

WHITE PAPER

Integrating Linux into IBM's On Demand Vision

Sponsored by: IBM

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May 2004

IDC OPINION

As Linux emerged from obscurity in the late 1990s, IBM was among the first large software and systems vendors to proactively embrace the fledgling operating system. While some industry observers may have considered IBM's interest in Linux to be premature at best, the early and broad, pan-hardware platform support that IBM has brought to the Linux community is beginning to pay off today.

With Linux integrated into its solution portfolio, for the first time in its history, IBM can run a common operating system and deliver unprecedented levels of application portability across four architecturally diverse platforms. Even more importantly, Linux factors heavily into IBM's strategy to provide total solutions and services that empower customers to flexibly configure, provision, and manage IT resources in response to business needs and market opportunity. This strategy, which is an important part of IBM's on demand vision, is currently unfolding, as IBM continues to deliver the integration and infrastructure management tools that make on demand business possible.

IBM's strategy for integrating Linux and its key eServer platforms into its on demand computing infrastructure is bold and comprehensive, and it offers a tremendous potential value for existing customers. The value proposition also has strong potential attraction to customers not currently using IBM solutions. Long term, IBM has even more riding on the success of this initiative — the health of IBM's non-Intel platforms will become increasingly dependent on Linux to bring next-generation applications to those systems.

We believe that IBM has done a good job building out its infrastructure and middleware software stack on its platform portfolio, but the next challenge remains significant: to drive more independent software vendor (ISV) support aboard zSeries, iSeries, and pSeries platforms. In particular, IBM's current focus on Performance Optimized with Enhanced RISC (POWER)-based solutions, including the pSeries and iSeries platforms as well as the new BladeCenter JS20, is receiving considerable attention both within the organization and in the marketplace and will likely be a primary focal point for IBM moving forward. We believe that IBM has the resources to continue to address these challenges and expect to see IBM move methodically toward this goal over the next year or two.

This IDC White Paper considers Linux in an on demand environment on IBM eServer hardware and IBM TotalStorage, and the infrastructure capabilities provided by:

- DB2
- Lotus
- Rational
- Tivoli
- WebSphere

TABLE OF CONTENTS

	P
In This White Paper	1
Situation Overview	1
What Is IBM's On Demand Initiative?	1
The Business Value of On Demand	1
The Role of Linux in Addressing the Needs of On Demand Businesses	2
The On Demand Operating Environment	4
The Components of the On Demand Operating Environment	4
IBM eServer Hardware Support for an On Demand Operating Environment.....	8
Hardware: xSeries	8
Blades and BladeCenter.....	9
pSeries	9
iSeries	11
zSeries	12
IBM Storage.....	13
How Linux Enables IBM's On Demand Vision	13
The Role of Linux	14
IBM's Software Strategy for Linux.....	15
IBM's Linux Software Portfolio.....	15
DB2 Information Management Family	16
WebSphere Family	16
Lotus Product Family.....	16
Tivoli Product Family	17
Rational Software Product Family	17
Future Outlook	18
Challenges/Opportunities	19
Conclusion	19

LIST OF FIGURES

	P
1 IBM's Essentials of an On Demand Breakthrough	2
2 IBM's On Demand Operating Environment—Infrastructure	3
3 IBM's On Demand Strategy Connects Customers with Business Solutions.....	8

IN THIS WHITE PAPER

This IDC White Paper reviews IBM's Linux strategy and the ways in which it ties into IBM's larger on demand initiative. The analysis considers the position and value proposition Linux offers on IBM's four eServer architectures: xSeries, pSeries, iSeries, and zSeries systems, as well the Linux support offered by IBM's TotalStorage offerings, and the infrastructure capabilities provided by DB2, Lotus, Rational, Tivoli, and WebSphere software.

SITUATION OVERVIEW

What Is IBM's On Demand Initiative?

On demand is a comprehensive initiative that is central to the IBM strategy, both business and technical. As defined by IBM, on demand has three key elements:

- ☒ Business transformation
- ☒ On demand operating environment
- ☒ Flexible financial delivery options

IBM categorizes on demand businesses as "enterprises whose business processes — integrated end-to-end across the company and with key partners, suppliers and customers — can respond with flexibility and speed to any customer demand, market opportunity or external threat."

The Business Value of On Demand

IBM's on demand initiative is not just a technology story. It is also a story of business transformation. Its core goal is to empower businesses to become flexible, responsive organizations that can react to changes in market opportunities and shifts in customer behavior where they present themselves.

For instance, a retailer that has a business transaction profile that is stable and relatively light for 10 months, then extremely heavy with unpredictable peak demands during the final two months of the year, needs to react to these changing requirements in a cost-effective manner. Meeting this business requirement is the intent of the technologies that constitute on demand.

Wimbledon

The All England Lawn Tennis and Croquet Club, or Wimbledon as it is known around the world, meets the challenge of unpredictable demand with a Linux solution. During a typical 2-week event, as many as 4 million users will make 27 million visits to the Wimbledon Web site. This enormous traffic bulge is not just a spike, but rather it represents many magnitudes of above-average pre- and post-tournament daily traffic. While IBM has any number of solutions that could scale up and down to serve this requirement, the solution deployed included Linux on xSeries, WebSphere Business Integrator, Tivoli Intelligent Orchestrator, and DB2, resulting in a 3-fold price/performance improvement.

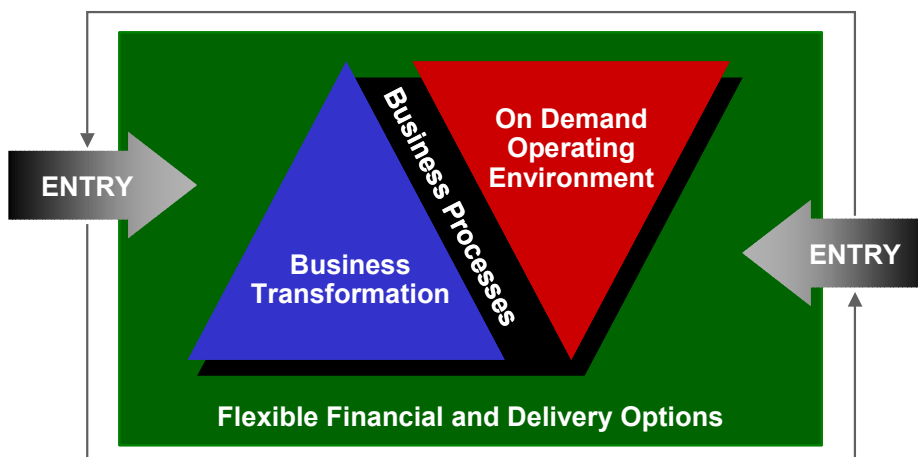
Of course, to enable flexibility and responsive execution at a business level requires the underlying architecture to easily support such changing requirements. Customers with integrated environments that are connected to their partners and suppliers have infrastructures that empower them to thrive in today's challenging economic environment. IBM's Global Services organization is positioned to assist customers in optimizing their approaches to today's business opportunities and challenges.

