By enabling administrators to create storage area networks (SANs) using standard Ethernet components, Internet SCSI (iSCSI) offers a key way to deploy simplified, cost-effective shared storage in data center environments. This storage can then support a variety of key enterprise software, including online transaction processing (OLTP) applications and the Microsoft Exchange messaging platform.

In November 2008, Principled Technologies performed tests commissioned by Dell to compare the OLTP performance and Microsoft Exchange Server 2007 performance of two iSCSI SAN arrays: the Dell PowerVault MD3000i and the HP StorageWorks 2000i. In both sets of tests, the Dell iSCSI SAN solution outperformed the HP iSCSI SAN solution across all tested metrics.

### COMPARING OLTP PERFORMANCE

In the OLTP tests, each iSCSI SAN array was configured with an expansion enclosure and two full shelves of disks of similar speed and size. The Dell PowerVault MD3000i array was connected to a Dell PowerVault MD1000 expansion enclosure and configured with a total of thirty 146 GB, 15,000 rpm Serial Attached SCSI (SAS) disks in a RAID-10 configuration as well as a 512 MB storage cache. The HP StorageWorks 2000i array was connected to an HP StorageWorks 2000sa expansion shelf and configured with a total of twenty-four 146 GB, 15,000 rpm SAS disks in a RAID-10 configuration as well as a 2 GB storage cache (1 GB per controller). Each SAN connected through a Dell PowerConnect™ 5448 switch to two Dell PowerEdge™ 2950 servers, each configured with two quad-core Intel® Xeon® E5405 processors at 2.0 GHz; 16 GB of RAM; one 80 GB, 7,200 rpm internal hard drive and one 73 GB, 15,000 rpm internal hard drive; the Microsoft Windows Server® 2003 Enterprise x64 Edition Release 2 (R2) OS with Service Pack 2 (SP2); and the Microsoft SQL Server® 2008 database platform.

The tests were based on the Dell DVD Store Version 2 (DS2) workload, an open source application designed to model an online DVD store in which simulated customers log in; browse movies by actor, title, or category; and purchase movies. It includes a back-end database component, a front-end Web application layer, and a driver layer that operates as

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a middle tier and actually executes the workload. The primary metric is orders per minute (OPM).³

Because the goal of the tests was to isolate and test database server storage, the test team did not use the Web application layer, and instead ran the driver application directly through its command-line interface. The DS2 application provides options to generate 10 MB, 1 GB, or 100 GB data sets; for these tests, the team made several modifications to the source code and to the DS2 application’s scripts to generate 250 GB of user data on a Linux® OS-based system. Each server ran a single instance of the DS2 application, which spawned 32 threads, simulating a heavily loaded environment. The load-generating system ran with no think time, sending requests as quickly as the servers could handle them.

Before starting each test run, the team deleted and re-created the database, rebooted the servers, and allowed the servers to sit idle for at least 10 minutes to allow them to finish all aspects of the boot process. They then ran the DS2 tests three times, using the Microsoft Windows® Reliability and Performance Monitor tool to create a data collector set to gather statistics once each second during the test runs. The OPM values for each server were averaged for the period from 480 seconds to 600 seconds into the test (a period of steady activity and heavy load that suffers from neither ramp-up nor ramp-down effects) for each of the three test runs; the averages from each server were then added together, with the median run serving as the result. To provide comparable results for the different disk counts in each solution, the results from the median run for each solution were divided by the total number of disks in that solution.

Figure 1 shows the DS2 results per disk from the median runs. In these runs, the Dell PowerVault iSCSI SAN provided 11 percent higher performance per disk than the HP StorageWorks iSCSI SAN: 847.5 OPM per disk for the Dell solution compared with 761.9 OPM per disk for the HP solution.

The test team also calculated the average throughput in average disk transfers per second from the data collector sets on the two servers for the same period, summed these results for the two servers, and divided the sum by the total number of disks. Figure 2 shows the average throughput per disk from the same runs that produced the median OPM results. In these runs, the Dell PowerVault iSCSI SAN delivered 48 percent higher throughput per disk than the HP StorageWorks iSCSI SAN: 1.60 MB/sec per disk for the Dell solution compared with 1.08 MB/sec per disk for the HP solution.

