Lab Validation Report

Microsoft Hyper-V

Scalable, Native Server Virtualization for the Enterprise

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Contents

ESG Lab Reports

The goal of ESG Lab reports is to educate IT professionals about emerging technologies and products in the storage, data management and information security industries. ESG Lab reports are not meant to replace the evaluation process that should be conducted before making purchasing decisions, but rather to provide insight into these emerging technologies. Our objective is to go over some of the more valuable feature/functions of products, show how they can be used to solve real customer problems and identify any areas needing improvement. ESG Lab's expert third-party perspective is based on our own hands-on testing as well as on interviews with customers who use these products in production environments. This ESG Lab report was sponsored by Microsoft.

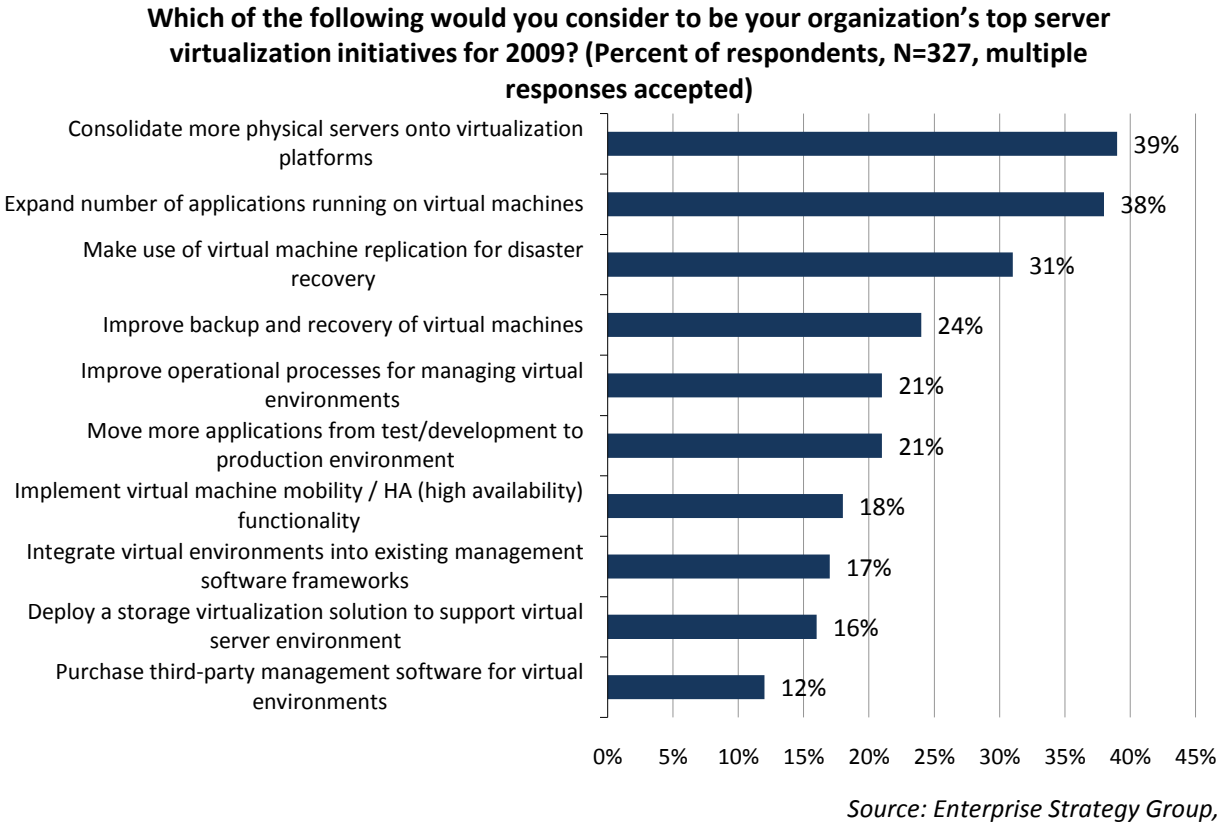
Introduction

Server virtualization remains a high priority for IT organizations of all sizes as businesses look to improve IT asset utilization, streamline operational efficiency, and enhance service level agreements with application owners. This report documents hands-on testing of Microsoft Hyper-V—paying special attention to ease of deployment, management simplicity, scalability, and performance.

Background

ESG recently conducted an in-depth survey of senior IT professionals concerning their organizations' IT spending plans and priorities for 2009.[1] As presented in Figure 1, respondents indicated that their top 2009 server virtualization goals are consolidating more physical servers onto virtualization platforms (39%) and expanding the number of applications running on virtual machines (38%). While virtualization solutions can offer many benefits, the fact that basic server consolidation was viewed as organizations' most important priority speaks to the core value of server virtualization: its ability to reduce capital and operational costs.

Figure 1. Server Virtualization Plans



Source: Enterprise Strategy Group, 2009.

The value of server virtualization is difficult to ignore given its many benefits for both IT operations and application owners. IT operations are able to reduce server provisioning times from hours to minutes and cut server deployment checklists in half while simultaneously improving hardware utilization and maintaining application performance. Application owners benefit from readily accessible IT resources, improved availability, and a platform that helps facilitate disaster recovery of workloads. Server virtualization additionally lowers data center operating costs by reducing power and cooling requirements and freeing up data center floor space. Deploying server virtualization enables businesses to predictably scale and easily manage IT resources without the constraints of

[1] Source: ESG Research Report, *2009 Data Center Spending Intentions Survey*, March 2009.

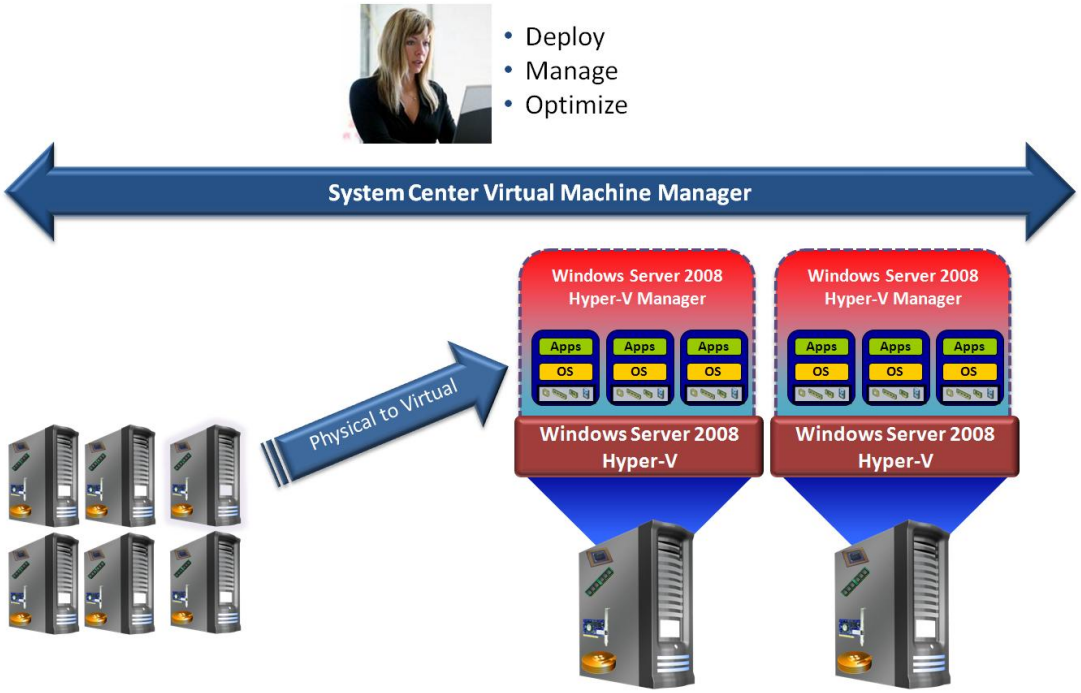
physical boundaries and inefficient use of IT assets that has been a consistent challenge in the past. Server virtualization solutions allow IT administrators to automate routine IT tasks and transparently tune resources, enabling them to scale based on the needs of the business without purchasing a new servers.

