June 2009

MANAGEMENT BRIEF

VALUE PROPOSITION FOR IBM VIRTUALIZATION SOLUTIONS

Bottom Line Impact for Enterprise Infrastructures

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EXECUTIVE SUMMARY

Value Proposition

In many organizations, IT infrastructures are fundamentally inefficient. Decades of case-by-case deployments, uncoordinated platform choices and ad hoc upgrades to support growth have created high levels of fragmentation. Capacity is underutilized, quality of service experienced by users is increasingly problematic, and costs and risks are too high.

The IBM Dynamic Infrastructure initiative is designed to meet these challenges. It is a combination of programs, products and services designed to improve service to users, reduce costs and more effectively manage risk across all components of organizational IT infrastructures. It extends across the full range of IBM platforms and places a new focus on applying new technologies to all infrastructure resources.

One of the most critical technologies in IBM's Dynamic Infrastructure strategy is virtualization. IBM is an industry leader in server as well as storage virtualization.

A key – and unique – IBM advantage has been that the company has been able to draw upon mainframe technologies. Virtualization originated on mainframe systems in the 1970s, and the IBM System z continues to offer the IT world's most mature and stable virtualization architecture.

Key mainframe virtualization capabilities, however, have been progressively transferred to other IBM platforms. Power, System x and BladeCenter servers all draw upon mainframe virtualization strengths.

IBM has also been one of the earliest and most effective supporters of x86 server virtualization solutions offered by VMware, Microsoft, Citrix and others. The company has invested heavily in optimizing and supporting all of these.

This report is about the benefits that IBM virtualization solutions can deliver to large as well as midsize organizations. Specifically, it looks at the potential bottom-line impact of these. Two examples presented in this report demonstrate a wide range of potential savings in server and storage costs, and in middleware and personnel costs associated with these.

In a large financial services company, effective deployment of IBM virtualization solutions is shown to reduce five-year costs of ownership for x86, UNIX server and disk storage infrastructures by 53 percent; i.e., costs are more than halved. In a midsize manufacturing company, costs of ownership are reduced by 44 percent.

Infrastructure Economics

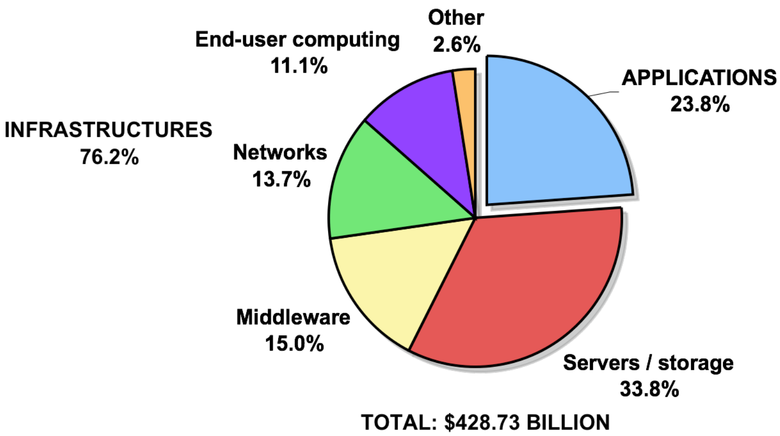
A key conclusion may be drawn. Virtualization should be pursued as a central component of broader strategies to improve the cost-effectiveness of organizational system infrastructures. The larger business value of such strategies may be simply demonstrated.

The business contribution of IT expenditure has been the subject of growing debate since the late 1990s. Business executives, consultants and analysts have long been frustrated by their inability to relate overall IT expenditure to business performance. Some have argued, "IT doesn't matter."

The issue, however, may be not the overall level of IT expenditure, but rather the way in which it is distributed. A strong case can be made that spending on underlying infrastructures has come to dominate IT budgets. This has occurred to the extent that, in many organizations, investment in new application capabilities has become entirely inadequate.

If IT expenditure is broken out into infrastructures and applications, the nature of the problem becomes apparent. Figure 1 shows 2008 IT expenditure by Fortune 1000 companies using these categories.

Figure 1
IT Expenditure on Infrastructures and Applications by Fortune 1000 Companies in 2008



Source: International Technology Group

Infrastructure costs include hardware acquisition and maintenance, licenses and support for all software except applications, facilities costs including data center occupancy, power and cooling, and system management personnel costs.

In 2008, more than three quarters of IT expenditure was on infrastructures. Of this, the single largest component was servers and storage.

It is difficult to resist the conclusion that a fundamental misalignment has developed between business requirements and the manner in which overall IT resources are allocated.

Users interact with, and business processes are enabled by applications. They are the direct source of business value. Underlying server, storage, middleware and network resources are merely the delivery mechanisms for these. Their contribution to business value is indirect. Yet, resources have been progressively diverted from applications to infrastructures.

One of the main drivers of this process has been fragmentation of server, storage and network infrastructures. This process has been most visible for x86 server bases, but has also extended to UNIX servers and storage systems. Low levels of capacity utilization and high administration overhead and energy costs have become pervasive.

More than any other technology or technique available in the IT world today, virtualization offers the potential to reverse this situation. Which means that there is an opportunity not only to realize short-term cost savings, but also to fundamentally increase the value that IT expenditure brings to businesses.

An effective organization-wide virtualization strategy could enable the average Fortune 1000 corporation to release from 10 to 15 percent of its total IT expenditure for investment in new initiatives. Expenditure on high-impact application initiatives with high business yields could be increased by wide margins. The bottom-line business impact would clearly be substantial.

Proof of Concept

General Approach

As a "proof of concept" of the potential bottom-line impact of virtualization, two composite profiles were developed for this report using data supplied by 26 companies in the same industries and approximate size ranges, with generally similar business profiles.

Input was obtained on applications, existing server and storage bases, staffing levels for system administration and related functions, and other variables for x86 and UNIX servers, and for disk storage systems. Using this data, two sets of scenarios were constructed:

1. ***Conventional scenarios*** represent existing IT environments within companies and are based on user-reported data. Scenarios include diverse multivendor bases of x86 and UNIX servers and disk systems.
2. ***IBM virtualized scenarios*** are for the same applications and workloads deployed on current-generation IBM System x and BladeCenter servers exploiting the full potential of VMware and equivalents (x86 servers); IBM POWER6-based Power servers exploiting the full potential of IBM PowerVM (UNIX servers); and IBM disk systems exploiting the full potential of SVC.

