SPC BENCHMARK 1™

FULL DISCLOSURE REPORT

MACROSAN TECHNOLOGIES CO., LTD.
MS7000G2-MACH

SPC-1 V3.9.1

SUBMISSION IDENTIFIER: A32020

SUBMITTED FOR REVIEW: OCTOBER 27, 2020

First Edition – October 2020

Trademarks

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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.spcresults.org.

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

Table of Contents

AUDIT CERTIFICATION

InfoSizing
The Right Metric For Sizing IT

Storage Performance Council
Certified Auditor

Yi Shen
11~12F, Building A
Intelligent e-Valley Road No. 482
qianmo Road, BinJiang District
Hangzhou, China

October 26, 2020

I verified the SPC Benchmark 1™ (SPC-1™ v3.9.1) test execution and performance results of the following Tested Storage Product:

MS7000G2-Mach

The results were:

SPC-1 IOPS™	**11,000,576**
SPC-1 Price-Performance	**$385.64/SPC-1 KIOPS™**
SPC-1 Total System Price	4,242,215.40
SPC-1 IOPS Response Time	0.337 ms
SPC-1 Overall Response Time	0.264 ms
SPC-1 ASU Capacity	209,379 GB
SPC-1 ASU Price	$20.27/GB

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 v.3.0.2. 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 MacroSAN Technologies Co., Ltd., 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 MacroSAN Technologies Co., Ltd., and can be found at www.spcresults.org under the Submission Identifier A32020.

Page **1** of **2**

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

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

- The physical capacity of the data repository (460,800 GB).
- The total capacity of the Application Storage Unit (209,379 GB).
- 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.
- 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:

The SPC-1 Specification requires PERSIST1 to be run with the following settings:

- 3-minute ramp up
- 10-minute measurement interval
- 1-minute ramp down
- 25% of the workload level of RAMPD_100

At sufficiently high IOPs levels and when run for the required times, the SPC-1 toolkit exhibits anomalous behavior which prevents the PERSIST1 test from completing properly.

The SPC Compliance Review Committee has reviewed this situation and granted permission for the test sponsor to run at reduced settings so that the PERSIST1 test can complete properly.

The following setting were used for this result.

- 3-minute ramp up
- 10-minute measurement interval
- 1-minute ramp down
- 17% of the workload level of RAMPD_100

Respectfully Yours,

Doug Johnson, Certified SPC Auditor

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

LETTER OF GOOD FAITH

Date: October 26, 2020

From: MacroSAN Technologies Co., Ltd.

To: Doug Johnson, SPC Auditor
PerfLabs, Inc. DBA InfoSizing
63 Lourdes Drive
Leominster, MA 01453-6709 USA

Subject: SPC-1 Letter of Good Faith for the MacroSAN MS7000G2-Mach

MacroSAN Technologies Co., Ltd. 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 V3.9.1 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.

Signed: Date:

October 26, 2020

Wang Zhiqiu
President
MacroSAN Technologies Co., Ltd.

SPC Benchmark 1™

Executive Summary

MS7000G2-Mach

SPC-1 IOPS™	**11,000,576**	SPC-1 Price Performance	**$385.64/SPC-1 KIOPS™**
SPC-1 IOPS Response Time	**0.337 ms**	SPC-1 Total System Price	**$4,242,215.40**
SPC-1 Overall Response Time	0.264 ms	SPC-1 Overall Discount	49.75%
		Currency / Target Country	USD / China
		Availability Date	Currently Available

Extensions

SPC-1 Data Reduction	NA
SPC-1 Encryption	NA
SPC-1 NDU	NA
SPC-1 Synchronous Replication	NA
SPC-1 Snapshot	NA

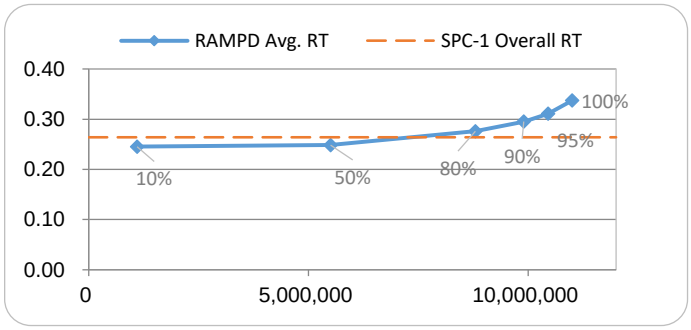
Storage Metrics

SPC-1 Data Protection Level	Protected 2
SPC-1 Physical Storage Capacity	460,800 GB
SPC-1 ASU Capacity	209,379 GB
SPC-1 ASU Price	$20.27/GB

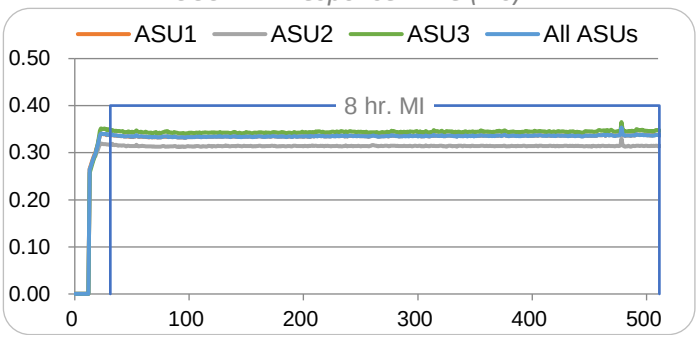
Priced Storage Configuration Summary

78	QLogic QLE2692 2-port FC HBAs
16	MS7000G2-Mach Active-Active Controllers
3,072	GB Total Cache (192 GB per controller)
256	16 Gb FC Ports (192 ports used)
288	1,600 GB SSDs
4	Brocade 6520 96-port Switches
2	10 Gb Ethernet 16-port Switches
1	Management Server
1	24-port 1 Gb Ethernet Switch
53	Total RUs

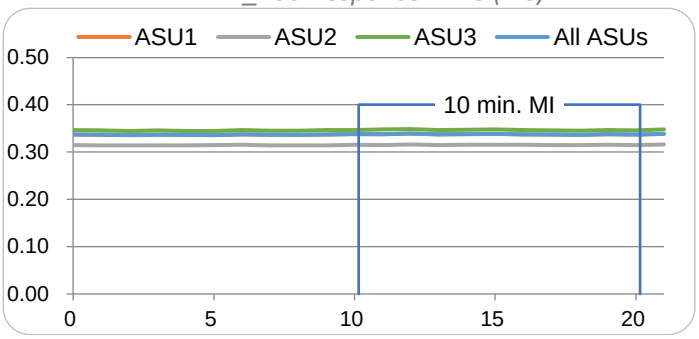
RAMPD Average Response Time (ms) vs. IOPS



SUSTAIN Response Time (ms)



RAMPD_100 Response Time (ms)



SPC Benchmark 1™ Specification Revision	v3.9.1
SPC Benchmark 1™ Workload Generator Revision	v3.0.2

Submitted for Review	October 27, 2020
Submission Details	www.storageperformance.org/r/A32020

PRICING DETAILS

Part No.	Description	Source	Qty	Unit Price	Ext. Price	Disc.	Disc. Price
Hardware & Software							
Management Suite	Management Suite(1Gb Ethernet 24-port Switch*1、Management Sever*1、KVM*1、Network Cable 1Gbps-3M*17)	1	1	11,420.21	11,420.21	50%	5,710.11
Ethernet Switch	1Gb Ethernet 24-Port+10Gb Ethernet -16-Port Switch	1	2	5,534.41	11,068.82	50%	5,534.41
MS1MMF010G	10Gb MultiMode Datacom SFP+ Optical Transceiver	1	32	417.28	13,352.96	50%	6,676.48
MS7000G2-Mach-384GB	MS7000G2-Mach Storage Controllers Unit (Dual Controllers, 5U, 384GB cache, 3Y 7x9xND Basic Svc&Warranty)	1	8	284,275.26	2,274,202.08	50%	1,137,101.04
MS2M7SD01T60M2NEA	1.6TB NVMe SSD Drive(2.5") for MS7000G2-Mach	1	288	15,461.21	4,452,828.48	50%	2,226,414.24
IOA4028A	8*16Gb FC I/O Module	1	32	10,541.73	337,335.36	50%	168,667.68
LIS_MS7000_MACH_BASE_STD	MacroSAN ODSP for Multi Control - MS7000G2-Mach Storage Management Software (Basic Storage Management, CRAID, support FC&iSCSI, System Monitoring and Warning)	1	1	34,260.62	34,260.62	50%	17,130.31
LIS_MS7000_MACH_2C_EXPAND	MacroSAN ODSP-MS7000G2-Mach Storage System Management Software -2 Controllers EXPAND	1	7	22,489.02	157,423.14	50%	78,711.57
MS1MMF010G	10Gb MultiMode Datacom SFP+ Optical Transceiver	1	32	417.28	13,352.96	50%	6,676.48
DLC05-DLC05-2MI2-L5/0.2	10M Fiber Cable(Multimode, LC-LC)	1	32	17.57	562.24	50%	281.12
QLogic QLE2692	Qlogic QLE2692 HBA Card, PCIE, 16Gbps 2-Ports, Fiber Channel Multimode LC Optic Interface	1	78	3,953.15	308,345.70	50%	154,172.85
FS6520	Brocade 6520 16Gbps FC Switch with 96 available ports ,including 96*16Gbps SFPs,Double-Power Supply,AC	1	4	189,985.36	759,941.44	50%	379,970.72
						Hardware & Software Subtotal	**4,187,047.01**
Support & Maintenance							
MS7000G2-MACH-SV-BS-SPU	MS7000G2-Mach Installation Service - Per Node	1	8	2,745.25	21,962.00	20%	17,569.60
MS7000G2-MACH-SV-GS-1Y-SPU	MS7000G2-Mach Svc&Warranty Upgrade - 7x24x4 Premium - Per Year Per Node	1	24	1,958.27	46,998.48	20%	37,598.79
						Support & Maintenance Subtotal	**55,168.39**
SPC-1 Total System Price							**4,242,215.40**
SPC-1 IOPS™							11,000,576
SPC-1 Price-Performance™ ($/SPC-1 KIOPS™)							**385.64**
SPC-1 ASU Capacity (GB)							209,379
SPC-1 ASU Price ($/GB)							**20.27**

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

Warranty: Pricing includes Premium service with: 24x7 online support, unlimited software upgrades and bug fixes, and on-site presence of a qualified maintenance engineer within 4 hours of a problem acknowledgement, inside the Target Market.

Differences Between Tested and Priced Storage Configurations

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

PUBLICATION DETAILS

This section provides contact information for the test sponsor and auditor, a revision history of this document, and a description of any exceptions or waivers associated with this publication.

Contact Information

Role	Name	Details
Test Sponsor Primary Contact	MacroSAN Technologies Co., Ltd. Yi Shen	www.macrosan.com/en/ shenyi@macrosan.com
SPC Auditor	InfoSizing Doug Johnson	www.sizing.com doug@sizing.com

Revision Information

Date	FDR Revision	Details
October 27, 2020	First Edition	Initial Publication

Exceptions and Waivers

The SPC-1 Specification requires PERSIST1 to be run with the following settings:

- 3-minute ramp up
- 10-minute measurement interval
- 1-minute ramp down
- 25% of the workload level of RAMPD_100

At sufficiently high IOPs levels and when run for the required times, the SPC-1 toolkit exhibits anomalous behavior which prevents the PERSIST1 test from completing properly.

The SPC Compliance Review Committee has reviewed this situation and granted permission for the test sponsor to run at reduced settings so that the PERSIST1 test can complete properly.

The following setting were used for this result.

