

```
MCR>@TEST1.CMD
>TIM
 10-MAR-82 10:16:07
>SET /UIC=[1,1]
>MAC @DR0:[311,114]TTMACNLST
>TKB @DR0:[11,114]TTTKBNMAP
>TIM
 10-MAR-82 10:27:38
>@ <EOF>
```

```
MCR>@TEST4.CMD
>TIM
 10-MAR-82 08:31:22
>PIP LP:=DB1:[*,*]*.*;*/FU
>TIM
 10-MAR-82 08:50:11
>@ <EOF>
MCR>
```

```
MCR>@TEST.DR
>TIM
 10-MAR-82 17:51:01
>PIP LP:=DR0:[1,1]*.*;*/FU
>TIM
 10-MAR-82 17:51:37
>PIP LP:=DR0:[2,1]*.*;*/FU
>TIM
 10-MAR-82 17:52:35
>PIP LP:=DR0:[100,107]*.*;*/FU
>TIM
 10-MAR-82 17:53:00
>PIP LP:=DR0:[11,114]*.*;*/FU
>TIM
 10-MAR-82 17:54:29
>PIP LP:=DR0:[1,213]*.*;*/FU
>TIM
 10-MAR-82 17:56:05
>@ <EOF>
>
MCR>
```

Figure A-2. Benchmark test command files. Test one (upper left) test four (lower left), and test five (right).

Table A-1. Results of benchmarks one thru four.

#	Benchmark Description	Execution Times		SI9775 Time Reduction
		SI9775	RP06	
1	Task build of terminal handler " TT.TSK "	691 s	716 s	3.49%
2	Oracle Querries	768 s	797 s	3.64%
3	Purge of 2182 files in 16 UFDs	431 s	458 s	5.90%
4	Full Disk Directory	1007 s	1129 s	10.81%

Table A-2. Benchmark five test results.

TEST # 1	CPU A booted from DR0: Total time: 191s	CPU A	23	36	16	55	61
TEST # 2	CPU B booted from DR0: Total time: 190s	CPU B	23	36	16	54	61
TEST # 3	Simultaneous execution CPU A booted from DR1: Total time: 274s	CPU A	40	59	27	86	51
	CPU B booted from DR0: Total time: 203s	CPU B	19	30	13	43	98
TEST # 4	Repeat of # 3 with CPU B start delayed 0.5s CPU A total time: 304s	CPU A	36	58	25	89	96
	CPU B total time: 304s	CPU B	36	58	25	89	96
TEST # 5	Simultaneous execution CPU A booted from DR0: Total time: 204s	CPU A	19	30	13	44	99
	CPU B booted from DR1: Total time: 274s	CPU B	39	61	25	88	61
TEST # 6	Repeat of # 5 with CPU A start delayed 0.5s CPU A total time: 312s	CPU A	37	60	25	90	99
	CPU B total time: 310s	CPU B	37	59	25	90	100
TEST # 7	Simultaneous execution CPU A booted from DB1: with DR0: mounted Total time: 126s	CPU A	15	26	10	35	41
	CPU B booted from DR1: Total time: 207s	CPU B	26	42	18	60	61
TEST # 8	Simultaneous execution CPU A booted from DR0: Total time: 147s	CPU A	14	24	10	33	65
	CPU B booted from DB1: with DR1: mounted Total time: 123s	CPU B	15	24	10	34	40

though the SI drive is divided into two logical units it must be remembered that a single head positioning mechanism is shared between both logical units. During dual channel operation only one CPU can ever have control over the head positioning mechanism. If one CPU is in control of the head positioning mechanism and the other CPU issues an I/O command, the command is ignored but the request is noted by arbitration logic in the drive. The requesting CPU will gain access of the head positioning mechanism after the I/O command issued by the first CPU has been completed.

Tests one and two are baseline times where the benchmark is executed on a single logical unit of the SI drive. Tests three-four, and five-six draw attention to a peculiarity in the dual channel arbitration logic. Execution times for one system are 35% longer when the command files are started simultaneously but when the commencement of one system command file execution is delayed 0.5 second the total execution times are very nearly equal. A side effect of this delay procedure was that the total execution times, though nearly equal, are still about 50% longer in the worst case.

