BLADE SERVER SSD PERFORMANCE COMPARISON: IBM FLEX SYSTEM x240 VS. HP PROLIANT BL460c GEN8

When investing in new blade infrastructure technologies to meet the computing needs of your organization, it is important to choose hardware that delivers robust throughput performance and meets your internal storage needs. Today's servers handle increasingly demanding workloads, and servers supporting high numbers of fast drives that can speed up user requests while providing sufficient storage capacity and drive system resiliency are vital.

In the Principled Technologies labs, we tested the I/O operations per second (IOPS) performance of the IBM Flex System x240 vs. the HP ProLiant BL460c Gen8 with the maximum drive count supported by each system – eight SSDs for the IBM and two SSDs for the HP. We used nine different workloads, including simulated database and Exchange email server activity. We found that the IBM Flex System x240 delivered up to 2.8 times the performance of the HP ProLiant BL460c Gen8 blade server on our workloads. By supporting a greater number of drives than the HP blade server, the IBM Flex System x240 compute node can provide faster performance for end users in the same single-wide/half-height form factor, while also providing both greater storage capacity and more storage resiliency by allowing for more RAID options.

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FASTER I/O PERFORMANCE

The internal storage that a server utilizes has a dramatic effect on I/O performance and the resulting experience that end users have when accessing databases, email, media, and more. SSDs greatly improve upon the performance of traditional hard disks not only because they can act as faster primary storage, but also because they can support the intelligent division of storage load. In other words, frequently accessed data can be placed directly on the SSDs while other data can be placed on slower external storage.

We used the Iometer tool to compare the performance of the IBM Flex System x240 with its maximum eight SSDs (through the Flex System Flash enablement kit) in both RAID 10 and RAID 5 configurations vs. the HP ProLiant BL460c Gen8 blade server with its maximum two SSDs in a RAID 1 configuration. We found that the high-speed SSD performance of the Flex System x240 delivered up to 177.7 percent more IOPS in RAID 10 and up to 182.3 percent more IOPS in RAID 5 than its competitor. The more IOPS that a server can handle, the more responsive requests are for the end user.

Iometer uses a variety of access specifications, or simulated workloads, in various block sizes and I/O patterns to approximate the various kinds of applications that a business may use. Testing the response of servers handling files in small or large blocks shows that the server is ready to handle the variety of tasks that your organization may require.

According to IBM, the 4-socket EP IBM Flex System x440 compute node also supports the 8-SSD RAID 0/1/5/10/50 and optional upgrade for RAID 6/60 configurations like the server in this study. IBM positions the x440 for high-end virtualization, mainstream databases, and memory intensive, high performance workloads. By supporting the same 8-SSD high IOPS configuration in both the x240 and x440, the IBM Flex System portfolio has the ability to support a wide range of database and virtualization needs. The IBM PureFlex and Flex System portfolios leverage a unique flash implementation called IBM Flex System Flash. Flex System Flash's combination of solid-state disk technology and high-speed controller architecture delivers greater performance than traditional HDDs. The Flex System Flash enablement kit used in this study allows both the IBM Flex System x240 and x440 compute nodes to support up to eight 1.8” SSD (4 hot-swappable, 4 embedded) drives for I/O-intensive workloads. Flex System Flash also enables hardware RAID 5/6 to provide redundancy, maximizing mission-critical data integrity.

ABOUT THE RESULTS

We first present the results of our small block size workloads, which simulated the I/O activity of Exchange 2003, 2007, 2010, and of an online transaction processing database (OLTP) in our Iometer workloads. The IBM Flex System x240 outperformed the HP ProLiant BL460c Gen8 in all of these small block size workloads at both RAID levels we tested, with up to 101.6 percent greater performance when comparing the IBM server in RAID 10 to the HP server in RAID 1, and up to 68.0 percent greater performance when comparing the IBM Flex System x240 in RAID 5 to the HP server in RAID 1. Figure 1 presents the IOPS the IBM Flex System x240 achieved in both RAID 10 and RAID 5 configurations compared to the HP ProLiant BL460c Gen8 in RAID 1 on the small-block-size simulated workloads we tested. (Note: In Figures 1 through 3, we show the percentage win for the IBM RAID configurations over the corresponding HP result at the top of each bar.)

