Lab Validation Report

Microsoft Hyper-V R2

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.

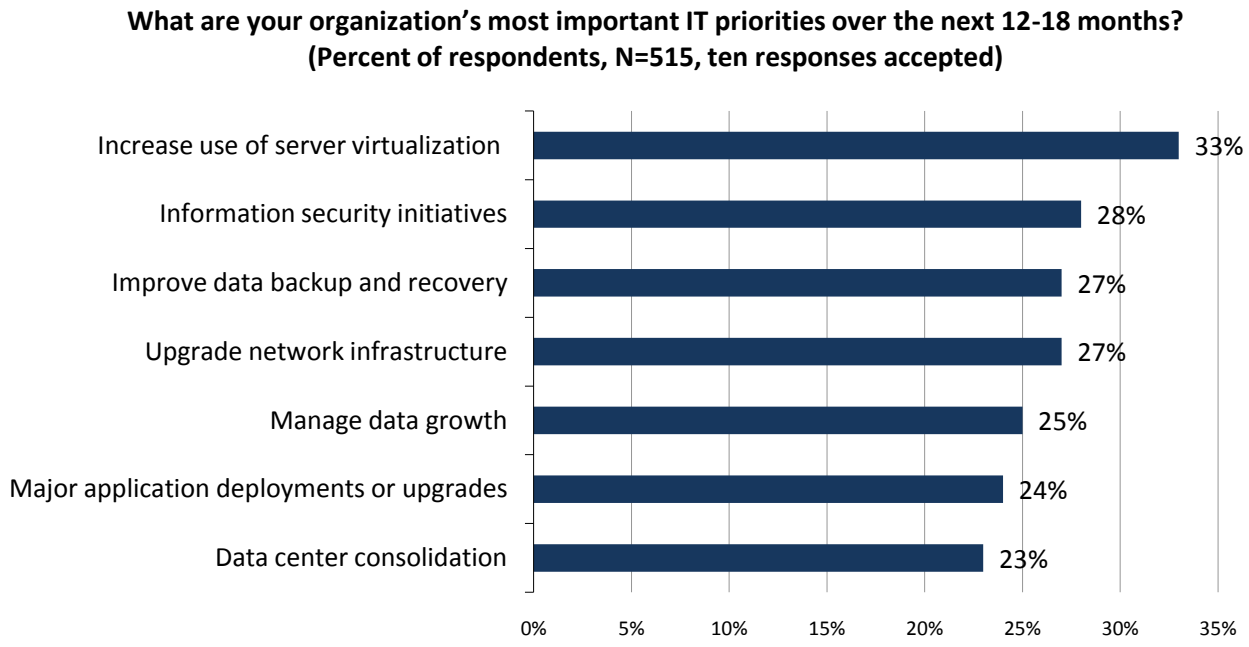
Introduction

Server virtualization remains a high priority for IT organizations of all sizes as they 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 server virtualization technology with a focus on the enhanced flexibility, availability, and performance of Microsoft Hyper-V R2.

Background

Server virtualization is a strategic initiative for IT organizations around the world. ESG conducted an in-depth survey of senior IT professionals concerning their organizations' most important IT priorities for the next 12-18 months;[1] as shown in Figure 1, server virtualization is clearly the number one priority.

Figure 1. Top IT Priorities



Source: Enterprise Strategy Group, 2010.

It's no surprise that server virtualization is a top priority given the dramatic benefits achieved by early adopters. As more and more applications are deployed onto a consolidated pool of servers, better utilization is slashing the capital costs of equipment. Operational costs are dropping as well. A consolidated pool of servers reduces the ongoing cost of power, cooling, and space in the data center. The manpower costs associated with deploying a new application drops as IT managers take advantage of centralized and automated management tools.

Besides the obvious benefits associated with increasing the efficiency of servers in the data center, server virtualization can also be used to enhance the flexibility and availability of IT applications and services. As applications are freed from the confines of a physical server infrastructure, server virtualization can be used to move those applications between servers and protect users from outages due to a physical server failure. In fact, ESG research indicates that virtual machine disaster recovery, backup, and mobility follow closely behind consolidating more physical servers in the list of the top ten server virtualization initiatives.[2]

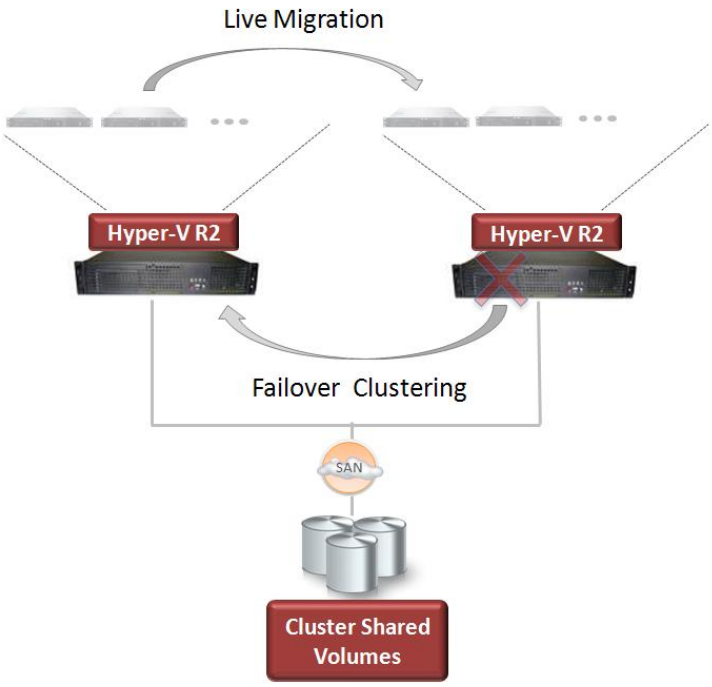
[1] Source: ESG Research Report, *2010 IT Spending Intentions Survey*, January 2010.
[2] Source: ESG Research Report, *2009 Data Center Spending Intentions Survey*, March 2009.

Introducing Hyper-V R2

Microsoft Hyper-V R2 is a bare metal hypervisor that enables the hosting of multiple virtual machines on the same physical server. The supported virtual machines can be a mix of almost all Microsoft (server and desktop) platforms in addition to a couple different Linux platforms. Hyper-V R2 is available in the Windows 2008 Server R2 operating system as well as Microsoft Hyper-V Server 2008 R2. Using familiar interfaces and wizards, Hyper-V R2 lets companies take advantage of existing Microsoft skill sets, training programs, and certifications.

Hyper-V R2, which was released in September 2009, includes a number of valuable enhancements to Microsoft's server virtualization platform. Performance enhancements include improved performance for virtualized applications which rely on virtual hard disks. New capabilities including Live Migration and Clustered Storage Volumes were added as well. As shown in Figure 2, Live Migration enhances the mobility of virtual machines while clustered shared volumes enhance availability during failover clustering.

