Overview of the HP Integrity rx1600, rx2600, rx4640, and rx5670 servers

A technical white paper from HP

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Executive summary

For many types of computing, systems based on the Intel® Itanium® 2 processor offer markedly superior performance over other systems that utilize RISC or IA-32 processors—while still maintaining a very competitive price. The HP Integrity rx1600, rx2600, rx4640, and rx5670 servers deliver price/performance that has changed the 64-bit server market.

The Integrity rx1600, rx2600, rx4640, and rx5670 servers utilize the HP-designed Scalable Processor Chipset zx1, which integrates the Intel Itanium 2 processor with industry-leading high-bandwidth and low-latency connections to memory and I/O. HP continues to prove the Intel Itanium architecture concept of highly parallel, 64-bit performance with a line-up of servers that are full featured, have a unique high-bandwidth system architecture, and use industry-leading commodity parts to ensure compatibility and economical pricing.

This white paper provides details about these HP Integrity servers, shows their features and benefits, discusses their electrical architectures, and provides a breakdown of their unique high-availability features. What's more, this paper illustrates how HP simplifies the transition from RISC and IA-32 while preserving an IT user's investment in existing software.

Introducing the Intel® Itanium® 2 processor

The Intel Itanium 2 processor is a milestone in the continuing evolution of microprocessors because it is the first enterprise-class 64-bit processor that has the power to become pervasive. Let's take a closer look at what this means.

Today, 32-bit servers or proprietary 64-bit RISC servers are the norm. They have respectable price/performance ratios but are either fundamentally limited in performance scalability or are exceedingly expensive.

Servers based on the Intel-architecture 32-bit (IA-32) processors, for example, are unable to address large amounts of memory efficiently. Meanwhile, 64-bit RISC architectures have the necessary performance and addressing, but they are more expensive and generally lock the customer into a proprietary operating environment and a single computer vendor. End users and IT professionals alike are clamoring for high performance and large addressing at an economical price. And they also are asking for pervasiveness so that they do not have to deal with multiple architectures and complexity.

HP and Intel co-developed the Intel Itanium 2 microarchitecture. The result is a high-performance, parallel 64-bit architecture that has the performance headroom to grow in the future and can be priced at a level to ensure its widespread adoption. The Intel Itanium 2 microarchitecture fulfills both of these promises and is likely to become pervasive very quickly. The Intel Itanium 2 processor is the fundamental building block of the entry-level HP Integrity rx1600, rx2600, rx4640, and rx5670 servers.

Itanium 2–based HP Integrity rx1600, rx2600, rx4640, and rx5670 servers

Itanium 2–based servers from HP are targeted at performance-hungry markets such as technical and scientific computing, Secure Sockets Layer (SSL) Web serving, application serving, and database applications. What's more, these systems are highly affordable, making them extremely attractive to software developers. Read on to learn about the system features that fulfill these promises.

HP Integrity rx1600 server at a glance

The HP Integrity rx1600 server uses the Low Voltage Intel Itanium 2 processor in a slim, 1U (3.5-inch height) system package. It provides industry-leading performance in a dense form factor. The Low Voltage (LV) Intel Itanium 2 processor delivers industry-leading $/FLOPS for compute-intensive workloads, at lower power levels, where space is at a premium. The HP Integrity rx1600 server supports up to two 1.0 GHz LV Intel Itanium 2 processors with 1.5 MB of on-chip L3 cache and as much as 16 GB of RAM. This means that it has extraordinary compute density. Fitting 41 servers into a 2-meter rack delivers an astounding 320 gigaFLOPS of potential power.

The Integrity rx1600 server also leverages the same management features as the Integrity rx2600 server. It is ideal for compute-intensive server farms in the high-performance technical and scientific computing markets, and it is a perfect fit for the network edge, security, and software engineering fields. Features such as memory chip

spare, an optional management processor, and high-availability clustering support make the Integrity rx1600 server a leader among high compute density servers.

The Integrity rx1600 server offers incredible investment protection with in-chassis upgrades to future Intel Itanium 2 processors. The Integrity rx1600 server is also flexible, with a choice of 64-bit operating systems—HP-UX, Linux®, or OpenVMS Evaluation Release (until 2Q 2004, when a production-quality release is expected)—to suit any need. And there's a full range of HP storage peripherals and I/O adapters to complete the package.

Figure 1. The HP Integrity rx1600 server is a rackmount unit.

HP Integrity rx1600 server details

HP Integrity rx1600 server product specifications

- Central processor
  - 1 or 2 Low Voltage Intel Itanium 2 processors at 1.0 GHz
- Cache (all on-chip)
  - 16 KB instruction and 16 KB data level 1 cache
  - 256 KB level 2 cache
  - 1.5 MB level 3 cache
- Main memory
  - 512 MB minimum to 16 GB maximum PC2100 parity-protected ECC chip spare DDR CL2 memory in 8 DIMM slots (DIMMs must be installed in groups of two)
  - 8.5 GB/s memory bandwidth
- Chipset
  - HP zx1 Chipset
  - 80-nanosecond memory latency
  - 6.4 GB/s system bus bandwidth
  - 3.5 GB/s aggregate I/O bandwidth
- Expansion slots
  - 1 PCI-X, 1 GB/s sustained, 64-bit 133 MHz, full-length
  - 1 PCI-X, 1 GB/s sustained, 64-bit 133 MHz, half-length
- Hot-plug disk drives (2 bays for 1-inch-high 3.5-inch disks)
  - 292 GB maximum internal storage
  - Integrated dual-channel Ultra320 SCSI controller
  - Disk sizes available: 36 GB 10,000 rpm; 73 GB 15,000 rpm; and 146 GB 10,000 rpm

- Removable media
  - One slimline media bay for optional IDE optical drives
  - Choice of 16X DVD-ROM or 16X/10X/40X CD-RW (also reads DVD)
- Core I/O interconnect ports
  - Gigabit-TX LAN with RJ-45 connector (10/100/1000BT auto-sensing)
  - 10/100BT LAN with RJ-45 connector and Wake-on-LAN capability
  - Ultra320 SCSI
  - General-purpose RS-232 serial ports
  - VGA
  - 2 USB Series A 2.0 (480 Mb/s) ports
  - Management processor interconnect:
    10/100BT management LAN with Web console access
    RS-232 local console
    RS-232 remote/modem console
    RS-232 general purpose
- Power and cooling
  - One 400 W power supply standard
  - 4 cooling fans
- Power requirements
  - Input current: 100–127 V ~5.5 A/200–240 ~V 2.8 A (auto-ranging)
  - Line frequency: 50 Hz to 60 Hz
  - Maximum power input: 700 W

Physical and environmental specifications

- Environmental specifications
  - Altitude:
    Operating: 3048 m (10,000 ft.) maximum
    Storage: 4572 m (15,000 ft.) maximum
  - Temperature:
    Operating: +05° C to +35° C (+41° F to +95° F)
    Non-operating: –40° C to +70° C (–40° F to +158° F)
  - Humidity:
    Operating: 15% to 80% (relative)
- Physical dimensions in rack orientation
  - Height: 4.3 cm (1.7 in.)
  - Width: 48.2 cm (19 in.)
  - Depth: 68.0 cm (26.8 in.)
- Net weight
  - Minimum standalone configuration: 22.4 kg (49.4 lb.)
  - Maximum standalone configuration: 25.5 kg (56.2 lb.)
  - Minimum rack configuration: 17.5 kg (38.6 lb.)
  - Maximum rack configuration: 22.2 kg (49.0 lb.)

Mechanical design and packaging of the HP Integrity rx1600 server

The exploded view reveals the location of major components as well as the mechanical and architectural features of the Integrity rx1600 server. It is partitioned into three electrical partitions—the system board, including CPUs, memory, and core I/O; the I/O backplane, including four PCI-X I/O slots; and the management processor board.

Figure 2. Major components of the HP Integrity rx1600 server

- **8 DIMM slots 512 MB to 16 GB with chip sparing**
- **Enhanced system mgmt card**
- **zx1 Chipset**
- **Deerfield CPUs**
- **Front panel**
- **2 PCI-X slots (133 MHz)**
- **400W power supply**
- **Slimline CD/DVD-R or CD-RW/DVD–R (optional)**
- **2 hot-swap Ultra320 drives (internal RAID support w/optional RAID card)**
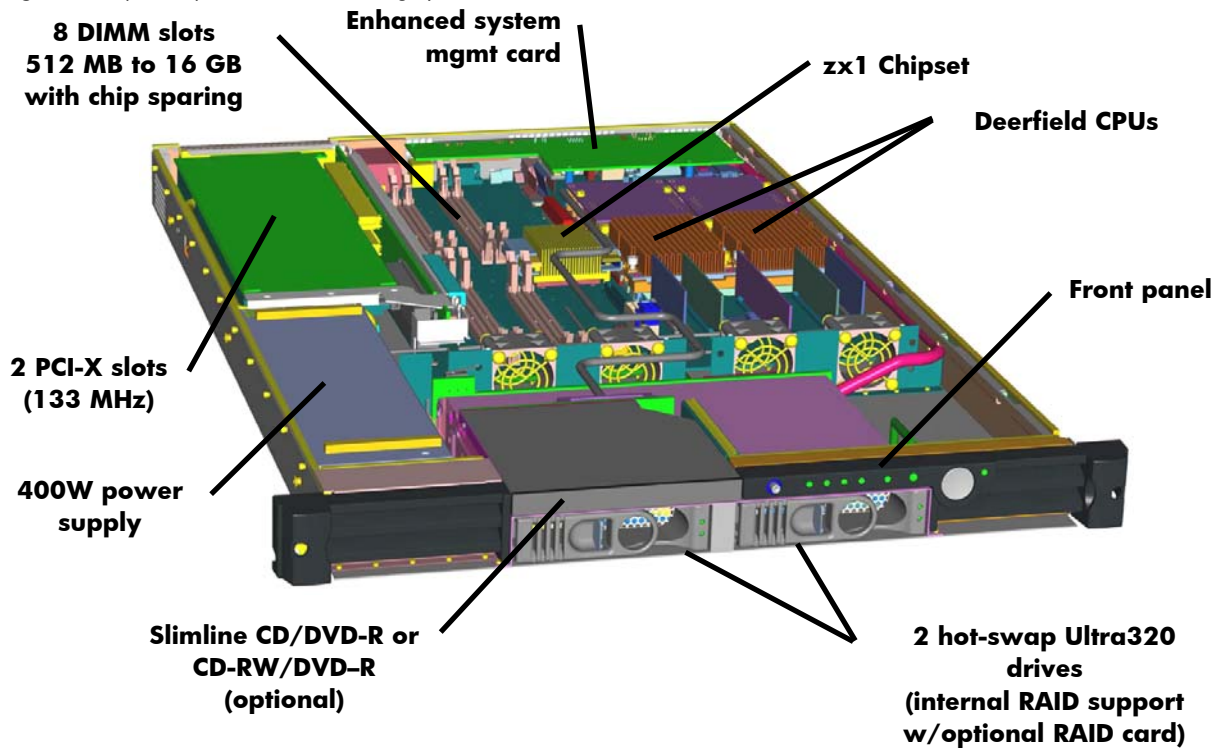
Two hot-swap disk drive bays are located in the lower right corner of the server (when viewed from the front). Just above the power supplies is a slimline optical media drive bay, supporting either a DVD or a DVD/CD-RW combo drive. Directly behind the power supplies and peripheral bays are four cooling fans.

