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LINUX for S/390: Scalability and Competitive Advantage

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Executive Summary

This white paper presents a short history of the LINUX® operating system, the benefits of the IBM® S/390® hardware and software solution, and a real-world financial case for deploying a large-scale enterprise and service provider solutions for UNIX® -based services. The case details a discussion of the value of common source between small and large systems for speedy deployment, and a realistic view of the total cost of ownership and time to market advantages of a substantial Linux for S/390 deployment.

This white paper is one of a series of three focusing on Linux for S/390. Also available is a white paper which addresses the concerns of technical managers, *Linux for S/390 Technical Solutions for Competitive Advantage*, and a brief for technical professionals, *Linux for S/390 Technical Notes on a Large-Scale Implementation*

Linux in the Marketplace

The Linux operating system is generating a large amount of press in the server and desktop systems industry as a significant competitor to traditional vendor-supplied operating systems solutions. The widely touted capabilities of Linux to support diverse hardware architectures with a common application programming interface and management architecture make it an attractive alternative to other operating systems. This white paper addresses the case for large scale enterprise and Internet-oriented data center server farm deployment using Linux for S/390. It also addresses the relative financial and competitive advantages of a virtual machine-based server infrastructure compared to a traditional discrete-system based approach.

What Is Linux?

Linux is an independently-developed UNIX implementation based on the AT&T System V Interface Design. Linus Torvalds, the initiator of the project and ongoing guiding spirit, developed the system as an exercise in writing an operating system environment for Intel-based systems, and subsequently released

his solution to the public as freely available code. Groups of enthusiasts have adapted the resulting code to a variety of platforms as diverse as the Palm Computing platform and most popular RISC and CISC architectures including Sun's SPARC architecture and IBM's PowerPC® and RS/6000® systems. Recently, mainstream hardware vendors such as Silicon Graphics and IBM have announced official efforts to deliver Linux as a mainstream production offering on architectures such as the SGI Power Challenge and IBM's S/390 mainframe systems. These vendors go beyond delivering code for specific hardware platforms, and include key service offerings such as systems installation, defect resolution, and support services.

What Is the Linux Marketplace?

With the adoption of Linux by both hardware vendors and software solutions providers as a stable, supportable mainstream server operating system, the marketplace for Linux installation has increased dramatically in the last 16 months. A 1999 study by IDC estimates that more than 6 million copies of Linux are in production on all platforms, and that during the 4th quarter of 1999, Linux system deployments increased by 450,000 more copies than Microsoft's competing Windows NT® Server based solution. Currently, the focus and successful niche for Linux is in the server environment, providing core Internet-based services such as mail, WWW service, FTP file servers, and a growing role in the LAN file and printer service arena. Dataquest estimates that more than 60% of the WWW servers in production on the global Internet are based on Linux technology.

Linux is especially applicable to environments where the following conditions hold:

- *Rapid deployment of highly integrated applications systems with complex management requirements.*
  Linux provides a rich set of common application development tools (compilers, editors, scripting languages, source code control systems) and industry-accepted applications (such as mail servers, WWW servers, and collaboration

tools) as part of the standard environment. These application tools and systems are identical on Linux systems running on different platforms, providing fast prototyping and deployment of new applications and services coupled with standard management capabilities that do not require 3rd party management applications.

- *Cost-margin sensitive large scale deployments such as enterprise server farms or Internet data centers.*
  Unlike most traditional operating system or application vendors, Linux does not require licensing or purchase of the environment on a per-use basis; the Linux environment is maintained for the public by the public and is freely available. Several vendors such as SuSE Linux, TurboLinux and Red Hat offer a prepackaged solution with support, however anyone is able to obtain and use Linux systems and applications code without charge. This model is a substantial savings over license costs of $500/copy or more for deployment of more traditional operating environments..

- *Server consolidation efforts to reduce management overhead and costs across the enterprise.*
  As distributed use of information technology permeates the organization, management costs associated with deployment of technology have increased dramatically. IDC estimates that while most organizations are attempting to hold IT costs at 10% growth per year, the infrastructure demands and operational costs are increasing at a 125-200% rate per year. These costs include additional staffing, systems, environmental modifications such as server facilities and HVAC, and disaster management and planning costs (such as backups, tapes, etc).

Linux offers a flexible, cost-effective solution to these three areas by leveraging a broad base of software development professionals worldwide, an advanced and flexible set of ready-to-use tools and applications included with the operating environment, and a license-free environment for deployments of any size.