Figure 1 provides a graphical view of the way in which IBM positions the relationship between business transformation/flexibility as well as its operating environments. It also illustrates how the business processes tie together the entry points of business needs and technology requirements.

FIGURE 1

IBM's Essentials of an On Demand Breakthrough

Where you start depends on *your* organization's priorities.



- **Increasing flexibility is the key — business models, processes, infrastructure, plus financing and delivery**

Source: IBM, 2004

The Role of Linux in Addressing the Needs of On Demand Businesses

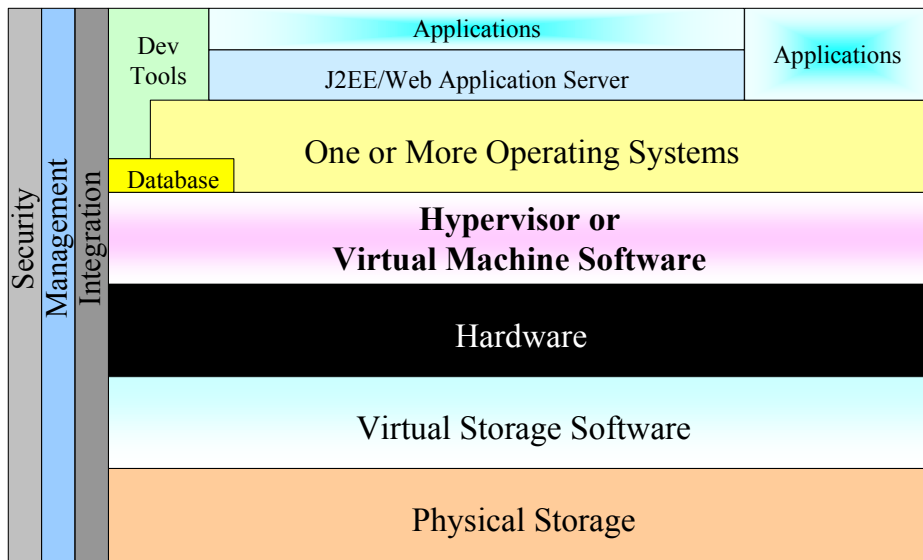
Having the ability to dynamically reassign existing system resources or deploy additional resources to applications or operating environment installations that require more capacity provides the direct benefit of enabling customers more fully to utilize the resources of their investments. However, dynamic provisioning capabilities are only a single aspect of the business benefit that on demand can provide to customers.

IDC notes that the comprehensive implementation of Linux as a native operating system aboard each of IBM's four eServer hardware lines — xSeries, pSeries, iSeries, and zSeries — makes it possible for Linux to connect today's Web-based applications with existing application logic and databases that generally have been in place aboard these platforms for years. IBM's adoption of Linux is an integral component of its plan to create a comprehensive set of technologies to extend the business value of its server platforms and is one of many proof points showing how IBM has embraced the movement to solutions based on open standards.

Figure 2 introduces the positioning of some of the key technologies being discussed in this IDC White Paper. The figure provides a representative view of how IBM's operating systems map into an environment that provides virtualization, automation, and a flexible infrastructure that supports multiple operating systems — including Linux.

FIGURE 2

IBM's On Demand Operating Environment—Infrastructure



Source: IDC, 2004

Using IBM's hypervisor technology aboard zSeries, iSeries, and pSeries systems and VMware ESX server aboard xSeries systems, the operating system software is abstracted away from the underlying hardware by means of a virtual hardware environment. The abstraction makes it possible to have multiple operating systems deployed on a single hardware platform. This technology became all the more interesting when Linux support was added to these platforms. Linux, when installed as a guest operating system, can benefit not only from the huge pool of resources available on zSeries, iSeries, and pSeries platforms, but can also benefit in zSeries and iSeries environments from the direct, high-speed virtual network connections to other operating environments hosted aboard the same hypervisor.

Using a hypervisor-level interconnection, it becomes possible for Linux to have exceptionally fast, efficient access to existing data stores that may currently reside on existing systems. This architecture allows new application deployment or Web enablement of existing applications to be carried out through deployment of one or more instantiations of a Linux operating system.

Looking above the operating system layer, J2EE Web application servers such as WebSphere provide another layer of application portability. While WebSphere is the preferred Web application server aboard IBM's eServer, there are a variety of third-party and open-source solutions available for Linux and Windows operating systems. Web application servers provide another level of virtualization from the underlying operating system application programming interfaces (APIs), which means that applications written in Java to a Web application server will be better insulated from the deployment operating system, making it more portable to other platforms.

The On Demand Operating Environment

The goals of the on demand operating environment are business flexibility and IT simplification. To build out IBM's vision for an on demand operating environment requires an orchestrated collection of hardware systems, software enablers including operating system software, virtual machine and hypervisor technology, as well as application environments designed for deployment both natively on the host operating systems and aboard J2EE environments, connected using a service-oriented architecture (SOA).

The Components of the On Demand Operating Environment

IBM has three key themes incorporated into its concept and implementation of an on demand operating environment: use of open industry standards; integration of people, processes, and information; and infrastructure management.

1. Open Industry Standards

There was a time when IBM was disinterested in open industry standards, but that was a different IBM than the company we see today. For more than a decade now, IBM has embraced open industry standards and, in our opinion, has set the mold for a large company that adopts, embraces, and extends industry standards. This perspective on the industry allowed IBM to recognize the potential for Linux early on, and the company was able to rationalize and balance the potential upside from adoption and the use of industry standards against the potential collateral damage such activities might have on its proprietary products.