The left side of the system houses the I/O backplane and I/O card bay. There are two PCI-X slots in the I/O card bay; one full-length slot and one half-length slot.

The right rear of the server contains the main system board. The system board contains two Intel Low Voltage Itanium 2 processor sockets, 8 memory DIMM slots, and the core I/O controllers. The management processor sits on an independent circuit board that attaches to the rear of the main system board.

Racking density

The Integrity rx1600 server is designed to provide unprecedented performance density. At only one EIA unit (EIA unit = 1.75 inches) per server, up to 41 systems can be installed into a single 2-meter HP cabinet.

The Integrity rx1600 server is supported in HP Rack System/E and 10000 series racks. The server is also supported in a variety of third-party, non-HP racks and cabinets.

Note: Dimensions for rack configuration are as follows: height = 1.7 inches (4.3 cm), depth = 26.8 inches (68.0 cm), width = 19 inches (48.2 cm).

HP Integrity rx2600 server at a glance

The HP Integrity rx2600 server is the industry's best-performing 2-way Itanium 2–based server. It has a sleek 2U footprint and can be equipped with up to two 1.5 GHz Intel Itanium 2 processors loaded with 6 MB of on-chip L3 cache and as much as 24 GB of RAM. This means that it has extraordinary compute density. Fitting 20 servers into a 2-meter rack delivers an astounding 240 gigaFLOPS of potential power.

The Integrity rx2600 server also has extensive availability and management features, which make it ideal for deployments in mission-critical data centers or compute-intensive server farms. Features such as hot-swap redundant components, memory chip spare, an integrated management processor, and high-availability clustering support make the Integrity rx2600 server the clear leader among 2-way Itanium 2–based servers.

The Integrity rx2600 server offers incredible investment protection with in-chassis upgrades to future Intel Itanium 2 servers. The Integrity rx2600 server is also flexible, with a choice of 64-bit operating systems—HP-UX, Linux, Microsoft® Windows®, or OpenVMS Evaluation Release (until 2H 2004, when a production-quality release is expected)—to suit any need. It can be installed in a rack or in a standalone, vertical tower configuration. And there's a full range of HP storage peripherals and I/O adapters to complete the package.

Figure 3. The HP Integrity rx2600 server can be installed in a rack or as a standalone unit

HP Integrity rx2600 server details

HP Integrity rx2600 server product specifications
- Central processor
  - 1 or 2 Intel Itanium 2 processors at 1.0 GHz, 1.3 GHz, 1.4 GHz, or 1.5 GHz
- Cache (all on-chip)
  - 16 KB instruction and 16 KB data level 1 cache
  - 256 KB level 2 cache
  - 1.5 MB level 3 cache (1.0 GHz and 1.4 GHz)
  - 3 MB level 3 cache (1.3 GHz)
  - 6 MB level 3 cache (1.5 GHz)
- Main memory
  - 1 GB minimum to 24 GB maximum PC2100 parity-protected ECC chip spare DDR CL2 memory in 12 DIMM slots (DIMMs must be installed in groups of four)
  - 8.5 GB/s memory bandwidth
- Chipset
  - HP zx1 Chipset
  - 80-nanosecond memory latency
  - 6.4 GB/s system bus bandwidth
  - 4.3 GB/s aggregate I/O bandwidth

- Expansion slots
  - 1 PCI-X, 1 GB/s sustained, 64-bit 133 MHz
  - 3 PCI-X, 0.5 GB/s sustained, 64-bit 133 MHz
  - Each slot is full-length and has an independent bus
- Hot-plug disk drives (3 bays for 1-inch-high 3.5-inch disks)
  - 438 GB maximum internal storage
  - Integrated dual-channel Ultra320 SCSI controller
  - Disk sizes available: 36 GB 15,000 rpm; 73 GB 15,000 rpm; and 146 GB 10,000 rpm
- Removable media
  - One slimline media bay for optional IDE optical drives
  - Choice of 16X DVD-ROM or 16X/10X/40X CD-RW (also reads DVD)
- Core I/O interconnect ports
  - Gigabit-TX LAN with RJ-45 connector (10/100/1000BT auto-sensing)
  - 10/100BT LAN with RJ-45 connector and Wake-on-LAN capability
  - Ultra320 SCSI
  - 2 general-purpose RS-232 serial ports
  - VGA
  - 4 USB Series A 2.0 (480 Mb/s) ports
  - Management processor interconnect:
    10/100BT management LAN with Web console access
    RS-232 local console
    RS-232 remote/modem console
    RS-232 general purpose
- Power and cooling
  - One 650 W hot-swap power supply standard
  - Optional second 650 W hot-swap power supply for N+1 redundancy
  - 4 cooling fans with N+1 redundancy
- Power requirements
  - Input current: 100–120 V 7.2 A/200–240 V 3.2 A (auto-ranging)
  - Line frequency: 50 Hz to 60 Hz
  - Maximum power input: 714 W

Physical and environmental specifications
- Environmental specifications
  - Altitude:
    Operating: 3000 m (10,000 ft.) maximum
    Storage: 4600 m (15,000 ft.) maximum
  - Temperature:
    Operating: +05° C to +35° C (+41° F to +95° F)
    Non-operating: –40° C to +70° C (–40° F to +158° F)
  - Humidity:
    Operating: 15% to 80% (relative)
- Physical dimensions in rack orientation
  - Height: 8.6 cm (3.4 in.)
  - Width: 48.2 cm (19 in.)
  - Depth: 68.0 cm (26.8 in.)
- Physical dimensions in standalone, vertical orientation
  - Height: 49.5 cm (19.5 in.)
  - Width: 29.7 cm (11.7 in.)
 - Depth: 67.3 cm (26.5 in.)

- Net weight
  - Minimum standalone configuration: 22.4 kg (49.4 lb.)
  - Maximum standalone configuration: 25.5 kg (56.2 lb.)
  - Minimum rack configuration: 17.5 kg (38.6 lb.)
  - Maximum rack configuration: 22.2 kg (49.0 lb.)

Mechanical design and packaging of the HP Integrity rx2600 server

The exploded view reveals the location of major components as well as the mechanical and architectural features of the Integrity rx2600 server. It is partitioned into three electrical partitions—the system board, including CPUs, memory, and core I/O; the I/O backplane, including four PCI-X I/O slots; and the management processor board.

Figure 4. Major components of the HP Integrity rx2600 server
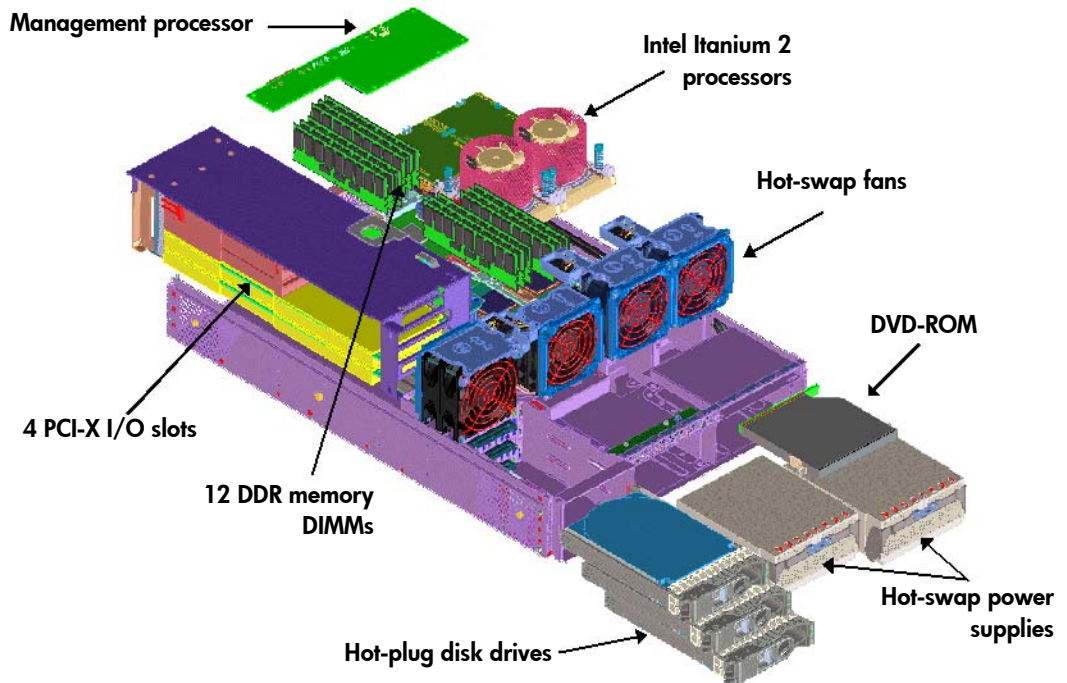
Two hot-swap power supply bays are located in the lower right corner of the server (when viewed from the front). Just above the power supplies is a slimline optical media drive bay, supporting either a DVD or a DVD/CD-RW combo drive. To the left of the unit's front are three bays for hot-plug hard disk drives. Directly behind the power supplies and peripheral bays are four hot-swap cooling fans.

The left side of the system houses the I/O backplane and I/O card bay. There are four PCI-X slots in the I/O card bay.

The right rear of the server contains the main system board. The system board contains two Intel Itanium 2 processor sockets, 12 memory DIMM slots, and the core I/O controllers. The management processor sits on an independent circuit board that attaches to the rear of the main system board.

Racking density

The Integrity rx2600 server is designed to provide unprecedented performance density. At only two EIA units (one EIA unit = 1.75 inches) per server, up to 20 systems can be installed into a single 2-meter HP cabinet.

The Integrity rx2600 server is supported in HP Rack System/E and 10000 series racks. The server is also supported in a variety of third-party, non-HP racks and cabinets.

Note: Dimensions for rack configuration are as follows: height = 3.4 inches (8.6 cm), depth = 26.8 inches (68.0 cm), width = 19 inches (48.2 cm).

