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The Economics of Virtualization: Moving Toward an Application-Based Cost Model

Sponsored by: VMware

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IDC OPINION

Server virtualization technologies have quickly become the default platform for today's datacenters. IT organizations are putting in place formal virtualization deployment policies and are strongly incenting application owners to use virtualized servers rather than offer standalone, dedicated servers on a per-application basis. In fact, IDC estimates that more than 50% of all server workloads today are deployed in a virtual machine (VM). As a result of this adoption, customers are now rethinking their approaches to quantifying the up-front and ongoing management costs associated with supporting their new virtualized server environment. Leading IT organizations are switching from the traditional server-based cost model to an *application-based cost model* because many applications, each in their own virtual machine, can now run on a single server.

- Rather than plan and budget for servers, organizations are now planning and budgeting for application instances, recognizing that with virtualization and multiple application instances per server, applications become the driving variable. These application-based cost models are helping customers to redefine metrics for the datacenter. For the purposes of this paper, we define an application as a single operating system (OS) instance and its associated workload.
- When one considers application-based cost models, what becomes increasingly important is VM density, or the number of virtual machines that can be supported on a single physical server. As VM density increases, application-based costs decline.
- As organizations invest in virtualization environments, they are creating "pools" of compute, network, and storage resources that allow them to scale their IT infrastructure as business demands dictate. Pools of compute allow IT organizations to continue to support growth in the application portfolio without a traditional linear increase in cost. Customers not only are reporting significant savings on server hardware but also are beginning to realize benefit from improved availability as compute pools allow them the flexibility to move virtual machines across physical servers.
- Application-based costing is a new metric required for the transformation of the datacenter. Historical efficiency metrics such as "servers per systems administrator" are being replaced with "applications per systems administrator," "OS instances per systems administrator," or "virtual machines per system administrator." Customers should now consider application portfolio–based costing rather than the increasingly less relevant server-based cost models of the past.

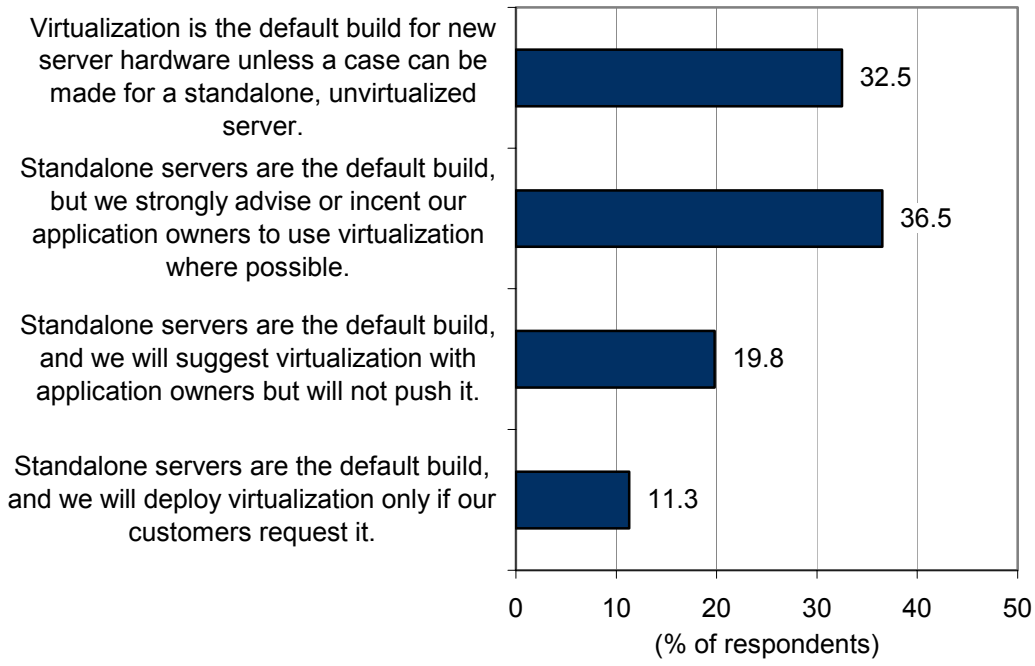
DATACENTER PARADIGM SHIFT

Server virtualization has become the "killer app" for the datacenter. Virtualization technologies have completely transformed the way in which customers build, deploy, and manage their systems infrastructure. Virtualization tools allow multiple logical servers or "virtual machines" to run on a single physical server. By consolidating applications onto fewer physical servers, customers have been able to slow the sprawl of physical servers within their datacenters. In fact, most datacenters today report that virtualization has become the default build for new server installations (see Figure 1).

FIGURE 1

Server Virtualization Adoption

Q. Which of the following statements most closely describes the build decision for NEW server hardware at your organization?



n = 400

Source: IDC's Server Virtualization Multiclient Study, 2008

IDC expects that for the next several years there will be considerable investment in building out IT environments in support of virtualized workloads. We predict that by 2012, more than 60% of all server workloads will run inside a virtual machine compared with just over 50% today. As customers convert their systems infrastructure from a dedicated model to a shared resource, they are also changing their approach to the procurement of servers, storage, and networking infrastructure to increase the total number of applications that can be supported across their system resources. Specifically, customers have taken steps to increase the density of virtual machines supported per server. By driving higher consolidation rates on their physical servers, customers are able to maximize their investments in systems hardware, software, and datacenter facilities.

