

STORAGE SYSTEM COMPARISON:

IBM SYSTEM STORAGE DS3524 EXPRESS AND HP STORAGEWORKS P2000 G3

IBM® System Storage® DS3524 Express:
Faster performance on critical applications, with
greater capacity and more scalability and protocol options



faster streaming media



faster Web server



faster email



versus HP StorageWorks P2000 G3

As the technology demands of your business grow, selecting the correct hardware is crucial to obtaining reliable performance. In addition to choosing server hardware, you must also carefully select your storage systems. Which storage array will speed up your performance for your employees or customers? Your company's best storage investment is an array that performs well to meet your present needs and can handle increasing workloads as your needs grow.

In our labs, we used the Iometer benchmarking tool to test the I/O operations per second (IOPS) performance of the new IBM System Storage DS3524 Express (IBM DS3524) and the HP StorageWorks P2000 G3 (HP P2000) simulating streaming media, Web file and video on demand servers, and mail and database server activity.

We found that the IBM DS3524 outperformed the HP P2000 across all three of our test scenarios. In our streaming media tests, the IBM DS3524 achieved an average IOPS win of 23.8 percent over the HP P2000. In our Web file server and Video on Demand tests, the IBM DS3524 achieved an average IOPS win of 31.6 percent over the HP P2000. In our mail and database server tests, the IBM DS3524 achieved an average IOPS win of 16.7 percent over the HP P2000.

These results show that selecting the IBM DS3524 over the HP P2000 can enhance your servers' performance in accessing stored data with these day-to-day tasks.



A PRINCIPLED TECHNOLOGIES TEST REPORT

Commissioned by IBM Corporation

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THE RIGHT STORAGE MAXIMIZES YOUR SERVER'S PERFORMANCE

Storage system summary

Both the IBM DS3524 and the HP P2000 had a dual-controller configuration and three disk enclosures, for a total of 84 15K 6Gbps SAS drives. The IBM DS3524 used 73GB drives and the HP P2000 used 72GB drives.

Your choice of storage array plays a key role in the responsiveness of your servers and applications. To gauge how well the IBM DS3524 and HP P2000 storage arrays performed, we used the Iometer benchmarking tool to simulate real-world workloads of a server and storage system handling the following:

- streaming media activity (100% sequential read tests)
- Web file server and Video on Demand activity (100% random read tests)
- typical I/O activity of mail and database servers (100% read, 100% write, and 70% read 4K random IOPS tests)

In addition to a strong performance edge, the IBM DS3524 offers two other advantages. While the HP P2000 allows a maximum of 32 drives per RAID group (at RAID level 50), the IBM DS3524 allows as many as 192 drives (at RAID levels 0 and 10). This extra capacity lets you allocate more drives into a single LUN to increase performance on a disk I/O-intensive application, such as one handling a large database. The HP P2000 system is also limited to 149 total drives or currently 288TB maximum raw storage capacity, while the IBM DS3500 series can scale to 192 total drives or currently 576TB maximum raw capacity.

The IBM DS3524 also offers more scalability from a host interface perspective. It offers a “pay as you grow” product structure. You can start with the low-cost base configuration of four 6Gbps SAS ports and use the IBM DS3524 as direct-attached storage until you need to scale up to a storage area network (SAN) interface. The 6Gbps SAS host ports on the IBM DS3524 have four 6Gbps lanes for a total of 24Gbps per port. As your business needs grow and you deploy more than four hosts, you can upgrade to a SAS switched environment using a 6Gbps SAS switch such as the 16-port LSI™ SAS6160 SAS Switch. If you require host connections longer than 20 meters, you can add 1Gbps or 10Gbps iSCSI or 8Gbps Fibre Channel ports to your controllers in addition to the SAS infrastructure and therefore tailor the IBM DS3524 to the best fit for your infrastructure's demands. The HP P2000 offers comparatively limited options. For more details, see Figure 8 in [Appendix A](#).

From a performance perspective, the IBM DS3524 was better equipped to handle streaming media than the HP P2000, as it processed an average of 23.8 percent more IOPS, which translates into faster data access (see Figure 1). We used a 100% sequential read test for streaming media because when a user accesses a streaming media file, the server is performing a read of existing data that is accessed in sequence off the storage.

Figure 1. The IBM DS3524 consistently outperformed the HP P2000 in the streaming media scenario. Higher numbers are better.

