



LenovoTM

SPC BENCHMARK 1TM
FULL DISCLOSURE REPORT

LENOVO
THINKSYSTEM DS4200

SPC-1 V3.4.0

SUBMISSION IDENTIFIER: A32002

SUBMITTED FOR REVIEW: JULY 19, 2017

First Edition – July 2017

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Benchmark Specification and Glossary

The official SPC Benchmark 1™ (SPC-1™) specification is available on the website of the Storage Performance Council (SPC) at www.storageperformance.org.

The SPC-1™ specification contains a glossary of the SPC-1™ terms used in this publication.

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AUDIT CERTIFICATION



Mr. Gabe Brewington
 Lenovo
 7001 Development Drive
 Morrisville, NC 27560

July 18, 2017

I verified the SPC Benchmark 1™ (SPC-1™ V3.4.0) test execution and performance results of the following Tested Storage Product:

ThinkSystem DS4200

The results were:

SPC-1 IOPS™	100,021
SPC-1 Price-Performance™	\$0.14/SPC-1 IOPS™
SPC-1 IOPS™ Response Time	0.485 <u>ms</u>
SPC-1 Overall Response Time	0.325 <u>ms</u>
SPC-1 ASU Capacity	2,267 GB
SPC-1 ASU Price	\$6.00/GB
SPC-1 Total System Price	\$13,580.85

In my opinion, these performance results were produced in compliance with the SPC requirements for the benchmark.

The testing was executed using the SPC-1 Toolkit Version v3.0.2. The audit process was conducted in accordance with the SPC Policies and met the requirements for the benchmark.

A Letter of Good Faith was issued by the Test Sponsor, stating the accuracy and completeness of the documentation and testing data provided in support of the audit of this result.

A Full Disclosure Report for this result was prepared by InfoSizing, reviewed and approved by the Test Sponsor, and can be found at www.storageperformance.org under the Submission Identifier A32002.

The independent audit process conducted by InfoSizing included the verifications of the following items:

- The physical capacity of the data repository;
- The total capacity of the Application Storage Unit (ASU);
- The accuracy of the Benchmark Configuration diagram;
- The tuning parameters used to configure the Benchmark Configuration;
- The Workload Generator commands used to execute the testing;
- The validity and integrity of the test result files;
- The compliance of the results from each performance test;
- The compliance of the results from each persistence test;
- The compliance of the submitted pricing model; and
- The differences between the tested and the priced configuration, if any.

The Full Disclosure Report for this result was prepared in accordance with the disclosure requirements set forth in the specification for the benchmark.

The following benchmark requirements, if any, were waived in accordance with the SPC Policies:

None.

Respectfully Yours,



Doug Johnson, Certified SPC Auditor

LETTER OF GOOD FAITH

Lenovo.com

8001 Development Dr.
Morrisville, NC 27560



July 18, 2017

From: Mike Fitzgerald, VP, Data Center Product Group Operations, Lenovo

Subject: SPC-1 Letter of Good Faith for Lenovo ThinkSystem DS4200

Lenovo is the SPC-1 Test Sponsor for the above-listed product. To the best of our knowledge and belief, the required SPC-1 benchmark results and materials we have submitted for that product are complete, accurate, and in full compliance with the 3.4 of the SPC-1 benchmark specification.

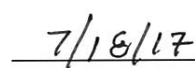
In addition, we have reported any items in the Benchmark Configuration and execution of the benchmark that affected the reported results even if the items are not explicitly required to be disclosed by the SPC-1 benchmark specification.

Sincerely,

Date:



Mike Fitzgerald



VP, Data Center Product Group Operations
Lenovo
Tel: 919-294-5813
Email: mefitzge@lenovo.com



SPC BENCHMARK 1™

EXECUTIVE SUMMARY

LENOVO THINKSYSTEM DS4200

SPC-1 IOPS™	100,021
SPC-1 Price-Performance™	\$0.14/SPC-1 IOPS™
SPC-1 IOPS™ Response Time	0.485 ms
SPC-1 Overall Response Time	0.325 ms
SPC-1 ASU Capacity	2,267 GB
SPC-1 ASU Price	\$6.00/GB
SPC-1 Total System Price	\$13,580.85
Data Protection Level	Protected 1 (RAID-10)
Physical Storage Capacity	4,800 GB
Pricing Currency / Target Country	U.S. Dollars / USA

SPC-1 V3.4.0

SUBMISSION IDENTIFIER: A32002

SUBMITTED FOR REVIEW: JULY 19, 2017

Benchmark Configuration Diagram

Lenovo x3550 M5 server

2x E5-2650 v3 (2.30 GHz, 10-Core, 25 MB)
16 GB Memory
Windows 2008 R2



Lenovo N2225 8-port 12Gb SAS HBA



Lenovo ThinkSystem DS4200

2x Controllers, each with:
- 8 GB
- 4x 12 Gb SAS Port (SFF-8644) (front end)
- 1x 12 Gb SAS Port (SFF-8644) (back end)
12x 400 GB SSD



Two 12Gb SAS Cables

Tested Storage Product Description

The Lenovo ThinkSystem DS4200 SAN array is performance optimized for primary storage, remote/branch offices, virtualization and backup. Offering 2x the performance of its predecessor, the DS4200 is powered by a Rapid Data Placement Engine and provides industry-leading price/performance and scalability.

With extreme flexibility and impressive performance and capacity, the DS4200 helps you tame the storage monster. Using 3.5-inch (LFF) or 2.5-inch (SFF) HDDs and SSDs, the DS4200 supports up to 240 drives (using 9 expansion units), as well as mixing LFF and SFF enclosures in the same array. The DS4200 offers connectivity options for 12G SAS, 8/16 Gb FC and 1/10 Gb iSCSI.

The ThinkSystem DS4200 is ideal for workloads such as primary storage, virtualized resources, consolidated backup, automated disaster recovery, and other similar-sized workloads. With performance and value in mind, and equipped with enterprise-class features, the DS4200 is designed to fit your needs now and into the future.

For additional information, please visit: <http://www3.lenovo.com/us/en/data-center/storage/storage-area-network/lenovo-thinksystem-ds-series/c/lenovo-thinksystem-ds-series>

Priced Storage Configuration Components

1 x N2225 SAS/SATA HBA
1 x ThinkSystem DS4200, with:
2 x Storage Controllers
8GB cache (16 GB total)
4 x 12 Gb SAS Front End Ports
1 x 12 Gb SAS Back End Connection
12 x 400 GB SSD

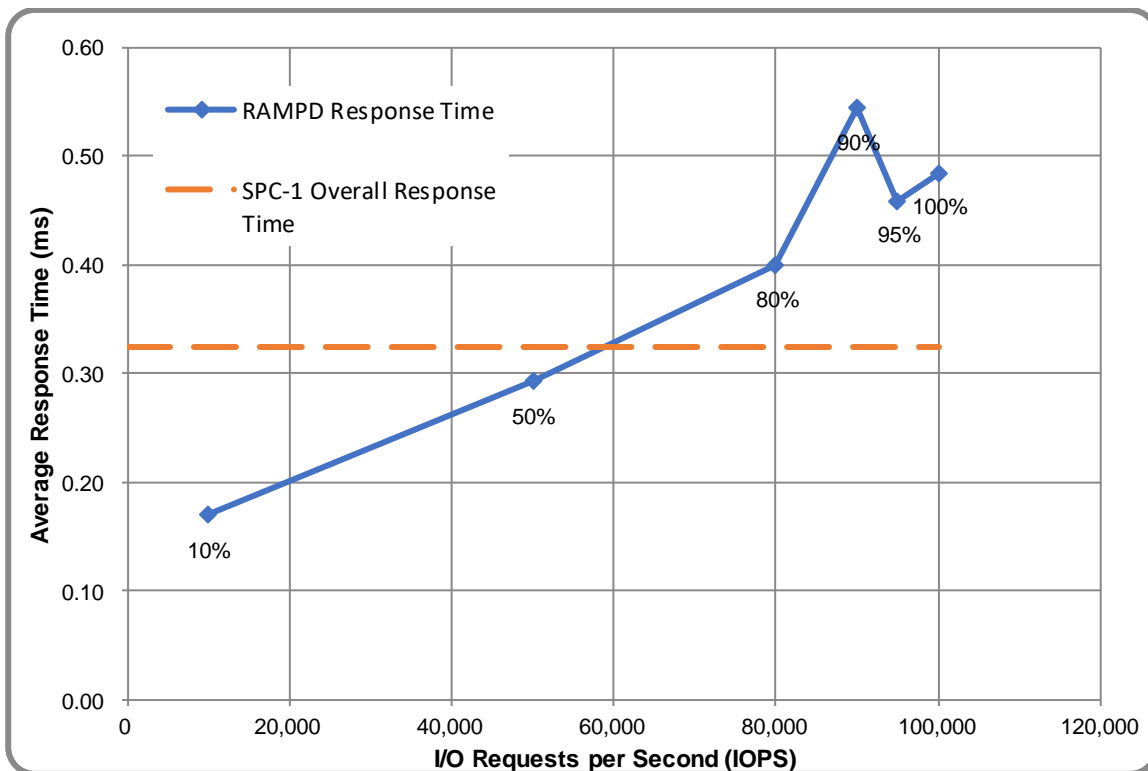
Storage Configuration Pricing

Part No.	Description	Qty	Unit Price	Ext. Price	Disc.	Disc. Price
Hardware						
4617A21	Lenovo ThinkSystem DS4200 SFF SAS Dual Cont	1	8,279	8,279	45%	4,553.45
01DC482	400GB 3DWD 2.5" SAS SSD	12	1,499	17,988	55%	8,094.60
00YL847	0.5M External MiniSAS HD 8644/MiniSAS HD 8	2	49	98	45%	53.90
00AE912	N2225 12Gb SAS/SATA HBA	1	299	299	45%	164.45
Hardware Subtotal						12,866.40
Support & Maintenance						
01JR528	3YR Technician Installed Parts 24x7 4 Hour Re	1	1,299	1,299	45%	714.45
Support & Maintenance Subtotal						714.45
SPC-1 Total System Price						13,580.85

Discount Details: The discounts shown are based on the storage capacity purchased and are generally available.

Availability Date: July 20, 2017.

Response Time and Throughput Graph



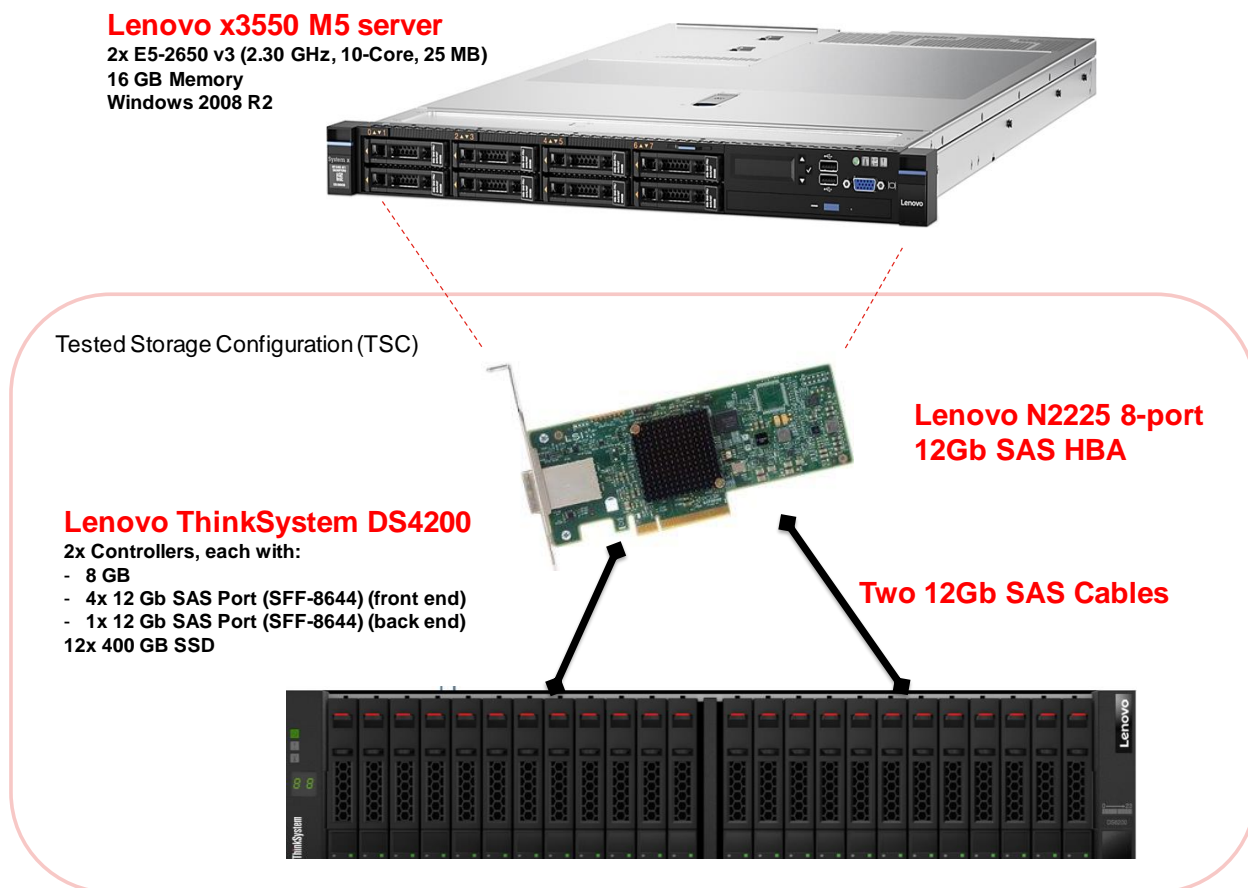
Contact Information	
Test Sponsor Primary Contact	Lenovo – http://www3.lenovo.com/us/en/data-center/ Gabe Brewington – gabe@Lenovo.com
SPC Auditor	InfoSizing – www.sizing.com Doug Johnson – doug@sizing.com

Revision Information	
SPC Benchmark 1™ Revision	V3.4.0
SPC-1 Workload Generator Revision	v3.0.2
Publication Revision History	Initial Publication

CONFIGURATION INFORMATION

Benchmark Configuration and Tested Storage Configuration

The following diagram illustrates the Benchmark Configuration (BC), including the Tested Storage Configuration (TSC) and the Host System(s).



