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Global Headquarters: 5 Speen Street Framingham, MA 01701 USA P.508.872.8200 F.508.935.4015 www.idc.com

WHITE PAPER

Business Value of Virtualized IT: Ensuring That Your Virtualized Servers and Storage Work in Harmony

Sponsored by: Citrix and NetApp

Richard L. Villars Al Gillen
Randy Perry
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EXECUTIVE SUMMARY

The expansion in the range of applications and server environments that companies are deploying will have a significant effect on how they set up their datacenters (including server and storage systems). Organizations are now dealing with rapid data growth and the use of virtualized servers to boost IT asset utilization, improve application availability, and reduce administrative burdens.

The virtualization of servers is affecting organizations' storage network environments, their policies for provisioning capacity, and their storage management and data protection practices. As is often the case, storage assets allocated to virtualized servers can help deliver significant business value, but when deployed incorrectly, they can often lead to "unintended consequences" that quickly minimize or overwhelm the original business value associated with server virtualization. These unintended consequences include:

- Long and expensive network rearchitecting and storage migration projects
- Struggles to match the rapid provisioning associated with virtualized servers
- Significant storage "overprovisioning" as virtual machines (VMs) quickly proliferate

The key to overcoming these unintended consequences is to deploy a networked storage solution that is also virtualized. Such solutions enable:

- Flexible, rapid, and efficient allocation of tiered storage
- Nondisruptive application movement and data migration
- Efficient snapshot and replication of OS/application images and data for backup, test, and configuration purposes
- Enhanced availability and rapid recovery for applications and data

Citrix and NetApp are two suppliers of virtualization solutions that are working together to ensure that companies obtain the full business value of IT virtualization. IT managers that acquire server and storage products would be well served if they evaluate how the solutions offered by Citrix and NetApp can allow them to deploy a harmonious virtualized IT environment.

BUSINESS VALUE OF VIRTUALIZATION

This IDC White Paper takes a specific look at the business value associated with the movement from a nonvirtualized server infrastructure to a server infrastructure where hypervisor technology is an integral component of the overall system architecture. It then examines how the implementation of a virtualized networked storage environment ensures that the business can fully achieve the benefits of a virtualized server environment.

This analysis takes a specific look at the positive impact of solutions that improve storage asset utilization, reduce the administrative costs of provisioning new applications, and improve application availability. For the purpose of this IDC White Paper, we compare and contrast virtualization levels: 0 (nonvirtualized); I (basic server virtualization with no networked storage); II (standard virtualization, which includes the addition of networked storage); and III (advanced virtualization, which also virtualizes the networked storage). Level IV (dynamic virtualization) is a future state not yet fully deployed at even the most leading-edge IT organizations.

See the Appendix for a complete discussion of the Business Value of Virtualization (BVOV) methodology and terms.

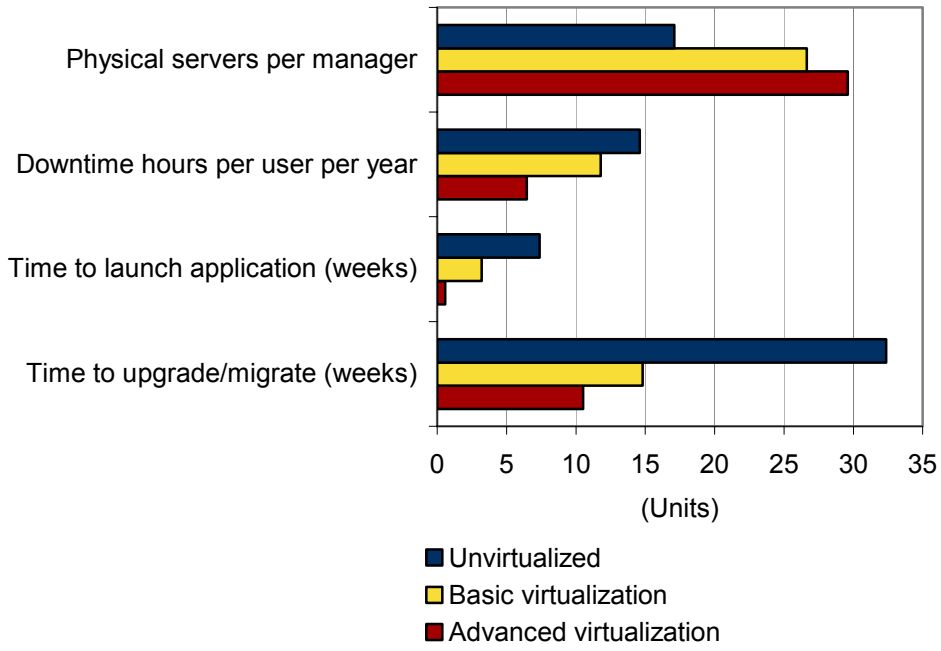
VALUE PROPOSITION OF SERVER VIRTUALIZATION

