THE BUSINESS VALUE OF SERVER VIRTUALIZATION: THE GDC CASE

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ABSTRACT

In today's competitive global economy, organizations need to be poised to respond faster to market changes, customer demands, and growth opportunities. In today's enterprise data centers, for example, it is not uncommon to find servers with utilization rates as low as 5 to 15 percent and storage with utilization rates of less than 50 percent. On the other hand, energy expenditures are going up due to high-density servers, storage power and cooling costs. While data center costs are increasing, the utilization of information technology (IT) assets, including servers and storage devices is very low. Today's x86 computer hardware was designed to run a single operating system and a single application, leaving most machines vastly underutilized. Since the advent of client-server technology, x86 server configuration has been the standard architecture and norm in most organizations. This technology meant that IT administrators spend so much time managing servers rather than innovating. Further, about 70% of a typical IT budget goes towards just maintaining the existing infrastructure, with little left for innovation and provision of quality services. The nature of GDC's business is complex - in terms of operations, locations and logistics. This scenario calls for robust solutions be put in place in order to meet user and business expectations. To do this, the need for an agile IT infrastructure cannot be over emphasized, one that is built to deliver better business outcomes. This paper, therefore, will discuss how GDC intends to overcome these challenges while improving the efficiency and availability of IT resources and applications. It will discuss how GDC will get more value and a higher return on investment by moving away from the old "one server, one application" model and embracing the modern solutions based on blade architectures. The paper will also discuss how, combined with the quickly maturing x86 hypervisor technologies, the synergy of blade architectures and virtualization offers the ability to dramatically increase utilization of server investments, boost uptime, provide a more resilient and available infrastructure, and roll out new infrastructure and services more quickly.

INTRODUCTION

In today's competitive global economy, organizations need to be poised to respond faster to market changes, customer demands, and growth opportunities. In today's enterprise data centers, for example, it is not uncommon to find servers with utilization rates as low as 5 to 15 percent and storage with utilization rates of less than 50 percent. On the other hand, energy expenditures are going up due to high-density servers, storage power and cooling costs. While data center costs are increasing, the utilization of information technology (IT) assets, including servers and storage devices is very low.

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The nature of GDC's business is complex - in terms of operations, locations and logistics. This scenario calls for robust solutions be put in place in order to meet user and business expectations. To do this, the need for an agile IT infrastructure cannot be over emphasized, one that is built to deliver better business outcomes.This paper,therefore, will discuss how GDC intends to overcome these challenges while improve the efficiency and availability of IT resources and applications. It will discuss how GDC will get more value and a higher return on investmentbymoving away from theold "one server, one application" model and embracing the modern solutions based on blade architectures. The paper will also discuss how, combined with the quickly maturing x86 hypervisor technologies, the synergy of blade architectures and virtualization offers the ability to dramatically increase utilization of serverinvestments, boost uptime, provide a more resilient and available infrastructure, androll out new infrastructure and services more quickly.

The latest IT and e-Business trends have brought in essential changes that allow businessesoperate in real-time information environment. It is no surprise that information relevancy, timelessand accuracy are specific issues which need specific emphases in order to understand andhaving proper insights in any business dynamics, in decision support, problem solving, reducinguncertainties and taking risks.

In his white paper entitled ***"Understanding the Business Value of x86 Virtualization and the Benefits of Virtualization - Optimized Hardware"***, Gary, Chen et al argues that Virtualization delivers compelling business value today, increasing by a factor of threethe number of users supported per server, improving availability of servers, enablingapplication scalability, and reducing costs across the board.

CURRENT SCENARIO

In the one year that GDC been in operations, a lot of investment has gone into developing a robust ICT infrastructure. The QA & ICT Department has developed policies and a roadmap in an effort to drive all processes and provide quality services which are aligned to the overall corporate strategy.