S/390 Overview

The S/390 family of hardware (and its predecessors) has been IBM's flagship enterprise system offering for decades. The S/390 has an unmatched record for high-availability, durability and capacity for mission-critical systems and data across a wide variety of enterprises and applications. Some of the classic strengths of the S/390 (ones that are seeing a renaissance of development in competing offerings) are:

- ***Availability.*** *Major system components are replicated as a standard feature, providing automatic recovery capability and automatic switchover to hot-spare components without interrupting system operation. Most major components can be serviced concurrently with normal system operations, limiting the exposure to unscheduled outages.*

- ***Manageability****. Multiple systems (both physical and virtual) can be monitored, controlled, and maintained from a single central point.*

- ***Scalability.*** *S/390 processors and I/O devices are available in a number of configurations designed to support requirements of as few as a dozen users to thousands of concurrent users managing data from the megabytes to the multi-terabyte range. Processors can be incrementally upgraded or replaced to meet growing demands, allowing the business to quickly and non disruptively adapt to changing business needs and requirements*

Recent events in the rapidly expanding Internet economy has highlighted the continuing importance of these types of design criteria – where IT is not only a component of the business but *is* the core business as is the case in dot.com startups and established Internet services such as eBay and amazon.com. These factors, coupled with IBM's substantial reduction in the cost of S/390 component systems over the last decade, are making a significant impact into the much-touted "cost savings" of alternative platforms.

Coupled with the hardware advantages shown above, the S/390 environment has well-tested abilities to allocate and manage resources to individual tasks

or even to partition its resources between separate system images running on the same physical box. This partitioning and resource capping ability is implemented at several levels – a hardware-based partitioning tool providing up to 15 separate partitions, or a software partitioning tool (the VM/ESA® operating system) providing thousands of individually managed partitions. As shown later in this paper, this ability to offer hundreds or thousands of partitions – literally virtual systems with disk, CPU and network connectivity within the same physical complex – offers a substantial time to market and competitive advantage over discrete systems.

The Case for Linux for S/390

The sheer technical accomplishment of being able to run a Linux environment on S/390 isn't the whole story. Linux for S/390 offers a number of concrete business benefits that provide value and competitive advantages to business entering the Internet-connected e-business world.

Cutting-Edge Internet Applications

Due to the open availability of Linux source code and utilities, Linux is rapidly becoming the development platform of choice for researchers and mainstream applications developers working on the cutting edge of new Internet services and application function developments. More than 10,000 existing Linux applications are available for Linux for S/390, and new open source and commercial applications are released daily.

New Internet applications and new protocols are developed and tested on Linux systems worldwide, and are available on the Linux platform first. Linux for S/390 makes those applications available on the S/390 immediately – no waiting period for conversion to traditional S/390 operating environments or infrastructure deployment-related delays for providing services on separate systems. This immediate availability allows businessses to react faster to new developments, and maintain current and flexible service offerings without substantial reengineering of infrastructure for each new tool.

Common Source Development Environment

The Linux for S/390 implementation is functionally identical to Linux implementations on other platforms and offers identical development tools, APIs and capabilities (modulo increases in processor capacity and I/O speed provided by the S/390 hardware). Application source can be developed and tested in inexpensive desktop machines and immediately moved to the large systems environment without modification. Correspondingly, applications developed for the large systems environment can be scaled down to smaller implementations on isolated platforms (such as remote offices with limited connectivity) without modification – the ability to use a common source environment and common tools on large and small systems offers the ability to adapt quickly to any business need.

Reliability of Hardware and Software Platform

The S/390 hardware and partitioning software represent more than three decades of research and product development in delivering a thoroughly reliable platform for mission-critical systems. As mentioned, the S/390 has a level of hardware reliability unmatched by any other system in the industry – hot spares for most major components, automatic recovery of failed components, and hot serviceability all combine to make the S/390 hardware an ideal platform for applications and services that are the core of any business.

Coupled with the designed-in hardware reliability, the software partitioning capability of the S/390 (particularly the VM/ESA operating system) has been providing virtual systems and testing environments since the late 1960s. This capability to support test applications and entire end-to-end business configurations simultaneously provides an unmatched ability to eliminate customer-visible errors in systems and deployments without risking the production systems or requiring additional dedicated testing hardware to sit idle during periods of low change activity.

Flexibility to Choose Best of Breed Solution

The virtual system capability of the S/390 provides customers the ability to match a solution set to a wide range of problems; for example, if a particular

application system requires the flexibility and cutting-edge Internet capabilities of Linux for S/390 but also requires access to enterprise data stored in DB/2® on OS/390®, both application and database can be securely and efficiently hosted on the same system with applications and database systems communicating at system bus speeds. The advantages of both environments can coexist and provide a more stable, more robust solution.