IBM has embraced both de facto and formal standards, including many of those used to construct Web services, such as J2EE, XML, Simple Object Access Protocol (SOAP), and Apache. The company has actively participated in community processes for Linux and other industry initiatives.

In parallel with its adoption of and support for Linux, IBM has aggressively moved toward application virtualization technology based on J2EE through its WebSphere product family. Like Linux, J2EE technology solved a serious problem IBM faced: how to ensure that next-generation applications would be developed for its platforms.

In addition, an SOA enables a modular approach to infrastructure and enables the software components to connect and interact. In an SOA environment, every application and resource is treated as a service. These services externalize their interfaces using industry standards. The result is that applications, infrastructure, and business processes can be treated as components that can be mixed and matched at will.

In the context of on demand, IBM has also adopted Open Grid Services Architecture, or OGSA, which is one way to develop an interconnection for distributed, heterogeneous environments. However, OGSA is not by default a component of on demand solutions, as other IBM technologies can provide high-performance interconnections, particularly in the context of collections of environments running above hypervisor layers.

2. Integration: People, Processes, and Information

IBM's strategy cites three key elements that need integration to achieve its on demand vision. The company describes the role of Linux as an enabling technology that helps to tie people, processes, and information together in a seamless manner. These categories can be further described as incorporating the following specific elements:

- ☒ **People.** Integration of people who, through their identity, may participate in communication systems such as email and instant messaging and interact in collaborative workspaces through technologies such as portal resources. IBM tools and services, including WebSphere Portal and Lotus Workplace, help perform such integration. IBM On Demand Workplace is a solution consisting of software, hardware, and services.
- ☒ **Processes.** Process is the ability to integrate business logic between legacy applications, current applications, and brand new application logic that is being developed for deployment aboard virtual environment layers such as Java virtual machines (JVMs) within Web application server environments. Business logic integration may also include connecting application environments and people through workflow. The use of industry standards such as HTTP, XML, SOAP, and J2EE helps to facilitate process integration.
- ☒ **Information.** Integration of corporate data held within databases and other data structures together with users in a seamless and environment-agnostic manner. Information integration becomes particularly important with the expansion of application logic to customer- or partner-facing capability and may be available on private or public networks. Note that integration may be intrasystem (across different operating environments located within a single physical system) or intersystem (across multiple physical systems). DB2 Information Integrator is an example of IBM's solutions for information integration.

3. Infrastructure Management

While it's interesting to talk about dynamically configured and managed environments, without the right tools to virtualize and automate system configurations and operations, the complexity goes up, not down, as the system-level flexibility increases.

Infrastructure management aims to reduce the complexity and simplify the management of an IT infrastructure while, at the same time, aligning it to business goals IBM describes infrastructure management as a set of capabilities: availability, security, optimization, provisioning, infrastructure orchestration, business service management, and resource virtualization. These capabilities can ensure the most efficient utilization of IT resources; provide business continuity through reliability, availability, privacy, and security; and enable organizations to quickly and more efficiently execute core business processes.

IBM is not a stranger to infrastructure management. Long before the current Grid initiative, customers ran their businesses on IBM's iSeries, pSeries and zSeries and automation technology integral to those environments. Within an on demand operating environment, automation plays a critical role.

IBM recently unveiled its Infrastructure Management family of offerings, based on Tivoli Intelligent ThinkDynamic Orchestrator, a product designed to provide policy-driven orchestration of Tivoli management capabilities currently enabling availability, security, optimization, and provisioning. The Infrastructure Management family is intended to provide the business-level management for on demand.

Infrastructure management carries significance for Linux when deployed aboard IBM hardware, in particular aboard xSeries hardware where the operating system is often installed directly onto the system without any virtualization layers. Using IBM's software management tools, systems can be provisioned or re-provisioned in response to customer application or capacity demands.

When appropriate for a given customer solution, virtualization can offer unique benefits and can be applied many layers of a system, as previously described in Figure 1. Virtualization of resources is not a new concept for IBM, which has a 30-year legacy of work on processor virtualization in its mainframe environment, with nearly 20 years of processor abstraction in the iSeries product line.

IBM's current zSeries virtualization resources include the Parallel Sysplex technology, which allows for the combination of up to 32 z/OS environments into a single logical resource. In addition, the z/VM software supports multiple guest operating systems aboard a z/VM instance.

Aboard the iSeries platform, the current hypervisor technology supports up to 10 partitions per physical central processing unit (CPU), with the main requirement being that one partition must be running OS/400. The remaining partitions can support either OS/400 or Linux as guest operating systems. IBM plans to add AIX 5L as another guest operating system during 2004. With zSeries virtualization technology (z/VM), businesses can support an unlimited number of virtual machine instances for VM, x/OS, VSE and TPX operating systems.

The pSeries platform incorporates similar hypervisor technology to the iSeries platform (which will merge into a single hypervisor layer in the near future), allowing the pSeries platform to support multiple instantiations of AIX or a mix of AIX and Linux. In addition, IBM has taken its clustering virtualization technology, originally developed specifically for AIX, and added support for Linux so that a heterogeneous, mixed system cluster can be developed and supported.

The 64-bit POWER architecture is increasingly a common denominator for IBM's strategy. Used aboard iSeries, pSeries, and JS20 products, POWER-based systems can typically scale up to 32-way configurations, and scale out as well. The capabilities exist to run OS/400, AIX, and Linux aboard the same physical system within individual partitions.

Aboard the xSeries platform, IBM works with a partner company, VMware Inc., so IBM can resell VMware's ESX server virtualization product. The VMware ESX Server product is a self-hosting virtual machine technology that allows multiple guest operating systems to be deployed aboard xSeries hardware. The guest operating systems include Linux, Windows NT Server, Windows 2000 Server and Server 2003, Novell NetWare, OS/2, and most other Intel architecture operating systems on the market. Through a global distribution and support agreement, IBM can provide and support this technology for its customers.

In the case of pSeries, iSeries, and zSeries systems, IBM's approach to hardware virtualization uses firmware rather than software technology. This strategy virtually eliminates overhead.

IDC believes that virtualization technologies will continue to grow in importance, and the detachment of software that enables business operations from the underlying hardware resources will accelerate the industry's delivery of provisioning and management technologies.