Five servers are currently in operation within the organization as described in the table below. All servers are of varying capabilities and features. Two Linux-based servers are running specialized Geochemical and Geophysical systems respectively.

Table 1

Server Make	Location	Role
Dell PowerEdge	Nakuru Office	GIS
Dell PowerEdge	Taj Towers	MS Exchange
HP Workstation	Nakuru Office	Geochemistry data processing and interpretation
HP Workstation	Nakuru Office	Geophysics data processing and interpretation
HP Pro	Riverside	MS TMG (Firewall, content management)
HP Pro	Taj Towers	MS TMG(Firewall, content management)
Hp Pro	Taj Towers	Phone Call Billing
HP Pro	Taj Towers	Domain Controller

In addition, six IBM BladeCenterservers are currently being assembled, installed and configured for the ERP System implementation. SAP business applications paired with BladeCenter servers allow businesses of all sizes to benefit from relevant, timely information with simple management, excellent performance and rock-solid reliability. With SAP Business Suite and SAP Business All-in-One on IBM BladeCenter servers, GDC will have the scalability to meet the dynamic needs of your business while reducing carbon footprint - without sacrificing application performance.

Four of these servers will be located at the primary site at GDC Riverside office while two will be at the Nakuru secondary site.

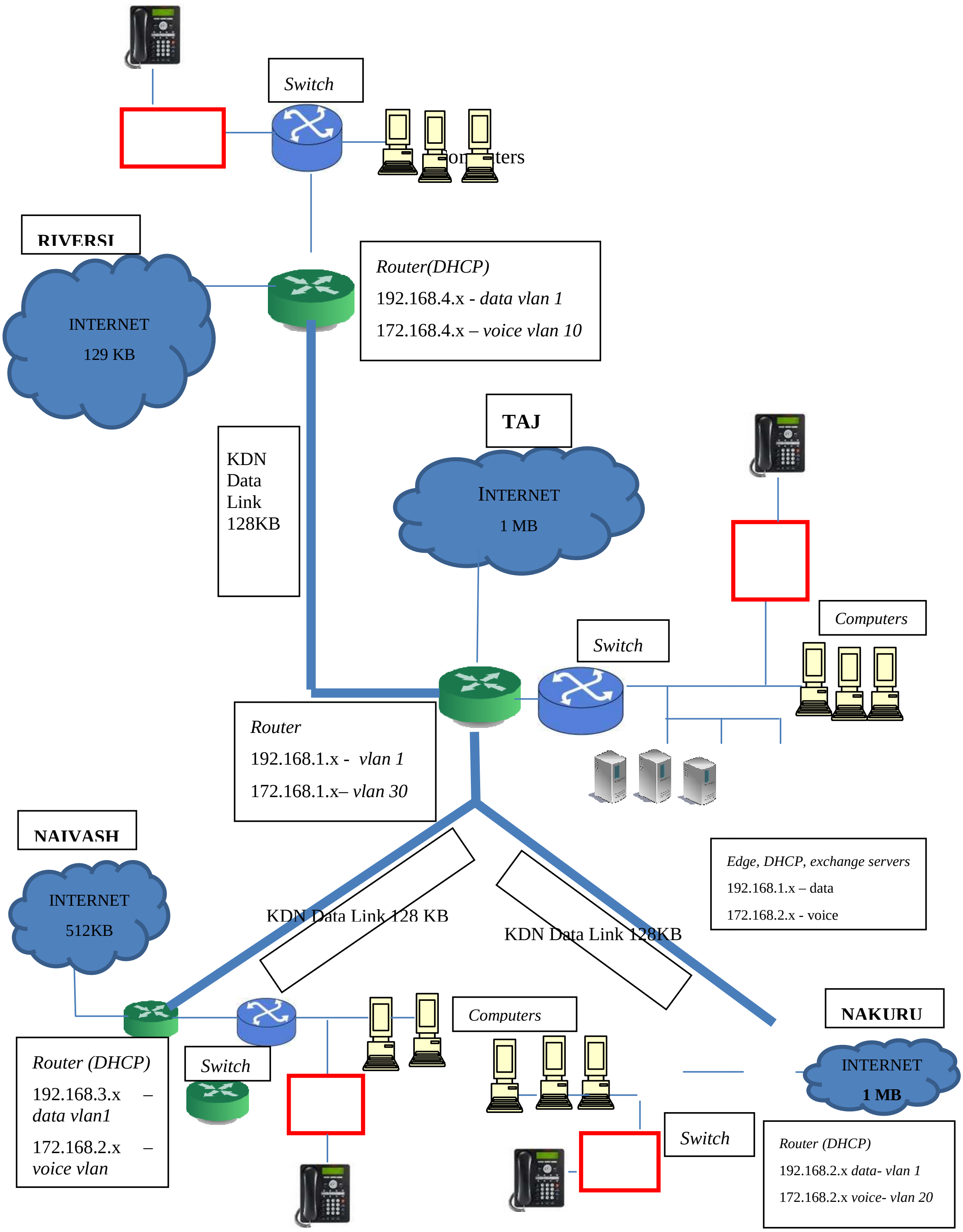
THE NETWORK

The current GDC topology is as shown in the figure below. Due to the rapid expansion and new systems being introduced, plans are currently in place to replace the link with high performing fibre connection at Riverside, Taj and Nakuru offices. This is especially to cater for the real time replication between the ERP servers at Riverside and Nakuru.

Understanding Virtualization:

Virtualization is a technique for hiding the physical characteristics of computing resources to simplify the way in which other systems, applications, or end users interact with those resources. Virtualization lets a single physical resource (such as a server, an operating system, an application, or storage device) appear as multiple logical resources; or making multiple physical resources (such as storage devices or servers) appear as a single logical resource. An application such as VMWare or Microsoft Virtual PC can let Windows run Linux or other applications and vice versa on a virtual PC.

Figure 1: Network Topology



