



**an overview of the Itanium™-based
hp rx4610 server**



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executive summary

The Itanium™ Processor Family is the next great stride in computing—and it's here today. For many types of computing, Itanium offers markedly superior performance over other chip designs. This white paper discusses the advantages of the Itanium architecture, and gives details about the rx4610, Hewlett-Packard's first server to use the 64-bit Itanium processor. The white paper illustrates where the rx4610 fits into HP's server lineup, explains the features of the new server, and discusses how HP makes the transition to Itanium easy—while preserving your investment in existing software.

why Itanium is the future of computing

The Itanium Processor Family (IPF) is based on the EPIC (Explicitly Parallel Instruction Computing) architecture developed by HP Labs. EPIC architecture far surpasses the sequential nature of today's processor architectures by allowing the software to communicate explicitly to the processor whenever operations can be done in parallel. It delivers the enhanced performance needed for the servers of the future.

The Itanium processor is a leap forward from today's RISC (Reduced Instruction Set Computing) chips. Its EPIC architecture serves as the enabler for future high-performance chips because it provides explicit parallelism, massive resources and inherent scalability not available with conventional RISC designs. EPIC makes possible increased performance by reducing the number of branches and branch mispredicts, and by reducing the effects of memory-to-processor latency.

The Itanium chip found in the rx4610 is just the beginning. In fact, there are at least four future IPF generations under development today. IPF will provide the building blocks for the next 20 years of high-performance computing.

rx4610 at a glance

The HP rx4610 is a symmetrical multiprocessing (SMP) server providing from two to four processors. Processor choices include either a 733-MHz/2-MB cache option or the ultra-high-performance 800-MHz/4-MB cache system. The enhanced 64-bit address space of the IPF architecture allows the rx4610 to scale from 1 GB all the way to 64 GB of memory, a level unprecedented in 4-way computing. Additionally, the rx4610 has 10 industry-standard PCI slots, providing up to 2.1 GB/sec of peak throughput—enough for virtually any bandwidth-intensive application. The system employs advanced high availability features, such as N+1 hot-plug power supplies and fans, hot-plug hard disks, error checking and correcting code on all data paths, and an integrated management bus to monitor essential voltage and temperature levels. The rx4610 also supports many of HP's enterprise storage peripherals, as well as our industry-leading connectivity solutions.

figure 1. front view of the rx4610 (with and without bezel)



rx4610 product specifications

- 2 to 4 64-bit Itanium processors
- 733-MHz/2-MB Level 3 cache; or 800-MHz/4-MB Level 3 cache
- 1- to 64-GB PC100 SDRAM ECC memory
- 8 hot-plug 64-bit x 66-MHz PCI slots
- 2 non-hot-plug 64-bit x 33-MHz PCI slots
- N+1 power and cooling
- 2 hot-plug 36-GB 10k rpm disk drives
- DVD-ROM drive
- LS-120 floppy
- 10/100Base-T Ethernet
- VGA, USB, PS/2, parallel and serial ports
- 2.1-GB/s system bus bandwidth
- 4.2-GB/s memory bandwidth
- 2.1-GB/s I/O bandwidth
- HP-UX 11i version 1.5, Windows® XP, Linux
- 7-EIA-unit, 19-inch rackmount chassis

A unique advantage of the rx4610 is its ability to handle multiple operating environments. The rx4610 supports HP-UX, Windows XP®, and Linux. Furthermore, because EPIC was invented by HP, IPF is binary-compatible with the PA-RISC processor architecture. There are over 16,000 applications currently available on the HP-UX operating environment for PA-RISC. Virtually all of these will run on the rx4610 without recompilation—a claim that no other UNIX® operating system can match. All in all, the rx4610 is the industry's best option for developers and IT managers who want to invent the future of computing.

rx4610 physical and environmental specifications

feature	details
model	hp rx4610
height	31.1 cm/ 12.25 in / 7U
width	44.4 cm/ 17.5 in
depth	71.1 cm/ 28.0 in
weight (max)	68 kg/ 150 lbs
required front clearance	3 in
required rear clearance	8 in
heat dissipation	6174 BTU/hr
acoustics	< 7.5 Bels

the rx4610 and the hp server lineup

The rx4610 is the entry-level IPF cornerstone of the HP server line. Together, HP Netserver and HP 9000 systems form the industry's leading line of servers for reliability, scalability, availability, and price/performance. This robust product line addresses the major computing challenges customers face today in online transaction processing, electronic commerce, Internet/intranet serving, enterprise resource planning, supply chain management, and technical applications.