Figure 2. Hyper-V R2 Flexibility and Availability Overview



Live Migration, which was introduced in Hyper-V R2, differs from Quick Migration, introduced in Hyper-V R1. A quick migration of a virtual machine from one physical server to another incurs a brief period of server unavailability. This gap, which typically last a few seconds, may be felt by end-users and in some cases may require an application restart. Live Migration eliminates this possibility—running virtual machines are moved between physical servers with no interruption.

A Clustered Storage Volume (CSV) is a highly available, shared storage volume that extends the capabilities of a Failover Cluster. A Failover Cluster is a collection of computers (nodes) that work together to increase the availability of an application or service. CSV allows multiple servers in a cluster to read and write at the same time while not having one node responsible for the volume's management. When a Live Migration is executed and its storage is provided by a CSV, the migration can occur very quickly since only the memory of the virtual machine needs to be migrated.

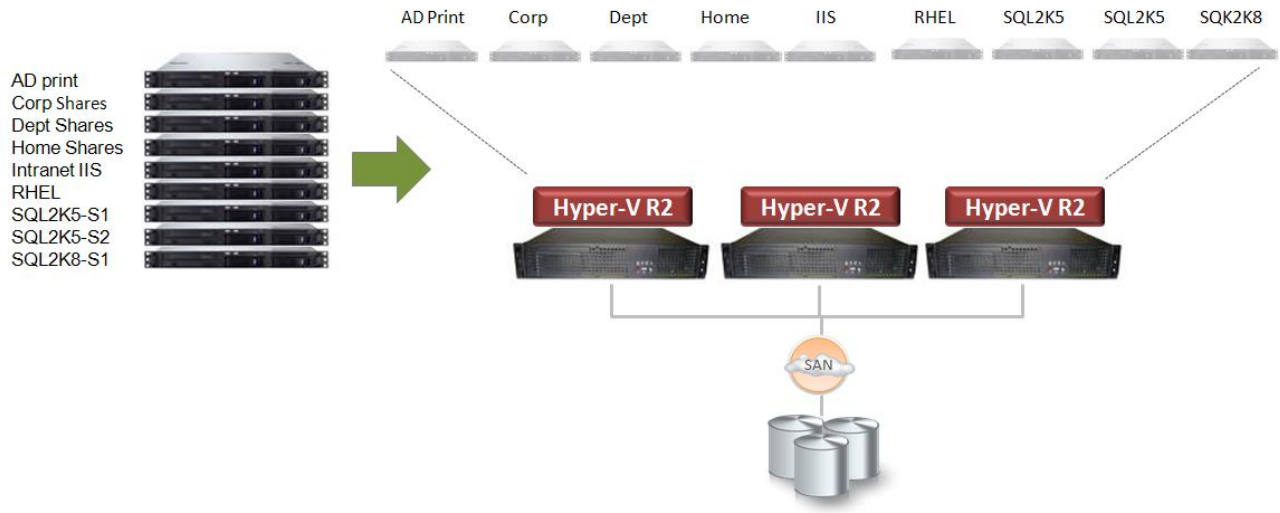
ESG Lab Validation

ESG Lab performed a hands-on evaluation of Hyper-V R2 server virtualization technology in a lab located on Microsoft's Redmond, Washington campus. Testing was performed with a goal of evaluating the flexibility, availability, and performance enhancements introduced in Hyper-V R2.

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 nine older physical servers were consolidated onto a cluster of new servers attached to a shared pool of SAS drives within a FC attached disk array.[3] The servers were configured to support a mix of services and applications including Active Directory and print services, network shared drives (Corp, Dept, Home), Intranet(IIS), Red Hat Linux(RHEL), and databases (Microsoft SQL Server 2005 and 2008). Microsoft Windows 2008 R2 Datacenter Edition, with built-in Hyper-V R2 support, was used to consolidate virtual servers onto a Failover Cluster using SAN-attached storage and Clustered Shared Volumes. A fourth server was used to manage the physical and virtual environment with Microsoft System Center Virtual Machine Manager (SCVMM).[4]

Figure 3. The ESG Lab Test Bed



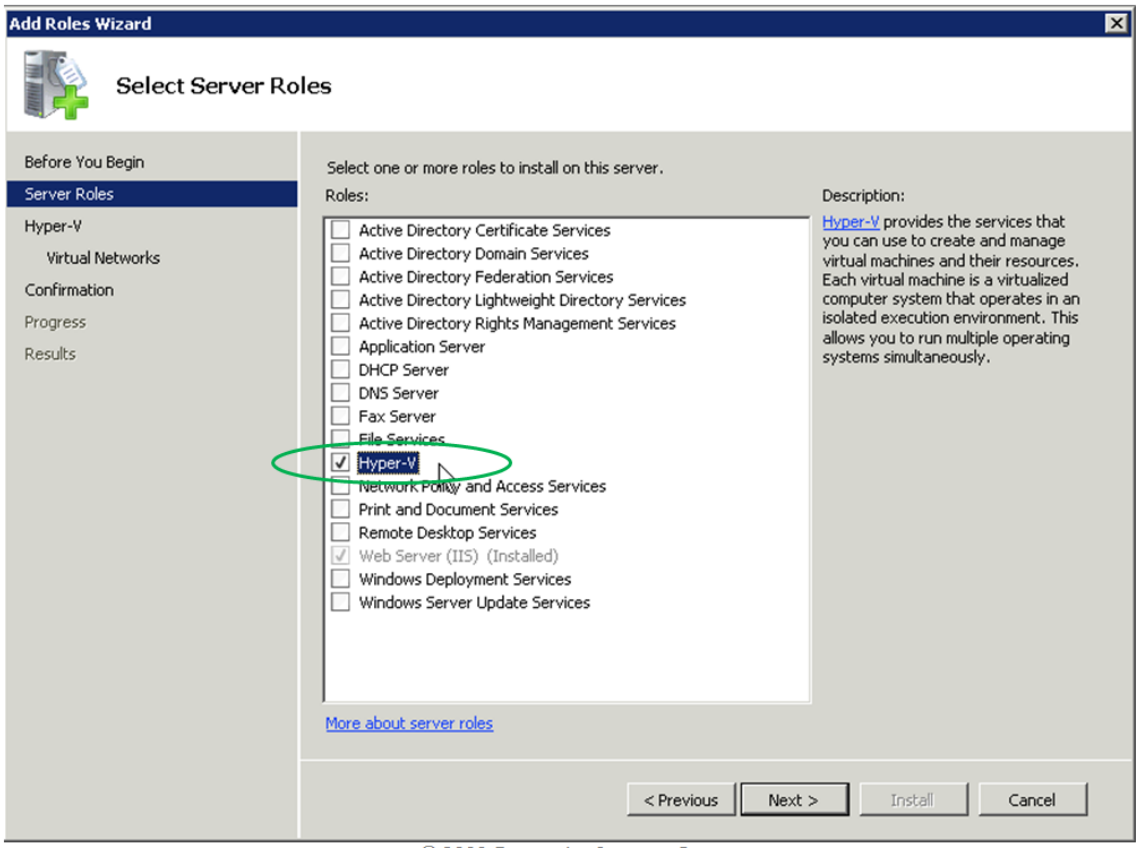
ESG Lab Testing

ESG Lab testing began with a bare metal installation of Windows 2008 R2 on the first 64 bit server. 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.