Server virtualization, the most common, is the masking of server resources, including the number and identity of individual physical servers, processors, and operating systems, from server users. The server administrator uses a software application to divide one physical server into multiple isolated virtual environments. The virtual environments are sometimes called virtual private servers, but they are also known as guests, instances, containers or emulations.

Virtual machines are based on the host/guest paradigm. Each guest runs on a virtual imitation of the hardware layer. This approach allows the guest operating system to run without modifications. It also allows the administrator to create guests that use different operating systems. The guest has no knowledge of the host's operating system because it is not aware that it's not running on real hardware. It does, however, require real computing resources from the host - so it uses a hypervisor to coordinate instructions to the CPU. The hypervisor is called a virtual machine monitor (VMM). It validates all the guest-issued CPU instructions and manages any executed code that requires addition privileges. VMware and Microsoft Virtual Server both use the virtual machine model.

The paravirtual machine (PVM) model is also based on the host/guest paradigm -- and it uses a virtual machine monitor too. In the paravirtual machine model, however, the VMM actually modifies the guest operating system's code. This modification is called porting. Porting supports the VMM so it can utilize privileged systems calls sparingly. Like virtual machines, paravirtual machines are capable of running multiple operating systems. Xen and UML both use the paravirtual machine model.

Virtualization at the OS level works a little differently. It isn't based on the host/guest paradigm. In the OS level model, the host runs a single OS kernel as its core and exports operating system functionality to each of the guests. Guests must use the same operating system as the host, although different distributions of the same system are allowed. This distributed architecture eliminates system calls between layers, which reduces CPU usage overhead. It also requires that each partition remain strictly isolated from its neighbors so that a failure or security breach in one partition isn't able to affect any of the other partitions. In this model, common binaries and libraries on the same physical machine can be shared, allowing an OS level virtual server to host thousands of guests at the same time. Virtuozzo and Solaris Zones both use OS-level virtualization.