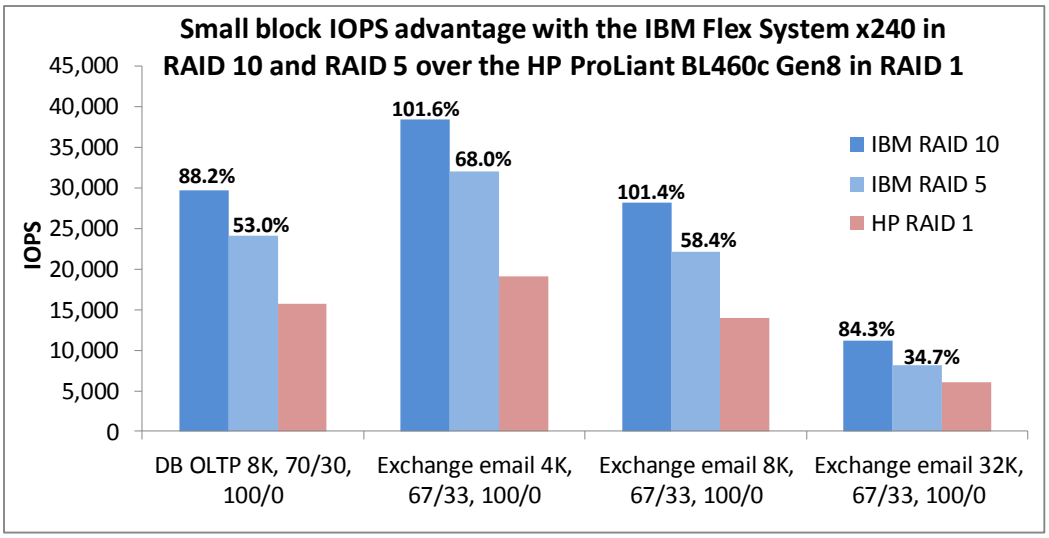
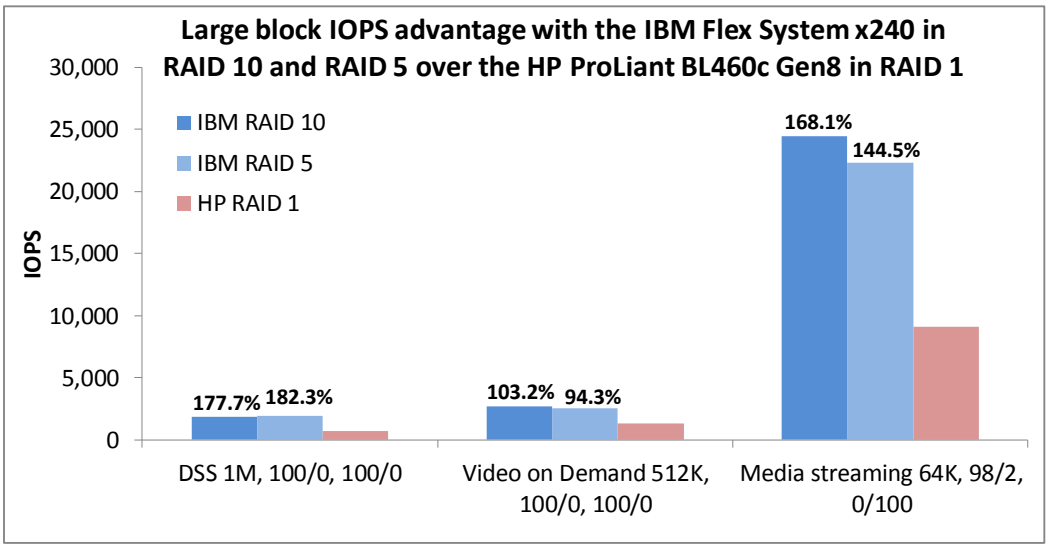


Figure 1: The IBM Flex System x240 in RAID 10 and RAID 5 configurations increased IOPS by up to 101.6 percent over the HP ProLiant BL460c Gen8 when handling simulated Exchange email requests and OLTP database activity.

