Record of Revision

Each time this manual is updated with a change packet, a change to part of a text page is indicated by a change bar in the margin directly opposite the change. A change bar in the footer of a text page indicates that most, if not all, of the text is new. A change bar in the footer of a page composed primarily of a table and/or figure may indicate that a change was made to that table/figure or, it could indicate that the entire table/figure is new. Change packets are assigned a numerical designator, which is indicated in the publication number on each page of the change packet.

Each time this manual is fully revised and reprinted, all change packets to the previous version are incorporated into the new version, and the new version is assigned an alphabetical revision level, which is indicated in the publication number on each page of the manual. A revised manual does not usually contain change bars.

REVISION	DESCRIPTION
	April 1992. Original printing.
A	March 1993. This revision includes extensive IOS changes, detailed peripheral error and troubleshooting information, and additional field repair procedures.
B	August 1993. This revision incorporates information about the CRAY EL98 system; in addition, the remote support information was completely revised. This revision replaces CMM-0431-0A0.
B1	March 1994. This change packet incorporates the memory HIPPI and new peripherals DD-5S and DS-3. It also includes revisions to the DD-4 control board and updates Remote Support cabling information.
B2	June 1994. This change packet includes revisions to field replacement procedures (FRPs) 13, 19, 21, and 23.
B3	December 1994. This change packet incorporates information about the new peripheral DD-5I.
B4	September 1995. This change packet corrects `mfdump` command information in the "UNICOS Dumps" subsection in Section 4.

PREFACE

The *CRAY EL Series Troubleshooting and Maintenance Manual* includes detailed information about the architecture of the major components of the CRAY Y-MP EL and the CRAY EL98 systems, the peripheral devices, and operations within the system. Troubleshooting and remote support information, as well as field replacement procedures, are provided. The appendix contains the instruction set for the CRAY Y-MP EL and CRAY EL98 systems.

Notational Conventions

The following conventions are used throughout this manual:

`Courier` type indicates directory pathnames, filenames, commands, and screen output.

`Courier bold` type indicates commands, options, and field inputs that you should enter.

The following conventions are used for command usage descriptions:

- The ↵ symbol indicates pressing the return key.
- The —> symbol indicates holding the MENU mouse button down and moving the mouse pointer to the next menu item.
- Commands must be entered as shown in the command syntax. Spaces must be included or left out as shown; do not use tabs.
- Square brackets [ ] indicate an optional entry.
- Angle brackets < > indicate a required entry.
- A vertical bar | indicates a choice.

Convention	Description
Lowercase *italic*	Variable information.
x	An unused value.
n	A specified value.
(value)	The contents of the register or memory location designated by value.
Register bit designators	Register bits are numbered from right to left as powers of 2. Bit 2^0 corresponds to the least significant bit of the register. One exception is the vector mask register. The vector mask register bits correspond to a word element in a vector register; bit 2^{63} corresponds to element 0 and bit 2^0 corresponds to element 63. Another exception is when the state of the 32 1-bit semaphore registers is loaded into an S register. SM0 goes into S register bit position 2^{63}, SM1 goes into S register bit position 2^{62}, and so on.
Number base	All numbers used in this manual are decimal, unless otherwise indicated. Octal numbers are indicated with an 8 subscript. Exceptions are register numbers, the instruction parcel in instruction buffers, and instruction forms, which are given in octal without the subscript.

The following list provides examples of the preceding conventions.

Example	Description
Transmit (A*k*) to S*i*	Transmit the contents of the A register specified by the *k* field to the S register specified by the *i* field.
167*ixk*	Machine instruction 167. The x indicates that the *j* field is not used.
Read n words from memory	Read a specified number of words from memory.
Bit 2^{63}	The value represents the most significant bit of an S register or element of a V register.
1000_8	The number base is octal.

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FIGURES (continued)

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1 SYSTEM OVERVIEW

The CRAY EL series computer system is a completely self-contained system in which the central processing units, input/output subsystems (IOS), and all peripherals can be included in one cabinet. The cabinet can be installed easily in most office environments that are equipped with a 200- to 250-Vac, 50- to 60-Hz power source.

The design of the CRAY EL98 system allows the use of two possible processor module types. One type consists of a single, complete CPU and is called the primary processor module. The second type consists of a primary processor module and a daughter board, which is called the secondary processor module. In this configuration, the secondary processor module shares a portion of the primary processor module's logic and becomes a second, dependent CPU.