Standalone pedestal configuration

The Integrity rx2600 server is also available in a standalone configuration when a cabinet is not desired. The standalone system is ideal for an office environment, under a desk, or on a shelf. The standalone configuration uses a stylish tower mounting shell, with the system simply placed inside this shell.

Note: Dimensions for standalone/pedestal configuration: height = 19.5 inches (49.5 cm), depth = 26.5 inches (67.3 cm), width = 11.7 inches (29.7 cm).

Workstation or server? Here's how to choose

HP also sells the Itanium 2–based HP Workstation zx6000. The HP Integrity rx2600 server and HP Workstation zx6000 are both 1- or 2-way Itanium 2–based systems. Both utilize HP's high-performance zx1 Chipset. Beyond that, however, the Integrity server is a very different class of system.

The Integrity rx2600 server is optimized for high-performance server I/O with four 133 MHz PCI-X slots, including one full-bandwidth 1 GB/s slot. The HP Workstation zx6000 is optimized for high-performance AGP graphics support. Moreover, the Integrity rx2600 server includes many high-availability features that are critical in commercial and many technical server environments; these high-availability features, such as chip spare memory and high-availability clustering support, are unique to the Integrity rx2600 server. This server is the best choice for compute node clusters and mission-critical commercial applications because of its advanced connectivity, remote manageability, and superior availability.

The two systems also support different versions of HP strategic operating systems. The Integrity rx2600 server supports the commercial and technical operating environments of HP-UX, Microsoft's Windows Server 2003 operating system, and OpenVMS. The HP Workstation zx6000 supports the client and technical versions of HP-UX as well as the Microsoft Windows XP client operating system. For Linux, the workstation and server support different distributions, focused on either client or server computing. The following table summarizes the differences between the Integrity rx2600 server and HP Workstation zx6000.

Comparing the HP Workstation zx6000 with the Integrity rx2600 server

	HP Workstation zx6000	HP Integrity rx2600 server
Category	Optimized for high-performance AGP graphics support for the 1- or 2-way technical computing workstation markets	Optimized for high-performance PCI-X I/O for the 2-way server and performance cluster markets
Target usage model	Computer-aided engineering, scientific research, life sciences, digital content creation rendering, mechanical CAD, workstation software development, graphics clusters	Computer-aided engineering clusters, scientific research clusters, secure Web serving, application serving, server software development
Intel Itanium 2 processors	One or two 1.3 GHz with 3 MB L3 on-chip cache, or one or two 1.5 GHz with 6 MB L3 on-chip cache	One or two 1.0 GHz or 1.4 GHz with 1.5 MB L3 on-chip cache, or one or two 1.3 GHz with 3 MB L3 on-chip cache, or one or two 1.5 GHz with 6 MB L3 on-chip cache
Memory capacity	24 GB Installed in pairs of DIMMs	24 GB of chip spare memory Installed in quads of DIMMs
System bus bandwidth	6.4 GB/s	6.4 GB/s
System memory bandwidth	8.5 GB/s	8.5 GB/s
Aggregate I/O bandwidth (at HP zx1 Chipset channels)	4.0 GB/s	4.0 GB/s
I/O slots	One AGP-4X (1 GB/s) 66 MHz Three PCI-X (0.5 GB/s) 133 MHz	One PCI-X (1 GB/s) 133 MHz Three PCI-X (0.5 GB/s) 133 MHz
Operating systems supported	HP-UX client and technical versions Microsoft Windows (client version) 64-bit Linux (workstation distributions)	HP-UX 11i v2 (commercial and technical versions) Microsoft Windows Server 2003, Enterprise Edition 64-bit Linux OpenVMS v8.1 Evaluation Release
Graphics support	3D and 2D AGP	2D via integrated VGA port
Audio support	Yes—optional PCI card	Not available
Internal storage	Three 3.5-inch bays for hot-plug Ultra320 SCSI devices	Three 3.5-inch bays for hot-plug Ultra320 SCSI devices
Management processor card	Optional	Standard

(continued)

Comparing the HP Workstation zx6000 with the HP Integrity rx2600 server *(continued)*		
Hot-plug disks	Yes	Yes
Memory chip spare	No	Yes
Redundant hot-swap power supplies	Optional	Optional
Redundant hot-swap fans	Yes	Yes
HP Serviceguard clustering support	No	Yes
Tower configuration	Yes (with quieter fans for deskside use)	Yes (with redundant fans)
Rack-optimized configuration	Yes—2U Maximum 20 systems in a 2-meter rack	Yes—2U Maximum 20 systems in a 2-meter rack

HP Integrity rx4640 server at a glance

This aggressively priced server brings you exceptional price/performance, reliability, and availability in a compact, rack-dense design to meet the most demanding enterprise-level computing requirements. The HP Integrity rx4640 server can be equipped with up to four Intel Itanium 2 processors loaded with 6 MB of on-chip L3 cache, as much as 64 GB of RAM, and six PCI-X I/O expansion slots. With a rack-dense 4U form factor, the Integrity rx4640 server maximizes the number of servers per rack for a better return on IT.

With a choice of operating systems, including HP-UX, Linux, Windows (in 1H 2004), and OpenVMS (Evaluation Release, pending a production-quality release in 2H 2004), the Integrity rx4640 server gives you total flexibility. This server also offers a pathway to the future with in-chassis upgrades to next-generation Intel Itanium 2 processors (available in 2004) as well as the HP mx2 dual-processor module (available in 1H 2004), which doubles the Intel Itanium 2 processor density without requiring more power or space.

The Integrity rx4640 server was designed to be easy to install, service, and maintain. It fits easily into HP 9000 server racks, Compaq ProLiant racks, and many third-party racks, using side-mounted slides and a cable management arm that install quickly without tools. The blue server identification LED can be activated locally or remotely for easy physical location of problem hardware, and the quick-find LED panel speeds problem diagnosis by identifying defective or mismatched hardware components. And you have the option of reducing maintenance costs by repairing the server yourself with field-replaceable parts and simple swap-out repairs.

Figure 5. You can fit up to 10 rack-optimized HP Integrity rx4640 servers into a 2-meter (40U) rack.

HP Integrity rx4640 server details

HP Integrity rx4640 server product specifications

- Central processor
  - 1, 2, 3, or 4 Intel Itanium 2 processors at 1.3 GHz or 1.5 GHz
- Cache (all on-chip)
  - 16 KB instruction and 16 KB data level 1 cache
  - 256 KB level 2 cache
  - 3 MB level 3 cache (1.3 GHz)
  - 6 MB level 3 cache (1.5 GHz)
- Main memory
  - 1 GB minimum to 64 GB maximum PC2100 parity-protected ECC chip spare DDR CL2 memory
  - Choice of either 16 DIMM or 32 DIMM memory carrier board
  - 12.8 GB/s memory bandwidth
- Chipset
  - HP zx1 Chipset
  - 105-nanosecond memory latency
  - 6.4 GB/s system bus bandwidth
  - 4.0 GB/s aggregate I/O bandwidth
- Expansion slots
  - 2 PCI-X on independent buses, 64-bit 133 MHz
  - 4 PCI-X on 2 shared buses, 64-bit 66 MHz
- Hot-plug disk drives (2 bays)
  - 292 GB maximum internal storage
  - Integrated dual-channel Ultra160 SCSI controllers
  - Optional high-availability (duplex) configuration for internal disk drives
  - Disk sizes available: 36 GB 15,000 rpm, 73 GB 15,000 rpm, 146 GB 10,000 rpm
- Removable media
  - Optional slimline DVD-ROM or DVD with CD-write capability
- Core I/O interconnect ports
  - Gigabit-TX LAN with RJ-45 connector (10/100/1000Base-T auto-sensing)
  - Ultra160 SCSI port for external peripherals
  - Management processor interconnect:
    10/100BT management LAN with Web console access
    RS-232 local console
    RS-232 remote/modem console
    RS-232 general purpose
  - 2 USB Series A 2.0 (480 Mb/s) ports
  - VGA
- Power and cooling
  - One 1200 W hot-swap power supply standard
  - Optional second 1200 W hot-swap power supply for N+1 redundancy
  - 6 cooling fans with N+1 redundancy
- Power requirements
  - Input current: 8 A at 200–240 V
  - Line frequency: 50 Hz to 60 Hz
  - Maximum power input: 1600 W (conservative), 1065 W (typical)

Physical and environmental specifications

- Environmental specifications
  - Altitude:
    Operating: 3000 m (10,000 ft.) maximum
    Storage: 4600 m (15,000 ft.) maximum
  - Temperature:
    Operating: +05° C to +35° C (+41° F to +95° F)
    Non-operating: −40° C to +70° C (−40° F to +158° F)
  - Humidity:
    Operating: 15% to 80% (relative, non-condensing)
- Physical dimensions in rack orientation
  - Height: 17.3 cm (6.8 in.), 4U EIA
  - Width: 48.2 cm (19 in.)
  - Depth: 69.0 cm (27.2 in.), including 2.9 cm (1.1 in.) front bezel
- Net weight
  - Maximum configuration: 45.4 kg (100 lb.)

Mechanical design and packaging of the HP Integrity rx4640 server

The interior view illustrates the location of major components as well as the mechanical and architectural features of the Integrity rx4640 server. The server is partitioned into two main electrical partitions—the system partition, including baseboard, CPU board, and memory carrier board; and the I/O partition, consisting of PCI-X I/O slots, core I/O, and the management processor.

Figure 6. Major components of the HP Integrity rx4640 server
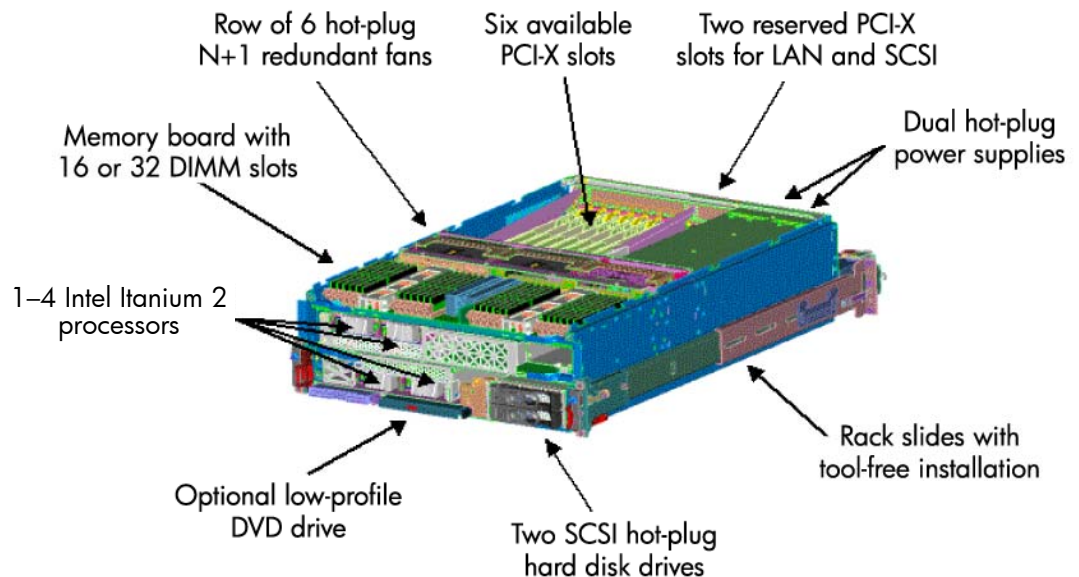
Removing the front bezel and a sheet-metal section that covers the top one-third and front of the server provides access to the memory and processor boards. Memory can be easily added to the server (when powered off) without removing the memory carrier. Depending on your choice of memory carriers, up to 16 or 32 DIMMs can be loaded into the server. Both the memory carrier and processor boards can be easily removed without tools by unlatching and sliding them forward.

