SPC BENCHMARK 1™

FULL DISCLOSURE REPORT

HUAWEI TECHNOLOGIES CO., LTD.
OCEANSTOR DORADO 18000 V6

SPC-1 V3.9.1

SUBMISSION IDENTIFIER: A32018

SUBMITTED FOR REVIEW: OCTOBER 2, 2020

First Edition – October 2020

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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.

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AUDIT CERTIFICATION

InfoSizing
The Right Metric For Sizing IT

Storage Performance Council
Certified Auditor

Zhong Xu
Huawei Technologies Co., Ltd.
Huawei Industrial Base, Bantian, Longgang
Shenzhen City
Guangdong Province
China

October 2, 2020

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

OceanStor Dorado 18000 V6

The results were:

SPC-1 IOPS™	**21,002,561**
SPC-1 Price-Performance	**¥2,913.78/SPC-1 KIOPS™**
SPC-1 Total System Price	61,196,712.28
SPC-1 IOPS Response Time	0.367 ms
SPC-1 Overall Response Time	0.286 ms
SPC-1 ASU Capacity	755,914 GB
SPC-1 ASU Price	¥80.96/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 v3.0.2. The audit process was conducted in accordance with the SPC Policies and met the requirements for the benchmark.

A Letter of Good Faith was issued by Huawei 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 Huawei Technologies Co., Ltd., and can be found at www.spcresults.org under the Submission Identifier A32018.

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 (1,105,920 GB).
- The total capacity of the Application Storage Unit (755,914 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
- 8-minute measurement interval
- 1-minute ramp down
- 10% of the workload level of RAMPD_100

Respectfully Yours,

Doug Johnson, Certified SPC Auditor

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LETTER OF GOOD FAITH

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Shenzhen city
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Tel: 0086-755-28780808
http://www.huawei.com/en/

Date: Sep 28, 2020

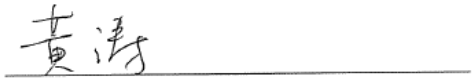
From: Huawei Technologies Co., Ltd.

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 Huawei OceanStor Dorado 18000 V6

Huawei 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 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:



2020-9-28

Tao Huang
Data Storage and Intelligent Vision Product Line

SPC Benchmark 1™

Executive Summary

OceanStor Dorado 18000 V6

SPC-1 IOPS™	**21,002,561**
SPC-1 IOPS Response Time	**0.367 ms**
SPC-1 Overall Response Time	0.286 ms

SPC-1 Price Performance	**¥2,913.78/SPC-1 KIOPS™**
SPC-1 Total System Price	**¥61,196,712.28**
SPC-1 Overall Discount	23.71%
Currency / Target Country	CNY / China
Availability Date	September 10, 2020

Extensions

★ SPC-1 Data Reduction	1.61
☆ SPC-1 Encryption	NA
☆ SPC-1 NDU	NA
☆ SPC-1 Synchronous Replication	NA
☆ SPC-1 Snapshot	NA

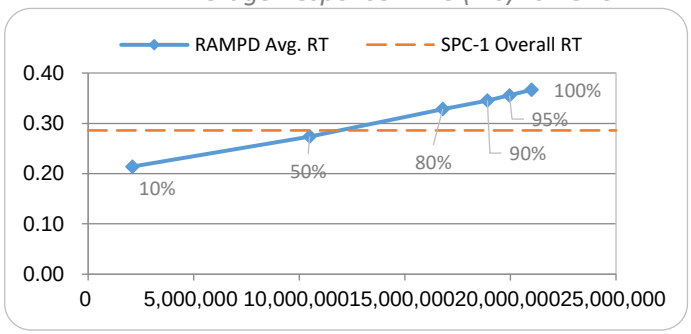
Storage Metrics

SPC-1 Data Protection Level	Protected 2
SPC-1 Physical Storage Capacity	1,105,920 GB
SPC-1 ASU Capacity	755,914 GB
SPC-1 ASU Price	¥80.96/GB

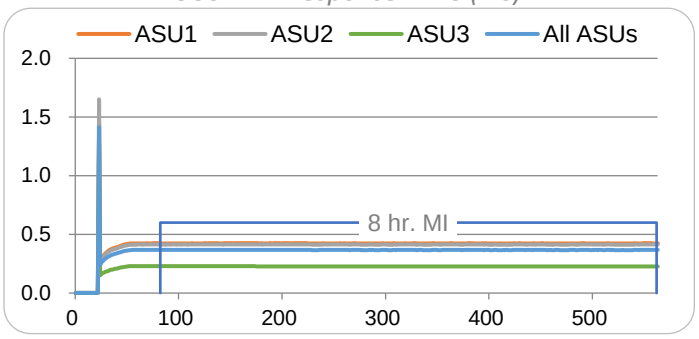
Priced Storage Configuration Summary

150	Huawei or Emulex 2-port 32 Gb FC HBAs
8	OceanStor Dorado 18000 V6 Engines
32	Active-Active Controllers
32	TB Total Cache
96	4-port 32 Gb FC Smart I/O Modules
576	1,920 GB NVMe SSDs
11	OceanStor SNS3664-32Gb FC Switches
2	Huawei 32-port 100 Gbps RDMA Switches
96	Total RUs

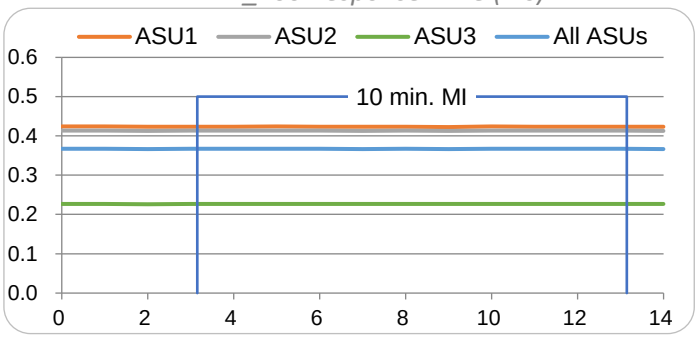
RAMPD Average Response Time (ms) vs. IOPS



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 2, 2020
Submission Details	www.storageperformance.org/r/A32018

PRICING DETAILS

Part No.	Description	Source	Qty	Unit Price	Ext. Price	Disc.	Disc. Price
Hardware & Software							
D18V6-4C-4T-N-T	Dorado 18000 V6 Controller Enclosure(4U,Four Ctrl,NVMe,AC\240V HVDC,4TB Cache,SPE74C0400)	1	8	3,362,772.00	26,902,176.00	30%	18,831,523.20
DV6-SMARTIO4*32FC-H	4 ports SmartIO I/O module(SFP28,32Gb FC)	1	96	14,241.36	1,367,170.56	0%	1,367,170.56
H-RDMA-BE	2 ports 100Gb RDMA I/O module(QSFP28,for Back-End)	1	48	4,321.80	207,446.40	0%	207,446.40
Scale-RDMA-H	2 ports 100Gb RDMA I/O module(QSFP28,Scale-out for switches)	1	32	4,321.80	138,297.60	0%	138,297.60
D18V6-SSD-NVMe-1.92T	1.92TB SSD NVMe Palm Disk Unit(7")	1	576	50,215.20	28,923,955.20	29%	20,536,008.20
D18V6-NVMe-DAE36	Smart NVMe Disk Enclosure(2U,AC\240V HVDC,Palm,Expansion Module,100Gb RDMA,36 Disk Slots,Without Disk Units,DAE63625U2)	1	24	132,398.00	3,177,552.00	30%	2,224,286.40
RACK-FR42H-17-IP	OceanStor Dorado V6 High-end Storage System Bay (Dorado 18000 V6 Controller Enclosure and Smart Disk Enclosure, Including Guide rails)	1	4	79,459.38	317,837.52	30%	222,486.27
PDU2000-32-11/2-B1-3M	AC Power Distribution Unit	1	16	871.22	13,939.52	30%	9,757.67
C3006BK01	Power Cable,600V/1000V,ZA-RVV,3x6mm^2,Black(3Cores:Brown,Blue,Yellow/Green),46A,Outdoor Cable,CE (Unit:meter)	1	160	47.00	7,520.00	0%	7,520.00
P-16mm^2-Y/G-LSZH	Power Cable,450V/750V,H07Z-K UL3386,16mm^2,Yellow/Green,107A,LSZH Cable,VDE,UL (Unit:meter)	1	20	27.00	540.00	0%	540.00
NS32GOLC07	Emulex,FC HBA,32Gb(LPe32000),1-Port,SFP+(with 1x Multi-mode Optical Transceiver),PCIe 3.0 x8	1	34	5,796.70	197,087.80	0%	197,087.80
BC5M02ETHLD	FC HBA Adapter,32G(Hi1822),Dual Port,SFP28(With Dual Optical Module),Half-height Half-length(included Half Handle bars and Full Handle bars),PCIe 3.0 x8	1	116	7,134.40	827,590.40	0%	827,590.40
SNS3664-4832G-AC-R	32Gb FC Switch,64 Ports(48 ports activated,with 48*32Gb Multimode SFPs,Port Side Exhaust Air Flow),Dual PS(AC),Include Enterprise Feature Bundle	1	11	842,545.20	9,267,997.20	0%	9,267,997.20
SN2R02FCRK3	Mount Kit	1	11	2,606.80	28,674.80	0%	28,674.80
CE8850-EI-F-B0A	CE8850-32CQ-EI Switch(32-Port 100GE QSFP28,2-Port 10GE SFP+,2*AC Power Module,2*FAN Box,Port-side Exhaust)	1	2	219,520.00	439,040.00	0%	439,040.00
SN2F01FCPC	SN2F02FCPC Patch Cord,DLC/PC,DLC/PC,Multi-mode,10m,A1a.2,2mm,42mm DLC,OM3 bending insensitive	1	502	144.00	72,288.00	0%	72,288.00
HSC-100G QSFP28-2M	High Speed Cable,100G QSFP28 Passive High Speed Cable,2m,QSFP28,CC8P0.4B(S),QSFP28,ETH 100GbE only for Storage	1	48	686.00	32,928.00	0%	32,928.00
HSC-100G QSFP28-2M	High Speed Cable,100G QSFP28 Passive High Speed Cable,2m,QSFP28,CC8P0.4B(S),QSFP28,ETH 100GbE only for Storage	1	32	686.00	21,952.00	0%	21,952.00
D18V6-LBS-Basic	Basic Software Licenses (Including OceanStor OS,DeviceManager,SmartThin,SmartMigration,HyperSnap,HyperReplication,HyperClone,SmartQoS,SmartErase,eService)	1	1	659,794.80	659,794.80	20%	527,835.84
D18V6-LBS-C-General	Capacity License (per TiB Effective Capacity,Including SmartDedupe&SmartCompression)	1	2,012	3,430.00	6,901,160.00	20%	5,520,928.00
					Hardware & Software Subtotal		**60,481,358.34**
Support & Maintenance							
88035TYF_88134UHK-1B0_36	Basic Software Licenses (Including OceanStor OS,DeviceManager,SmartThin,SmartMigration,HyperSnap,HyperReplication,HyperClone,SmartQoS,SmartErase,eService)-Hi-Care Application Software Upgrade Support Service OceanStor Dorado 18000 V6 Basic Software Licenses-36Month(s)	1	1	237,534.36	237,534.36	0%	237,534.36
8814151798	Solid Storage Hardware Installation Servce	1	1	113,052.80	113,052.80	0%	113,052.80
8814151805	Solid Storage Planning and Design Service	1	1	63,235.48	63,235.48	0%	63,235.48
8814151818	Solid Storage Commissioning Service	1	1	51,744.98	51,744.98	0%	51,744.98
8814151831	Solid Storage Acceptance Service	1	1	249,786.32	249,786.32	0%	249,786.32
					Support & Maintenance Subtotal		**715,353.94**
SPC-1 Total System Price							**61,196,712.28**
SPC-1 IOPS™							21,002,561
SPC-1 Price-Performance™ ($/SPC-1 kIOPS™)							**2,913.78**
SPC-1 ASU Capacity (GB)							755,914
SPC-1 ASU Price ($/GB)							**80.96**

Pricing Details: All prices are in CNY and reflect prices generally available in China.

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

Warranty: Hi-Care Premier On-Site Service includes: 7*24 Technical Assistance Center Access. Access to all new software updates and Online Support. 24*7*4-hour Onsite Hardware Replacement.

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	Huawei Technologies Co., Ltd. Mao Han	www.huawei.com hanmao@huawei.com
SPC Auditor	InfoSizing Doug Johnson	www.sizing.com doug@sizing.com

Revision Information

Date	FDR Revision	Details
October 2, 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
- 8-minute measurement interval
- 1-minute ramp down
- 10% of the workload level of RAMPD_100

CONFIGURATION INFORMATION

Tested Storage Product Description

Employing Huawei's brand-new hardware platform and the fully interconnected architecture of SmartMatrix to provide symmetric active-active services, the high-end storage systems set unprecedented standards for industry reliability, tolerating the failure of 1 out of 2 controller enclosures and 7 out of 8 controllers.

In addition, the storage systems utilize Huawei-developed intelligent chips, FlashLink® intelligent algorithms — purpose designed for flash media — End-to-End (E2E) Non-Volatile Memory Express (NVMe) architecture, the intelligence and efficiency of the Smart series, and the high reliability of the Hyper series. They also feature a built-in AI chip — a first in the industry — to make storage more intelligent for application operations.

