Lab Validation
Report

Microsoft SQL Server 2008 R2 and Hyper-V R2 SP1 Performance Analysis

Virtualizing Tier-1 Application Workloads with Confidence

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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

This report presents the results of ESG Lab testing of the performance and scalability of Hyper-V R2 SP1 server virtualization technology. Testing with a tier-1 virtualized Microsoft SQL Server 2008 R2 application workload was used to confirm that Hyper-V R2 SP1 can be used to lower total cost of ownership, increase scalability, and maintain performance.

The Next Wave of Server Virtualization

Many organizations are currently reaping the benefits of server virtualization, including lower IT capital and operating costs and greater IT efficiency. Nevertheless, these benefits appear to be only the tip of the iceberg; experienced organizations are moving beyond these initial benefits to improve application provisioning, maintenance, availability, and backup/recovery processes. Server virtualization's benefits appear to come in waves that are closely correlated with organizational experience and confidence with the technology.

As illustrated in Figure 1, over time, organizations tend to move through three distinct phases as they deploy server virtualization technology. They begin by virtualizing IT-owned applications and utilities (e.g., file and print services). Typically, the key objectives during this first wave of virtualization are consolidation, manageability, and cost reduction. As organizations gain confidence in virtualization technology, tier-2 applications (e.g., Active Directory) are consolidated during the second wave of adoption. In this phase, the agility and availability of IT services are often enhanced as IT managers take advantage of virtualization technology to migrate applications from physical servers (e.g., Microsoft Live Migration) to the increased fault tolerance provided within the virtualization layer(e.g., Microsoft Clustered Shared Volumes). As organizations continue on a path toward 100% virtualization, ensuring the performance and scalability of tier-1 applications (e.g., mission-critical SQL Server database applications) is a key objective.

Figure 1. Application Type Virtualization Timeline
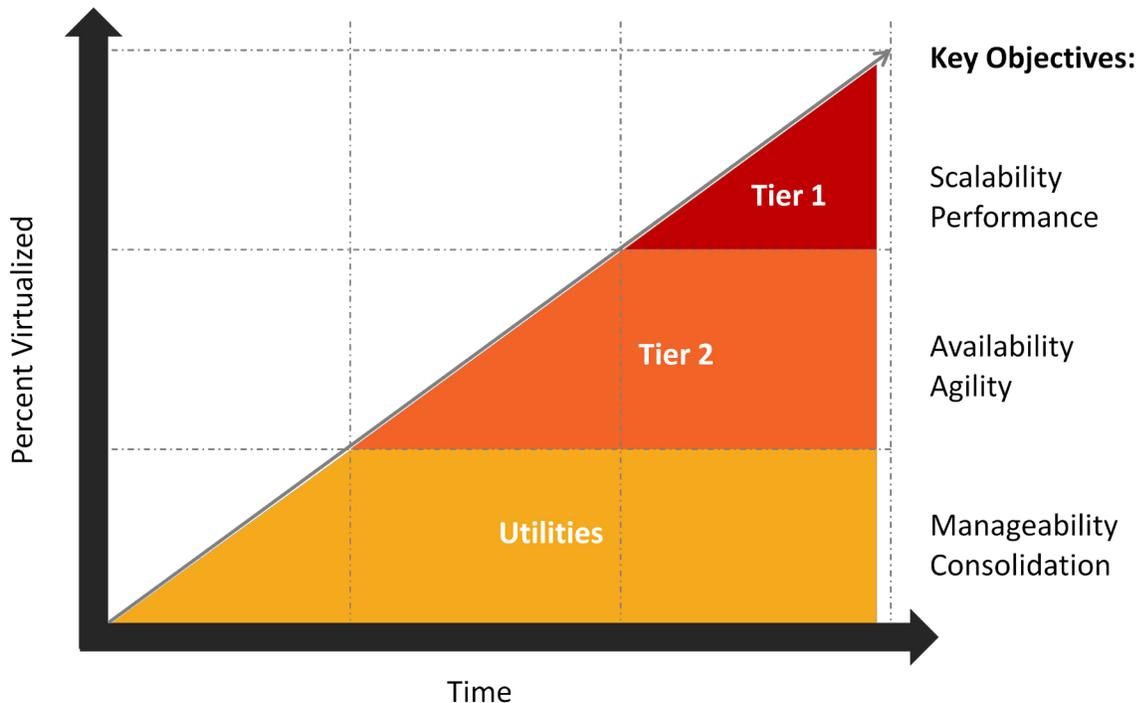
Source: Enterprise Strategy Group, 2011.

Server Virtualization is a Top IT Priority

Server virtualization is becoming ubiquitous as a strategic initiative for IT organizations around the world. Of 1,602 respondents to a recent ESG research survey, nearly three-quarters (74%) say their organization currently uses server virtualization.[1] In addition, as part of its annual IT spending intentions research, ESG surveyed senior IT professionals concerning their organizations' most important IT priorities for the next 12-18 months; as shown in Figure 2, server virtualization is clearly their most important priority for the coming year and beyond, making it the third year in a row that it has ranked at the top of the priority list.[2] Businesses recognize the value that server virtualization delivers and will continue to make investments in the technology in order to drive further efficiencies in their IT environments.

Figure 2. Top IT Priorities

Which of the following would you consider to be your organization's most important IT priorities over the next 12-18 months? (Percent of respondents, N=611, ten responses accepted)

Priority	Percent
Increase use of server virtualization	30%
Manage data growth	24%
Information security initiatives	24%
Major application deployments or upgrades	23%
Improve data backup and recovery	22%
Desktop virtualization	21%
Data center consolidation	21%
Business continuity/disaster recovery programs	20%
Large-scale desktop / laptop PC refresh	19%
Regulatory compliance initiatives	18%

Source: Enterprise Strategy Group, 2011.