The Sprawling Datacenter

Over the past 16 years, IDC has tracked the changing landscape of the datacenter. During this time, we have observed a dramatic shift in both the types and the numbers of technologies installed. For many years, the strategy for IT sites has been to install at least one physical server per application, and often three to five servers per application, when taking into account test/development, staging, and disaster recovery environments. This has led to an explosion in the number of physical systems and devices installed and has resulted in multiple distributed IT sites to support the ever growing population of installed servers and storage systems. IDC's measurement data depicted in Figure 2 demonstrates the rising costs and management burdens of the datacenter over time. As a result, IT organizations now face the following challenges in operating today's datacenter:

- **Physical server sprawl.** The number of installed physical servers has increased sixfold from just over 5 million in 1996 to more than 30 million in 2008. This increase is due to the rapid adoption of x86-based architecture. More than 90% of all installed servers today are x86-based systems compared with just 60% in 1996. As a consequence of the huge numbers of installed servers, staffing costs on systems maintenance have risen 600% to over $120 billion annually, and the cost to power and cool installed servers has more than tripled from $2 billion to $10 billion per year during that same period. IDC projects that these costs will continue to escalate unless new management frameworks and policies are implemented.

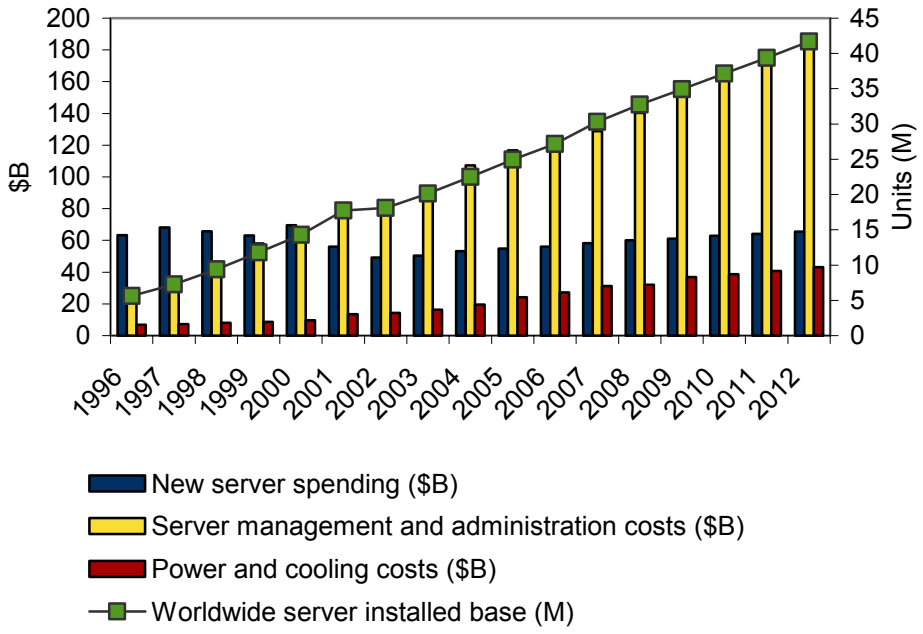
- **Overprovisioning and underutilized assets.** While the rise in the number of installed systems has been dramatic, equally concerning is the low utilization of these servers. Most applications consume a fraction of a server's total capacity, averaging 5–10% utilization on a typical x86 server.

- **Lack of integrated management tools and service management frameworks.** With any sprawl such as this, it is not surprising that customers have multiple, disparate systems management tools in place that have both unique and overlapping functionality. Many customers have underinvested in systems management and automation tools relative to the investments they have made in systems infrastructure. This has meant that many datacenters employ manually intensive processes, including the integration of service management frameworks, resulting in greater burdens on staffing.

- **Aging facilities.** The average age of a datacenter in the United States is 12 years. This means that the typical datacenter was built to support a substantially smaller number of servers that required far less power and cooling, rack space, and cabling. IDC has observed that this factor has caused a substantial replacement of older sites with newer datacenters, as well as the retrofit of existing datacenters.

