

Performance Advantage of Dell PowerEdge R900 over HP DL585 Running Microsoft Hyper-V

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Talk Back

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Executive Summary

Information Technology organizations are finding that combining today's industry standard servers based on multi-core processors with server virtualization can create highly efficient solutions. A series of tests were run comparing a Dell™ PowerEdge™ R900 server using new Intel six-core processors against previous generation quad-core processor servers. Microsoft Windows Server 2008's server virtualization technology Hyper-V was used as the basis with many Virtual Machines running on each of the servers tested. The results of these tests showed that the Dell PowerEdge with Intel six-core processors was able to outperform quad-core processor based servers, with increased performance per watt efficiency.

Introduction

Two trends with the server industry over the past several years have been the increasing number of cores per processor socket and the use of server virtualization software. These two trends work well when put together because server virtualization software allows all of the available processing power in a server to be shared by a number of virtual machines at the same time. Using Hyper-V, the new server virtualization role for Microsoft Windows Server 2008, a Dell PowerEdge R900 was tested using new 6-core Intel processors against an R900 with Intel 4-core processors and an HP DL585 with AMD 4-core processors. The test measured the potential performance increase due to the additional processing cores.

MultiCore Processors

The new 6 core Intel Xeon 7400 series processors provide an increase in the number of cores for the Xeon processors which had previously been a maximum of four. This trend to increase cores as a way to increase performance has almost completely replaced the previous trend of increasing the clock speed. The speed of the processors measured in MHz has remained in the same range as the previous Xeon 7300 series processors, but performance has been increased because the number of processing cores has increased. It is widely expected that the number of cores will continue to be increased as the primary method for increasing performance.

The new Intel Xeon processors tested in this whitepaper use both L2 and L3 cache along with six cores to provide a high performance server processor that is ideal for running many virtual machines. The following figure shows the basic architecture of the Intel Xeon 7400 series processor.

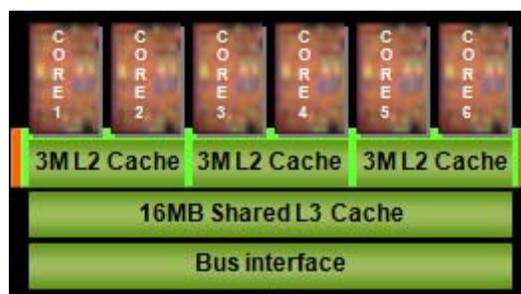


Figure 1 Intel Xeon 7400 Series Processor Diagram

Microsoft Hyper-V

With the large amount of processing power available in servers, it is less likely that a single application will need its own dedicated server. With virtualization software it is possible to use a single physical server as a host for many virtual machines. Each virtual machine is configured to have a portion of the resources

of its host physical server which can be much more efficient resulting in higher utilization of servers while still providing good performance.

Microsoft Hyper-V is a virtualization layer, often referred to as a hypervisor, which provides an abstraction between the hardware and virtual machines. Additionally there is a parent partition where Windows Server 2008 x64 resides and provides the Hyper-V Administrator tool to create VMs or child partitions. Hyper-V is an optional role of Windows Server 2008 x64. It can be enabled and run on any Windows Server 2008 x64 system with processors that support virtualization.¹

Hardware

The PowerEdge R900 is a four-socket server that supports Intel® Xeon® 7300 and 7400 series processors. The Dell test team initially configured the PowerEdge R900 with four quad-core Intel Xeon X7350 processors at 2.93 GHz. This resulted in a total of 16 cores. For another round of testing the PowerEdge R900 was upgraded with the new six-core Intel Xeon processors which increased the total cores to 24. The upgrade only required a BIOS update and the new processors. The system was otherwise configured the same for all tests with 128 GB of RAM, one additional Intel gigabit NIC, and the onboard PERC 6/i for local storage.