- 3-minute ramp up
- 10-minute measurement interval
- 1-minute ramp down
- 17% of the workload level of RAMPD_100

CONFIGURATION INFORMATION

Tested Storage Product Description

MacroSAN MS7000G2-Mach is an all-flash storage array based on NVMe protocol newly launched by MacroSAN Technologies, which uses NVMe SSD as storage medium. MS7000G2-Mach storage products adopt a brand-new hardware architecture and software algorithm for the NVMe protocol, release the performance of flash memory particles in all directions, and provide several times the read and write performance of traditional flash memory arrays. The MacroSAN MS7000G2-Mach all-flash storage product can provide extreme performance, comprehensive data protection and full product lifecycle solutions for key services such as data center IO-intensive and delay sensitivity.

Host System and Tested Storage Configuration Components

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

Host Systems
39 x Sugon I620-G30, each with: 2 x Intel® Xeon® Silver 4116 CPU (2.1 GHz, 12-Core, 16.5 MB L3) (20 host systems) 2 x Intel® Xeon® Silver 4214 CPU (2.2 GHz, 12-Core, 16.5 MB L3) (19 host systems) 64 GB Main Memory (all host systems) CentOS Linux Release 7.4.1708 (all host systems)
Tested Storage Configuration
78 x QLogic QLE2692 2-port HBAs
16 x MS7000G2-Mach Active-Active Controllers, each with: 192 GB cache (3,072 GB total) 32 x 8-port 16 Gbps FC I/O modules (256 ports total, 192 used) 8 x 4-port 10 Gb Ethernet 8 x 5U Internal Enclosures, each with: 36 x 1,600 GB SSDs (288 total)
2 x 10 Gb Ethernet 16-port switches 1 x 1 Gb Ethernet 24-port switch 1 x Management Server

Component Changes in Revised Full Disclosure Report

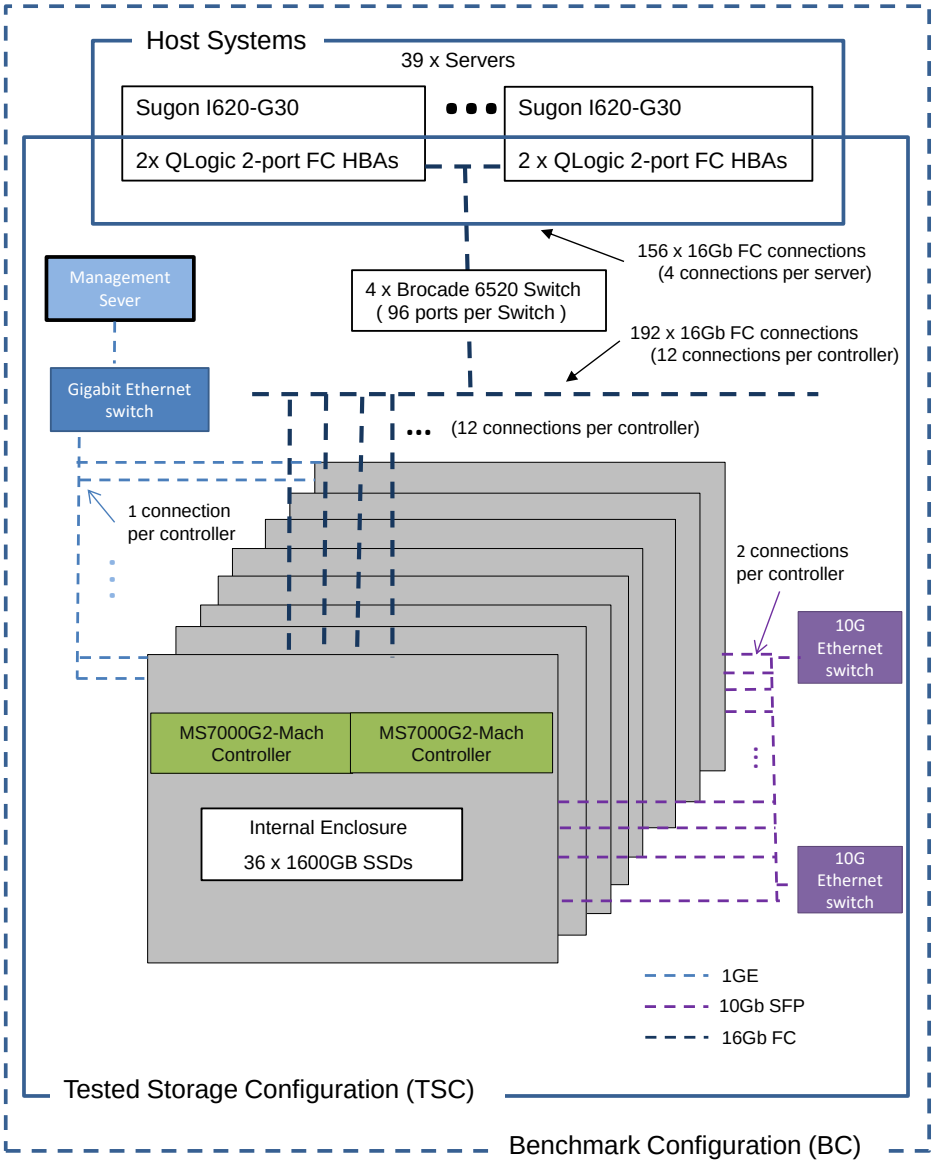
The following table outlines component changes that were made in revisions to this Full Disclosure Report.

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

Configuration Diagrams

BC/TSC Configuration Diagram

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



Storage Network Configuration

The Tested Storage Configuration (TSC) comprised an external storage subsystem of eight MacroSAN MS7000G2 Storage Controller Units, each with two storage controllers. They were driven by 39 host systems (Sugon I620-G30). Each host had one 16 Gb FC connection to each of four Brocade 6520 switches (156 total connections). Each of the 16 storage controllers had three 16 Gb FC connections to each of the four Brocade switches (192 total connections).

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 Application Storage Unit Mapping

The following table details the capacity of the Application Storage Units (ASUs) and how they are mapped to logical volumes (LVs). All capacities are reported in GB.

	LV per ASU	LV Capacity	Used per LV	Total per ASU	% ASU Capacity	Optimized*
ASU-1	30	3,140.6	3,140.6	94,220.8	45.0%	No
ASU-2	3	31,406.9	31,406.9	94,220.8	45.0%	No
ASU-3	3	6,979.3	6,979.3	20,937.9	10.0%	No
	SPC-1 ASU Capacity			209,379		

*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. All capacities are reported in GB.

Devices	Count	Physical Capacity	Total Capacity
NVMe SSD	288	1,600.0	460,800.0
	Total Physical Capacity		**460,800**
	Physical Capacity Utilization		**45.44%**

Data Protection

The data protection level used for all LVs was **Protected 2 (RAID10)**, which was accomplished by configuring 48 pools, each 6 drives, into 48 RAID-10 arrays. All

components and access paths from the Host systems to the Storage Devices were redundant.

Space Optimization Information

Description of Utilized Techniques

The TSC did not use any space optimization techniques.

Physical Free Space Metrics

The following table lists the Physical Free Space as measured at each of the required points during test execution. If space optimization techniques were not used, "NA" is reported.

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

The following table lists the required space optimization metrics. If space optimization techniques were not used, "NA" is reported.

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

BENCHMARK EXECUTION RESULTS

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

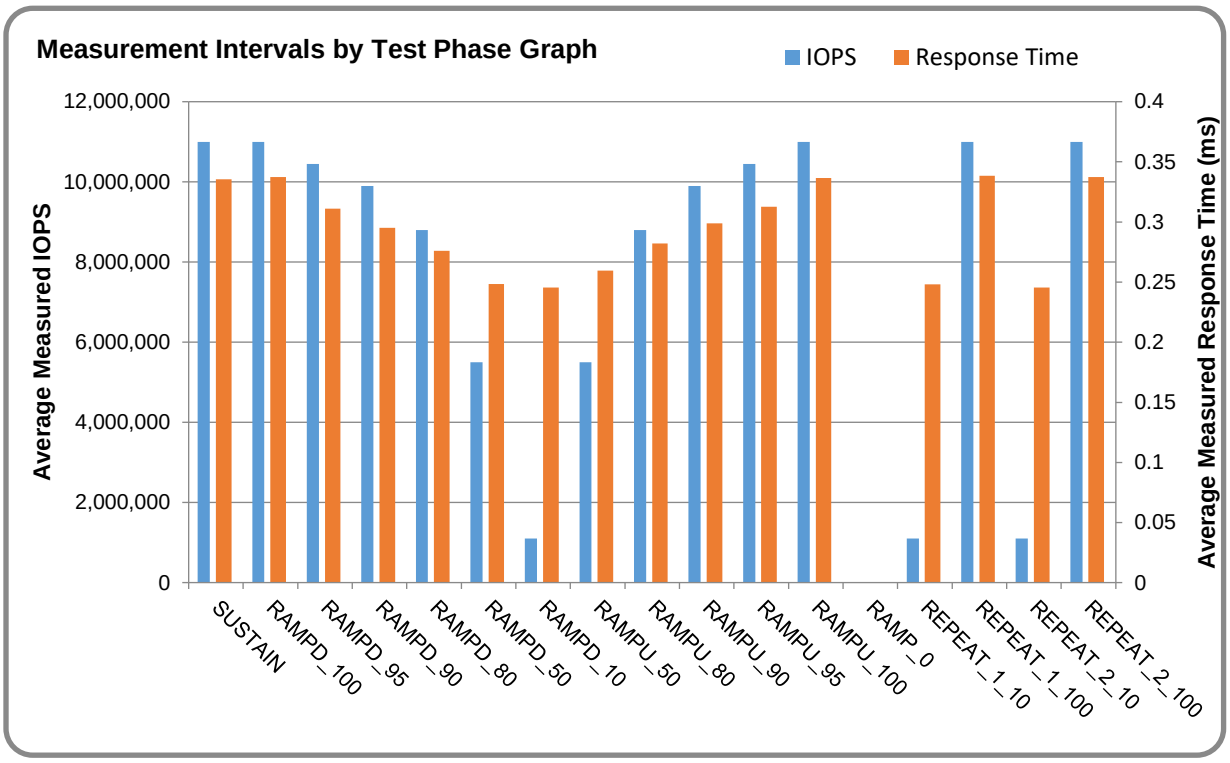
Benchmark Execution Overview

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).

