



# SPC BENCHMARK 1™

# FULL DISCLOSURE REPORT

## LENOVO
## THINKSYSTEM DS6200

## SPC-1 V3.6

**SUBMISSION IDENTIFIER: A32006**

**SUBMITTED FOR REVIEW: MAY 17, 2018**

## First Edition – May 2018



## Trademarks

SPC Benchmark 1, SPC-1, SPC-1 IOPS, SPC-1 LRT and SPC-1 Price-Performance are trademarks of the Storage Performance Council.

Lenovo, ThinkSystem, and the Lenovo logo are trademarks or registered trademarks of Lenovo in the United States and other countries. All other brands, trademarks, and product names are the property of their respective owners.

## 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.spcresults.org.

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

# Table of Contents

# AUDIT CERTIFICATION



Mr. Shawn Andrews
Lenovo
7001 Development Drive
Morrisville, NC 27560

May 15, 2018

I verified the SPC Benchmark 1™ (SPC-1™ V3.6) test execution and performance results of the following Tested Storage Product:

**Lenovo ThinkSystem DS6200**

The results were:

| | |
|---|---|
| **SPC-1 IOPS™** | **180,006** |
| **SPC-1 Price-Performance™** | **$93.29/SPC-1 KIOPS™** |
| SPC-1 IOPS™ Response Time | 0.518 ms |
| SPC-1 Overall Response Time | 0.344 ms |
| SPC-1 ASU Capacity | 2,267 GB |
| SPC-1 ASU Price | $7.41/GB |
| SPC-1 Total System Price | $16,791.99 |

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 v3.0.2-1-g823a. 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.spcresults.org under the Submission Identifier A32006.

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

63 Lourdes Dr. | Leominster, MA 01453 | 978-343-6562 | www.sizing.com

- 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

63 Lourdes Dr. | Leominster, MA 01453 | 978-343-6562 | www.sizing.com

# LETTER OF GOOD FAITH

Lenovo.com

8001 Development Dr.
Morrisville, NC 27560

May 15, 2018

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

**Subject: SPC-1 Letter of Good Faith for Lenovo Think Systems DS6200**

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 the product are complete, accurate, and in full compliance with the 3.6 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 reporting results even if the items are not explicitly required to be disclosed by the SPC-1 benchmark specification.

Sincerely,

Mike Fitzgerald

Date

5/15/18

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



# SPC BENCHMARK 1™

# EXECUTIVE SUMMARY

# LENOVO
# THINKSYSTEM DS6200

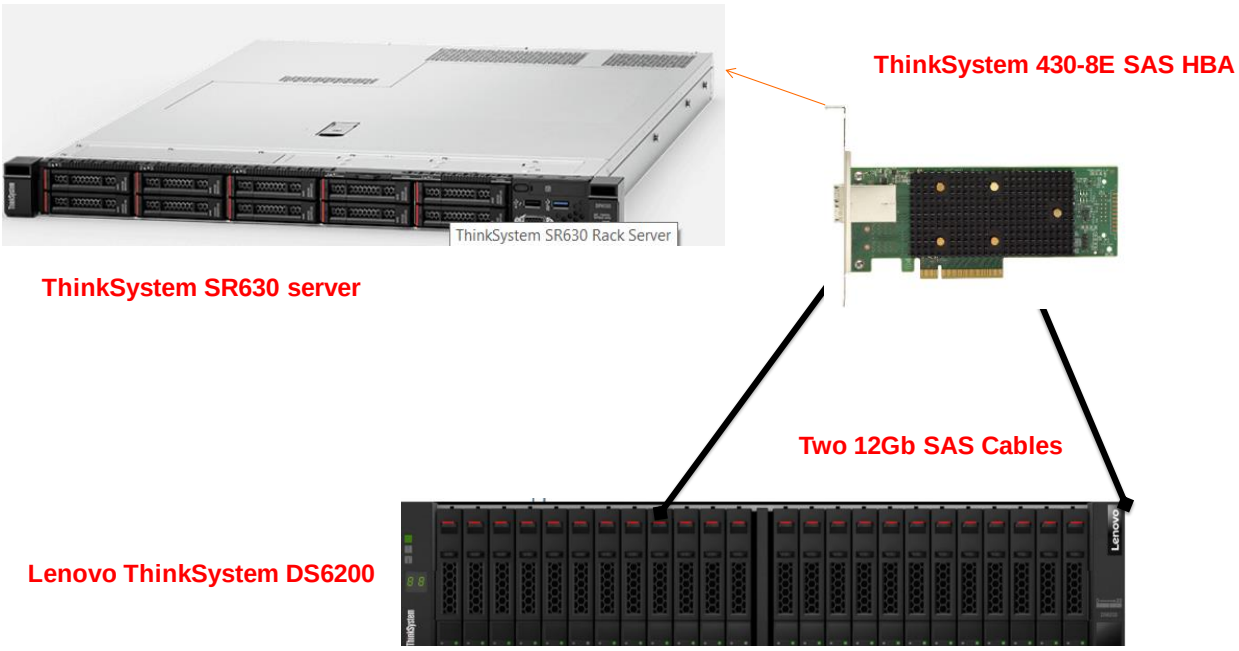
| | |
|---|---|
| **SPC-1 IOPS™** | **180,006** |
| **SPC-1 Price-Performance™** | **$93.29/SPC-1 KIOPS™** |
| SPC-1 IOPS™ Response Time | 0.518 ms |
| SPC-1 Overall Response Time | 0.344 ms |
| SPC-1 ASU Capacity | 2,267 GB |
| SPC-1 ASU Price | $7.41/GB |
| SPC-1 Total System Price | $16,791.99 |
| Data Protection Level | Protected 1 (RAID-10) |
| Physical Storage Capacity | 4,800 GB |
| Pricing Currency / Target Country | U.S. Dollars / USA |

**SPC-1 V3.6**

**SUBMISSION IDENTIFIER: A32006**

**SUBMITTED FOR REVIEW: MAY 17, 2018**

## Benchmark Configuration Diagram




## Tested Storage Product Description

The Lenovo ThinkSystem DS6200 SAN array is performance optimized for deployment in the datacenter to run your mission critical workloads. Offering 50% greater performance than the DS4200, the DS6200 is powered by a Rapid Data Placement Engine and provides industry-leading price/performance and scalability, along with high availability.

With extreme flexibility and impressive performance and capacity, the DS6200 helps you tame the storage monster. Using 3.5-inch (LFF) or 2.5-inch (SFF) HDDs and SSDs, the DS6200 supports up to 240 drives (using 9 expansion units) or 276 drives using (3) D3284 High Density Enclosures, as well as mixing LFF and SFF enclosures in the same array.

The Lenovo ThinkSystem DS6200 is designed for mission critical workloads running in the datacenter with performance and value in mind, and equipped with enterprise-class features, the DS6200 is designed to fit your needs now and into the future.

## Priced Storage Configuration Components

| |
|---|
| **1 x ThinkSystem 430-8E SAS HBA** |
| **1 x ThinkSystem DS6200, with:**<br>**2 x Storage Controllers**<br>**16 GB cache (32 GB total)**<br>**4 x 12 Gb SAS Front End Ports**<br>**1 x 12 Gb SAS Back End Connection**<br>**12 x 400 GB SSD** |

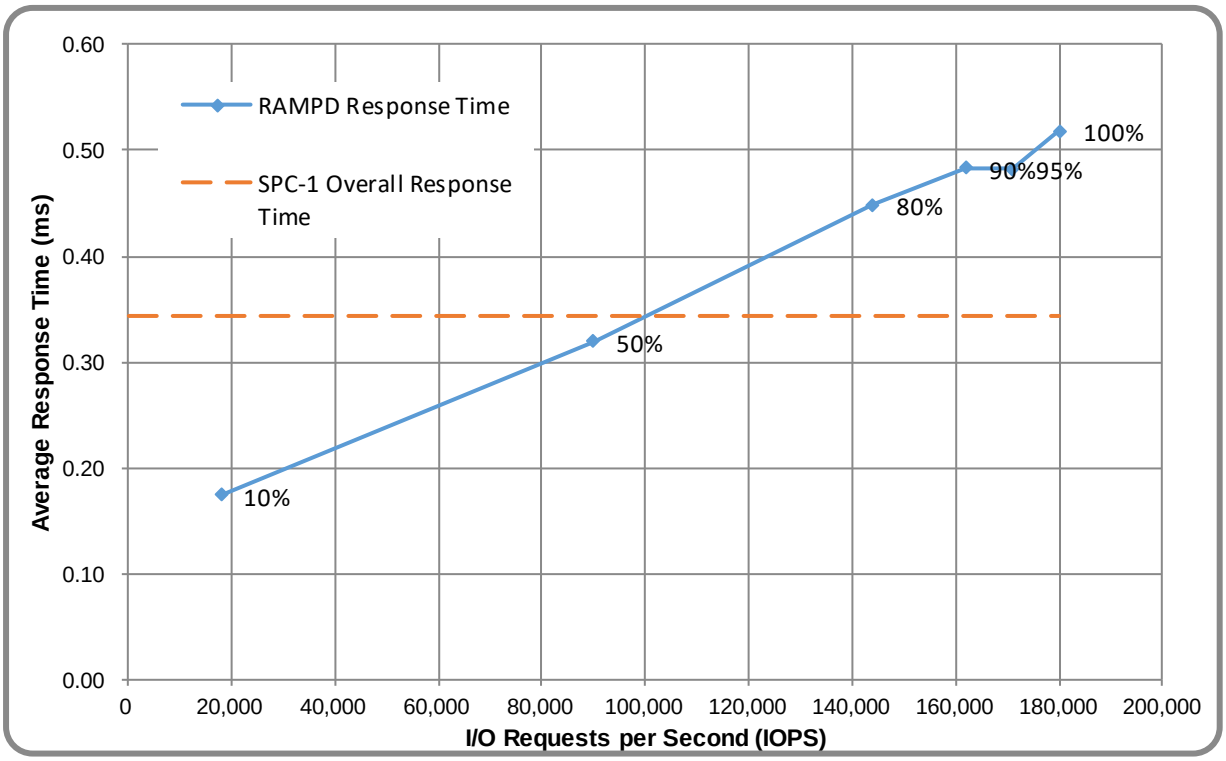
## Storage Configuration Pricing

| Part No. | Description | Source | Qty | Unit Price | Ext. Price | Disc. | Disc. Price |
|---|---|---|---|---|---|---|---|
| **Hardware & Software** | | | | | | | |
| 4619A21 | ThinkSystem DS6200 SFF SAS Dual Controller Unit | 1 | 1 | 11,499.00 | 11,499.00 | 45% | 6,324.45 |
| 01DC462 | Lenovo Storage 400GB 10DWD 2.5" SAS SSD | 1 | 12 | 1,599.00 | 19,188.00 | 52% | 9,210.24 |
| 00YL847 | External MiniSAS HD 8644/MiniSAS HD 8644 .5M | 1 | 2 | 49.00 | 98.00 | 45% | 53.90 |
| 7Y37A01090 | ThinkSystem 430-8E SAS HBA | 1 | 1 | 499.00 | 499.00 | 45% | 274.45 |
| **Hardware & Software Subtotal** | | | | | | | **15,863.04** |
| **Support & Maintenance** | | | | | | | |
| 01JR529 | 3Yr 24x7 4Hr Response | 1 | 1 | 1,689.00 | 1,689.00 | 45% | 928.95 |
| **Support & Maintenance Subtotal** | | | | | | | **928.95** |
| | | | | | | | |
| **SPC-1 Total System Price** | | | | | | | **16,791.99** |
| SPC-1 IOPS™ | | | | | | | 180,006 |
| **SPC-1 Price-Performance™ ($/SPC-1 KIOPS™)** | | | | | | | **93.29** |
| SPC-1 ASU Capacity (GB) | | | | | | | 2,267 |
| **SPC-1 ASU Price ($/GB)** | | | | | | | **7.41** |