Dorado 18000 V6 can meet all performance or reliability demands of core services for medium and large enterprises, banks, and data centers, making them well-suited to the carrier, finance, government, and manufacturing industries

For more details, visit:

https://e.huawei.com/en/products/cloud-computing-dc/storage/all-flash-storage/dorado-8000-18000-v6

Host System and Tested Storage Configuration Components

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

Host Systems
18 x Huawei FusionServer RH2288H V3, 57 x Huawei FusionServer 2288H V5 Intel® Xeon® E5-2667 v4 (3.20GHz, 8-cores, 25 MB L3) – RH2288H V3 servers Intel® Xeon® Gold 5120T (2.20GHz, 14-cores, 19.25 MB L3) – 2288H V5 servers 320 GB (7 hosts), 256GB (35 hosts), 192GB (5 hosts), 128GB (11 hosts), 96 GB (3 hosts), 64 GB (14 hosts) CentOS Linux release 7.4.1708 (Core)
Tested Storage Configuration
116 x Huawei 2-port 32 Gb FC HBAs, 34x Emulex LPe32000 2-port 32 Gb FC HBAs
8 x OceanStor Dorado 18000 V6 Engine, each with: 4 x Controllers, each with: 1 TB cache (32 TB total) 12 x 4-port 32 Gbps Smart I/O Modules (384 ports total, 352 ports used) 6 x 2-port 100 GB RDMA I/O Modules 4 x 2-port 100 GB RDMA Cluster Modules 3 x Smart NVMe Disk Enclosures 72 x 1920 GB NVMe SSDs (576 total SSDs) (TSC *continued on next page*)

(TSC *continued from previous page*)

2 x Huawei CE8850-32CQ-EI 32-port 100 Gbps RDMA Switches
11 x Huawei SNS3664 64-port 32 Gb FC Switches (48 ports activated)
704 ports total
528 ports activated
502 ports used

Component Changes in Revised Full Disclosure Report

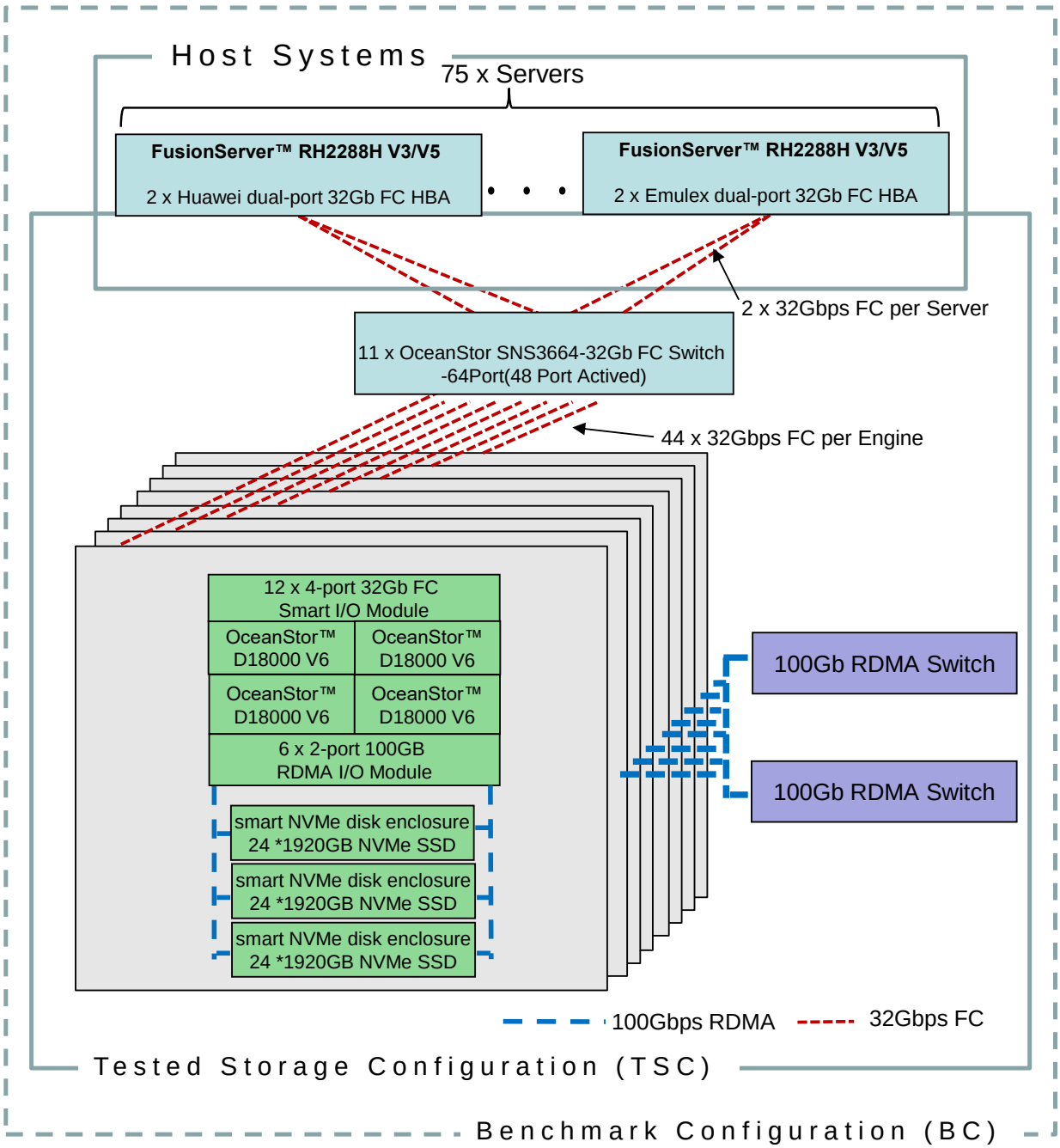
The following table outlines component changes that were made in revisions to this Full Disclosure Report.

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) involved an external storage subsystem made of 32 OceanStor Dorado 18000 V6 controllers grouped in sets of four (forming eight nodes). These were driven by 75 host systems (Huawei FusionServer RH2288H V3 / 2288H V5). Each host system had two 32 Gb FC connections to two of 11 switches. Each of the eight storage nodes had 44 32 Gb FC connections to the 11 switches. The eight storage nodes were interconnected via 100 GB RDMA switches.

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	18	18,897.8	18,897.8	340,161.4	45.0%	Yes
ASU-2	18	18,897.8	18,897.8	340,161.4	45.0%	Yes
ASU-3	4	18,897.8	18,897.8	75,591.4	10.0%	Yes
	SPC-1 ASU Capacity			755,914	*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	576	1,920.0	1,105,920.0
	Total Physical Capacity		**1,105,920**
	Physical Capacity Utilization		**68.35%**

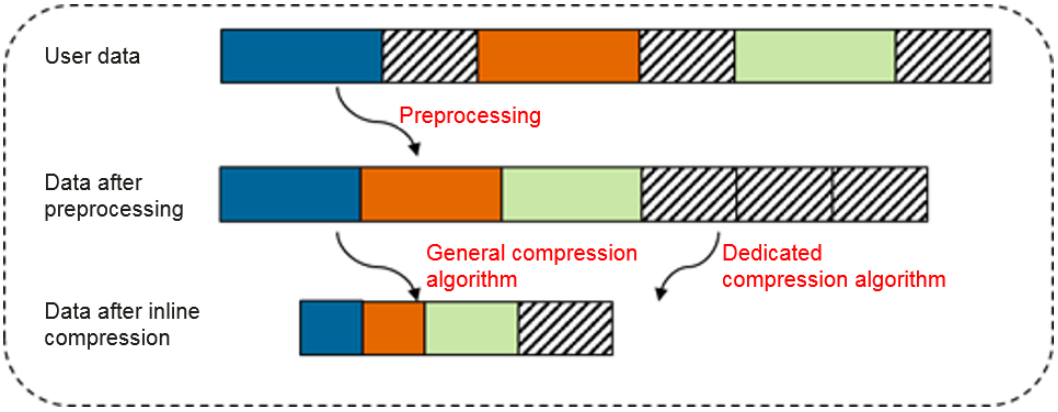
Data Protection

The data protection level used for all LVs was **Protected 2 (RAID6)**, which was accomplished by configuring 8 pools of 72 drives each into 16 RAID6 arrays each.

Space Optimization Information

Description of Utilized Techniques

The OceanStor Dorado V6 combines both inline and post-process compression. Inline and post-process compression technologies include preprocessing and general compression. Before compressing data, preprocessing identifies data characteristics of data flows and rearranges data based on the characteristics. The following figure explains preprocessing and general compression.



OceanStor Dorado V6 uses verification data rearrangement technology. For each data block with a grain granularity, Dorado V6 inserts data verification information after every 512 bytes of data. Because random data exists in the verification information, the calculation of the compression algorithm may be disturbed by the random data, resulting in a low compression ratio. Therefore, data rearrangement separates user data from parity data, compresses the user data, and reduces the parity data in a customized way. In this way, a better compression ratio and higher compression and decompression speeds can be obtained.

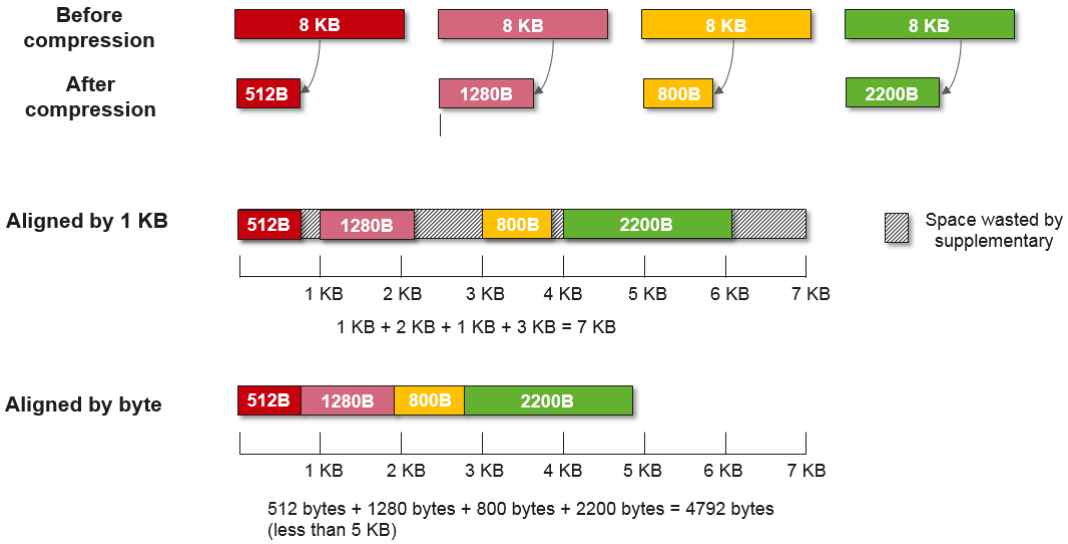
The pre-processed user data is compressed by using a Huawei-developed compression algorithm, and parity data is compressed by using a dedicated compression algorithm. The related compression algorithms use Huawei-developed innovative patented technologies.

Additionally, the OceanStor Dorado V6 uses Huawei's patented byte-level data compaction technology, which eliminates space waste caused by alignment during storage and maximizes the compression algorithm effect. In Dorado V3, data blocks

are aligned at a minimum granularity of 512 bytes. If the data block size is less than 512 bytes, all zeros will be filled into the unwritten space. After the data is compressed, the data size may not be 512 bytes and therefore, a large number of zero padding operations are required, wasting storage space.

Alignment by byte reduces the space that requires zero padding, improving space usage. This provides a higher reduction ratio than the 1 KB alignment granularity generally used in the industry.

The following figure shows the byte-level data compaction technology for I/Os of the 8 KB size.



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	918,750.59
After ASU Pre-Fill	529,663.66
After Repeatability Test Phase	529,655.65

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	1.94
SPC-1 Space Effectiveness Ratio	1.61

BENCHMARK EXECUTION RESULTS

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

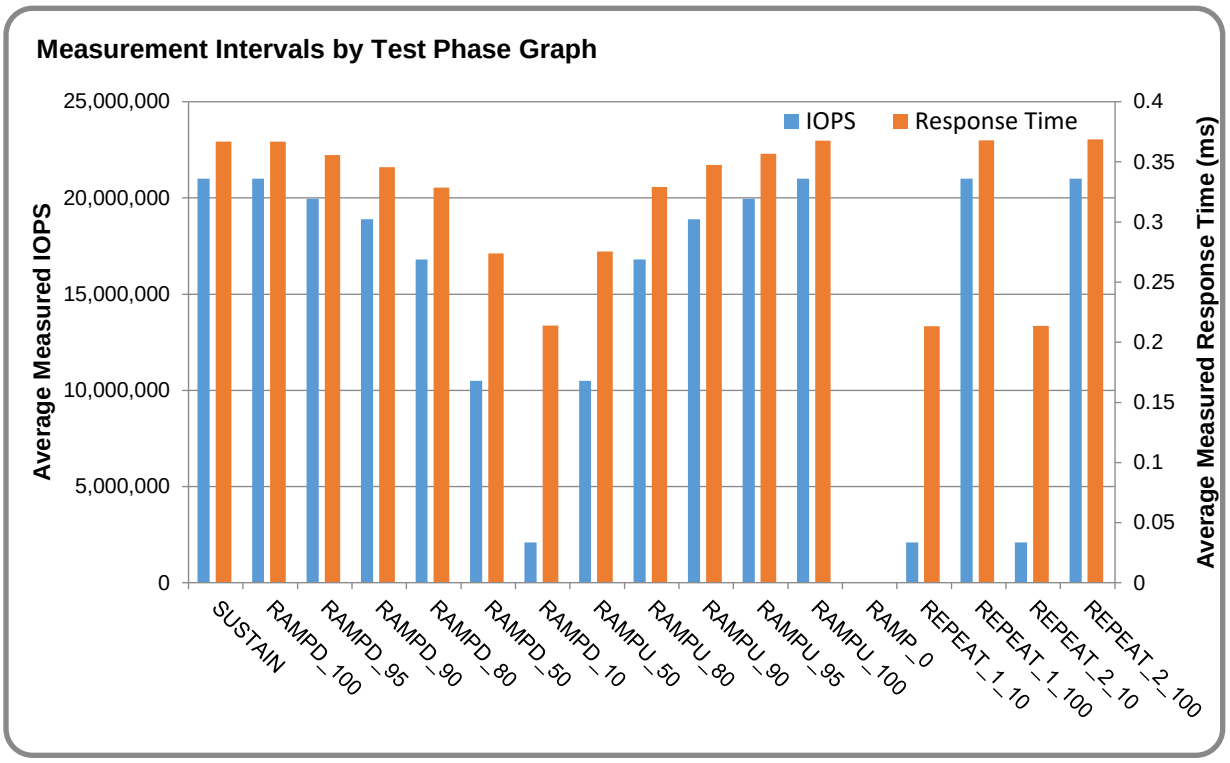
Benchmark Execution Overview

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).