ESG's data has confirmed that a massive wave of server virtualization expansion is well underway. For example, while 58% of organizations have virtualized 30% or less of their total population of servers today, 58% of organizations expect to have virtualized more than 40% of all of their servers 24 months from now. The data also indicates that more of these new virtual servers will be run in production environments. On average, the percentage of VMs run in production will increase from 39% today to 58% within two years.

Given the fact that 59% of organizations have not yet virtualized tier-1 applications and that the greatest benefits to be gained with virtualization come with the virtualization of these mission-critical applications and workloads, ESG expects to see an increasing number of organizations tackling tier-1 virtualization.

But while organizations have virtualized all types of applications, many just aren't ready or sophisticated enough to move beyond the low hanging fruit. The majority (59%) of respondents are not yet virtualizing tier-1 applications,
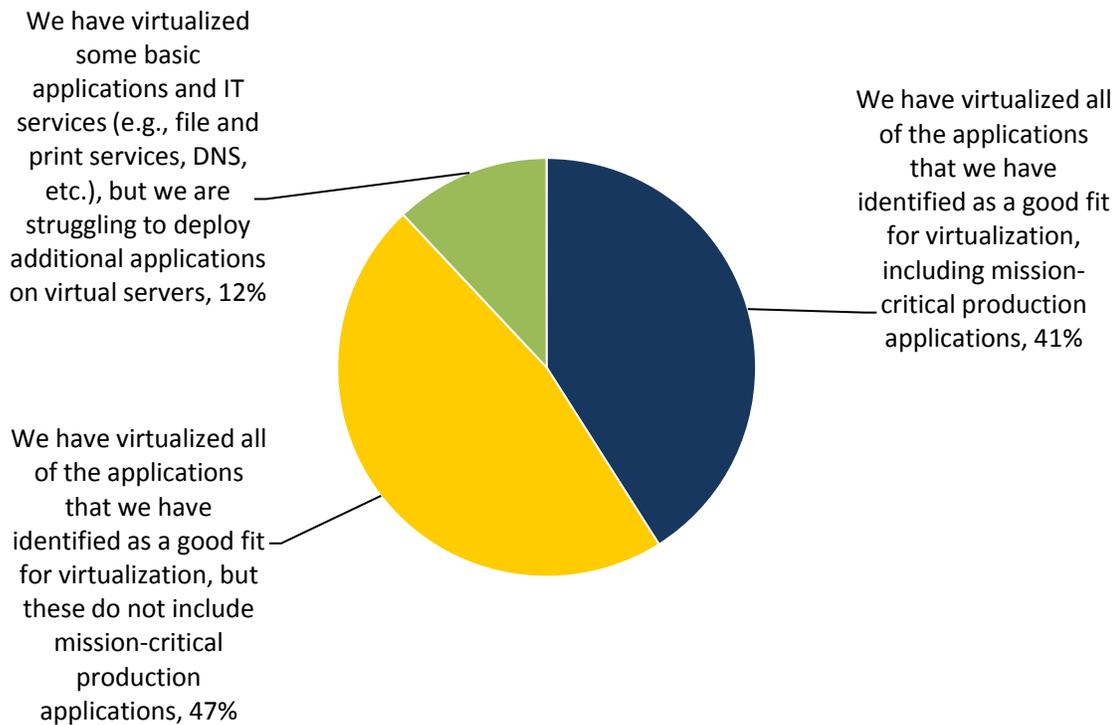
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[1] Source: ESG Research Report, *The Evolution of Server Virtualization*, November 2010.
[2] Source: ESG Research Report, *2011 IT Spending Intentions Survey*, January 2011.

with 12% of that group virtualizing only basic workloads—such as file and print services—and struggling to deploy additional applications on virtual servers (see Figure 3).

Figure 3. How Organizations are Using Server Virtualization

Which of the following choices best describes the extent to which your organization is currently using server virtualization technology? (Percent of respondents, N=463)

We have virtualized some basic applications and IT services (e.g., file and print services, DNS, etc.), but we are struggling to deploy additional applications on virtual servers, 12%

We have virtualized all of the applications that we have identified as a good fit for virtualization, including mission-critical production applications, 41%

We have virtualized all of the applications that we have identified as a good fit for virtualization, but these do not include mission-critical production applications, 47%

Source: Enterprise Strategy Group, 2011.