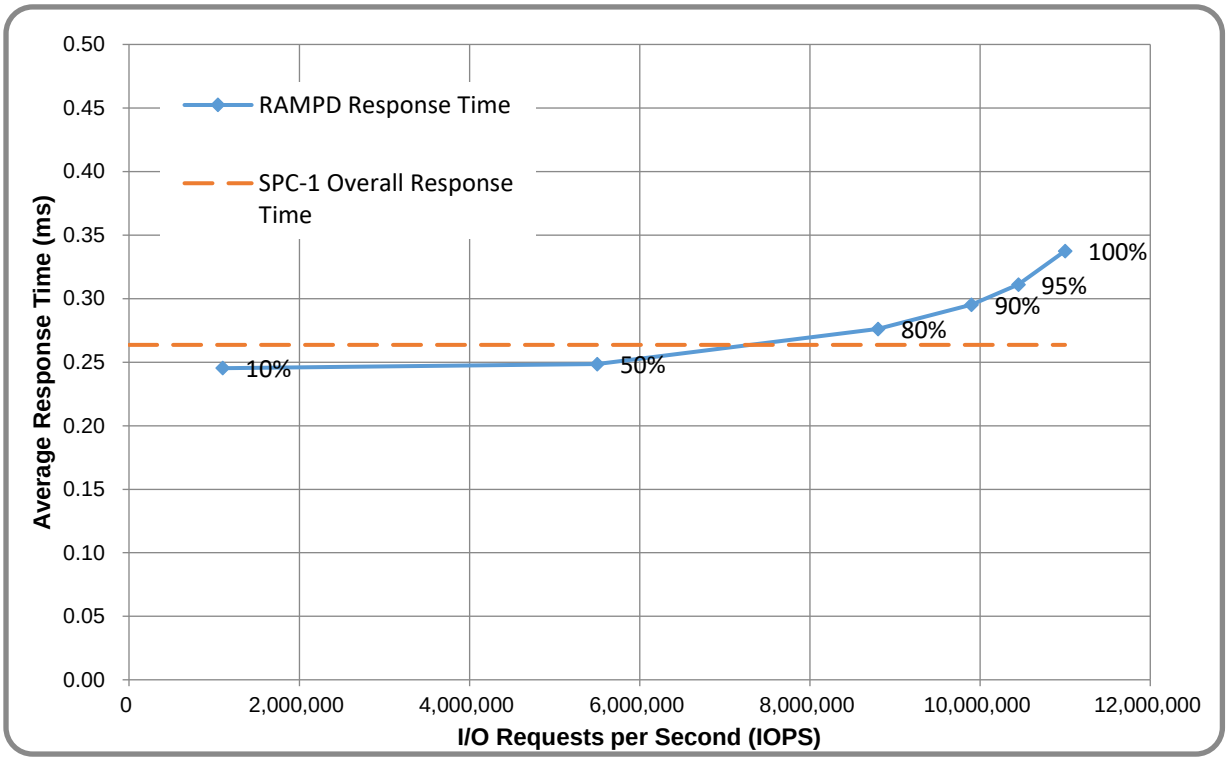
Measurement Intervals by Test Phase Graph

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



Response Time vs. Throughput Graph

The following graph presents the average Response Times versus the average IOPS for RAMPD_100 to RAMPD_10.



ASU Pre-Fill

The following table provides a summary of the Pre-Fill performed on the ASU prior to testing.

ASU Pre-Fill Summary			
Start Time	19-Oct-20 16:53:18	**Requested IOP Level**	27,962 MB/sec
End Time	19-Oct-20 18:57:51	**Observed IOP Level**	28,019 MB/sec
Duration	2:04:33	For additional details see the Supporting Files.	

SUSTAIN Test Phase

SUSTAIN – Results File

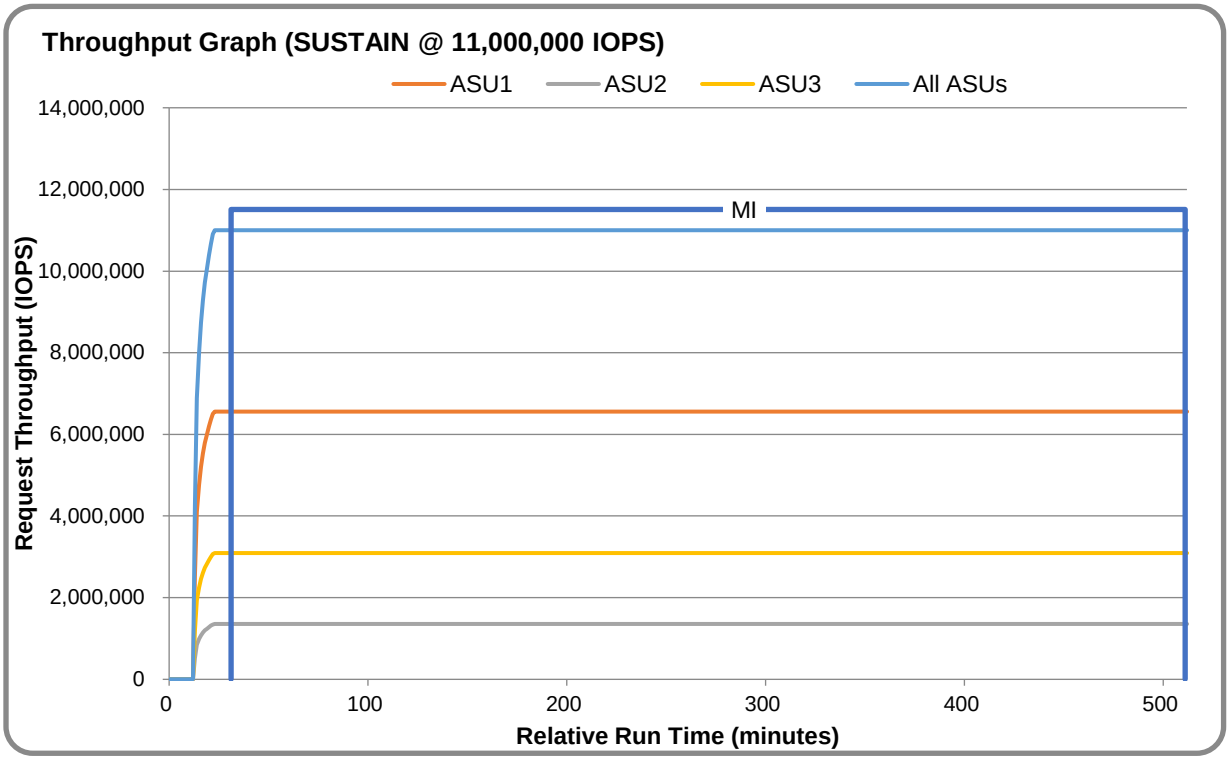
The results file generated during the execution of the SUSTAIN Test Phase is included in the Supporting Files (see Appendix A) as follows:

- **SPC1_METRICS_0_Raw_Results.xlsx**

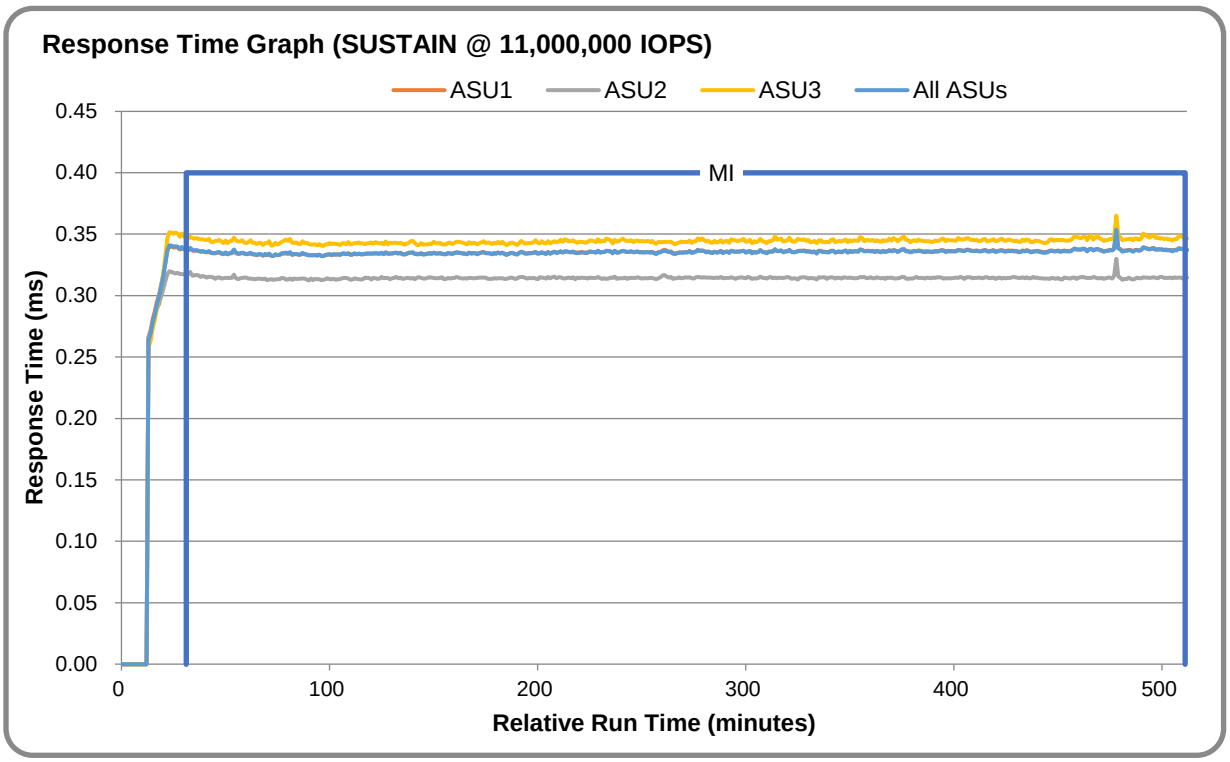
SUSTAIN – Execution Times

Interval	Start Date & Time	End Date & Time	Duration
Transition Period	19-Oct-20 19:15:07	19-Oct-20 19:35:06	0:19:59
Measurement Interval	19-Oct-20 19:35:06	20-Oct-20 03:35:07	8:00:01

