SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

HITACHI DATA SYSTEMS CORPORATION
HITACHI UNIFIED STORAGE VM

SPC-1 V1.13

Submitted for Review: April 30, 2013
Submission Identifier: A00131
Revised: March 20, 2014

First Edition – April 2013

Trademarks

Table of Contents

AUDIT CERTIFICATION

Mel Boksenbaum
Hitachi Data Systems Corporation
750 Central Expressway M/S U9922
Santa Clara, CA 95050

April 22, 2013

The SPC Benchmark 1™ Reported Data listed below for the Hitachi Unified Storage VM was produced in compliance with the SPC Benchmark 1™ v1.13 Onsite Audit requirements.

SPC Benchmark 1™ v1.13 Reported Data	
Tested Storage Product (TSP) Name: Hitachi Unified Storage VM	
Metric	**Reported Result**
SPC-1 IOPS™	181,492.24
SPC-1 Price-Performance	$3.52/SPC-1 IOPS™
Total ASU Capacity	52,556.608 GB
Data Protection Level	Protected 2 *(Mirroring)*
Total Price (including three-year maintenance)	$638,638.24
Currency Used	U.S. Dollars
Target Country for availability, sales and support	USA

The following SPC Benchmark 1™ Onsite Audit requirements were reviewed and found compliant with 1.13 of the SPC Benchmark 1™ specification:

- A Letter of Good Faith, signed by a senior executive.
- The following Data Repository storage items were verified by physical inspection and information supplied by Hitachi Data Systems Corporation:
  - ✓ Physical Storage Capacity and requirements.
  - ✓ Configured Storage Capacity and requirements.
  - ✓ Addressable Storage Capacity and requirements.
  - ✓ Capacity of each Logical Volume and requirements.
  - ✓ Capacity of each Application Storage Unit (ASU) and requirements.
- The total Application Storage Unit (ASU) Capacity was filled with random data, using an auditor approved tool, prior to execution of the SPC-1 Tests.

Storage Performance Council
643 Bair Island Road, Suite 103
Redwood City, CA 94062
AuditService@storageperformance.org
650.556.9384

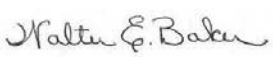
AUDIT CERTIFICATION *(CONT.)*

- An appropriate diagram of the Benchmark Configuration (BC)/Tested Storage Configuration (TSC).
- Physical verification of the components to match the above diagram.
- Listings and commands to configure the Benchmark Configuration/Tested Storage Configuration, including customer tunable parameters that were changed from default values.
- SPC-1 Workload Generator commands and parameters used for the audited SPC Test Runs.
- The following Host System requirements were verified by physical inspection and information supplied by Hitachi Data Systems Corporation:
  - ✓ The type of Host System including the number of processors and main memory.
  - ✓ The presence and version number of the SPC-1 Workload Generator on the Host System.
  - ✓ The TSC boundary within the Host System.
- The execution of each Test, Test Phase, and Test Run was observed and found compliant with all of the requirements and constraints of Clauses 4, 5, and 11 of the SPC-1 Benchmark Specification.
- The Test Results Files and resultant Summary Results Files received from Hitachi Data Systems Corporation for each of following were authentic, accurate, and compliant with all of the requirements and constraints of Clauses 4 and 5 of the SPC-1 Benchmark Specification:
  - ✓ Data Persistence Test
  - ✓ Sustainability Test Phase
  - ✓ IOPS Test Phase
  - ✓ Response Time Ramp Test Phase
  - ✓ Repeatability Test
- There were no differences between the Tested Storage Configuration and Priced Storage Configuration.
- The submitted pricing information met all of the requirements and constraints of Clause 8 of the SPC-1 Benchmark Specification.
- The Full Disclosure Report (FDR) met all of the requirements in Clause 9 of the SPC-1 Benchmark Specification.
- This successfully audited SPC measurement is not subject to an SPC Confidential Review.

Audit Notes:

There were no audit notes or exceptions.

Respectfully,



Walter E. Baker
SPC Auditor

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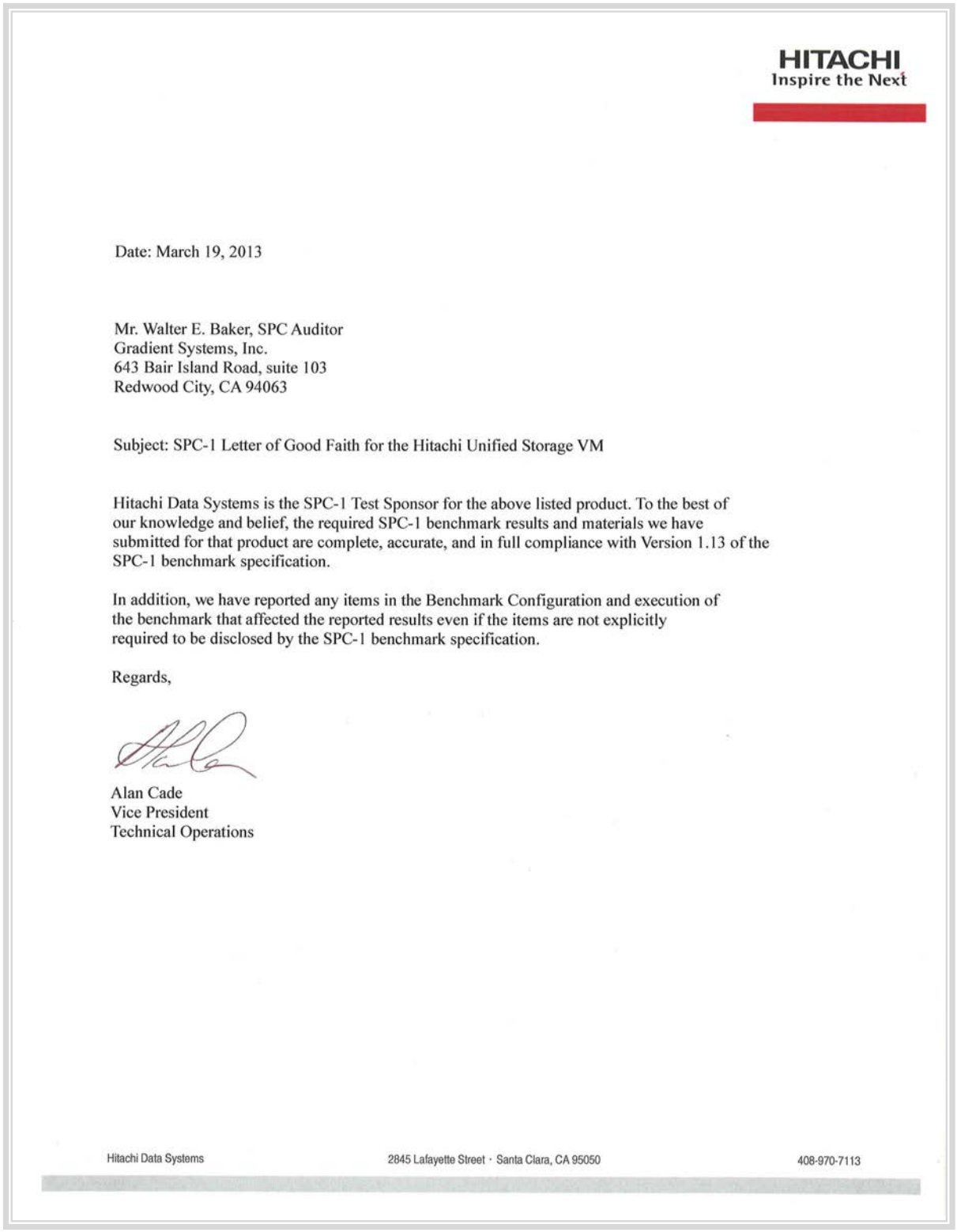
LETTER OF GOOD FAITH



HITACHI
Inspire the Next

Date: March 19, 2013

Mr. Walter E. Baker, SPC Auditor
Gradient Systems, Inc.
643 Bair Island Road, suite 103
Redwood City, CA 94063

Subject: SPC-1 Letter of Good Faith for the Hitachi Unified Storage VM

Hitachi Data Systems 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 Version 1.13 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.

Regards,

Alan Cade
Vice President
Technical Operations

Hitachi Data Systems 2845 Lafayette Street · Santa Clara, CA 95050 408-970-7113

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	Hitachi Data Systems Corporation –http://www.hds.com David Cordero – david.cordero@hds.com 750 Central Expressway M/S U9922 Santa Clara, CA 95050 Phone: (617) 838-4040 FAX: (617) 838-4040
Test Sponsor Alternate Contact	Hitachi Data Systems Corporation –http://www.hds.com Mel Boksenbaum – mel.boksenbaum@hds.com 750 Central Expressway M/S U9922 Santa Clara, CA 95050 Phone: (408) 970-7922 FAX: (408) 327-3066
Auditor	Storage Performance Council – http://www.storageperformance.org Walter E. Baker – AuditService@StoragePerformance.org 643 Bair Island Road, Suite 103 Redwood City, CA 94063 Phone: (650) 556-9384 FAX: (650) 556-9385

Revision Information and Key Dates

Revision Information and Key Dates	
SPC-1 Specification revision number	V1.13
SPC-1 Workload Generator revision number	V2.3.0
Date Results were first used publicly	April 30, 2013
Date the FDR was submitted to the SPC	April 30, 2013
Date revised FDR was submitted to the SPC Revised pricing (page 15) and resulting price-related Reported Data (page 12)	March 20, 2014
Date the Priced Storage Configuration is available for shipment to customers	currently available
Date the TSC completed audit certification	April 22, 2013

Tested Storage Product (TSP) Description

Hitachi Unified Storage VM can manage all of your existing storage and consolidate all of your data in a single, virtualized platform to ease the management of information. Hitachi Unified Storage VM is built with trusted Hitachi reliability for application availability, performance and lower cost of ownership. Delivering enterprise storage virtualization in a unified platform lets you manage information more efficiently.

HUS VM places emphasis on high availability with nondisruptive microcode and hardware upgrades, automatic failover architecture with redundant, hot-swappable components, dual data paths and dual control paths and nonvolatile backup of cache using a combination of battery and flash disk drives. Universal data replication can be provided for local and remote data protection across multiple data centers.

Intelligent, controller-based storage virtualization provides a platform for aggregating all storage services for multivendor storage systems. Host-transparent movement, copy and migration of data between storage is enabled with reduced interruption of applications. Hitachi Command Suite provides the software management platform for advanced data and storage management that helps improve administration, operations, provisioning, performance and resilience. Automated data placement enables higher performance and lower cost storage tiers, placing the right data in the right place, at the right time.

Summary of Results

SPC-1 Reported Data	
Tested Storage Product (TSP) Name: Hitachi Unified Storage VM	
Metric	**Reported Result**
SPC-1 IOPS™	181,492.24
SPC-1 Price-Performance™	$3.53/SPC-1 IOPS™
Total ASU Capacity	52,566.608 GB
Data Protection Level	Protected 2 *(Mirroring)*
Total Price	$639,914.24
Currency Used	U.S. Dollars
Target Country for availability, sales and support	USA

SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

SPC-1 Price-Performance™ is the ratio of **Total Price** to **SPC-1 IOPS™**.

Total ASU (Application Storage Unit) **Capacity** represents the total storage capacity available to be read and written in the course of executing the SPC-1 benchmark.

A **Data Protection Level** of **Protected 2** using ***Mirroring*** configures two or more identical copies of user data.

> ***Protected 2:*** *The single point of failure of any* ***component*** *in the configuration will not result in permanent loss of access to or integrity of the SPC-1 Data Repository.*

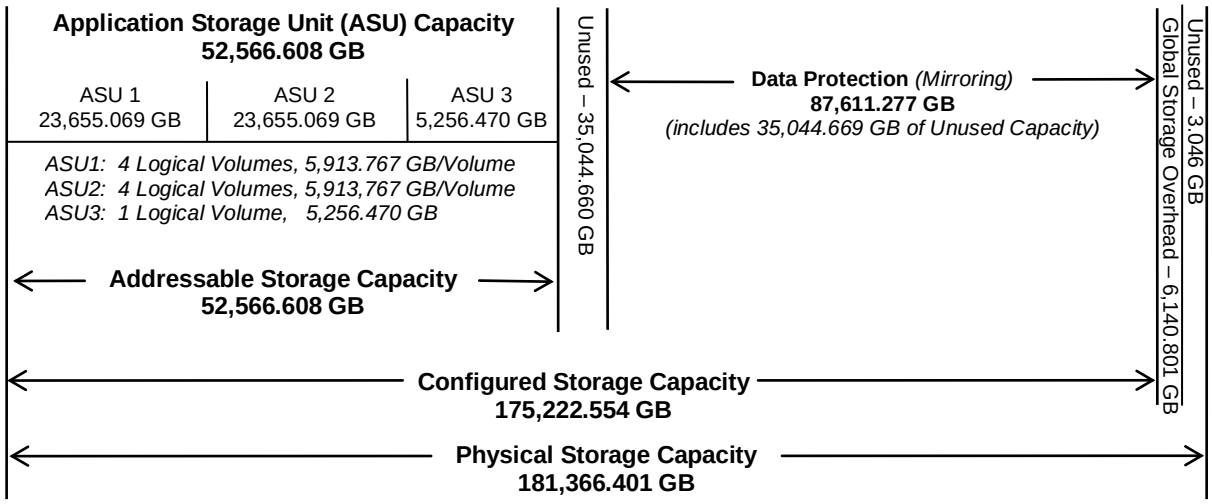
Total Price includes the cost of the Priced Storage Configuration plus three years of hardware maintenance and software support as detailed on page 15.

Currency Used is formal name for the currency used in calculating the **Total Price** and **SPC-1 Price-Performance™**. That currency may be the local currency of the **Target Country** or the currency of a difference country *(non-local currency)*.

The **Target Country** is the country in which the Priced Storage Configuration is available for sale and in which the required hardware maintenance and software support is provided either directly from the Test Sponsor or indirectly via a third-party supplier.

Storage Capacities, Relationships, and Utilization

The following diagram *(not to scale)* and table document the various storage capacities, used in this benchmark, and their relationships, as well as the storage utilization values required to be reported.



SPC-1 Storage Capacity Utilization	
Application Utilization	28.98%
Protected Application Utilization	57.97%
Unused Storage Ratio	38.65%

Application Utilization: Total ASU Capacity *(52,566.608 GB)* divided by Physical Storage Capacity *(181,366.401 GB).*

Protected Application Utilization: Total ASU Capacity *(52,566.608 GB)* plus total Data Protection Capacity *(87,611.277 GB)* minus unused Data Protection Capacity *(35,044.669 GB)* divided by Physical Storage Capacity *(181,366.401 GB).*

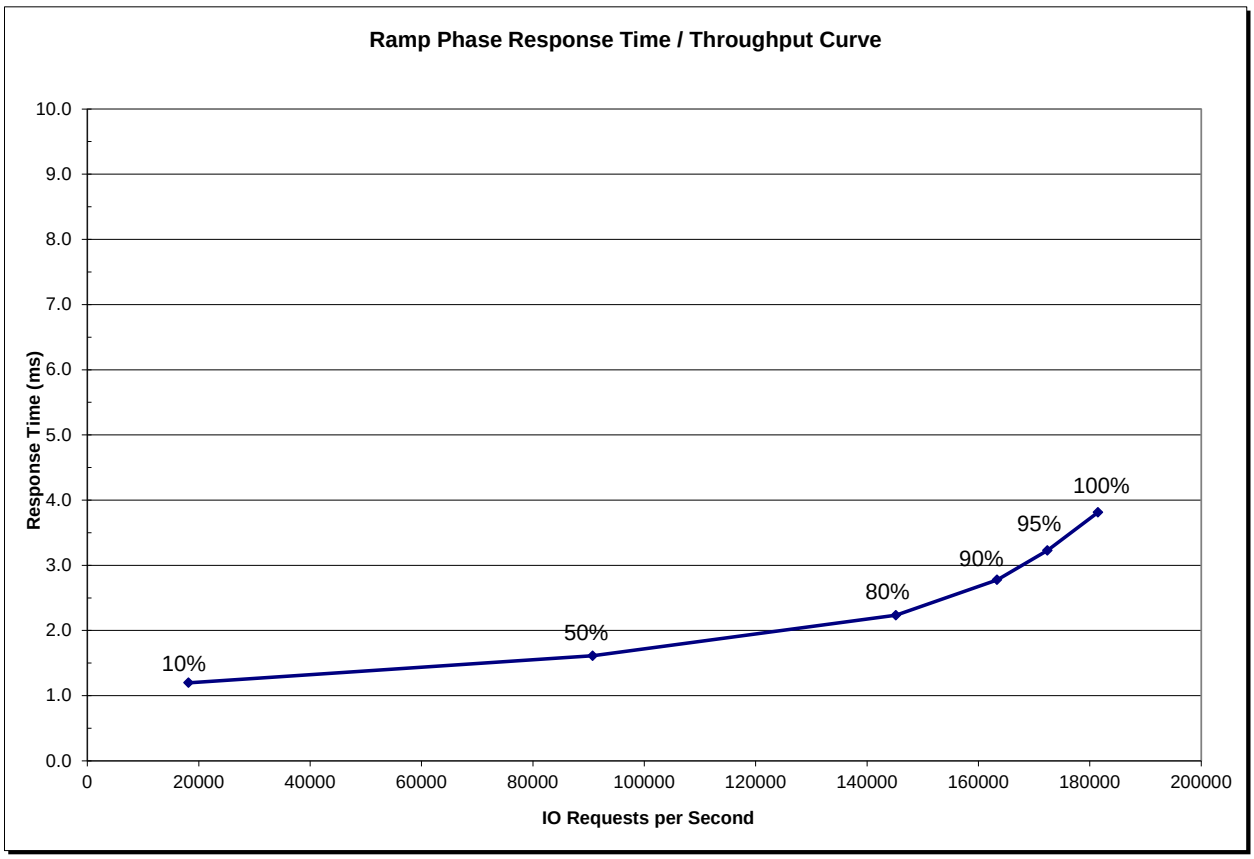
Unused Storage Ratio: Total Unused Capacity *(70,092.384 GB)* divided by Physical Storage Capacity *(181,366.401 GB)* and may not exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 24-25.