Five-year costs for hardware, maintenance, systems and database software, personnel for system or storage administration and related tasks, and facilities were then calculated for each scenario.

Systems software costs for server scenarios include licenses and five-year support for operating systems, system management tools and, where appropriate, virtualization software. Database software costs include five-year support and, where appropriate, new license costs for Microsoft SQL Server (x86 server scenarios) and Oracle (UNIX server scenarios).

Systems software costs for disk storage scenarios include operating systems, storage management and, where appropriate, point-in-time copy, remote replication, host access and other software.

Server and storage costs were calculated using "street" prices (i.e., discounted prices paid by users). Personnel costs were calculated based on prevailing annual salaries for UNIX, Windows and Linux system administrators; and storage administrators.

Facilities cost calculations include data center occupancy, power and cooling equipment, and energy consumption. Costs for power and cooling equipment were calculated using discounted acquisition and maintenance prices for leading vendor offerings. Energy costs were calculated using a conservative assumption for average price per kilowatt/hour.

All costs are for the United States.

Financial Services Company

This profile is of a diversified retail bank with approximately $400 billion in assets, $15 billion in revenues and more than 1,600 branches. It employs around 55,000 people.

Scenarios for this company are as follows:

- ***Conventional scenarios***. At the beginning of the five-year cost measurement period, conventional scenarios include 3,852 x86 and 242 UNIX servers. x86 servers include a variety of models from Dell, HP, IBM, Sun and others, while UNIX servers include the platforms shown in figure 2.

Figure 2

UNIX Server Conventional Scenario: Platforms

SUN MICROSYSTEMS	HEWLETT-PACKARD	OTHER PLATFORMS
E25K, E6800, E4900, E4800, E2900, M4000, V890, V880, V490, V480, V40Z, X4600, X4500, X4200, X4100, X2000, Blade 6000, various	Superdome, rx8640, rx8620, rx7620, rx6600, rx4640, rx3600, rx2660, rx2620, rp8420, rp8400	IBM pSeries 690, 670, 650, 615, System p 570, 550, 520, 510, 505, Power 570, BladeCenter Silicon Graphics Altix 450
Total: 158 servers	Total: 41 servers	Total: 43 servers

The conventional disk storage scenario includes 1,488 terabytes (TB) of centralized and distributed disk storage. Disk systems include Dell, EMC, HP, Hitachi, IBM and Sun platforms.

Conventional scenarios correspond to the server and storage environments found in many large organizations today. There is no coordinated strategy for server or storage virtualization.

- ***IBM virtualized scenarios***. In these, beginning of period totals are reduced to 1,431 System x and BladeCenter servers, and 43 Power servers ranging from dual-core blades to 32-way Power 570 models. Disk storage includes 768 TB of IBM DS8000 and DS5000 physical disk system capacity in SVC environments.

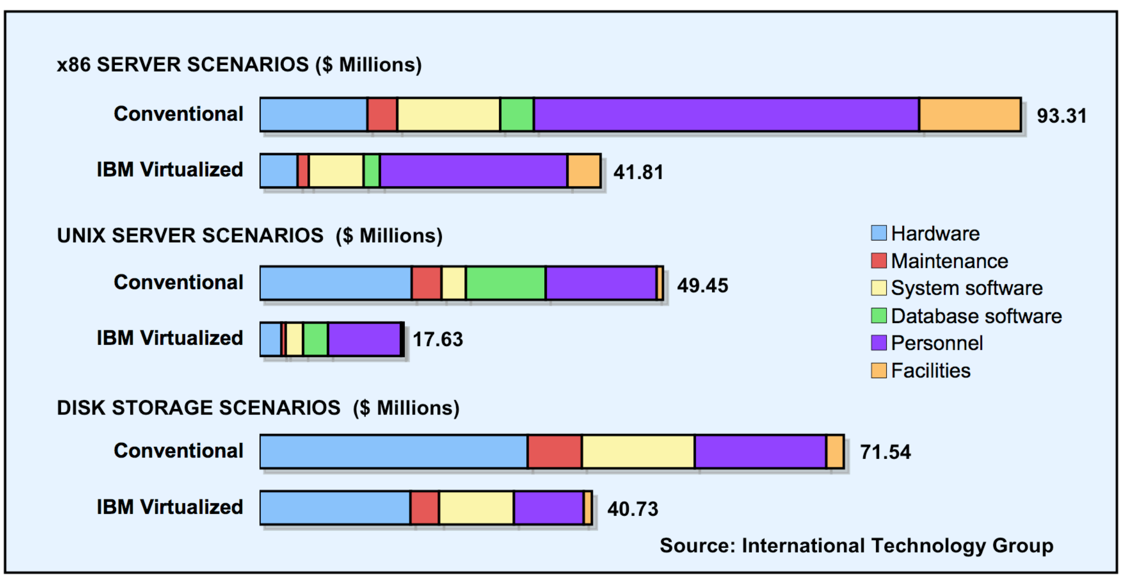
  In these scenarios, an effective virtualization strategy has been put in place across organizational server and storage bases.

For both sets of scenarios, allowance is made for capacity growth over the measurement period, with the result that end-of-period totals are higher. This is particularly the case for disk storage capacity.

Five-year costs for these scenarios are summarized in figure 3.

