

RAID CONTROLLER PERFORMANCE COMPARISON: IBM SOLUTION VS. HP SOLUTION

IBM® System x3650 M3 server with the IBM ServeRAID M5015 storage controller



*with MegaRAID FastPath™ enabled

delivered up to **252%** more I/O than the HP ProLiant DL380 G7

OUR FINDINGS

Today's servers handle increasingly demanding workloads, and require fast drives to quickly process database and email requests. An effective RAID controller that maximizes the performance of enterprise-level, high-performance solid-state drives (SSDs) lets you get the most from your server. In our tests, an IBM System x3650 M3 server with the IBM ServeRAID M5015 RAID storage controller and MegaRAID FastPath enabled allowed us to maximize performance gains from high-end SSD storage options, delivering up to 252.25 percent greater input/output (I/O) performance than the HP ProLiant DL380 G7 server with the HP Smart Array P410i RAID controller.

OUR PROCESS

In our testing, we equipped both the HP server and the IBM server with eight Pliant™ enterprise-level high-performance SSDs. Having identical storage in each server allowed us to fairly measure the maximum SSD performance capabilities of each storage solution. We used the Iometer benchmark to gauge how well each storage solution could handle a variety of common storage tasks. We ran 11 Iometer access specifications, including OLTP database, Microsoft® Exchange Server, media streaming, video on demand, file server, and typical OS workloads. We ran these tests against three common RAID levels: RAID 0, RAID 5, and RAID 10.



PROJECT OVERVIEW

We tested the following server and storage solutions:

- IBM System x3650 M3 server with the IBM ServeRAID M5015 storage controller and MegaRAID FastPath enabled using eight internal Pliant SSDs (IBM solution)
- HP ProLiant DL380 G7 server with the HP Smart Array P410i RAID controller using eight internal Pliant SSDs (HP solution)

For testing, each server ran Microsoft Windows Server® 2008 R2 Enterprise Edition. The goal of this report is to show the performance increase one can expect with the IBM solution over the HP solution.

Figures 1 and 2 show the percentage wins for the IBM solution over the HP solution across the three RAID levels. We present the results in two charts, larger percentage wins and smaller percentage wins, for easier readability. The IBM solution delivered from 2.19 percent to 252.25 percent greater performance in input/output per second (IOPS) over the HP solution.

Averaging all 11 access specifications for each RAID level, this means an overall performance increase for the IBM solution over the HP solution of 90.41 percent, 124.07 percent, and 111.06 percent for RAID levels 0, 5, and 10, respectively.

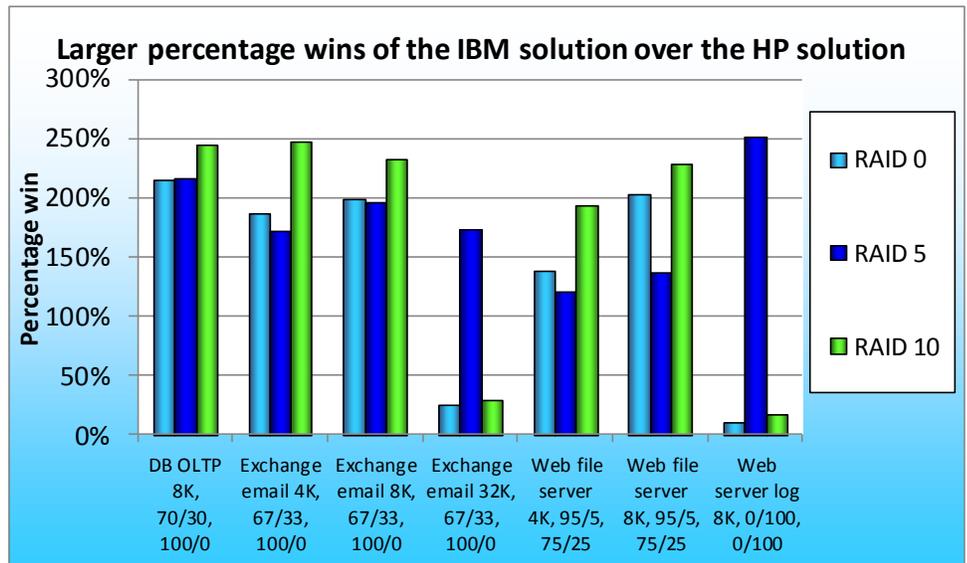


Figure 1: Larger percentage wins for the IBM solution across RAID levels 0, 5, and 10.