Response Time – Throughput Curve

The Response Time-Throughput Curve illustrates the Average Response Time (milliseconds) and I/O Request Throughput at 100%, 95%, 90%, 80%, 50%, and 10% of the workload level used to generate the SPC-1 IOPS™ metric.

The Average Response Time measured at any of the above load points cannot exceed 30 milliseconds or the benchmark measurement is invalid.



Response Time – Throughput Data

	10% Load	50% Load	80% Load	90% Load	95% Load	100% Load
I/O Request Throughput	18,153.64	90,749.00	145,203.04	163,360.54	172,412.62	181,491.24
Average Response Time (ms):						
All ASUs	1.20	1.61	2.23	2.78	3.23	3.81
ASU-1	1.70	2.28	3.12	3.85	4.48	5.18
ASU-2	1.10	1.49	2.15	2.71	3.17	3.75
ASU-3	0.17	0.25	0.38	0.52	0.60	0.95
Reads	2.78	3.72	5.09	6.27	7.29	8.25
Writes	0.16	0.24	0.37	0.50	0.58	0.92

Priced Storage Configuration Pricing

Product Description	Qty	Unit List Price	Product List Price
Power Cable 250VAC 10A IEC320-C14	58	$39.00	$2,262.00
Dummy Drive for SFF (2U) Trays	64	$0.00	$0.00
Baying kit external	4	$5.90	$23.60
Solution 19 in rack ROW MIN	2	$8,110.00	$16,220.00
4GB USB memory stick with lanyard	1	$0.00	$0.00
HUS VM B/E I/O Module	4	$1,393.00	$5,572.00
HUS VM Drive Box (SFF)	28	$6,765.00	$189,420.00
HUS VM Controller Chassis	1	$74,000.00	$74,000.00
HUS VM 300GB SAS 15K RPM HDD SFF for CBSS/DBS-Base	608	$1,720.00	$1,045,760.00
HUS VM 4x8Gbps FC Interface Adapter	8	$3,267.00	$26,136.00
LAN Cable 14ft	1	$0.00	$0.00
RJ-45 Modular In-Line Coupler 6 Conductor	1	$4.00	$4.00
PDU 0RU 22xC13 1Phase 208V 30A NEMA L6-30P	2	$1,236.00	$2,472.00
PDU 0RU 12xC13 1Phase 208V 30A NEMA L6-30P	2	$735.00	$1,470.00
Universal rail kit includes left and right rails	29	$154.00	$4,466.00
HUS VM Cache Flash Memory Module (supports 160GB)	1	$9,888.00	$9,888.00
HUS VM 16GB Cache Module	8	$4,295.00	$34,360.00
Hardware Components:		---	**$1,412,053.60**
HUS VM Hitachi Base Operating System Base License (20TB)	1	$27,000.00	$27,000.00
HUS VM Hitachi Base Operating System 60TB Block License	1	$55,900.00	$55,900.00
Software Components:		---	**$82,900.00**
HUS VM Service Installation	1	$2,750.00	$2,750.00
HUS VM Hardware Maintenance Support - Includes 3 years of Standard Support (24 x 7 x 4 hour response)	1	$60,594.48	$60,594.48
HUS VM Storage Software Support - Includes 3 years of Standard Support	1	$37,305.00	$37,305.00
Installation and Support:		---	**$100,649.48**
Brocade 360 switch w/ 24 active ports,Full Fabric,24 SWL 8Gb BR SFPs, Fixed Rack Mount plus 3 year support	1	$5,147.00	$5,147.00
Brocade 360 switch w/ 24 active ports,Full Fabric,24 SWL 8Gb BR SFPs, Fixed Rack Mount plus 13 months maintenance (spare)	1	$4,934.00	$4,934.00
Emulex LightPulse Dual Port Fibre Channel Host Bus Adapter LPE12002-M8	4	$1,380.00	$5,520.00
Fibre Channel Cables	20	$21.50	$430.00
Third Party Components:		---	**$16,031.00**

Hardware Components	**$1,412,053.60**	**65%**	**$494,218.76**
Software Components	**$82,900.00**	**65%**	**$29,015.00**
Installation & Support	**$100,649.48**	**0%**	**$100,649.48**
Third Party Components	**$16,031.00**	**0%**	**$16,031.00**
Total:			**$639,914.24**

The above pricing includes hardware maintenance and software support for three years, 7 days per week, 24 hours per day. The hardware maintenance and software support provides the following:

- Acknowledgement of new and existing problems with four (4) hours.
- Onsite presence of a qualified maintenance engineer or provision of a customer replaceable part within four (4) hours of the above acknowledgement for any hardware failure that results in an inoperative Price Storage Configuration that can be remedied by the repair or replacement of a Priced Storage Configuration component.

Differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration

A second 24-port FC switch was included in the Priced Storage Configuration as a spare to fulfill one of the requirements for a data protection level of **Protected 2**.

The switch used in the TSC was a Brocade 5120 switch. A Brocade 360 switch was substituted for the Brocade 5120 in the Priced Storage Configuration due to EOL of the 5120. The Brocade 360 switch provides equivalent functionality and performance as the Brocade 5120 for the SPC-1 benchmark measurements.

Priced Storage Configuration Diagram

4 - Emulex LPe12002 dual-port 8 Gb FC HBAs

8 - 8 Gbps FC connections

Brocade 360 24-port 8 Gb FC Switch

16 - 8 Gbps FC connections

Hitachi Unified Storage VM

2 Virtual Storage Controllers with:

2 cache blades, 1 per controller, with:
64 GB cache per blade *(128 GB total)*
80 GB flash per blade for cache backup *(160 GB total)*

2 processor blades, 1 per controller, with 8 GB of local memory per blade *(16 GB total)*

8 - FC Host Port Adapters, 4 per controller
(4 - 8 Gbps ports per adapter)
(32 ports total)

4 - SAS I/O Modules, 2 per controller
(2 - 4x6 Gbps ports per module)
(4 - 6 Gbps links per port)
(8 links per SAS I/O module, 32 total)

28 - Drive Enclosures

608 - 300 GB SAS 15K RPM disk drives
(24 enclosures each with 24 drives)
(4 enclosures each with 8 drives)

2 - 19" Racks with PDUs

Priced Storage Configuration Components

Priced Storage Configuration:
4 – Emulex LightPulse LPe12002-M8 8Gbps dual port FC HBAs
2 – Brocade 360 FC switch, 24 active ports, 24 8Gb SFPs *(a second switch was included to serve as a spare)*
Hitachi Unified Storage VM 1 HiStar-based storage controller with: 2 Main blades with: 64 GB cache per blade *(128 GB total)* 80 GB flash for cache backup per blade *(160 GB total)* 1 flash battery per blade *(2 total)* 2 Microprocessor blades with 8 GB of local memory per blade *(16 GB total)* 8 – FC Host Port Adapters *(4 – 8 Gbps ports per adapter)* *(16 ports per controller, 32 ports total)* *(8 ports used per controller, 16 total used)* 4 – SAS I/O Modules *(2 – 8x6Gbps ports per module)* *(4 ports per controller, 8 ports total, 8 ports used)* *(4 – 8x6Gbps links per port)* *(8 links per module, 32 total links, 32 links used)*
28 – Drive Enclosures
608 – 300 GB SAS 15K RPM disk drives *(24 disk enclosures each with 24 disk drives)* *(4 disk enclosures each with 8 disk drives)*
2 – 19” racks with PDUs

In each of the following sections of this document, the appropriate Full Disclosure Report requirement, from the SPC-1 benchmark specification, is stated in italics followed by the information to fulfill the stated requirement.

CONFIGURATION INFORMATION

Benchmark Configuration (BC)/Tested Storage Configuration (TSC) Diagram

Clause 9.4.3.4.1

A one page Benchmark Configuration (BC)/Tested Storage Configuration (TSC) diagram shall be included in the FDR…

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC) is illustrated on page 20 *(Benchmark Configuration/Tested Storage Configuration Diagram)*.

Storage Network Configuration

Clause 9.4.3.4.1

…

5. *If the TSC contains network storage, the diagram will include the network configuration. If a single diagram is not sufficient to illustrate both the Benchmark Configuration and network configuration in sufficient detail, the Benchmark Configuration diagram will include a high-level network illustration as shown in Figure 9-8. In that case, a separate, detailed network configuration diagram will also be included as described in Clause 9.4.3.4.2.*

Clause 9.4.3.4.2

If a storage network was configured as a part of the Tested Storage Configuration and the Benchmark Configuration diagram described in Clause 9.4.3.4.1 contains a high-level illustration of the network configuration, the Executive Summary will contain a one page topology diagram of the storage network as illustrated in Figure 9-9.

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC) was configured with local storage and, as such, did not employ a storage network.

Host System(s) and Tested Storage Configuration (TSC) Table of Components

Clause 9.4.3.4.3

The FDR will contain a table that lists the major components of each Host System and the Tested Storage Configuration (TSC). Table 9-10 specifies the content, format, and appearance of the table.

The Host System(s) and TSC table of components may be found on page21 *(Host Systems and Tested Storage Configuration Components)*.

Benchmark Configuration/Tested Storage Configuration Diagram

2 - Hitachi CB 2000 Model E55A2 blade servers

4 - Emulex LPe12002 dual-port 8 Gb FC HBAs
(2 HBAs per server)

4 - 8 Gbps FC connections ... ... *4 - 8 Gbps FC connections*

Brocade 5120 24-port 8 Gb FC Switch

• • • *16 - 8 Gbps FC connections*

Hitachi Unified Storage VM

1 HiStar-based storage controller with:

2 Main blades with:
64 GB cache per blade *(128 GB total)*
80 GB flash per blade for cache backup *(160 GB total)*

2 Microprocessor blades with 8 GB of local memory per blade *(16 GB total)*

8 - FC Host Port Adapters
(4 - 8 Gbps ports per adapter)
(32 ports total)

4 - SAS I/O Modules
(2 - 4x6 Gbps ports per module)
(4 - 6 Gbps links per port)
(8 links per SAS I/O module, 32 total)

28 - Drive Enclosures

608 - 300 GB SAS 15K RPM disk drives
(24 enclosures each with 24 drives)
(4 enclosures each with 8 drives)

2 - 19" Racks with PDUs

Host Systems and Tested Storage Configuration Components

Host System:	Tested Storage Configuration (TSC):
2 – Hitachi Compute Blade 2000 Model E55A2, each with 2 – Intel® Xeon® 5690 six core 3.46 GHz processors, 12 MB Intel® SmartCache per processor 96 GB main memory Red Hat Enterprise Linux 6.3 (x86_64) Linux Logical Volume Manager LVM version 2.02.95-10 PCIe	4 – Emulex LightPulse LPe12002-M8 8Gbps dual port FC HBAs
	1 – Brocade 5120 FC switch, 24 active ports, 24 8Gb SFPs
	Hitachi Unified Storage VM 1 HiStar-based storage controller with: 2 Main blades with: 64 GB cache per blade *(128 GB total)* 80 GB flash for cache backup per blade *(160 GB total)* 1 flash battery per blade *(2 total)* 2 Microprocessor blades with 8 GB of local memory per blade *(16 GB total)* 8 FC Host Port Adapters *(4 – 8 Gbps ports per adapter)* *(16 ports per controller, 32 ports total)* *(8 ports used per controller, 16 total used)* 4 SAS I/O Modules *(2 – 8x6Gbps ports per module)* *(4 ports per controller, 8 ports total, 8 ports used)* *(4 – 8x6Gbps links per port)* *(8 links per module, 32 total links, 32 links used)*
	28 – Drive Enclosures
	608 – 300 GB SAS 15K RPM disk drives *(24 disk enclosures each with 24 disk drives)* *(4 disk enclosures each with 8 disk drives)*
	2 – 19” racks with PDUs

Customer Tunable Parameters and Options

Clause 9.4.3.5.1

All Benchmark Configuration (BC) components with customer tunable parameter and options that have been altered from their default values must be listed in the FDR. The FDR entry for each of those components must include both the name of the component and the altered value of the parameter or option. If the parameter name is not self-explanatory to a knowledgeable practitioner, a brief description of the parameter's use must also be included in the FDR entry.

Appendix B: Customer Tunable Parameters and Options on page 63 contains the customer tunable parameters and options that have been altered from their default values for this benchmark.

Tested Storage Configuration (TSC) Description

Clause 9.4.3.5.2

The FDR must include sufficient information to recreate the logical representation of the TSC. In addition to customer tunable parameters and options (Clause 4.2.4.5.3), that information must include, at a minimum:

- *A diagram and/or description of the following:*
  - *All physical components that comprise the TSC. Those components are also illustrated in the BC Configuration Diagram in Clause 9.2.4.4.1 and/or the Storage Network Configuration Diagram in Clause 9.2.4.4.2.*
  - *The logical representation of the TSC, configured from the above components that will be presented to the Workload Generator.*
- *Listings of scripts used to create the logical representation of the TSC.*
- *If scripts were not used, a description of the process used with sufficient detail to recreate the logical representation of the TSC.*

Appendix C: Tested Storage Configuration (TSC) Creation on page 64 contains the detailed information that describes how to create and configure the logical TSC.

SPC-1 Workload Generator Storage Configuration

Clause 9.4.3.5.3

The FDR must include all SPC-1 Workload Generator storage configuration commands and parameters.

The SPC-1 Workload Generator storage configuration commands and parameters for this measurement appear in Appendix D: SPC-1 Workload Generator Storage Commands and Parameters on page 80.

ASU Pre-Fill

Clause 5.3.3

Each of the three SPC-1 ASUs (ASU-1, ASU-2 and ASU-3) is required to be completely filled with specified content prior to the execution of audited SPC-1 Tests. The content is required to consist of random data pattern such as that produced by an SPC recommended tool.

The configuration file used to complete the required ASU pre-fill appears in Appendix D: SPC-1 Workload Generator Storage Commands and Parameters on page 80.

SPC-1 DATA REPOSITORY

This portion of the Full Disclosure Report presents the detailed information that fully documents the various SPC-1 storage capacities and mappings used in the Tested Storage Configuration. SPC-1 Data Repository Definitions on page 59 contains definitions of terms specific to the SPC-1 Data Repository.

Storage Capacities and Relationships

Clause 9.4.3.6.1

Two tables and an illustration documenting the storage capacities and relationships of the SPC-1 Storage Hierarchy (Clause 2.1) shall be included in the FDR.

SPC-1 Storage Capacities

The Physical Storage Capacity consisted of 181,366.401 GB distributed over 608 disk drives, each with a formatted capacity of 298.300 GB. There was 3.04 GB (0.002%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 6,140.801 GB (3.39%) of the Physical Storage Capacity. There was 70,089.338 GB (40.00%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 100.00% of the Addressable Storage Capacity resulting in 0.000 GB (0.00%) of Unused Storage within the Addressable Storage Capacity. The Data Protection *(Mirroring)* capacity was 87,611.277 GB of which 52,566.608 GB was utilized. The total Unused Storage capacity was 70,092.384 GB.

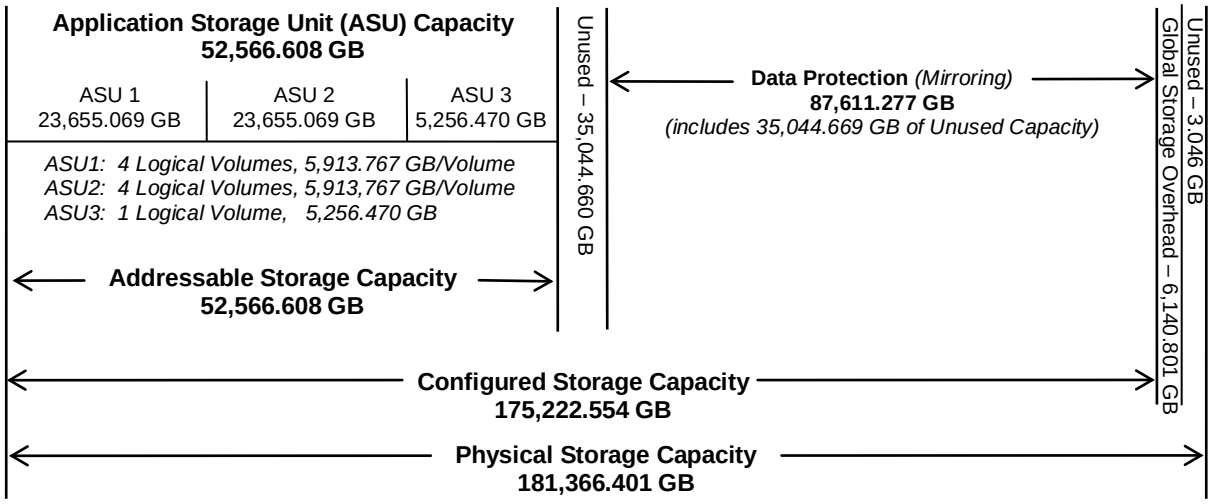
Note: The configured Storage Devices may include additional storage capacity reserved for system overhead, which is not accessible for application use. That storage capacity may not be included in the value presented for Physical Storage Capacity.

SPC-1 Storage Capacities

Storage Hierarchy Component	Units	Capacity
Total ASU Capacity	Gigabytes (GB)	52,566.608
Addressable Storage Capacity	Gigabytes (GB)	52,566.608
Configured Storage Capacity	Gigabytes (GB)	175,522.554
Physical Storage Capacity	Gigabytes (GB)	181,366.401
Data Protection *(Mirroring)*	Gigabytes (GB)	87,611.277
Required Storage	Gigabytes (GB)	0.000
Global Storage Overhead	Gigabytes (GB)	6,140.801
Total Unused Storage	Gigabytes (GB)	70,092.384

SPC-1 Storage Capacities and Relationships Illustration

The various storage capacities configured in the benchmark result are illustrated below *(not to scale)*.



SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	Configured Storage Capacity	Physical Storage Capacity
Total ASU Capacity	100.00%	30.00%	28.98%
Required for Data Protection *(Mirroring)*		50.00%	48.31%
Addressable Storage Capacity		30.00%	28.98%
Required Storage		0.00%	0.00%
Configured Storage Capacity			96.61%
Global Storage Overhead			3.39%
Unused Storage:			
Addressable	0.00%		
Configured		40.00%	
Physical			0.002%

Storage Capacity Utilization

Clause 9.4.3.6.2

The FDR will include a table illustrating the storage capacity utilization values defined for Application Utilization (Clause 2.8.1), Protected Application Utilization (Clause 2.8.2), and Unused Storage Ratio (Clause 2.8.3).

