SPC Benchmark 1™

Full Disclosure Report

Fujitsu Limited
ETERNUS DX200 S4

SPC-1 v3.4.0

Submission Identifier: A32001

Submitted For Review: May 31, 2017

Third Edition – February 2018

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.storageperformance.org.

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

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SPC Benchmark 1™ v3.4.0   Full Disclosure Report   Submission Identifier: A32001
Fujitsu Limited   Submitted for Review: May 31, 2017
ETERNUS DX200 S4

AUDIT CERTIFICATION

Kun Katsumata
Fujitsu Limited
1250 East Arques Ave.
PO Box 3470
Sunnyvale, CA 94088-3470

May 31, 2017

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

ETERNUS DX200 S4

The results were:

SPC-1 IOPS™	300,056
SPC-1 Price-Performance™	**$0.22/SPC-1 IOPS™**
SPC-1 IOPS™ Response Time	0.598 ms
SPC-1 Overall Response Time	0.336 ms
SPC-1 ASU Capacity	3,924 GB
SPC-1 ASU Price	$36.21/GB
SPC-1 Total System Price	$63,935.19

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.storageperformance.org under the Submission Identifier A32001.

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;
- 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

FUJITSU

Kanagawa-ken,Kawasaki-shi,Nakahara-ku,Kamikodanaka,4-1-1,JAPAN211-8588
Phone: 044-754-3423

May 31, 2017
From: Yoshinori Terao, Fujitsu Limited

To: Doug Johnson, SPC Auditor
InfoSizing
63 Lourdes Drive
Leominster, MA 01453-6709. U.S.A.

Contact Information: Kun Katsumata
                     Fujitsu America, Inc.
                     1250 East Arques Ave. PO Box 3470
                     Sunnyvale, CA 94088, U.S.A.

Subject: SPC-1 Letter of Good Faith for the FUJITSU Storage ETERNUS DX200 S4

Fujitsu Limited 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 V3.4 of the
SPC-1 benchmark specification.

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

Signed: Date:

Yoshinori Terao   _May 31, 2017_

Yoshinori Terao
Vice President, System Development Div. II

SPC BENCHMARK 1™

EXECUTIVE SUMMARY

FUJITSU LIMITED
ETERNUS DX200 S4

SPC-1 IOPS™	**300,056**
SPC-1 Price-Performance™	**$213.08/SPC-1 KIOPS™**
SPC-1 IOPS™ Response Time	0.598 ms
SPC-1 Overall Response Time	0.336 ms
SPC-1 ASU Capacity	3,924 GB
SPC-1 ASU Price	36.21/GB
SPC-1 Total System Price	63,935.19
Data Protection Level	Protected 2 (RAID1)
Physical Storage Capacity	8,000 GB
Pricing Currency / Target Country	U.S. Dollars / USA

SPC-1 V3.4.0

SUBMISSION IDENTIFIER: A32001

SUBMITTED FOR REVIEW: MAY 31, 2017

Benchmark Configuration Diagram

ETERNUS DX200 S4
20 drives (total 20 drives)

Standard Fujitsu
42 U Rack
with dual 20A 240VAC
PDU

DX200 S4 Control Enclosure
(2 Controllers, 64 GB memory,
2 x 4 port 16Gbps FC Channel Adapters)

4 x 16Gbps
Fibre Channel
Links

4 x 16Gbps
Fibre Channel
Links

2 x Fujitsu PRIMERGY
RX2540M1 Servers each with:
2 x 2.3GHZ Intel E5-2699 CPUs,
396GB memory,
4 x LPE16002 HBAs
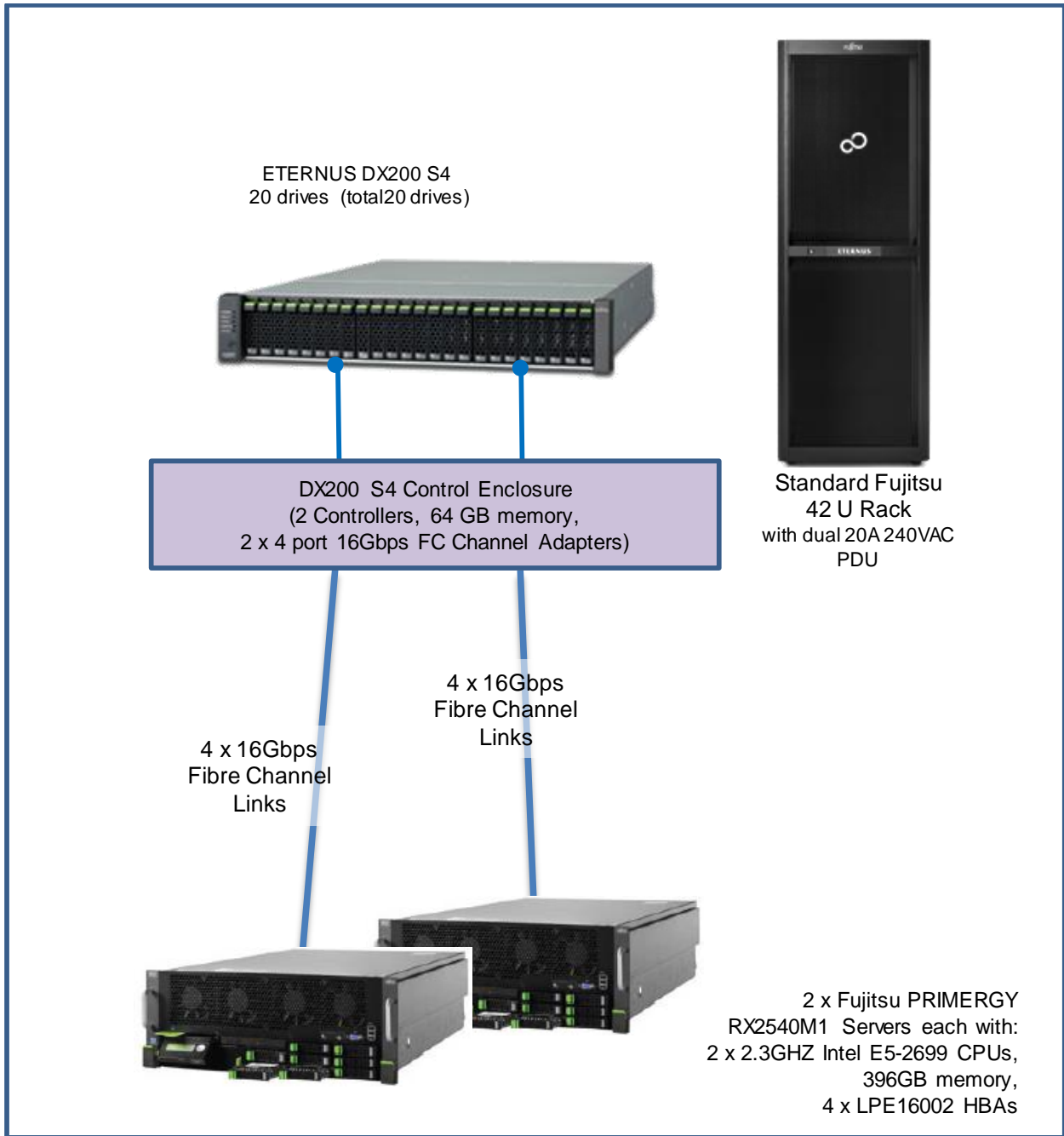
Tested Storage Product Description

The scalable and unified Fujitsu Storage ETERNUS DX200 S4 delivers enterprise-class functionality to small and medium-sized companies and subsidiaries with an excellent price/performance ratio. It is the perfect solution when consolidating data for server virtualization, e-mail, databases and business applications as well as centralized file services.

Priced Storage Configuration Components

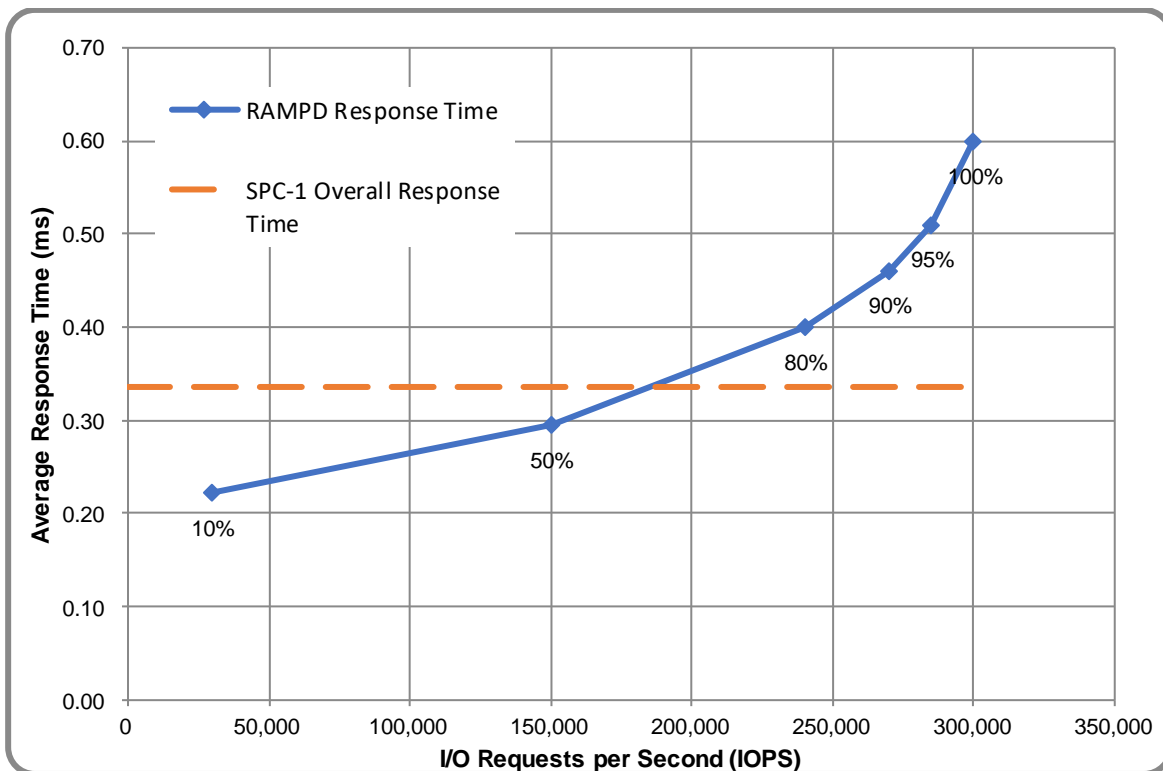| |
|---|
| **4 x Emulex LPe16002 dual port 16 Gb Fibre Channel HBAs** |
| **1 x DX200 S4, with:**
    2 x Controller Modules (CM) each with:
        32 GB cache (64 GB total)
        1 x Channel Adapter (CA) with
            4 x 16 Gbps Fibre Channel Host Ports
    20 x 400 GB SSD devices (without Hot Spare) |