Server virtualization can be viewed as part of an overall virtualization trend in enterprise IT that includes storage virtualization, network virtualization, and workload management. This trend is one component in the development of autonomic computing, in which the server environment will be able to manage itself based on perceived activity. Server virtualization can be used to eliminate server sprawl, to make more efficient use of server resources, to improve server availability, to assist in disasterrecovery, testing and development, and to centralize server administration.

The potential for virtual server consolidation is extremely attractive to companies that specialize in providing and managing their client's network resources.

Any organization might face the challenges brought on by dozens - or even hundreds - of servers, but these companies can easily fill a data center with systems dedicated to their various clients.

THE BUSINESS VALUE OF VIRTUALIZATION

This 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.The figures used in this analysis were the results of a study done by an American research firm, International Data Corporation (IDC) and published in a white paper Gary, Chen et al ***"Understanding the Business Value of x86 Virtualization and the Benefits of Virtualization - Optimized Hardware"***. The discussion demonstrates the benefits GDC will earn by implementing virtualization.

Users per Server, ICT Manager

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 ICT infrastructure manager increases from approximately 2,300 to over 3,500.

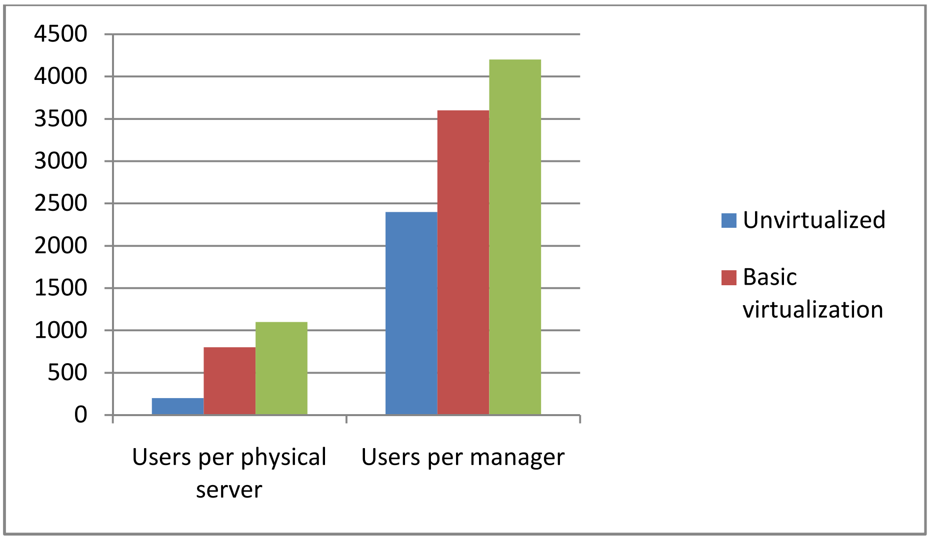


FIGURE 1

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

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

Servers per Manager, Downtime, Time to Launch, Time to Upgrade/Migrate

Figure 2 below provides several additional metrics that illustrate the impact of moving to avirtualized infrastructure. The number of physical servers per manager increases from17 in an unmanaged, unvirtualized environment to over 25 in a basic virtualizationenvironment and almost 30 in an advanced virtualization infrastructure.