Tests seven and eight executed in the shortest total time due to one CPU being booted from the RP06. The decreased execution time can be contributed directly to the manner in which the operating system performs output to a line printer. When a PIP command requests output to a line printer the operating system first builds a spooler file in a dedicated UFD on the system disk, then sends the contents of the spooler file to the line printer. For tests one through six the spooler file was built on the same pack as were the UFDs of which a directory was requested. In tests seven and eight the system booted from the RP06 was able to overlap disk seeks and increase throughput by reading the UFDs on one logical unit of the SI drive while building the spooler file on the RP06 system disk. Even though the CPU booted from the SI drive was still required to build a spooler file on the SI drive, as in tests one through six, execution time reduction was noted because the RP06 booted CPU was not in contention with the SI booted CPU for disk access as was the case for tests one through six. In test seven the double drive system (CPU A booted from the RP06) was 39% faster than was CPU B while booted from logical unit zero of the SI drive. In test eight CPU A was now booted solely from logical unit zero and was only 16.3% slower than the double drive system. Test eight exhibited the best configuration for maximum throughput.

A.7 Conclusions

Overall the SI 9775 Winchester Drive performed very well and outperformed the DEC RP06 except in the area of magtape backup for obvious reasons. All benchmarks executed in less time on the SI drive when compared directly with the RP06 results with time improvements ranged from 3.5% to 10%.

Individual access of each logical unit by different CPUs was an impressive feature that allows flexible system configurations. At the TOAS Facility each CPU may be operated alone and have access of up to four logical disk units (two RP06 drives at 176 Mbytes each and two logical units in the SI drive at 300 Mbytes each. A problem with this feature was discovered when a successful attempt was made to boot both CPUs from the same logical unit within the SI drive. There did not seem to be any safeguard to prohibit this situation from occurring.

COLOR TERMINAL COMPARISON

The following report describes three color graphic terminals that were considered by the government for installation at the TOAS Facility. Based on current price-capabilities comparison, the CG 7900 terminal was purchased and is part of the IIPL hardware suite. This data was previously unpublished and compares the physical and performance characteristics of a distributed graphics system (Chromatics) with a host driven system (Full -9400: Partial SU1655).

B-1 Chromatics CGC 7900

The CGC 7900 features a 16-bit CPU, 19 inch color (raster scan) CRT, two 40MB Winchester disk drives along with double density dual floppy disks, drives along with double density dual floppy disks, and high resolution color graphics incorporated into a single cabinet. The CGC 7900 is TEMPEST approved.

CGC 7900 architecture is based on a "system bus" where the CPU, memory, I/O controllers, and other system modules interface to a common bus. This allows for system expansion and up grading.

The CPU is based on the Motorola MC 68000 16-bit microprocessor. This processor executes all functions necessary to run the system. The graphic displays are based on two separate groups of refresh memory (bit maps) plane sets where the number of refresh memory planes is proportional to the number of simultaneously displayable colors (eight bit planes are required to display 256 colors). The maximum bit plane configuration is eight planes in each of the two groups. These two groups are alternately viewable. A single overlay bit map allows selected areas of a display to be masked or enhanced.

Processors	Video Display
-16-bit microprocessor	-19 inch color CRT
-Capable of 16 and 32-bit operations	-1024 x 768 viewable pixels
-24-bit address bus (16MB address range)	-Each convergence adjustment ratio)

-61 basic instructions

-Also contains a small processor resident in the 151 key keyboard

-Optional raster processor

-Over 16 million possible colors

-Complex sound generator

Memory

- 128K of RAM per buffer card of user and instruction memory (expandable)
- 32K of EPROM expandable to 64K
- Four 128K planes of bit map RAM memory (two planes per group expandable to 16 total planes - eight per group)
- 4K of static MOS or CMOS RAM
- 4K x 19-bits of overlay RAM
- 256 x 24-bits of color look-up table RAM

Bit Maps

- Maximum of 256 displayable colors
- Color selection Pallette (programmable color look-up table
- Blink between any two colors
- 12,090 character cells (76 lines at 170 characters per line)
- 1024 x 1024 resolution
- Variable character size in X and Y directions
- 96 standard ASCII character set
- Up to eight individually addressable windows

Overlay

- Eight foreground and background colors
- Bit map visible through overlay
- 4080 character cells (48 lines at 85 characters per line
- 96 standard ASCII character set
- 5 x 7 dot matrix

B-2 RAMTEK 9400

The RM 9400 Display Generator is a raster scan video display system that drives campatible monochrome and color CRT monitors. This system is cabable of single or multichannel operation and may be configured as an output peripherial or as an on-line interactive display system. The system is sold in modularized units or options (i.e., CRT monitor and keyboard can be ordered separately from basic graphics generator hardware.)

Multi-bus architecture and multi-processors enable simultaneous operation of different processing elements within the system.