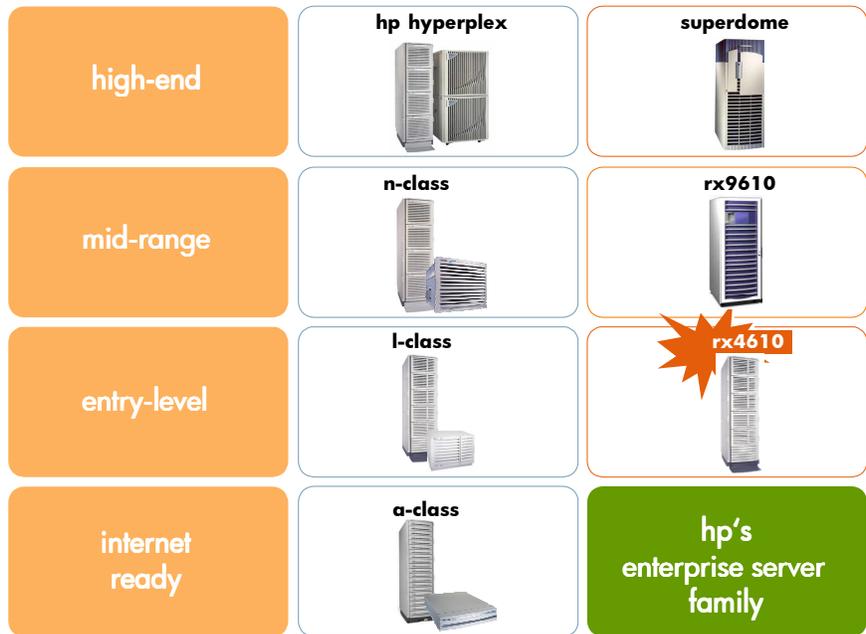
At the low end, affordable A- and L-Class servers effortlessly handle Internet workloads and enterprise-size applications. Both platforms also add leadership price/performance, and include bundled Internet software solutions.

In the mid-range, the N-Class delivers the high-performance, compact Internet-era UNIX server platform that today's executives are demanding. With up to 8 PA-8600 processors, the N-Class provides the robust performance and scalability needed for the most demanding workloads.

At the high end, the HP Superdome server has become the pacesetter, thanks to its exceptional OLTP performance, availability, scalability, and manageability. Superdome, coupled with HP's always-on infrastructure strategy, provides UNIX application performance and Internet-critical high availability to meet the rigorous demands of e-services and systems consolidation, as well as large-scale, highly complex technical modeling and simulations.

All HP servers provide excellent investment protection with a smooth transition path to future PA-RISC, IA-32, and Itanium architectures. HP will continue to enhance and deliver the PA-RISC product line so that customers can choose when to make the transition to Itanium. Indeed, most of HP's PA-RISC servers are *board-upgradable to future generations of Itanium processors*. So whether your business requires cutting-edge e-services, systems consolidation, or a host of other solutions, our power-packed HP servers are business-critical-proven and ready to meet the challenge—today and tomorrow.

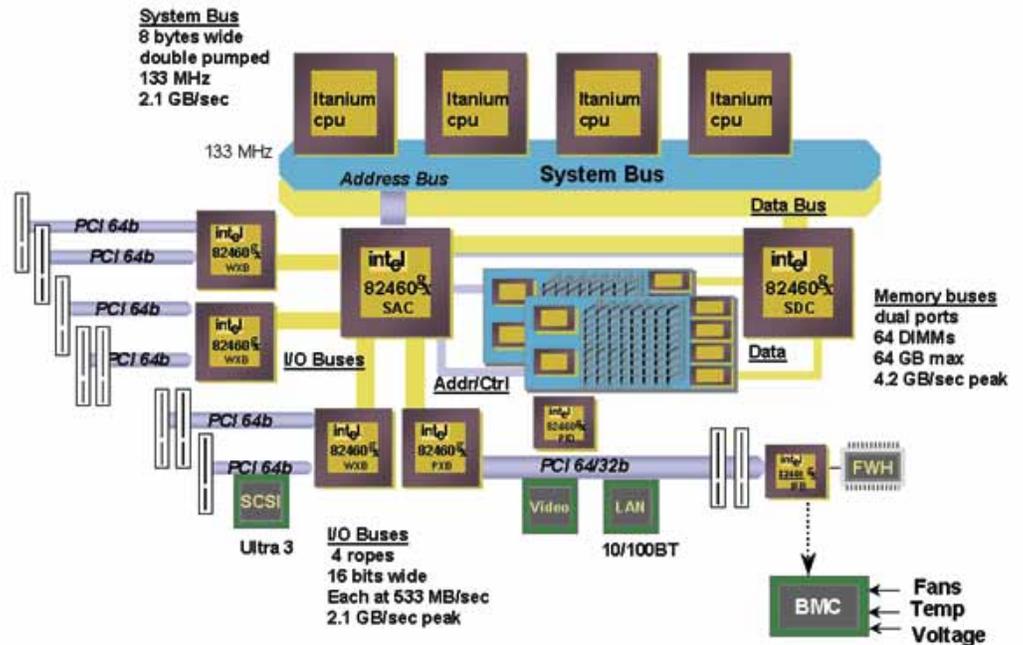
figure 2. the industry's strongest UNIX lineup—top to bottom