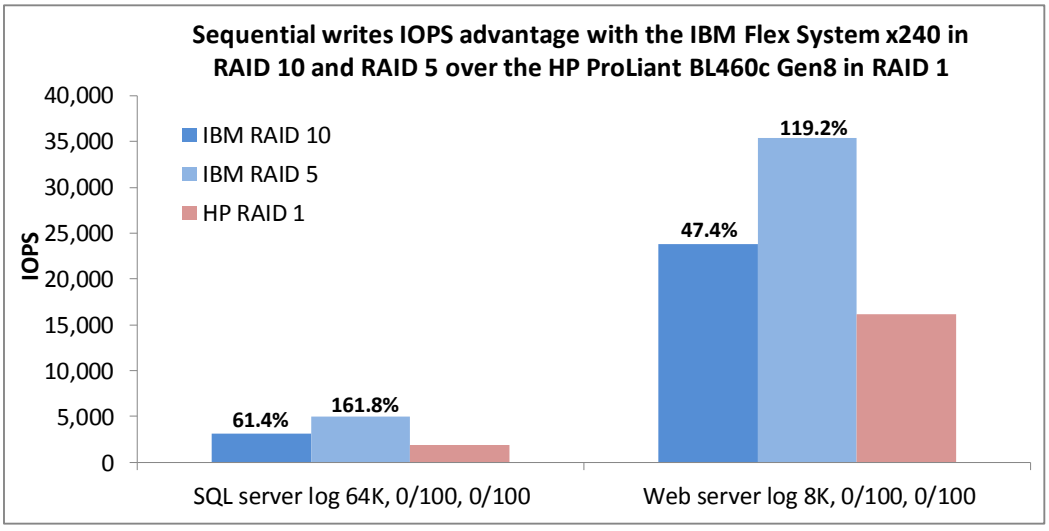
Next, we show our results from the large block size tests, which simulated the I/O activity of a Decision Support System (DSS) database and both streaming media and video. The IBM Flex System x240 delivered up to a whopping 182.3 percent performance increase over the HP ProLiant BL460c Gen8. Figure 2 presents the IOPS achieved for the IBM Flex System x240 in RAID 10 and RAID 5 configurations over the HP ProLiant BL460c Gen8 in RAID 1 on the large-block-size simulated workloads in our testing. Note that because the block sizes are so large for the first two access specifications, the maximum throughput limitations essentially even out the RAID 10 and RAID 5 numbers.

Figure 2: The IBM Flex System x240 in RAID 10 and RAID 5 configurations increased IOPS by up to 182.3 percent over the HP ProLiant BL460c Gen8 when handling DSS database and both streaming media and video simulation workloads.



Finally, we tested simulated log activity, which consisted of sequential writes to the drives. This includes our simulated workloads representing SQL Server logs or a smaller block size log such as that of a Web server. In our testing, we found that the IBM Flex System x240 provided significantly better performance both in smaller and larger block simulated log activity — up to a 161.8 percent improvement over the HP ProLiant BL460c Gen8. Figure 3 presents the IOPS achieved for the IBM Flex System x240 in RAID 10 and RAID 5 configurations over the HP ProLiant BL460c Gen8 in a RAID 1 configuration on the simulated log activity workloads in our testing.

Figure 3: The IBM Flex System x240 in RAID 10 and RAID 5 configurations increased IOPS by up to 161.8 percent over the HP ProLiant BL460c Gen8 in RAID 1 when handling log activity.



Note that in the case of these pure sequential writes, the RAID 5 configuration provides higher performance because RAID 5 allows the theoretical max throughput of seven SSDs (seven data drives and one parity) compared to the theoretical max throughput of four SSDs in RAID 10 being written to.

As our results show, the flexible options available to you from the greater number of drives in the IBM Flex System x240 mean that you are able to get considerably greater performance spanning across a wide array of I/O patterns.

MORE STORAGE CAPACITY AND GREATER STORAGE RESILIENCY

Holding up to eight SSDs, the IBM Flex System x240 can accommodate more SSDs than the HP ProLiant BL460c Gen8 blade server, which can house only two SSDs internally. In addition to providing better performance than the HP ProLiant BL460c Gen8, the higher number of SSDs in the IBM Flex System x240 gives your organization greater capacity in production deployments as well as more fault-tolerant configuration options.