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

**Availability Date**: Currently available.

## Response Time and Throughput Graph



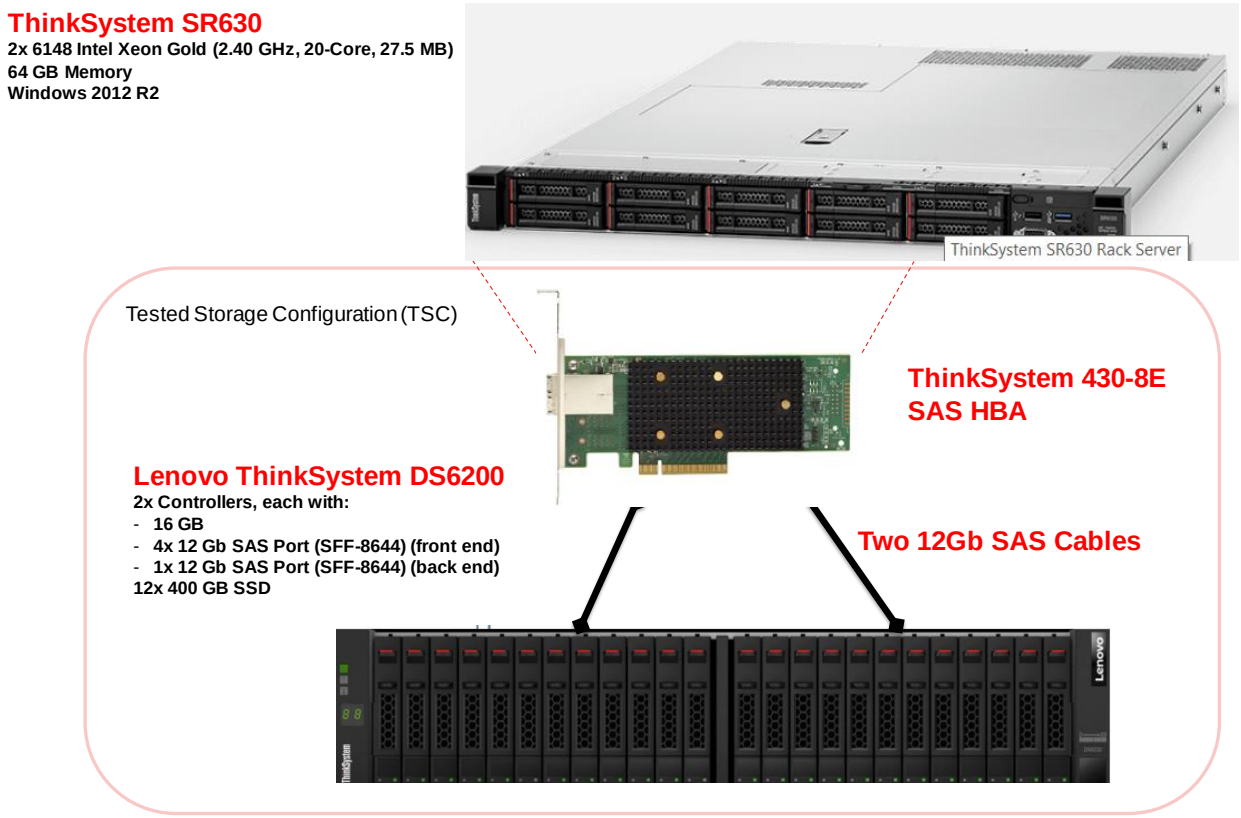

| Contact Information | |
|---|---|
| **Test Sponsor Primary Contact** | Lenovo – http://www3.lenovo.com/us/en/data-center/<br>Shawn Andrews – sandrews@lenovo.com |
| **SPC Auditor** | InfoSizing – www.sizing.com<br>Doug Johnson – doug@sizing.com |

| Revision Information | |
|---|---|
| **SPC Benchmark 1™ Revision** | V3.6 |
| **SPC-1 Workload Generator Revision** | v3.0.2-1-g823a |
| **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 ThinkSystem SR630<br>2 x Intel Xeon Gold 6148 (2.40 GHz, 20-Core, 27.5 MB L3)<br>64 GB Main Memory<br>Windows 2012 R2 |
| **Tested Storage Configuration** |
| **1 x ThinkSystem 430-8E SAS HBA** |
| **1 x ThinkSystem DS6200, with:**<br>**2 x Storage Controllers**<br>**16 GB cache (32 GB total)**<br>**4 x 12 Gb SAS Front End Ports**<br>**1 x 12 Gb SAS Back End Connection**<br>**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 | Optimized* |
|---|---|---|---|---|---|---|
| **ASU-1** | 1 | 1,019.7 | 1,019.7 | 1,019.7 | 45.0% | No |
| **ASU-2** | 1 | 1,019.7 | 1,019.7 | 1,019.7 | 45.0% | No |
| **ASU-3** | 1 | 227.7 | 227.7 | 227.7 | 10.0% | No |
| | | | **SPC-1 ASU Capacity** | 2,267 | *See Space Optimization Techniques | |

## 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 |
|---|---|---|---|
| Lenovo Storage 400GB 10DWD | 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).

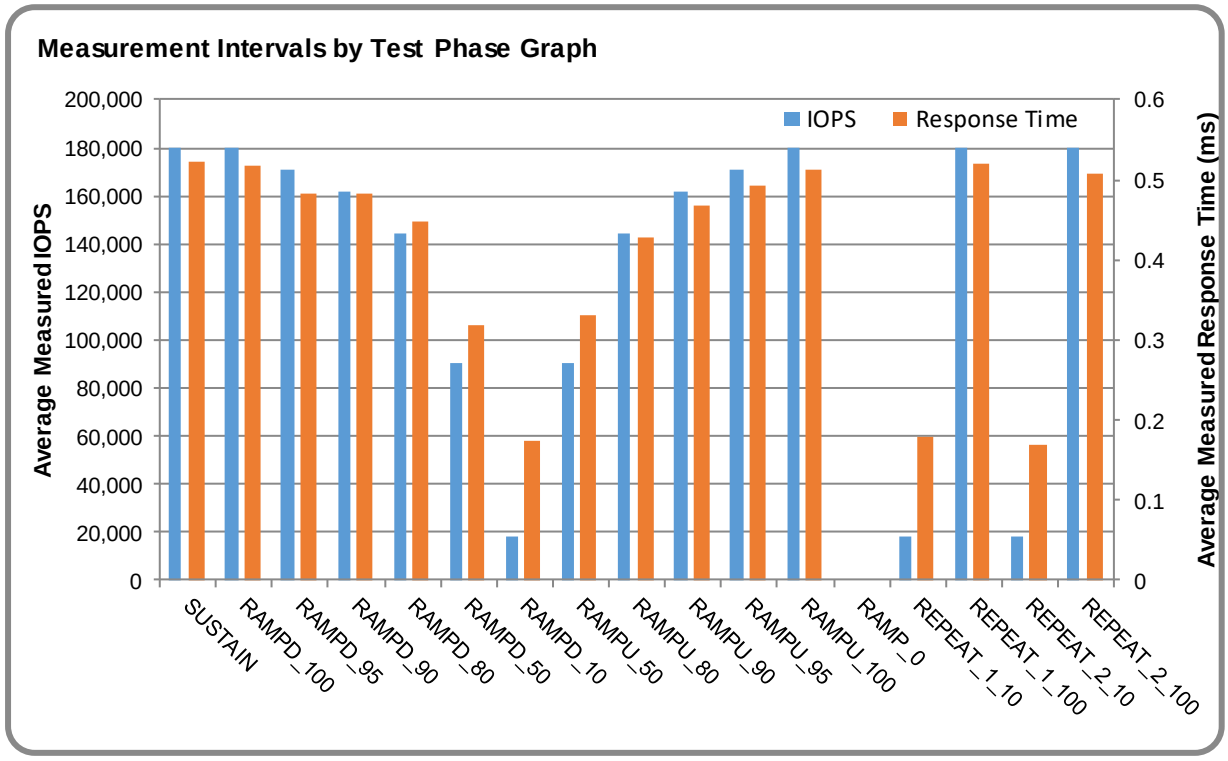
### Primary Metrics Test Phases

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

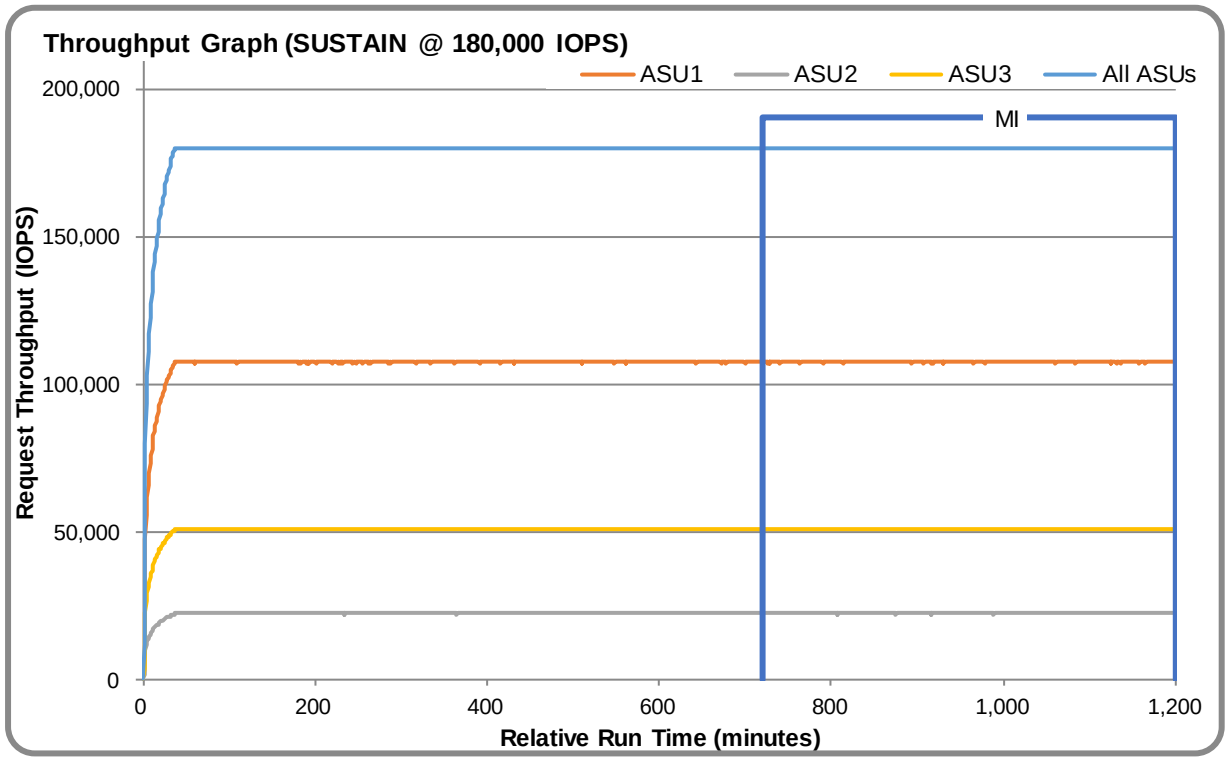
The results file generated during the execution of the SUSTAIN Test Phase is included in the Supporting Files (see Appendix A) as follows:

- **SPC1_METRICS_0_Raw_Results.xlsx**

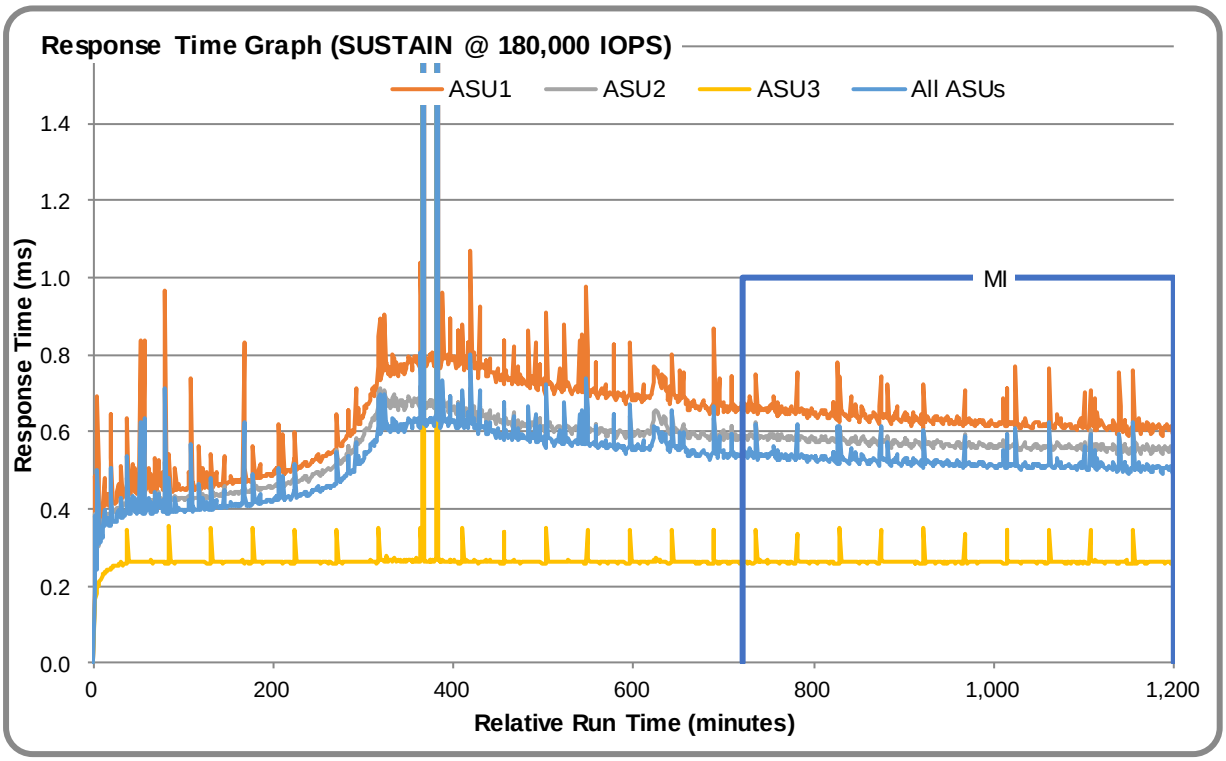
## SUSTAIN – Execution Times

| Interval | Start Date & Time | End Date & Time | Duration |
|---|---|---|---|
| **Transition Period** | 05-May-18 12:40:02 | 06-May-18 00:40:01 | 11:59:59 |
| **Measurement Interval** | 06-May-18 00:40:01 | 06-May-18 08:40:02 | 8:00:01 |

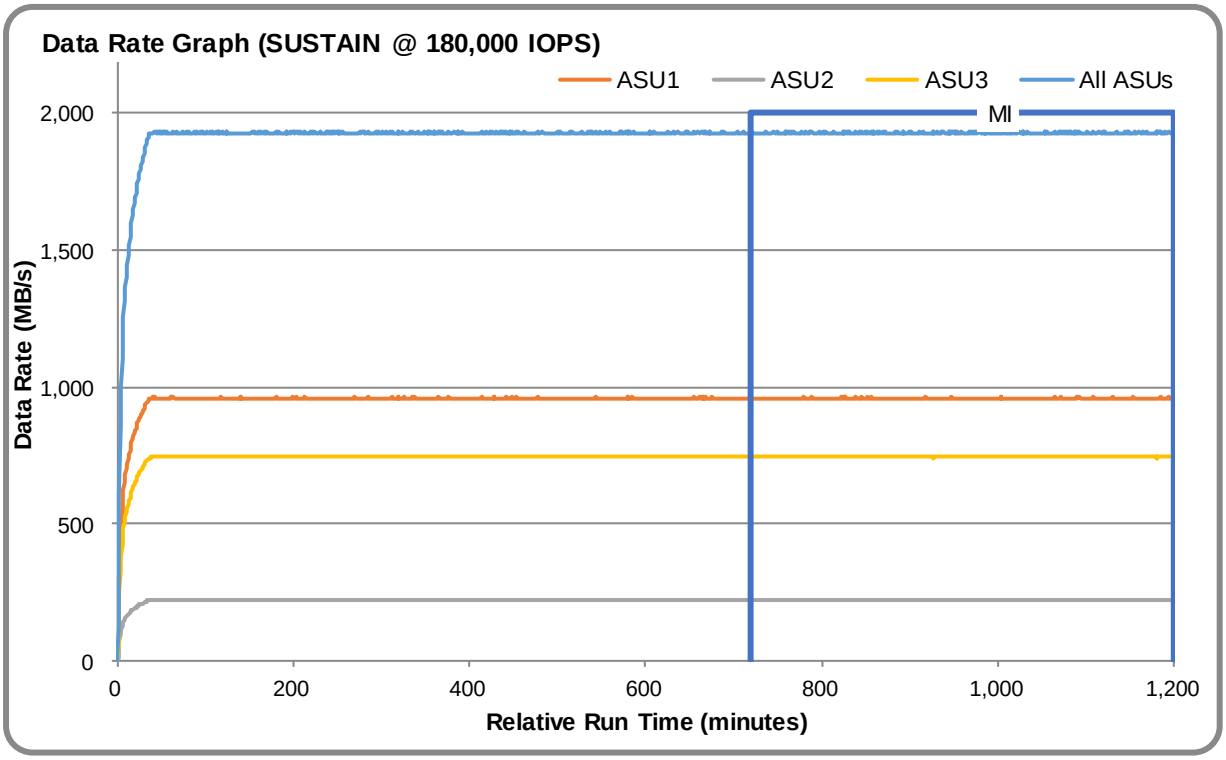
## SUSTAIN – Throughput Graph



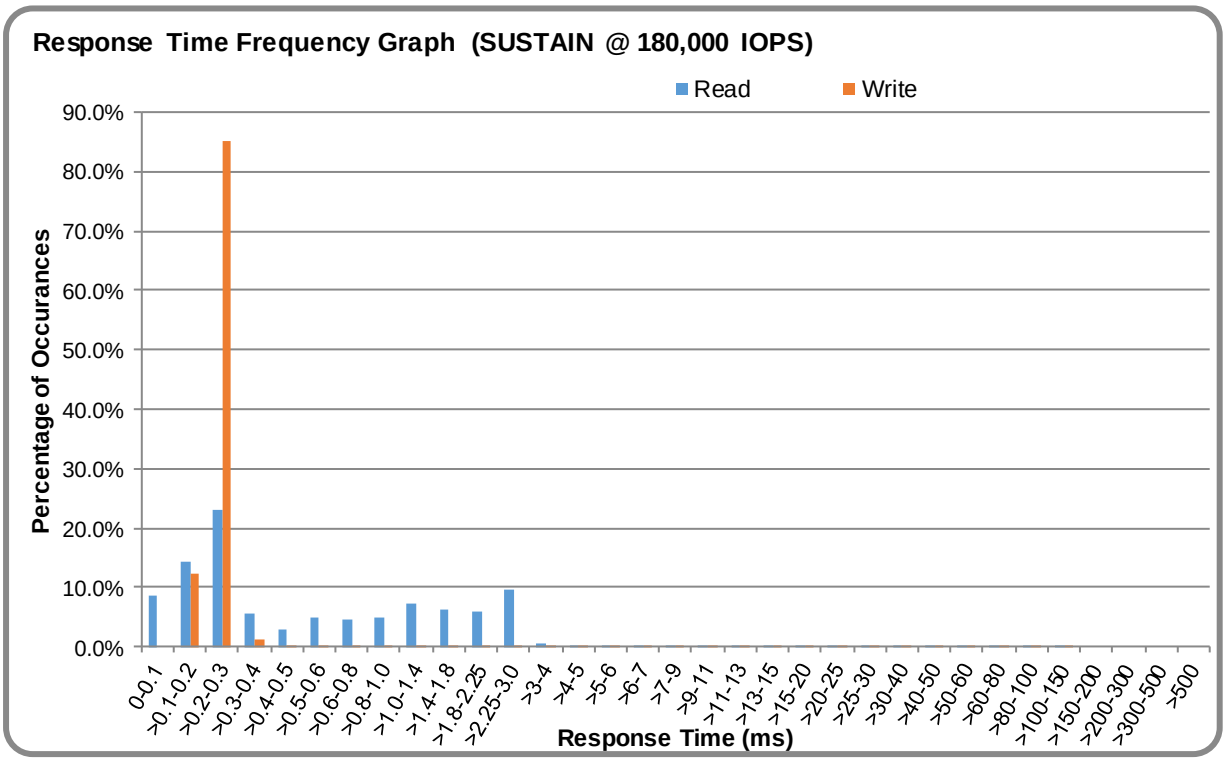
## SUSTAIN – Response Time Graph




## 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** | 0.0017 | 0.0005 | 0.0011 | 0.0006 | 0.0022 | 0.0012 | 0.0016 | 0.0005 |
| **Difference** | 0.003% | 0.003% | 0.009% | 0.001% | 0.005% | 0.005% | 0.004% | 0.001% |

# RAMPD_100 Test Phase

## RAMPD_100 – Results File

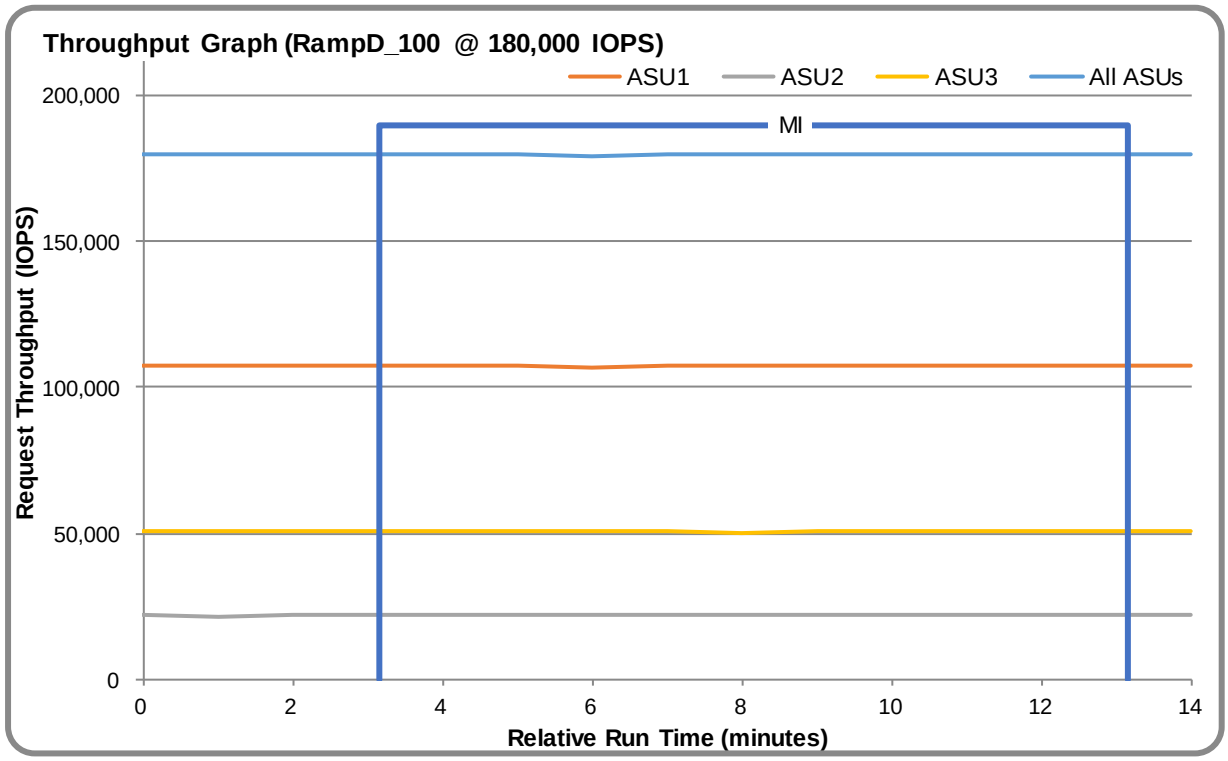
The results file generated during the execution of the RAMPD_100 Test Phase is included in the Supporting Files (see Appendix A) as follows:

- **SPC1_METRICS_0_Raw_Results.xlsx**

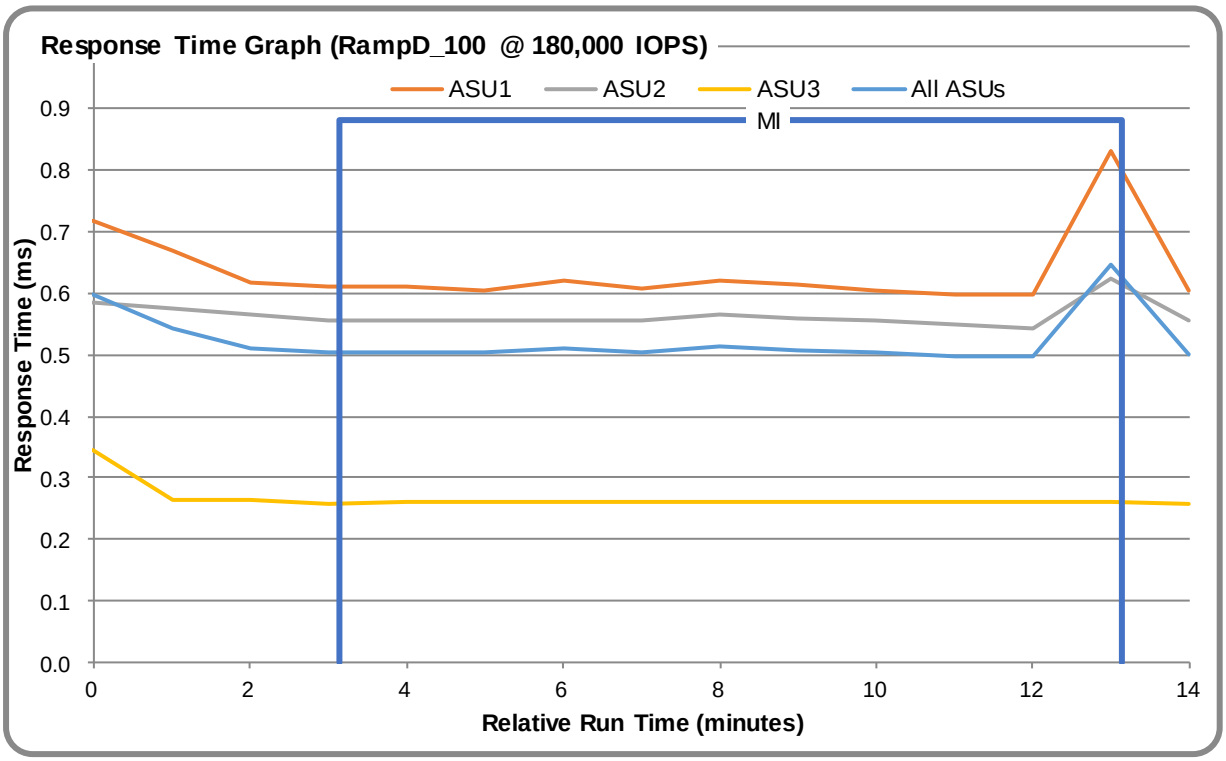
## RAMPD_100 – Execution Times

| Interval | Start Date & Time | End Date & Time | Duration |
|---|---|---|---|
| **Transition Period** | 06-May-18 08:41:01 | 06-May-18 08:44:01 | 0:03:00 |
| **Measurement Interval** | 06-May-18 08:44:01 | 06-May-18 08:54:02 | 0:10:01 |

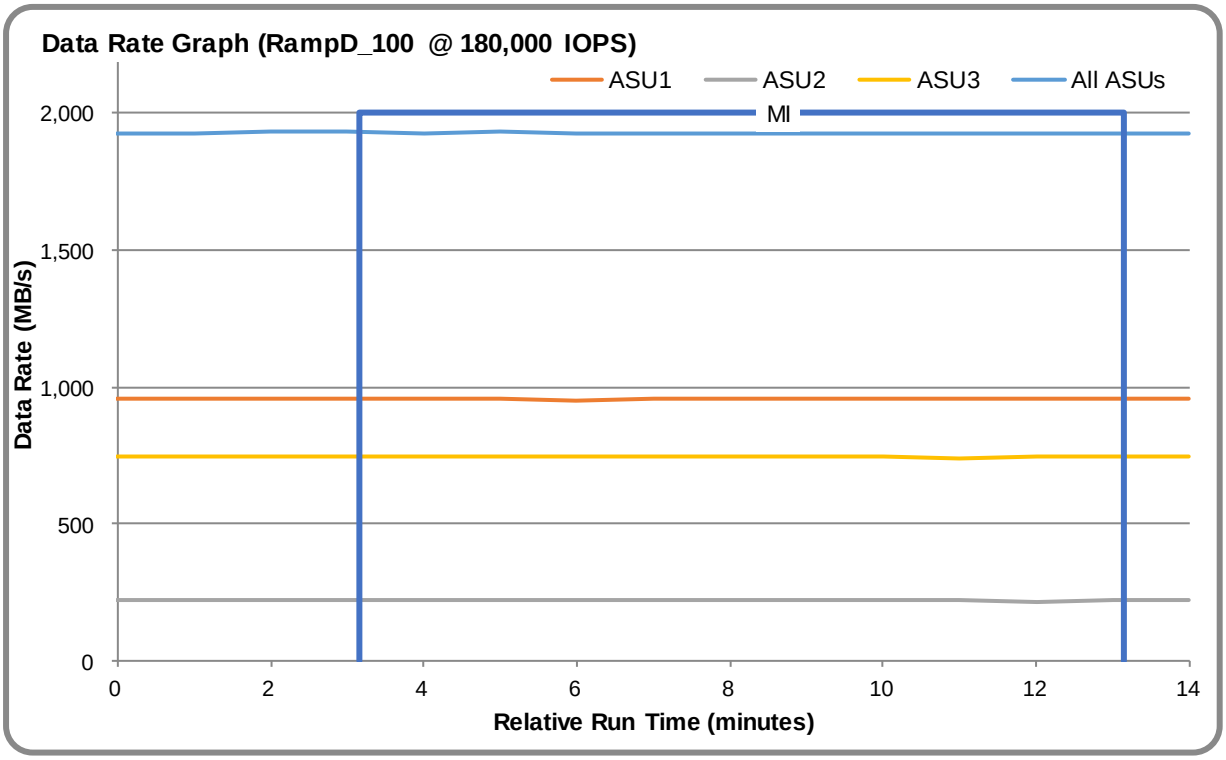
## RAMPD_100 – Throughput Graph



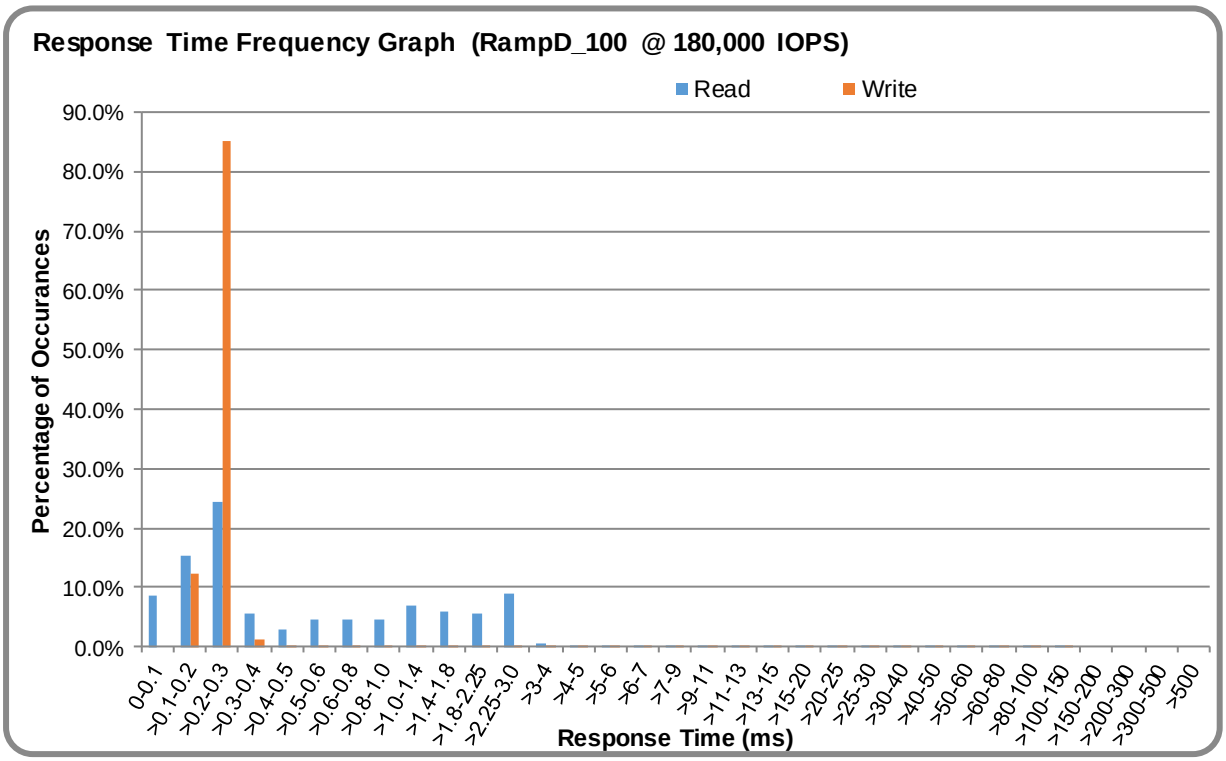
## RAMPD_100 – Response Time Graph




## 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 | 0.2810 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| **Variation** | 0.0009 | 0.0004 | 0.0009 | 0.0008 | 0.0025 | 0.0013 | 0.0018 | 0.0004 |
| **Difference** | 0.028% | 0.012% | 0.022% | 0.006% | 0.051% | 0.060% | 0.006% | 0.010% |

## RAMPD_100 – I/O Request Summary

| | |
|---|---|
| **I/O Requests Completed in the Measurement Interval** | 108,003,070 |
| **I/O Requests Completed with Response Time <= 30 ms** | 107,983,104 |
| **I/O Requests Completed with Response Time > 30 ms** | 19,966 |