Figure 3

Five-year Cost Comparisons for Conventional and IBM Virtualized Scenarios: Financial Services Company

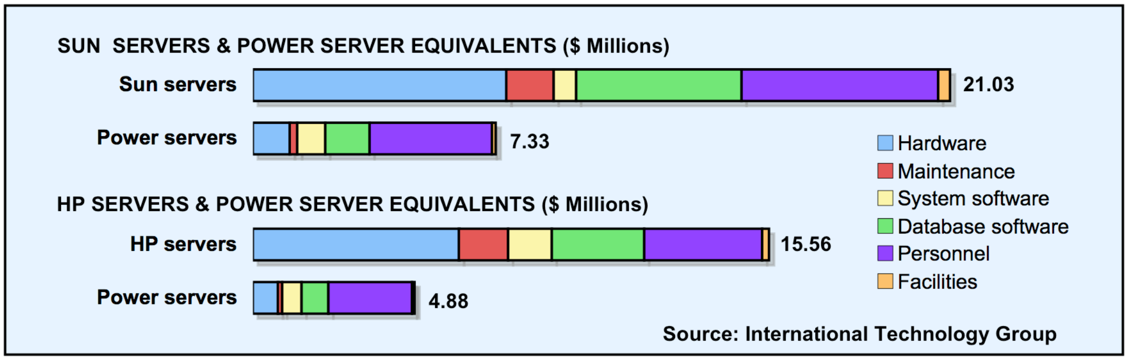


Five-year costs for IBM virtualized scenarios are 55 percent lower than conventional equivalents for x86 servers, 64 percent lower for UNIX servers, and 43 percent lower for disk systems.

There are a number of variations in comparative costs between platforms. For UNIX servers, five-year costs for Power servers in IBM virtualized scenarios were 65 percent lower than for Sun servers, and 69 percent lower than for HP servers in conventional scenarios. These costs are broken out in figure 4.

Figure 4

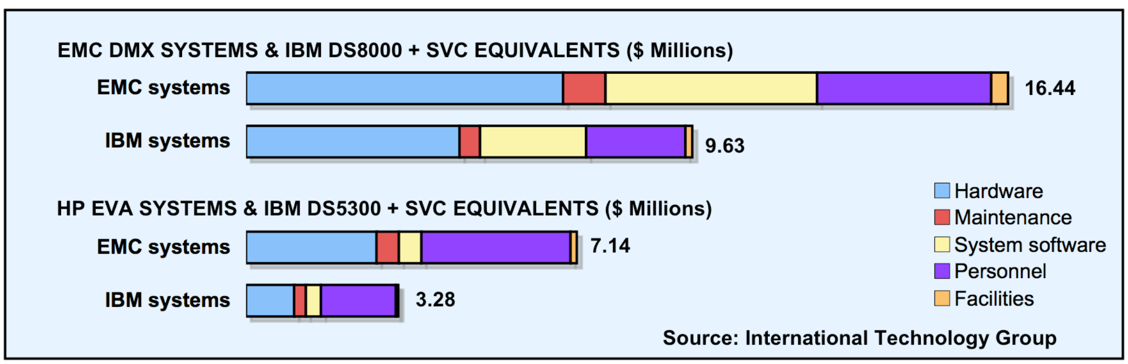
Five-year Cost Comparisons for Conventional and IBM Virtualized Scenarios: Financial Services Company – UNIX Server Breakouts



For high-end disk storage, five-year costs for IBM DS8000 systems and SVC in IBM virtualized scenarios were 41 percent lower than for EMC DMX equivalents. For midrange disk storage, costs for IBM DS5000 systems and SVC were 54 percent lower than for HP Enterprise Virtual Array (EVA) equivalents. These costs are broken out in figure 5.

Figure 5

Five-year Cost Comparisons for Conventional and IBM Virtualized Scenarios: Financial Services Company – Disk Systems Breakouts



IBM virtualized scenarios for both companies assume that organizations apply best practice techniques in configuring servers and disk systems to take advantage of the potential of virtualization, and in managing VMware, PowerVM and SVC environments.

Manufacturing Company

This profile is of a discrete manufacturing company with approximately with $800 million in revenues and around 3,000 employees.

The company's core enterprise resource planning (ERP) and supply chain management (SCM) systems are deployed on UNIX servers. A variety of Windows applications are deployed on x86 servers.

Scenarios for the manufacturing company are as follows:

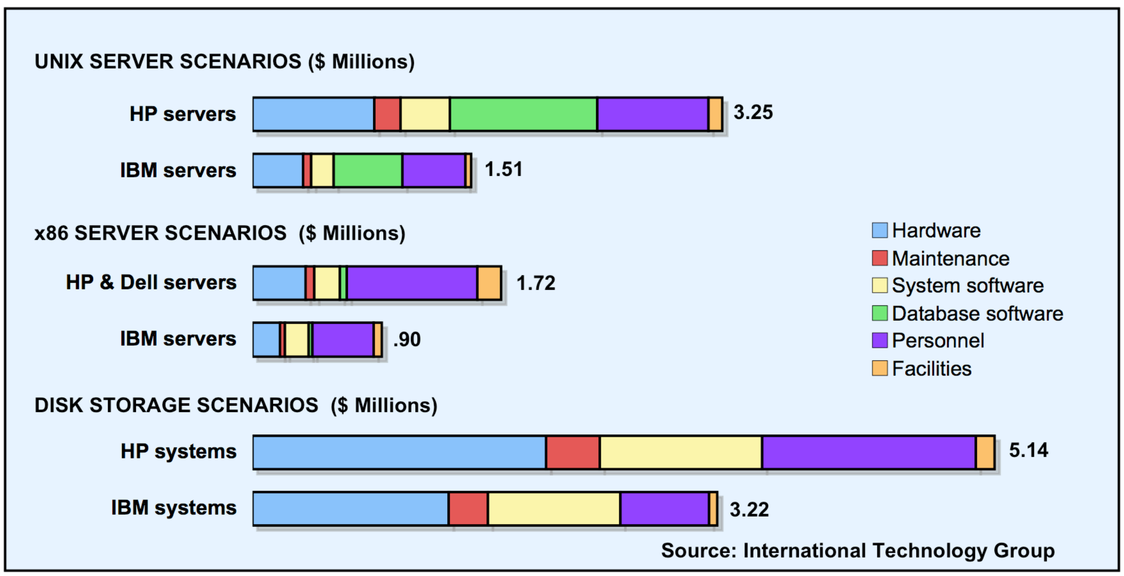
- ***Conventional scenarios***. At the beginning of the five-year cost measurement period, conventional scenarios include 7 Hewlett-Packard Integrity and 9000 UNIX servers, and 63 Dell PowerEdge and HP ProLiant x86 servers. The conventional disk storage scenario includes 83.4 TB of physical disk capacity on HP EVA systems.
- ***IBM virtualized scenarios***. In these, beginning of period totals include 3 Power 550 and 520 servers, 29 System x and BladeCenter servers, and SVC-enabled DS5300 disk systems with 38.4 TB of physical disk capacity.