A media bay located at the lower front of the server accepts an optional, slimline DVD drive. Located to the right of the media bay are the power switch and LED indicators for system status. A pair of hot-plug, low-profile disk drives are located in the lower right front corner of the server.

Three pairs of redundant, hot-swap fans span the width of the server behind the processor board, memory board, and other assemblies located in the front half of the server.

Behind the bank of fans are two hot-swap power-supply bays at the right rear of the server. Each power supply has a pull-through fan where air exits at the rear. To the left of the power supplies and behind the bank of fans are eight PCI-X slots. Factory-installed SCSI controller and Ethernet LAN cards occupy two of these slots. The remaining six PCI-X slots have hot-plug capability and can be loaded with I/O cards selected by the end user.

Racking density

The Integrity rx4640 server offers unparalleled performance density. At four EIA units per server, up to ten servers can be installed into a single 2-meter rack cabinet.

The Integrity rx4640 server is supported in HP Rack System/E, 10000 series, 9000 series, and 7000 series rack cabinets. The server is also supported in a variety of third-party, non-HP racks and cabinets. Refer to the *HP Server Configuration Guide* for the latest list of qualified third-party racks.

Note: Dimensions for rack configuration are as follows: height = 6.8 inches (17.3 cm), depth = 27.2 inches (69.0 cm), width = 19 inches (48.2 cm).

High-availability slider rails

The Integrity rx4640 server comes standard with a pair of side-mounted high-availability (HA) slider rails, which use no additional vertical space and can be installed without tools. With the HA slider rails, the unit can be completely serviced without removing it from the rack, thus allowing side-by-side racks of systems to be completely supported without sacrificing floor space for side access to the system.

Cabinet spacing requirements

The Integrity rx4640 server requires a minimum of 24 inches (61 cm) of free space in both the front and rear of the cabinet for proper ventilation. During product installation and servicing, a total of 30 inches (76 cm) of free space is needed at the front of the cabinet.

Standalone (rackless) configuration

When a cabinet is not desired, the Integrity rx4640 server is also available in a standalone (rackless) configuration. The standalone system is ideal for a back room or on a shelf; however, the standalone server should not be placed in an office environment due to acoustic and RFI characteristics. The standalone configuration utilizes the same internal chassis and front plastic bezel as the racked version. A tubular steel frame attaches to the sides and wraps around the bottom of the server. The Integrity rx4640 server can be positioned either on its bottom or side when the tubular frame is attached. The frame also makes it easy for two people to pick up and move the server. Up to three Integrity rx4640 servers can be stacked in a horizontal position, as in a rack, with plastic brackets that snap onto the steel tubes.

Note: Dimensions for standalone configuration are as follows: height = 10.28 inches (26.1 cm), depth = 27.36 inches (69.5 cm), width = 20.95 inches (53.2 cm).

HP Integrity rx5670 server at a glance

The HP Integrity rx5670 server is the industry's most expandable 4-way Itanium 2–based server. This server can be equipped with up to four Intel Itanium 2 processors, as much as 96 GB of RAM, and ten PCI-X I/O expansion slots. Simply put, the Integrity rx5670 server is the highest-performing, most expandable 4-way server on the market.

The Integrity rx5670 server also has extensive availability and management features, which make it ideal for deployment in mission-critical data centers or compute-intensive server farms. Features such as hot-swap redundant components, memory chip spare, an integrated management processor, and high-availability clustering support make the Integrity rx5670 server ideal for nearly any computing environment.

Furthermore, the Integrity rx5670 server was designed for investment protection. It is the only Itanium 2–based server that can be "built" by a board-swap, in-chassis upgrade from an existing RISC server. In fact, *any HP 9000 rp5400, rp5430, rp5450, rp5470, or L-Class server can be upgraded to an HP Integrity rx5670 server!* This allows HP PA-RISC customers to quickly upgrade their investment to the Intel Itanium 2 microarchitecture.

The Integrity rx5670 server is flexible, too. It offers a choice of 64-bit operating systems, including HP-UX, Linux, or Microsoft Windows. And it can be installed in a rack or in a standalone, pedestal configuration along with a host of choices from the full range of HP storage peripherals and I/O adapters.

Figure 7. The HP Integrity rx5670 server is suitable for rack-mount or standalone duty

HP Integrity rx5670 server details

HP Integrity rx5670 server product specifications
- Central processor
  - 1, 2, 3, or 4 Intel Itanium 2 processors at 1.3 GHz or 1.5 GHz
- Cache (all on-chip)
  - 16 KB instruction and 16 KB data level 1 cache
  - 256 KB level 2 cache
  - 3 MB level 3 cache (1.3 GHz)
  - 6 MB level 3 cache (1.5 GHz)
- Main memory
  - 1 GB minimum to 96 GB maximum PC2100 parity-protected ECC chip spare DDR CL2 memory
  - 1 or 2 memory carrier boards with 24 DIMM slots each
  - 12.8 GB/s memory bandwidth

- Chipset
  - HP zx1 Chipset
  - 105-nanosecond memory latency
  - 6.4 GB/s system bus bandwidth
  - 4.0 GB/s aggregate I/O bandwidth
- Expansion slots
  - 3 PCI-X on independent buses, 64-bit 133 MHz
  - 6 PCI-X on 3 shared buses, 64-bit 66 MHz
  - 1 PCI for graphics/USB, 64-bit 33 MHz
- Hot-plug disk drives (4 bays)
  - 584 GB maximum internal storage
  - 2 dual Ultra160 SCSI controllers
  - Optional high-availability (duplex) configuration for internal disk drives
  - Disk sizes available: 36 GB 15,000 rpm, 73 GB 15,000 rpm, 146 GB 10,000 rpm
- Removable media
  - One open media bay for optional SCSI devices
  - Choice of DVD-ROM or DDS-3
- Core I/O interconnect ports
  - Gigabit-TX LAN with RJ-45 connector (10/100/1000BT auto-sensing)
  - Ultra160 SCSI port for external peripherals
  - Management processor interconnect:
    10/100BT management LAN with Web console access
    RS-232 local console
    RS-232 remote/modem console
    RS-232 general purpose
  - 2 USB Series A 2.0 (480 Mb/s) ports (optional)
  - VGA (optional)
- Power and cooling
  - 2 930 W hot-swap power supplies standard
  - Optional third 930 W hot-swap power supply for N+1 redundancy
  - 8 cooling fans with N+1 redundancy
- Power requirements
  - Input current: 10 A at 100–120 V, 5 A at 200–240 V (voltage auto-ranging)
  - Line frequency: 50 Hz to 60 Hz
  - Maximum power input: 1600 W (conservative), 1250 W (typical)

Physical and environmental specifications
- Environmental specifications
  - Altitude:
    Operating: 3000 m (10,000 ft.) maximum
    Storage: 4600 m (15,000 ft.) maximum
  - Temperature:
    Operating: +05° C to +35° C (+41° F to +95° F)
    Non-operating: –40° C to +70° C (–40° F to +158° F)
  - Humidity:
    Operating: 15% to 80% (relative, non-condensing)
- Physical dimensions in rack orientation
  - Height: 31.1 cm (12.2 in.), 7U EIA
  - Width: 48.2 cm (19 in.)
 - Depth: 77.4 cm (30.5 in.)

- Net weight
  - Maximum configuration: 72.6 kg (160 lb.)

Mechanical design and packaging of the HP Integrity rx5670 server

The exploded view illustrates the location of major components as well as the mechanical and architectural features of the Integrity rx5670 server. The server is partitioned into two main electrical partitions—the system partition, including baseboard, CPU board, and memory carrier boards; and the I/O partition, consisting of PCI-X I/O slots, core I/O, and the management processor.

Figure 8. Major components of the HP Integrity rx5670 server
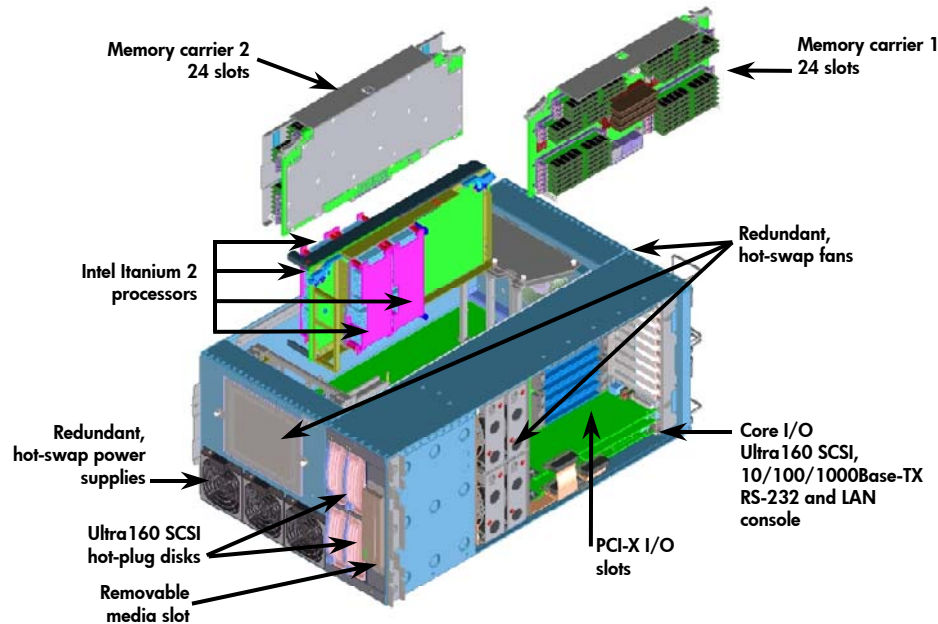
Three hot-swap power supply bays are located in the lower left corner of the server (when viewed from the front). To the right of the front panel, a peripheral bay provides space for four hot-plug disks and one removable media device (either DVD-ROM or DDS-3). Directly above the power supply bays is the first of eight hot-swap cooling fans.