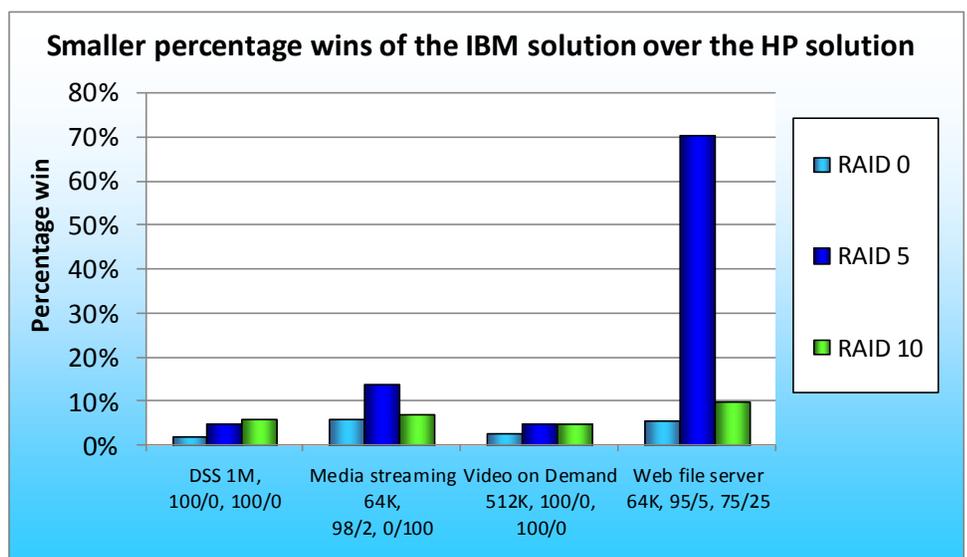


Figure 2: Smaller percentage wins for the IBM solution across RAID levels 0, 5, and 10.

WHAT WE TESTED

Iometer measures IOPS on single and clustered systems. Iometer performs I/O operations to stress a system, and then records the performance of these I/O operations and the system stress they create. Iometer can create and measure workloads on a single system or on networked systems. We used Iometer version 2006.07.27 on each server to simulate various typical server workloads on the IBM solution and on the HP solution. We used the same Iometer workload across both storage solutions, but tuned the number of outstanding I/Os to obtain the maximum possible input/output operations per second (IOPS) for each controller and each RAID level we tested.

Figure 3 details the Iometer access specifications we used. We present the number of outstanding I/Os and other specific settings we used during testing in Figure 6 of the Test configurations section.

Access specification name and block size	Percentage read	Percentage write	Percentage random	Percentage sequential
DB-OLTP 8K	70%	30%	100%	0%
DSS 1M	100%	0%	100%	0%
Exchange email 4K	67%	33%	100%	0%
Exchange email 8K	67%	33%	100%	0%
Exchange email 32K	67%	33%	100%	0%
Media streaming 64K	98%	2%	0%	100%
Video on Demand 512K	100%	0%	100%	0%
Web file server 4K	95%	5%	75%	25%
Web file server 8K	95%	5%	75%	25%
Web file server 64K	95%	5%	75%	25%
Web server log 8K	0%	100%	0%	100%

Figure 3: The Iometer access specification settings we used in our testing.

SYSTEM COMPARISON

Figure 4 shows a side-by-side comparison of the key hardware features of the two solutions. Appendix A presents the detailed system information for the test servers.