For both scenarios, allowance is again made for server as well as storage capacity growth over the measurement period.

Five-year costs for IBM virtualized scenarios are 48 percent lower than conventional equivalents for x86 servers, 53 percent lower for UNIX servers and 37 percent lower for disk systems. Combined costs are 44 percent lower.

These results are summarized in figure 6.

Figure 6
Five-year Cost Comparisons for Conventional and IBM Virtualized Scenarios: Manufacturing Company



In IBM virtualized scenarios, lower UNIX server costs are due to higher levels of consolidation for multiple system images enabled by PowerVM technology. More granular partitioning, as well as superior Power server performance, means that the same workloads are handled by fewer, smaller servers.

Lower x86 server costs reflect the scalability and performance strengths of IBM X-Architecture servers, which enable these to support larger numbers of VMware images than HP and Dell platforms. More effective System x and BladeCenter management features, as well as higher levels of energy efficiency also translate into lower personnel and facilities costs respectively.

Lower disk storage costs for IBM virtualized scenarios are due to use of SVC, which more than halves the amount of physical disk storage required, as well as to industry-leading DS5300 performance.

Positioning IBM

The potential benefits of enterprise-scale virtualization are diverse. Organizations have realized not only cost savings, but also increased flexibility of provisioning (virtual resources can be deployed more rapidly and easily than physical systems), improved availability, more effective backup, recovery and security of data, and other benefits.

The server and storage environments that must be addressed in most organizations are even more diverse. At the end of 2008, for example, the average Fortune 1000 corporation contained more than 4,800 x86 and UNIX servers running a variety of operating systems, databases and tools.

The same corporation also had mainframes, midrange systems and almost 300 TB of server disk storage capacity on centralized and distributed platforms, employing multiple disk technologies and media types.

In larger organizations, all of these numbers may be significantly greater. Even midsize businesses must deal with multivendor installations and levels of technological diversity that have increased dramatically during the last decade and will continue to increase in the future.

No single virtualization solution can meet all requirements. It will be necessary to employ multiple solutions. It will also be necessary to put facilities in place that can manage each of these effectively, while allowing for integrated management of physical and virtualized resources at the enterprise level.

The IBM offerings described in this document meet these requirements. They include industry-leading capabilities for UNIX and x86 server virtualization; SVC, the most widely-used, highest-performing storage virtualization solution; and a set of server, storage and enterprise management facilities whose interoperability and functional breadth are unrivalled by any other vendor.

Although many server and storage vendors offer virtualization capabilities, or support third-party solutions such as VMware, few have developed and implemented a coordinated virtualization strategy across all of their platforms. IBM has done so. Virtualization enjoys a strategic focus in IBM platform strategy that is significantly greater than that of any competitor.

The list of vendors who can meet the full range of virtualization requirements is very short. IBM clearly stands at the top of this list.

IBM VIRTUALIZATION SOLUTIONS

Power Servers

Power Virtualization

The IBM Power server platform is the market share leader in UNIX servers. It is also the recognized industry leader in performance – according to most industry benchmarks, Power servers outperform HP Integrity and Sun SPARC64 platforms with the same number of cores by two to three times – as well as in availability, security, energy efficiency and other areas.

Virtualization capabilities for Power servers are implemented through the firmware-based PowerVM offering and through functions built into hardware and the IBM AIX and i operating systems. Red Hat and SUSE Linux are also supported on this platform. More than 80 percent of latest-generation POWER6-based Power servers are shipped with PowerVM enabled.

PowerVM capabilities include two complementary forms of partitioning:

1. Firmware-based ***Logical Partitions (LPARs)*** are a mainframe-derived "hard" partitioning technology that can be configured in increments as small as 1/100th of a processor core. Up to 254 LPARs are supported on a single physical Power server.

   Since 2001, users of the Power platform and its predecessors have employed LPARs to support even large-scale, business-critical production systems. They are widely used to support SAP, PeopleSoft, Oracle E-Business Suite, JD Edwards, Infor and other leading ERP systems, as well as a wide range of other transactional and business intelligence solutions.

   LPARs are supported by industry-leading system and workload management functions built into the Power platform, PowerVM and AIX software.

   Resources may be allocated and reallocated between partitions in response to changing workload demands. Control mechanisms ensure that priority systems do not experience bottlenecks. For LPARs, the system evaluates utilization every 10 milliseconds, and may change resource allocations as rapidly.

   Power servers also support use of Virtual I/O Servers, which allow LPARs to share I/O adapters. This approach, which has also been widely adopted by Power server users, may significantly reduce the number of local area network (LAN) and storage area network (SAN) adapters required to support large virtualized configurations.

2. Software-based ***Workload Partitions (WPARs***) allow users to create multiple software-based partitions within a single AIX instance. WPARs run within LPARs. Up to 3,000 WPARs per LPAR are supported.

   WPARs provide additional flexibility and capacity utilization improvements, and simplify patching and other operating system maintenance tasks. They are typically employed for lighter-duty production applications as well as for development, test and other non-production instances.

   Extensive management capabilities are provided by the WPAR Manager component of AIX.

Power partitioning mechanisms are tightly integrated with system and workload management capabilities built into firmware and software. The implications are important.

Partitioning creates the potential for high levels of capacity utilization. The extent to which this will occur in practice, however, depends heavily on the mechanisms that allocate system resources between, and monitor and control workload execution processes across partitions. If these mechanisms are ineffective, a high proportion of system capacity may be idle at any given time.

Close integration of partitioning and workload management capabilities also minimizes the risk that surges in workloads running in individual partitions will impact performance and availability. This makes it possible to use Power partitions even for highly business-critical applications.

Competitive Platforms

HP and Sun also offer partitioning options. Hard partitioning capabilities include HP nPartitions (nPars), which are supported on the company's Integrity platform, and Dynamic Domains, which are supported on Sun SPARC64-based M series servers. However, these are built around cell board (HP's term) or System Board (Sun's term) structures and offer significantly less granularity.

nPars may be configured only in increments of four processors (eight cores). Dynamic Domains can be configured in increments of one System Board with four processors (16 cores using quad-core SPARC64 processors), or one-quarter of a System Board with one processor (4 cores), along with one quarter of the board's memory and I/O resources.