Introducing Server Virtualization Solutions with Microsoft Hyper-V

Microsoft Hyper-V is a bare metal hypervisor, installed directly on a physical server, that enables multiple virtual machines running a mix of Windows and Linux workloads to share a common pool of compute, memory, network and storage resources. Hyper-V is built into the Windows 2008 operating system and is easy to configured using familiar Windows interfaces. Hyper-V lets companies take advantage of existing Microsoft skill sets, training programs, and certifications; installation, daily administration, and routing management tasks all have a familiar look and feel. IT administrators get to leverage an environment with which they already have experience and confidence.

The Hyper-V Manager Microsoft Management Console (MMC) snap-in, built into Windows Server 2008, provides administration access to Hyper-V servers and guest virtual machines. Microsoft System Center Virtual Machine Manager (SCVMM) further extends administration and management tasks to include both physical and virtual resources including Microsoft Virtual Server 2005 R2, VMware environments, and Hyper-V. Figure 2 illustrates a mixed workload environment utilizing virtual and physical resources utilizing SCVMM as a centralized platform, which can be used to deploy, manage, and optimize an organization's physical and virtual server infrastructures.

Figure 2. Microsoft Server Consolidation with Hyper-V



Administrators leverage Microsoft virtualization and management solutions to create virtual machines, perform physical to virtual (P2V) migrations, allocate resources, optimally distribute workloads, and create a view of the entire environment. Microsoft management solutions enable administrators to gain control of the highly dynamic and mobile nature of virtualization while they continue to consolidate resources and achieve improved hardware utilization rates.

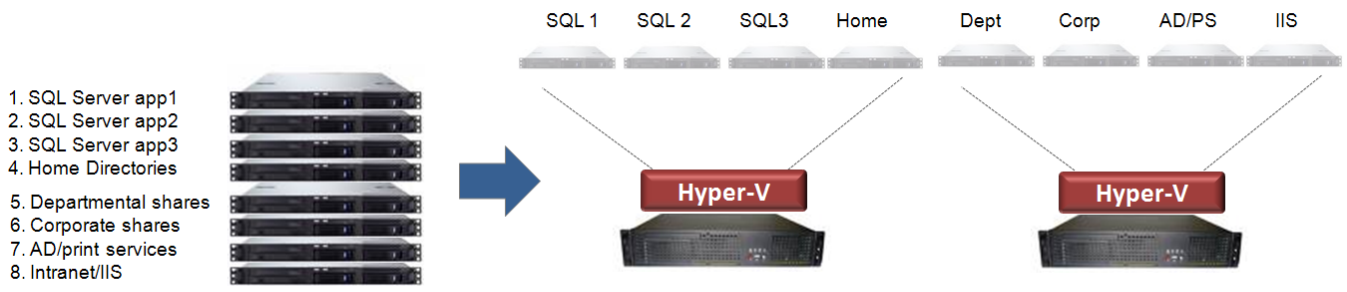
ESG Lab Validation

ESG Lab performed a hands-on evaluation of Hyper-V server virtualization technology in a lab located at Microsoft's Redmond, Washington campus. Testing was performed with a goal of evaluating ease of deployment for a consolidated pool of virtual servers using Hyper-V support built into Microsoft Windows 2008. The capabilities and familiar look and feel of Microsoft management tools as well as the performance overhead of Hyper-V server virtualization were also examined.

Getting Started

The test bed used during the ESG Lab validation was designed to emulate a physical to virtual server migration, as shown in Figure 3. Commonly deployed applications and services running on eight older physical servers were consolidated onto a pair of quad core servers attached to a shared pool of SAS drives within a FC attached disk array.[2] The eight servers were configured to support a mix of database applications (Microsoft SQL Server), network attached file shares (home, departmental, corporate), Active Directory, and print and intranet services (IIS). Microsoft Windows 2008 Data Center Edition, with built-in Hyper-V support, was used to consolidate four virtual server images on each of the physical servers. A third quad core server[3] was used to manage the physical and virtual environment with SCVMM.

Figure 3. The ESG Lab Test Bed



ESG Lab Testing

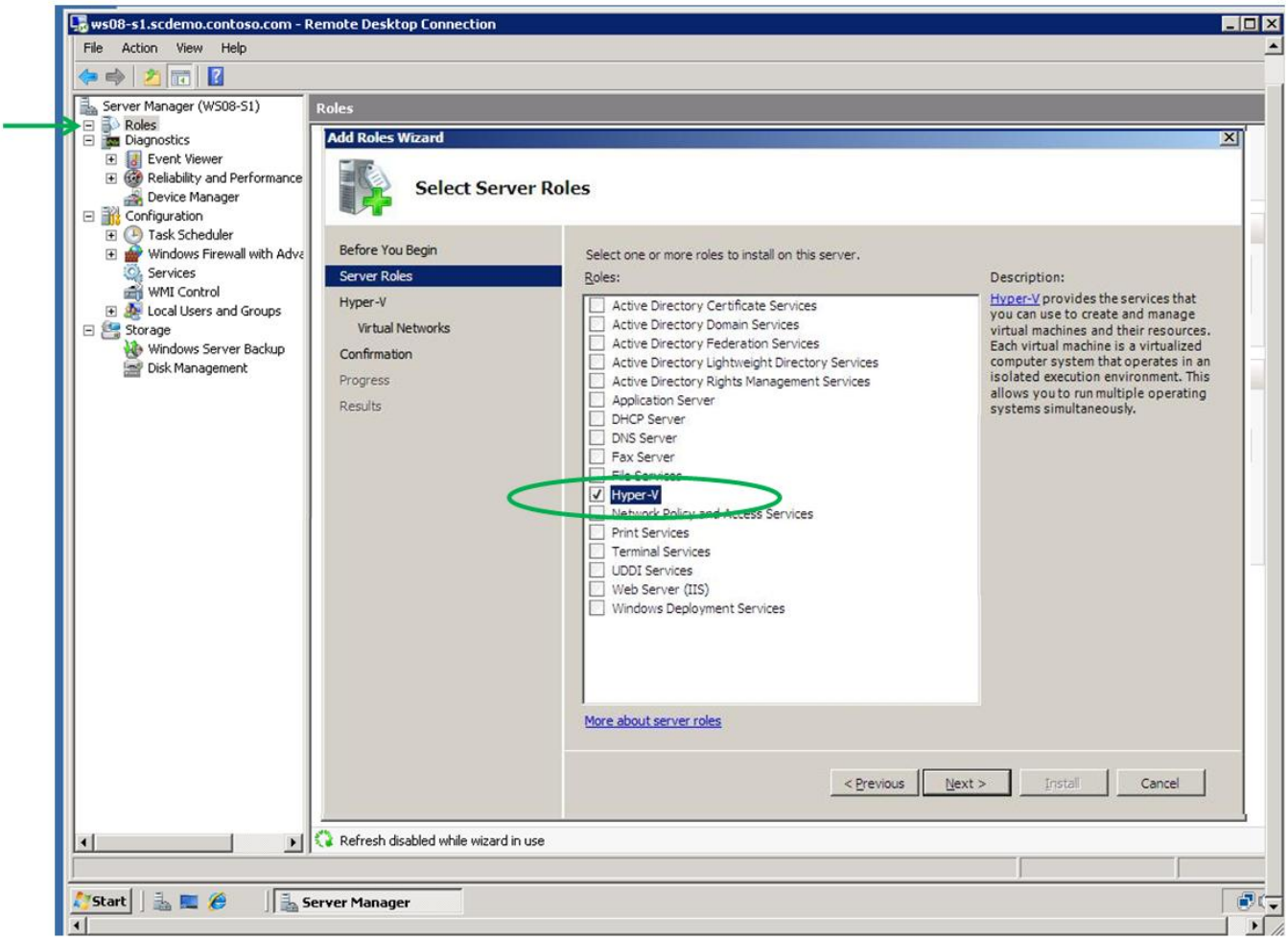
ESG Lab testing began with a bare metal installation of Windows 2008 on the first of the quad core servers. Six mouse clicks and 20 minutes later, the familiar Windows installation process was complete. At this point, the server looked and behaved like any physical server running a Microsoft Windows operating system.