Grid offers another important approach to virtualization. When discussing a "grid" computing architecture, the first mental image that materializes is that of a loosely joined network of functionally identical systems working on a highly parallel application designed for deployment to individual nodes within a network. The availability of virtualization technologies, such as JVM, has lowered the direct dependency on functionally identical hardware and software, but still, the concept of a grid has not previously incorporated disparate collections of hardware.

Enter IBM and its grid computing initiative. Simply stated, when IBM says "grid," think "open standards enabling application provisioning and management across heterogeneous architectures." IBM's current initiative relies heavily on the Globus Project's OGSA. In its quest for an industry-standard way of building a utility computing infrastructure, IBM has concluded that the Globus OGSA toolkit provides the best mix of technologies built upon an openly available architecture that has potential to become a formal industry standard.

Charles Schwab

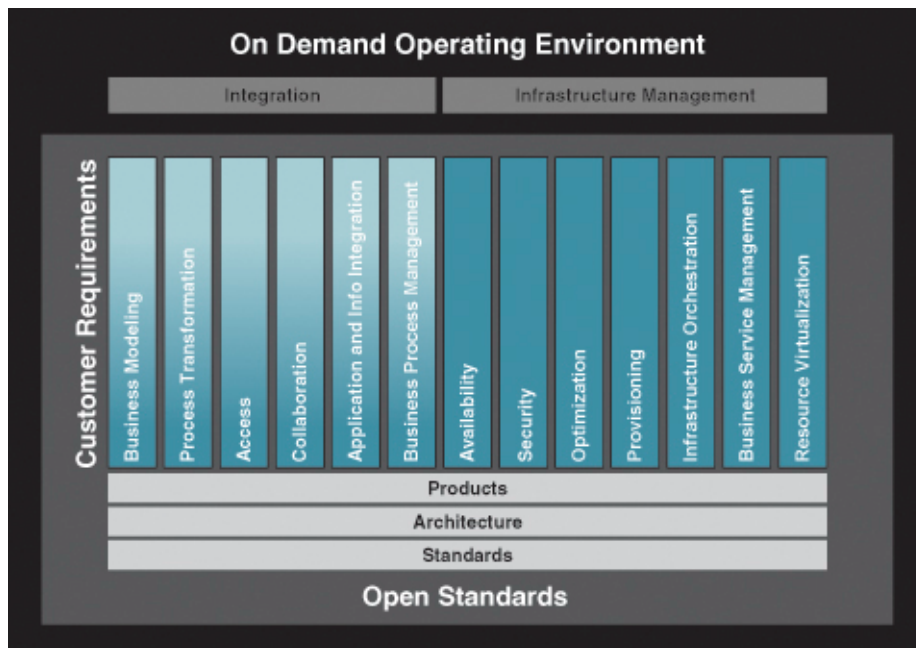
The challenge for financial services industry leader Charles Schwab was simple: The company wanted financial portfolio simulations to complete more quickly (seconds instead of minutes or even hours) so that a large number of iterations could be run without costing the company a lot of money. Equally important, the company wanted to minimize the time its 2,000 brokers — high value employees — spent waiting for results from the simulation. The company procured eServer xSeries systems from IBM, Red Hat Enterprise Linux Advanced Server, and uses IBM's grid software tools. The system went online in December 2003, and the results are impressive. Brokers would typically have to initiate simulations and follow up with customers after results were in. The processing time alone took between 8 or 10 minutes up to several hours. By comparison, a broker can now initiate a simulation while on the phone with a customer and typically within 30 seconds have a response to supply to the customer. The business benefit to Charles Schwab is that the interaction with the client and the level of service provided make best use of the client's time, position Charles Schwab as a responsive investment consultant, and most importantly, open the potential to increase the amount of business that each customer does with Charles Schwab.

Although it can be confusing at times, when IBM describes a "grid" architecture, it is more a statement about how individual systems will be managed, provisioned, and leveraged than a statement about the architecture of the application being deployed.

Figure 3 presents a graphical view for how IBM positions the relationship between its products and customer solutions.

FIGURE 3

IBM's On Demand Strategy Connects Customers with Business Solutions



Source: IBM, 2004

IBM eServer Hardware Support for an On Demand Operating Environment

Hardware: xSeries

A strong partnership with Intel reinforced by several successive quarters of robust growth has enabled the xSeries family to become a major contributor to the company's ongoing market share gains.

IBM's Enterprise X-Architecture combines IBM-developed application-specific integrated circuit (ASIC) logic with industry-standard Intel microprocessors to achieve scalable configurations in greater than 8-way symmetric multiprocessor (SMP) designs. IBM has differentiated itself as a supplier of scalable Intel-based server

systems, competing most closely with Unisys in that regard. IBM's system management offering, IBM Director, delivers granular control of x86-based server systems. IBM's long-term plan for xSeries systems is to focus the brand on Intel 64-bit Itanium and 32-bit Xeon processors, both with and without 64-bit extensions.

From a software perspective, IBM's xSeries platforms support multiple Linux distributions, as well as Windows and NetWare. Aboard xSeries platforms, IBM resells hardware virtualization software made by VMware. This product offers customers the capability to run multiple instances of single operating systems, or even multiple operating systems including Linux, Windows, NetWare, and OS/2 concurrently on the same server.

eServer e325 and Opteron Support

With the launch of AMD's Opteron processor, IBM unveiled the xSeries e325, a 1U rack-optimized chassis that can support up to two AMD Opteron processors. The Opteron processor supports both 32-bit or 64-bit x86 operating systems. When using 64-bit operating systems, both 32-bit and 64-bit applications can be run concurrently. This leads to a convenient combination of built-in scalability and backwards compatibility.

Blades and BladeCenter

IBM's move into blade computing with its eServer BladeCenter chassis and the BladeCenter HS20 in late 2002 was well received in the marketplace. This product strategy ties directly into IBM's new scale-out approach to enterprise system configuration and management and is integral to IBM's low-end, high volume on demand server strategy. When eServer BladeCenter is combined with IBM's Tivoli Intelligent ThinkDynamic Orchestrator and the IBM Tivoli systems management products, it becomes realistic to configure, deploy, and manage compute resources in a blade configuration on an enterprise scale.