Hardware specifications	IBM solution	HP solution
Server platform	IBM System x3650 M3 (7945)	HP ProLiant DL380 G7
Processor	Intel® Xeon® processor E5620	Intel Xeon processor E5620
RAID controller	IBM ServeRAID M5015	HP Smart Array P410i
RAID controller driver	LSI™ Corp. 4.31.1.64 (2/4/2010)	HP 6.20.0.64 (02/22/2010)
RAID controller firmware	2.120.03.1108	3.00
Memory (GB)	24	24
Drive layout	8 x 150GB SAS Pliant LB150S SSDs. OS on one partition; lometer target partition using the remaining space on the drives	8 x 150GB SAS Pliant LB150S SSDs. OS on one partition; lometer target partition using the remaining space on the drives
Drive firmware	T117	T117

Figure 4: Key hardware features of the two solutions.

WHAT WE FOUND

We report the percentage win of the IBM solution over the HP solution from our custom lometer tests, based on the IOPS scores of each test. For all tests, higher IOPS numbers are better. We ran each test three times and report IOPS results from the median run. We then calculated the percentage win for the IBM solution for each access specification at RAID levels 0, 5, and 10.

Figure 5 shows the percentage win of the IBM solution over the HP solution for the three RAID levels. Web server log 8K at RAID 5 demonstrates the highest percentage win for the IBM solution, at 252.25 percent greater IOPS than the HP solution. For detailed test results, see Appendix B.

Access specification name and block size	Percentage win of IBM solution over HP solution RAID 0	Percentage win of IBM solution over HP solution RAID 5	Percentage win of IBM solution over HP solution RAID 10
DB-OLTP 8K	215.30%	216.68%	245.57%
DSS 1M	2.19%	5.05%	5.86%
Exchange email 4K	186.45%	171.75%	247.61%
Exchange email 8K	198.53%	197.09%	232.31%
Exchange email 32K	25.28%	173.54%	29.05%
Media streaming 64K	6.05%	13.93%	6.97%
Video on Demand 512K	2.88%	4.90%	4.95%
Web file server 4K	138.39%	121.44%	193.28%
Web file server 8K	202.79%	137.73%	228.55%
Web file server 64K	5.63%	70.37%	10.07%
Web server log 8K	11.07%	252.25%	17.42%
Average across 11 access specifications	90.41%	124.07%	111.06%

Figure 5: Percentage win results of the IBM solution over the HP solution during internal SSD testing for RAID levels 0, 5, and 10. Higher numbers are better.

TEST CONFIGURATIONS

Host servers

- IBM System x3650 M3 server, Intel Xeon processor E5620, 24 GB of memory (4 x 6 GB)
- HP ProLiant DL380 G7 server, Intel Xeon processor E5620, 24 GB of memory (4 x 6 GB)

Iometer settings

- 1 worker per target
- Dataset size set to use 50 percent of available space in target volume per target
- Outstanding I/Os tuned for each access specification per drive set, per RAID level

Figure 6 displays the outstanding I/O settings for each access specification we tested.

Access specification	IBM solution outstanding I/Os			HP solution outstanding I/Os		
	RAID 0	RAID 5	RAID 10	RAID 0	RAID 5	RAID 10
DB-OLTP 8K, 70/30, 100/0	256	256	256	64	32	128
DSS 1M, 100/0, 100/0	16	32	32	32	16	16
Exchange email 4K, 67/33, 100/0	256	128	256	128	32	128
Exchange email 8K, 67/33, 100/0	256	256	256	64	32	128
Exchange email 32K, 67/33, 100/0	128	128	128	128	16	128
Media streaming 64K, 98/2, 0/100	256	256	256	256	256	256
Video on Demand 512K, 100/0, 100/0	64	64	64	64	32	64
Web file server 4K, 95/5, 75/25	256	128	256	32	64	64
Web file server 8K, 95/5, 75/25	256	256	256	32	128	64
Web file server 64K, 95/5, 75/25	256	256	256	256	64	256
Web server log 8K, 0/100, 0/100	256	256	256	256	256	256

Figure 6: Outstanding I/O settings for each access specification we tested.