Total Cost of Ownership

To illustrate the value of the Linux for S/390 solution, let's examine a real-world deployment case. A telecommunications carrier planned to create a managed router service. This required the creation of a very large server farm to provide basic Internet services. They considered several alternatives from vendors, and were faced with the choice of implementing either a traditional discrete server farm solution or a virtual server solution based on S/390 hardware, VM/ESA and Linux for S/390. The service required dedicated servers for each customer to guarantee performance and security because of the lack of resource control and accounting capability in mainstream UNIX and Windows NT systems.

The planned customer base was initially 250 customers but, if the service was successful, this could grow rapidly to as many as 2500. Each customer required two smaller servers for Internet domain name service and one larger server for an I/O intensive collaboration and database application. Here are the alternative cost cases:

The Discrete 'Server Farm' Solution

The discrete system solution was based on 500 Sun™ Ultra Enterprise 2 (UE2) and 250 Ultra Enterprise 1000 (UE1000, similar to Netra t1800) servers in a traditional machine-room style deployment. The 750 servers were connected to Cisco® Catalyst LAN switches and connected to the global Internet using Cisco 7513 routers. Each UE2 system was listed at $10,514 each (list price with 1G RAM, 36G disk), and each UE1000 was priced at $22,600 list. Networking equipment would have totaled $1.2 million in Cisco LAN switches

and router hardware. Significant discounting would be expected on such a large acquisition, but this 3-year cost of ownership case reflects actual price to be paid by this customer.

- *Space Requirements*

  This was a major new service and provision of floor space for up to 7000 servers (10,000 square feet) was required. The 7000 server target reflects an ongoing decision process for the customer that allowed them to assess expansion requirements and evaluate additional facilities as the farm increased in size. While they were aware that the full configruation would not fit in the initial space acquisition, the initial acquisition would provide sufficient space to demonstrate commercial viability and justify full acquisition of the larger requirement in the future. Existing machine room space could not be modified to meet these requirements, so a new building had to be acquired to house the hardware for the solution. The estimated cost of raised floor space in the geographic area the company was considering was very expensive at $27/sq ft/month or about $3.2 million per year. This space estimate includes rack space, accessways, control center space and utility access spaces.

  Each set of customer servers consumed one-half of a rack, giving a requirement for 125 4x4 foot racks (at more than $3000 for each rack), plus an additional 30 racks for network and LAN equipment.

  The 10,000 square feet of space required a $750,000 battery backup installation. Twenty percent of this was allocated to the initial 250-customer server farm solution, however the full installation was required to support expansion and future requirements. Over 12 miles of network and power cabling would be required to support the initial 250 customers.

- *Operations People and Systems Management Support Systems*

  To provide adequate network and system support management of the proposed environment, an additional 20 UE1000 servers were required to support deployment of the Tivoli ® TME 10 enterprise management suite. The Tivoli software was costed at over $30,000 per management server, with an additional license cost of $350 per customer server to provide visibility, console management capability, applications management, and backup capability for the original 250 servers.

Network and systems operations staff would have been increased by a minimum of 8 persons per shift for a 24x7 operations facility (total 30 FTE, including managers and support staff). The total burdened salary for the current skills required for this service in this geographic area was in the range of $140-190K per year.

- ***Deployment - Building, Servers, Customer Activation***

  The proposed building deployment was estimated to take 5-7 months to acquire, build out, wire and equip a 10,000 square foot space. To deploy and manage the server environment, an estimated 30 FTE staff were required to build configure, and deploy systems. In addition to the full time employees, consulting services were required to impelement this solution. The cost for the consulting services was approximately $5,000,000. Once operational, the estimated time delay between a customer order and fulfillment of that order (systems ready to hand over to the customer) was 11 working days.

- ***Total 3-year Cost***

  The total estimated first year costs for the discrete system solution was estimated at $10,907,000 for Sun server hardware, $1,200,000 for Cisco LAN hardware, $585,000 for racks and cabling, $1,314,500 for management servers and software, an estimated $4,800,000 per year in salaries and $3,200,000 per year space rental. Cost of ownership for the first year would have been more than $28,000,000, with an ongoing cost exceeding $8,000,000 per year. The estimated total 3-year cost of this solution was $44,000,000.

