The Scalable Enterprise: Price/Performance Benefits of VMware ESX Server on the Dell PowerEdge 6650 vs. the IBM xSeries 445

Enterprise Product Group (EPG)

Dell White Paper

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Section 1

Executive Summary

This paper examines the price/performance ratio of VMware® server virtualization software on two 4-processor Dell™ PowerEdge™ 6650 servers, compared to a competitive 8-processor system. By comparing a virtualization deployment based on two 4-processor Dell PowerEdge 6650 servers to a single 8-processor IBM xSeries 445 server, both running the same VMware virtualization software stack, we demonstrate that the Dell configuration delivers 27% better price/performance than the IBM server.

Section 2

Introduction

The Dell & VMware ESX Server Price/Performance Advantage

As discussed in our prior paper, "The Scalable Enterprise: VMware ESX Server™ on the Dell PowerEdge 6650" (http://www.dell.com/downloads/global/solutions/SE-VMware-PE6650%2002-04-04.pdf), server virtualization based on Dell 4-processor servers and VMware software can offer significant benefits when compared to a similar deployment on an 8-way or larger server. These benefits, detailed in the above-referenced paper, include risk mitigation, expansion flexibility, and operational flexibility.

In the current study, we focus on price/performance, and compare a server virtualization deployment using two 4-processor Dell PowerEdge 6650 servers to a single, similarly configured 8-processor IBM eServer xSeries 445 server, both running the same VMware virtualization software stack.

The tests performed in this study simulate a test-and-development environment in which a scaled-down version of an enterprise's Microsoft SQL Server™ database (a 1 GB version of the 100 GB DVD Store used in the previous paper) has been captured in a virtual machine and cloned to provide multiple developers identical environments with which to do their application development and stress testing. Sixteen such virtual machines were created and then stress tested on the IBM xSeries 445 8-way server. Two PowerEdge 6650 4-way servers, each running eight such virtual machines, were stressed in the same manner.

The two PE6650s, with a total price of $91,604 (including VMware ESX Server), could handle 9.2% more orders per minute than the $106,442 IBM xSeries 445 (also including VMware ESX Server), for a price/performance advantage of 27%.

Section 3

ESX Server Setup

The Hardware

Two Dell PowerEdge 6650 servers and an IBM eServer xSeries 445 server were used for the testing. Each PowerEdge 6650 was configured with four 2.8 GHz Intel® Xeon™ Processors MP and 16 GB of memory. The IBM xSeries 445 server was configured with eight 2.8 GHz Intel Xeon Processors MP and 32 GB of memory. When comparing the two Dell servers and the single IBM server we were comparing a like number of processors and the same amounts of memory.

VMware ESX Server allows the user to specify the use of all the Gigabit Ethernet[1] Network Interface Controllers (NICs) on each system. Each system has one ESX Server Service Console, which is used to administer and configure ESX Server. One onboard NIC on each system was dedicated to the ESX Server Service Console on that system. Additionally, on each Dell PE6650, one Intel Pro 1000XT Gigabit NIC was dedicated to the Virtual Machines on that system whereas on the IBM xSeries 445, two Intel Pro 1000XT Gigabit NICs were dedicated to Virtual Machines (thus keeping the number of Virtual Machines per NIC constant throughout the test. The details are shown in Table 1.

	Each Dell PowerEdge 6650	IBM eServer xSeries 445
Virtualization Software	VMware ESX Server 2.0.1 ($3,750 per 2-CPU license)	VMware ESX Server 2.0.1 ($3,750 per 2-CPU license)
Virtualization Software Price	$15,000	$15,000
Servers		
CPU	4x 2.8 GHz Intel Xeon Processors MP w/ 2MB L3 cache	8x 2.8 GHz Intel Xeon Processors MP w/2MB L3 Cache
Memory	16 GB	32 GB
Internal Disks	2x 18 GB	2 x 36 GB
NICs	2x 10/100/1000 Mb/s (internal) 2x Intel Pro 1000XT Gb	2x 10/100/1000 Mb/s (internal) 2x Intel Pro 1000XT Gb
Disk Controller	PERC/3 Dual Channel	IBM ServeRAID
Fibre Channel Host Bus Adapter	QLogic 2340	QLogic 2340