The wizard shown in Figure 4 was used to enable the Hyper-V role from the Server Manager console on the physical server. The wizard-driven user interface used to enable the Hyper-V role was similar to the one used for configuring common server roles including Active Directory and print services.

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

Figure 4. Enabling Hyper-V



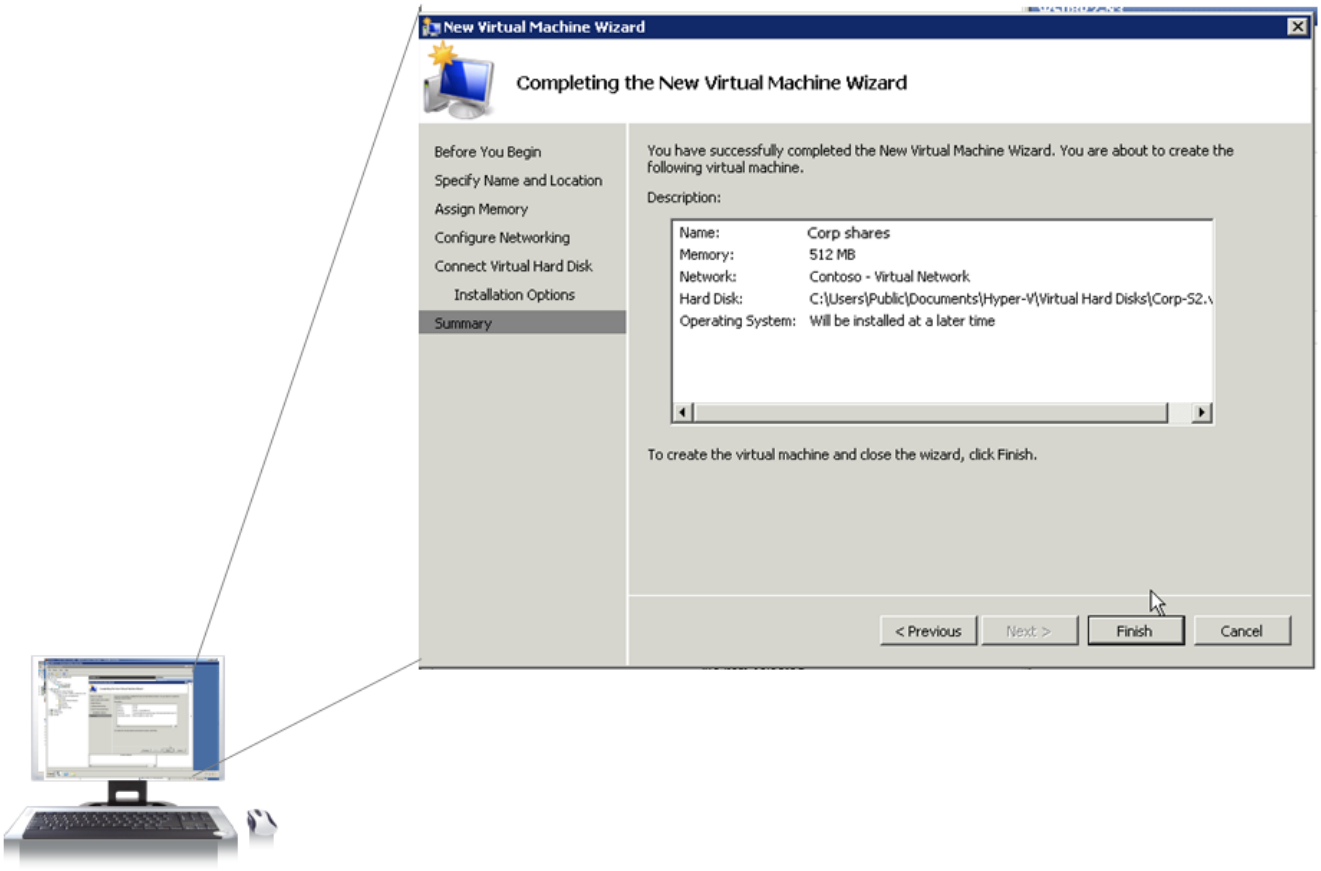
Six mouse clicks and a reboot later, the Hyper-V R2 enabled server was ready for the configuration of the first virtual machine.

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 on the physical server 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



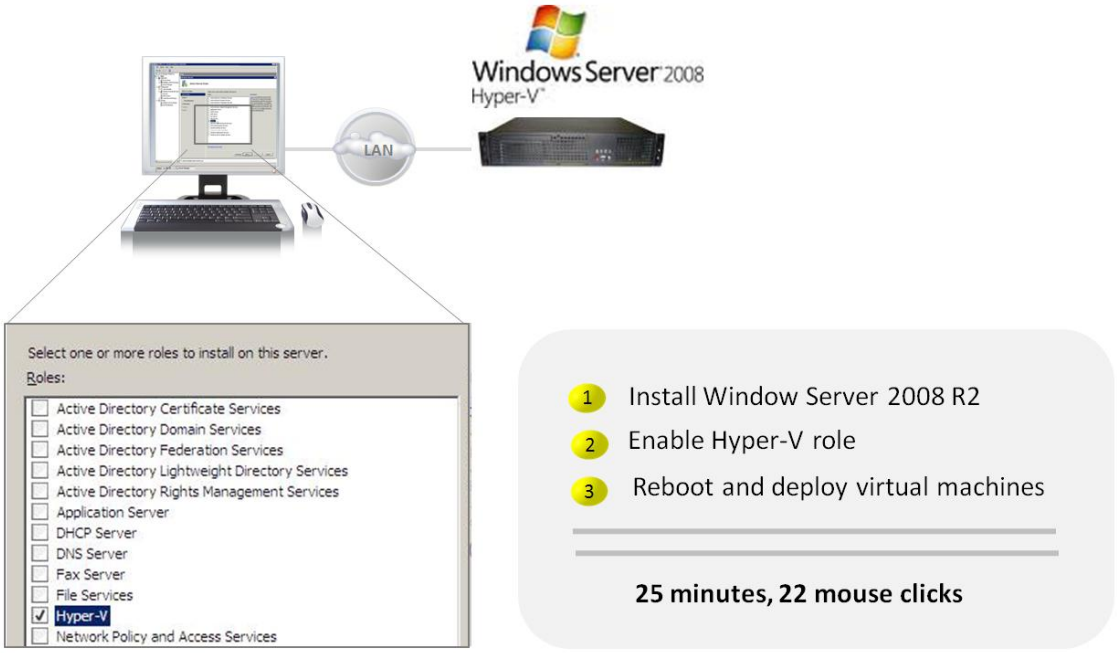
Ten mouse clicks and 42 seconds after getting started with the wizard, the first virtual machine was running a network-based operating system install.

ESG Lab found that getting started with Hyper-V R2 is a straightforward, intuitive process. At a high level, familiar wizard-driven graphical user interfaces built into Windows Server 2008 R2 were used to configure Hyper-V in three steps:

1. Install Windows Server 2008 R2
2. Enable Hyper-V role
3. Reboot and configure virtual machines

As shown in Figure 6, the first virtual machine was up and running 25 minutes and 22 mouse clicks after starting a bare metal installation of Windows Server 2008 R2.