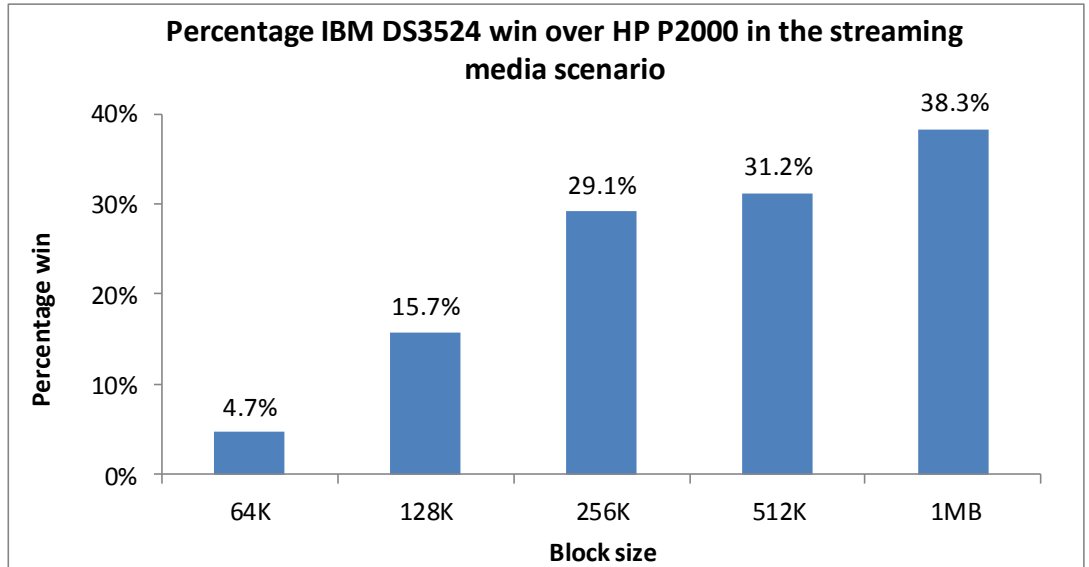


Figure 2 shows the median streaming media test results in IOPS for each block size.

Streaming media scenario			
Block size	IBM DS3524	HP P2000	IBM percentage win
64K	17,161.09	16,392.40	4.7%
128K	9,887.95	8,542.90	15.7%
256K	5,598.83	4,335.56	29.1%
512K	2,867.69	2,186.37	31.2%
1MB	1,511.57	1,093.18	38.3%

Figure 2. Results, in IOPS, from the streaming media scenario using a queue depth of 4. Higher numbers are better.

We present median results from our additional tests in the [What we found section](#) and detailed results for all three runs for each test in [Appendix B](#).

WHAT WE FOUND

Figure 3 shows the results from the Web file and Video on Demand scenario. The IBM DS3524 outperformed the HP P2000 by an average of 31.6 percent in random read activity across a range of block sizes. Web file servers and Video on Demand servers mostly serve as access points for many different stored files, so the vast majority of I/O activity in this case is random reads. A 100% random read access specification therefore best tests the performance you could expect on these types of servers.

Figure 3. The IBM DS3524 consistently outperformed the HP P2000 in the Web file server and Video on Demand scenario. Higher numbers are better.

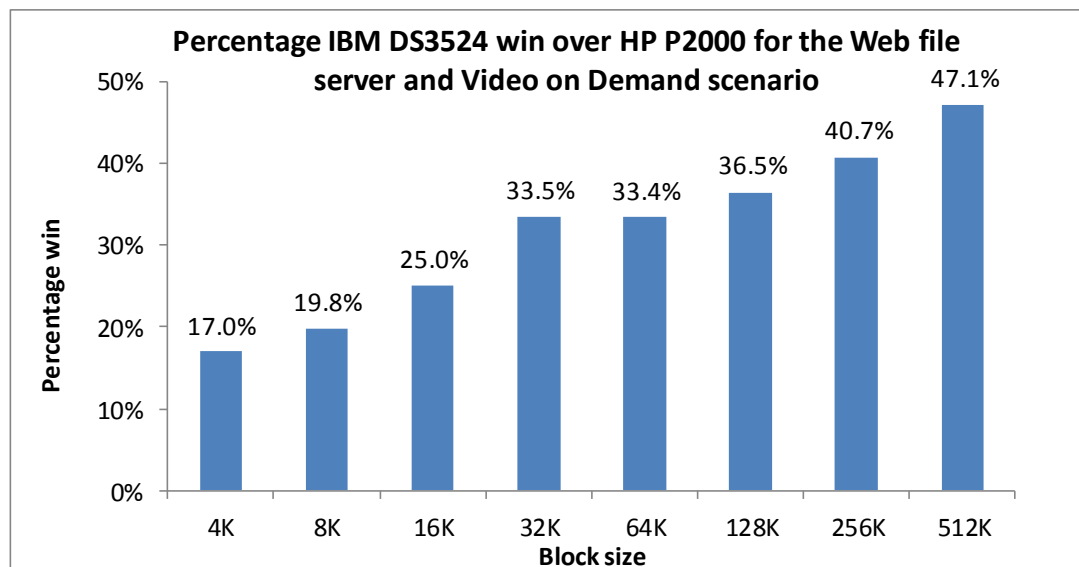


Figure 4 shows the median Web file server and Video on Demand test results in IOPS for each block size.

Web file server and Video on Demand scenario					
Block size	Queue depth	IBM DS3524	Queue depth	HP P2000	IBM percentage win
4K	256	28,373.69	256	24,254.51	17.0%
8K	256	27,275.43	128	22,761.82	19.8%
16K	256	25,339.93	128	20,267.77	25.0%
32K	256	22,197.51	128	16,626.93	33.5%
64K	512	16,270.86	128	12,198.67	33.4%
128K	128	9,798.14	512	7,179.67	36.5%
256K	32	5,409.27	64	3,844.31	40.7%
512K	16	2,840.62	32	1,930.60	47.1%

Figure 4. Results, in IOPS, from the Web file server and Video on Demand scenario using various queue depths. Higher numbers are better.