FIGURE 2

Worldwide IT Spending on Servers, Power and Cooling, and Management/Administration, 1996–2012



Source: IDC, 2008

Mainstream Server Virtualization Adoption

Leading organizations have found that effective server virtualization directly addresses each of the datacenter challenges discussed earlier. Customers have seen virtualization reduce server sprawl, increase server utilization, ease management, and avoid datacenter facility outgrowth. Server virtualization has also completely changed the economic model of today's datacenter. By deploying multiple applications on a physical server, customers are now able to drive higher levels of efficiencies in both IT infrastructure and IT staff. Even as they become more efficient, IT organizations deploying virtualization technologies, at the same time, have improved availability, reduced disaster risk, and become more responsive to their end customers by leveraging the following benefits:

- **Physical server consolidation.** Consolidation remains the main driver for deploying virtualization technologies today. The amount of server hardware deployed can be substantially reduced, leading to lower up-front and ongoing hardware cost savings. Specifically, consolidating multiple applications on a single server requires fewer physical systems to be purchased in support of a growing application portfolio. The follow-on benefits include fewer hardware maintenance agreements as well as a reduced burden on systems administrators by saving time on procuring, deploying, and maintaining multiple systems. Other direct benefits include reduced energy demands for the datacenter and lower requirements for floor space and rack space.

- **Improved availability and disaster recovery.** Customers are increasingly creating a business case for virtual hardware based on reducing system downtime. Mobility tools offer customers the ability to migrate a virtual machine from one piece of physical server hardware to another. These tools were initially deployed when an application required additional hardware resources; however, customers have found these technologies particularly useful for reducing planned downtime and alleviating the pressure on shrinking maintenance windows. Mobility tools are also used to combat unplanned downtime and can be used alone or in conjunction with existing high-availability tools such as clustering and replication. Over time, we expect that customers will be able to regularly move virtual machines not just across the datacenter floor but also from one site to another, creating a new paradigm for disaster recovery.

- **Improved flexibility.** Virtualization has allowed customers to be more responsive to the business. Virtual server deployments can literally reduce the time to deploy a server to minutes compared with days or even weeks for a physical server deployment, meaning that time to market is significantly reduced. Virtualization also decouples the server hardware from the application, meaning maintenance of legacy applications is greatly simplified.

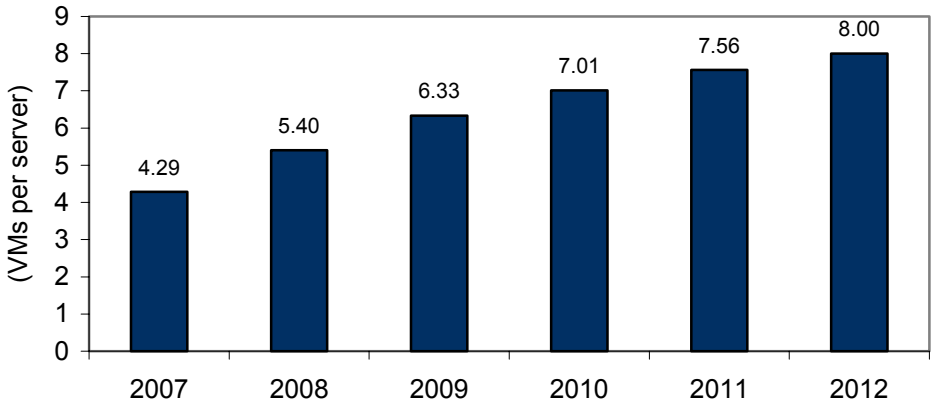
As a result of the direct and indirect benefits from server virtualization, adoption continues to rise at a dramatic rate among IT organizations. Both the penetration of virtualization and the number of virtual machines that are being deployed on physical systems are increasing.

Virtual Machine Densities on the Rise

Until recently, customers have had modest goals for the number of virtual machines installed per physical server. After years of building in overhead on hardware resources to help guarantee service-level agreements (SLAs), many customers were happy to take utilization of their servers from 5% or 10% to 30% or 40% of capacity. This has meant that on average, the ratio of VMs to servers has been approximately 5 to 1. IDC expects that VM densities will double from 2007 to 2012, from 4.3 VMs per server on average to 8 VMs per server (see Figure 3). This ratio obviously changes depending on the hardware configuration — clearly the richer the system configuration, the greater the number of VMs installed. IDC routinely sees customers standardizing on consolidation ratios of 10 or 12 to 1 and leading-edge customers deploying 25, 30, or even 40 VMs per physical server. Figure 4 demonstrates the average number of VMs deployed per physical server, according to a recent IDC survey of 400 systems administrators.

FIGURE 3

Server Virtualization Densities, 2007–2012



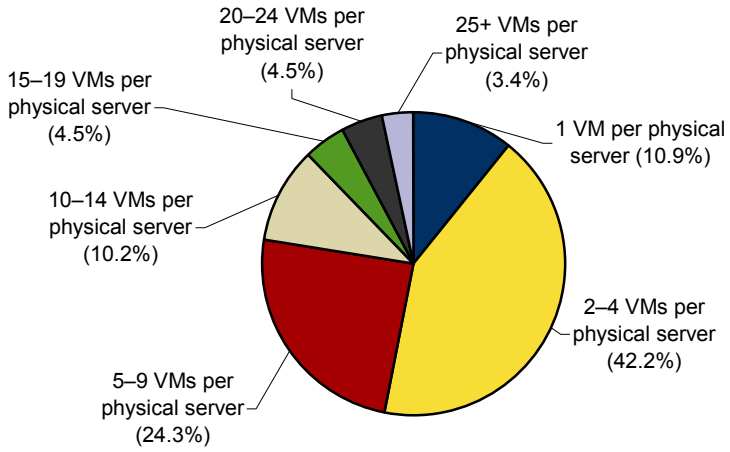
n = 400

Source: IDC's Server Virtualization Multiclient Study, 2008

FIGURE 4

Server Virtualization Densities, 2008

Q. Thinking of all your virtualized servers, estimate the percent that fall into each of the following consolidation ranges of virtual servers to physical servers [must sum to 100%].



