VMware ESX Server Performance on Dual-Core Dell PowerEdge 2850 Servers

Several Dell™ PowerEdge™ server models can be equipped with dual-core Intel® Xeon® processors. Dell engineers tested the Dell PowerEdge 2850 server with both single-core and dual-core processors, and the results showed a 28 to 51 percent performance gain when moving from single-core to dual-core processors.

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Multi-core processors are designed to improve hardware performance compared to traditional single-core processors. Dual-core processors from Intel are now available in eighth-generation Dell PowerEdge server models, including the Dell PowerEdge 2850. To determine the benefits of dual-core processors in a VMware ESX Server software–based virtual computing environment, a team of Dell engineers tested two Dell PowerEdge 2850 servers, one equipped with two single-core processors and another equipped with two dual-core processors. On these servers, the test team deployed VMware ESX Server software and created multiple virtual machines (VMs) to run three different types of enterprise applications: a Microsoft® SQL Server™ database, the NetBench benchmark (simulating a file server), and the LAMP (Linux®, Apache, MySQL, PHP) Web platform.

Hardware configuration and setup
The Dell PowerEdge 2850 server is a 2U dual-processor system with an 800 MHz frontside bus and up to 16 GB of RAM. Both PowerEdge 2850 servers used for testing were configured with 8 GB of RAM. The PowerEdge 2850 server can be equipped with either single-core or dual-core Intel Xeon processors. In the test environment, the single-core processors were 3.6 GHz and the dual-core processors were 2.8 GHz. The PowerEdge 2850 server supports up to six internal disks, offers three PCI slots, and includes dual on-board Gigabit Ethernet1 network interface cards (NICs). In each test server, two of the PCI slots were used for QLogic QLA2340 Fibre Channel host bus adapters (HBAs) to provide connectivity to the storage area network (SAN). An Intel PRO 1000XT Gigabit Ethernet NIC was used in the third PCI slot. By equipping each server with three NICs, testers were able to dedicate one NIC to the VMware ESX Server service console, one to the VMs, and one to VMware VMotion™ VM migrations. Figure 1 summarizes the configuration of the PowerEdge 2850 servers tested.

Both servers were connected to the SAN via the QLogic QLA2340 HBAs. The dual HBAs in each server enabled ESX Server software to provide failover across multiple paths to the logical units (LUNs). SAN storage was provided by a Dell/EMC CX700 array. The VMs used in the test were spread across ten 73 GB, 10,000 rpm Fibre Channel disks located on the CX700 storage array. These disks were divided into two five-disk (4 + 1) RAID-5 LUNs. The VMs running Microsoft SQL Server, NetBench, and LAMP were evenly divided on the two LUNs so that half of each workload type were on each LUN. Figure 2 summarizes the SAN configuration used in the test environment.

1 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.
Virtualization software | VMware ESX Server 2.5.2
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CPU | Two single-core Intel Xeon processors DP at 3.6 GHz with 2 MB L2 cache or two dual-core Intel Xeon processors DP at 2.8 GHz with 2 MB L2 cache per core
Memory | 8 GB
Internal disks | Two 73 GB drives
NICs | Two 10/100/1,000 Mbps internal NICs and one Intel PRO 1000XT Gigabit Ethernet NIC
Disk controller | Dell PowerEdge RAID Controller 4, embedded integrated
Fibre Channel HBA | QLogic QLA2340 HBA
Form factor | 2U (3.5 inches)

Figure 1. Configuration for PowerEdge 2850 servers used in test environment

VMware ESX Server software for virtualized platform

The Dell team installed VMware ESX Server 2.5.2 virtual infrastructure software on both Dell PowerEdge 2850 servers used in testing. VMware ESX Server allows several operating systems and applications to run on the same physical server simultaneously by providing a virtualization layer that resides just above the hardware layer. ESX Server software creates VM “containers” on the physical server, enabling each VM to run its own OS, which in turn governs its own set of applications and services.

Because ESX Server isolates each VM from other VMs residing on the same physical server just as physical systems are isolated from one another, administrators have a great amount of flexibility in using ESX Server to run different types of applications and operating systems at the same time. Each VM can be rebooted or powered down without affecting other VMs running on the same physical server. This capability allows administrators to patch or upgrade and then reboot an application on one VM without incurring downtime for other VMs running on that physical system.

Test workloads to simulate utility applications

To simulate how enterprises typically run applications on VMs using ESX Server, in October 2005 the test team increased the number of VMs until CPU utilization for the entire physical server reached 85 percent. This represents a reasonably high level of usage for a production server, but it is well below the maximum 100 percent utilization that is used by many industry-standard benchmarks—and a 100 percent utilization level is not typically reached in production.