**COMPARING MICROSOFT EXCHANGE SERVER 2007 PERFORMANCE**

The Microsoft Exchange tests used a similar configuration to the OLTP tests, with each iSCSI SAN array configured with an expansion enclosure and two full
shelves of disks of similar speed and size. The Dell PowerVault MD3000i array was connected to a Dell PowerVault MD1000 expansion enclosure and configured with a total of thirty 146 GB, 15,000 rpm Serial Attached SCSI (SAS) disks in a RAID-10 configuration as well as a 512 MB storage cache. The HP StorageWorks 2000i array was connected to an HP StorageWorks 2000sa expansion shelf and configured with a total of twenty-four 146 GB, 15,000 rpm SAS disks in a RAID-10 configuration as well as a 1 GB storage cache (512 MB per controller). Each SAN connected through a Dell PowerConnect 5448 switch to one Dell PowerEdge 2950 server configured with two quad-core Intel Xeon E5405 processors at 2.0 GHz; 16 GB of RAM; one 80 GB, 7,200 rpm internal hard drive; and Microsoft Windows Server 2003 Enterprise x64 Edition R2 with SP2.

The tests were based on the Microsoft Exchange Server Jetstress tool, which is designed to stress the storage arrays using the maximum sustainable Exchange type of I/O and show how long it takes the storage under load to respond to an I/O request. The test team calculated the values for three Jetstress test parameters that define the simulated Exchange mailbox profile:

- **Database I/Os per second (IOPS):** The tested user profile was based on the Microsoft profile for very heavy Exchange Server 2007 cached-mode users. These users average 30 sent and 120 received messages per day, and the load averages 0.5 database IOPS for each user.
- **Mailbox size:** The tests assumed an average mailbox size of 250 MB, a relatively small size that was selected because the test team wanted a large number of mailboxes against which to measure I/O performance.
- **Number of mailboxes:** The test team formatted each disk and set up the RAID configuration for each, and then calculated the mailbox count for each system by determining the number of 250 MB mailboxes that would use 60 percent of the remaining disk space on each test system. The test team selected the 60 percent capacity figure to provide a production-sized database that left room for log files and growth; a total of 80 percent of the usable disk capacity was allocated for the database logical units (LUNs), with the remaining 20 percent allocated to log LUNs. The number of mailboxes was rounded down to the nearest multiple of 50.

The test team ran the Jetstress disk subsystem test with automatic tuning to identify a thread count, and then ran the initial performance test using that thread count. If the system passed the initial performance test run, the team continued to retest using higher thread counts to push the IOPS to the maximum, stopping when Jetstress reported a failing user experience rating. If the system failed the initial performance test run, the team retested using lower thread counts until Jetstress reported a passing user experience rating. If the test failed using a single thread, the team reduced the number of mailboxes until Jetstress gave a passing user experience rating. This process...
identified the highest IOPS score the system could achieve while receiving a passing user experience rating. The team then carried out two additional runs using the settings from the run that produced those results, with the median run serving as the result. Each test ran for two hours. As with the OLTP tests, to provide comparable results for the different disk counts in each solution, the results from the median run for each solution were divided by the total number of disks in that solution.

The primary Jetstress result is achieved IOPS, which is the sum of the average database disk reads and database disk writes per second during the test. Figure 3 shows the Jetstress achieved IOPS per disk from the median runs. In these runs, the Dell PowerVault iSCSI SAN provided 59 percent higher performance per disk than the HP StorageWorks iSCSI SAN: 156.3 achieved IOPS per disk for the Dell solution compared with 98.6 achieved IOPS per disk for the HP solution.

Achieved IOPS includes only database disk I/O; Jetstress also provides separate results for log disk write I/O. Figure 4 shows the average log disk write IOPS from the same runs that produced the median achieved IOPS results. In these runs, the Dell PowerVault iSCSI SAN provided 24 percent higher performance per disk: 37.0 log IOPS per disk for the Dell solution compared with 29.9 log IOPS per disk for the HP solution.

The test team also gathered the average throughput in average disk transfers per second from data logged by the Microsoft Windows Performance Monitor tool. Figure 5 shows the average throughput per disk from the same run that produced the median achieved IOPS results. In these runs, the Dell PowerVault iSCSI SAN delivered 53 percent higher throughput per disk than the HP StorageWorks iSCSI SAN: 1.50 MB/sec per disk for the Dell solution compared with 0.98 MB/sec per disk for the HP solution.

**HIGH-PERFORMANCE iSCSI SAN**

The Dell PowerVault MD3000i is designed to provide a simplified, scalable, high-performance platform for shared storage in data center environments. In these Principled Technologies tests, the Dell PowerVault MD3000i outperformed the HP StorageWorks 2000i across a variety of metrics designed to evaluate iSCSI SANs in OLTP and Microsoft Exchange Server 2007 environments—helping demonstrate the levels of performance possible when supporting these types of common data center workloads.