

WHITE PAPER

Understanding the Business Value of x86 Virtualization and the Benefits of Virtualization-Optimized Hardware

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EXECUTIVE SUMMARY

The benefits of moving to a virtualized server infrastructure are substantial, immediate, and enduring. There is an achievable short-term payback of from three to four months for the initial move to virtualized server infrastructure, and there is a compelling business case for subsequent investment in management tools to realize the full benefits of virtualization. Cost advantages make the early case, with additional benefits including system resiliency and IT agility building through the use of management tools.

This IDC White Paper presents the key conclusions and analysis for a broad category of virtualized server infrastructures, from initial deployments of servers in relatively static consolidations to increasingly well-managed, broader deployments spanning numerous servers and workload types. The data presented in this paper reflects a broad landscape of datacenter environments, spanning a range of server operating systems and hypervisors. One of the key players in this emerging and dynamic marketplace is IBM, a leading provider of datacenter hardware, operating systems software, and management tools for the enterprise. This paper discusses the overall business benefits of virtualization, examines the stages of virtualization maturity, and describes the related IBM solution offerings.

We compare three categories of system configuration: unvirtualized servers, servers using basic virtualization, and servers using advanced virtualization. IDC analysis of the potential to lower IT costs by moving to a virtualized infrastructure finds that the savings can be significant:

- ☒ Adopting a simple virtualized infrastructure can result in a reduction of up to 39% of total deployment costs per user and a reduction of 80% of total annual server hardware costs per user compared with an unvirtualized static x86 server configuration. Described in this IDC White Paper as "basic virtualization," this starting point of virtualization refers to basic x86 server consolidation using virtualization software. It is commonly applied to test and development environments, along with at least some production use.

- ☒ Our research finds that the use of more advanced virtualization technology, along with increasingly sophisticated systems management tools that manage both the guest environments and the virtualization engines themselves, can further extend the benefits of virtualization significantly.

- ☒ An optimally managed or "advanced virtualization" infrastructure, described as an infrastructure that includes penetration of virtualized servers of more than 25%, storage virtualization, and the use of systems management tools, can deliver a total reduction of up to 59% per user per year.

IN THIS WHITE PAPER

This IDC White Paper compares the relative costs and business value of traditional physical server installations (i.e., each operating system with its own physical hardware) with those of virtualized environments (i.e., using hypervisor software to operate two or more operating systems and their related workloads on a single physical server).

The paper reviews traditional cost-based metrics such as total cost of ownership (TCO) and return on investment (ROI). It also enumerates many other benefits — i.e., benefits that transcend the expected hardware footprint reductions — delivered by a move to a virtualized server infrastructure. They include elements such as reductions in IT staff labor costs associated with the move to a virtualized infrastructure, changes to unplanned downtime along with the associated cost savings and user productivity associated with that downtime reduction, and the resulting agility that this next-generation environment offers to IT staff and to employees who use the systems supported by IT.

The paper covers traditional TCO metrics that measure cost outlays over a specific time period and provide a primary method of weighing alternative purchase decisions. It goes beyond these metrics as well to help organizations evaluate the TCO by weighing *all* the factors contributing to cost, including initial acquisition costs for hardware and software; the cost of IT staffing; outsourcing costs associated with deployment, support, or maintenance; and the cost of system downtime, which adversely affects end users' ability to access applications and data.

The paper goes beyond traditional TCO measures that compare systems, particularly basic infrastructure workloads, that offer a relative commodity-level value to users. By comparison, our paper's ROI measures the specific benefit that one expects to achieve by investing in this solution or technology. The paper measures ROI in terms of a period of time to pay back the investment made.

Defining Business Value of Virtualization

While cost-based metrics continue to be highly relevant and informative, IDC research goes a step further and also considers what we call the "business value" associated with new technology adoption. Business value not only considers quantitative, cost-based metrics but also goes further to describe nonquantifiable (or difficult-to-quantify) factors, including adherence to standards, asset management,

application availability, application development and deployment, performance considerations, and the ability of a company to respond to changing business conditions. This latter point, commonly called "business agility," is typically articulated in terms of the number of days to deploy an application to a given number of users or systems. Business value ultimately represents the best overall objective measure of total customer value — especially for the type of infrastructure workloads that IDC is analyzing in this study. In this context, the paper covers the unique value-add and differentiation of virtualization-optimized x86 servers.

METHODOLOGY

IDC analysts have been conducting TCO, ROI, and business value studies for the past 15 years. Through the years, IDC has developed a substantial database of information that paints a robust picture of operational costs and IT labor associated with supporting traditional servers.

Most often, the information in our database is captured during studies of specific platforms. In a typical study, IDC would conduct interviews with a substantial number of end-user organizations — typically between 10 and 50 organizations — and during that interview process, capture verbatim information about the staffing required to deploy, operate, support, respond to outages and problems, and manage and provision new applications through the life cycle of a given server or collection of servers. A given study generally focuses on a particular architecture or operating system. For the purpose of this business value analysis, we are looking at x86 platforms running widely deployed operating systems such as Windows and Linux. It is likely that other operating systems aboard the x86 platform (Solaris, in particular) would have behavioral characteristics similar to those of the operating systems already well studied.

We applied this data against knowledge from two other key areas: virtualization trends (drawing on research about current consolidation rates using the latest data from 2009) and the types of workloads being consolidated in virtualized environments (drawing on results from a multiclient study run by IDC focusing on virtualization adoption in the industry). Secondly, we used TCO/ROI study data from research done on the use of systems management products. When these three sources of information are combined, the output produces a comparative evaluation of a virtualized infrastructure versus the same basic infrastructure used in conjunction with highly capable enterprise systems management tools.

Calculating the Benefits

All IDC business value models are composed of data largely collected from enterprises. Underlying the business value model of server virtualization are multiple data sets gathered during 2006 and 2007, with detailed usage data drawn from interviews conducted directly with medium-sized and large companies, factored with the latest 2009 consolidation ratio data. Those organizations are predominantly headquartered in North America; however, IDC believes that the conclusions of this research are generally applicable to other regions of the world.

The underlying models used to calculate the business value model of server virtualization, the output of which is presented in this document, include three major components:

- ☒ **The TCO model.** IDC's TCO model compares the total costs of delivering business applications to users. This model normalizes the deployment environment to standard two-socket servers in virtualized and nonvirtualized configurations. However, IDC believes that four-socket servers provide parallel value that will only increase as their price/performance continues to climb. Metrics calculated in this model include users per server, users per IT staff, hours of downtime, and support hours of IT staff by server support activity. These values are then used to calculate operations and user productivity costs, as well as to determine metrics associated with server configurations and costs, which are then compared with standard hardware, software, and datacenter infrastructure costs.
- ☒ **Cost comparisons.** The business value calculations also calculate the cost/benefit model that compares the cost-saving benefits of the virtualized environment with the investment required to migrate from a nonvirtualized environment to a virtualized environment.
- ☒ **ROI analysis.** The ROI analysis model looks at the discounted cash flows of the virtualized environment over three- and five-year time periods. This IDC White Paper presents only the three-year ROI data because virtualization typically provides quick returns.

