sun microsystems, inc.

Sun-2/120 and Sun-2/170

Configuration Guide

February 1, 1984

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Introduction

When configuring Sun Workstations, the most important guide is a good understanding of the intended applications of the system or network. For each basic configuration question there are corresponding application questions and implications:

Configuration Question	Application Question	Configuration Implication
How much main memory?	Are the applications compute-intensive, I/O intensive, or primarily interactive?	Additional main memory improves interactive response time but has less effect on computation times.
How much disk space?	Are the application programs large? Do they use large virtual address spaces? How large are the data files used?	Large virtual address space requires large swap files in addition to the data storage requirements of the applications.
More memory or local disk?	Are the applications paging-intensive or I/O intensive?	Additional main memory reduces paging traffic to the disk but has less effect on data I/O throughput.
Hardware Floating Point?	Do the applications perform heavy floating-point computation?	Hardware floating point calculations require 1/3 the software time, on average.

In addition, whether configuring a standalone Sun Workstation or a network of Sun Workstations, either diskless or with local mass storage, there are several general configuration topics that require careful evaluation in the context of the intended application:

Hardware Configuration — Individually, each proposed workstation must have a correctly configured set of boards and options. Number of Multibus slots, power requirements, P2 connector signals, and junction panel slots all impose distinct upper limits on configuration flexibility.

Disk Capacity — While total disk requirements depend primarily on the user's application needs, a basic understanding of the organization of disk storage on Sun systems and the size of the Sun software distribution helps select disk drives with adequate capacity.

Diskless Workstations — The number of diskless workstation clients that a single server can support is a complex function of the hardware configuration of each client (especially the amount of main memory), the hardware configuration of the server (especially the number of disk controllers and the type of disk drive), and the nature of the user's applications.

This field training manual first gives specific examples of many of the most common configurations of *individual* Sun Workstations. Then it explains in greater detail each of the constraints that may have to be considered in configuring these workstations. Finally, it discusses some of the issues involved in configuring a *network* of Sun Workstations.

Standard Workstation Configurations

The following diagrams show the base configurations of both the Sun-2/120™ and Sun-2/170™ workstations, before any options are installed. "Pa" and "Pc" (on the Sun-2/120) and "Pa", "Pb", and "Pc" (on the Sun-2/170) indicate slots spanned by a single connector block on the P2 bus. In the following examples, cards shown in **boldface** are essential parts of the illustrated configuration. Cards shown in *italics* are possible additions to the illustrated configuration.

Sun-2/120 - Standard Sun-2/120 Deskside SunStation

1	**Sun-2 68010 Processor**	**Pa**
2	**Sun-2 1 MByte Main Memory**	**Pa**
3		**Pa**
4	**Sun-2 10 Mbps Ethernet**	**Pa**
5		**Pa**
6	**Sun-2 Monochrome Video Controller**	**Pa**
7		**Pc**
8		**Pc**
9		

Note: All Sun-2™ Workstations mount the card cage vertically, with slot 1 at left when viewed from the front.

The basic Sun-2/120 Deskside™ SunStation™ includes the Sun-2 68010 Processor, Sun-2 1 MByte Main Memory, Sun-2 Monochrome Video Controller, bitmapped monochrome display, keyboard, mouse, and Sun-2 10 Mbps Ethernet™ interface. A basic Sun-2/120 is configured as a diskless node (no local mass storage) and requires connection to a Sun fileserver.

Sun-2/120FS - Standard Deskside Sun Fileserver

1	**Sun-2 68010 Processor**	**Pa**
2	**Sun-2 1 MByte Main Memory**	**Pa**
3		**Pa**
4	**Sun-2 10 Mbps Ethernet**	**Pa**
5		**Pa**
6	**Sun-2 P2 Terminator Board**	**Pa**
7		**Pc**
8		**Pc**
9		

The Sun-2/120FS is a Sun-2/120 without the monochrome display, keyboard, mouse, or monochrome video controller. Note that there is a board replacing the monochrome video controller, however; see the explanation in the section labelled *Multibus System Backplane and P2 Bus Connectors.*

The Sun-2/120FS is in all other respects identical to the Sun-2/120. All configuration examples for the Sun-2/120 that follow apply to both the Sun-2/120 and Sun-2/120FS.

Sun-2/170 - Standard Rackmountable Sun Workstation

1	**Sun-2 68010 Processor**	**Pa**
2	**Sun-2 1 MByte Main Memory**	**Pa**
3	**Sun-2 1 MByte Main Memory**	**Pa**
4		**Pa**
5		**Pa**
6	**Sun-2 P2 Terminator Board**	**Pa**
7		**Pb**
8		**Pb**
9		**Pb**
10		**Pb**
11		**Pb**
12	**Sun-2 10 Mbps Ethernet**	**Pc**
13		**Pc**
14		
15		

The Sun-2/170 rackmountable Sun Workstation provides 15 Multibus slots instead of the 9 in the Sun-2/120, offering greater expansion capability and capacity for additional peripherals. The basic Sun-2/170 includes the Sun-2 68010 Processor, 2 MBytes Main Memory, and Sun-2 10 Mbps Ethernet interface.