Clause 2.8.1

Application Utilization is defined as Total ASU Capacity divided by Physical Storage Capacity.

Clause 2.8.2

Protected Application Utilization is defined as (Total ASU Capacity plus total Data Protection Capacity minus unused Data Protection Capacity) divided by Physical Storage Capacity.

Clause 2.8.3

Unused Storage Ratio is defined as Total Unused Capacity divided by Physical Storage Capacity and may not exceed 45%.

SPC-1 Storage Capacity Utilization	
Application Utilization	28.98%
Protected Application Utilization	57.97%
Unused Storage Ratio	38.65%

Logical Volume Capacity and ASU Mapping

Clause 9.4.3.6.3

A table illustrating the capacity of each ASU and the mapping of Logical Volumes to ASUs shall be provided in the FDR. … Logical Volumes shall be sequenced in the table from top to bottom per its position in the contiguous address space of each ASU. The capacity of each Logical Volume shall be stated. … In conjunction with this table, the Test Sponsor shall provide a complete description of the type of data protection (see Clause 2.4.5) used on each Logical Volume.

Logical Volume Capacity and Mapping		
ASU-1 (23,655.069 GB)	**ASU-2 (23,655.069 GB)**	**ASU-3 (5,256.470 GB)**
4 Logical Volumes 5,913.767 GB per Logical Volume (5,913.767 GB used per Logical Volume)	4 Logical Volumes 5,913.767 GB per Logical Volume (5,913.767 GB used per Logical Volume)	1 Logical Volume 5,256.470 GB per Logical Volume (5,256.470 GB used per Logical Volume)

The Data Protection Level used for all Logical Volumes was **Protected 2** using ***Mirroring*** as described on page 12. See "ASU Configuration" in the **IOPS Test Results File** for more detailed configuration information.

SPC-1 BENCHMARK EXECUTION RESULTS

This portion of the Full Disclosure Report documents the results of the various SPC-1 Tests, Test Phases, and Test Runs. An SPC-1 glossary on page 59 contains definitions of terms specific to the SPC-1 Tests, Test Phases, and Test Runs.

Clause 5.4.3

The Tests must be executed in the following sequence: Primary Metrics, Repeatability, and Data Persistence. That required sequence must be uninterrupted from the start of Primary Metrics to the completion of Persistence Test Run 1. Uninterrupted means the Benchmark Configuration shall not be power cycled, restarted, disturbed, altered, or adjusted during the above measurement sequence. If the required sequence is interrupted other than for the Host System/TSC power cycle between the two Persistence Test Runs, the measurement is invalid.

SPC-1 Tests, Test Phases, and Test Runs

The SPC-1 benchmark consists of the following Tests, Test Phases, and Test Runs:

- **Primary Metrics Test**
  - Sustainability Test Phase and Test Run
  - IOPS Test Phase and Test Run
  - Response Time Ramp Test Phase
    - 95% of IOPS Test Run
    - 90% of IOPS Test Run
    - 80% of IOPS Test Run
    - 50% of IOPS Test Run
    - 10% of IOPS Test Run (LRT)
- **Repeatability Test**
  - Repeatability Test Phase 1
    - 10% of IOPS Test Run (LRT)
    - IOPS Test Run
  - Repeatability Test Phase 2
    - 10% of IOPS Test Run (LRT)
    - IOPS Test Run
- **Data Persistence Test**
  - Data Persistence Test Run 1
  - Data Persistence Test Run 2

Each Test is an atomic unit that must be executed from start to finish before any other Test, Test Phase, or Test Run may be executed.

The results from each Test, Test Phase, and Test Run are listed below along with a more detailed explanation of each component.

Primary Metrics Test – Sustainability Test Phase

Clause 5.4.4.1.1

The Sustainability Test Phase has exactly one Test Run and shall demonstrate the maximum sustainable I/O Request Throughput within at least a continuous eight (8) hour Measurement Interval. This Test Phase also serves to insure that the TSC has reached Steady State prior to reporting the final maximum I/O Request Throughput result (SPC-1 IOPS™).

Clause 5.4.4.1.2

The computed I/O Request Throughput of the Sustainability Test must be within 5% of the reported SPC-1 IOPS™ result.

Clause 5.4.4.1.4

The Average Response Time, as defined in Clause 5.1.1, will be computed and reported for the Sustainability Test Run and cannot exceed 30 milliseconds. If the Average Response time exceeds that 30-milliseconds constraint, the measurement is invalid.

Clause 9.4.3.7.1

For the Sustainability Test Phase the FDR shall contain:

1. *A Data Rate Distribution graph and data table.*
2. *I/O Request Throughput Distribution graph and data table.*
3. *A Response Time Frequency Distribution graph and table.*
4. *An Average Response Time Distribution graph and table.*
5. *The human readable Test Run Results File produced by the Workload Generator (may be included in an appendix).*
6. *A listing or screen image of all input parameters supplied to the Workload Generator (may be included in an appendix).*
7. *The Measured Intensity Multiplier for each I/O stream.*
8. *The variability of the Measured Intensity Multiplier, as defined in Clause 5.3.13.3.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in Appendix E: SPC-1 Workload Generator Input Parameters on Page 82.

Sustainability Test Results File

A link to the test results file generated from the Sustainability Test Run is listed below.

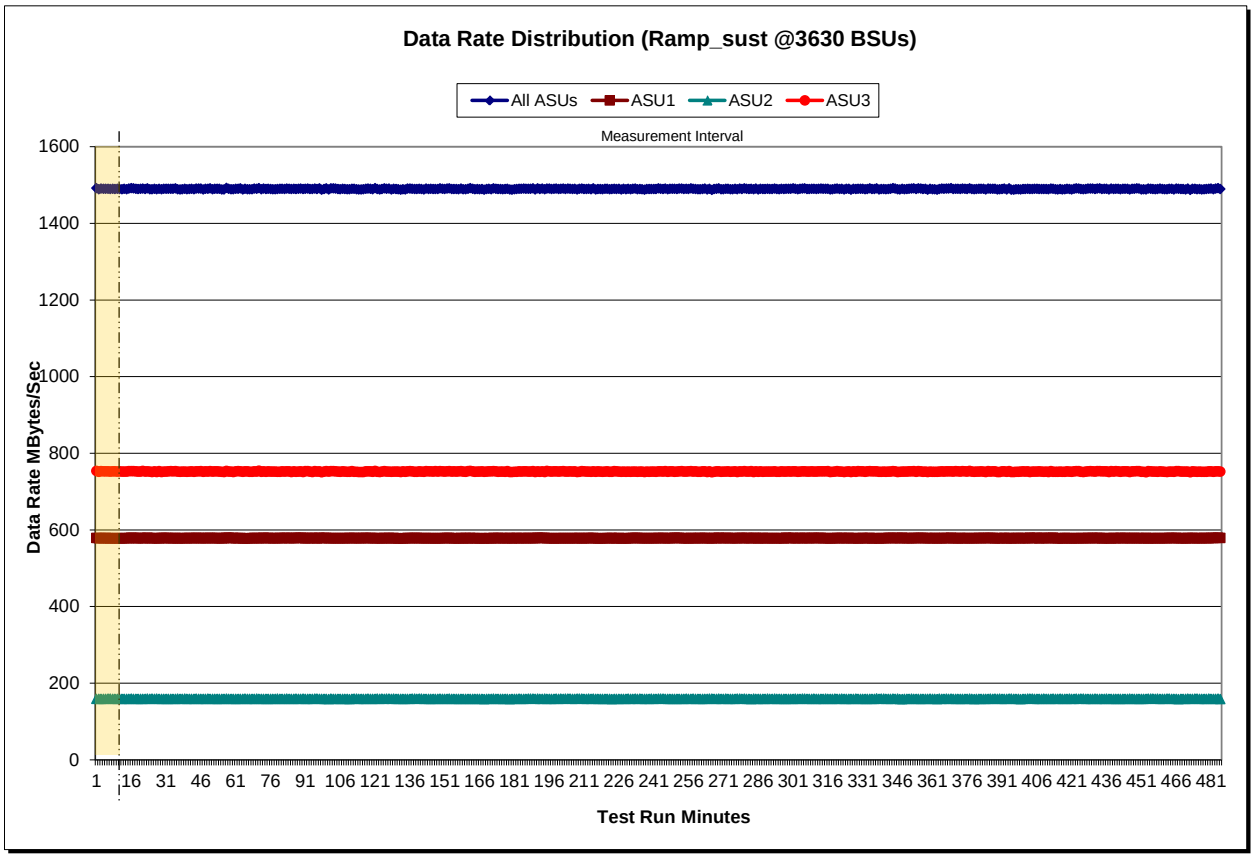
Sustainability Test Results File

Sustainability – Data Rate Distribution Data (MB/second)

The Sustainability Data Rate table of data is not embedded in this document due to its size. The table is available via the following URL:

Sustainability Data Rate Table

Sustainability – Data Rate Distribution Graph

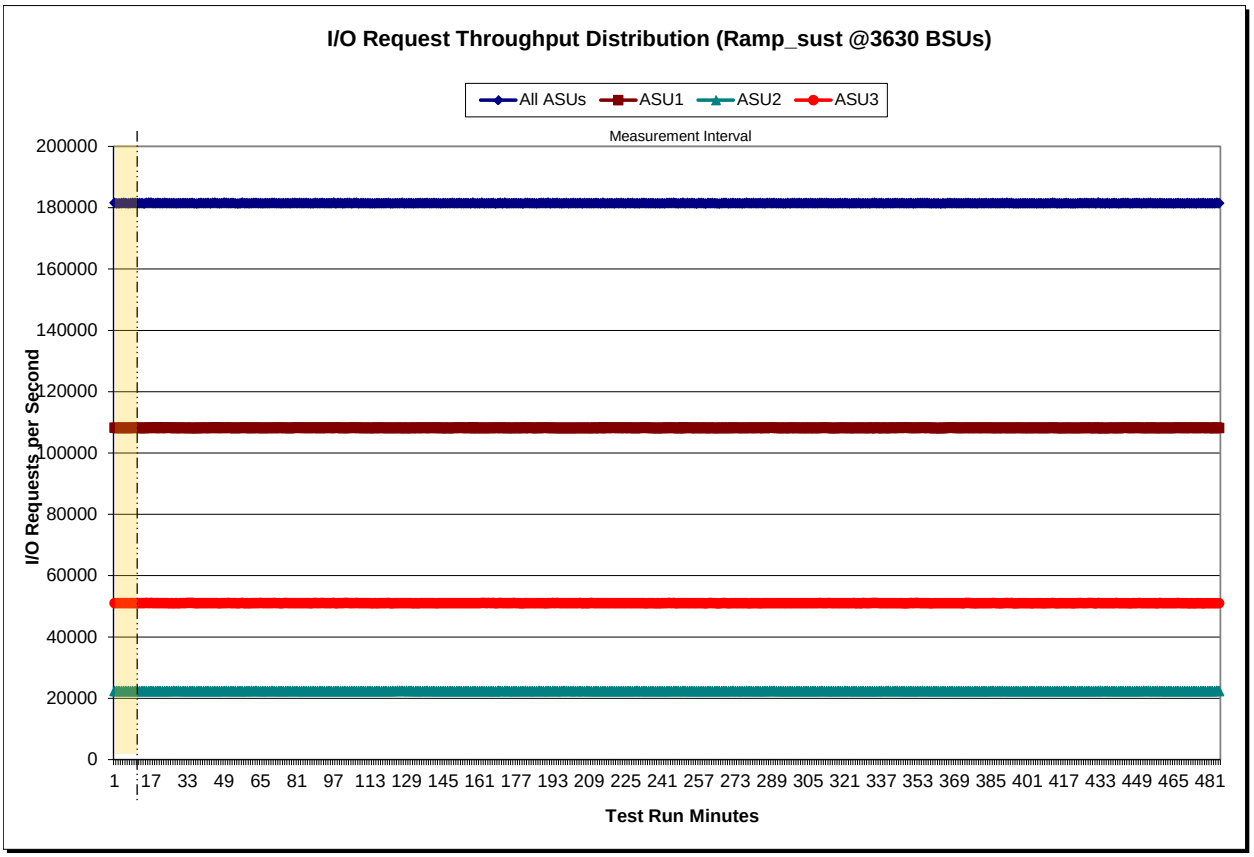


Sustainability – I/O Request Throughput Distribution Data

The Sustainability I/O Request Throughput table of data is not embedded in this document due to its size. The table is available via the following URL:

Sustainability I/O Request Throughput Table

Sustainability – I/O Request Throughput Distribution Graph

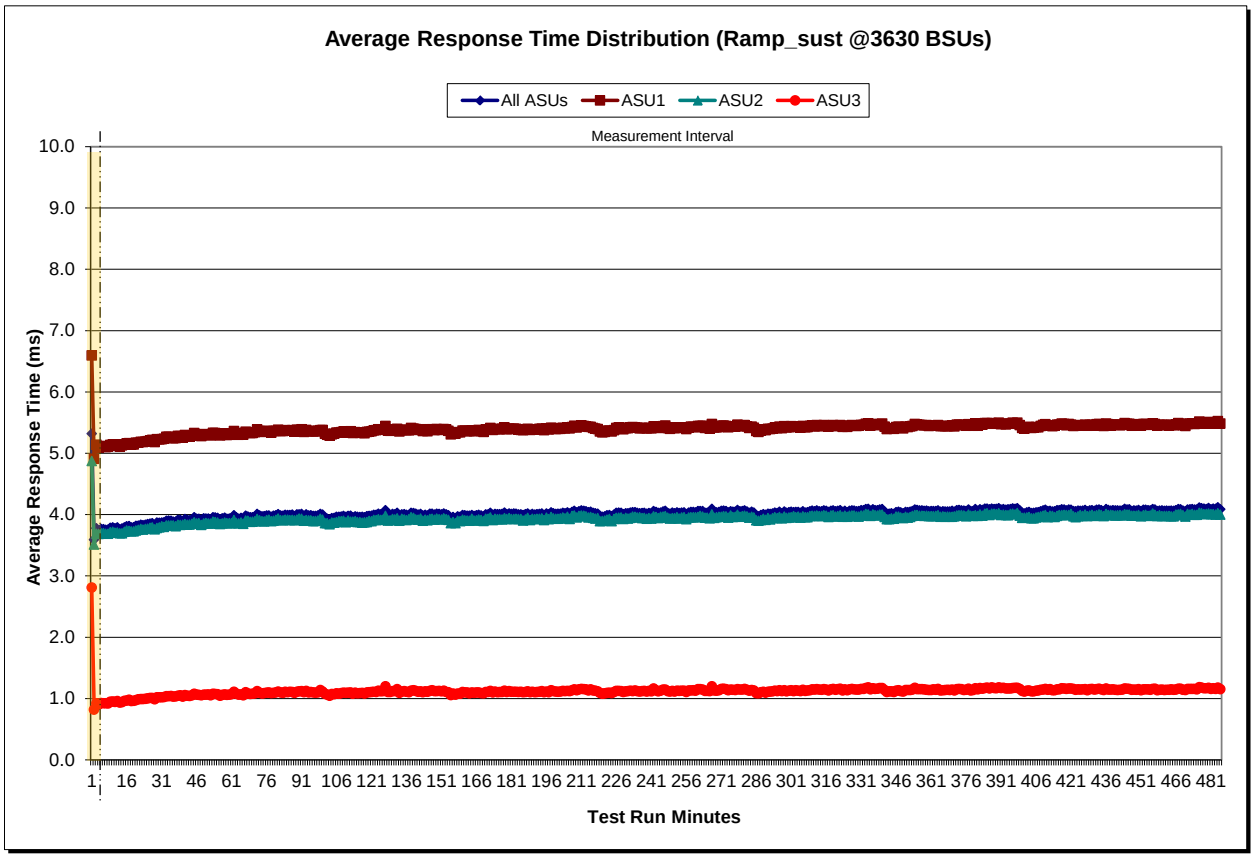


Sustainability – Average Response Time (ms) Distribution Data

The Sustainability Average Response Time table of data is not embedded in this document due to its size. The table is available via the following URL:

Sustainability Average Response Time Table

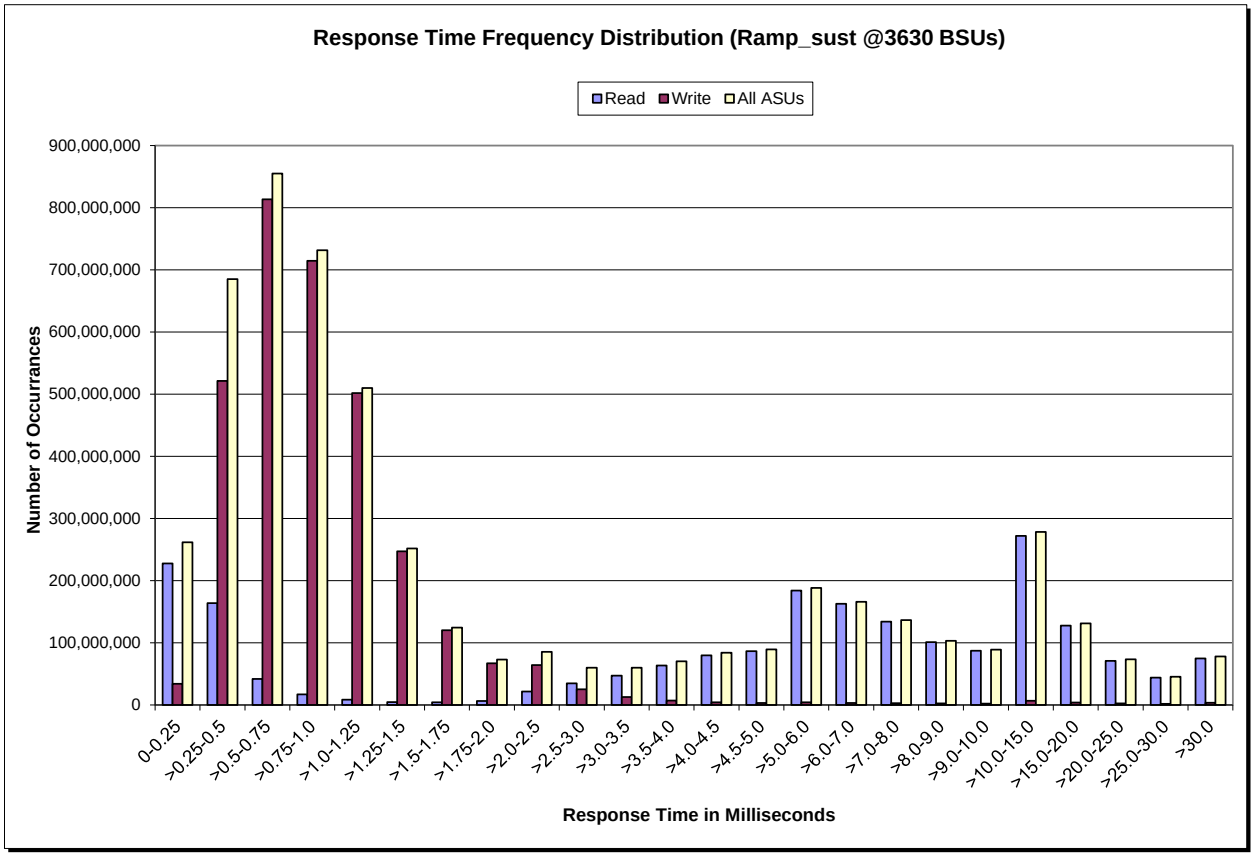
Sustainability – Average Response Time (ms) Distribution Graph