SITUATION OVERVIEW

Since its emergence in the early 2000s, virtual machine (VM) and hypervisor software technology aboard x86 servers has quickly become one of the most disruptive technologies in IT infrastructure. The ability to virtualize servers and reclaim excess capacity caught the interest of datacenter managers who sought to reduce capital spending and faced difficult power and cooling problems.

The first phase of customer adoption of virtualization is really a continuation of a trend in the industry that began in 2000. Predominantly, this phase involved IT simplification. Physical consolidation efforts and workload migration efforts started in the early 2000s later began to merge with virtualization adoption plans, as x86-based solutions from VMware matured to the point of delivering good-enough scale and performance. As a result, customers began to do legacy rehosting of aging operating environments such as Windows NT 4.0 to get the benefits of the new hardware that was available to them.

By 2003 the market began to evolve toward a new way of using virtualization software on x86 servers. About 70% of all virtualization software deployments in 2003 were related to software development and testing — applying it inside a sandbox of large organizations' test and development labs for consolidation purposes. But by the end of 2005, IDC saw spending shift from consolidating software development and testing environments toward trying to consolidate applications within the production part of the IT infrastructure.

Since then, the industry has transitioned to focus more heavily on production-level consolidation, which today continues to be a primary motivator for customers to bring virtualization within their organizations. In the interim, a variety of competitive solutions have entered the market, including multiple implementations of the open source Xen hypervisor technology and KVM into Linux and Microsoft's Hyper-V.

In 2009, several trends are expected. Production-level consolidation will continue, and it will begin to extend to the most mission-critical and performance-sensitive applications. Virtualizing these applications will demand virtualization-optimized hardware to reduce hypervisor overhead and, in particular, address I/O latency and throughput. In addition, as CPU core counts and memory sizes increase, VM density will continue to rise, putting more burden on individual servers to be highly available and fault tolerant.

Beyond consolidation, enterprises are beginning to leverage the hypervisor for extended use cases such as high availability, disaster recovery, and resource optimization. Virtualization offers a cheaper and sometimes better way to perform these tasks, taking advantage of the instant provisioning and live migration features.

The market is changing quickly, with the hypervisor layer no longer the key differentiator that it was even three years ago. IDC is seeing other aspects of virtualization become the real differentiators — in particular, the management, availability, and flexibility of the solutions that work in conjunction with the base hypervisor. And in light of the current economy, users will demand immediate cost savings and a quicker ROI from any solution they implement.

The next generation of virtualization has the potential to bring unprecedented efficiency and service levels to the datacenter, but it will also require some level of rearchitecting. Server virtualization will have tighter integration and coordination with network, I/O, and storage virtualization, eliminating stovepipes. Operations will be policy based and service oriented/driven. This will require an automated and intelligent management capability on top of the hypervisor to achieve a dynamic datacenter. The characteristics of this kind of infrastructure will naturally lend themselves to an internal cloud delivery model, where users can self-service and provision resources instantly, scale their applications, and be charged a utility-like rate. Virtualization will also enable easier sourcing from external clouds, as abstraction is a key step in achieving internal to external cloud interoperability.

In the following sections, we refer to metrics that define the relative maturity of virtualization adoption. In the Appendix, we describe five discrete levels of virtualization maturity. The following pages refer to three of these levels: 0 (unvirtualized), I (basic virtualization), and III (advanced virtualization). We have not yet seen the fifth maturity grouping, dynamic virtualization (level IV), deployed at even the most leading-edge IT organizations.

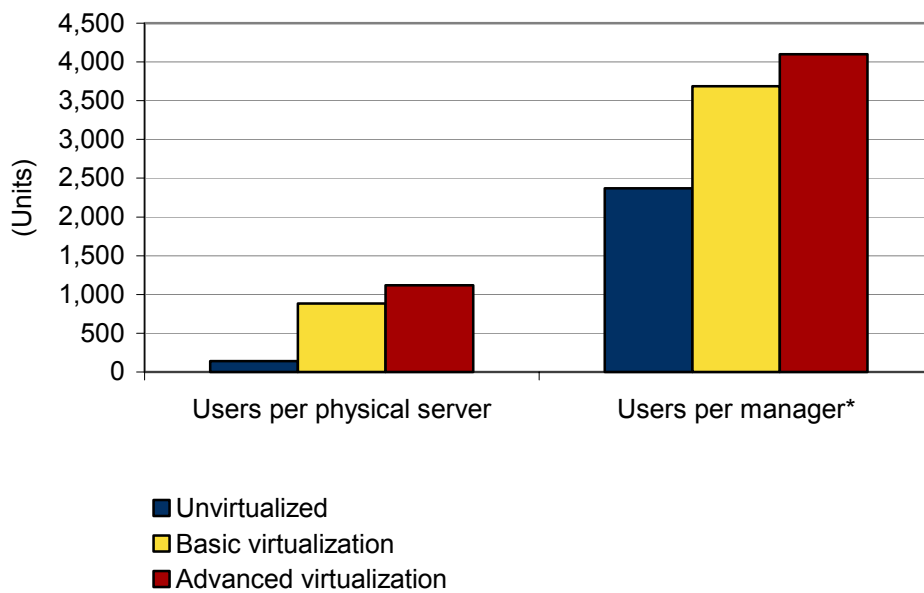
THE BUSINESS VALUE OF VIRTUALIZATION

As noted earlier, this IDC White Paper presents a detailed analysis of the value proposition associated with moving from an unvirtualized environment to a basic virtualization scenario or an advanced virtualization deployment.

Figure 1 shows the direct impact of increasing the number of workloads on servers that are using virtualization software. Merely moving from an unvirtualized infrastructure to a basic virtualization infrastructure boosts the number of users per server from 140 to 882. Likewise, because of the reduced hardware management requirements, the number of users per IT infrastructure manager increases from approximately 2,300 to over 3,500.

