SAS STORAGE ARRAYS: EMAIL PERFORMANCE

Dell™ PowerVault™ MD3220 delivers 147.7% better email performance

versus

on Microsoft® Exchange 2007

Dell PowerVault MD3000

OUR FINDINGS

The responsiveness and user experience of a company's email infrastructure relies heavily on the underlying storage subsystem. In Principled Technologies' tests in our labs, the new 6Gbps Dell PowerVault MD3220 serial-attached SCSI storage array exceeded the email performance of the older 3Gbps Dell PowerVault MD3000 by 147.7 percent while supporting a heavy Microsoft Exchange 2007 workload. Our results show that upgrading to the Dell PowerVault MD3220 can boost a company's email performance and let it support more users.

OUR PROCESS

To gauge how well each storage array would handle email, we used the Microsoft Exchange Server Jetstress tool. Jetstress simulates the email activity of an increasing number of users. It reports the Microsoft Exchange 2007 database IOPS and log IOPS that a storage system delivers while maintaining satisfactory responsiveness. To give each array a chance to perform at its peak, we used the maximum number of drives it could support—96 for the Dell PowerVault MD3220, and 45 for the Dell PowerVault MD3000—and we configured multiple paths to its controller.

APRIL 2010

A PRINCIPLED TECHNOLOGIES TEST REPORT

Commissioned by Dell Inc.

PROJECT OVERVIEW

We tested the following storage devices:

- Dell PowerVault MD3220 (6 Gbps)
- Dell PowerVault MD3000 (3 Gbps)

The goal was to determine which solution provided better performance and throughput for Exchange 2007 email workloads. We represent performance in terms of total input/output operations per second (IOPS) and total throughput.

We configured both the Dell PowerVault MD3220 and the Dell PowerVault MD3000 to use a comparable proportion of their usable capacity. We created identical test beds for both devices that consisted of two Dell PowerEdge™ R710 rack servers to generate the workload on the arrays. Both arrays use serial-attached SCSI (SAS) technology for their connection to the servers as well as their connection to the SAS hard drives. The MD3220 supports 6Gbps SAS while the MD3000 supports 3Gbps SAS technology.

We ran the tests three times to ensure repeatability, and report the results from the run that produced the median total IOPS.

WORKLOAD

Microsoft developed Jetstress 2007 to help administrators measure the reliability of the storage array, primary storage performance, and streaming backup/recovery performance by heavily stressing the disk subsystem before putting their Exchange server into a production environment. We ran the primary storage performance tests only, which stress the storage arrays using the maximum sustainable Exchange 2007 I/O that the storage system can handle while providing acceptable responsiveness over a 2-hour period.

Jetstress simulates the Exchange database and log file loads that a specific number of users produce. The tests do not have a single workload; instead, testers create a simulated Exchange mailbox profile that defines the Jetstress workload. Jetstress tests both responsiveness and throughput, giving a pass/fail rating and reporting read and write latencies for responsiveness and reporting throughput in I/O operations per second. We calculated values for three Jetstress test parameters that define the simulated Exchange 2007 mailbox profile: targeted database IOPS per user, average mailbox size, and number of mailboxes.

- **Targeted database IOPS per user.** We based our tested user profile for this report on the Microsoft profile for heavy Exchange 2007 cached mode users. These users average 20 sent and 80 received

messages per day, a load that averages 0.32 database IOPS for each user. We used this average with 20 percent headroom as our targeted database IOPS per user for a total of 0.40 IOPS target.

- **Mailbox size.** We selected a mailbox size that allowed us to utilize 60 percent of the smallest RAID group. The mailbox size we used was 139 MB per user for the Dell PowerVault MD3220 array and 62 MB per user for the Dell PowerVault MD3000 array.
- **Number of mailboxes.** To provide an adequate load on the arrays, we set the number of mailboxes to 12,000 per array.

The overall Jetstress test result is a pass/fail rating based on whether the system's performance falls within acceptable latency thresholds. All the results we report are from runs that passed.

SYSTEM COMPARISON

Figure 1 shows a side-by-side comparison of the key hardware differences between the storage arrays. Appendix A presents detailed system information.