Normally, a network server is dedicated to the task of providing network service, and is not used simultaneously as a workstation. For this reason the Sun-2 bitmapped monochrome display is not part of the basic Sun-2/170 product, though it may be added as an option. Customers must supply an ASCII terminal (which attaches to CPU serial port A) for use as the system console, if the bitmapped display is not ordered. Sun tests the Sun-2/170 with a TeleVideo® 925 terminal, though most common ASCII terminals should be acceptable.

Workstation Configurations with Expansion Options

Sun-2/120 - Diskless Deskside SunStation with Color Display

1	**Sun-2 68010 Processor**	**Pa**
2	**Sun-2 1 MByte Main Memory**	**Pa**
3	*Sun-2 1 MByte Main Memory*	**Pa**
4	**Sun-2 10 Mbps Ethernet**	**Pa**
5		**Pa**
6	**Sun-2 Monochrome Video Controller**	**Pa**
7	*Floating Point Processor*	**Pc**
8		**Pc**
9	**Sun Color Video Controller**	

The basic Sun-2/120 Deskside SunStation can be expanded with a variety of options. This example workstation illustrates how a Sun-2/120 might be configured with 2 megabytes of main memory, the optional hardware floating point processor, and the medium-resolution Sun color video controller (in addition to the monochrome video controller). This workstation is still a diskless node, though a powerful one. It has no local mass storage, but instead uses its Ethernet interface to access a Sun fileserver over the network.

Sun-2/120 - Standalone Deskside SunStation - Internal Disk

1	**Sun-2 68010 Processor**	**Pa**
2	**Sun-2 1 MByte Main Memory**	**Pa**
3	*Sun-2 1 MByte Main Memory*	**Pa**
4	*Sun-2 10 Mbps Ethernet*	**Pa**
5	**Sun-2 SCSI Host Adapter**	**Pa**
6	**Sun-2 Monochrome Video Controller**	**Pa**
7	*Floating Point Processor*	**Pc**
8		**Pc**
9	*Sun Color Video Controller*	

When the Sun-2/120 is configured as a standalone workstation, it requires a local disk and tape drive. The interface for both of these devices, in the most common case, is the **Sun-2 SCSI Host Adapter**, which supports the 42 MByte, 5 1/4-inch Winchester disk drive and the 1/4-inch cartridge tape drive that are available as internally-mounted options on the Sun-2/120. (The SCSI-to-ST-506 [disk] and SCSI-to-QIC-II [tape] controller boards that come with these peripherals are *not* Multibus boards. The controllers mount on the side of the Multibus card cage.)

The diagram illustrates how a Sun-2/120 would be configured with 2 megabytes of main memory, the optional hardware floating point processor, and a color video controller, in addition to the integral disk and tape drive. With a local disk and tape drive, the Sun-2 Ethernet interface may be deleted from the standard configuration, so it is shown here as an option. Alternatively it can retain its Ethernet interface so that it can be connected to a network, perhaps accessing a fileserver for additional shared mass storage.

Sun-2/120 - Standalone Deskside SunStation - External Disk

1	**Sun-2 68010 Processor**	**Pa**
2	**Sun-2 1 MByte Main Memory**	**Pa**
3	*Sun-2 1 MByte Main Memory*	**Pa**
4	*Sun-2 10 Mbps Ethernet*	**Pa**
5	**Sun-2 SCSI Host Adapter**	**Pa**
6	**Sun-2 Monochrome Video Controller**	**Pa**
7	*Floating Point Processor*	**Pc**
8	**SMD Disk Controller**	**Pc**
9	*Sun Color Video Controller*	

In this configuration, the internal 5 1/4-inch disk has been replaced (or supplemented) by an external SMD disk drive contained in a second pedestal. A standalone Sun-2/120 requires both a local disk and tape drive, so the Sun-2 SCSI Host Adapter is still used to support the 1/4-inch cartridge tape drive that is mounted internally in the first Sun-2/120 pedestal.

If a 1/2-inch tape drive were desired instead of the 1/4-inch tape, the 1/2-inch Tape Controller would be installed in slot 7, forcing the Floating Point Processor to slot 9. The Sun-2 SCSI Host Adapter would be deleted, and the Sun Color Video Controller could be installed in slot 5.

Sun-2/120 - Deskside SunStation with 4 Megabytes Main Memory

1	**Sun-2 68010 Processor**	**Pa**
2	**Sun-2 1 MByte Main Memory**	**Pa**
3	**Sun-2 1 MByte Main Memory**	**Pa**
4	**Sun-2 1 MByte Main Memory**	**Pa**
5	**Sun-2 1 MByte Main Memory**	**Pa**
6	**Sun-2 Monochrome Video**	**Pa**
7	**Sun-2 SCSI Host Adapter**	**Pc**
8	**SMD Disk Controller**	**Pc**
9	*Sun-2 10 Mbps Ethernet*	

For applications that require extremely large amounts of main memory, the Sun-2/120 and Sun-2/170 support up to 4 megabytes of high-speed RAM. Installing four megabytes of memory requires moving several controllers from their "normal" location, as indicated in this configuration. The example workstation is equipped with a 1/4-inch tape drive and SMD disk drive in a second pedestal, in addition to the large main memory. This workstation might also have an Ethernet interface.