Since its emergence in the early 2000s, virtual machine and hypervisor software technology aboard x86 servers has quickly become one of the most talked-about new technologies in IT infrastructure. The ability to virtualize servers and reclaim excess capacity has caught the interest of datacenter managers who are facing difficult power and cooling problems, the need for additional IT capacity to react to market changes, and a lack of significant capital resources.

Today, the focus is increasingly on production-level consolidation. Aspects of virtualization such as performance management, availability, and flexibility that extend functionality beyond the base hypervisor are becoming the real differentiators. Figure 1 illustrates the impact of moving to a virtualized infrastructure. The number of physical servers per manager nearly doubles in an advanced virtualization infrastructure (which leverages virtualized network storage).

FIGURE 1

Business Value of Virtualized Server Deployment: IT Benchmarks



Source: IDC's Business Value of Virtualization Research, 2008

Figure 1 also illustrates the first business value elements that go beyond hard total cost of ownership (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 configuration 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 systems. All operating systems map to the same portfolio of drivers provided by the virtualization software.

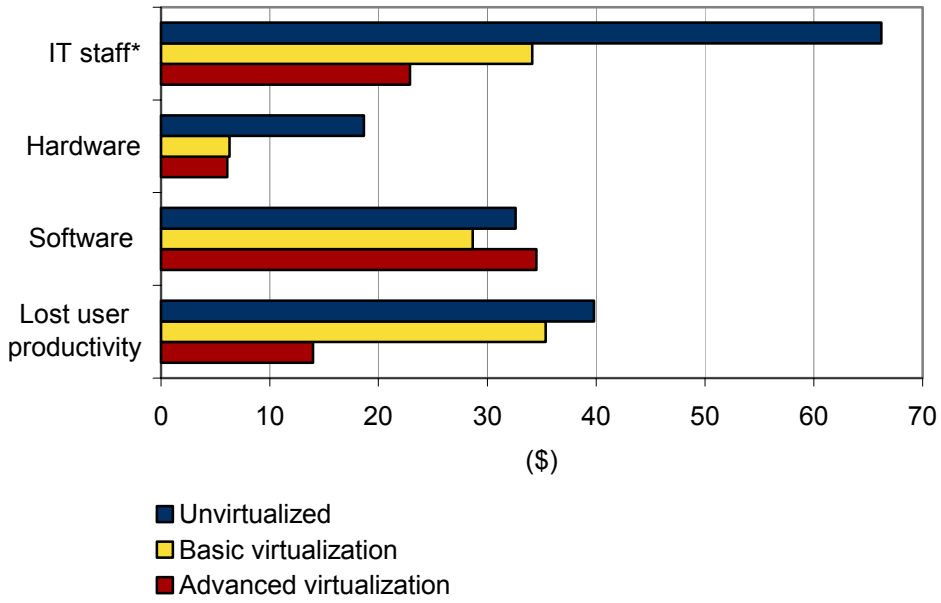
- **Ability to migrate workloads easily.** In the case of downtime reduction, operating systems can be moved from one server to another to facilitate repairs or maintenance, allowing the complete avoidance of lengthy downtime associated with that service (this requires use of networked storage to scale effectively). It is also possible to take this migration ability a step further and use it to support lower-cost disaster recovery of applications at remote locations.

- **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.

Figure 2 depicts the measurable cost-saving metrics that come with a move to a virtualized infrastructure.