# Response Time Ramp Test

## Response Time Ramp Test – Results File

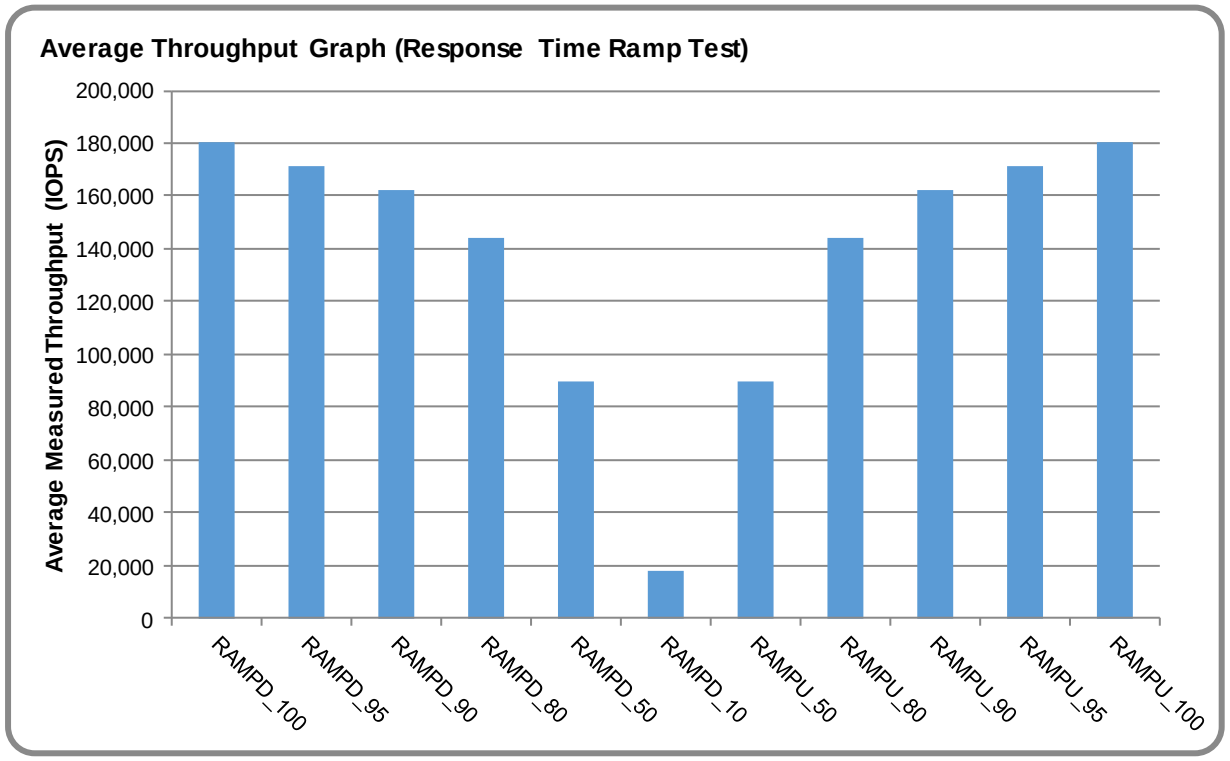
The results file generated during the execution of the Response Time Ramp Test is included in the Supporting Files (see Appendix A) as follows:

- **SPC1_METRICS_0_Raw_Results.xlsx**

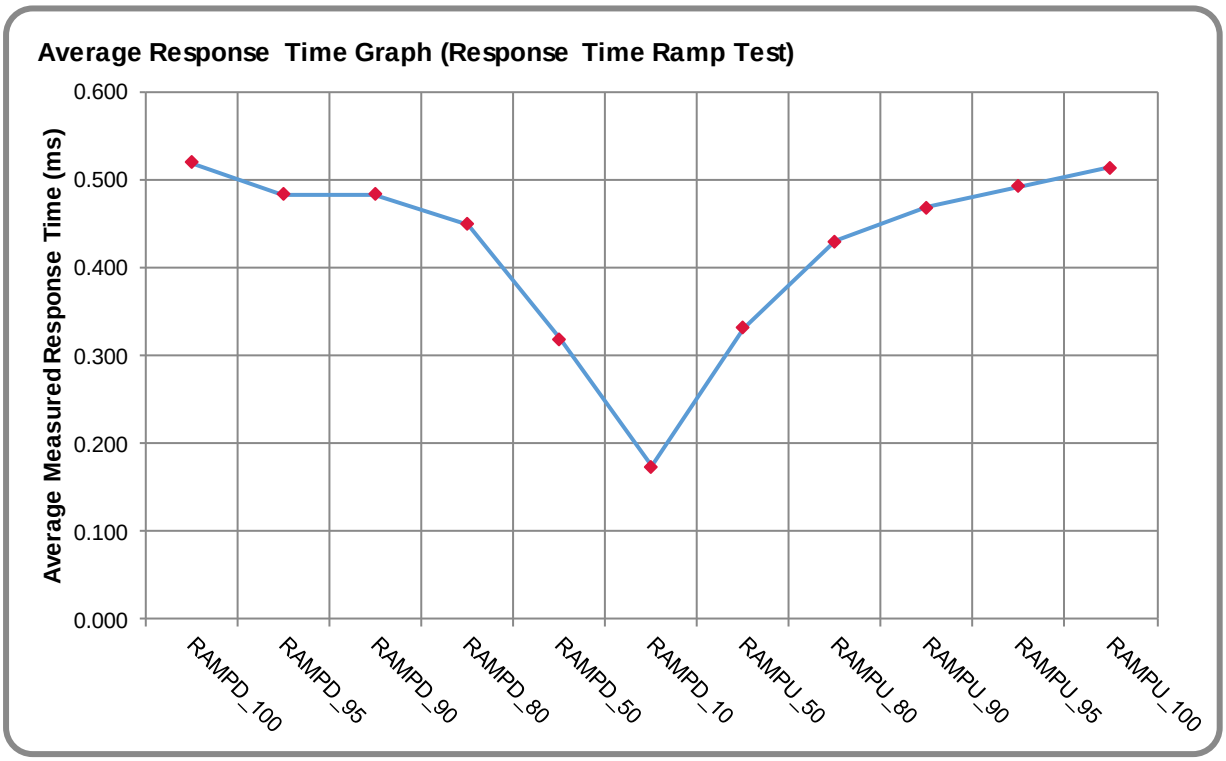
## Response Time Ramp Test – Phases

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).

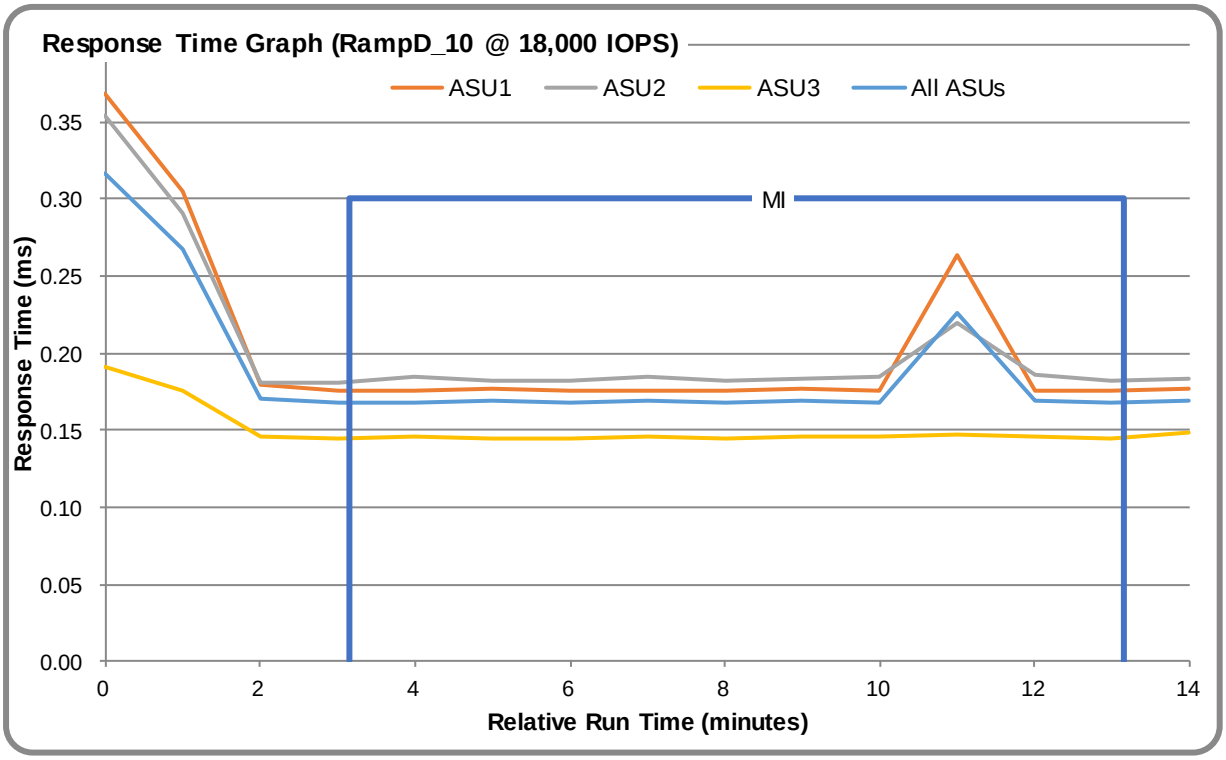
## Response Time Ramp Test – Average Throughput Graph