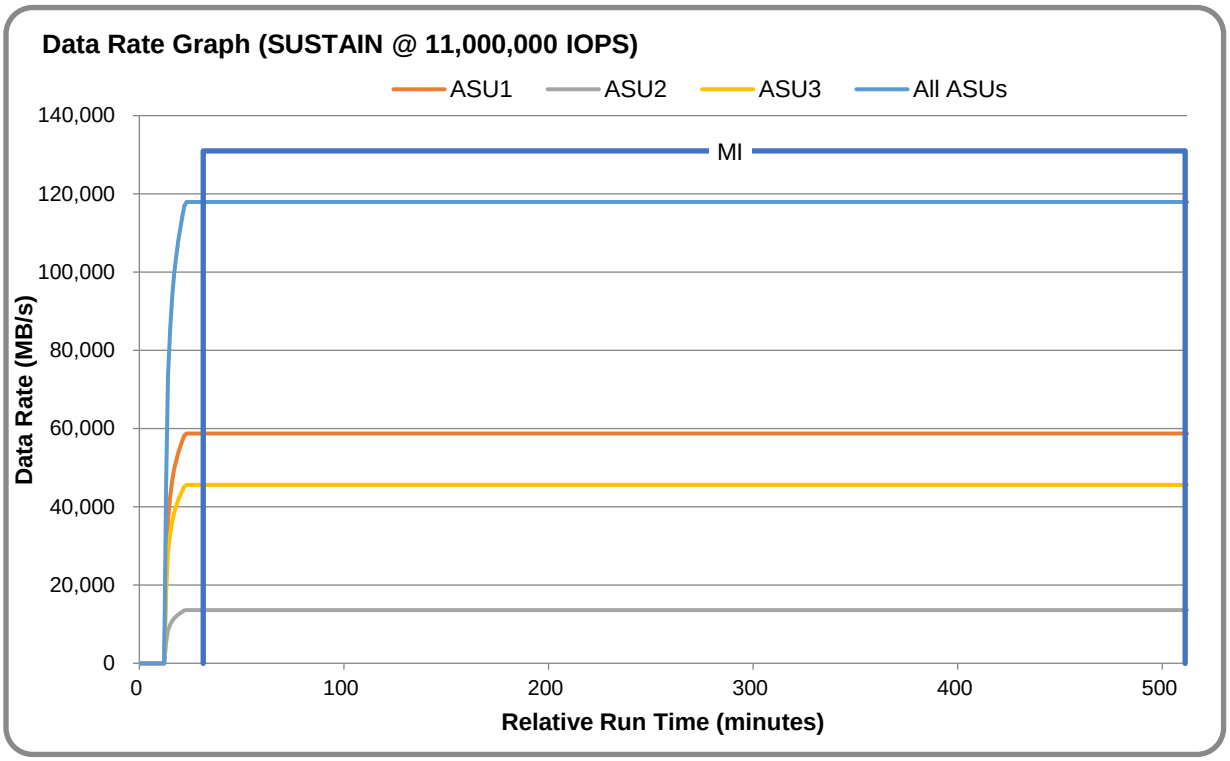
SUSTAIN – Throughput Graph



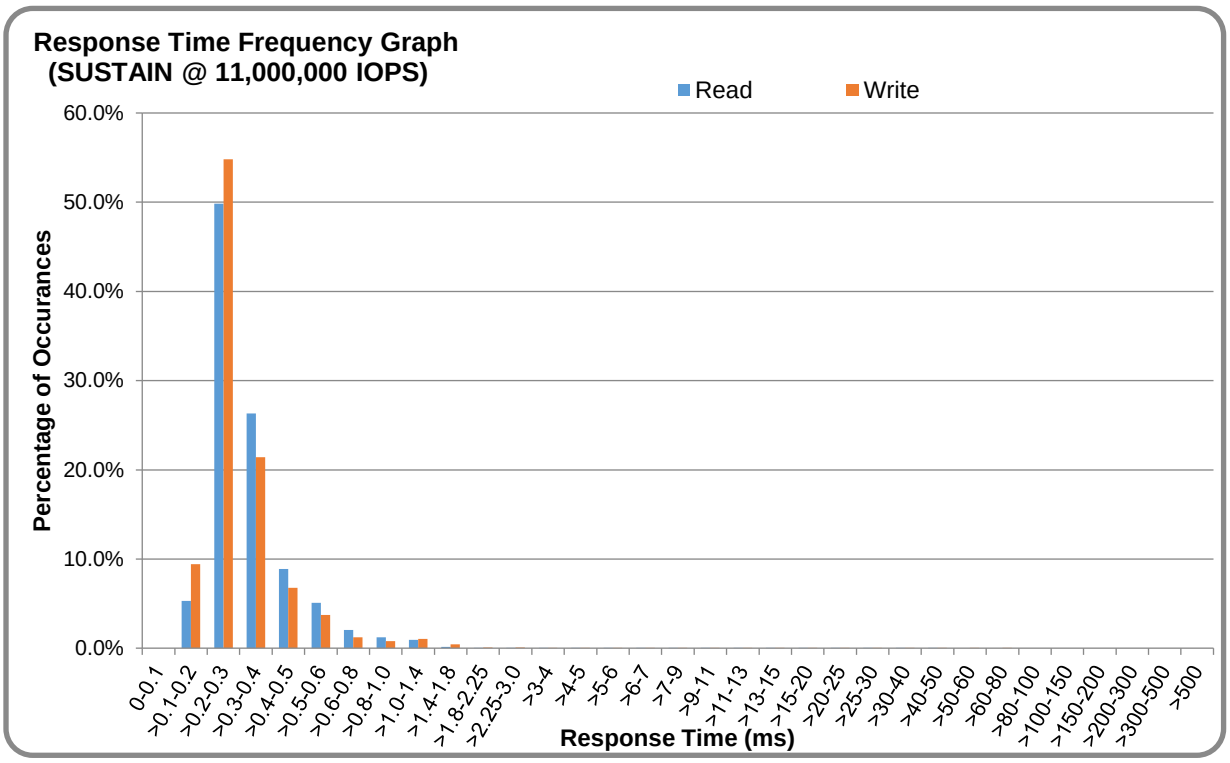
SUSTAIN – Response Time Graph



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 Defined 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	0.0002	0.0001	0.0001	0.0001	0.0003	0.0001	0.0002	0.0001
Difference	0.005%	0.001%	0.005%	0.001%	0.004%	0.004%	0.003%	0.001%

RAMPD_100 Test Phase

RAMPD_100 – Results File

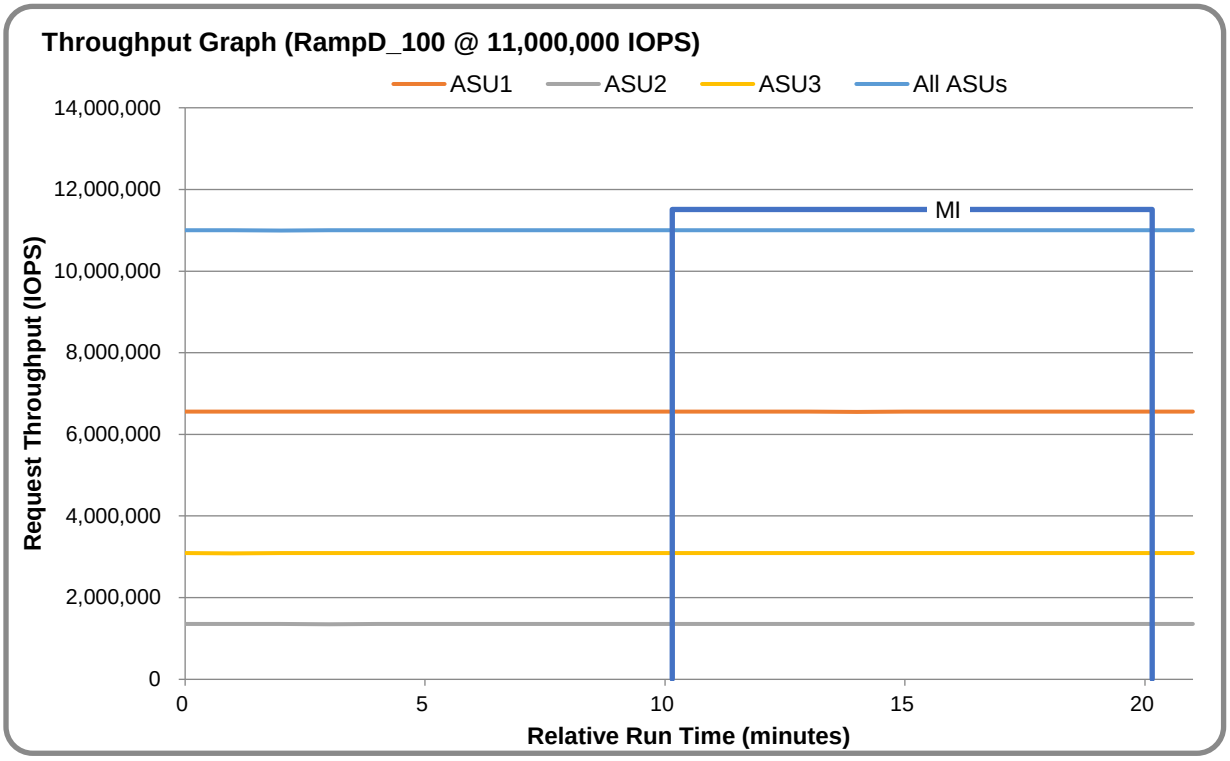
The results file generated during the execution of the RAMPD_100 Test Phase is included in the Supporting Files (see Appendix A) as follows:

- **SPC1_METRICS_0_Raw_Results.xlsx**

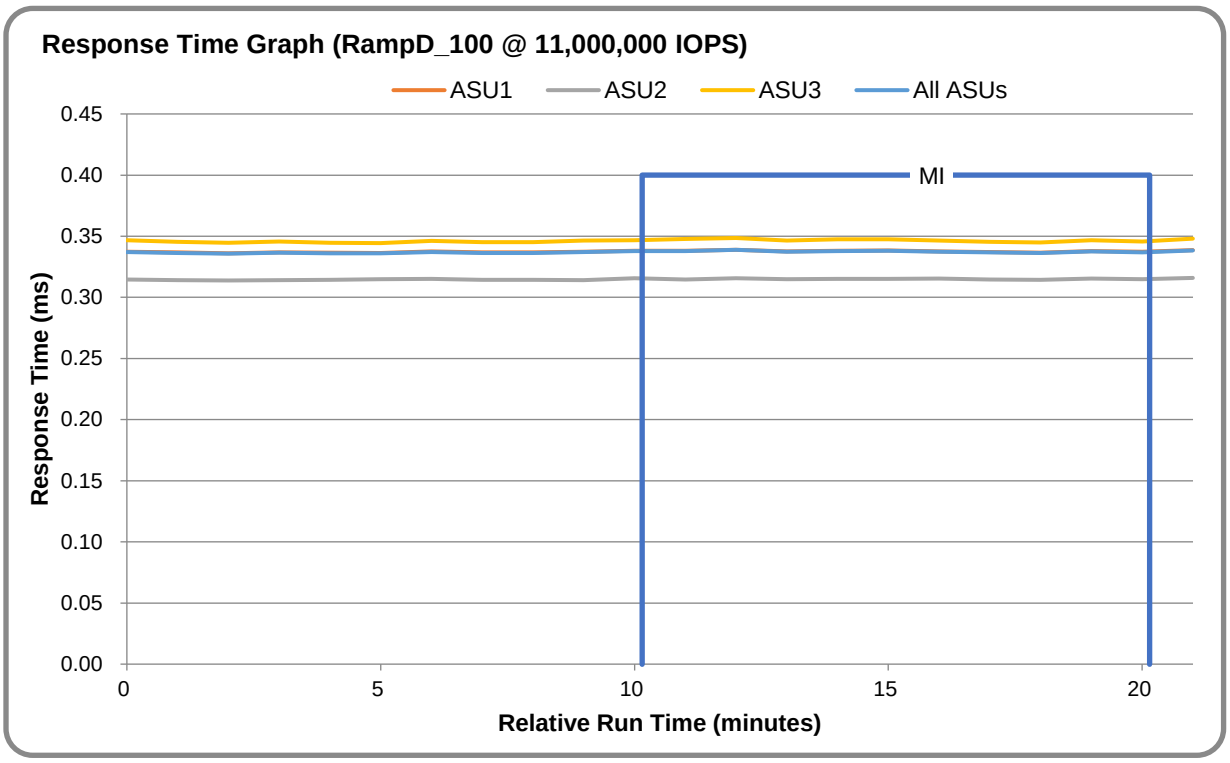
RAMPD_100 – Execution Times

Interval	Start Date & Time	End Date & Time	Duration
Transition Period	20-Oct-20 03:36:06	20-Oct-20 03:46:06	0:10:00
Measurement Interval	20-Oct-20 03:46:06	20-Oct-20 03:56:07	0:10:01