Overcoming Tier-1 Virtualization Concerns

While server virtualization adoption continues to gain momentum, IT organizations still have numerous hurdles to overcome in order to move closer to a 100% virtualized data center. ESG's data indicates that many organizations struggle with concerns over performance, technology complexity, integration, security, organizational confusion, and a basic lack of knowledge and skills that they believe will be the byproducts of virtualizing tier-1 environments.
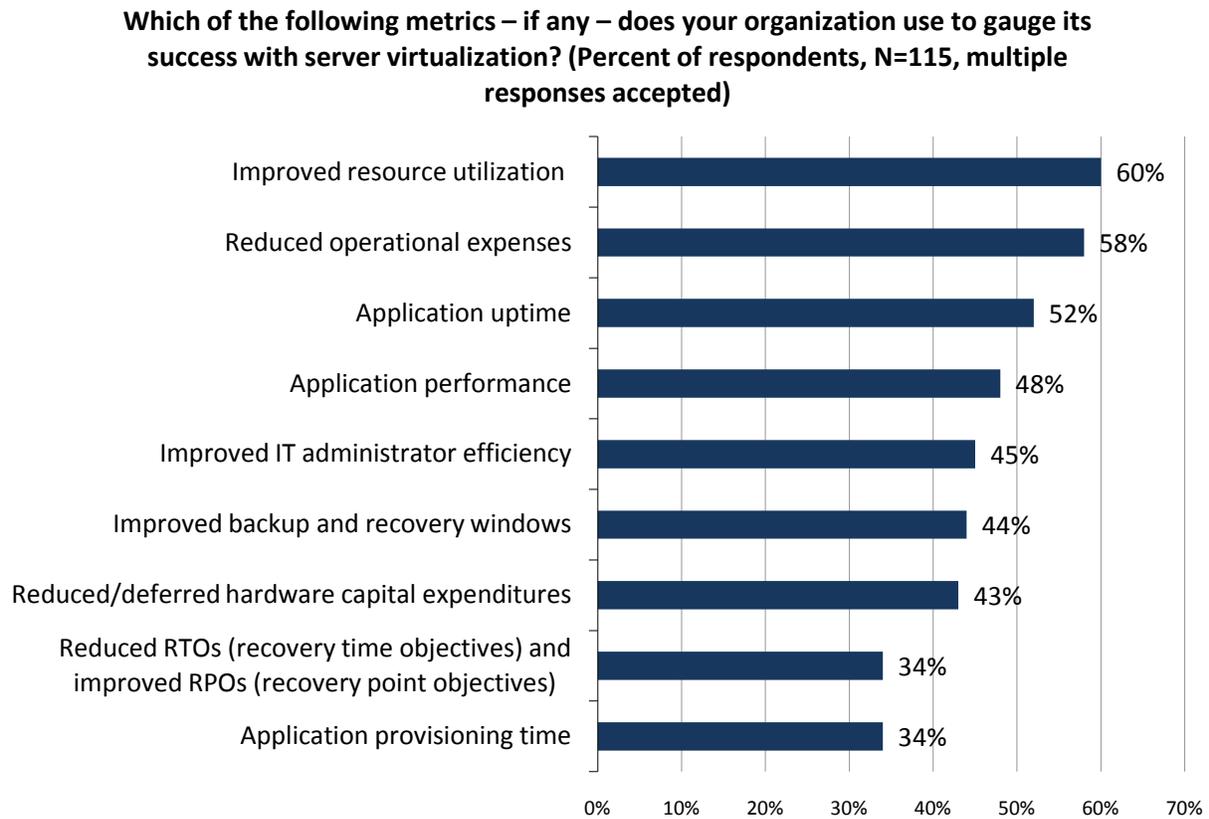
When it comes to virtualizing business-critical multi-user applications, in addition to the general concerns already cited, organizations have many additional worries:

- Will the virtualization layer add a lot of performance overhead?
- Can the virtualized infrastructure scale to continue to meet their needs?
- Can performance SLAs for virtualized business critical applications be met with confidence?

Despite the challenges, experienced organizations with more mature virtualization deployments are rapidly moving beyond the initial benefits of consolidation, finding that more extensive use of virtualization can help improve application backup/recovery, bolster application availability, and automate IT processes. They have come to realize that the real metrics that matter in a virtual environment are those focused on availability and performance, and measure the success of their virtualization efforts not only by their ability to reduce costs and increase efficiency, but also by their ability to meet application performance requirements.

Of these more mature organizations surveyed by ESG, 52% and 48% cited application uptime and performance, respectively, as metrics used to gauge the success of their virtualization deployments, as detailed in Figure 4.

Figure 4. Organization Metrics for Gauging Virtualization Success

Which of the following metrics – if any – does your organization use to gauge its success with server virtualization? (Percent of respondents, N=115, multiple responses accepted)

Metric	Percent
Improved resource utilization	60%
Reduced operational expenses	58%
Application uptime	52%
Application performance	48%
Improved IT administrator efficiency	45%
Improved backup and recovery windows	44%
Reduced/deferred hardware capital expenditures	43%
Reduced RTOs (recovery time objectives) and improved RPOs (recovery point objectives)	34%
Application provisioning time	34%

Source: Enterprise Strategy Group, 2011.

Many of these early adopter organizations have now virtualized whole infrastructures, including business-critical applications like SQL Server. In other words, application performance is a top criterion for virtualization success that is being addressed by the early adopters who have fully embraced server virtualization.

Microsoft Server 2008 R2 SP1 Hyper-V

Microsoft Hyper-V 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 is available in the Windows 2008 Server operating system as well as Microsoft Hyper-V Server 2008. Using familiar interfaces and wizards, Hyper-V lets companies take advantage of existing Microsoft skill sets, training programs, and certifications. Hyper-V R2, which was released in July 2009, includes a number of enhancements that improve the performance and scalability of virtualized application workloads:

- **Storage-specific Enhancements** which increase IO performance, iSCSI connection performance, multi-path performance, fault tolerance, configuration error recovery, and overall storage solution manageability.
- **Live Migration and Clustered Shared Volumes** which enhances the serviceability and mobility of virtualized application workloads.
- **Increased Scale-out and Scale-up Workload Support** which improves the resource efficiency and performance of virtualized application workloads compared to previous versions of Microsoft Windows Server.

Hyper-V R2 SP1, which was released in February 2011, added capabilities which enhance the agility and flexibility of virtualize server environments including:

- **Dynamic Memory** which enables the virtualization server to pool and dynamically add or remove memory based on virtual machine usage, allowing for higher consolidation ratios.
- **RemoteFX** introduced a set of enhancements for the Remote Desktop Protocol (RDP) protocol which delivers a rich end user experience for Virtual Desktop Infrastructure (VDI).

