

# The power of Carrier-Grade Linux applications built on the Intel® Itanium® architecture

White paper



## Table of contents

- Abstract** ..... 2
- Introduction** ..... 2
- The growth of Linux: leveraging the enterprise** ..... 2
- Linux + Itanium—a winning combination for telecom** ..... 4
  - High performance ..... 4
  - Future-proof ..... 4
  - 32-bit or 64-bit systems? ..... 4
- HP Integrity servers—leading the way** ..... 5
  - Leadership validated by the industry ..... 6
  - Benchmarks documenting performance ..... 6
- HP Services to maximize Linux and Itanium-based platform investments** ..... 6
- Conclusion** ..... 7
- Appendix** ..... 8



# Defining the role of industry-standard 64-bit processing in telecom applications

## Abstract

The Linux operating system is rapidly growing as a popular choice to support an ever-expanding range of applications. As computing demands in the telecommunications network increase, the 64-bit Intel® Itanium® architecture provides a natural growth path for compute-intensive and mission-critical applications.

Because it was originally written for an Intel-based platform, Linux has proved to be a very popular and cost-effective computing option. Recently, driven largely by the Open Source Development Labs “Carrier-Grade Linux” initiative (OSDL/CGL), Linux is making significant inroads into telecommunications applications.

In this paper, we will examine how the Itanium architecture and Carrier-Grade Linux offer service providers an exciting opportunity to leverage the global trend toward commodity computing platforms and cost-effective open-source solutions. Moreover, we will demonstrate that HP’s impressive track record in mission-critical systems, combined with leadership in Carrier-Grade Linux on the Itanium architecture, can be a powerful combination in next-generation telecommunications.

## Introduction

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

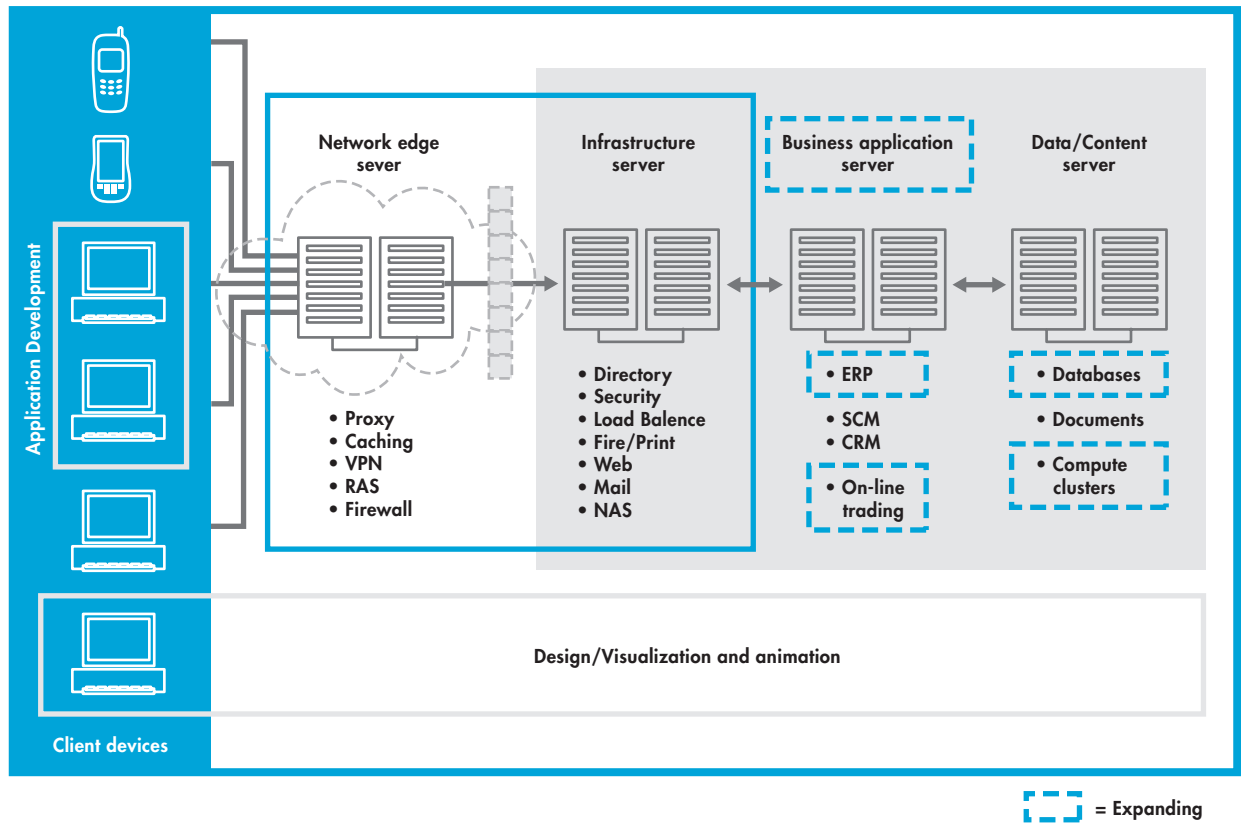
As Linux’s growth continues, the demands on processing power will also increase, in many cases pushing current 32-bit platforms beyond their limits. For Linux solutions built on the Intel IA-32 architecture, the Intel Itanium architecture provides an easy and natural growth path to a higher level of computing performance and capacity in a cost-effective, 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 Intel Itanium architecture can reside side-by-side with 32-bit solutions, as well as with complementary systems in the heterogeneous telecommunications environment.