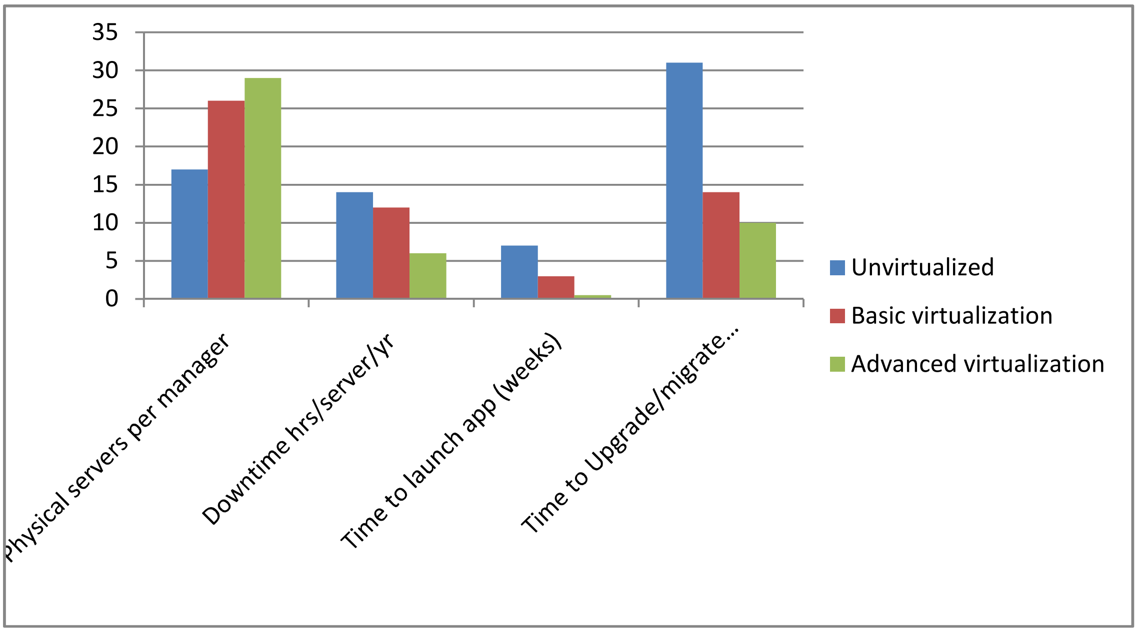


FIGURE 2

* 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:

- 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.
- 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.

Annual Costs per User

Except for software licensing schemas that enable unlimited instances per processor - for example, Windows Server 2008 Data Center allows unlimited OS instances perprocessor in a server - software costs generally remain consistent, or are evenslightly higher, after the move to a fully managed infrastructure. Hardware and staffing costs falldramatically in a move to a basic virtualizationscenario, and even further in advanced virtualization. In parallel, lost user productivity, the cost of downtime, drops mostsignificantly during a move from basic virtualization to advanced virtualization deployment.

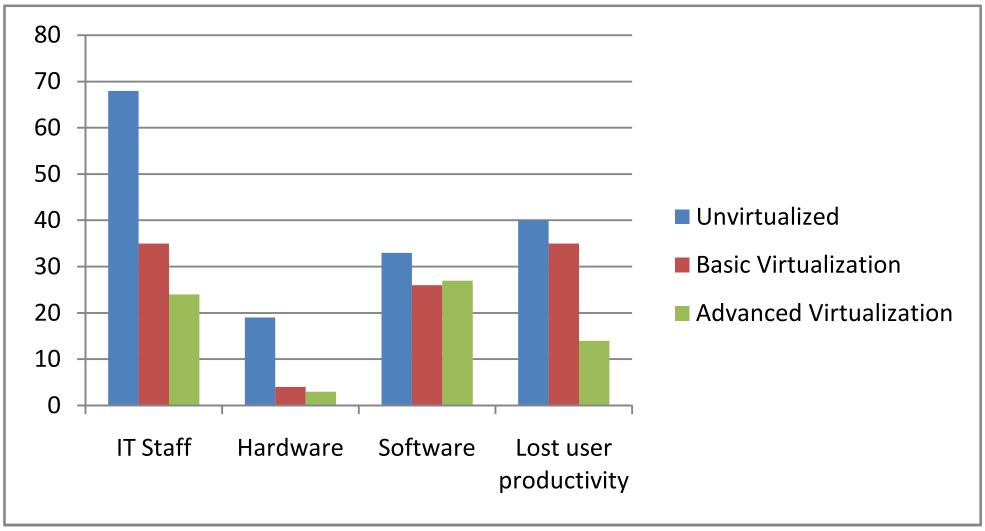


FIGURE 3

* 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

This indicate that the use of increasingly standardized operating systemimages deployed on hypervisors (with increasingly common sets of drivers anddevices) leads to more stable environments, a key contributor to the reduction incosts associated with supporting servers and the basic operating systemconfigurations run on those servers.