The right side of the system houses the I/O backplane and I/O card bay. There are twelve PCI-X/PCI slots in the I/O card bay. Two or three of these slots are factory-loaded with core I/O cards, depending on the choice of operating system. The remaining nine or ten slots are available for a wide variety of optional I/O adapter cards. Two pairs of fans provide cooling for the I/O bay as well as the peripheral bay.

An opening at the top of the server provides access to the CPU board, memory carriers, and system baseboard. In aggregate, these boards provide support for up to four CPUs and 48 DIMMs.

Racking density

The Integrity rx5670 server is designed to provide performance density that easily adapts to different environments. At seven EIA units per server, up to five servers can be installed into a single 2-meter HP cabinet.

The Integrity rx5670 server is supported in HP Rack System/E and 10000 series racks. The server is also supported in a variety of third-party, non-HP racks and cabinets. Refer to the *HP Server Configuration Guide* for the latest list of qualified third-party racks.

Note: Dimensions for rack configuration are as follows: height = 12.2 inches (31.1 cm), depth = 30.5 inches (77.5 cm), width = 19 inches (48.2 cm).

High-availability slider rails

There are two rail options, static or slider, available for racking the Integrity rx5670 server into an HP cabinet. The high-availability (HA) slider rails were designed to allow easy service access to the system as well as to enable hot-swapping of the four fans in the side cavity.

With the HA slider rails, the unit can be completely serviced without removing it from the rack, thus allowing side-by-side racks of systems to be completely supported without sacrificing floor space for side access to the system. For this reason, the high-availability slider rails are highly recommended.

Note: The slider mechanism occupies one EIA unit of rack space. When used with the Integrity rx5670 server, the combination will occupy eight EIA units of rack space. Static rails do not consume EIA space within the cabinet, leaving more EIA space for peripherals. However, using static rails prohibits hot-swapping of the I/O bay fans.

Cabinet spacing requirements

The Integrity rx5670 server requires a minimum of 24 inches (61 cm) of free space in both the front and rear of the cabinet for proper ventilation. During product installation and servicing, a total of 32 inches (82 cm) of free space is needed at the front of the cabinet. The depth of HP Rack System/E cabinets is 39 inches (99 cm). Therefore, a minimum of 87 inches (221 cm) of total space is needed for each cabinet during normal operation. An additional 8 inches (21 cm) is needed during installation and servicing.

Standalone/Deskside configuration

When a cabinet is not desired, the Integrity rx5670 server is also available in a standalone configuration. The standalone system is ideal for an office environment, under a desk, or on a shelf. The standalone configuration utilizes the same internal chassis and front plastic bezel as the racked version. However, a sheet metal cover, base, and casters are added for functionality and aesthetics. Casters can be removed.

Note: Dimensions for standalone/deskside configuration are as follows: height = 14.5 inches (36.8 cm), depth = 30.5 inches (77.5 cm), width = 19 inches (48.2 cm).

In-box upgrade from PA-RISC servers

Any PA-RISC-based HP 9000 rp5400, rp5430, rp5450, rp5470, or L-Class server is field-upgradable to an HP Integrity rx5670 server. The server's chassis, power, and cooling infrastructure are identical to legacy rp54xx and L-Class systems. Customers simply order the appropriate upgrade product numbers, and an HP customer engineer will arrive to swap the components. Please see the *HP Integrity rx5670 Ordering Guide* for more information.

Itanium 2–based HP Integrity server architecture

This section discusses the electrical architecture of the HP Integrity rx1600, rx2600, rx4640, and rx5670 servers. Topics covered include the HP zx1 Chipset, block diagrams, and I/O layout.

Overview of the HP Scalable Processor Chipset zx1

HP develops chipsets to meet the needs of enterprise and technical customers. In a world where every company has access to the same 64-bit processors, HP's strength is to develop and tune systems to deliver the kind of performance and reliability that IT, engineering, and research professionals demand.
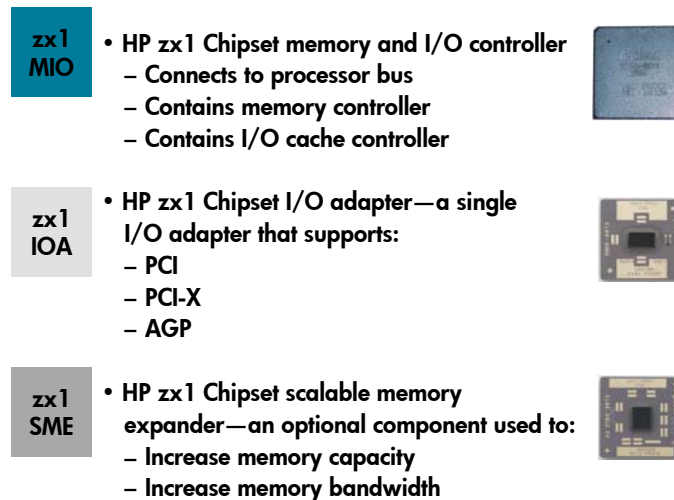
The HP zx1 Chipset is the central building block of the HP Integrity rx1600, rx2600, rx4640, and rx5670 servers. The HP zx1 Chipset is a modular three-chip solution designed for cost-effective, high-bandwidth, low-latency 1- to 4-way symmetrical multiprocessing (SMP) servers and workstations. Invented entirely by HP, the HP zx1 Chipset is an exclusive value-add in the standards-based world of Itanium 2–based platform computing.

The HP zx1 Chipset consists of three modular components:

- The HP zx1 Chipset memory and I/O controller connects to the processor bus and contains dual memory controllers and the I/O cache controller. It interfaces with the Intel Itanium 2 processor bus and provides a low-latency connection to DDR memory, either directly or through zx1 Chipset scalable memory expanders. The controller can connect up to 12 zx1 memory expanders for quadruple the base memory capacity. It can also connect up to eight zx1 Chipset I/O adapters, capable of sustaining 4.0 GB/s of I/O bandwidth.

- The HP zx1 Chipset I/O adapter chip is a scalable solution designed to support PCI-X, PCI, and AGP bus architectures. It provides a scalable I/O implementation for a wide variety of systems. The Integrity rx1600, rx2600, rx4640, and rx5670 servers do not deploy AGP graphics bus technology. AGP is available in the HP zx2000 and zx6000 Workstations, which also employ the HP zx1 Chipset.

- The HP zx1 Chipset scalable memory expander is an optional component used to increase memory capacity and increase memory bandwidth. Acting as a memory hub, it decreases the number of signal loads on the memory bus, thereby allowing the system to increase its memory transfer rate. Memory expanders are not used in the Integrity rx1600 or rx2600 server. The Integrity rx4640 server, however, deploys 6 memory expanders, resulting in large memory capacity (up to 64 GB over 32 DIMM slots) and bandwidth (12.8 GB/s). Likewise, the Integrity rx5670 server uses 12 memory expanders on two memory carriers to provide an exceptional memory capacity of 96 GB (over 48 DIMMs) with 12.8 GB/s bandwidth.

Figure 9. The three components of the HP zx1 Chipset

zx1 MIO
- HP zx1 Chipset memory and I/O controller
  - Connects to processor bus
  - Contains memory controller
  - Contains I/O cache controller

zx1 IOA
- HP zx1 Chipset I/O adapter—a single I/O adapter that supports:
  - PCI
  - PCI-X
  - AGP

zx1 SME
- HP zx1 Chipset scalable memory expander—an optional component used to:
  - Increase memory capacity
  - Increase memory bandwidth

The HP zx1 Chipset was designed with several goals in mind:

- **Provide the best performance**—For demanding applications that don't fit within the processor cache, the memory system design is the key to performance. The HP zx1 Chipset's memory bandwidth has been optimized with dual memory controllers to provide from 8.5 to 12.6 GB/s of memory bandwidth with 80 to 105 nanoseconds of open page latency.

- **Provide the right functionality**—Use systems that include both memory capability and PCI-X support.
  - At 16 GB, 24 GB, 64 GB, and 96 GB, respectively, the Integrity rx1600, rx2600, rx4640, and rx5670 servers provide enough memory capacity for the most demanding tasks.
  - The Integrity rx1600, rx2600, rx4640, and rx5670 servers support 133 MHz PCI-X buses capable of handling the latest generation of high-speed I/O adapters.

- **Enable a family of systems via a modular, multi-chip design**—Designers can choose the chipset components they need and select the number of these components to meet system cost and design requirements. For example, the more expandable Integrity rx4640 and rx5670 servers deploy HP zx1 Chipset scalable memory expanders for greater memory capacity. The Integrity rx1600 and rx2600 servers, on the other hand, do not deploy zx1 Chipset scalable memory expanders, resulting in lower system costs.

The HP zx1 Chipset is ideal for use with the Intel Itanium 2 processor because it complements the processor's price/performance advantages. Moreover, the new zx1 Chipset leverages HP's co-developer knowledge of the CPU itself. Indeed, the HP zx1 Chipset was the turn-on vehicle for the Intel Itanium 2 processor in February 2001. At that time, Itanium 2–based systems with the HP zx1 Chipset were already running HP-UX, Linux, and Microsoft Windows.

Features and benefits of the HP zx1 Chipset

Feature	User benefit
High memory bandwidth, low memory latency	Top application performance, faster time to solution
High memory capacity	Optimum performance for large models/databases
133 MHz PCI-X	Highest-performance I/O adapters
Modularity	Family of Intel Itanium processor-based servers and workstations, each optimized for the right level of cost and scalability

Architectural overview of the HP Integrity rx1600 server

The HP Integrity rx1600 server supports either one or two Low Voltage Intel Itanium 2 processors linked to the HP zx1 Chipset memory and I/O controller through a 200 MHz, double-pumped 128-bit front-side system bus. Total bandwidth on the system bus is 6.4 GB/s.