SQL Server 2008 R2

Microsoft SQL Server 2008 R2 is a relational model database server that's used to develop and deploy database applications, improve IT and developer efficiency, and deliver highly scalable and manageable business intelligence services. Key capabilities of Microsoft SQL Server 2008 R2 include:

- **Trusted Scalability** with support for the largest available x64 and Itanium hardware (up to 256 logical processors). With SQL Server 2008 R2, organizations can take advantage of hardware processor and memory maximums with no limit to the number of processor cores.
- **Self-service Business Intelligence**, a major focus for the SQL Server 2008 R2 release. A new feature called Master Data Services improves the management of mission-critical business intelligence data. Also new is an event-processing framework, StreamInsight, which provides monitoring and analysis of streaming data sources, and SQL Server PowerPivot for Excel, which empowers a new class of business users to build and share powerful business intelligence solutions with little or no IT support.
- **SQL Server Data Compression** which reduces hardware costs, optimizes storage, and improves IO performance. Using UCS-2 encoding, the compression capabilities built into SQL Server 2008 R2 can be used to reduce storage capacity requirements up to 50%.
- **Virtualization Ready** consolidation of database applications onto fewer servers with Hyper-V R2 SP1. With a flexible licensing model that allows for up to four virtual database servers per licensed physical server, there are no restrictions on moving virtual servers between licensed host machines.

A growing number of businesses are looking beyond the initial benefits of increased consolidation and manageability that can be achieved with when virtualizing tier-1 application workloads. And yet, according to ESG research, 59% of organizations have not yet virtualized tier-1 applications. Performance concerns are among the top reasons cited as preventing companies from using virtualization more pervasively. The balance of this report summarizes the results of ESG Lab testing designed to evaluate the performance of a fully virtualized Hyper-V R2 SP1 infrastructure running a tier-1 Microsoft SQL Server 2008 R2 application workload.
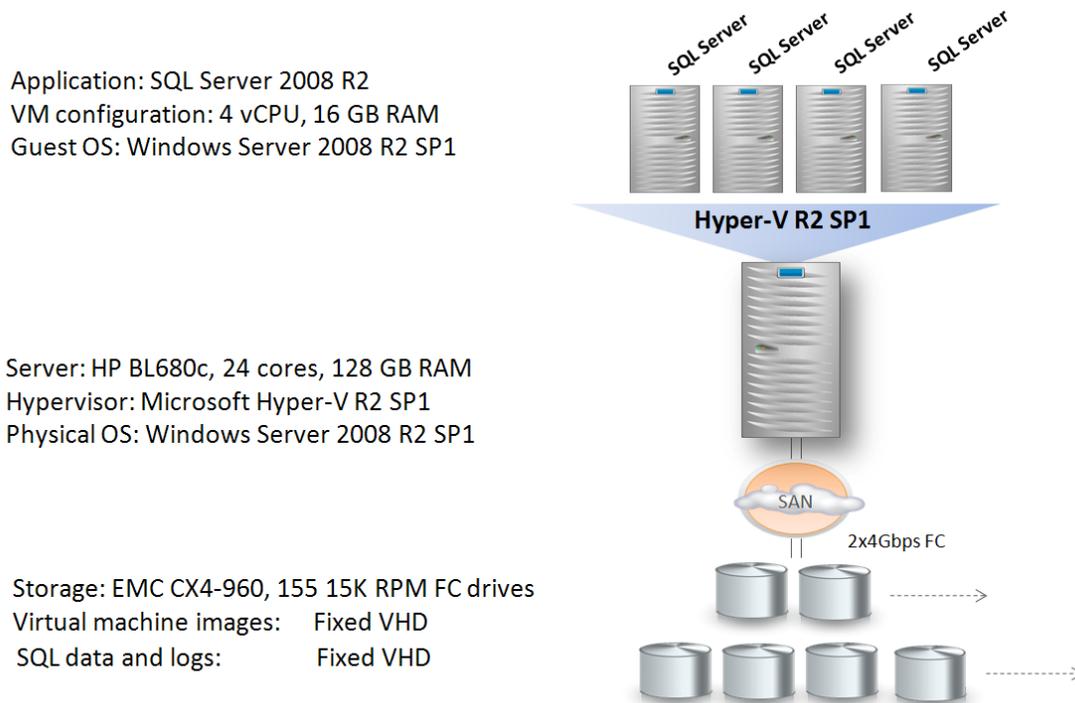
ESG Lab Validation

ESG Lab performed hands-on testing of a virtualized tier-1 application workload in the Microsoft Enterprise Engineering Center (EEC) in Redmond, Washington. The workload used during ESG Lab testing was designed to emulate the database activity of users in a typical online brokerage firm as they generated trades, performed account inquiries, and did market research. The workload was composed of ten transaction types with a defined ratio of execution. Four of the transactions perform database updates, the rest were read-only.

The workload was deployed in one to four virtual machines with a goal of stressing the Hyper-V R2 SP1 virtualization layer. The workload generated a high level of IO activity with small access sizes and spent a lot of execution time at the operating system kernel level. These characteristics, combined with a large cache resident working set, created a workload that was well suited for evaluating the efficiency of the Hyper-V R2 SP1 virtualization layer.

An overview of the test bed used during ESG Lab testing is depicted in Figure 5. SQL Server 2008 R2 virtual machines were configured with four virtual CPUs and 16 GB of RAM on an HP BL680c blade server with 24 CPU cores and 128 GB of RAM. The server was connected to an EMC CX4-960 disk array with 155 15K RPM disk drives.[3]

Figure 5. The ESG Lab Test Bed

Application: SQL Server 2008 R2
VM configuration: 4 vCPU, 16 GB RAM
Guest OS: Windows Server 2008 R2 SP1

Server: HP BL680c, 24 cores, 128 GB RAM
Hypervisor: Microsoft Hyper-V R2 SP1
Physical OS: Windows Server 2008 R2 SP1

Storage: EMC CX4-960, 155 15K RPM FC drives
Virtual machine images: Fixed VHD
SQL data and logs: Fixed VHD

Windows Server 2008 R2 SP1 was installed on internally mirrored drives in the blade server. Windows Server 2008 R2 SP1 guest operating systems and SQL Server application data was installed on fixed virtual hard drives (VHDs) which were stored on the SAN attached disk array. The EMC PowerPath driver is used to load balance IO over a pair of 4 Gbps FC connections between the server and the storage system. EMC Virtual Provisioning (a.k.a., thin provisioning) was not used during the configuration of logical units (LUNs) on the CX4-960 disk array.