Next, we turned on Hyper-V server virtualization and configured the first virtual machine. Enabling Hyper-V from the native Server Manager console was easy and intuitive. Managing the Hyper-V role looked and felt the same as the commonly deployed roles routinely deployed in Windows servers Active Directory, Web, and print services.

As shown in Figure 6, the wizard used to enable the Hyper-V role was launched from the native Server manager console using a Microsoft Management Console (MMC) plug-in. The expandable navigation tree used to manage the Hyper-V role, shown on the left, is the same interface that is routinely used to manage event logs, scheduled tasks, services, and storage. The wizard-driven configuration panel towards the middle is similar to that which is used for common server roles including Active Directory, DHCP, DNS, and print services.

[2] Configuration details are listed in the Appendix.
[3] For simplicity, the management server is not shown in this diagram.

Figure 4. Enabling Hyper-V



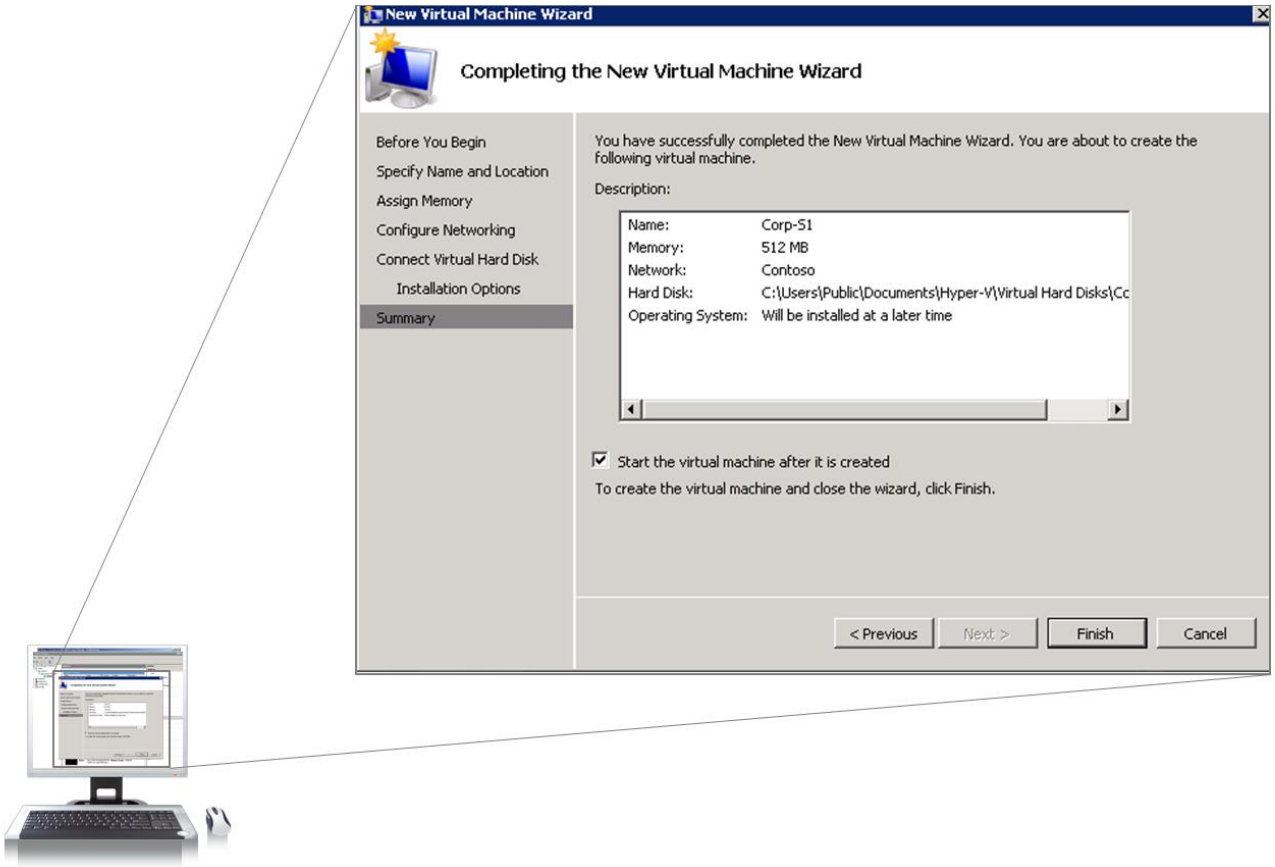
Six mouse clicks and a reboot later, the Hyper-V enabled server was ready for the configuration of the first virtual machine.

At a high level, three methods are commonly used to create a virtual machine (VM) in a Hyper-V environment:

1. Create a new VM from scratch
2. Clone an existing VM
3. Import an existing physical or virtual server

A wizard launched from the Hyper-V Manager console was used to create the first VM from scratch. Clone and import methods were used later in the ESG Lab validation to create additional virtual machines. As shown in Figure 5, a Hyper-V Manager wizard accessed from the Server Manager console was used to configure the first virtual machine with 512 MB of virtual memory, a virtual network connection, and a virtual hard disk (VHD).

Figure 5. Creating a Virtual Machine



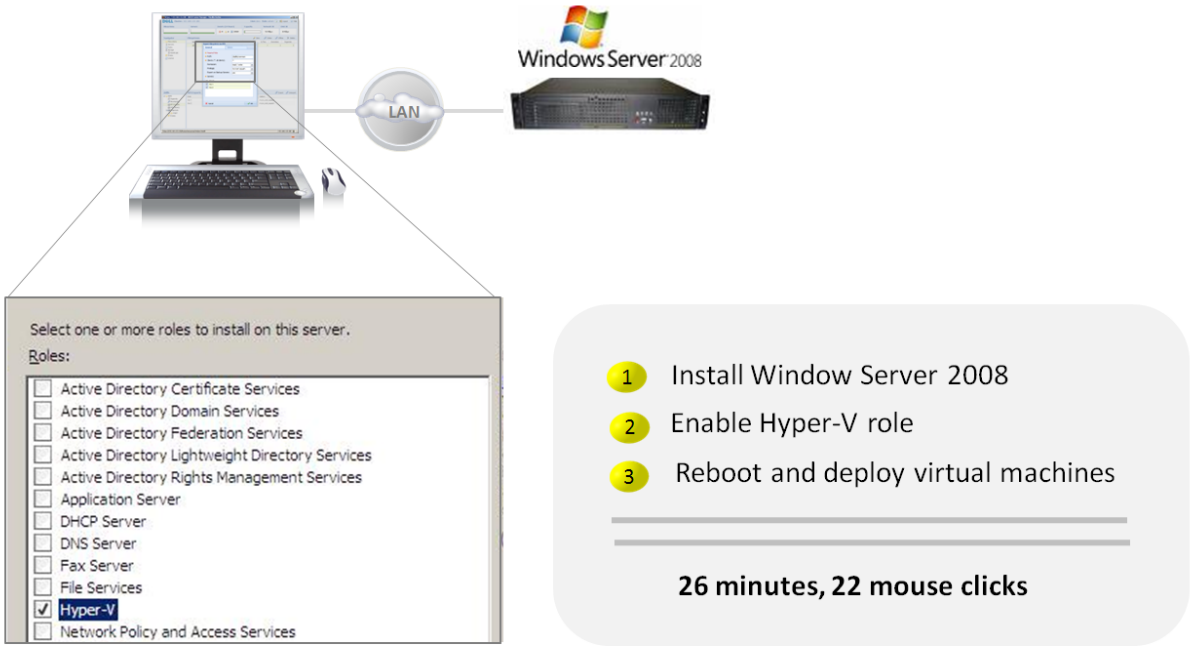
Ten mouse clicks and 42 seconds after getting started with the wizard, the first virtual machine was up running a network-based operating system install.

