

# TECHNOLOGY BRIEF

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Compaq Computer  
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Communications

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## Compaq ProLiant 7000 Server Technology

*This technology brief describes the high-performance, high-availability, and management technologies built into the Compaq ProLiant 7000 Server. The high-performance technologies include Intel's 32-bit Pentium® II Xeon™ processor, as well as improvements to the ProLiant 7000's PCI bus architecture. Compaq has fulfilled its promise to extend the functionality of the ProLiant 7000 by providing an upgrade path to four or eight Pentium II Xeon processors.*

*The high-availability technologies include: PCI Hot Plug technology, redundant network interface controllers, redundant hot-plug power supplies, drives, and fans; and redundant processor power modules. The ProLiant 7000 design also contains easy-access components that reduce downtime for service or upgrades. The ProLiant 7000 incorporates key management technologies, such as the Integrated Management Display, Integrated Remote Console, and Auto-Default ROM Configuration, that further enhance availability.*

*The intended audience for this paper is the engineer or system administrator familiar with existing Compaq technology and servers. For those less familiar with Compaq technology, please see the related technology briefs referenced in this document. For more information about the ProLiant 7000, see the complete list of features at <http://www.compaq.com/products/servers/ProLiant7000/quickspecs.html>.*

Please direct comments regarding this communication to the ECG Technology Communications Group at this Internet address: [TechCom@compaq.com](mailto:TechCom@compaq.com)

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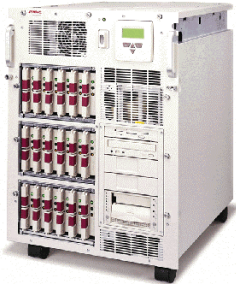
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**Compaq ProLiant 7000 Server Technology**

Second Edition (June 1998)

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ProLiant 7000 Server

### INTRODUCTION

In today's business environment, customers require powerful servers with fault-tolerant features to keep their businesses running 24 hours a day, 7 days a week. The Compaq ProLiant 7000 Server provides breakthrough high-performance and high-availability technologies that keep the server up and running in the most demanding 7x24 environments. This technology brief explains the features of the new ProLiant 7000 Servers that support Pentium II Xeon processors, and how previously purchased ProLiant 7000 Servers can be upgraded to support up to four Pentium II Xeon processors. This upgrade path provides investment protection and gives customers confidence of a long life for the ProLiant 7000.

This technology brief also describes the management technologies of the ProLiant 7000 Server. Many of these technologies are covered in more detail in separate technology briefs, which are referenced in this document.

### HIGH-PERFORMANCE TECHNOLOGIES

#### Pentium II Xeon Processor Technology

The Pentium II Xeon processor uses the same core architecture as previous Pentium II processors, and it continues the same 32-bit technology line, which makes it fully software compatible with all current Pentium Pro and Pentium II processors. Like the Pentium Pro and Pentium II processors, the Pentium II Xeon uses dynamic execution techniques and a dual independent bus structure. The dual independent bus structure provides a separate bus between the processor and the secondary level 2 (L2) cache. See the technology brief *Deschutes Family Processor Technology*, document number [ECG050/0698](#) for more details on the IA32 architecture and the Pentium II Xeon processor.

The Pentium II Xeon processor provides higher levels of performance through architectural enhancements including:

- 100-MHz AGTL+ system bus
- Processor frequencies starting at 400 MHz and increasing to 450 MHz and beyond
- Full-speed L2 cache bus
- L2 cache configurations starting at 512 KB and 1MB and increasing to 2 MB
- Slot 2 cartridge
- Support for up to 64 GB of cacheable system memory
- MMX technology

#### 100-MHz AGTL+ System Bus

An important enhancement is the move from the 66-MHz GTL+ bus used by the Pentium Pro and Pentium II processors to the higher frequency 100-MHz AGTL+ bus. This provides faster data pathways between the processor and random access memory (RAM), and between the processor and system peripherals.

#### 400- and 450-MHz Core Processor Frequencies

One of the most significant differences between the Pentium II Xeon processor and current Pentium Pro processors is the much higher processor frequency. Pentium II Xeon processors, currently at 400 MHz, are expected to reach 450 MHz by the end of 1998, and to increase beyond 450 MHz in later versions.

### Larger Cache Sizes

The Pentium II Xeon processor supports larger L2 caches than previous Intel processors. Pentium II Xeon processors are initially available in 512-KB and 1-MB configurations with future plans for a 2-MB cache. In contrast, the Pentium Pro processor has a maximum 1-MB cache. The larger data cache provides a significant performance boost, especially in symmetric multiprocessing (SMP) configurations and systems used in memory-intensive applications, such as on-line transaction processing.

### Full-Speed L2 Cache Bus

Previous Pentium II processors have a half-speed L2 cache bus that connects the cache memory and the central processing unit (CPU) core. This means a 266-MHz Pentium II actually transfers data between the L2 cache and CPU core at 133 MHz. In contrast, the Pentium II Xeon processor has a full-speed cache bus, which means that a 400-MHz Pentium II Xeon processor transfers data between the L2 cache and processor core at a full 400 MHz. The combination of the full-speed cache bus and the larger cache size greatly enhances the performance of the Pentium II Xeon processor relative to the Pentium Pro and previous Pentium II processors, especially in larger SMP configurations and memory-intensive applications.

### Slot 2 Cartridge

Pentium II processors are packaged in a single edge contact (SEC) cartridge. The SEC cartridge for a Pentium II processor inserts into the Slot 1 connector on the motherboard, while the Pentium II Xeon's SEC cartridge inserts into the Slot 2 connector. The form factor of the Slot 2 cartridge is larger than that of the Slot 1. Compared with the Slot 1 cartridge, the Slot 2 cartridge has

- More pins (330 pins versus 242 pins for the Slot 1).
- Support for a four-processor multiprocessing bus.
- Load and signal integrity modifications.
- The ability to deliver more power to support the larger, full-speed L2 cache.

The larger cartridge and corresponding motherboard connector for the Pentium II Xeon processor require more pins. The additional pins on the Slot 2 cartridge provide support for a four-processor (4P) multiprocessing system bus. Load and signal integrity modifications in the new design allow a Pentium II Xeon processor to drive up to four main loads on the AGTL+ bus—three other processors and a memory and I/O controller. This allows the Pentium II Xeon to scale to 4P configurations. The extra pins also provide the additional power and ground connections needed to support the larger, full-speed L2 cache.

### 64-GB Cacheable Address Space

The Pentium II Xeon processor is able to access up to 64 GB of RAM; however, the memory controller chipset determines the actual size of supported memory. Initial Pentium II Xeon chipsets support memory configurations up to 8 GB.

### MMX Technology

The Pentium II Xeon processor supports MMX instructions, which allow certain applications to operate on multiple data locations with a single instruction call to the processor. The MMX functions are primarily used in multimedia applications such as audio and video manipulation; however, increasing numbers of specialized business applications are being written to take advantage of MMX capabilities.



*Pentium II Xeon (Slot 2 cartridge)*



*Pentium II (Slot 1 cartridge)*

**Pentium II Xeon Performance**

Compaq tested performance of Pentium II Xeon processors in the ProLiant 7000 server using two industry-standard benchmarks: the TPC-C benchmark test and the TPC-D version 1.3.1 benchmark test. The TPC-C benchmark measures performance in an on-line transaction processing environment, while the TPC-D benchmark represents a broad range of decision support (DS) applications that require complex, long-running queries against large complex data structures. Real-world business questions were written against this model, resulting in 17 complex queries.