With the HP ProLiant BL460c Gen8 blade server, two internal SSDs allow for only a RAID 1 configuration in a fault tolerant production deployment. The IBM Flex System x240, on the other hand, gives your organization additional configuration options such as RAID 5 (higher capacity), RAID 10 (higher overall performance), and an optional upgrade for a RAID 6 configuration (higher resiliency). Other options like RAID 5 with a hot spare are also available. This added flexibility in the IBM Flex System x240 not only provides the storage resiliency to protect your business information from a drive failure, but also offers more options for increased total storage capacity. Additionally, the extra RAID options allow you to maximize usable capacity when compared to total raw capacity in a fault tolerant configuration. For our testing, we configured both solutions with 200GB SSDs, but the highest capacity drive available with the IBM Flex System x240 is 400GB SSDs, and the HP ProLiant BL460c Gen8 blade offers 800GB SSDs, which is what we used for this comparison. Even with the highest capacity 800GB SSDs that HP offers, the largest fault-tolerant drive configuration available for the HP ProLiant BL460c Gen8 (RAID 1) provides only 800GB usable storage capacity. The IBM Flex System x240, when configured with eight 400GB SSDs, offers up to 2.8TB of usable storage capacity. When comparing usable vs. raw capacity for each configuration, the IBM server's RAID 5 option allows you to use 87.5 percent of your total raw capacity, considerably greater than the usable 50 percent on the HP servers RAID 1-only option. Figure 4 compares the maximum internal storage capacity of the two systems at various fault-tolerant RAID configurations.

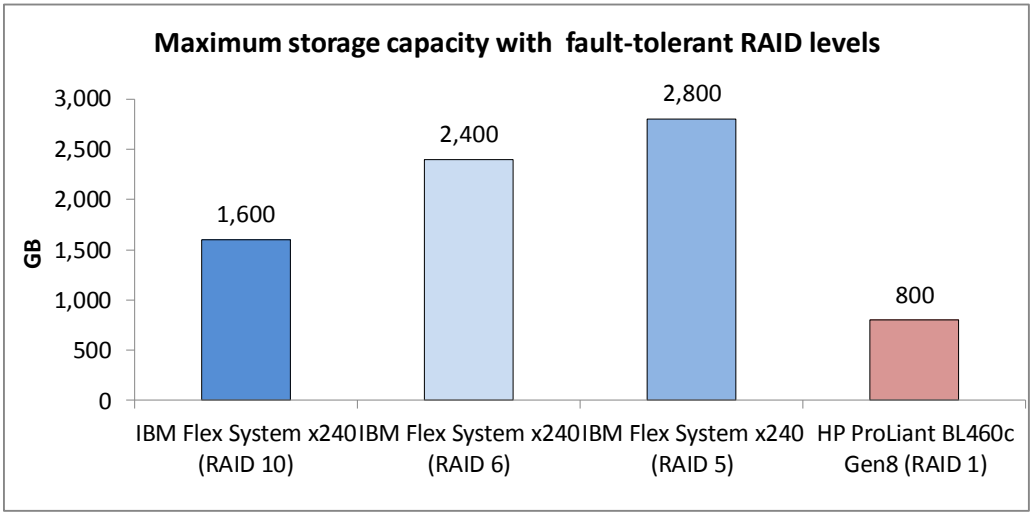


Figure 4: With RAID fault tolerance, the IBM Flex System x240 with eight 200GB SSDS holds up to 1.4TB of storage—75 percent more than the HP ProLiant BL460c Gen8 configured with two 800GB SSDs.

If data integrity is of the utmost importance to your business, the eight-SSD-capacity of the IBM Flex System x240 offers more options and greater storage resiliency than the HP ProLiant BL460c Gen8. With the HP ProLiant BL460c Gen8, if you were to lose two drives, you would suffer a complete data loss. By configuring your IBM Flex System x240 server in a RAID 5 configuration and selecting one of your SSDs to act as a hot spare, or by upgrading to a RAID 6 configuration with the optional upgrade key, your server can sustain a loss of up to two drives in your configuration while your data remains intact.

WHAT WE FOUND

Figure 5 compares the detailed results of our Iometer tests, in IOPS, for the IBM Flex System x240 in a RAID 10 configuration and the HP blade server, and the percent win for the IBM Flex System x240 across the nine access specifications in our testing. We ran each test three times and report IOPS results from the median run.