FIGURE 2

Business Value of Virtualized Server Deployment: Annual Costs per User



Note: IT staff costs include full life cycle, support, and deployment; hardware costs include servers, storage, operating system, and applications.

Source: IDC's Business Value of Virtualization Research, 2008

Consistent with the findings of many previous IDC TCO studies, one of the most significant line items is the staffing costs. Unlike previous IDC studies, however, this study finds that a substantial drop in server staffing costs is realistic in a move to a basic virtualization scenario, with further gains in server and storage staffing costs possible with a move to an advanced virtualization scenario.

STORAGE FOR VIRTUALIZED SERVERS: THE CONSEQUENCES OF GOOD INTENTIONS

The expanded use of server virtualization solutions is having a profound effect on companies' overall IT investments, including development of new disaster recovery practices and a move toward a "services" delivery model for new applications. Less visibly at the business level, the effect of server virtualization on the underlying storage environment is quite complex.

The virtualization of servers is affecting organizations' storage network environments, their policies of provisioning capacity, and their storage management and data protection practices. As is often the case, storage assets allocated to virtualized servers can help deliver significant business value, but when deployed incorrectly, they can often lead to "unintended consequences" that quickly minimize or overwhelm the original business value associated with server virtualization.

The Shift to Networked Storage: Better Utilization Versus Network Bottlenecks

Server virtualization drives significant reductions in physical server assets. In advanced virtualization and dynamic virtualization cases, its extensive adoption can reduce the number of deployed servers by 50% or more. Virtualized servers are also much more likely to access networked storage which is a prerequisite for companies that want to take advantage of advanced features such as workload migration (e.g., XenMotion) and disaster recovery.

The value of moving to networked storage is well documented, but its usefulness was traditionally limited to larger, more data-intensive servers due to the up-front and ongoing management costs associated with SAN infrastructures. Even large companies, with thousands of servers, often limited use of networked storage to 10% to 20% of installed servers. Virtualized servers, running many applications concurrently now, make it possible to extend the value of networked storage to a majority of servers in the organization.

Virtualization-driven storage consolidation, however, comes with risks. We spoke with a number of companies that reported the following scenario: They began deploying 4 to 8 virtualized servers running 4 to 6 VMs each. These 16 to 48 VMs were connected via a SAN to a modular storage array with 4 SAN links. Over a 12-month period, they doubled the virtualized servers and doubled the number of VMs on each virtualized server (translating into 64 to 200 VMs) while still using only 4 storage links. As an unintended consequence, SAN performance and the modular array began showing major signs of stress. The storage administrators had to rearchitect existing SANs and undertake expensive, time-consuming storage migration projects (rebalancing assets across multiple arrays) to recalibrate the overall environment.

Rapid Storage Provisioning: Responsiveness Versus Overindulgence

Despite the significant boost in connections noted earlier, individual virtual servers are not currently major consumers of storage capacity (a reflection of the types of applications that ran on these consolidated systems). A number of companies reported, however, that their initial choice of networked storage platform for virtualized servers led to problems down the road. Many used systems that couldn't scale to meet performance requirements, triggering time-consuming and expensive system swaps.

Other companies placed the storage for their virtualized servers on their most expensive storage systems because that is where they had excess capacity. Not surprisingly, the cost of storage for more virtualized servers on these platforms severely limited potential cost savings. It also had the unintended consequence of

disrupting the often finely tuned performance characteristics of these systems, thereby threatening the performance of other mission-critical applications. IT managers yet again faced costly and time-consuming data migration projects.

Finally, this storage choice issue can be quickly exacerbated by the phenomenon of virtual server sprawl. Rapid response to requests for new processing and storage capacity is one of the key selling points of virtualization, but rapid provisioning of new VMs can quickly translates into two significant problems:

- Storage administrators face the challenge of keeping up with the rapid provisioning associated with virtualized servers. (It does no good to provision a new VM in minutes or hours if it still takes days to set up the underlying storage.)
- Administrators must also deal with "overprovisioning" of storage for VMs that can soon counteract the cost savings associated with server virtualization.

For storage administrators, virtualized storage solutions that provide rapid and "thin" storage provisioning and cross-system data migration/replication and deduplication of VM images on primary storage systems will play a critical role in enabling enterprisewide use of server virtualization technologies.