ESG Lab found that getting started with Hyper-V is a straightforward, intuitive process. At a high level, familiar wizard-driven graphical user interfaces built into Windows Server 2008 were used to configure Hyper-V in three steps:

1. Install Windows Server 2008
2. Enable Hyper-V role
3. Reboot and configure virtual machines

As shown in Figure 6, the first virtual machine was up and running 26 minutes and 22 mouse clicks after starting a bare metal installation of Windows Server 2008.

Figure 6. Getting Started with Hyper-V



Why This Matters

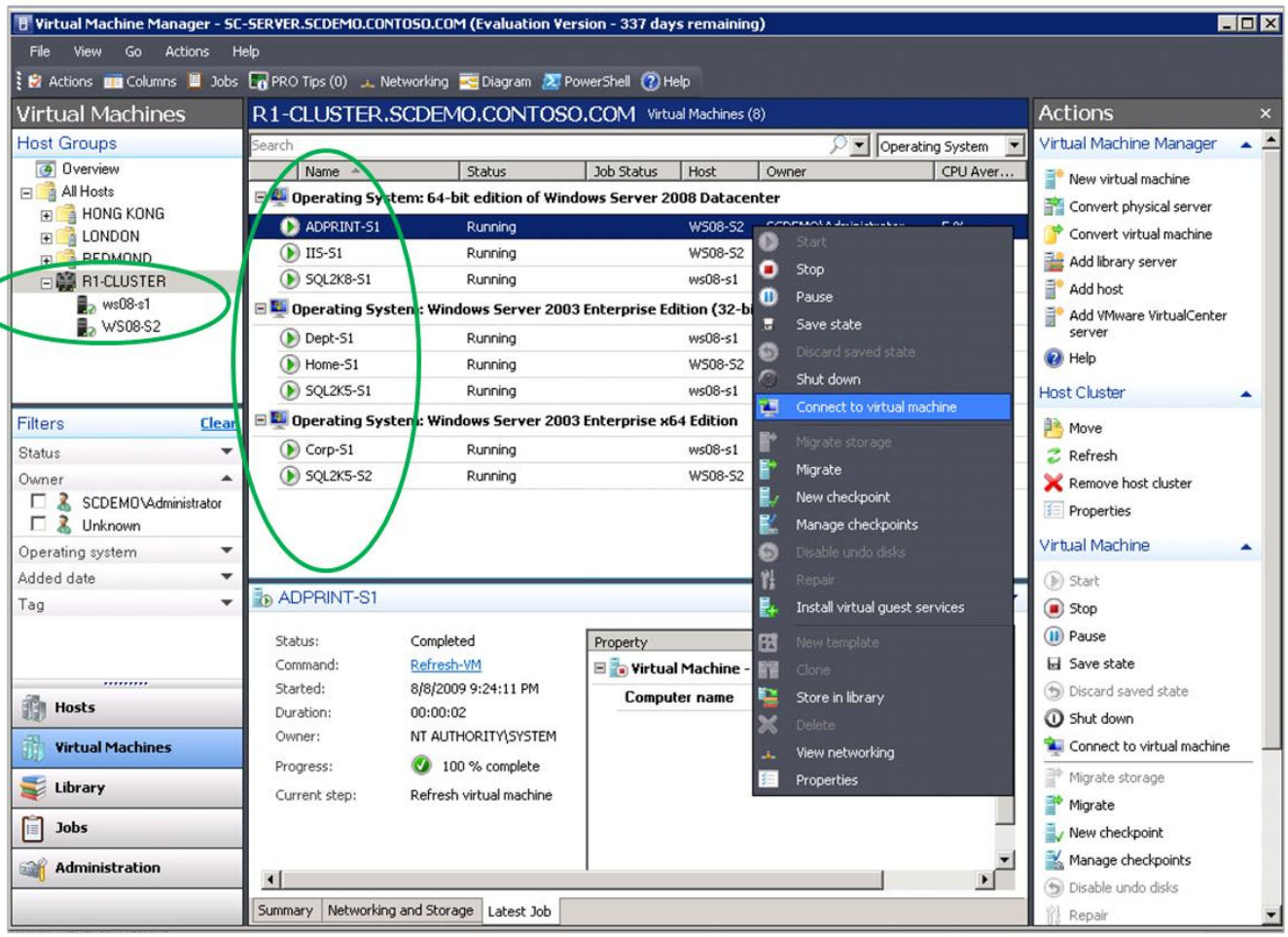
Under-utilized servers, a lack of physical space, and the need to improve server availability are driving a growing number of IT decision makers to make major commitments to initiatives such as server virtualization, multi-core servers, blades, and server consolidation programs. As organizations begin to realize the benefits of server consolidation, quick and easy deployment using familiar tools and processes saves time and money.

ESG Lab has confirmed that the bare metal Hyper-V support built into Windows 2008 can be deployed in less than 30 minutes using familiar Windows-based server management tools.

Scaling Out

As shown in Figure 7, ESG Lab created a cluster (R1-Cluster) using two multi-core servers (ws08-s1, ws08-s2) to run eight virtual machines supporting a mix of 64 and 32 bit operating systems.

Figure 7. Eight Virtual Machines on Two Physical Servers



Why This Matters

A recent ESG survey indicates that 49% of IT managers report server consolidation as a top initiative for which organizations will increase or maintain spending.[4] The reasons why are obvious: server consolidation increases utilization and availability as it reduces the amount of equipment that needs to be purchased, managed, powered, and cooled. ESG Lab has confirmed that the server virtualization technology built into Microsoft Windows Server 2008 can be used to consolidate eight—or more—physical servers running a mix of commonly deployed business applications onto a clustered pair of multi-core servers.

[4] Source: ESG Research Report, *2009 Data Center Spending Intentions Survey*, March 2009.