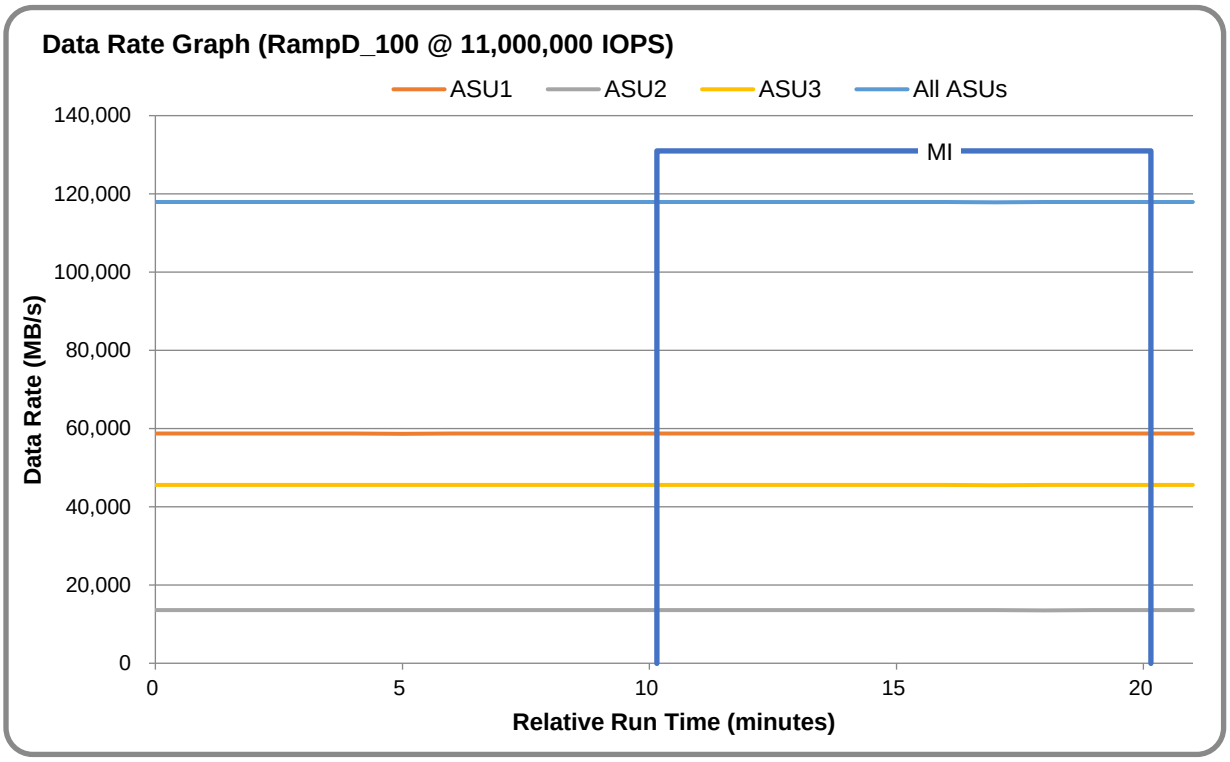
RAMPD_100 – Throughput Graph



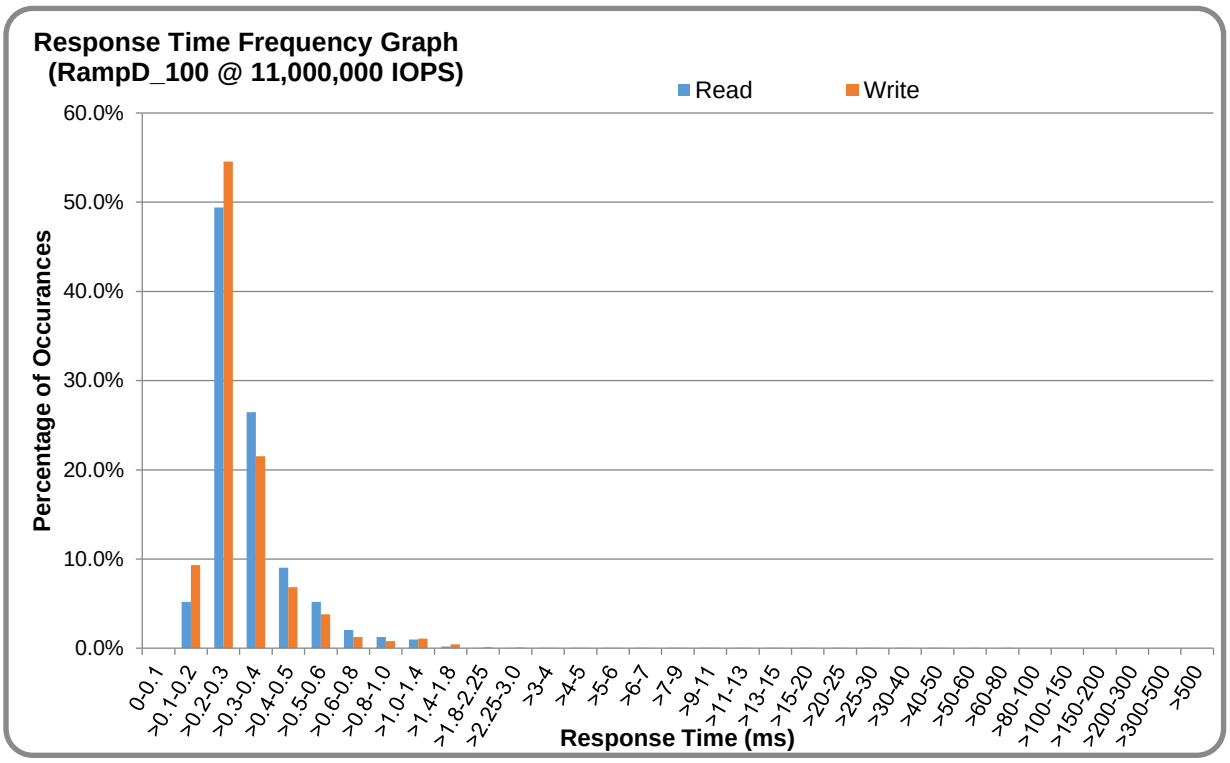
RAMPD_100 – Response Time Graph



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 Defined 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	0.0002	0.0000	0.0001	0.0001	0.0002	0.0001	0.0002	0.0001
Difference	0.000%	0.000%	0.003%	0.001%	0.014%	0.000%	0.005%	0.000%

RAMPD_100 – I/O Request Summary

I/O Requests Completed in the Measurement Interval	6,600,371,143
I/O Requests Completed with Response Time <= 30 ms	6,600,336,752
I/O Requests Completed with Response Time > 30 ms	34,391

Response Time Ramp Test

Response Time Ramp Test – Results File

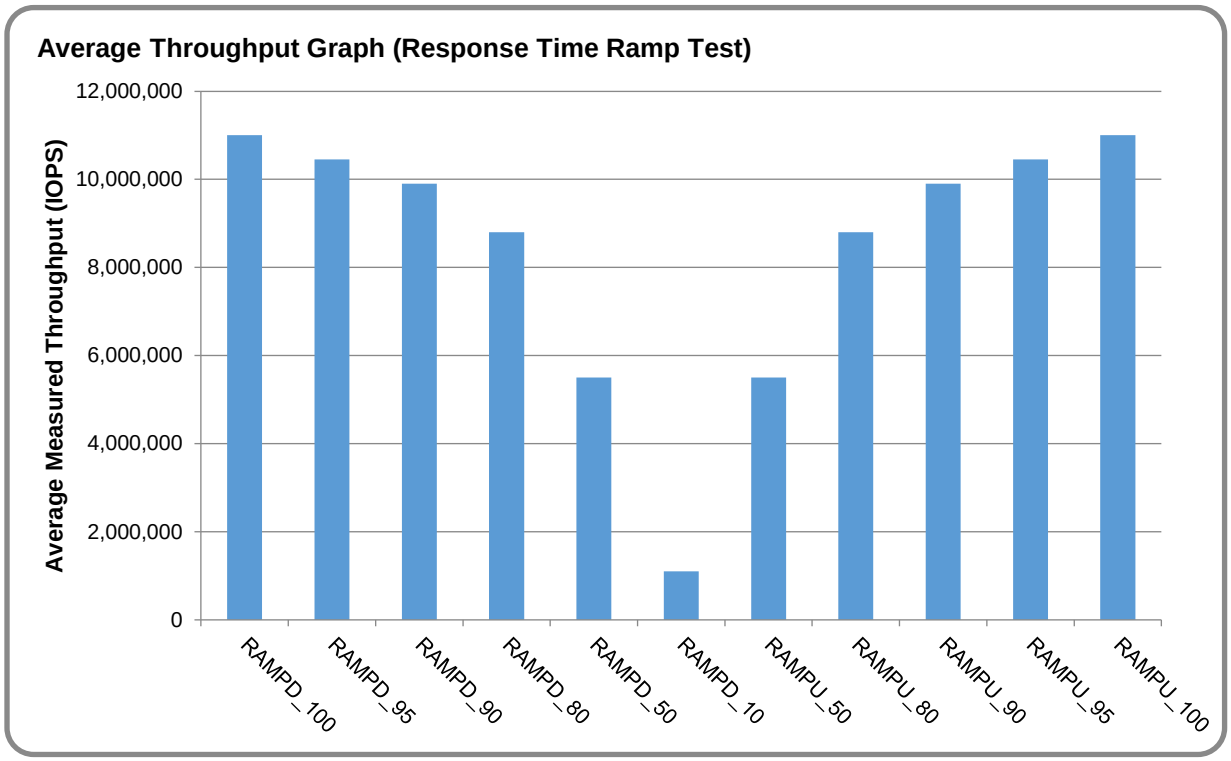
The results file generated during the execution of the Response Time Ramp Test is included in the Supporting Files (see Appendix A) as follows:

- **SPC1_METRICS_0_Raw_Results.xlsx**

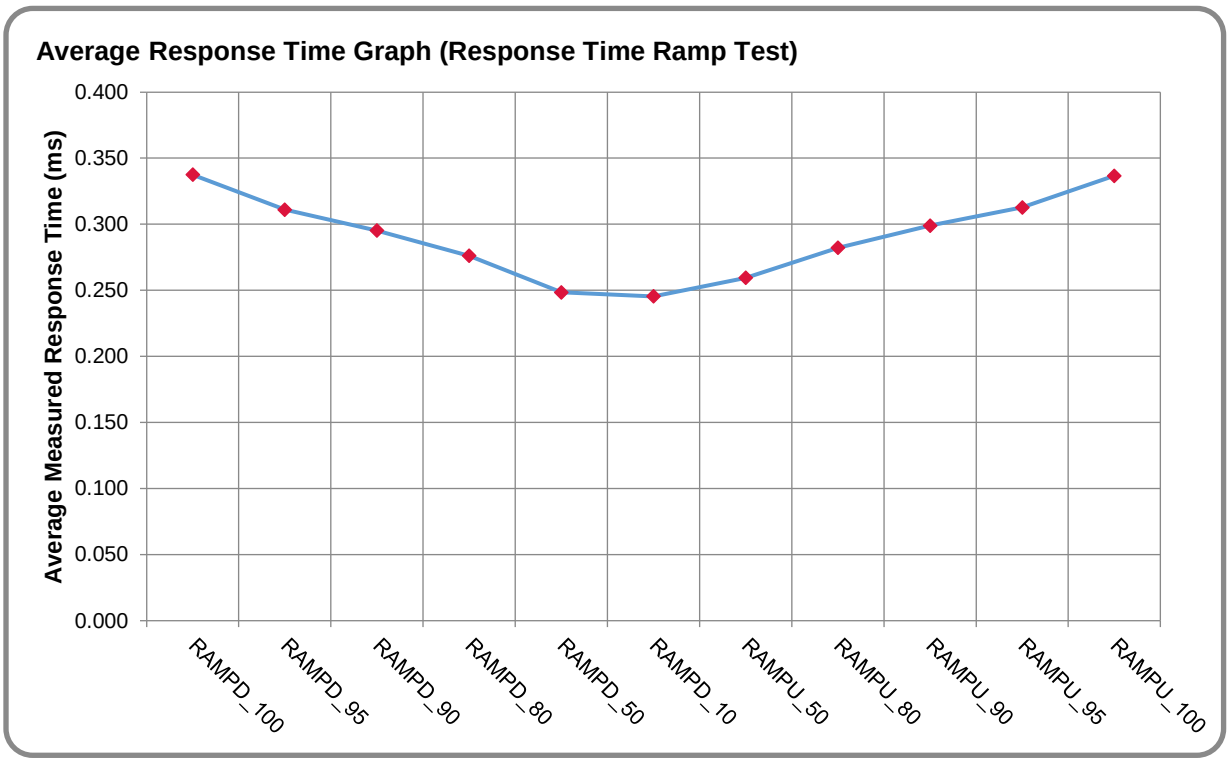
Response Time Ramp Test – Phases

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).