Tables 1 and 2 show the configurations used for these benchmark tests and the performance results, which set new industry-wide performance levels for a single-node Intel-based system. For a full discussion of these benchmark results in comparison to published benchmark results for other 4-way and 8-way systems, read the Compaq Benchmark Summaries available at <http://www.compaq.com/products/servers/proliant7000-xeon/>.

**Table 1: Results of TPC-C Benchmark Test**

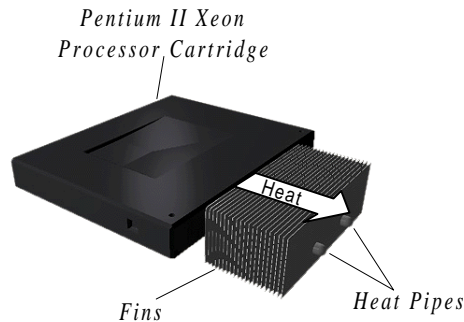
<b>System</b>	Compaq ProLiant 7000 Server
<b>No. of Processors</b>	4
<b>Processor Type Speed/L2 Cache</b>	Pentium II Xeon 400 MHz/1 MB
<b>TPC-C Throughput</b>	18,127 tpmC
<b>Price:Performance</b>	\$27 per tpmC
<b>OS</b>	Windows NT Server 4.0 Enterprise Edition
<b>Database</b>	Microsoft SQL Server 7.0 Enterprise Edition

**Table 2: Results of TPC-D Benchmark Test**

<b>System</b>	Compaq ProLiant 7000 Server
<b>No. of Processors</b>	4
<b>Processor Type Speed/L2 Cache</b>	Pentium II Xeon 400 MHz/1 MB
<b>TPC-D Power</b>	1694.6 QPPD @100 GB
<b>TPC-D Throughput</b>	553.1 QthD @100 GB
<b>Price:Performance</b>	\$390.65 per QphD @ 100 GB
<b>OS</b>	Windows NT 4.0
<b>Database</b>	Oracle 8.0.4

### Thermal Design

Compaq has designed an innovative thermal cooling solution for the Pentium II Xeon processor that contributes to increased system reliability and future performance scalability to 8-way architectures. Heat pipes transfer heat away from the Slot 2 cartridge thermal plate to cooling fins mounted atop the cartridge (Figure 1).



*Figure 1: Heat pipes and fins for the Pentium II Xeon processor cartridge.*

This top-mounted position and the direction of the cooling fins are advantageous in two important ways. First, this design cools efficiently regardless of the direction of air flow (vertical or horizontal). Therefore, the same Slot 2 cartridge and heat sink combination used in the ProLiant 7000 4-way configuration can also be used in future 8-way configurations by simply reorienting the processors. Second, because the heat fins are top mounted, the redundant processor power module can be placed in its optimal position, next to the processor, to maintain short signal trace lengths across the 100-MHz system bus (Figure 2). The resulting improvements to power supply regulation and system bus signal quality increase system reliability. Moreover, the smaller spacing between processor sockets makes possible future upgrades to 8-way Pentium II Xeon architectures using the same chassis design.

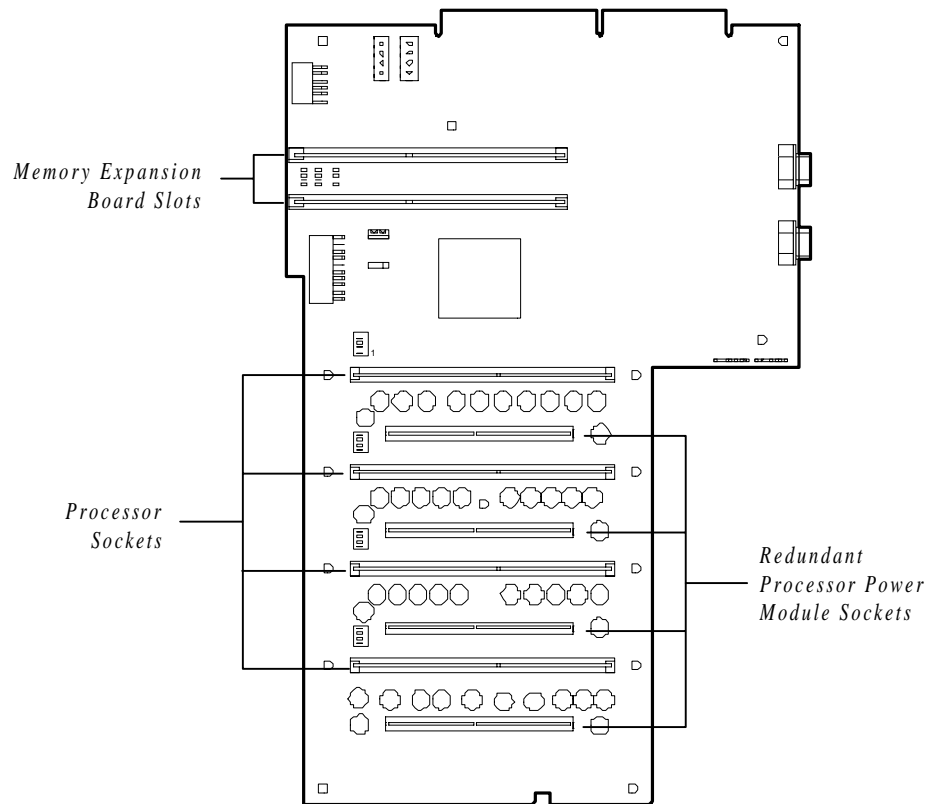


Figure 2: Processor Board.

### ProLiant 7000 Architecture

The ProLiant 7000 architecture allows customers to scale the processor and memory subsystems to run their mission-critical applications. The following sections describe the ProLiant 7000 architecture—the processor board, memory expansion boards, input/output (I/O) board, and standard peripheral board.

#### Processor Board

The processor board (Figure 2) has four sockets for Pentium II Xeon processors, four sockets for redundant processor power modules, and two slots for memory expansion boards. The redundant processor power modules maintain the precise voltage requirements of the processors. The memory expansion boards allow customers to scale system memory up to 8 GB. The ProLiant 7000 ships with one Pentium II Xeon processor, one redundant processor power module, and two memory expansion boards. Processor terminator cards are also provided with the server. A processor terminator card must remain in each processor socket not occupied by a processor.

#### Memory Expansion Boards

The ProLiant 7000 ships with two memory expansion boards installed on the processor board. As shown in Figure 3, each memory expansion board has sixteen memory sockets (four banks of four sockets) for Dual In-Line Memory Modules, or DIMMs. The DIMMs must be installed in sets of

four, and each DIMM in a given bank must be the same size, type, and speed. The ProLiant 7000 memory expansion board has the following features:

- Error Checking and Correcting (ECC) Memory with single-bit error correction and detection down to a single DIMM, and multi-bit error detection down to the memory bank.
- Extended Data Out (EDO)<sup>1</sup>, 60-ns DIMMs in 16-, 32-, 64-, 128-, and 256-MB sizes.
- Expandable to 8 GB (2 memory expansion boards x 16 DIMMS x 256-MB/DIMM).
- Peak data transfer rate of 1.6 GB/s
- Concurrent CPU-to-memory and PCI-to-memory accesses.