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Source: IDC's Server Virtualization Multiclient Study, 2008

IDC research shows that customers are expecting to achieve utilization rates of 60–80% on their hardware. This goal, in combination with future hardware and software improvements in multicore processor technology, memory addressability, and I/O optimization, will allow customers to continue to improve their VM density levels. Also critical to the success of virtualization are improvements in reliability, particularly as greater numbers of applications become dependent on fewer numbers of physical servers. More powerful and reliable systems will be fundamental to the ongoing success of virtualization. We expect five advances in both infrastructure technology and infrastructure practice to continue to significantly advance VM density:

- **Increased use of mobility tools for workload balancing and high availability.** One of the important precursors to increasing VM densities is the ongoing adoption of mobility tools for the use of high availability. As the numbers of applications per physical server rise, so too does the disruption to users and transactions should the hardware fail. While many customers today implement mobility tools to avoid planned downtime and improve maintenance windows, the increased use of these tools for workload balancing, unplanned downtime, and disaster recovery will be very important to avoiding the dangers of "placing all their eggs in one basket." To this end, customers have to plan carefully to ensure that sufficient resources are available to the pool of virtualization resources should hardware overcommit or fail and a significant number of applications be moved to another physical server. Software and hardware advances also mean that the overhead on physical systems is declining, providing additional spare resources to enable mobility.

- **Exploiting hardware assist technologies.** Significant innovation has taken place over the past several years to embed virtualization assist technologies within systems hardware. These technologies provide more direct access to hardware and help offload software execution. This is particularly evident among the major processing vendors with processor-level improvements built specifically for the performance of virtual workloads. Intel VT-x, VT-c, and VT-d technologies and AMD-V technologies are making modifications at code execution to address virtualization overhead and provide more direct access to physical memory, storage, I/O, and networking. Additionally, as multicore technologies continue to improve over time, customers will have increasing opportunities to drive up VM densities with the growth in the number of cores per processor. In fact, virtualization actually unlocks the full potential of multicore systems, and customers will be looking to balance out other systems technologies.

- **Improved memory access.** Given the advancements in multicore technologies, customers report today that the biggest constraint on increasing VM densities lies in the ability to access memory on a physical system. Software innovations, such as memory overcommit from VMware, enable customers to provision more memory to virtual machines than is available on a physical host by sharing memory pages between VMs. In addition to software improvements, we continue to see customers buying server hardware with large numbers of DIMM slots to support additional physical memory. Typically, we see virtualized x86 servers with 32GB of RAM compared with 4GB of RAM on unvirtualized servers.

- **Integrated systems purpose built for virtualization.** Increasingly OEMs are delivering purpose-built servers that are designed from the ground up to support virtual machines. These are tightly integrated server, storage, and networking systems that seek to reduce the complexities in bringing together different environments and devices. While these systems tend to be more proprietary in nature, the trade-off is in simplifying deployment and maintenance. These systems also have large memory footprints and specialized technologies to reduce virtualization overheads.

- **Accelerated use of best practices and policy-based automation tools to alleviate IT staff burden.** As the number of virtual machine instances increases dramatically, customers are obligated to reevaluate their existing deployment and management policies to move from a static infrastructure to a virtualized and increasingly mobile infrastructure. The management of virtual machines today remains fairly manual, and without implementing best practices along with tools that automatically readjust hardware resource based on application SLAs, the burden on systems administrators continues to climb. Until customers automate the mobility of virtual machines, administrators are left with the ongoing task of manual patch management and updates. While there is good benefit today from virtualization in lowering the deployment and installation effort, substantial systems administrator benefits are difficult to realize without automation.

The Customer Benefits of Increased Virtualization Densities

Now that customers are deploying more mature virtualization environments and are able to make use of newer, more efficient hardware, the increasing VM densities become a function of the ability to drive significantly higher utilization rates on server infrastructure. By leveraging the combined resources of a set of systems, customers are starting to take a new approach to capacity planning, IT budgeting, and cost allocation. Rather than implementing a server-based budgeting paradigm, they are implementing a budgeting framework that spotlights applications or virtual images as the prime and central variable. Leading IT organizations are already switching from the traditional server-based cost model to an application-based cost model.