Cost Reduction

ICT labour cost savings can exceed 50% merely by a move to basic virtualization and over 70% in an advanced scenario.While hardware cost reductions are roughly equal across different levels ofvirtualization. An advanced virtualization scenario delivers reductions incosts due to downtime that are over 30 percentage points greater than those of abasic virtualization deployment. This cost savings alone, along with the less tangiblebusiness value that comes from greater systems availability, would likely justify muchof the investment costs associated with deploying an advanced virtualization environment.

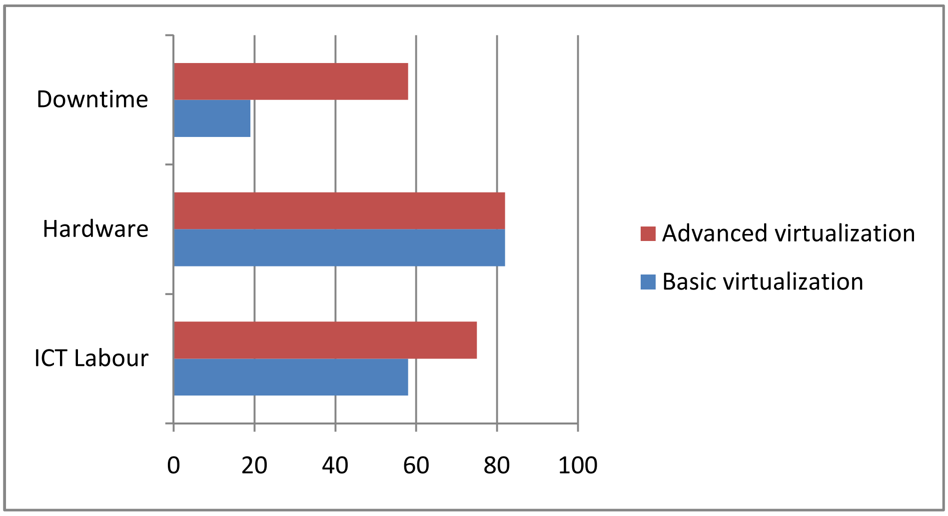


FIGURE 4

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

Agility Enhancement

There arebusiness benefits that come from using a management solution inan advanced virtualization environment. While initial deployment and/or redeploymentcosts are marginally reduced for an advanced virtualization deployment, it is possibleto achieve 36 points of incremental benefit from using management tools in anadvanced virtualization deployment, when used for the deployment of new software.Of course, even for a basic virtualization deployment, the cost savings versus thoseof an unvirtualized environment are dramatic.