	Dell PowerVault MD3220	Dell PowerVault MD3000
		
Arrays	Dell PowerVault MD3220	Dell PowerVault MD3000
Disks	24x 146GB SAS 15k 2.5", 72x 73GB SAS 15k (96 total)	13x 146GB SAS 15k 3.5", 32x 73GB SAS 15k (45 total)
Disk layout	We created 20 four-disk RAID groups and created one volume on each RAID group for the database mailstores. We created 2 eight-disk RAID groups and divided each of them into 10 separate volumes for logging.	We created 9 four-disk RAID groups and created one volume on each RAID group for the database mailstores. We created 2 four-disk RAID groups and divided one into 4 separate volumes for logging and the other into 5 separate volumes for logging.
Formatted storage capacity	4,078 GB	1,903 GB
Connection	SAS	SAS
Multi-pathing	Yes	Yes
RAID technology	RAID 10	RAID 10

Figure 1: Storage system configuration information.

WHAT WE FOUND

Figure 2 shows the Exchange Server 2007 total IOPS the two storage arrays achieved. As Figure 2 shows, the Dell PowerVault MD3220 achieved 18,575 total IOPS, while the Dell PowerVault MD3000 achieved only 7,499 total IOPS. The Dell PowerVault MD3220 achieved 147.7 percent greater total IOPS than did the Dell PowerVault MD3000.

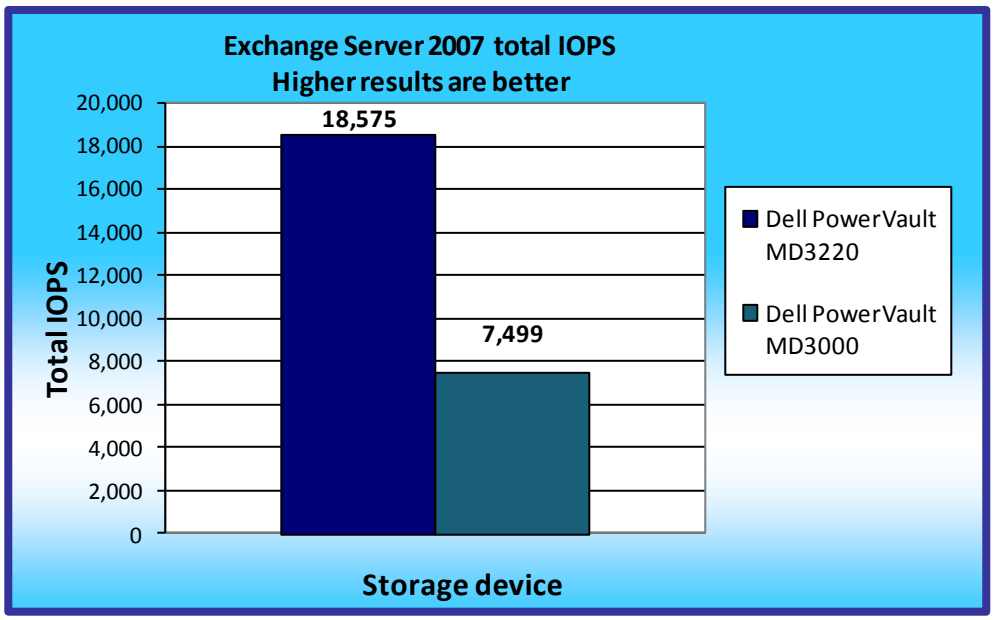

Figure 2: Exchange Server 2007 total IOPS results for the storage arrays during the Jetstress test. We combine database IOPS and log IOPS to determine total IOPS.

Figure 3 shows the Exchange Server 2007 throughput the two storage arrays achieved. The Dell PowerVault MD3220 achieved 164.20 MB/s, while the Dell PowerVault MD3000 achieved 51.90 MB/s. The Dell PowerVault MD3220 achieved 216.4 percent greater total throughput than did the Dell PowerVault MD3000.