A 20,000 customer database was configured within each virtual machine with a goal of scaling up to 80,000 customers during the four virtual machine test. Performance of a single virtual machine virtualized with Hyper-V R2 SP1 was compared to the performance of the physical server configured with the same resources (4 CPU cores and 16 GB of RAM).

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[3] Configuration details are documented in the Appendix.

The Results

The sum of the number of transactions processed per second and the average response time for the ten transaction types were monitored as a scalable number of customers was emulated on a single physical server virtualized with Hyper-V R2 SP1. The results are summarized in Figure 6 and Table 1.

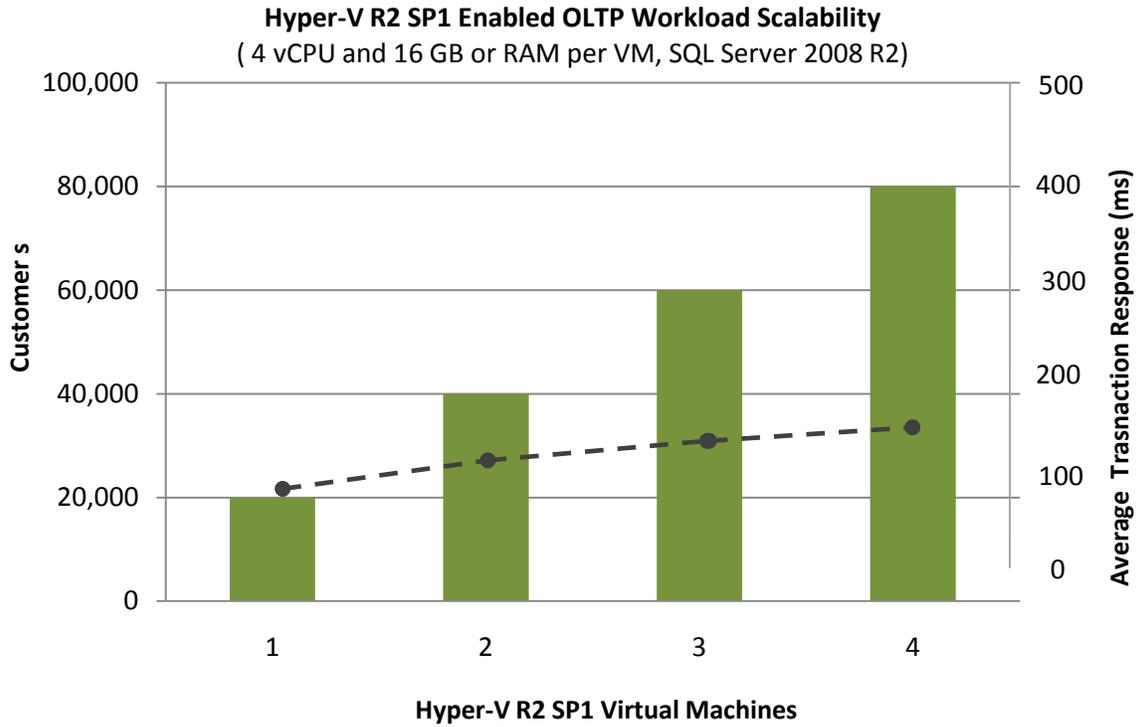*Figure 6. Brokerage OLTP Hyper-V R2 SP1 Workload Scalability*

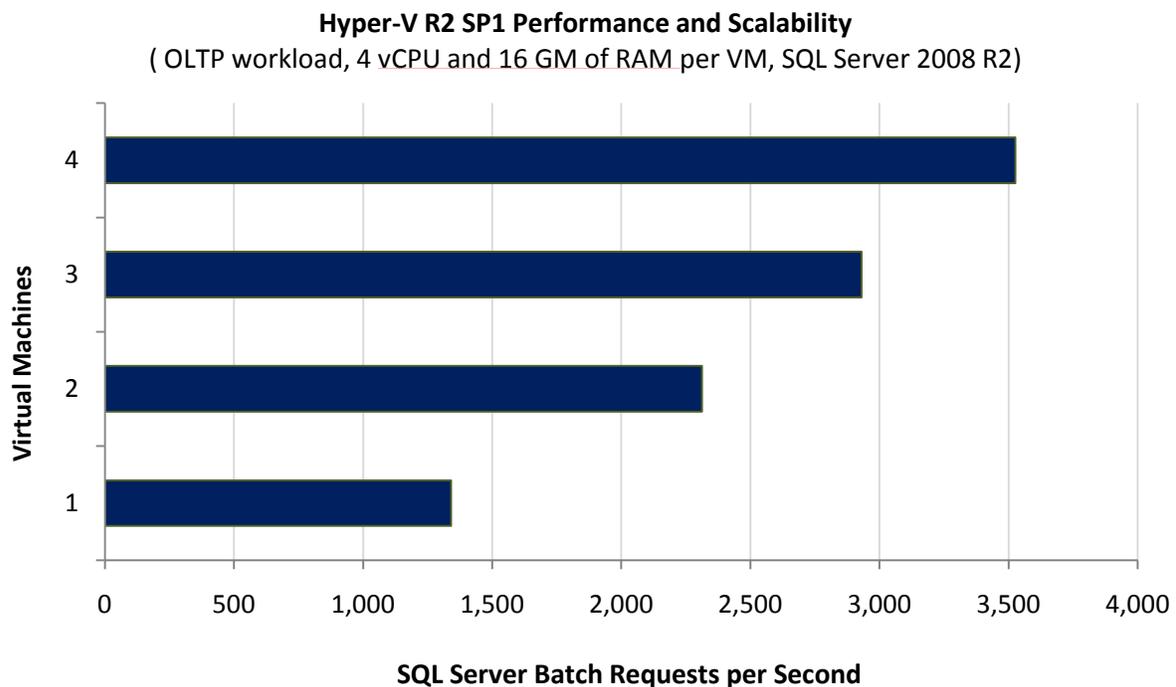**Hyper-V R2 SP1 Enabled OLTP Workload Scalability**
(4 vCPU and 16 GB or RAM per VM, SQL Server 2008 R2)