As LPARs can be configured in increments as small as 1/100th of a processor core, the result is a level of hard partitioning granularity up to 400 or 800 times greater than for HP and Sun equivalents respectively. Figure 7 shows these disparities.

Figure 7
Minimum Hard Partition Sizes: HP, IBM Power and Sun Technologies

HP INTEGRITY	SUN M SERIES	IBM POWER
nPars – 8 cores	Dynamic Domains – 4 to 16 cores (quad-core SPARC64 processors)	LPARs – 1/100th core

A further limitation of the HP and Sun approaches is that the number of hard partitions that may be supported on a single physical server is limited. Even on the largest HP Superdome models, only 16 nPars are supported, and on high-end Sun M9000 servers, only 24 Dynamic Domains are supported. Moreover, nPars and Dynamic Domains are not supported on smaller HP Integrity or Sun M series models.

Figure 8 shows these limitations.

Figure 8
Numbers of Hard Partitions Supported: HP and Sun UNIX Server Platforms

HEWLETT-PACKARD					
Model	**rx2660 rx3600**	**rx6600**	**rx7640**	**rx8640**	**Superdome**
Processors	1 – 2	1 – 4	1 – 8	1 – 16	1 – 64
nPars	n/a	n/a	1 – 2	1 – 4	1 – 16
SUN MICROSYSTEMS					
Model	**M3000**	**M4000**	**M5000**	**M8000**	**M9000**
Processors	1	1 – 4	1 – 8	1 – 16	1 – 64
Dynamic Domains	n/a	1 – 2	1 – 4	1 – 16	1 – 24

In comparison, up to 254 LPARs may be employed on all Power server models, including blades.

HP and Sun servers also support software-based partitioning. HP vPars are supported on the same Integrity models as nPars, while Integrity Virtual Machines are supported on all models. Sun Logical Domains are supported on the company's T series CoolThreads servers.

The granularity of these is, however, again significantly less than for WPARs. Figure 9 summarizes minimum partition sizes for these technologies.

Figure 9
Minimum Software-based Partition Sizes: HP, IBM and Sun Technologies

HP INTEGRITY	SUN MICROSYSTEMS	IBM
vPars – 1 core Integrity Virtual Machines – 1/20th core	Logical Domains – 1/8th core (T series servers only) Solaris Containers – No limit	WPARs – No limit

Sun Solaris Containers is a software-based partitioning method that enables users to create multiple application-specific partitions with single instances of the Solaris operating system; i.e., it is functionally similar to IBM WPARs. Neither technology has a specific size limit.

Partition granularity has emerged as an increasingly significant factor in server deployment flexibility and costs. Higher levels of granularity enable greater consolidation of small system and application instances. Power server users, for example, routinely configure 20 to 50 LPARs on a single physical platform, and some have deployed up to 100.

Sub-core granularity has grown increasingly important as processors have become more powerful. Partitions of 0.1 of a core or less are increasingly common in many organizations, and next-generation processors will reinforce this trend.

High levels of granularity can be achieved with HP and Sun software-based partitions. However, hard partitioning remains the norm for production systems of all types. While software-based techniques may also be found in production environments, they are typically used for light-duty, non-critical applications.

From this perspective, Power LPAR granularity represents a major differentiator compared not only with HP and Sun UNIX servers, but also with x86 server virtualization tools such as VMware that offer only software-based partitioning.

Integration of system and workload management capabilities is also significantly more advanced in Power virtualization architecture than is the case for HP, Sun and x86 equivalents.

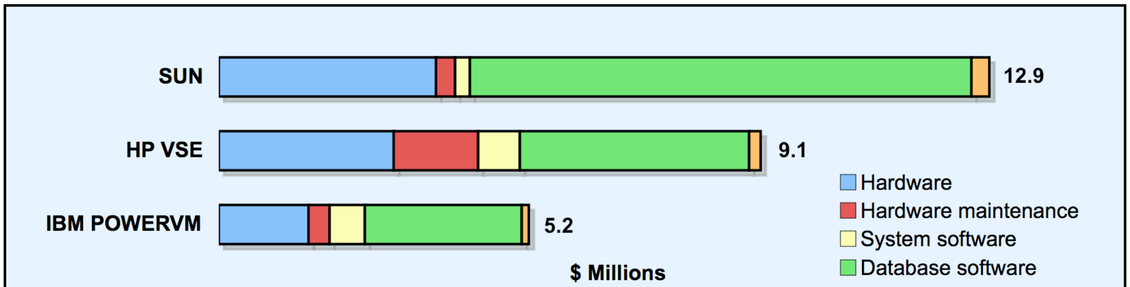
Comparative Costs

The Power platform's combination of more powerful processors and higher partition granularity has a major cost impact. A recent study by the authors of this report found, for example, that five-year costs for major UNIX system deployments averaged 43 percent and 60 percent less for use of Power servers than for HP and Sun equivalents respectively.

Comparisons were between Power servers equipped with PowerVM; HP Integrity servers employing nPars, vPars and Integrity Virtual Machines; and Sun M and T series servers employing Dynamic Domains, Logical Domains and Solaris Containers.

Figure 10 illustrates these results, which are for major deployments of heavily virtualized, database-intensive systems in large and midsize organizations.

Figure 10
Average Five-year Costs for HP, IBM and Sun UNIX Servers for Major System Deployments



Source: International Technology Group

Costs include Oracle databases. As Oracle prices on a per processor basis, the smaller numbers of cores in Power database server configurations translated into a significant cost advantage. This would also be the case for other vendor software offerings priced in the same manner.

System x and BladeCenter

IBM has supported VMware, Microsoft Virtual Server and Hyper-V, and Xen, since these first appeared, on its System x and BladeCenter platforms.