Storage Configuration Pricing

	Description	Qty	Unit Price	Ext. Price	Disc.	Disc. Price
	Hardware					
ET204AU	DX200 S4 Base System Rackmount (AC200V, 2RU)(2.5" type)	1	3,260	3,260	40%	1,956.00
ETVCHFJ	Controller module for DX200 S4 （2CM, 16Gbit/s, FC, 4port, for Standard model）	1	15,190	15,190	40%	9,114.00
ETVHHG	Host interface for DX100 S4/DX200 S4 （16Gbit/s, FC, 2port)	2	1,820	3,640	40%	2,184.00
ETVSA4A	SSD(2.5inch) 400GB x1 for DX200 S4	20	3,090	61,800	40%	37,080.00
S26361-F4994-L502	PFC EP LPe16002	8	1,418	11,344	40%	6,806.40
ETFKC05U	AC Power Cords (125V - IEC320-C14, 0.5m)	2	80	160	40%	96.00
61-343827-003	Fibre Channel Host IF Cable LC/LC - 3m	8	132	1,056	0%	1,056.00
				Hardware Subtotal		**58,292.40**
	Support & Maintenance					
	Provide 24 hour per day / 7days per week 4 hour response maintenance for 36 months					
ETD200-W025360-ADE	Warranty Service, 36 monthsStandard, 9x5 phone, NBD response	1	-	-	0%	-
ETD200-U004361-ADE	Warranty Uplift, 36 monthsEnhanced plus, 24x7 4hr Onsite	1	7,053	7,053	20%	5,642.78
			Support & Maintenance Subtotal			**5,642.78**
	SPC-1 Total System Price					**63,935.19**

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

Availability Date: Currently Available.
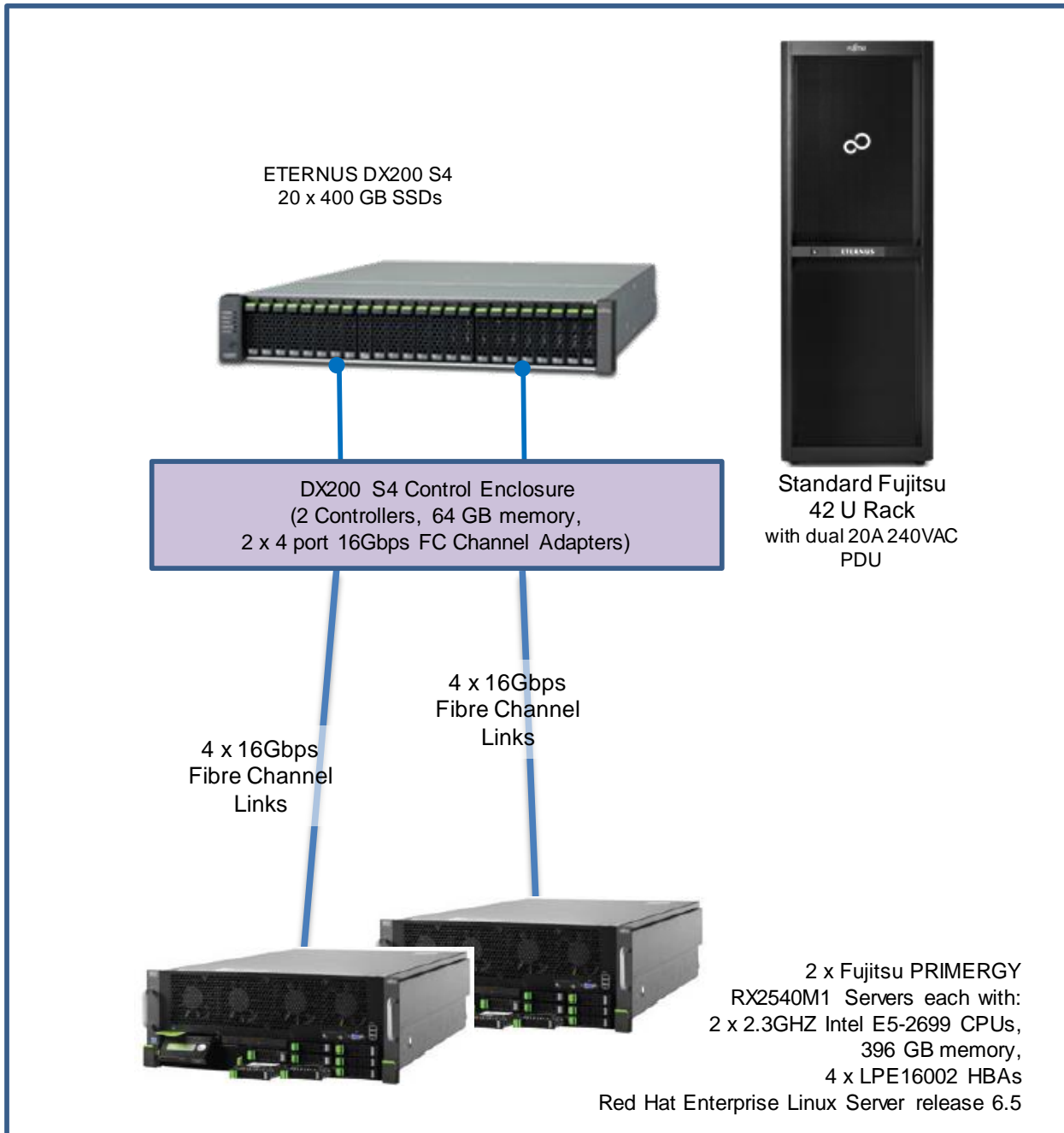
Response Time and Throughput Graph

Contact Information	
Test Sponsor Primary Contact	Fujitsu Limited – http://www.fujitsu.com/services/computing/storage/ Kun Katsumata – kkatsumata@us.fujitsu.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	v3.0.2-1-g823a

Publication Revision History	• First Edition: May 31, 2017
	• Second Edition: February 15, 2018
	   ○ Updated SPC-1 Price-Performance™ metric based on SPC-1 v3.6.0 definition.
	• Third Edition: April 17, 2018
	   ○ Correct Committed Data Persistence Implementation description. Correct typos in RAID group info in Appendix D.

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).

ETERNUS DX200 S4
20 x 400 GB SSDs

DX200 S4 Control Enclosure
(2 Controllers, 64 GB memory,
2 x 4 port 16Gbps FC Channel Adapters)

Standard Fujitsu
42 U Rack
with dual 20A 240VAC
PDU

4 x 16Gbps
Fibre Channel
Links

4 x 16Gbps
Fibre Channel
Links

2 x Fujitsu PRIMERGY
RX2540M1 Servers each with:
2 x 2.3GHZ Intel E5-2699 CPUs,
396 GB memory,
4 x LPE16002 HBAs
Red Hat Enterprise Linux Server release 6.5

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

2 x Fujitsu PRIMERGY RX2540 M1 Servers, each with:
      2 x Intel Xeon E5-2600 V3 (2.3 GHz, 36 Cores, 45 MB L3)
      384 GB Main Memory
      Red Hat Enterprise Linux Server release 6.5

Tested Storage Configuration
4 x Emulex LPe16002 dual port 16 Gb Fibre Channel HBAs

1 x DX200 S4, with:
      2 x Controller Modules (CM) each with:
            32 GB cache (64 GB total)
            1 x Channel Adapter (CA) with
                  4 x 16 Gbps Fibre Channel Host Ports
20 x 400 GB SSD devices (without Hot Spare)

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	1,767	1,766	1,766	45.0%
ASU-2	1	1,767	1,766	1,766	45.0%
ASU-3	1	392	391	391	10.0%
			SPC-1 ASU Capacity	3,924	

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	20	400.0	8,000.0
	Total Physical Capacity		8,000
	Physical Capacity Utilization		49.05%

Data Protection

The data protection level used for all logical volumes was **Protected 2 (RAID1)**, which was accomplished by configuring dual controllers, dual power, dual fans, and RAID1 device protection.