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

## The growth of Linux: leveraging the enterprise

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.”

**Figure 1:** Typical Linux workloads in enterprise environments.



Linux growth is also substantiated by IDC. According to IDC, Linux server revenue will increase at a compound annual growth rate (CAGR) of 28.3 percent, with worldwide Linux revenues growing from US\$2.3 billion in 2002 to U.S.\$7.9 billion in 2007. 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 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, virtual private networking (VPN), domain name system (DNS) services, 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 been used to develop the animation for several notable films, including Shrek and Spirit: Stallion of the Cimarron from DreamWorks SKG.

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

The popularity of Linux for certain applications is understandable. Linux was originally written for the Intel chipset and is a natural migration path from current IA-32 or proprietary computing architectures to industry-standard Itanium-based platforms. In addition, because it is open source software, Linux affords developers a great deal of flexibility to customize the operating system for highly specialized requirements. 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, as well as to drive rapid improvements in stability, security, and application availability. These characteristics, combined with the rapid convergence of telecommunications networks toward the Internet Protocol suite, make Carrier-Grade Linux a natural choice for deployment. Additionally, the commodity price/performance leverage from industry-standard computing makes Intel platforms, such as the Itanium architecture an excellent investment for telecom infrastructure.

For 21 consecutive quarters, HP has led the industry in unit market share of Linux servers, and currently holds a market share of 29.4 percent. In addition, HP is the market leader for Itanium-based systems, and it is the first company to offer an Itanium-based server that is fully certified for Network Equipment Building Standards (NEBS) Level 3 environments. Clearly, HP is uniquely positioned to help service providers and equipment vendors maximize opportunities for gaining value from Linux in telecommunications—on IA-32 and Itanium-based platforms.

## Linux + Itanium—a winning combination for telecom

The value of Linux within the enterprise is well understood, and the new capabilities of the Itanium-based platform only serve to enhance that value. The value of Carrier-Grade Linux in the telecommunications space is only beginning to gather momentum, but the potential for highly available, cost-effective platforms based on Linux and the Itanium architecture is virtually unlimited. To fully appreciate this fact, it is useful to first examine the high-level benefits offered by the Intel Itanium architecture.

### High performance

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

- **World record floating-point performance**—On an HP Integrity rx2600, the SPEC\_fp2000 base result of 2119 is a world record for any processor; and for the Itanium processor, this is only the beginning.
- **World record integer performance**—On an Integrity rx26005, the SPEC\_int2000 base result of 1322 is a new world record for any processor.
- **More memory addressability**—The length of time required to access large data sets affects performance, throughput and responsiveness for critical telecommunications functions. Disk drives are hundreds or thousands of times slower than main memory. As a result, in-memory databases are often crucial for telecom applications. 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 Intel Itanium architecture, very large data sets can be kept in main memory where high memory bandwidth provides instantaneous data access for time-critical network applications.

It is important to note that the Intel Itanium architecture is still at the beginning of its life cycle. With the latest release of the Itanium 2–6M “Madison” processor, new world records are being set in many performance benchmarks.