Display Processor

- Directly or indicrectly controls each element of the display system
- Utilizes a Z80 microprocessor
- Contains 32K of RAM and 32K of EPROM
- General purpose interface (16-bit parallel), three serial ports
- Cycle stealing DMA and timer
- Memory map that accommodates 512K of RAM with 96K reserved for internal software control

Memory Control Processor

- Draws alphanumerics, graphics, images, etc. into refresh memory
- Performs window clipping, entity detection, pan, and zoom
- Special purpose 16-bit microprocessor with dedicated ROM, RAM, and support logic

Video Generator

- Transforms the stored images into industry compatible video signals that drive high resolution monitors
- Up to 4096 colors (one generator)
- Color, overlay, intensity, and blink accomplished by PROM coding
- Any of n displayable colors of various intensities (video generator dependent)

Refresh Memory

- MOS RAM for picture storage in dot matrix form
- Memory planes organized as one to eight planes up to 16-bits each
- Each 16-bit cell defines a single pixel on one or more CRTs

Computer Interface

- Forms a 16-bit parallel high speed data link between a host computer and the RM 9400 Display Generator
- Off-the-shelf interfaces available for most minicomputers and mainframes
- Most interfaces incorporate or utilize DMA

DMA Sequencer

- Performs high speed non-processor transfers involving multiple devices on system bus
- Controls up to 14 ports and 7 subloops

B-3 Sperry Univac SU-1655 Dual Screen Color Terminal

The 1655 is a microprogrammable terminal consisting of a micro controller, display refresh memory, instruction memory, I/O interface, and two raster scan color CRTs.

The INTEL 8080 8-bit microprocessor controls all data transfers and most functional events through direct interface of major system elements. The display refresh memory is implemented in hardware and not microprocessor dependent. This terminal meets TEMPEST requirements.

Display

- 525 line raster scan 15 inch color CRT
- Each screen has 1920 character locations (24 lines at 80 characters per line
- 5 x 7 dot matrix smoothed to 9 x 13 for better clarity

Instruction Memory

- INTEL 8080 microprocessor
- 16K to RAM
- Expandable to 32K in increments of 8K

Display Refresh Memory

- Up to 10 memory planes
- Overlay capability by priority assignment of certain memory planes
- 16K of 11-bit RAM (minimum of 32K for graphics option)
- Display Refresh Memory organized into two display pages of 2K each
- Hardware refresh (not microprocessor controlled)

Bootstrap Memory

- 512 bytes of ROM for bootstrap load and limited testing

GLOSSARY

Access	Seeking, reading, or writing data on a storage device
Access method	Techniques for locating data (e.g., serieal access, random access, remote access, virtual sequential access method (VSAM), hierarchial indexed sequential access method (HISAM)
Access time	The time that elapses between an instruction being given to access data and that data being available for use
Address	An identification (number, name, label) for a location in which data is stored
ADP	Automated Data Processing
Algorithm	A computational proedure or technique
AM	Amplitude modulation
Amplitude Modulation	Method of signal transmission in which the amplitude of the sine wave carrier signal is changed in accordance with the information to be transmitted
Analog Signal	A signal that has the form of a continuously varying physical quantity, i.e., voltage
ASCII	American Standard Code for Information Interchange - an eight leve code
ASR	Automatic Send-Receive teletypewriter machine
Assemble	To convert a routine coded in a higher level computer language into actual machine language instructions
Associative storage	Storage which is adressed by content rather than by location
Asychronous transmission	Start-stop transmission; transmission in which each information character (word or block) is individually synchronized by use of a start and stop elements
Attribute	A field containing information about an entity

Baud	Unit of signaling speed; normally the same as bits per second
Baudot	Five bit, 32 character code used by some TTY transmission systems
BCD	Binary Coded Decimal - a six bit alphanumeric code
Binary code	An electrical representation of information expressed in the base two number system
Binary search	A method for searching a sequential file/table; procedure is based on algorithm that divides data into two equal groups and determines which group contains the required data and then repeats procedure with that group
Bit	A contraction of the words "binary digit" - smallest amount of information that can be represented (normally thought of as a one or zero)
Blocking	Combining two or more records so that they are jointly read or written by one machine instruction
BPS	Bits per second
bpi	Bits per inch
BR-1566	Massbus controller used to interface the BR-1569 to the PDP-11/70
BR-1569	Communications multiplexer that supports 8-32 channels - manufactured by Bunker Ramo - part of baseline configuration
Byte	A group of data handled as a unit (commonly 8 bits is to one byte)
Cache memory	High speed memory placed between slower main memory and the processor; cache increases effective memory transfer rate
CATIS	Computer Aided Tactical Information System
chaff	Small, light scraps of paper tape
chip	The substrate on which LSI circuits are fabricated; sometimes referred to as the circuits themselves