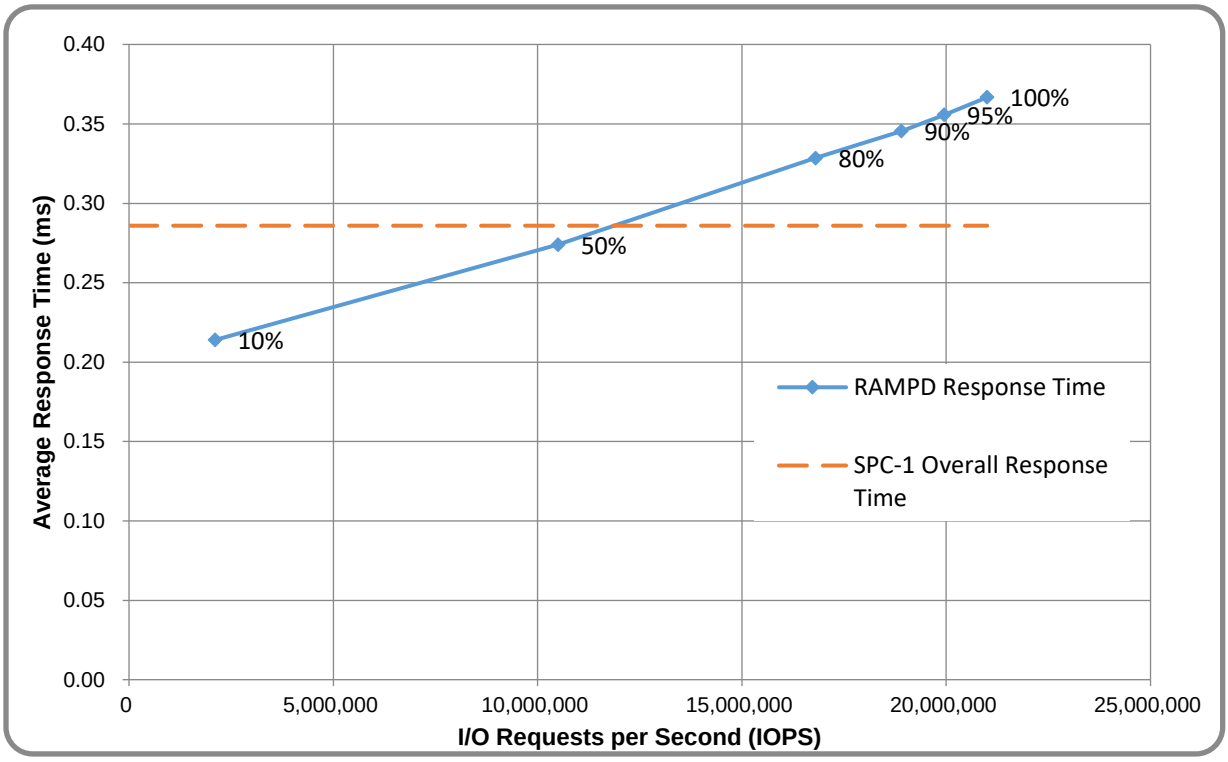
Measurement Intervals by Test Phase Graph

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	29-Sep-20 09:43:40	**Requested IOP Level**	240,000 MB/sec
End Time	29-Sep-20 10:43:18	**Observed IOP Level**	211,234 MB/sec
Duration	0:59:39	For additional details see the Supporting Files.	

SUSTAIN Test Phase

SUSTAIN – Results File

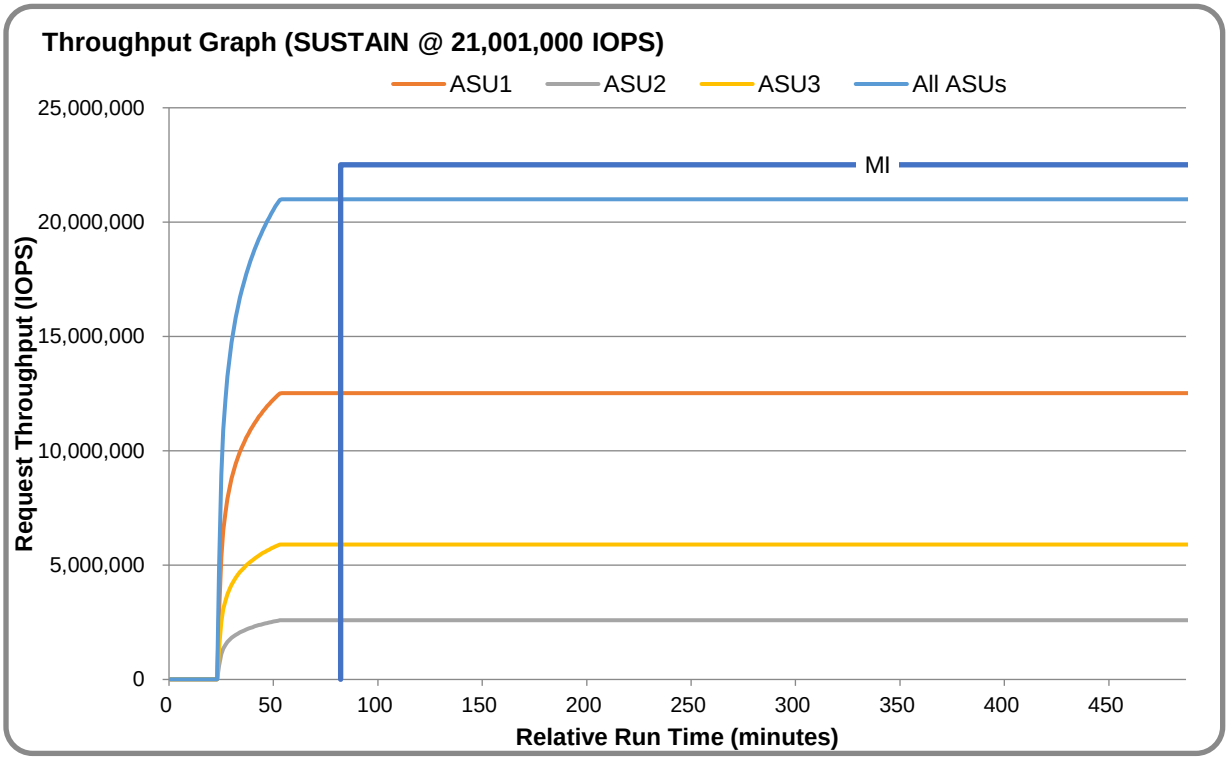
The results file generated during the execution of the SUSTAIN Test Phase is included in the Supporting Files (see Appendix A) as follows:

- **SPC1_METRICS_0_Raw_Results.xlsx**

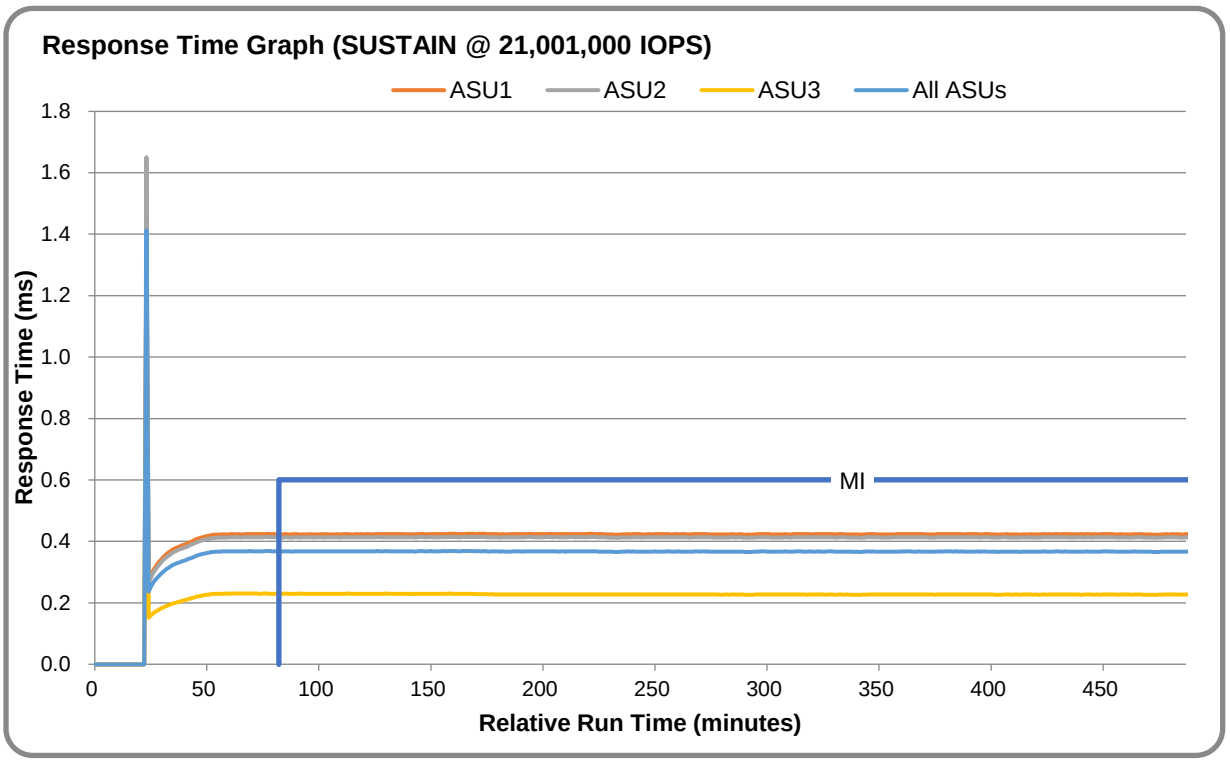
SUSTAIN – Execution Times

Interval	Start Date & Time	End Date & Time	Duration
Transition Period	29-Sep-20 11:15:34	29-Sep-20 12:15:32	0:59:58
Measurement Interval	29-Sep-20 12:15:32	29-Sep-20 20:15:33	8:00:01

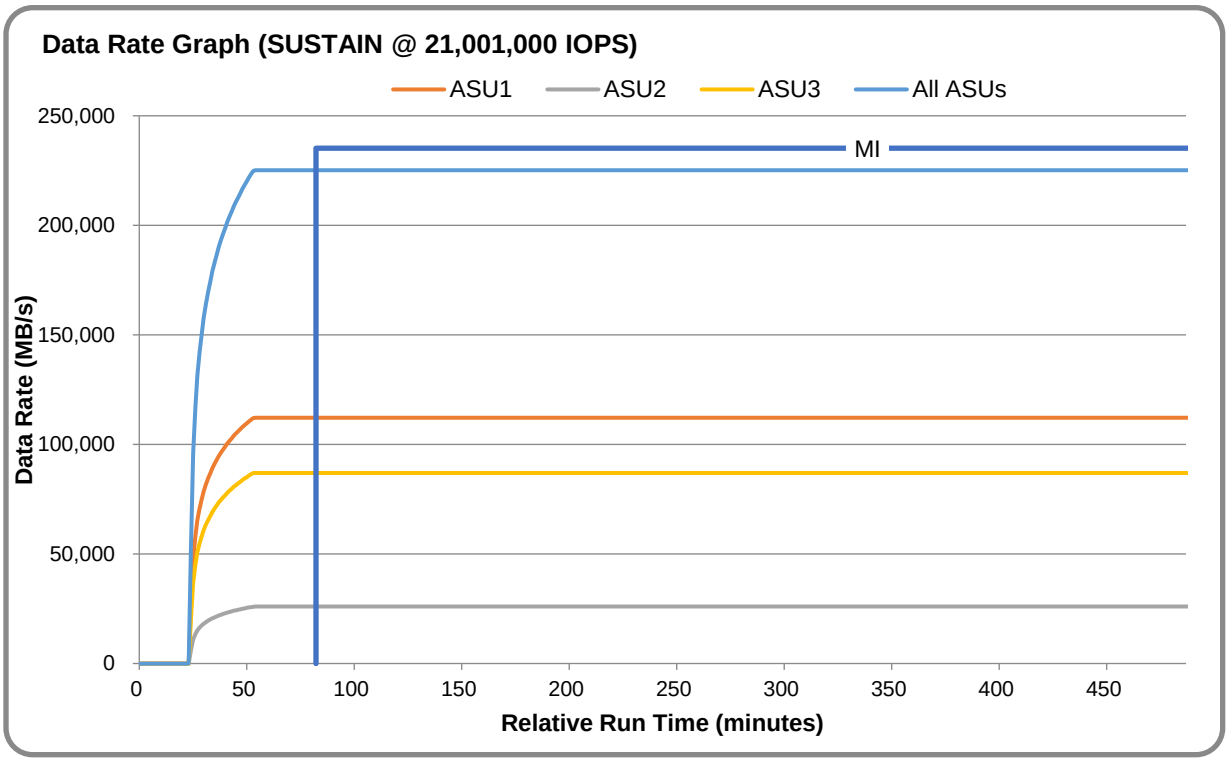
SUSTAIN – Throughput Graph



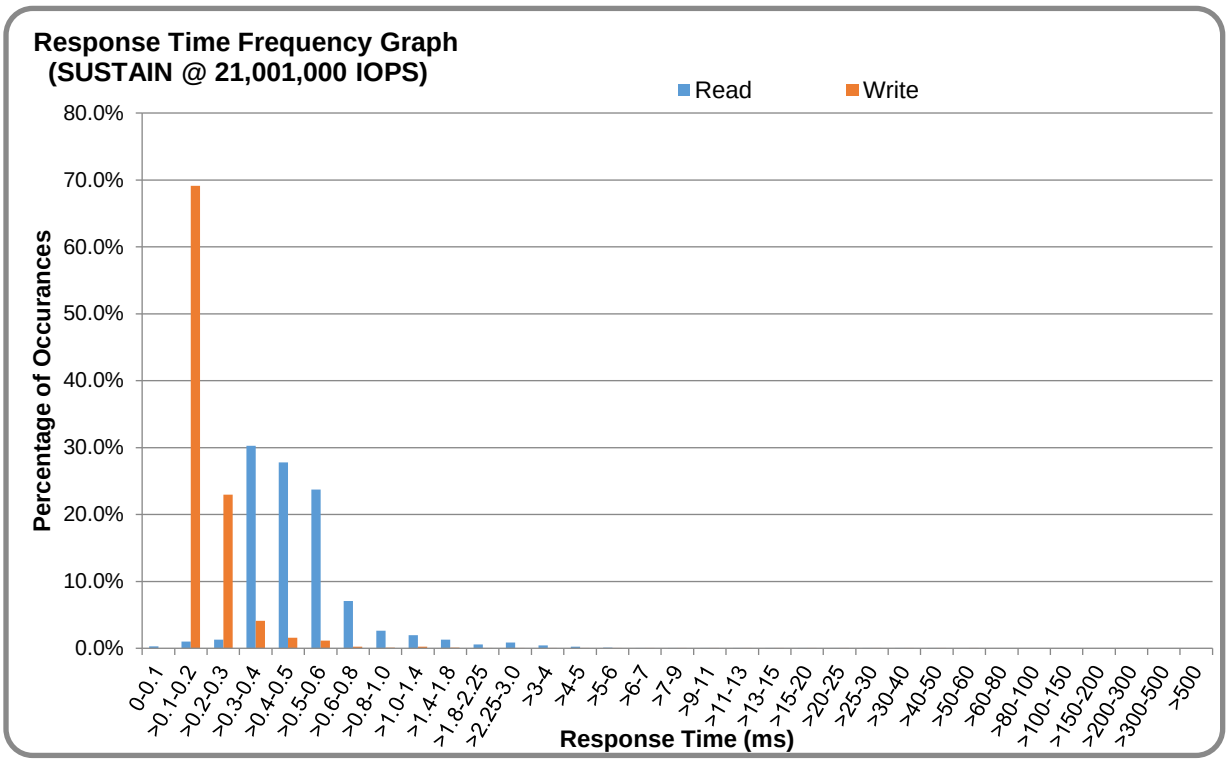
SUSTAIN – Response Time Graph



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	0.0001	0.0000	0.0001	0.0001	0.0002	0.0001	0.0001	0.0000
Difference	0.005%	0.002%	0.004%	0.000%	0.004%	0.004%	0.005%	0.001%