The BladeCenter HS20 is a 2-way Intel Xeon-based server. In early 2004, IBM extended its blade server line to include the 4-way Xeon-based HS40. Taking the blade concept even further, IBM has begun to offer its BladeCenter JS20 product, a 2-way product configured with a RISC-based IBM POWERPC 970 processor that can plug into the same BladeCenter chassis — alongside HS20 and HS40 blade servers — and can be managed by Tivoli Intelligent ThinkDynamic Orchestrator.

This provides customers with the flexibility to intermix HS20 and HS40 blade servers configured with Linux, Windows, and NetWare along with JS20 blade servers running AIX and Linux. One 7U BladeCenter chassis can hold up to 56 processors in this mix-and-match fashion, taking only the rack space required by seven 2-way 1U servers.

pSeries

The pSeries family continues to see price reductions as well as enhancements, such as the incorporation of new POWER 4 RISC technology into the product line. The performance of the p630 allowed IBM to grow its volume pSeries worldwide revenue during 2003, and IDC believes that the continued incorporation of POWER 4 technology into lower-end models will increase the overall competitiveness of the pSeries Unix servers over time.

The pSeries platform can allocate resources to LPARs on the basis of one-tenth of a processor. This platform, like the pSeries and zSeries systems, also offers capacity upgrade on demand. A customer can buy a 3-way system that is actually a 6-way system utilizing only three processors. In the event that additional capacity is required, customers can then turn on the fourth, fifth, and sixth processors. Memory, storage, and backup capacity can be allocated dynamically, as well.

Another major initiative positively affecting the pSeries is on the software front: IBM has made a major commitment to delivering and fully supporting Linux aboard its pSeries RISC platforms.

As IBM's software portfolio aboard xSeries, iSeries, and zSeries platforms is maturing, resources are now being focused on boosting the competitiveness of Linux on the pSeries platform. IBM's software business operations have brought software products such as 32-bit DB2 (mid-2003), Tivoli, IBM compilers, and WebSphere (late 2003) over to Linux aboard pSeries hardware. Looking ahead, the company expects to continue the momentum.

IBM's partner companies are helping with this initiative, with Red Hat bringing its Red Hat Enterprise Linux technology over to pSeries, joining the SUSE Linux Enterprise Server technology already available there. Oracle has released a downloadable developer edition of its database software for pSeries and has committed to supporting Oracle 10i on Linux on POWER. This adds to the 64-bit DB2 downloadable developer edition that's also available.

IBM believes two deployment scenarios will be most common, the first being deployment of Linux as a guest operating system aboard a system already running AIX. This configuration typically will use Linux placed in a dedicated LPAR aboard a system already running AIX.

The second deployment scenario is one for which IBM created what it calls "Linux-ready" platforms, which are pSeries systems configured for deployment with Linux, with no AIX software installed. This solution is targeted at customers using Linux that are looking for 64-bit solutions for computational and mission-critical applications needing high levels of RAS.

University of Washington

Under a recent initiative started by the United States Library of Congress, a new archive slated to preserve film, television, and digital video images by cataloging and providing a directory of video collections is being created through a joint effort at three universities — Rutgers University Libraries, the University of Washington in Seattle, and the Georgia Institute of Technology Interactive Media Technology Center. Called the Moving Images Collection (MIC), the archive will become part of the Library of Congress' permanent archives and be available over the Internet. To create a robust and scalable infrastructure for the new system, the University of Washington chose SUSE Linux Enterprise Server running on IBM pSeries hardware. The other major decision was to go with the IBM Directory Server technology running on pSeries p610 systems. The project is well on the road to completion, and the selection of Linux allowed the Library of Congress to save significant dollars in software costs.

iSeries

IBM's continued investment in the iSeries platform is evident by the latest iSeries POWER 5 announcement. The iSeries and pSeries platforms continue on a path taking the two product families toward hardware convergence. The same POWER processor technology is used in both systems, and the hypervisor technology used to virtualize system resources and provide support for multiple operating environments is on a convergence path, as well.

The history of the iSeries customers — many of which reluctantly added Windows NT systems beside their iSeries platforms during the 1990s for print, file, and Web serving — has led to some server sprawl that can now be consolidated. There are indications that iSeries customers favorably view a consolidation of services, including as file, print, DNS, DHCP and Web (often from Windows platforms), to Linux on iSeries. IBM believes that many iSeries customers that continue to use Windows NT 4.0 today are candidates to consolidate additional servers aboard iSeries platforms running OS/400 and Linux in LPARs.

The iSeries family of servers supports up to 10 logical partitions per processor to a maximum of 254. For example, the

eServer iSeries i5 Virtualization Engine supports automatic processor resource movement to partitions with the heaviest demands. With the iSeries family, OS/400 partitions can host I/O resources for the Linux partitions. This storage virtualization allows Linux to leverage OS/400's advanced storage.

This platform, like the pSeries and zSeries systems, also offers capacity upgrade on demand. A customer can buy a 3-way system that is actually a 6-way system that is utilizing only three processors. In the event that additional capacity is required, customers can then turn on the fourth, fifth, and sixth processors.

GHY International

GHY International is a custom broker that services its customers by expediting shipments between Canada and the United States. GHY concluded that Linux fit the bill as the primary server for a critical imaging application the company needed, which ensured Linux would have a permanent home within the company's infrastructure. To simplify its environment, GHY International physically consolidated a heterogeneous environment aboard a pair of iSeries platforms. The first system, an iSeries 270, runs Lotus Domino as well as the company's internally developed customs applications. The second system, an iSeries 820 — with the requisite OS/400 LPAR in place mainly to manage the system resources — is used only for Linux partitions. The system leverages Red Hat Enterprise Linux and includes LPARs running Squid for Web proxy; DNS and firewall services; a critical, document imaging application; and the corporate Web site. That critical document application today accesses 1.5 million scanned images and 300,000 transactional files. The bottom-line results include an out-of-pocket cost savings of \$30,000 on the hardware acquisition and a 14% under-budget result for the year's IT expenses. But more important, the IT staff of 3 continues to support the infrastructure. The better news is that staff members now find that they spend only 5% of their time supporting the servers. Thus, they have time to focus on end-user issues and attend to another important list: requests for improvements and new features in the company's applications.

IBM's effort to converge the iSeries and pSeries platforms from a hardware perspective has a desirable side effect for independent software vendors (ISVs) targeting Linux. While some porting/recompiling work is required to bring an application to the iSeries platform from an x86-based Linux environment, the effect for the ISV is that, because of the hardware convergence, bringing a Linux application to either platform means the market opportunity for the ISV is actually the sum total of the Linux on POWER or Linux on iSeries together with Linux on pSeries and JS20 BladeCenter products.

