

Linux on the Intel
Itanium platform

march 2003



position paper

the power of Linux applications built on the Intel Itanium architecture

understanding the role of 64-bit Linux for enterprise applications

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abstract: The Linux® operating system is rapidly growing as a popular choice to support an ever expanding range of enterprise applications. As demands in enterprise computing continue, many applications will outgrow the 32-bit platform. The 64-bit Intel® Itanium® architecture provides a natural growth path to a higher level of computing power for a host of compute-intensive and mission-critical enterprise applications.

Because it was originally written for an Intel-based platform, Linux has proved to be a very popular and cost-effective computing option at the edge of the network—and Linux continues to make further inroads into the important enterprise arena. In this paper, we will examine how Itanium-based Linux platforms offer organizations an exciting opportunity to accelerate compute-intensive processes and perform more complex problem solving or analysis with fewer computing resources and at an excellent price/performance ratio. Moreover, we will demonstrate that HP has the leadership and experience in Linux and the Itanium platform to guide any size project toward success.

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introduction

The popularity of the Linux operating system has grown significantly in recent years. Initially deployed at the edge of the network for running open source applications such as the Apache web server, Linux today is appearing in embedded devices, high-performance technical computing environments, and certain enterprise applications. Further enhancing its appeal, Linux is available on many platforms, including the 64-bit Intel Itanium processing platform.

As Linux growth continues, the demands on processing power will also increase, in many cases pushing current 32-bit platforms beyond their limits. For Linux solutions built on the Intel IA-32 architecture, the Itanium architecture provides an easy and natural growth path to a higher level of computing performance and capacity in an industry-standard form factor. Even for applications that currently use proprietary 64-bit architectures, the benefits of moving to an industry-standard processing platform that can leverage the price/performance advantages of open source Linux will be difficult to ignore. In addition, new Linux solutions built on the Itanium architecture can reside side-by-side with 32-bit solutions, as well as with complementary UNIX and Microsoft Windows systems in a heterogeneous IT environment.

While numerous papers and articles have been written on the benefits of Linux (see Linux References in the Appendix), this paper will help IT managers better understand how Linux running on the Intel Itanium platform provides unique and compelling business value. In the following pages, we will examine the exciting new opportunities offered by the Itanium architecture. We will then discuss how HP helps organizations leverage the combined value of Linux and the Itanium platform to take IT environments into the next generation of industry-standard computing—today.

the growth of Linux in corporate IT

Linux is rapidly becoming a leading enterprise operating environment and, according to Meta Group, Intel has become the *de facto* Linux platform in corporate IT environments. What's more, Meta Group projects that Intel servers running Linux will "have gained more than 25 percent overall server market share by 2005/06."¹

Linux growth is also substantiated by IDC. According to IDC, Linux server revenue will increase at a compound annual growth rate (CAGR) of 27 percent, with worldwide Linux revenues growing from \$2.3 billion in 2002 to \$6.5 billion in 2006.² The majority of Linux servers deployed today are based on the industry-standard Intel IA-32 architecture.

This projected growth for Linux is not surprising. Linux has proved to be a reliable, stable, efficient, and scalable operating system for a range of enterprise-class applications. For example, Linux runs more than 40 percent of all web servers today and is becoming the preferred operating environment to handle workloads at the "edge" of the network such as web serving, caching, VPN, DNS, firewall, etc. Linux is also growing to become a dominant operating environment in the realm of technical computing, and has been widely deployed in many of the world's largest supercomputers, having demonstrated its strength in interconnecting large numbers of compute nodes as clusters or farms. Other technical computing application areas where Linux is strong include Life Sciences, Scientific Research, and Digital Content Creation (DCC), where it is making quite a name for itself in the Media and Entertainment industry having produced the animation for several notable films such as *Shrek* and *Spirit, Stallion of the Cimarron* from DreamWorks SKG.

Figure 1 below summarizes those application areas where Linux is currently being deployed, as well as those emerging areas where Linux is gaining ground.