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 Time measured over the Measurement Interval (MI) of each Test Phase.
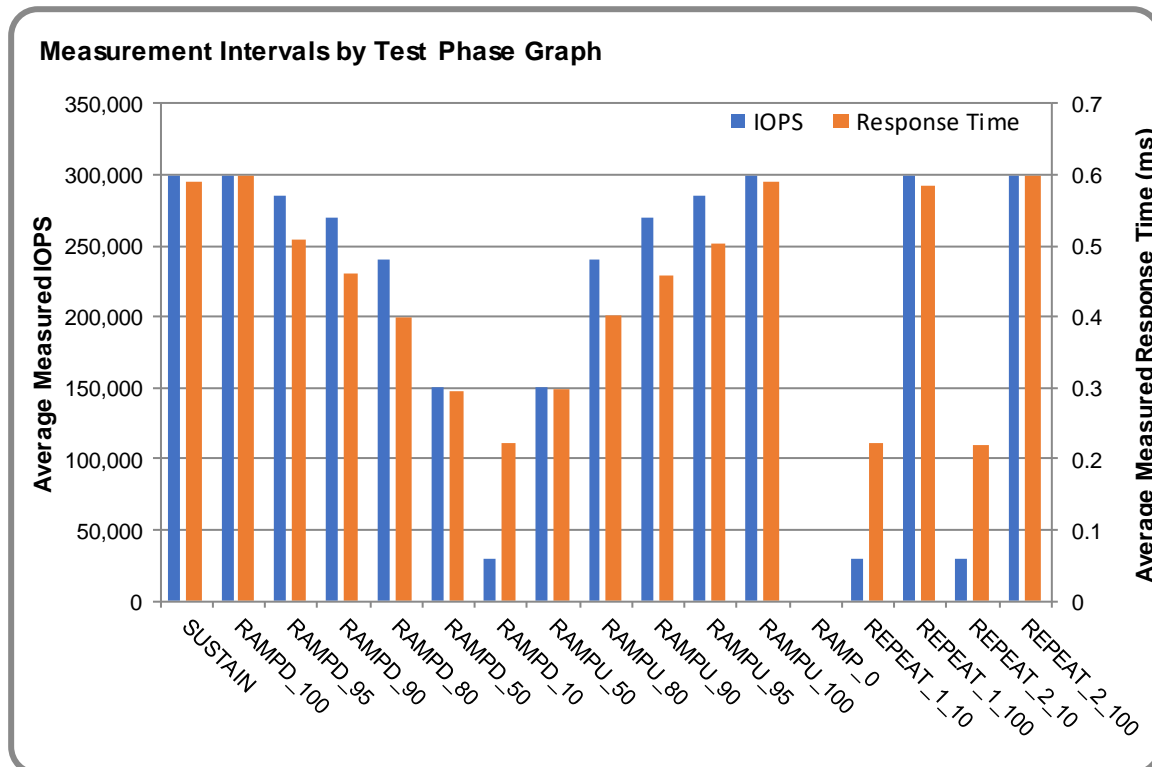
Exception and Waiver

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:
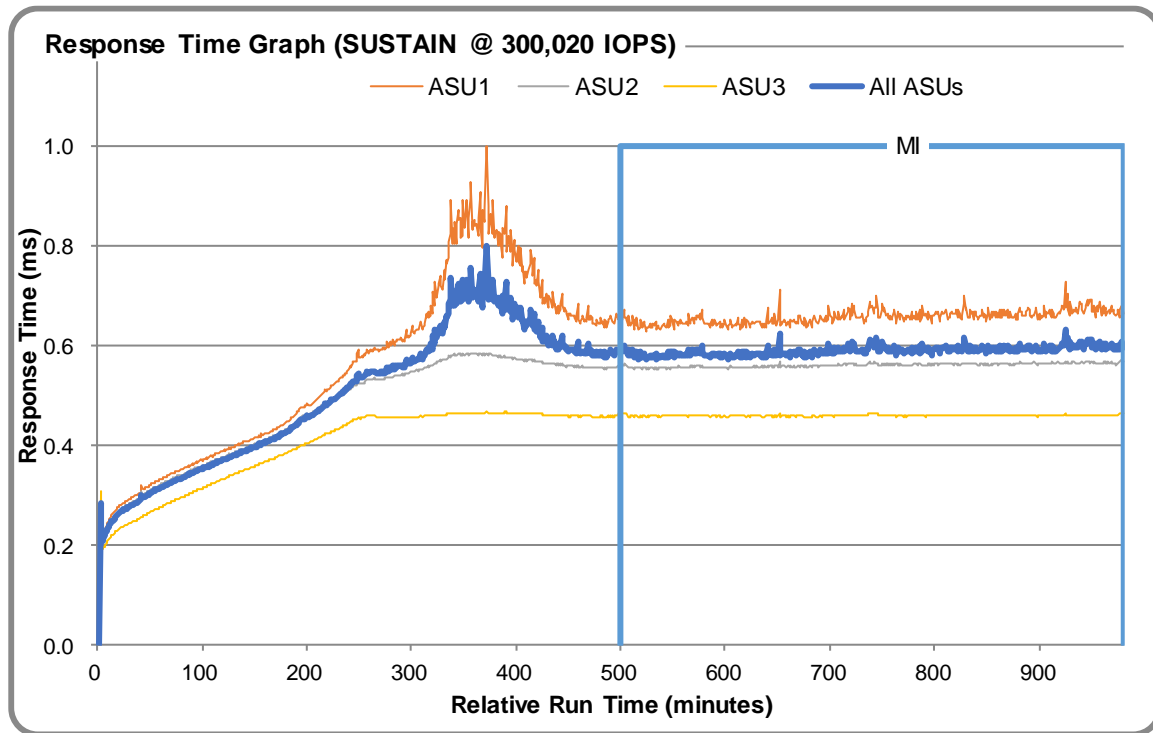
- **SPC1_METRICS_0_Raw_Results.xlsx**

SUSTAIN – Execution Times

Interval	Start Date	Start Time	End Time	Duration
Transition Period	23-May-17	06:22:48.000	14:42:48.000	8:20:00.000
Measurement Interval	23-May-17	14:42:48.000	22:42:49.000	8:00:01.000

SUSTAIN – Throughput Graph
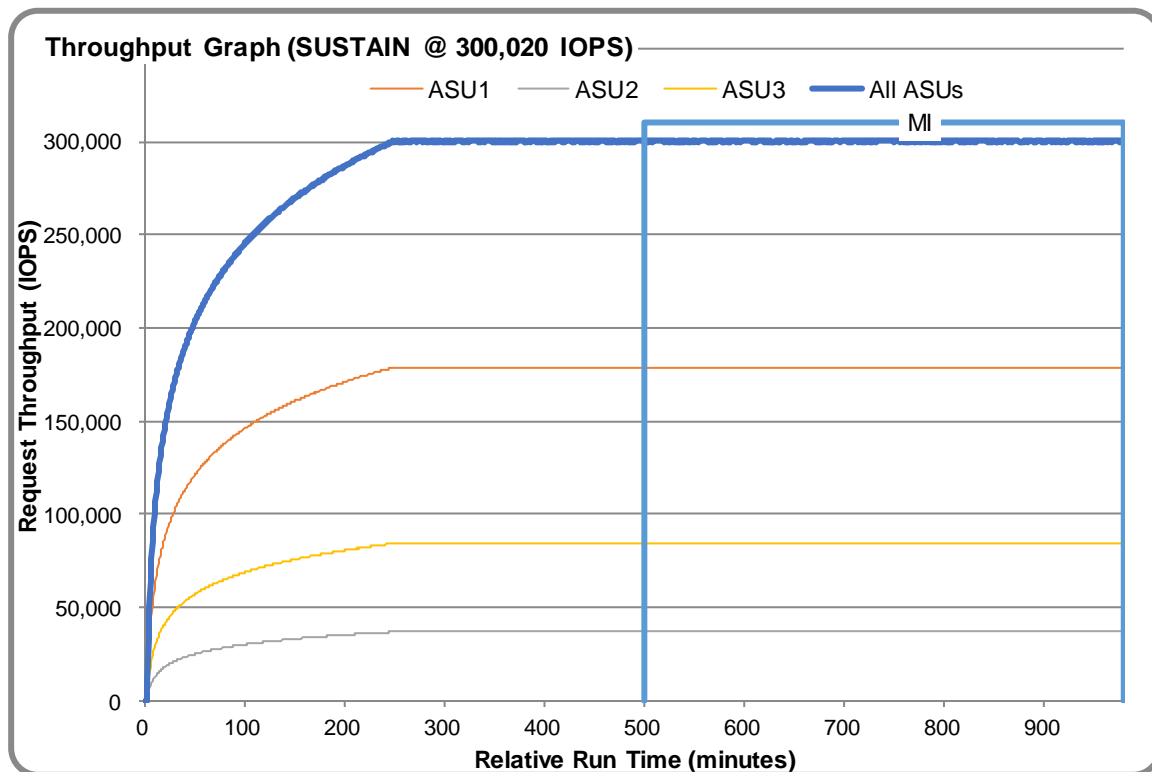
SUSTAIN – Response Time Graph

Response Time Graph (SUSTAIN @ 300,020 IOPS)