Storage Network Configuration

The Benchmark Configuration utilized direct-attached storage.

Host System and Tested Storage Configuration Components

The following table lists the components of the Host System(s) and the Tested Storage Configuration (TSC).

Host Systems
1 x Lenovo x3550 M5 Server 2 x E5-2650 v3 (2.30 GHz, 10-Core, 25 MB L3) 16 GB Memory Windows 2008 R2

Tested Storage Configuration
1 x N2225 SAS/SATA HBA
1 x ThinkSystem DS4200, with: 2 x Storage Controllers 8 GB cache (16 GB total) 4 x 12 Gb SAS Front End Ports 1 x 12 Gb SAS Back End Connection 12 x 400 GB SSD

Differences Between Tested and Priced Storage Configurations

There were no differences between the Tested Storage Configuration and the Priced Storage Configuration.

Component Changes in Revised Full Disclosure Report

The following table outlines component changes that were made in revisions to this Full Disclosure Report.

Original Component	Revised Component	Description of Change
n/a	n/a	Initial submission

Benchmark Configuration Creation Process

Customer Tuning Parameters and Options

All the customer tuning parameters and options that have been altered from their default values for this benchmark are included in Appendix C and in the Supporting Files (see Appendix A).

Tested Storage Configuration Creation

A detailed description of how the logical representation of the TSC was created is included in Appendix D and in the Supporting Files (see Appendix A).

Tested Storage Configuration Inventory

An inventory of the components in the TSC, as seen by the Benchmark Configuration, is included in Appendix E and in the Supporting Files (see Appendix A).

Workload Generator Storage Configuration

The SPC-1 Workload Generator storage configuration commands and parameters used to invoke the execution of the tests are included in Appendix F and in the Supporting Files (see Appendix A).

Logical Volume Capacity and ASU Mapping

The following table details the capacity of each ASU and how they are mapped to logical volumes (LV).

	LV per ASU	LV Capacity	Used per LV	Total per ASU	% ASU Capacity
ASU-1	1	1,019	1,019	1,019	45.0%
ASU-2	1	1,019	1,019	1,019	45.0%
ASU-3	1	227	227	227	10.1%
SPC-1 ASU Capacity				2,267	

Physical Storage Capacity and Utilization

The following table details the Physical Capacity of the storage devices and the Physical Capacity Utilization (percentage of Total Physical Capacity used) in support of hosting the ASUs.

Devices	Count	Physical Capacity	Total Capacity
400 GB SSD	12	400.0	4,800.0
Total Physical Capacity			4,800
Physical Capacity Utilization			47.23%

Data Protection

The data protection level used for all logical volumes was **Protected 1 (RAID-10)**, which was accomplished by configuring 2 pools of 6 drives into 2 RAID-10 arrays.

BENCHMARK EXECUTION RESULTS

This portion of the Full Disclosure Report documents the results of the various SPC-1 Tests, Test Phases, and Test Runs.

Benchmark Execution Overview

Workload Generator Input Parameters

The SPC-1 Workload Generator commands and input parameters for the Test Phases are presented in the Supporting Files (see Appendix A).

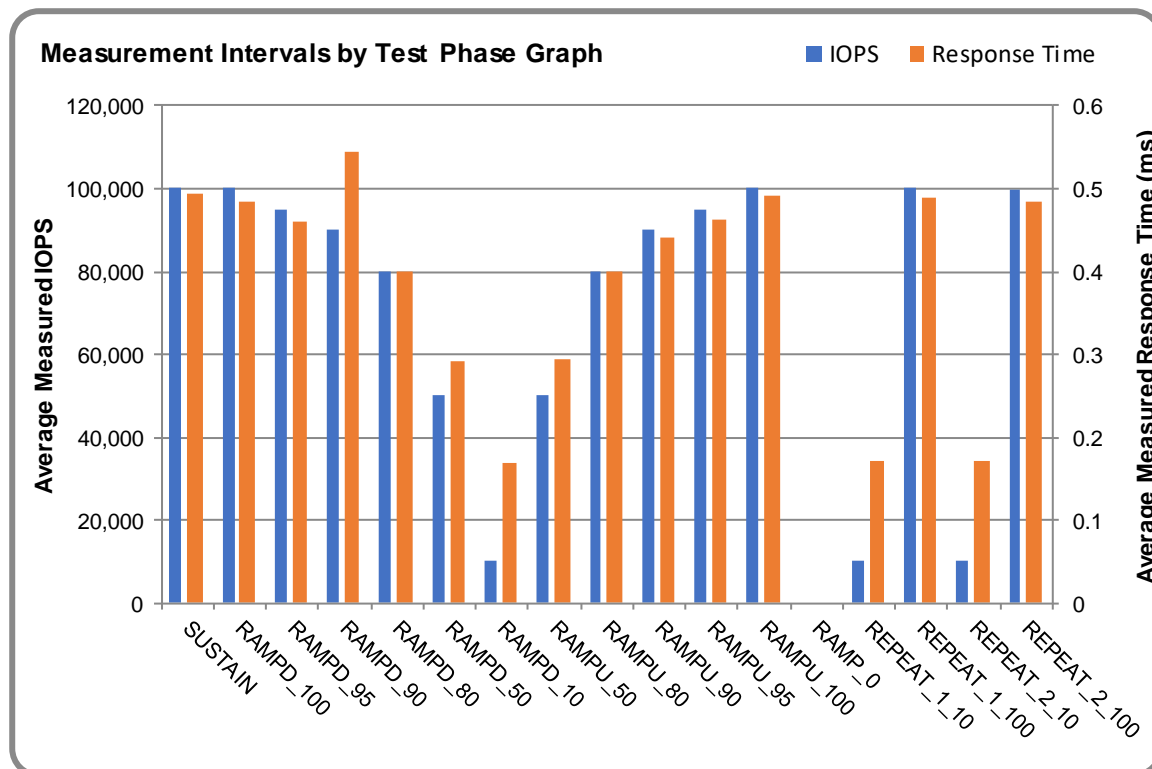
Primary Metrics Test Phases

The benchmark execution consists of the Primary Metrics Test Phases, including the Test Phases SUSTAIN, RAMPD_100 to RAMPD_10, RAMPU_50 to RAMPU_100, RAMP_0, REPEAT_1 and REPEAT_2.

Each Test Phase starts with a transition period followed by a Measurement Interval.

Measurement Intervals by Test Phase Graph

The following graph presents the average IOPS and the average Response Times measured over the Measurement Interval (MI) of each Test Phase.



Exception and Waiver

None.

SUSTAIN Test Phase

SUSTAIN – Results File

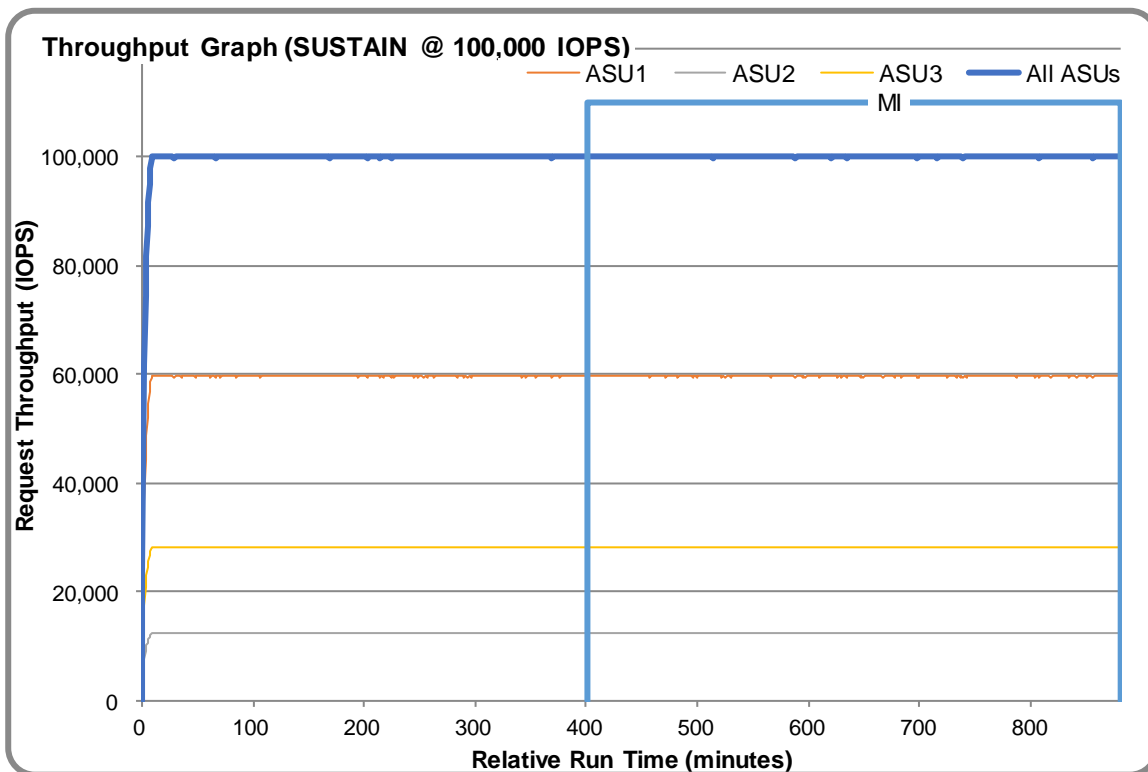
The results file generated during the execution of the SUSTAIN Test Phase is included in the Supporting Files (see Appendix A) as follows:

- SPC1_METRICS_0_Raw_Results.xlsx

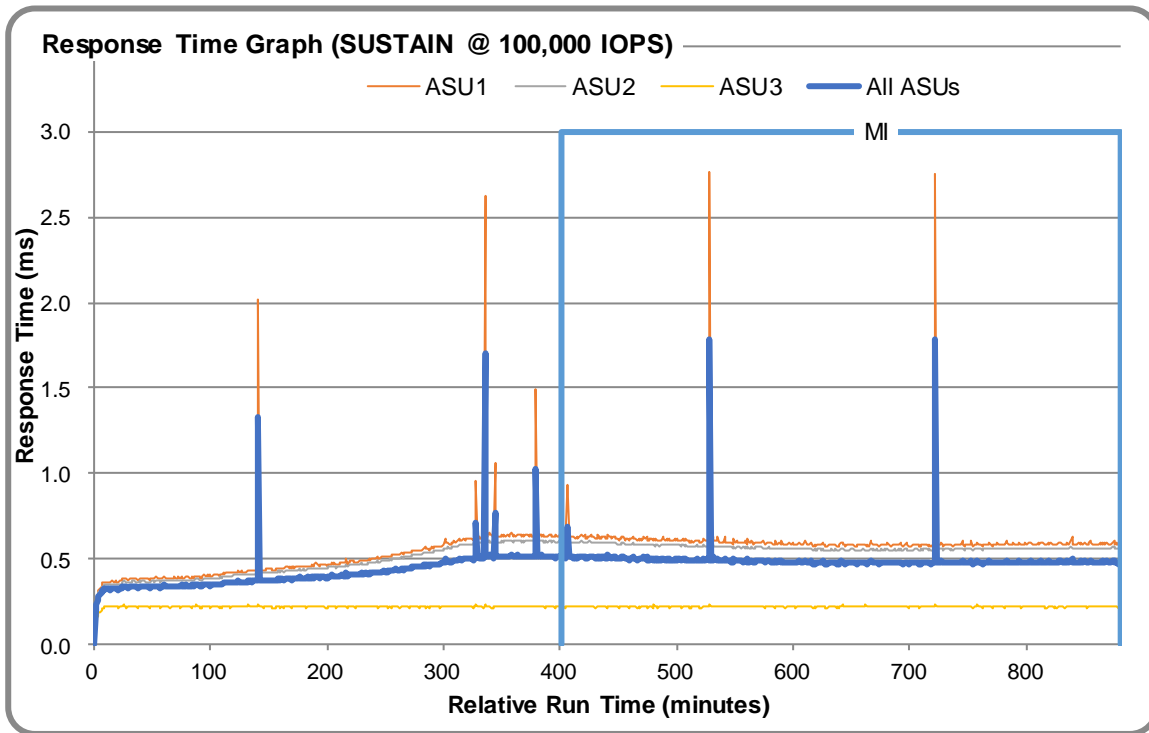
SUSTAIN – Execution Times

Interval	Start Date	Start Time	End Time	Duration
Transition Period	13-Jul-17	16:53:22.000	23:33:19.000	6:39:57.000
Measurement Interval	13-Jul-17	23:33:19.000	07:33:19.000	8:00:00.000