¹ Richardson, Brian, *Meta Delta*, "Linux Servers: No "Silver Bullet" for Total Cost of Ownership," 22 November 2002

² Worldwide Server Market Forecast, 2001-2006, IDC, November 2002

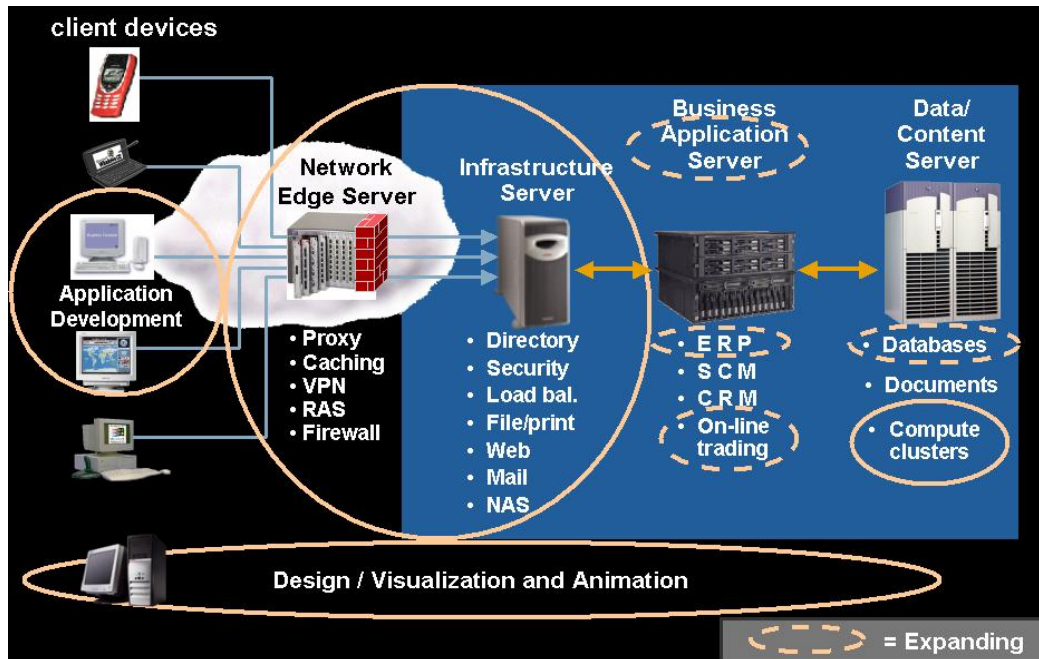


figure 1 – typical Linux workloads

The popularity of Linux for certain applications is understandable. Linux was originally written for the Intel chipset and is a natural fit for IT organizations looking for a seamless path from current IA-32 to Itanium platforms. In addition, because it is open source software, Linux affords developers a great deal of flexibility to customize the operating system to meet highly specialized requirements. And with a development community that encompasses thousands of developers worldwide, Linux offers a nearly continuous stream of new applications and development tools to enhance its functionality and performance.

For 19 consecutive quarters, HP has led the industry in unit market share of Linux servers³, and currently holds a share of 28.7 percent.⁴ Further underscoring this track record of success, industry-standard HP ProLiant servers have been the leading choice among all IA-32 Linux servers, out-pacing Dell and IBM. In addition, HP is the market share leader for Itanium-based systems. Clearly, HP is uniquely positioned to help organizations maximize opportunities for gaining value from Linux—on IA-32 *and* Itanium platforms.

Linux on the Itanium platform — a winning combination

The value of Linux within the enterprise is well understood, and the new capabilities of the Itanium platform serve to only enhance that value. To fully appreciate this fact, it is useful to examine first the high-level benefits offered by the Itanium architecture.

comparing architectures

The Itanium architecture offers a number of unique capabilities that distinguish it from any other platform on the market today, including:

³ HP “historical” market share is represented by the sum total of pre-merger Compaq and pre-merger HP market shares

⁴ IDC 4Q 2002 Quarterly Server Tracker

- **Highest floating-point performance** – On an HP Server rx5670 running Linux, the SPEC_{fp2000} base result of 1431⁵ is a world record for any processor and, for the Itanium platform, this is only the beginning.
- **More memory addressability** – The length of time required to store large data sets affects performance, throughput, responsiveness, and customer satisfaction. Disk drives are hundreds or thousands of times slower than main memory. While 32-bit systems have a 4 GB memory limit, 64-bit systems have a theoretical limit of hundreds of thousands of terabytes. With the full 64-bit addressability provided by the Itanium architecture, very large data sets can be kept in main memory. In addition, the low latency and high memory bandwidth of the Itanium architecture provides high-speed access to large data sets in memory. The result is faster time-to-discovery, faster time-to-market, and faster time-to-revenue for applications such as analytics, data warehousing, database query, simulation, scientific computing, and financial risk modeling.
- **64-bit environment for computing and development** – Many application developers of 64-bit UNIX applications are looking to Linux as an environment to streamline their software development. Moving to Linux and open source software is often a desirable direction, but regressing to a 32-bit environment is not. Therefore, Linux on the Itanium platform provides developers with the winning combination of 64-bit computing and the total cost of ownership (TCO) benefits of Linux that they require.