Configuration and Change Management: Ease of Use Versus Administrative Overload

The most significant long-term challenge of server virtualization for storage administrators isn't managing storage network performance or capacity growth. Rather, it is reducing the operational burden associated with backup/recovery as well as moves, adds, and changes for these virtual servers. We talked with a number of storage administrators who reported that backup and ongoing storage management were becoming bottlenecks to future expansion plans. They also reported that aggressive adoption of server virtualization quickly translated into a doubling, tripling, or even quadrupling of administrative workloads.

Resetting the Bar for Backup

Storage administrators need data protection solutions that allow them to better coordinate backup processes while also reducing duplication of backup data through single-instance copies and data deduplication.

Companies are trying to squeeze "more" backups through fewer physical servers. The backup window for individual virtualized servers is unchanged, but the physical servers are being used efficiently, so there are fewer cycles for backups and less time to complete all backups. Adding these new systems to the networked storage backup process also jeopardized existing backup windows for other applications and quickly consumed backup capacity resources on nearline and virtual tape storage systems.

Overcoming Storage Configuration Limitations

Storage solutions suppliers must present the utilization, availability, and operational benefits of virtualized block-level storage in terms that mesh with the expectations of the IT staff that are managing and growing virtualized server environments.

With regard to moves, adds, and changes, the main culprit is often the existing block-level networked storage environments. Any application modification (e.g., new servers, new storage, movement of users, or new functions) still typically requires a complex series of manual reconfigurations on end-user systems (files), servers (blocks or files), and storage arrays. These consume valuable IT staff resources, increase the potential for error (downtime), and contribute to increasingly long lead times in application deployment and modification. The addition of tens, hundreds, or thousands of VMs often leads to the unintended consequence of overwhelming storage administration teams.

Network technologies such as iSCSI and NPIV for FC address the basic connectivity issues. IT departments, however, increasingly want to pool diverse storage assets and applications while shielding server and application administrators from the complexities of physically provisioning, reconfiguring, and managing storage resources. They need solutions that introduce layers of logical abstraction (storage virtualization) between the physical ports on an array, the blocks of data on specific sets of disks, and the volumes or files that servers and applications need to access.

VALUE PROPOSITION OF NETWORKED AND VIRTUALIZED STORAGE

The expansion in applications and server environments that companies are deploying will have a significant effect on how they set up their datacenters (including server and storage systems). Storage systems suppliers are addressing these challenges by introducing layers of logical abstraction (storage virtualization) between the physical drives on an array and the data volumes that servers and applications access.

Table 1 shows the direct impact of moving virtualized servers to networked storage as well as the added benefit of leveraging advanced storage virtualization capabilities. Companies can significantly reduce the aggregate (wasted) storage capacity dedicated to individual applications. Merely shifting to networked storage for virtualized servers can reduce storage capacity dedicated to each server by almost 75%. Likewise, organizations can expect a threefold increase in the amount of storage administered per manager.

TABLE 1

Storage Efficiency Increase: IT Benchmarks

	Used Capacity	TB per IT Staff	Capacity (TB) Dedicated per Server
Nonvirtualized	20%	23.5	1.00
Basic virtualization	40%	41.4	0.50
Advanced virtualization	70%	72.4	0.29

Source: IDC, 2008

In Table 2, we also see the first business value elements that go beyond hard TCO data. A few items stand out and deserve discussion:

- **Flexible allocation of tiered storage.** Virtualized networked storage can leverage tiers of storage with different performance and cost characteristics, so administrators can assign applications to different storage pools.
- **Easy and nondisruptive data migration.** Data sets can be moved to more cost- or performance-oriented storage pools without disrupting server operations. Nondisruptive data migration also provides the flexibility to move virtual machine images as part of business continuity and disaster recovery efforts.
- **Efficient snapshot and replication of operating systems and applications for backup, 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.
- **Enhanced availability and rapid recovery for applications and data.** Companies can quickly restore applications by restarting them on another virtualized server. In many cases, this recovery can be automated, thereby reducing the need to use clustered solutions for high availability.