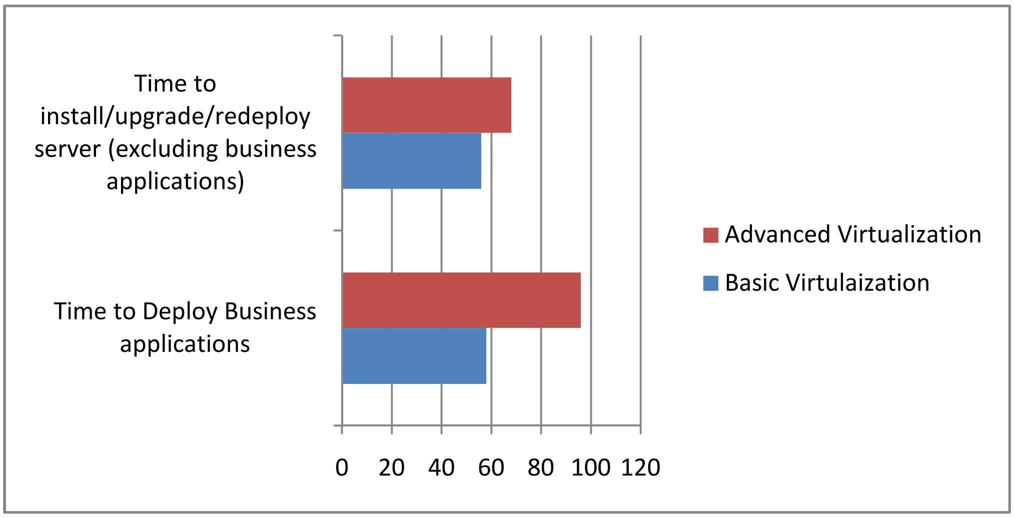


FIGURE 5

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

Annual TCO

Figure 6 presents an overall view of the annual TCO, comparing the three deployments. Customers moving from an unvirtualized environment to a basic virtualizationenvironment can lower their total annual costs by 39% per user per year. Organizations that move to advanced virtualization will realizea 59% cost savings per year per user compared with an unvirtualized environment.

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

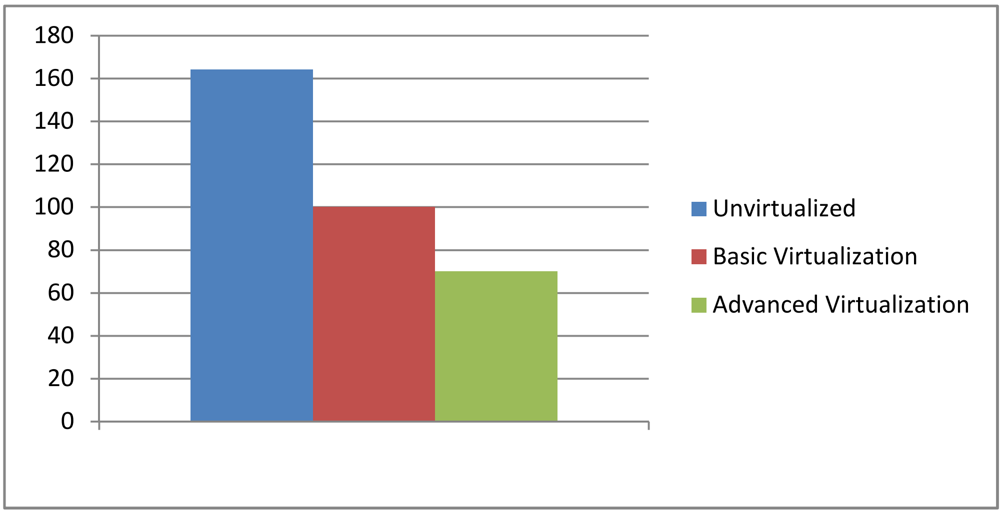


FIGURE 6

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

Return on Investment Calculations

By deploying basic virtualization GDC will realize costs savings of $163per user over three years with a total investment of $28 per user. An average company deploying basicvirtualization could see an ROI of 486% and payback in less than half a year - threeto four months - including deployment time. This is a very significant ROI for arelatively low-cost, low-risk initiative.

In the advanced virtualization scenario, average benefits increase by over 25%(primarily through enhanced ICT operations and user productivity cost reductions),while costs per user decline due to lower hardware costs.

CHALLENGES/OPPORTUNITIES

Any new technology faces challenges, and these challenges are usuallycounterbalanced against interesting new opportunities that the new technology canaddress. Virtualization software and the associated systems management tools thatenable an advanced virtualization deployment certainly face these factors.