Application-Based Cost Models

There is no doubt that significant server hardware savings are associated with virtualization. Consolidation on its own has many benefits that deliver very real savings for customers. As shown in Figure 5, customers see the following major areas of hard cost savings:

- Server, storage, and network hardware costs
- Power and cooling savings
- Real estate and rack space reduction
- Software licensing

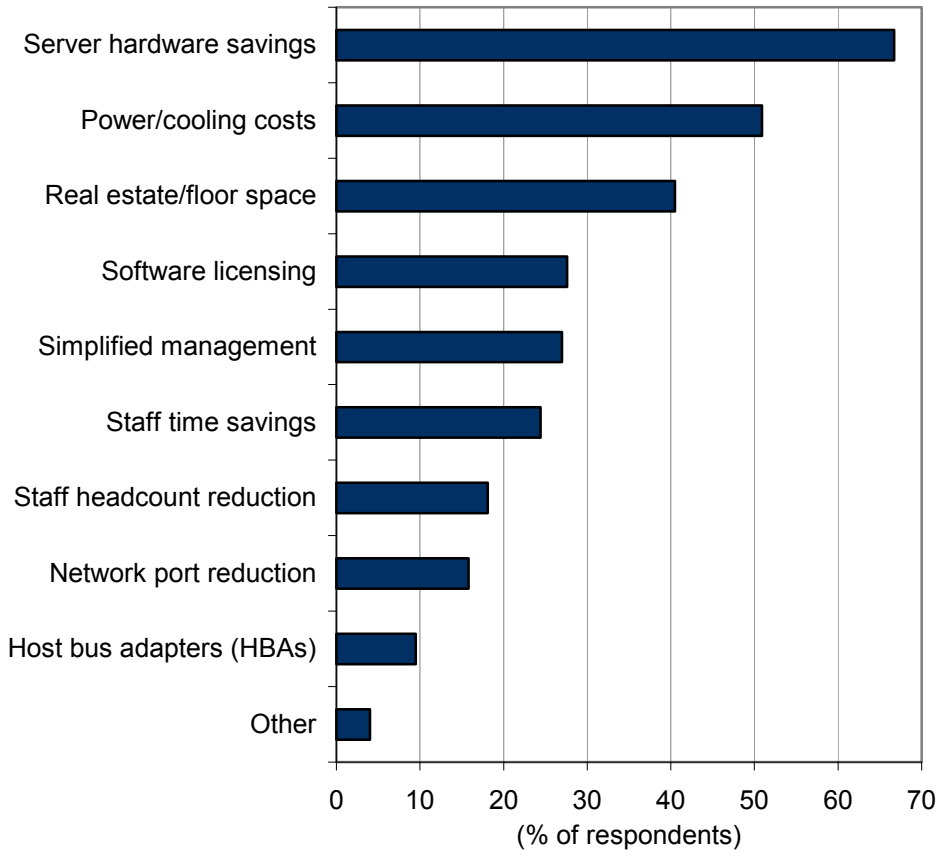
- Simplified management
- Savings on IT staff time

Customers are finding that as their virtual environments expand, they are able to achieve higher levels of utilization on their virtualized servers and that adding new servers — albeit virtual — comes at very minimal cost. In essence, by putting in place a pool of compute resources, customers have more options when adding new virtual machines, and their ability to scale applications with the demands of the business dramatically improves without incurring the traditional linear cost increases for hardware.

FIGURE 5

Areas of Savings Through Virtualization

Q. What were the top three areas of savings with server virtualization?



n = 400

Source: IDC's Server Virtualization Multiclient Study, 2008

Customer Case Study: Landmark Healthcare

Table 1 provides a customer profile of Landmark Healthcare.

TABLE 1

Landmark Healthcare Customer Profile

Industry	Health insurance provider specializing in claims processing and claims analysis for chiropractic medicine
Revenue	$20+ million
Number of employees	108
Number of physical servers installed prior to virtualization (2008)	96
Number of physical servers installed at completed virtualization — phase 1 (2009)	39
Number of physical servers installed at completed virtualization — phase 2 (2010)	3
Savings from virtualization	Annualized costs per application dropped 40% from $1,514 to $894

Source: Landmark Health Insurance

Company Profile

Landmark Healthcare is an insurance provider for chiropractic medicine. The company is transitioning its business from that of a pure-play insurance company to specializing in claims processing and claims analytics for other healthcare providers.

Situation

As a result of the change in Landmark's business, the company has experienced significant growth in its server and storage infrastructure as it moves toward a highly transactional-based business. Its applications are primarily homegrown in support of data processing and data analytics activities for its claims applications. Landmark turned to virtualized solutions to lower the up-front costs of new server hardware and desktops and to reduce the time to deploy new systems infrastructure.

Virtualization Solution

Landmark started virtualizing both servers and desktops 12 months ago using VMware. During this time, Landmark has consolidated 64 server-based applications onto 3 physical servers and 15 desktops onto 2 physical servers. Its virtualized applications are mission critical, supporting the company's core business operations as well as being client facing. The company plans to deploy all new applications on virtual machines and also consolidate 35 applications that remain on standalone servers to virtualized servers. In addition, the company plans to move 100 desktops to virtual servers. All applications are now considered candidates for virtualization at Landmark. The only applications that may remain on dedicated physical servers are those needing specialized hardware device drivers, such as fax servers and Web servers.