Circular buffer	A queue that has front and rear pointers to keep track of information in a defined area
Circular file	An organization for a file of high volatility, in which new records being added replace the oldest records
CODASYL	Conference of Data Description Languages; DBMS type
Concatenate	To line together - a concatenated data set is a collection of logically connected data sets
Control character	A character whose occurrence initiates, modifies, or stops an on-going operation
CPU	Control Processing Unit
Cylinder	A concept of storage using magnetic disks - a area read without moving the arms of the disk drive
DASD	Direct Access Storage Device
Data	Numbers, text, fact, information which are represented in a formal structure so that it can be processed by computers
Data administrator	An individual with an overview of an organizations data base
Data base	A collection of interrelated data stored together to serve one or more applications
Data base management system	The collection of software required for using the data base
Data dictionary	A catalogue of all data types giving their names and structures
Data structure	Well defined format and access conventions associated with a particular class of information
Db, db	Decibel
DBCS	Data Base Control System
DBMS	Data Base Management System
DCL	DEC Command Language

DCL	Device Control Logic
DEC	Digital Equipment Corporation
Decibel	A unit for measuring relative strength of a signal parameter such as power, voltage, etc.
DEC/X-11	A configurable system exerciser diagnostic program in the MAINDEC-11 diagnostic package
DDL	Data Definition Language
Demodulation	The process of retrieving data from a modulated carrier signal - the opposite of modulation
Diagnostic	A program that tests logic and reports any faults it detects
Direct access	Retrieval or storage of data by a reference to its location on a volume, rather than relative to the previously retrieved or stored data
DL 11E	Single line asychronous interface manufactured by DEC
DMA	Direct Memory Access
DPU	Display Processing Unit
DVM	Digital Volt Meter
EBCDIC	Extended Binal Coded Decimal Interchange Code; an eight bit alpha-numeric code
ECC	Error Correction Code
EDP	Electronic Data Processing
EIA	Electronics Industry Association
EIA Interface	A standard set of signal characteristics (time duration, voltage, and current) specified by the Electronic Industries Association
Error-correcting code	A code having a sufficient number of signal elements to allow error detecting and/or correcting at the receiving station

Even parit;	A check (or count) of a block of data to insure that an even number of bits are contained in the block
Fatal Error	An error in a system or program that inhibits any further system operation or program execution
FDM	Frequency Division Multiplex
FDX	Full Duplex
Fiber Optics Waveguides	Filaments of glass through which a light is transmitted for long distances by means of internal reflections
Field	A set of contiguous bytes in a record
I/O	Input/Output - refers to computer generated information displays and input
I/O channel	An equipment that forms part of the input/output system
ips	Inches per second
KSR	Keyboard Send Receive teletype machine
LA-36	30 characters per second dot matrix printer commonly used as a console device
Label	A set of symbols used to identify an item, record, message or file
LED	Light Emitting Diode
Link	The process of connecting object modules into a contiguous executable task
List	An ordered set of data items, a chain
Logical	Data organization, hardware, or system that is perceived by the applications programmer, different from real (physical) form
Longitudinal redundancy check	A method of checking the reliability of a block of data
LRC	Longitudinal Redundancy Check

LSI	Large Scale Integration; method of placing many electronic circuits on one small chip
MAINDEC-11	A system diagnostic package containing the XXDP monitor and system component diagnostics
MASSBUS	36 bit wide data path between the CPU, memory and high speed peripherals
MDLI	Minimum Device Level Interface
Mbyte, MB	Mega-byte; 1,000,000 bytes
Mean time to failure	The average length of time for which the system or component works without failing
Mean time to repair	Average time required to repair the system or component
FM	Frequency Modulation
FPP	Floating Point Processor
Frequency	The rate at which a current alternates
Frequency division multiplex	Multiplex system in which the available transmission frequency range is divided into narrower bands
Frequency modulation	Method of modifying the frequency of the sine wave carrier to support information transmission
Full Duplex	Equipment capable of transmission simultaneously in two directions
Gate	A basic logic circuit
Half Duplex	A circuit that can transmit information in both directions, but not simultaneously
Hamming Code	A error correcting/detecting code using redundant bits
Hertz	A unit of frequency measurement, i.e., one hertz equals one cycle per second
HD	Half Duplex