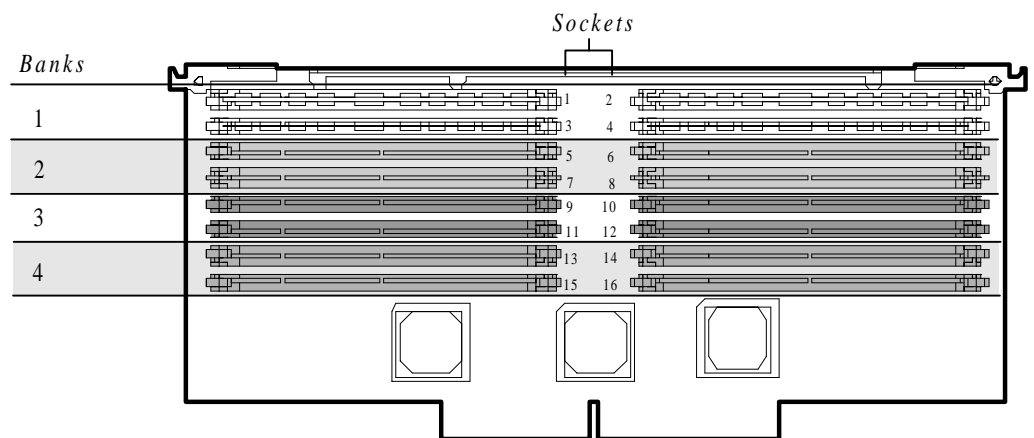


Figure 3: Bank designations and DIMM socket numbers on Memory Expansion Board.

The peak memory transfer rate of 1.6 GB/s supports the maximum data rates on the processor bus (800 MB/s) and PCI buses (532 MB/s) concurrently, using industry standard ECC EDO DIMMs. Each memory board contains four banks of 4:1 interleaved DIMMs. Accesses to banks of memory on the memory board are overlapped using Address Bit Permuting (ABP). Accesses to banks of memory that reside on separate boards are overlapped using Card to Card (C2C) interleaving. The ABP and C2C interleaving features are automatically enabled when banks of memory are populated with the same type of DIMMs.

### I/O Board

The I/O board (Figure 4) has ten expansion slots and three 33-MHz PCI buses:

- Five 64-bit PCI Hot Plug slots (PCI Bus 3)
- Four 32-bit PCI Hot Plug slots (PCI Buses 1 and 2)
- One ISA modem slot

The five 64-bit PCI expansion slots on PCI Bus 3 include three PCI Hot Plug slots and two PCI Hot Plug slots with extended SCSI. All 32-bit PCI adapters work in any of the five 64-bit expansion slots, and all 64-bit adapters work in the 32-bit expansion slots. In addition, the two extended PCI slots allow the Smart Array 3100ES Controller to route three SCSI buses to the I/O

<sup>1</sup> For more information on Compaq's memory technology, see technology brief *Memory Technology Evolution*, document number [518A/0697](#).



## TECHNOLOGY BRIEF *(cont.)*

board (slot 10/11 SCSI ports 1, 2, and 3) where the buses are cabled to the three internal drive cages. This eliminates cabling between the controller and I/O board.

Slots 5 and 6 on PCI Bus 2 are shared with an embedded dual-channel SCSI controller (SCSI ports 2 and 3). Slots 3 and 4 on PCI Bus 1 are shared with the Standard Peripheral Board. The aggregate peak data transfer rate across the three PCI buses is 532 MB/s. Because of the high bandwidth of the three PCI buses, PCI bus load balancing is not required.

The system interlocks provide a closed-loop checking mechanism for verifying proper component mating and cabling interconnects between critical server components. Three LEDs on the I/O board can be used to isolate improperly mated components. To protect critical components, the server will not power up if the interlock is broken.

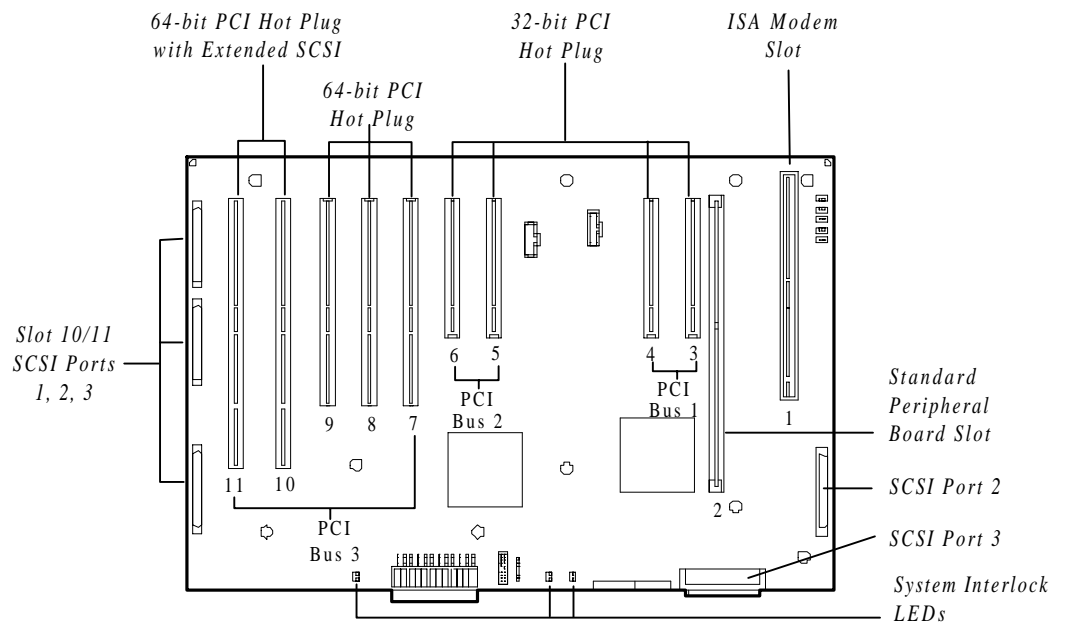


Figure 4: I/O Board.

### Standard Peripheral Board

The Standard Peripheral Board (Figure 5) contains ASICs (among them four Compaq-designed ASICs) to provide connections for all system management and legacy components. This includes connectors for the mouse, keyboard, IDE CD-ROM, diskette drive, video, parallel devices, SCSI devices, and Integrated Management Display (IMD). The system ROM, configuration switch, and battery for CMOS are also located on this board.

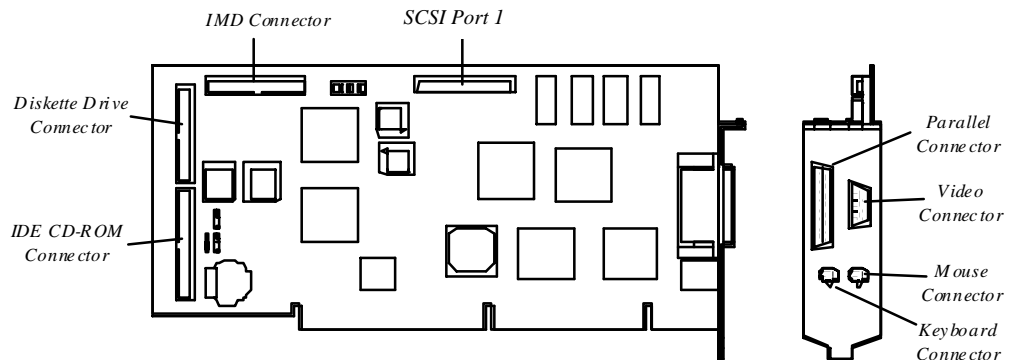


Figure 5: Standard Peripheral Board.