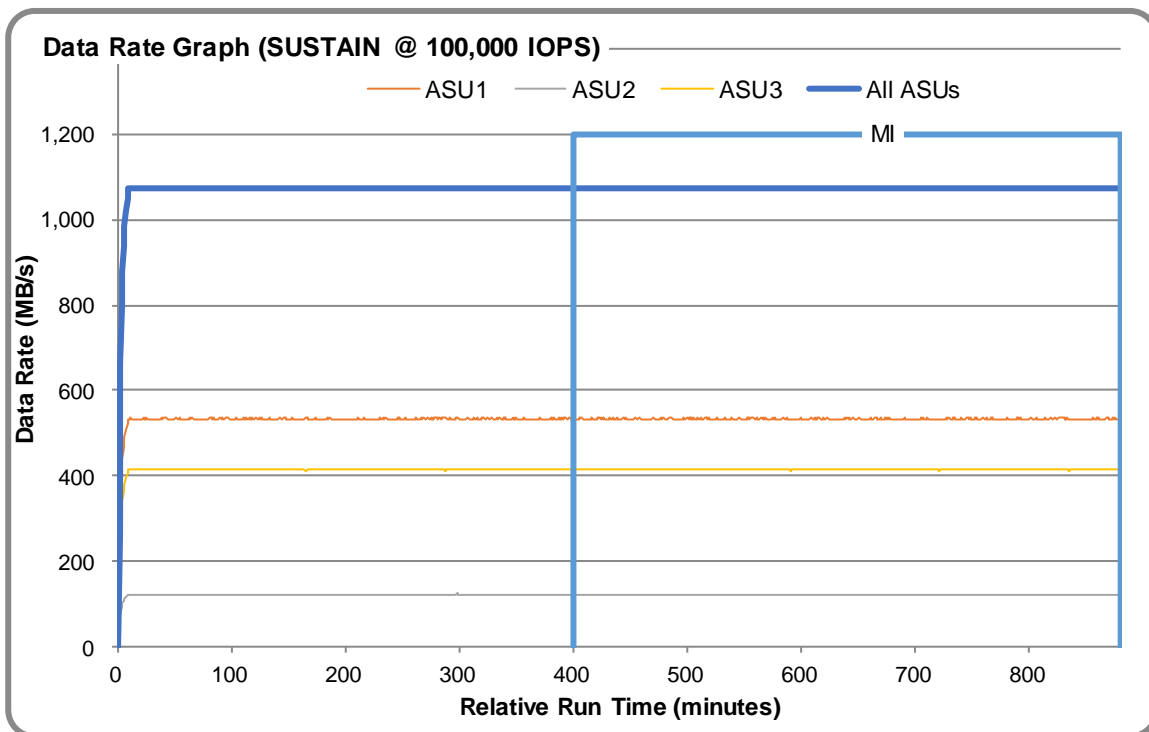
SUSTAIN – Throughput Graph



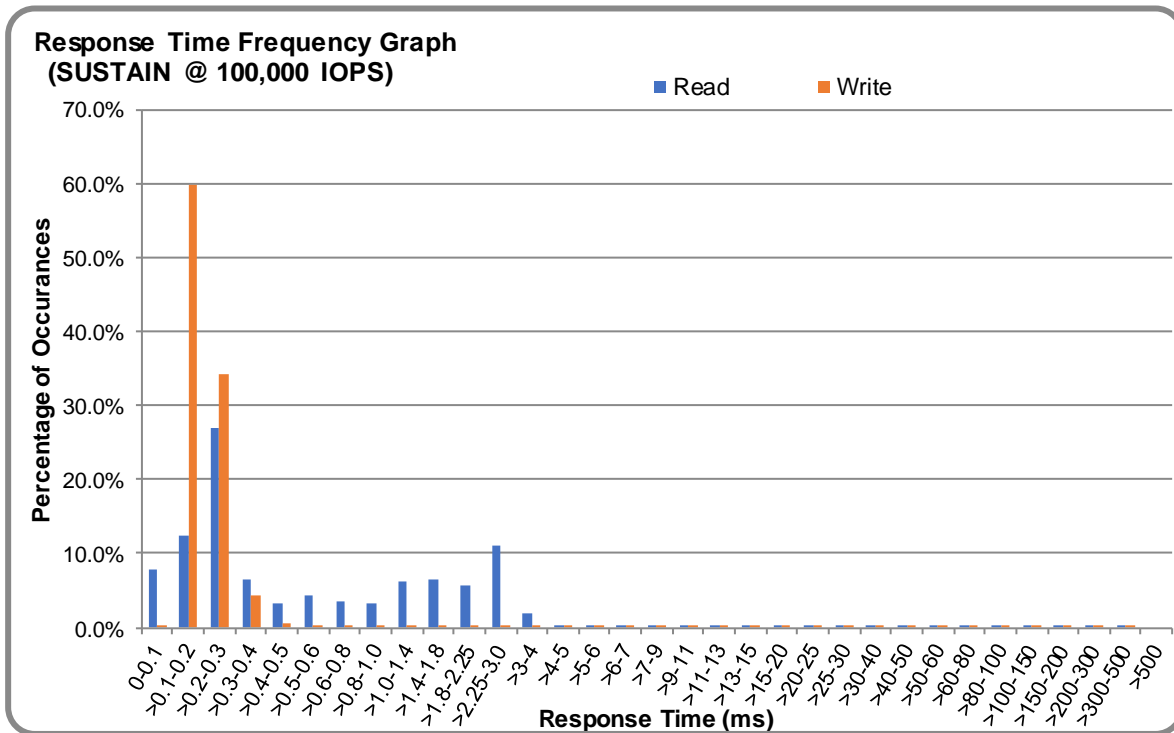
SUSTAIN – Response Time Graph



SUSTAIN – Data Rate Graph



SUSTAIN – Response Time Frequency Graph



SUSTAIN – Intensity Multiplier

The following table lists the targeted intensity multiplier (Defined), the measured intensity multiplier (Measured) for each I/O STREAM, its coefficient of variation (Variation) and the percentage of difference (Difference) between Target and Measured.

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
Defined	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Measured	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Variation	0.0022	0.0006	0.0015	0.0009	0.0031	0.0016	0.0021	0.0007
Difference	0.003%	0.003%	0.010%	0.003%	0.014%	0.005%	0.020%	0.002%

RAMPD_100 Test Phase

RAMPD 100 – Results File

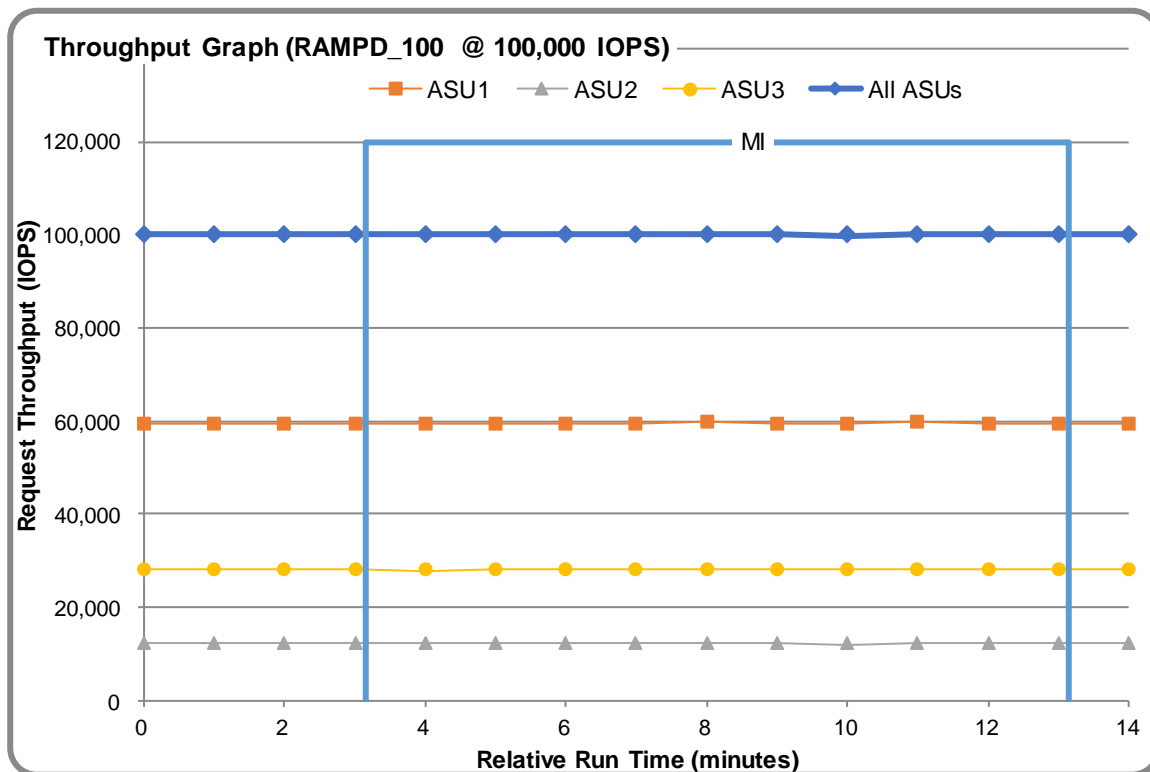
The results file generated during the execution of the RAMPD_100 Test Phase is included in the Supporting Files (see Appendix A) as follows:

- SPC1_METRICS_0_Raw_Results.xlsx

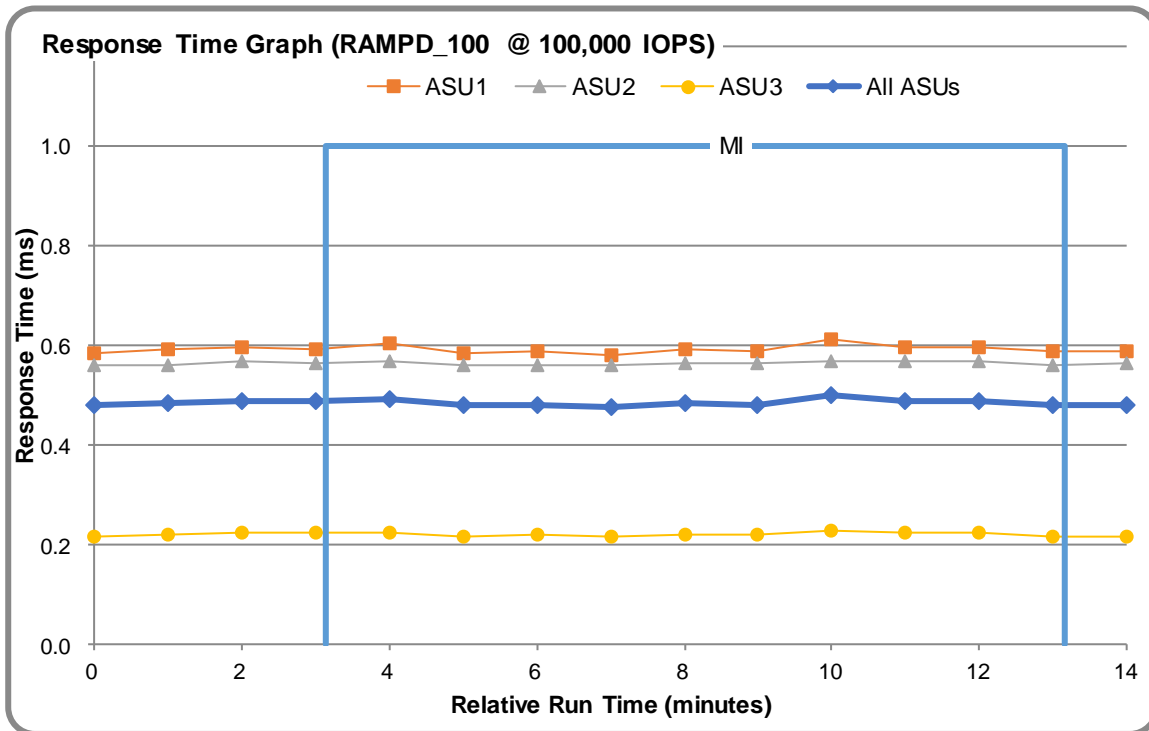
RAMPD 100 – Execution Times

Interval	Start Date	Start Time	End Time	Duration
Transition Period	14-Jul-17	07:34:19.000	07:37:19.000	0:03:00.000
Measurement Interval	14-Jul-17	07:37:19.000	07:47:19.000	0:10:00.000