TABLE 2

Business Value of Virtualized Deployment: IT Benchmarks

IT Benchmarks	Physical Servers per Manager	Storage-Related Downtime Hours per Server per Year	Time to Launch Application (Weeks)
Nonvirtualized	17	3.200	7.37
Basic virtualization	27	0.032	3.19
Advanced virtualization	30	0.026	0.57

Source: IDC, 2008

Return on Investment Calculations

Companies that have deployed networked storage in conjunction with server virtualization (basic virtualization) as a replacement for existing standalone servers with internal or direct-attached storage are realizing costs savings of $5,274 per server over three years with a total investment of $1,075 per server. Using IDC's standard discount rate of 12%, the average company deploying this level of virtualization could see a return on investment (ROI) of 387% and payback in fewer than 10 months, including deployment time. This is a very significant ROI for a relatively low-cost, low-risk initiative.

In environments where companies use virtualized networked storage as well (advanced virtualization), average benefits increased by 139% (primarily through IT staffing savings), while hard costs per server decline by 73% because of lower hardware costs. Table 3 presents the ROI story associated with a move to a basic virtualization deployment or an advanced virtualization deployment.

TABLE 3

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

	Basic Virtualization	Advanced Virtualization
Total benefits	$5,274	$12,617
Total investment	$1,075	$1,635
Discounted benefits	$4,248	$9,871
Discounted investment	$873	$1,373
Net present value (NPV)	$3,375	$8,498
Return on investment (ROI)	387%	619%
Payback (months after deployment)	5.9	4.4
Discount rate	12.0%	12.0%

Source: IDC's Business Value of Virtualization Research, 2008

These findings make it clear that IT administrators can avoid significant pitfalls and gain significant additional benefits by deploying storage solutions that complement server virtualization solutions. The key capabilities to look for include:

- Virtual storage pools and thin provisioning that boost utilization rates and reduce IT administration overhead
- Performance monitoring and tuning solutions that allow administrators to proactively manage server/storage workloads
- Automated data migration, protection, and replication services that enable more automated and scalable business continuity in a local datacenter and at remote locations
- Space-efficient data copy and data deduplication capabilities that help administrators manage the proliferation of duplicate data

The next section of this IDC White Paper examines server and storage virtualization solutions from Citrix and NetApp and examines how leveraging both can help organizations run a more scalable and efficient virtualized datacenter.

THE CITRIX/NETAPP SOLUTION

Citrix Systems Inc. is a global provider of application delivery solutions. It provides an application delivery infrastructure and end-to-end virtualization platform that includes application virtualization for delivering Windows-based applications, server virtualization for delivering workloads across both physical and virtual servers, and desktop virtualization to ensure simple, secure, and cost-effective delivery of Windows desktops to users anywhere. The company is focused on ensuring that customers can reap significant benefits from the synergism its virtualization solutions deliver.

Citrix XenServer, the company's server virtualization solution, is based on the open source Xen hypervisor, which was created by the founders of XenSource. XenSource was acquired by Citrix in October 2007. Citrix XenServer extends the Xen hypervisor to include pooled server resource management, graphical and command-line management, and enhanced support for Microsoft Windows running in virtual machines. Since the acquisition, Citrix has enhanced the server provisioning capabilities of XenServer, including development of common provisioning for physical and virtual servers. As part of this ongoing work, Citrix recognizes that XenServer and its advanced functions must operate in coordination with back-end networked storage systems, such as those provided by NetApp.

NetApp Storage Solutions

NetApp is a provider of networked storage and information management solutions. It provides a broad portfolio of storage systems for small, medium-sized, and large businesses that are built on a common set of hardware and software components. From the hardware perspective, NetApp's solutions include multiple connectivity options (FC, iSCSI, NFS, and CIFS) on a common platform; multiple tiers of storage capacity that can be independently tuned and upgraded in terms of capacity, disk performance, or network performance; and platforms (V-Series) that can manage other vendors' storage (protecting past investments in storage systems).