### HIGH-AVAILABILITY TECHNOLOGIES

Industry tolerance of server downtime continues to decrease as companies become more global, decentralized, and aware of downtime costs. A 1996 study<sup>2</sup> found that 37 percent of Fortune 1000 companies require recovery from failure in less than three minutes. The ProLiant 7000 answers the demand for high availability by incorporating the following features into the server hardware:

- Redundant network interface controller technology
- Redundant, hot-plug fans
- Redundant processor power modules
- Redundant, hot-plug power supplies
- Hot-plug drives
- Compaq Smart Array 3100ES Controller
- PCI Hot Plug technology for PCI adapters

Redundant components ensure that the server is highly fault-tolerant. In many cases, if a power supply, fan, processor power module, or I/O board fails, the redundant standby component can take over operation with no downtime to the server. With the addition of hot-plug capabilities, server downtime can be eliminated while components are being replaced, added, or upgraded.

<sup>2</sup> Demand Assessment Requirements Tracking Study, Executive Summary, The Standish Group International, 1996.

### **Redundant Network Interface Controller Technology**

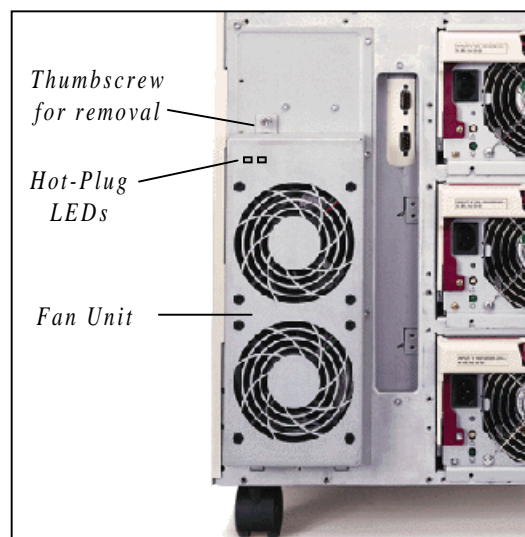
Compaq's Redundant Netelligent NIC technology allows two similar NICs to share a single instance of device driver code. One NIC becomes the active network controller and the other NIC acts as a standby controller. If the active NIC fails, the network traffic can be switched automatically to the standby NIC. This redundancy eliminates the NIC or cable as a single point of failure. With PCI Hot Plug technology, the failed NIC can be replaced without shutting down the system. Thus, the end-user can have continuous service and the administrator can greatly reduce both planned and unplanned downtime.

**Note:** Software that supports a redundant NIC configuration is available on the Compaq Support Software CD that ships with the server.

The ProLiant 7000 supports a Netelligent dual-port 10/100 TX PCI Network Interface Controller (NIC). The NIC has two ports for 10BaseT or 100TX Ethernet. The ports are seen as two separate local area networks LANs, both supporting full-duplex Ethernet (20 Mb/s) and Fast Ethernet (200 Mb/s). If only one of the ports is used, a terminator plug is provided for the unused port. Redundancy is also available across the two ports with one NIC.

### **Redundant Hot-Plug Fans**

The ProLiant 7000 has two primary hot-plug fans (external) and two redundant fans (internal) for the processor and memory section. The pair of primary hot-plug fans for the processor and memory section is enclosed in a single fan unit (Figure 6). The primary hot-plug fans spin under rotor control; while the internal, redundant fans spin freely in the server airflow because they are not required for cooling. Should the primary fan unit fail, the redundant fans start automatically. The hot-plug primary fan unit can be easily removed by means of a single thumbscrew. The hot-plug LEDs indicate the status of the fans: Green indicates the fans are functioning properly, and amber indicates the fans have failed.



*Figure 6: Hot-plug (external) primary fan unit for the processor and memory section.*

The server also has one primary hot-plug fan and one redundant hot-plug fan for the I/O board in the upper section of the server (Figure 7). Should the primary fan fail, the redundant fan will start automatically.

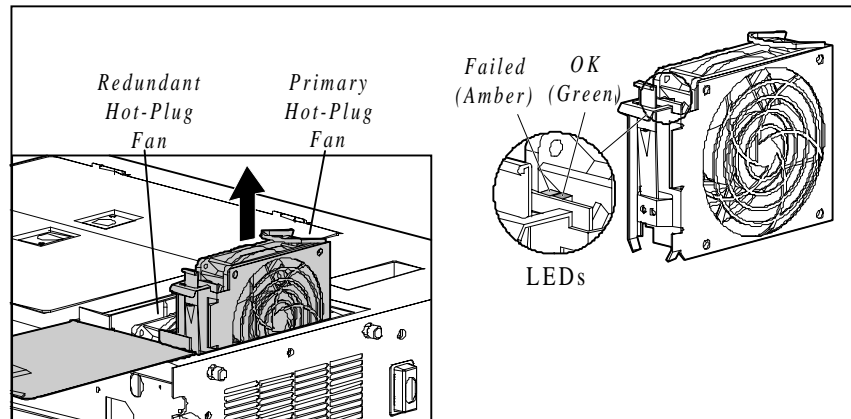


Figure 7: Hot-plug fans for the I/O section.

The server fan control logic operates independent of the system processor and operating system (OS). Regardless of the OS that is running or its condition, the fan control logic and the server temperature monitoring circuitry work together to cool the server effectively.

The fans have two speeds: normal and high. Under typical circumstances, the normal fan speed is sufficient to cool up to four processors, eighteen hard disk drives, and ten I/O expansion boards. As a precaution against increases in ambient air or localized internal temperatures, Compaq has established three thermal trip points, as shown in Figure 8. When the first thermal trip point is reached, the fans adjust automatically to high speed to increase cooling.

Users can select whether to enable the following server response to the second thermal trip point. If the internal air temperature exceeds the second trip point, the OS initiates a controlled shutdown of the server. Simultaneously, a warning message is sent to the IMD and Compaq Insight Manager. The server restarts automatically when it has cooled sufficiently.

Finally, in the unlikely event server temperature continues to rise, a third trip point shuts down the power supplies to protect critical components from overheating. The server restarts automatically when it has cooled sufficiently.