It is important to note that the Itanium architecture is still at the beginning of its lifecycle—the second-generation Itanium 2 processors just became available in the summer of 2002—and is already producing impressive performance results. Further performance gains should be expected with the release of the third-generation Itanium processor set—code named Madison—and as the Itanium platform continues to evolve.

the Itanium platform for Linux applications

The Itanium platform clearly offers advanced performance and capacity capabilities that can accentuate the benefits of Linux. The question remains, however, when to choose the Itanium platform for deploying Linux applications. The answer depends on several factors specific to each individual enterprise, such as current IT environment, experience, future plans, dependence on ISV applications, etc.

As a starting point for making an informed decision, HP provides some general guidelines as presented in Figure 2 below.

⁵ Source: <http://www.spec.org/cpu2000/results/cfp2000.html>

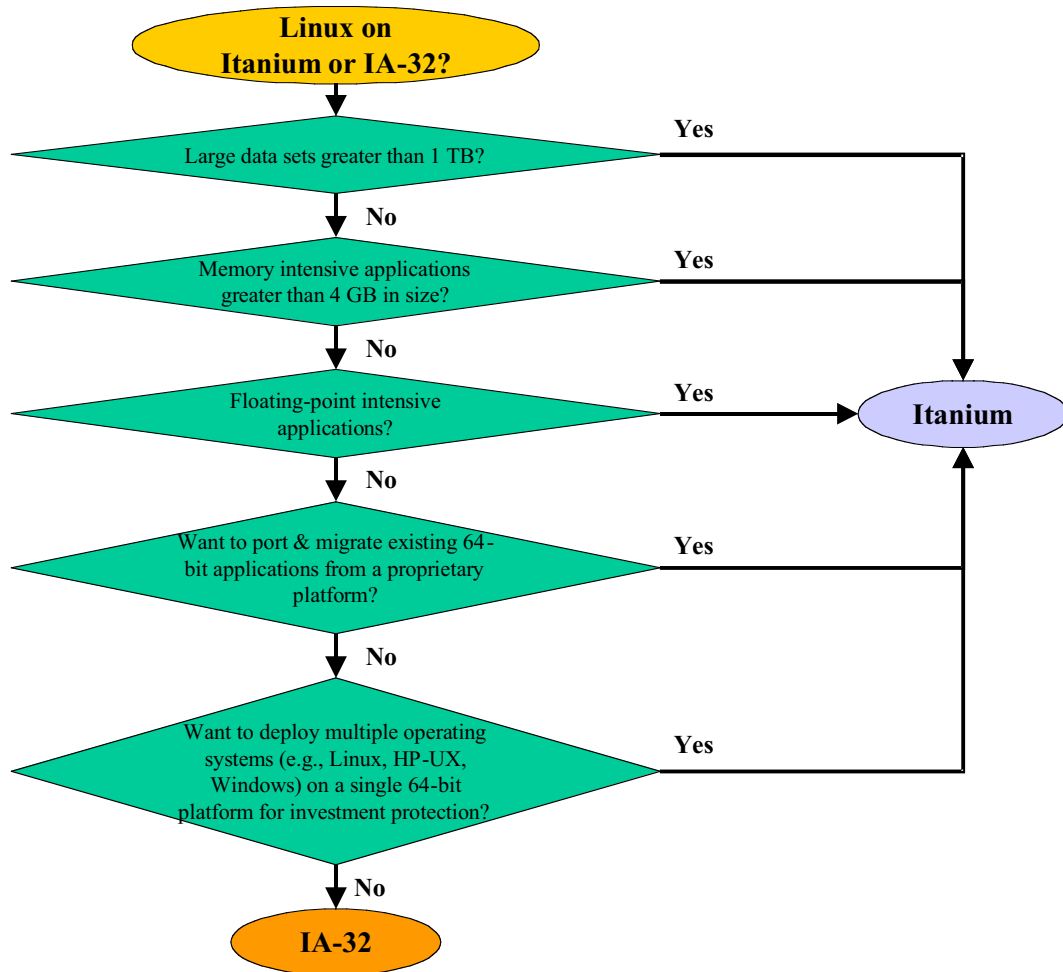


figure 2 – guidelines for deploying Linux on Itanium-based systems

Given the capabilities of the Itanium architecture, and considering the guidelines above, let's examine some market opportunities and workloads that are ripe for Itanium-based Linux applications. Table 1 below summarizes these opportunities and highlights major ISVs that have made a commitment to migrating their applications onto Linux for the Itanium platform.

table 1: summary of best opportunities for Linux on the Itanium platform

Market Opportunities	Why?	Key ISVs Committed
High-Performance Technical Computing – scientific research, life & materials sciences, oil & gas, government & defense, computer-aided engineering	Heavy use of floating-point operations; large data sets; 64-bit computing with high memory bandwidth and low latency means faster calculations, more in-depth data analysis, and more vivid, precise modeling and simulation – all for quicker time-to-breakthroughs	Adina, MSC.Software, Accelrys, Earth Decision Sciences, Metacomp Technologies, Mecalog, Platform Computing, Linux NetworX, Scyld, Scali, Cluster File Systems
Large Database Applications – data warehousing, data mining, and online analytical processing (OLAP)	Load entire databases into memory for faster data access, faster throughput, and faster time-to-discovery	Oracle9i, Sybase Adaptive Server Enterprise, IBM DB2 and Informix, TeraText Solutions
Enterprise Resource Planning (<i>Limited</i>)	Large data sets can be processed in memory for faster response times and support for more users	SAP mySAP