Internal storage test configurations

For our testing, we created a single RAID virtual drive in the RAID level to be tested. We allocated a 40GB partition for the operating system (OS) and utilized the remaining space in the drives to create an Iometer target partition. We then set the dataset size in Iometer to occupy 50 percent of the available space in the Iometer target partition. Figure 7 shows the specific hardware configuration and partitioning for each drive set and RAID level during testing. These were consistent across the three RAID levels, except for the Iometer partition size and dataset size, which are dependent on the RAID configuration. We determined the 50 percent dataset size based on the available formatted space in the target Iometer partition size in Windows®. We used this configuration for both the IBM and HP solutions.

RAID level	Number and size of drives	OS partition size	Target Iometer partition size	Dataset size
0	8 x 150 GB	40 GB	1,070 GB	535 GB
5	8 x 150 GB	40 GB	931 GB	466 GB
10	8 x 150 GB	40 GB	515 GB	257 GB

Figure 7: Hardware configurations for each drive set and RAID level during testing.

HOW WE TESTED

To obtain the maximum performance from the IBM ServeRAID M5015 controller on the IBM System x3650 M3 server, we installed the controller card into a PCIe x8 slot on the PCIe extender riser card rather than the dedicated PCIe slot of the SAS controller riser card. On the HP ProLiant DL380 G7 server, the HP Smart Array P410i RAID controller is integrated into the server board. Because we were testing MegaRAID FastPath, we set the write policy on the IBM solution to write through. In order to test write-through mode on the HP solution, we disabled the array accelerator.

IBM System x3650 M3 server

Accessing the RAID WebBIOS on the IBM System x3650 M3

1. Boot the system.
2. When prompted, press F12 to enter Setup.
3. In the System Configuration and Boot Management screen, highlight System Settings, and press Enter.
4. Highlight Adapters and UEFI Drivers, and press Enter.
5. To compile the list of drivers, press Enter.
6. Under LSI EFI SAS Driver, select the first option (I-PciRoot...), and press Enter.
When the setup prompts you, press 1 for WebBIOS.

Setting up a test volume on the IBM System x3650 M3

1. When LSI GUI loads, select the adapter (ServeRAID M5015 SAS/SATA Controller), and click Start.
2. In the left WebBIOS pane, click Configuration Wizard.
3. Under Please choose appropriate configuration, type `select New Configuration` and click Next.
4. When the setup asks Are you sure you want to clear the configuration, click Yes.
5. Under Select Configuration Method, select Manual Configuration, and click Next.
6. In the Drive Group Definition window, select the first drive (Slot 0) in the Drives pane, and click Add to Array.
7. Repeat Step 6 for the remaining drives.
8. When all the drives have been added, click Accept DG in the Drive Groups pane.
9. Click Next.
10. In the Span Definition window, select the Drive Group 0 in the Array With Free Space pane, and click Add to Span.
11. Click Next.
12. In the Virtual Drive Definition window, set the RAID Level to 0, set the Write Policy to Write Through, and click Accept.
13. When the prompt asks Are you sure you want to select Write Through mode? click Yes.
14. Click Next.
15. In the Configuration Preview window, click Accept.
16. When asked, Save this Configuration? click Yes.
17. When asked if you want to Initialize, click Yes.
18. In the Virtual Drives pane, select Slow Initialize, and click Go.

19. When asked if you want to Proceed with Initialization, click Yes.
20. When Initialization completes, click Home.
21. Press Ctrl+Alt+Delete to reboot the system.

Installing the operating system

Installing Windows Server 2008 R2 Enterprise

1. Boot the server, and insert the Windows Server 2008 R2 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 9/15/2010. 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.

Creating the target volume

1. Click Start→Administrative Tools→Server Manager.
2. In the left pane, double-click Storage and click on Disk Management.
3. In the bottom center pane under Disk 0, right click the partition labeled Unallocated.
4. Click New Simple Volume.
5. At the Welcome screen, click Next.
6. At the Specify volume size screen, leave the default (maximum size) and click Next.
7. Make sure the drive letter assigned to the volume is E, leave the other defaults, and click Next.
8. At the Format Partition window, check that Perform a quick format is selected, leave other defaults, and click Next.
9. To create the volume, click Finish.