rx4610 architecture

Figure 3 shows the relationship of the rx4610 main blocks and the buses that connect them. The rx4610 uses the Intel® high-performance 460GX core electronics chipset, specifically designed for 64-bit EPIC computing. This chipset brings unprecedented levels of bandwidth to 4-way, Intel-powered systems.

figure 3. overview of rx4610 architecture



The rx4610 system bus is 8 bytes wide, and runs at 133 MHz. Data is carried on both the leading and falling edges of the clock cycle, and is protected by error checking and correcting (ECC) code to detect and correct single-bit errors. In total, the system bus provides 2.1 GB/sec of bandwidth to the four Itanium CPUs.

The memory bus has two ports, each providing 2.1 GB/sec of bandwidth to 32 memory slots. The combined memory bandwidth, over both ports and all 64 memory slots, is 4.2 GB/sec. The 460GX I/O controller has four 533-MB/sec I/O channels. These channels are laid out to provide 2.1 GB/sec of bandwidth to the rx4610's PCI slots and core I/O.

64-bit address space and memory capacity

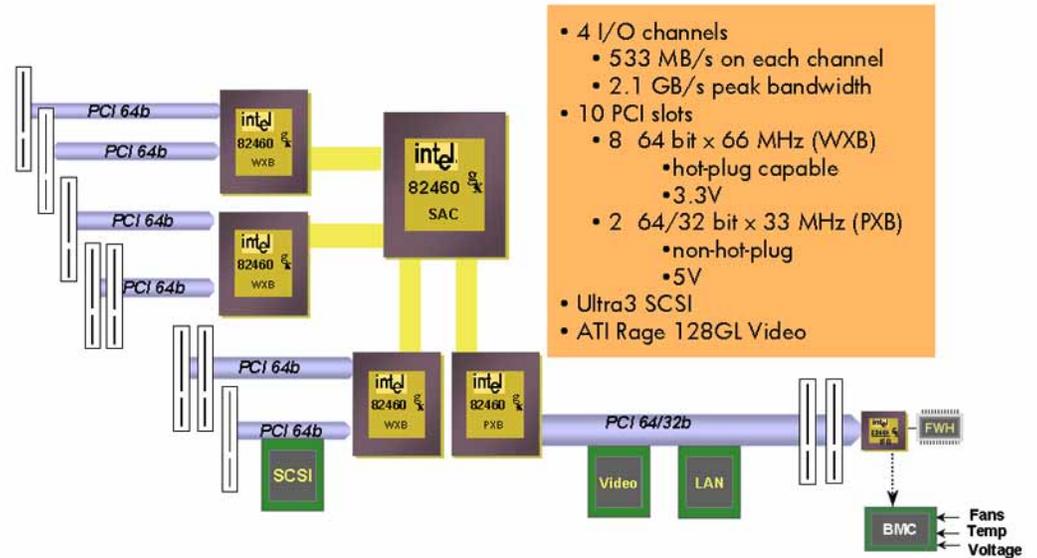
The rx4610 provides memory scalability that is unprecedented in 4-way computing. The server's processor/memory complex, which slides out of the side of the chassis, has a total of 64 memory slots—32 on the top of the complex and 32 on the bottom. The system accepts PC100 synchronous dynamic random access memory (SDRAM). The memory is mounted on 72-bit dual inline memory modules (DIMMs). For high availability, the DIMMs employ enhanced error checking and correcting (ECC) code to detect and correct single-bit errors.

Memory must be installed in sets of four DIMMs. Memory can be ordered in kits of four different sizes: 1 GB (4x256-MB DIMMs), 2 GB (4x512-MB DIMMs), and 4 GB (4x1-GB DIMMs). Total system memory scales from a minimum of 1 GB to a maximum of 64 GB. DIMMs are loaded in a specific order that is labeled next to each DIMM slot on the processor/memory complex. If more than two processors are configured, users should load memory on both sides of the processor/memory complex to fully utilize both memory ports and to optimize system performance.