One to four processor modules can be installed in the CRAY EL series primary, or mainframe cabinet. The primary cabinet also holds four memory boards, an IOS using a Versabus Modular Eurocard (VMEbus)-based assembly, and optional peripherals requested by the customer. Another component in the primary cabinet is the small computer system interface (SCSI) subsystem known as the maintenance SCSI. The SCSI subsystem consists of a cartridge-type streaming tape drive, a 204-Mbyte hard disk drive, and an optional 8-mm helical scan tape drive. The SCSI tape drives are used to install any new releases of software as they become available. It is also used as the system backup and boot device.

The primary cabinet is designed so that another standard cabinet can be bolted to the primary cabinet to expand the system. As many as three expansion cabinets can be connected to the system for additional IOS and peripheral capabilities.

Figure 1-1 shows how three expansion cabinets are configured with the CRAY EL series system. Figure 1-2 shows a two-cabinet CRAY EL series system.

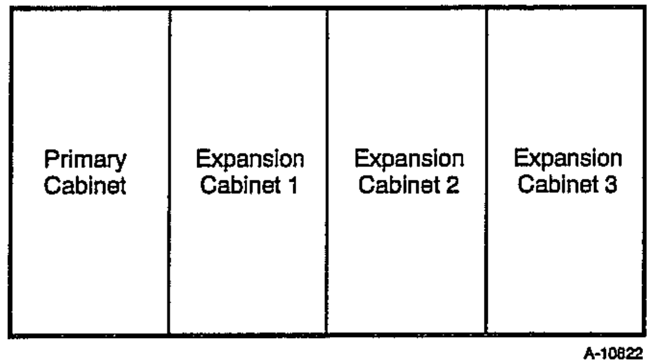

Figure 1-1. Left Side View (Maximum Configuration)

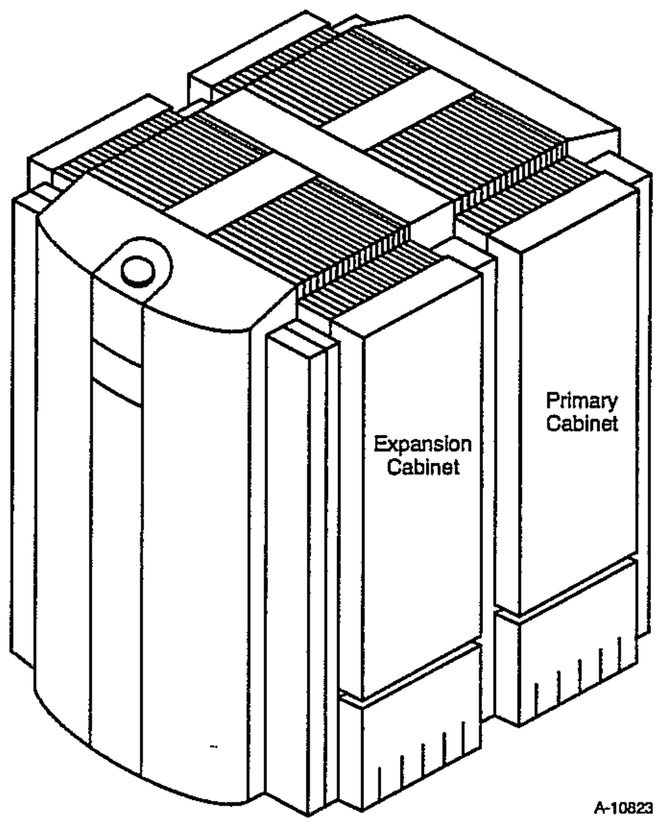

Figure 1-2. CRAY EL Series Computer System (Right Side View)

All CRAY EL series system cabinets are air cooled by integrated fans at both the top and bottom of the chassis. This form of cooling is referred to as vertical cooling.

Peripheral Device Options

The following list describes the peripheral devices available with the CRAY EL series system and their characteristics. Customers select peripheral devices according to their requirements.