FIGURE 1

Business Value of Virtualized Deployment: Users per Server, IT Manager



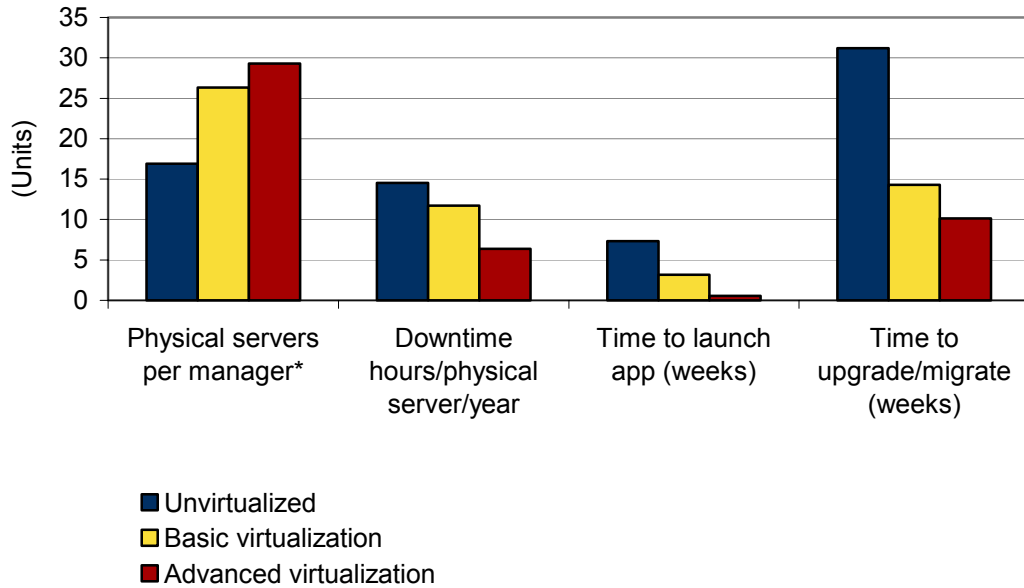
* The IT infrastructure manager is responsible for regression test, configuration and release management, incident/problem resolution, security, storage, capacity, and availability management.

Source: IDC's Business Value of Virtualization Research, 2009

Figure 2 provides several additional metrics that illustrate the impact of moving to a virtualized infrastructure. The number of physical servers per manager increases from 17 in an unmanaged, unvirtualized environment to over 25 in a basic virtualization environment and almost 30 in an advanced virtualization infrastructure.

FIGURE 2

Business Value of Virtualized Deployment: Servers per Manager, Downtime, Time to Launch, Time to Upgrade/Migrate



* The IT infrastructure manager is responsible for regression test, configuration and release management, incident/problem resolution, security, storage, capacity, and availability management.

Source: IDC's Business Value of Virtualization Research, 2009

Figure 2 includes the first business value elements that go beyond hard TCO data — the reduction of downtime hours on an annual basis and the significant reduction in time to launch applications. While there are multiple contributors to this downward shift, a few items stand out and deserve discussion:

- ☒ **More standardized configurations of servers.** Because a virtualized environment requires a level of standardization of the underlying operating system, it becomes easier to drive uptime through consistent configuration and patching of server operating system. No longer does each operating system require one or more unique drivers that are specific to a particular hardware configuration; instead, all operating systems map to the same portfolio of drivers provided by the virtualization software. This also helps ease the deployment of new applications because the underlying operating system is far more likely to be in a known and well-understood configuration. In addition, the ability to clone and replicate VMs from approved templates ensures exact configurations.

- ☒ **Ability to migrate workloads easily.** In the case of downtime reduction, operating systems can be moved from one server to another to facilitate repairs or maintenance, avoiding the lengthy downtime normally associated with that service. In the past, operating systems were tightly married to the underlying

hardware, making it impossible to move the workload to an alternate server on a short-term basis. Even without live migration, it is possible to suspend an operating system and its workload, relocate it to another physical server, and bring it back up in only minutes. With live migration and advanced software, migrations can be made with no user-perceptible downtime. More innovative solutions can tie in data from applications and hardware to move VMs based on that performance or failure data.

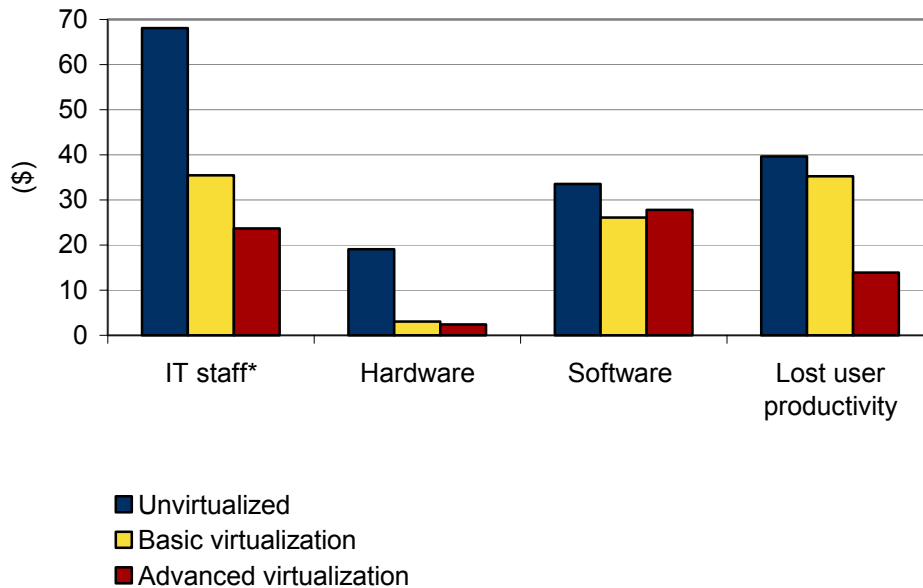
- ☒ **Ability to snapshot and replicate operating systems** for test and configuration purposes. When IT deploys new applications, it now becomes possible, with little more than some mouse clicks, to replicate environments that can be used for testing and experimentation. "Trialing" a new application in a server operating system becomes easy and virtually risk free. This improves the speed and quality of software testing, allowing production deployments to launch faster.

Figure 3 depicts the measurable cost-saving metrics that come with a move to a virtualized infrastructure.

Except for software licensing schemas that enable unlimited instances per processor — for example, Windows Server 2008 Data Center allows unlimited OS instances per processor in a server — software costs generally remain consistent, or are even slightly higher, after the move to a fully managed infrastructure. Hardware costs fall dramatically. Consistent with many previous IDC TCO studies, one of the most significant line items is the staffing costs. However, unlike previous IDC studies, a substantial drop in staffing costs is realistic in a move to a basic virtualization scenario, with further gains possible with a move to an advanced virtualization scenario. In parallel, lost user productivity, the cost of downtime, drops most significantly during a move from basic virtualization to the more tightly managed advanced virtualization deployment.

FIGURE 3

Business Value of Virtualized Deployment: Annual Costs per User



* IT staff costs include full life-cycle support and deployment for hardware, storage, operating system, and applications.

Source: IDC's Business Value of Virtualization Research, 2009

Our findings indicate that the use of increasingly standardized operating system images deployed on hypervisors (with increasingly common sets of drivers and devices) leads to more stable environments, a key contributor to the reduction in costs associated with supporting servers and the basic operating system configurations run on those servers.