	IBM Flex System x240 (RAID 10)	HP ProLiant BL460c Gen8 (RAID 1)	IBM Flex System x240 (RAID 10) percent win
DB OLTP 8K, 70/30, 100/0	29,667.64	15,767.70	88.2%
DSS 1M, 100/0, 100/0	1,861.08	670.09	177.7%
Exchange email 4K, 67/33, 100/0	38,413.74	19,051.82	101.6%
Exchange email 8K, 67/33, 100/0	28,168.72	13,988.69	101.4%
Exchange email 32K, 67/33, 100/0	11,186.57	6,070.60	84.3%
Media streaming 64K, 98/2, 0/100	24,490.73	9,134.69	168.1%
SQL server log 64K, 0/100, 0/100	3,090.89	1,915.60	61.4%
Video on Demand 512K, 100/0, 100/0	2,668.68	1,313.02	103.3%
Web server log 8K, 0/100, 0/100	23,811.70	16,156.39	47.4%

Figure 5: Iometer test results, in IOPS, for the access specifications we tested

Figure 6 gives a detailed comparison of the results of our Iometer tests, in IOPS, for the IBM Flex System x240 in a RAID 5 configuration and the HP blade server, and the percent win for the IBM Flex System x240 across the nine access specifications in our testing.

	IBM Flex System x240 (RAID 5)	HP ProLiant BL460c Gen8 (RAID 1)	IBM Flex System x240 (RAID 5) percent win
DB OLTP 8K, 70/30, 100/0	24,131.12	15,767.70	53.0%
DSS 1M, 100/0, 100/0	1,891.50	670.09	182.3%
Exchange email 4K, 67/33, 100/0	32,011.59	19,051.82	68.0%
Exchange email 8K, 67/33, 100/0	22,155.84	13,988.69	58.4%
Exchange email 32K, 67/33, 100/0	8,174.31	6,070.60	34.7%
Media streaming 64K, 98/2, 0/100	22,335.78	9,134.69	144.5%
SQL server log 64K, 0/100, 0/100	5,015.82	1,915.60	161.8%
Video on Demand 512K, 100/0, 100/0	2,551.30	1,313.02	94.3%
Web server log 8K, 0/100, 0/100	35,416.22	16,156.39	119.2%

Figure 6: Iometer test results, in IOPS, for the access specifications we tested

WHAT WE TESTED

To measure disk performance of the two solutions, we used the Iometer tool, which measures IOPS on both 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. We used Iometer 2006.7.27 to simulate various typical server workloads on the IBM Flex System x240 and the HP ProLiant BL460c Gen8. We used the same Iometer workload with one Iometer worker and same 100GB dataset on both solutions, but tuned the number of outstanding I/Os to obtain the maximum possible IOPS for both solutions.

To determine the optimum number of outstanding I/Os for both solutions across the different access specifications, we ran each of the access specifications at increasing outstanding I/O, or queue depth, up to 256. We then determined the optimal outstanding I/O based on where the IOPS first peaks before either flattening or decreasing. Figure 7 displays the outstanding I/O settings for each access specification we tested.

Access specification and block size	IBM Flex System x240 (RAID 10) outstanding I/Os	IBM Flex System x240 (RAID 5) outstanding I/Os	HP ProLiant BL460c Gen8 (RAID 1) outstanding I/Os
DB-OLTP 8K, 70/30, 100/0	256	256	64
DSS 1M, 100/0, 100/0	8	256	8
Exchange email 4K, 67/33, 100/0	256	256	32
Exchange email 8K, 67/33, 100/0	256	256	32
Exchange email 32K, 67/33, 100/0	256	256	16
Media streaming 64K, 98/2, 0/100	256	256	4
SQL Server log 64K, 0/100, 0100	256	32	2
Video on Demand 512K, 100/0, 100/0	32	64	16
Web server log 8K, 0/100, 0/100	256	256	4

Figure 7: Outstanding I/Os for each access specification and each solution in our tests.

Note: IBM also supports more exotic and more expensive solid-state options such as Fusion I/O technology. For our testing configurations in this study, we compared SSD-only options between the two vendors.