### Future-proof

In addition to world-class performance, the Itanium + Linux architecture offers future-proofing benefits for mission-critical deployments, including:

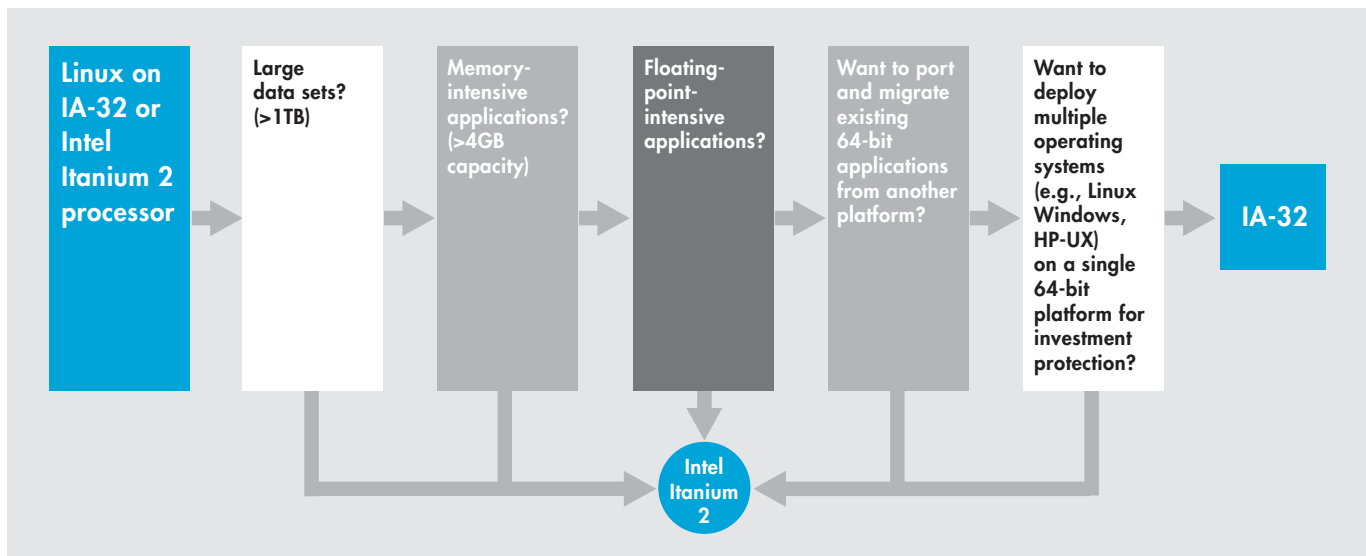
- **64-bit environment**—Many application developers of 64-bit UNIX® applications are looking to Linux as an environment to streamline their software development. Moving to Linux and open source software is often a desirable direction, but regressing to a 32-bit environment is not. Therefore, Linux on Itanium-based platforms provides developers with the winning combination of 64-bit computing and the total cost of ownership (TCO) benefits of Linux that they require.
- **COTS price/performance**—The considerable price/performance advantages of COTS (commercial, off-the-shelf) computing environments cannot be overstated. As telecommunications and enterprise networking technologies converge, service providers who maintain custom or proprietary architectures will face increasing price pressure from their customers. Leveraging COTS technologies in highly available, low-cost platforms will become necessary for survival.
- **Open-Source**—An industry-standard computing platform coupled with the “community-escrow” model of open-source software ensures perpetual access to critical technologies—even when important system vendors change or disappear.

### 32-bit or 64-bit systems?

The Itanium platform clearly offers advanced performance and capacity capabilities that can accentuate the benefits of Carrier-Grade Linux. However, appropriate deployment of Itanium platforms depends on several factors, such as current computing environment, future plans, dependence on third-party applications and more.

As a starting point for making an informed decision, HP provides some general guidelines for 32-bit vs. 64-bit computing environments, as presented in Figure 2. In cases where the industry-standard 64-bit environment is appropriate, a variety of open-source and industry-leading software packages and development tools are available to accelerate time-to-market. In fact, several major independent software vendors (ISVs) have already made a commitment to migrating applications onto the Linux and Itanium platform, including Oracle®9i and 10g, Sybase Adaptive Server Enterprise, IBM DB2 and Informix, TeraText Solutions, and HP Serviceguard for Linux. In addition, world-class development tools are available for the Linux/Itanium platform, including Intel Compiler 7.0, Rational Software, BEA JRockit, Etnus, Pallas and TIBCO software.

**Figure 2:** Guidelines for deploying Carrier-Grade Linux on systems with Intel Itanium 2 processors.



With mounting competitive pressures, the business impact of deploying network infrastructure based on Carrier-Grade Linux and Integrity servers is profound. Based on this platform, and leveraging the availability of mature applications and tools, equipment vendors and network operators can optimize many aspects of their value chain, including:

- **Speed**—Rapid, cost-effective design, development, prototyping, and production of competitive new products
- **Interoperability**—Reliance on truly interoperable components and network elements that comply with the latest industry standards
- **Resources**—Leverage the vast number of independent software developers who rely on Linux as their primary development platform
- **Cost**—Achieve all of these objectives with the high-performance Intel Itanium architecture and the lower total cost of ownership of Linux.