Aboard the iSeries, both Red Hat and SUSE Linux are available.

zSeries

Predecessors to IBM's current zSeries product offerings created the gold standard in virtualization technologies, scaling — both up and out — and offering support for multiple operating systems long ago. The current zSeries products build on this 35 years of experience and continue to offer an environment that is more robust and scalable than just about any other platform.

The zSeries platform has long been known for its built-in autonomic capabilities, which make for a platform that detects and corrects errors and potential problems without interruption to the software. The platform is designed for broad levels of scalability, and customers can utilize capacity on demand technologies, providing scale-up facilities when customers need them.

Boscov's

Boscov's, a retail chain employing 10,000 people at 40 store locations through the mid-Atlantic region of the United States, was struggling with high IT costs associated with its distributed systems infrastructure. After doing some evaluation on the cost savings of running SUSE Enterprise Linux on IBM zSeries, Boscov's found the numbers so encouraging that it eventually implemented an enterprisewide rollout of Linux. The company built its ebusiness framework with IBM WebSphere Commerce for Linux and uses a storage area network (SAN) based on IBM TotalStorage Enterprise Storage Server (ESS) for storage support. Boscov's currently has about 100 instances of SUSE Enterprise Linux running aboard its zSeries system, including development, test, quality assurance, and production. Those instances replace about 80 discrete four-way systems. Between the full-time equivalents not hired and servers that Boscov's didn't have to buy, the company is quickly approaching a 7-figure savings, driven primarily through the move to Linux. "I don't think we've seen yet the full potential of Linux. Everybody is looking at the lower cost footprint," says Senior Vice President and CIO Harry Roberts. "We, as IT execs, need to position ourselves so we can take advantage of the lowest cost of operation that is out there."

Since the introduction of fully supported Linux aboard the zSeries family in 2000, a move that the industry initially viewed as a curiosity, IBM has made it quite clear that it is serious about supporting Linux aboard mainframe systems. Because Linux can leverage existing systems management tools, operational costs can be tightly controlled, as well.

The launch of IBM's Linux-specific eServer zSeries 800 product line in 2002 marked another major milestone in the evolution of Linux. Equally important, the support of Linux aboard the rest of IBM's mainframe line using z/VM allows the consolidation of multiple applications onto a single zSeries platform.

IBM Storage

IBM treats Linux as a tier 1 operating environment and has a clear strategy to support it. First, new storage products from IBM will support key enterprise Linux distributions as soon as the products are available. Second, IBM will support new distribution releases and kernel errata within 30 days. Finally, IBM TotalStorage will support Linux at a level equivalent to the storage products' native platform operating system. IBM's goal is to test and support Linux aboard all of its storage products, giving customers more flexibility and choice.

Given Linux's key role in IBM's on demand strategy, storage support needs to play an equally flexible role. For example, the IBM TotalStorage Enterprise Storage Server, IBM TotalStorage FAST Storage Servers, and linear tape open (LTO) products have been optimized for Linux.

McCamish Systems

McCamish Systems provides outsourcing solutions and software products to companies that are in the life insurance and financial services industries. The company's model is outsourcing solutions, which includes moving toward an xSeries rack or blade configuration and FASTT700 Storage. The FASTT700 benefits include storage redundancy, no single point of failure, and scalability, while xSeries provides the ability to compartmentalize the customer's configuration on a single xSeries server running Linux. This model greatly simplifies the security audit requirements and eliminates any competition for resources between different customers' applications. Another benefit is that business continuity services for xSeries platforms are affordable to acquire and easy to locate. Today, this company is representative of the leading edge of Linux adoption. With a move toward Linux as the primary operating system running its mission-critical business operations, McCamish Systems is able to support customers including 5 out of the industry's top 10 insurance companies in the country, one of the nation's top 3 banks, and one of the industry's largest financial services companies.

IBM supports Linux on SAN Volume Controller, SAN File System, Data Facility Storage Management Subsystems (DFSMS), Tivoli Storage Resource Manager, and Tivoli Storage Manager.

How Linux Enables IBM's On Demand Vision

IBM's strategy of supporting four discrete eServer platforms has long been positioned as a strength, while competitors have maintained that this strategy represents a weakness. IDC believes there to be truth in both perspectives. However, we also believe that application compatibility has long been a challenge for IBM. Application-incompatible platforms mean redundancy in development, redundancy of application development and support, and the creation of fundamental barriers that make it difficult for partners and customers to scale up, down, or across IBM's product line.

The emergence of Linux represents one component of a two-part strategy that has the potential to resolve some of the incompatibility issues facing users. It also can truly enable IBM's strategy of offering a scalable set of solutions with on demand capabilities.

Combining Linux with IBM's endorsement of J2EE as the platform for next-generation applications and the support for an SOA — productized throughout IBM's WebSphere product line — offers customers extraordinary flexibility for application development, deployment, and run-time execution. IBM's on demand intentions go beyond an operating system strategy. IBM's vision calls for the integration not only of application environments, but also across users, data, and workspaces.

The Role of Linux

Linux clearly plays a starring role in IBM's play to build an on demand vision. The availability of Linux as a native operating system aboard all four of its eServer platforms offers the following benefits:

- ☒ **Deployability and manageability by existing platforms.** Linux environments can be deployed and managed and have resource allocation provided by either the hypervisor layer or a combination of the hypervisor and the host operating system on zSeries, iSeries, and pSeries systems. Aboard xSeries systems, the deployment and management is performed by other management software tools provided by IBM.
- ☒ **Inclusion in an outsourced solution.** Linux is increasingly becoming a key element of IBM's outsourced utility offering. IBM currently offers a virtual Linux-based service called "Managed Hosting," which the company delivers from its datacenters around the world. Through this initiative, IBM demonstrates that the service can be delivered from any geography to any geography, as necessary. IDC notes that IBM's outsourcing initiatives are exclusive of, and not an integral part of, its on demand and grid initiatives.
- ☒ **Ability to participate in clusters and external grids.** The presence of Linux as a native environment aboard IBM's platforms allows those platforms to increasingly participate in external clusters and grids that may include systems other than IBM hardware, but that support Linux operating environments.
- ☒ **Enabler of next-generation applications.** With few college graduates entering the job market with strong programming skills in RPG, COBOL, and other legacy languages, it becomes increasingly important to offer environments that support modern applications without major rewrites.
- ☒ **Standardization of tools and utilities to support each environment.** With a common operating system environment such as Linux, the development of related technologies such as middleware, transaction processors, and management tools can be more common across each environment. While it's unlikely that such products would become 100% identical, the challenge of maintaining different versions for Linux on four different platforms is far less challenging than maintaining technologies that run natively aboard z/OS and OS/390, OS/400, AIX, and Windows.