The Immediate Benefits of Virtualization

Figures 1, 2, and 3 provide a detailed look at the positive impact of virtualization. The reduced cost, higher user density per server and per manager, and improved availability are side effects of the virtual infrastructure, but other benefits such as improved agility come along at no extra cost. Some of the key points presented in these figures include the following:

- ☒ **User density increases dramatically.** The average user density grows by a factor of six on a per-server basis, while the number of users per server manager almost doubles.
- ☒ **Availability increases.** A side effect of virtualization is that system availability goes up even for the most basic configurations of a virtualized infrastructure. The real benefit comes from an advanced virtualization scenario in which downtime drops by 50%.

- ☒ **Service-level noncompliance decreases.** Once virtualized, an application that needs more scalability can be moved to a server that can fulfill that requirement with little more than a few clicks of the mouse.
- ☒ **Cost decreases.** Cost reductions occur across the board and especially in hardware (80%), but with future deployments, customers can move to server operating systems that offer unlimited virtualization rights, extending their savings dramatically in many cases.

Side Effects of Virtualization

New System Management Challenges

While server virtualization brings many advantages in terms of cost savings and operating efficiencies, it also brings new and expanded requirements for system management. Server virtualization based on hypervisors introduces a new layer between the operating system and the hardware and creates new objects to manage. These objects include virtual server host systems, guest virtual machines stored in Virtual Hard Disk (VHD) libraries or deployed on host servers, as well as the need to manage "guest" operating systems and applications deployed in virtual machines.

Typically, server virtualization results in some level of operating system proliferation, or "virtual machine sprawl," which may substantially increase the overall number of server operating system images that need to be managed by system administrators. System management software is needed to perform the standard management functions required for physical systems, but now for virtual machine images as well.

Particular requirements exist for migrating physical server images to virtual images (P2V), as well as managing growing libraries of virtual images. Some functions, such as performance management, require extended capabilities to properly represent systems and applications running in guest environments.

System management functions can be well served by an approach that combines physical and virtual server management under a common umbrella that integrates functions and views — such as consolidated views that show all deployed physical and virtual servers with associated resources. In addition, management of the virtualized server environment needs to follow established IT processes or process standards for system management functions, such as ITIL best practices. In advanced virtualization cases, software for adaptive policy-based management and orchestration can be used to automate resource optimization and complex workflow scenarios to meet service-level requirements.

New Hardware Design Points

While virtualization clearly provides tremendous and varied benefits to an enterprise, it also has wider implications for purchasing decisions. IDC has seen virtualization driving new hardware designs, optimized for virtualization. While consolidation on existing servers has excellent value, as customers move into the next stage of virtualization maturity and go through normal server refresh cycles, new specially tailored hardware will enable them to do more with virtualization. Some of the areas that virtualization has impacted are as follows:

- ☒ **Focus on reducing hypervisor overhead.** The first generations of virtualization incurred significant overhead, limiting the applications that the technology could virtualize. However, advances in CPU and their corresponding chipsets now accelerate and offload many hypervisor functions, reducing overhead significantly. Over time, the overhead for virtualization is expected to drop to near zero.
- ☒ **Increased robustness.** Enterprises looking for the greatest returns from virtualization are searching for ways to increase density and pack more VMs per server. New CPU architectures are packing more cores per socket and allow for very large system memory capacities, the two main factors that determine how many VMs a given server can host.
- ☒ **I/O latency and throughput.** One of the biggest limitations for virtualizing certain workloads such as databases was I/O performance, a traditionally weak area of hypervisor performance. Software hypervisor optimizations have been made over several versions but now increasingly are accelerated by hardware. System chipsets, NICs, and HBAs are being designed with new I/O features that work well with VMs, relieving resource contention, providing QoS, reducing latency, and increasing overall throughput to allow even I/O-intensive applications to be virtualized.
- ☒ **More fault tolerant systems.** Consolidating servers has the effect of making each server more mission critical than if it hosted only one OS and application. A server failure now means that multiple systems are affected. While hypervisors do allow quicker recovery from these kinds of failures, they are not a perfect solution. VMs may be left in an inconsistent state or have data corruption issues that go unnoticed until the failure becomes catastrophic. In addition, while restarting these workloads on another hypervisor is relatively quick compared with restoring on bare metal, there still can be significant minutes of downtime that would impact all the VMs running on the server.

FUTURE OUTLOOK

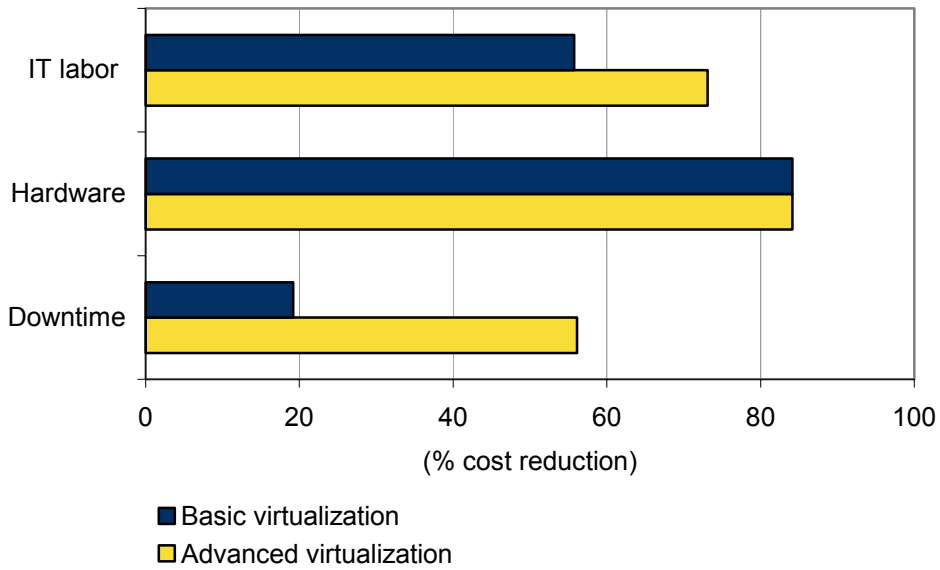
Figure 4 depicts the direct cost reductions associated with moving from an unvirtualized environment to either a basic virtualization environment or an advanced virtualization environment.

IT labor cost savings can exceed 50% merely by a move to basic virtualization. Moving to a fully managed virtualized environment typical of an advanced virtualized deployment would further reduce IT labor costs by over 15 percentage points, leading to a savings of over 70%.

While hardware cost reductions are roughly equal across different levels of virtualization, the value of a full life-cycle management solution shows clearly when comparing downtime costs. An advanced virtualization scenario delivers reductions in costs due to downtime that are over 30 percentage points greater than those of a basic virtualization deployment. This cost savings alone, along with the less tangible business value that comes from greater systems availability, would likely justify much of the investment costs associated with deploying systems management tools to get to an advanced virtualization environment.