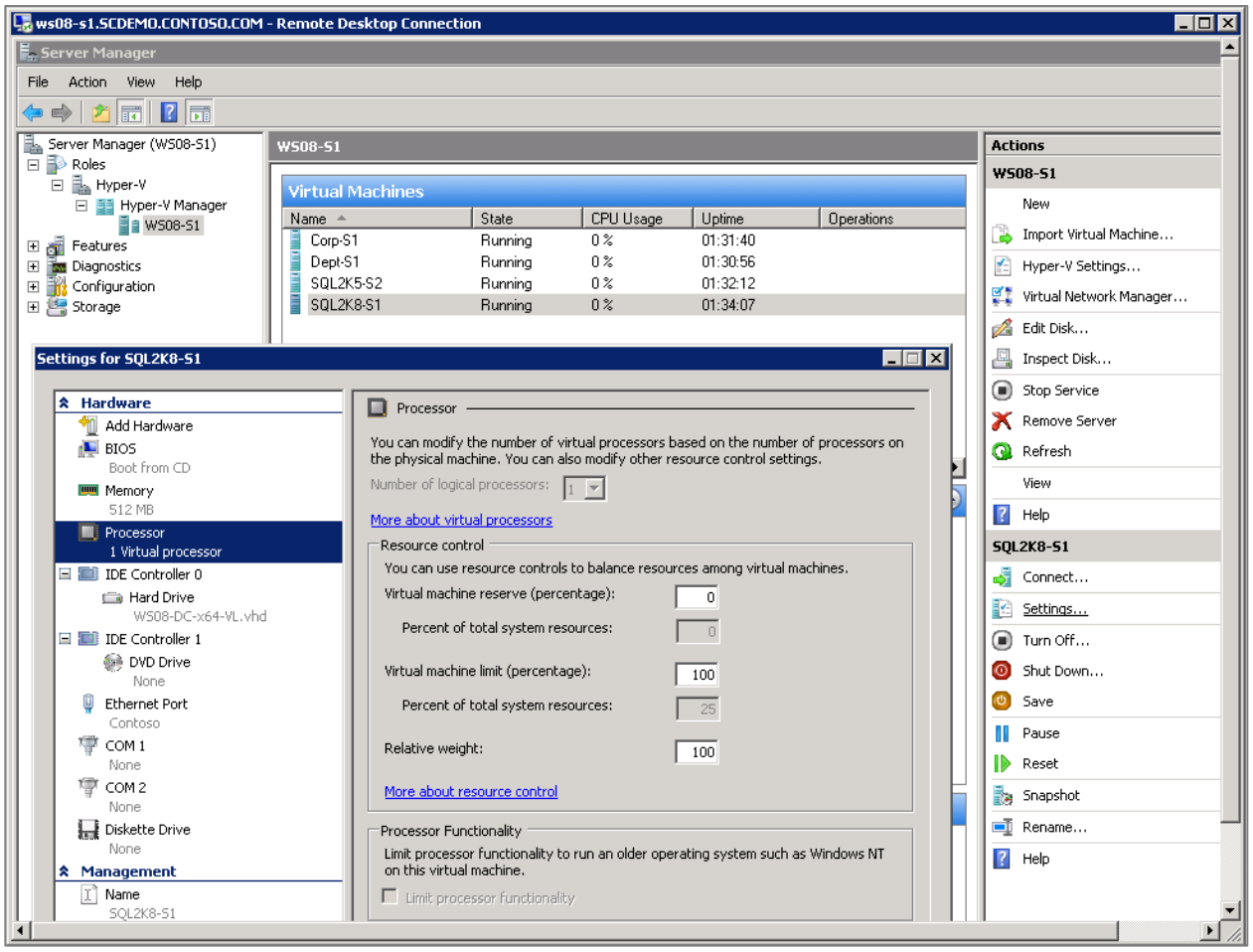
Ease of Management

Microsoft's growing suite of management tools can be used to deploy, manage, and optimize physical and virtual server infrastructure. At the lowest level, virtual servers are managed by the Hyper-V Manager built into Windows Server 2008. Virtual machines running on multiple clustered servers can also be managed using System Center Virtual Machine Manager (SCVMM). At the highest level, System Center Operations Manager (SCOM) provides a consolidated view of an organization's entire server infrastructure (physical and virtual) . ESG Lab used each of these management interfaces during the validation.

ESG Lab Testing

As described earlier in this report, Hyper-V Manager is accessed from the Server Manager console as a familiar MMC plug-in. Hyper-V Manager can be used to inspect the configuration of an existing virtual machine. In the example shown in Figure 8, virtual processor resources are allocated to a virtual machine running a Microsoft SQL Server application.

Figure 8. Managing Virtual Machine Resources

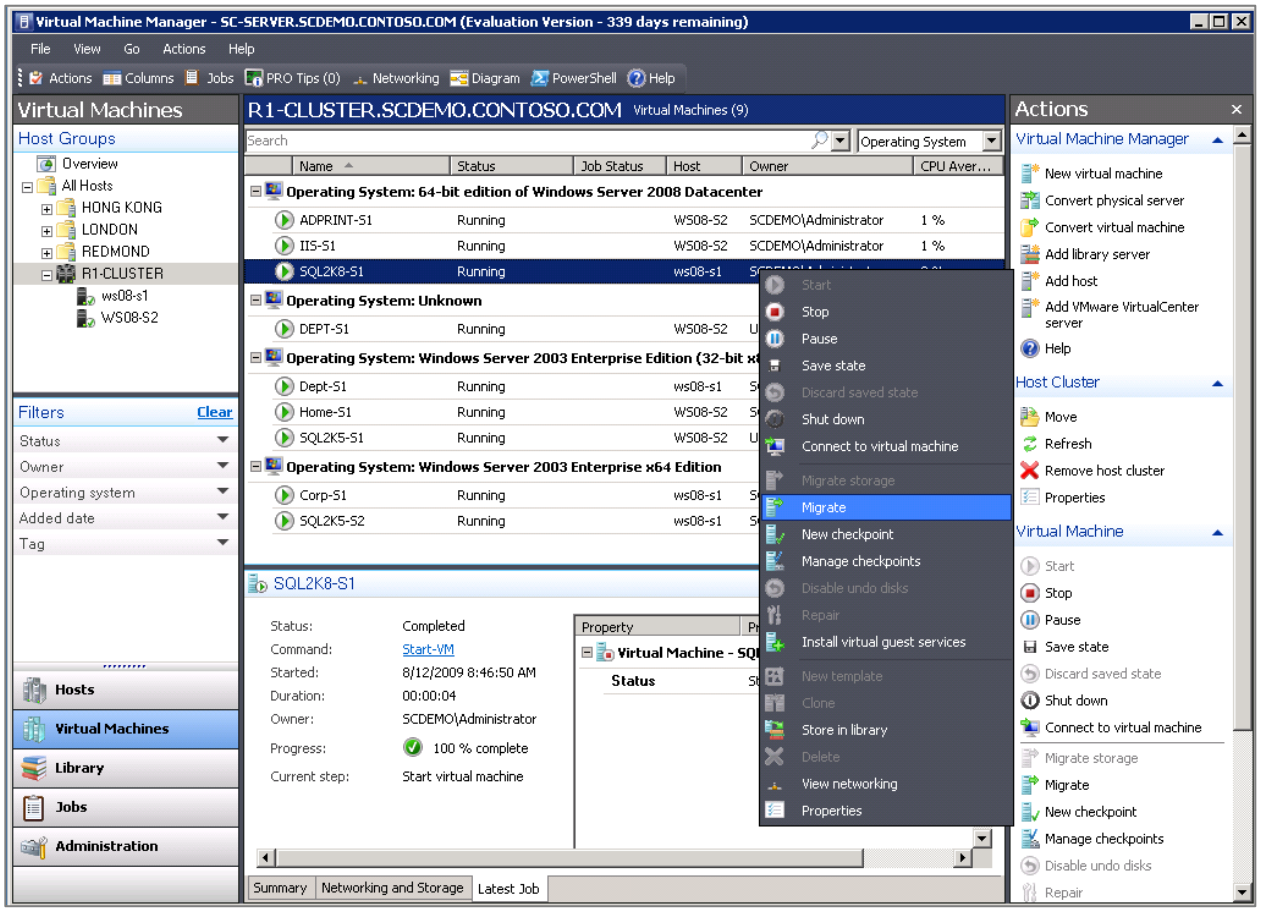


Note that Hyper-V Manager can also be used to perform a number of vital virtual server management tasks including creating a new virtual machine; importing an existing virtual machine; defining disk and network settings; and stopping, starting, and creating snapshots of virtual machines.