RAMPD_100 Test Phase

RAMPD_100 – Results File

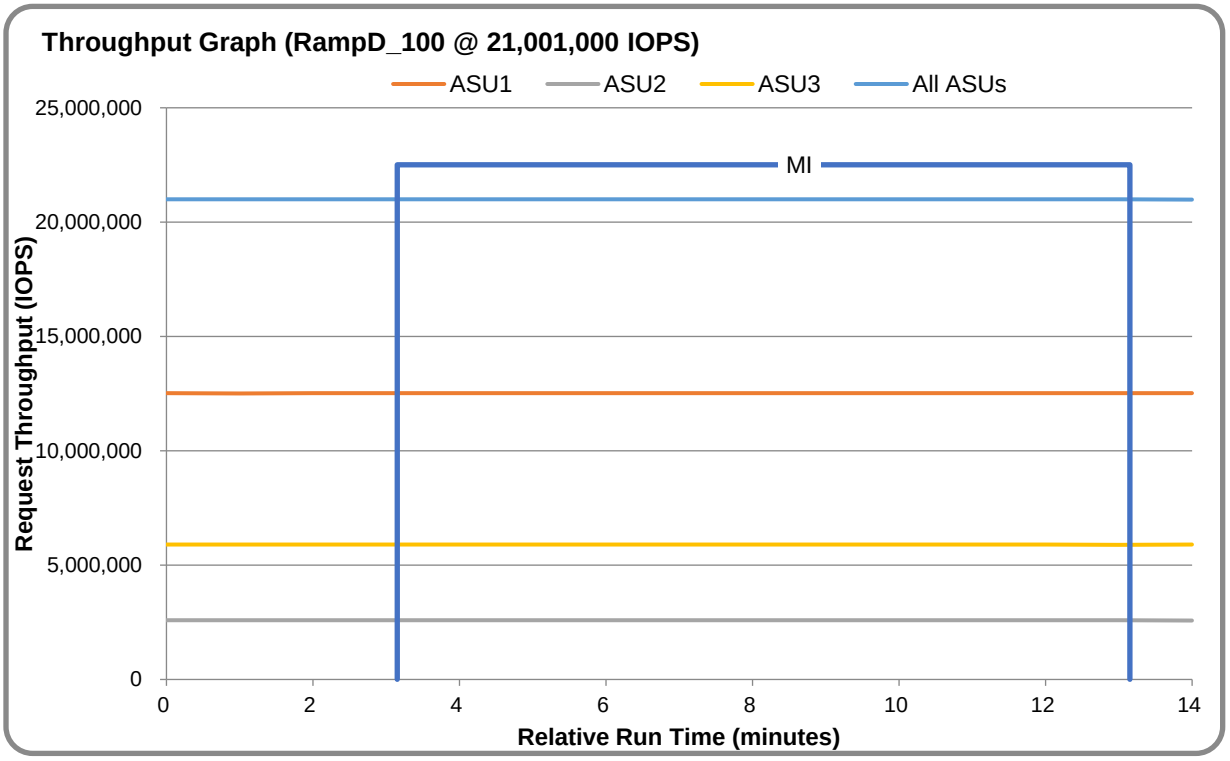
The results file generated during the execution of the RAMPD_100 Test Phase is included in the Supporting Files (see Appendix A) as follows:

- **SPC1_METRICS_0_Raw_Results.xlsx**

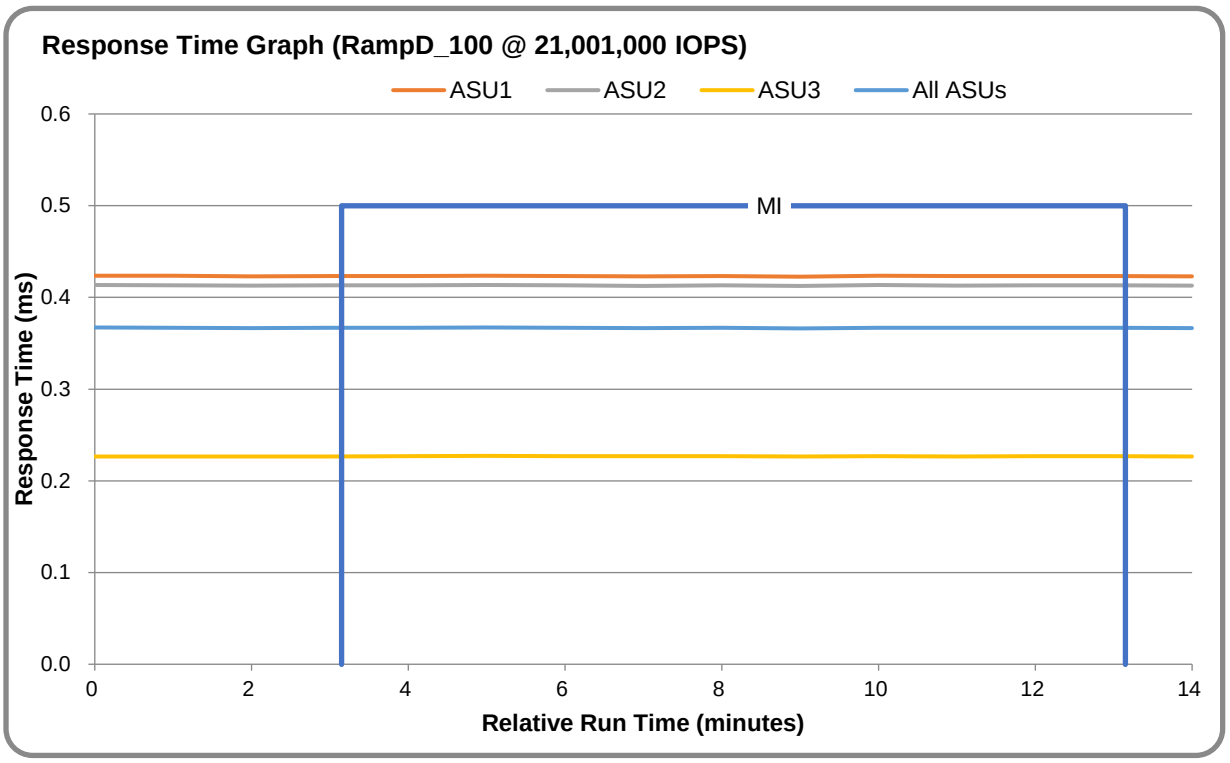
RAMPD_100 – Execution Times

Interval	Start Date & Time	End Date & Time	Duration
Transition Period	29-Sep-20 20:16:32	29-Sep-20 20:19:32	0:03:00
Measurement Interval	29-Sep-20 20:19:32	29-Sep-20 20:29:33	0:10:01

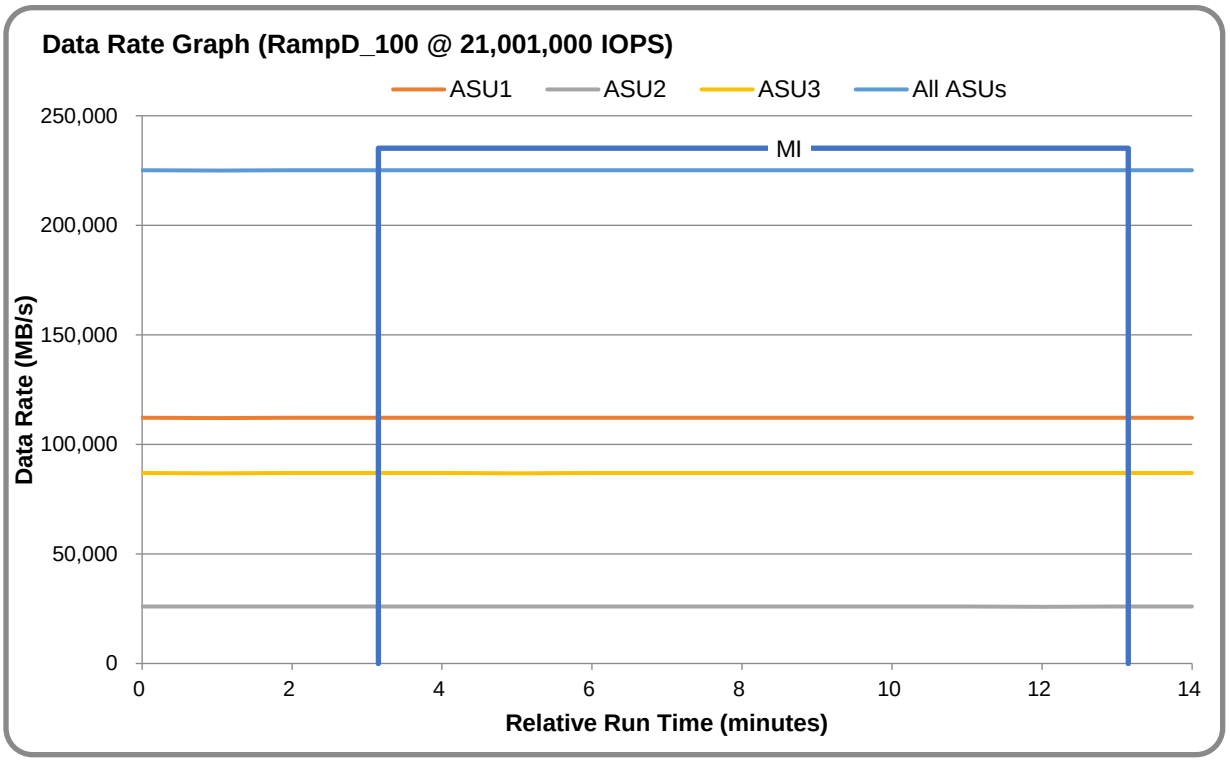
RAMPD_100 – Throughput Graph



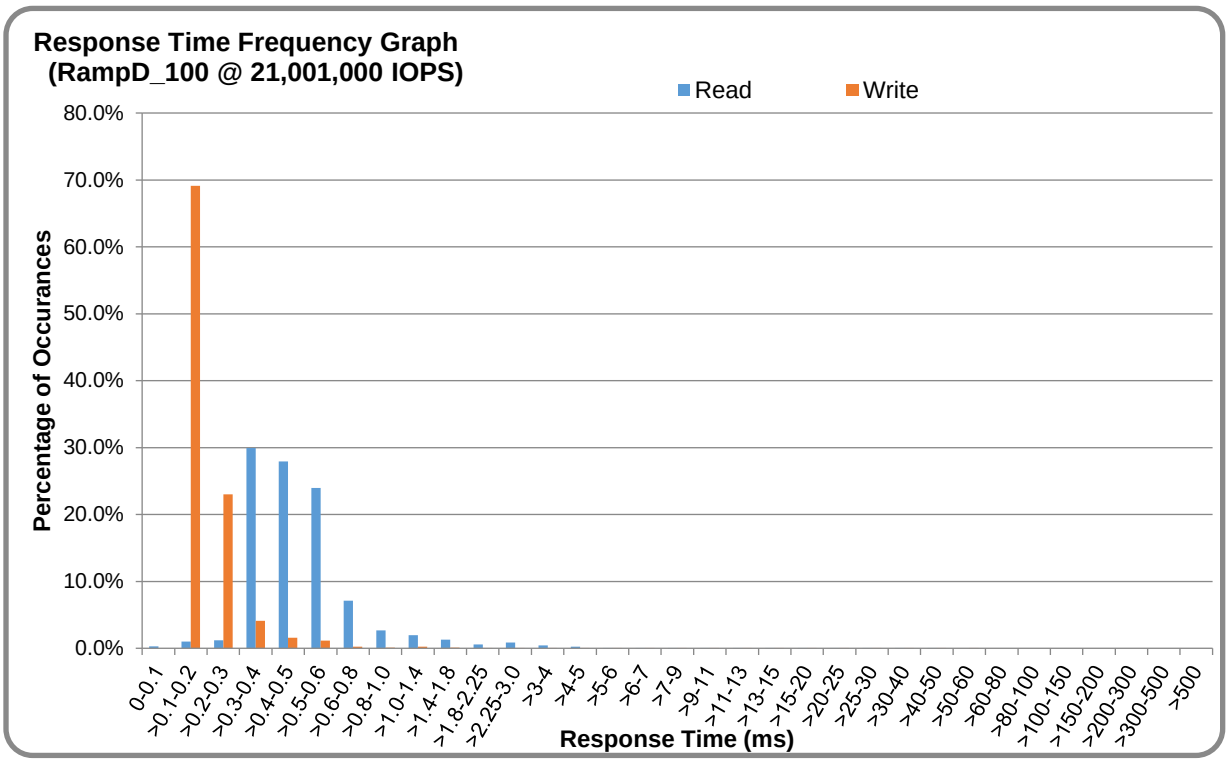
RAMPD_100 – Response Time Graph



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	0.0000	0.0002	0.0001	0.0002	0.0000
Difference	0.004%	0.003%	0.006%	0.001%	0.003%	0.001%	0.001%	0.000%

RAMPD_100 – I/O Request Summary

I/O Requests Completed in the Measurement Interval	12,601,458,944
I/O Requests Completed with Response Time <= 30 ms	12,601,392,940
I/O Requests Completed with Response Time > 30 ms	66,004