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.

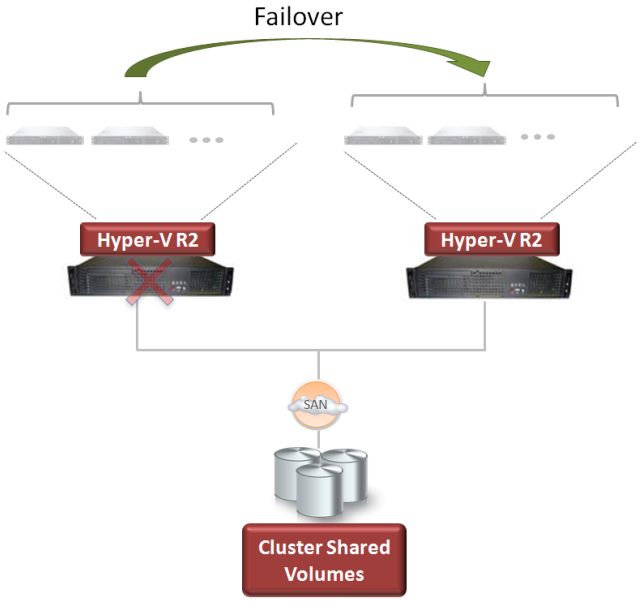
ESG Lab has confirmed that the bare metal Hyper-V support built into Windows 2008 R2 can be deployed in less than 30 minutes using familiar Windows-based server management tools.

Availability

Microsoft has improved the availability of applications running within a virtual server infrastructure with Hyper-V R2 enhancements, including a new feature called Clustered Storage Volume (CSV). A CSV can be created and mounted by servers that are attached to the same storage system through a storage area network. By simply turning on the failover and clustering feature on two or more nodes in a cluster, CSV provides automated and transparent failover of virtual machine from one physical server to another. CSV can also be used to accelerate the migration of virtual machines within a cluster. While CSV creates a single name space which enhances the availability of a Microsoft-enabled virtual server infrastructure, it is recommended but not required for transparent failover or migration.

As shown in Figure 7, cluster shared volume support in Hyper-V R2 enables transparent failover. In this example, a virtual machine running on the failed server on the left has been configured to use a SAN-attached clustered shared volume, which is visible to both of the servers in the cluster. When the failure occurs, running applications fail over transparently to the healthy server on the right.

Figure 7. Transparent Failover with Clustered Shared Volumes



ESG Lab Testing

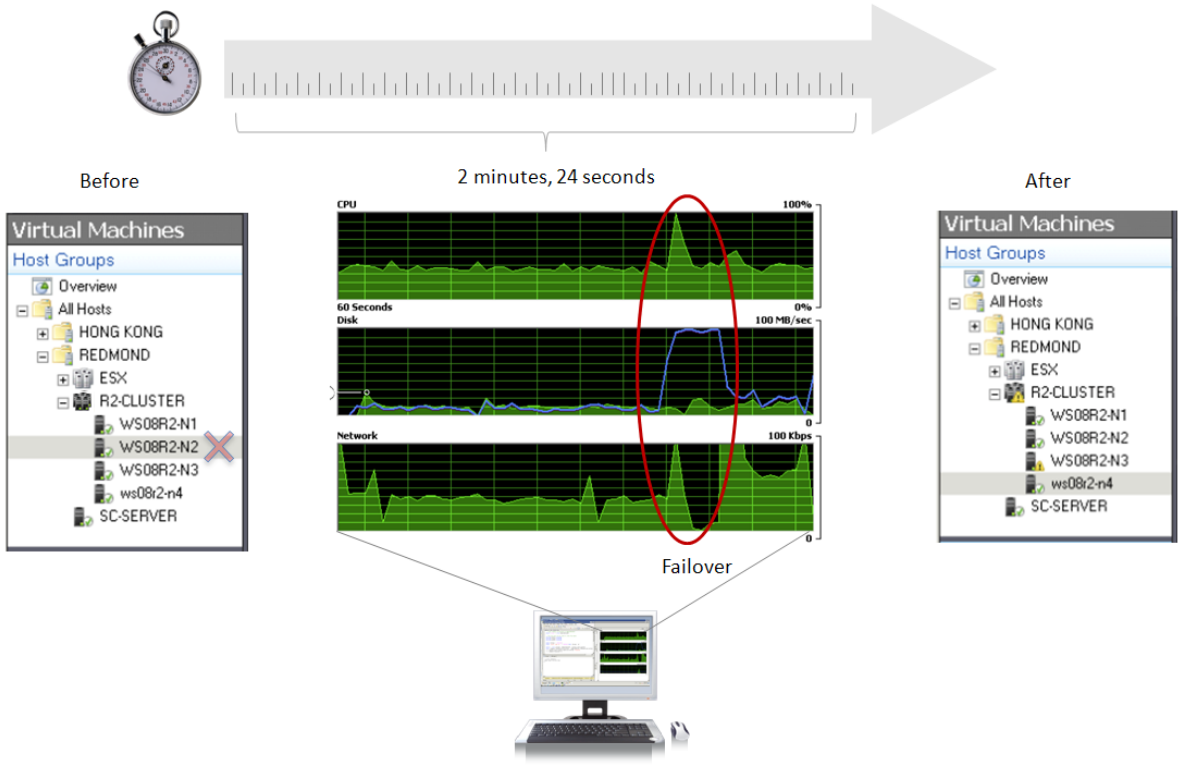
ESG Lab tested a CSV-enabled failover using a Microsoft SQL Server 2008 database running within a virtual machine hosted by Hyper-V R2. The database was installed on a clustered shared volume running within a three-node Hyper-V R2 cluster. A SQL select statement was run against a 952,576 row production database harvested from ESG's internal IT operation. The long running SQL query performed a join of three tables. The server running the SQL query was powered down as the SQL query was running.

After a few seconds, a remote desktop session connection with the virtual machine was lost. The SCVMM console was updated to show that the server was no longer available. Forty seconds later, the remote desktop session reconnected automatically with the virtual machine running on a healthy virtual machine in the cluster.

Figure 8 provides an overview of the failover process. The "before" picture on the left shows the state of the cluster before the server was powered down. At this point, the virtual machine was running on the third node in the cluster (WS08R2-N3). The "after" picture on the right shows the state of the cluster after the failover. Note that SCVMM has changed the status of the cluster and the third node to show a yellow alert.

The performance graph shown in the middle of Figure 8 was captured on the virtual machine running the SQL query during the failover. Note the spike in CPU activity and drop in network activity during the actual failover. Less than three minutes after injecting the error, the virtual machine had automatically failed over to a healthy node in the cluster. The SQL query that was started before the server failure completed without error.