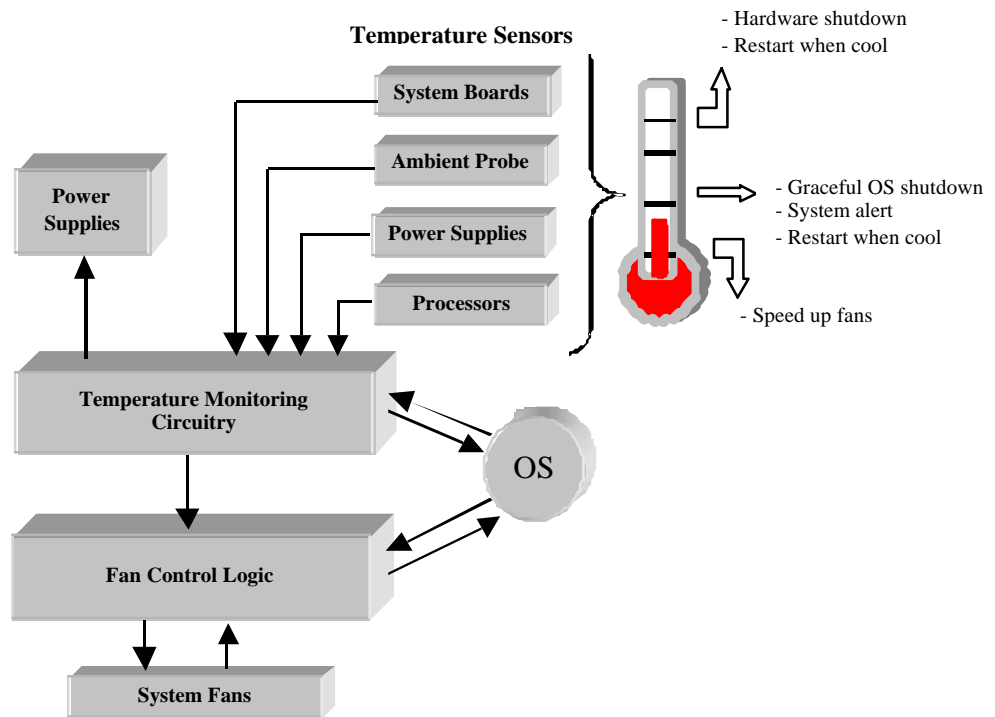


Figure 8: Schematic diagram of fan control logic.

### Redundant Processor Power Modules

Each processor in the ProLiant 7000 has its own redundant processor power module (PPM). PPMs are also known as voltage regulator modules. The PPMs deliver the precise voltage requirements of the processors. The core voltage for the 400-MHz Pentium II Xeon processor is 2.0 V and the voltage for the cache is 2.5 V.

Compaq PPMs are programmable and support all current and future versions of Slot 2 processors. Each PPM module has redundant circuitry. If a failure occurs in one circuit of the module, the other circuit automatically takes over the task of regulating power to the processor.

The ProLiant 7000 ships standard with one redundant PPM. An additional redundant PPM is available in each processor option kit.

### Redundant Hot-Plug Power Supplies

The ProLiant 7000 uses one of the newest Compaq technologies to reduce downtime: intelligent, redundant, hot-plug power supplies. The server ships standard with two, dual-rated 750 W/500 W power supplies and supports three power supplies for an n+1 redundant configuration. The power supplies are connected to a separate power backplane in the server. Even if a power supply fails, its internal fans will continue to operate and help cool the server.

The power supply has an embedded microcontroller and an Inter-Integrated Circuit (I<sup>2</sup>C) bus that communicates the status back to the system health drivers.<sup>3</sup> The health drivers then send status information to the IMD and to Compaq Insight Manager.

<sup>3</sup> For additional details about Compaq's intelligent power supplies, see the technology brief *Intelligent Power Supply Technology*, document number [ECG016/0198](#).

## TECHNOLOGY BRIEF *(cont.)*

The microcontroller performs the following functions:

- *Self-test* - The intelligent power supplies perform their own power-on self-test that checks temperature, RAM integrity, ROM version, analog-to-digital conversion accuracy, and non-volatile memory integrity of the power supply.
- *Auto Line Sensing* - Because the power supplies are rated for both 750W (at 220V) and 500W (at 110V), a line-sensing feature automatically recognizes which line voltage is connected. The user does not need to configure the supply for voltage.
- *LED Standby Controls* - The microcontroller also drives two status light-emitting diodes (LEDs) on the back of the power supply that indicate AC and DC power status, as shown in Figure 9. This gives the user vital status information at a glance.

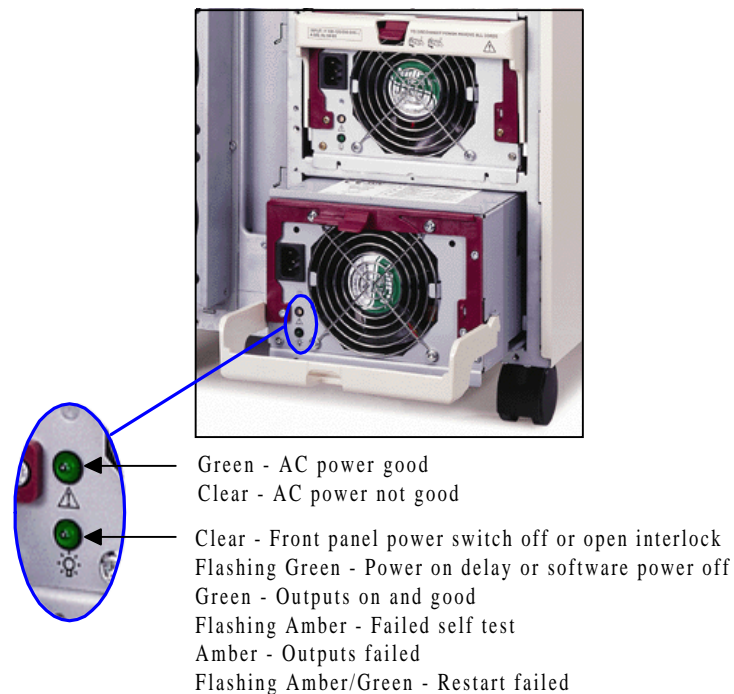


Figure 9: Power supply LED status indicators.

**Power Down Controls**

As shown in Figure 10, the server power switch connects to the microcontroller rather than directly to the power line. This means that turning off the power switch does not turn off power instantly. Instead, the microcontroller communicates with the system board and the OS by way of the I<sup>2</sup>C bus. The power down controls can be configured in one of three ways:

- Secure Mode - Power supply will not shut down if power switch is flipped.
- Delay Mode - Power supply will shut down after a 10-second delay. This allows time to reactivate the switch if it was mistakenly flipped.
- Graceful Shut Down - A 10-second delay counter begins as a message warning of an imminent power-down goes to Compaq Insight Manager and the IMD. Because of the communication between the microcontroller and the OS, the OS can delay the power down until all running applications have properly closed. Should the OS not be running, the power goes down when the delay counter expires.

The power down control feature is supported under Microsoft Windows NT 4.0. Both Novell and SCO are planning to implement the power down control in the future.