- ☒ **A common interface to the outside world.** Another key benefit of using Linux as the common denominator on IBM's platforms is its ability to support applications developed not for IBM, but for Linux aboard IBM's platforms. No longer will ISVs be forced to become experts on multiple operating systems to reach customers of that platform. Instead, supporting a Linux solution potentially extends an ISV's reach to all of IBM's customer base.
- ☒ **Direct support for open source development projects.** The open source project development model has proven itself to be an effective way to develop a technology, but these projects are typically designed first and foremost for deployment on other open source technologies, with Linux being among the most likely early targets.

IBM's Software Strategy for Linux

IBM has embraced Linux as if it were one of its internally developed operating system products. Backing up this perspective, the on demand operating environment is receiving full support from all parts of IBM's software organization. As a result, products originating from DB2, Lotus, Rational, Tivoli, and WebSphere as well as the developer tools group all are available for Linux. For customers, this means that the entire IBM Software stack is available for and fully supported on Linux.

The strategy to grow the Linux "ecosystem" begins with IBM's partner programs and its tools offerings. The company has a multi-pronged strategy to reach all levels of the market. At the top tier, IBM is focusing on the largest ISV partners. Vendors in this category get direct assistance from IBM to help them place their solutions into user organizations. At the next level, IBM is working with ISV partners to deliver applications that customers need aboard Linux systems. At the third tier, IBM works with corporate Linux developers to integrate and utilize IBM's infrastructure software products for their internal development.

IBM's Linux Software Portfolio

Taking a look at the IBM software portfolio for Linux illustrates just how seriously the company views the Linux opportunity. IBM's aim with its software portfolio on Linux is to provide an open and comprehensive platform enabling the easy integration, deployment, development, and management of applications across heterogeneous server environments resulting in lower costs and higher performance.

IBM has successfully launched its product suite for Linux first on xSeries products, with zSeries and iSeries platforms coming next. The final platform, one that only recently began to see a comprehensive suite of products for Linux, is the pSeries. However, it would be wrong to assume that, because pSeries was last on the list of product deployments, it is not an important priority for IBM. In fact, the company is currently embarking in an aggressive program to ramp up marketing for Linux solutions aboard pSeries hardware.

DB2 Information Management Family

With the emergence of Linux, IBM quickly moved to extend its DB2 Information Management portfolio with native Linux support. DB2 Universal Database for Linux was one of the first major IBM products to be available on Linux, with an evaluation copy of DB2 first bundled on a Linux sampler CD that accompanied Red Hat Linux in 1999. The DB2 Universal Database for Linux originates from the same source code that is used to generate DB2 Universal Database for Unix on AIX, Solaris, and HP-UX as well as Windows.

DB2 for Linux is available currently for Linux operating environments running on eServer xSeries, iSeries, pSeries, and zSeries systems. The DB2 family includes industry-specific solutions such as DB2 Warehouse Manager (often used for business intelligence applications), DB2 Content Manager, and DB2 Information Integrator. DB2 Everywhere fills out the portfolio for embedded and mobile Linux solutions.

WebSphere Family

IBM has positioned its WebSphere J2EE application server technology as a tool for decoupling application dependence upon operating system APIs for several years. The strategy initially was used as a way to build platform-independent applications and as an ideal tool for porting existing applications across a variety of platforms, while preserving the business logic those environments have contained within them.

IBM's WebSphere Application Server, WebSphere MQ, and WebSphere Studio provide an environment that enables deployment and integration of applications into an IBM on demand environment. WebSphere provides customers with the four capabilities required for such deployments: a build-to-integrate platform, integrated application development, deployment and administration facilities, and intelligent application quality of service (QoS) optimization.

WebSphere for Linux provides an environment with application services including transaction management, security, clustering, performance, availability, connectivity, and scalability. WebSphere helps customers deploy and manage applications ranging from simple Web sites to powerful ebusiness solutions.

Lotus Product Family

Since purchasing Lotus Development Corp. in 1993, IBM has expanded the reach of Lotus groupware and collaborative solutions across all of its product lines. Today, from the zSeries systems on down to the xSeries platform, IBM has a Domino solution available on Linux. In addition, the Lotus Workplace product presents a J2EE-based solution for collaboration and worker interaction that provides tools such as messaging, e-meetings, calendaring and scheduling that integrate into the current workspace. Based on the Eclipse framework, the Workplace client technology is an installable runtime platform that is seen as the basis for future offerings from IBM.

Domino was among the first products that IBM software developers ported to Linux, with that move being completed in late 1999. This move provided Domino developers with the opportunity to run their existing applications on Linux systems without requiring changes to the applications. The latest version, Domino 6, offers

policy-based administration yielding lower management costs, better scalability and reliability, and centrally managed archiving, mail journaling, and anti-spam control. Domino 6 also supports J2EE and XML standards, along with its tighter integration with WebSphere, which makes it easier to create businesses applications for Web services environments.

Tivoli Product Family

One of IBM's other major acquisitions in the 1990s was Tivoli Corp., acquired in 1996. Tivoli has become the mainstay of IBM's autonomic computing initiative, and the company now has product offerings that provide end-to-end systems management capabilities.

The goal of Tivoli is to provide support for networks of heterogeneous systems, and the support of Linux is a required element to reach that mandate. The company's investments over the past several years have focused on the necessary support elements as Linux transitions from an infrastructure server to a role as a general application server.

Tivoli's products break down into four major business segments, including security management, which includes identity management, access management, and risk management modules; a set of optimization products for storage management, backup, recovery, and workload scheduling; orchestration and provisioning, including configuration management tools,; and business service management and availability management technologies.