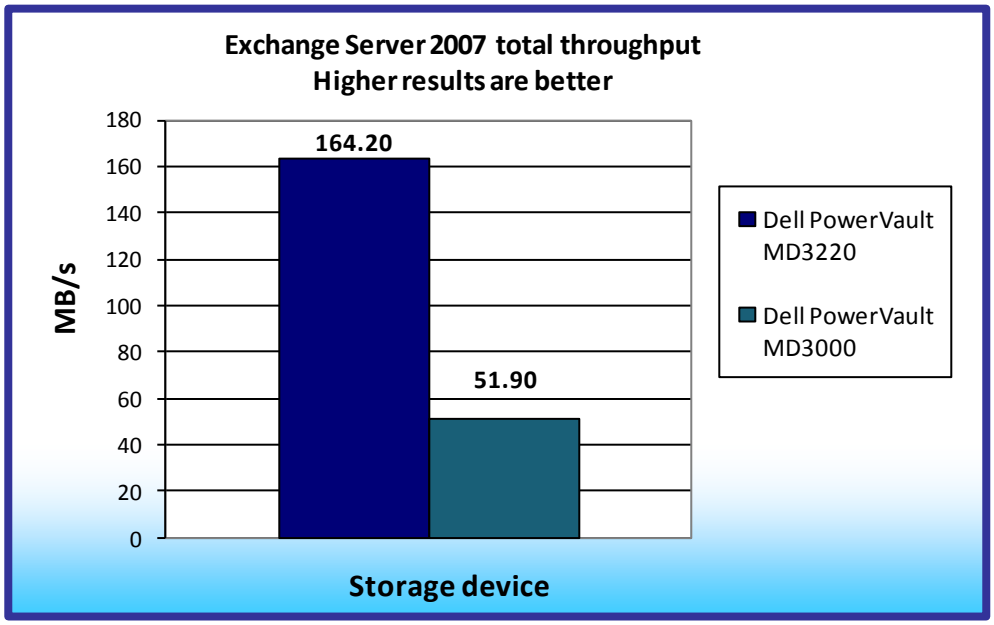

Figure 3: Exchange Server 2007 total throughput results for the storage arrays during the Jetstress test. We combine read and write throughput to determine total throughput.

We report the median of the three runs. Appendix B provides complete results.

HOW WE TESTED

We first 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, we continued to retest using higher thread counts to push IOPS to the maximum, stopping when Jetstress reported a failing user experience rating. If the system failed the initial performance test run, we retested using lower thread counts until Jetstress reported a passing user experience rating. If the test failed using just a single thread, we reduced the number of mailboxes until Jetstress gave a passing user experience rating. This process identified the highest IOPS score that the system could achieve while receiving a passing user experience rating. We then performed two additional runs using the settings from the run that produced those results. We ran each test for 2 hours, the default run time for a Jetstress test. Jetstress reports results in I/O operations per second. We gathered the following results from the Jetstress report:

- Database disk reads per second
- Database disk writes per second
- Achieved IOPS (sum of database disk reads and writes per second)
- Log writes per second (log IOPS)
- Total IOPS (sum of achieved IOPS and log IOPS)

To find the amount of data moved by Jetstress in those operations, or throughput, Jetstress provides Windows Performance Monitor logs of server performance. We gathered the following results from those logs:

- Average disk transfers per second
- Average disk reads (MB per second)
- Average disk writes (MB per second)
- Average disk transfers (MB per second)

The results we report in Figures 2 and 3 are 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.

APPENDIX A – STORAGE CONFIGURATION AND SETUP

This appendix includes the parameters we used for simulated Exchange configuration calculations, the results of those calculations for the tested arrays, and the steps we took to configure the arrays.

Simulated Exchange configuration calculations

We defined the simulated Exchange configuration using the following guidelines:

- 12,000 users simulated
- Initial database size, equal to 60 percent of the formatted capacity of the smallest RAID group
- Average mailbox size of approximately 139 MB for the Dell PowerVault MD3220 and 62 MB for the Dell PowerVault MD3000
- One mailbox per user

We calculated the simulated Exchange configuration using the parameters in Figure 4. Figure 5 shows the simulated Exchange configuration, Figure 6 shows the primary storage hardware, Figure 7 shows the primary storage software on the host server, and Figure 8 shows the primary storage disk configuration.

Item	Value
IOPS per mailbox	0.40 (0.32 is typical of a heavy user profile plus 20% headroom)
Database files capacity utilization percentage of the smallest RAID Group	60%
Mode	Cached
Number of hosts	2
Number of mailbox stores/storage group	1

Figure 4: Simulated Exchange configuration parameters.