	HP ProLiant DL585 G2	PowerEdge R900 Quad-Core	PowerEdge R900 Six-Core
Virtualization software	Microsoft Windows Server 2008 Enterprise with Hyper-V 1.0	Microsoft Windows Server 2008 Enterprise with Hyper-V 1.0	Microsoft Windows Server 2008 Enterprise with Hyper-V 1.0
Processor	Four quad-core AMD Opteron 2.4 GHz 8358 SE processors with 512L L2 and 2 MB L3 cache	Four quad-core Intel X7350 Xeon processors at 2.93 GHz with 4MB L2 Cache Per Core Pair	Four six-core Intel E7450 Xeon processors at 2.4 GHz with 3 MB L2 Cache per Core Pair and 12MB L3 Shared Cache
HyperTransport / Frontside bus	1 GHz	1,066 MHz	1,066 MHz
Memory	128 GB (32x 667 MHz PC2-5300 DDR2 4GB DIMMs)	128 GB (32x 667 MHz fully buffered 4GB DIMMs)	128 GB (32x 667 MHz fully buffered 4GB DIMMs)
Internal disks	Two Serial Attached SCSI (SAS) 73 GB, 15,000 rpm drives	Two Serial Attached SCSI (SAS) 146 GB, 15,000 rpm drives	Two Serial Attached SCSI (SAS) 146 GB, 15,000 rpm drives
Network interface card (NIC)	Four 10/100/1,000 Mbps internal NICs	Four 10/100/1,000 Mbps internal NICs	Four 10/100/1,000 Mbps internal NICs
Disk controller	Smart Array P400	PERC 6/i	PERC 6/i

*This term does not connote an actual operating speed of 1 Gbps. For high-speed transmission, connection to a Gigabit Ethernet server and network infrastructure is required.

Table 1: Configurations for the HP ProLiant DL585 G2 server and the Dell PowerEdge R900 servers

The HP ProLiant DL585 G2 is a four-socket server that supports the AMD Opteron 8000 series of processors. The test team configured a DL585 G2 with four 2.4 GHz quad core Opteron 8358 SE processors and 128 GB of RAM. Each processor is coupled with RAM and connected to each other via a 1GHz

HyperTransport™ bus. This keeps the memory closer to the processors, and in many cases ends up providing faster access because of this direct connection. Configuration details are shown in Table 1.

The PowerEdge R900 and HP ProLiant DL585 G2 were connected to a dedicated Ethernet based iSCSI storage area network (SAN) with a dual-port Intel gigabit PCI Express NIC. The storage utilized was four Dell EqualLogic™ PS5000XV arrays each with 16 146 GB, 15,000 rpm disks, for a total of 64 disks. Dell PowerConnect 5448 gigabit Ethernet switches were used to for the iSCSI SAN. The EqualLogic Host Integration Kit's Remote Configuration was used to configure the iSCSI settings such that only the iSCSI subnet and NICs would be used for iSCSI traffic. The iSCSI software initiator included with Windows Server 2008 was used to connect via two NIC ports to the EqualLogic storage.

A RAID-10 storage pool with all four EqualLogic PS5000XV arrays was configured and eight 200 GB volumes were created in this storage pool. With EqualLogic storage arrays the volumes are spread across the member arrays automatically to optimize performance. During this testing these volumes were the only active volumes, so they were spread evenly across the member arrays. Four volumes were assigned to the R900 and four to the DL585. VMs were created and evenly divided across the volumes. Table 2 summarizes the storage configuration used in the test environment.

	Dell/EqualLogic PS5000XV
iSCSI Connections	3x 1 Gb/s per Array
Arrays	4x Dual Controller PS5000XV Arrays Each with 16x 146 GB 15,000 rpm disks (Total of 64 Disks)
Storage Pool	1 RAID-10 (With all four PS5000XV Arrays as Members)
Volumes (LUNs)	Eight 200 GB (four assigned to each server)

Table 2: Configuration of the Dell EqualLogic PS5000 iSCSI storage array

Windows Server 2008 Virtualization Testing Platform Configuration

In order to configure the systems to run Hyper-V both test servers were installed with Windows Server 2008 x64 Enterprise Edition. The Hyper-V role was then added to enable the hypervisor. The version of Hyper-V that shipped with Windows Server 2008 was a beta so it was necessary to then apply the Hyper-V update for Windows Server 2008 patch, available from Microsoft's website, which upgrades Hyper-V to the final version.

Virtual Machine Creation and Configuration

To compare the relative performance of the PowerEdge R900 and the HP DL585 G2 servers, a set of Windows Server 2008 virtual machines was created. An initial VM was created and then installed with x64 Windows Server 2008, and x64 SQL Server 2005 with service pack 2. The Hyper-V Integration Services were also installed in the VM which has drivers optimized for Hyper-V VMs. The medium size Dell DVD Store (<http://www.delltechcenter.com/page/DVD+Store>) database of approximately 1GB was then created using the scripts included with the DVD Store kit. The DVD Store database simulates the database back end of a simple Web-based storefront. The database size is as setup for this test is small (approximately 1 GB), and representative of a database used for development or testing.²

The initial VM was then replicated by using sysprep to first prepare the virtual disk for replication and then doing a simple file copy of the virtual hard disk. The virtual hard disks were evenly distributed across the LUNs assigned to the server on the EqualLogic arrays. To complete the VM replication, new VMs were created and configured to use the new virtual hard disks. Table 3 shows the configuration for the VMs in the test environment.