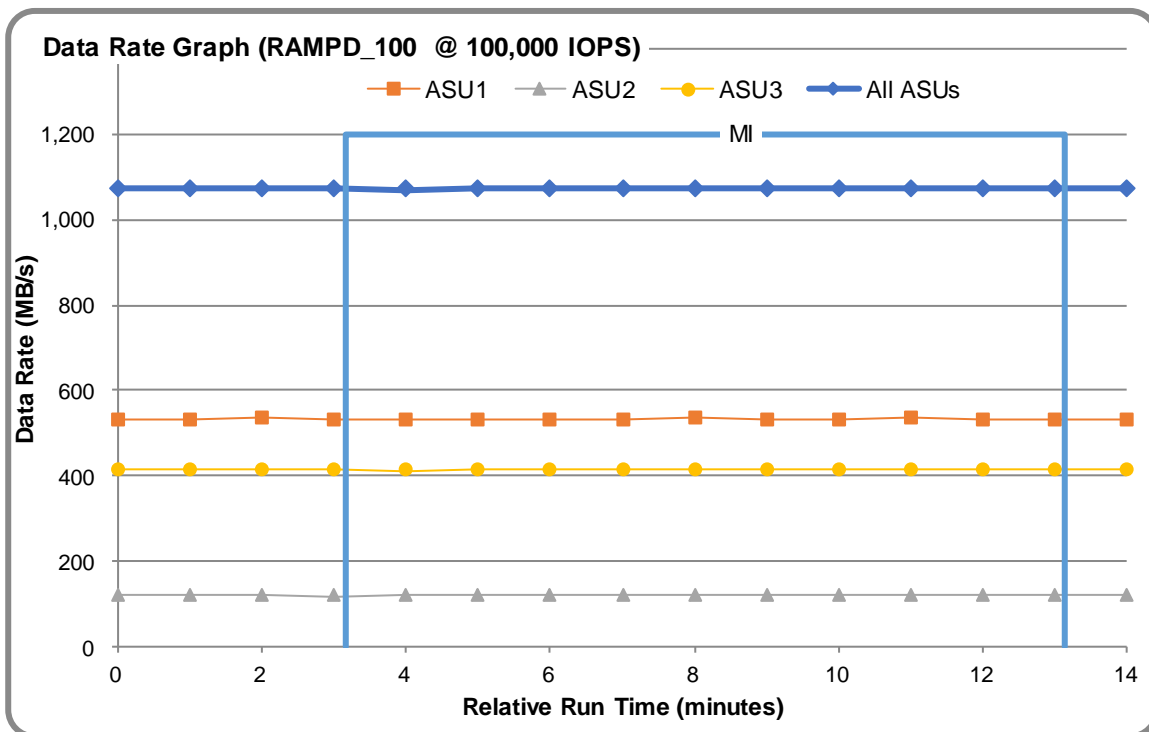
RAMPD 100 – Throughput Graph



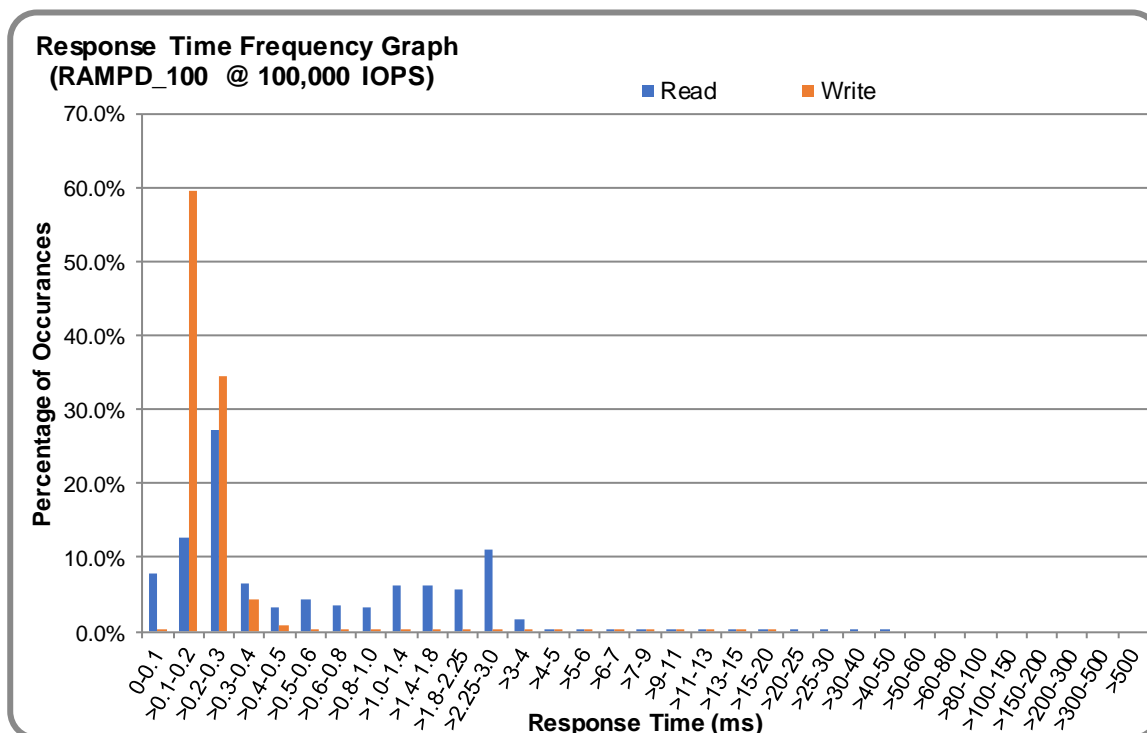
RAMPD 100 – Response Time Graph



RAMPD 100 – Data Rate Graph



RAMPD 100 – Response Time Frequency Graph



RAMPD 100 – Intensity Multiplier

The following table lists the targeted intensity multiplier (Defined), the measured intensity multiplier (Measured) for each I/O STREAM, its coefficient of variation (Variation) and the percentage of difference (Difference) between Target and Measured.

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
Defined	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Measured	0.0350	0.2811	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Variation	0.0022	0.0007	0.0023	0.0006	0.0028	0.0016	0.0015	0.0006
Difference	0.015%	0.026%	0.053%	0.021%	0.002%	0.003%	0.038%	0.001%

RAMPD 100 – I/O Request Summary

I/O Requests Completed in the Measurement Interval	60,012,547
I/O Requests Completed with Response Time <= 30 ms	60,012,424
I/O Requests Completed with Response Time > 30 ms	123

Response Time Ramp Test

Response Time Ramp Test – Results File

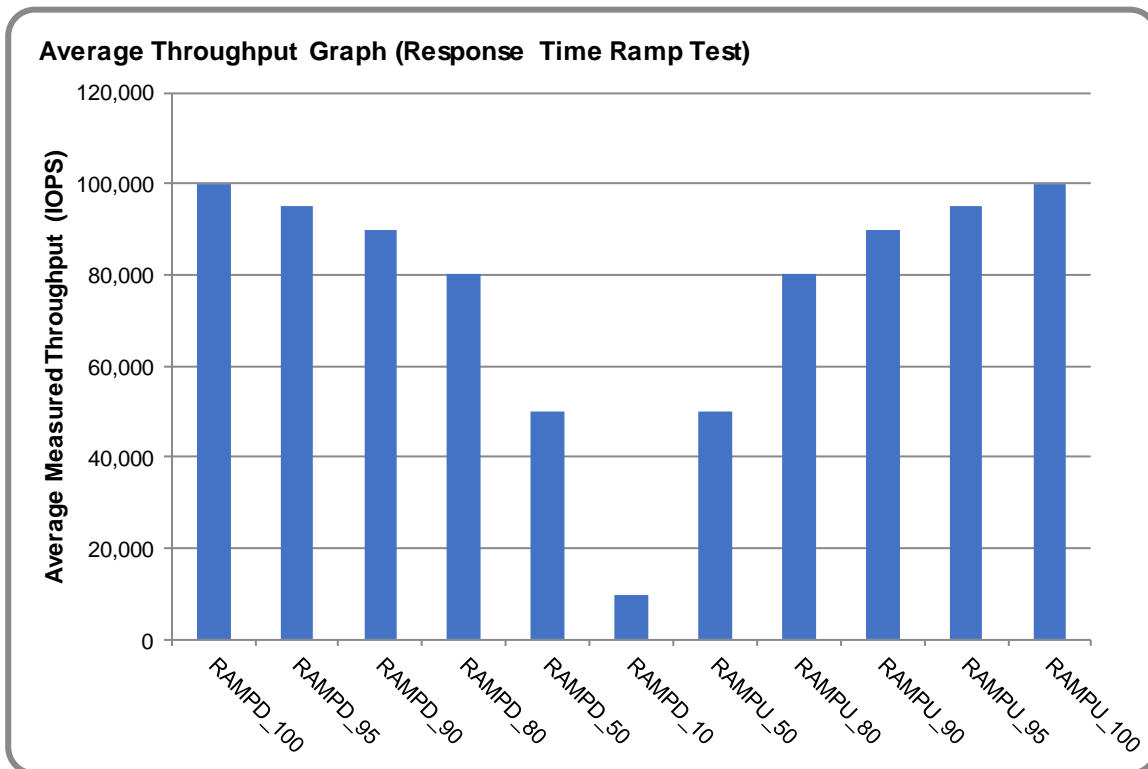
The results file generated during the execution of the Response Time Ramp Test is included in the Supporting Files (see Appendix A) as follows:

- **SPC1_METRICS_0_Raw_Results.xlsx**

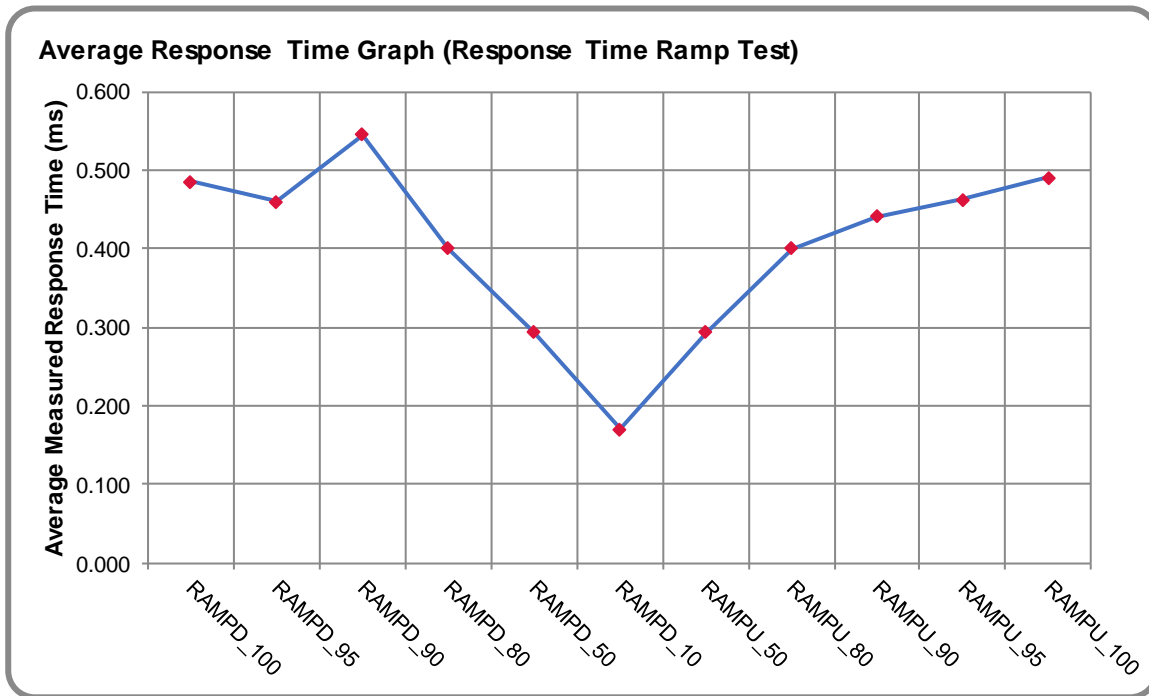
Response Time Ramp Test – Phases

The Response Time Ramp Test is comprised of 11 Test Phases, including six Ramp-Down Phases (executed at 100%, 95%, 90%, 80%, 50%, and 10% of the Business Scaling Unit) and five Ramp-Up Phases (executed at 50%, 80%, 90%, 95%, and 100% of the Business Scaling Unit).