Support for third-party solutions, however, does not translate into a lack of differentiation. Two sets of IBM System x and BladeCenter capabilities are particularly significant for users of VMware and equivalents. These are:

1. ***X-Architecture***. This is an Intel Xeon-based server design, currently in its fourth generation, that is optimized for high levels of system-wide performance and scalability. The design, which is based in part upon IBM mainframe architecture, enables servers to scale in a manner that maximizes not only processor, but also memory and I/O performance.

   Latest-generation X-Architecture servers include the x3850 M2, which may be configured with up to 4 Intel Xeon processors, and the x3950 M2, which may be configured with up to 16, for totals of 24 and 96 cores respectively using six-core processors. IBM is the only first-tier x86 server vendor to offer a Xeon-based platform that scales beyond four processors.

2. ***Availability optimization***. System x and BladeCenter servers benefit from reliability, availability and serviceability features that are more sophisticated and effective than those of any other x86 server platform.

   Capabilities include high levels of component reliability and redundancy; hot-add and hot-swap functions (i.e., the ability to add or replace components without taking servers offline); extensive diagnostic, and fault isolation and resolution facilities; Predictive Failure Analysis, which reduces risks of unplanned outages; and 24x7 electronic service coverage.

These capabilities provide value for a wide range of applications. They are, however, particularly important for organizations seeking to consolidate x86 servers.

X-Architecture servers enable higher levels of consolidation than may be realized with conventional x86 platforms. Between 50 and 100 virtual instances have been routinely deployed on these platforms and, in some cases, the number has been in the 100 to 200 range. Eight- and 16-way x3950 models have proved particularly popular for VMware consolidation.

Server consolidation also increases vulnerability to outages, because "more eggs are in fewer baskets." A server failure may disable multiple applications, and impact multiple business operations and user groups. The availability optimization strengths of System x and BladeCenter servers enable organizations to materially reduce the risks that would otherwise accompany consolidation.

A further differentiator for System x and BladeCenter servers is the Systems Director 6.1 management solution. Systems Director 6.1 provides system management capabilities for physical servers, as well as for VMware, Microsoft and Xen virtual resources.

In addition, the x3950 M2 is offered with an embedded hypervisor capability based on VMware ESXi. Virtualized applications can be deployed "out of the box"; i.e., without server modifications.

SAN Volume Controller

At yearend 2003, the average U.S. Fortune 500 corporation contained around 20 TB of server disk capacity on all platforms. By yearend 2008, this had increased to around 295 TB. On current trends, it will exceed 2,400 TB (2.4 petabytes) by the end of 2013.

Although growth rates vary between industries and applications, there are few organizations of any size that are not experiencing rapid expansion of storage volumes. This will clearly continue. In some cases, the increase over the next five years may be by orders of magnitude.

Disk storage growth rates are significantly higher than for server populations, and the case for enterprise-level virtualization initiatives is correspondingly stronger. Piecemeal deployments of virtualization solutions will be rapidly overwhelmed by growth elsewhere in organizations.

Although a variety of storage virtualization hardware and software products have appeared over the last decade, most cannot realistically be characterized as "enterprise-level" solutions. SVC is an exception.

Introduced in 2003, SVC is – by a wide margin – the world's most widely used storage virtualization enabler. At the time of writing, more than 5,000 systems and 12,000 nodes were installed worldwide, representing a total virtualized capacity of around 20,000 TB.

SVC installations range from two nodes to more than 20 nodes (controller-based nodes are configured in clustered pairs for availability purposes), and from 2 TB to more than 500 TB. The maximum limit for a single node is eight petabytes. Users range from Fortune 50 corporations supporting hundreds of terabytes to midsize businesses with fewer than 1,000 employees supporting less than ten terabytes.

Users of earlier SVC versions have routinely achieved increases in disk capacity utilization of two to three times, in some cases reaching levels of over 85 percent. The latest SVC release, 4.3, implements further efficiency improvements in areas such as thin disk provisioning (Space Efficient Virtual Disks) and space utilization for copying (Space-Efficient FlashCopy).

SVC may be used with more than 200 disk systems, including the principal offerings of IBM, EMC, Fujitsu, Hitachi Data Systems (HDS), HP, NetApp, Sun and others. It also supports more than 40 operating systems, along with a wide range of SAN switches, software tools and interface standards.

An SVC configuration achieved performance of close to 275,000 Input/Output Operations Per Second (IOPS) for the SPC-1 benchmark controlled by the Storage Performance Council (SPC), the industry's leading consortium for storage system performance measurement.

This was, as figure 11 shows, the second highest SPC-1 performance ever recorded by the council.

Figure 11
SVC and Competitive SPC-1 Benchmark Results

System	Accepted	Disks	IOPS
TMS RamSan 400	2008-01-25	N/A	291,209
IBM SVC 4.3	2008-10-15	1,536	274,997
IBM SVC 4.2	2008-07-12	1,536	272,505
3PAR InServ T800	2008-09-02	1,280	224,989
HDS USP V	2007-10-01	1,024	200,245
HP StorageWorks X24000*	2007-10-01	1,024	200,245
Sun StorageTek 999OV*	2007-10-01	1,024	200,245
IBM SVC 3.1	2005-10-25	672	155,519
IBM DS8300 Turbo	2006-12-05	512	123,033
Fujitsu ETERNUS8000	2007-08-20	640	115,090

*OEM version of HDS USP V
Source: Storage Performance Council

The highest SPC-1 benchmark result was recorded for the Texas Memory Systems RamSan 400, which employs solid-state memory. It is used primarily for high-end compute-intensive applications.

IBM has indicated, however, that it will provide support for up to 2.4 TB of solid-state storage for SVC. According to the company, SVC performance with this capability will be around 800,000 IOPS, which would be significantly higher than the RamSan-400 record.

The latest SVC result, which was obtained using SVC controllers and IBM DS4700 disk systems, continues an established tradition. In SPC-1 tests, SVC has consistently outperformed disk systems offered by 3PAR, HDS, HP, NetApp, Sun and others. EMC has not participated in SPC tests since 2000.

System z

The System z implements the industry's longest-established and most highly developed virtualization architecture. z/VM and its predecessors have hosted mainframe operating system guests since the 1970s, and LPAR capability has been widely employed since it was first introduced in 1988.