Response Time Ramp Test

Response Time Ramp Test – Results File

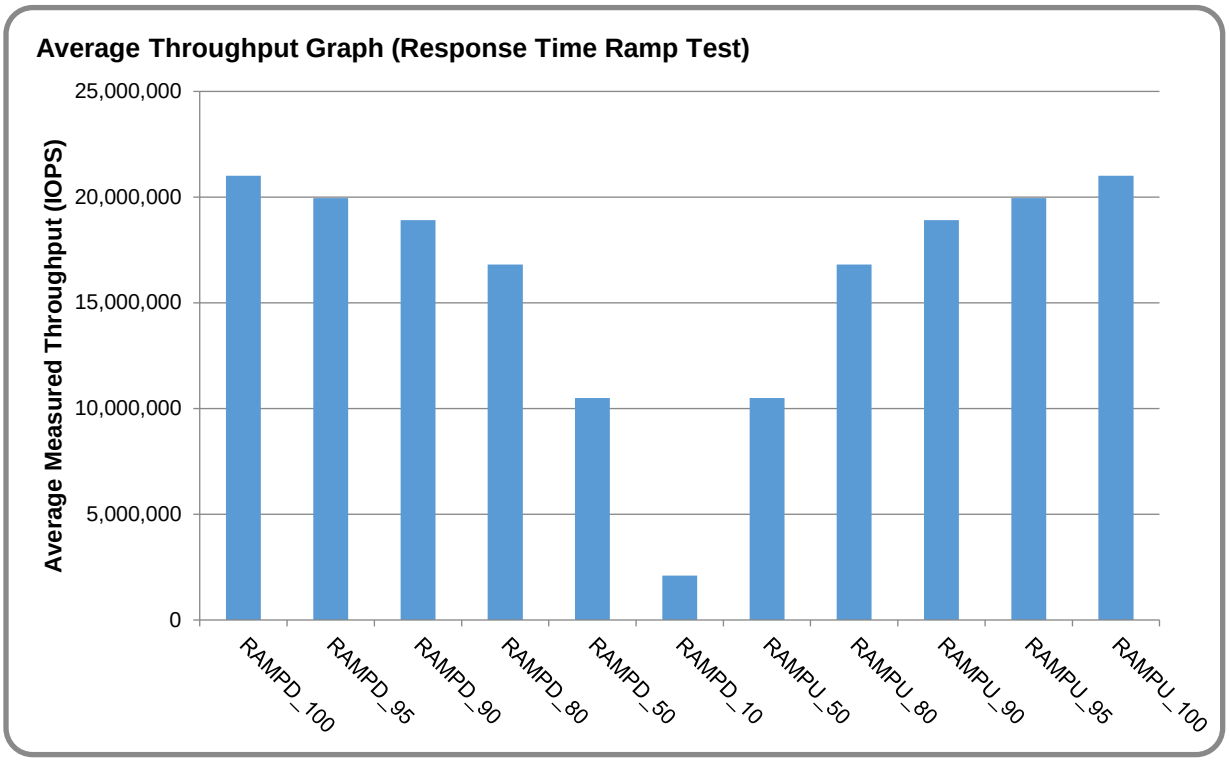
The results file generated during the execution of the Response Time Ramp Test is included in the Supporting Files (see Appendix A) as follows:

- **SPC1_METRICS_0_Raw_Results.xlsx**

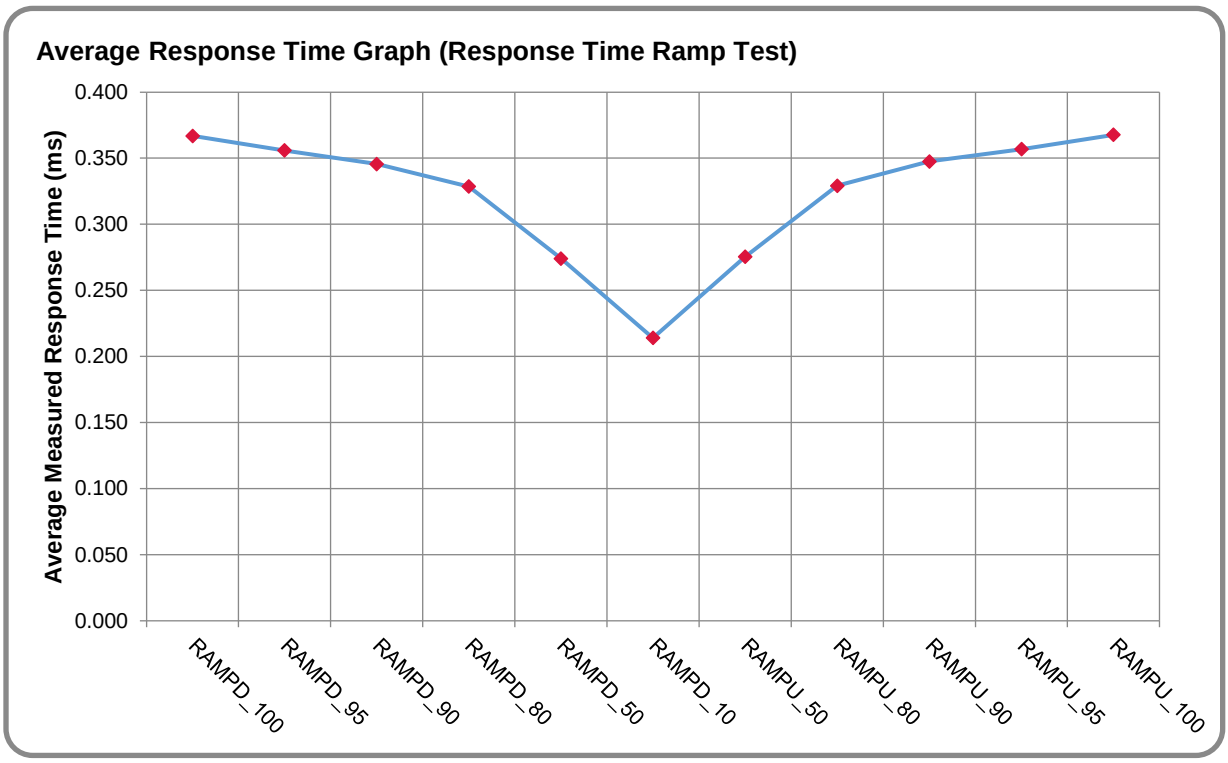
Response Time Ramp Test – Phases

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).

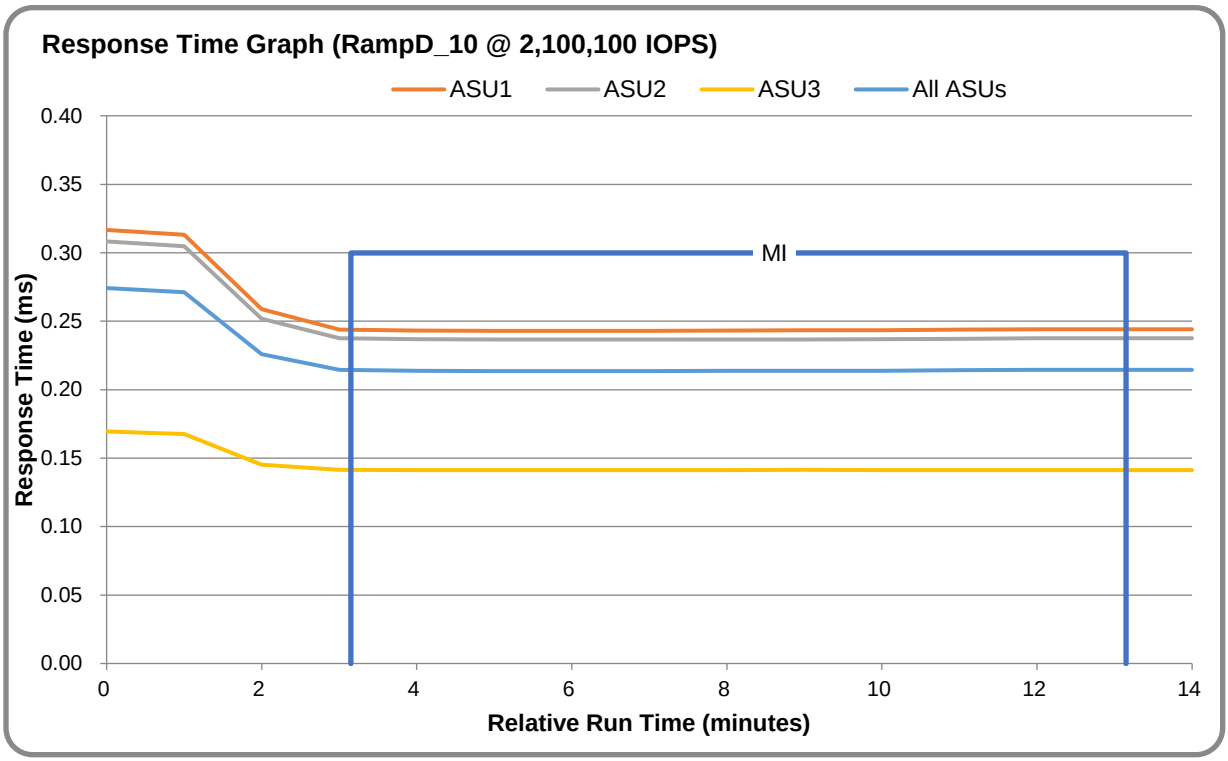
Response Time Ramp Test – Average Throughput Graph



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:

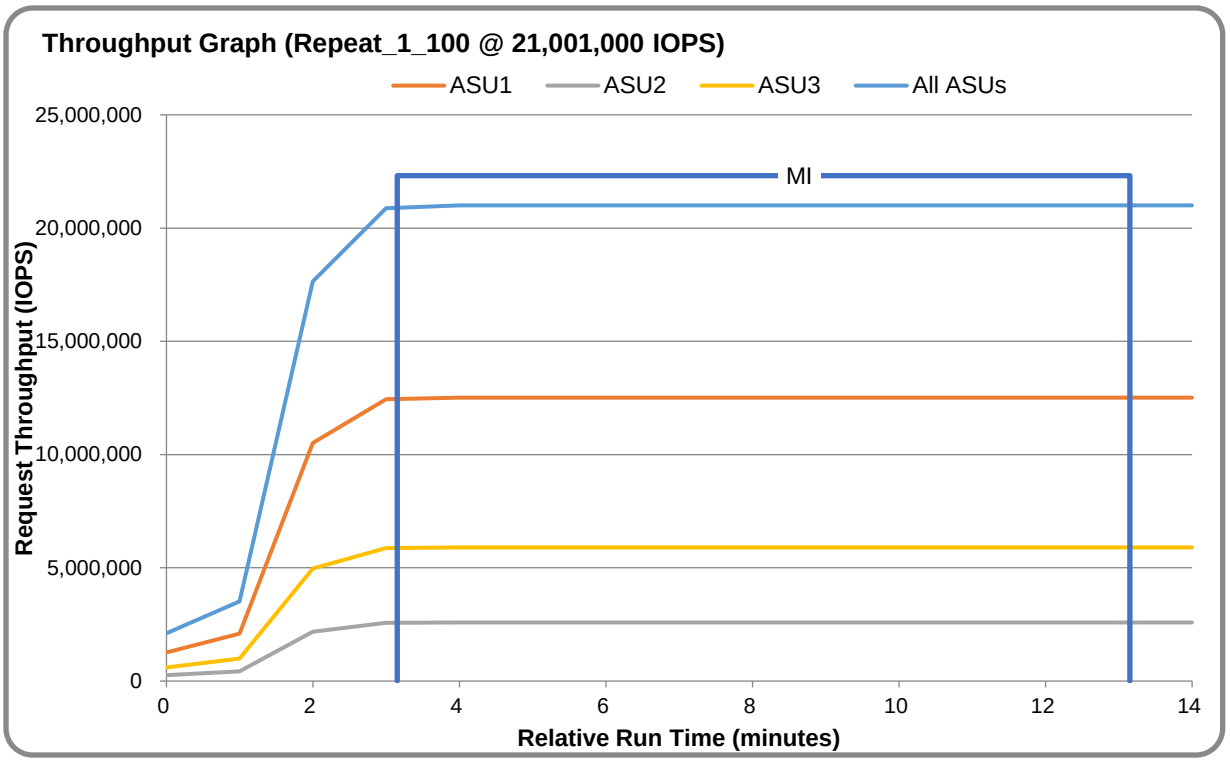
- **SPC1_METRICS_0_Raw_Results.xlsx**

Repeatability Test Results

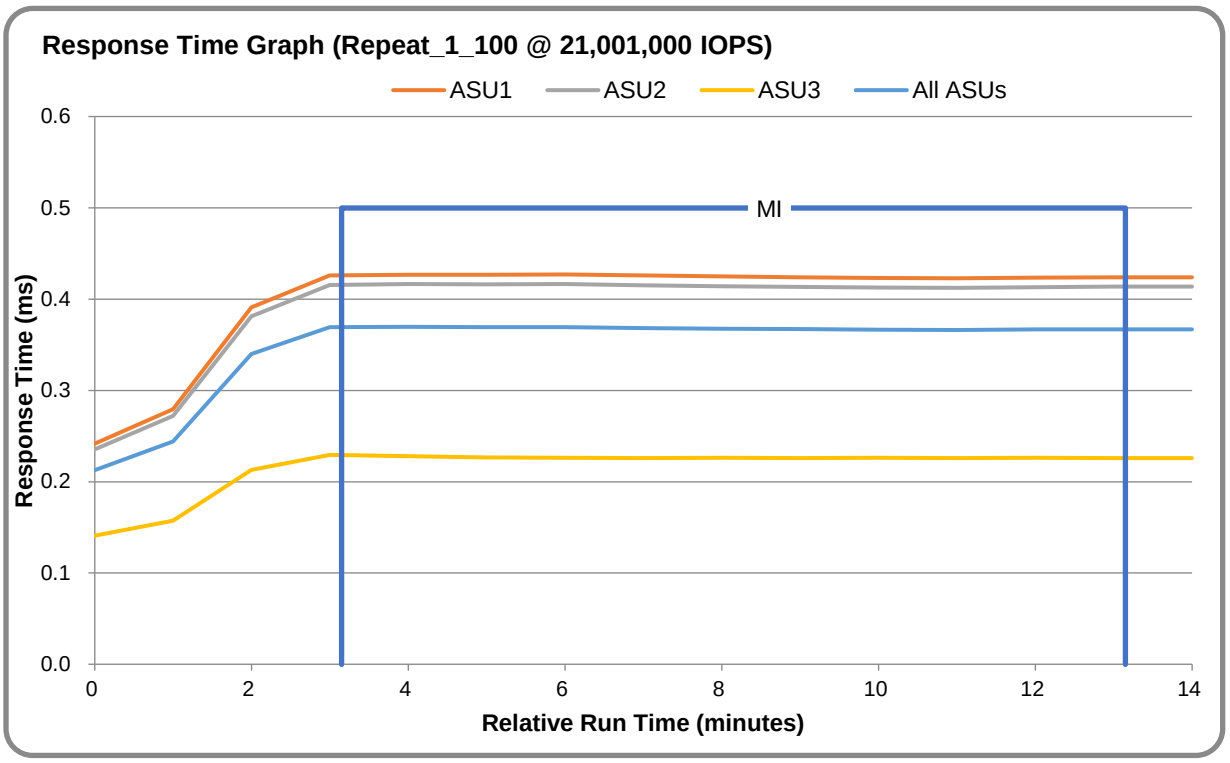
The throughput measurements for the Response Time Ramp Test (RAMPD) and the Repeatability Test Phases (REPEAT_1 and REPEAT_2) are listed in the table below.