Simulated Exchange configuration

System	Dell PowerVault MD3220	Dell PowerVault MD3000
Number of Exchange mailboxes simulated	12,000	12,000
Number of hosts	2	2
Mailbox size (MB)	139	62
Number of storage groups	20	9
Number of mailbox stores/storage group	1	1
Number of mailboxes/mailbox store	600	1,333
Simulated profile: I/Os per second per mailbox	0.40 (0.32 plus 20% headroom)	0.40 (0.32 plus 20% headroom)
Database LUN size (GB)	136 and 272	136 and 272
Log LUN size (GB)	27	68
Initial total database size for performance testing (GB)	1,629	733
Percentage formatted capacity of smallest RAID group used by Exchange database	60%	60%

Figure 5: Simulated Exchange configuration.

Primary storage hardware

System	Dell PowerVault MD3220	Dell PowerVault MD3000
Total number of disks tested in solution	96	45 (44 active)
Storage connectivity (Fibre Channel, SAS, SATA, iSCSI)	SAS	SAS
Storage model and OS/firmware revision	Dell PowerVault MD3220 Firmware 97.70.03.62	Dell PowerVault MD3000 Firmware 07.35.31.60
Storage memory	4 GB (2 GB per controller)	1 GB (512 MB per controller)
Number of storage controllers	2	2
Number of storage ports	8 (4 used)	4

Figure 6: Primary storage hardware.

Primary storage software on host server

System	Dell PowerVault MD3220	Dell PowerVault MD3000
Server HBA/NIC driver	Dell 6Gbps SAS HBA 2.0.12.10	Dell SAS 5/E Adapter Controller 1.29.3.0
Multi-pathing	Yes	Yes
Host OS	Windows Server 2008 SP2 x64	Windows Server 2008 SP2 x64
Server ESE.dll file version	08.02.0176.000	08.02.0176.000

Figure 7: Primary storage software on host server.

Primary storage disk configuration

System	Dell PowerVault MD3220	Dell PowerVault MD3000
Disk type and speed	24x 146GB SAS 15k, 72x 73GB SAS 15k	12x 146GB SAS 15k 36x 73GB SAS 15k
Raw capacity per disk (GB)	73 and 146	73 and 146
Number of physical disks in test	96	44
Total raw storage capacity (GB)	8,760	4,380
Raid level	RAID 10	RAID 10
Total formatted capacity (GB) (1GB=2^30 bytes)	4,078	1,903

Figure 8: Primary storage disk configuration (Mailbox Store and transactional logs).

APPENDIX B – TEST RESULTS

Figure 9 provides test results for the storage arrays, as well as information about the simulated Exchange configuration that defines the test workload. We ran the Jetstress primary storage performance test three times for each storage array, and then determined the median.

System	Dell PowerVault MD3220	Dell PowerVault MD3000
Total IOPS (higher is better)		
Server 1 Database IOPS - Run 1	7,926.180	2,749.752
Server 2 Database IOPS - Run 1	7,919.197	3,444.077
Server 1 Log IOPS - Run 1	1,263.822	574.441
Server 2 Log IOPS - Run 1	1,247.713	731.200
Total IOPS - Run 1	**18,356.912**	**7,499.470**
Server 1 Database IOPS - Run 2	7,952.331	2,759.957
Server 2 Database IOPS - Run 2	7,973.266	3,745.345
Server 1 Log IOPS - Run 2	1,333.367	571.825
Server 2 Log IOPS - Run 2	1,316.144	724.246
Total IOPS - Run 2	**18,575.108**	**7,801.373**
Server 1 Database IOPS - Run 3	7,975.887	2,690.159
Server 2 Database IOPS - Run 3	7,996.756	3,424.960
Server 1 Log IOPS - Run 3	1,332.321	575.351
Server 2 Log IOPS - Run 3	1,311.826	732.988
Total IOPS - Run 3	**18,616.790**	**7,423.458**
Median total IOPS	**18,575.108**	**7,499.470**
Additional results from median run		
Database disk reads/sec	8,214.86	2,712.57
Database disk writes/sec	7,710.73	3,481.26
Log writes/sec	2,649.51	1,305.64
Average disk reads MB/sec	64.34	12.73
Average disk writes MB/sec	99.89	39.17
Average disk transfers MB/sec	164.20	51.90

Figure 9: Jetstress primary performance test results for the storage arrays.