Installing MegaRAID Storage Manager on IBM System x3650 M3

1. Download MegaRAID Storage Manager for Windows v. 6.9.0600 from <http://www-947.ibm.com/support/entry/portal/docdisplay?Indocid=MIGR-5077712>
2. Double click setup.exe.
3. At the InstallShield Wizard window for installing requirements, click OK.
4. Click Yes to install Microsoft Visual C++® 2005.
5. At the Welcome screen for the InstallShield Wizard, click Next.
6. Accept the terms in the license agreement, and click Next.
7. At the Customer Information screen, fill in the appropriate information, and click Next.
8. Accept the Default destination folder, and click Next.
9. Leave the default Setup Type as Complete, and click Next.
10. Click Install.
11. Click Finish.

Viewing configuration options via the MegaRAID Storage Manager

1. Double-click the MegaRAID Storage Manager desktop icon.
2. Select the Host server for the appropriate controller, and click Login.
3. Enter the login Username and Password, leave the Login mode at the default of Full Access, and click Login.
4. View the configuration and other options by navigating the Dashboard, Physical, and Logical tabs on the left side.

HP ProLiant DL380 G7 server

Accessing RAID BIOS on the HP ProLiant DL380 G7

1. Boot the server.
2. When the window prompts you to Press any key to view Option ROM messages, press any key.
3. When the HP Smart Array P410i Controller posts, press F8 when the setup prompts you to enter the Option ROM Configuration.

Setting up a test volume on the HP ProLiant DL380 G7

1. On the Main Menu, select Create Logical Drive, and press Enter.
2. All drives should be selected by default, but if they are not, select each one by highlighting it and pressing the Space Bar.

3. Press the Tab key to navigate to the RAID Configuration pane, select the appropriate RAID level, and press Enter.
4. At the notification screen, press F8 to save the configuration.
5. At the Configuration saved screen, press Enter to continue.
6. Press Esc to exit.

Installing the operating system

Installing Windows Server 2008 R2 Enterprise

1. Boot the server, and insert the Windows Server 2008 R2 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 settings

We installed all recommended and critical Windows updates through 9/15/2010. 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.

Creating the target volume

1. Click Start→Administrative Tools→Server Manager.
2. In the left pane, double-click Storage, and click Disk Management.
3. In the bottom center pane under Disk 0, right-click the partition labeled Unallocated.
4. Click New Simple Volume.
5. At the Welcome screen, click Next.
6. At the Specify volume size screen, leave the default (maximum size), and click Next.
7. Make sure the drive letter assigned to the volume is E, leave the other defaults, and click Next.
8. At the Format Partition window, check that Perform a quick format is selected, leave other defaults, and click Next.
9. Click Finish to create the volume.

Installing the HP Array Configuration Utility

1. Download the ProLiant Support Pack for Microsoft Windows Server 2008 R2 from <http://h20000.www2.hp.com/bizsupport/TechSupport/SoftwareDescription.jsp?lang=en&cc=us&prodTypeId=15351&prodSeriesId=4091412&prodNameId=4091432&swEnvOID=4064&swLang=13&mode=2&taskId=135&swItem=MTX-358b3bcb8b5241ceb740ccdd6d> and follow HP's instructions on how to prepare the installer.
2. Open the installer (hpsum.exe).
3. In the Source Selections window, accept the defaults, and click Start Inventory.
4. In the Select Installation Host(s) window, select Local Host, and click Next.
5. In the Select Bundle Filter window, check the box next to ProLiant Support Pack for Microsoft Windows Server 2008 R2, and click OK.
6. In the Select Items to be Installed window, accept the defaults, and click Install.