Application Development – organizations porting & migrating their in-house applications and ISVs moving to Linux on Itanium	Linux on the Itanium platform provides developers with the complete 64-bit instructions and data environment they require to move to Linux from proprietary 64-bit UNIX environments, while also providing the opportunity to re-architect source code to optimize performance	Many open source development tools, Intel Compiler 7.0, Rational Software, BEA JRockit, Etnus, Pallas, Tibco Software
Financial Services – financial and economic modeling	Floating-point performance for Monte Carlo simulations means faster time-to-solutions and a competitive edge	Primarily in-house applications

Given mounting competitive pressures, the business impact of running Linux applications on the Itanium platform is profound. Pharmaceutical and chemical companies could accelerate research to deliver new breakthroughs in drug discovery, agricultural biotechnology, genomics, and environmental management. Researchers could produce structural analyses, crash simulations, heat transfer analyses, and computational fluid dynamics faster, more efficiently, and with greater precision. And manufacturers could design, develop, prototype, and produce new competitive products more quickly and cost effectively to counter shorter product lifecycles and shrinking margins. Most important, all of this can be achieved with the higher performance of the Itanium architecture and the lower total cost of ownership of Linux.

For enterprise applications that support large databases, critical business processes, and advanced application development, the Linux OS on the Itanium platform offers very powerful benefits. Again, the large memory addressing and performance capabilities that the Itanium architecture offers for complex transactions can be the ideal solution for 32-bit applications that are running short on horsepower, or for 64-bit UNIX applications looking to move to a Linux environment. As with technical computing applications, the applications that benefit from Linux today will only gain ground when ported to the Itanium platform. And the fact is, growth in web serving requirements, ever-expanding databases, and intensifying business demands all make a strong case for higher-performance, more efficient computing.

The fact is, to be prepared for *tomorrow*, the time is right *today* for building Linux test beds and launching new Linux projects built on the Itanium architecture.

hp – leading the way for Linux on the Itanium platform

Clearly, the industry is prepared to take Linux into the 64-bit processing world—and HP is leading the way ...