Moving up from the Hyper-V Manager interface running on each of multi-core Windows 2008 Servers, SCVMM running on a third server was used to manage all eight virtual machines from a single user interface. As shown in Figure 9, this interface not only provided a centralized point of control for stopping, starting, and connecting to

virtual machines, it was also used to perform a quick migration of virtual machines from one physical server to another. In addition to the pulldown menu accessed with a right click shown in the diagram, quick migrations were also performed by dragging and dropping a VM from one physical server to another.

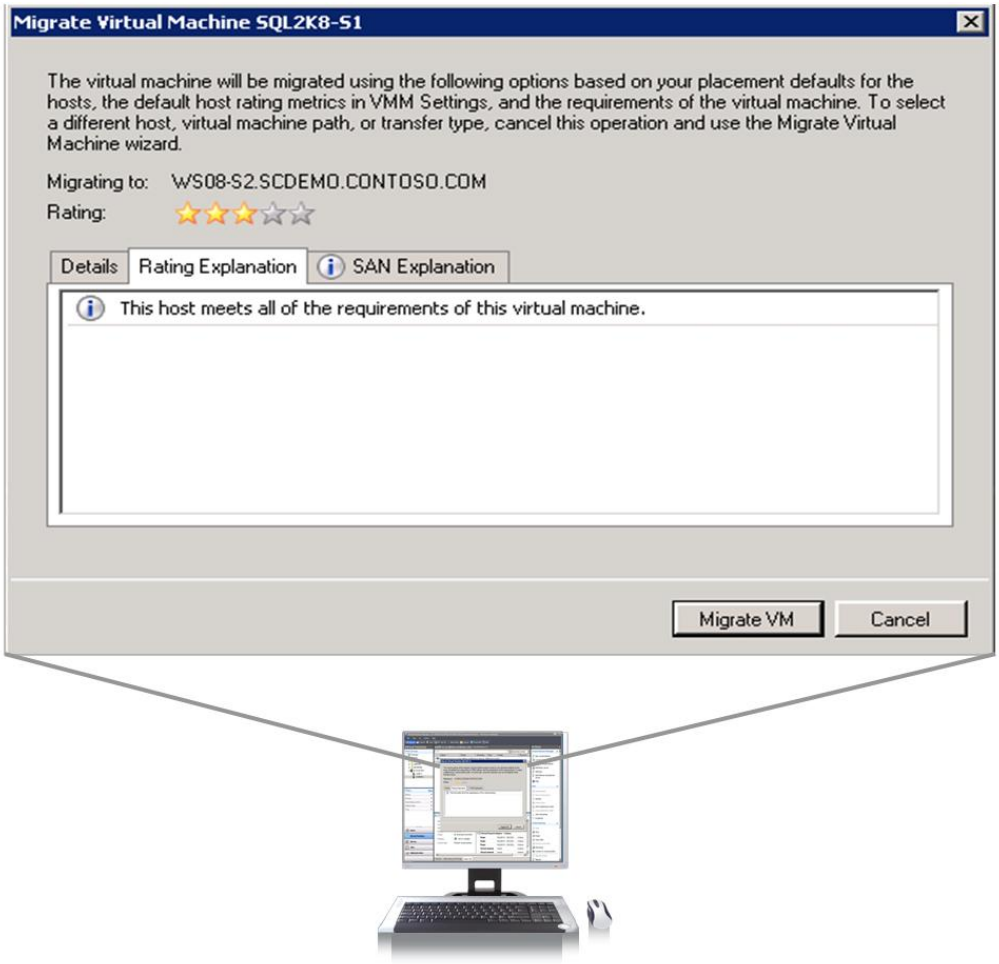
Figure 9. Starting a Virtual Machine Migration



ESG Lab performed a quick migration of the SQL2K8-S1 VM as a long running directory-level file copy operation was running. The virtual machine did not have to be paused or shut down and the migration completed in 28 seconds. The file copy paused for a few seconds and then completed without error.

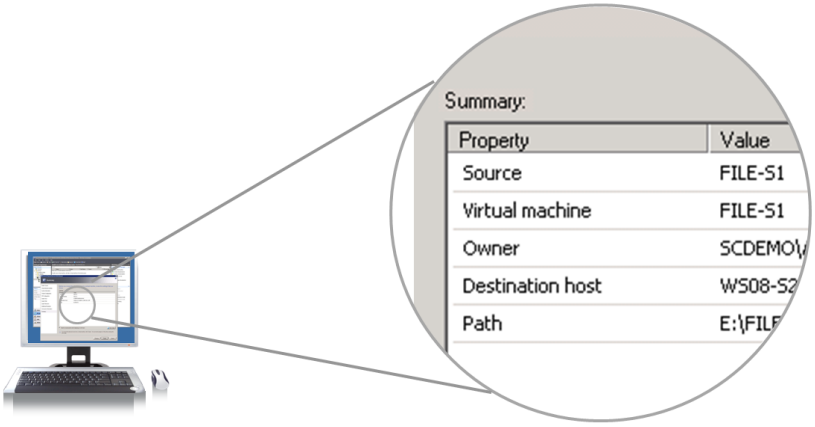
Microsoft's intelligent placement technology was observed during the migration. As shown in Figure 10, intelligent placement uses a star rating for easy decision making when planning migrations. ESG Lab noted that intelligent placement algorithms can be customized and migration from VMware environments is supported.

Figure 10. Intelligent Placement



SCVMM was also used to convert a physical server to a virtual machine running in the R1-Cluster. It took 18 mouse clicks to configure the intuitive wizard driven physical to virtual (P2V) conversion process. The conversion completed in one hour and six minutes. The server was alive and available throughout the migration.