I/O subsystem design

The rx4610 has four high-speed I/O channels. Each channel provides 533 MB/s of peak I/O throughput. Figure 4 illustrates how these channels allocate bandwidth to the PCI expansion slots, the integrated multifunction core I/O, and the baseboard management controller.

figure 4. I/O architecture of the rx4610 server



The first I/O channel (on the top left of figure 4) connects to two hot-plug, 64-bit x 66-MHz PCI slots. These two slots should be reserved for the highest performing I/O cards, such as Gigabit Ethernet or Fibre Channel storage adapters. The next I/O channel connects to three additional hot-plug, 64-bit x 66-MHz PCI slots. The third I/O channel connects to three additional hot-plug, 64-bit x 66-MHz PCI slots, as well as to the Ultra3 SCSI subsystem. The SCSI subsystem includes an integrated, dual-channel Ultra3 SCSI controller, two internal disks, and one external connector. All of the eight I/O expansion slots referenced above are keyed for 3.3V PCI cards.

The fourth and final I/O channel connects to a 33-MHz PCI bus. This bus then connects to two PCI slots, as well as to the multifunction core I/O and the baseboard management controller. These final two PCI slots accept 5V, 64/32-bit x 33-MHz PCI cards. Neither of these two slots are hot-plug-capable.

The integrated multifunction core I/O includes the following components and ports:

- 10/100Base-T LAN with RJ-45 connector
- PS/2 keyboard and mouse ports
- Parallel port
- IDE controller for the internal LS-120 floppy (IDE 0) and DVD-ROM (IDE 1)
- 2 universal serial bus ports
- 2 RS-232 serial ports
- SVGA graphics with 16 MB of video memory—HP-UX only supports text-mode on the SVGA port

special features of the rx4610 server

Besides the benefits of the Itanium chip and superior architecture, the rx4610 also has several other features and enhancements that make it a most attractive choice.

multiple upgrade and migration paths for investment protection

The rx4610 is the first HP server to use the Itanium processor. Several generations of Itanium are in development, with the next-generation McKinley due out in 2002. HP will provide an investment-protection product upgrade from the rx4610 to a McKinley-based system when it becomes available.

These future systems will also utilize new PCI-X functionality and will offer enhanced HP-UX features. Furthermore, HP will provide migration services for Itanium users who want to re-deploy their rx4610 systems on another operating system. So you can, for example, purchase an rx4610 with HP-UX today, then migrate to Linux for future development purposes. It all adds up to the industry's best Itanium investment-protection program.

high availability and manageability

The rx4610 has numerous high availability features that are unmatched in the entry-level server market—features such as redundant hot-swap fans and power, hot-plug I/O and disks, single-bit error detection and correction on data paths, and proactive error detection and notification. Additionally, the server deploys several management features to log server events and proactively administer system functions.

advanced error detection, correction, and containment

Data stored in the rx4610's main memory is protected by error correction code (ECC) to detect and correct single-bit errors. Similarly, the Itanium processor employs ECC code to detect and correct single-bit data errors in the processor's L2 data cache, L3 tag and data cache, and system bus. Parity checking is provided on the processor's L1 cache. When the ECC code corrects an error, a message is sent to the operating system platform monitor, which then maintains error statistics. If a particular memory module or processor displays a large number of corrected errors, a user can proactively replace components, thereby avoiding critical, unplanned failures in the future.

baseboard management controller (BMC)

The Baseboard Management Controller (BMC) is a microcontroller that links into the intelligent platform management interface (IPMI) sensors in the system. The BMC autonomously monitors system platform management events and logs their occurrence in the non-volatile system event log (SEL). System platform management events include over-temperature and over-voltage conditions as well as fan failures. This table lists the major BMC functions:

- Access to monitored information so system management software can poll and retrieve the present status of the platform.
- Functions for the front-side system controls and indicators, including control of system power, hard resets, power LED displays, cooling fault detection, general fault detection, and power fault LED displays. The BMC provides this control both when system is powered down and is functioning on standby power only, and when the system is powered up.
- Access to the non-volatile sensor data record (SDR) repository. Sensor data records provide information that the system management software uses to automatically configure itself for the number and type of intelligent platform management interface (IPMI) sensors in the system (for example, temperature and voltage sensors).
- System power control
- Platform event paging (PEP) / platform event filtering (PEF)
- Power distribution board monitoring
- Temperature and voltage monitoring
- Fan failure monitoring
- Processor presence monitoring
- Speaker "beep" capability on standby and when system is powered up
- Itanium processor SEEPROM interface
- Processor temperature monitoring
- Hot-plug PCI slot status monitoring
- Processor bus speed setting
- Chassis fan failure light control

- Chassis power fault light control
- Chassis power light control
- SDR/SEL timestamp clock
- Boardset FRU information interface
- Fault resilient booting (FRB)
- Front panel diagnostic interrupt handling (also called the Init switch)
- Diagnostic interrupt (Init status monitor)
- Event receiver
- Secure mode control, including video blank option monitoring and control, and front panel lock/unlock initiation.
- IPMI management controller initialization agent
- Wake on LAN / Power on LAN support

redundant, hot-swap power supplies

Every rx4610 comes standard with four 800-watt, hot-swap power supplies. The minimum number of power supplies is three. The system uses two separate power cords, each supplying current to one or two supplies.