Operating System	Workload	Memory	Disk	Number of Virtual NICs	Number of virtual processors
Windows Server 2008 x64	Microsoft SQL Server 2005 x64	2048 MB	18 GB	1	1

Table 3: Configurations for the virtual machines used in the test environment

Testing Methodology

To simulate how enterprises typically run applications on VMs in a production environment, the test team increased the number of VMs until processor

utilization for the entire physical server was as close to 80 percent as possible. This represents a reasonably high level of usage that still allowed for workload spikes. The test team calculated utilization levels by averaging the values from the HyperVisor Logical Processor, % Total Run Time windows performance counter during each test.

The test workload ran simultaneously on multiple VMs under the same load. By keeping all settings on the VM and driver systems identical and then observing how many VMs could be run simultaneously, the test team was able to measure how many VMs each physical server could support as well as the total throughput across all VMs.

The ds2sqlserverdriver.exe program that is included with the DVD Store was used to drive the workload against the VMs. This driver program connects directly to the SQL Server database and simulates the load that an application server with many users logging on, browsing and purchasing items from an online store would create against the database. For these tests each VM was being driven by an instance of the driver program with 10 threads and a .2 second delay time.

Performance and Power Consumption Results

The VMs were run on the servers in successive tests, adding VMs in each round as described the previous section, until total CPU utilization on the server reached 80%. A power meter attached to the servers measured the power consumption during these tests. Combining both the performance and power numbers allowed for a final calculation of performance per watt.

Performance and Power Consumption. Performance with a virtualized server can be measured in two components. The first is a sizing or capacity which is the number of VMs that can be supported. This immediately leads to the second component, which is the aggregate performance that those VMs are able to achieve. The performance results from the testing are presented both in number of VMs and the sum of the associated performance, Orders Per Minute (OPM) of those VMs.

The power consumption of systems has become a real issue for customers and needs to be considered as part of the overall server performance. An important factor when measuring power consumption is the configuration and load level of the server. The power numbers recorded and reported here are heavily dependent on the amount of RAM, number of PCI adapters, number of internal disks, and the amount of load on the system. All of the configuration options were kept as equal as possible between the systems for this reason.

The difference in the number of VMs and the OPM performance metric indicated the relative difference in performance. The test team calculated the performance results for the SQL Server 2005 VMs by totaling the OPM from all the VMs running in the test environment. Table 4 summarizes the performance results including the power consumption for the three servers tested.

	Number of VMs	Total Server CPU Utilization	Performance in Orders Per Minute (OPM)	Dell v. HP Performance Advantage %	Avg Power Consumption (W)	Performance Per Watt (OPM/W)	Dell v. HP OPM/W Advantage %
HP DL585 G2 Quad-Core	26	80 %	58,355		739	81.0	
Dell R900 Quad-Core	30	80 %	62,983	8 %	971	64.7	- 20%
Dell R900 Six-Core	40	80 %	74,084	27 %	864	85.7	6 %

Table 4: Workload performance results for each server in the test environment

These results show that the Dell R900 with six-core Intel Xeon 7450 processors provided a 27% performance advantage over the HP DL585 G2 with AMD Opteron quad-core processors and a 6% advantage in performance per watt. A second key finding is that by simply upgrading the processors in the R900 the performance increased by approximately 18% while power consumption decreased by 11% resulting in a 33% improvement in performance per watt.

Conclusions

The combination of high performance and efficiency make the PowerEdge R900 an excellent Microsoft Hyper-V virtualization server. The testing results showed that an R900 with six-core Intel Xeon 7450 processors was able to outperform an HP DL585 G2 with AMD Opteron quad-core processors by 27% while still having a 6% advantage in performance per watt. In comparison the R900 with Intel Xeon quad-core processors was able to outperform the HP DL585 G2, but with a 20% disadvantage in performance per watt. This shows that the new six-core processors are key in providing a more efficient high performance platform for Microsoft Hyper-V workloads as they are the only difference between the two R900 server configurations tested.

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1 Microsoft has not certified support of the Hyper-V role of Windows Server 2008 on systems with over 16 cores at the time of publication of this whitepaper.

2 The use of Microsoft SQL Server 2005 in these tests does not indicate that Dell or Microsoft has tested or certified SQL Server with VMware virtualization software. As described at support.microsoft.com/?kbid=897615, Microsoft typically does not support problems with Microsoft operating systems or applications that run on VMs using non-Microsoft virtualization software unless the same problem can be reproduced outside the VM environment.

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