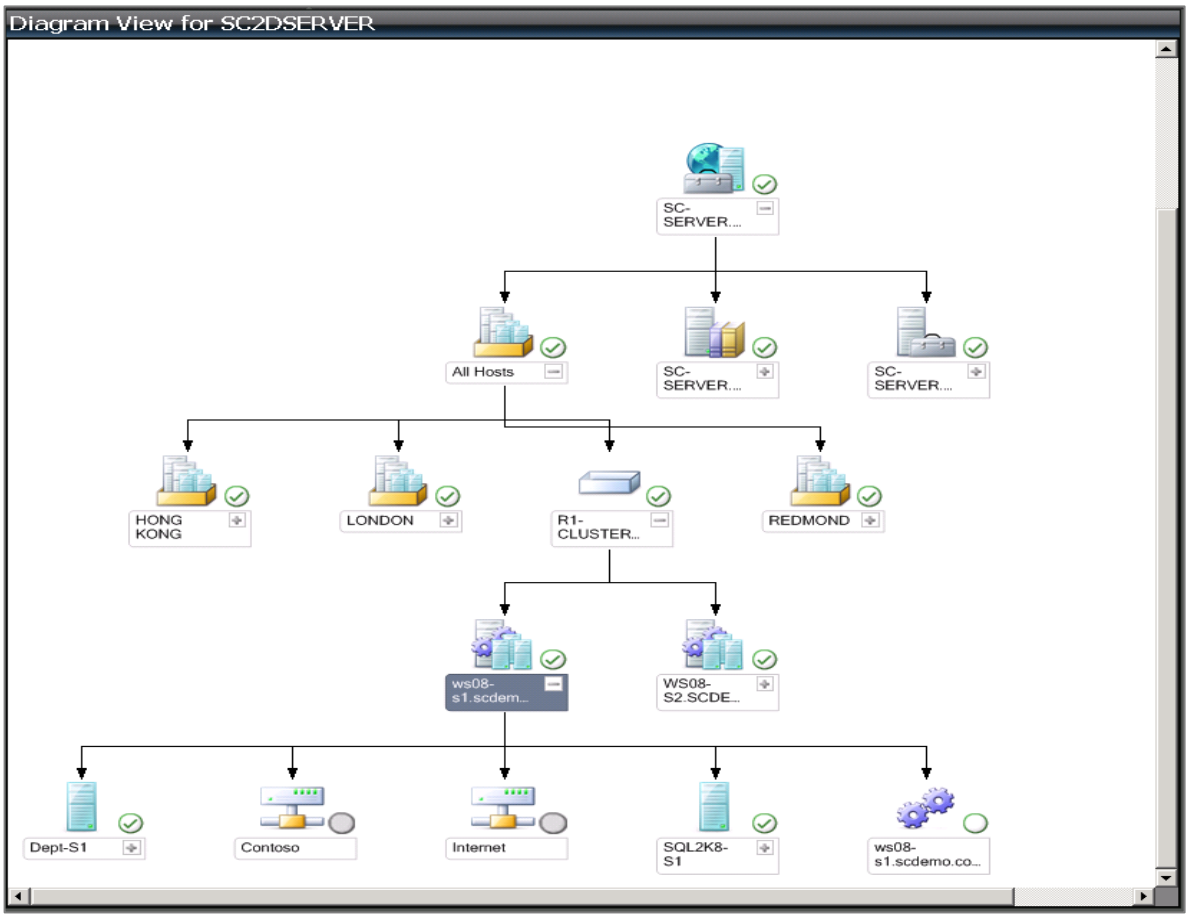
Figure 11 Physical to virtual (P2V) conversion



Last, but not least, ESG Lab examined the organization-wide management capabilities of Microsoft System Center Operations Manager (SCOM) in a consolidated virtual server environment. As shown in Figure 12, SCOM was used to display a hierarchical view of the infrastructure. In this example, SCOM running on a physical server was used to

manage clusters of virtual machines in multiple data centers (Hong Kong, London, and Redmond). The ESG Lab R1-cluster in Redmond is composed of two physical servers (ws08-s1, ws08-s2). The virtual machines (dept-S1, sql2k3-s1) and virtual networks (Contoso, Intranet) running on one of the physical servers are shown.

Figure 12. System Center Operations Manager



Why This Matters

During a recent ESG survey of 530 IT professionals, over one-third (38%) of respondents stated that they expected server virtualization to extensively impact their organization's IT management strategy in the next 24 months.[5] Easy to manage server virtualization solutions are needed if IT managers are to meet these strategic objectives quickly and cost effectively.

ESG Lab has confirmed that Microsoft's growing suite of management tools can be used as a powerful platform for deploying, managing, and optimizing virtual (and physical) server infrastructure using interfaces that are familiar to Windows administrators.

[5] Source: ESG Market Report, *Best Practices and Cost Reduction Strategies for Today's Virtual Data Centers*, August 2009.

Performance

In this section, we'll take a look at the results of ESG Lab testing of the performance of applications running on a physical server and on a Hyper-V virtual machine.

ESG Lab Testing

ESG Lab used four real-world application workloads to evaluate the physical and virtual performance of Microsoft Windows 2008 Data Center Edition R1:

1. *Application Install*: a timed installation of Visio 2007 using a distribution image stored on a network attached shared drive within a private network.
2. *Directory level copy*: a timed copy an 860 MB directory with 2,014 files to a temporary directory. The c:\windows\win32 directory was copied to a temporary directory on the same C: drive.
3. *Subsequent copies*: the directory level copy was repeated with much of the IO activity happening in cache. The average of three cached copy operations was recorded.
4. *SQL query*: a long running SQL select statement using a 25,000 row production database from ESG's internal IT operation was timed. The SQL query performed a join of three tables. The average duration of three select statements was recorded.

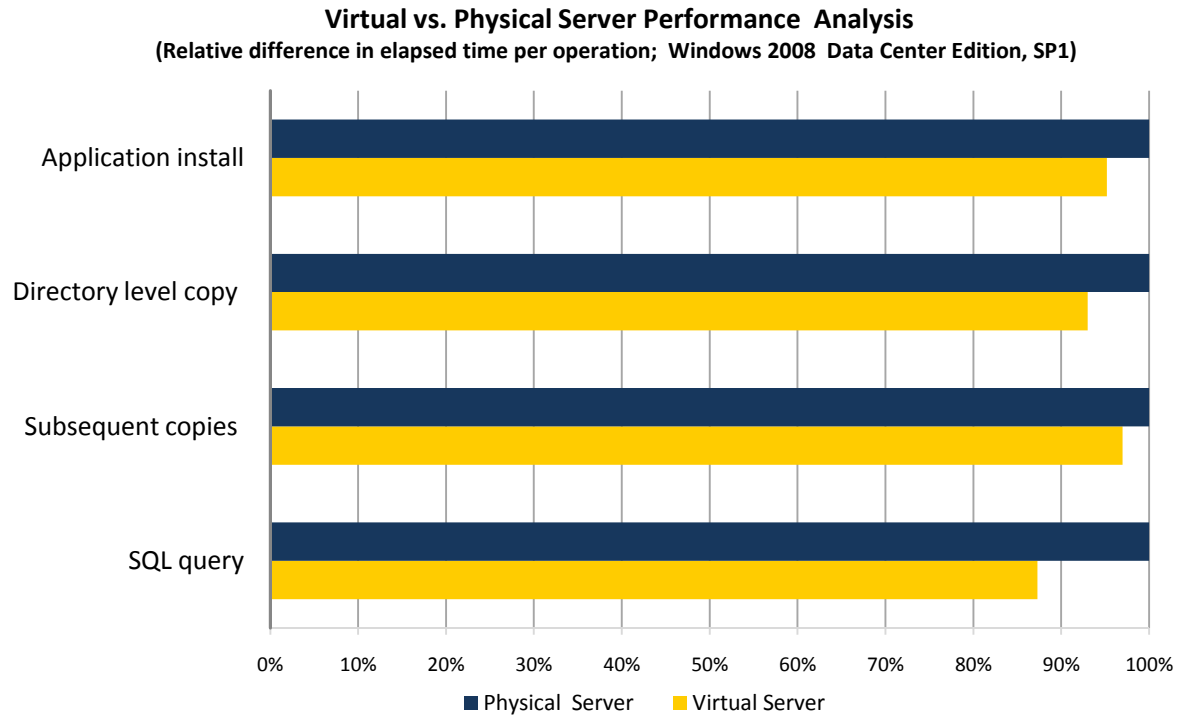
The HP blade server used for this test was equipped with four 2.2 GHz dual-core AMD Opteron processors and eight gigabytes of RAM. Comparing physical and virtual performance on the same server was accomplished after a reboot with Hyper-V role enabled and disabled. During the virtual server testing, the server was configured with a single virtual server, which used nearly all of the physically available hardware resources (all eight CPU cores, seven out of eight GB of RAM).

Physical and virtual testing was performed within a 40 GB logical C: drive. The C: drive was built using a single LUN presented by a FC attached HP MSA storage array with six 15K SAS drives configured as a single RAID-5 group (5+1). The Hyper-V C: drive was configured as a basic virtual hard disk (VHD). The results are shown in Table 1 and Figure 13.