Since the late 1990s, the use of z/VM has expanded to include support for Linux guests. To date, more than 1,300 System z customers have employed this capability to deploy new Linux applications, as well as to consolidate existing x86 server bases. More than 2,500 applications have been written or migrated to run on SUSE, Red Hat and other Linux variants on System z.

Linux guests may be hosted on System z platforms using LPARs or Integrated Facilities for Linux (IFLs), which are dedicated processors.

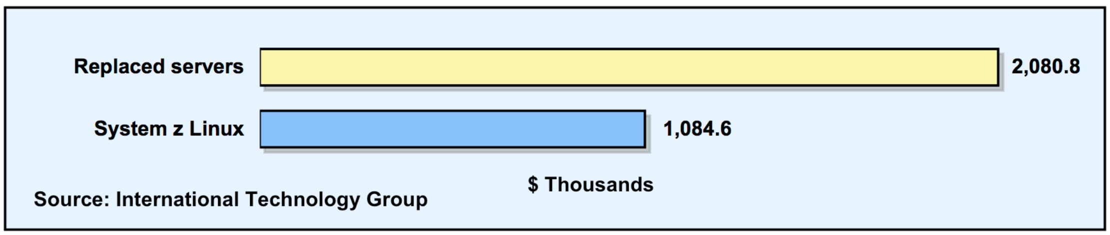
The current System z high-end platform, the z10 Enterprise Class (EC), supports up to 64 IFLs. The z10 Business Class (BC), which is designed for midsize businesses, supports up to 10 IFLs. Depending on applications and workloads, z10 EC systems can support between 1,000 and 10,000, and z10 BC systems can support between 150 and 1,500 Linux virtual servers on a single physical platform.

Organizations that have consolidated x86 servers using System z Linux have reported a variety of benefits. Guest applications benefit from the industry-leading availability, security and disaster recovery strengths of the System z platform.

Major savings have also typically been realized in personnel – full time equivalent (FTE) system administration staffing is significantly lower than for distributed x86 server installations – as well as in energy costs.

A recent study of the results of System z server consolidation initiatives by the authors of this report documented system administration savings. It was found that FTE staffing levels and corresponding three-year personnel costs for System z Linux installations averaged 48 percent less than for distributed environments. Figure 12 summarizes these results.

Figure 12
Three-year System Administration Costs for x86 and System z Linux Server Installations



Organizations had replaced between 50 and 450 Windows, Linux and Sun Solaris servers using up to six IFLs. Savings may be greater when larger numbers of servers are consolidated.

For existing System z users, the addition of Linux virtualization capability has also proved economically attractive in other ways. IBM's pricing model for IFLs is, for example, a great deal more aggressive than for conventional processors.

Organizations have also found that existing System z infrastructures and skill bases can often be leveraged for comparatively low incremental costs. Existing System z platforms are supported by disk and tape storage systems, networks and communications facilities, and power and cooling infrastructures that can expand to handle new Linux workloads.

Existing backup and recovery mechanisms, failover clusters, and operations support systems and processes can typically be extended to cover IFLs. Existing System z specialists in system and storage management, backup and recovery, operations, and other data disciplines can also typically handle these tasks for IFLs as well as for z/OS systems.

Management Solutions

New Proliferation Challenges

Discussions of the benefits of virtualization often focus on the advantages of reducing numbers of physical servers and disk systems. Physical consolidation may yield important benefits. But organizations have also found that rapid growth in numbers of virtual images creates new management challenges.

At the end of 2008, the average Fortune 1000 corporation contained around 4,200 physical x86 servers. If current trends continue, by the end of 2013, the same organization will contain more than 6,000 physical x86 servers – growth in physical bases is expected to continue, albeit at a slower rate – and between 5,000 and 10,000 virtual x86 servers.

Similar trends can be expected for UNIX servers and disk storage. In all three areas, it is a great deal easier and faster to create virtual resources than to acquire, install and activate physical systems. Organizations will be faced with new, potentially even less controllable, forms of proliferation. They will also be faced with the need to integrate management of physical and virtual resources in new ways.

Early virtualization adopters often failed to plan for these effects. Management challenges were not apparent, or were easily dealt with for small-scale projects. As virtualization came into widespread use, however, the picture changed. Initial momentum was often lost as new management complexities emerged, and it was realized that major new investments in tools, skills and practices were required.

Experience has shown that, at the enterprise level, realizing the benefits of virtualization is not a simple or inexpensive process. But challenges may be materially reduced if effective management infrastructures are put in place at an early stage.

Vendors and Tools

The field of management vendors and tools is fragmented. For x86 servers, organizations typically employ basic server management packages such as Dell OpenManage, HP Systems Insight Manager and IBM Director, along with a plethora of tools from Microsoft, VMware and others. For UNIX servers and storage systems, vendor- and platform-specific solutions are the norm.

At the enterprise level, broader suites of service management solutions are offered by vendors such as BMC Software, CA (formerly Computer Associates), HP (Business Technology Optimization solutions) and IBM (Tivoli solutions). These tend, however, to be employed to manage centralized computing environments supporting business-critical systems rather than distributed server and storage bases.

The result is often a collection of management silos built around diverse sets of tools with, at best, limited integration and interoperability across IT infrastructures. Moreover, tools of choice are not designed to manage virtualized resources, which have emerged on the IT scene only recently.

It is unlikely that a single management solution could be employed to deal with the challenges of the virtualized enterprise. IT environments are too diverse and, in most organizations, it would be difficult to impose common operating structures and practices. A more realistic approach would be to standardize on multiple, compatible solutions that could be progressively integrated at the enterprise level.