When using all four supplies, the system has N+1 protection. In the case of a single power supply failure, the system will continue to operate with only three functioning supplies. Hot swapping is as simple as removing the bezel, locating the failed supply by scanning the LEDs, unlatching the supply, and sliding it out of the chassis. Another advantage of hot-swap power supplies is their ability to support preventive maintenance programs. For instance, while the rx4610 continues to operate, you can remove the power supplies one at a time to vacuum away any dust buildup.

redundant, hot-swap cooling

The rx4610 uses six hot-swap fans to cool system components. Two 120-mm fans in the upper part of the chassis cool the I/O bay, while four 172-mm fans in the lower part of the chassis cool the processors, memory, and drive bays. The fans are arranged in an N+1 configuration so that any one fan can fail and not affect system uptime. An LED indicator on each fan assembly identifies whether a fan is active or has failed.

In the event of a fan failure, simply remove and replace the fan while the system continues to run. As with power supplies, you can remove fans one at a time for cleaning and preventive maintenance.

hot-plug disk drives

The rx4610 has two internal SCSI disks accessible from the front of the server. These disks can be removed and inserted, or hot-plugged, while the system continues to operate. Although hot-plugging a disk drive requires the assembly to be de-configured before removal and re-configured before the system can utilize the newly inserted assembly, this is easily accomplished—manually through operating system commands, or automatically through a hardware RAID controller.

The two internal disks are on a single Ultra3 SCSI channel. For enhanced availability, a second Ultra3 channel connects to the external SCSI connector on the rear of the system. This enables mirroring data from internal drives to external drives across separate SCSI channels. If one channel fails, the data is still accessible.

hot-plug PCI I/O slots

The rx4610's ability to hot-plug PCI cards offers excellent flexibility for adding, reconfiguring, and maintaining I/O functions while the system continues to operate. No reboot is required. To gain access to the PCI cards in rackmounted systems, simply slide the system forward and lift the I/O bay cover at the top rear of the chassis. The rx4610 has ten PCI I/O slots, and eight of those slots are hot-plug-ready.

Hot-pluggable I/O cards have both hardware and software components. The hardware requirements of the cards are met by the electronics on the I/O backplanes and by mechanical design in the I/O card cage. Bus idling, slot-to-slot electromechanical isolation, per-slot power and reset control, and visual indicators are all components of the total hot-plug hardware solution. With associated software, any card located in a hot-pluggable PCI slot can be removed, replaced, or added without power cycling, rebooting the system, or impacting the operation of other I/O transactions. (Note that software support for the hot-plug PCI feature is not available in HP-UX 11i version 1.5. It will be supported in future releases of HP-UX for Itanium.)

internal removable media

The rx4610 has both an LS-120 floppy drive and an internal DVD-ROM drive. Both are linked to an enhanced IDE interface. The LS-120 drive can read and write to 120-MB media as well as legacy 1.44-MB floppies. The DVD-ROM drive mounts directly above the left power bay at the front of the chassis. It can read up to 650 MB of data from one disk, and provides backward read compatibility with CD-ROM media. Both drives are mounted on removable trays for simple system assembly and service.

system control panel

For ease of management, the rx4610 front panel contains a system control panel consisting of an LCD display, a set of LEDs, and several buttons.

LCD panel—Displays information from the power-on self test that is part of the boot process. Power-on self test checks the drives, processors, memory, keyboard, and most installed peripheral devices, and displays the information on the LCD panel. Once the system is booted, the LCD displays the processor frequency used in the server, either 733 MHz or 800 MHz.

Control panel buttons and LEDs—The control panel buttons and LEDs display diagnostic information and provide user interaction:

- Power button—Turns the server on or off.
- Reset button—Resets the server and runs the power-on self test.
- INIT button—Delivers a crash dump, similar to the transfer of control (TOC) button in HP's PA-RISC servers.
- System power LED (green)—Indicates the presence of dc power in the server.
- Power fail LED (amber)—Indicates a power failure.
- Fan fail LED (amber)—Indicates a fan failure.
- General fault LED (amber)—Indicates a hot-plug PCI fault.
- Drive fail LED (amber)—When lit continuously, indicates a drive fault. When flashing, indicates a drive reset in progress.
- Drive activity LED (green)—Flashes to indicate read or write activity to an internal drive.
- Drive power LED (green)—Indicates the presence of a drive and power to the drive.