## 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:

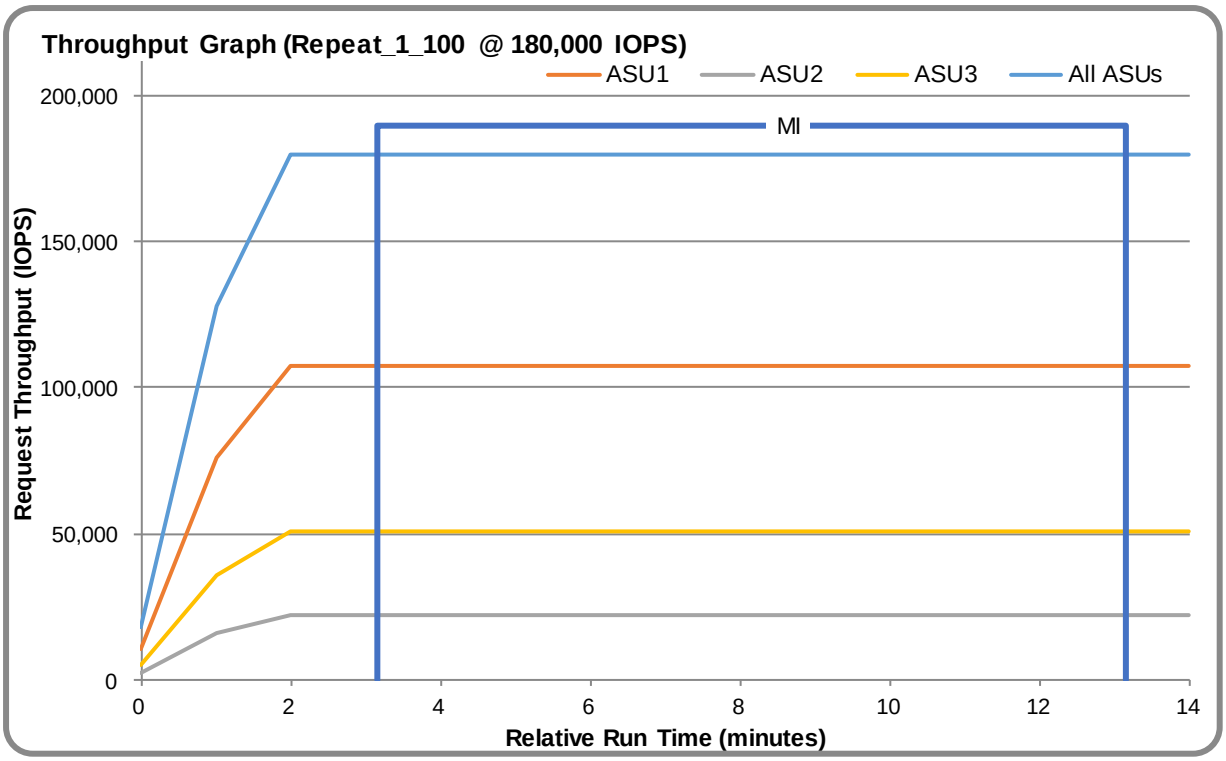
- **SPC1_METRICS_0_Raw_Results.xlsx**

## Repeatability Test Results

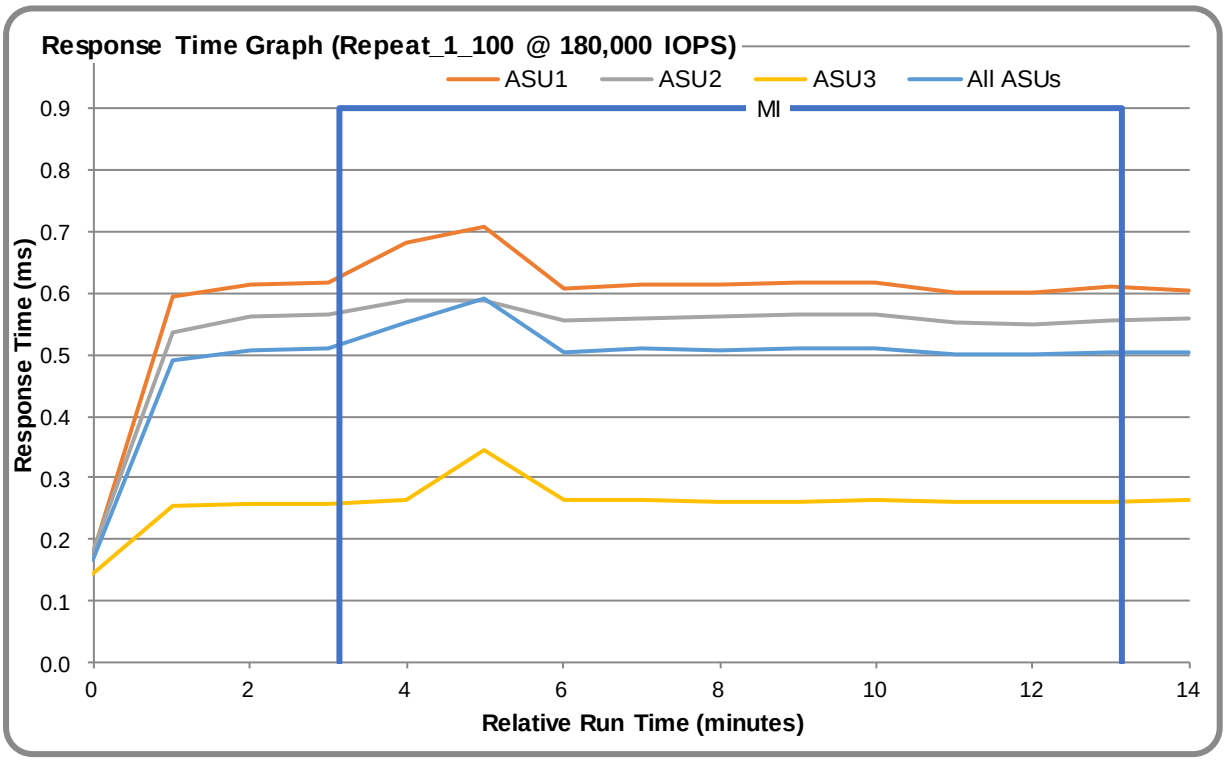
The throughput measurements for the Response Time Ramp Test (RAMPD) and the Repeatability Test Phases (REPEAT_1 and REPEAT_2) are listed in the tables below.

| Test Phase | 100% IOPS | 10% IOPS |
|---|---|---|
| RAMPD | 180,006.2 | 18,000.0 |
| REPEAT_1 | 180,007.3 | 18,007.0 |
| REPEAT_2 | 180,016.6 | 18,003.7 |

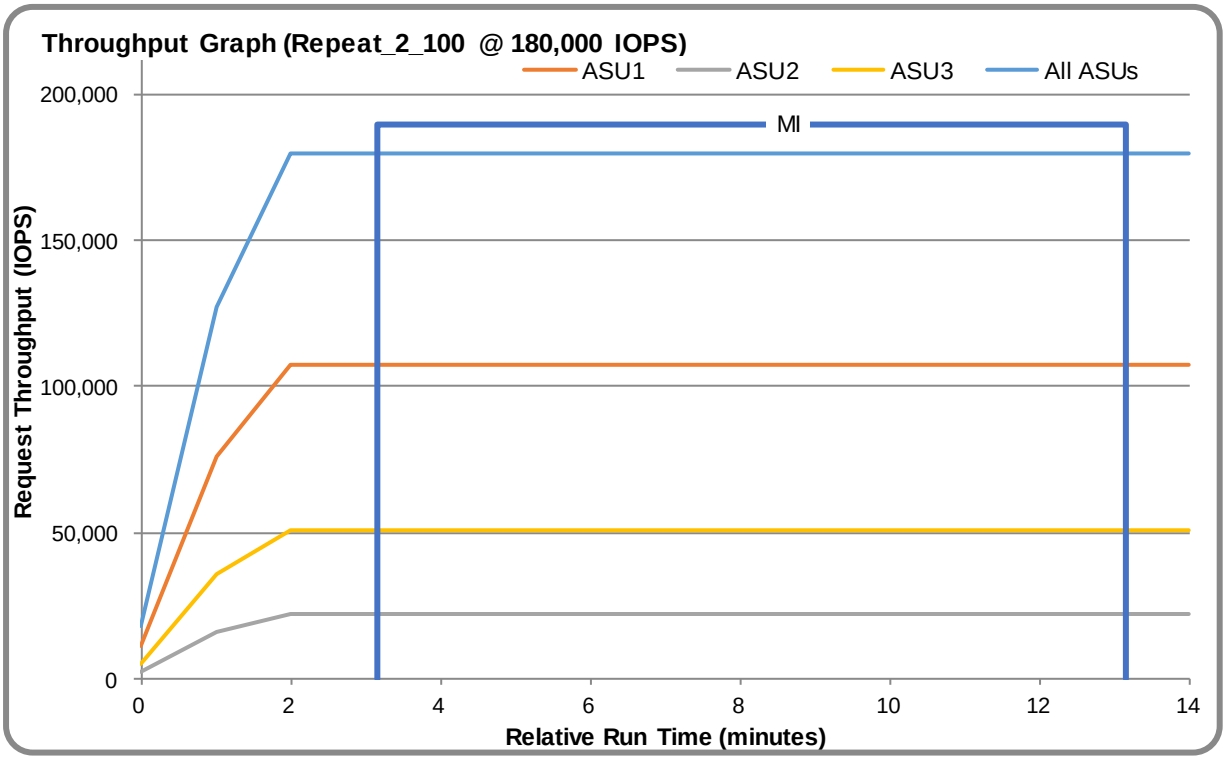
## REPEAT_1_100 – Throughput Graph



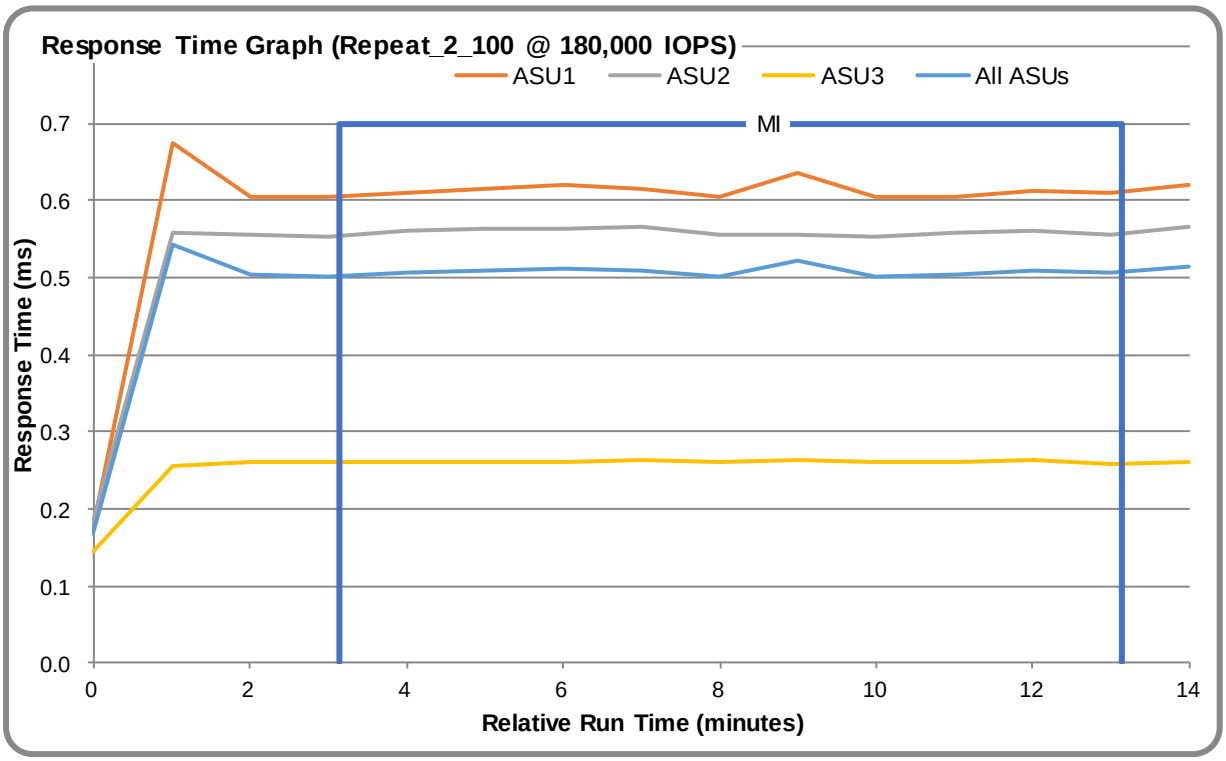
## REPEAT_1_100 – Response Time Graph




## 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 | 0.2811 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| **Variation** | 0.0018 | 0.0003 | 0.0014 | 0.0005 | 0.0023 | 0.0010 | 0.0022 | 0.0007 |
| **Difference** | 0.090% | 0.022% | 0.064% | 0.018% | 0.125% | 0.030% | 0.138% | 0.005% |

### 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 | 0.2811 | 0.0699 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| **Variation** | 0.0013 | 0.0005 | 0.0013 | 0.0005 | 0.0015 | 0.0006 | 0.0021 | 0.0004 |
| **Difference** | 0.027% | 0.037% | 0.080% | 0.011% | 0.003% | 0.000% | 0.053% | 0.006% |

# Space Optimization Techniques

## Description of Utilized Techniques

The TSC did not utilize any space optimization techniques.

## Physical Free Space Metrics

If space optimization techniques were utilized, the following table lists the Physical Free Space as measured at each of the required points during test execution.

| Physical Free Space Measurement | Free Space (GB) |
|---|---|
| **After Logical Volume Creation** | NA |
| **After ASU Pre-Fill** | NA |
| **After Repeatability Test Phase** | NA |

## Space Optimization Metrics

If space optimization techniques were utilized, the following table lists the required space optimization metrics.

| Metric | Value |
|---|---|
| **SPC-1 Space Optimization Ratio** | NA |
| **SPC-1 Space Effectiveness Ratio** | NA |

# 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** | 36,993,646 |
| **Total Number of Logical Blocks Verified** | 34,656,696 |
| **Total Number of Logical Blocks Overwritten** | 2,336,950 |
| **Total Number of Logical Blocks that Failed Verification** | 0 |
| **Time Duration for Writing Test Logical Blocks (sec.)** | 600 |
| **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 DS6200 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 save and restore data in the case of an emergency shutdown during power loss. The supercapacitors are used to 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 use the CLI (see Appendix C) | | |
| **/D_Creation** | **Storage configuration creation** | **root** |
| DS6200_volume_map.bash | Create disk groups, volumes, and mapping | /D_Creation |
| **/E_Inventory** | **Configuration inventory** | **root** |
| /0505_Before | Configuration before the run | /E_Inventory |
| /0505_After | Configuration after the run | /E_Inventory |
| **/F_Generator** | **Workload generator** | **root** |
| SPC1.asu | ASU configuration file | /F_generator |
| Basic_full_run_S6200_0505.bat | Execute all test phases excludinPERSIST_2 | /F_generator |
| SPC1_METRICS | Metrics file used | /F_generator |

# APPENDIX B: THIRD PARTY QUOTATION

All components are directly available through the Test Sponsor.