Table 1. ESG Lab Performance Results

Operation	Physical	Virtual	Difference
Application install	00:05:52.000	00:06:09.000	4.8%
Directory level copy	00:00:41.680	00:00:33.660	7.1%
Subsequent copies	00:00:05.660	00:00:05.830	3.0%
SQL query	00:00:47.566	00:00:53.630	12.7%

Figure 13. ESG Lab Performance Results



What the Numbers Mean

- It took five minutes and 52 seconds to install an application on the physical server running Windows 2008 Data Center Edition SP1
- It took six minutes and nine seconds to install the same application on the same hardware running the same operating system running within a Hyper-V enabled virtual machine
- The difference in performance is relatively low (4.8%)
- The directory level copy and subsequent copies were also relatively low (7.1% and 3.0% respectively)
- A long running Microsoft SQL query took 12.7% longer when running in a virtual server
- The manageably low performance impact of Hyper-V won't be detected by the vast majority of end-users and applications

Why This Matters

A bare metal hypervisor sits between the server hardware and the operating systems and applications which rely on that hardware. As a result, the hypervisor introduces performance overhead an application running alone on a physical server does not. High overhead would limit the types of applications, and the number of applications, that can be virtualized per physical server.

ESG Lab measured a low Hyper-V performance overhead of 3.0 to 12.7 percent in a Microsoft Windows 2008 Data Center 2008 R1 environment. ESG Lab believes that this relatively minor performance impact is easily justified given the compelling consolidation, manageability, and cost saving benefits that can be achieved with Hyper-V—especially given the continuously improving performance of industry standard servers.

ESG Lab Validation Highlights

- ☑ Using familiar Windows-based tools, ESG Lab installed and configured a Windows Server 2008 R1 Datacenter server with bare metal Hyper-V server virtualization support in 26 minutes and 22 mouse clicks.
- ☑ Eight virtual machines running a mix of common business applications and a variety of 32 and 64 bit Microsoft Windows operating systems were consolidated onto a clustered pair of multi-core blade servers.
- ☑ Server Manager with the Hyper-V Manager MMC plug-in, SCVMM, and SCOM were used to deploy, manage, and optimize the virtualized infrastructure.
- ☑ SCVMM was used to perform a quick migration (28 seconds) of a running virtual machine from one physical server to another. A long running directory level copy that was running during the migration completed without error.
- ☑ SCVMM was used to perform a physical to virtual (P2V) conversion of a Windows server.
- ☑ ESG Lab measured a manageably low performance difference between real-world application workloads running on a physical Windows Server 2008 R1 server and a Hyper-V enabled virtual machine running on the same server.

Issues to Consider

- ☑ While quick migration of virtual machines between physical servers is an online operation, it does cause a momentary interruption in application and network availability in Windows 2008, R1. As a result, a quick migration of production applications running on Windows Server 2008 R1 is not recommended during normal business hours. This limitation has been removed with the introduction of live migration support in Windows Server 2008 R2. Windows Server 2008 R2 was available for beta testing in non-production environments when this report was published.
- ☑ While ESG Lab has confirmed that Hyper-V overhead is manageably low in Windows Server 2008 R1, Microsoft claims that Hyper-V performance has been improved in Windows Server 2008 R2. In particular, the performance of applications which rely on dynamic VHDs that can be expanded on the fly has been noticeably improved for write intensive workloads. As a result, basic VHDs were recommended as a best practice for performance sensitive applications (e.g., a multi-user database application) when this report was published.
- ☑ While not test during this ESG Lab Validation, one of the more compelling capabilities of Microsoft's integrated suite of virtualization management tools is the ability to manage physical and virtual servers—including virtual servers running over a VMware hypervisor—from a single pane of glass.

The Bigger Truth

Server virtualization is on a rapid and pervasive adoption path. The cause—and effect—of this is the clear value proposition provided by these solutions. In a recent global research survey of 706 end-users, ESG found that the impact and benefits of implementing server virtualization are driving organizations to trust server virtualization with some of their most mission critical applications as they recognize that the benefits extend well beyond physical server consolidation and improved resource utilization.

Clearly, server virtualization provides a wide range of benefits, including better server resource utilization; increased consolidation of physical servers; and reduced consumption of floor space, power, and cooling. In addition, ESG is finding that server virtualization is rapidly becoming an enabler of server management and data center automation. Virtual machines can be quickly provisioned, optimized, and tracked throughout their lifecycles and management tools are beginning to be able to manage physical servers and virtual machines as well as heterogeneous server virtualization solutions. Disaster recovery and high availability are important— in some cases, they are the primary drivers for running production workloads on a virtualized infrastructure.

ESG Lab has confirmed that Microsoft's growing family of server virtualization solutions have been built with each of these benefits in mind. Bare metal Hyper-V, which is built into Windows Server 20008, provides the underlying virtualization technology that enables server consolidation. Wizard driven configuration with a familiar Windows look and feel enables rapid server provisioning (less than 30 minutes during ESG Lab testing). A robust family of virtualization enabled management tools (e.g., Hyper-V Manager MMC plug-in, SCVMM, SCOM) ensures that virtual—and physical—servers can be quickly provisioned, optimized, and tracked throughout their lifecycles. Powerful heterogeneous management capabilities tested by ESG Lab—including quick migration and physical to virtual (P2V) conversion—have turned server virtualization into an enabler of server management and data center automation.

ESG Lab testing has proven that the performance overhead of Hyper-V is manageably low compared to the outstanding benefits of server virtualization. Moreover, ESG believes that a recent focus in the market on the relative differences in performance between competitive hypervisor technologies is a disservice to IT managers. Given the big picture benefits of server virtualization and the rapid advances in multi-core server technology, a relative difference between technologies that are 90%, or more, efficient matters little. The overall capabilities of the solution, including how well it works with existing processes and technologies, matters much more. As an analogy, imagine you were trading in a car that gets 10 miles per gallon for one of two cars that each gets more than 100 miles to the gallon. Both of the new cars will be more than ten times more efficient that your old car. For most car buyers, an efficiency difference of a mile or two per gallon would be a minor consideration compared to price, performance, service, and options.

Speaking of price, ESG Lab believes that the cost of purchasing and owning a server virtualization solution is a vital consideration. Microsoft Hyper-V Server 2008 is a free download, limited in terms of support for total memory, number of processors, and quick migration. Microsoft Windows Server 2008 Standard, Enterprise, and Data Center editions each include a Hyper-V license for a single physical server as well as licensing for one, four, and unlimited virtual machines, respectively. Microsoft Hyper-V Manager is included as a MMC snap-in to get customers started. SCOM and SCVMM extract the maximum value of virtualization investments with a centralized, heterogeneous management platform with a familiar Windows look and feel. Considering the additional savings that can be achieved when you leverage existing investments in Microsoft training, certification, and interoperability, the bottom line is simple— IT managers save time and money with the Hyper-V support that is built into Microsoft Windows 2008.

Appendix

Table 2. ESG Lab Test Bed

Servers	
Two HP blade servers	AMD64 servers with 4x 2.2MHz dual-core AMD Opteron processors and 8 GB RAM
Storage	
HP StorageWorks MSA 2012fc, vLCA56-27	6x300 GB 15K RPM 3Gb/sec SAS drives, 5+1 RAID-5
Connectivity	
Storage	4 Gb/sec Fibre Channel
LAN	1 Gb/sec Ethernet
Software	
Physical Operating System	Microsoft Windows Server 2008 R1 Datacenter, SP 1
Virtual Operating Systems	64 bit Microsoft Windows Server 2008 Datacenter Edition 32 bit Microsoft Windows Server 2003 Enterprise Edition 64 bit Microsoft Windows Server 2003, Enterprise Edition
Database software	Microsoft SQL Server 2005

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