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:

- Microsoft Exchange Server
  - Two Dell PowerEdge R710 servers installed with the following software:
    - Microsoft Windows Server® 2008 SP2 x64
    - Jetstress 08.02.0060.000
    - Exchange 2007 SP2 08.02.0176.000 ESE binaries
- Switch
  - One Dell PowerConnect™ 5448 switch
    - Cat6e cables used
- Storage systems under test
  - One Dell PowerVault MD3220 array
    - Three Dell PowerVault MD3220 disk enclosures attached
  - One Dell PowerVault MD3000 Array
    - Two Dell PowerVault MD1000 disk enclosures attached

Figure 10 provides highlights of the Dell PowerEdge R710 server configuration. Figure 11 in Appendix D provides complete configuration details.

Dell PowerEdge R710 rack server	
Processors	Two quad-core Intel® Xeon® Processor X5570s at 2.93 GHz
Memory	48 GB, 6 x 8 GB, 1,333 MHz
Internal disk	One 146GB, 15K RPM Seagate ST9146852SS SATA drive
Network	Integrated Quad Port Broadcom BCM5709C
Operating system	Microsoft Windows Server 2008 SP2
Test software	Jetstress 2007 08.02.0060.000 with Exchange 2007 SP2 x64 08.02.0176.000 ESE binaries

Figure 10: Dell PowerEdge R710 server configuration highlights.

APPENDIX D – SERVER CONFIGURATION INFORMATION

Figure 11 provides detailed configuration information about the test server.

Server	Dell PowerEdge R710
General dimension information	
Height (inches)	3.50
Width (inches)	17.50
Depth (inches)	27.00
U size in server rack (U)	2
Power supplies	
Total number	1
Wattage of each (W)	570
Cooling fans	
Total number	5
Dimensions (h x w) of each	2.50” x 2.50”
Voltage (V)	12
Amps (A)	1.60
General processor setup	
Number of processor packages	2
Number of cores per processor package	4
Number of hardware threads per core	2
CPU	
Vendor	Intel
Name	Xeon X5570
Stepping	D0
Socket type	LGA1366
Core frequency (GHz)	2.93
L1 cache	4 x 32 KB + 32 KB
L2 cache	4 x 256 KB
L3 cache (MB)	8
Platform	
Vendor and model number	Dell PowerEdge R710
Motherboard model number	0M233H
Motherboard revision number	13
BIOS name and version	Dell 1.3.6 (12/14/2009)
BIOS settings	Default
Memory modules	
Total RAM in system (GB)	48
Vendor and model number	Samsung M393B1K70BH1-CH9
Type	PC3-10600R
Speed (MHz)	1,333
Speed in the system currently running @ (MHz)	1,333

Server	Dell PowerEdge R710
Timing/latency (tCL-tRCD-iRP-tRASmin)	9-9-9-9
Size (GB)	8
Number of RAM modules	6
Chip organization	Double-sided
Hard disk	
Vendor and model number	Seagate ST9146852SS
Number of disks in system	1
Size (GB)	146
Buffer size (MB)	16
RPM	15,000
Type	SAS
Network card/subsystem	
Vendor and model number	Broadcom BCM5709C
Type	Integrated

Figure 11: Detailed system configuration information for the server we used for testing.

APPENDIX E – TEST PROCEDURES

We set up our test environment and installed Microsoft Windows 2008 Server x64 Enterprise Edition Service Pack 2 on the test server. To get starting values for the first Jetstress performance test run, we ran the Jetstress disk subsystem throughput test and used its estimated thread count as the thread count for the first Jetstress performance test.

Installing Microsoft Windows 2008 Server x64 Enterprise Edition Service Pack 2 on the server

We began our testing by installing a fresh copy of Microsoft Windows 2008 Server x64 Enterprise Edition Service Pack 2 on the server. We followed this process for each installation:

1. Assign a computer name of *server*.
2. For the licensing mode, use the default setting of five concurrent connections.
3. Enter a password for the administrator logon.
4. Select Eastern Time Zone.
5. Use typical settings for the Network installation.
6. Turn Windows Firewall off.

Note: We used default BIOS settings on the server. We installed all recommended Windows Updates through 3/4/2010.

Installing Jetstress

We followed this process to install Jetstress on the test server:

1. Download the Microsoft Exchange Server Jetstress Tool (64-bit) v. 08.02.0060 from http://www.microsoft.com/downloads/details.aspx?FamilyID=73dfe056-0900-4dbb-b14a-0932338cecac&DisplayLang=en.
2. Run Jetstress.msi.
3. Click Next.
4. Accept the terms of the License Agreement, and click Next.
5. Click Next.
6. Click Next.
7. Click Close.
8. Copy the following files from an Exchange 2007 SP2 64-bit installation disk:
    - ese.dll
    - eseperf.dll
    - eseperf.hxx
    - eseperf.ini
9. Paste the files in C:\Program Files\Exchange Jetstress.
10. Run JetstressWin.exe.
11. Click Start new test.
12. Click Exit.