# APPENDIX C: TUNING PARAMETERS AND OPTIONS

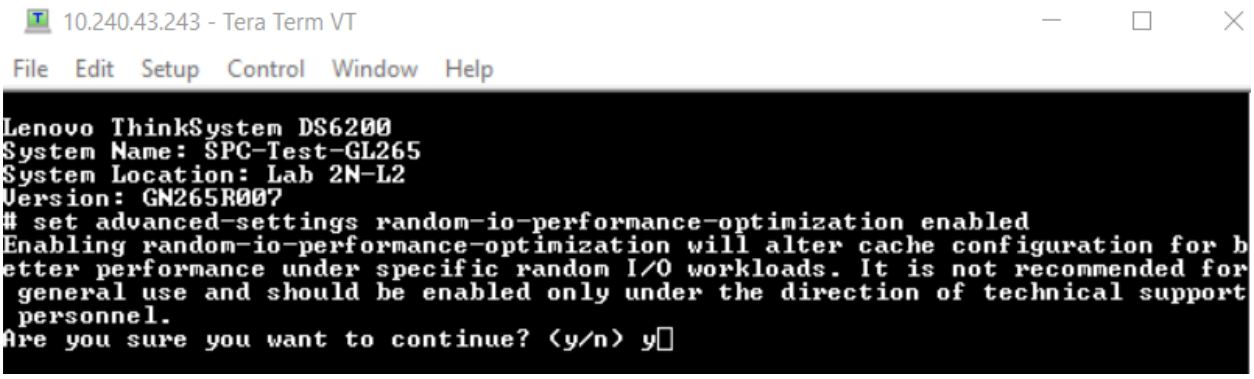
The standard DS6200 Controller CLI was used to apply the necessary tuning parameters for the test.