For telecommunications applications that require large in-memory databases, critical business processes and advanced application development, the full suite of tools for Carrier-Grade Linux on Itanium-based platforms 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 legacy 64-bit UNIX applications looking to move from a decaying proprietary support base to an open, future-proof Linux environment.

In the rapidly evolving world of next-generation IP-based communications, the requirements for large databases, fast-packet processing and mission-critical operations are constantly increasing. These factors make a strong case for high-performance, cost-effective computing platforms.

## HP Integrity servers—leading the way

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

- **Scope**—HP has the most robust lineup of Itanium 2-based systems. From the HP Integrity family of enterprise-class servers—ranging from the two-processor rx2600 up to the 64-processor Superdome—to the powerful zx2000 and zx6000 workstations, HP is leading the move to 64-bit industry-standard computing.
- **NEBS certification**—HP has the world's first Itanium-based server platform that is fully certified at NEBS Level 3 for operation in the most demanding telecommunications environments, and this platform has already been deployed in major networks.

- **Linux**—HP led the effort to support the Itanium architecture within the Linux kernel. Such experience uniquely positions HP to lead the move toward Linux solutions on Itanium-based platforms as this market continues to grow.
- **Standards**—HP is a key contributor to the OSDL Carrier-Grade Linux initiative and has already fielded critical telecommunications infrastructure based on CGL and the cx2600 Itanium 2 platform.
- **Compatibility**—The multiple operating system strategy that HP offers with the Integrity server family is delivering unmatched customer choice and interoperability for multiple partners in commercial, enterprise and telecommunications environments.
- **Support**—HP offers a broad range of award-winning Linux support and services.

It all adds 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, with:

- **IA-64 Linux kernel**—HP led the way in bringing the Linux kernel to the Itanium-based platform; in fact, HP engineers were the primary architects of the Linux kernel for the Intel Itanium processor and today still maintain this work in the open source community. Moreover, we have been offering a Software Developers Kit (SDK) for Itanium-based HP systems running Linux since 2000, and this kit has been distributed to more than 10,000 developers.
- **Community**—HP established the Gelato Federation ([www.gelato.org](http://www.gelato.org)), a worldwide consortium focused on enabling open source Itanium-based solutions for Linux for academic, government and industrial research. And HP is a founding member and continues to sit on the Board of Directors for OSDL, a Linux open source development and testing lab in Oregon and Japan.
- **Carrier-Grade Linux**—HP engineers and experts were early participants in the development of requirements and performance specifications for the OSDL Carrier-Grade Linux initiative. HP developed the first commercially available server-class distribution of CGL for Itanium platforms.

- **Carrier-grade platforms**—The HP commitment to Linux in the telecommunications arena has been recognized by multiple partnerships, co-development efforts and large deployments of critical wireless and wireline telecommunications infrastructure based on CGL and the cx2600 NEBS platform.

#### Benchmarks documenting performance

The momentum for Carrier-Grade Linux on HP Integrity servers is growing significantly, particularly as organizations recognize the truly remarkable performance gains that can be achieved at a very cost-effective level. For example, a recent TPC-C benchmark with HP, Oracle®, and Red Hat resulted in record-breaking performance and outstanding price/performance. An Integrity server rx5670 with four 1.5 GHz Itanium 2 processors, running Red Hat Enterprise Linux AS with Oracle10g Database Standard Edition and ten ProLiant DL360 G3 clients, produced TPC-C throughput of 136,110 tpmC at a price/performance ratio of \$4.09/tpmC. This level of performance certainly demonstrates that Linux on HP Integrity servers is very competitive and offers a viable alternative for Oracle database applications.

In benchmark testing using the HP Scalable Processor Chipset zx1, the HP Integrity rx2600 server5 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.