Sun-2/170 - Fully Configured Rackmountable Sun Workstation

1	**Sun-2 68010 Processor**	**Pa**
2	**Sun-2 1 MByte Main Memory**	**Pa**
3	**Sun-2 1 MByte Main Memory**	**Pa**
4	*Sun-2 1 Mbyte Main Memory*	**Pa**
5	*Sun-2 1 Mbyte Main Memory*	**Pa**
6	**Sun-2 P2 Terminator Board**	**Pa**
7	**1/2-inch Tape Controller**	**Pb**
8	**SMD Disk Controller**	**Pb**
9	*SMD Disk Controller*	**Pb**
10		**Pb**
11	*Floating Point Processor*	**Pb**
12	**Sun-2 10 Mbps Ethernet**	**Pc**
13	*Sun-2 10 Mbps Ethernet*	**Pc**
14	*Sun-2 SCSI Host Adapter*	
15	*Sun Color Video Controller*	

This Sun-2/170 rackmountable Sun Workstation is configured as a large fileserver that could support a cluster of diskless Sun Workstations. It is equipped with an SMD disk controller (with one or two disks attached, with up to 380 MB formatted capacity each) and a 1/2-inch tape controller and drive for backup.

With the 15 slots of a Sun-2/170, many additional options are possible. A fileserver may have multiple disk controllers as well as multiple disk drives, for increased capacity and reduced contention for the disk controller. A workstation acting as a gateway between two physically separate Ethernets will have a second Ethernet interface. Users may desire both 1/2-inch tape for system backup and 1/4-inch tape for "personal I/O", requiring the SCSI host adapter in addition to the 1/2-inch tape controller.

This example Sun-2/170 requires a separate ASCII terminal connected to serial port A for its system console. It could be equipped instead with the Sun-2 high-resolution bitmapped display, Sun-2 keyboard, mouse, and Sun-2 Monochrome Video Controller in place of the Sun-2 P2 Terminator Board. *(Note that the number of junction panel slots available for external connectors does not allow the substitution of the bitmapped display for the ASCII terminal at the same time as all the options shown above.)*

Maximum Supported Configurations

The following table shows the maximum number of each Sun-2 Workstation option that is supported on either a Sun-2/120 or Sun-2/170. Not all maximums can be installed simultaneously, even on a Sun-2/170; power, junction panel space, and other factors described below impose additional limits.

Sun-2 Workstation Option	Sun-2/120 Maximum	Sun-2/170 Maximum
Sun-2 68010 Processor Board	1	1
Sun-2 1 MByte Main Memory Boards	4	4
Sun-2 Monochrome Video Controllers	1	1
Sun-2 Ethernet interfaces	2	2
Sun Color Video Controllers	1	1
Floating Point Processor	1	1
Sun-2 SCSI Host Adapters	1	1
5 1/4-inch disks per SCSI	2	2
1/4-inch tape drive per SCSI	1	1
SMD disk controllers	2	2
SMD drives per controller	2 †	2 †
1/2-inch tape controllers	1	1
1/2-tape drives per controller	1	1

Serial Port Configuration and Speed

There are two asynchronous serial ports on a Sun-2 68010 processor board, and four additional asynchronous serial ports on the optional SCSI Host Adapter. These serial ports are configured as "DTE"s (*Data Terminal Equipment*) with modem control signals. They are intended for driving output devices such as printers or plotters, or connecting lower-speed input devices such as modems.

The serial ports on both these boards are programmed I/O devices (rather than DMA devices) and have only a 3-character hardware buffer each. While they support both high-speed output (up to 19.2 Kbaud) and input (up to 9.6 Kbaud), the system may occasionally lose characters, depending on other system activity, if several ports steadily generate input at full speed. (This could occur if the ports were connected to other computer systems or to high-bandwidth data acquisition devices that sent data constantly.) Continuous high data rate activity on the serial ports also degrades significantly the performance and responsiveness of other system activities.

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† The SMD disk controller supplied by Sun supports up to four disk drives on one controller. Sun UNIX supports two drives per controller. Sun recommends the use of a second disk controller when more than two drives are installed on the system.

Sun Workstation Main Memory Useage

The basic memory size for a Sun-2/120 is one megabyte. The Sun UNIX™ operating system kernel occupies a portion of the first megabyte of memory. Also in that megabyte are the basic system I/O buffers and disk cache buffers. The remainder is available for user programs.

The SunWindows™ system operates as a collection of "user programs", as far as the operating system is concerned. If a user is running the SunWindows system on his workstation, a portion of the memory available to user programs will be taken up by the working set of memory pages for the window system processes, even before the user begins running *his* "user programs" in the windows. When deciding on main memory requirements, these pages should be thought of as resident, because if they swap out, window system response will degrade.