ASCII console for hp-ux

The rx4610 features local ASCII console support for HP-UX users, and supports a PS/2 keyboard as well as a recommended console connection via the SVGA video port. Virtually any SVGA monitor can be used, although HP recommends using an inexpensive monitor because the console displays text only. A mouse is not required for HP-UX console interaction.

space-saving rack density

The rx4610 is designed to provide unprecedented performance density that easily adapts to different environments. At 7 EIA units, or 7U (1U = 1.75 inches), up to five systems can be installed into a single 2-meter cabinet. With the high cost of computer room floor space, this small footprint dramatically lowers total cost of ownership.

The rx4610 can be factory-integrated into the HP Rack System/E cabinets as shown here:

- A4900A: Rack System/E25 1.25-meter cabinet—up to 3 servers
- A4901A: Rack System/E33 1.6-meter cabinet—up to 4 servers
- A4902A: Rack System/E41 2.0-meter cabinet—up to 5 servers

The rx4610 can also be field-installed into Rack System/E and older generation HP cabinets. Both the factory integrated and field installed rack kits include sliding rails that allow the server to extend out the front of the cabinet for service. Front, top and side access is provided, allowing service of all system components.

complementary design and packaging

The rx4610 has been designed to fit into environments ranging from data centers to deskside developer stations. The industrial design is coordinated for a consistent appearance with other HP servers and peripherals.

how hp makes the Itanium transition easy

If you're making or planning the transition to Itanium, you'll appreciate the fact that the rx4610 server is an *addition* to the current lineup and not a replacement. For example, even the I/O and storage peripherals are a subset of the current products that are supported with the current PA-RISC-based servers.

Hewlett-Packard offers the broadest range of Itanium-based servers, so we're able to satisfy most customer needs with this latest generation of processors. At the same time, HP is also continuing to enhance and deliver the very successful PA-RISC-powered product line, ensuring the smoothest and most successful transitions in the industry to the Itanium Processor Family.

binary compatibility

Though it has Itanium processors, the rx4610 offers *binary compatibility with current HP PA-RISC-based servers!* With approximately 16,000 applications currently available on HP-UX, continuity from your existing HP-UX environment to this new phase of computing is important. And not only is HP offering the new-architecture rx4610 server, it is also further enhancing the current PA-RISC product line. Such parallel development and binary compatibility allow you stay abreast of new developments, then make the transition to Itanium on your own timeframe. In fact, binary compatibility with existing HP-UX software is unmatched by any UNIX vendor in the industry—and is another example of HP's commitment to provide investment protection along with the smoothest possible transition to this new generation of computing architecture.

hp-ux operating system

Because HP and Intel co-invented the Itanium Processor Family, the IPF was actually designed with HP-UX in mind. And the HP-UX operating system provides the important continuity between existing PA-RISC-based servers and the new servers based on Itanium. In fact, the HP-UX operating system that runs on the new Itanium-based servers is actually the very same OS that runs on the latest PA-RISC-based servers. This means complete binary compatibility between applications, and software portability across these two environments.

figure 5. the hp-ux operating system offers a significant number of advantages for Itanium

selecting hp-ux	
features	key advantages
industry leading porting capabilities	<ul style="list-style-type: none"> • build environment • cross compilers • PTAC 
application availability	<ul style="list-style-type: none"> • binary compatibility from PA-RISC to Itanium Processor Family using dynamic translation • enables over 16,000 applications available now on hp-ux
scalability	<ul style="list-style-type: none"> • across the performance spectrum to 16 processors • to 128 processor by 2002
robust	<ul style="list-style-type: none"> • fully tested to hp production standards
proven	<ul style="list-style-type: none"> • dot release of hp-ux

- **Industry-leading porting capabilities:** HP provides the development tools to efficiently deploy applications onto HP-UX. These tools include cross compilers, debuggers, and system analysis tools. In addition, HP provides porting services through HP's Partner Technology Access Centers (PTAC) to assist ISV's in moving applications over to HP-UX on Itanium.
- **Application availability:** HP-UX currently supports over 16,000 applications. To protect your application software investment, HP-UX is designed to operate PA-RISC commands in dynamic translation mode on Itanium hardware platforms. You can simply run your existing apps in binary compatibility mode; or, for more performance-sensitive applications, migrate your applications over to Itanium to exploit more of the advantages that this new architecture has to offer.
- **Scalability:** Initially, HP-UX 11i Version 1.5 scales up to 16 Itanium CPUs, which will fully address the needs of today's Itanium customers. HP-UX 11i Version 1.6 will support future McKinley-based Itanium systems. More improvements in scalability are expected in future releases of HP-UX.
- **Interoperability:** HP-UX addresses Windows and Linux interoperability at all levels, including APIs, ABIs, GNU toolset and compiler support, open source tools and complete porting, tuning and optimization services. This means you can enjoy an even greater number of applications available on Itanium. And with tools like these at your fingertips, application migration between HP-UX, Linux, and 64-bit Windows is made much easier. In the future, application migration between the three operating systems will be seamless!
- **Robust:** HP-UX 11i on Itanium has been fully tested to meet all HP quality requirements including uptime, manageability, and supportability. HP's manufacturing, test, and field service requirements will be met with all releases of HP-UX on Itanium.
- **Proven:** HP-UX is HP's proven and reliable operating system for Itanium. Rather than offering a new operating system to our customers, HP-UX 11i Version 1.5 is a mere a dot release of an operating system that our customers already trust.