Sustainability – Response Time Frequency Distribution Data

Response Time (ms)	0-0.25	>0.25-0.5	>0.5-0.75	>0.75-1.0	>1.0-1.25	>1.25-1.5	>1.5-1.75	>1.75-2.0
Read	227,543,869	163,609,874	41,542,611	16,920,917	8,205,365	4,536,110	4,236,925	6,047,879
Write	34,046,123	521,336,197	813,333,510	714,630,317	501,745,131	247,011,597	120,044,219	66,726,474
All ASUs	261,589,992	684,946,071	854,876,121	731,551,234	509,950,496	251,547,707	124,281,144	72,774,353
ASU1	163,679,070	345,145,099	389,337,448	325,006,282	226,929,248	111,637,728	55,005,051	33,700,342
ASU2	82,982,672	102,161,931	87,698,557	74,525,096	53,108,522	26,246,938	12,646,784	7,244,204
ASU3	14,928,250	237,639,041	377,840,116	332,019,856	229,912,726	113,663,041	56,629,309	31,829,807
Response Time (ms)	**>2.0-2.5**	**>2.5-3.0**	**>3.0-3.5**	**>3.5-4.0**	**>4.0-4.5**	**>4.5-5.0**	**>5.0-6.0**	**>6.0-7.0**
Read	21,332,876	34,636,397	47,178,907	63,198,676	79,485,557	86,329,985	184,082,507	162,598,391
Write	63,901,038	25,064,731	12,464,850	6,803,006	4,234,677	2,903,313	4,181,641	3,152,583
All ASUs	85,233,914	59,701,128	59,643,757	70,001,682	83,720,234	89,233,298	188,264,148	165,750,974
ASU1	46,472,674	41,871,110	47,573,760	59,358,626	72,676,543	78,120,685	165,394,196	145,205,074
ASU2	8,288,059	5,738,350	5,995,822	7,286,530	8,904,430	9,608,971	20,630,199	18,803,212
ASU3	30,473,181	12,091,668	6,074,175	3,356,526	2,139,261	1,503,642	2,239,753	1,742,688
Response Time (ms)	**>7.0-8.0**	**>8.0-9.0**	**>9.0-10.0**	**>10.0-15.0**	**>15.0-20.0**	**>20.0-25.0**	**>25.0-30.0**	**>30.0**
Read	133,890,081	100,833,994	87,051,226	271,766,674	127,348,950	70,852,035	43,645,762	74,726,321
Write	2,607,632	2,226,249	1,924,920	6,656,987	3,724,696	2,272,248	1,457,356	3,224,652
All ASUs	136,497,713	103,060,243	88,976,146	278,423,661	131,073,646	73,124,283	45,103,118	77,950,973
ASU1	119,585,801	90,115,735	77,783,129	242,095,260	112,962,319	62,644,685	38,534,957	64,610,467
ASU2	15,437,900	11,668,966	10,074,838	32,357,495	15,799,257	9,030,046	5,617,695	11,117,186
ASU3	1,474,012	1,275,542	1,118,179	3,970,906	2,312,070	1,449,552	950,466	2,223,320

Sustainability – Response Time Frequency Distribution Graph



Sustainability – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

IM – Intensity Multiplier: *The ratio of I/Os for each I/O stream relative to the total I/Os for all I/O streams (ASU1-1 – ASU3-1) as required by the benchmark specification.*

Clauses 5.1.10 and 5.3.15.2

MIM – Measured Intensity Multiplier: *The Measured Intensity Multiplier represents the ratio of measured I/Os for each I/O stream relative to the total I/Os measured for all I/O streams (ASU1-1 – ASU3-1). This value may differ from the corresponding Expected Intensity Multiplier by no more than 5%.*

Clause 5.3.15.3

COV – Coefficient of Variation: *This measure of variation for the Measured Intensity Multiplier cannot exceed 0.2.*

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
COV	0.002	0.001	0.001	0.001	0.002	0.001	0.002	0.000

Primary Metrics Test – IOPS Test Phase

Clause 5.4.4.2

The IOPS Test Phase consists of one Test Run at the 100% load point with a Measurement Interval of ten (10) minutes. The IOPS Test Phase immediately follows the Sustainability Test Phase without any interruption or manual intervention.

The IOPS Test Run generates the SPC-1 IOPS™ primary metric, which is computed as the I/O Request Throughput for the Measurement Interval of the IOPS Test Run.

The Average Response Time is computed for the IOPS Test Run and cannot exceed 30 milliseconds. If the Average Response Time exceeds the 30 millisecond constraint, the measurement is invalid.

Clause 9.4.3.7.2

For the IOPS Test Phase the FDR shall contain:

1. *I/O Request Throughput Distribution (data and graph).*
2. *A Response Time Frequency Distribution.*
3. *An Average Response Time Distribution.*
4. *The human readable Test Run Results File produced by the Workload Generator.*
5. *A listing or screen image of all input parameters supplied to the Workload Generator.*
6. *The total number of I/O Requests completed in the Measurement Interval as well as the number of I/O Requests with a Response Time less than or equal to 30 milliseconds and the number of I/O Requests with a Response Time greater than 30 milliseconds.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in Appendix E: SPC-1 Workload Generator Input Parameters on Page 82.

IOPS Test Results File

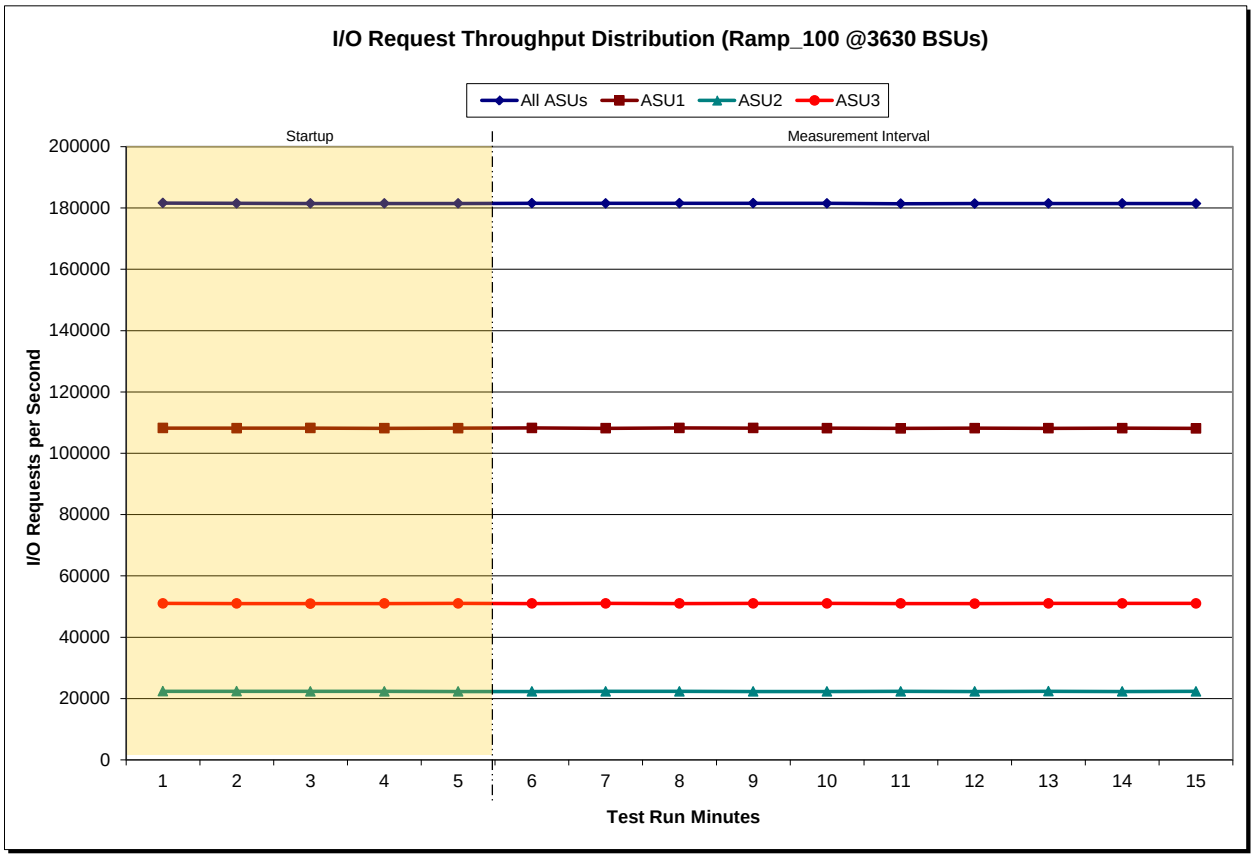
A link to the test results file generated from the IOPS Test Run is listed below.

IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

3,630 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	1:10:04	1:15:05	0-4	0:05:01
Measurement Interval	1:15:05	1:25:05	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	181,603.43	108,220.62	22,360.30	51,022.52
1	181,501.83	108,164.28	22,353.90	50,983.65
2	181,470.12	108,194.68	22,315.47	50,959.97
3	181,475.88	108,156.65	22,336.22	50,983.02
4	181,488.63	108,181.53	22,300.67	51,006.43
5	181,557.70	108,253.62	22,303.90	51,000.18
6	181,499.00	108,147.95	22,331.98	51,019.07
7	181,545.78	108,245.97	22,332.77	50,967.05
8	181,537.23	108,214.93	22,313.72	51,008.58
9	181,502.52	108,171.38	22,300.88	51,030.25
10	181,394.95	108,087.97	22,331.37	50,975.62
11	181,450.67	108,188.60	22,307.13	50,954.93
12	181,491.17	108,132.40	22,354.93	51,003.83
13	181,488.02	108,167.70	22,305.70	51,014.62
14	181,445.37	108,088.40	22,330.47	51,026.50
Average	***181,491.24***	***108,169.89***	***22,321.29***	***51,000.06***

IOPS Test Run – I/O Request Throughput Distribution Graph

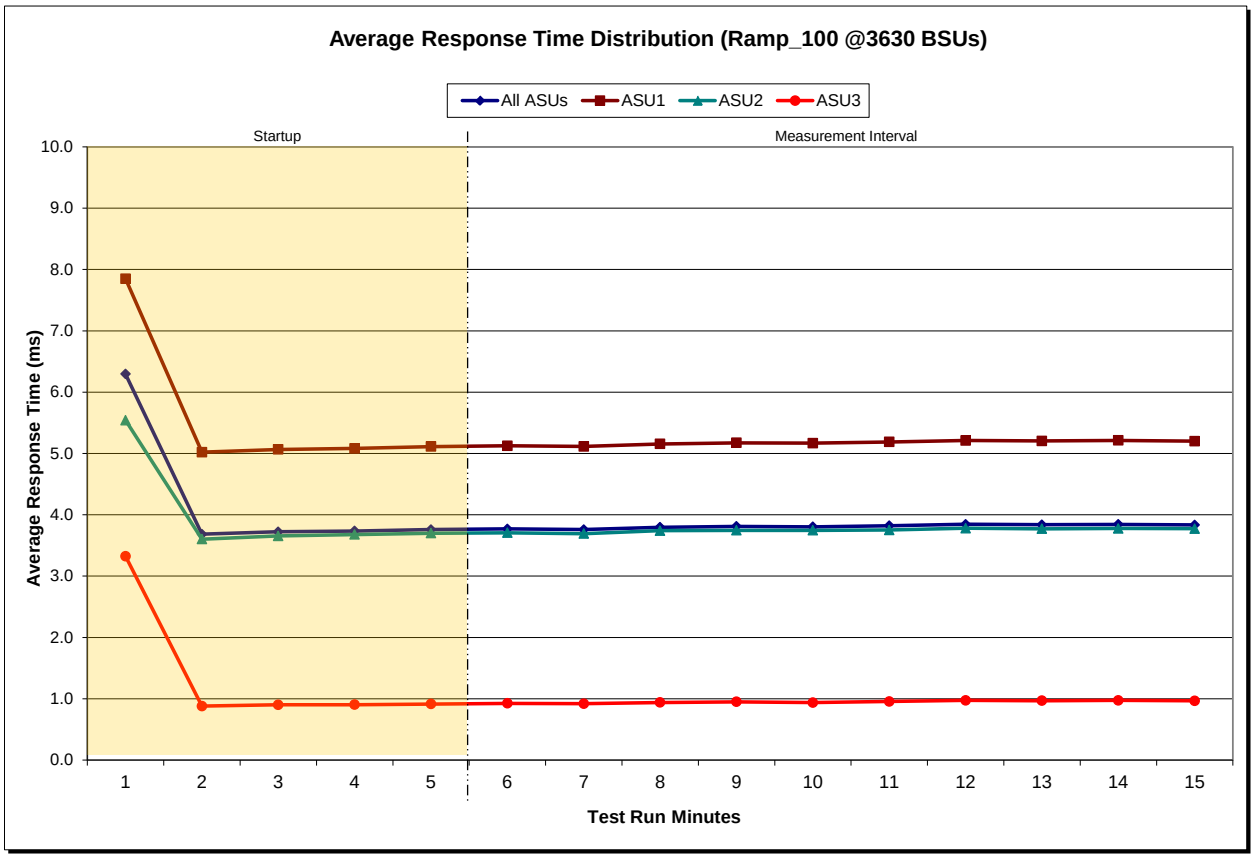


IOPS Test Run – Average Response Time (ms) Distribution Data

3,630 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	1:10:04	1:15:05	0-4	0:05:01
Measurement Interval	1:15:05	1:25:05	5-14	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	6.29	7.85	5.54	3.32
1	3.68	5.02	3.60	0.88
2	3.72	5.07	3.65	0.90
3	3.73	5.08	3.68	0.90
4	3.76	5.11	3.70	0.91
5	3.77	5.12	3.71	0.92
6	3.76	5.11	3.69	0.92
7	3.80	5.16	3.74	0.94
8	3.81	5.17	3.75	0.95
9	3.80	5.17	3.75	0.94
10	3.82	5.19	3.75	0.95
11	3.85	5.21	3.78	0.97
12	3.84	5.20	3.77	0.97
13	3.84	5.21	3.78	0.97
14	3.83	5.20	3.77	0.97
Average	***3.81***	***5.18***	***3.75***	***0.95***

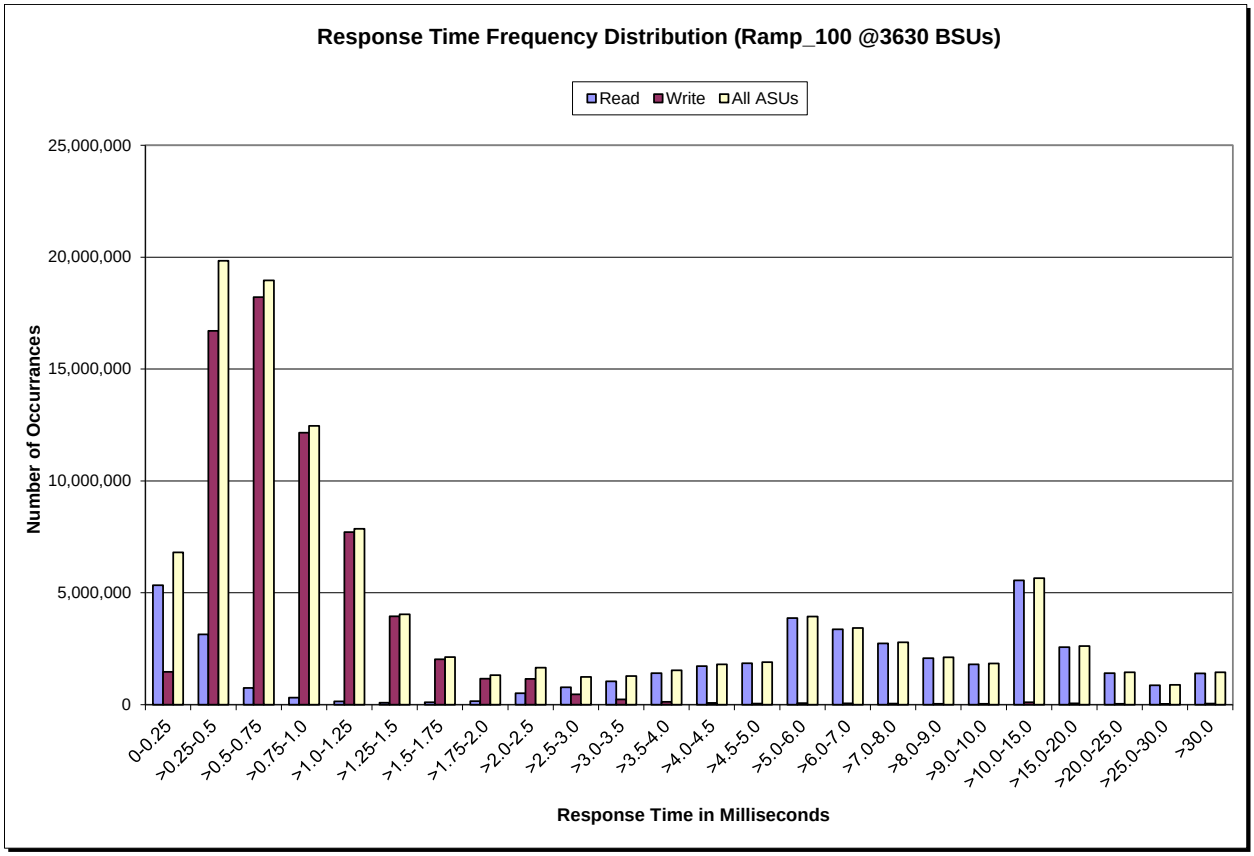
IOPS Test Run – Average Response Time (ms) Distribution Graph