Figure 10. The HP Integrity rx1600 server architecture features Intel Itanium 2 processors and the HP zx1 Chipset
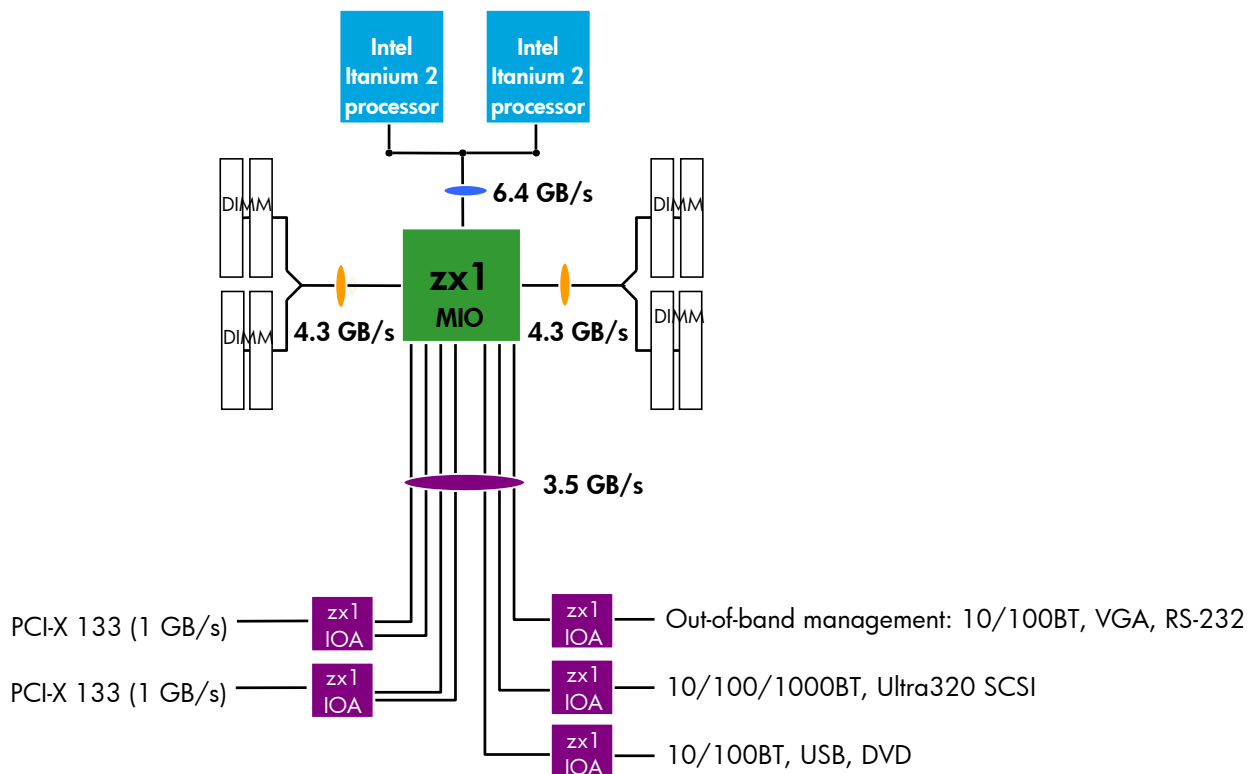
Memory DIMMs are attached directly to two 266 MHz, 4.3 GB/s memory buses. Combined memory bandwidth across both buses is 8.5 GB/s. Each bus links up to six double data rate (DDR) DRAM memory DIMMs. Total system memory capacity is 16 GB, via twelve 8 GB DIMMs.
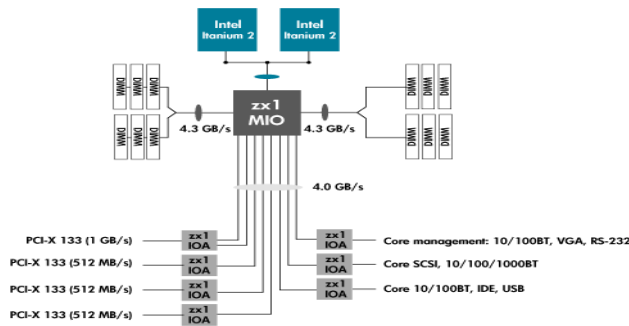
The I/O architecture consists of seven 0.5 GB/s channels allocated among five zx1 Chipset I/O adapters. Each of these seven adapters provides a PCI-X or PCI bus to the available I/O slots and core I/O devices. The first four channels connect to two 133 MHz PCI-X I/O slots, providing 1 GB/s of sustained throughput per slot. These slots are ideal for high-bandwidth I/O adapters such as high-performance clustering interconnect. The remaining three

20

I/O channels link to three PCI buses, which in turn link to the core LAN, SCSI, IDE, and USB interfaces and to the management processor.

Architectural overview of the HP Integrity rx2600 server

The HP Integrity rx2600 server supports either one or two Intel Itanium 2 processors linked to the HP zx1 Chipset memory and I/O controller through a 200 MHz, double-pumped 128-bit front-side system bus. Total bandwidth on the system bus is 6.4 GB/s.

Figure 11. The HP Integrity rx2600 server architecture features Intel Itanium 2 processors and the HP zx1 Chipset


Memory DIMMs are attached directly to two 266 MHz, 4.3 GB/s memory buses. Combined memory bandwidth across both buses is 8.5 GB/s. Each bus links up to six DDR DRAM memory DIMMs. Total system memory capacity is 24 GB, via twelve 2 GB DIMMs.

The I/O architecture consists of eight 0.5 GB/s channels allocated among seven zx1 Chipset I/O adapters. Each of these seven adapters provides a PCI-X or PCI bus to the available I/O slots and core I/O devices. The first two channels connect to a single 133 MHz PCI-X I/O slot, providing 1 GB/s of sustained throughput. This slot is ideal for high-bandwidth I/O adapters such as high-performance clustering interconnect. The next three I/O channels link to three independent 133 MHz PCI-X I/O slots, each with 0.5 GB/s of sustained throughput. The remaining three I/O channels link to three PCI buses, which in turn link to the core LAN, SCSI, IDE, and USB interfaces and to the management processor.

Architectural overview of the HP Integrity rx4640 server

The HP Integrity rx4640 server supports one, two, three, or four Intel Itanium 2 processors linked to the zx1 memory and I/O controller through a 200 MHz, double-pumped 128-bit system bus. Total bandwidth on the system bus is 6.4 GB/s.

Figure 12. The HP Integrity rx4640 server supports up to four Intel Itanium 2 processors linked to the HP zx1 Chipset
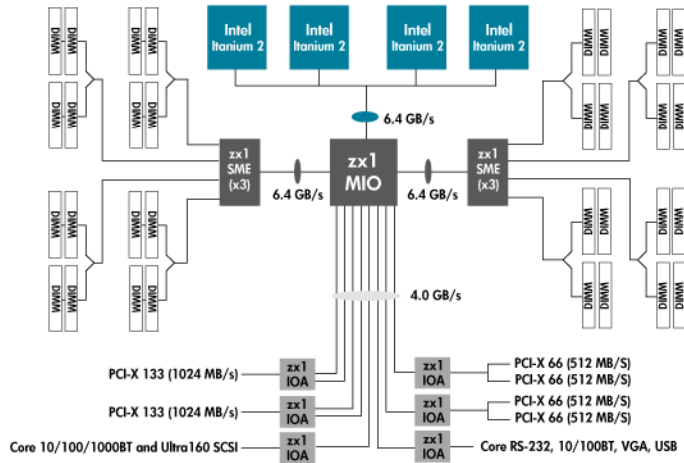
The zx1 Chipset memory controller links to two independent 200 MHz, 6.4 GB/s memory buses. Each bus connects to three zx1 scalable memory expanders, which in turn allocate bandwidth to the DDR DRAM memory DIMMs. Total DIMM capacity is either 16 or 32 units on a single memory carrier board.

The I/O architecture consists of eight 0.5 GB/s channels allocated among six zx1 Chipset I/O adapters. Each of these six adapters provides a PCI-X or PCI bus to the available I/O slots and core I/O devices. The first two I/O channels connect to an independent 133 MHz PCI-X I/O slot with 1.0 GB/s of sustained throughput. The next two I/O channels connect to an identical 133 MHz PCI-X slot. Two more I/O channels connect to a pair of zx1 Chipset I/O adapters, each of which in turn connects to a pair of 66 MHz PCI-X I/O slots. Each slot-pair shares 0.5 GB/s of bandwidth.

The final two I/O channels connect to the core I/O. One channel provides 0.5 GB/s of bandwidth to the core 10/100/1000BT LAN as well as to the dual-channel Ultra160 SCSI controller. The other channel provides 0.5 GB/s of bandwidth to the core management LAN, RS-232 serial ports, USB ports, and VGA.

Architectural overview of the HP Integrity rx5670 server

The HP Integrity rx5670 server supports one, two, three, or four Intel Itanium 2 processors linked to the zx1 Chipset memory and I/O controller through a 200 MHz, double-pumped 128-bit system bus. Total bandwidth on the system bus is 6.4 GB/s.

Figure 13. The HP Integrity rx5670 server supports up to four Intel Itanium 2 processors linked to the HP zx1 Chipset
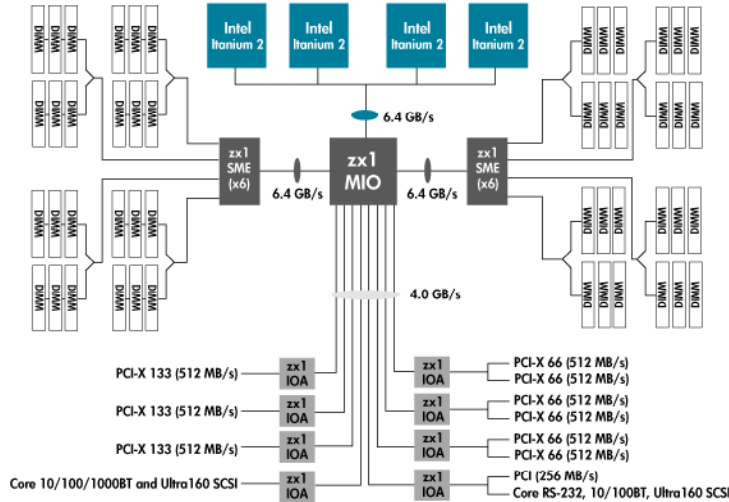
The zx1 Chipset memory controller links to two independent 200 MHz, 6.4 GB/s memory buses. Each bus connects to six zx1 Chipset scalable memory expanders, which in turn allocate bandwidth to the DDR DRAM memory DIMMs. Total DIMM capacity is 48 units, distributed over two 24 DIMM memory carrier boards, with one board on each memory bus.

The server can operate with only one memory carrier board; however, this will only use one memory bus and, therefore, only half of the available memory bandwidth. For maximum performance, the Integrity rx5670 server should be configured with both memory carrier boards, allowing full utilization of the server's 12.8 GB/s total memory bandwidth.