With HP-UX, Hewlett-Packard provides the smoothest and easiest transition to the next-generation hardware. This is especially important for those "home-grown" applications that are so critical in today's IT environments. Hewlett-Packard can seamlessly keep customers' environments evolving to the latest technology while maintaining proven reliability and accessibility to thousands of applications.

Hardware is important, but it's not everything. The reason that HP stands head and shoulders above our competitors lies in the value-added services we offer—training, consulting, support, and more. For example, although the vast majority of Hewlett-Packard customers will find the transition to the Itanium Processor Family simple and seamless, we offer transition services worldwide for customers who need more assistance. These services will make this upgrade as smooth as possible. HP can provide assistance every step of the way, from assessment and design to verification and deployment.

Itanium quick start service

To help make the transition to Itanium, this service provides you with hands-on assistance to help get started with HP-UX on Itanium. Using our Itanium Quick Start Service, you can more quickly begin the transition to Itanium computing—and begin right away to exploit the advantages that this technology has to offer.

partner technology access centers

Another service to help our partners in the transition to the Itanium Processor Family is through HP's Partner Technology Access Centers (PTACs). These centers help our partners port and test their applications on the new architecture.

If you choose to migrate to the new Itanium platform during the first generation of processors, you may qualify for upgrades and financial incentives.

**seamless
transition—even
for home-grown
applications
transition help
from hp**

**upgrades and
financial incentives**

conclusion

Itanium is the future of computing. And with servers like the rx4610, HP is ready to put Itanium performance in your data center today. The rx4610 is ready to go to work, delivering superior performance in applications such as data warehouses, customer relationship management, and financial services. It's the industry's best option for developers and IT managers who desire better, safer e-commerce, improved business intelligence, faster scientific processing, and more-lifelike digital content. What's more, HP makes the transition to Itanium easy and straightforward, with an unbeatable combination of hardware, software, and support.

for more information

Looking for more information about Itanium and the rx4610 servers? HP product information and technical documentation is available online at www.docs.hp.com

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

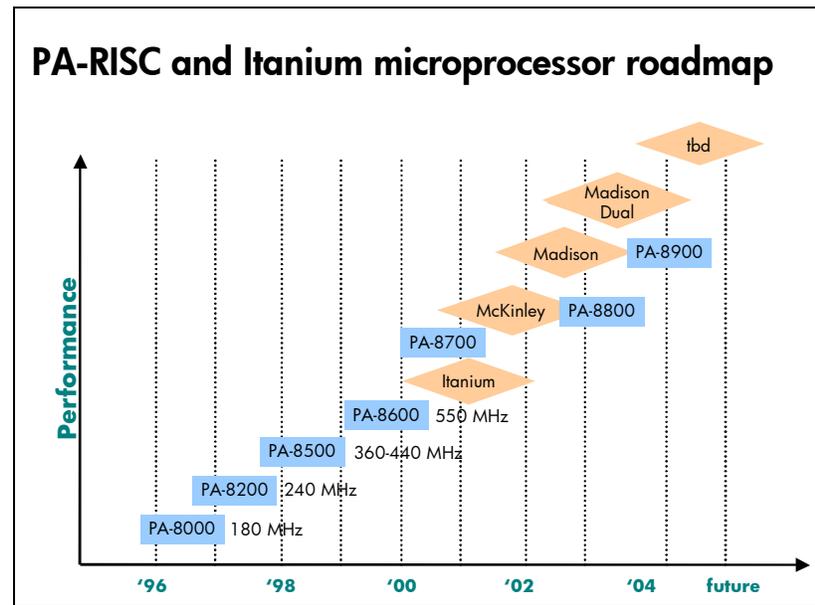
appendix: Itanium advantages in your computing future

hp's CPU roadmap

The Itanium Processor Family has a number of advantages for your computing future. But you don't have to switch to Itanium now to continue improving performance and scalability. In fact, HP offers not only a wide range of Itanium servers, but also a commitment to continued development of servers based on our PA-RISC processor lineup. Either way, you can't go wrong with HP.