Table 1. Hyper-V R2 SP1 Workload Scalability

Customers	Virtual Machines	vCPU Utilization	SQL Server Batch Reqs/Sec	Transactions per Second	Response Time (Milliseconds)
20,000	1	80%	1,341	715	90
40,000	2	78%	2,313	1,229	110
60,000	3	74%	2,931	1,577	130
80,000	4	73%	3,526	1,815	140

What the Numbers Mean

- Each of the four virtual machines was populated with a Microsoft SQL Server R2 database supporting 20,000 brokerage customers.
- A constant workload which emulated 35 concurrent users was tested within each virtual machine.
- Transactions per second increased from 715 to 1,815 as the number of virtual machines running on a single physical server increased from one to four.
- Manageably low average transaction response time increased from 90 milliseconds during the single VM test to 140 milliseconds during the four VM test.

CPU utilization and SQL Server batch requests per second was monitored to confirm that SQL Server was busy during ESG Lab testing. A high average virtual CPU utilization of 73% and a high rate of 3,526 SQL Server batch requests per second were recorded during the four virtual machine test. To put this into perspective, Microsoft documentation indicates that "over 1,000 batch requests per second indicate a very busy SQL Server."[4] Of course, this is a relative number that depends on the power of the hardware used to deploy SQL Server applications. In this case, the efficiency of Hyper-V R2 SP1 running on a powerful multi-core server attached to a Fibre Channel disk array with fast 15K RPM drives provided more than enough horsepower to support a "very busy SQL Server."

Figure 7. Brokerage OLTP SQL Server Batch Request Scalability

Hyper-V R2 SP1 Performance and Scalability
(OLTP workload, 4 vCPU and 16 GM of RAM per VM, SQL Server 2008 R2)

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[4] http://www.sqlteam.com/forums/topic.asp?TOPIC_ID=64044

The number of transactions processed per second at the application level is a good measure of the amount of work that a virtualized infrastructure can handle. As shown in Figure 8, the sum of the number of brokerage transactions per second scaled predictably as Hyper-V R2 SP1 virtual machines were added.

Figure 8. Brokerage OLTP Database Transaction Scalability

Hyper-V R2 SP1 Performance and Scalability
(OLTP workload, 4 vCPU and 16 GB of RAM per VM,SQL Server 2008 R2)
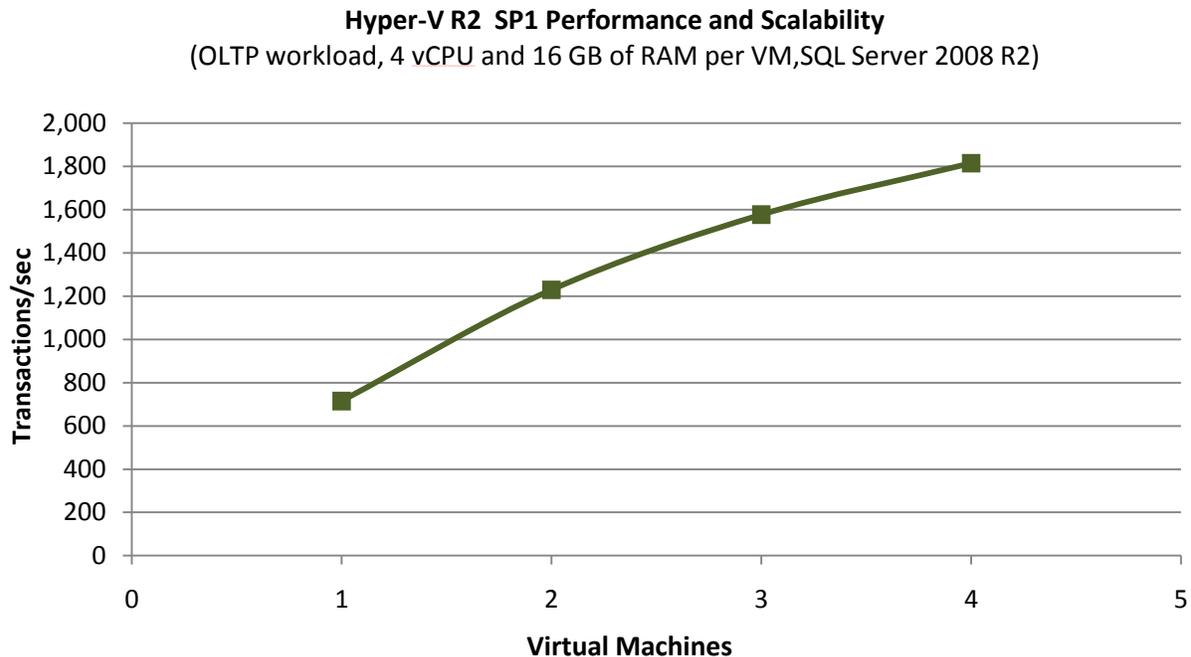
Why This Matters

Database health is critical to business managers, application owners, and enterprise IT teams; the life of an organization literally resides in its database servers. Take away the ability to reliably run enterprise applications or complete customer transactions and watch business come to a standstill. For IT organizations supporting large numbers of users, hesitation to implement virtualization stems in part from the perception that it adds overhead and won't allow performance to scale predictably, particularly when it comes to multi-user, business-critical applications relied upon by the majority of the business. In a recent ESG survey, 25% of respondents reported that performance issues were a leading factor preventing them from using virtualization more pervasively.