Disk units

- DD-3 medium-performance disk unit
  - Provides 1.3 Gbytes of storage; uses 5.25-in. enhanced serial drive interface (ESDI) drive
  - Has a 2-Mbyte/s peak, 1.9-Mbyte/s sustained transfer rate
  - Packaged maximum eight drives per PE-3 drawer with a shared power supply
  - Manufactured by Hitachi, Ltd. as Hitachi model DK-516-15
- DC-3 controller
  - Provides error-correction code (ECC) and media defect management
  - Controls up to four ESDI DD-3 disk drives
  - Manufactured by Ciprico Inc. as CIPRICO model RF-3411
- DD-4 high-performance disk unit
  - Includes a 2.7-Gbyte unformatted 8-inch two-head intelligent peripheral interface (IPI) dual-port disk drive
  - Has a 7.5-Mbytes/s peak, 6- to 7-Mbyte/s sustained transfer rate
  - Packaged two disk drives per PE-4 drawer with one power supply per drive
  - Manufactured by Seagate Technology, Inc. as Sabre VII drive
- DC-4 controller
  - Uses intelligent peripheral interface (IPI)-2 protocol
  - Contains two IPI channels; each channel can support two DD-4 disk drives

    - Manufactured by Xylogics, Inc. as Xylogics model SV7800

- DAS-2 disk array subsystem
    - Is an intelligent disk array controller system
    - Includes a bank of eight 1.3-Gbyte 5.25 in. ESDIs for storage, plus one for parity and one spare (all contained in one drawer)
    - Has a peak transfer rate of 13 Mbytes/s for data blocks that contain 1-Mbyte or more
    - Uses hardware bit striping to distribute data evenly across all drives
    - Has 12-Gbyte unformatted capacity
    - Manufactured by Maximum Strategy, Inc.
    - Is not available with the CRAY EL98 system

Tape units

- TD-2 9-track tape drive subsystem
    - Includes one TC-2 tape controller unit that is manufactured by Ciprico, Inc. as CIPRICO model TM-3000
    - Includes one TD-2 800 bpi (NRZI), 1600 bpi (PE), 3200 bpi (DPE), 6250 bpi (GCR) 9-track low-profile tape drive, 125 ips. Manufactured by Storage Technology Corporation as model 9914
- TD-3 0.5-inch cartridge tape drive
    - Includes one SCSI peripheral controller (SI-1) that is manufactured by Ciprico, Inc. as CIPRICO model 3564
    - Includes one 18-track tape drive in low-profile configuration that is manufactured by Storage Technology Corporation as model 4220
- Cartridge tape drive (EXABYTE models)
    - Is an EX-2 5.0-Gbyte, 8-mm tape drive that is manufactured by EXABYTE Corporation as EXABYTE model EX3-8500
- Cartridge tape drive

- Uses a 0.25-in. cartridge (QIC) with 1.6-Gbytes of storage
- Manufactured by Archive Technology, Inc. as the Anaconda model 2750

Special devices

- DR-1 removable disk system that uses dual 5.25-in. ESDI disks in easily removable cartridges designed to protect data from damage during transport
- DR-1 requires a DC-3
- DR-2 removable IOS disk drive

Processor Overview

The processor in the CRAY Y-MP EL computer system is located on a single 16 x 22 inch printed circuit (PC) board; however, the processor module of a CRAY EL98 computer system consists of two PC boards, the primary module and the secondary module. These PC boards contain all of the logic associated with the CRAY EL series system processor. Very large scale integration (VLSI) solid-state technology enables a relatively small PC board to contain an entire processor.

The VLSI chips used in the processor are application-specific integrated circuits (ASICs). They are constructed using complementary metal oxide semiconductors (CMOS). The ASICs are available in a variety of package sizes. The internal construction of the ASIC consists of between 60,000 and 200,000 undefined gates. This massive number of gates is contained in a 2 x 2 inch package, which consumes an average of 5 watts at + 5 volts.

The processor module for the CRAY Y-MP EL system contains 23 separate ASICs, and the processor module for the CRAY EL98 system contains 39 ASICs, with each consisting of nine application types as described in Section 2.

The secondary processor module of the CRAY EL98 system contains 16 ASICs and shares the functions of 7 ASICs on the primary module. Each secondary processor connects to the primary processor via stand-off connectors using 558 signal pins. The ASICs that reside on the secondary processor are:

- 1 AS ASIC
- 8 DS ASICs
- 4 EU ASICs
- 1 MC ASIC
- 1 PC ASIC
- 1 RC ASIC

The ASICs shared with the primary processor are:

- 1 AR ASIC
- 2 CC ASICs
- 4 MD ASICs

The CRAY Y-MP EL system is designed to contain up to four independent processors; the processors can work in conjunction by using shared registers or using the common memory section. The CRAY EL98 system can contain four processor modules that can provide up to eight independent processors; the processors can work in conjunction by using shared registers or using the common memory section. An additional PC board in the CRAY EL98 system is mounted on the top of the mainframe card cage, called the memory arbitration bus (MAB), to provide arbitration between the processor modules. Each processor connects to the system backplane using 1,230 signal pins.