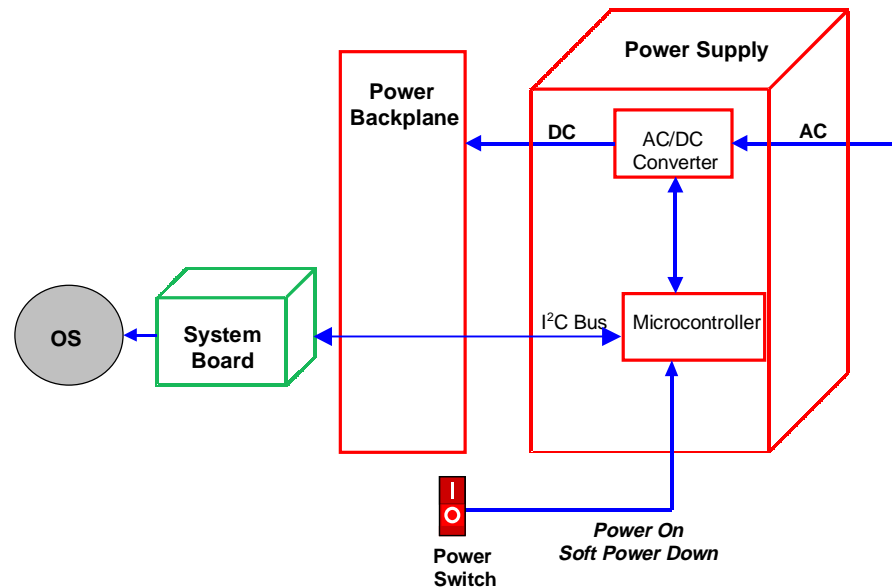


Figure 10: Power supply schematic.

**Load Balancing**

The power supplies automatically load balance to within 10 percent of the average current of all supplies. Before the power comes up, the master power supply matches its output load rails to those of the other power supplies so that the load is automatically balanced across all power supplies. If one supply fails, the load balancing feature allows the other supplies to pick up the remaining power load quickly.

**Power Factor Correction**

Compaq's intelligent power supplies have built-in power factor correction to synchronize the voltage and current phases. This ensures maximum power is available. It also reduces the return current in the ground line, which reduces the overall power consumption.

### Hot-Plug Capability

When a power supply is hot swapped, the microcontroller governs the power-up and power-down sequences, enables the health drivers to calculate redundancy “on the fly,” and informs the health drivers of changes in load. Compaq hot-plug power supplies are readily identifiable by their port-colored bezel, as shown in Figure 11.

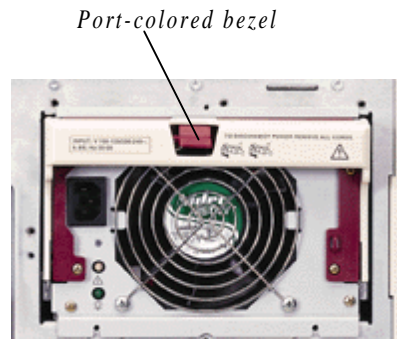


Figure 11: Front view of power supply with port-colored bezel.

### Hot-Plug Hard Disk Drives

The ProLiant 7000 has three internal drive cages for hot-plug drives. Each removable drive cage holds either six 1-inch drives or four 1.6-inch drives or a combination of both. This gives users the flexibility to configure the server for either maximum number of spindles or maximum storage capacity. Maximizing the number of spindles reduces overall capacity, but it increases performance in database or other disk-intensive applications. When the server is configured for maximum capacity, it can hold 218 GB of storage (12 drives x 18.2 GB per 1.6-inch drive = 218.4 GB). When configured for maximum number of spindles, the server can hold 163.8 GB (18 drives x 9.1 GB per 1-inch drive = 163.8 GB).

### Compaq Smart Array 3100ES Controller

The Compaq Smart Array 3100ES controller<sup>4</sup> is a 3-channel, Wide-Ultra SCSI-3 controller that ships standard in the ProLiant 7000. The architecture of the Smart Array 3100ES improves on the Compaq SMART-2 Array Controller by:

- Simplifying SCSI cabling configuration.
  - The extended SCSI connector routes three SCSI buses.
  - Three Wide-Ultra SCSI-3 buses are routed to the server’s three internal drive cages.
- Improving serviceability through PCI Hot Plug capabilities.
- Increasing performance with 64 MB of removable, battery-backed cache board (56 MB for read/write cache).
- Allowing all three drive cages to be configured as one contiguous RAID.
- Faster processor memory
- Future support for controller redundancy

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<sup>4</sup> For more information, see technology brief *Compaq Smart Array Controller Technology*, document number [ECG079/0698](#).



### **PCI Hot Plug Technology for PCI Adapters**

The Compaq ProLiant 7000 and ProLiant 6500 servers are the first standards-based servers to incorporate industry-standard PCI Hot Plug technology. This technology, pioneered by Compaq, adds hot-plug capabilities to existing PCI adapters for increased system availability and serviceability. Compaq led the industry by licensing its PCI Hot Plug implementation to Intel, thus broadening customer access to this standard technology.

Compaq's implementation of PCI Hot Plug differs from implementations by other vendors whereby several slots are powered down at once or an entire PCI bus is powered down. Compaq incorporated electronics into the server to control each PCI Hot Plug slot individually, so that a single slot can be powered down without affecting the operation of the other slots.

Compaq's implementation of the PCI Hot Plug standard allows the following capabilities while the system is running:

- *Hot replacement*—replacing a single PCI adapter with a similar adapter
- *Hot upgrade*—replacing a PCI adapter with an upgraded adapter
- *Hot expansion*—adding a PCI adapter to an empty slot

The ProLiant 7000 is designed to support all three hot-plug capabilities for all 64-bit and 32-bit PCI Hot Plug slots. These capabilities can be added incrementally, depending on the OS implementation.

For more information about major OS vendors that support PCI Hot Plug, refer to the following technology briefs:

- *PCI Hot Plug Technology*, document number [ECG080/0698](#)
- *PCI Hot Plug Technology with Novell Architecture*, document number [ECG081/0698](#)
- *PCI Hot Plug Technology with SCO Software Architecture*, document number [ECG082/0698](#)
- *Deploying PCI Hot Plug on Compaq Servers in a Microsoft Windows NT Environment*, document number [064A/0797](#)

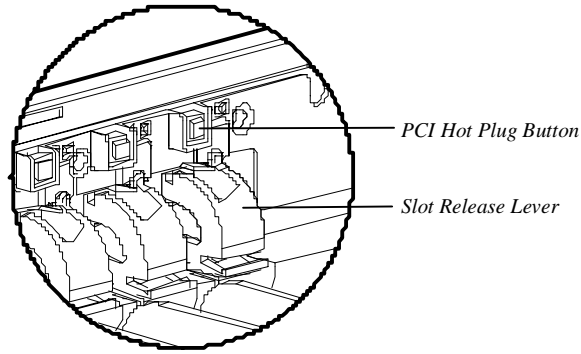
PCI Hot Plug technology is backward compatible with existing industry-standard adapters. While new drivers are required to implement hot-plug capabilities, no changes are required to the vast majority of existing adapters. These leading independent hardware suppliers are committed to modifying their device drivers to be hot-plug aware: Adaptec, AMI, Dialogic, Digi International, Madge, Mylex, QLogic, Standard Microsystems Corporation, SysKonnnect, and 3Com. In addition, Compaq is delivering hot-plug capable drivers for its own leading PCI adapters.

### **PCI Hot Plug Electronics**

Compaq's primary electronic component is the PCI Hot Plug controller, which performs the following essential tasks:

- *PCI Bus Control* - The hot-plug controller communicates with devices on the PCI bus to electrically isolate any single PCI slot from the rest of the system. Isolating a single slot allows replacement of an adapter without interrupting the server or other active adapters.
- *Power Control* - The controller receives a command from the OS to power-up or power-down a single PCI slot. To perform this function, the controller uses slot-specific power control electronics. The power-control electronics allow proper power sequencing on the PCI bus and guarantee safe control of the power to the individual PCI adapters.