ESG Lab confirmed that the manageably low overhead of Hyper-V R2 SP1 can be used to consolidate a tier-1 database application workload with confidence. A single server hosting a virtualized SQL Server 2008 R2 infrastructure deployed within four Hyper-V R2 SP1 virtual machines supported up to 80,000 simulated brokerage customers. Response times remained manageably low (under 150 milliseconds) as virtual machines and simulated brokerage users were added.

ESG research further validates the value of deploying SQL in a virtualized environment, with 39% of respondents having already deployed tier-2 database applications (i.e., Oracle Standard, Microsoft SQL, MySQL, etc.) and an additional 49% having plans or interest in deploying on production virtual machines.

Hyper-V Performance Efficiency

Testing was performed with a goal of quantifying the manageably low difference in performance between the brokerage application running in a Hyper-V R2 SP1 virtual machine and a native physical server. Performance of a single virtual machine was compared with the performance of the native physical server after it was configured with the Windows msconfig utility to use the same resources (4 CPU cores and 16 GB of RAM).

As shown in Figure 9, a 20,000 customer brokerage workload deployed in a Hyper-V R2 SP1 virtual machine processed 12% fewer transactions per second compared to the same workload running on a similarly configured physical server.

Figure 9. Hyper-V R2 SP1 virtualization Overhead Analysis

Hyper-V R2 SP1 Performance vs. Native
(OLTP workload, 4 CPU cores, SQL Server 2008 R2)

Physical Server ■   *Hyper-V R2 SP1 Virtual Machine* ■
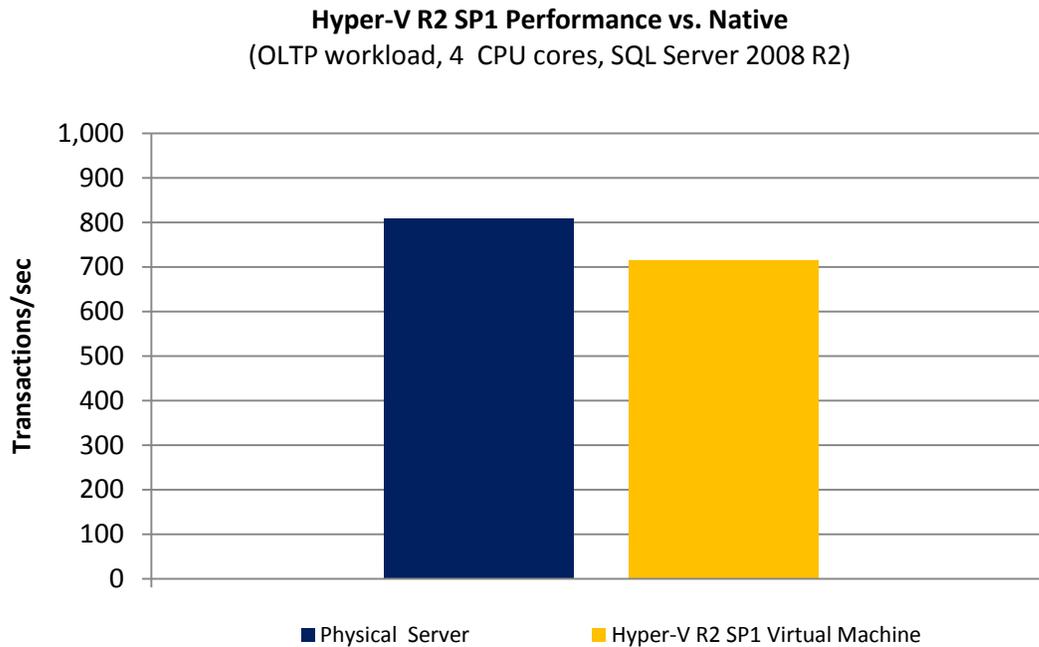
Why This Matters

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 a Hyper-V R2 SP1 overhead of 12% for a busy tier-1 database application workload. ESG Lab believes that this manageably low performance impact is easily justified given the compelling consolidation, manageability, and cost saving benefits that can be achieved with Hyper-V R2 SP1; especially given the continuously improving performance of industry standard server hardware.

ESG Lab Validation Highlights

- ☑ A single server hosting a virtualized SQL Server 2008 R2 infrastructure deployed within four Hyper-V R2 SP1 virtual machines supported a tier-1 application which simulated up to 80,000 brokerage customers.
- ☑ Manageably-low Hyper-V SP SP1 overhead of 12% was recorded when comparing the performance of a physical server to a virtual machine configured with same number of virtual CPU cores and the same amount of RAM.

Issues to Consider

- ☑ "Utility-class" database applications are a great place to start with the consolidation of Microsoft SQL Server applications using Microsoft Hyper-V R2 SP1. These applications have modest performance and availability requirements and are often deployed with third-party software applications or developed within departments of an organization. High rates of consolidation and savings can be achieved by consolidating this class of SQL Server application workloads onto a fewer number of servers. At the other end of the spectrum, applications requiring more than the four virtual CPU cores and 64 GB of RAM supported by Hyper-V R2 SP1 may not be good candidates for virtualization.
- ☑ Capacity planning and performance analysis of existing SQL Server applications is recommended to not only determine if a SQL Server workload is suitably for virtualization, but also to plan the amount of processor, memory, and network resources that needs to be configured within each virtual machine.
- ☑ The test results presented in this report are based on a benchmarks deployed in a controlled environment. Due to the many variables in each production data center environment, capacity planning and testing in your own environment is recommended.
- ☑ Default server BIOS, operating system, and SQL Server settings were used during ESG Lab testing. As expected after any benchmark test of this magnitude, analysis of the results indicates that tuning would probably yield slighter higher absolute results. Given that the goal of this test was not to generate a big number, ESG Lab is confident that the results presented in this report meet the objective of demonstrating the performance and scalability of tier-1 application workloads running in a consolidated Hyper-V R2 SP1 environment.
- ☑ A growing number of best practices, tuning guidelines, and proof points from Microsoft, its partners, and ESG Lab are available for reference when planning, deploying, and tuning virtualized SQL Server applications.