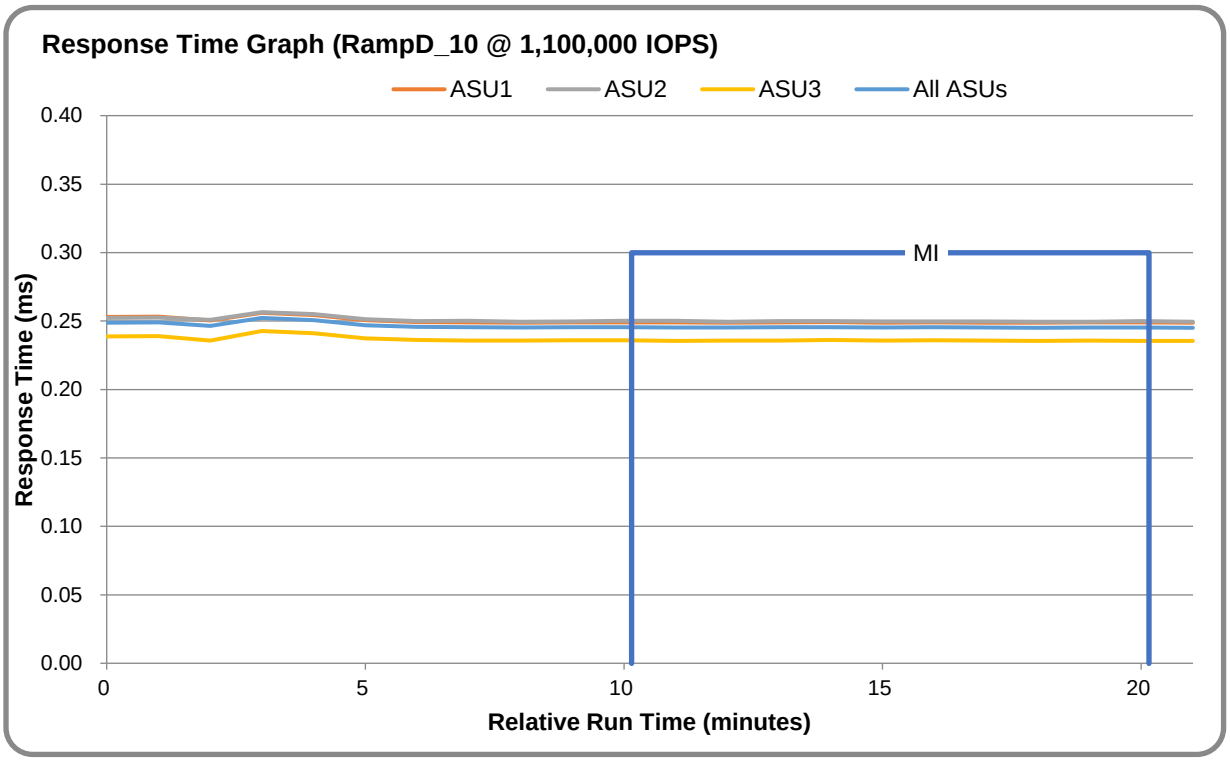
Response Time Ramp Test – Average Throughput Graph



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:

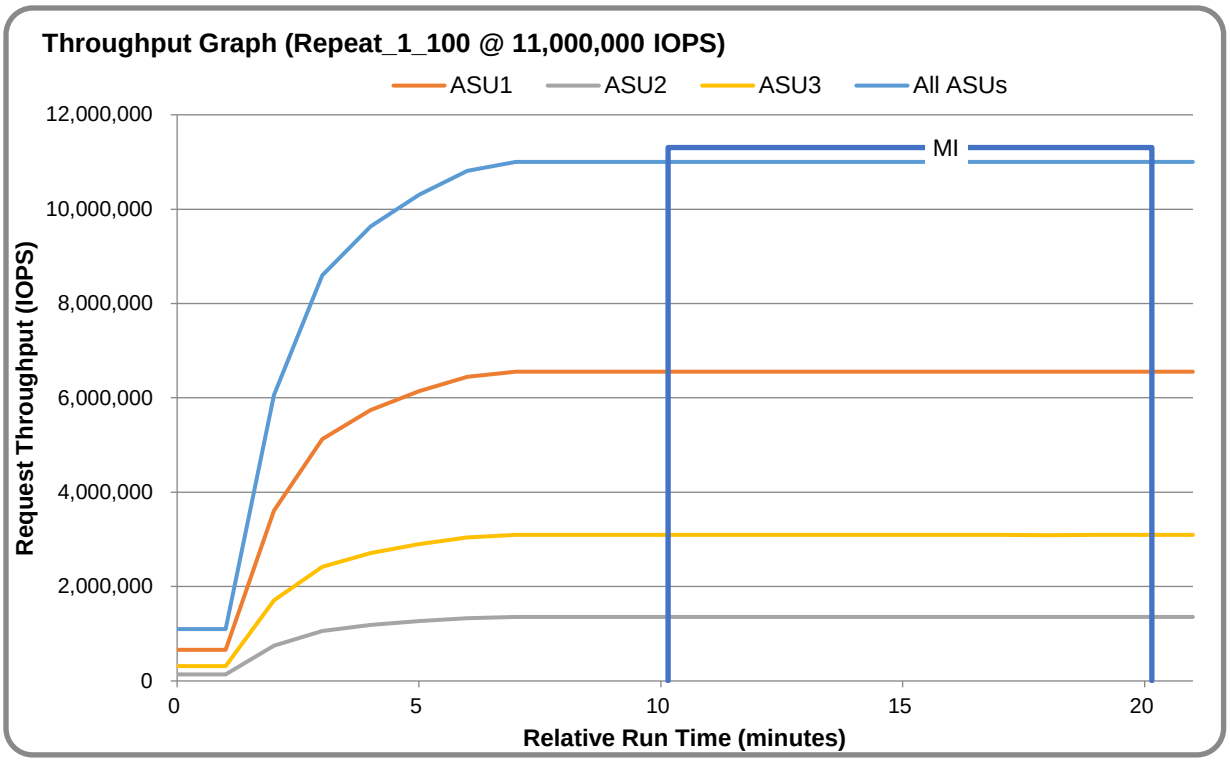
- **SPC1_METRICS_0_Raw_Results.xlsx**

Repeatability Test Results

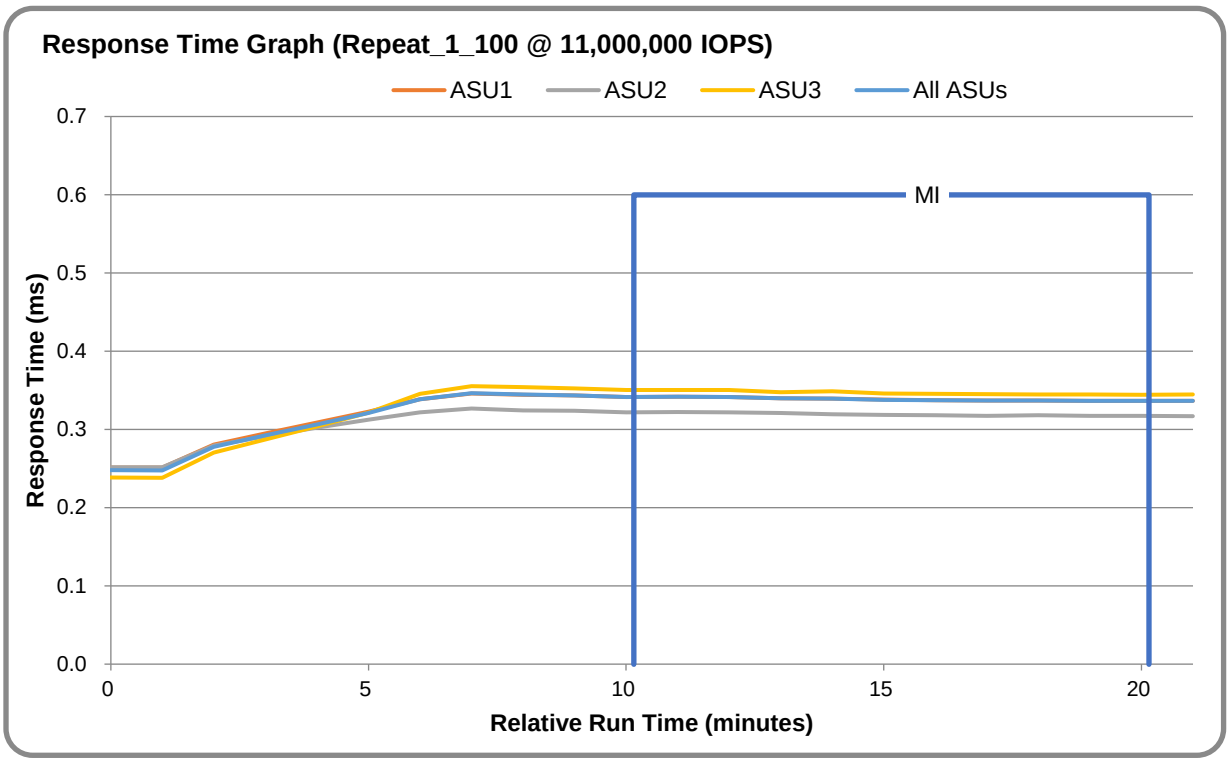
The throughput measurements for the Response Time Ramp Test (RAMPD) and the Repeatability Test Phases (REPEAT_1 and REPEAT_2) are listed in the table below.

Test Phase	100% IOPS	10% IOPS
RAMPD	11,000,576.6	1,100,070.7
REPEAT_1	11,000,748.4	1,099,995.0
REPEAT_2	11,000,561.9	1,100,060.4