FIGURE 4

Business Value of Virtualized Deployment: Cost Reductions

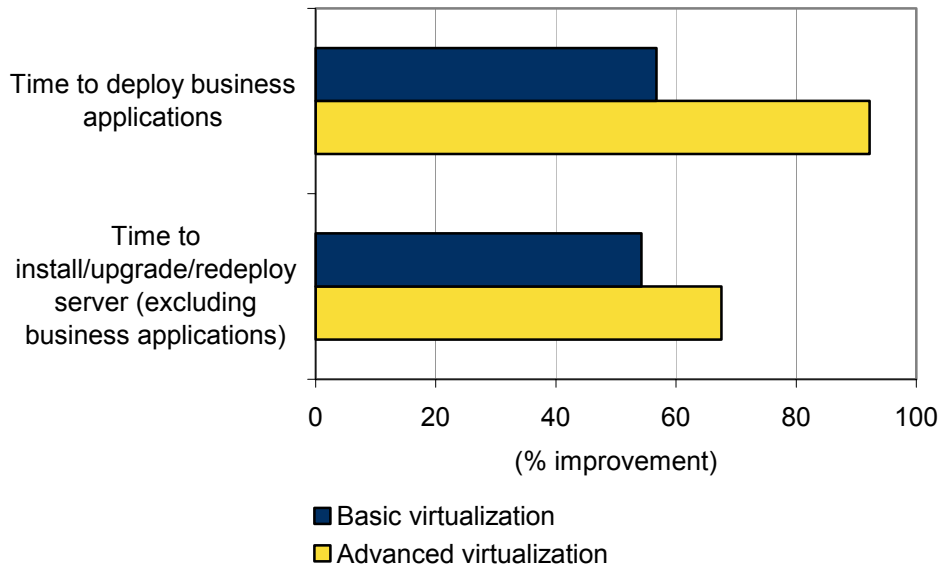


Source: IDC's Business Value of Virtualization Research, 2009

Figure 5 shows the business benefit that comes from using a management solution in an advanced virtualization environment. While initial deployment and/or redeployment costs are marginally reduced for an advanced virtualization deployment, it is possible to achieve 36 points of incremental benefit from using management tools in an advanced virtualization deployment, when used for the deployment of new software. Of course, even for a basic virtualization deployment, the cost savings versus those of an unvirtualized environment are dramatic.

FIGURE 5

Business Value of Virtualized Deployment: Agility Enhancements



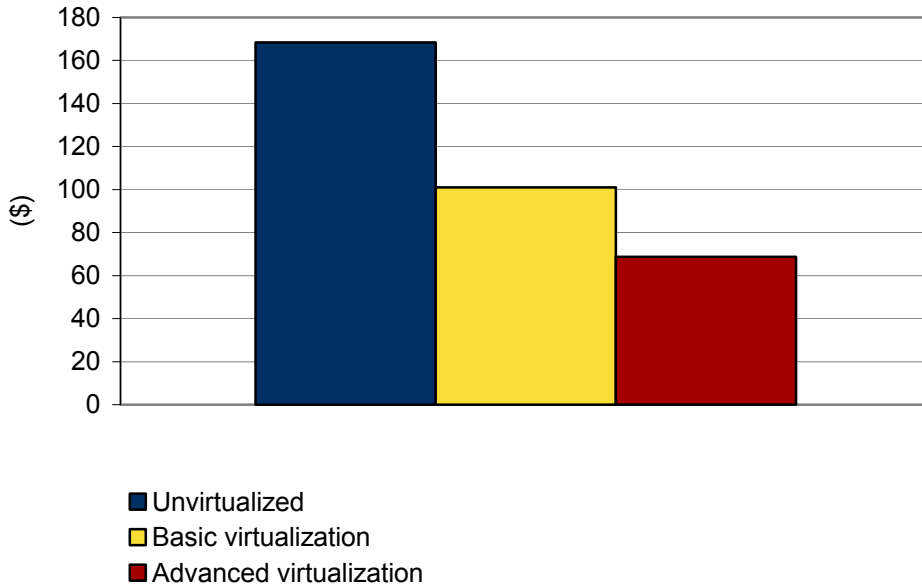
Source: IDC's Business Value of Virtualization Research, 2009

Figure 6 presents an overall view of the annual TCO, comparing unvirtualized, basic virtualization, and advanced virtualization deployments. As illustrated in Figure 6, customers moving from an unvirtualized environment to a basic virtualization environment can lower their total annual costs 39%, or from \$168 per user per year to \$103 per user per year. Organizations that move to advanced virtualization will realize a 59% cost savings per year per user compared with an unvirtualized environment, or a reduction of costs from \$168 per supported user per year to \$69 per supported user per year.

These cost savings are dramatic and illustrate the reason why virtualization adoption is pervasively sweeping the industry.

FIGURE 6

Business Value of Virtualized Deployment: Annual Total Costs per User



Source: IDC's Business Value of Virtualization Research, 2009

Return on Investment Calculations

Companies that have deployed basic virtualization are realizing costs savings of \$163 per user over three years with a total investment of \$28 per user. Using IDC's standard discount rate of 12%, we found that the average company deploying basic virtualization could see an ROI of 486% and payback in less than half a year — three to four months — including deployment time. This is a very significant ROI for a relatively low-cost, low-risk initiative.

In the advanced virtualization scenario, average benefits increase by over 25% (primarily through enhanced IT operations and user productivity cost reductions), while costs per user decline due to lower hardware costs. Table 1 presents the ROI story associated with a move to a basic virtualization deployment or an advanced virtualization deployment.

TABLE 1

Business Value of Virtualization: Three-Year ROI Analysis (All Values per Server)

	Basic Virtualization	Advanced Virtualization
Total benefits	\$163	\$208
Total investment	\$28	\$22
Discounted benefits	\$128	\$162
Discounted investment	\$22	\$17
NPV	\$106	\$145
ROI	486%	853%
Payback (months after deployment)	4.20	2.96
Discount rate	12%	12%

Source: IDC's Business Value of Virtualization Research, 2009

IDC uses a discounted cash flow methodology to conduct ROI analysis. The elements in Table 1 include the following items:

- ☒ **Total benefits** are the total cost savings per supported user over a three-year period.
- ☒ **Total investment** is the investment in hardware, software, services, and IT staff time to implement the virtualization solution per user over the same three-year period.
- ☒ **Discounted benefits** are the net benefits users realize after discounting for the cost of money.
- ☒ **Discounted investment** is the actual investment after accounting for the cost of money.
- ☒ **Net present value (NPV)** is the net discounted benefit (discounted benefits – discounted investment).
- ☒ **Return on investment (ROI)** is the ratio of the NPV to the discounted investment. It is used to compare investment opportunities.
- ☒ **Payback** is the time at which cash flow becomes positive. This is the period of time in months after the completion of deployment for the initial investment to be paid back. It is the best measurement of risk.
- ☒ **Discount rate** is the cost of money consisting of the average cost of capital plus a risk factor to allow for unforeseen costs or delayed realization of benefits.