Figure 8. Cluster Failover while Executing Long-running SQL Query



Why This Matters

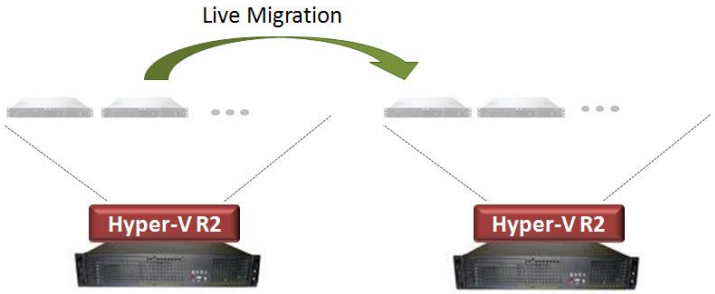
IT managers typically get started with server virtualization to reduce capital and operational costs with a goal of improving the efficiency of their infrastructure. As applications are freed from the confines of a physical infrastructure, IT managers can begin to take advantage of the increased availability and resiliency server virtualization enables.

ESG Lab has confirmed that Clustered Shared Volume and Failover Clustering support in Microsoft Hyper-V R2 can be used to increase the availability of IT services as it automates the recovery of virtual machines after a server failure.

Flexibility

Live Migration is one of the highlights of Hyper-V R2. As shown in Figure 9, Live Migration is used to move a running virtual machine from one physical server to another with zero downtime.

Figure 9. Live Migration with Hyper-V R2

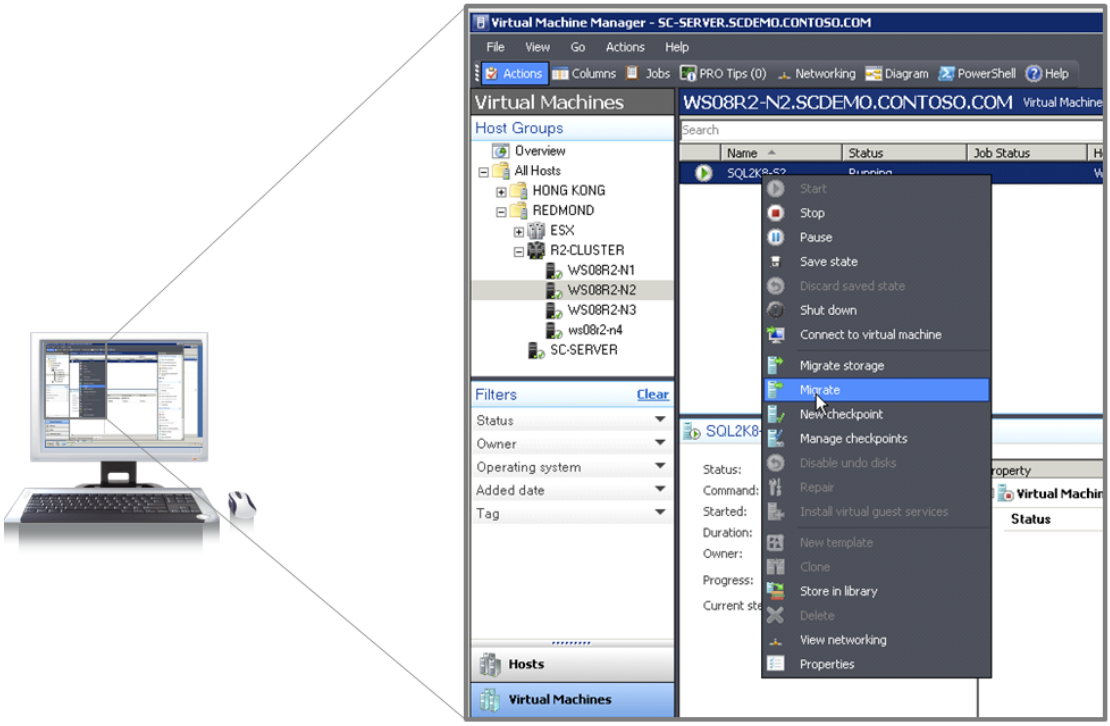


Live Migration differs from Quick Migration, introduced in Hyper-V R1, because Quick Migration causes a brief period of application and network interruption as the virtual machine is paused and restarted on a new server. This pause, which lasts less than a minute and can be tolerated by most applications, has been eliminated with Live Migration.

ESG Lab Testing

Selecting which virtual machine to migrate, and which server to move it to, was intuitively simple using Microsoft System Center Virtual Machine Manager (SCVMM). The SCVMM GUI was used to drag and drop virtual machines from one server to another. A right click on a running virtual machine provided yet another intuitive way to kick off a Live Migration. This method is shown in Figure 11.

Figure 10. Using SCVMM to Perform a Live Migration

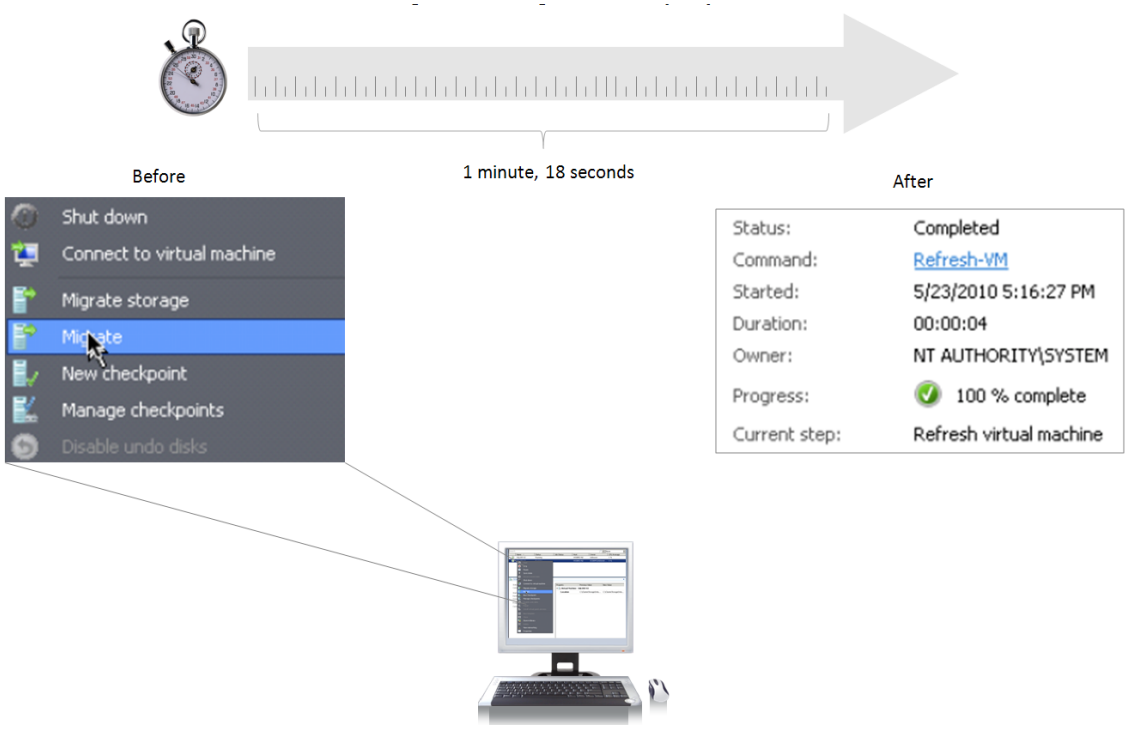


ESG Lab noted that that SCVMM is not required to perform a live migration. While the Failover Cluster Manager snap in that is built into Windows Server 2008 R2 can also be used to perform a Live Migration, ESG Lab found that performing and monitoring a Live Migration from SCVMM is slightly more intuitive and user friendly.