IN CONCLUSION

As you invest in new nodes for your blade infrastructure, you want to get the most performance, capacity, and resiliency per node for your investment. In our tests, the IBM Flex System x240 consistently outperformed the HP ProLiant BL460c Gen8 server on the simulated workloads – increasing IOPS by as much as 177.7 percent, or 2.8 times the IOPS, in a RAID 10 configuration, and as much as 182.3 percent, or 2.8 times the IOPS, in a RAID 5 configuration. Based on this data, you could expect a single IBM Flex System x240 to do the work of multiple HP ProLiant BL460c Gen8 servers; if you have a heavily I/O-constrained environment with similarly shaped data streams. Additionally, the IBM Flex System x240 provides greater capacity, up to 2.8TB, and more fault tolerant options, including a RAID 5 configuration that could be advantageous for your business, whether you are looking for servers to handle your databases, Exchange email, streaming media, and more.

APPENDIX A – SYSTEM CONFIGURATION INFORMATION

Figure 8 provides detailed configuration information for the test systems.

System	IBM Flex System x240	HP ProLiant BL460 Gen8
Power supplies	IBM Flex System Enterprise Chassis	HP BladeSystem c7000 Blade Enclosure
Total number	2	6
Vendor and model number	IBM 69Y5823	HP 588603-B21
Wattage of each (W)	2,504	2,450
First cooling fan	IBM Flex System Enterprise Chassis	HP BladeSystem c7000 Blade Enclosure
Total number	8	10
Vendor and model number	IBM 46C9702	HP 412140-B21
Dimensions (h x w)	3.5” x 3.5”	3.5” x 3.0”
Volts	12	12
Amps	7.2	16.5
Second cooling fan	IBM Flex System Enterprise Chassis	N/A
Total number	4 (2 fan modules of 2 fans each)	N/A
Vendor and model number	IBM 46C9704	N/A
Dimensions (h x w)	3.5” x 1.625” (each fan module)	N/A
Volts	12	N/A
Amps	5.65	N/A
General		
Number of processor packages	2	2
Number of cores per processor	6	6
Number of hardware threads per core	2	2
System power management policy	Balanced	Balanced
CPU		
Vendor	Intel	Intel
Name	Xeon	Xeon
Model number	E5-2620	E5-2620
Stepping	C2	C2
Socket type	2011 LGA	2011 LGA
Core frequency (GHz)	2.0	2.0
Bus frequency	7.2 GT/s	7.2 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	15 MB	15 MB
Platform		
Vendor and model number	IBM Flex System x240	HP ProLiant BL460c Gen8
Motherboard model number	00Y2738	654609-001
BIOS name and version	IBM B2E118BUS 1.10 (08/11/2012)	HP I31 (7/15/2012)
BIOS settings	Default	Default

System	IBM Flex System x240	HP ProLiant BL460 Gen8
Memory module(s)		
Total RAM in system (GB)	32	32
Vendor and model number	Micron MT36JSF1G72PZ-1G6M1FF	Samsung M393B1K70DH0-CK0Q8
Type	PC3-12800R	PC3L-12800R
Speed (MHz)	1,600	1,600
Speed running in the system (MHz)	1,600	1,600
Timing/Latency (tCL-tRCD-tRP-tRASmin)	11-11-11-28	11-11-11-28
Size (GB)	8	8
Number of RAM module(s)	4	4
Chip organization	Double-sided	Double-sided
Rank	Dual	Dual
Operating system		
Name	Microsoft Windows Server 2012 Datacenter	Microsoft Windows Server 2012 Datacenter
Build number	9200	9200
File system	NTFS	NTFS
Kernel	ACPI x64-based PC	ACPI x64-based PC
Language	English	English
Graphics		
Vendor and model number	Matrox® G200	Matrox G200eH
Graphics memory (MB)	Integrated	Integrated
Driver	6.2.9200.16384 (6/21/2006)	4.0.1.5 (6/20/2012)
RAID controller		
Vendor and model number	IBM ServeRAID M5115	HP Smart Array P220i
Firmware version	23.7.0-0029 (9/11/2012)	3.04 (9/4/2012)
Driver version	5.2.127.64 (5/7/2012)	6.24.0.64 (7/12/2012)
Cache size (MB)	1024	512
Solid state drives		
Vendor and model number	IBM SG9XCS1F	HP MO0200FBRWB
Number of drives	8	2
Size (GB)	200	200
Type	SATA	SAS
Ethernet adapters		
Vendor and model number	Emulex OC11102-F-X	HP FlexFabric 10Gb 2-port 554FLB
Type	Adapter	Integrated
Driver	4.2.313.0 (7/19/2012)	4.2.313.0 (7/2/2012)
USB ports		
Number	1 internal, 2 External (via KVM dongle)	2 External (via HP SUV connector)
Type	2.0	2.0