SUSTAIN – Data Rate Graph

Data Rate Graph (SUSTAIN @ 300,020 IOPS)
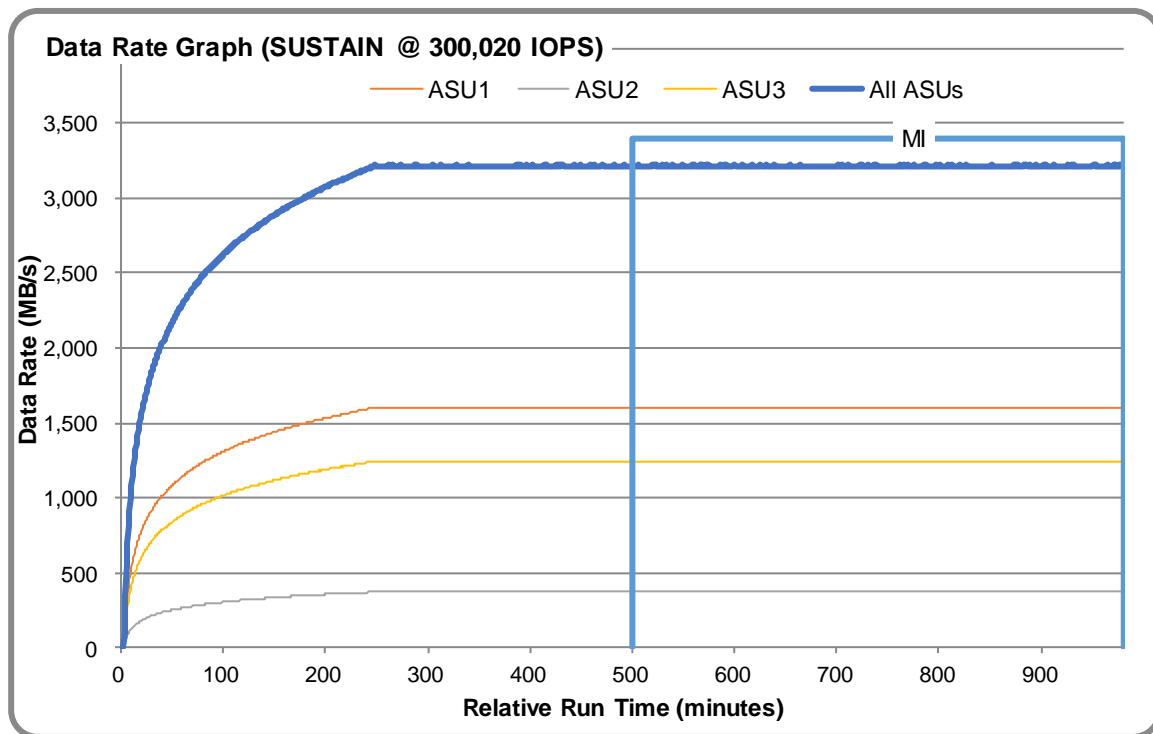
SUSTAIN – Response Time Frequency Graph
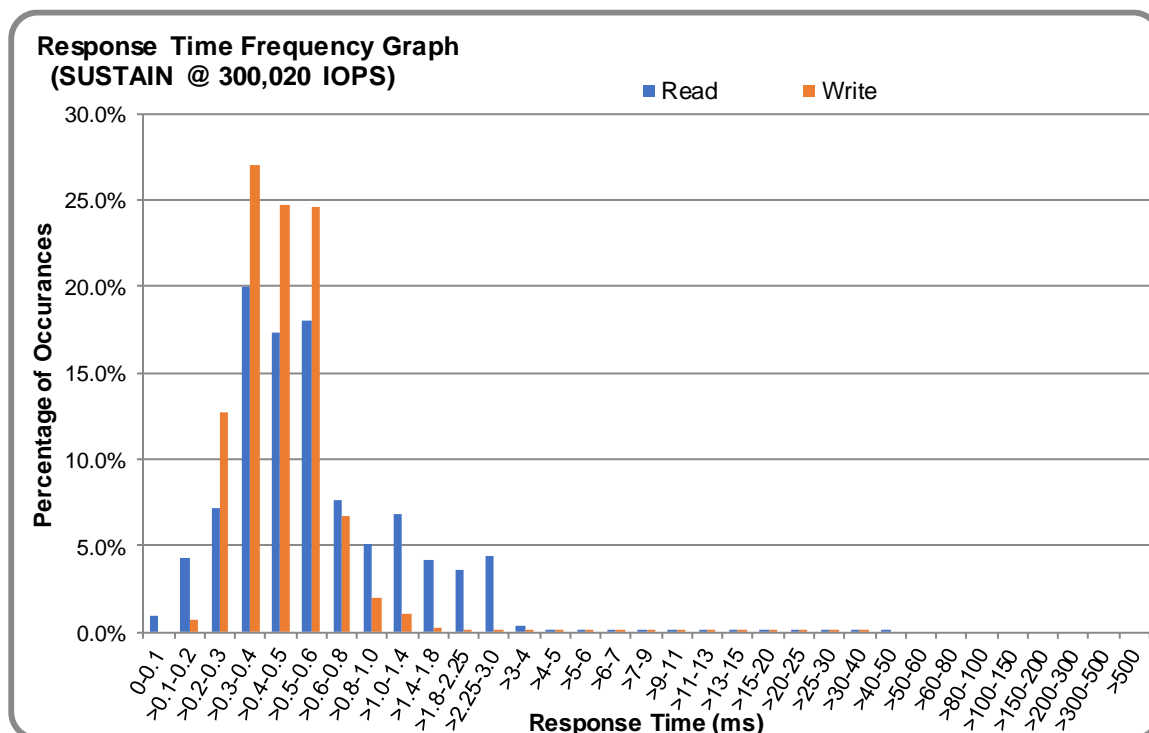
SUSTAIN – Intensity Multiplier

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.

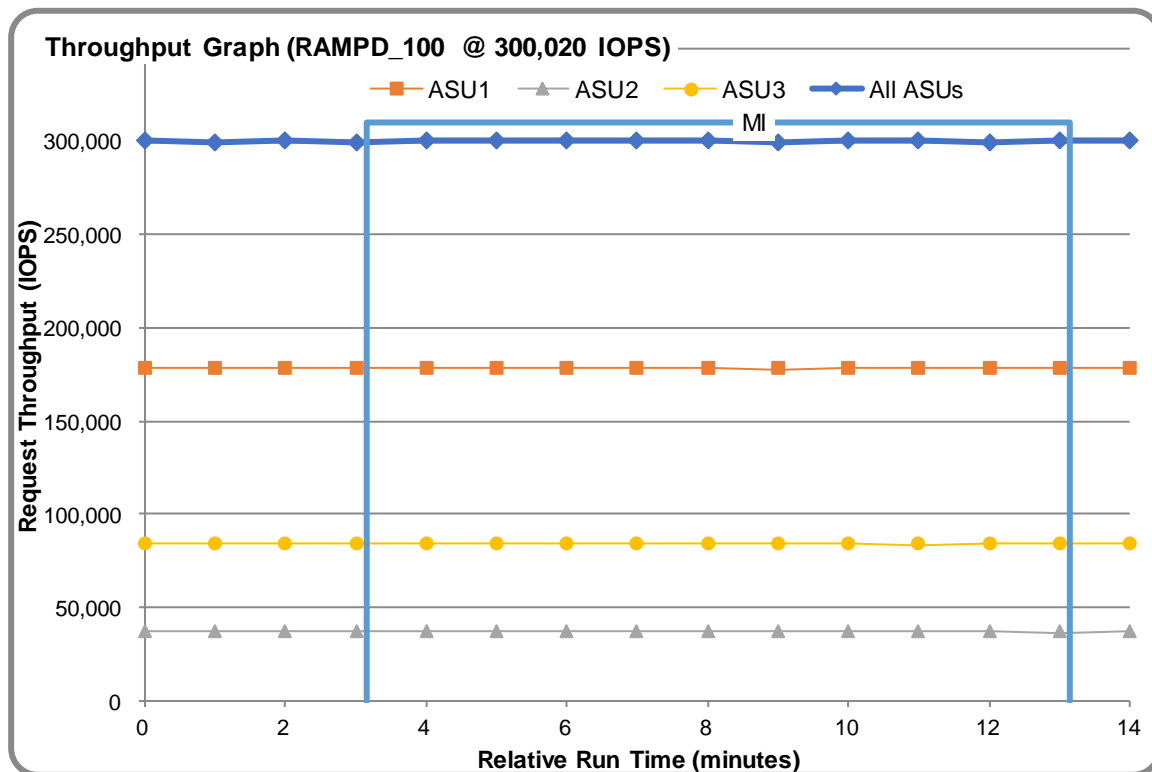|	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
Defined	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Measured	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
Variation	0.0012	0.0004	0.0008	0.0005	0.0018	0.0008	0.0012	0.0004
Difference	0.003%	0.001%	0.002%	0.000%	0.006%	0.005%	0.005%	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	23-May-17	22:43:48.000	22:46:48.000	0:03:00.000
Measurement Interval	23-May-17	22:46:48.000	22:56:49.000	0:10:01.000

RAMPD_100 – Throughput Graph

RAMPD_100 – Response Time Graph

Response Time Graph (RAMPD_100 @ 300,020 IOPS)

ASU1   ASU2   ASU3   All ASUs
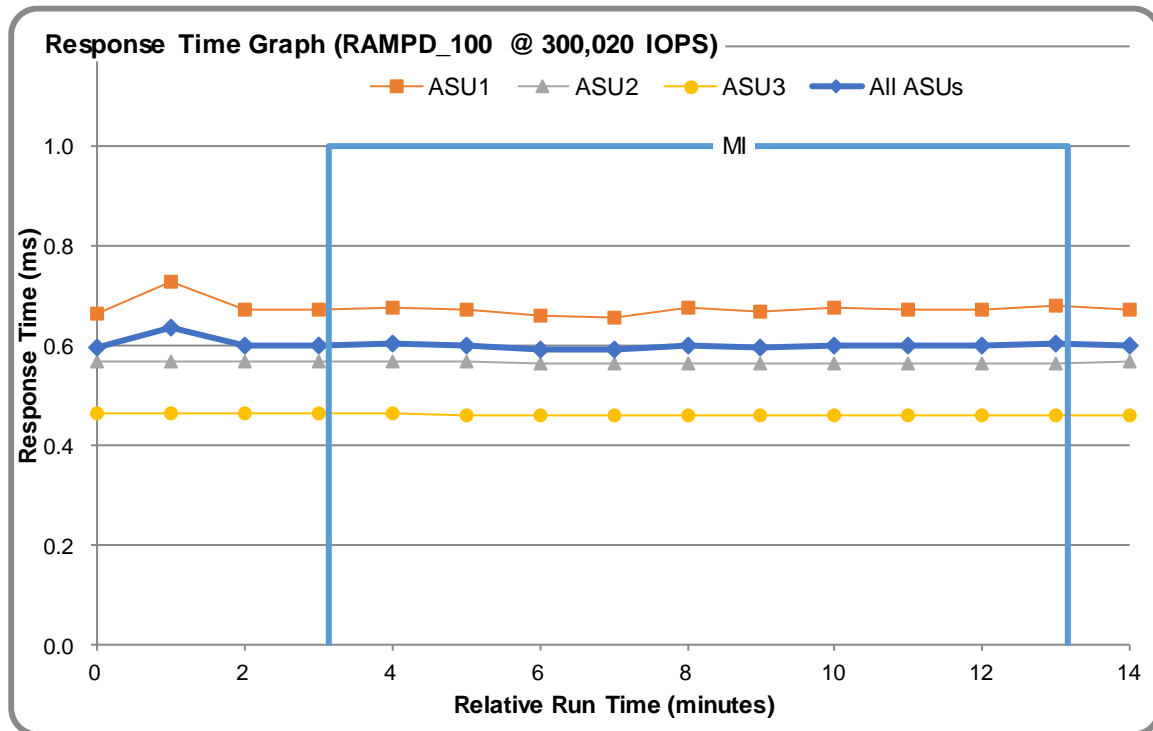
RAMPD_100 – Data Rate Graph

Data Rate Graph (RAMPD_100 @ 300,020 IOPS)