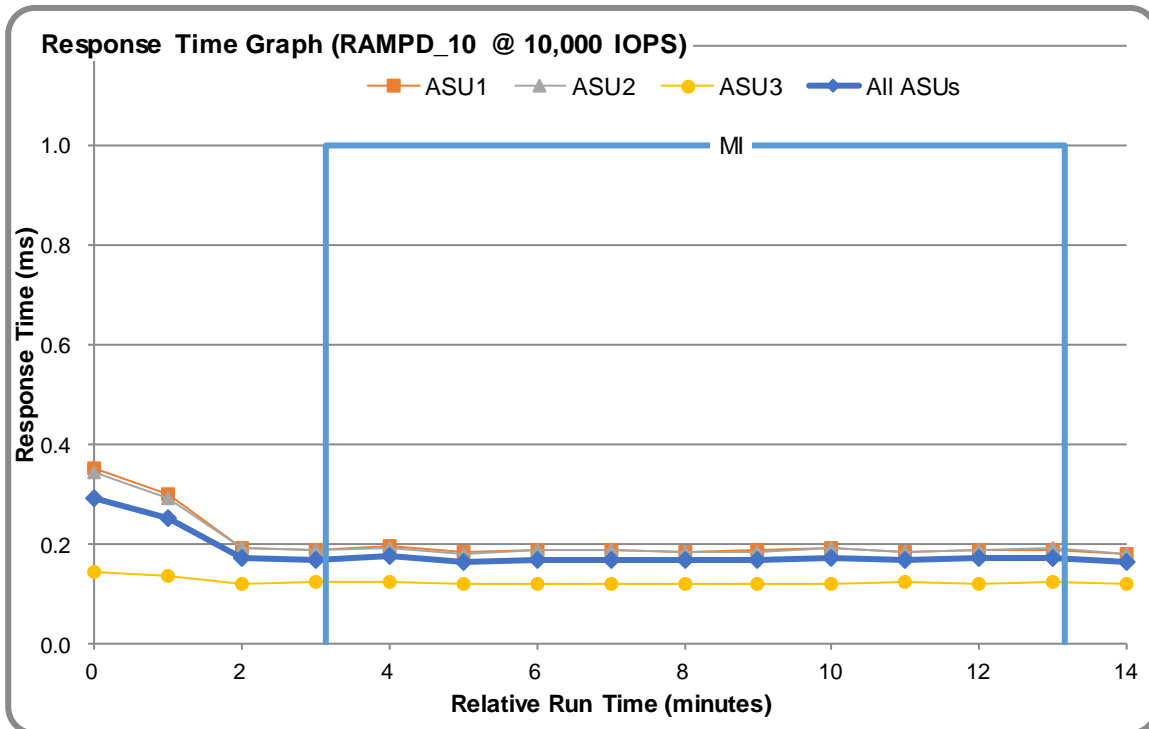
Response Time Ramp Test – Average Throughput Graph



Response Time Ramp Test – Average Response Time Graph



Response Time Ramp Test – RAMPD 10 Response Time Graph



Repeatability Test

Repeatability Test Results File

The results file generated during the execution of the Repeatability Test is included in the Supporting Files (see Appendix A) as follows:

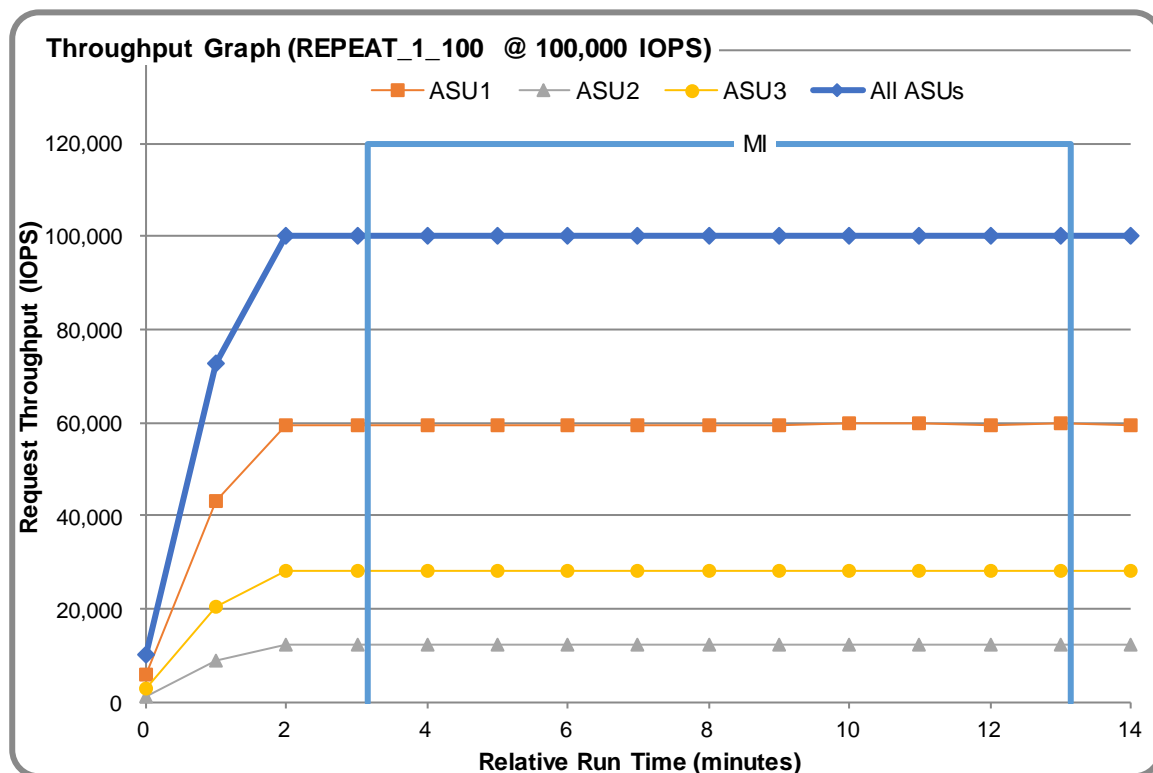
- SPC1_METRICS_0_Raw_Results.xlsx

Repeatability Test Results

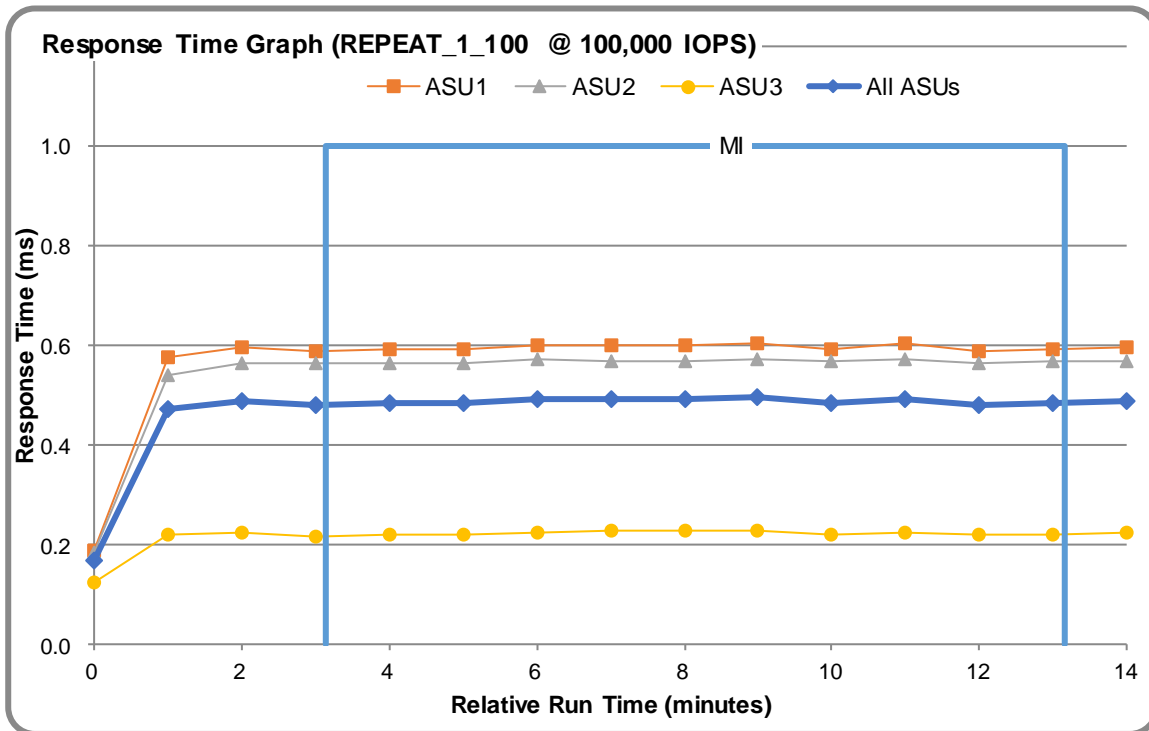
The throughput measurements for the Response Time Ramp Test (RAMPD) and the Repeatability Test Phases (REPEAT_1 and REPEAT_2) are listed in the tables below.

Test Phase	100% IOPS	10% IOPS
RAMPD	100,021.8	9,998.3
REPEAT_1	100,014.4	10,009.8
REPEAT_2	99,993.0	9,993.7