All processors run on a 30-nanosecond (ns) clock. This clock is provided by a separate clock module mounted on the rear of the mainframe card cage. Also mounted on the rear of the card cage is a scan chain multiplex module that controls the scan process during a system master clear (MC) operation and at any time a scan of the memory board is requested by the operating system or the operator.

Memory Overview

Central memory in the CRAY EL series system is distributed across four PC boards. Each PC board is 16 x 22 inches (the same size as the processor board) and is composed of two ASIC types used for data control and fanout. Each board contains nine ASICs and a specific number of dynamic random-access memory integrated circuits (DRAMs). The number of DRAMs depends upon the customer's choice of available memory options.

The CRAY EL series system can be ordered with a 32-Mword, a 64-Mword, a 128-Mword, a 256-Mword, or a 512-Mword central memory. In the case of the 32-Mword, 64-Mword, and 256-Mword options, the memory PC boards are half-populated modules. The 32-Mword, 64-Mword, and 128-Mword modules are populated with 1M x 4 DRAMs, and the 256-Mword and 512-Mword modules are populated with 4M x 4 DRAMs.

The CRAY EL series system central memory contains a total of 64 banks spread across the four modules. Each module contains 16 banks and is considered a memory section. These 16 banks are separated into lower and upper banks on each board. Thus, a half-populated memory board uses only the lower bank, but still retains the full 16 banks of memory. This means that a fully populated memory module uses both upper and lower banks.

Figure 1-3 shows the chassis locations of the ten modules in the CRAY EL series computer system. Note that this figure represents a top view, with the front of the chassis at the bottom of the diagram. Also represented in Figure 1-3 is the MAB, shown in the center of the diagram.

The entire mainframe is controlled by a clock circuit contained on a separate circuit board that is mounted on the back of the mainframe card cage. The circuit board consists of three different clock circuits: one for normal clock speed (30 ns), one for fast clock speed (27 ns), and one for slow clock speed (33 ns). The fast and slow circuits are used only to isolate an intermittent problem in the system. There is no preventive maintenance that requires the running of clock margins. The clock circuit board also contains an external clock path through which an external clock can be connected to the system while the normal clock circuits are disabled.

A scan-logic board is attached to the back of the mainframe card cage. This circuit board provides paths to each of the processor modules that allow the operation of a scan chain. This scan chain is currently used to condition several operational registers before a deadstart exchange sequence occurs. The scan circuits can also be used as a diagnostic tool in the case of catastrophic failures that require more than the usual suite of diagnostic tools provided to the product specialist.