Height	4 Rack Units (4U) or 7-inches	4 Rack Units (4U) or 7-inches
Server Prices	$76,604 (2x $38,302)	$91,442
Total Price[2] (Servers & VMware software)	$91,604 (Total for 2 Servers)	$106,442
Source	www.dell.com 03/18/04	www.ibm.com 03/18/04

Table 1: Configuration of PowerEdge 6650s and IBM xSeries 445 used in VMware ESX Server test

The PowerEdge 6650 servers and the IBM xSeries 445 server were attached to a Storage Area Network (SAN) via QLogic 2340 fibre channel Host Bus Adapters (HBA). The SAN consisted of a Dell/EMC CX600 fibre channel controller and one external Disk Array Enclosure 2 (DAE2) with ten 73 GB drives. (See Figure 1 and Table 2 below for details). Note that the price of the SAN was not included in our calculation of the IBM and Dell server prices. We created two 5-disk RAID 5 logical units (LUNs) and assigned them to the ESX Server farm. When using VirtualCenter and VMotion to enable the movement of virtual machines from one server to another, the storage used by the virtual machines must be visible to all the ESX Server hosts. So the two LUNs used by the virtual machines were assigned to all three servers.

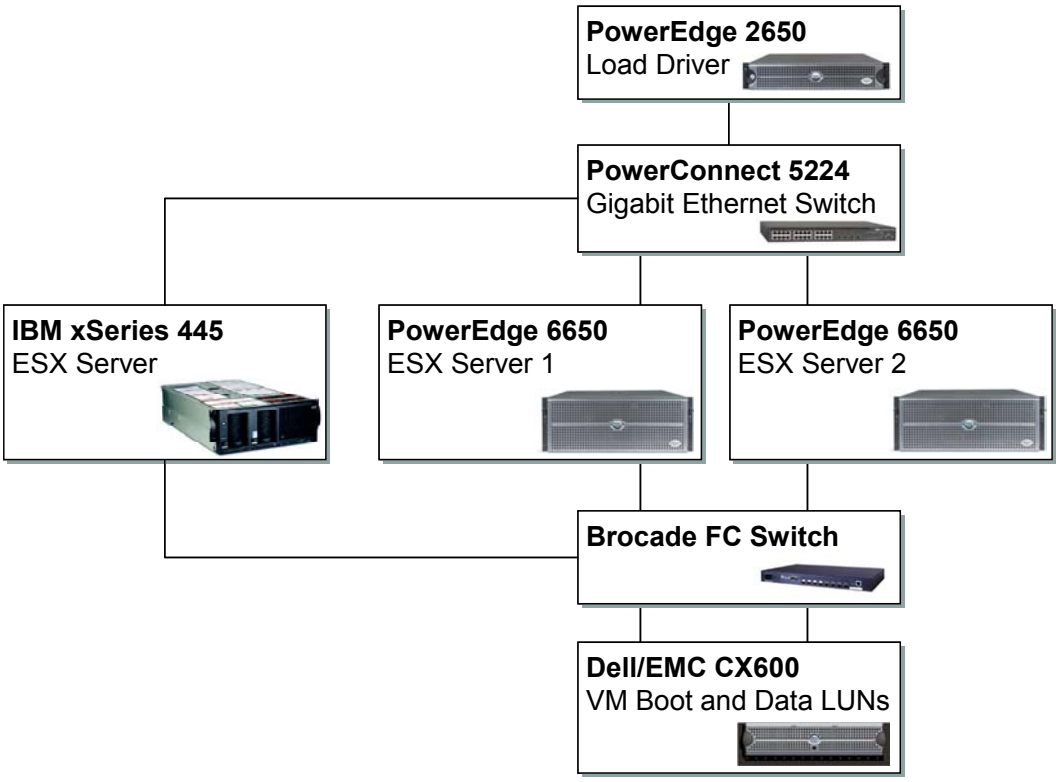

Figure 1: Dell and IBM Server and Storage Configuration

Controller	1 Dell/EMC CX600
Disk Enclosures	1 Dell/EMC DAE2
Disks	10 x 73 GB/ 10K RPM
LUNs	2 5-Disk RAID 5 LUN for Virtual Machines
Software	Navisphere® Manager Access Logix™