As shown in Figure 11, a Live Migration with an active SQL query running took one minute and eighteen seconds to complete. The SQL query took a bit longer to run than before the migration (17%), but continued to run without interruption. An active remote desktop connection to the virtual machine remained connected throughout.

Note that since the SQL database was installed on a clustered volume that was shared by all of the virtual machines in the cluster, the migration did not require the movement of the database which was stored on a virtual hard disk. In this example, a copy of a 40 GB virtual C: drive was avoided as Hyper-V R2 moved a virtual machine in less than two minutes.

Figure 11. Zero Downtime Live Migration



Why This Matters

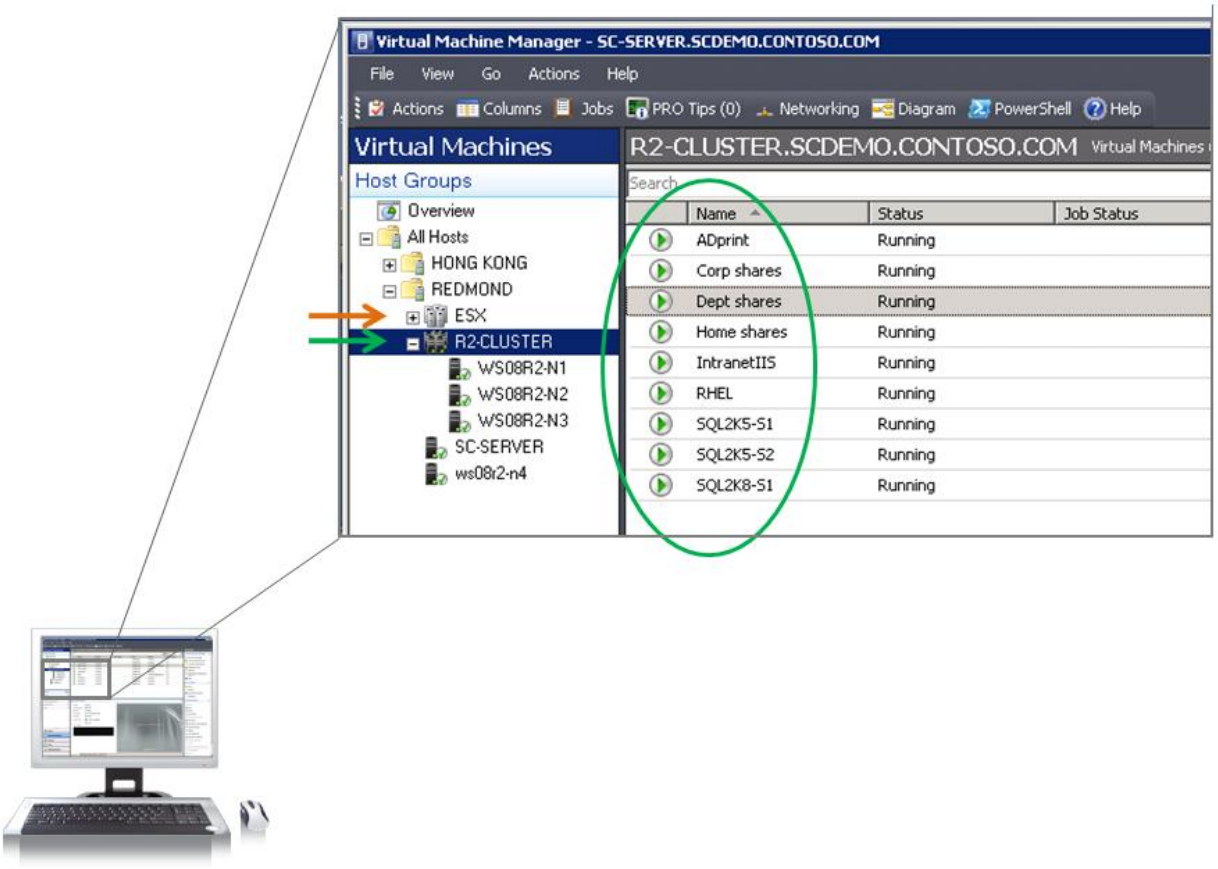
Application unavailability leads to lost productivity and, in some cases, to a loss in revenue. While Quick Migration limits application unavailability during a server migration to a minute or less, ESG Lab has confirmed that Live Migration moves running applications with zero downtime.

Live Migration increases flexibility as it eliminates application downtime during routine maintenance activities (e.g., moving applications to another server to accommodate a hardware upgrade). Flexibility can also be increased as it lets IT managers respond quicker to the changing needs of the business (e.g., moving a critical application away from a busy server).

Scaling Out

As shown in Figure 12, ESG Lab continued to populate a failover cluster (R2-Cluster) deployed on three 64 bit servers to run nine virtual machines supporting a mix of 64 and 32 bit operating systems.

Figure 12. Nine Virtual Machines on Hyper-V R2 Cluster



Note that the Microsoft SCVMM GUI can not only be used to manage a consolidated cluster of virtual machines hosted by Microsoft Hyper-V hypervisors, it can also be used to manage virtual machines hosted by VMware ESX.

Why This Matters

A recent ESG survey indicates that 42% of IT managers report server consolidation as a top initiative for which their organizations will increase or maintain spending.[5] 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 R2 can be used to consolidate physical servers running a mix of commonly deployed business applications onto a consolidated cluster of virtualized servers.

[5] Source: ESG Research Report, *2010 IT Spending Intentions Survey*, January 2010.

Performance

Hyper-V R2 includes a number of performance enhancements that increase virtual machine performance. Hyper-V R2 added support for Second Level Address Translation (SLAT), which uses hypervisor offload capabilities in modern CPUs to improve VM performance. The maximum number of logical processors has increased to 64 and supporting up to 384 virtual machines per server. Live Migration across different CPU versions within the same processor family has also been added (e.g., Intel Core 2-to-Intel Pentium 4 or AMD Opteron-to-AMD Athlon).

Hyper-V R2 also improves the performance of virtualized applications that store information on a Virtual Hard Disk (VHD). A virtual hard disk is a file that encapsulates a hard disk image. VHDs first were created to be the storage media for virtual machines. Today, VHDs are used to ship trial versions of software, in backup solutions, for bug triage (e.g., customers can convert a physical disk to virtual and share it), and even to store multiple boot environments. VHD was integrated into Windows Server 2008 R2 which added native support. Native support means the technology has been integrated into the operating system.