IOPS Test Run –Response Time Frequency Distribution Data

Response Time (ms)	0-0.25	>0.25-0.5	>0.5-0.75	>0.75-1.0	>1.0-1.25	>1.25-1.5	>1.5-1.75	>1.75-2.0
Read	5,339,985	3,137,117	745,035	306,335	147,239	88,376	103,480	157,193
Write	1,460,049	16,702,095	18,215,079	12,148,808	7,713,406	3,942,781	2,023,113	1,159,343
All ASUs	6,800,034	19,839,212	18,960,114	12,455,143	7,860,645	4,031,157	2,126,593	1,316,536
ASU1	4,187,014	9,606,106	8,516,877	5,518,985	3,488,661	1,794,094	960,090	635,374
ASU2	1,974,430	2,581,059	1,943,682	1,270,920	812,988	419,358	216,626	130,733
ASU3	638,590	7,652,047	8,499,555	5,665,238	3,558,996	1,817,705	949,877	550,429
Response Time (ms)	**>2.0-2.5**	**>2.5-3.0**	**>3.0-3.5**	**>3.5-4.0**	**>4.0-4.5**	**>4.5-5.0**	**>5.0-6.0**	**>6.0-7.0**
Read	504,366	777,147	1,042,431	1,405,857	1,722,327	1,846,527	3,863,342	3,368,330
Write	1,150,023	462,863	231,916	123,704	74,609	49,146	68,592	51,080
All ASUs	1,654,389	1,240,010	1,274,347	1,529,561	1,796,936	1,895,673	3,931,934	3,419,410
ASU1	947,536	898,617	1,033,048	1,309,174	1,567,576	1,666,201	3,462,521	3,002,639
ASU2	160,476	120,482	130,064	160,711	192,878	205,035	434,718	390,411
ASU3	546,377	220,911	111,235	59,676	36,482	24,437	34,695	26,360
Response Time (ms)	**>7.0-8.0**	**>8.0-9.0**	**>9.0-10.0**	**>10.0-15.0**	**>15.0-20.0**	**>20.0-25.0**	**>25.0-30.0**	**>30.0**
Read	2,738,080	2,075,565	1,802,785	5,549,798	2,563,845	1,407,410	861,414	1,395,642
Write	41,551	34,574	30,294	104,510	56,647	34,560	21,780	43,944
All ASUs	2,779,631	2,110,139	1,833,079	5,654,308	2,620,492	1,441,970	883,194	1,439,586
ASU1	2,441,750	1,851,228	1,607,544	4,934,092	2,267,584	1,241,041	758,912	1,204,735
ASU2	316,200	240,601	209,110	663,028	320,494	180,607	111,257	206,827
ASU3	21,681	18,310	16,425	57,188	32,414	20,322	13,025	28,024

IOPS Test Run –Response Time Frequency Distribution Graph



IOPS Test Run – I/O Request Information

I/O Requests Completed in the Measurement Interval	I/O Requests Completed with Response Time = or < 30 ms	I/O Requests Completed with Response Time > 30 ms
108,894,093	107,454,507	1,439,586

IOPS Test Run – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

IM – Intensity Multiplier: *The ratio of I/Os for each I/O stream relative to the total I/Os for all I/O streams (ASU1-1 – ASU3-1) as required by the benchmark specification.*

Clauses 5.1.10 and 5.3.15.2

MIM – Measured Intensity Multiplier: *The Measured Intensity Multiplier represents the ratio of measured I/Os for each I/O stream relative to the total I/Os measured for all I/O streams (ASU1-1 – ASU3-1). This value may differ from the corresponding Expected Intensity Multiplier by no more than 5%.*

Clause 5.3.15.3

COV – Coefficient of Variation: *This measure of variation for the Measured Intensity Multiplier cannot exceed 0.2.*

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.350	0.2810
COV	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001

Primary Metrics Test – Response Time Ramp Test Phase

Clause 5.4.4.3

The Response Time Ramp Test Phase consists of five Test Runs, one each at 95%, 90%, 80%, 50%, and 10% of the load point (100%) used to generate the SPC-1 IOPS™ primary metric. Each of the five Test Runs has a Measurement Interval of ten (10) minutes. The Response Time Ramp Test Phase immediately follows the IOPS Test Phase without any interruption or manual intervention.

The five Response Time Ramp Test Runs, in conjunction with the IOPS Test Run (100%), demonstrate the relationship between Average Response Time and I/O Request Throughput for the Tested Storage Configuration (TSC) as illustrated in the response time/throughput curve on page 14.

In addition, the Average Response Time measured during the 10% Test Run is the value for the SPC-1 LRT™ metric. That value represents the Average Response Time of a lightly loaded TSC.

Clause 9.4.3.7.3

The following content shall appear in the FDR for the Response Time Ramp Phase:

1. *A Response Time Ramp Distribution.*
2. *The human readable Test Run Results File produced by the Workload Generator for each Test Run within the Response Time Ramp Test Phase.*
3. *For the 10% Load Level Test Run (SPC-1 LRT™ metric) an Average Response Time Distribution.*
4. *A listing or screen image of all input parameters supplied to the Workload Generator.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in Appendix E: SPC-1 Workload Generator Input Parameters on Page 82.

Response Time Ramp Test Results File

A link to each test result file generated from each Response Time Ramp Test Run list listed below.

95% Load Level

90% Load Level

80% Load Level

50% Load Level

10% Load Level

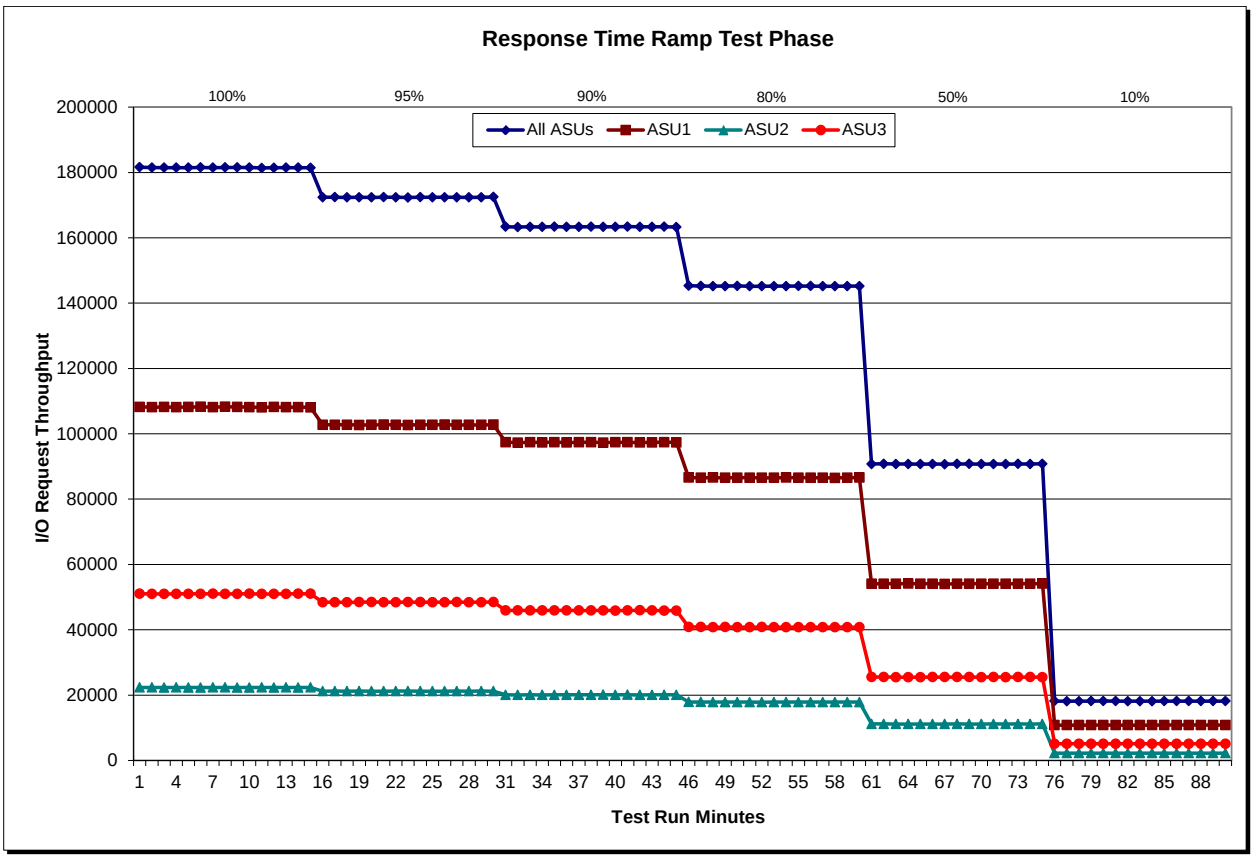
Response Time Ramp Distribution (IOPS) Data

The five Test Runs that comprise the Response Time Ramp Phase are executed at 95%, 90%, 80%, 50%, and 10% of the Business Scaling Unit (BSU) load level used to produce the SPC-1 IOPS™ primary metric. The 100% BSU load level is included in the following Response Time Ramp data table and graph for completeness.

The Response Time Ramp data table is not embedded in this document due to its size. The table is available via the following URL:

100% Load Level - 3,630 BSUs	Start	Stop	Interval	Duration	95% Load Level - 3,448 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	1:10:04	1:15:05	0-4	0:05:01	Start-Up/Ramp-Up	1:25:32	1:30:33	0-4	0:05:01
Measurement Interval	1:15:05	1:25:05	5-14	0:10:00	Measurement Interval	1:30:33	1:40:33	5-14	0:10:00
(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3	*(60 second intervals)*	All ASUs	ASU-1	ASU-2	ASU-3
0	181,603.43	108,220.62	22,360.30	51,022.52	0	172,394.97	102,773.30	21,201.52	48,420.15
1	181,501.83	108,164.28	22,353.90	50,983.65	1	172,422.85	102,766.58	21,227.73	48,428.53
2	181,470.12	108,194.68	22,315.47	50,959.97	2	172,370.38	102,758.65	21,208.23	48,403.50
3	181,475.88	108,156.65	22,336.22	50,983.02	3	172,394.72	102,695.75	21,224.07	48,474.90
4	181,488.63	108,181.53	22,300.67	51,006.43	4	172,388.03	102,711.98	21,188.35	48,487.70
5	181,557.70	108,253.62	22,303.90	51,000.18	5	172,432.55	102,804.43	21,209.32	48,418.80
6	181,499.00	108,147.95	22,331.98	51,019.07	6	172,408.92	102,772.78	21,221.40	48,414.73
7	181,545.78	108,245.97	22,332.77	50,967.05	7	172,349.87	102,677.07	21,223.17	48,449.63
8	181,537.23	108,214.93	22,313.72	51,008.58	8	172,432.27	102,748.92	21,208.43	48,474.92
9	181,502.52	108,171.38	22,300.88	51,030.25	9	172,400.73	102,770.50	21,189.03	48,441.20
10	181,394.95	108,087.97	22,331.37	50,975.62	10	172,407.43	102,800.17	21,188.72	48,418.55
11	181,450.67	108,188.60	22,307.13	50,954.93	11	172,418.67	102,734.23	21,216.75	48,467.68
12	181,491.17	108,132.40	22,354.93	51,003.83	12	172,388.62	102,740.42	21,209.95	48,438.25
13	181,488.02	108,167.70	22,305.70	51,014.62	13	172,395.60	102,736.52	21,219.95	48,439.13
14	181,445.37	108,088.40	22,330.47	51,026.50	14	172,491.50	102,790.53	21,210.97	48,490.00
Average	***181,491.24***	***108,169.89***	***22,321.29***	***51,000.06***	***Average***	***172,412.62***	***102,757.56***	***21,209.77***	***48,445.29***
90% Load Level - 3,267 BSUs	**Start**	**Stop**	**Interval**	**Duration**	**80% Load Level - 2,904 BSUs**	**Start**	**Stop**	**Interval**	**Duration**
Start-Up/Ramp-Up	1:41:01	1:46:02	0-4	0:05:01	Start-Up/Ramp-Up	1:56:29	2:01:30	0-4	0:05:01
Measurement Interval	1:46:02	1:56:02	5-14	0:10:00	Measurement Interval	2:01:30	2:11:30	5-14	0:10:00
(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3	*(60 second intervals)*	All ASUs	ASU-1	ASU-2	ASU-3
0	163,391.62	97,410.13	20,079.92	45,901.57	0	145,349.23	86,604.42	17,890.00	40,854.82
1	163,299.93	97,303.58	20,068.55	45,927.80	1	145,255.87	86,513.30	17,876.53	40,866.03
2	163,351.92	97,381.23	20,085.68	45,885.00	2	145,221.13	86,599.50	17,861.08	40,760.55
3	163,339.25	97,360.93	20,061.53	45,916.78	3	145,214.27	86,536.43	17,846.83	40,831.00
4	163,432.58	97,426.20	20,084.45	45,921.93	4	145,260.35	86,572.92	17,871.63	40,815.80
5	163,344.62	97,322.77	20,092.72	45,929.13	5	145,185.27	86,552.52	17,873.45	40,759.30
6	163,352.35	97,380.42	20,084.88	45,887.05	6	145,190.98	86,527.97	17,835.73	40,827.28
7	163,386.87	97,426.63	20,075.33	45,884.90	7	145,207.40	86,540.42	17,869.20	40,797.78
8	163,348.60	97,293.80	20,130.47	45,924.33	8	145,216.43	86,595.55	17,854.87	40,766.02
9	163,347.92	97,393.45	20,076.40	45,878.07	9	145,227.32	86,562.47	17,868.07	40,796.78
10	163,420.80	97,395.85	20,120.92	45,904.03	10	145,248.52	86,577.03	17,853.55	40,817.93
11	163,365.22	97,322.55	20,068.35	45,974.32	11	145,174.12	86,533.43	17,857.60	40,783.08
12	163,352.55	97,362.40	20,073.92	45,916.23	12	145,164.60	86,484.17	17,862.28	40,818.15
13	163,400.58	97,423.32	20,102.02	45,875.25	13	145,206.70	86,563.48	17,844.22	40,799.00
14	163,285.93	97,343.52	20,075.68	45,866.73	14	145,209.05	86,594.23	17,852.18	40,762.63
Average	***163,360.54***	***97,366.47***	***20,090.07***	***45,904.01***	***Average***	***145,203.04***	***86,553.13***	***17,857.12***	***40,792.80***
50% Load Level - 1,815 BSUs	**Start**	**Stop**	**Interval**	**Duration**	**363**	**Start**	**Stop**	**Interval**	**Duration**
Start-Up/Ramp-Up	2:11:54	2:11:54	0-4	0:00:00	Start-Up/Ramp-Up	0:00:00	0:00:00	0-4	0:00:00
Measurement Interval	2:11:54	2:11:54	5-14	0:00:00	Measurement Interval	0:00:00	0:00:00	5-14	0:00:00
(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3	*(60 second intervals)*	All ASUs	ASU-1	ASU-2	ASU-3
0	90,741.62	54,073.88	11,165.00	25,502.73	0	18,160.42	10,819.17	2,241.83	5,099.42
1	90,806.27	54,104.07	11,163.37	25,538.83	1	18,137.60	10,804.63	2,236.37	5,096.60
2	90,750.38	54,098.65	11,155.08	25,496.65	2	18,141.67	10,811.70	2,233.25	5,096.72
3	90,751.10	54,136.77	11,156.92	25,457.42	3	18,152.77	10,800.28	2,240.57	5,111.92
4	90,724.37	54,093.78	11,146.23	25,484.35	4	18,189.50	10,836.47	2,245.18	5,107.85
5	90,734.82	54,100.32	11,130.52	25,503.98	5	18,156.97	10,817.30	2,228.03	5,111.63
6	90,688.20	54,024.22	11,146.00	25,517.98	6	18,128.88	10,812.08	2,227.50	5,089.30
7	90,765.17	54,071.07	11,167.45	25,526.65	7	18,137.48	10,809.65	2,227.72	5,100.12
8	90,789.82	54,112.08	11,157.53	25,520.20	8	18,134.25	10,805.12	2,227.33	5,101.80
9	90,703.28	54,086.52	11,145.93	25,470.83	9	18,162.68	10,833.68	2,236.32	5,092.68
10	90,760.20	54,053.33	11,170.55	25,536.32	10	18,173.20	10,829.20	2,238.83	5,105.17
11	90,711.23	54,079.68	11,149.37	25,482.18	11	18,163.83	10,827.30	2,235.63	5,100.90
12	90,785.68	54,100.63	11,165.82	25,519.23	12	18,159.63	10,830.30	2,222.98	5,106.35
13	90,744.70	54,090.28	11,149.28	25,505.13	13	18,152.57	10,810.55	2,230.73	5,111.28
14	90,806.90	54,139.50	11,165.63	25,501.77	14	18,166.93	10,837.77	2,239.38	5,089.78
Average	***90,749.00***	***54,085.76***	***11,154.81***	***25,508.43***	***Average***	***18,153.64***	***10,821.30***	***2,231.45***	***5,100.90***