In workstations with more than one megabyte of memory, the kernel automatically allocates a *shadow frame buffer*. This main memory copy of the actual frame buffer allows faster graphics operations. As the size of physical memory increases, the system also automatically allocates additional I/O buffers for use as disk buffer cache. The table below illustrates the approximate allocation of up to four megabytes of memory in a normal Sun Workstation:

Sun UNIX Main Memory Allocation

Allocated To:	**Memory Used**	**Available User Memory**	**Total Main Memory**
Sun UNIX Kernel (Code) †	350 KB		1 MB
Sun UNIX Kernel (I/O buffers)	50 KB		
SunWindows (Resident Pages)	150 KB		
Available to User Programs	474 KB	474 KB	
Sun UNIX Kernel (Shadow Frame Buffer)	128 KB		2 MB
Sun UNIX Kernel (additional disk cache)	100 KB		
Available to User Programs	796 KB	1270 KB	
Sun UNIX Kernel (additional disk cache)	100 KB		3 MB
Available to User Programs	924 KB	2194 KB	
Sun UNIX Kernel (additional disk cache)	100 KB		4 MB
Available to User Programs	924 KB	3118 KB	

Workstations should be equipped with sufficient main memory to avoid thrashing (excessive swapping) by the virtual memory manager. One megabyte is adequate for a workstation to run several windows where the user is doing software development (editing, debugging, occasional compilation, etc.). Additional memory is probably necessary to run multiple windows with more complex applications (large CAD simulations, parallel compilations, etc.). Two megabytes are sufficient for any but the most memory-intensive applications.

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† Each workstation's kernel should be configured to support only those devices present in that workstation; this can eliminate up to 100 KBytes of unnecessary drivers.

Multibus System Backplane, DMA Priority, and P2 Bus Connectors

The backplane in a Sun-2/120 or Sun-2/170 is implemented as a single large printed circuit board covering both the P1 (basic) and P2 (private) busses. Sun has designed these multi-layer backplanes specifically to support the high-speed operation of large numbers of Multibus cards, especially large amounts of main memory. Both support parallel priority arbitration, permitting any slot to contain a bus master (DMA device).

The backplanes implement the IEEE-796 standard, commonly known as the Multibus. Sun Multibus boards support the basic Multibus standard, which provides for signals only on the P1 bus. In particular, Sun Multibus boards do not support the extended (24-bit) addressing mode that generates additional address signals on the P2 bus. Some Sun-designed cards used in a Sun Workstation use the P2 connector block as a high-speed local interconnect bus.

On the Sun-2/120, the Multibus P2 connector block physically spans all 9 slots on the card cage backplane but is divided electrically into 3 separate segments. On the Sun-2/170, the Multibus P2 connector block physically spans all 15 slots on the card cage backplane but is divided electrically into 5 separate segments. The section of the P2 bus labelled "Pa" is always used as the high-speed private memory bus. The Sun-2 processor board, in slot 1, terminates one end of this bus. In systems with the Sun-2 high-resolution bitmapped display, the monochrome video controller, in slot 6, terminates the other end of the P2 bus. In systems without the monochrome display, another board containing only the termination circuitry substitutes for the display controller. This leaves up to four slots for main memory expansion. *No boards that put other signals (e.g. 24-bit extended addressing) on the P2 connector may be inserted into "Pa".*

The Sun-2 68010 processor design allows DMA devices, which communicate over the P1 bus, to have direct access through the processor board to main memory, which is connected on the P2 bus only to the processor. Parallel priority arbitration means that access to the system bus is granted to the highest priority device that requests it; priority is determined by the location of the card in the card cage. The highest priority slot in the card cage is slot 1 (at the left when viewed from the front), with priority decreasing to the right.

Finding the proper priority order for DMA boards requires understanding device and bus latencies, bus and device bandwidths, device or system performance penalties for missed transfers. It also requires experimentation, since the proper order depends on the data transfer rate of the device, the amount of buffering the board supports, and the characteristics and useage of other devices in the system. The Sun-2 68010 processor is always installed in slot 1, making it the highest priority board. Sun Microsystems® has determined the proper slot for other DMA devices supplied by Sun, and the **Normal** column in the table below indicates that slot. If a customer adds DMA boards not supplied by Sun Microsystems, system analysis and testing will be required to select the proper slot.

The following table lists each card supplied in workstations by Sun, shows which cards are bus masters (DMA devices), and lists the possible and normal slots for installing each card. Note that more than one card may be "normally" in the same slot. If both of those cards are present in a system, one will be installed in an alternate location subject to the other configuration constraints. For example, if both a floating point processor and 1/2-inch tape controller are installed, the floating point processor could move to slot 8 or 9.

Multibus Board	DMA Device	P2 Signals	Sun-2/120 Slot Allowed	Sun-2/120 Slot Normal	Sun-2/170 Slot Allowed	Sun-2/170 Slot Normal
Sun-2 68010 Processor	Yes	Sun P2	1	1	1	1
Sun-2 1 MB Main Memory	---	Sun P2	2 to 5	2	2 to 5	2 and 3
Sun-2 Monochrome Video	---	Sun P2	6	6	6	6
Sun-2 P2 Terminator Board	---	---	6	6	6	6
Sun-2 Ethernet Controller	---	†	2 to 5	4	2 to 5	12
			7 to 9		7 to 15	
Sun-2 SCSI Host Adapter	Yes	---	2 to 5	5	2 to 5	14
			7 to 9		7 to 15	
Sun Color Display Controller	---	‡	2 to 5	9	2 to 5	15
			7 to 9		7 to 15	
1/2-inch Tape Controller	Yes	24-bit	7 to 9	7	7 to 15	7
SMD Disk Controller	Yes	24-bit	7 to 9	8	7 to 15	8
Floating Point Processor	---	24-bit	7 to 9	7	7 to 15	11

† Hardware configuration jumpers determine whether the Sun-2 Ethernet Controller puts signals on the P2 bus. Normally, those jumpers are open and the board puts no signals on the P2 bus. However, the board always grounds the following signals:

Signal line	Extended Multibus Definition
P2-26	-15 volts
P2-32	Bus Master ALE
P2-38	AUX Reset
P2-55	Reserved - Bussed

If grounding these signals interferes with a non-Sun-supplied Multibus board, the Sun-2 Ethernet controller and that board may not share a P2 connector. This *caveat* does not affect any Sun-supplied boards.