ASU1   ASU2   ASU3   All ASUs
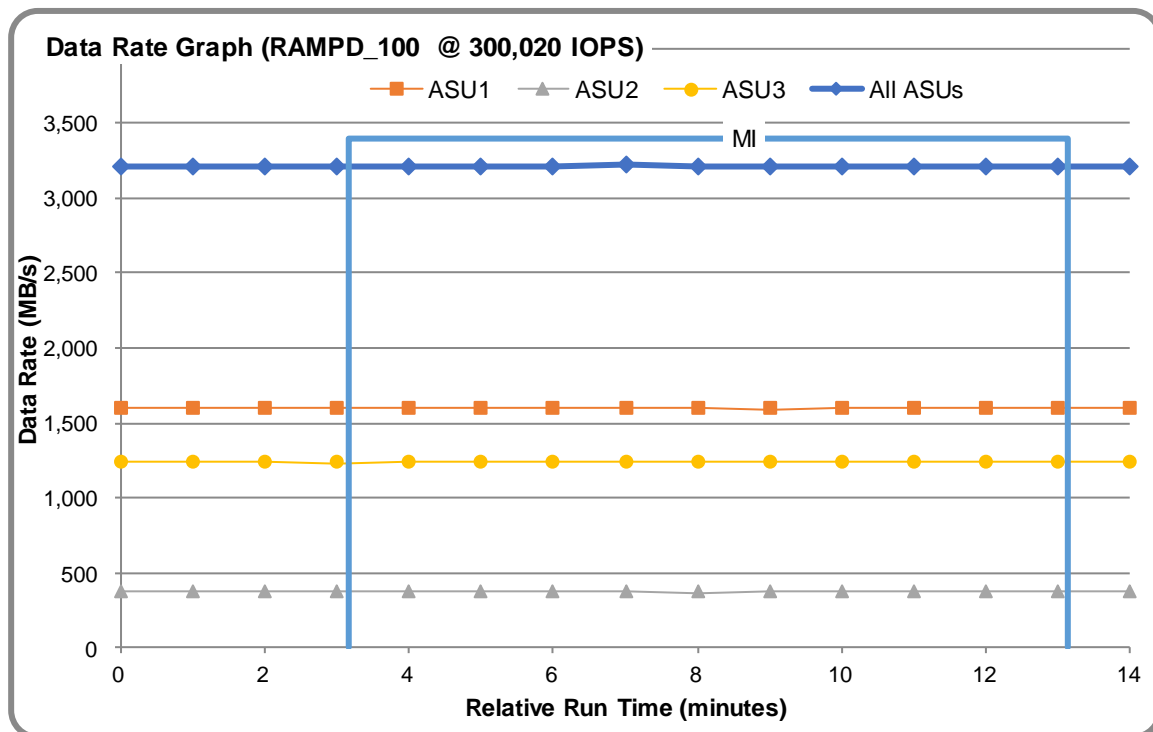
RAMPD_100 – Response Time Frequency Graph
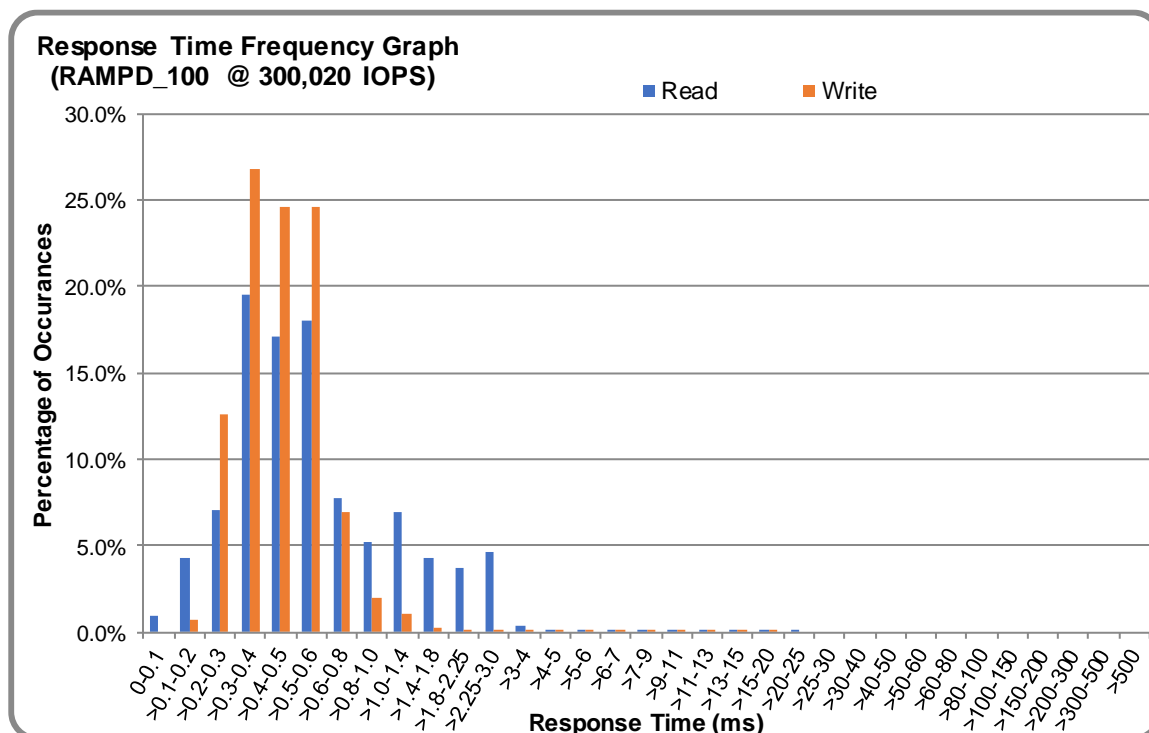
RAMPD_100 – Intensity Multiplier

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	0.2809
Variation	0.0016	0.0002	0.0008	0.0005	0.0022	0.0010	0.0010	0.0004
Difference	0.051%	0.005%	0.007%	0.017%	0.019%	0.003%	0.065%	0.019%

RAMPD_100 – I/O Request Summary

I/O Requests Completed in the Measurement Interval	180,030,016
I/O Requests Completed with Response Time <= 30 ms	180,030,016
I/O Requests Completed with Response Time > 30 ms	0