NetApp's hardware foundation is complemented by advanced software capabilities that allow IT administrators to more easily set up, consistently manage, and quickly update all of their storage systems. These capabilities include advanced storage virtualization facilities including virtual volumes and thin provisioning; zero penalty snapshot copies that are also space efficient; data deduplication capability on primary storage, secondary storage, and archival storage; enhanced data protection capabilities (RAID-DP) for high-capacity SATA storage; and a suite of data copy and replication services for supporting requirements of both local and remote business continuity and regulatory compliance.

NetApp Adapter for XenServer

NetApp offers these capabilities across all server/application environments, and the company is working aggressively to make sure that these capabilities are easy to deploy and use behind virtual server environments such as XenServer. It provides an integrated adapter built right into XenServer, allowing server administrators to easily access and manage the associated NetApp storage directly from the same interfaces

(including the XenCenter console as well as the XenServer command line and XenAPI interfaces). Managers use functions such as fast snapshot and cloning, fast backup and recovery, RAID-DP, data deduplication, and thin provisioning.

Enabling management of these common storage functions within the same console increases server administrators' productivity as they no longer have to wait for a storage administrator to provision storage for a VM or provide a backup copy of lost data. By integrating storage operations into virtualization management operations, the number of tasks needed to be performed by the administrator is also reduced, eliminating work and potential error.

Challenges/Opportunities for Citrix and NetApp

For IT solutions providers such as Citrix and NetApp, the dynamic nature of the IT environment poses a number of challenges. Organizations, no matter how committed they are to virtualization, have a wide variety of IT products in place; therefore, whatever solutions they deploy must also provide value in existing nonvirtualized environments. Citrix and NetApp provide advanced solutions that allow large enterprises and midsize organizations to extend the value of virtualization deeper into their IT environments. Many of these functions also help companies better deliver improved services in nonvirtualized environments.

The biggest challenge for many companies that want to leverage capabilities such as rapid provisioning and rapid recovery is actually coordinating the use of each company's products. Citrix and NetApp are responding to this challenge by delivering a plug-in called an "adapter" with the latest version of XenServer. This adapter enables virtual machines to be provisioned, and advanced storage capabilities to be configured and managed, directly from the XenServer graphical and command line management interfaces, as well as from the XenCenter API. Citrix and NetApp must continue to tighten the integration of their management tools and further clarify the best practices and procedures for optimal operations.

Another major challenge for IT administrators expanding their use of virtualization (server and/or storage) is a potential loss of visibility into actual systems and application performance. This "loss" of visibility is a growing concern as companies expand their use of virtualized servers and storage in production environments. Both Citrix and NetApp need to deliver greater instrumentation and new performance management systems that make it possible to "break through" the virtualized layer and deliver true end-to-end performance monitoring. Only such visibility will allow organizations to leverage virtualization to automatically rebalance workloads based on performance and energy conditions.

The final challenge for Citrix and NetApp is to continue educating their business partners and customers on the benefits of setting up an environment that takes advantage of both virtualized server and virtualized networked storage capabilities. This coordinated effort will play a key role in helping midsize businesses build and use IT solutions that are consolidated, dynamic, and adaptable to future needs.

FINAL THOUGHTS AND ESSENTIAL GUIDANCE

IT managers at large and midsize enterprises are wrestling with many of the same challenges as they seek to extend the business value of virtualization. They are looking for server virtualization and networked storage solutions that improve the use of existing IT assets. Meeting these objectives, however, takes more than just selecting the right solution. They also need to make wise implementation decisions that shield them from costly system reconfigurations and storage migrations.

IT managers that acquire server and storage products must evaluate suppliers such as Citrix and NetApp, as well as their business partners, based on more than just who is providing the cheapest or highest-performing systems. IT managers need partners that can help them overcome or avoid the traditional shortcomings:

- Underuse of installed assets
- Less-than-optimal data/application availability
- Excessive administrative overhead

IT managers should judge suppliers based upon how well their complete solutions allow them to optimize the use of IT investments now and for an extended period. They also need to look for business partners that leverage emerging solutions to address specific application and business challenges while delivering faster, more consistent implementations with minimal risk of disruption to applications, processes, and business operations.

APPENDIX

BVOV Methodology

IDC analysts have initiated a wide range of TCO, ROI, and business value studies related to IT solutions over 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 server and storage environments.