Major Benefits of Virtualization

- Reduced spend on server hardware while removing older, unreliable server hardware
- Lowered power and cooling demands on the server room
- Reduced floor and rack space by consolidating nine racks of equipment to two racks and streamlined the server room to improve the customer walkthrough experience
- Improved server utilization
- Increased IT management productivity (more systems run per administrator) and faster time to market (VMs are deployed in hours compared with weeks for physical servers.)
- Reduced costs for backup software, operating system, and database licensing
- Improved performance of applications compared with performance on older servers and desktops
- Improved application availability by eliminating planned downtime for server maintenance and shorter recovery time objective (RTO) and recovery point objective (RPO) in case of unplanned downtime

Key Takeaways from Landmark Case

- The organization found that in the first year, as it moved from a dedicated server environment to three virtual servers running both Windows and Linux, annualized costs per application dropped 40% from $1,514 to $894.
- The number of installed servers dropped from 96 to 35 in the first year and is expected to decline to just 3 in 2009.
- Despite additional investments in a new storage infrastructure to enable high-availability features (i.e., VMware HA, VMotion, VMware Fault Tolerance, and Data Recovery) by virtualizing all its applications, Landmark expects to see a 60% reduction in its annual costs per application compared with its physical environment.
- The key to this business case lies in the ability of Landmark to drive up VM densities by significantly increasing the number of applications per physical server. With an increasing dependence on a smaller set of server hardware, the requirement for near zero downtime becomes table stakes for supporting its business. This midsize business has realized that by continuing to invest in a pool of infrastructure, it is able to lower its annual costs per application while building a more robust solution that can support the growing needs of the business.

Phase 1: Server Consolidation — Virtualized 64 Applications on 3 Servers

Landmark has a total of 96 server-based applications installed (80% Windows and 20% Linux) and started virtualizing its server infrastructure as part of an overall consolidation project in 2008. In total, Landmark moved 64 of its applications to virtual servers, and in the process, its annual cost per application declined by 40% from $1,514 to $894 (see Table 2). Landmark also consolidated 15 desktops onto two older servers; however, these figures are not included in the analysis in this paper.

TABLE 2

Business Case for Moving to Virtualization: 2008 Annualized Costs

	Partially Virtualized Infrastructure 2008		Physical Deployment 2008	
Server hardware	$24,539	35 installed servers + 3 new servers (2 x single socket x quad core + 1 x dual socket x quad core)	$58,406	96 installed servers
Storage hardware	$–		$–	Direct-attached storage only
Networks: switches	$12,979	Two new switches purchased	$12,979	8 installed switches
Virtualization software	$3,600	VMware Infrastructure 3 Foundation and vCenter Foundation (Acc. Kit)	NA	
Systems management software	$2,466	Costs for server-based backup	$6,230	Costs for server-based backup
Operating system licensing	$13,394	25 Windows Standard Server licenses + 4 Processor Windows Datacenter Server licenses for 3 new servers	$16,861	92 Windows Standard Server licenses
Databases	$16,188	12 SQL Standard licenses	$16,188	12 SQL Standard licenses
Power and cooling costs	$12,640	Electricity costs for 38 servers	$34,671	Electricity costs for 96 servers
Total	$85,807		$145,336	
Number of applications	96		96	
Number of installed physical servers	35		96	
Virtual machine density (applications per physical server)	21		NA	
Cost per application	$894		$1,514	

Note: All pricing reflects Landmark's annualized costs and street pricing inclusive of discounts.

Source: Landmark Healthcare, 2009

Landmark made limited investments as it built out its virtualized server environment with VMware ESX. It purchased three new servers: two single-socket, quad-core systems and one dual-socket, quad-core server. The 64 applications on these virtualized servers are primarily for data transactions and data analytics, core to Landmark's business, but with modest memory and I/O requirements. As a result of the limited hardware demands from its applications and the utilization of memory overcommit functionality in VMware ESX, Landmark was able to achieve average consolidation ratios of 21 applications per server. This is more than four times the industry average, and improvements in VM density over time will be a critical success factor for the company in driving down costs per application while continuing to respond to the needs of the business.

By moving its applications to virtual machines, Landmark was able to replace aging white-box servers with newer, more reliable systems. The net result is a more capable server environment with half the number of installed servers in its server room, resulting in lower real estate requirements and lower energy demands.

Landmark did not reduce staff as part of this consolidation; however, it is able to continue to grow its application environment with the same number of staff due to the fact that it spends less time on server deployments and hardware maintenance.

Phase 2: 100% Virtualized Infrastructure with Always-on IT

Landmark has realized that the benefits of virtualization extend much further than server consolidation and has decided to invest in adding the necessary hardware and software components to move to a fully virtualized datacenter. Landmark is building a pool of server, storage, and networking resources that can drive up virtual machine densities while improving overall application availability. As more of its environment becomes consolidated on fewer servers, improved availability and uptime becomes a requirement. While Landmark expects to minimize costs on a per-application basis over time, it recognizes that it will need to invest in a different type of infrastructure as it moves forward. Initially, Landmark's cost per application continues to decline (see Table 3) to $643; however, as its storage environment grows in relation to the increase in the number of applications supported, cost per application will increase to just over $800. The change in its infrastructure environment shifts from what used to be incremental costs for server hardware to incremental costs for storage hardware.