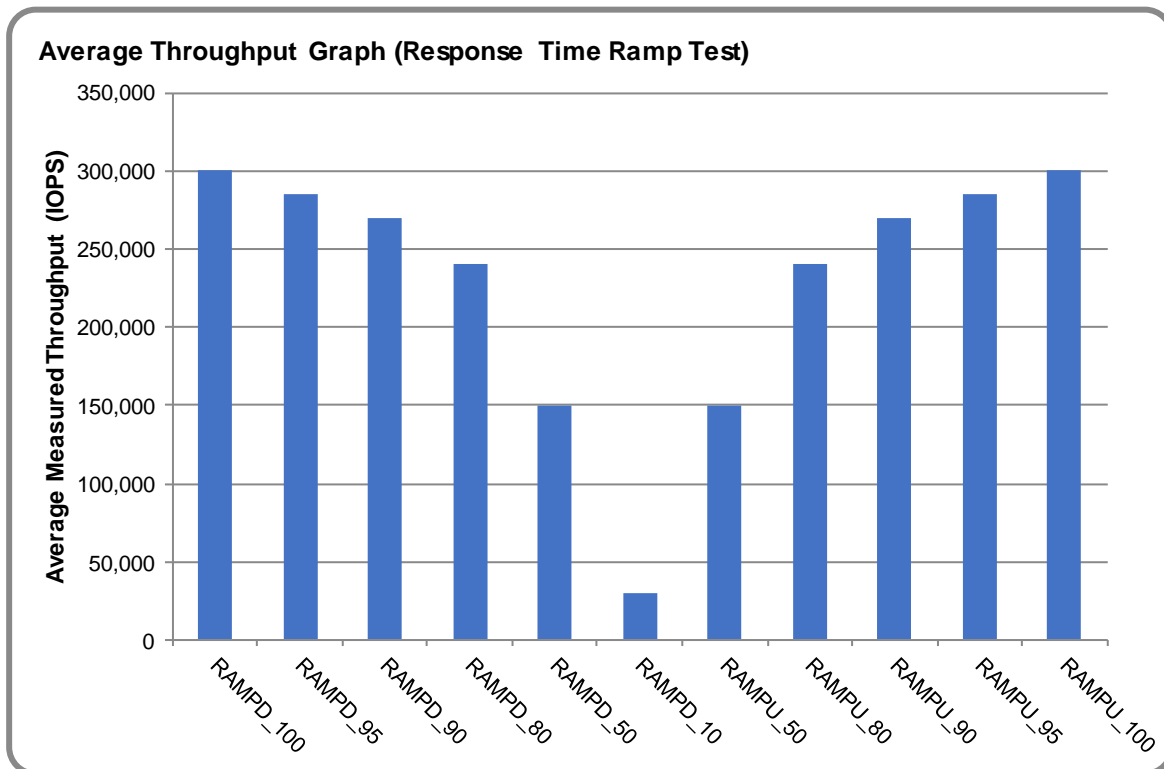# Response Time Ramp Test

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**

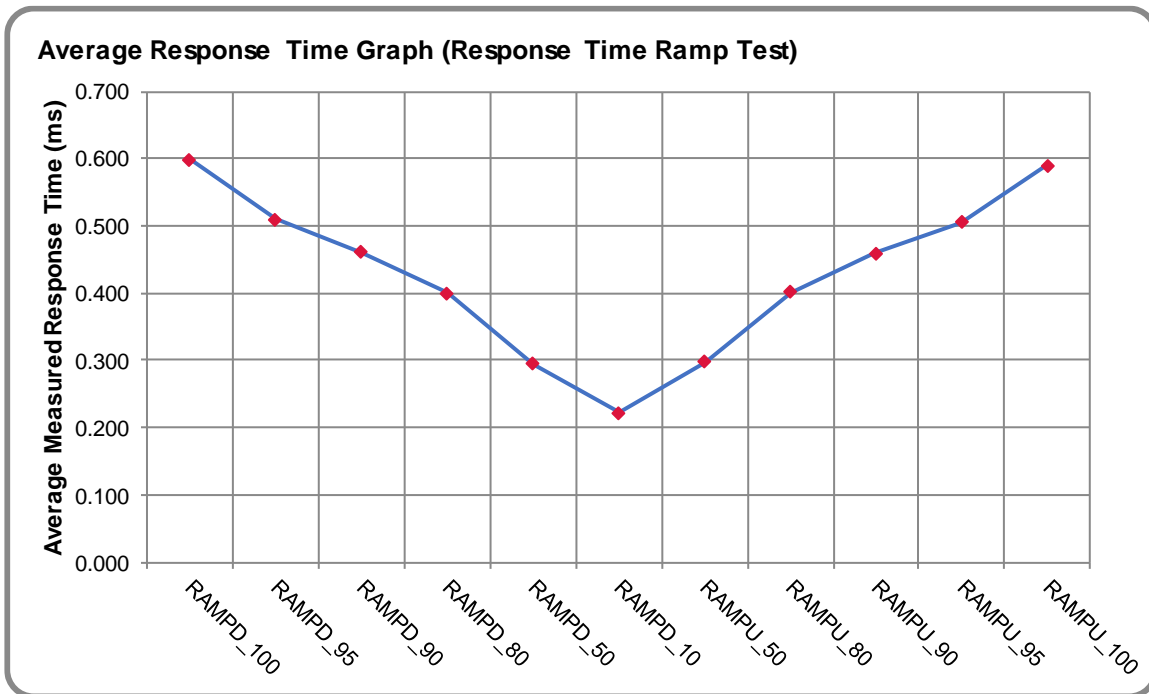## Response Time Ramp Test – Phases

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).
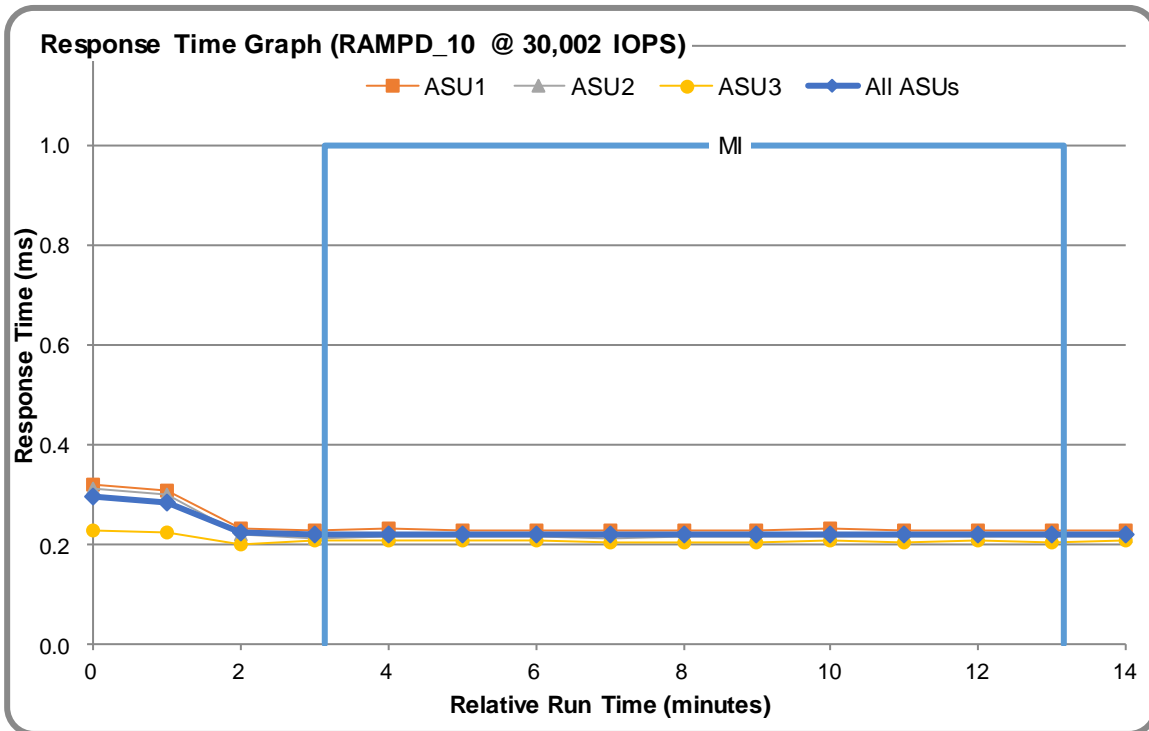
Response Time Ramp Test – Average Throughput Graph

Average Throughput Graph (Response Time Ramp Test)

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	300,056.8	30,006.2
REPEAT_1	300,008.6	30,002.1
REPEAT_2	300,022.6	30,008.0

REPEAT_1_100 – Throughput Graph
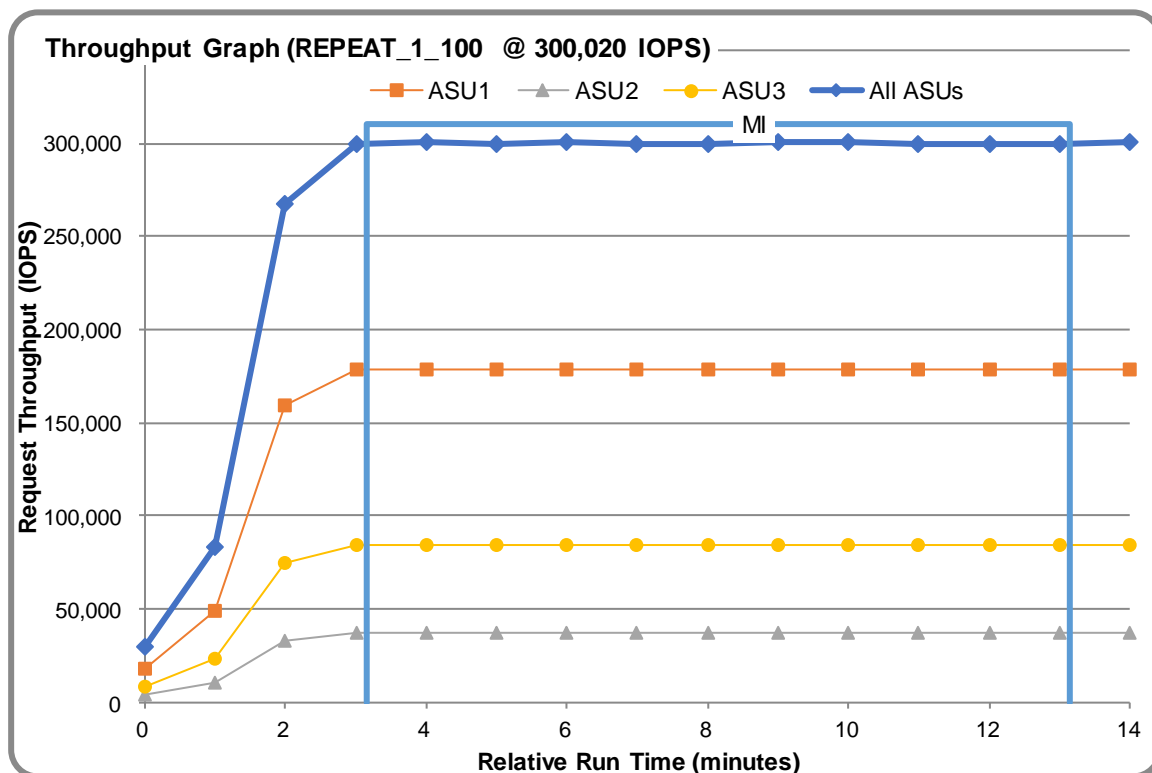
REPEAT_1_100 – Response Time Graph

Response Time Graph (REPEAT_1_100 @ 300,020 IOPS)
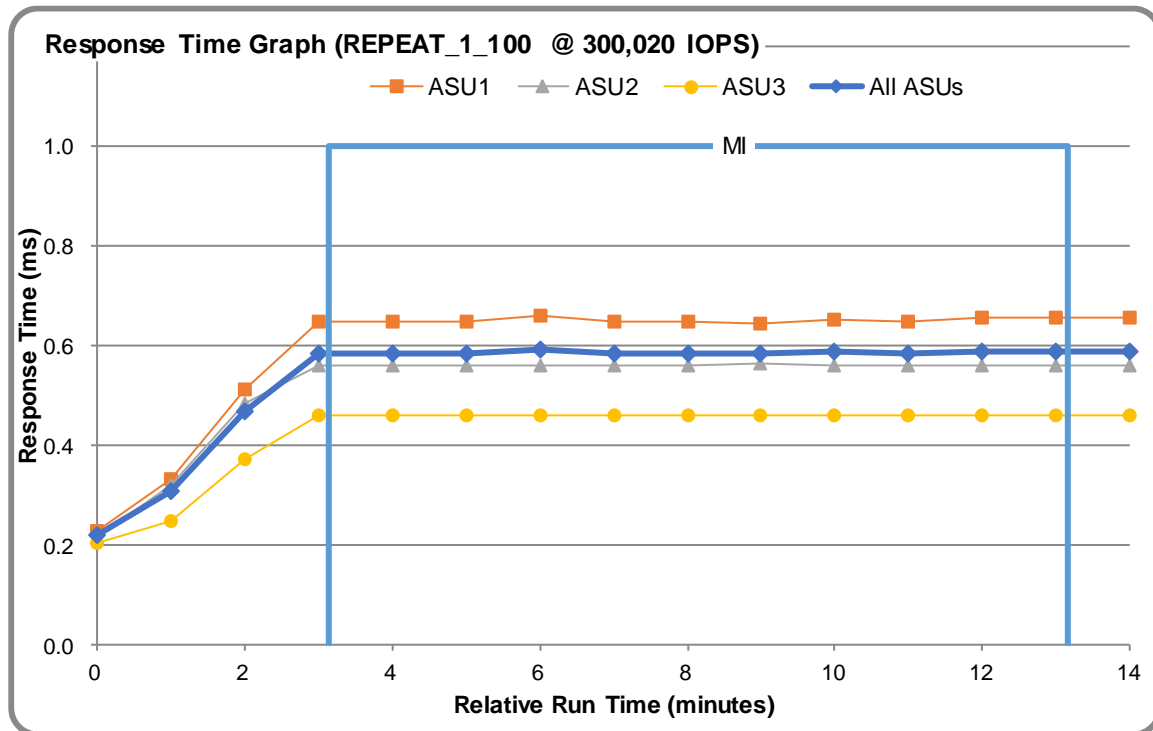
REPEAT_2_100 – Throughput Graph