Figure 5 shows the results from the mail and database server scenario. The IBM DS3524 outperformed the HP P2000 by an average of 16.7 percent in pure read, pure write, and mixed read and write I/O (random) activity using a small 4K block size. Specifically, the IBM DS3524 was 17.0 percent faster in 100% read, 18.1 percent faster in 100% write, and 14.9 percent faster in 70% read/30% write.

Mail and database servers typically perform a combination of small block reads and writes. We tested a 100% read, 100% write, and mixed 70% read/30% write access specifications using a small block size to determine how the storage solutions would perform if operating with this type of I/O activity.

Figure 5. The IBM DS3524 consistently outperformed the HP P2000 in the mail and database server scenario. Higher numbers are better.

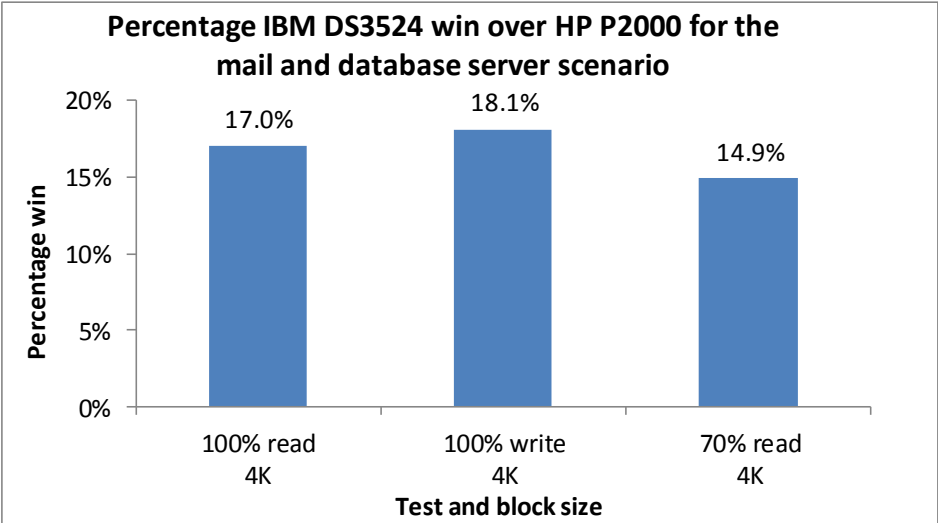


Figure 6 shows the median results in IOPS for the Mail and database server scenario.

Mail and database server scenario–4K block size					
	Queue depth	IBM DS3524	Queue depth	HP P2000	IBM percentage win
100% read	128	28,373.69	128	24,254.51	17.0%
100% write	256	14,363.40	256	12,159.41	18.1%
70% read	16	21,610.14	16	18,803.50	14.9%

Figure 6. Results, in IOPS, from the mail and database server scenario using various queue depths. Higher numbers are better.

WORKLOAD

Iometer performs I/O operations on a server in order to stress the disk-subsystem, and then records the performance of and stress created by these I/O operations. Iometer can create and measure workloads on a single system or on networked systems. We used Iometer version 2006.07.27 on an IBM System x3650 M3 server to simulate our three workloads (streaming media, Web file server and Video on Demand, and mail and database servers) on each of the storage arrays by creating access specifications that closely mirror the disk activity of each. We present the specific settings we used during testing in [Appendix A](#).

HOW WE TESTED

The test server for each storage system consisted of a single IBM System x3650 M3 rack server running Microsoft® Windows Server® 2008 R2 SP1 Enterprise Edition. These servers generate the workload for measuring performance on the storage. We used a dual-port Fibre Channel card to connect the servers to the storage. For all tests, we used a dual controller configuration.

To measure dual controller performance, we configured each test server with a dual-port Fibre Channel card and connected a port to each of the controllers. Each storage system had 84 drives, separated into seven 12-disk RAID groups. We created and assigned an Iometer worker to a volume on each RAID group.

We configured the Iometer Dynamo to run on an IBM System x3650 M3 server. We set Iometer to run for a total of 5 minutes with a 60-second ramp-up time for each run. For all tests, we ran workloads using several common block sizes at multiple queue depths for each access specification, and then selected the queue depth that provided the maximum IOPS.

We gathered the following results from the Iometer result files:

- Disk sequential read tests (Dual controller, 100% read IOPS, median runs)
- Disk random read tests (Dual controller, 100% read IOPS, median run)
- 4K random IOPS tests 100% Read, 100% Write, 70% Read (Dual controller, median run)

We ran the tests three times to ensure repeatability, and report the results from the run that produced the median total IOPS. [Appendix C](#) provides details of our test environment. [Appendix D](#) provides configuration details of our test server. [Appendix E](#) details the testing procedures we followed.

CONCLUSIONS

The consistent performance wins of the IBM System Storage DS3524 Express over the HP StorageWorks P2000 G3 across our test scenarios demonstrate the ability of the IBM DS3524 to quickly process and route data in commonly used scenarios. This can make your servers better able to handle user requests, increasing server efficiency for your business.

The IBM DS3500 series of storage systems also offers more connectivity options and mixed protocol choices and have a “pay as you grow” configuration capability. The HP P2000 G3 portfolio offers fewer host connectivity choices, supports fewer mixed-protocol choices, and requires you to make more protocol decisions at the time of purchase.