Rational Software Product Family

IBM's most recent major addition to its software product portfolio in 2003 was the Rational Software line, which now forms the core of its software development platform. Linux support from Rational is currently focused on two areas: development of Linux applications through integrated development environment (IDE) support and reduction of the total cost of ownership (TCO) of software by providing Linux-based platform support for managing software assets. The Rational products, which promote use of software engineering best practices helps drives rapid application design and development, and consists of the following components:

- ☒ **Requirements and analysis tools.** This category includes automated development tools, business modeling, and data modeling tools.
- ☒ **Design and construction tools.** This group includes the WebSphere Studio IDE. Additional tools included offer design modeling, component testing, and run-time analysis.
- ☒ **Automated testing products.** Testing tools enable running quality assurance on software products and testing for code consistency, quality, functionality, and performance.

- ☒ **Software configuration management (SCM) tools.** These products include change and version control, asset management, and defect tracking. Rational SCM Linux support gives developers the flexibility to work in their preferred IDEs while related software assets can be assessed and managed on Linux servers.
- ☒ **Life-cycle management.** Life-cycle management is used to manage the development process, organize requirements, and measure development progress.

FUTURE OUTLOOK

IDC's projections call for Linux server operating environment shipments to show a 2002–2007 compound annual growth rate (CAGR) of 16.6%. In parallel with this increase, the shift toward "enterprise" Linux distributions is going to have a positive effect on the average selling prices (ASPs) of Linux server operating environments and will help drive Linux operating system revenue generation upward.

IDC's projections call for Linux server operating environment shipments to show a 2002–2007 CAGR of 16.6%.

By 2007, IDC projects that there will be 2.8 million new Linux paid server operating environments being shipped each year, versus the current rate of 1.3 million per year. Significantly, Linux will comprise almost a third (32.3%) of all server shipments by that time, grabbing almost 50% more market share from its current base of 23.1%.

Another trend that will continue to accelerate Linux deployments is the focus of large systems vendors, including IBM, HP, and Sun, on promoting it. IBM in particular has a vested interest in seeing Linux prosper, because it solves challenges that must be resolved to ensure the long-term health of its business. IBM and other large players are critical in the survival and growth of Linux, given their enormous marketing resources. Independent Linux vendors such as Red Hat have comparatively limited reach.

IDC expects the pool of IT professionals with Linux skills to increase substantially during the forecast period. Professionals in Unix environments can easily make the transition to Linux, which is built on a similar — but not identical — kernel. In addition, Linux usage is widespread on college campuses. The increasing availability of Linux skills will help drive down deployment and maintenance costs and, therefore, alleviate concerns around long-term TCO and support issues.

IBM's position within the Linux market is multifaceted, with the company competing for a piece of the commodity 32-bit Intel x86 and AMD x86-compatible market, and with IBM vying for the higher margin and larger footprint of Linux on 64-bit extended x86 processors from AMD and Intel within the eServer family. At the high end, IBM has delivered powerful and scalable 64-bit Linux solutions built on pSeries and iSeries systems on the POWER processors, as well as aboard zSeries hardware. IBM has hinted that it will expand its low-end POWER Linux offerings.

We believe IBM is well positioned to capitalize on the larger system configurations. Furthermore given IBM's large ISV partner community and its ability to motivate that community to support the company's platforms, it is reasonable to believe that applications' availability, particularly those specific to verticals of significant interest to IBM's Linux initiative (including retail, financial services, and government), will increase at a healthy pace.

CHALLENGES/OPPORTUNITIES

IBM's commitment to Linux is not without its challenges. Furthermore, elements of its initiative take the company into niche opportunities that may be far enough askew from the Linux mainstream that IBM may find itself fighting an uphill battle for market and mindshare. The following are additional challenges:

- ☒ **Non-Intel platform solutions.** While IBM's xSeries and BladeCenter products clearly have the mainstream Linux-on-Intel market well covered, Linux solutions on IBM's pSeries, iSeries, and zSeries platforms are less mainstream. J2EE-based applications deployed aboard these platforms will likely be less problematic, but Linux applications accessing native APIs require at least a recompile and potentially a more comprehensive porting operation to function properly.
- ☒ **32-bit versus 64-bit environments.** A corollary to the non-Intel platform issue is the gulf between 32- and 64-bit environments. Intel platforms are primarily 32-bit solutions, while pSeries, iSeries, and zSeries solutions are 64-bit platforms that offer 32-bit compatibility. This gap, however, is closing due to the acceptance of Opteron-based systems within the Linux community, and will close further as Intel brings forward a product line based on 64-bit extensions to x86 processor technology.
- ☒ **SCO Group litigation.** The continuing threat of end-user litigation on the part of the SCO Group is an impediment to long-term growth of the Linux operating environment. While IDC research has found high levels of awareness about this issue, end users so far have not broadly reduced their deployment plans for Linux as a direct result of this activity.
- ☒ **Microsoft won't sit still.** Microsoft has never been known to be passive in the face of competition. Its dominance continues to increase, despite the presence of Linux, and the company has successfully managed to convert more and more customers to long-term volume licensing, locking in a revenue stream for three to five years to come. Microsoft correctly recognizes that Linux presents a highly dangerous threat and can be expected to compete vigorously with Linux.
- ☒ **Continued support from ISVs is critical.** For IBM's strategy to continue to succeed and expand, the company requires continued support from vendors of infrastructure software and applications. In particular, zSeries and iSeries platforms would present a more attractive solution to ISV solution providers currently targeting xSeries (and other x86/x86 extended platforms) if all of the key Linux infrastructure software products were available on the high-end systems.

CONCLUSION

IBM's strategy for integrating Linux and its four key eServer platforms into its grid-enabled on demand infrastructure is bold and comprehensive and offers a tremendous potential value for existing customers. The value proposition has the potential to be strong for noncustomers and customers that wish to use one of these platforms for consolidation purposes.

Ultimately, IBM has even more riding on the success of this initiative. The long-term health of IBM's non-Intel platforms is in no small way dependent on Linux for the applications that may well make up the next-generation deployments.

We believe that IBM has done a good job building out the software stack aboard its platform portfolio, but the next challenge remains significant: to drive more ISV support on zSeries, iSeries, and pSeries platforms. We believe that IBM has the resources to continue to drive this issue toward resolution and expect to see IBM move methodically toward this goal over the next year or two.

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