- HP was first-to-market with Itanium 2-based servers (rx2600 and rx5670) and workstations (zx2000 and zx6000) with Linux.
- As co-developer of the Itanium architecture and leader of the Linux kernel effort within the Linux community, HP is uniquely positioned to lead the Itanium-based Linux market as this market begins to grow.
- HP is building one of the fastest Linux supercomputers in the world for the U.S. Department of Energy, as highlighted later in this paper.
- The multi-OS strategy that HP offers for Itanium is delivering unmatched customer choice and interoperability for the Samsung Advanced Institute of Technology, as highlighted later in this paper.
- HP offers a broad range of award-winning Linux support and services

It all stacks up to a powerful advantage for any organization that is looking to get a jump start on the future of high-performance, high-efficiency computing. Let's explore these points a bit further.

leadership validated by the industry

HP believes that leadership in the open source community is important as a means to accelerate innovation for Linux and improve the support that organizations can obtain to maximize their results. Specifically, HP led the way in bringing the Linux kernel to the Itanium platform; in fact, HP engineers were the primary architects of the Itanium-based Linux kernel and remain the maintainers of the Linux kernel for the Itanium platform. Moreover, we have been offering a Software Developers Kit (SDK) for Itanium-based HP systems running Linux since 2000, which has been distributed to over 10,000 developers.

In addition, HP established the Gelato Federation (www.gelato.org), a worldwide consortium focused on enabling open source Itanium-based Linux solutions for academic, government, and industrial research. And HP is a founding member and continues to sit on the Board of Directors for the Open Source Development Lab, a Linux open source development and testing lab in Oregon and Japan.

The momentum for Linux on Itanium platforms is likely to grow significantly, particularly as organizations recognize the truly remarkable performance gains that can be achieved at a very cost-effective level. For example, recent TPC-C benchmarks with HP, Oracle, and Red Hat resulted in record-breaking performance and outstanding price/performance. An HP Server rx5670 with four 1 GHz Itanium 2 processors, running Red Hat Linux Advanced Server with Oracle 10i Database Standard Edition and eight ProLiant DL360 clients, produced TPC-C throughput of 80,495 at a price/performance of \$5.30/tpmC⁶. This level of performance certainly demonstrates that Linux on the Itanium platform is very competitive and offers a viable alternative for Oracle database applications.

Our depth of involvement in championing Linux and the Itanium platform has gained the trust and support of HP customers around the world. As mentioned earlier, HP is the industry leader for Linux on IA-32 and Itanium platforms, and organizations have been able to leverage our Linux leadership and expertise for successful implementations.

⁶ Source: TPC, 2002.

applying Itanium-based Linux solutions to solve real problems

Pacific Northwest National Laboratories (PNNL)

Most important, the power of Linux on the Itanium platform is being demonstrated outside the lab to solve real problems. A prime example of this is at the Pacific Northwest National Laboratories (PNNL), where HP is building an Itanium 2- and Linux-based cluster in the Molecular Science Computing Facility—part of the U.S. Department of Energy. The PNNL project will create an 11+ teraFLOP HP supercomputer based on 960 dual-CPU Itanium 2 compute nodes with a total of 6.8 TB of memory, linked through a Quadrics high-performance interconnect to 170 TB of storage in an HP storage area network (SAN). Upon completion, it is expected to be the world's fastest Linux-based computer and to rank among the five most powerful supercomputers on the planet.

The HP supercomputer will boost performance 30 times over PNNL's current systems, enabling researchers to solve ever more complex problems with higher reliability and accuracy, and in a shorter time. In fact, using this new system, complex calculations that once required a month to complete will now be completed in a single day. It is interesting to note that these achievements are possible using fewer, yet faster, processors to perform many more computations in a shorter period of time.

With the kind of results already being shown at PNNL, organizations around the globe can expect Itanium-based Linux systems to revolutionize the computing world.

Samsung Advanced Institute of Technology (SAIT)

The Samsung Advanced Institute of Technology (SAIT) is a research center specializing in grid computing. SAIT acquires the latest technology and commercializes it for a variety of markets such as energy and biotechnology. They have not only been impressed with the performance of the Itanium 2-based servers from HP, but they have also been able to pursue a strategy based on multiple operating systems. SAIT is creating a supercomputing environment using 16 HP rx2600 servers running Linux and HP-UX. The multiple operating system strategy from HP enables SAIT to acquire the technology expertise needed to develop, test, and introduce future systems, regardless of operating system.