ESG Lab Testing

ESG Lab performed a series of tests designed to confirm Microsoft's claim that fixed VHD performance is on par with native physical drive performance in Windows Server 2008 R2. The performance of real-world applications before and after virtualization on a modern CPU with SLAT support was tested as well. Performance testing began with an evaluation of fixed VHD performance on a high performance 64 bit server with 110 GB of RAM and four AMD Opteron 8439 processors with Rapid Virtualization Indexing (RVI is AMD's version of SLAT), each with six cores (24 cores total).

A fixed VHD is a file that is equal in size to a logical drive when it is created. Because the physical storage required for a fixed size VHD is allocated when the file is created, there is a better chance at optimal placement and organization on-disk which yields the best performance. The disadvantage is that space is committed even if it is not used. A dynamically expanding VHD allocates capacity on demand as data is written by applications. While the performance of dynamically expanding VHDs has improved significantly in Windows Server 2008 R2, their read/write performance is generally slower than fixed disks.[6] ESG Lab tested the performance of a fixed VHD.

The industry standard open source Iometer utility was used to generate workloads which mimic the IO profiles of real-world applications typically deployed in a virtual server environment. Iometer version 2008.06.18 was used. [7] Four workloads were tested: SQL log, OLTP, file server, and Exchange DB.[8]

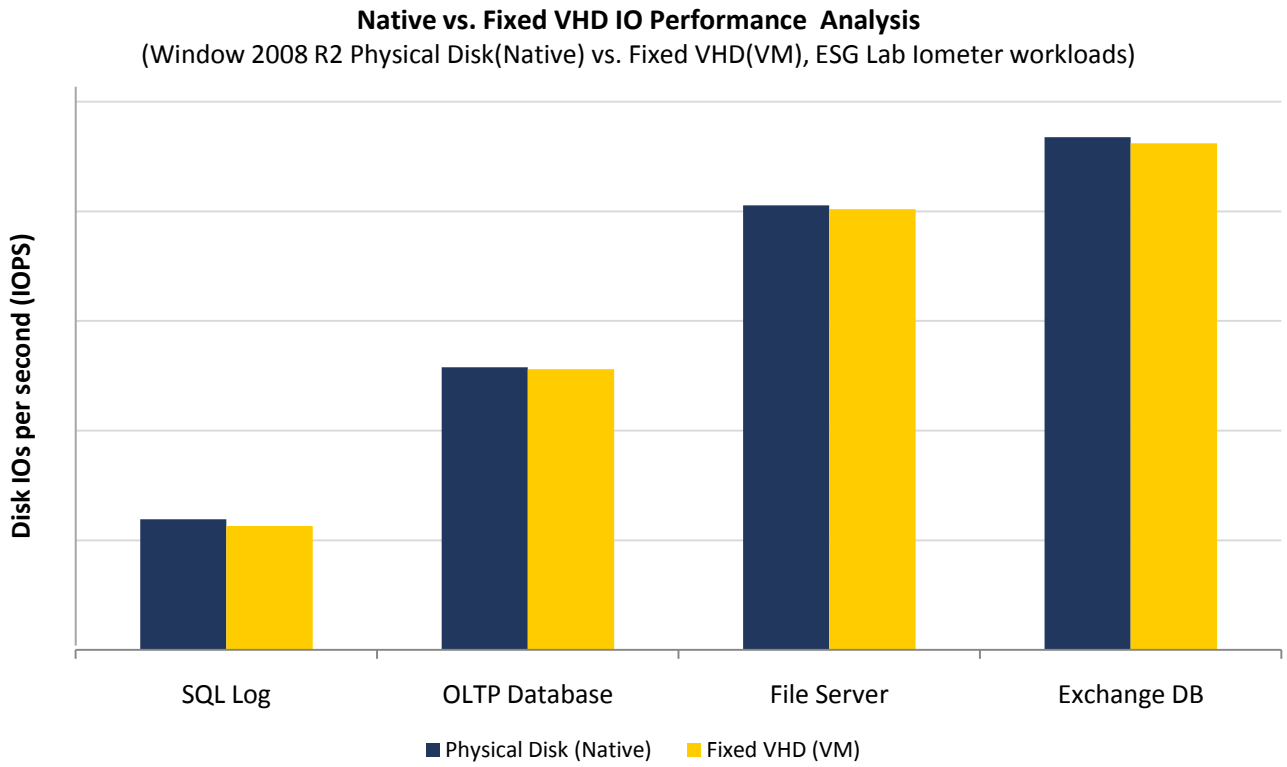
Native testing on a server running Windows Server 2008 R2 Datacenter was performed using a 40 GB physical disk (a.k.a., raw disk or bare metal disk). Results were compared with a 40 GB fixed VHD running within a Hyper-V R2 VM configured on the same physical server. Capacity was provided by a Fibre Channel attached HP MSA storage array with six 15K SAS drives configured in a RAID-5 group (5+1). A two minute Iometer test run with a five minute ramp period was used. The average of three test runs was compared. The results are shown in Figure 13.

[6] Microsoft indicates that the performance of a dynamic VHD support is approximately 87% of a native hard disk. http://blogs.technet.com/b/virtualization/archive/2009/07/22/windows-server-2008-r2-hyper-v-server-2008-r2-rtm.aspx

[7] http://sourceforge.net/projects/iometer/

[8] To learn more about ESG Lab Iometer workloads, see http://www.enterprisestrategygroup.com/using-esg-lab-workloads/.