Figure 8: System configuration information for the two test systems.

APPENDIX B - HOW WE TESTED

Configuring the IBM Flex System x240 and the HP ProLiant BL460c Gen8

For the IBM Flex System x240, we set up the eight 200GB SSDs in two different configurations in our testing—in a single RAID 10 virtual drive or a single RAID 5 virtual drive. For the HP ProLiant BL460c Gen8 server, we configured the two 200GB SSDs in a single RAID 1 virtual drive. For both IBM Flex System x240 configurations and the HP ProLiant BL460c Gen8 server, we created 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 a 100GB dataset size in Iometer so that both the IBM Flex System x240 and the HP ProLiant BL460c Gen8 server had the same size dataset. We installed and configured Windows Server 2012 Datacenter on both solutions using the following steps.

Installing Microsoft Windows Server 2012 Datacenter from the external CD/DVD drive

1. Insert the installation media into the external CD/DVD drive, and restart the server.
2. When the option appears, press the appropriate key to select the desired boot device.
3. After selecting the external CD/DVD drive, press any key when prompted to boot from DVD.
4. When the installation screen appears, click My language is English.
5. Leave language, time/currency format and input method as default, and click Next.
6. Click Install now.
7. When the Windows Setup window appears, click No thanks when it prompts you to go online to install updates.
8. Select Windows Server 2012 Datacenter (Server with a GUI), and click Next.
9. Check I accept the license terms, and click Next.
10. Click Custom: Install Windows only (advanced).
11. Press Alt+A to open advanced partition options. Delete any partitions until there is only Drive 0 Unallocated Space.
12. Select Drive 0 Unallocated Space, and click Next, at which point Windows will begin installing, and will restart automatically after completing.
13. When the Settings page appears, fill in the Password and Reenter Password fields with the same password.
14. Log in with the password you set up previously.

Configuring Windows Update

1. In the left pane of the Server Manager window, click Local Server.
2. In the main frame, next to Windows Update, click Not configured.
3. In the Windows Update window, in the main pane, click Let me choose my settings.
4. Under Important updates, select Never check for updates (not recommended), and click OK.
5. In the left pane, click Check for updates, and install all available updates.
6. Close the Windows Update window.

Configuring Windows Firewall

1. In Server Manager, click Tools→Windows Firewall with Advanced Security.
2. In the Overview section, click Windows Firewall Properties.
3. In the Domain Profile tab, for Firewall state, click Off.
4. In the Private Profile tab, for Firewall state, click Off.
5. In the Public Profile tab, for Firewall state, click Off.
6. Click OK.
7. Close the Windows Firewall Properties window.

Setting up Remote Desktop

1. In the Local Server tab of the Server Manager window, next to Remote Desktop, click Disabled.
2. In the System Properties window that appears, in the Remote Desktop section, select the Allow remote connections to this computer radio button, and click OK when the warning message appears.
3. Uncheck Allow connections only from computers running Remote Desktop with Network Level Authentication (recommended), and click OK.

Disabling IE Enhanced Security Configuration

1. In the Local Server tab of the Server Manager window, next to IE Enhanced Security Configuration, click On.
2. In the Internet Explorer Enhanced Security Configuration window, select the Off radio buttons for both Administrators and Users, and click OK.

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 9.

Access specification name and block size	% read	% write	% random	% 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
OS paging 64K	90	10	0	100
SQL Server Log 64K	0	100	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 9: Access specification details for our Iometer tests.

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 100 GB of the target volume, using sectors as the unit of measurement.
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.

ABOUT PRINCIPLED TECHNOLOGIES

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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.