In benchmark testing using the HP Scalable Processor Chipset zx1, the rx2600 server achieved superior performance compared to similar systems from other vendors—supporting a system bus bandwidth of 6.4 GB/s and a main memory bus bandwidth of 8.5 GB/s. The HP system also exhibited superior price/performance compared with existing RISC platforms and efficiently processed complicated, data-intensive work typical of Samsung's customers.

hp services to maximize Linux and Itanium investments

Often, when exploring new technology, IT professionals must take a leap of faith. Not so with Linux and the Itanium platform. We have seen how these breakthrough technologies have performed in laboratory testing; and we've seen how Itanium-based Linux supercomputers are revolutionizing research capabilities in the real world. Today, organizations in a wide range of industries and academic settings can gain immediate benefits from Linux and the Itanium architecture—without making huge investments or risking those investments. HP is ready to share its expertise and experience to provide that assurance.

HP offers an extensive portfolio of award-winning Linux professional and support services⁷ that can help organizations begin to integrate Itanium-based Linux solutions into their IT environments—whether porting just a portion of an application to “test the waters” or launching a new project to gain immediate business advantage.

As illustrated in Figure 3 below, HP makes it easy for an organization to select just the services it needs to be successful.

⁷ HP received the “Best Value” award for its Linux Services from Network Computing, May 2002

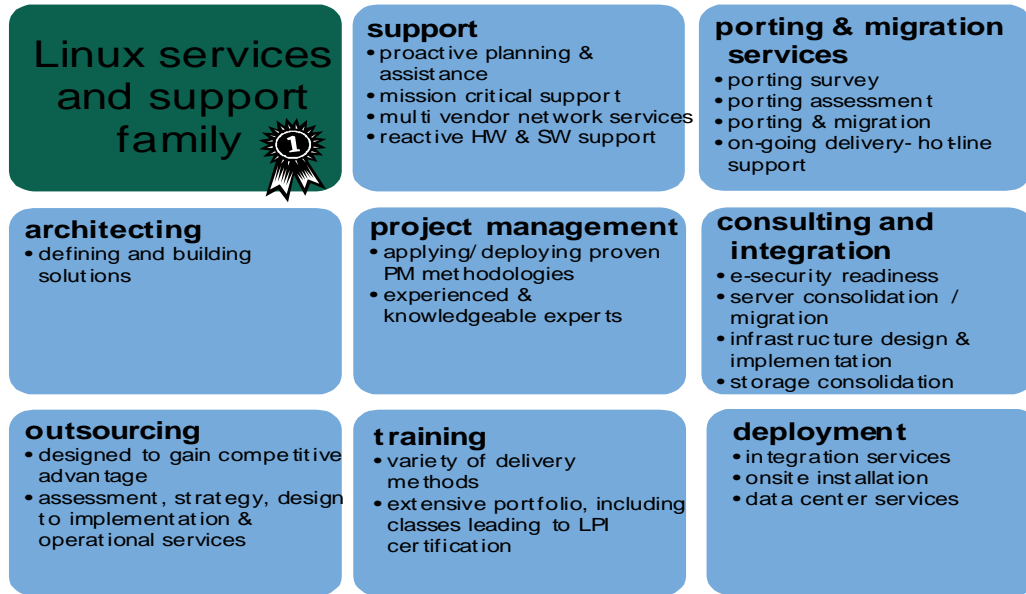


figure 3 – lifecycle services for Linux and the Itanium platform available from hp

conclusion

As we have seen, Itanium-based Linux platforms offer organizations an exciting opportunity to accelerate compute-intensive processes and perform more complex problem solving or analysis with fewer computing resources and at an excellent price/performance ratio. Linux has proven itself to be the operating system of choice for certain high-performance technical computing and enterprise applications. And with its large memory addressing and data bandwidth, advanced parallel processing, and superior floating-point performance, the Itanium architecture can now take Linux capabilities to a whole new level of performance.

Whether exploring Itanium-based Linux applications in a small test bed, or planning a large implementation that spans the enterprise, HP has the leadership and experience in Linux and the Itanium platform to guide any size project toward success. We are the recognized leader in Linux and Itanium market share and have already demonstrated the power of Linux and the Itanium platform in building one of the world's largest Linux-based supercomputers.

The combination of powerful, next-generation technology and the proven expertise of HP is a formula for success in realizing the long-term value from Linux solutions built on the 64-bit Itanium architecture.

appendix

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