‡ Hardware configuration jumpers determine whether Sun Color Display Controller puts any signals on the P2 bus. Normally, those jumpers are open and the board neither puts signals nor grounds signals on the P2 bus. Thus it may be installed in any free slot. Color boards originally shipped with Sun-1 systems (models 100, 100U, 150, or 150U) do not have these jumpers. These older color boards always generate P2 signals, so they must be installed in slots with their own private P2 connector or no P2 connector. Boards with the jumpered P2 signals are identified by serial numbers greater than 206, or the part number 501-0461-03.

Power Supply

Sun-2 Workstations use a number of different power supplies, depending on the specific model of workstation and whether certain factory-installed options are ordered (the integral 5 1/4-inch disk or 1/4-inch tape in a Sun-2/120 requires a larger power supply). All of these power supplies have five outputs: +5, -5, +12, -12, and +24 volts. The power supply must be specified for 110 volts or 220 volts at the time the system is ordered.

For most potential configurations, the power supply will not be a limiting factor. In a few unusual cases, the peak current rating from the +5 volt supply may be a constraint. In other configurations the *total* power output may be the limiting factor, rather than the power at any one voltage. The following table lists the power available in each Sun-2 Workstation configuration.

Sun Workstation Power Supply - Available Current (Amps)

Voltage	-----Sun-2/120----- (400 watt)	(750 watt)	Sun-2/170 (750 watt)
+5	50	100	100
-5	5	5	5
+12	10	10	10
-12	10	3	3
+24	8	3	3

The following table lists the power consumption of each board and component supplied by Sun Microsystems for these workstations. Note that a minimum stand-alone Sun-2/120 deskside workstation (Sun-2 CPU, Sun-2 1 MByte main memory, Sun-2 monochrome video, 5 1/4-inch disk, and 1/4-inch tape) requires approximately 210 watts, including 27.5 amps at +5 volts. For the power requirements of any other Multibus boards, please consult the manufacturer's specifications.

Sun Workstation Component Power Consumption

Component	Amps +5V	Amps -5V	Amps +12V	Amps -12V	Amps +24V	Total Watts
Sun-2 68010 Processor	6.0	-	-	-	-	30
Sun-2 1 MByte Main Memory	3.0	-	-	-	-	15
Sun-2 Monochrome Display Ctlr	4.0	-	-	-	-	20
Sun-2 P2 Terminator Board	-	-	-	-	-	0
Sun-2 10 Mbps Ethernet Ctlr	6.0	-	0.5	-	-	36
Sun-2 SCSI Host Adapter	5.0	-	-	-	-	25
Sun Color Display Controller	6.0	1.2	-	-	-	36
1/2-inch Tape Controller	4.0	-	-	-	-	20
SMD Disk Ctlr-Xylogics 450	8.0	1.0	-	-	-	45
Floating Point Processor	4.0	-	-	-	-	20
5 1/4-inch Disk Drive	1.5	-	3.5	-	-	51
SCSI-to-ST-506 Adapter	2.0	-	0.5	-	-	16
1/4-inch Tape Drive	4.0	-	-	-	1.0	44
SCSI-to-QIC-II Adapter	2.0	-	-	-	-	10

Junction Panel Configurations (External Cable Connectors)

Many of the options available for Sun Workstations, especially peripheral options, require bringing internal cables from the Multibus card cage to the back of the workstation. There, connectors are provided for the external cables that connect the workstation to the peripheral device. Some options require only one connector (such as an Ethernet interface) while others require two or more (such as SMD disk command and data cables).

Each model of Sun Workstation uses a similar scheme for routing these internal cables to a *junction panel* mounted on the back of the main enclosure. Sun-2/120 and Sun-2/170 junction panel plates are not the same size, however. In general, for each potential option there is a corresponding junction panel plate (occasionally more than one) containing the required connectors.

The number of slots available for these junction panel plates may place an upper limit on the number of peripheral options that can be added to one workstation. The first table below shows the number of junction panel slots on each model of Sun-2 workstation. The second table shows the number of slots required for each option sold by Sun Microsystems.