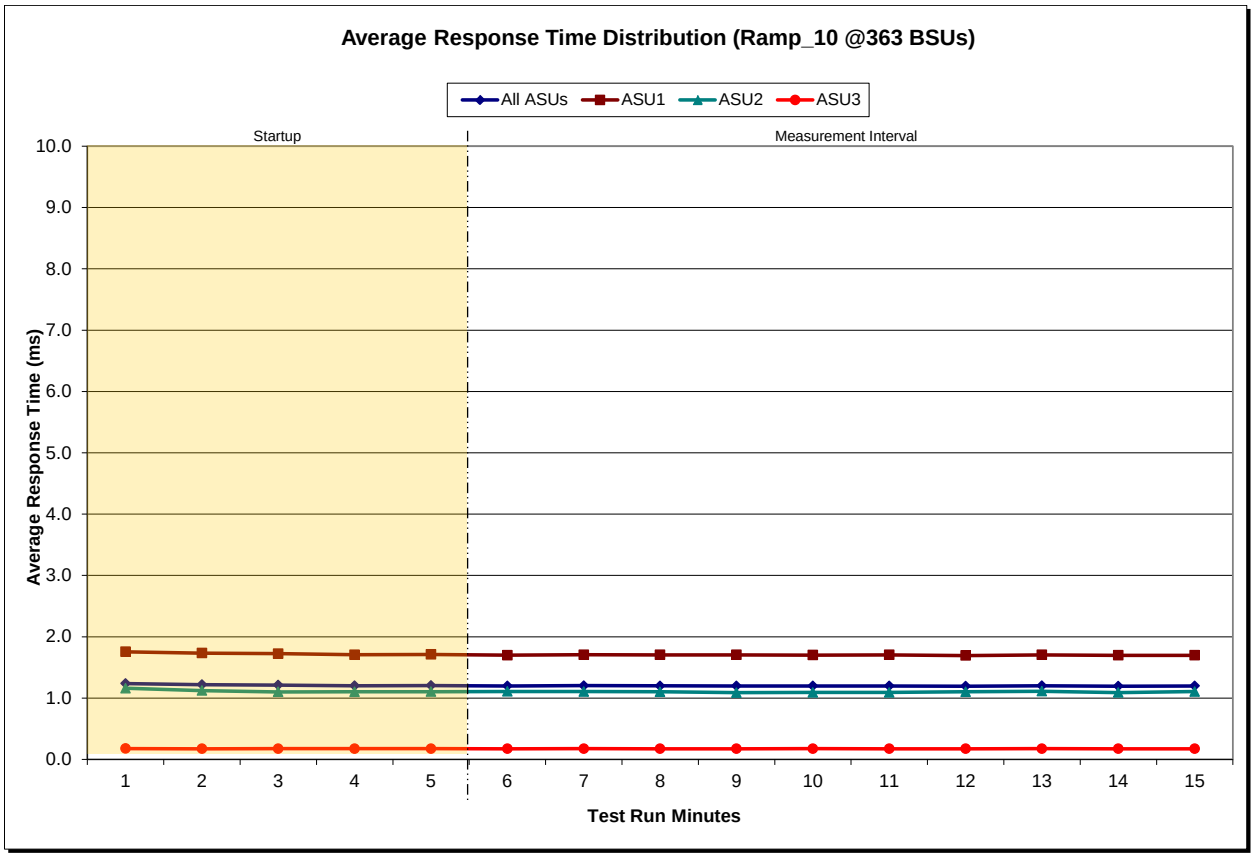
Response Time Ramp Distribution (IOPS) Graph



SPC-1 LRT™ Average Response Time (ms) Distribution Data

363 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	2:27:19	2:32:20	0-4	0:05:01
Measurement Interval	2:32:20	2:42:20	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.24	1.75	1.16	0.18
1	1.22	1.73	1.12	0.17
2	1.21	1.72	1.10	0.17
3	1.20	1.71	1.10	0.18
4	1.20	1.71	1.10	0.17
5	1.20	1.70	1.11	0.17
6	1.20	1.71	1.11	0.17
7	1.20	1.70	1.10	0.17
8	1.20	1.70	1.09	0.17
9	1.20	1.70	1.09	0.18
10	1.20	1.70	1.09	0.17
11	1.19	1.69	1.10	0.17
12	1.20	1.70	1.11	0.18
13	1.19	1.70	1.09	0.17
14	1.20	1.70	1.11	0.17
Average	***1.20***	***1.70***	***1.10***	***0.17***

SPC-1 LRT™ Average Response Time (ms) Distribution Graph



SPC-1 LRT™ (10%) – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

IM – Intensity Multiplier: *The ratio of I/Os for each I/O stream relative to the total I/Os for all I/O streams (ASU1-1 – ASU3-1) as required by the benchmark specification.*

Clauses 5.1.10 and 5.3.15.2

MIM – Measured Intensity Multiplier: *The Measured Intensity Multiplier represents the ratio of measured I/Os for each I/O stream relative to the total I/Os measured for all I/O streams (ASU1-1 – ASU3-1). This value may differ from the corresponding Expected Intensity Multiplier by no more than 5%.*

Clause 5.3.15.3

COV – Coefficient of Variation: *This measure of variation for the Measured Intensity Multiplier cannot exceed 0.2.*

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2811	0.0700	0.2099	0.0180	0.0700	0.0349	0.2810
COV	0.004	0.002	0.004	0.002	0.007	0.004	0.003	0.002

Repeatability Test

Clause 5.4.5

The Repeatability Test demonstrates the repeatability and reproducibility of the SPC-1 IOPS™ primary metric and the SPC-1 LRT™ metric generated in earlier Test Runs.

There are two identical Repeatability Test Phases. Each Test Phase contains two Test Runs. Each of the Test Runs will have a Measurement Interval of no less than ten (10) minutes. The two Test Runs in each Test Phase will be executed without interruption or any type of manual intervention.

The first Test Run in each Test Phase is executed at the 10% load point. The Average Response Time from each of the Test Runs is compared to the SPC-1 LRT™ metric. Each Average Response Time value must be less than the SPC-1 LRT™ metric plus 5% or less than the SPC-1 LRT™ metric plus one (1) millisecond (ms).

The second Test Run in each Test Phase is executed at the 100% load point. The I/O Request Throughput from the Test Runs is compared to the SPC-1 IOPS™ primary metric. Each I/O Request Throughput value must be greater than the SPC-1 IOPS™ primary metric minus 5%. In addition, the Average Response Time for each Test Run cannot exceed 30 milliseconds.

If any of the above constraints are not met, the benchmark measurement is invalid.

Clause 9.4.3.7.4

The following content shall appear in the FDR for each Test Run in the two Repeatability Test Phases:

1. *A table containing the results of the Repeatability Test.*
2. *An I/O Request Throughput Distribution graph and table.*
3. *An Average Response Time Distribution graph and table.*
4. *The human readable Test Run Results File produced by the Workload Generator.*
5. *A listing or screen image of all input parameters supplied to the Workload Generator.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in Appendix E: SPC-1 Workload Generator Input Parameters on Page 82.

Repeatability Test Results File

The values for the SPC-1 IOPS™, SPC-1 LRT™, and the Repeatability Test measurements are listed in the tables below.

	SPC-1 IOPS™
Primary Metrics	***181,491.24***
Repeatability Test Phase 1	181,476.01
Repeatability Test Phase 2	181,464.49

The SPC-1 IOPS™ values in the above table were generated using 100% of the specified Business Scaling Unit (BSU) load level. Each of the Repeatability Test Phase values for SPC-1 IOPS™ must greater than 95% of the reported SPC-1 IOPS™ Primary Metric.

	SPC-1 LRT™
Primary Metrics	***1.20 ms***
Repeatability Test Phase 1	1.19 ms
Repeatability Test Phase 2	1.19 ms

The average response time values in the SPC-1 LRT™ column were generated using 10% of the specified Business Scaling Unit (BSU) load level. Each of the Repeatability Test Phase values for SPC-1 LRT™ must be less than 105% of the reported SPC-1 LRT™ Primary Metric or less than the reported SPC-1 LRT™ Primary Metric minus one (1) millisecond (ms).

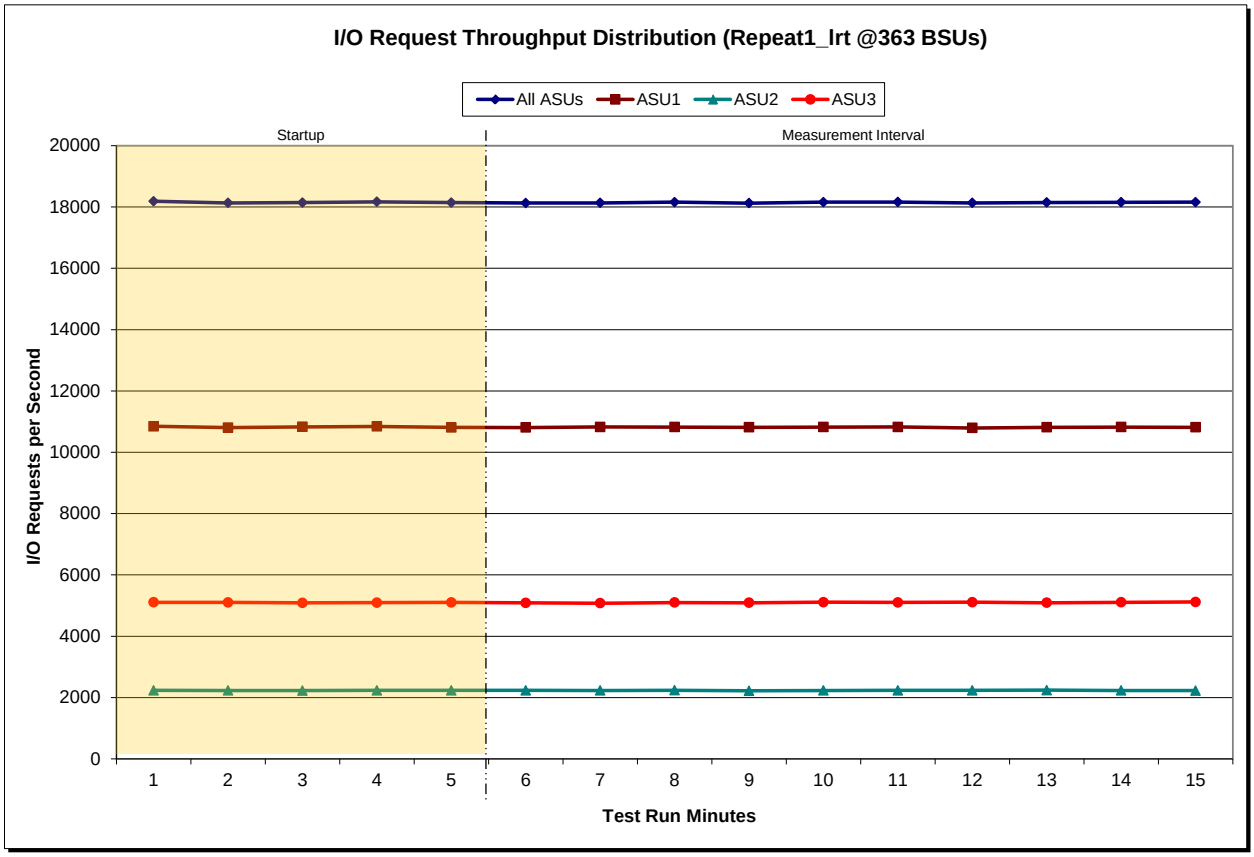
A link to the test result file generated from each Repeatability Test Run is listed below.

Repeatability Test Phase 1, Test Run 1 (LRT)
Repeatability Test Phase 1, Test Run 2 (IOPS)
Repeatability Test Phase 2, Test Run 1 (LRT)
Repeatability Test Phase 2, Test Run 2 (IOPS)

Repeatability 1 LRT – I/O Request Throughput Distribution Data

363 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	2:43:39	2:48:39	0-4	0:05:00
Measurement Interval	2:48:39	2:58:39	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	18,187.25	10,846.78	2,233.50	5,106.97
1	18,132.78	10,804.08	2,228.12	5,100.58
2	18,144.52	10,830.13	2,227.22	5,087.17
3	18,169.42	10,841.52	2,234.32	5,093.58
4	18,142.55	10,808.82	2,232.87	5,100.87
5	18,129.12	10,806.35	2,234.27	5,088.50
6	18,131.88	10,824.07	2,230.42	5,077.40
7	18,157.65	10,820.98	2,238.40	5,098.27
8	18,125.17	10,814.70	2,219.62	5,090.85
9	18,157.05	10,819.90	2,229.62	5,107.53
10	18,160.60	10,824.47	2,233.65	5,102.48
11	18,132.68	10,791.02	2,233.45	5,108.22
12	18,145.82	10,812.27	2,241.22	5,092.33
13	18,155.02	10,821.13	2,230.12	5,103.77
14	18,157.48	10,813.87	2,227.48	5,116.13
Average	***18,145.25***	***10,814.88***	***2,231.82***	***5,098.55***

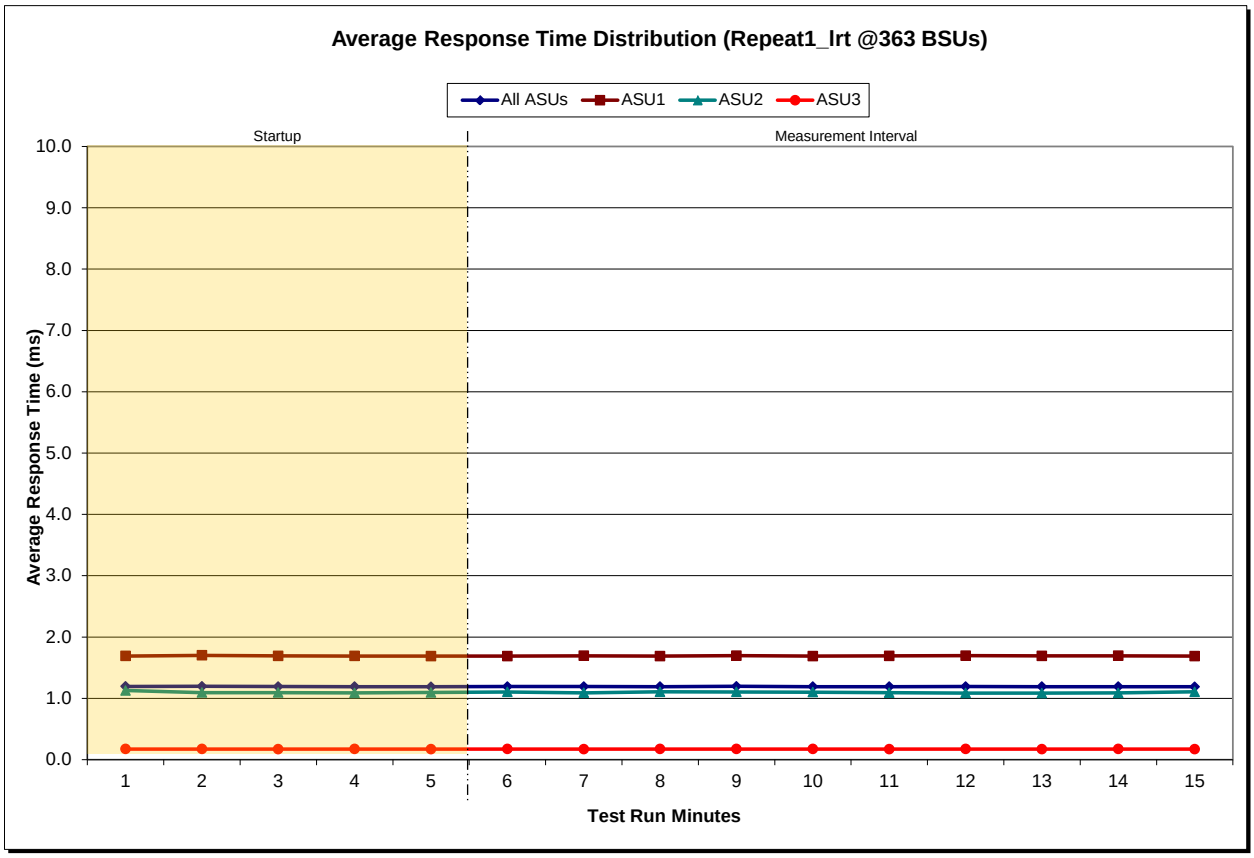
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



Repeatability 1 LRT –Average Response Time (ms) Distribution Data

363 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	2:43:39	2:48:39	0-4	0:05:00
Measurement Interval	2:48:39	2:58:39	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.19	1.69	1.13	0.17
1	1.20	1.70	1.09	0.17
2	1.19	1.69	1.09	0.17
3	1.19	1.69	1.09	0.17
4	1.19	1.69	1.09	0.17
5	1.19	1.69	1.10	0.17
6	1.19	1.69	1.09	0.17
7	1.19	1.69	1.11	0.17
8	1.20	1.70	1.10	0.17
9	1.19	1.69	1.10	0.17
10	1.19	1.69	1.09	0.17
11	1.19	1.70	1.09	0.17
12	1.19	1.69	1.08	0.17
13	1.19	1.69	1.09	0.17
14	1.19	1.69	1.11	0.17
Average	***1.19***	***1.69***	***1.10***	***0.17***