The I/O architecture consists of eight 0.5 GB/s channels allocated among eight zx1 Chipset I/O adapters. Each of these eight adapters provides a PCI-X or PCI bus to the available I/O slots and core I/O devices. The first three I/O channels connect to three independent 133 MHz PCI-X I/O slots, each with 0.5 GB/s of sustained throughput. The next three I/O channels connect to three zx1 Chipset I/O adapters, each of which in turn connects to a pair of 66 MHz PCI-X I/O slots. Each slot-pair shares 0.5 GB/s of bandwidth.

The final two I/O channels connect to the core I/O. One channel provides 0.5 GB/s of bandwidth to the core 10/100/1000BT LAN as well as to one dual-channel Ultra160 SCSI controller. The other channel provides 0.5 GB/s of bandwidth to the core management LAN, RS-232 serial ports, another dual-channel Ultra160 SCSI controller, and a 33 MHz PCI slot. The 33 MHz slot is ideal for the optional VGA/USB adapter (HP product number A6869A). The VGA/USB card is automatically placed in this slot on systems that are factory-loaded with Microsoft Windows operating systems.

Extensible firmware interface

The extensible firmware interface (EFI) is an interface between the HP-UX, Linux, and Windows operating systems and the Itanium 2–based platform firmware. The file system supported by the extensible firmware interface is based on the file allocation table (FAT) file system. EFI allows the use of FAT-32 for the system partition. (The system partition is required on a bootable disk for the Itanium 2–based platform.)

For a hard disk, the system partition is a contiguous grouping of sectors on the disk. The starting sector and size are defined by the EFI partition table residing on the second logical block of the hard disk and/or by the master boot record (MBR), which resides on the first sector of the hard disk. The system partition can contain directories, data files, and EFI images. The EFI system firmware may search the \EFI directory of the EFI system partition, EFI volume, to find possible EFI images that can be loaded. (The HP-UX boot loader is one example of an EFI image.)

Baseboard management controller

The baseboard management controller provides ease of system management. The baseboard management controller supports the industry-standard Intelligent Platform Management Interface (IPMI) specification. This specification describes the management features that have been built into the system. These features include diagnostics, configuration management, hardware management, and troubleshooting. The baseboard management controller interacts with the management processor to provide the highest level of system manageability and high-availability monitoring.

The baseboard management controller provides the following:

- 40 MHz ARM7TDMI RISC core, 1 MB flash ROM, 512 KB battery-backed RAM
- Power and reset management
- System "health" management: fans, power supplies, temperatures, voltages
- Event logging and reporting: system event log, forward progress log, diagnostic LEDs on status panel
- Device inventory
- Hardware and data protection: automatic clean OS shutdown on critical events, secure storage of system configuration parameters, protection of system flash ROM
- Link to dedicated out-of-band management processor (MP) via Intelligent Platform Management Bus (IPMB); enables remote management through the MP LAN or MP serial ports
- Compliance with Intelligent Platform Management Interface 1.0

HP management processor

The management processor (MP) is included as a standard part of the HP Integrity rx2600, rx4640, and rx5670 servers and is an optional feature of the HP Integrity rx1600 server. This processor provides a remote interface into the baseboard management controller to manage system resources, diagnose the health of the system, and facilitate system repair. Administrators can interact with the management processor on a dedicated, out-of-band (that is, independent of the main system data paths) communication link that can be accessed via RS-232 serial ports or a 10/100BT management LAN.

The management processor minimizes or eliminates the need for the system administrator to be physically at the system to perform tasks such as diagnostics, system management, or even hard resets. The management processor has its own battery backup, so it can be accessed even in the unlikely event that the main system power is out and the operating system has stopped functioning.

Here are some of the features enabled by the management processor:

- System management over the Internet or intranet (Web console)
- System console redirection
- Console mirroring
- System configuration for automatic restart
- Viewing history log of system events
- Viewing history log of console activity
- Setting MP inactivity timeout thresholds
- Remote system control
- Remote power cycle (except for MP housekeeping power)
- Viewing system status
- Event notification to system console, e-mail, pager, and/or HP Response Centers; e-mail and pager notification work in conjunction with HP's Event Monitoring System (EMS)
- Automatic hardware protection of critical environmental problems
- Access to management interface and consoles on WAN failure (modem required)

- Automatic system restart
- Forward progress indicator (via a virtual front panel)
- Out-of-band manageability and system firmware update
- Configuration of manageability and console security
- Secure Sockets Layer (SSL) encryption on Web console access

Figure 14. High-level depiction of the HP Integrity rx1600, rx2600, rx4640, and rx5670 servers' management processor architecture
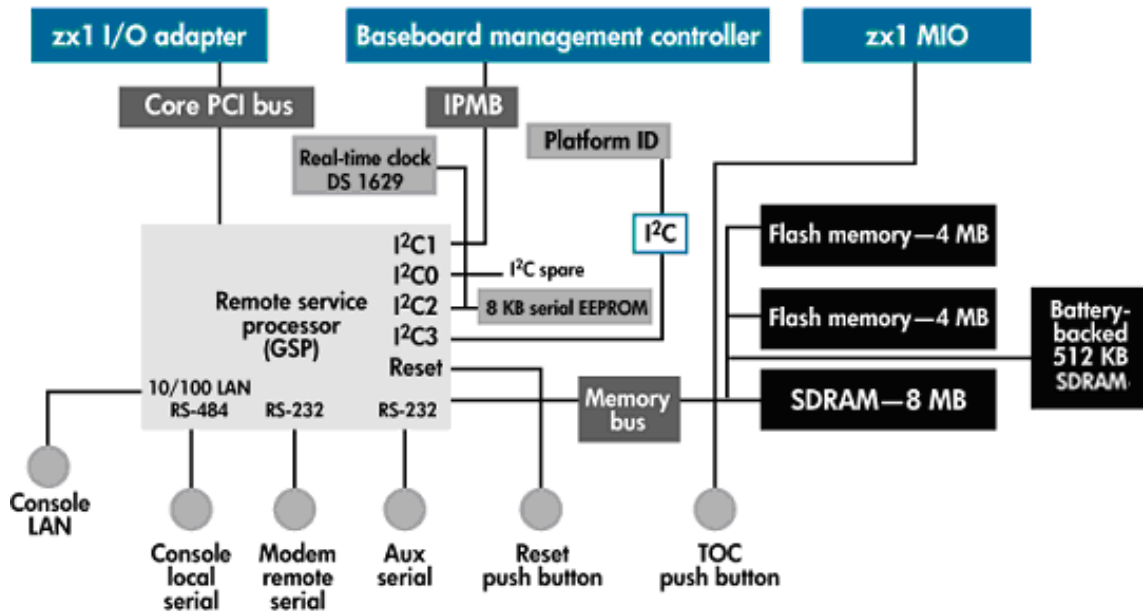
Built for high availability

The HP Integrity rx5670, rx4640, and rx2600 servers have been designed to be an integral part of a mission-critical environment, delivering from 99.95% availability to close to 99.999% availability, depending on the specific solution configuration. Delivering these levels of uptime requires a strong base of single-system high availability (SSHA) in the hardware. The Integrity rx5670, rx4640, and rx2600 servers have redundancy and resiliency built in from the ground up, starting with the chassis infrastructure, through the I/O, then continuing through the memory and processor subsystems.

The servers' strong SSHA is further bolstered by HP's fault event monitoring service (EMS). And for the maximum possible uptime, any of the three servers can be configured as an integral part of a high-availability cluster, using clustering software such as HP Serviceguard.

High-availability chassis infrastructure (power and cooling)

Fans in the Integrity rx5670, rx4640, rx2600, and rx1600 servers provide excellent cooling, pulling cool air from the front of the unit, flowing the air back over internal system components, and then discharging heated air out the back of the server. All the fans in the Integrity rx5670, rx4640, and rx2600 servers are easily accessible and provide N+1 redundancy.

These servers have high-availability power supplies, too. The Integrity rx5670, rx4640, and rx2600 servers' power subsystems provide high availability with N+1 redundant power options. The Integrity rx5670 server comes standard with two hot-swap power supplies, and an optional third supply can be ordered for 2+1 redundancy. The Integrity rx4640 and rx2600 servers each come standard with a single hot-swap power supply; an optional second supply gives these servers 1+1 redundancy of power supplies. To further enhance availability, each power supply has its own dedicated power feed or line cord. Cords can be plugged into separate power grids for the maximum level of power protection.

Hot-plug disk drives

The Integrity rx5670 server supports up to four SCSI disks, the Integrity rx4640 server supports up to two, the Integrity rx2600 server supports up to three, and the Integrity rx1600 supports up to two. All disks are accessible from the front of the system and can be removed (or hot-plugged) while the server continues to run.

Two dual-channel SCSI controllers manage the four internal hot-plug disks in the Integrity rx5670 server. For added availability, disk pairs are on separate channels as well as separate SCSI controllers. This means that with disk mirroring, a SCSI controller, SCSI channel, or root disk could fail and the server would continue to run properly.

A dual-channel SCSI controller manages the pair of disks in the Integrity rx4640 server. The disks can be configured either on a single SCSI channel or one disk on each of the two channels with disk mirroring for added availability. When only one SCSI channel is used for the disks, the second can be connected to an external device such as a tape drive.

A single dual-channel SCSI controller manages the three disks in the Integrity rx2600 server. One channel links to two internal disks; the second channel is connected to the third internal disk. This allows disk mirroring across separate SCSI channels, further enhancing availability.

A single dual-channel SCSI controller manages the two disks in the Integrity rx1600 server. One channel links to two internal disks, another channel links to an external connector.

Multiple I/O channels

The multiple zx1 Chipset I/O channels in the Integrity rx5670, rx4640, rx2600, and rx1600 servers provide failover, load balancing, and failure isolation. In these servers, failures on one channel do not disrupt activities on other channels. Furthermore, the servers deploy fully independent PCI-X buses to isolate traffic on I/O adapters. If a problem occurs on one adapter, it will not interfere with traffic on another bus.

ECC and chip spare memory

The memory systems for the Integrity rx5670, rx4640, rx2600, and rx1600 servers utilize error-correcting code to correct single-bit errors, and they use HP's chip spare technology to protect against multi-bit errors.

Chip spare enables an entire SDRAM chip on a DIMM to be bypassed in the event that a multi-bit error is detected on that SDRAM. In order to use the chip spare functionality, identical-sized DIMMs must be loaded in quads. Different DIMM sizes are supported, as long as they are in different quads. For example, a quad of 512 MB DIMMs can be loaded along with a second quad of 1 GB DIMMs, and chip spare will be enabled on all the DIMMs.

Because of the chip spare feature, the Integrity rx5670, rx4640, rx2600, and rx1600 servers are completely resilient to all SDRAM failures, regardless of the number of bits involved in the fault condition. This virtually eliminates memory failures as a source of system errors.