Throughput Graph (REPEAT_2_100 @ 300,020 IOPS)
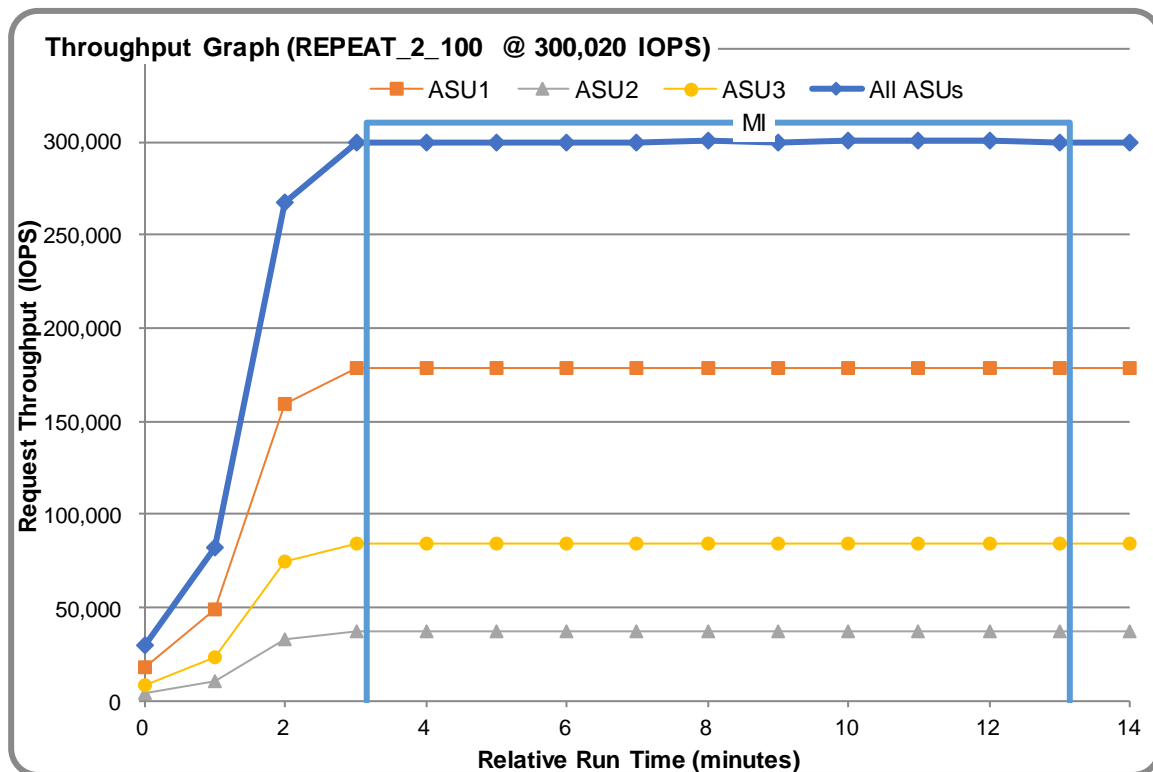
REPEAT_2_100 – Response Time Graph

Response Time Graph (REPEAT_2_100 @ 300,020 IOPS)
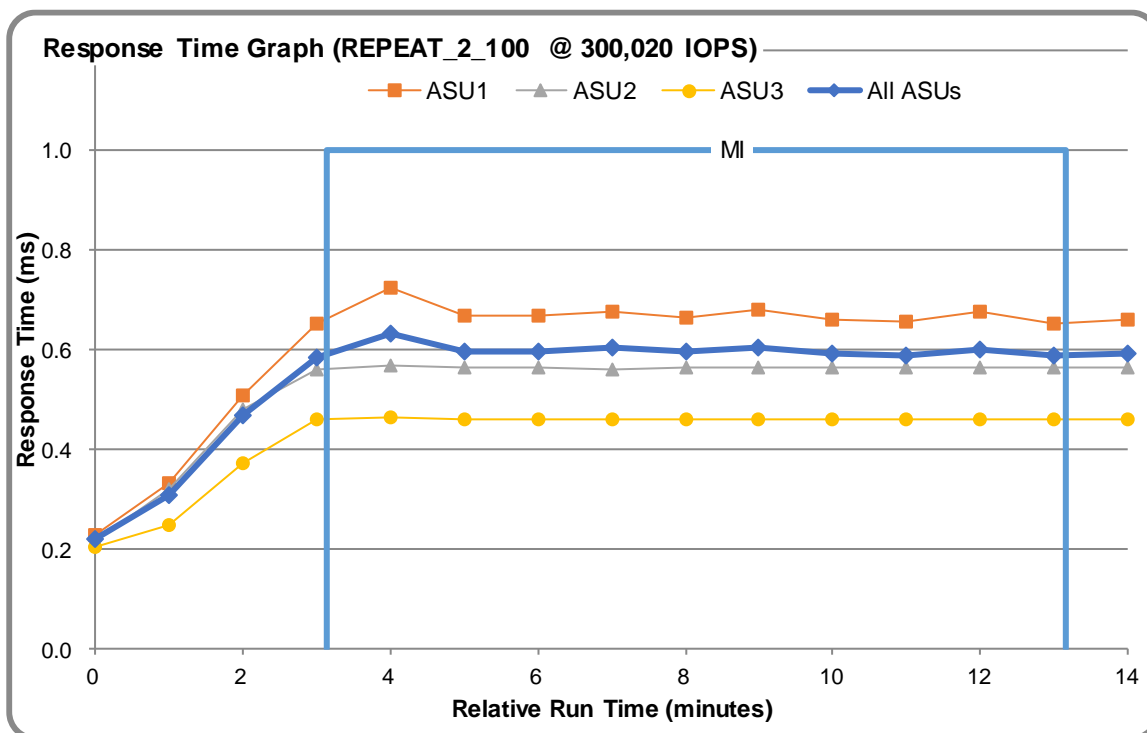
Repeatability Test – Intensity Multiplier

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	0.0011	0.0004	0.0011	0.0004	0.0014	0.0007	0.0013	0.0004
Difference	0.007%	0.004%	0.049%	0.000%	0.054%	0.002%	0.015%	0.007%

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	0.2809
Variation	0.0007	0.0004	0.0011	0.0004	0.0010	0.0010	0.0012	0.0004
Difference	0.035%	0.006%	0.042%	0.008%	0.008%	0.035%	0.032%	0.018%

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	37,112,148
Total Number of Logical Blocks Verified	20,498,997
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

ETERNUS DX200S4 model guarantees data security in case all of the redundant power supplies fail. When the controller detects voltage drop from all power supplies the Battery Backup Unit (BBU) provides temporary power sufficient for dirty cache data to be evacuated into the internal SSD named Boot Utility Device (BUD). The BUD protects the data indefinitely until the power is restored.

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**
All tuning done via GUI (see Appendix C)		
/D_Creation	**Storage configuration creation**	**root**
doFDRcfg.sh	Shell script to configure the array	/D_Creation
DX200S4_20170329.exp	Configuration CLI expect script	/D_Creation
showFormatStatus.exp	Check for physical format progress	/D_Creation
DX200S4_20170317makeLV.sh	Linux LVM configuration script	/D_Creation
/E_Inventory	**Configuration inventory**	**root**
log_JX170523054522_BeforeF.zlg_001.txt	Configuration details before the run	/E_Inventory
log_JX170523054522_AfterJ.zlg_001.txt	Configuration details after the run	/E_Inventory
/F_Generator	**Workload generator**	**root**
SPC1.DX200S4_20170302.asu	ASU configuration file	/F_generator
SPC1.DX200S4_20170302.hst	Host configuration file	/F_generator
doFDRall_1XV.sh	Master execution control script part 1	/F_generator
doFDRAll_2H.sh	Master execution control script part 2	/F_generator
exportLog.exp		/F_generator

APPENDIX B: THIRD PARTY QUOTATION

All components are directly available through the Test Sponsor.

APPENDIX C: TUNING PARAMETERS AND OPTIONS

The standard Fujitsu GUI was used to apply the Tuning options for this test.

1. In order to execute some of the commands listed below it is necessary to create an user account with maintainer role. Please create such user account and login with the new account.