Linux for S/390 Virtual Server Solution

To examine alternatives, the Telco hired a consulting firm to analyze the discrete solutions and provide some alternative solutions. One of the alternative solutions involved an S/390, VM/ESA and Linux for S/390. In the same categories shown above, the S/390 based solution offered superior price-performance and manageability at substantially lower cost. It was estimated that 400 MIPS of S/390 capacity and 3 Terabytes of disk space would be required to provide the same service as the distributed server solution. The S/390 G5 machine ran virtual machines with Linux for S/390 serving all system and support functions

for routing, WWW services, and other system management and configuration functions.

The sizing projection for the S/390 solution reflects an investment in scalability to grow the farm without additional investment for a period of time.

- ***Space Requirements***

  A S/390 G5 or G6 class CPU and IBM Enterprise Storage Server™ (sometimes referred to as a" Shark") disk cabinet consume approximately 400 square feet of space. As this system was capable of running all 750 virtual Linux servers in these two cabinets there were obvious physical space savings. This S/390 Enterprise Storage Server ("Shark") combination has the potential to support up to 40,000 virtual servers in the same floor space if necessary. Only 2 external racks were required to host the Cisco 7513 routers to connect the G5 to the incoming IP network. The G5 server and VM/ESA provided virtual system replacements for the LAN and server infrastructure, reducing the total cost of the network connection hardware required to $375,000 for Cisco routers and hardware. A S/390 G5 processor and disk subsystem was acquired on the used market for under $750,000. UPS was also required costing $135,000. All this equipment could be comfortably placed in the existing machine room. At the time the solution was designed, IBM had not yet announced, or made available, solutions that further improve the cost effectiveness of the S/390 solution. New introductions such as Integrated Facility for Linux engines for the S/390 that provide additional horsepower for Linux workloads at a substanstial reduction in price, and the more powerful zSeries 900 systems would likely have caused the customer to pursue new technology, available today, to support the production environment.

- ***Operations People and System Management Support Systems***

  The VM/ESA operating system provides many system management and resource control tools as integral components of the operating system. No additional management control servers or software tools were required for this solution. In addition, the telco was able to implement a resource accounting system to ensure that any customers not meeting their target performance goals were notified and prompted to upgrade their service. The

integrated nature of the VM based solution also allowed much of the configuration and performance management of the virtual Linux servers to be completely automated. Consequently this solution only required an incremental increase in the operations staff of 3 FTE.

- ***Deployment***

  The VM/ESA based solution provided tools that completely automated the deployment of the customer servers. These tools enabled the deployment of a fully operational service in 48 days with no additional in-house deployment staff required. The automation development required $465,000 of initial setup and consulting time, but no additional consulting time for maintenance and monitoring for following years due to modular design and flexibility of the VM programming tools and environment.

- ***Total 3-year Cost***

  The estimated cost to deploy and operate the S/390, VM/ESA and Linux for S/390 solution was $2,800,000 for the first year, and drops substantially in following years to $1.1 million/year. The time to profitability and long term cost of ownership advantages are substantial. The 3-year total cost of the S/390 solution was estimated at about $5,000,000.

- ***Time To Market***

  Coupled with the substantial cost savings for the S/390 based solution, we now turn to the competitive time to market advantage. In an Internet-driven world where "the competition is only a click away", the time to deploy and provide billable services is a measurable competitive advantage. Businesses undergoing the e-business transformation are often stunned by the new requirements for responsiveness and competitive edge that the new economy requires. In our example implementation, the time to market for the discrete solution was 11 days from payment to delivery. In the virtual server S/390 implementation, the automated approach means that the creation of a virtual server can be reduced to seconds. In the solution described above, a new customer can be configured and ready to use in approximately 90 seconds, per server—the time it takes to verify the customer's credit card. By

employing the virtual server technology present in VM/ESA, this type of automation and integration into customer provisioning systems is both simple and flexible – and sets the bar for the next generation of e-business.

Conclusion

Organizations entering the Internet-driven marketplace need to deploy new services quickly and provide very reliable services to distinguish themselves from the world-wide melee of competitors in the marketplace. The cost and time to market advantages provided by the S/390, VM/ESA and Linux for S/390 solutions provide a powerful and flexible alternative to traditional "server farm" solutions for businesses wanting the legendary reliability of the S/390 coupled with cutting-edge Internet technology. In addition, the same "virtual server" solution allows business value by allowing existing systems to be fully brought to bear on the same problems – there is no requirement to convert or replace existing systems with new, untested hardware or software solutions. Finally, the total operational cost of the environment is the most convincing argument for the S/390 solution – the solution optimizes resources, staff, and capabilities to provide the most powerful, reliable and flexible Internet solution available.

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