APPENDIX A – TEST PARAMETERS AND STORAGE HARDWARE

This appendix includes the Iometer parameters we used to simulate our test workloads.

Streaming media scenario (disk sequential read tests) configuration

We defined the simulated streaming media workload using the following parameters:

- 64K, 128K, 256K, 512K, and 1M block sizes
- 100% reads, 0% writes
- 0% random, 100% sequential
- One worker per target

Web file and Video on Demand scenario (disk random read tests) configuration

We defined the simulated Web file server and Video on Demand workload using the following parameters:

- 4K, 8K, 16K, 32K, 64K, 128K, 256K, and 512K block sizes
- 100% reads, 0% writes
- 100% random, 0% sequential
- One worker per target

Mail and database scenario (4K random IOPS tests) configuration

We defined the simulated mail and database workload using the following parameters:

- 4k block size
- 100% reads, 0% writes; 0% reads, 100% writes; and 70% reads, 30% writes
- 100% random, 0% sequential
- One worker per target

Figure 7 shows a comparison of the storage hardware we tested.

Primary storage hardware

System	IBM System Storage DS3524 Express	HP StorageWorks P2000 G3
Firmware version	07.70.45.00	TS201P007
Number of storage controllers	2	2
Storage connectivity (iSCSI, SAS, SATA, Fibre Channel)	Fibre Channel	Fibre Channel
Number of Fibre Channel ports	4 per storage controller (8 total)	2 per storage controller (4 total)
Storage memory	4 GB (2 GB per controller)	4 GB (2 GB per controller)
Total number of disks tested in solution	84	84
Number of volumes	7 (12 drives per volume)	7 (12 drives per volume)
RAID level	RAID 10	RAID 10
Turbo performance	Enabled	N/A
Hard disk		
Vendor and model number	IBM 9FT066-039	HP EH0072FARWC
Disk size	73 GB	72 GB
RPM	15K	15K
Disk type	SAS 6Gbps	SAS 6Gbps

Figure 7. Storage hardware comparison.

Scalability of the storage hardware ports

Figure 8 presents the functional port options available with the two storage arrays. Unlike the HP StorageWorks P2000, the IBM System Storage DS3524 Express can support either SAS and Fibre Channel ports running simultaneously or SAS and iSCSI ports running simultaneously. The IBM DS3500 series of storage arrays offers more host connectivity and mixed protocol options and a “pay as you grow” configuration capability.

System host connectivity options	IBM System Storage DS3524 Express	HP StorageWorks P2000 G3
SAS	Four 6Gbps SAS ports	Eight 6Gbps SAS ports
	Eight 6Gbps SAS ports	
Fibre Channel	Eight 8Gbps Fibre Channel ports	Four 8Gbps Fibre Channel ports
1Gbps iSCSI	Eight 1Gbps iSCSI ports	Eight 1Gbps iSCSI ports
10Gbps iSCSI	Four 10Gbps iSCSI ports	Four 10Gbps iSCSI ports
SAS + Fibre Channel	Four 6Gbps SAS ports + Eight 8Gbps Fibre Channel ports	Not Available
SAS + 1Gbps iSCSI	Four 6Gbps SAS ports + Eight 1Gbps iSCSI ports	Not Available
SAS + 10Gbps iSCSI	Four 6Gbps SAS ports + Four 10Gbps iSCSI ports	Not Available
Fibre Channel + 1Gbps iSCSI	Not Available	Four 8Gbps Fibre Channel ports + Four 1Gbps iSCSI ports

Figure 8. Functioning port/protocol options available with the two storage arrays.

APPENDIX B – TEST RESULTS

Figures 9 through 14 provide the peak IOPS test results for the storage arrays. We ran the Iometer test three times for each storage array, and then determined the median.

Streaming media: IBM DS3524 Dual controller, 100% read IOPS				
Block size	Run 1	Run 2	Run 3	Median run
64K	17,190.04	17,064.46	17,161.09	17,161.09
128K	9,151.94	9,887.95	9,967.07	9,887.95
256K	5,598.83	5,651.92	5,492.38	5,598.83
512K	2,867.69	2,847.76	2,876.07	2,867.69
1MB	1,511.57	1,449.21	1,515.89	1,511.57

Figure 9. Detailed streaming media results for the IBM DS3524 using a queue depth of 4. Higher numbers are better.

Streaming media: HP P2000 Dual controller, 100% read IOPS				
Block size	Run 1	Run 2	Run 3	Median run
64K	16,368.66	16,401.28	16,392.40	16,392.40
128K	8,542.83	8,542.90	8,543.62	8,542.90
256K	4,335.56	4,328.28	4,335.87	4,335.56
512K	2,186.37	2,186.03	2,186.48	2,186.37
1MB	1,093.18	1,093.08	1,093.25	1,093.18

Figure 10. Detailed streaming media results for the HP P2000 using a queue depth of 4. Higher numbers are better.