IBM AND X86 VIRTUALIZATION

Virtualization continues to be a significant driver of change in the server market today. Over the past several years, virtualization has helped shape the design and technical evolution of server hardware down to the component level. With the slashing of IT budgets, the recession has helped to accelerate this trend as end users are increasingly moving toward virtualization as a viable cost-saving alternative through its advantages in higher hardware utilization, power efficiency, high availability, and disaster recovery.

IBM has designed its x86 hardware portfolio to address these needs by providing purpose-built platforms designed to be optimized for a virtualization environment. This is accomplished through its wide range of product offerings, including blades, racks, towers, and HPC-oriented form factors. IBM also provides leading management tools for these environments through IBM Systems Director, which provides end users with an advanced management console through its heterogeneous support for both virtual servers and physical servers via a single interface. Additionally, reliability, availability, and serviceability (RAS) functionality, an extremely important feature especially for servers supporting virtualization environments, is fully supported by a wide range of technologies developed exclusively by IBM.

As stated earlier, the more advanced the virtualization environment, the greater the potential cost savings. Through greater utilization, availability, power efficiency, and manageability, IBM has optimized its hardware to provide advanced capabilities for virtualization workloads across its portfolio to deliver greater and faster ROI, as follows:

- ☒ IBM supports the latest multicore x86 processors from Intel and AMD. Several new systems have been released around Intel's latest Nehalem processor providing support for enormous memory footprints as well as Intel's Virtualization Technology (VT). Several AMD models are also available, providing full support for the latest ultra-efficient Opteron processors. IBM also has its own x86 chipset designed specifically to complement and enhance standard Intel and AMD designs for added enterprise functionality, improving utilization, performance, and reliability for virtualized environments.
- ☒ IBM's eX4 technology, designed to allow datacenter managers to run very large numbers of VMs per server with reliability, allows users to scale their System x Enterprise Servers' nodes or chassis (up to 16 sockets and 96 cores) and memory (up to 1TB) to handle the most demanding virtualized workloads confidently.
- ☒ IBM includes an embedded 4GB flash drive containing a version of VMware's ESXi hypervisor on several of its systems — including the System x3550 M2, x3650 M2, and x3850 M2 as well as the BladeCenter HS21, HS21 XM, HS22, LS22, and LS42 servers — providing out-of-the-box virtualization support even for diskless configurations.

- ☒ IBM supports solid state drives (SSDs) in many server models. Servers using these drives leverage the SSDs' freedom from the risk of mechanical failure — thus reducing the server's potential downtime as well as lowering its energy consumption. The SSDs consume only 2W apiece and generate very little wasted energy.
- ☒ For users looking for more upgrade flexibility, the AMD Opteron processor-based x3755 offers the use of a CPU Pass Thru card, which enables the use of one- or three-processor configurations as opposed to the traditional two- or four-processor designs.
- ☒ IBM's servers are specially engineered with Calibrated Vecteded Cooling technology that provides optimal airflow, as it is needed, through the internal hardware components, which both increases efficiency and lowers the risk of downtime due to overheating.

Through both rack-based and blade platforms, IBM provides leading high-end x86 solutions designed specifically with the intent to support virtualization environments. These solutions provide on-demand virtualization capacity, allowing users to expand as they require more memory, I/O, and processing power to support additional virtual machines.

With its rack-based x3850 M2 and x3950 M2 models, IBM offers the fourth generation of its X-Architecture with its ScaleXpander technology. This allows users to scale up their servers from four-processor sockets in one node or chassis all the way up to 16 sockets in four connected chassis, providing support for up to 96 cores of processing power (up to 1TB of memory) plus 28 high-throughput PCIe adapter slots. This, in turn, provides support for up to 32DIMM slots per chassis for a total of up to 128DIMMs in up to four connected chassis. This is an attractive option for end users who wish to support more VMs per physical server. Users have the ability to start with a single chassis with four sockets and scale up as their memory, I/O, and performance requirements increase to support additional VMs in the same environment without having to deploy a separate device.

Blades continue to be a perfect complement to virtualization and consolidation activities in datacenters today. The unique form factor provides enhanced energy efficiency and manageability advantages due to its highly integrated nature. IBM BladeCenter servers offer several advantages for virtualization, including IBM's PowerVM and Integrated Virtualization Manager, which increases flexibility by enabling virtualization to extend to IBM AIX and IBM i operating systems (on its JS series of blade servers). These tools allow users to consolidate workloads with ease through a browser-based interface. Additionally, Open Fabric Manager provides leading I/O virtualization capabilities integrated directly into the chassis, which reduces the need for additional physical interfaces and enables automated failover between blade servers. Through BladeCenter, IBM also offers Active Energy Manager to allow users to control, maintain, and cap power usage throughout the system while also providing metrics on actual (versus estimated) energy usage.

According to IDC survey data, users are packing more VMs per physical server than ever before and are expected to continue that trend going forward. As of 2005, users

were consolidating about three VMs per physical server. IDC expects this rate to increase to eight VMs by 2012, nearly tripling the number of VMs supported per server. As the number of VMs per physical server increases, so does the potential fallout that could occur in the event of any downtime. This makes RAS features, a stronghold of the mainframe market, increasingly relevant to x86 servers. IBM provides a plethora of RAS capabilities as standard features in its x86 platforms, including:

- ☒ Memory protection features such as IBM's Memory ProteXion (x3850 and x3950 models), IBM Chipkill, advanced ECC, memory mirroring support, and memory scrubbing
- ☒ Predictive failure analysis for many components, including processors, memory, HDDs, voltage regulator modules, fans, power supplies, L4 cache, and PCIe slots (These alerts are sent to IBM Systems Director before the failure occurs, providing advance notice to the administrator and allowing proactive live migration of VMs off of failing hardware to prevent downtime.)
- ☒ IBM's Light-Path Diagnostics, which provides a series of LEDs throughout the system to guide the administrator to the failing component for easy servicing

A comprehensive management tool is crucial for users approaching a more advanced stage of virtualization. Controlling the entire environment, both physical and virtual, from a single console is important when addressing issues such as VM sprawl. IBM's management software, IBM Systems Director, helps end users address these and many other issues plaguing VM environments today. This software provides IT administrators with a high-level management view by working closely with an array of existing system management tools across IBM x86, non-IBM x86, IBM Power, and System Z systems, as well as storage systems. IBM Systems Director interoperates with leading hypervisors on these platforms, such as VMware and Xen Server, to ease management and administration complexities. For example, in the event of a major hardware failure, IBM Systems Director will alert the hypervisor to perform a live migration of applications on that device to another server with available capacity, effectively minimizing any potential downtime. IBM Systems Director also helps battle rising IT costs by providing a holistic tool that handles everything from deployment and integration to ongoing maintenance. IBM Systems Director 6.1 responds to today's energy concerns by providing sophisticated power management capabilities, allowing the monitoring and management of power distribution to a single server or a group of servers. IBM Systems Director provides comprehensive management solutions across both physical and virtual servers and across multiple hypervisor platforms.