Test Phase	100% IOPS	10% IOPS
RAMPD	21,002,561.5	2,100,176.8
REPEAT_1	21,002,381.6	2,100,207.8
REPEAT_2	21,002,451.3	2,100,237.7

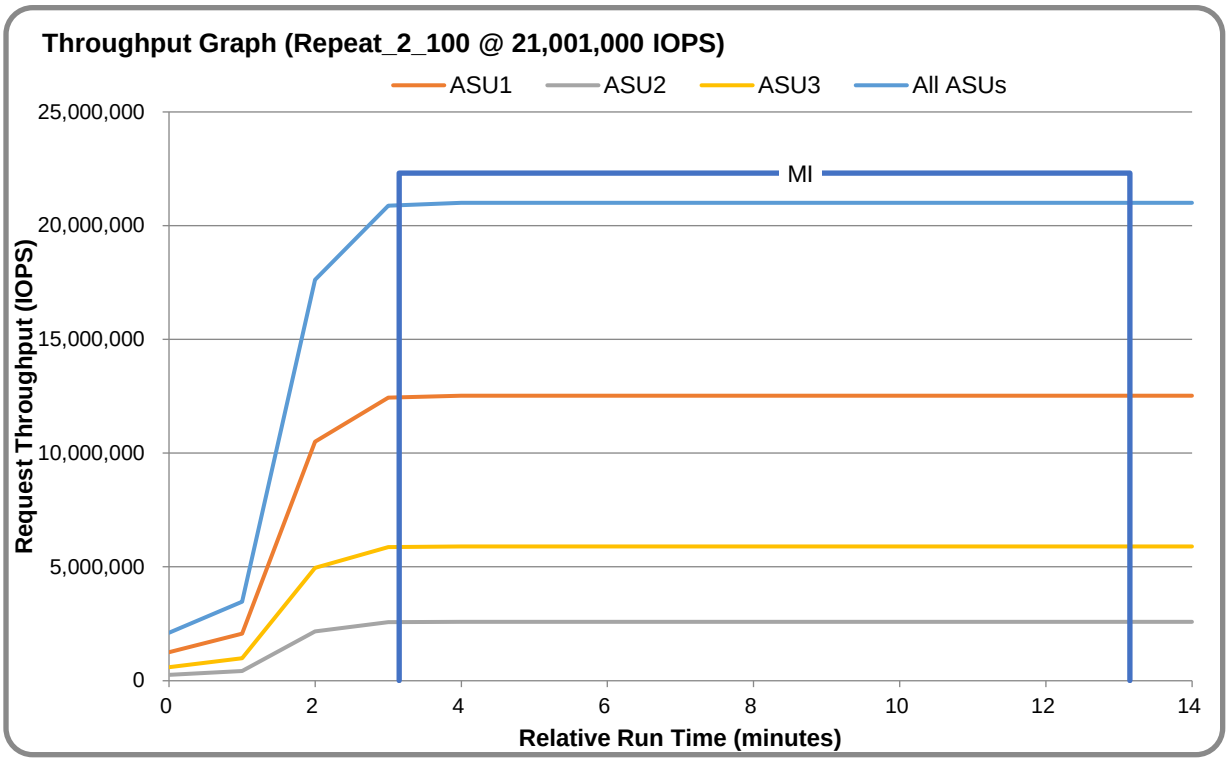
REPEAT_1_100 – Throughput Graph



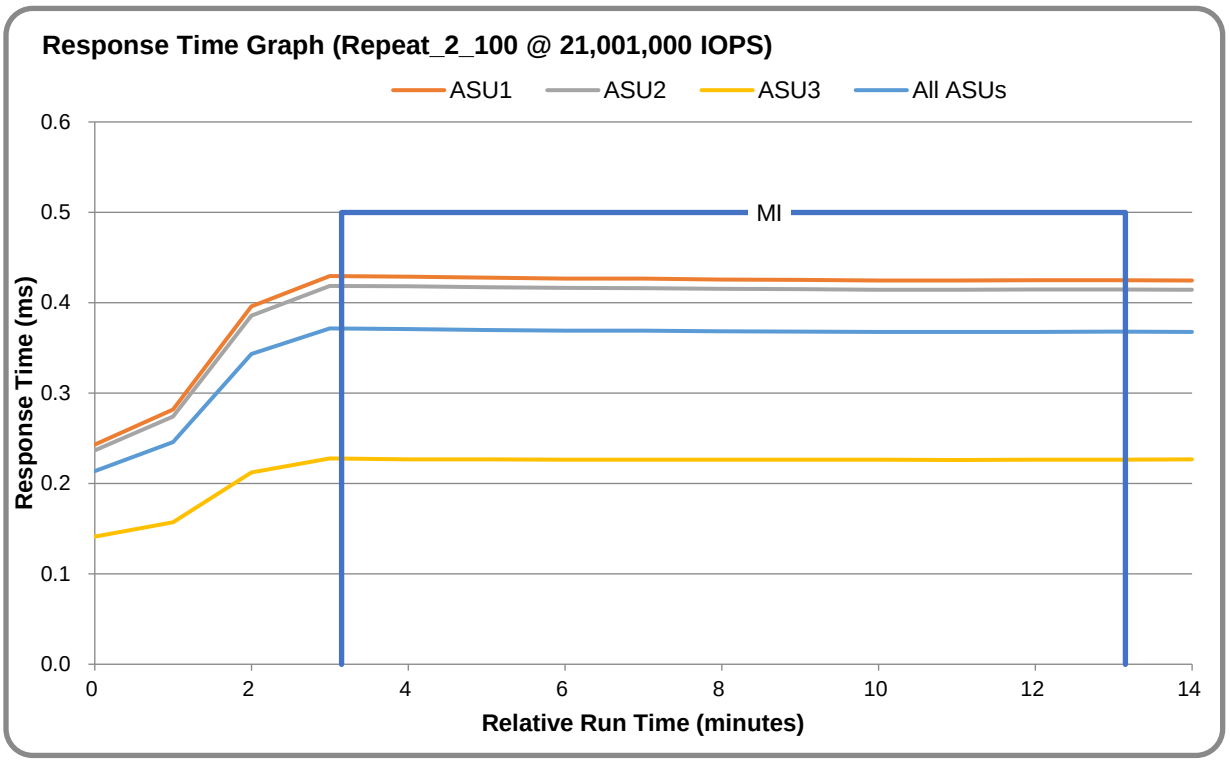
REPEAT_1_100 – Response Time Graph



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 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	0.0001	0.0000	0.0001	0.0000	0.0001	0.0001	0.0002	0.0000
Difference	0.005%	0.001%	0.008%	0.001%	0.003%	0.001%	0.008%	0.002%

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	0.0000	0.0001	0.0000	0.0002	0.0001	0.0002	0.0000
Difference	0.012%	0.002%	0.003%	0.000%	0.003%	0.003%	0.010%	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	1,473,358,091
Total Number of Logical Blocks Verified	734,243,998
Total Number of Logical Blocks Overwritten	739,114,093
Total Number of Logical Blocks that Failed Verification	0
Time Duration for Writing Test Logical Blocks (sec.)	480
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

Committed data persistence is implemented at two levels. At the drive level, data loss is prevented using RAID6 arrays. At the controller level, all caches are mirrored across controllers, where write requests are only completed once the local cache has been successfully mirrored in another controller's cache. In addition, cache content is protected from a loss of power by flushing the cache content to permanent flash memory as soon as a power loss is detected. The flushing action is powered by a battery backup located in each controller.

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**
aoi-max-nr.sh	Set maximum asynchronous I/O	/C_Tuning
nr_requests.sh	Increase disk queue depth	/C_Tuning
scheduler.sh	Change the I/O scheduler	/C_Tuning
/D_Creation	**Storage configuration creation**	**root**
mklun.txt	Create the storage environment	/D_Creation
mkvolume.sh	Create the logical volumes	/D_Creation
/E_Inventory	**Configuration inventory**	**root**
profile1_storage.log	List of storage devices before INIT	/E_Inventory
profile1_volume.log	List of logical volumes before INIT	/E_Inventory
profile2_storage.log	List of storage devices after restart	/E_Inventory
profile2_volume.log	List of logical volumes after restart	/E_Inventory
storageCap_info_stage1.txt	Storage report before INIT	/E_Inventory
storageCap_info_stage2.txt	Storage report after INIT	/E_Inventory
storageCap_info_stage3.txt	Storage report after REPEATABILITY	/E_Inventory
/F_Generator	**Workload generator**	**root**
75host.HST	Host configuration file	/F_generator
full_run.sh	Execute all test phases	/F_generator
slave_asu.asu	Define LUNs hosting the ASUs	/F_generator

APPENDIX B: THIRD PARTY QUOTATION

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

APPENDIX C: TUNING PARAMETERS AND OPTIONS

The following scripts were used to set the tuning parameters and options.

- aio-max-nr.sh – set the maximum number of AIO operations to 10485760
- nr_requests.sh – set nr_requests to 4096 for each drive
- scheduler.sh – set the I/O scheduler to noop for each device

Details are available in the Supporting Files (see Appendix A).

APPENDIX D: STORAGE CONFIGURATION CREATION

Step 1: Create Disk Domains, Storage Pools, LUNs, LUN Group

mklun.txt is a script including all the CLI commands to create disk domains, storage pools, LUNS:

- Create 8 ***disk_domain***
- Create 8 ***storage_pool***
- Create 128 ***lun***
- Create 5 ***lun_group(lg0-lg4)***
- Add the 128 LUNs to each ***lun_group***, ***lg0-lg4***

```
create disk_domain name=dd0 disk_list=DAE000.0-23,DAE020.0-23,DAE060.0-23 disk_domain_id=0
create disk_domain name=dd1 disk_list=DAE100.0-23,DAE120.0-23,DAE160.0-23 disk_domain_id=1
create disk_domain name=dd2 disk_list=DAE200.0-23,DAE220.0-23,DAE260.0-23 disk_domain_id=2
create disk_domain name=dd3 disk_list=DAE300.0-23,DAE320.0-23,DAE360.0-23 disk_domain_id=3
create disk_domain name=dd4 disk_list=DAE400.0-23,DAE420.0-23,DAE460.0-23 disk_domain_id=4
create disk_domain name=dd5 disk_list=DAE540.0-23,DAE520.0-23,DAE560.0-23 disk_domain_id=5
create disk_domain name=dd6 disk_list=DAE600.0-23,DAE620.0-23,DAE660.0-23 disk_domain_id=6
create disk_domain name=dd7 disk_list=DAE700.0-23,DAE720.0-23,DAE760.0-23 disk_domain_id=7


create storage_pool name=p0 capacity=remain raid_level=RAID6 pool_id=0 disk_domain_id=0
create storage_pool name=p1 capacity=remain raid_level=RAID6 pool_id=1 disk_domain_id=1
create storage_pool name=p2 capacity=remain raid_level=RAID6 pool_id=2 disk_domain_id=2
create storage_pool name=p3 capacity=remain raid_level=RAID6 pool_id=3 disk_domain_id=3
create storage_pool name=p4 capacity=remain raid_level=RAID6 pool_id=4 disk_domain_id=4
create storage_pool name=p5 capacity=remain raid_level=RAID6 pool_id=5 disk_domain_id=5
create storage_pool name=p6 capacity=remain raid_level=RAID6 pool_id=6 disk_domain_id=6
create storage_pool name=p7 capacity=remain raid_level=RAID6 pool_id=7 disk_domain_id=7

create lun_workload_type general name=8KBgrain io_size=8KB dedup_enabled=no compression_enabled=yes id=16

create lun name=lun0 workload_type_id=16 pool_id=0 capacity=5600GB lun_id=0 lun_type=thin
create lun name=lun1 workload_type_id=16 pool_id=0 capacity=5600GB lun_id=1 lun_type=thin
create lun name=lun2 workload_type_id=16 pool_id=0 capacity=5600GB lun_id=2 lun_type=thin
create lun name=lun3 workload_type_id=16 pool_id=0 capacity=5600GB lun_id=3 lun_type=thin
create lun name=lun4 workload_type_id=16 pool_id=0 capacity=5600GB lun_id=4 lun_type=thin
create lun name=lun5 workload_type_id=16 pool_id=0 capacity=5600GB lun_id=5 lun_type=thin
create lun name=lun6 workload_type_id=16 pool_id=0 capacity=5600GB lun_id=6 lun_type=thin
create lun name=lun7 workload_type_id=16 pool_id=0 capacity=5600GB lun_id=7 lun_type=thin
create lun name=lun8 workload_type_id=16 pool_id=0 capacity=5600GB lun_id=8 lun_type=thin
create lun name=lun9 workload_type_id=16 pool_id=0 capacity=5600GB lun_id=9 lun_type=thin
create lun name=lun10 workload_type_id=16 pool_id=0 capacity=5600GB lun_id=10 lun_type=thin
create lun name=lun11 workload_type_id=16 pool_id=0 capacity=5600GB lun_id=11 lun_type=thin
create lun name=lun12 workload_type_id=16 pool_id=0 capacity=5600GB lun_id=12 lun_type=thin
```

```
create lun name=lun13 workload_type_id=16 pool_id=0 capacity=5600GB lun_id=13 lun_type=thin
create lun name=lun14 workload_type_id=16 pool_id=0 capacity=5600GB lun_id=14 lun_type=thin
create lun name=lun15 workload_type_id=16 pool_id=0 capacity=5600GB lun_id=15 lun_type=thin
create lun name=lun16 workload_type_id=16 pool_id=1 capacity=5600GB lun_id=16 lun_type=thin
create lun name=lun17 workload_type_id=16 pool_id=1 capacity=5600GB lun_id=17 lun_type=thin
create lun name=lun18 workload_type_id=16 pool_id=1 capacity=5600GB lun_id=18 lun_type=thin
create lun name=lun19 workload_type_id=16 pool_id=1 capacity=5600GB lun_id=19 lun_type=thin
create lun name=lun20 workload_type_id=16 pool_id=1 capacity=5600GB lun_id=20 lun_type=thin
create lun name=lun21 workload_type_id=16 pool_id=1 capacity=5600GB lun_id=21 lun_type=thin
create lun name=lun22 workload_type_id=16 pool_id=1 capacity=5600GB lun_id=22 lun_type=thin
create lun name=lun23 workload_type_id=16 pool_id=1 capacity=5600GB lun_id=23 lun_type=thin
create lun name=lun24 workload_type_id=16 pool_id=1 capacity=5600GB lun_id=24 lun_type=thin
create lun name=lun25 workload_type_id=16 pool_id=1 capacity=5600GB lun_id=25 lun_type=thin
create lun name=lun26 workload_type_id=16 pool_id=1 capacity=5600GB lun_id=26 lun_type=thin
create lun name=lun27 workload_type_id=16 pool_id=1 capacity=5600GB lun_id=27 lun_type=thin
create lun name=lun28 workload_type_id=16 pool_id=1 capacity=5600GB lun_id=28 lun_type=thin
create lun name=lun29 workload_type_id=16 pool_id=1 capacity=5600GB lun_id=29 lun_type=thin
create lun name=lun30 workload_type_id=16 pool_id=1 capacity=5600GB lun_id=30 lun_type=thin
create lun name=lun31 workload_type_id=16 pool_id=1 capacity=5600GB lun_id=31 lun_type=thin
create lun name=lun32 workload_type_id=16 pool_id=2 capacity=5600GB lun_id=32 lun_type=thin
create lun name=lun33 workload_type_id=16 pool_id=2 capacity=5600GB lun_id=33 lun_type=thin
create lun name=lun34 workload_type_id=16 pool_id=2 capacity=5600GB lun_id=34 lun_type=thin
create lun name=lun35 workload_type_id=16 pool_id=2 capacity=5600GB lun_id=35 lun_type=thin
create lun name=lun36 workload_type_id=16 pool_id=2 capacity=5600GB lun_id=36 lun_type=thin
create lun name=lun37 workload_type_id=16 pool_id=2 capacity=5600GB lun_id=37 lun_type=thin
create lun name=lun38 workload_type_id=16 pool_id=2 capacity=5600GB lun_id=38 lun_type=thin
create lun name=lun39 workload_type_id=16 pool_id=2 capacity=5600GB lun_id=39 lun_type=thin
create lun name=lun40 workload_type_id=16 pool_id=2 capacity=5600GB lun_id=40 lun_type=thin
create lun name=lun41 workload_type_id=16 pool_id=2 capacity=5600GB lun_id=41 lun_type=thin
create lun name=lun42 workload_type_id=16 pool_id=2 capacity=5600GB lun_id=42 lun_type=thin
create lun name=lun43 workload_type_id=16 pool_id=2 capacity=5600GB lun_id=43 lun_type=thin
create lun name=lun44 workload_type_id=16 pool_id=2 capacity=5600GB lun_id=44 lun_type=thin
create lun name=lun45 workload_type_id=16 pool_id=2 capacity=5600GB lun_id=45 lun_type=thin
create lun name=lun46 workload_type_id=16 pool_id=2 capacity=5600GB lun_id=46 lun_type=thin
create lun name=lun47 workload_type_id=16 pool_id=2 capacity=5600GB lun_id=47 lun_type=thin
create lun name=lun48 workload_type_id=16 pool_id=3 capacity=5600GB lun_id=48 lun_type=thin
create lun name=lun49 workload_type_id=16 pool_id=3 capacity=5600GB lun_id=49 lun_type=thin
create lun name=lun50 workload_type_id=16 pool_id=3 capacity=5600GB lun_id=50 lun_type=thin
create lun name=lun51 workload_type_id=16 pool_id=3 capacity=5600GB lun_id=51 lun_type=thin
create lun name=lun52 workload_type_id=16 pool_id=3 capacity=5600GB lun_id=52 lun_type=thin
create lun name=lun53 workload_type_id=16 pool_id=3 capacity=5600GB lun_id=53 lun_type=thin
create lun name=lun54 workload_type_id=16 pool_id=3 capacity=5600GB lun_id=54 lun_type=thin
create lun name=lun55 workload_type_id=16 pool_id=3 capacity=5600GB lun_id=55 lun_type=thin
create lun name=lun56 workload_type_id=16 pool_id=3 capacity=5600GB lun_id=56 lun_type=thin
create lun name=lun57 workload_type_id=16 pool_id=3 capacity=5600GB lun_id=57 lun_type=thin
create lun name=lun58 workload_type_id=16 pool_id=3 capacity=5600GB lun_id=58 lun_type=thin
create lun name=lun59 workload_type_id=16 pool_id=3 capacity=5600GB lun_id=59 lun_type=thin
create lun name=lun60 workload_type_id=16 pool_id=3 capacity=5600GB lun_id=60 lun_type=thin
create lun name=lun61 workload_type_id=16 pool_id=3 capacity=5600GB lun_id=61 lun_type=thin
```

```
create lun name=lun62 workload_type_id=16 pool_id=3 capacity=5600GB lun_id=62 lun_type=thin
create lun name=lun63 workload_type_id=16 pool_id=3 capacity=5600GB lun_id=63 lun_type=thin
create lun name=lun64 workload_type_id=16 pool_id=4 capacity=5600GB lun_id=64 lun_type=thin
create lun name=lun65 workload_type_id=16 pool_id=4 capacity=5600GB lun_id=65 lun_type=thin
create lun name=lun66 workload_type_id=16 pool_id=4 capacity=5600GB lun_id=66 lun_type=thin
create lun name=lun67 workload_type_id=16 pool_id=4 capacity=5600GB lun_id=67 lun_type=thin
create lun name=lun68 workload_type_id=16 pool_id=4 capacity=5600GB lun_id=68 lun_type=thin
create lun name=lun69 workload_type_id=16 pool_id=4 capacity=5600GB lun_id=69 lun_type=thin
create lun name=lun70 workload_type_id=16 pool_id=4 capacity=5600GB lun_id=70 lun_type=thin
create lun name=lun71 workload_type_id=16 pool_id=4 capacity=5600GB lun_id=71 lun_type=thin
create lun name=lun72 workload_type_id=16 pool_id=4 capacity=5600GB lun_id=72 lun_type=thin
create lun name=lun73 workload_type_id=16 pool_id=4 capacity=5600GB lun_id=73 lun_type=thin
create lun name=lun74 workload_type_id=16 pool_id=4 capacity=5600GB lun_id=74 lun_type=thin
create lun name=lun75 workload_type_id=16 pool_id=4 capacity=5600GB lun_id=75 lun_type=thin
create lun name=lun76 workload_type_id=16 pool_id=4 capacity=5600GB lun_id=76 lun_type=thin
create lun name=lun77 workload_type_id=16 pool_id=4 capacity=5600GB lun_id=77 lun_type=thin
create lun name=lun78 workload_type_id=16 pool_id=4 capacity=5600GB lun_id=78 lun_type=thin
create lun name=lun79 workload_type_id=16 pool_id=4 capacity=5600GB lun_id=79 lun_type=thin
create lun name=lun80 workload_type_id=16 pool_id=5 capacity=5600GB lun_id=80 lun_type=thin
create lun name=lun81 workload_type_id=16 pool_id=5 capacity=5600GB lun_id=81 lun_type=thin
create lun name=lun82 workload_type_id=16 pool_id=5 capacity=5600GB lun_id=82 lun_type=thin
create lun name=lun83 workload_type_id=16 pool_id=5 capacity=5600GB lun_id=83 lun_type=thin
create lun name=lun84 workload_type_id=16 pool_id=5 capacity=5600GB lun_id=84 lun_type=thin
create lun name=lun85 workload_type_id=16 pool_id=5 capacity=5600GB lun_id=85 lun_type=thin
create lun name=lun86 workload_type_id=16 pool_id=5 capacity=5600GB lun_id=86 lun_type=thin
create lun name=lun87 workload_type_id=16 pool_id=5 capacity=5600GB lun_id=87 lun_type=thin
create lun name=lun88 workload_type_id=16 pool_id=5 capacity=5600GB lun_id=88 lun_type=thin
create lun name=lun89 workload_type_id=16 pool_id=5 capacity=5600GB lun_id=89 lun_type=thin
create lun name=lun90 workload_type_id=16 pool_id=5 capacity=5600GB lun_id=90 lun_type=thin
create lun name=lun91 workload_type_id=16 pool_id=5 capacity=5600GB lun_id=91 lun_type=thin
create lun name=lun92 workload_type_id=16 pool_id=5 capacity=5600GB lun_id=92 lun_type=thin
create lun name=lun93 workload_type_id=16 pool_id=5 capacity=5600GB lun_id=93 lun_type=thin
create lun name=lun94 workload_type_id=16 pool_id=5 capacity=5600GB lun_id=94 lun_type=thin
create lun name=lun95 workload_type_id=16 pool_id=5 capacity=5600GB lun_id=95 lun_type=thin
create lun name=lun96 workload_type_id=16 pool_id=6 capacity=5600GB lun_id=96 lun_type=thin
create lun name=lun97 workload_type_id=16 pool_id=6 capacity=5600GB lun_id=97 lun_type=thin
create lun name=lun98 workload_type_id=16 pool_id=6 capacity=5600GB lun_id=98 lun_type=thin
create lun name=lun99 workload_type_id=16 pool_id=6 capacity=5600GB lun_id=99 lun_type=thin
create lun name=lun100 workload_type_id=16 pool_id=6 capacity=5600GB lun_id=100 lun_type=thin
create lun name=lun101 workload_type_id=16 pool_id=6 capacity=5600GB lun_id=101 lun_type=thin
create lun name=lun102 workload_type_id=16 pool_id=6 capacity=5600GB lun_id=102 lun_type=thin
create lun name=lun103 workload_type_id=16 pool_id=6 capacity=5600GB lun_id=103 lun_type=thin
create lun name=lun104 workload_type_id=16 pool_id=6 capacity=5600GB lun_id=104 lun_type=thin
create lun name=lun105 workload_type_id=16 pool_id=6 capacity=5600GB lun_id=105 lun_type=thin
create lun name=lun106 workload_type_id=16 pool_id=6 capacity=5600GB lun_id=106 lun_type=thin
create lun name=lun107 workload_type_id=16 pool_id=6 capacity=5600GB lun_id=107 lun_type=thin
create lun name=lun108 workload_type_id=16 pool_id=6 capacity=5600GB lun_id=108 lun_type=thin
create lun name=lun109 workload_type_id=16 pool_id=6 capacity=5600GB lun_id=109 lun_type=thin
create lun name=lun110 workload_type_id=16 pool_id=6 capacity=5600GB lun_id=110 lun_type=thin
```

```
create lun name=lun111 workload_type_id=16 pool_id=6 capacity=5600GB lun_id=111 lun_type=thin
create lun name=lun112 workload_type_id=16 pool_id=7 capacity=5600GB lun_id=112 lun_type=thin
create lun name=lun113 workload_type_id=16 pool_id=7 capacity=5600GB lun_id=113 lun_type=thin
create lun name=lun114 workload_type_id=16 pool_id=7 capacity=5600GB lun_id=114 lun_type=thin
create lun name=lun115 workload_type_id=16 pool_id=7 capacity=5600GB lun_id=115 lun_type=thin
create lun name=lun116 workload_type_id=16 pool_id=7 capacity=5600GB lun_id=116 lun_type=thin
create lun name=lun117 workload_type_id=16 pool_id=7 capacity=5600GB lun_id=117 lun_type=thin
create lun name=lun118 workload_type_id=16 pool_id=7 capacity=5600GB lun_id=118 lun_type=thin
create lun name=lun119 workload_type_id=16 pool_id=7 capacity=5600GB lun_id=119 lun_type=thin
create lun name=lun120 workload_type_id=16 pool_id=7 capacity=5600GB lun_id=120 lun_type=thin
create lun name=lun121 workload_type_id=16 pool_id=7 capacity=5600GB lun_id=121 lun_type=thin
create lun name=lun122 workload_type_id=16 pool_id=7 capacity=5600GB lun_id=122 lun_type=thin
create lun name=lun123 workload_type_id=16 pool_id=7 capacity=5600GB lun_id=123 lun_type=thin
create lun name=lun124 workload_type_id=16 pool_id=7 capacity=5600GB lun_id=124 lun_type=thin
create lun name=lun125 workload_type_id=16 pool_id=7 capacity=5600GB lun_id=125 lun_type=thin
create lun name=lun126 workload_type_id=16 pool_id=7 capacity=5600GB lun_id=126 lun_type=thin
create lun name=lun127 workload_type_id=16 pool_id=7 capacity=5600GB lun_id=127 lun_type=thin

create lun_group name=lg0 lun_group_id=0
create lun_group name=lg1 lun_group_id=1
create lun_group name=lg2 lun_group_id=2
create lun_group name=lg3 lun_group_id=3
create lun_group name=lg4 lun_group_id=4

add lun_group lun lun_group_id=0 lun_id_list=0-127
add lun_group lun lun_group_id=1 lun_id_list=0-127
add lun_group lun lun_group_id=2 lun_id_list=0-127
add lun_group lun lun_group_id=3 lun_id_list=0-127
add lun_group lun lun_group_id=4 lun_id_list=0-127
```

Step 2: Create Mapping View, Host Group and Host

Execute the following commands using the OceanStor Dorado 18000 V6 CLI from the Host System to complete the following:

- Create 5 ***hosts***(***host0-host4***)
- Create 5 ***host_group*** (***hg0-hg4***)
- Add *5* ***host*** to 5 ***host_group*** and each ***host_group*** contains one ***host***
- Add the FC ports' WWN to 5 ***hosts***, each host contains less than 32 port WWN. 150 port WWN total.
- Create 5 ***mapping_view*** (***map_view0- map_view 4***)

```
create host name=host0 operating_system=Linux host_id=0
create host name=host1 operating_system=Linux host_id=1
create host name=host2 operating_system=Linux host_id=2
create host name=host3 operating_system=Linux host_id=3
create host name=host4 operating_system=Linux host_id=4
```

```
create host_group name=hg0 host_id_list=0 host_group_id=0
create host_group name=hg1 host_id_list=1 host_group_id=1
create host_group name=hg2 host_id_list=2 host_group_id=2
create host_group name=hg3 host_id_list=3 host_group_id=3
create host_group name=hg4 host_id_list=4 host_group_id=4

create mapping_view name=map_view0 lun_group_id=0 host_group_id=0
create mapping_view name=map_view1 lun_group_id=1 host_group_id=1
create mapping_view name=map_view2 lun_group_id=2 host_group_id=2
create mapping_view name=map_view3 lun_group_id=3 host_group_id=3
create mapping_view name=map_view4 lun_group_id=4 host_group_id=4

add host initiator host_id=0 initiator_type=FC wwn=2101541310b9692b
add host initiator host_id=0 initiator_type=FC wwn=210178b46ad48bd7
add host initiator host_id=0 initiator_type=FC wwn=210078b46ad48bfc
add host initiator host_id=0 initiator_type=FC wwn=210078b46ad48bcc
add host initiator host_id=0 initiator_type=FC wwn=2101541310b96929
add host initiator host_id=0 initiator_type=FC wwn=210178b46ad48bd5
add host initiator host_id=0 initiator_type=FC wwn=100000109b5b405e
add host initiator host_id=0 initiator_type=FC wwn=100000109b5b3e2c
add host initiator host_id=0 initiator_type=FC wwn=100000109b5b3e0d
add host initiator host_id=0 initiator_type=FC wwn=100000109b5b3c26
add host initiator host_id=0 initiator_type=FC wwn=10000090faf20f2c
add host initiator host_id=0 initiator_type=FC wwn=100000109b56d290
add host initiator host_id=0 initiator_type=FC wwn=100000109b34525d
add host initiator host_id=0 initiator_type=FC wwn=100000109b345167
add host initiator host_id=0 initiator_type=FC wwn=100000109b582d61
add host initiator host_id=0 initiator_type=FC wwn=2101341e6bb70683
add host initiator host_id=0 initiator_type=FC wwn=210178b46ad48bff
add host initiator host_id=0 initiator_type=FC wwn=210178b46ad48c05
add host initiator host_id=0 initiator_type=FC wwn=2100185644ce0a3e
add host initiator host_id=0 initiator_type=FC wwn=210178b46ad48bdf
add host initiator host_id=0 initiator_type=FC wwn=100000109b582b80
add host initiator host_id=0 initiator_type=FC wwn=100000109b582cc7
add host initiator host_id=0 initiator_type=FC wwn=210178b46ad48beb
add host initiator host_id=0 initiator_type=FC wwn=210178b46ad48be3
add host initiator host_id=0 initiator_type=FC wwn=210178b46ad48be9
add host initiator host_id=0 initiator_type=FC wwn=210178b46ad48bef
add host initiator host_id=0 initiator_type=FC wwn=210178b46ad48b05
add host initiator host_id=0 initiator_type=FC wwn=210178b46ad48afd
add host initiator host_id=0 initiator_type=FC wwn=2101541310b96a4b
add host initiator host_id=0 initiator_type=FC wwn=2101541310b9691d

add host initiator host_id=1 initiator_type=FC wwn=210178b46ad48be1
add host initiator host_id=1 initiator_type=FC wwn=210178b46ad48bdb
add host initiator host_id=1 initiator_type=FC wwn=210178b46ad48bd1
add host initiator host_id=1 initiator_type=FC wwn=210178b46ad48ac9
add host initiator host_id=1 initiator_type=FC wwn=210178b46ad48ab7
add host initiator host_id=1 initiator_type=FC wwn=210178b46ad48b03
```

```
add host initiator host_id=1 initiator_type=FC wwn=210178b46ad48b09
add host initiator host_id=1 initiator_type=FC wwn=210178b46ad48aff
add host initiator host_id=1 initiator_type=FC wwn=2101541310b9691f
add host initiator host_id=1 initiator_type=FC wwn=210178b46ad48bf5
add host initiator host_id=1 initiator_type=FC wwn=2101541310b96921
add host initiator host_id=1 initiator_type=FC wwn=2101541310b96a47
add host initiator host_id=1 initiator_type=FC wwn=210178b46ad48abf
add host initiator host_id=1 initiator_type=FC wwn=210178b46ad48bbf
add host initiator host_id=1 initiator_type=FC wwn=2101541310b9691b
add host initiator host_id=1 initiator_type=FC wwn=2101541310b96935
add host initiator host_id=1 initiator_type=FC wwn=2101541310b96919
add host initiator host_id=1 initiator_type=FC wwn=2101541310b96955
add host initiator host_id=1 initiator_type=FC wwn=2101541310b9692d
add host initiator host_id=1 initiator_type=FC wwn=2101541310b96923
add host initiator host_id=1 initiator_type=FC wwn=210178b46ad48bb3
add host initiator host_id=1 initiator_type=FC wwn=210178b46ad48bb1
add host initiator host_id=1 initiator_type=FC wwn=2101541310b96951
add host initiator host_id=1 initiator_type=FC wwn=2101541310b96953
add host initiator host_id=1 initiator_type=FC wwn=210178b46ad48bcf
add host initiator host_id=1 initiator_type=FC wwn=210178b46ad48af9
add host initiator host_id=1 initiator_type=FC wwn=210178b46ad48bed
add host initiator host_id=1 initiator_type=FC wwn=210178b46ad48bf3
add host initiator host_id=1 initiator_type=FC wwn=210078b46ad48af6
add host initiator host_id=1 initiator_type=FC wwn=210078b46ad48bfa
add host initiator host_id=1 initiator_type=FC wwn=2100185644cdf53c
add host initiator host_id=1 initiator_type=FC wwn=2100745aaa4abd46

add host initiator host_id=2 initiator_type=FC wwn=200000e0fc5f8a02
add host initiator host_id=2 initiator_type=FC wwn=2101541310b969d7
add host initiator host_id=2 initiator_type=FC wwn=2100185644ce0334
add host initiator host_id=2 initiator_type=FC wwn=2101541310b969a3
add host initiator host_id=2 initiator_type=FC wwn=100000109b5b3b33
add host initiator host_id=2 initiator_type=FC wwn=100000109b5b3c89
add host initiator host_id=2 initiator_type=FC wwn=100000109b582bd7
add host initiator host_id=2 initiator_type=FC wwn=100000109b34523c
add host initiator host_id=2 initiator_type=FC wwn=100000109b34535c
add host initiator host_id=2 initiator_type=FC wwn=100000109b56d2f0
add host initiator host_id=2 initiator_type=FC wwn=100000109b56d296
add host initiator host_id=2 initiator_type=FC wwn=100000109b56d344
add host initiator host_id=2 initiator_type=FC wwn=100000109b5b3ff0
add host initiator host_id=2 initiator_type=FC wwn=100000109b5b3d24
add host initiator host_id=2 initiator_type=FC wwn=100000109b5b3b57
add host initiator host_id=2 initiator_type=FC wwn=100000109b5b3d21
add host initiator host_id=2 initiator_type=FC wwn=100000109b32a3c6
add host initiator host_id=2 initiator_type=FC wwn=100000109b582bf2
add host initiator host_id=2 initiator_type=FC wwn=2100745aaa4abd52
add host initiator host_id=2 initiator_type=FC wwn=2100185644ce0c32
add host initiator host_id=2 initiator_type=FC wwn=210178b46ad48bc1
add host initiator host_id=2 initiator_type=FC wwn=2100745aaa4abdb6
```

```
add host initiator host_id=2 initiator_type=FC wwn=2101541310b969df
add host initiator host_id=2 initiator_type=FC wwn=2101745aaa4abd4f
add host initiator host_id=2 initiator_type=FC wwn=100000109b582d1e
add host initiator host_id=2 initiator_type=FC wwn=100000109b582bad
add host initiator host_id=2 initiator_type=FC wwn=100000109b582cd7
add host initiator host_id=2 initiator_type=FC wwn=100000109b582b83

add host initiator host_id=3 initiator_type=FC wwn=100000109b582da5
add host initiator host_id=3 initiator_type=FC wwn=100000109b582cc4
add host initiator host_id=3 initiator_type=FC wwn=100000109b582c3d
add host initiator host_id=3 initiator_type=FC wwn=100000109b582b86
add host initiator host_id=3 initiator_type=FC wwn=2101541310b96971
add host initiator host_id=3 initiator_type=FC wwn=2101541310b96a3b
add host initiator host_id=3 initiator_type=FC wwn=2101541310b9697b
add host initiator host_id=3 initiator_type=FC wwn=2101541310b969e5
add host initiator host_id=3 initiator_type=FC wwn=100000109b8f462b
add host initiator host_id=3 initiator_type=FC wwn=2100541310b969d4
add host initiator host_id=3 initiator_type=FC wwn=2101541310b96917
add host initiator host_id=3 initiator_type=FC wwn=2101541310b96989
add host initiator host_id=3 initiator_type=FC wwn=2101541310b969d1
add host initiator host_id=3 initiator_type=FC wwn=2101541310b9699b
add host initiator host_id=3 initiator_type=FC wwn=2100541310b96a50
add host initiator host_id=3 initiator_type=FC wwn=2100541310b969f0
add host initiator host_id=3 initiator_type=FC wwn=2100541310b969e8
add host initiator host_id=3 initiator_type=FC wwn=2100541310b96a28
add host initiator host_id=3 initiator_type=FC wwn=2100541310b96a2a
add host initiator host_id=3 initiator_type=FC wwn=2100541310b96a26
add host initiator host_id=3 initiator_type=FC wwn=2101541310b96991
add host initiator host_id=3 initiator_type=FC wwn=2101541310b96997
add host initiator host_id=3 initiator_type=FC wwn=2101541310b96a09
add host initiator host_id=3 initiator_type=FC wwn=2100541310b96a2c
add host initiator host_id=3 initiator_type=FC wwn=2100541310b96924
add host initiator host_id=3 initiator_type=FC wwn=2100541310b96a2e
add host initiator host_id=3 initiator_type=FC wwn=2100541310b96994
add host initiator host_id=3 initiator_type=FC wwn=2100541310b9698a
add host initiator host_id=3 initiator_type=FC wwn=2100541310b96974
add host initiator host_id=3 initiator_type=FC wwn=2100541310b96a32

add host initiator host_id=4 initiator_type=FC wwn=2100541310b9694c
add host initiator host_id=4 initiator_type=FC wwn=2100541310b96a52
add host initiator host_id=4 initiator_type=FC wwn=2100541310b969d8
add host initiator host_id=4 initiator_type=FC wwn=2100541310b969c6
add host initiator host_id=4 initiator_type=FC wwn=2101541310b96a07
add host initiator host_id=4 initiator_type=FC wwn=2101541310b96a23
add host initiator host_id=4 initiator_type=FC wwn=2100541310b9699c
add host initiator host_id=4 initiator_type=FC wwn=2100541310b9697e
add host initiator host_id=4 initiator_type=FC wwn=2100541310b969ec
add host initiator host_id=4 initiator_type=FC wwn=2100541310b96a40
add host initiator host_id=4 initiator_type=FC wwn=2100541310b969a4
```

```
add host initiator host_id=4 initiator_type=FC wwn=2100541310b96a10
add host initiator host_id=4 initiator_type=FC wwn=2100541310b969e2
add host initiator host_id=4 initiator_type=FC wwn=2100541310b96998
add host initiator host_id=4 initiator_type=FC wwn=2101541310b96a19
add host initiator host_id=4 initiator_type=FC wwn=2101541310b96a31
add host initiator host_id=4 initiator_type=FC wwn=2101541310b96a55
add host initiator host_id=4 initiator_type=FC wwn=2101541310b96993
add host initiator host_id=4 initiator_type=FC wwn=2101541310b96981
add host initiator host_id=4 initiator_type=FC wwn=2101541310b96a17
add host initiator host_id=4 initiator_type=FC wwn=2100541310b96968
add host initiator host_id=4 initiator_type=FC wwn=2100541310b96a0a
add host initiator host_id=4 initiator_type=FC wwn=2100541310b969da
add host initiator host_id=4 initiator_type=FC wwn=2100541310b9697c
add host initiator host_id=4 initiator_type=FC wwn=2101185644cdf93f
add host initiator host_id=4 initiator_type=FC wwn=2101541310b969ef
add host initiator host_id=4 initiator_type=FC wwn=210078b46ad48ba2
add host initiator host_id=4 initiator_type=FC wwn=210078b46ad48b9e
add host initiator host_id=4 initiator_type=FC wwn=100000109b582d3f
add host initiator host_id=4 initiator_type=FC wwn=2101541310b96939
```

Step 3: Create Volumes on the Master Host System

Execute the **mkvolume.sh** script on the Master Host System to create 40 logical volumes as follows:

1. **Create Physical Volume**

   Create 128 physical volumes using the **pvcreate** command.

2. **Create Volumes Groups**

   Create one volume group (**vg1**) using the **vgcreate** command and the following 128 physical volumes:

   /dev/sdb /dev/sdc /dev/sdd /dev/sde /dev/sdf /dev/sdg /dev/sdh /dev/sdi /dev/sdj /dev/sdk /dev/sdl /dev/sdm /dev/sdn /dev/sdo /dev/sdp /dev/sdq /dev/sdr /dev/sds /dev/sdt /dev/sdu /dev/sdv /dev/sdw /dev/sdx /dev/sdy /dev/sdz /dev/sdaa /dev/sdab /dev/sdac /dev/sdad /dev/sdae /dev/sdaf /dev/sdag /dev/sdah /dev/sdai /dev/sdaj /dev/sdak /dev/sdal /dev/sdam /dev/sdan /dev/sdao /dev/sdap /dev/sdaq /dev/sdar /dev/sdas /dev/sdat /dev/sdau /dev/sdav /dev/sdaw /dev/sdax /dev/sday /dev/sdaz /dev/sdba /dev/sdbb /dev/sdbc /dev/sdbd /dev/sdbe /dev/sdbf /dev/sdbg /dev/sdbh /dev/sdbi /dev/sdbj /dev/sdbk /dev/sdbl /dev/sdbm /dev/sdbn /dev/sdbo /dev/sdbp /dev/sdbq /dev/sdbr /dev/sdbs /dev/sdbt /dev/sdbu /dev/sdbv /dev/sdbw /dev/sdbx /dev/sdby /dev/sdbz /dev/sdca /dev/sdcb /dev/sdcc /dev/sdcd /dev/sdce /dev/sdcf /dev/sdcg /dev/sdch /dev/sdci /dev/sdcj /dev/sdck /dev/sdcl /dev/sdcm /dev/sdcn /dev/sdco /dev/sdcp /dev/sdcq /dev/sdcr /dev/sdcs /dev/sdct /dev/sdcu /dev/sdcv /dev/sdcw /dev/sdcx /dev/sdcy /dev/sdcz /dev/sdda /dev/sddb /dev/sddc /dev/sddd /dev/sdde /dev/sddf /dev/sddg /dev/sddh /dev/sddi /dev/sddj /dev/sddk /dev/sddl /dev/sddm /dev/sddn /dev/sddo /dev/sddp /dev/sddq /dev/sddr /dev/sdds /dev/sddt /dev/sddu /dev/sddv /dev/sddw /dev/sddx /dev/sddy **Create Logical Volumes**

- Create 18 logical volumes, each with a capacity of 17600 GiB, on **vg1** for ASU-1.

- Create 18 logical volumes, each with a capacity of 17600 GiB, on **vg1** for ASU-2.
- Create 4 logical volumes, each with a capacity of 17600 GiB, on **vg1** for ASU-3.

Step 4: Change the Scheduler on each Host System

Execute the **scheduler.sh** script on the Host System to change the I/O scheduler from cfq to noop on each Host System, which will result in all incoming I/O requests inserted into a simple, unordered FIFO queue.

Step 5: Change the nr_requests on each Host System

Execute the **nr_requests.sh** script on the Host System to change nr_requests from 128 to 4096 on each Host System for each device.

Step 6: Change the aio-max-nr on each Host System

Execute the **aio-max-nr.sh** script on the Host System to change the maximum number of AIO operations to 10485760.

APPENDIX E: CONFIGURATION INVENTORY

An inventory of the TSC was collected during the execution of the script full_run.sh. It generated the following log files.

- profile1_storage.log – list of configured storage before the INIT phase
- profile1_volume.log – list of configured volumes before the INIT phase
- profile2_storage.log – list of configured storage after TSC restart
- profile2_volume.log – 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 ASUs accessed by the SPC-1 workload generator are defined using the script slave_asu.asu.

The phases of the benchmark are executed using the script full_run.sh. The script pauses at the end of the PERSIST_1 test phase. Once the TSC has been restarted, the PERSIST_2 test phase is executed by pressing ENTER from the console where the script has been invoked.

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