Viewing configuration options via HP Array Configuration Utility

1. Open the utility by clicking Start→All Programs→HP System Tools→HP Array Configuration Utility→HP Array Configuration Utility.
2. Under the Configuration tab, use the drop-down menu to select an available device, and choose Smart Array P410i in Embedded Slot.
3. Use the options on the screen to view configuration and available options.

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 Figure 3.
 - 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 # of Outstanding I/Os according to the corresponding value shown in Figure 6.
 - e. Set the Maximum disk size to half the size of the target volume, using sectors as the unit of measurement. To calculate correct sector size for each RAID level:
 - i. Click Start → Computer.
 - ii. Right click on the target volume, E.
 - iii. Click Properties.
 - iv. Note the size of Free Space in bytes and divide it by 2.
 - v. Divide the quotient from Step iv. by 512. The result is the Maximum disk size.
 - f. Under Results Display, make sure that Iometer has selected Start of Test.
 - g. Under Test Setup, set the Run Time to 4 minutes and the Ramp Up Time to 60 seconds.
 - h. Save the configuration.
3. Exit Iometer.

Running the test

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.

APPENDIX A – SERVER CONFIGURATION INFORMATION

Figure 8 provides detailed configuration information about the test servers.

System	IBM System x3650 M3 (7945)	HP ProLiant DL380 G7
Power supplies		
Total number	2	2
Vendor and model number	Emerson 7001484-J000 Rev H	HP DPS-750RB A
Wattage of each (W)	675	750
General		
Number of processor packages	2	2
Number of cores per processor	4	4
Number of hardware threads per core	2	2
System power management policy	Balanced	Balanced
CPU		
Vendor	Intel	Intel
Name	Xeon	Xeon
Model number	E5620	E5620
Stepping	B1	B1
Socket type	Socket 1366 LGA	Socket 1366 LGA
Core frequency (GHz)	2.40	2.40
Bus frequency	5.8 GT/s	5.8 GT/s
L1 cache	32 KB + 32 KB (per core)	32 KB + 32 KB (per core)
L2 cache	256 KB (per core)	256 KB (per core)
L3 cache	12 MB (shared)	12 MB (shared)
Platform		
Vendor and model number	IBM System x3650 M3 (7945)	HP ProLiant DL380 G7
Motherboard model number	IBM 69Y4438	ProLiant DL380 G7
Motherboard chipset	Intel 5520	Intel 5520
BIOS name and version	IBM Corp. D6E148BUS-1.08	HP v.P67 (05/14/2010)
BIOS settings	Default	Default

System	IBM System x3650 M3 (7945)	HP ProLiant DL380 G7
Memory module(s)		
Total RAM in system (GB)	24	24
Vendor and model number	IBM 47J0156	Samsung M393B5270CH0-CH9Q4
Type	PC3-10600R	PC3-10600R
Speed (MHz)	1,333	1,333
Speed running in the system (MHz)	1,067	1,067
Timing/Latency (tCL-tRCD-tRP-tRASmin)	7-7-7-20	7-7-7-20
Size (GB)	4	4
Number of RAM module(s)	6	6
Chip organization	Double-sided	Double-sided
Rank	Dual	Dual
SSD drive		
Vendor and model number	Pliant LB0150S	Pliant LB0150S
Number of disks in system	8	8
Size (GB)	150	150
Type	SAS SSD	SAS SSD
Firmware	T117	T117
Disk controller		
Vendor and model	IBM ServeRAID M5015	HP Smart Array P410i Controller
Controller cache (MB)	512	512
Controller driver	LSI Corp. 4.31.1.64 (2/4/2010)	HP 6.20.0.64 (02/22/2010)
Controller firmware	2.120.03.1108	3.00
RAID configuration	0, 5, 10, 50	0, 5, 10, 50
Settings	MegaRAID FastPath enabled; Write policy set to write-through	Array Accelerator Disabled; Write-policy set to write-through
Operating system		
Name	Windows Server 2008 R2	Windows Server 2008 R2
Build number	7600	7600
File system	NTFS	NTFS
Kernel	ACPI x64-based PC	ACPI x64-based PC
Language	English	English
Graphics		
Vendor and model number	Matrox® G200eV (Maxim)	ATI ES1000
Graphics memory (MB)	8	64