TABLE 3

Highly Available Virtualized Infrastructure

	Highly Available Virtualized Infrastructure 2009	Highly Available Virtualized Infrastructure 2010	Highly Available Virtualized Infrastructure 2011	
Server hardware	$7,030	$7,030	$7,030	1 new HP G6 server slated for purchase in 2009 and retirement of one installed server for a total of 3 physical servers
Storage hardware	$16,224	$28,392	$54,756	1 new 16TB iSCSI SAN slated for installation in 2009; expects to double capacity each subsequent year
Networks: switches	$12,979	$12,979	$12,979	8 installed switches
Virtualization software	$4,572	$4,572	$4,572	Upgraded to vSphere 4.0 Advanced in 2009
Systems management software	$130	$130	$130	Costs for server-based backup
Operating system licensing	$12,987	$12,987	$12,987	6 Processor Windows Datacenter Server licenses
Databases	$12,474	$12,474	$12,474	2 SQL Enterprise licenses for unlimited SQL deployments on a single physical machine
Power and cooling costs	$1,083	$1,083	$1,083	Electricity costs for 3 servers
Total	$67,480	$79,648	$106,012	
Number of applications	105	115	130	
Number of installed physical servers	3	3	3	
Virtual machine density (applications per physical server)	35	38	43	
Cost per application	$643	$693	$815	

Note: All pricing reflects Landmark's annualized costs, not street pricing.

Source: Landmark Healthcare, 2009

Over the next 12 months, Landmark intends to build "100% virtual always-on IT," adding an iSCSI SAN environment for application mobility and high availability. By implementing a SAN, Landmark can deploy VMware's HA, VMotion, Fault Tolerance, and Data Recovery features so that virtual machines can be readily moved from one physical server to another. As a result, application availability will be improved and downtime will fall to almost zero, substantially improving the RTO of today's solution. Today, if Landmark loses a host server, the virtual machines need to be recovered from tape, which could take many hours if it loses a server with 20–30 virtual machines installed. The combination of VMware business continuity capabilities, hypervisor architecture, and other features such as memory overcommit, along with investments in newer server hardware with higher memory configurations, will provide

Landmark with sufficient resources to virtualize all its applications, including several databases, without the expectation of expanding its installed server footprint. This will enable an even denser environment than it has today on its server-based and desktop-based applications. Landmark is planning to make some fairly significant investments around its new SAN infrastructure with annualized costs starting at just over $16,000 in 2009 and climbing to more than $50,000 in 2011 as it doubles its storage environment annually. Landmark understands that this investment is required for a fully virtualized environment, with the payback coming in guaranteed application availability and, more importantly, response to its customers.

Figure 6 and Table 4 compare the annualized costs incurred by Landmark Healthcare in 2008 with its previously unvirtualized environment and the company's expected investments for 2009–2011. Figure 6 clearly shows the decelerating application-based costs and the inverse relationship with climbing VM densities.

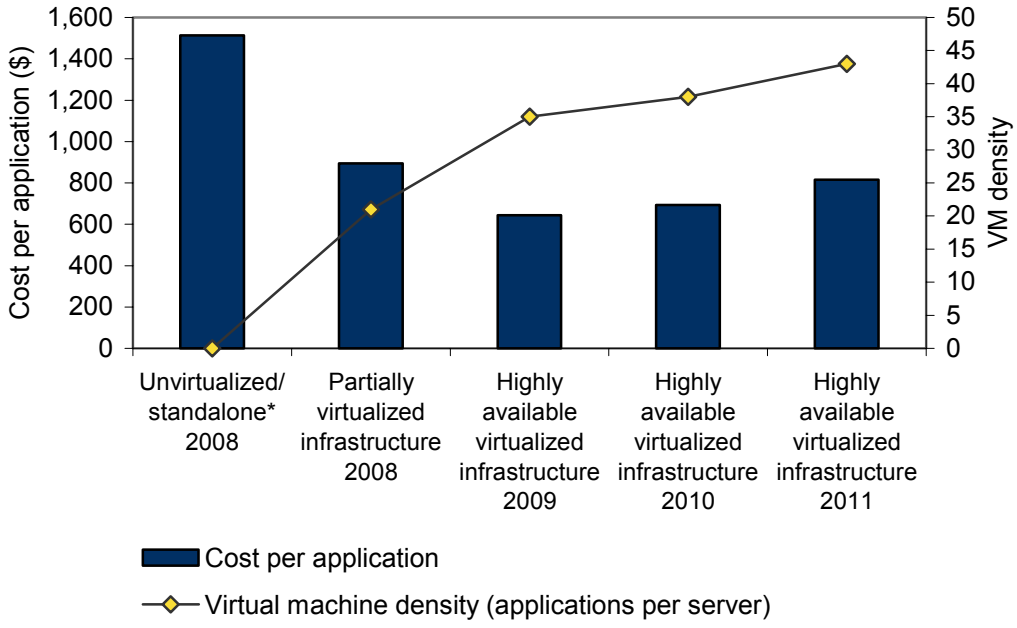
- VM densities are expected to rise from 21 applications per physical server in 2008 to 43 applications per physical server in 2011 by utilizing advances in both hardware and software virtualization technologies. By more achieving more than three times the VM density of typical customers (21 versus 6), Landmark has been able to reduce its annual cost per application by 40% over its previous standalone environment.