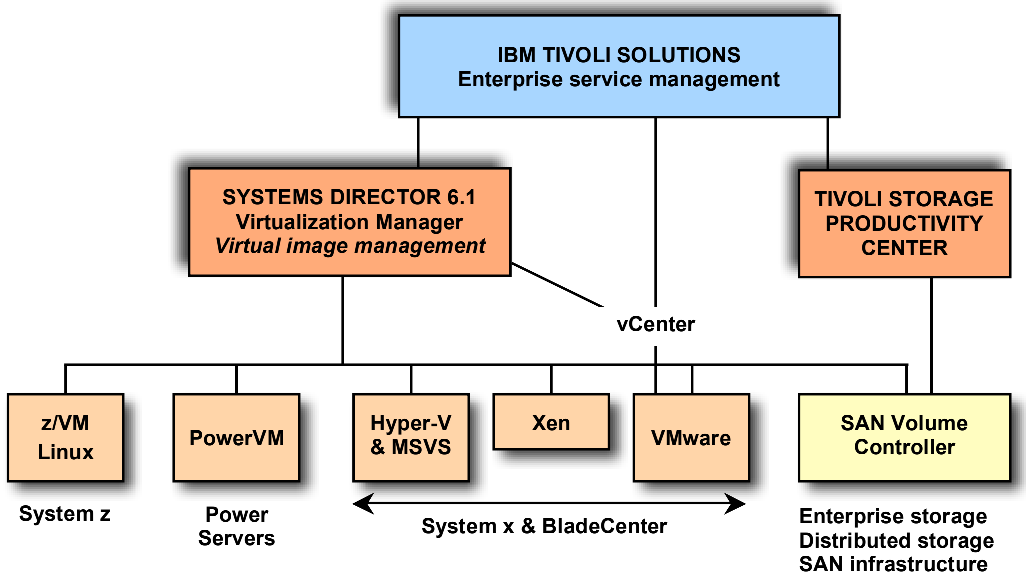
Which is what IBM offers.

IBM Solutions

The three principal IBM management offerings – Systems Director 6.1, Tivoli Storage Productivity Center (TPC) and the IBM Tivoli portfolio – provide a unified enterprise management solution set, illustrated in figure 13.

This solution set fully supports all of the IBM platform virtualization solutions described in this report. Interfaces are also provided to VMware vCenter Server (formerly VirtualCenter).

Figure 13
IBM Enterprise Management Solution Set



Distributed disk systems and SAN infrastructures may be managed through IBM Systems Director 6.1 or TPC, which supports the full range of IBM disk systems along with many non-IBM equivalents. Non-IBM systems may also be managed by Tivoli solutions.

Systems Director 6.1

Introduced in 2008, Systems Director 6.1 is the principal IBM solution for management of the company's distributed server and storage platforms.

Systems Director 6.1 provides a broad range of discovery, monitoring and management functions for Power, System x and BladeCenter servers (it supports all of the major operating systems that run on these platforms), along with IBM midrange and small disk systems, RAID controllers and other devices.

Unlike the earlier IBM Director product, which it has replaced, Systems Director 6.1 was designed "from the ground up" to manage virtual and physical resources. It supports the full range of PowerVM, VMware ESX, Microsoft Virtual Server (MSVS) and Hyper-V, and Xen virtual resources as well as SVC-enabled distributed disk systems and z/VM Linux guests.

A key role is played by the Virtualization Manager component of System Director, which provides lifecycle management services for supported virtual resources. Services include creation, editing, relocation and deletion of these, along with status tracking, alert processing and creation of automated event response plans.

IBM has also announced plans to add virtual image management capability. According to the company, this will automate cloning, capturing, customizing and deployment of PowerVM, VMware ESX and Xen virtual system images across organizational server bases. Future support for z/VM Linux guests is also expected.

Systems Director 6.1 interfaces to Tivoli solutions through IBM Tivoli Monitoring (ITM). ITM enables data collected by Systems Director 6.1 to be aggregated with metrics from other Tivoli-managed resources for management as well as reporting, analytical and planning purposes.

Tivoli Storage Productivity Center

Tivoli Storage Productivity Center is the principal IBM solution for management of physical and virtual disk resources, file systems and SAN infrastructures.

TPC provides management services for a wide range of IBM and non-IBM disk systems. These include management of data replication processes such as point-in-time copying by the IBM FlashCopy solution, and remote asynchronous and synchronous replication by IBM Global Mirror and Metro Mirror respectively through SVC. Global Mirror and Metro Mirror are widely used disaster recovery solutions.

All management services may be delivered through SVC.

IBM Tivoli Solutions

The IBM Tivoli solution portfolio is the industry's broadest suite of enterprise service management offerings. It includes more than 450 products developed internally by IBM, and obtained through more than 40 acquisitions of and investments in leading-edge specialist suppliers.

Internally developed as well as externally sourced applications implement a common data model, and have been equipped by IBM with extensive automation capabilities. The company has also engineered process structures that allow for high levels of integration across conventional management silos.

Tivoli solutions fully support all of the IBM platform virtualization capabilities described in this report.

ABOUT THE INTERNATIONAL TECHNOLOGY GROUP

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. . . this could affect your future growth and profit prospects

The International Technology Group (ITG), established in 1983, is an independent research and management consulting firm specializing in information technology (IT) investment strategy, cost/benefit metrics, infrastructure studies, deployment tactics, business alignment and financial analysis.

ITG was an early innovator and pioneer in developing total cost of ownership (TCO) and return on investment (ROI) processes and methodologies. In 2004, the firm received a Decade of Education Award from the Information Technology Financial Management Association (ITFMA), the leading professional association dedicated to education and advancement of financial management practices in end-user IT organizations.

The firm has undertaken more than 100 major consulting projects, released approximately 160 management reports and white papers, and delivered nearly 1,800 briefs and presentations to individual clients, user groups, industry conferences and seminars throughout the world.

Client services are designed to provide factual data and reliable documentation to assist in the decision-making process. Information provided establishes the basis for developing tactical and strategic plans. Important developments are analyzed and practical guidance is offered on the most effective ways to respond to changes that may impact or shape complex IT deployment agendas.

A broad range of services is offered, furnishing clients with the information necessary to complement their internal capabilities and resources. Customized client programs involve various combinations of the following deliverables:

Status Reports	In-depth studies of important issues
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Management Briefings	Periodic interactive meetings with management
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Telephone Consultation	Immediate response to informational needs

Clients include a cross section of IT end users in the private and public sectors representing multinational corporations, industrial companies, financial institutions, service organizations, educational institutions, federal and state government agencies as well as IT system suppliers, software vendors and service firms. Federal government clients have included agencies within the Department of Defense (e.g. DISA), Department of Transportation (e.g. FAA) and Department of Treasury (e.g. U.S. Mint).

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