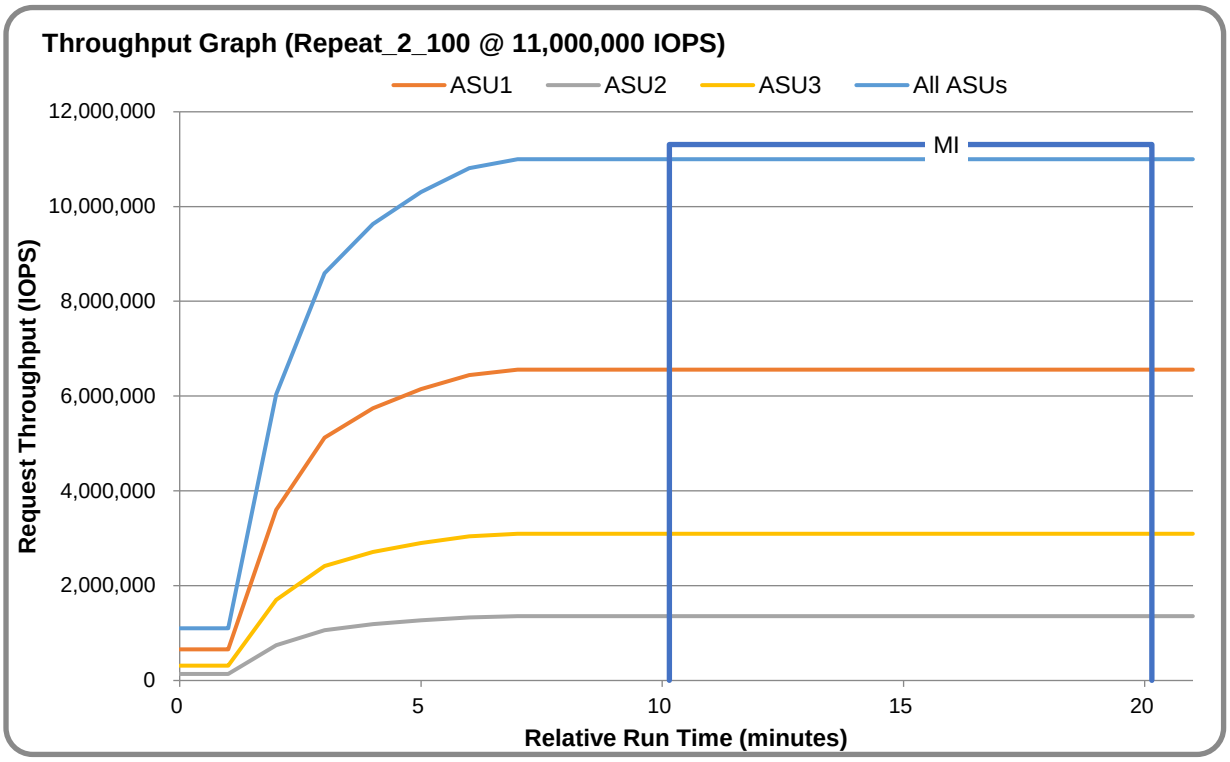
REPEAT_1_100 – Throughput Graph



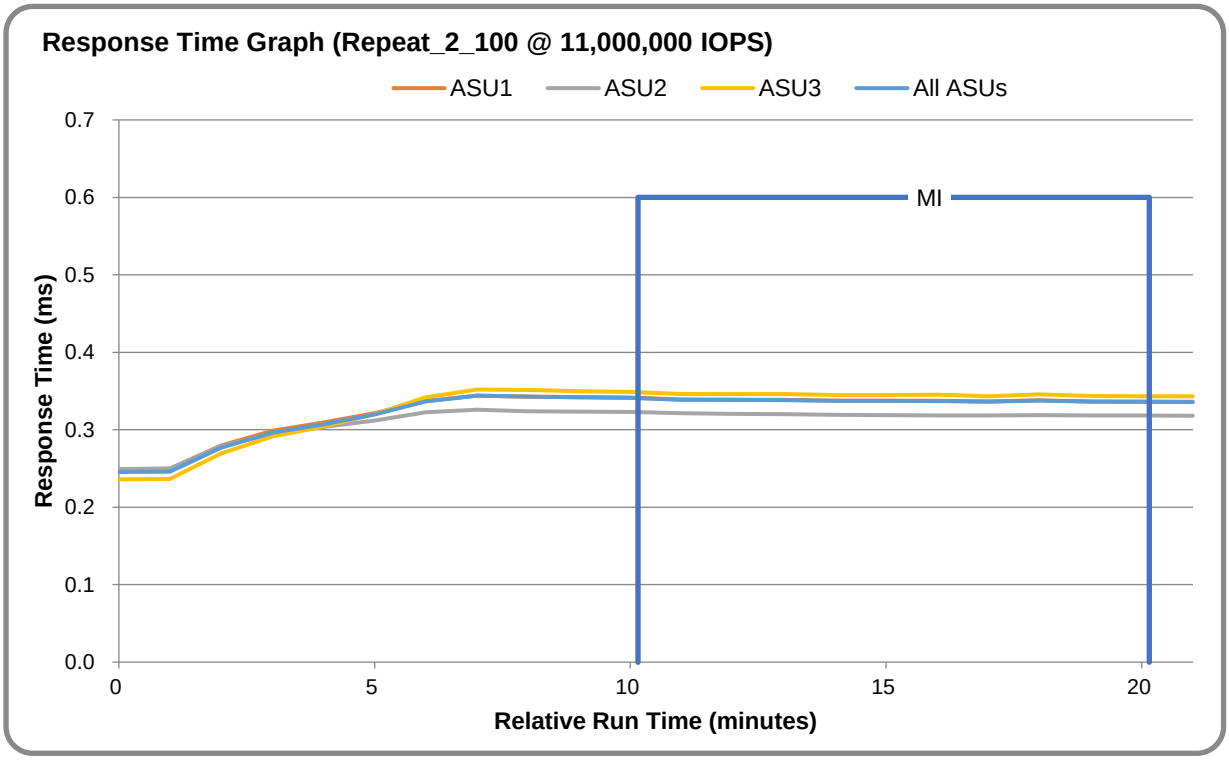
REPEAT_1_100 – Response Time Graph



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 Defined 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	0.0003	0.0001	0.0001	0.0001	0.0002	0.0001	0.0002	0.0001
Difference	0.003%	0.003%	0.001%	0.002%	0.011%	0.007%	0.003%	0.003%

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	0.0002	0.0001	0.0001	0.0001	0.0003	0.0002	0.0003	0.0001
Difference	0.004%	0.000%	0.002%	0.002%	0.001%	0.002%	0.008%	0.002%

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	1,544,784,565
Total Number of Logical Blocks Verified	754,816,683
Total Number of Logical Blocks Overwritten	789,967,882
Total Number of Logical Blocks that Failed Verification	0
Time Duration for Writing Test Logical Blocks (sec.)	601
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

Each Node of MS7000G2-Mach has six system disks and three batteries in the Storage Processor Unit where the two Active-Active Controllers reside. When a failure occurs and the Storage Processor Unit loses power, the controllers can flush the data in the cache to the system disks for permanent preservation with the built-in battery. When the Node is started again, the data on the system disk will be recovered automatically.

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**
aio-max-nr.sh	Set maximum asynchronous I/O	/C_Tuning
nr_request.sh	Increase disk queue depth	/C_Tuning
scheduler.sh	Change the I/O scheduler	/C_Tuning
/D_Creation	**Storage configuration creation**	**root**
init_MS7000G2-Mach.sh	Create the storage environment	/D_Creation
mklvm_MS7000G2-Mach.sh	Create the logical volumes	/D_Creation
lvm-active.sh	Activate the logical volumes	/D_Creation
/E_Inventory	**Configuration inventory**	**root**
profile_MS7000G2-Mach.sh	Captures storage devices profiles	/E_Inventory
profile_start_MS7000G2-Mach.txt	List of storage devices before INIT	/E_Inventory
profile_end_MS7000G2-Mach.txt	List of storage devices after restart	/E_Inventory
volume_list.sh	Captures list of logical volumes	/E_Inventory
volume_listing_start.txt	List of logical volumes before INIT	/E_Inventory
volume_listing_end.txt	List of logical volumes after restart	/E_Inventory
/F_Generator	**Workload generator**	**root**
40p.HST	Host configuration file	/F_generator
slave_asu.asu	Defines LUNS hosting the ASUs	/F_generator
MS7000G2-Mach_test_phase1.sh	Execute test phases up to VERIFY_1	/F_generator
MS7000G2-Mach_test_phase2.sh	Execute PERSIST_1	/F_generator
MS7000G2-Mach_test_phase3.sh	Execute PERSIST_2	/F_generator

APPENDIX B: THIRD PARTY QUOTATION

All components are available directly through the Test Sponsor (MacroSAN Technologies Co., Ltd.).

APPENDIX C: TUNING PARAMETERS AND OPTIONS

The following scripts, listed below, were used to set tuning parameters and options:

- aio-max-nr.sh to set the maximum asynchronous I/O
- nr_request.sh to increase the disk queue depth
- scheduler.sh to change the I/O scheduler

The scripts described above are included in the Supporting Files (see Appendix A).

APPENDIX D: STORAGE CONFIGURATION CREATION

Step 1: Create Storage Pool, RAIDs, LUNs, Clients, Mapping and deploy LUNs.

Execute the init_MS7000G2-Mach.sh script on either of the Storage Controllers via a CLI session to complete the following:

1. Create 6 storage pool for each Node.
2. Create 48 RAID10,each Node has 6 RAID10
3. Create 384 LUNs(8 LUNs in per RAID10, ALL LUNs have a capacity of 520GB).
4. Create 156 Clients each Node.
5. Add Host System FC Initiators to Clients (1 Initiator per Client)
6. Create Storage Targets to Clients (6 Target per Client and each Target is associated with 1 FC port)
7. Add LUNs to Targets (4 LUNs per Target)

Step 2: Create Volumes on the Master Host System

Configure the multipath.conf file and enable the multipath service. Execute the mklvm_MS7000g2-Mach.sh script on the Master Host System to create 36 logical volumes as follows:

1. Create Physical Volume

Create 384 physical volumes using the pvcreate command.

2. Create Volumes Groups

Create 3 volume groups using the vgcreate command as follows:

Create vg1 using the following 128 physical volumes: /dev/mapper/mpathfhp /dev/mapper/mpathfgf /dev/mapper/mpathfho /dev/mapper/mpathfgk /dev/mapper/mpathfih /dev/mapper/mpathfhb /dev/mapper/mpathfif /dev/mapper/mpathfgq/dev/mapper/mpathfcz /dev/mapper/mpathfcv /dev/mapper/mpathfdi /dev/mapper/mpathfco /dev/mapper/mpathezj /dev/mapper/mpatheyv /dev/mapper/mpatheza /dev/mapper/mpatheyy /dev/mapper/mpathfjh /dev/mapper/mpathfib /dev/mapper/mpathfjc /dev/mapper/mpathfhm /dev/mapper/mpathfjx /dev/mapper/mpathfiu /dev/mapper/mpathfjs /dev/mapper/mpathfik /dev/mapper/mpathfdz /dev/mapper/mpathfdl /dev/mapper/mpathfdw /dev/mapper/mpathfds /dev/mapper/mpathfad /dev/mapper/mpathezn /dev/mapper/mpathfag /dev/mapper/mpathezq /dev/mapper/mpathflv /dev/mapper/mpathfkh /dev/mapper/mpathflr /dev/mapper/mpathfiy /dev/mapper/mpathfmd /dev/mapper/mpathfkz /dev/mapper/mpathfmj /dev/mapper/mpathfkw /dev/mapper/mpathffp /dev/mapper/mpathfer /dev/mapper/mpathffo /dev/mapper/mpathfeo /dev/mapper/mpathfbh /dev/mapper/mpathfap /dev/mapper/mpathfbg /dev/mapper/mpathfas /dev/mapper/mpathflf /dev/mapper/mpathfmi /dev/mapper/mpathfln /dev/mapper/mpathfmc /dev/mapper/mpathfhf /dev/mapper/mpathfmx /dev/mapper/mpathfcm /dev/mapper/mpathfni /dev/mapper/mpathffj /dev/mapper/mpathfft /dev/mapper/mpathffc /dev/mapper/mpathffy /dev/mapper/mpathfbz /dev/mapper/mpathfbl /dev/mapper/mpathfcc /dev/mapper/mpathfbk /dev/mapper/mpathfjp /dev/mapper/mpathfgh /dev/mapper/mpathfjv /dev/mapper/mpathfgm /dev/mapper/mpathfjd /dev/mapper/mpathfhd /dev/mapper/mpathfke /dev/mapper/mpathfgv /dev/mapper/mpathfdb /dev/mapper/mpathfcx /dev/mapper/mpathfei /dev/mapper/mpathfcq /dev/mapper/mpathezv /dev/mapper/mpathezf /dev/mapper/mpathfai /dev/mapper/mpatheze /dev/mapper/mpathfjj /dev/mapper/mpathfie /dev/mapper/mpathfjg /dev/mapper/mpathfhk /dev/mapper/mpathfka /dev/mapper/mpathfiq /dev/mapper/mpathfjw /dev/mapper/mpathfio /dev/mapper/mpathfeb /dev/mapper/mpathfdn /dev/mapper/mpathfdy /dev/mapper/mpathfdq /dev/mapper/mpathfbb /dev/mapper/mpathezr /dev/mapper/mpathfay /dev/mapper/mpathezi /dev/mapper/mpathflx /dev/mapper/mpathfkl /dev/mapper/mpathflu /dev/mapper/mpathfiv /dev/mapper/mpathfly /dev/mapper/mpathflc /dev/mapper/mpathfmm /dev/mapper/mpathfky /dev/mapper/mpathffr /dev/mapper/mpathfet /dev/mapper/mpathffm /dev/mapper/mpathfeq /dev/mapper/mpathfbn /dev/mapper/mpathfch /dev/mapper/mpathfbq /dev/mapper/mpathfcg /dev/mapper/mpathflb /dev/mapper/mpathfmn /dev/mapper/mpathflk /dev/mapper/mpathfmh /dev/mapper/mpathfhh /dev/mapper/mpathfmz /dev/mapper/mpathfli /dev/mapper/mpathfng /dev/mapper/mpathffh /dev/mapper/mpathffv /dev/mapper/mpathffa /dev/mapper/mpathfga /dev/mapper/mpathfaj /dev/mapper/mpathfcd /dev/mapper/mpathfam /dev/mapper/mpathfbu