All slots have a new push-button control (the PCI Hot Plug Button) that allows slot control at the server. Like other hot-plug components in the server, the PCI Hot Plug Buttons are port-colored as shown in Figure 12.



*Figure 12: PCI Hot Plug Buttons for ProLiant 7000 (top view of I/O section).*

If the green PCI Hot Plug LED for the slot is on, pushing the PCI Hot Plug Button will stop all activity to the slot and allow any cached data to be cleared before the power to the slot is interrupted. While the slot powers down, the green LED blinks. The green LED will turn completely off when it is safe to open the slot release lever and remove the PCI adapter. Once the PCI adapter has been replaced, pushing the PCI Hot Plug Button will reactivate the slot. Alternatively, these same operations can be performed by using the PCI Hot Plug software application.

### **Mechanical Design**

Compaq designed the ProLiant 7000 system chassis for safe and easy installation and removal of PCI adapters. The ProLiant 7000 has nine PCI Hot Plug slots—five 64-bit slots and four 32-bit slots.

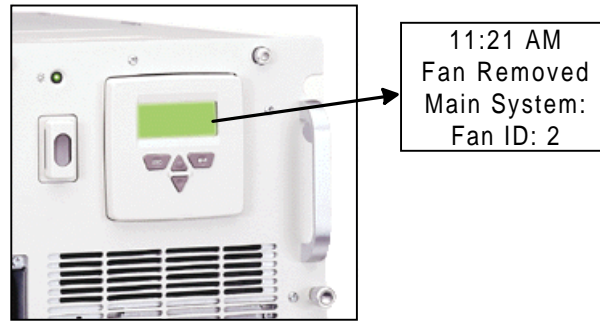
The hot-plug slots are spaced wide enough to allow users to remove and replace adapters without electrically contacting (shorting) other components. Flexible slot separators are also used between the hot-plug slots to reduce the risk of electrical shorting. On top of the server chassis, a lockable access door over the hot-plug slots allows an administrator easy access to hot-plug adapters.

### **MANAGEMENT TECHNOLOGIES**

Fault-tolerant, redundant features are only part of what makes Compaq servers highly available. Compaq also integrates management tools into the server hardware to improve availability and reduce downtime. The Integrated Management Display (IMD) and Integrated Remote Console (IRC) provide essential information at a glance and allow users easy remote access to their servers. In addition to these management technologies, the auto-default ROM configuration provides default configuration settings for most devices.

### **Integrated Management Display**

The IMD (Figure 13) is a backlit liquid crystal display (LCD) that allows administrators to enter server and contact information. Just as importantly, the IMD displays critical information, warning messages, and error messages in an easy-to-understand format.



*Figure 13: Integrated Management Display with sample alert message.*

A 5V auxiliary power line supplies power to the IMD whenever the server power line is plugged in. Even if the server power goes down, the auxiliary line continues to power the IMD so that critical information, such as the last error message and the administrator's name, can be obtained.

The IMD unit contains its own static memory. This memory contains both the software code to control the IMD and the text messages shown on the display. All software enhancements added in the future will be available through a flashable ROMpaq. Also during POST, all event logs, system information, and administrator information upload from the system nonvolatile RAM. During runtime, new events are stored in both the nonvolatile RAM and the IMD SRAM. If the IMD unit is removed and replaced, all key event and system information is still available.

### **Integrated Remote Console**

IRC consists of a Compaq-designed Application Specific Integrated Circuit (ASIC) and associated firmware. IRC allows out-of-band, or asynchronous, management capabilities such as remote console and remote reset. These capabilities are independent of the state of the network OS. With IRC, an administrator has full text mode video and keyboard access even if the OS is down. The administrator has the ability to access the server, perform diagnostics, reset the system, watch the reset process remotely, and view reset sequences, regardless of whether the OS is functional.

For more information about IRC, refer to the Compaq technology brief *Remote Server Management with Integrated Remote Console*, document number [582A/1096](#).

### **Auto-Default ROM Configuration**

When the system is first powered on, the system ROM detects the unconfigured state of the hardware and provides default configuration settings for most devices. By providing this initialization, the system can run *Diagnostics* and other software applications before running the normal *SmartStart* and *System Configuration* applications.

If the user inserts a *System Configuration*, *Diagnostics*, or *SmartStart* CD in the CD-ROM drive prior to powering on the server, the system ROM will boot using that CD. If the system ROM does not detect one of these CDs, the user will be prompted for the intended operating system. The system will reboot if any operating system-dependent configurations have changed with the new operating system selection. If the selected operating system-dependent configurations are the

same as the current configurations, the system will boot normally. The OS selection may be changed during subsequent reboots.

### SERVICEABILITY FEATURES

By providing easy access to server components, the ProLiant 7000 design further reduces the downtime associated with upgrades and field maintenance.

The processor board, memory boards, and the I/O board are mounted using lever-actuated quick-release modules that allow tool-less replacement. In addition, the processor and I/O boards are separated in the chassis so that each can be replaced independently (Figure 14).

The I/O board is located in the top of the chassis to allow easy access for adding or replacing I/O boards. This is an important convenience for using the hot-plug slots.

The internal drive cages are separated into three units. Each drive cage unit can be removed by sliding it out from the front of the server. This allows easy replacement of hot-plug drives as the customer upgrades to next-generation drive technology.

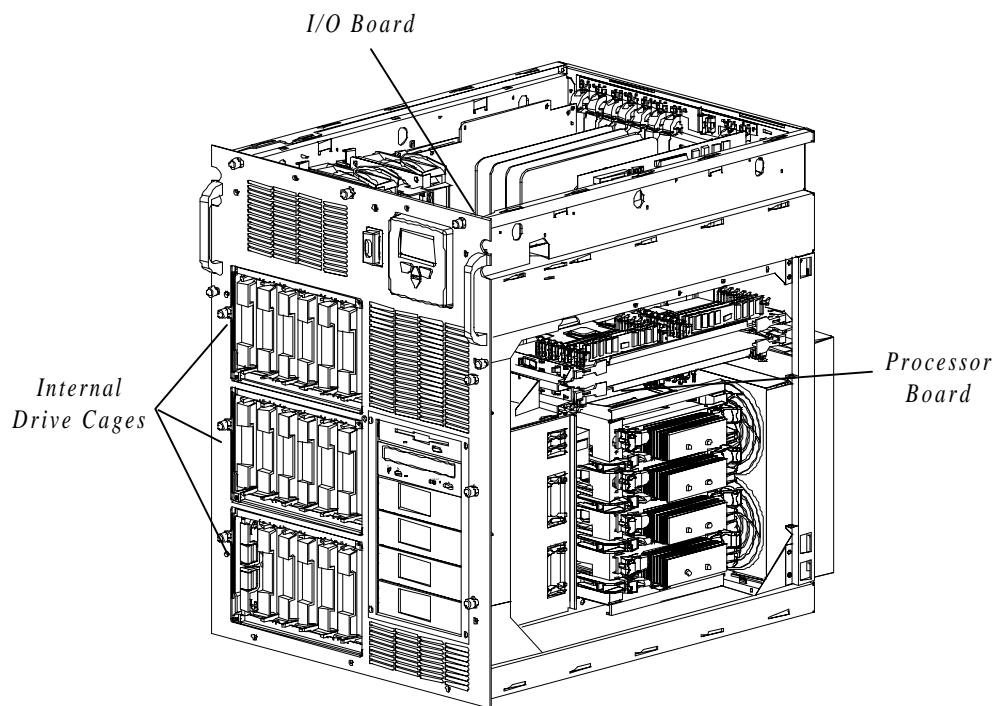


Figure 14: ProLiant 7000 chassis.