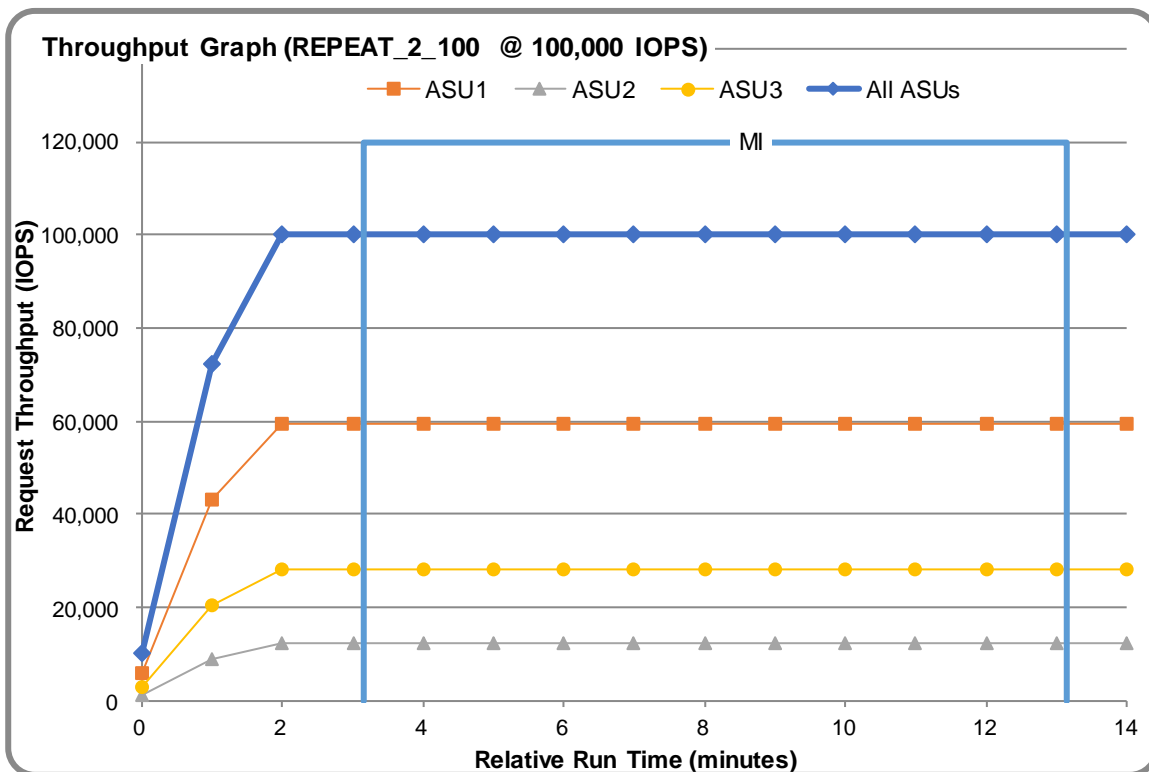
REPEAT 1 100 – Throughput Graph



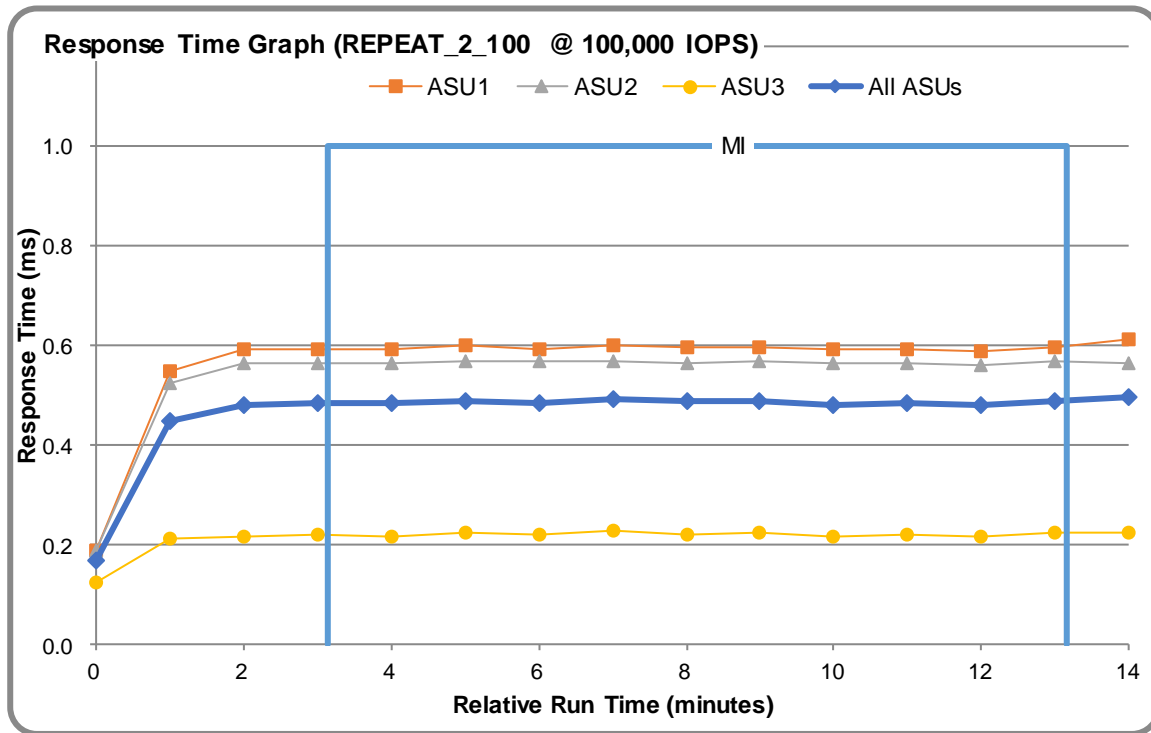
REPEAT 1 100 – Response Time Graph



REPEAT 2 100 – Throughput Graph



REPEAT 2 100 – Response Time Graph



Repeatability Test – Intensity Multiplier

The following tables lists the targeted intensity multiplier (Defined), the measured intensity multiplier (Measured) for each I/O STREAM, its coefficient of variation (Variation) and the percent of difference (Difference) between Target and Measured.

REPEAT_1_100 Test Phase

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
Defined	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Measured	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Variation	0.0031	0.0010	0.0009	0.0005	0.0036	0.0009	0.0018	0.0008
Difference	0.041%	0.004%	0.030%	0.010%	0.058%	0.051%	0.068%	0.017%

REPEAT_2_100 Test Phase

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
Defined	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Measured	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Variation	0.0028	0.0008	0.0013	0.0005	0.0024	0.0014	0.0028	0.0006
Difference	0.035%	0.015%	0.054%	0.002%	0.045%	0.062%	0.041%	0.006%

Data Persistence Test

Data Persistence Test Results file

The results files generated during the execution of the Data Persistence Test is included in the Supporting Files (see Appendix A) as follows:

- **SPC1_PERSIST_1_0_Raw_Results.xlsx**
- **SPC1_PERSIST_2_0_Raw_Results.xlsx**

Data Persistence Test Execution

The Data Persistence Test was executed using the following sequence of steps:

- The PERSIST_1_0 Test Phase was executed to completion.
- The Benchmark Configuration was taken through an orderly shutdown process and powered off.
- The Benchmark Configuration was powered on and taken through an orderly startup process.
- The PERSIST_2_0 Test Phase was executed to completion.

Data Persistence Test Results

Data Persistence Test Phase: Persist1	
Total Number of Logical Blocks Written	12,365,840
Total Number of Logical Blocks Verified	12,098,920
Total Number of Logical Blocks Overwritten	266,920
Total Number of Logical Blocks that Failed Verification	0
Time Duration for Writing Test Logical Blocks (sec.)	300
Size in bytes of each Logical Block	8,192
Number of Failed I/O Requests in the process of the Test	0

Committed Data Persistence Implementation

The DS4200 uses Supercapacitors and a local Compact Flash for cache protection. Each controller in the subsystem has a local Compact Flash which can be used to store and restore data in the case of an emergency shutdown during power loss. Data persists when the supercapacitors maintain power to the memory subsystem and processor to allow a fire hose dump of the data to the Compact Flash during an unexpected power loss.

APPENDIX A: SUPPORTING FILES

The following table details the content of the Supporting Files provided as part of this Full Disclosure Report.

File Name	Description	Location
/SPC1_RESULTS	Data reduction worksheets	root
SPC1_INIT_0_Raw_Results.xlsx	Raw results for INIT Test Phase	/SPC1_RESULTS
SPC1_METRICS_0_Quick_Look.xlsx	Quick Look Test Run Overview	/SPC1_RESULTS
SPC1_METRICS_0_Raw_Results.xlsx	Raw results for Primary Metrics Test	/SPC1_RESULTS
SPC1_METRICS_0_Summary_Results.xlsx	Primary Metrics Summary	/SPC1_RESULTS
SPC1_PERSIST_1_0_Raw_Results.xlsx	Raw results for PERSIST1 Test Phase	/SPC1_RESULTS
SPC1_PERSIST_2_0_Raw_Results.xlsx	Raw results for PERSIST2 Test Phase	/SPC1_RESULTS
SPC1_Run_Set_Overview.xlsx	Run Set Overview Worksheet	/SPC1_RESULTS
SPC1_VERIFY_0_Raw_Results.xlsx	Raw results for first VERIFY Test Phase	/SPC1_RESULTS
SPC1_VERIFY_1_Raw_Results.xlsx	Raw results for second VERIFY Test Phase	/SPC1_RESULTS
/C_Tuning	Tuning parameters and options	root
Tuning was done using the CLI (see Appendix C)		
/D_Creation	Storage configuration creation	root
DS4200_volume_map.sh	Create Disk Groups, Volumes and Mapping	/D_Creation
/E_Inventory	Configuration inventory	root
DS4200_BEFORE_LOG_0713	Configuration before the run	/E_Inventory
DS4200_AFTER_log_0713	Configuration after the run	/E_Inventory
/F_Generator	Workload generator	root
SPC1.asu	ASU configuration file	/F_generator
Basic_full_run_4200_0713.bat	Execute all test phases exclude PERSIST_2	/F_generator

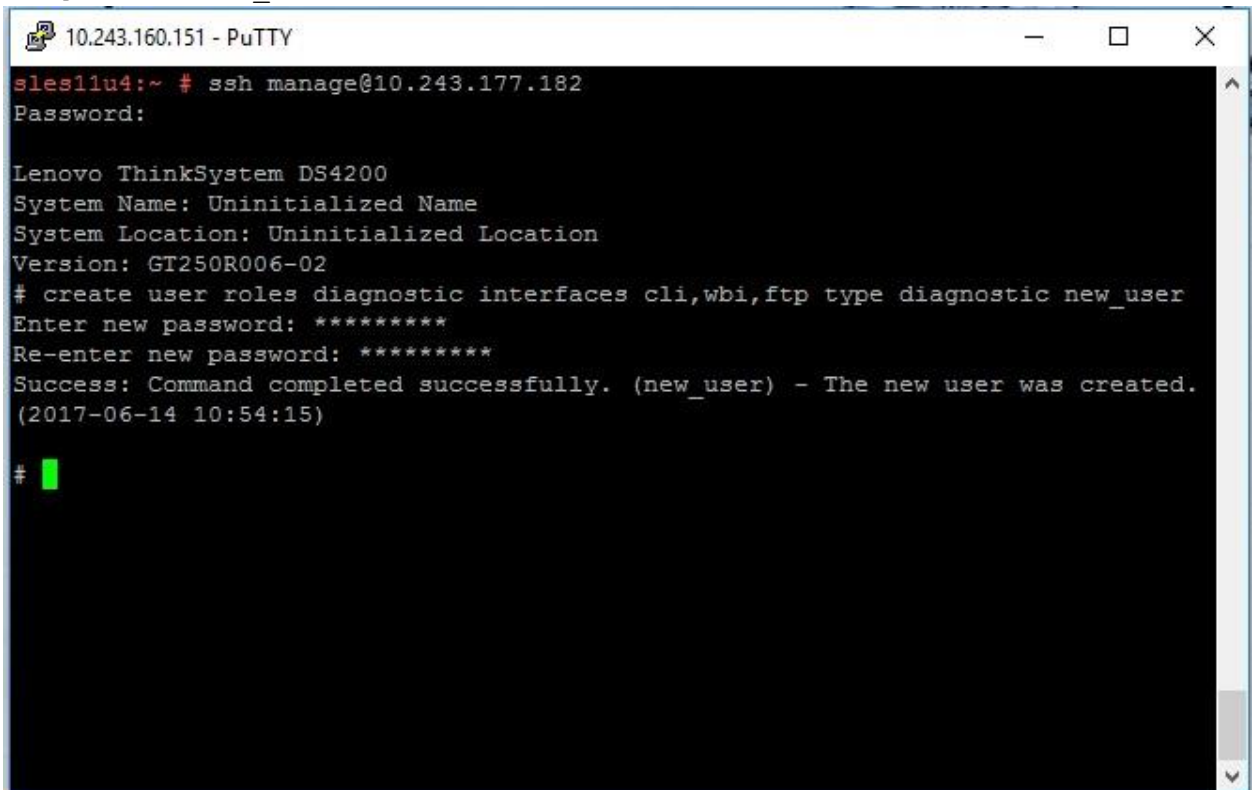
APPENDIX B: THIRD PARTY QUOTATION

None.

APPENDIX C: TUNING PARAMETERS AND OPTIONS

The standard DS4200 Controller CLI was used to apply the necessary tuning parameters for the test.