Figure 13. Hyper-V Fixed Virtual Hard Disk Performance Overhead Analysis



What the Numbers Mean

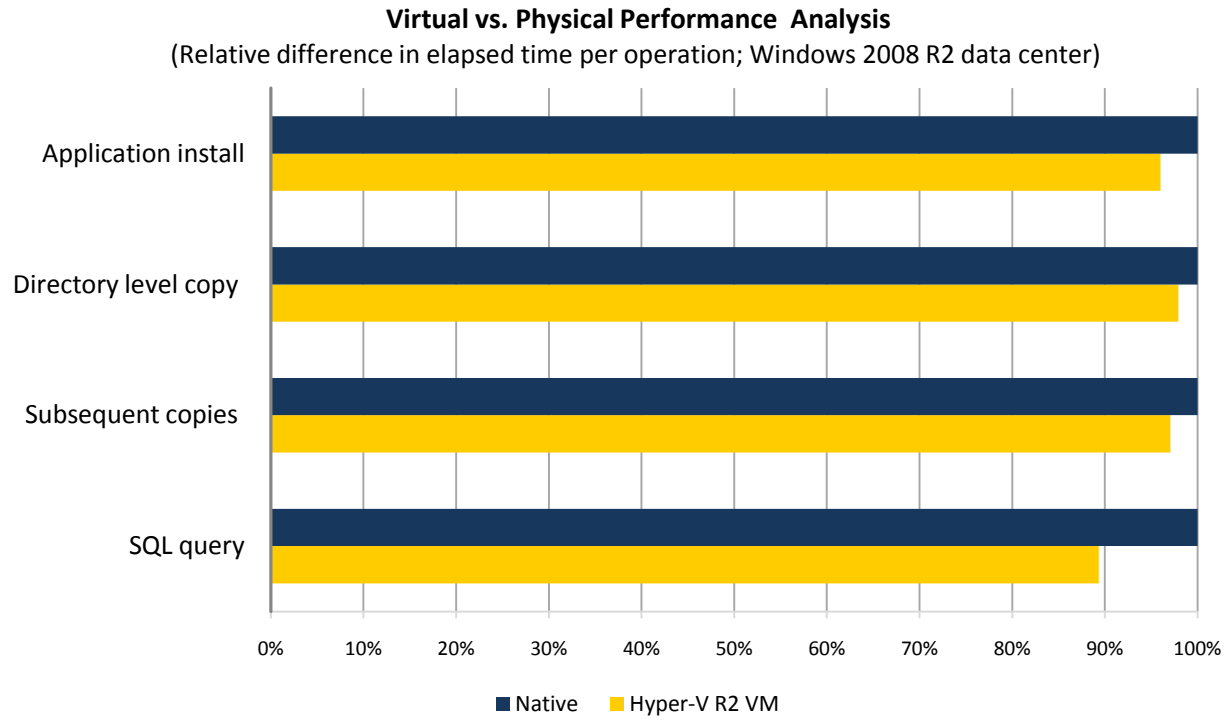
- ESG Lab testing indicates that native VHD performance is nearly the same as a native physical disk in Windows Server 2008 R2 (95% to 99%).
- Excellent VHD performance is due to a number of performance improvements in Windows Server 2008 R2 including integration of VHD support in the operating system.
- Prior to Hyper-V R2, customers often relied on pass through disks to optimize the performance of applications which store information on a SAN attached disk arrays. Pass through disks can also be used to take advantage of advanced data protection and disaster recovery capabilities built into disk arrays (e.g., snapshot sand remote mirroring). R2 performance improvements make VHDs a more viable alternative to a pass through disk in a SAN attached environment.

During the next set of tests, ESG Lab evaluated the performance overhead of Hyper-V R2 in Microsoft Windows 2008 R2 Datacenter edition. Physical and virtual performance was compared for the following application workloads:

1. *Application install*: a timed installation of Microsoft SQL Server 2008 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 952,756 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 compared.

Comparing physical and virtual performance on the same server was accomplished after a reboot with Hyper-V role enabled. The physical server was tested with all of the available CPU cores (64) and RAM (110 GB). During virtual server testing, the server was configured with a single virtual machine which used four CPU cores and 64 GB of RAM. Physical and virtual testing was performed with a 40 GB logical C: drive. The virtual configuration was tested with the C: drive configured as an NFTS volume on a fixed VHD. The results are shown in Figure 14.

Figure 14.Hyper-V R2 Application Overhead Analysis



What the Numbers Mean

- The difference in performance for real-world application workloads is relatively low (2% to 11%)
- Some of the performance difference may be due to the fact that *native Windows Server 2008 R2 tests were performed with all of the available CPU and RAM in the physical server (64 cores, 110 GB of RAM).* In contrast, the *Hyper-V R2 VM tests were performed with the maximum amount supported CPU and RAM for a single Hyper-V R2 virtual machine (8 cores, 64 GB of RAM)*.
- In ESG Lab's opinion, the manageably low performance impact of Hyper-V R2 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 compared to an application running alone on a physical server. High overhead would limit the types, and number, of applications that can be virtualized per physical server.

ESG Lab measured manageably low fixed VHD and virtualized application overhead in a Microsoft Windows 2008 R2 Datacenter 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 R2; 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 R2 Datacenter server with bare metal Hyper-V R2 virtualization support in 25 minutes and 22 mouse clicks.
- ☑ ESG Lab has confirmed that Clustered Shared Volume and Failover Clustering support in Microsoft Hyper-V R2 can be used to increase the availability of IT services as it provides quick and transparent recovery of virtual machines after a server failure. A remote desktop connection to a VM running a SQL query was restored forty seconds after powering down a physical server in a cluster. The SQL query completed without error.
- ☑ Live Migration was used to move running applications between physical servers with zero downtime. A remote desktop connection to a VM running a SQL query remained available throughout the migration. The SQL query completed without error.
- ☑ Nine 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 cluster of multi-core blade servers.
- ☑ Microsoft management tools with a familiar look and feel (Server Manager with the Hyper-V Manager MMC plug-in and SCVMM) were used to deploy, manage, and optimize the virtualized infrastructure.
- ☑ ESG Lab measured manageably low fixed VHD and virtualized application overhead in a Microsoft Windows Server 2008 R2 environment (2% to 11%).

Issues to Consider

- ☑ While not tested 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.
- ☑ Another core capability not tested by ESG Lab is the ability to Live Migrate VMs between servers in the same processor family (Intel Core 2 to Intel Pentium 4).
- ☑ Applications requiring more than the 8 CPU cores and 64 GB of RAM supported by Hyper-V R2 are not a good candidate for server virtualization.
- ☑ While a fixed VHD performs better than a dynamically allocated VHD, the disadvantage is that space is committed even if it is not used.

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 server virtualization 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 R2, which is built into Windows Server 2008 R2, 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 ensures that virtual—and physical—servers can be quickly provisioned, optimized, and tracked throughout their lifecycles. Powerful flexibility and availability capabilities tested by ESG Lab—including Live Migration, Clustered Shared Volumes, and improved performance—are turning Microsoft server virtualization technology into an enabler of server management and data center automation.

Microsoft's growing suite of management tools (e.g., SCOM and SCVMM) magnifies the value of Hyper-V R2. With Microsoft System Center, you can manage at the application level regardless of whether applications are deployed on a physical server or a virtual server. You can manage virtual machines running on a mix of hypervisors from Microsoft, VMware, or Xen.

ESG Lab testing has proven that the performance overhead of Hyper-V R2 is manageably low compared to the outstanding benefits of server virtualization. Moreover, ESG believes that a misdirected focus on the relative differences in performance between competitive hypervisor technologies is a disservice to IT managers. Given the dramatic 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 R2 is a free download, limited in terms of support for total memory, number of processors, and quick migration. Microsoft Windows Server 2008 R2 Standard, Enterprise, and Datacenter editions each include a Hyper-V R2 license for a single physical server as well as licensing for one, four, and unlimited virtual machines, respectively. 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 R2 support built into Microsoft Windows Server 2008 R2.

Appendix

Table 1. ESG Lab Test Bed

Servers	
Five blade servers	One server with four 2.81 GHz AMD Opteron 8439 processors, each with six cores (24 total cores) and 110 GB RAM. Four servers with 4 x 2.2GHz 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 R2 Datacenter Edition
Virtual operating systems	64 bit Microsoft Windows Server 2008 R2 Datacenter Edition 32 bit Microsoft Windows Server 2003 Enterprise Edition 64 bit Microsoft Windows Server 2003, Enterprise Edition Red Hat Linux, version 5
Software	Microsoft SQL Server 2008 Microsoft SQL Server 2005 64 bit Iometer 2008.06.18
ESG Lab Iometer workloads	File Server, OLTP, SQL Log, Exchange DB available here: http://www.enterprisestrategygroup.com/using-esg-lab-workloads/.

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