System	IBM System x3650 M3 (7945)	HP ProLiant DL380 G7
Driver	Matrox Graphics Inc. 1.1.3.0 (10/28/2009)	ATI Technologies 8.240.50.5000 (06/23/2009)
Ethernet		
Vendor and model number	Broadcom® BCM5709C NetXtreme® II GigE	HP NC382i DP Multifunction Gigabit Server Adapter
Type	Integrated	Integrated
Driver	Broadcom 5.2.14.0 (12/17/2009)	HP 5.2.14.0 (12/17/2009)
Optical drive(s)		
Vendor and model number	HL-DT-ST GT30N	N/A
Type	DVD-RW	N/A
USB ports		
Number	4	4
Type	2.0	2.0

Figure 8: Configuration information for the test servers.

APPENDIX B – DETAILED TEST RESULTS

Figure 9 shows our test results, in IOPS, for the median run of the IBM solution.

Access specification name and block size	RAID 0	RAID 5	RAID 10
DB-OLTP 8K, 70/30, 100/0	138,080.65	45,562.16	103,275.74
DSS 1M, 100/0, 100/0	1,652.40	1,663.22	1,668.63
Exchange email 4K, 67/33, 100/0	152,798.41	47,298.22	116,780.04
Exchange email 8K, 67/33, 100/0	136,358.99	43,561.02	96,035.59
Exchange email 32K, 67/33, 100/0	46,027.00	17,136.84	29,923.91
Media streaming 64K, 98/2, 0/100	27,832.07	26,139.97	27,623.12
Video on Demand 512K, 100/0, 100/0	3,321.74	3,322.01	3,333.59
Web file server 4K, 95/5, 75/25	149,007.18	100,393.84	154,730.57
Web file server 8K, 95/5, 75/25	159,070.76	93,185.59	153,501.36
Web file server 64K, 95/5, 75/25	28,304.75	24,511.92	28,137.86
Web server log 8K, 0/100, 0/100	90,876.16	39,267.40	53,775.68

Figure 9: IOPS results from the IBM solution testing. Higher numbers are better.

Figure 10 shows our test results, in IOPS, for the median run of the HP solution.

Access specification name and block size	RAID 0	RAID 5	RAID 10
DB-OLTP 8K, 70/30, 100/0	43,793.09	14,387.23	29,885.60
DSS 1M, 100/0, 100/0	1,617.04	1,583.30	1,576.25
Exchange email 4K, 67/33, 100/0	53,341.70	17,405.10	33,594.84
Exchange email 8K, 67/33, 100/0	45,676.86	14,662.62	28,899.19
Exchange email 32K, 67/33, 100/0	36,739.83	6,264.78	23,187.04
Media streaming 64K, 98/2, 0/100	26,244.08	22,944.28	25,822.21
Video on Demand 512K, 100/0, 100/0	3,228.84	3,166.90	3,176.42
Web file server 4K, 95/5, 75/25	62,505.07	45,336.87	52,759.40
Web file server 8K, 95/5, 75/25	52,535.64	39,197.78	46,721.34
Web file server 64K, 95/5, 75/25	26,795.45	14,387.23	25,564.04
Web server log 8K, 0/100, 0/100	81,815.17	11,147.44	45,798.46

Figure 10: IOPS results from the HP solution testing. Higher numbers are better.

ABOUT PRINCIPLED TECHNOLOGIES



Principled Technologies, Inc.
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We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools.

When the assessment is complete, we know how to present the results to a broad range of target audiences. We provide our clients with the materials they need, from market-focused data to use in their own collateral to custom sales aids, such as test reports, performance assessments, and white papers. Every document reflects the results of our trusted independent analysis.

We provide customized services that focus on our clients' individual requirements. Whether the technology involves hardware, software, Web sites, or services, we offer the experience, expertise, and tools to help our clients assess how it will fare against its competition, its performance, its market readiness, and its quality and reliability.

Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.

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