Workstation Model	Junction Panel Slots (Total)	Slots Used (Basic System)
Sun-2/120	9	3
Sun-2/120FS	9	2
Sun-2/170	7	1†

Sun Workstation Option Junction Panel Requirements

Option	External Connectors	Sun-2/120 Slots	Sun-2/170 Slots
Standard System			
Sun-2 68010 Processor	(2) Serial Ports	1	1†
Sun-2 1 MByte Main Memory	---	-	-
Sun-2 Monochrome Video	Video, Keyboard, Mouse	1	1
Sun-2 10 Mbps Ethernet Ctlr	Ethernet Transceiver	1	1
System Options			
SCSI Host Adapter	SCSI Bus, (4) Serial	2	1
SMD Disk Ctlr-Xylogics 450	SMD Command, (4) Data	2	1
1/2-inch Tape Controller	(2) Tape Control	2	1
Color Display Controller	(4) BNC Coaxial Cable	1	1
Floating Point Processor	---	-	-

Note that a minimum stand-alone Sun-2/120 deskside workstation (Sun-2 CPU, Sun-2 1 MByte main memory, Sun-2 monochrome video, 5 1/4-inch disk, and 1/4-inch tape) uses four (4) junction panel slots.

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† The first junction panel plate on the Sun-2/170 contains connectors for two basic system components: Sun-2 CPU (2 serial ports) and Sun-2 Ethernet (Ethernet transceiver).

External Peripheral Cabling Considerations

Each SMD disk drive option for a Sun-2/120 or Sun-2/170 is equipped with an *SMD Command In* and *SMD Command Out* connector. Subject to the present software limit of two disk drives per controller, any combination of SMD disks may be daisy-chained to the same controller. Separate *SMD Data* cables run from each disk drive to the Sun-2/120 or Sun-2/170 system enclosure.

The Sun-2/120 disk expansion pedestal was designed to stand next to the Sun-2/120 system pedestal. The length of the external disk command and data cables is two (2) feet. The Sun-2/170 disk and tape options were designed for installation in the same 19-inch rack as the Sun-2/170 system. In this case, and for the 1/2-inch tape drive on the Sun-2/120, the length of the external disk and tape command and data cables is six (6) feet.

Disk Storage Requirements

Sun Microsystems quotes the capacity of the disk drive options offered with Sun Workstations in *formatted* megabytes (for example, 42 MB for the integral 5 1/4-inch disk option on the Sun-2/120). When configuring a system, this number is more useful than the unformatted capacities quoted by disk drive vendors, but even formatted capacity does not tell the entire story.

In the normal situation, software divides the formatted disk into a number of "logical disks," or *partitions*. One or more of these partitions are used for swap space. For these partitions the useable capacity is the full formatted capacity.

UNIX *filesystems* are built in other partitions. In these cases the useable capacity (megabytes of user data that will fit in the partition) is reduced from the formatted capacity by approximately 7 percent. Operating system data structures that maintain directory information for the partition occupy the "lost" space.

The Sun UNIX filesysystem, by default, reserves an additional 10% of a partition's available storage for free space. This allows the operating system to make efficient disk sector allocation decisions. Users may change this parameter to recover (some of) the reserved free space, using the *tunefs* command, but this may result in reduced performance due to excessive disk seeking.

Sun UNIX, with all its utilities, on-line documentation, configuration modules for the kernel, and games, occupies a substantial amount of disk storage. Providing the ability to run processes with large virtual address spaces (up to 16 megabytes each) also requires large amounts of swap space for the data part of that address space. Finally, the UNIX programming environment is file-intensive; many programs create temporary files for scratch storage, buffers, or failure protection, while printing, electronic mail, and *uucp* all use temporary files for spooled messages and output. For optimum system useability and performance it is essential to configure Sun Workstations and Sun networks with adequate disk capacity; all of these factors must be considered to estimate disk requirements.

Properly configuring adequate disk storage for a network of Sun Workstations or a standalone Sun Workstation requires considering application requirements as well as the size of the basic Sun software distribution. For a network cluster, it also requires understanding the basic disk structure used to support diskless workstations. The first table that follows breaks out the minimum size of the standard Sun software distribution. The next diagram shows the default logical disk layout for a standalone workstation, and the the following diagram shows the default logical disk layout for a network disk server.

Minimum Disk Requirements
of the Sun UNIX Software Distribution

Software Category	Space Required (Megabytes)
Editors, Text Processing Tools /bin/{ed,diff} /usr/bin/{*bib,checkeq,eqn,*grep, look,refer,*roff,spell*,tbl} /usr/dict/* /usr/ucb/{checknr,ex/vi,grep,soelim}	1.25 MB
Compilers and Programming Tools /bin/{adb,as,cc,ld,make} /usr/include/* /lib /usr/lib/* /usr/bin/{f77,lex,lint,yacc} /usr/sccs/* /usr/ucb/{dbx,eyacc,pc,pi,pix,pmerge,px,pxp,pxref,sccs}	6.25 MB
SunCore™ Libraries /usr/lib/libcore{,77}.a	0.75 MB
SunWindows Tools and Libraries /usr/lib/lib{pixrect,suntool,sunwindow}.a /usr/suntool/*	1.75 MB
Networking, News, and Mail /bin/{mail,rmail} /usr/lib/sendmail* /etc/hosts* /usr/bin/{*news,tip,uu*} /etc/in.* /usr/spool/* /usr/etc/in.* /usr/ucb/{mail,prmail}	1.25 MB
Other Utilities and UNIX Operating System /vmunix /usr/bin/* /bin/* /usr/dict/* /dev/* /usr/etc/* /etc/* /usr/mdec/* /stand/* /usr/ucb/*	7.00 MB
Configurable UNIX Kernel /sys/*	1.50 MB
Required Temporary File Space /tmp/* /usr/tmp/*	2.00 MB
Minimum **excluding User Files**	21.75 MB
On-line Documentation /usr/man/*	2.90 MB
Standard Demo Programs /usr/demo/*	3.75 MB
Games /usr/games/*	1.75 MB
Complete **excluding User Files**	30.15 MB

The estimates contained in this table reflect Sun UNIX release 1.0. They will fluctuate (and generally increase) from one release to the next as additional utilities, window system tools, and demos are added to the system.