1. You first must create a user account with the proper privileges to enable the tuning.
2. To do that, login with the manage user account and run the following command:
create user roles diagnostic interfaces wbi,cli,ftp type diagnostic new_user



```
10.243.160.151 - PuTTY
sles11u4:~ # ssh manage@10.243.177.182
Password:

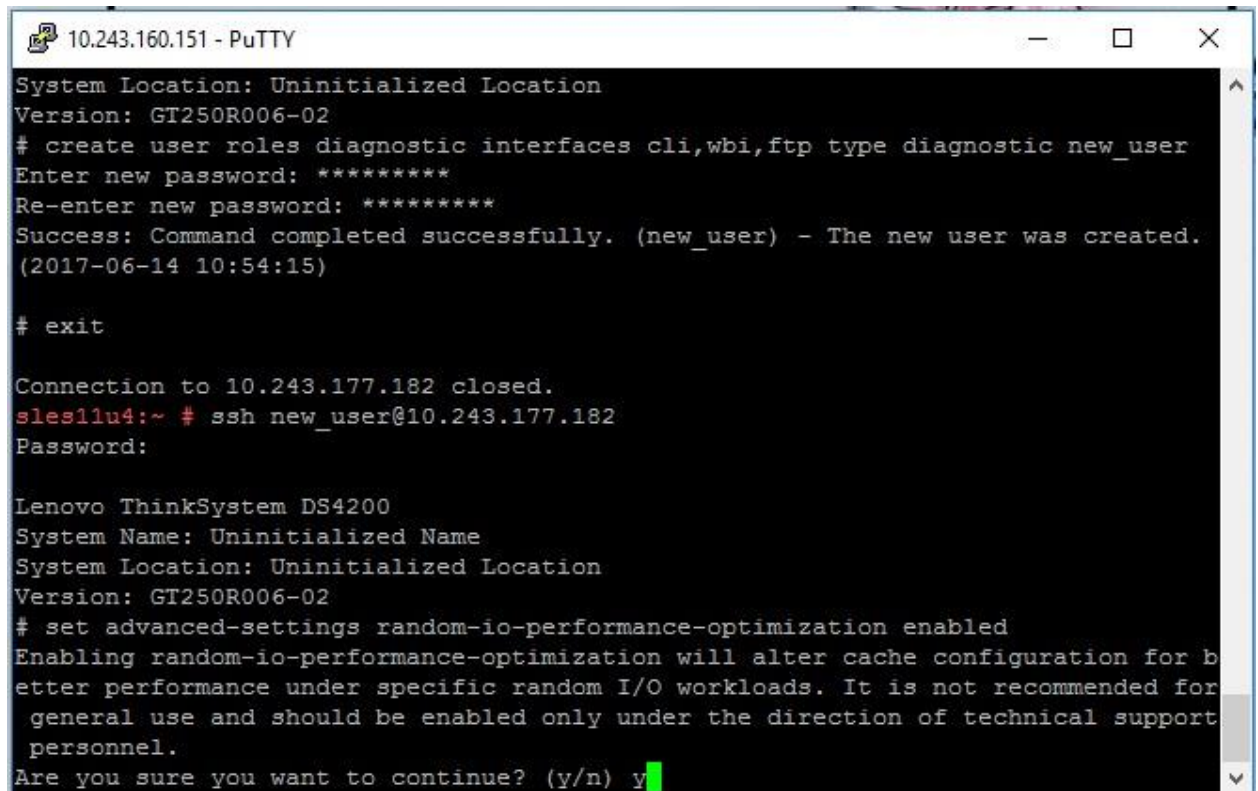
Lenovo ThinkSystem DS4200
System Name: Uninitialized Name
System Location: Uninitialized Location
Version: GT250R006-02
# create user roles diagnostic interfaces cli,wbi,ftp type diagnostic new_user
Enter new password: *****
Re-enter new password: *****
Success: Command completed successfully. (new_user) - The new user was created.
(2017-06-14 10:54:15)

# █
```

3. Once you have created the user you must login with that user account

4. Then run the following command:

```
set advanced-settings random-io-performance-optimization enabled
```



```
10.243.160.151 - PuTTY
System Location: Uninitialized Location
Version: GT250R006-02
# create user roles diagnostic interfaces cli,wbi,ftp type diagnostic new_user
Enter new password: *****
Re-enter new password: *****
Success: Command completed successfully. (new_user) - The new user was created.
(2017-06-14 10:54:15)

# exit

Connection to 10.243.177.182 closed.
sles11u4:~ # ssh new_user@10.243.177.182
Password:

Lenovo ThinkSystem DS4200
System Name: Uninitialized Name
System Location: Uninitialized Location
Version: GT250R006-02
# set advanced-settings random-io-performance-optimization enabled
Enabling random-io-performance-optimization will alter cache configuration for b
etter performance under specific random I/O workloads. It is not recommended for
general use and should be enabled only under the direction of technical support
personnel.
Are you sure you want to continue? (y/n) y
```

5. Disable disk groups background scrub command:

```
set advanced-settings background-scrub disabled
```

APPENDIX D: STORAGE CONFIGURATION CREATION

Storage groups and volumes are created using the following script (DS4200_volume_map.sh):

```
ssh manage@10.243.177.182 "add disk-group disks
0.0,0.1:0.2,0.3:0.4,0.5 level raid10 pool a type virtual; add disk-
group disks 0.6,0.7:0.8,0.9:0.10,0.11 level raid10 pool b type
virtual; create volume pool a size 510GB ASU1-A; create volume pool
a size 510GB ASU2-A; create volume pool a size 114GB ASU3-A; create
volume pool b size 510GB ASU1-B; create volume pool b size 510GB
ASU2-B; create volume pool b size 114GB ASU3-B; map volume lun 10
ports A0 ASU1-A; map volume lun 11 ports A0 ASU2-A; map volume lun
12 ports A0 ASU3-A; map volume lun 13 ports B0 ASU1-B; map volume
lun 14 ports B0 ASU2-B; map volume lun 15 ports B0 ASU3-B"
```

1. The add disk group commands are used to create 2 pools with a single disk group per pool
add disk-group disks 0.0,0.1:0.2,0.3:0.4,0.5 level raid10 pool a
type virtual
add disk-group disks 0.6,0.7:0.8,0.9:0.10,0.11 level raid10 pool
b type virtual
2. Each Disk group is configured with (6) 400GB SSDs in a RAID 10 layout
3. The create volume commands are used to assign (3) volumes to each of the disk groups
configured in step 1

```
create volume pool a size 510GB ASU1-A
create volume pool a size 510GB ASU2-A
create volume pool a size 114GB ASU3-A
create volume pool b size 510GB ASU1-B
create volume pool b size 510GB ASU2-B
create volume pool b size 114GB ASU3-B
```

4. The volumes are then mapped to either the A0 or B0 SAS port in the final 6 commands.

```
map volume lun 10 ports A0 ASU1-A
map volume lun 11 ports A0 ASU2-A
map volume lun 12 ports A0 ASU3-A
map volume lun 13 ports B0 ASU1-B
map volume lun 14 ports B0 ASU2-B
map volume lun 15 ports B0 ASU3-B
```

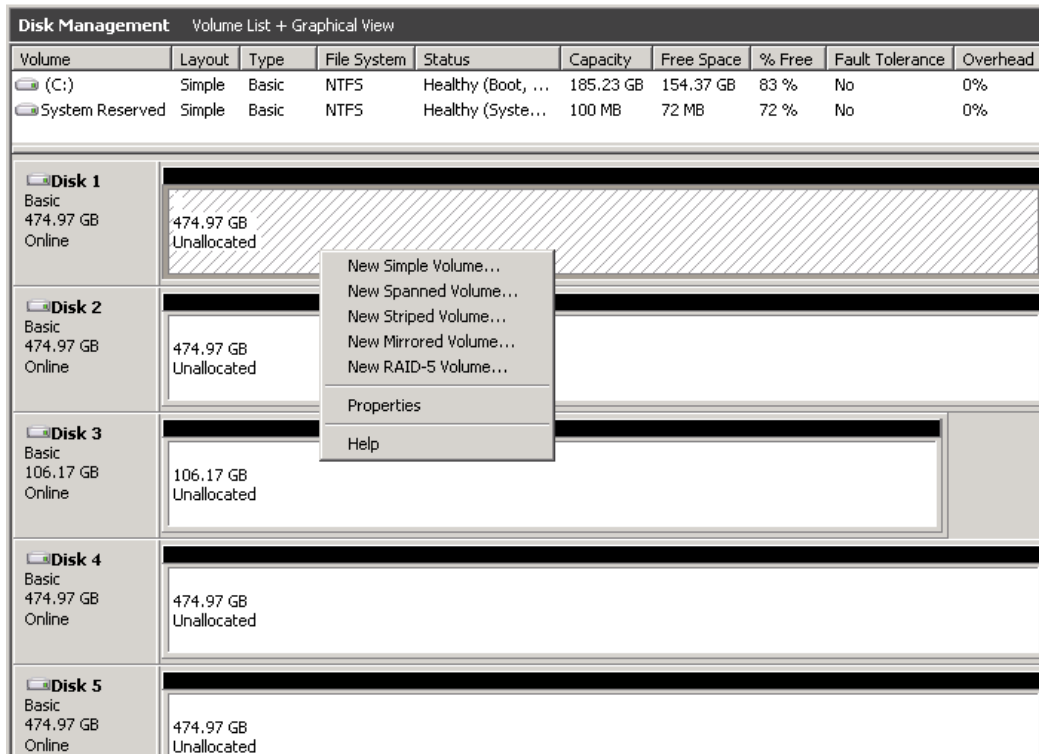
The Host will see the Disks after mapping. Make the disks online and initialized.

Next, use Windows Disk Management to create the striped ASU volumes.

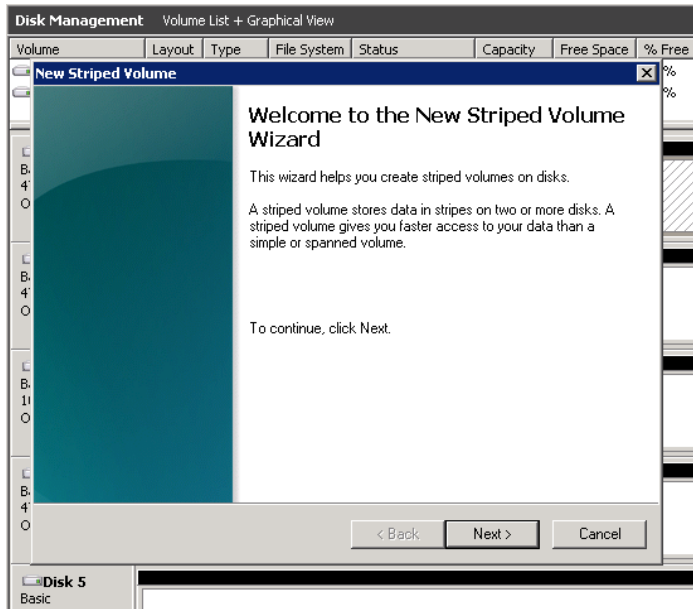
"Physical Disk"	LUN #	ASU	Drive Letter
1 and 4	10 and 13	ASU-1	I:

2 and 5	11 and 14	ASU-2	J:
3 and 6	12 and 15	ASU-3	K:

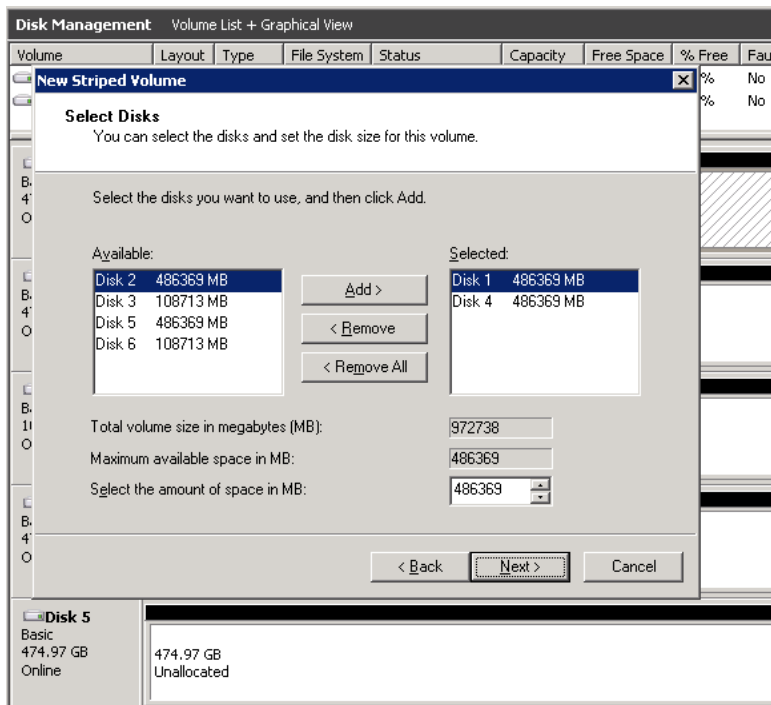
1. Start Disk Management
2. Right click on Disk 1, and select **New Striped Volume...**