Preparing for the test

To prepare for the test, we first ran a Jetstress disk subsystem throughput test to find a starting point for tuning the mailbox profile.

1. Run JetstressWin.exe.
2. Click Start new Test, and click Next.
3. Select Create a new test configuration file.
4. Name the file `ArrayName_Initial_Run.xml` and click Next.
5. Select Test disk subsystem throughput, and click Next.
6. Change the value to 60 in the Size the database storage capacity percentage box.
7. Leave the default value of 100 in the Target IOPS using throughput capacity percentage box, and click Next.
8. Select Performance, and click Next.
9. Set the test duration to 2 hours, and click Next.
10. Set the number of storage groups.
11. Leave the number of databases set to 1, and click Next.
12. Select Create new databases.
13. Click Execute Test.
14. Once the test has finished, record the thread count from the disk subsystem throughput. We use this value as the thread count for the first Jetstress test run in Step 14 below.

Running the test

Before testing, we ensured that all storage ports were active and connected at full speed for maximum performance and availability. We then followed this process for each test on both Dell PowerEdge R710s:

1. Run JetstressWin.exe.
2. Click Start new Test, and click Next.
3. Select Create a new test configuration file.
4. Name the file `ArrayName_Run#.xml` and click Next.
5. Select Test an Exchange mailbox profile.
6. Enter a description in the text box, and click Next.
7. Set the number of mailboxes 6,000.
8. Type `.4` for IOPS/mailbox.
9. Set the Mailbox size to 139 MB for the Dell PowerVault MD3220 or 62 MB for the Dell PowerVault MD3000.
10. Check the Suppress tuning and use thread count (per-storage group) checkbox.
11. For the first run, enter the number of threads that the automatic tuning from the Disk subsystem throughput test chose. (Note: For subsequent runs, use the thread count you calculate in Step 21.) Click Next.
12. Select the Performance test type, and click Next.
13. Set the test duration to 2 hours.
14. Set the number of storage groups to 8, and leave the number of databases at 1.

15. Click the white box under … for Group1 Database1, and attach the corresponding db# database partition (where # represents 1 through 8).
16. Repeat Step 15 multiple times, matching the storage group with its corresponding db# partition.
17. Click the white box under … for Log1, and attach the corresponding log# partition (where # represents 1 through 8).
18. Repeat Step 17 multiple times, matching the log with its corresponding log# partition, and click Next.
19. Select Create new databases, and click Next.
20. Click Execute Test.
21. Wait for the test to finish; then check the output files to see if the run reported errors or failed by exceeding the Jetstress latency thresholds for the log or database files.
    a. If the run had errors or the latency exceeded the thresholds, proceed based on whether the run prior to this run passed or also failed:
        i. If the previous run was successful, its results show the maximum IOPS score. Save those results as Run 1 results.
        ii. If the previous run also had errors or exceeded the latency thresholds, decrease the number of threads by 1, and perform another run.
    b. If the run succeeds, perform the following steps:
        i. Save from the following files:
            - The Jetstresswin configuration file used (e.g., ServerName_Run#.xml)
            - Performance_(TimeStamp).html
            - Performance_(TimeStamp).blg
            - DBChecksum_(TimeStamp).html
            - DBChecksum_(TimeStamp).blg
        ii. Record the items that we show in Appendix B, Figure 9: Jetstress primary performance test results for the storage arrays.
        iii. Check the results for the run prior to this run, and proceed based on whether that run passed or failed.
            1. If the previous run was successful, increase the number of threads by one, and perform another run.
            2. If the previous run had errors or exceeded the latency thresholds, the current runs results show the maximum IOPS score. Save those results as the Run 1 results.
22. Repeat the test two more times using the thread count used in the run that produced the results saved as Run 1 results in Step 21.

ABOUT PRINCIPLED TECHNOLOGIES

Principled Technologies, Inc.
1007 Slater Road, Suite 300
Durham, NC, 27703
www.principledtechnologies.com

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.

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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.