Hollerith code	A alphanumeric code used in card readers and sorters
HZ	Hertz
IAS	Interactive Applications System
IC	Integrated Circuit
Index	A table used to determine the location of a record
Intelligent terminal	A terminal that can perform data processing-manipulation tasks without relying on the host computer
Interface	The boundary between two pieces of equipment: consists of physical characteristics, signal strengths, information codes, protocols etc.
Interleaved	Assigning consecutive physical memory addresses alternately between two memory controllers
Inverted file	A file structure which permits fast spontaneous searching for previous unspecified information -independent lists or indices are maintained in records keys which are accessable according to the values of specific fields
PDP 11/70	Programmable Digital Processor; the 11/70 is the most powerful 16 bit minicomputer in the DEC 11 series family of processors; part of TOAS baseline configuration
PDS-4L	Stand-alone graphic refresh CRT terminal - part of baseline configuration; manufactured by Imlac
Peripheral device	Input or output devices of a computer (i.e., printers, magnetic tape drives, disks, consoles, CRTs, etc.)
PMI	Preventive Maintenance Inspection
Protocol	A fixed procedure required to initiate and maintain a communications process
RADC	Rome Air Development Center, Griffiss AFB, NY
RAM	Random Access Memory

Random access	The ability to access data directly without searching through other extraneous data
Real time	A process or transmission which occurs sufficiently fast that it is used in essentially the same manner as if it were instantaneous
Redundancy check	An automatic or programmed check based on characters used especially for checking pruposes
Response time	The time the system takes to react to a given command or execute a particular process
RH-70	Massbuss controller for high speed peripherals
RF	Radio Frequency
RFI	Radio Frequency Interference
RO	Receive Only
ROM	Read Only Memory
RP06	A dual access moving head disk system; each pack can store 176 MB; part of TOAS baseline configuration
RS-232 Interface	An EIA standard for interfacing terminals and computer equipment
MHz	Megahertz - a unit of frequency measurement equal to one million hertz
mil	Measurement of thickness; 0.001 inch
MODEM	Modulator-Demodulator; a device that can modulate a signal for transmission and demodulate for reception
Modulation	A process of changing the characteristics of the carrier signal to reflect the values of the transmitted data
MOS	Metal Oxide Semiconductor; a type of LSI chip
MPG	Maintenance Program Generator
MSI	Medium Scale Integration; solid state technology with fewer circuits per chip than LSI

MTTF	Mean time to failure
MTTR	Mean time to repair
Multi-access	The capability to allow several users simultaneous access to the computer
Multiplex	Using a common channel to support more than one process or user by dividing the frequency band into narrower bands (FDM) or using time slots (TDM)
Multiplexer	A device that enables more than one signal to be sent simultaneously over one physical circuit
Multiprogramming	The method which supports several independent jobs processed together to maximize system performance
Multi-thread	The ability of a process (normally a data base management system) to support more than one user accessing a file or portion of code
MUSDAB	Multi-Source Data Base - Advanced R&D data base/effort to support Project 2315
Node	A point of junction between links - a switching or processing center
On-line	A device that is connected directly to the computer; normally thought of as an interactive device
Parity check	The process of adding non-information bits to a block of data to make the total number of bits even or odd
Seek	The mechanical movement of the flying head involved in locating a record on a random access device
Semaphore	A mechanism for synchronizing a set of processes; used to preclude one process from changing data (or code) being used by another process
Serial	An interface in which the bits of data are transmitted or processed one at a time
Simplex circuit	A circuit that allows transmission in a single direction only

Soft copy	A temporary record - normally associated with a CRT display unit
SPC	Small Peripheral Controller
Stop bit	The signal characteristic that denotes end of transmission
SU-1652	A dual screened CRT developed by Sperry Univac and used in the automated intelligence community
Synchronous	Having a constant time interval between successive bits, characters, or events
Task	A linked group of object modules ready for execution
TDM	Time Division Multiplex
TDMA	Time Division Multiplex Access
Teletype	Trademark of the Teletype Corporation that produces tape punches, page printers, etc. used for communications systems
Throughput	The total amount of useful information processed during a specified interval
Time division multiple access	Physically separated devices are allowed access to a single device by allocating time slots to each one
TOAS	Tactical Operations Analysis Support Facility - the RADC test and demonstration facility at Langley AFB, Virginia
TTY	Teletype
UIC	User Identification Code
UFD	User File Description
UNIBUS	18 bit data path connecting all DEC peripheral devices to the 11/70 CPU
Virtual	Adjective implying that something in reality is different than it appears to a set of programs or users

VRC	Vertical Redundancy Check
Word	A sequence of bits or characters treated as a unit; two bytes (16 bits) is one DEC 11/70 word
WPM	Words per minute
Xerox 1750	45 CPS letter quality daisy wheel printer -part of TOAS baseline configuration
XXDP	The "catch-all" name for the diagnostic programs contained in the MAINDEC-II diagnostic package

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