  Running SQL Server 2008 in a Hyper-V Environment - Best Practices and Performance Recommendations
  High Performance SQL Server Workloads on Hyper-V
  Microsoft SQL Server 2008 Server Consolidation
  Performance Tuning Guidelines for Windows Server 2008 R2

  ESG Lab Validation: Microsoft Hyper-V R2 - Scalable Native Server Virtualization for the Enterprise
  ESG Lab Validation: Mixed Workload Performance in Microsoft Hyper-V R2 Environments

  Mixed Workloads on Microsoft Hyper-V and NetApp Fabric MetroCluster
  Consolidating Large Microsoft SQL Server Databases on the IBM System x3850 X5 with Microsoft Hyper-V
  The Benefits of Virtualizing Microsoft SQL Server in Hitachi Storage Environments

The Bigger Truth

Respondents to a recent ESG survey indicated that increasing the use of server virtualization was their number one IT priority over the last two years and will continue to be the top priority for the next 12-18 months. While server virtualization penetration continues to gain momentum, IT organizations still have numerous hurdles to overcome in order to deploy it more widely and move closer to a 100% virtualized data center.

It isn't unusual for organizations to focus server virtualization efforts on consolidation until they build the confidence and expertise to consider the next tier of applications; ESG found that 59% have yet to employ virtualization where it will provide the most benefit: their mission-critical tier-1 applications. For IT organizations supporting large numbers of users, hesitance to implement virtualization stems from the perception that it adds performance overhead and unpredictable scalability and availability to the tier-1, multi-user, business-critical applications relied upon by the majority of their users.

While these performance concerns are certainly understandable, ESG has found that the latest virtualization technology has gone a long way to address those concerns. Modern multi-core processors now come with built-in acceleration for virtualization. Modern hypervisor software has now become increasingly efficient, fast, and scalable. In addition, a set of application-specific best practices and blueprints have been developed to provide proven performance scalability.

ESG Lab hands-on testing has confirmed that Microsoft Hyper-V R2 SP1 technology can be used to meet the performance and scalability requirements of virtualized tier-1 Microsoft SQL Server 2008 R2 application workloads. Predictably low response times and near linear performance scalability was achieved during ESG Lab testing as a single server hosting a virtualized SQL Server 2008 R2 infrastructure deployed within four Hyper-V virtual machines supported up to 80,000 simulated database customers. A Hyper-V SP SP1 overhead of 12% was recorded when comparing the performance of a physical server to a single VM configured with same number of virtual CPU cores and the same amount of RAM. ESG Lab believes that this manageably low overhead can be easily justified given the proven benefits of server virtualization technology and the ever-increasing power of the latest servers with hardware-assisted virtualization performance optimization.

While ESG believes that hypervisor performance is a rarely the barrier when virtualizing tier-1 applications, several impediments could certainly slow progress. For example, ESG research indicates that the top factors preventing organizations from using server virtualization more pervasively are lack of budget and legacy systems/applications running on non-supported platforms. Beyond these factors, users point to more universal problems like security concerns, lack of server virtualization skills, and organizational complexity that cover the gamut of people, process, and technology.

Virtualizing SQL Server applications workloads with Hyper-V R2 SP1 enables businesses to overcome scalability and performance concerns as they lower costs and increase the agility and availability of a consolidated IT infrastructure. With the hypervisor support that's built into Windows Server 2008 R2 SP1, IT organizations can lower costs and benefit from existing skill sets using tools with which their staff is already familiar. Administrators avoid complicated support models and, although not extensively highlighted within this report, should also consider the value of using Microsoft System Center as a management tool to centrally monitor and manage both physical and virtual resources across multiple hypervisors from the hardware to the application level.

Put it all together and it's clear that Hyper-V R2 SP1, included at no additional charge in Microsoft Server 2008 R2 SP1, can be used to virtualize Microsoft SQL Server application workloads with confidence.

Appendix

Table 2. ESG Lab Test Bed

Software	
Hypervisor	Hyper-V R2 SP1
Native O/S	Windows Server 2008 R2, Data Center Edition (64-bit), SP1, version 6.1.7601
Guest O/S	Windows Server 2008 R2, Data Center Edition (64-bit), SP1, version 6.1.7601
Database	Microsoft SQL Server 2008 R2, Data Center Edition (64-bit), version 10.50.1600.1
Multi-path	EMC PowerPath version 5.2
Hardware	
Server	HP BL680x G5 with 24 2.4 GHz Intel Xeon E7540 CPU cores and 128 GB of RAM
Storage	EMC CLARiiON CX4-960 with 155 15K RPM FC drives
LUNs	SQL Database: 700 GB RAID-10 RAID-10 over 88 drives Guest O/S and utilities: 140 GB RAID-10 over 24 drives (thick provisioned) Logs: 50 GB RAID-10 over 16 drives Thick LUNs (i.e., EMC virtual provisioning/thin provisioning was not configured)
SAN	4 Gbps Fibre Channel
Virtual Machine Configuration	
CPU	Four virtual CPUs per VM
RAM	16 GB per VM
Storage	Fixed Virtual Hard Drive (VHD)