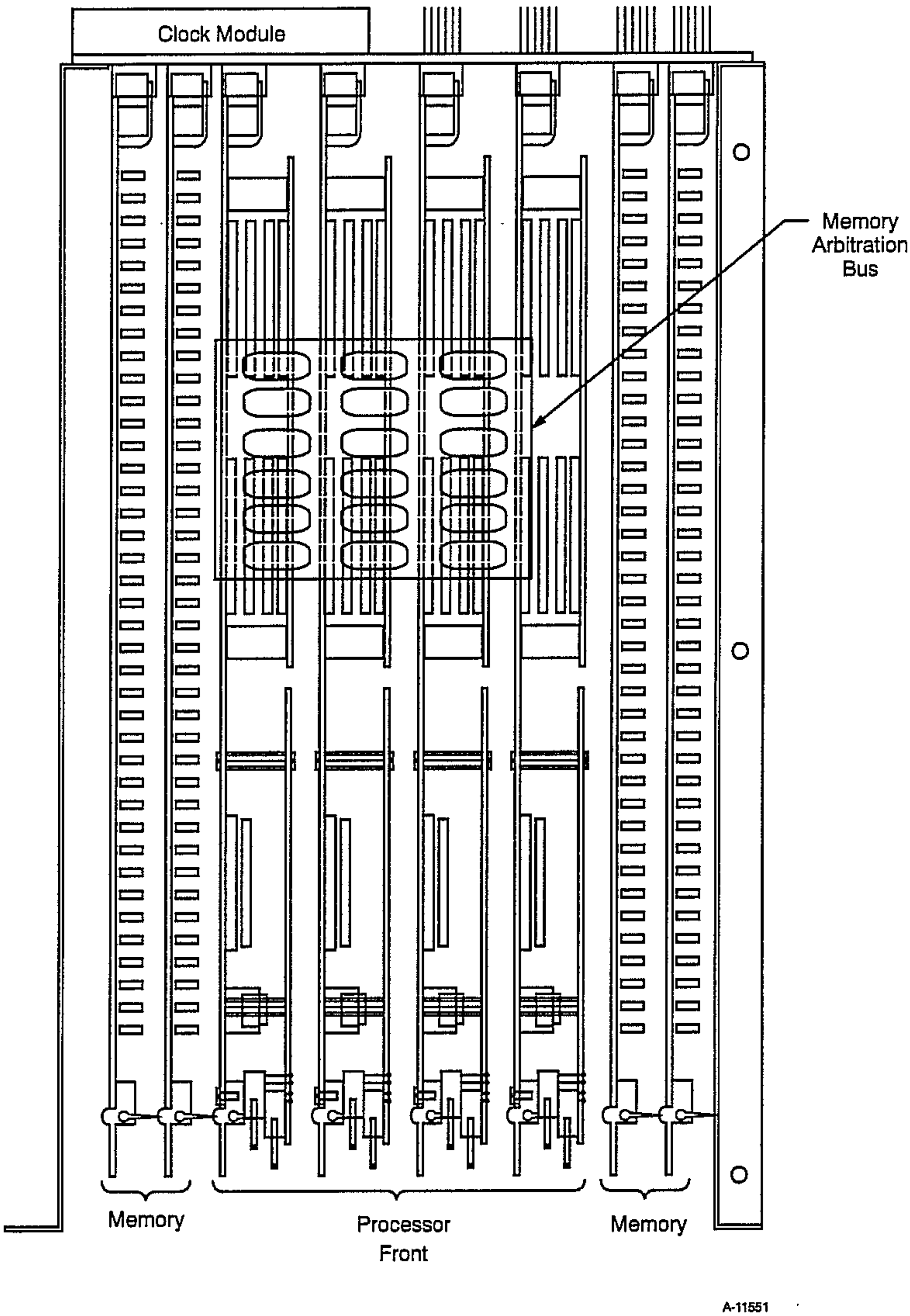

Figure 1-3. Chassis, Top View

Input/Output Subsystem Overview

The IOS for the CRAY EL series system provides customers with the maximum choice of peripheral equipment. The IOS is a VME-based system that communicates with the mainframe via the Y1 bus (a 40-Mbyte/s channel) connected to the input/output buffer board (IOBB). The IOBB is the only Cray Research, Inc. proprietary board within the IOS. All other functions within the IOS are performed using vendor-supplied VME boards.

The standard VME mechanical chassis is a 19-inch rack-mounted chassis that is air cooled, supports standard 6U x 160 mm VME boards, and requires a 750-watt power supply. The backplane is a modular design based on a 10-slot system. The backplane configurations include:

- 10-slot + 10-slot option
- 10-slot + 6-slot + 4-slot option
- 6-slot + 4-slot + 6-slot + 4-slot option

Each cabinet within the CRAY EL series system contains a VMEbus chassis. In its maximum configuration, this VMEbus can be configured as the 6-slot, 4-slot, 6-slot, 4-slot option, resulting in a maximum of 16 IOS configurations (4 cabinets x 4 IOSs per cabinet = 16 IOSs per system). The customer decides how many IOSs to include in a system, depending on desired performance.

The IOS configuration requires use of a 68030-type microprocessor and as many as eight peripheral controllers to handle data transfers. A possible IOS configuration is represented in Figure 1-4. The types of controllers used are defined by the customer's choice of system peripherals.