Web file server and Video on Demand: IBM DS3524 Dual controller, 100% read IOPS					
Block size	Queue depth	Run 1	Run 2	Run 3	Median run
4K	256	28,373.69	28,360.81	28,381.43	28,373.69
8K	256	27,275.43	27,277.89	27,272.48	27,275.43
16K	256	25,338.58	25,339.93	25,357.50	25,339.93
32K	256	22,190.86	22,197.52	22,197.51	22,197.51
64K	512	16,285.68	16,244.79	16,270.86	16,270.86
128K	128	9,801.24	9,790.57	9,798.14	9,798.14
256K	32	5,409.27	5,405.05	5,411.93	5,409.27
512K	16	2,840.62	2,839.15	2,842.38	2,840.62

Figure 11. Detailed Web file server and Video on Demand results for the IBM DS3524. Higher numbers are better.

Web file server and Video on Demand: HP P2000 Dual controller, 100% read IOPS					
Block size	Queue depth	Run 1	Run 2	Run 3	Median run
4K	256	24,254.51	24,108.56	24,258.17	24,254.51
8K	128	22,773.10	22,596.38	22,761.82	22,761.82
16K	128	20,267.77	20,148.40	20,271.99	20,267.77
32K	128	16,626.93	16,507.80	16,634.92	16,626.93
64K	128	12,198.67	12,121.94	12,210.35	12,198.67
128K	512	7,179.67	7,148.35	7,180.56	7,179.67
256K	64	3,844.38	3,842.68	3,844.31	3,844.31
512K	32	1,930.60	1,929.58	1,930.68	1,930.60

Figure 12. Detailed Web file server and Video on Demand results for the HP P2000. Higher numbers are better.

Mail and database server: IBM DS3524 Max disk random IOPS					
Block size	Queue depth	Run 1	Run 2	Run 3	Median run
4K - 100% Read	256	28,373.69	28,360.81	28,381.43	28,373.69
4K - 100% Write	16	14,366.64	14,342.69	14,363.40	14,363.40
4K - 70% Read	128	21,605.52	21,622.61	21,610.14	21,610.14

Figure 13. Detailed mail and database server results for the IBM DS3524. Higher numbers are better.

Mail and database server: HP P2000 Max disk random IOPS					
Block size	Queue depth	Run 1	Run 2	Run 3	Median run
4K - 100% Read	256	24,254.51	24,108.56	24,258.17	24,254.51
4K - 100% Write	16	12,159.41	12,166.54	12,132.05	12,159.41
4K - 70% Read	128	18,803.50	18,794.18	18,806.31	18,803.50

Figure 14. Detailed mail and database server results for the HP P2000. Higher numbers are better.

APPENDIX C – TEST ENVIRONMENT

We created a test bed in a climate-controlled room for each storage system. Each test bed included the following components:

- Two IBM System x3650 M3 servers installed with the following software:
 - Microsoft Windows Server 2008 R2 SP1 Enterprise Edition
 - Iometer 2006.07.27
- Switch
 - One NetGear® ProSafe® JGS524 switch
- Storage systems under test
 - One IBM System Storage DS3524 Express
 - Three IBM EXP3524 disk enclosures attached
 - One HP StorageWorks P2000 G3 Array
 - Three HP D2700 disk enclosures attached

Figure 15 provides highlights of the IBM System x3650 M3 server configuration. Figure 16 in [Appendix D](#) provides complete configuration details.

IBM System x3650 M3 server	
Processors	One quad-core Intel® Xeon® processor X5570 at 2.93 GHz
Memory	24 GB, 3 x 8 GB, 1,333 MHz
Internal disk	Two 300GB, 10K RPM IBM 42D0638 SAS drive
Fibre Channel card	IBM QLogic™ QLE2562
Operating system	Microsoft Windows Server 2008 R2 SP1 Enterprise
Test software	Iometer 2006.07.27

Figure 15. IBM System x3650 M3 server configuration highlights.

APPENDIX D – SERVER CONFIGURATION INFORMATION

Figure 16 provides detailed configuration information about the test server for each storage array.

Server	IBM System x3650 M3 type 7945 (IBM DS3524 storage)	IBM System x3650 M3 type 7945 (HP P2000 storage)
Power supplies		
Total number	1	1
Vendor and model number	Emerson 7001484-J000 REV E	Emerson 7001484-J000 REV E
Wattage of each (W)	675	675
Cooling fans		
Total number	3	3
Vendor and model number	Delta Electronics Inc. GFB0812SHS	Delta Electronics Inc. GFB0812SHS
Dimensions (h x w) of each (inches)	3.35 x 3.23	3.35 x 3.23
Volts	12	12
Amps	1.20	1.20
General processor setup		
Number of processor packages	1	1
Number of cores per processor	4	4
Number of hardware threads per core	8	8
System power management policy	Balanced	Balanced
CPU		
Vendor	Intel	Intel
Name	Xeon	Xeon
Model number	X5570	X5570
Stepping	D0	D0
Socket type	Socket 1366 LGA	Socket 1366 LGA
Core frequency (GHz)	2.93	2.93
Intel QPI Speed	6.4 GT/s	6.4 GT/s
L1 cache	4 x 32 KB	4 x 32 KB
L2 cache	4 x 256 KB	4 x 256 KB
L3 cache	8 MB	8 MB
Platform		
Vendor and model number	IBM System x3650 M3 type 7945	IBM System x3650 M3 type 7945
Motherboard model number	69Y4438	69Y4438
Motherboard chipset	Intel 5520	Intel 5520
BIOS name and version	IBM Corp. D6E150CUS-1.11 02/08/2011	IBM Corp. D6E150CUS-1.11 02/08/2011
BIOS settings	Default	Default
Memory modules		
Total RAM in system (GB)	24	24
Vendor and model number	Samsung M393B1K70BH1-CH9	Samsung M393B1K70BH1-CH9
Type	PC3-10600R	PC3-10600R
Speed (MHz)	1,333	1,333