In the partitioning tables that follow, the number of megabytes shown reflects megabytes of formatted disk space *before* UNIX filesystems are constructed in any

partitions. Please note that the indicated sizes are minimal. Running large virtual address space applications, especially with multiple active windows, is likely to require much larger swap partitions than those shown.

Normal Disk Partitioning for a Standalone System

Partition Contents	Partition Size (42 MB Disk)	Partition Size (larger disks)
root filesystem (/)	8 MB	8 MB
[swap space]	8 MB	16 MB
user filesystem (/usr)	26 MB	40 MB +

Normal Disk Partioning for a Network Disk Server

Partition Contents	Partition Size
server filesystem	8 MB
[server swap space]	6 MB
public filesystem (/pub)	20 MB
clientA filesystem	8 MB
[clientA swap space]	6 MB
clientB filesystem	8 MB
[clientB swap space]	6 MB
clientC filesystem	8 MB
[clientC swap space]	6 MB
(etc.)	(etc.)

In the server configuration, the root filesystem for each node contains private data belonging to that node, while the public filesystems are accessible to all nodes. There is always one root filesystem containing all files (including "/usr") and one swap area per node, including the server, plus one public filesystem. There may be more than one public filesystem, and each node may have more than one private filesystem.

The following table shows the software from the basic distribution that is normally placed into the standard public filesystem:

Minimum Public Partition Disk Requirements of the Sun UNIX Software Distribution

Software Category	Space Required (Megabytes)
Editors, Text Processing Tools	1.25 MB
Compilers and Programming Tools	6.25 MB
SunCore Libraries	0.75 MB
SunWindows Tools and Libraries	1.75 MB
Networking, News, and Mail (except /usr/spool/*)	1.00 MB
Other Utilities and UNIX Operating System (except /dev/* and /etc/*)	5.75 MB
Minimum **excluding User Files**	18.00 MB
On-line Documentation	2.90 MB
Standard Demo Programs	3.75 MB
Games	1.75 MB
Complete **excluding User Files**	26.40 MB

Note that the normal public partition size does not allow loading */usr/man/**, */usr/demo/**, and */usr/games/**.

Example: Using the normal allocations, a 10-user network with a dedicated server requires 34 MB for the server and public area plus 14 MB per client, for a total of 174 MB. This is a relatively small disk configuration for such a network. On each workstation, the largest virtual address space that any application process could have is under 4 MB.

Swap Partition Size and Process Virtual Address Space

When Sun UNIX is running in multi-user mode (the normal situation), there are several processes running that perform system-related housekeeping functions. The operating system requires that swap space be available for these processes as well as user programs. With one user logged in at the Sun Workstation console but idle, these processes require just under 2 MB of swap space. One user, running the window system with four "virtual terminal" windows, but no application programs, requires approximately 4 MB of swap space.

Especially with smaller partitions, the operating system swap space allocation algorithms do not allow the use of all available swap space for a single process. For this reason the largest virtual address space that one process may have depends in a non-straightforward way on the size of the swap partition. This relationship is illustrated in the following table, which was measured with Sun UNIX running multiuser but without the window system:

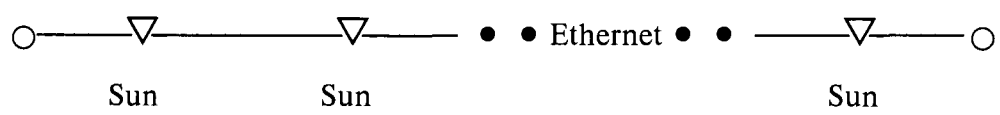
Swap Partition Size	Maximum Virtual Address Space
4 MB	1.7 MB
6 MB	3.3 MB
8 MB	6.1 MB
12 MB	11.2 MB
16 MB	16.0 MB

Other, lesser considerations affect the maximum virtual address space. First, all of the quoted maximum virtual address spaces in the table above include 32 KB of per-process virtual memory management overhead. This space is not available to the user's application program. Second, all UNIX programs are divided into three segments: *text* (code), *data*, and *stack*. For swap space purposes, the effective size of each of these segments is the next higher multiple of 32 KB, which may leave small unused fragments at the end of each segment.

Because swap space usage is dynamic, calculating precise swap space requirements is difficult. For example, the code part of programs is usually sharable among all users of the program (e.g. the *csh* command interpreter, which might be running in several virtual terminal windows), so *text* swap space is required only for the first instance of a process running that program. When establishing disk configurations, swap space should be allocated with a generous margin over estimated application requirements.