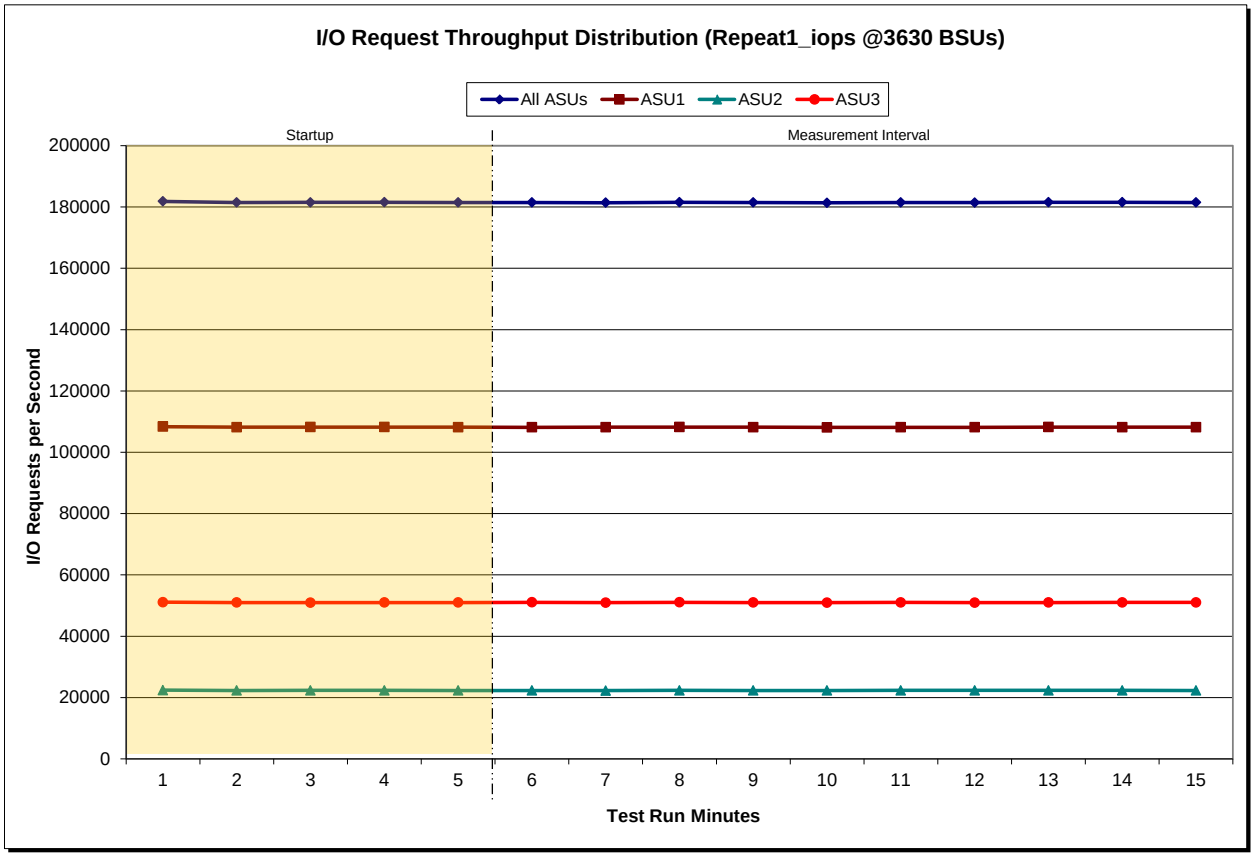
Repeatability 1 LRT –Average Response Time (ms) Distribution Graph



Repeatability 1 IOPS – I/O Request Throughput Distribution Data

3,630 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	2:59:11	3:04:12	0-4	0:05:01
Measurement Interval	3:04:12	3:14:12	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	181,843.03	108,371.68	22,388.10	51,083.25
1	181,468.95	108,175.27	22,297.70	50,995.98
2	181,514.42	108,214.37	22,344.63	50,955.42
3	181,534.55	108,212.03	22,321.88	51,000.63
4	181,464.72	108,183.20	22,287.83	50,993.68
5	181,476.32	108,142.90	22,287.88	51,045.53
6	181,415.78	108,190.02	22,272.42	50,953.35
7	181,563.17	108,194.23	22,316.47	51,052.47
8	181,459.35	108,161.13	22,311.85	50,986.37
9	181,366.90	108,119.35	22,309.88	50,937.67
10	181,476.08	108,140.47	22,323.50	51,012.12
11	181,422.38	108,151.60	22,325.15	50,945.63
12	181,560.78	108,229.87	22,332.80	50,998.12
13	181,542.28	108,181.47	22,325.17	51,035.65
14	181,477.03	108,160.87	22,310.78	51,005.38
Average	***181,476.01***	***108,167.19***	***22,311.59***	***50,997.23***

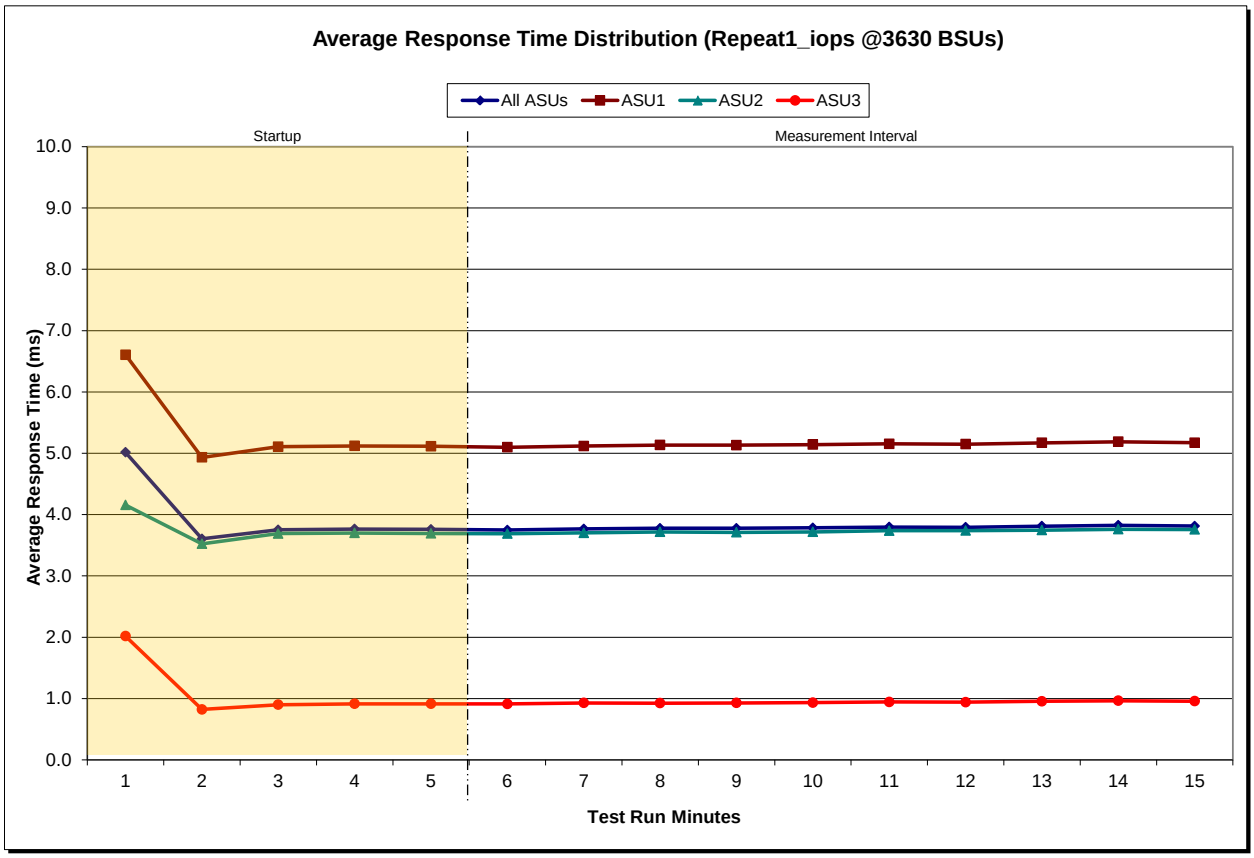
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



Repeatability 1 IOPS –Average Response Time (ms) Distribution Data

3,630 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	2:59:11	3:04:12	0-4	0:05:01
Measurement Interval	3:04:12	3:14:12	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	5.01	6.61	4.16	2.02
1	3.60	4.93	3.52	0.82
2	3.75	5.11	3.69	0.90
3	3.76	5.12	3.70	0.91
4	3.76	5.11	3.69	0.91
5	3.75	5.10	3.69	0.91
6	3.77	5.12	3.70	0.93
7	3.78	5.13	3.72	0.92
8	3.78	5.13	3.71	0.93
9	3.78	5.14	3.72	0.93
10	3.80	5.15	3.74	0.94
11	3.79	5.15	3.74	0.94
12	3.81	5.17	3.75	0.95
13	3.82	5.19	3.76	0.96
14	3.81	5.17	3.76	0.96
Average	***3.79***	***5.15***	***3.73***	***0.94***

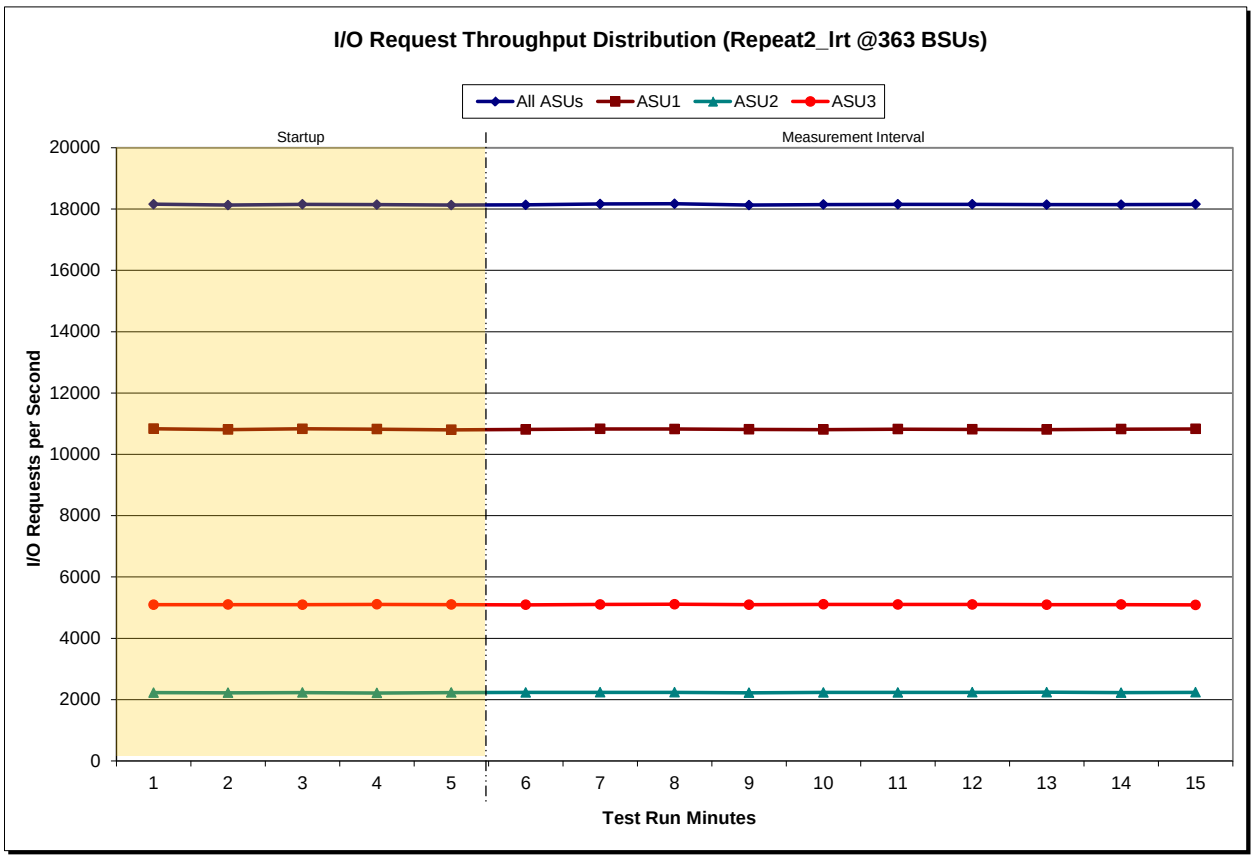
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

363 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	3:15:31	3:20:31	0-4	0:05:00
Measurement Interval	3:20:31	3:30:31	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	18,158.55	10,837.30	2,225.75	5,095.50
1	18,128.42	10,806.42	2,223.85	5,098.15
2	18,154.08	10,831.62	2,229.23	5,093.23
3	18,143.55	10,821.67	2,216.88	5,105.00
4	18,128.47	10,800.70	2,230.52	5,097.25
5	18,135.98	10,809.55	2,233.75	5,092.68
6	18,166.55	10,828.57	2,235.33	5,102.65
7	18,172.27	10,824.90	2,238.12	5,109.25
8	18,130.83	10,813.02	2,224.28	5,093.53
9	18,145.77	10,808.62	2,233.25	5,103.90
10	18,154.55	10,820.20	2,232.22	5,102.13
11	18,154.33	10,814.80	2,237.73	5,101.80
12	18,143.75	10,805.92	2,241.33	5,096.50
13	18,144.73	10,820.23	2,226.73	5,097.77
14	18,154.58	10,827.28	2,238.00	5,089.30
Average	***18,150.34***	***10,817.31***	***2,234.08***	***5,098.95***

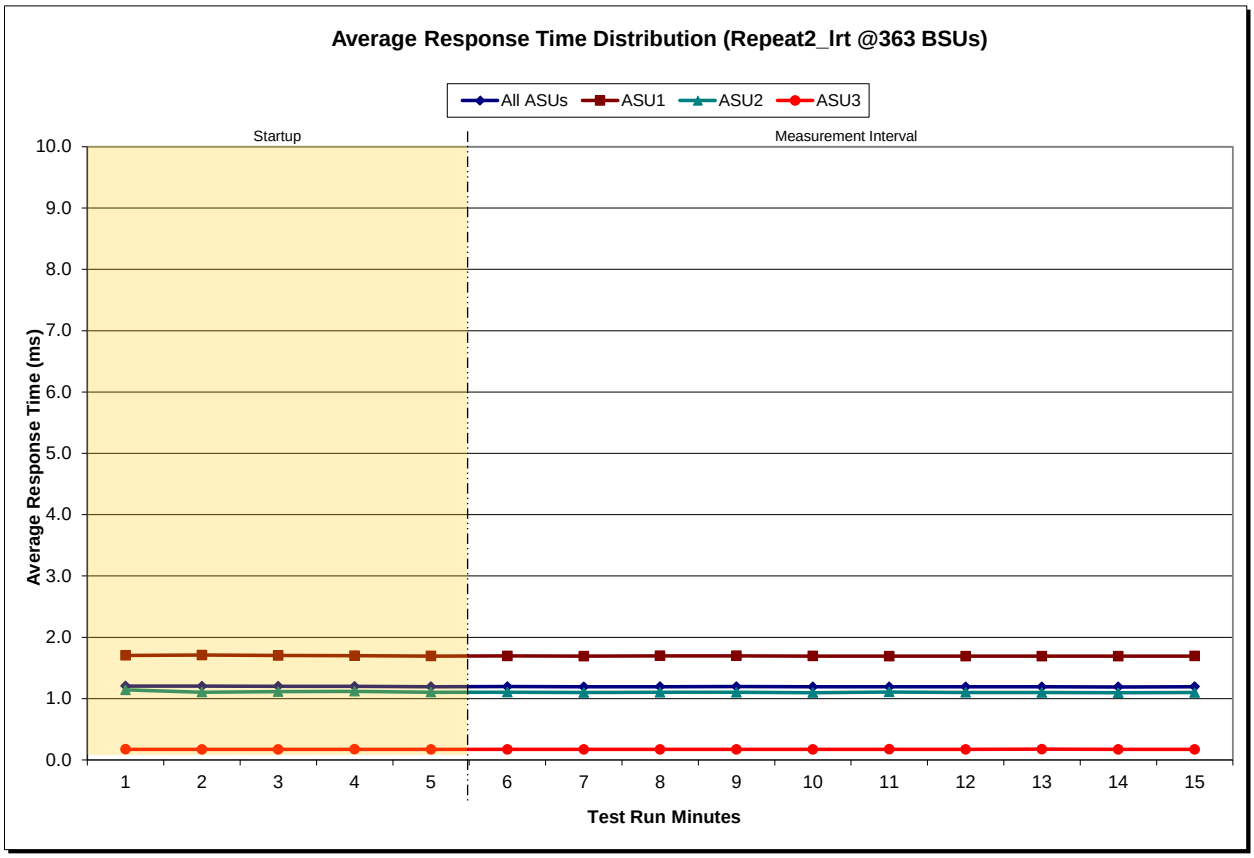
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



Repeatability 2 LRT –Average Response Time (ms) Distribution Data

363 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	3:15:31	3:20:31	0-4	0:05:00
Measurement Interval	3:20:31	3:30:31	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.21	1.70	1.14	0.17
1	1.20	1.71	1.10	0.17
2	1.20	1.70	1.11	0.17
3	1.20	1.70	1.12	0.17
4	1.19	1.69	1.10	0.17
5	1.20	1.70	1.10	0.17
6	1.19	1.69	1.10	0.17
7	1.19	1.70	1.10	0.17
8	1.20	1.70	1.10	0.17
9	1.19	1.69	1.10	0.17
10	1.19	1.69	1.11	0.17
11	1.19	1.69	1.10	0.17
12	1.19	1.69	1.10	0.17
13	1.19	1.69	1.09	0.17
14	1.19	1.69	1.10	0.17
Average	***1.19***	***1.69***	***1.10***	***0.17***