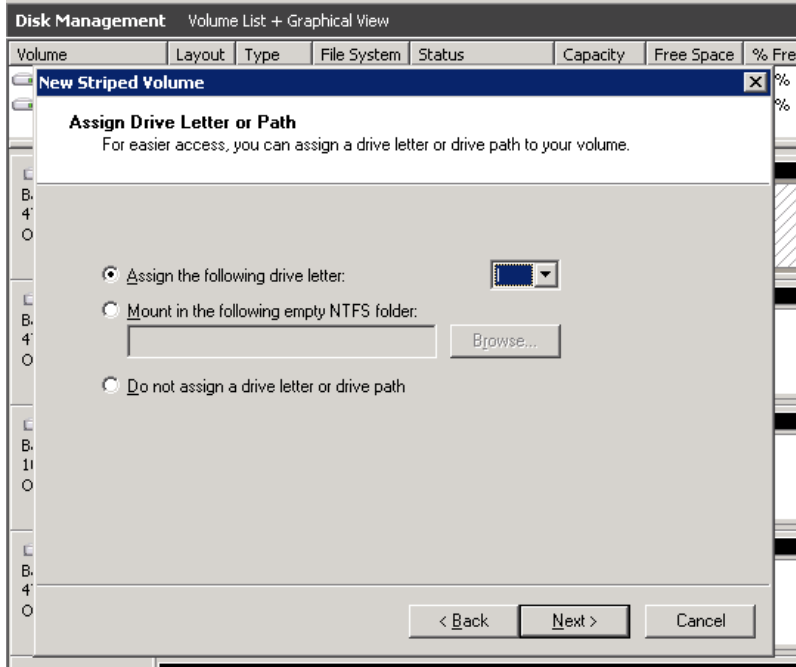
3. Wizard pops up. Select **Next**



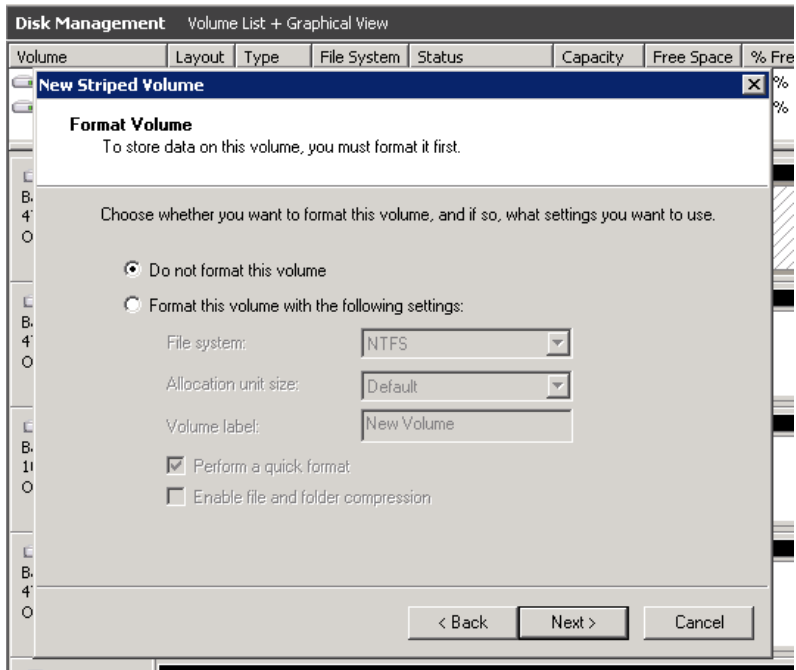
4. On **New Striped Volume** window, highlight **Disk 4** and click on **Add>**
5. **Disk 1** and **Disk 4** in the selected area, click **Next**



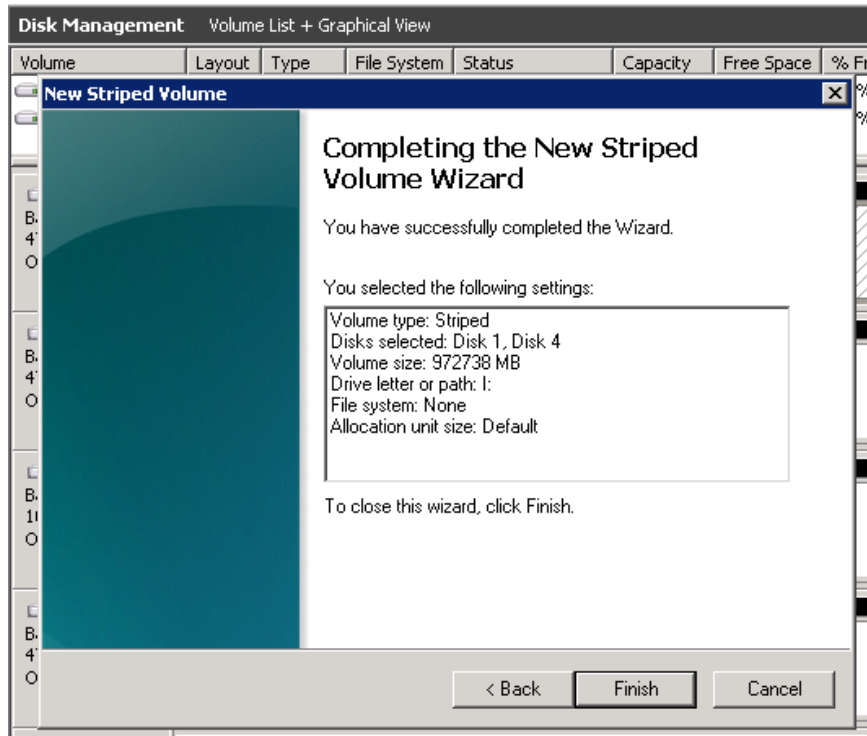
6. Click **Assign the following drive letter**, select **I**, then **Next**



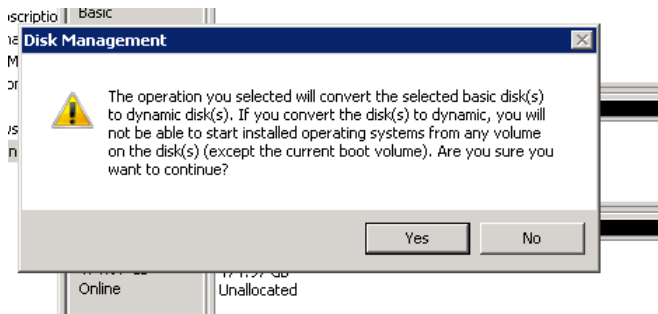
7. On **Format Volume** window, select **Do not format this volume**, then **Next**



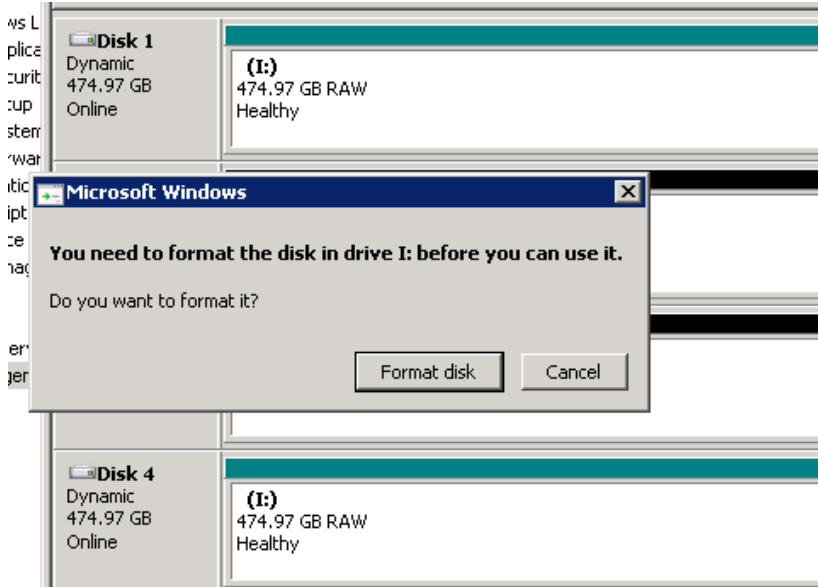
8. **Completing the New Striped Volume Wizard**, click **Finish**



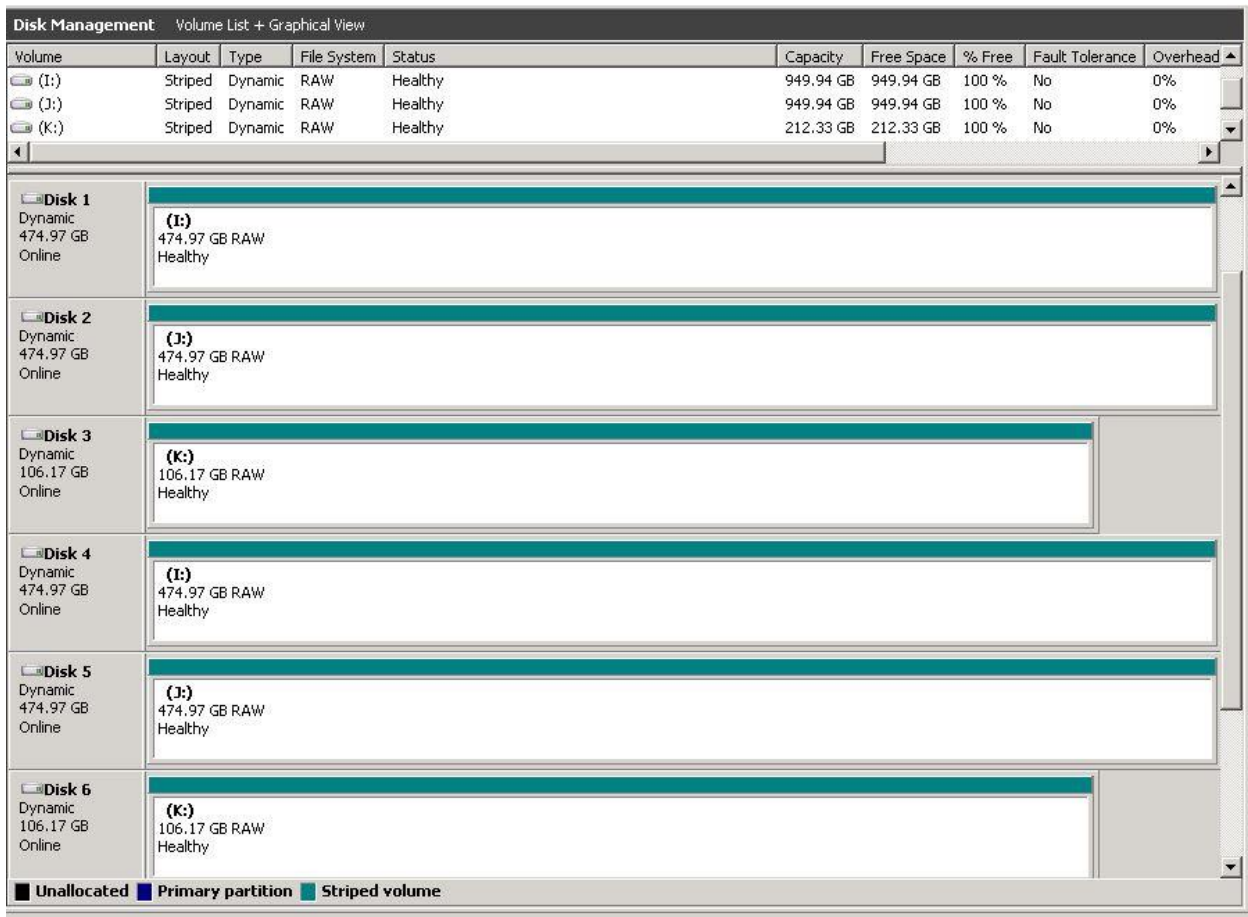
9. Disk Management confirmation, click **Yes**



10. Microsoft Windows asking to format disk, click **Cancel**



11. Repeat steps 2 – 10 for drives J: and K:
12. After all three logical volumes have been created, Disk Management will look as this:



APPENDIX E: CONFIGURATION INVENTORY

The Test Storage Configuration was collected before and after the test phases. The CLI commands were used.

```
# show system
# show controllers
# show versions detail
# show ports
# show disks encl
# show volumes detail
# show disk-groups
```

The outputs of the commands were in the log files:

/DS4200_BEFORE_log_0713 Before the test

/DS4200_AFTER_log_0713 After the test

APPENDIX F: WORKLOAD GENERATOR

The ASU Definition file is included in the Supporting Files.

SPC1.asu

```
OFFSET=0
SIZE=0
ASU=1
DEVICE=\\.\\i:
ASU=2
DEVICE=\\.\\j:
ASU=3
DEVICE=\\.\\k:
```

The full-run of the test used the script ***basic_full_run_4200_0713.bat*** and manually invoke the PERSIST_2 after the TSC was restarted.

basic_full_run_4200_0713.bat

```
set IOPS=100000
set INIT_IOPS=600
set PERSIST_IOPS=25000
set OUTPUT=full_run_output_S4200_0713
set STORAGE=SPC1.asu
set SPC1=spc1_v3.0.2

%SPC1% -run SPC1_INIT      -output %OUTPUT% -iops %INIT_IOPS% -storage
%STORAGE%
%SPC1% -run SPC1_VERIFY   -output %OUTPUT% -iops 100      -storage
%STORAGE%
%SPC1% -run SPC1_METRICS  -output %OUTPUT% -iops %IOPS% -storage
%STORAGE%
%SPC1% -run SPC1_VERIFY   -output %OUTPUT% -iops 100      -storage
%STORAGE%
%SPC1% -run SPC1_PERSIST_1 -output %OUTPUT% -iops %PERSIST_IOPS% -
storage %STORAGE%
echo "Now Restart the TSC and run:"
echo "4200run > .\SPC1_v3.0.2 -run SPC1_PERSIST_2 -output
full_run_output_S4200_0713 -iops 25000 -storage SPC1.asu"
```

Manually invoke PERSIST_2:

```
.\SPC1_v3.0.2 -run SPC1_PERSIST_2 -output full_run_output_S4200_0713 -
iops 25000 -storage SPC1.asu
```