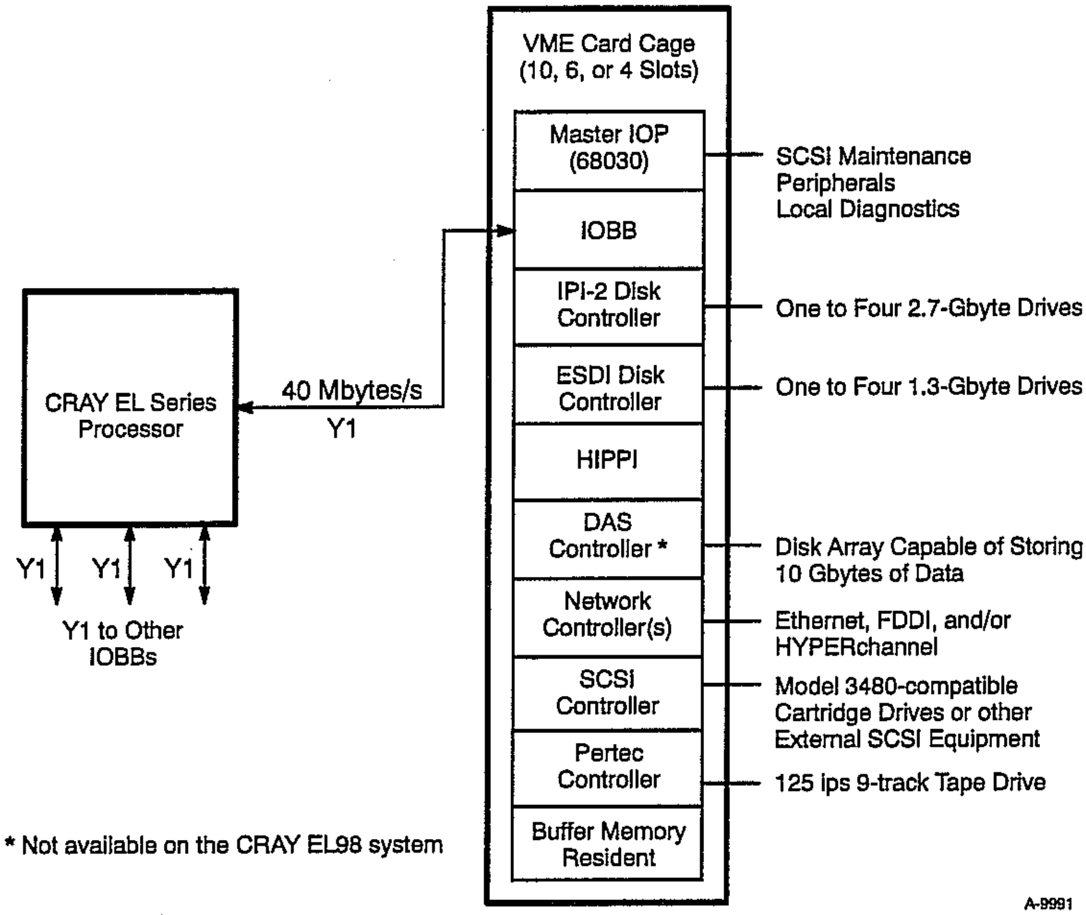

Figure 1-4. IOS Configuration

The Maintenance SCSI

The maintenance SCSI consists of two required peripherals, one of which is a Winchester-technology hard disk drive capable of storing 204 Mbytes of data. This disk drive maintains the IOS kernel, the IOS diagnostic binary files, and the UNICOS operating system. The second SCSI peripheral is a QIC 1.3-Gbyte streaming cartridge (0.25-in. tape) tape drive. An optional product that can also be connected is the 8-mm helical scan tape drive, capable of storing 5 Gbytes of data.

The primary purpose of a SCSI device is to provide a boot storage address to bring the system from a cold or dead machine state to an operating state. The maintenance SCSI also uses the tape drives to make system backup tapes or to load new operating system releases.

The operating system kernel (UNICOS) resides on the maintenance hard drive. Similarly, the offline IOS diagnostics, which are a part of the IOS kernel, are resident on the hard disk. No other maintenance diagnostics are on the hard disk.

System Console

The CRAY EL series system uses a WYSE 60 terminal manufactured by Wyse Technology, Inc. as the system console. Using this system console, it is possible to boot the operating system and to perform other system functions as allowed under the operating system. This system console is an integral part of the CRAY EL series system.

Maintenance Workstation

An optional proprietary maintenance workstation model EL (MWS-EL) is connected to a separate input bus. This workstation is a Sun-4 permanently connected to the system or a portable windowing workstation that is brought to the site by the product specialist and is not considered part of the CRAY EL series system. Instead, the MWS-EL is owned by the maintenance organization and is available for maintenance representative use only. This workstation provides a remote access connection from the communications gateway hub and, in the case of an on-site visit from a maintenance representative, provides a platform for maintenance functions.

The MWS-EL contains a hard disk drive with a complete copy of the mainframe maintenance environment (MME), which is used to isolate problems in the processor or memory using the offline diagnostics available to the CRAY EL series system.

The MWS-EL is connected to the CRAY EL series system via an RS-422 connection that connects to the IOP controller board in each of the incorporated IOSs. The master IOP, which resides in IOS0 slot 0, acts as the MWS-EL arbitrator and must be installed in that location for correct MWS-EL operation. However, the MWS-EL has individual access to all IOSs.