Server	IBM System x3650 M3 type 7945 (IBM DS3524 storage)	IBM System x3650 M3 type 7945 (HP P2000 storage)
Speed running in the system (MHz)	1,333	1,333
Timing/Latency (tCL-tRCD-tRP-tRASmin)	9-9-9-24	9-9-9-24
Size (GB)	8	8
Number of RAM module(s)	3	3
Chip organization	Double-sided	Double-sided
Rank	2	2
Hard disk		
Vendor and model number	IBM 42D0637	IBM 42D0637
Number of disks in system	2	2
Size (GB)	300	300
Buffer size (MB)	64	64
RPM	10,000	10,000
Type	SAS	SAS
Internal disk controller		
Vendor and model	IBM ServeRAID M5015	IBM ServeRAID BR10i v2
Controller driver	LSI Corporation 1.31.2.0 9/28/2009	LSI Corporation 1.31.2.0 9/28/2009
Controller firmware	2.120.03-1160	1.30.05.00-IR
RAID configuration	RAID 1	RAID 1
Fibre channel card		
Vendor and model	IBM QLogic QLE2562	IBM QLogic QLE2562
Controller driver	QLogic 9.1.9.25 11/17/2010	QLogic 9.1.9.25 11/17/2010
Firmware	2.32	2.32
Operating system		
Name	Windows Server 2008 R2 SP1 Enterprise Edition	Windows Server 2008 R2 SP1 Enterprise Edition
Build number	7601	7601
Service pack	Service Pack 1	Service Pack 1
File system	NTFS	NTFS
Kernel	ACPI x64-based PC	ACPI x64-based PC
Language	English	English
Graphics		
Vendor and model number	Matrox® G200eV (Maxim)	Matrox G200eV (Maxim)
Graphics memory	16 MB	16 MB
Driver	Matrox Graphics Inc. 1.1.4.0 8/16/2010	Matrox Graphics Inc. 1.1.4.0 8/16/2010
Ethernet		
Vendor and model number	Broadcom® BCM5708C NetXtreme® II GigE	Broadcom BCM5708C NetXtreme II GigE
Type	PCI-E	PCI-E
Driver	Broadcom 6.2.9.0 2/4/2011	Broadcom 6.2.9.0 2/4/2011

Server	IBM System x3650 M3 type 7945 (IBM DS3524 storage)	IBM System x3650 M3 type 7945 (HP P2000 storage)
Optical drive(s)		
Vendor and model number	HL-DT-ST DVDRAM GT30N ATA Device	N/A
Type	DVD/CD-ROM drives	N/A
USB ports		
Number	4	4
Type	2.0	2.0

Figure 16. Detailed system configuration information for the servers we used for testing.

APPENDIX E – TEST PROCEDURES

Installing the operating system

Installing Windows Server 2008 R2 Enterprise with Service Pack 1

1. Boot the server, and insert the Windows Server 2008 R2 SP1 installation DVD in the DVD-ROM drive.
2. At the Language Selection screen, click Next.
3. Click Install Now.
4. Select Windows Server 2008 Enterprise (Full Installation) x64, and click Next.
5. Click the I accept the license terms check box, and click Next.
6. Click Custom.
7. Click Drive options (advanced).
8. Delete any existing partitions.
9. Ensure the first drive is selected, and click New.
10. Click Apply.
11. Click OK.
12. Click Next.
13. At the User's password must be changed before logging on warning screen, click OK.
14. Type your new password into both fields, and click the arrow to continue.
15. At the Your password has been changed screen, click OK.

Windows Server 2008 R2 settings

We installed all recommended and critical Windows updates through 6/15/2011. In addition, we downloaded and installed the latest drivers.

Disabling Windows Firewall

1. Click Start→Administrative Tools→Windows Firewall with Advanced Security.
2. Under the Overview heading, click Windows Firewall Properties.
3. Click the drop-down menu beside Firewall state, and select Off.
4. Click the Private Profile tab.
5. Click the drop-down menu beside Firewall state, and select Off.
6. Click the Public Profile tab.
7. Click the drop-down menu beside Firewall state, and select Off.
8. Click OK to close the Properties window.
9. Close the Windows Firewall with Advanced Security window.

Disabling Display Sleep

1. Click Start→Control Panel.
2. Click System and Security.
3. Click Power Options.
4. Next to the selected power plan (Balanced), click Change plan settings.
5. Under the drop-down menu next to Turn off display sleep, select Never.
6. Click Save Changes, and close the Edit Plan Settings Window.

Adding the Microsoft Multipath I/O feature

1. Click Start→Command Prompt.
2. Type `ocsetup MultipathIo /norestart` and press Enter.
3. Type `mpclaim -n -i -a`
4. Type `exit` and press Enter.