Virtualization will continue to mature, as will the hardware that supports it. Through support for industry-standard hardware, proven reliability, superior systems management, and lead performance capabilities, IBM provides a holistic offering to those new to virtualization as well as those with established environments.

CUSTOMER CASE STUDY

CBH Group

The CBH Group is a grain logistics and marketing company based in Western Australia that buys grain from its grower shareholders and sells to overseas markets. It supports the entire grain value chain from storage, handling, and transport to marketing, shipping, and processing. With approximately \$1 billion in annual revenue, CBH employs approximately 1,000 employees, with 63 of those being ICT staff. Of the ICT staff, about half are developers. CBH has been overhauling its IT infrastructure over the past several years to get to a system that would take it into the next generation.

Standardization, Consolidation, and the Capacity for Growth

A large part of this new architecture is server virtualization, which CBH has implemented using VMware's Virtual Infrastructure. CBH has operated a virtual test environment since 2005 and began using virtualization for production workloads in 2007. Brad Harvey, CBH Group's ICT Infrastructure Manager, explains, "In our old setup, we had about 150 physical servers all from various vendors spread out across our region [most of Western Australia], which is very large. It made servicing and maintenance very difficult, and we wanted to centralize these servers into the datacenter. But in the datacenter, we were also running out of power capacity, cooling capacity, and floor space. Fortunately, the old servers weren't that powerful and we calculated that we could get a very high consolidation ratio by putting them onto some pretty substantial servers. Ultimately, we were able to consolidate 150 servers onto 10, and we standardized on the IBM x3850 M2, which has just proved to offer a great processing-per-dollar capability for us. They're really quite substantial."

CBH's default server build is a four-socket, 16-core processor configuration with 128GB of RAM. CBH decided to go with new servers for several reasons. First, it had initiated an ongoing initiative to standardize the infrastructure because over the years it had accumulated servers from a variety of vendors and in a variety of configurations and form factors. Second, CBH felt that the old servers, while certainly capable of running a hypervisor, were not optimized for the task and would not be able to achieve high consolidation ratios or the virtual machine performance of a modern server with virtualization-optimized hardware. CBH worked with IBM representatives in Perth to configure a server that would meet its goals of high VM density and virtualization-optimized performance to significantly reduce the virtualization overhead. Along with the new server, the CBH Group also installed an IBM DS4800 SAN, which is essential for enabling many of virtualization's advanced features such as high availability and load balancing. Today, CBH runs about 30 VMs per host, an excellent consolidation ratio in the industry. The servers are still only about 30% utilized, giving CBH more headroom to grow. CBH also had been running some non-x86 workloads on IBM iSeries and pSeries, which it was able to consolidate onto new iSeries servers that can virtualize pSeries workloads.

Improving Uptime and Reliability

Virtualization has also had a tremendous positive impact on CBH's reliability and uptime. "Virtualization gives a lot of resiliency in several ways," says Harvey. "With a VM, you can easily roll things back to a known state in the event of a misconfiguration, patch failure, or unforeseen event. And with hardware independence, you can move and restart the VM on another host if you need to. But on the flip side, when you consolidate, you have in our case 30 logical servers on one physical host, so if that physical host goes down, you have more exposure." With virtualization making each server more mission critical, it was imperative for CBH to invest in the reliability and redundancy features in the x3850 M2.

To get an extra layer of protection, CBH split its 10 servers into two separate datacenters with 5 servers each. Each datacenter uses SAN replication to replicate the VMs to the other datacenter so that if one site goes offline, the other can take over. Each datacenter also has a T3500 physical library to create a second copy of the data. Using a combination of ultra-reliable server hardware, local restart, and high-availability features, along with site-to-site DR capabilities, has given CBH the ability to meet a very stringent set of recovery time and recovery point objectives, a set of requirements that are crucial to allowing the company to achieve success in a highly competitive market.

As another benefit of virtualization, CBH was able to improve reliability and security by keeping up with patching more effectively. Harvey explains, "Before virtualization, that small chance that the patch will break something led to a reluctance to patch. It was difficult to have a great backup or DR strategy for 150 physical servers, so if the patch had a problem, it was very disruptive. Plus, the sheer number of patches these days can be overwhelming, especially as you multiply it by the number of servers you have. Once we virtualized, we had rollback and recovery built into the infrastructure for all the virtual servers, so that really gave us much more confidence to patch as we knew we could easily recover if it went wrong. Keeping up to date on patches and fixes has really improved our reliability and performance."

The Continuing Journey

CBH has made tremendous improvements in its infrastructure with virtualization, but the journey continues. By buying robust servers, the company has additional headroom for expansion, which it calculates will save \$50,000 per year on hardware. In addition to capex savings, CBH has seen operational savings due to improved server management, which while not easily quantifiable are very obvious, according to Harvey. CBH plans to virtualize its remaining bare metal workloads — its database servers and an SAP ERP system. Upgrades to the storage switching fabric and investments in IBM's SAN Volume Controller (SVC) for storage virtualization and the use of thin provisioning have solved its storage problems, but its Ethernet network is due for a facelift. Along with the networking hardware, CBH is investigating the virtual switch capability of vSphere for better insight and management of the network. CBH is also looking into better management tools such as VMware's Site Recovery Manager to better automate its DR processes and IBM Systems Director to integrate physical and virtual management.

Reflecting on the journey so far and the future goals, Harvey remarks, "We are basically headed right now towards an internal cloud architecture. It wasn't something we consciously decided on from the beginning, but as we began to put various pieces in place, the more sense it begins to make. We're very satisfied with our VMware infrastructure and the IBM hardware behind it. I think it's worth mentioning that one of the things that really appealed to us was when it came to the iSeries, the storage, and the ESX host, IBM seemed to offer an overall strategy that could basically meld those three elements together for us. We saw that as a real bonus in going down the IBM path given that we already had some of these components. The fact that there was a road map for all of this within IBM certainly gave us a level of comfort."

CHALLENGES/OPPORTUNITIES

Any new technology faces challenges, and these challenges are usually counterbalanced against interesting new opportunities that the new technology can address. Virtualization software and the associated systems management tools that enable an advanced virtualization deployment certainly face these factors.