Ethernet Cabling Considerations

The general structure of an Ethernet cable installation looks like the following:



○ = Ethernet Terminator
▽ = Ethernet Transceiver

There are two general categories of Ethernet transceivers. The *cut-and-insert* style requires breaking the Ethernet cable and mounting special male connectors on the cut ends of the cable. The *vampire-tap* style requires special tools for boring a hole in the insulation and outer shield of the Ethernet cable. Each Sun Workstation is supplied with an Ethernet transceiver of the *cut-and-insert* type, which has two female connectors for attaching to the Ethernet cable.

For small or very localized Ethernet installations, customers may purchase 15-meter lengths of Ethernet cable from Sun Microsystems. Male connectors are already mounted on the 15-meter Ethernet cable lengths sold by Sun. Included with each Sun Workstation transceiver is a set of the special male connectors for the ends of the Ethernet cable. These extra connectors are for customers attaching a Sun Workstation to an existing Ethernet cable. For larger or more separated installations, Sun recommends that customers purchase longer unbroken lengths of Ethernet cable from vendors such as Belden Cable or 3COM Corporation.

Each electrically continuous Ethernet cable must be terminated at both ends by Ethernet terminators. Sun Microsystems sells Ethernet terminators already equipped with the male connectors that attach directly to a Sun Ethernet transceiver. The terminators do not attach directly to the 15-meter lengths of Ethernet cable.

Sun Workstations may serve as gateways between physically separate Ethernets. When a gateway is in place, users see a single logical network and have transparent access to all the systems on both physical networks. For performance reasons, Sun UNIX places two small limits on this transparency: a fileserver node and its clients must be on the same physical network, and a fileserver will serve clients on only one physical network, even if the fileserver node is also a gateway node.

A gateway workstation simply has one Ethernet connection to each of the separate Ethernet cables. The software that performs the internetwork routing is included in the standard Sun UNIX software release. The hardware required is an additional Ethernet interface and transceiver, available as an option on each model of Sun Workstation.

Network Server Configurations

Any model of Sun Workstation equipped with appropriate peripherals may act as a network resource for services such as printing, electronic mail forwarding, network-wide accounting and error logging, and network disk storage. The standard Sun UNIX release supports all these capabilities. Depending on activity load and performance requirements, one node may provide all services, particular nodes may be dedicated to providing each service, or an intermediate approach may be most appropriate. There may also be more than one node providing certain high-demand services, for example two network disk servers on the same physical Ethernet.

The most difficult assessment to make in advance is the proper mix of "diskfull" and "diskless" clients, and the hardware configuration of each, that one network disk server will support while providing acceptable response time to each client. The answer to the question depends on many configuration variables and most strongly on the network activity generated by the users' applications. Adequate quantitative performance data has not yet been developed, so this issue of the *Sun Workstation Configuration Guide* presents a qualitative evaluation of the major issues involved.

Sun UNIX permits a maximum of 20 client workstations per network disk server. These clients may be completely diskless, or they may have their own local disk as well as sharing the network disk server. For many applications, one server with twenty diskless clients will not provide adequate performance. Based on the experience of existing Sun Workstation network installations both at customer sites and internal to Sun Microsystems, 12 to 16 diskless users running a wide mix of tasks in multiple windows (editing, *troff*ing, compilations, debugging, graphics programs, electronic mail) is a more realistic upper bound.

Other than the applications running on each workstation, the most important variables for selecting configurations are the server disk configuration, the amount of main memory on each client and whether the client has a local disk. Sun UNIX Release 1.0 does not support overlapped seeks for multiple disk drives on one controller. Adding a second disk drive to a controller will increase on-line capacity but will not significantly increase performance. Adding a second disk drive with its own controller will increase performance if data is distributed appropriately across both disks.

The Sun UNIX maximum of 20 clients per server is applicable regardless of the amount of disk storage attached to the server. The network disk configuration utility supplied with Sun UNIX enforces other maximums based on the amount of disk storage: with one 65 MByte disk, two (2) clients; with one 130 MByte disk, ten (10) clients; with one 380 MByte disk, twenty (20) clients. The first two of these limits result in *tiny* disk space allocations for the client workstations, however. Please refer to the *Disk Storage Requirements* section above for additional information.

If certain applications make use of large virtual address spaces in ways that cause extensive paging, the most effective performance boost for the entire network will come from adding main memory to the workstation(s) running those applications (see *Sun Workstation Main Memory Useage*, above). If other applications process large amounts of disk data serially, the network will benefit more from adding a local disk drive to the appropriate workstation(s).

A cluster of Sun Workstations is normally evaluated against a timeshared super-minicomputer system performing the same application. The workstation approach replicates the pieces of the computing environment most critical to predictability and responsiveness: the processor, main memory, and bitmapped graphics display. In the base case, mass storage is centralized by both approaches; the difference is what "bus" (backplane or Ethernet) is used to access mass storage.

If the intended application is limited by competition for the disk arm(s) under timesharing, the workstation approach may ameliorate that problem. Disk caching occurs in *each* workstation, providing a much larger effective disk cache and at the same time a much higher cache hit rate.

Other approaches for improving performance (adding additional disk drives and/or controllers and distributing data properly among them) apply to both workstations and timesharing systems. The workstation approach offers additional possibilities that are not possible or not cost-effective for time-sharing systems, however. Workstations can each be customized to the requirements of the application running on that workstation.

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