Configuring the IBM System Storage DS3500 Express

Installing IBM System Storage DS Storage Manager 10 on IBM System x3650 M3

1. Download and extract the IBM System Storage DS Storage Manager for Windows 2008 R2.
2. Double click SMIA-WSX64-10.77.35.16.exe.
3. At the language selection screen, select English, and click OK.
4. At the Introduction screen, click Next.
5. At the Copyright Statement screen, click Next.
6. At the License Agreement screen, accept the terms of the license agreement, and click Next.
7. At the Choose Install Folder screen, accept the default, and click Next.
8. At the Select Installation Type screen, select Typical, and click Next.
9. At the Automatically Start Monitor? Screen, leave the default of Automatically Start Monitor (Recommended), and click Next.
10. In the Antivirus/Backup Exclusion pop-up window, click OK.
11. In the Support Monitor Profiler Default Configuration Settings pop-up window, click OK.
12. At the Pre-Installation Summary screen, click Install.
13. When the installation completes, click Done.

Adding the storage subsystem and viewing configuration options via the IBM DS Storage Manager 10

1. Click Start→All Programs→DS Storage Manager 10 Client→DS Storage Manager 10 Client.
2. Click the Setup tab. In the Select Addition Method pop-up window, select Manual, and click OK.
3. In the Add Storage Subsystem – Manual window, make sure the Out-of-band management radio button is selected, and enter the IP address of both controller modules on the IBM System Storage DS3524 Express. Click Add.
4. In the Storage Subsystem Added pop-up window, click No.
5. Click the Devices tab.
6. Under Discovered Storage Subsystems, double-click Storage Subsystem DS3500.
7. Enter the password, and click OK.
8. View the configuration and other options by navigating the Summary, Logical, Physical, Mappings, and Setup tabs.

Creating an array and logical drive

1. Click Start→Applications→DS Storage Manager 10 Client→DS Storage Manager 10 Client,
2. Under the Setup tab, click Manage a Storage Subsystem.
3. In the Select Storage Subsystem pop-up window, ensure that the DS3524 is highlighted, and click OK.
4. Enter the password, and click OK.
5. In the DS3524 management window, hit the plus by the name of the storage subsystem, click Total Unconfigured, click Array on the menu, and click Create.
6. At the Introduction (Create Array) screen, click Next.
7. At the Array Name & Drive Selection screen, enter a name for the array, select the Manual (Advanced) radio button, and click Next.
8. At the Manual Drive Selection window, set the RAID level to 1 and select two of the drives in the Unselected drives pane by clicking on one, holding down Shift, and clicking on another.
9. Click Add.
10. Repeat steps 8 and 9 until 12 drives are added to the Select drives pane. **Note:** On the IBM System Storage DS3524, when more than two drives are added to a RAID 1, it is automatically configured as a RAID 10.
11. Click Calculate Capacity.
12. Click Finish.
13. In the Array Created pop-up window, click Yes to create a logical drive using the new array.

14. At the Introduction (Create Logical Drive) screen, click Next.
15. At the Specify Capacity/Name screen:
 - a. Enter the total free capacity in the New logical drive capacity field.
 - b. Provide a Logical Drive name.
 - c. Leave the default logical drive parameters at Use recommended settings.
 - d. Click Next.
16. At the Specify Logical Drive-to-LUN Mapping screen, select the Default Mapping radio button, ensure that the Host type is set to Windows 2000/Server 2003/Server 2008 Non-Clustered (supports DMP), and click Finish.
17. In the Creation Successful pop-up window, click No.
18. In the Completed pop-up window, click OK.
19. Repeat steps 5 through 18 six times for each logical drive.

Installing the IBM MPIO Device Specific Module (DSM) v1.03.0305.0409

Note: The IBM MPIO DSM downloads with the DS System Storage Manager 10 (above) and can be located in the same directory to which the manager setup application was extracted.

1. Double-click SMIA-WSX64-01.03.0305.0504.exe.
2. At the Welcome screen, click Next.
3. At the License Agreement screen, accept the agreement, and click Next.
4. At the Ready to Install the Program screen, click Install.
5. When the Installation completes, click Finish.
6. At the prompt to restart the system, click Yes.

Configuring the DS3524 for Fibre Channel and mounting the test volumes

1. Click Start→Administrative Tools→MPIO.
2. On the Discover Multi-Paths tab, highlight the HP P2000G3 FC/iSCSI device, and click Add.
3. In the Reboot Required pop-up window, click Yes.
4. When the system reboots, click Start→Administrative Tools→Server Manager.
5. In the left pane, expand the Storage node, and click Disk Management.
6. In the bottom middle pane, find the new test volumes. For each new volume, right-click the name (i.e., Disk 1), and click Online.
7. Right-click again, and click Initialize.
8. In the Initialize Disk pop-up window, select MBR, and click OK.
9. Right-click the volume, and click New Simple Volume.
10. At the Welcome screen, click Next.
11. At the Specify Volume Size screen, make sure the Simple volume size matches the Maximum disk space, and click Next.
12. At the Assign Drive Letter or Path screen, note the assigned drive letter, and click Next.
13. At the Format Partition, accept the default format settings, make sure Perform a quick format is selected, and click Next.
14. Click Finish, and repeat steps 9 through 13 for the remaining six volumes.