Create vg2 using the following 128 physical volumes: /dev/mapper/mpathfhq /dev/mapper/mpathfgg /dev/mapper/mpathfgu /dev/mapper/mpathfgn /dev/mapper/mpathfii /dev/mapper/mpathfhc /dev/mapper/mpathfhx /dev/mapper/mpathfgx/dev/mapper/mpathfda /dev/mapper/mpathfcw /dev/mapper/mpathfdj /dev/mapper/mpathfcr /dev/mapper/mpathezk /dev/mapper/mpatheyw /dev/mapper/mpathezl /dev/mapper/mpatheyt /dev/mapper/mpathfji /dev/mapper/mpathfic /dev/mapper/mpathfjl /dev/mapper/mpathfhu /dev/mapper/mpathfjy /dev/mapper/mpathfiw /dev/mapper/mpathfki /dev/mapper/mpathfht /dev/mapper/mpathfea /dev/mapper/mpathfdm /dev/mapper/mpathfed /dev/mapper/mpathfdf /dev/mapper/mpathfae /dev/mapper/mpathezo /dev/mapper/mpathfab /dev/mapper/mpathezz /dev/mapper/mpathflw /dev/mapper/mpathfkj /dev/mapper/mpathfkn /dev/mapper/mpathfip /dev/mapper/mpathfmf /dev/mapper/mpathfla /dev/mapper/mpathfms /dev/mapper/mpathfkp /dev/mapper/mpathffq /dev/mapper/mpathfes /dev/mapper/mpathfev /dev/mapper/mpathfej /dev/mapper/mpathfbi /dev/mapper/mpathfaq /dev/mapper/mpathfav /dev/mapper/mpathfat /dev/mapper/mpathflh /dev/mapper/mpathfmk /dev/mapper/mpathfmr /dev/mapper/mpathfnb /dev/mapper/mpathfhg /dev/mapper/mpathfmy /dev/mapper/mpathflq /dev/mapper/mpathfnl /dev/mapper/mpathffk /dev/mapper/mpathffu /dev/mapper/mpathfff /dev/mapper/mpathfgd /dev/mapper/mpathfca /dev/mapper/mpathfbm /dev/mapper/mpathfbx /dev/mapper/mpathfbv /dev/mapper/mpathfjq /dev/mapper/mpathfgi /dev/mapper/mpathfjz /dev/mapper/mpathfgr /dev/mapper/mpathfjf /dev/mapper/mpathfhe /dev/mapper/mpathfiz /dev/mapper/mpathfgz /dev/mapper/mpathfdc /dev/mapper/mpathfcy /dev/mapper/mpathfdt /dev/mapper/mpathfct /dev/mapper/mpathezw /dev/mapper/mpathezg /dev/mapper/mpathezx /dev/mapper/mpathezb /dev/mapper/mpathfjk /dev/mapper/mpathfig /dev/mapper/mpathfjn /dev/mapper/mpathfhy /dev/mapper/mpathfkc /dev/mapper/mpathfis /dev/mapper/mpathfkf /dev/mapper/mpathfhr /dev/mapper/mpathfec /dev/mapper/mpathfdo /dev/mapper/mpathfef /dev/mapper/mpathfdd /dev/mapper/mpathfbc /dev/mapper/mpathezs /dev/mapper/mpathfaz /dev/mapper/mpathezt /dev/mapper/mpathflz /dev/mapper/mpathfkm /dev/mapper/mpathfkq /dev/mapper/mpathfim /dev/mapper/mpathfmb /dev/mapper/mpathfle /dev/mapper/mpathfmv /dev/mapper/mpathfkt /dev/mapper/mpathffs /dev/mapper/mpathfeu /dev/mapper/mpathfex /dev/mapper/mpathfel /dev/mapper/mpathfbo /dev/mapper/mpathfci /dev/mapper/mpathfbd /dev/mapper/mpathfcj /dev/mapper/mpathfld /dev/mapper/mpathfmo /dev/mapper/mpathfmp /dev/mapper/mpathfnd /dev/mapper/mpathfhi /dev/mapper/mpathfna /dev/mapper/mpathflm /dev/mapper/mpathfnj /dev/mapper/mpathffi /dev/mapper/mpathffw /dev/mapper/mpathffd /dev/mapper/mpathfgb /dev/mapper/mpathfak /dev/mapper/mpathfce /dev/mapper/mpathfan /dev/mapper/mpathfbr

Create vg3 using the following 128 physical volumes: /dev/mapper/mpathfhn /dev/mapper/mpathfgj /dev/mapper/mpathfgw /dev/mapper/mpathfgp /dev/mapper/mpathfid /dev/mapper/mpathfgo /dev/mapper/mpathfhz /dev/mapper/mpathfgy/dev/mapper/mpathfdh /dev/mapper/mpathfcn /dev/mapper/mpathfdk /dev/mapper/mpathfcs /dev/mapper/mpatheyz /dev/mapper/mpatheyx /dev/mapper/mpathezm /dev/mapper/mpatheyu /dev/mapper/mpathfjb /dev/mapper/mpathfhl /dev/mapper/mpathfjm /dev/mapper/mpathfhv /dev/mapper/mpathfjr /dev/mapper/mpathfij /dev/mapper/mpathfkk /dev/mapper/mpathfhw /dev/mapper/mpathfdv /dev/mapper/mpathfdr /dev/mapper/mpathfee /dev/mapper/mpathfdg /dev/mapper/mpathfaf /dev/mapper/mpathezp /dev/mapper/mpathfac /dev/mapper/mpathfaa /dev/mapper/mpathflp /dev/mapper/mpathfix /dev/mapper/mpathfko /dev/mapper/mpathfir /dev/mapper/mpathfmg /dev/mapper/mpathfkv /dev/mapper/mpathfmu /dev/mapper/mpathfks /dev/mapper/mpathffn /dev/mapper/mpathfen /dev/mapper/mpathfew /dev/mapper/mpathfek /dev/mapper/mpathfbf /dev/mapper/mpathfar /dev/mapper/mpathfaw /dev/mapper/mpathfau /dev/mapper/mpathfll /dev/mapper/mpathfma /dev/mapper/mpathfmt /dev/mapper/mpathfnc /dev/mapper/mpathfcl /dev/mapper/mpathfnh /dev/mapper/mpathfls /dev/mapper/mpathfnm /dev/mapper/mpathffb /dev/mapper/mpathffx /dev/mapper/mpathfffg /dev/mapper/mpathfge /dev/mapper/mpathfcb /dev/mapper/mpathfbj /dev/mapper/mpathfby /dev/mapper/mpathfbw /dev/mapper/mpathfjt /dev/mapper/mpathfgl /dev/mapper/mpathfkb /dev/mapper/mpathfgs /dev/mapper/mpathfkd /dev/mapper/mpathfgt /dev/mapper/mpathfja /dev/mapper/mpathfha /dev/mapper/mpathfeh /dev/mapper/mpathfcp /dev/mapper/mpathfdu /dev/mapper/mpathfcu /dev/mapper/mpathfah /dev/mapper/mpathezd /dev/mapper/mpathezy /dev/mapper/mpathezc /dev/mapper/mpathfje /dev/mapper/mpathfhj /dev/mapper/mpathfjo /dev/mapper/mpathfia /dev/mapper/mpathfju /dev/mapper/mpathfil /dev/mapper/mpathfkg /dev/mapper/mpathfhs /dev/mapper/mpathfdx /dev/mapper/mpathfdp /dev/mapper/mpathfeg /dev/mapper/mpathfde /dev/mapper/mpathfax /dev/mapper/mpathezh /dev/mapper/mpathfba /dev/mapper/mpathezu /dev/mapper/mpathflt /dev/mapper/mpathfit /dev/mapper/mpathfkr /dev/mapper/mpathfin /dev/mapper/mpathfml /dev/mapper/mpathfkx /dev/mapper/mpathfmw /dev/mapper/mpathfku /dev/mapper/mpathfffl /dev/mapper/mpathfep /dev/mapper/mpathfey /dev/mapper/mpathfem /dev/mapper/mpathfbp /dev/mapper/mpathfcf /dev/mapper/mpathfbe /dev/mapper/mpathfck /dev/mapper/mpathflj /dev/mapper/mpathfme /dev/mapper/mpathfmq /dev/mapper/mpathfnf /dev/mapper/mpathflg /dev/mapper/mpathfne /dev/mapper/mpathflo /dev/mapper/mpathfnk /dev/mapper/mpathfez /dev/mapper/mpathffz /dev/mapper/mpathffe /dev/mapper/mpathfgc /dev/mapper/mpathfal /dev/mapper/mpathfbt /dev/mapper/mpathfao /dev/mapper/mpathfbs

3. Create Logical Volumes

Create 10 logical volumes ,which capacity is 2925 GB, on vg1 for ASU-1.

Create 10 logical volumes ,which capacity is 2925 GB, on vg2 for ASU-1.

Create 10 logical volumes ,which capacity is 2925 GB, on vg3 for ASU-1.

Create 1 logical volume ,which capacity is 29250 GB, on vg1 for ASU-2.

Create 1 logical volume ,which capacity is 29250 GB, on vg2 for ASU-2.

Create 1 logical volume ,which capacity is 29250 GB, on vg3 for ASU-2.

Create 1 logical volume ,which capacity is 6500 GB, on vg1 for ASU-3.

Create 1 logical volume ,which capacity is 6500 GB, on vg2 for ASU-3.

Create 1 logical volume ,which capacity is 6500 GB, on vg3 for ASU-3.

4. Activate each Logical Volume

Execute the lvm-active on the Slave Host Systems ,the script will make each logical volume available (activate).

Step 3: Change the Scheduler on each Host System,change the nr_request,aio on each Host System

Execute the scheduler.sh script on each Host System to change the scheduler of each block device from cfq to noop.

Execute the nr_request.sh script on each Host System to change the nr_request of each block device from 64 to 1024.

Execute the aio-max-nr.sh script on each Host System to change the aio-max-nr to 1048576.

APPENDIX E: CONFIGURATION INVENTORY

An inventory of the TSC was collected during the execution of the scripts MS7000G2-Mach_test_phase1.sh and MS7000G2-Mach_test_phase3.sh. The following log files were generated.

- profile_start_MS7000G2-Mach.txt – list of configured storage before the INIT phase
- volume_listing_start.txt – list of configured volumes before the INIT phase
- profile_end_MS7000G2-Mach.txt – list of configured storage after TSC restart
- volume_listing_end.txt – list of configured volumes after TSC restart

The above log files are included in the Supporting Files (see Appendix A).

APPENDIX F: WORKLOAD GENERATOR

The host parameters for the SPC-1 workload generator were defined using the script 40p.HST.

The ASUs accessed by the SPC-1 workload generator are defined using the script slave_asu.asu.

The initial test phases of the benchmark are executed using the scripts MS7000G2-Mach_test_phase1.sh. The PERSIST_1 phase is invoked by the script MS7000G2-Mach_test_phase2.sh. This is followed by a full shutdown and power down of the TSC. Once the TSC has been restarted, the PERSIST_2 test phase is executed using the script MS7000G2-Mach_test_phase3.sh.

The above scripts are included in the Supporting Files (see Appendix A).