Table 2: Dell/EMC Storage Configuration

A Dell PowerEdge 2650 was used to drive a load against SQL Server databases that were installed in virtual machines on the three servers. (The cost of this server also was not included in our calculation of the hardware and virtual software costs of the 2 sets of servers.) Our previous paper, "The Scalable Enterprise: VMware ESX Server™ on the Dell PowerEdge 6650" (http://www.dell.com/downloads/global/solutions/SE-VMware-PE6650%2002-04-04.pdf), used a very similar server and storage configuration. The primary change in this paper was the addition of the IBM server and the change to two RAID 5 LUNs.

Virtual Machines

A single virtual machine was created and then used as the master for cloning the rest of the virtual machines used in this test. The virtual machine was created with 512 MB of RAM, 1 CPU, and a 10 GB hard drive on the SAN, and Windows 2003 Server Enterprise Edition as the guest operation system. Half of the virtual machines were assigned to one of the LUNs and the other half to the other LUN. In the same way, half of the virtual machines were assigned to use one of the Intel NICs and the other half were assigned to the other Intel NIC. This provided a simple way to load balance the virtual machines across the hardware.

Setting	Value
Operating System	Windows 2003 Server, Enterprise Edition
CPUs	1
RAM	512 MB
Hard Disk Size	10 GB

Table 3: VMware Virtual Machine Settings

Section 5

The Test

Each of the virtual machines used in this test ran a 1GB version of the DVD Store Microsoft SQL Server application used in the previous paper.[3] The database on each virtual machine contained 2 million customers, 900,000 orders, and 100,000 titles. The same load driver as in the previous study was used to drive an order entry workload against each virtual machine. The results are shown in Table 4. The 16 virtual machine database servers could handle 9.2% more orders per minute while running on the two Dell PowerEdge 6650 4-way servers than while running on the IBM xSeries 445 8-way server. Factoring in the list configuration prices, the IBM xSeries 445's price/performance is 27% higher than the two Dell 6650s' price/performance.[2]

	Two Dell PowerEdge 6650s	IBM xSeries 445
Number of virtual machines	8 per PowerEdge 6650	16
Orders per minute (opm)	31,665	28,984
CPU Utilization	91%	91%
Dell Performance Advantage	9.2%	-
Configuration Price	$91,604	$106,442
Price/Performance ($/opm – lower is better)	2.893	3.672
Dell Price/Performance Advantage	27%	-

Table 4: VMware ESX Server Test Results

Section 6

Conclusions

Running identical VMware virtualization software stacks on two Dell PowerEdge 6650 servers and on an IBM xSeries 445 server, utilizing the Dell-developed database virtual machine performance test described in this paper, the Dell systems achieved a price/performance advantage of 27%. Consistent with Dell's Scalable Enterprise strategy, this advantage is an example of the value that Dell provides to its customers by leveraging industry-standard components to provide excellent price/performance.

[1]This term does not connote an actual operating speed of 1 Gb/sec. For high speed transmission, connection to a Gigabit Ethernet server and network infrastructure is required.

[2] Prices for IBM's xSeries 445 and the Dell PowerEdge 6650 are from Dell's and IBM's online stores as of March 18, 2004. Each system is configured as shown in *Table 1* above. The prices also include VMware ESX Server software for both configurations. Both IBM and Dell system prices assume no fibre channel HBAs in the servers, since the HBAs are considered to be part of the external storage configuration whose hardware price also was not included.

[3] The use of Microsoft SQL Server in this test does not indicate that Microsoft has tested or certified SQL Server installations over VMware virtualization software. Furthermore, as described in Microsoft Knowledge Base article # 273508 (http://support.microsoft.com/default.aspx?scid=kb;[LN];273508), Microsoft does not support issues that occur in Microsoft operating systems or programs that run in a virtual machine until it is determined that the same issue can be reproduced outside the virtual machine environment.