Configuring the HP StorageWorks P2000 G3

Installing the HP StorageWorks P2000 MSA Support Pack

1. Download the HP StorageWorks P2000 Software Bundle for Microsoft Windows Server 2008 R2 (x64) v. 3.35 from <http://h20000.www2.hp.com/bizsupport/TechSupport/SoftwareIndex.jsp?lang=en&cc=us&prodNameId=4118575&prodTypeId=12169&prodSeriesId=4118559&swLang=8&taskId=135&swEnvOID=4064>
2. Double-click the msa2000.bundle-3.35.w2k8r2.x64.exe, and click Run.

3. In the HP Self Extracting Package pop-up window, click Extract.
4. Navigate to the directory where the installer extracted the files, and click setup.exe.
5. At the Source Selections screen, ensure that Both is selected under Types of updates to use, and click Start Inventory.
6. At the Select Installation Host(s) screen, select Local Host, and click Next.
7. In the One or more pre-defined bundles were found window, check the box next to HP StorageWorks P2000 Software Bundle for Microsoft Windows Server 2008 R2 (x64), and click OK.
8. At the Select Items to be Installed screen, accept the defaults, and click Install.
9. When the installation is complete, click Finish.

Configuring Vdisks and volumes on the HP StorageWorks P2000 G3

1. Log into the HP Storage Management Utility.
2. In the Configuration View pane, right-click Vdisks, highlight Provisioning, and click Create Vdisk.
3. In the Create Vdisk section, enter a Vdisk name, set the RAID level to RAID-10, set the Number of Sub-Vdisks to 6, and leave the other fields at their defaults.
4. In the Enclosures Front View pane, select 12 drives (2 for each sub-Vdisk).
5. Scroll to the bottom of the section, and click Create Vdisk.
6. In the Success pop-up window, click OK.
7. Repeat steps 2 through 6 to create 6 more Vdisks.
8. In the Configuration View pane, under Vdisks, right-click the first Vdisk created above, highlight Provisioning, and click Create Volume.
9. In the Create Volume Enter a Volume name, for LUN enter a corresponding number (i.e., the first LUN should be named '1', the second '2', etc.) and leave all other fields to their default settings, ensuring that the Size slider is set to the Vdisks full capacity, the checkbox by Map is checked, and Access is set to read-write.
10. Click Apply.
11. In the Success pop-up window, click OK.
12. Repeat steps 8 through 11 six times for each remaining Vdisk, providing a different LUN number for each Volume.
13. Click Start→Administrative Tools→MPIO.
14. On the Discover Multi-Paths tab, highlight the HP P2000G3 FC/iSCSI device, and click Add.
15. In the Reboot Required pop-up window, click Yes.
16. When the system reboots, click Start→Administrative Tools→Server Manager.
17. In the left pane, expand the Storage node, and click Disk Management.
18. In the bottom middle pane, find the new test volumes. For each new volume, right-click the name (i.e., Disk 1), and click Online.
19. Right-click again, and click Initialize.
20. In the Initialize Disk pop-up window, select MBR, and click OK.
21. Right-click on the volume, and click New Simple Volume.
22. At the Welcome screen, click Next.
23. At the Specify Volume Size screen, make sure the Simple volume size matches the Maximum disk space, and click Next.
24. At the Assign Drive Letter or Path screen, note the assigned drive letter, and click Next.
25. At the Format Partition, accept the default format settings, make sure Perform a quick format is selected, and click Next.
26. Click Finish and repeat steps 21 through 25 for the remaining six volumes.

Setting up Iometer

Installing and configuring Iometer

1. Download the Iometer 2006.07.27 package for Windows from www.iometer.org/doc/downloads.html.
2. Double-click the installer, and click Run.
3. At the Welcome window, click Next.
4. At the License Agreement window, click I Agree.
5. At the Choose Components window, leave the defaults selected, and click Next.
6. At the Choose Install Location window, change the Destination Folder to C:\Iometer 2006.07.27, and click Install.
7. When the installation completes, click Finish.

Setting up the individual Iometer workloads

We used the following settings for each test:

1. Open Iometer.exe.
2. For each access specification:
 - a. Create the access specification to match the configurations in Appendix A.
 - b. Verify that the access specification has the following additional settings:
 - i. Under Burstiness, set Transfer Delay to 0ms, and set Burst Length to 1 I/O.
 - ii. Under Align I/Os, select Sector Boundaries.
 - iii. Under Reply Size, select No Reply.
 - c. Under Topology, select the computer name, and click the Start a New Disk Worker on Selected Manager button until you have one worker assigned to each target volume.
 - d. Under Disk Targets, set the appropriate queue depth.
 - e. Under Results Display, make sure that Iometer has selected Start of Test.
 - f. Under Test Setup, set the Run Time to 4 minutes and the Ramp Up Time to 60 seconds.
 - g. Save the configuration.
3. Exit Iometer.

Running the test

Note: We created a batch file to automatically run all the access specifications and saved it as run.bat to C:\Iometer 2006.07.27.

1. Reboot the system.
2. After logging in, open a command prompt.
3. Type `cd c:\Iometer 2006.07.27` and press Enter.
4. Type `run.bat` and wait 10 minutes.
5. Press Enter.
6. After all access specifications finish running, remove the result files from the server.
7. Repeat steps 1 through 6 two more times for a total of three runs.

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