Most often, the information in our database is captured during studies of specific platforms. In a typical study, IDC conducts interviews with a substantial number of end-user organizations — typically between 10 and 50 organizations. During that interview process, IDC captures 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, collection of servers, and supporting storage assets. A given study generally focuses on a particular architecture or operating system.

For the purpose of this business value analysis, we looked at x86 platforms running operating systems such as Windows and Linux. We also looked at the storage systems (direct attached and networked) that store the information used by these servers.

We applied this data against knowledge from several key areas:

- Current server and storage virtualization trends (drawing on research about current consolidation rates)
- 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)
- TCO/ROI study data from research done on the use of networked storage solutions

When these three sources of information are combined, the output produces a comparative evaluation of a virtualized infrastructure (both servers and storage) versus the same basic infrastructure used in a nonvirtualized environment.

Defining Virtualization Adoption Maturity

IDC analysts use a set of metrics to define the relative maturity of virtualization adoption. Table 4 shows the five discrete levels of virtualization maturity. For the purpose of this IDC White Paper, we compare and contrast virtualization levels 0 (nonvirtualized), I (basic virtualization), II (standard virtualization), and III (advanced virtualization). Dynamic virtualization is a future state not yet fully deployed at even the most leading-edge IT organizations.

TABLE 4

IDC Virtualization Maturity Index

Category	Virtualization Level	Description
Nonvirtualized	0	Physical x86 server/physical OS usage — no virtualization. No use of networked storage, with most servers using internal storage.
Basic virtualization	I	Basic x86 server consolidation using virtualization, commonly used in test and development scenarios, but production use is not widespread. Limited use of direct-attached and networked storage. No advanced functionality such as live migration; automation and management are limited or applied selectively.
Standard virtualization (with networked storage)	II	Includes a mixture of uses ranging from test and development, to static server consolidation, to a mix of production workloads. This scenario includes limited use of dynamic capabilities. Penetration could exceed 15% of x86 servers. It leverages networked storage (NAS or SAN) to boost storage asset utilization and may use advanced features such as live migration for limited set of application workloads.
Advanced virtualization (with virtualized storage)	III	Widely virtualized infrastructure (>25%) includes both server virtualization and storage virtualization for virtual volumes, thin provisioning, and data replications. Management tools along with automation such as workload redistribution and automatic workload migration used both on live VMs and on cold OS images. Live migration used both for meeting service-level agreements and for availability purposes.
Dynamic virtualization	IV	Majority of x86 systems (>50%) use hypervisors. Live migration, active image, and workload management used comprehensively so new systems go online virtualized. Storage resources extensively virtualized across multiple locations. Moving to adopt network and I/O virtualization as those technologies emerge.

Source: IDC's Business Value of Virtualization Research, 2008

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 describes nonquantifiable (or difficult-to-quantify) factors ranging from adherence to standards, asset management, application availability, application deployment and deployment, performance considerations, as well as 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 or the time saved by not having to disrupt applications during upgrades or data migrations. 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.

This IDC White Paper compares environments at four of the five levels: nonvirtualized, basic virtualization, standard virtualization, and advanced virtualization. In this study, our assumptions are that a server in an nonvirtualized environment will be provisioned at under 10% capacity in terms of both processing and storage utilization.

By comparison, a server deployed in a basic virtualization environment will be provisioned at from 20% to 40% capacity for processors but still under 20% for storage, while a server in an advanced virtualization environment will be highly leveraged and will be provisioned to consume 40% to 60% or more of that server's capacity on a day-to-day basis. Storage utilization rates will be over 50%.

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. Those organizations are predominantly headquartered in North America.

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

1. **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-processor servers in virtualized and nonvirtualized configurations. Metrics calculated in this model include storage capacity allocated per server, users per server, users per IT staff, hours of downtime, and support hours of IT staff by server and storage support activities. These values are then used to calculate operations and user productivity costs, as well as to determine metrics associated with server and storage configurations and costs, which are then compared with standard hardware, software, and datacenter infrastructure costs.

2. **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.

3. **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 the story is strong for a three-year payback.

IDC uses a discounted cash flow methodology to conduct ROI analysis. The elements in Table 3 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).
- **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 provides 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.