### PROLIANT 7000 UPGRADE PATH

Customers require investment protection and a long life for their servers. The ProLiant 7000 is engineered to take advantage of new technology such as the Pentium II Xeon processor and to allow a growth path for the future. Specifically, the ProLiant 7000 has been designed with the flexibility to accommodate future needs for up to eight processors.

The ProLiant 7000 Server provides investment protection by retaining essential system components and the chassis serial number. When customers upgrade previously purchased ProLiant 7000 Servers to a Pentium II Xeon four- or eight-processor (4- or 8-way) configuration, they will leverage the following components:

- Chassis
- Rack mounting kit
- Serial number
- Agency labels
- Power supplies
- Memory DIMMs (4-way upgrade only)
- Hard disk drives and backplanes
- Integrated Management Display
- CD-ROM, tape, and floppy drives (4-way upgrade only)
- All PCI adapter boards
- Keyboard
- Monitor

The upgrade will reduce the total cost of ownership over the lifetime of the server, including administrative and hardware costs. Because many enterprise operating systems, application software installations, and warranties are linked to the hardware serial numbers, continuation of the chassis serial number reduces administration costs.

The chassis design and replaceable components of the ProLiant 7000 allow unprecedented flexibility. Early engineering analysis shows that the Pentium II Xeon processor and the 100-MHz bus it supports create more power and thermal load than the current Pentium Pro-based systems. In planning for the Pentium II Xeon processor and 4-way requirements, Compaq engineered the ProLiant 7000 power supplies and chassis with “headroom” to accommodate this additional load.

### **Power Supplies**

The ProLiant 7000 design allows the intelligent power supplies to share the power load. With three power supplies installed, there is enough power to run up to eight processors and still maintain redundancy. In a redundant configuration, the supplies deliver up to 1500 W; while in a nonredundant configuration, they deliver up to 2250 W of power. This far exceeds typical power configurations for SMP servers, which range in maximum power capabilities from 700 to 840 W.

### **Fan Cooling Capacity**

The fans have also been designed with extra “headroom” to allow for future growth paths with additional processors. As mentioned previously, the fans have both high- and low-speed settings. Performance testing of the ProLiant 7000 shows that even in 35°C ambient air with all four processors loaded, the fans maintain adequate cooling inside the box while running at low speed. The excellent fan performance and the extra room inside the chassis provide ample airflow and cooling to support a future upgrade to eight Slot 2 processors.

### Chassis Design

The ProLiant 7000 chassis has been engineered with flexibility, expandability, and longevity in mind. The chassis design features three key elements:

- Extra space
- Adaptable cabinet design
- Extra airflow

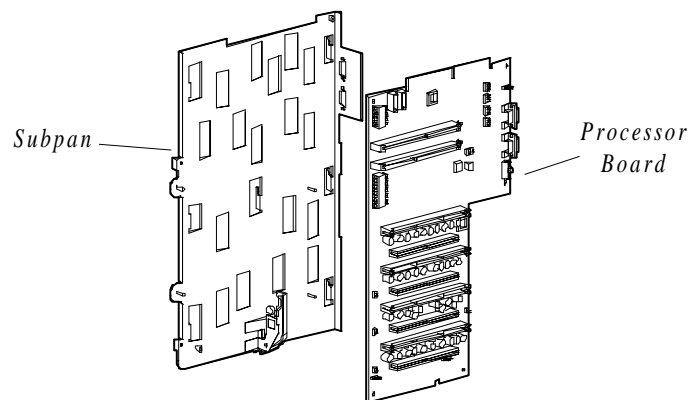
Pentium Pro processors are packaged in a pin-grid array (PGA) form factor, while the Pentium II Xeon processor from Intel has the new Single Edge Contact (SEC) cartridge form factor. The SEC cartridge and its associated heat sink are larger than the Pentium Pro PGA and require significantly more room in the chassis. When designing the ProLiant 7000 chassis, Compaq included enough room to accommodate the new Pentium II SEC cartridge form factor and up to eight processors.

The chassis design also has the “headroom” to accommodate the additional airflow needed to cool an 8-way Pentium II Xeon configuration. The fans are mounted on sheet metal inserts that can easily be changed during the 8-way upgrade to provide the additional thermal capacity required.

The ProLiant 7000 chassis design is extremely adaptable. As mentioned earlier, the chassis features separate compartments for the processor and I/O, which allow them to be replaced independently. All the sheet metal surrounding essential components can be easily changed to accommodate additional processors. This includes the processor board, the I/O board, and the I/O slots.

### Processor Board

The ProLiant 7000 processor board is placed on a sheet metal subpan, as shown in Figure 15. The ProLiant 7000 Pentium Pro-based servers can be adapted to a new Pentium II Xeon-based system by simply removing the old subpan and sliding the new subpan and system board into the existing space.



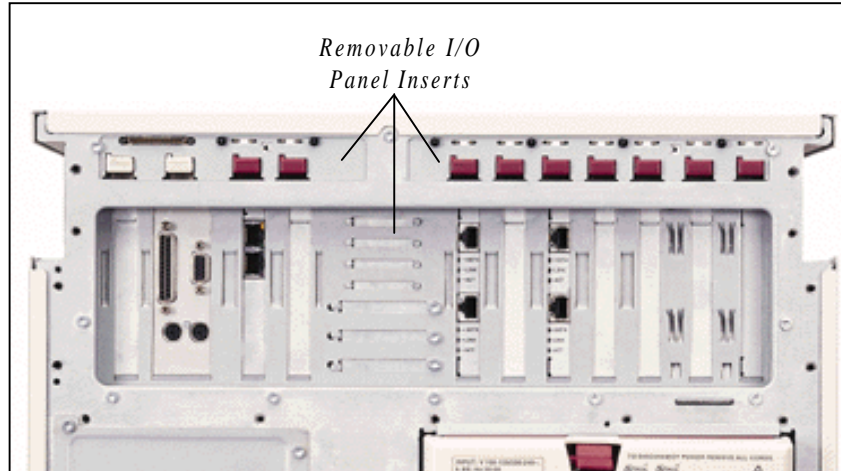
*Figure 15: Processor board and its corresponding subpan.*

### I/O Board

Like the processor board, the I/O board mounts on a subpan. A new I/O board and a new subpan of the same or different size can be added without a chassis change.

### I/O Slots

With the upgrade, the ProLiant 7000 I/O section will increase the I/O bandwidth to match the higher processing bandwidth. Because the I/O slots are defined by a panel insert rather than solid sheet metal (Figure 16), the upgrade can be accomplished easily by replacing the I/O panel inserts.



*Figure 16: I/O panel inserts can be replaced to upgrade server.*

### CONCLUSION

As business requirements become more demanding, Compaq will continue to deliver servers that meet those requirements and that can be expanded to meet future needs as well. The ProLiant 7000 offers many hot-plug and redundant technologies that allow virtually continuous uptime for all key server components. Customers can be confident of their investment in the ProLiant 7000 because of its planned upgrade path to future 32-bit processor technology with up to eight processors.