2. Change DCMF (Disk Command Multiplication Factor) value from the default (1) to (10) for all RAID Groups.
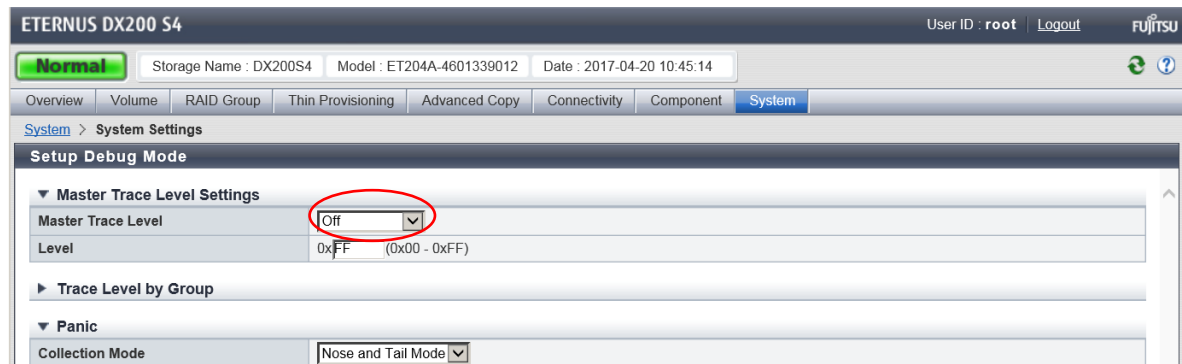   The following GUI screen (RAID Group -> Tuning -> Modify RAID Group Parameter is used for each RAID Group and the DCMF parameter is changed to 10 as highlighted in yellow below:
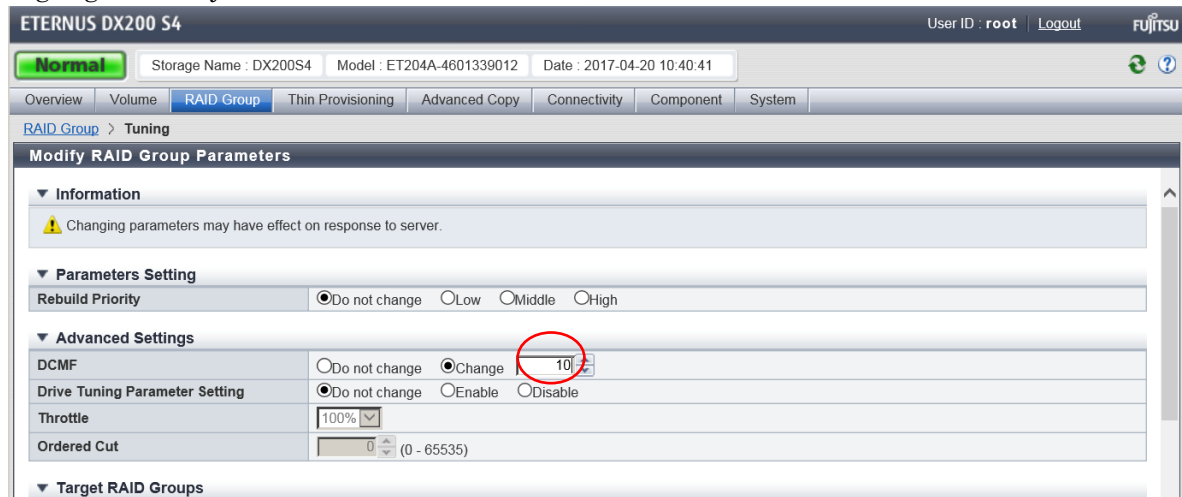
3. Disable Debug Trace
   The following GUI setting was applied.
   System-> System Settings -> Setup Debug Mode: The Master Trace Leve was set to Off (Default: Standard)
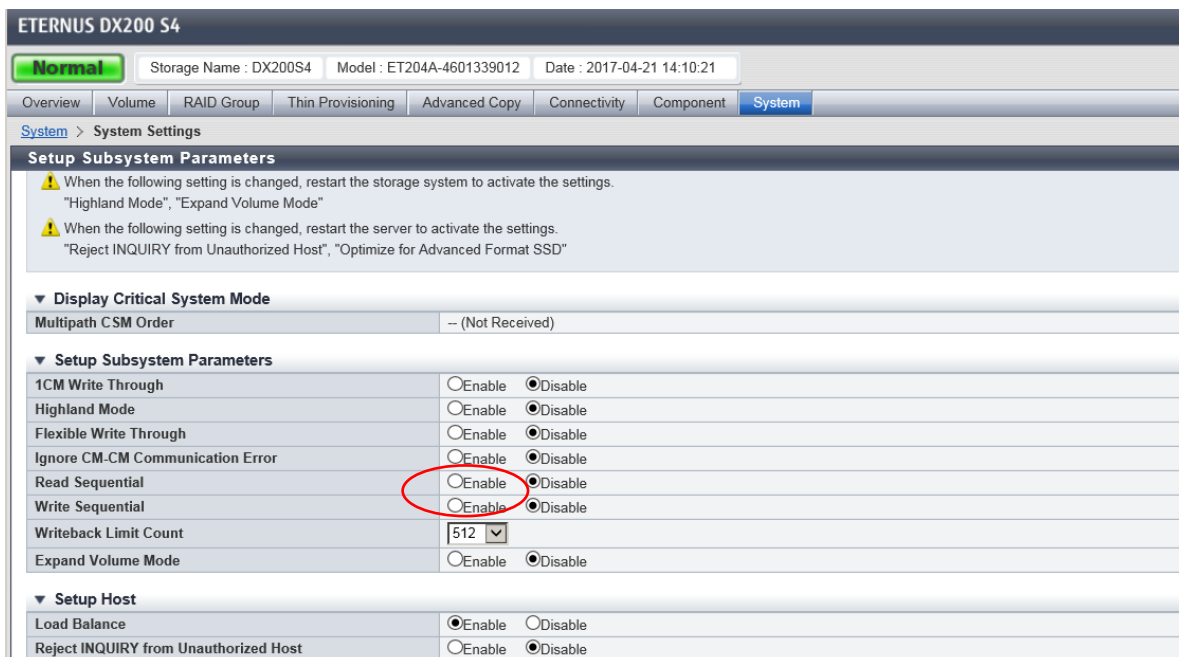
4. Disable Read Sequential/Write Sequential
    The following GUI setting was applied.
    System-> System Settings -> Setup Subsystem Parameters:

    The Read Sequential/Write Sequential was set to Disable (Default: Enable)

APPENDIX D: STORAGE CONFIGURATION CREATION

The standard Fujitsu Command Line tool (CLI) was used to create the ETERNUS DX200 S4 SPC-1 configuration.

The 'master' script, **doFDRcfg.sh**, was executed, which in turn, invoked the script, **DX200S4_20170329.exp**. The 'master' script included shell commands to monitor the progress as the physical formatting proceeded, which used the **expect** script **showFormatStatus.exp** to pick up the status information from the array.

The **DX200S4_20170329.exp** script completed steps 1-4, described below for the 16 host port configuration.

Each **expect** script included the **docli** procedure, which was used to issue the CLI commands to the array. That procedure used **ssh** for communication with the array. A second procedure in the script, **doexit**, was used to conclude the execution sequence at the end of the script.

Step 1 – Creation of RAID Groups

A total of 10 RAID Groups were created, according to the configuration plan, **ConfigurationDesign_Dx200S4_20170329.xlsx**, which is typically prepared in concert with a Fujitsu SE. Each RAID Group was made up of 2 disk drives in a RAID1 configuration and assigned to a specific CM for operational control. The RAID Groups were named RG00 through RG09.

Step 2 – Creation of the Logical Volumes

Wide striped logical volumes were created across 2 sets of RAID Groups (each with 10 RAID Groups). Three volumes were created on each of the RAID Groups, one for each of the three ASUs, for a total of 6 logical volumes. The sizes of two volumes created on the 2 sets for ASU-1 and ASU-2 were set to 842600 MiB each. The sizes of the volume on the 2 sets for ASU-3 were set to 187264 MiB each.

Step 3 – Creation of the Global Hot Spares

No drives were designated as the Global Hot Spare.

Step 4 – Assignment of LUN Mapping to the Linux Host Systems

The **DX200S4_20170329.exp** script provided mapping to 16 host ports.

The port LUN mapping was assigned for each of the Logical Volumes using two ports on each of the four Channel Adapters (CA) in each of the two Controller Modules (CM). Each of the volumes, which were defined on RAID Groups owned by CM-0, were assigned LUN numbers on the active ports on the four CAs installed on CM-0. Each of the volumes, which were defined on RAID Groups owned by CM-1, were assigned LUN numbers on the active ports on the four CAs installed on CM-1.

Step 5 – Creation of the two way striped logical volumes.

Built in logical volume manager in Linux is used to stripe each pair of LUNs presented by DX200S4 array.

This is done in 3 steps included in the DX200S4_20170317makeLV.sh script.

1. Create Physical Volumes (PV) for each LUN presented from DX200S4.
   ```
   pvcreate /dev/disk/by-id/scsi-3600000e00d2800000028003400000000
   pvcreate /dev/disk/by-id/scsi-3600000e00d2800000028003400010000
   pvcreate /dev/disk/by-id/scsi-3600000e00d2800000028003400020000
   pvcreate /dev/disk/by-id/scsi-3600000e00d2800000028003400030000
   pvcreate /dev/disk/by-id/scsi-3600000e00d2800000028003400040000
   pvcreate /dev/disk/by-id/scsi-3600000e00d2800000028003400050000
   ```

2. Create Three Volume Groups with physical extent size of 32MiB
   ```
   vgcreate -s32m asu1vg /dev/disk/by-id/scsi-
   3600000e00d2800000028003400000000 /dev/disk/by-id/scsi-
   3600000e00d2800000028003400030000
   vgcreate -s32m asu2vg /dev/disk/by-id/scsi-
   3600000e00d2800000028003400020000 /dev/disk/by-id/scsi-
   3600000e00d2800000028003400050000
   vgcreate -s32m asu3vg /dev/disk/by-id/scsi-
   3600000e00d2800000028003400010000 /dev/disk/by-id/scsi-
   3600000e00d2800000028003400040000
   ```

3. Create Three Logical Volumes for each ASU with 32MiB Stripe size
   ```
   lvcreate -l 100%VG -i2 -I32768 -n asu1 asu1vg
   lvcreate -l 100%VG -i2 -I32768 -n asu2 asu2vg
   lvcreate -l 100%VG -i2 -I32768 -n asu3 asu3vg
   ```

Referenced Scripts

The following files are included in the Supporting Files for reference.

doFDRcfg.sh

DX200S4_20170329.exp

showFormatStatus.exp

DX200S4_20170317makeLV.sh

APPENDIX E: CONFIGURATION INVENTORY

The following files (included in the Supporting Files) capture the configuration before and after the test run.

- log_JX170523054522_BeforeF.zlg_001.txt

- log_JX170523054522_AfterJ.zlg_001.txt

APPENDIX F: WORKLOAD GENERATOR

ASU Definition File:

The content of the ASU Definition file is included in the Supporting Files.

SPC1.DX200S4_20170302.asu

Host Definition File:

The content of the Host Definition file for the two-host configuration used is included in the Supporting Files.

SPC1.DX200S4_20170302.hst

'Master' Execution Script

The following 'master' script was used to execute the required ASU pre-fill, Primary Metrics Test *(Sustainability Test Phase, IOPS Test Phase, and Response Time Ramp Test Phase)*, Repeatability Test *(Repeatability Test Phase 1 and Repeatability Test Phase 2)*, the SPC-1 Persistence Test Run 1 and the SPC-2 Persistence Test in an uninterrupted sequence with doFDRall_1XV.sh and doFDRall_2H.sh.

The 'master' script invokes various other scripts which appear below in the **Referenced Scripts** section with a brief description of each referenced script.

The following files are included in the Supporting Files.

doFDRall_1XV.sh

doFDRall_2H.sh

Referenced Scripts

The 'master' script invokes the following script (included in the Supporting Files) in order to export the log file from the storage array.

exportLog.exp