The CPU roadmap illustrates HP's commitment to long-term processor and architecture innovation, which enables HP to provide the massive resources needed for future computing requirements.

figure 6. hp's CPU roadmap to the future includes both Itanium and PA-RISC



Note that several PA-RISC enhancements are scheduled after the introduction of Itanium. This allows customers to move to the new architecture when they are ready, not when their vendor forces them to. Customers can continue to rely on binary compatibility across the Itanium and PA-RISC families, enabling seamless interoperability with legacy applications on HP systems. Binary compatibility protects customers' investments, enabling rapid growth and adoption of new technology infrastructures. In addition, customers can couple existing applications and operating systems with advanced processor technology, yielding distinct performance improvements.

Itanium processor architecture

Featuring 64-bit capabilities, improved floating-point performance, a large register set, explicitly parallel design, and built-in encryption, Itanium offers a number of advantages over other chip designs. One key to its high performance is its EPIC (Explicitly Parallel Instruction Computing) architecture, co-invented by HP and Intel. EPIC architecture includes a unique combination of innovative features that overcome the performance limitations of traditional architectures. Using techniques such as explicit parallelism, predication, and speculation, the Itanium Processor Family can deliver superior instruction level parallelism (ILP) and increased instructions per cycle (IPC) to address the current and future requirements of demanding Internet, high-end server, and workstation applications. In addition, the IPF architecture provides headroom and scalability for continued future growth. The following paragraphs further illustrate the IPF advantages over existing RISC-based processors.

predication enhances parallelism

Branches are a severe performance challenge to out-of-order RISC architectures. Traditional architectures use a technique called branch prediction to predict the correct path. Mispredicts commonly occur with this technique about 5–10 percent of the time, resulting in rather severe performance penalties—as much as 30–40 percent.

EPIC architecture uses a technique called *predication* to execute both paths in parallel to overcome the limitations of traditional architectures. EPIC architecture also provides efficient support for multi-way branches and parallel compares; both features allow n-way branching in one machine cycle, significantly speeding execution. In all cases, the predicate indicates whether a particular branch and its associated data values are “turned on” or “turned off.” Branches that are “turned on” continue to execute, and as soon as any branch is “turned off” execution ceases.

Predicates, which are part of every EPIC architecture conditional, provide a very efficient way to “turn off” execution of a branch that is not taken. Predicates also improve efficiency in setting up and exiting from a loop, handling dynamic prediction, and doing n-way compares. Predication reduces branches and associated mispredicts, thereby increasing performance. Predication is particularly useful in applications with hard-to-predict branches, such as large databases, data mining, data warehousing, and similar tasks.

Lacking the mechanism of predication, it is not surprising that traditional RISC architectures have had little success with instruction-level parallelism. The reason why ILP (instruction level parallelism) works with EPIC architecture is the use of completely new architectural constructs such as predicates that are not available to any existing RISC architecture.

speculation minimizes the effect of memory latency

In the current environment, CPU’s are getting faster at a much higher rate than memory. We expect this trend to continue in the future, possibly at even a faster rate thereby increasing the gap between the CPU and memory speeds. Thus, the latency of memory is a big performance bottleneck in today’s systems.

To reduce the impact of memory latency, traditional architectures allow the compiler and the processor to schedule loads before the data is needed. But branches act as a barrier to load hoisting. The EPIC architecture found in the Itanium Processor Family employs a technique called *speculation* to initiate loads from memory earlier in the instruction stream—even before a branch. This allows early retrieval of information from memory, so it is available when the “use” is required. Speculation increases instruction level parallelism and reduces the impact of memory latency, resulting in handsome performance gains.

With traditional RISC architectures, you either get error rates that cancel out the performance advantages of speculative execution, or you use non-faulting loads and add error-detecting instructions that cancel out the advantages of speculative execution. But in EPIC architecture, the compiler can aggressively load data well ahead of time (speculation) without paying the penalties required for all RISC architectures.

Speculation has broad applications benefits. It is particularly effective for code with frequent cache accesses—for example, in operating systems, large databases, high-end EDA, and compute server-based applications.

inherent scalability delivers easy expansion

Traditional architectures, in addition to restricted instruction level parallelism, also have relatively fewer hardware resources to support the parallel execution. In contrast, the EPIC architecture-based processors of the Itanium Processor Family include 128 general-purpose integer registers, 128 floating point registers, 64 predicate registers, and many execution units to ensure top-notch serving for demanding workloads. The architecture is inherently scalable, allowing easy expansion of the number of hardware execution units and increased parallel execution, and providing maximum headroom for scalability with full compatibility.

what this means in a server

The implementation of EPIC design philosophy in the Itanium Processor Family enables industry-leading performance and excellent scalability. This architecture offers a compelling set of benefits, especially for high-end servers and workstations.

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