Some other vendors deal with multi-bit SDRAM failures by accepting the fact that they will occur. That is, they use a scheme that supports only failure detection, not failure correction. HP believes that this is unacceptable and a dangerous choice for servers in business-critical environments. In fact, server systems that employ failure detection but not correction are at high risk to fail due to memory problems.

CPU error correction and dynamic processor resiliency

In the Integrity rx1600, rx2600, rx4640, and rx5670 servers, L1 and L2 caches both have full single-bit error checking and correcting as well as double-bit error detection. Additionally, all the instruction and data paths also have single-bit error-checking and -correcting capabilities. What's more, the system processor bus has parity detection, and the data path is covered by error correction.

The Integrity rx1600, rx2600, rx4640, and rx5670 servers employ dynamic processor resiliency (DPR), too. With DPR, any CPU generating correctable cache errors at a rate deemed unacceptable is de-allocated from use by the system. This feature helps protect against a CPU degrading to the point where it may cause system crashes.

DPR works like this: When excessive errors are reported against a CPU, the CPU is deactivated (that is, the operating system will not schedule any new processes on it). The system firmware remembers the CPU's serial number and the time when this action was taken. From then on, at each poll interval the system monitor checks (by comparing the serial numbers) to see if the CPU has been replaced or not. If the processor has been replaced, its history is reset.

If the system is rebooted before the offending CPU has been replaced, the monitor generates a warning message and immediately de-allocates the CPU. (Such CPU de-allocation is only supported in the HP-UX operating system. It is not supported in Windows or Linux.)

Comprehensive error logs

All system events are stored in the system event log (SEL) in nonvolatile memory. In addition, system firmware creates activity and forward progress logs (FPLs) in nonvolatile memory. In all but the most extreme situations—that is, in more than 95 percent of cases—this information will be sufficient to diagnose system failures to a single replaceable part. The SEL and FPL are available to both the management processor (and therefore are available remotely) and to system-level tools, leading to quick and accurate diagnosis.

Fault management throughout the lifecycle

Fault management is HP's overall strategy and program to provide a complete value chain for detection, notification, and repair of system problems. Fault management starts right during the design phase, when hardware and OS designers include capabilities and instrumentation points that provide the ability to detect and isolate system anomalies. Monitors are created to poll for system health information or to asynchronously respond to instrumentation points that have been designed into the system to report problems or faults.

Fault management also involves implementing several methods for maintaining historical event information, allowing preservation of information for analysis or trending. Faults that generate errors and warnings are automatically logged to syslog, while notes and audit information are copied to an event log. Other options are available for preserving historical information as well.

Fault management provides immediate alerts of problems—and even potential problems—as soon as they are detected, so customers can take corrective action. In some cases fault monitors are actually smart enough to repair faults or prevent them from occurring.

Capabilities of fault monitors

Fault management, coupled with the monitoring capabilities, keeps tabs on the health of system components and generates close to real-time events when problems develop. These events can trigger corrective action to enable the system to continue functioning, or they can trigger alerts to systems personnel to appropriately handle the situation before it becomes more severe.

Fault monitors are able to:

- Poll the system for health information
- Handle asynchronous events that have been designed into the hardware or software
- Perform corrective action when possible
- De-allocate failing memory before it fails (dynamic memory resiliency)
- De-allocate failing processors before they fail (dynamic processor resiliency)
- De-configure failed processors from the working set before the next reboot
- Shut down the system when power failure causes a switch to UPS
- Manage events so that system performance is not hindered in the face of errors
- Provide information on problem causes and what actions to take

Notification and integrated enterprise management

Fault management currently uses the HP EMS (Event Monitoring Service) infrastructure for its notification methodology. EMS enables a wide variety of notification methods, including pager, e-mail, SNMP traps, system console, system log, text log file TCP/UDP, and HP OpenView Operations center (OPC) messaging. Fault

management events can be viewed directly on the server or through HP Insight Manager, which can aggregate information from multiple systems in the data center.

Customers also have the option to integrate fault management events with enterprise management software from HP (OpenView) or from BMC, Tivoli, Computer Associates, or MicroMuse.

Added options with HP support

For customers who purchase HP support, fault management events can be forwarded to the HP support organization. In this case, HP can take responsibility for monitoring, filtering, and trending the events and taking action on items that need attention.

At the premium end of HP's support offerings, customers can also sign up to receive services from HP's High Availability Observatory (HAO). The HAO provides continuous and proactive monitoring of the customer's environment via a dedicated and private ISDN network. The ISDN link allows secure information flow between the customer site and HP's support organization and provides HP support engineers with direct access to the customer's system. As part of the HAO implementation, HP installs a support node at the customer site, and this node is connected securely to the HP support organization.

Proactive, not reactive

Fault management uses the philosophy of proactive (as opposed to reactive) management of problems. Fault management provides highly accurate fault diagnosis the first time, even as the problem occurs, and initiates or allows fast corrective action. Fault management results in a substantial decrease in unplanned downtime.

An easy transition for RISC and IA-32 users

A major feature of the Intel Itanium 2 processor and HP's new servers is backward compatibility of the Intel Itanium 2 processor with IA-32 and PA-RISC processors. Backward compatibility is particularly useful for applications that are not performance-intensive or for system utilities and development tools that aid in porting and migration. Although most existing IA-32 and PA-RISC binaries are compatible, optimal performance can only be achieved once an application is compiled specifically for the Intel Itanium 2 processor.

Running 32-bit Windows applications

32-bit Microsoft Windows binaries can run on the 64-bit Windows operating system using the Intel Value Engine (IVE) hardware and WOW64 software emulation, which is already part of 64-bit Microsoft Windows. The OS automatically detects whether the application is 32-bit or 64-bit and handles it accordingly.

Additionally, Microsoft and Intel have now made available IA-32 Execution Layer (EL) software. The IA-32 EL is a software binary that is available for download now from Microsoft; it will be integrated into Windows Server 2003 Service Pack 1. Whenever a 32-bit application is launched, the operating system will call the EL to translate the 32-bit application into a native Itanium 2–based application. The EL, working in conjunction with an Intel Itanium 2 processor, is expected to yield application performance similar to that of a 1.5 GHz Intel Xeon™ Processor MP. Because EL compatibility is gained via software translation, the EL will deliver further performance improvements on faster Intel Itanium processors released in the future. The EL is expected to supersede the Intel Value Engine hardware feature because it will clearly provide much better performance on 32-bit applications.

Running 32-bit Linux applications

32-bit Linux binaries can be run on Itanium 2–based systems using the processor's built-in hardware translation feature. The Intel Value Engine hardware is part of the Intel Itanium 2 processor, and it gives a basic IA-32 functionality. If an application is performance-critical, recompiling the application will allow it to take advantage of the strengths of the Intel Itanium 2 microarchitecture.

The IA-32 Execution Layer

Beginning in the second half of 2003, 32-bit software compatibility will be enhanced via the Intel IA-32 Execution Layer (IEL). IEL is a software binary that will be integrated into major Itanium 2–based operating system releases. Whenever a 32-bit Intel application is launched, the operating system will call the IEL to translate the 32-bit application into a native Itanium 2–based application. IEL, working in conjunction with an Intel Itanium 2 processor, is expected to yield application performance similar to that of a 1.5 GHz Intel Xeon Processor MP. Because IEL compatibility is gained via software translation, the IEL will deliver further performance improvements

on faster Intel Itanium processors released in the future. The IEL is expected to supersede the Intel Value Engine hardware feature since it will clearly provide much better performance on 32-bit applications.

Running RISC applications

Users can run their PA-RISC binaries unchanged and completely transparently, thanks to the Aries dynamic code translator that is part of HP-UX 11i. This translator allows running 32-bit and 64-bit PA-RISC applications on the Intel Itanium 2 microarchitecture without the need to recompile. A straightforward recompile of 32-bit and 64-bit PA-RISC applications yields native Intel Itanium 2 processor binaries.

Porting and migration services: transition help from HP

Thousands of programs run quite well in Intel Itanium processor compatibility mode with minimal changes. However, porting these applications to the Intel Itanium 2 processor allows them to run even better because they can then take full advantage of the new processor's distinctive capabilities.

To help customers make the transition to the Intel Itanium Processor Family and get the most from this exciting new technology, HP offers a flexible set of services. Customers can select from the following:

- Porting and migration workshop
- Porting and migration guidance
- Porting and migration detailed assessment
- Porting and migration solution delivery
- Online services

See www.hp.com/products1/itanium/services/porting_migration.html for all the details on these services.

Conclusion

On the road to becoming truly pervasive, the Intel Itanium 2 processor is faster and more capable than its predecessor. Now, with the Integrity rx1600, rx2600, rx4640, and rx5670 servers, HP offers powerful servers based on the Intel Itanium 2 processor and featuring the new HP zx1 Chipset. The Integrity rx1600 server utilizes one or two Low Voltage Intel Itanium 2 processors and up to 16 GB of memory, the Integrity rx2600 server utilizes one or two Intel Itanium 2 processors and up to 24 GB of memory, the Integrity rx4640 server can be equipped with as many as 4 processors and as much as 64 GB of memory, and the Integrity rx5670 server utilizes as many as 4 processors and as much as 96 GB of memory. These servers offer cutting-edge, 64-bit power along with excellent price/performance.

The new servers are optimized for complex, floating-point-intensive computations, providing faster time to solution for demanding applications. They are especially suited to SSL Web serving, and they offer significant performance advantages over both IA-32- and RISC-based systems for Windows and database applications. They're also perfect for running SAP, Siebel, PeopleSoft, and SAS business application suites.

The Intel Itanium 2 processor's ability to run IA-32 and RISC binaries without modification helps ensure protection for previous software investments, and HP's porting services can effect a complete transition that takes full advantage of the Intel Itanium architecture. Another advantage is that customers with either of these servers can run any of four industry-leading operating systems—HP-UX, Linux, Windows, or OpenVMS Evaluation Release (until 2H 2004, when a production-quality release is expected). This multi-OS capability overcomes the complexities and challenges associated with deploying and maintaining a heterogeneous operating environment.

Whether for technical computing or commercial IT, the HP Integrity rx1600, rx2600, rx4640, and rx5670 servers offer superior power, scalability, and efficiency—with lower costs.

For more information

Looking for more information about the Intel Itanium Processor Family? Find out more about the architecture and how HP can help you make your transition by visiting:
www.hp.com/go/itanium

Or visit our Itanium-based servers and workstations site at:
www.hp.com/products1/itanium/servers_workstations/index.html

Or contact any of our worldwide sales offices or HP Channel Partners (in the U.S., call 1-800-637-7740).

HP product information and technical documentation is available online at:
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