- Costs per application declined from $1,514 to $894 in 2008 with simple consolidation.

- Landmark's need for improved application availability and automated load balancing capabilities requires the introduction of an iSCSI SAN. Despite this additional investment, application-based costs continue to decline to $643 in 2009 but begin to climb in 2010 and 2011 as storage requirements grow along with the expected increase in the application portfolio.

FIGURE 6

Landmark Healthcare Annualized Cost per Application by Year and Virtual Machine Density



Source: Landmark Healthcare, 2009

TABLE 4

Landmark Healthcare Virtualization Case Study Summary

	Physical Deployment 2008	Partially Virtualized Infrastructure 2008	Highly Available Virtualized Infrastructure 2009	Highly Available Virtualized Infrastructure 2010	Highly Available Virtualized Infrastructure 2011
Server hardware	$58,406	$24,539	$7,030	$7,030	$7,030
Storage hardware	$–	$–	$16,224	$28,392	$54,756
Networks: switches	$12,979	$12,979	$12,979	$12,979	$12,979
Virtualization software	NA	$3,600	$4,572	$4,572	$4,572
Systems management software	$6,230	$2,466	$130	$130	$130
Operating system licensing	$16,861	$13,394	$12,987	$12,987	$12,987
Databases	$16,188	$16,188	$12,474	$12,474	$12,474
Power and cooling costs	$34,671	$12,640	$1,083	$1,083	$1,083
Total annualized costs	$145,336	$85,807	$67,480	$79,648	$106,012
Total number of applications	96	96	105	115	130
Total number installed servers	96	35	3	3	3
Total number of virtualized servers for applications	0	3	3	3	3
Number virtualized applications	–	64	105	115	130
Number of standalone applications	96	32	–	–	–
Virtual machine density (applications per physical server)	NA	21	35	38	43
Number of virtualized desktops	–	15	115	115	115
Number of virtualized servers for desktops	–	2	3	3	3
Virtual machine density (desktops)	NA	8	38	38	38
Cost per application	$1,514	$894	$643	$693	$815

Source: Landmark Healthcare, 2009

Advice for Customers

Rather than standardizing on a specific number of virtual machines per physical server, IT organizations should seek to maximize the number of virtual machines on a per physical server basis. By driving up VM densities, customers are able not only to reduce costs but also to leverage the advantage of a pool of IT resources. In thinking of future virtualization investments, IT organizations should consider the following:

- **The metrics for measuring IT efficiency are changing.** Static benchmarks that relied upon physical hardware are becoming irrelevant and are being replaced with a more application portfolio–centric set of metrics.

- **To drive up VM densities, customers must consider a combination of both hardware and software improvements.** Embedded hardware functionality, along with hypervisor tuning and complementary management tools, is driving more direct access to the virtual machine and the physical hardware, which is freeing up resources to allow a greater number of VMs per server. IDC believes that this trend will continue and that IT organizations must pay attention to this evolving space.

- **Higher levels of VM density are more often limited by memory access than processing resources.** Use of memory overcommit capabilities from VMware, as well as deploying larger configurations of physical memory, is critical. Taking virtualization to the next level beyond simple consolidation is very difficult without VM clustering and shared storage. It is important to recognize that driving up VM densities is a function of the ability to leverage resources across a pool of compute rather than the capabilities of any one physical server resource. Creating clusters of similar operating systems enables higher *transparent page sharing* rates, leading to better memory saving and lower costs per application.

- **Consider configuring SMP VMs with fewer virtual CPUs.** Many applications have been provisioned on physical servers with multiple CPUs in order to meet application demands based on the hardware available when the application was originally deployed. By the time an application is redeployed on a virtualized environment, the underlying hardware capabilities, such as CPU speed, may have progressed to a point where the number of CPUs originally used are no longer necessary, even when the application is deployed in a shared virtualized environment. Therefore, it may be appropriate to configure the VM with fewer CPUs, which will enable other virtual machines to run on the same host, which increases density and lowers the cost per application.

- **Use hierarchical resource pools to enable applications to match IT resources to the business organization.** This enables applications to share a common pool of resources, which reduces cost per application by increasing utilization rates while still preserving the ability of business organizations or application owners to retain control over the resources that an application needs. This capability enables applications typically segregated onto their own hardware to share a common set of servers while still enabling control over their resource utilization priorities.

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