Challenges

- ☒ **Moving from distributed to consolidated infrastructure.** The data presented in this IDC White Paper clearly illustrates the business justification for moving to a virtualized infrastructure. With any new technology, the return always comes *after* the investment. Therefore, an investment and executive backing are needed to spend money to save more money later.
- ☒ **Aligning and/or minimizing management tools in use.** Most organizations have multiple management tools in their infrastructure, along with proponents or departments that will resist consolidation aboard a smaller number of tools.
- ☒ **Consolidating version inconsistencies.** Moving to an advanced virtualization infrastructure mandates having relatively high degrees of consistency in the virtual servers that run on the infrastructure. This goal, as attractive as it sounds, is inconsistent with the deployments at a typical company. Therefore, the physical-to-virtual migration/consolidation activities are not as simple, straightforward, and easily accomplished as the advertisements often suggest.
- ☒ **Up-front investment avoidance (whatever the benefit).** While consolidating on a virtualized platform will certainly provide a positive ROI over time, many IT departments may have difficulty securing the capital required to invest in the new systems. Some IT managers may find it easier to simply purchase a few more servers to support what applications they need to in order to get them through the economic downturn rather than purchase, potentially expensive, systems onto which to consolidate their infrastructure. Hardware costs alone can be enough to deter investment. However, additional software licensing costs for the leading virtualization applications can add up-front expense. Larger environments will also often incur additional up-front cost for more sophisticated management tools to manage both physical and virtual environments.

- ☒ **Reeducating IT on best practices.** As with any new technology, there is a required learning curve to understand best practices. For example, customers that were once used to operating a diverse infrastructure with many different OS images will need to adapt to working with a small number of standard images. Many of the previous issues found by having these diverse deployments, such as BIOS or DLL issues, will no longer be as apparent. Instead, IT will need to develop skills around configuration of virtual machines and management of a virtual environment. Challenges lie in learning new license/usage compliance rules as well as transitioning skill sets from OS management to systems, configuration, and virtualization management.

Opportunities

- ☒ **Cost reductions and business value.** As indicated by the data presented in this document, the cost reductions are potentially huge and can continue to accrue as additional servers are migrated from a distributed physical infrastructure to a virtualized consolidated infrastructure. Even the most progressive organizations typically have integrated virtualization software into only 20% of their systems, with the vast majority of the industry under 10% penetrated. The potential upside for organizations remains huge.
- ☒ **Agility benefits.** While agility benefits come first and foremost from having a solid management system in place, layering that solid management tool set on top of a virtual infrastructure multiplies those benefits.
- ☒ **Reduction of unscheduled downtime.** A virtual infrastructure carries with it both a benefit and a risk. The benefit is that hypervisors and management tools can dramatically reduce unscheduled downtime and can minimize or completely eliminate scheduled downtime. The risk is that by consolidating more operating systems aboard a smaller number of physical servers, those physical servers each become increasingly critical resources because of all the software loaded aboard those machines and are more at risk due to a hardware failure.
- ☒ **Green IT benefits.** Moving to a virtualized infrastructure that reduces the number of physical servers has a direct impact on power and cooling requirements and associated carbon emissions. Even better, moving to a virtualized x86 infrastructure may delay or eliminate the need for datacenter expansion. For some organizations, it may actually lead to datacenter consolidation.
- ☒ **Future-proofing (cloud computing readiness).** Virtual machines allow IT administrators to get used to maintaining a logical environment as opposed to individual 1:1 configurations. This will help to ease their transition to a cloud computing model that is based heavily in virtual assets, a trend that IDC expects to greatly proliferate in the near future. In addition, virtualization of the infrastructure is a key step to evolving to an internal cloud architecture, which will drive higher efficiency with the datacenter and enable interfacing with external clouds.

CONCLUSION

Virtualization delivers compelling business value today, increasing by a factor of five the number of users supported per server, improving availability of servers, enabling application scalability, and reducing costs across the board.

The business case is clear and the options abound. In particular, the introduction of modern virtualization solutions based on advanced system architectures — which can offer both intelligent configuration and management and the ability to sense, predict, and enable the replacement of failing hardware components before they cause system shutdown — can help promote uptime and efficient resource usage, particularly when used in direct combination with the high-quality hypervisors available on the market today.

These same technologies can lower costs directly through an immediate reduction of power and cooling costs and subsequently deliver a long-term benefit through lower IT administrative costs that continue to benefit IT organizations and their parent companies year after year. IDC believes that these benefits accrue for integrated virtual and physical management solutions such as those available across IBM's System x and BladeCenter virtualization portfolio, described previously. They can offer customers the ability to scale virtualized workloads — which are likely to increase considerably as virtualization takes hold — up and out with reliability and performance.

IDC believes that organizations using x86 solutions today should move to adopt such a next-generation solution. In the process, they will gain better utilization of server resources and reductions in acquisition, deployment, and power and cooling costs. Further, the long-term benefits of reducing staff costs and increasing business agility leads to other long-term benefits that will continue for years to deliver returns on the investment required to put this solution in place.

APPENDIX

Virtualization Maturity Index

IDC analysts have developed a set of metrics to define the relative maturity of virtualization adoption. Table 2 shows five discrete levels of virtualization maturity. For the purpose of this IDC White Paper, we compare and contrast virtualization levels 0 (unvirtualized), I (basic virtualization), and III (advanced virtualization). Dynamic virtualization (level IV) is a future state not yet deployed at even the most leading-edge IT organizations.

TABLE 2

IDC Virtualization Maturity Index

Category	Virtualization Level	Description
Unvirtualized	0	Physical x86 server/physical OS usage — no virtualization. Systems are configured at less than 10% capacity.
Basic virtualization	I	Basic x86 server consolidation using virtualization, commonly used in test and development scenarios, but production use is not widespread. Advanced functionality such as live migration; automation and management are limited or applied selectively. Systems are utilized at 20% to 40% capacity.
Standard virtualization	II	Includes a mixture of uses ranging from test and development, to static server consolidation, to a mix of production workloads, with systems configured to utilize approximately 30% to 50% capacity. This scenario includes limited use of dynamic capabilities. Penetration could exceed 15% of x86 servers. It uses management tools on both OS images and application workloads on a moderate to widespread basis and may use advanced features such as live migration for some application workloads.
Advanced virtualization	III	Widely virtualized infrastructure (>25%) includes both server virtualization and at least some storage virtualization. Management tools along with automation such as workload redistribution and automatic workload migration are used on both live VMs and on cold OS images. Live migration is used both for meeting service-level agreements and for availability purposes. Systems are utilized on average at 40% to 60% or more of capacity.
Dynamic virtualization	IV	Majority of x86 systems (>50%) use hypervisors. Live migration, active image, and workload management are used comprehensively so new systems go online virtualized. Storage resources are virtualized; moving to adopt network and I/O virtualization as those technologies emerge.

Source: IDC's Business Value of Virtualization Research, 2009

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