To compare relative performance differences between single-core and dual-core processors in the PowerEdge 2850 server, the test team ran three different types of enterprise workload: Microsoft SQL Server 2000 with an online transaction processing (OLTP) workload, Novell SUSE Linux with a LAMP stack, and Microsoft Windows Server 2003 with NetBench 7.03.2

Each workload ran on multiple VMs and under the same load at the same time. 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 the physical server could support. Figure 3 shows the configuration of the VMs used in the test environment.

**Microsoft SQL Server 2000.** On the SQL Server 2000 VMs, the test team installed Microsoft Windows Server 2003 and SQL Server 2000 with Service Pack 4 (SP4). The SQL Server version of the Dell DVD Store database was loaded into SQL Server 2000 using the scripts provided with the DVD Store application. The complete DVD Store application code, including the SQL Server version and a LAMP version, is freely available for public use under the GNU General Public License (GPL) at linux.dell.com/dvdstore. The DVD Store database simulates the database back end of a simple Web-based storefront. The database is small, approximately 1 GB, and representative of a database used for development or testing.

To simulate a load against the VM, the test team used the DVD Store driver program, which is included as part of the DVD Store download. Each SQL Server 2000 VM was driven by a single thread of the driver application with a 20-millisecond delay.

**SUSE LAMP.** For the LAMP workload, the test team installed Novell SUSE Linux Enterprise Server 9, Apache 2, and MySQL 5 on a VM. The MySQL version of the Dell DVD Store application was loaded into MySQL 5, and the PHP version of the DVD Store application was

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set up on Apache. In this setup, the Web tier and the database tier ran on the same VM to have a complete LAMP stack.3

The driver for the LAMP stack differs from the driver used in the SQL Server testing in that it emits HTTP requests and receives HTML code returned from the Apache/PHP layer, whereas the SQL Server driver communicates directly with the database. However, the test team measured the same parameters for this workload: total orders per minute (OPM) handled by the application and average response time as experienced by simulated customers. Each SUSE LAMP VM was driven by a single thread of the driver program with a 30-millisecond delay in this test.

NetBench 7.03. NetBench 7.03, developed by PC Magazine, is a benchmark tool that is designed to simulate a file server workload. The program creates and accesses a set of files according to predefined scripts. NetBench is typically run with an increasing number of client engines running against a single server to measure how much throughput (in megabytes per second) can be achieved with a given number of client connections.

To determine how many VMs could run on an ESX Server host, the Dell test team increased the number of VMs and the number of client engines at the same rate, until the CPU utilization on the ESX Server host reached 85 percent. NetBench 7.03, with the included standard DiskMix script, was used with a 0.6-second think time to connect two client engines to each VM. This simulates multiple file servers hosted on the same ESX Server system, similar to a file server consolidation scenario. The driver systems on which the client engines ran had mapped drives to all of the VMs in the test. In NetBench, the test directories path file was modified so that, as successive client engines were added, they would use the next drive letter, which corresponded to the next VM.

Results of single-core and dual-core performance tests
First, the VMs used in testing were run on the PowerEdge 2850 with single-core Intel Xeon processors at 3.6 GHz in successive tests, adding VMs in each round until the total CPU utilization on the system reached 85 percent. Then, using VMware VMotion software, the VMs were moved to the PowerEdge 2850 with dual-core Intel Xeon processors at 2.8 GHz and the process was repeated. The difference in the number of VMs and the associated performance metric—OPM for SQL Server and LAMP and megabytes per second for NetBench—indicated the relative difference in performance. The test team calculated the percent performance gain by using these two metrics.

In this test study, the SQL Server 2000, SUSE LAMP, and NetBench workloads all demonstrated a significant increase in performance when moved from single-core to dual-core Intel Xeon processors. Performance gains of 51 percent for the SQL Server 2000 workload and 50 percent for the NetBench workload were achieved on the dual-core PowerEdge 2850. The LAMP workload showed a 28 percent increase in performance when running on the dual-core system. These test results demonstrate that performance gains range depending on the type of workload. Figure 4 summarizes the test results for all three workloads running on the PowerEdge 2850 in both single-core and dual-core configurations.

Multi-core technology in virtual environments
Dual-core Intel Xeon processors are designed to provide a significant boost in performance over single-core Intel Xeon processors. In the Dell tests described in this article, a VMware ESX Server–based virtual computing environment demonstrated performance gains of up to 51 percent when workloads were moved from a single-core to a dual-core platform. The test results also indicate that performance increases vary depending on the type of work being performed by the VMs. In addition, these test results show that more VMs can be hosted on a physical server using dual-core processors compared to a physical server using single-core processors—and thus a greater overall throughput is possible with dual-core processors.

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