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
```

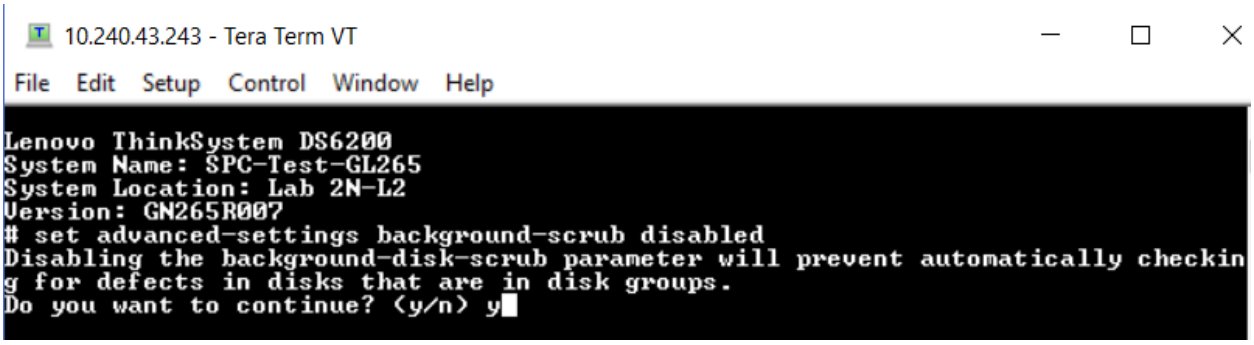

3. Once you have created the user you must login with that user account
4. Then run the following command:

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




5. Disable disk groups background scrub command:

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




Note: Disk scrubbing is an important background maintenance task. Typical best-practice in production environments is to schedule it for regular intervals during non-peak hours. Disk scrubbing was disabled during this test as an "ease of benchmarking" practice to avoid scheduling issues. Disabling disk scrubbing in a production environment is not recommended.

# APPENDIX D: STORAGE CONFIGURATION CREATION

Storage groups and volumes are created using the following script (`DS6200_volume_map.bash`):

1. `ssh manage@10.240.43.243 "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 large-virtual-extents enable; create volume pool a size 510GB ASU2-A large-virtual-extents enable; create volume pool a size 114GB ASU3-A large-virtual-extents enable; create volume pool b size 510GB ASU1-B large-virtual-extents enable; create volume pool b size 510GB ASU2-B large-virtual-extents enable; create volume pool b size 114GB ASU3-B large-virtual-extents enable; 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; set pool a overcommit disable; set pool b overcommit disable"`
2. 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
   ```
3. Each Disk group is configured with (6) 400GB SSDs in a RAID 10 layout
4. The create volume commands are used to assign (3) volumes to each of the disk groups configured in step 1 with the large virtual extents enabled to aid in the page allocation
   ```
   create volume pool a size 510GB ASU1-A large-virtual-extents enable
   create volume pool a size 510GB ASU2-A large-virtual-extents enable
   create volume pool a size 114GB ASU3-A large-virtual-extents enable
   create volume pool b size 510GB ASU1-B large-virtual-extents enable
   create volume pool b size 510GB ASU2-B large-virtual-extents enable
   create volume pool b size 114GB ASU3-B large-virtual-extents enable
   ```
5. 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
```

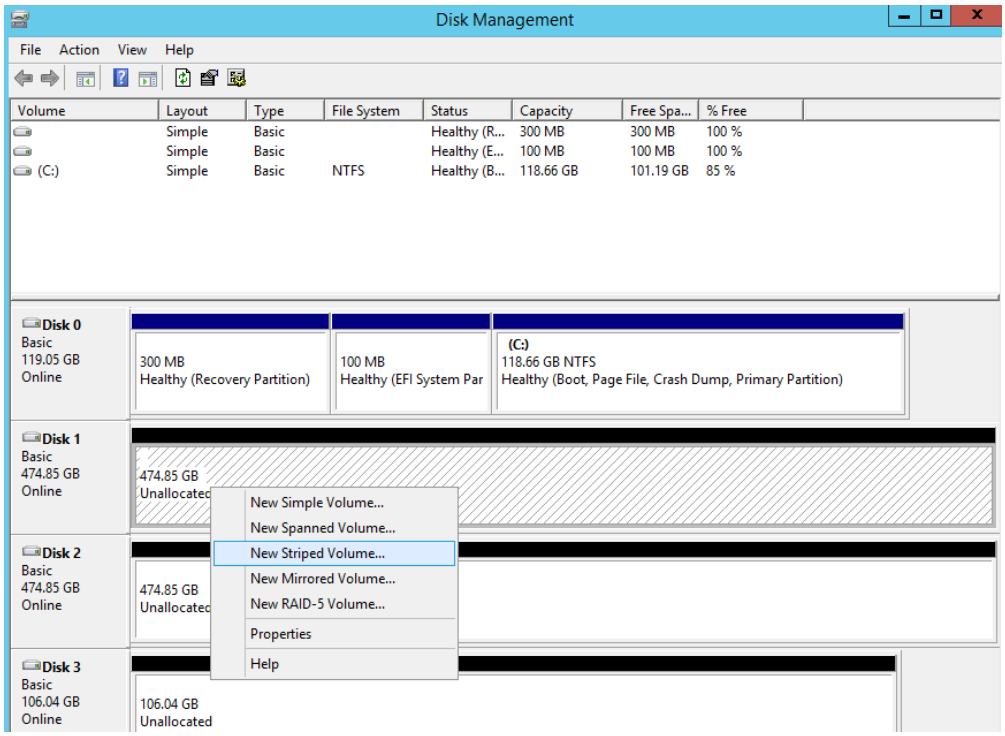
6. The last step is to disable the pool overcommit so that all pages are allocated into the proper pool

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

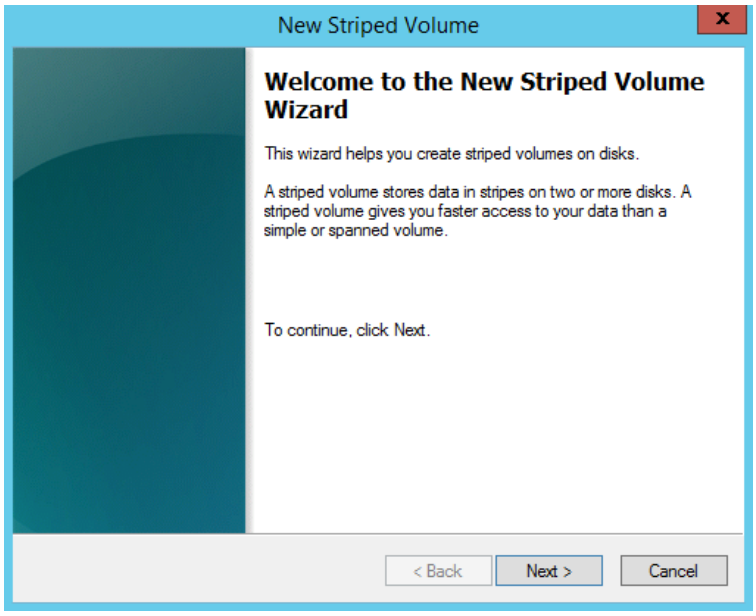
Next, use Windows Disk Management to create the striped ASU volumes.

| "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: |

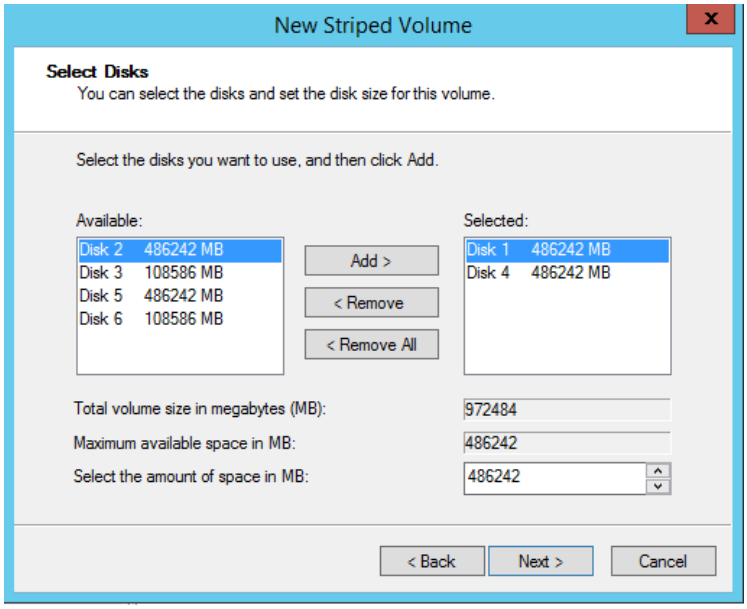
1. Start Disk Management
2. Right click on Disk 1, and select **New Striped Volume…**



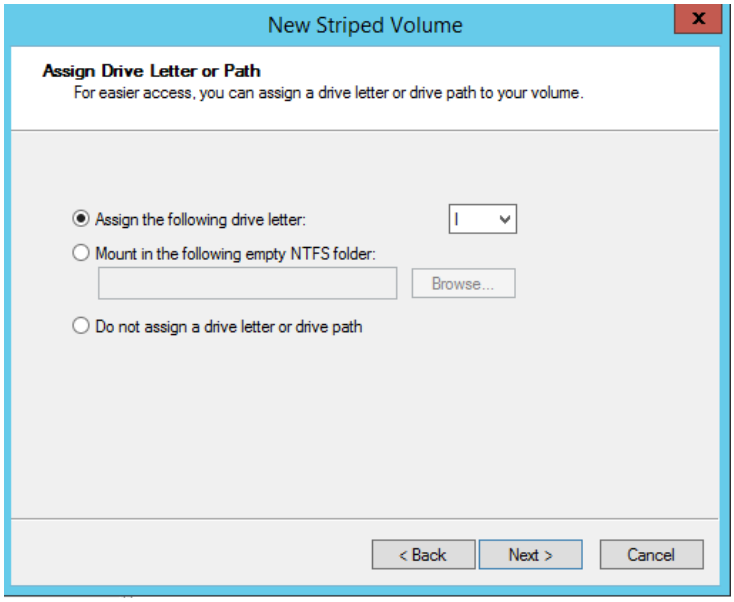

3. Wizard pops up. Select **Next**



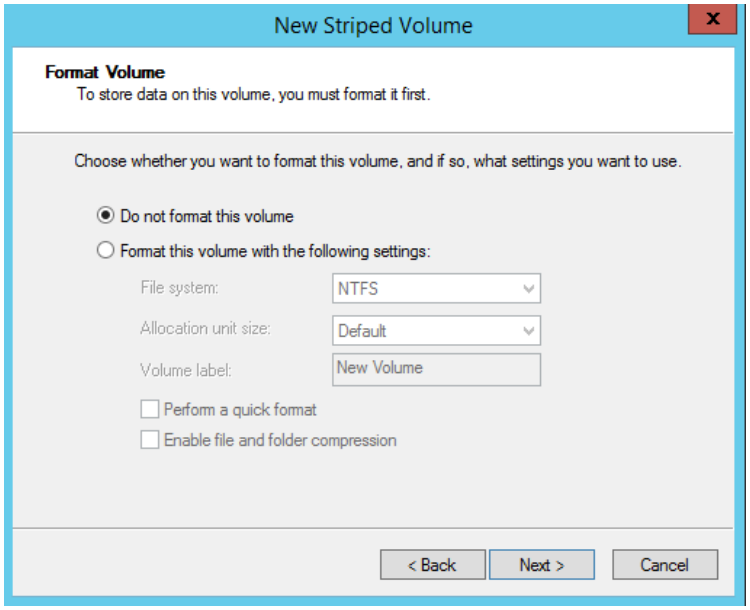

4. On **New Striped Volume** window, highlight **Disk 4** and click on **Add>**
5. **Disk 1** and **Disk 4** in the selected area, click **Next**



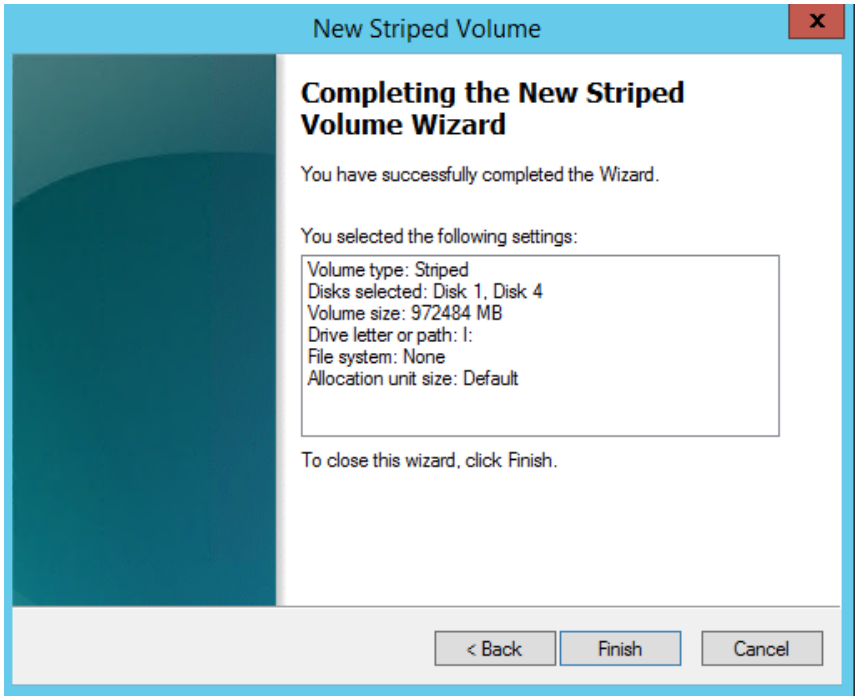

6. Click **Assign the following drive letter**, select **I**, then **Next**



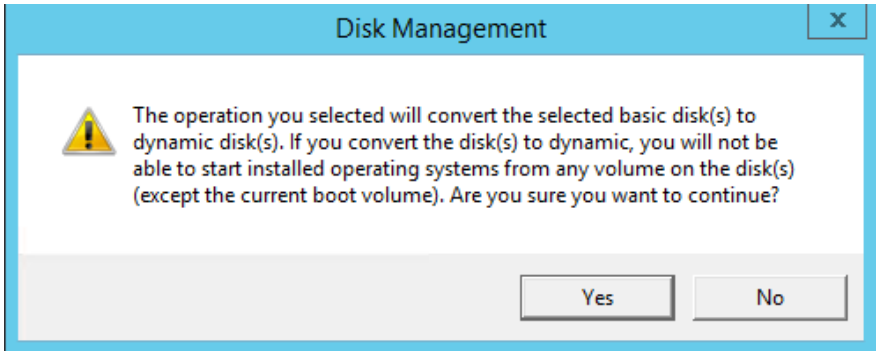

7. On **Format Volume** window, select **Do not format this volume**, then **Next**



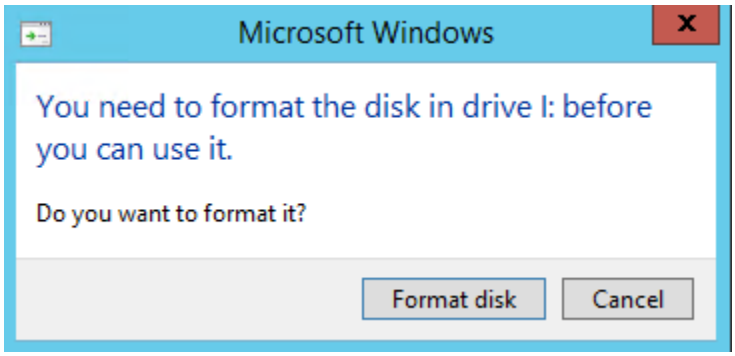

8. **Completing the New Striped Volume Wizard**, click **Finish**



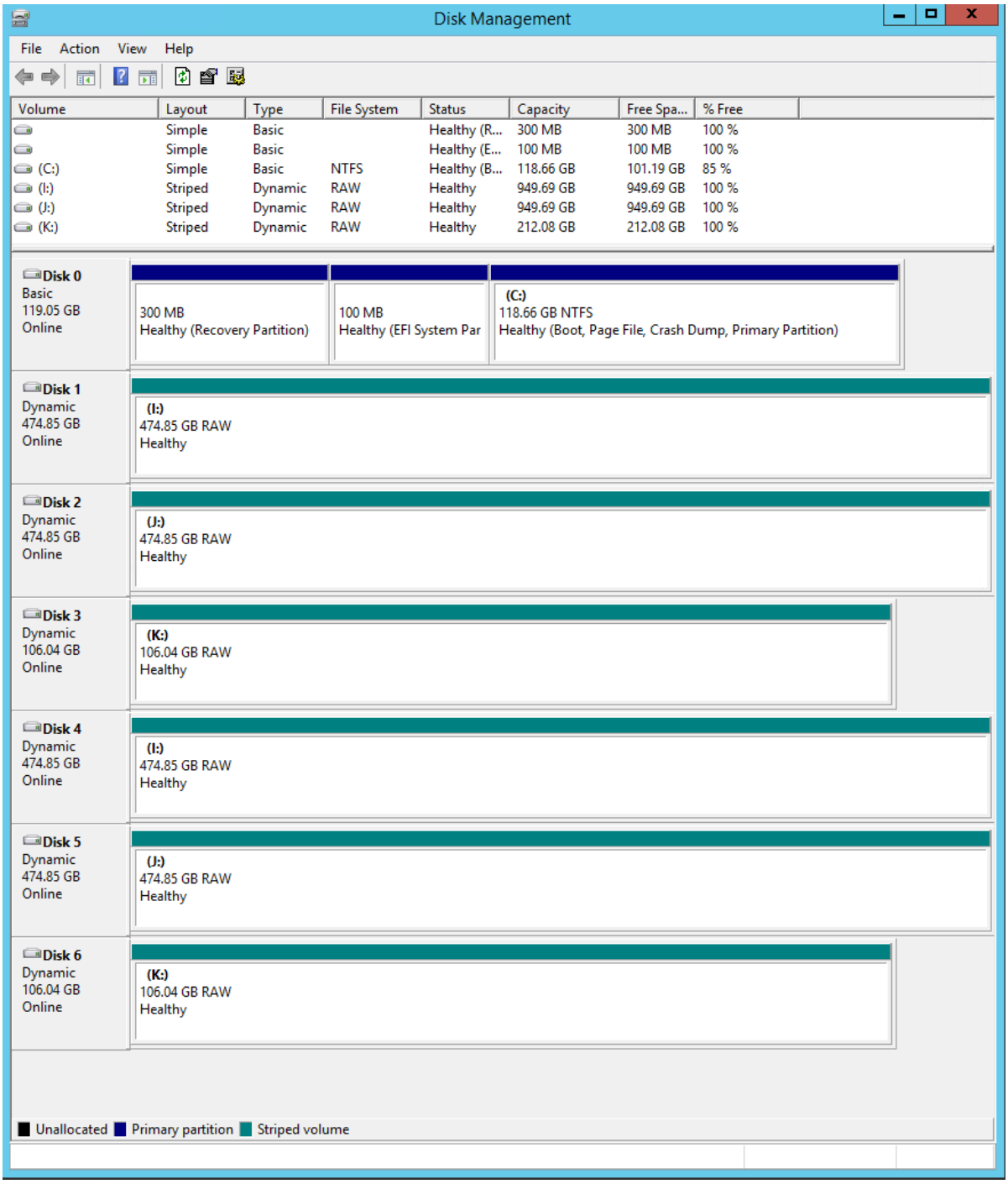

9. Disk Management confirmation, click Yes




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:


Disk Management
File Action View Help
Volume Layout Type File System Status Capacity Free Spa... % Free
Simple Basic Healthy (R... 300 MB 300 MB 100 %
Simple Basic Healthy (E... 100 MB 100 MB 100 %
(C:) Simple Basic NTFS Healthy (B... 118.66 GB 101.19 GB 85 %
(I:) Striped Dynamic RAW Healthy 949.69 GB 949.69 GB 100 %
(J:) Striped Dynamic RAW Healthy 949.69 GB 949.69 GB 100 %
(K:) Striped Dynamic RAW Healthy 212.08 GB 212.08 GB 100 %
Disk 0
Basic
119.05 GB
Online
300 MB
Healthy (Recovery Partition)
100 MB
Healthy (EFI System Par
(C:)
118.66 GB NTFS
Healthy (Boot, Page File, Crash Dump, Primary Partition)
Disk 1
Dynamic
474.85 GB
Online
(I:)
474.85 GB RAW
Healthy
Disk 2
Dynamic
474.85 GB
Online
(J:)
474.85 GB RAW
Healthy
Disk 3
Dynamic
106.04 GB
Online
(K:)
106.04 GB RAW
Healthy
Disk 4
Dynamic
474.85 GB
Online
(I:)
474.85 GB RAW
Healthy
Disk 5
Dynamic
474.85 GB
Online
(J:)
474.85 GB RAW
Healthy
Disk 6
Dynamic
106.04 GB
Online
(K:)
106.04 GB RAW
Healthy
Unallocated
Primary partition
Striped volume

# 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:

/0505_Before  Before the test

/0505_After  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_S6200_0505.bat*** and manually invoke the PERSIST_2 after the TSC was restarted.

***basic_full_run_S6200_0505.bat***

```
set IOPS=180000

set INIT_IOPS=1000

set PERSIST_IOPS=45000

set OUTPUT=full_run_output_S6200_0505

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 "S6200run > .\SPC1_v3.0.2 -run SPC1_PERSIST_2 -output
full_run_output_S6200_0505 -iops 45000 -storage SPC1.asu"

echo "with any other options you used in this run"
```

Manually invoke PERSIST_2:

```
.\SPC1_v3.0.2 -run SPC1_PERSIST_2 -output full_run_output_S6200_0505 -
iops 45000 -storage SPC1.asu
```