Challenges

Moving from distributed to consolidated infrastructure - The data presentedin this paper clearly illustrates the business justification for moving toa virtualized infrastructure. With any new technology, the return always comesafter the investment. Therefore, an investment and executive backing are neededto spend money to save more money later.

Aligning and/or minimizing management tools in use - Most organizationshave multiple management tools in their infrastructure, along with proponents ordepartments that will resist consolidation aboard a smaller number of tools.

Consolidating version inconsistencies - Moving to an advanced virtualizationinfrastructure mandates having relatively high degrees of consistency in thevirtual servers that run on the infrastructure. This goal, as attractive as it sounds,is inconsistent with the deployments at a typical company. Therefore, thephysical-to-virtual migration/consolidation activities are not as simple,straightforward, and easily accomplished as the advertisements often suggest.

Up-front investment avoidance- While consolidating ona virtualized platform will certainly provide a positive ROI over time, many ICTdepartments may have difficulty securing the capital required to invest in the newsystems. Some ICT managers may find it easier to simply purchase a few moreservers to support what applications they need to in order to get them throughthe economic downturn rather than purchase, potentially expensive, systemsonto which to consolidate their infrastructure. Hardware costs alone can beenough to deter investment. However, additional software licensing costs for theleading virtualization applications can add up-front expense. Larger environmentswill also often incur additional up-front cost for more sophisticated managementtools to manage both physical and virtual environments.

Reeducating ICT on best practices - As with any new technology, there is arequired learning curve to understand best practices. For example, customersthat were once used to operating a diverse infrastructure with many different OSimages 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 asBIOS or DLL issues will no longer be as apparent. Instead, ICT will need todevelop skills around configuration of virtual machines and management of avirtual environment. Challenges lie in learning new license/usage compliancerules as well as transitioning skill sets from OS management to systems,configuration, and virtualization management.

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.

Opportunities

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 (Disaster Recovery) - 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.

Focus on reducing hypervisor overhead - 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 - 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.

Agility benefits - While agility benefits come first and foremost from having asolid management system in place, layering that solid management tool set ontop of a virtual infrastructure multiplies those benefits.

Green IT benefits - Moving to a virtualized infrastructure that reduces the numberof physical servers has a direct impact on power and cooling requirements andassociated carbon emissions. Even better, moving to a virtualized x86infrastructure may delay or eliminate the need for datacenter expansion. Forsome organizations, it may actually lead to datacenter consolidation.

Future-proofing (cloud computing readiness) - Virtual machines allow ITadministrators to get used to maintaining a logical environment as opposed toindividual 1:1 configurations. This will help to ease their transition to a cloudcomputing model that is based heavily in virtual assets, a trend that IDC expectsto greatly proliferate in the near future. In addition, virtualization of theinfrastructure is a key step to evolving to an internal cloud architecture, which will drive higher efficiency with the datacenter and enable interfacing with externalclouds.

IT consolidation - With virtualization, many physical servers and storage units can be consolidated into one virtual server or storage pool. This can result in a 10:1 or greater ratio of virtual servers on a single physical server. This helps stop physical server and storage sprawl and solve the problem of devices that are under-utilized, consume too much space, and cost too much to power, cool, and maintain.

Development and testing - Virtualization can also improve the efficiency of test and development environment. With virtualization, multiple operating systems and versions can be run on fewer servers and workstations. This helps support complex development and testing environments with limited resources.

CONCLUSION

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

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

These same technologies can lower costs directly through an immediate reduction ofpower and cooling costs and subsequently deliver a long-term benefit through lowerICT administrative costs that continue to benefit GDC year after year. These benefits accrue for integratedvirtual and physical management solutions available in the newly acquired IBM'sSystem BladeCenter virtualization portfolio.

GDC will gain better utilization of serverresources and reductions in acquisition, deployment, and power and cooling costs.Further, the long-term benefits of reducing staff costs and increasing business agilityleads to other long-term benefits that will continue for years to deliver returns on the investment required to put this solution in place.