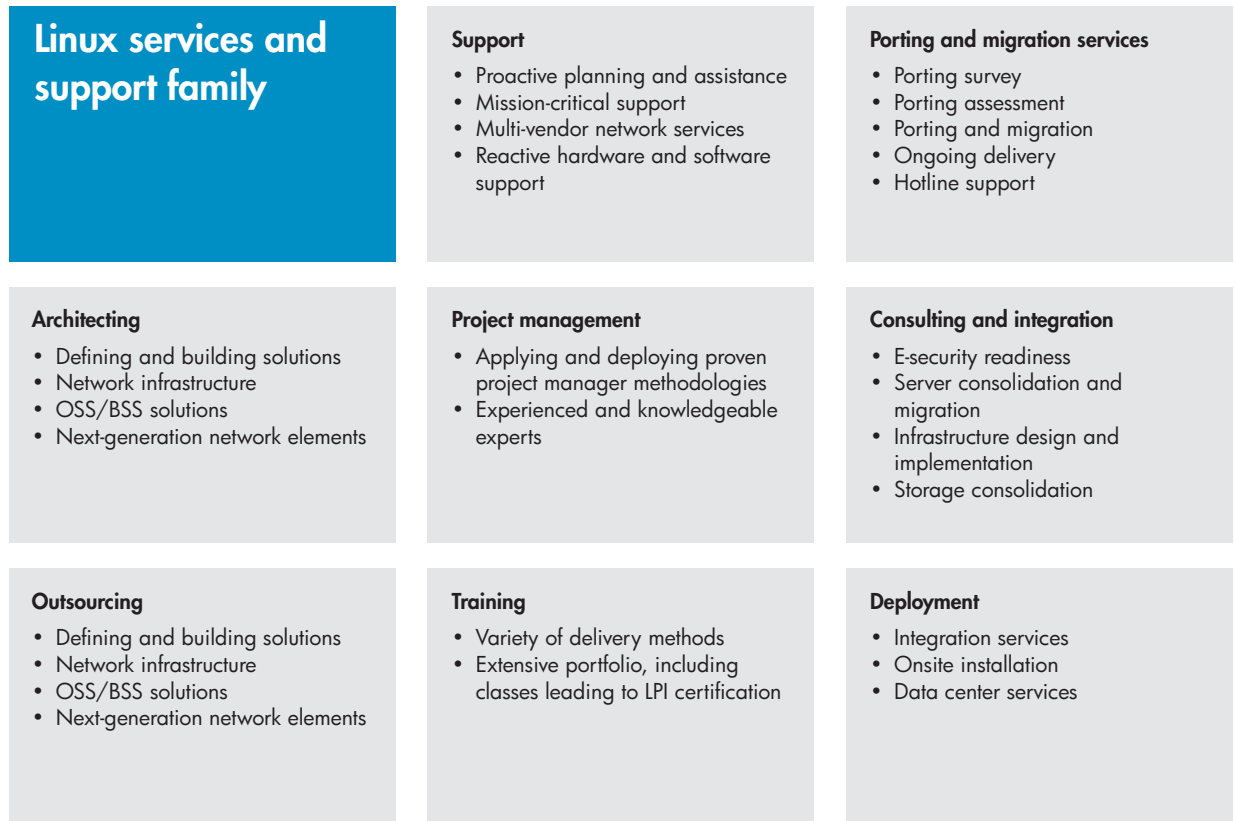
## HP Services to maximize Linux and Itanium-based platform investments

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

HP offers an extensive portfolio of award-winning Linux professional and support services that can help service providers and network operators begin to integrate Itanium-based solutions for Carrier-Grade Linux into their operating 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, HP makes it easy to select just the services you need to be successful.

**Figure 3:** Life-cycle services for Linux and the Itanium-based platform available from HP.



## Conclusion

As we have seen, Itanium-based platforms and Carrier-Grade Linux offer equipment manufacturers and network operators an exciting opportunity to accelerate next-generation network infrastructure at an excellent price/performance ratio. Linux has proved to be the operating system of choice for technical computing and enterprise applications, and it is rapidly supplanting conventional proprietary systems for demanding telecommunications applications. With its large memory addressing and data bandwidth, advanced parallel processing, and superior floating-point performance, the Intel Itanium architecture can now take Linux capabilities to a whole new level of performance for mission-critical network environments.

Whether exploring Itanium-based applications for Linux in a small test bed or planning a large, mission-critical implementation, HP has the leadership and experience in Linux- and Itanium-based platforms to guide any size project toward success. As the recognized market share leader in Linux- and Itanium-based platforms, we have

already demonstrated the power of this platform in building one of the world's largest Linux-based supercomputers. Now, with the world's first Itanium-based platform certified for NEBS Level 3 environments and Carrier-Grade Linux, we've extended this powerful combination of technologies into the telecommunications environment.

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 Intel Itanium architecture.

To be prepared for tomorrow, the time is right today for evaluating Carrier-Grade Linux on HP Integrity servers.

# Appendix

## Linux references

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  - This handbook is a comprehensive guide exploring the emergence of Linux and its value proposition.
- Open Source Development Laboratory—Carrier-Grade Linux, [www.osdl.org](http://www.osdl.org)
  - This industry forum is focused on better positioning Linux and Linux-based software components as the basis for highly available and robust communications products.
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