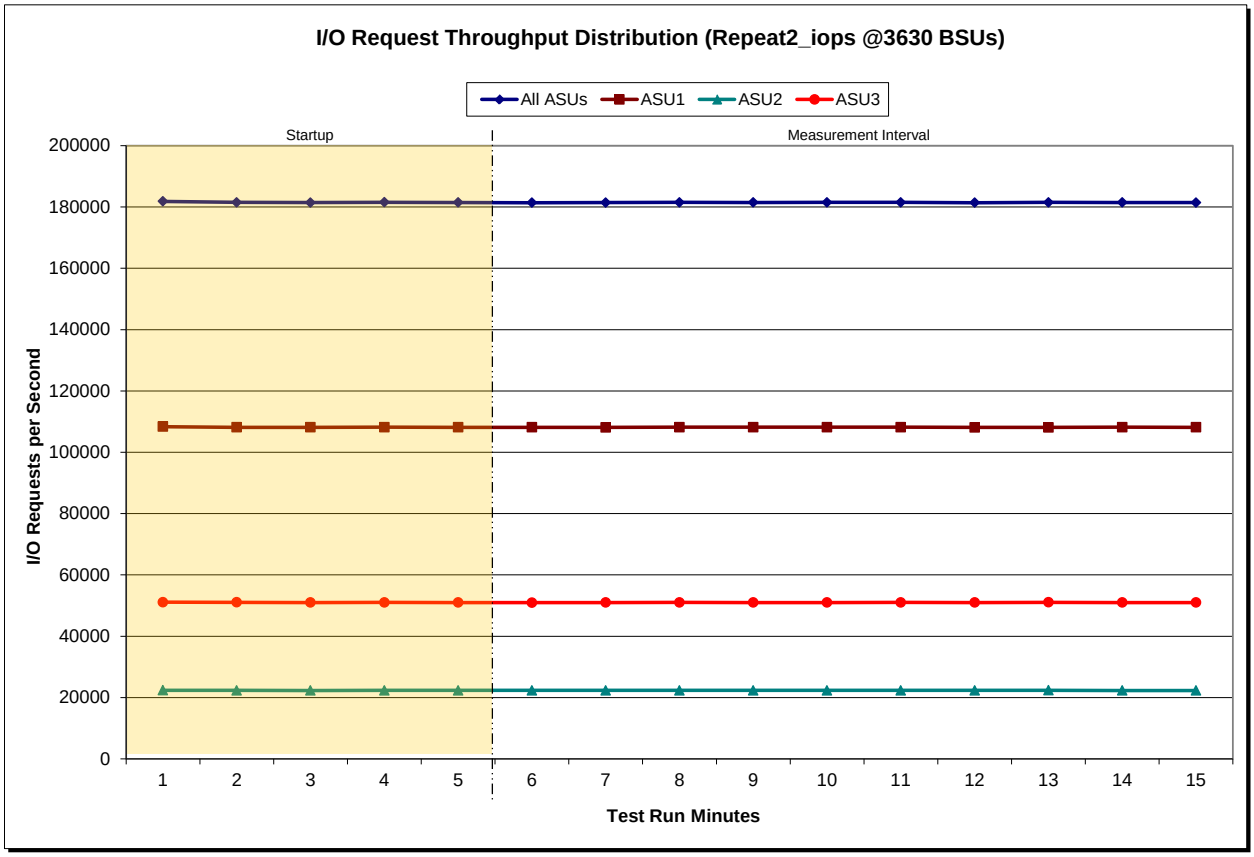
Repeatability 2 LRT –Average Response Time (ms) Distribution Graph



Repeatability 2 IOPS – I/O Request Throughput Distribution Data

3,630 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	3:31:04	3:36:05	0-4	0:05:01
Measurement Interval	3:36:05	3:46:05	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	181,825.77	108,351.73	22,386.43	51,087.60
1	181,526.93	108,151.23	22,324.03	51,051.67
2	181,426.95	108,129.08	22,310.83	50,987.03
3	181,548.17	108,190.03	22,338.13	51,020.00
4	181,465.47	108,155.28	22,316.00	50,994.18
5	181,400.30	108,124.22	22,326.18	50,949.90
6	181,427.88	108,110.37	22,334.40	50,983.12
7	181,503.65	108,172.45	22,324.05	51,007.15
8	181,469.48	108,166.85	22,317.70	50,984.93
9	181,504.30	108,165.27	22,344.12	50,994.92
10	181,510.33	108,171.15	22,323.02	51,016.17
11	181,408.35	108,100.97	22,318.47	50,988.92
12	181,507.18	108,089.77	22,362.72	51,054.70
13	181,484.48	108,178.27	22,308.78	50,997.43
14	181,428.95	108,139.53	22,300.98	50,988.43
Average	***181,464.49***	***108,141.88***	***22,326.04***	***50,996.57***

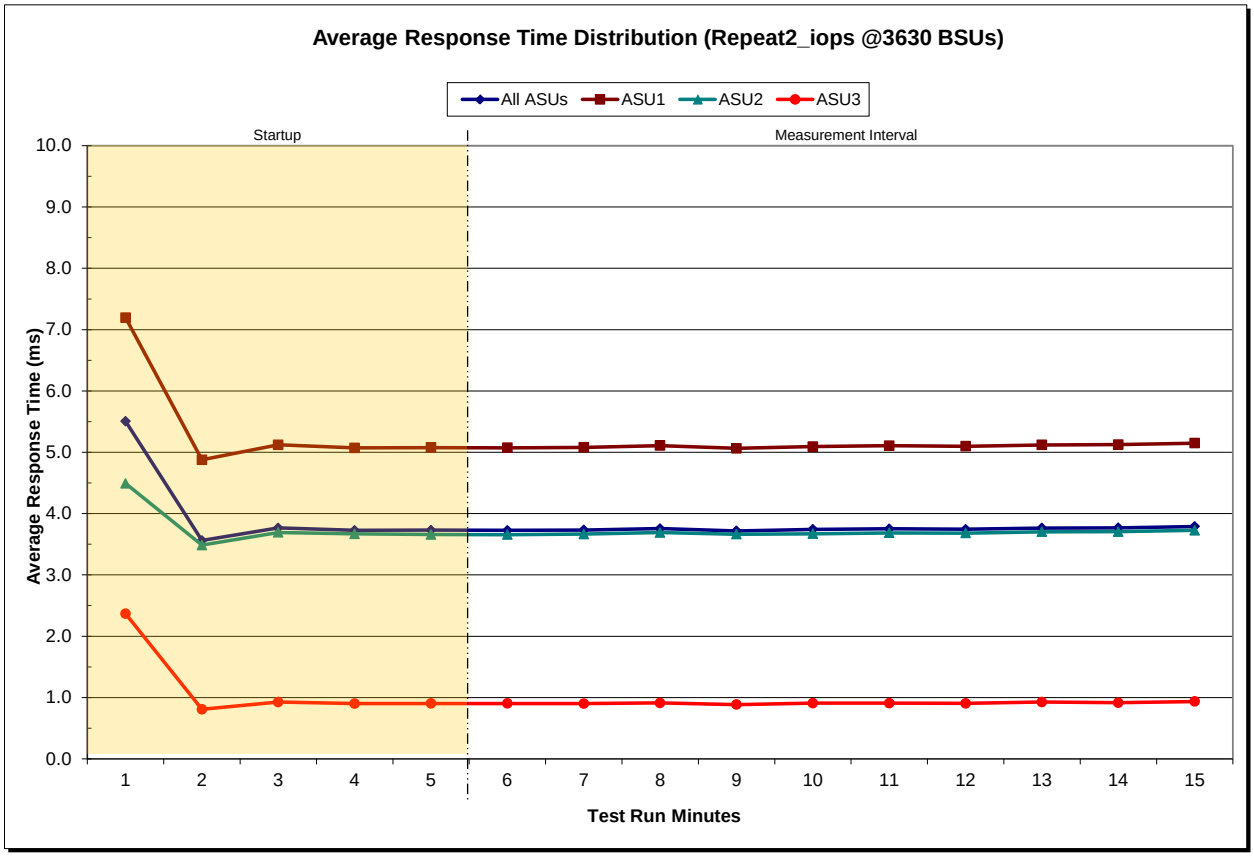
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



Repeatability 2 IOPS –Average Response Time (ms) Distribution Data

3,630 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	3:31:04	3:36:05	0-4	0:05:01
Measurement Interval	3:36:05	3:46:05	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	5.51	7.19	4.49	2.37
1	3.56	4.88	3.49	0.81
2	3.77	5.12	3.69	0.93
3	3.73	5.07	3.67	0.90
4	3.73	5.08	3.66	0.90
5	3.73	5.07	3.66	0.90
6	3.73	5.08	3.67	0.90
7	3.75	5.11	3.69	0.91
8	3.72	5.06	3.66	0.89
9	3.74	5.09	3.67	0.91
10	3.75	5.11	3.69	0.91
11	3.75	5.10	3.68	0.90
12	3.76	5.12	3.70	0.93
13	3.77	5.12	3.70	0.92
14	3.79	5.15	3.73	0.93
Average	***3.75***	***5.10***	***3.68***	***0.91***

Repeatability 2 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 1 (LRT)
Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

IM – Intensity Multiplier: *The ratio of I/Os for each I/O stream relative to the total I/Os for all I/O streams (ASU1-1 – ASU3-1) as required by the benchmark specification.*

Clauses5.1.10 and 5.3.15.2

MIM – Measured Intensity Multiplier: *The Measured Intensity Multiplier represents the ratio of measured I/Os for each I/O stream relative to the total I/Os measured for all I/O streams (ASU1-1 – ASU3-1). This value may differ from the corresponding Expected Intensity Multiplier by no more than 5%.*

Clause 5.3.15.3

COV – Coefficient of Variation: *This measure of variation for the Measured Intensity Multiplier cannot exceed 0.2.*

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0699	0.2101	0.0180	0.0701	0.0350	0.2810
COV	0.004	0.001	0.003	0.002	0.008	0.003	0.008	0.002

Repeatability 1 (IOPS)
Measured Intensity Multiplier and Coefficient of Variation

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
COV	0.001	0.001	0.001	0.001	0.002	0.001	0.002	0.001

Repeatability 2 (LRT)
Measured Intensity Multiplier and Coefficient of Variation

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0351	0.2807	0.0701	0.2101	0.0180	0.0701	0.0350	0.2809
COV	0.007	0.001	0.002	0.002	0.006	0.003	0.006	0.001

Repeatability 2 (IOPS)
Measured Intensity Multiplier and Coefficient of Variation

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0700	0.2099	0.0180	0.0700	0.0350	0.2810
COV	0.002	0.000	0.001	0.001	0.001	0.001	0.001	0.000

Data Persistence Test

Clause 6

The Data Persistence Test demonstrates the Tested Storage Configuration (TSC):

- *Is capable of maintain data integrity across a power cycle.*
- *Ensures the transfer of data between Logical Volumes and host systems occurs without corruption or loss.*

The SPC-1 Workload Generator will write 16 block I/O requests at random over the total Addressable Storage Capacity of the TSC for ten (10) minutes at a minimum of 25% of the load used to generate the SPC-1 IOPS™ primary metric. The bit pattern selected to be written to each block as well as the address of the block will be retained in a log file.

The Tested Storage Configuration (TSC) will be shutdown and restarted using a power off/power on cycle at the end of the above sequence of write operations. In addition, any caches employing battery backup must be flushed/emptied.

The SPC-1 Workload Generator will then use the above log file to verify each block written contains the correct bit pattern.

Clause 9.4.3.8

The following content shall appear in this section of the FDR:

1. *A listing or screen image of all input parameters supplied to the Workload Generator.*
2. *For the successful Data Persistence Test Run, a table illustrating key results. The content, appearance, and format of this table are specified in Table 9-12. Information displayed in this table shall be obtained from the Test Run Results File referenced below in #3.*
3. *For the successful Data Persistence Test Run, the human readable Test Run Results file produced by the Workload Generator (may be contained in an appendix).*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in Appendix E: SPC-1 Workload Generator Input Parameters on Page 82.

Data Persistence Test Results File

A link to each test result file generated from each Data Persistence Test is listed below.

Persistence 1 Test Results File

Persistence 2 Test Results File

Data Persistence Test Results

Data Persistence Test Results	
Data Persistence Test Run Number: 1	
Total Number of Logical Blocks Written	399,503,456
Total Number of Logical Blocks Verified	194,427,920
Total Number of Logical Blocks that Failed Verification	0
Time Duration for Writing Test Logical Blocks	10 minutes
Size in bytes of each Logical Block	512
Number of Failed I/O Requests in the process of the Test	0

In some cases the same address was the target of multiple writes, which resulted in more Logical Blocks Written than Logical Blocks Verified. In the case of multiple writes to the same address, the pattern written and verified must be associated with the last write to that address.

PRICED STORAGE CONFIGURATION AVAILABILITY DATE

Clause 9.4.3.9

The committed delivery data for general availability (Availability Date) of all products that comprise the Priced Storage Configuration must be reported. When the Priced Storage Configuration includes products or components with different availability dates, the reported Availability Date for the Priced Storage Configuration must be the date at which all components are committed to be available.

The Hitachi Unified Storage VM as documented in this Full Disclosure Report iscurrently available for customer purchase and shipment.

PRICING INFORMATION

Clause 9.4.3.3.6

The Executive Summary shall contain a pricing spreadsheet as documented in Clause 8.3.1.

Pricing information may be found in the Priced Storage Configuration Pricing section on page 15.

TESTED STORAGE CONFIGURATION (TSC) AND PRICED STORAGE CONFIGURATION DIFFERENCES

Clause 9.4.3.3.8

The Executive Summary shall contain a list of all differences between the Tested Storage Configuration (TSC) and the Priced Storage Configuration.

A list of all differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration may be found in the Executive Summary portion of this document on page 15.

ANOMALIES OR IRREGULARITIES

Clause 9.4.3.10

The FDR shall include a clear and complete description of any anomalies or irregularities encountered in the course of executing the SPC-1 benchmark that may in any way call into question the accuracy, verifiability, or authenticity of information published in this FDR.

There were no anomalies or irregularities encountered during the SPC-1 Onsite Audit of the Hitachi Unified Storage VM.

APPENDIX A: SPC-1 GLOSSARY

"Decimal" *(powers of ten)* Measurement Units

In the storage industry, the terms "kilo", "mega", "giga", "tera", "peta", and "exa" are commonly used prefixes for computing performance and capacity. For the purposes of the SPC workload definitions, all of the following terms are defined in "powers of ten" measurement units.

A kilobyte (KB) is equal to 1,000 (10^3) bytes.

A megabyte (MB) is equal to 1,000,000 (10^6) bytes.

A gigabyte (GB) is equal to 1,000,000,000 (10^9) bytes.

A terabyte (TB) is equal to 1,000,000,000,000 (10^{12}) bytes.

A petabyte (PB) is equal to 1,000,000,000,000,000 (10^{15}) bytes

An exabyte (EB) is equal to 1,000,000,000,000,000,000 (10^{18}) bytes

"Binary" *(powers of two)* Measurement Units

The sizes reported by many operating system components use "powers of two" measurement units rather than "power of ten" units. The following standardized definitions and terms are also valid and may be used in this document.

A kibibyte (KiB) is equal to 1,024 (2^{10}) bytes.

A mebibyte (MiB) is equal to 1,048,576 (2^{20}) bytes.

A gigibyte (GiB) is equal to 1,073,741,824 (2^{30}) bytes.

A tebibyte (TiB) is equal to 1,099,511,627,776 (2^{40}) bytes.

A pebibyte (PiB) is equal to 1,125,899,906,842,624 (2^{50}) bytes.

An exbibyte (EiB) is equal to 1,152,921,504,606,846,967 (2^{60}) bytes.

SPC-1 Data Repository Definitions

Total ASU Capacity: The total storage capacity read and written in the course of executing the SPC-1 benchmark.

Application Storage Unit (ASU): The logical interface between the storage and SPC-1 Workload Generator. The three ASUs (Data, User, and Log) are typically implemented on one or more Logical Volume.

Logical Volume: The division of Addressable Storage Capacity into individually addressable logical units of storage used in the SPC-1 benchmark. Each Logical Volume is implemented as a single, contiguous address space.

Addressable Storage Capacity: The total storage (sum of Logical Volumes) that can be read and written by application programs such as the SPC-1 Workload Generator.

Configured Storage Capacity: This capacity includes the Addressable Storage Capacity and any other storage (parity disks, hot spares, etc.) necessary to implement the Addressable Storage Capacity.

Physical Storage Capacity: The formatted capacity of all storage devices physically present in the Tested Storage Configuration (TSC).

Data Protection Overhead: The storage capacity required to implement the selected level of data protection.

Required Storage: The amount of Configured Storage Capacity required to implement the Addressable Storage Configuration, excluding the storage required for the three ASUs.

Global Storage Overhead: The amount of Physical Storage Capacity that is required for storage subsystem use and unavailable for use by application programs.

Total Unused Storage: The amount of storage capacity available for use by application programs but not included in the Total ASU Capacity.

SPC-1 Data Protection Levels

Protected 1: The single point of failure of any ***storage device*** in the configuration will not result in permanent loss of access to or integrity of the SPC-1 Data Repository.

Protected 2: The single point of failure of any ***component*** in the configuration will not result in permanent loss of access to or integrity of the SPC-1 Data Repository.

SPC-1 Test Execution Definitions

Average Response Time: The sum of the Response Times for all Measured I/O Requests divided by the total number of Measured I/O Requests.

Completed I/O Request: An I/O Request with a Start Time and a Completion Time (see "I/O Completion Types" below).

Completion Time: The time recorded by the Workload Generator when an I/O Request is satisfied by the TSC as signaled by System Software.

Data Rate: The data transferred in all Measured I/O Requests in an SPC-1 Test Run divided by the length of the Test Run in seconds.

Expected I/O Count: For any given I/O Stream and Test Phase, the product of 50 times the BSU level, the duration of the Test Phase in seconds, and the Intensity Multiplier for that I/O Stream.

Failed I/O Request: Any I/O Request issued by the Workload Generator that could not be completed or was signaled as failed by System Software. A Failed I/O Request has no Completion Time (see "I/O Completion Types" below).

I/O Request Throughput: The total number of Measured I/O requests in an SPC-1 Test Run divided by the duration of the Measurement Interval in seconds.

In-Flight I/O Request: An I/O Request issued by the I/O Command Generator to the TSC that has a recorded Start Time, but does not complete within the Measurement Interval (see "I/O Completion Types" below).

Measured I/O Request: A Completed I/O Request with a Completion Time occurring within the Measurement Interval (see "I/O Completion Types" below).

Measured Intensity Multiplier: The percentage of all Measured I/O Requests that were issued by a given I/O Stream.

Measurement Interval: The finite and contiguous time period, after the TSC has reached Steady State, when data is collected by a Test Sponsor to generate an SPC-1 test result or support an SPC-1 test result.

Ramp-Up: The time required for the Benchmark Configuration (BC) to produce Steady State throughput after the Workload Generator begins submitting I/O Requests to the TSC for execution.

Ramp-Down: The time required for the BC to complete all I/O Requests issued by the Workload Generator. The Ramp-Down period begins when the Workload Generator ceases to issue new I/O Requests to the TSC.

Response Time: The Response Time of a Measured I/O Request is its Completion Time minus its Start Time.

Start Time: The time recorded by the Workload Generator when an I/O Request is submitted, by the Workload Generator, to the System Software for execution on the Tested Storage Configuration (TSC).

Start-Up: The period that begins after the Workload Generator starts to submit I/O requests to the TSC and ends at the beginning of the Measurement Interval.

Shut-Down: The period between the end of the Measurement Interval and the time when all I/O Requests issued by the Workload Generator have completed or failed.

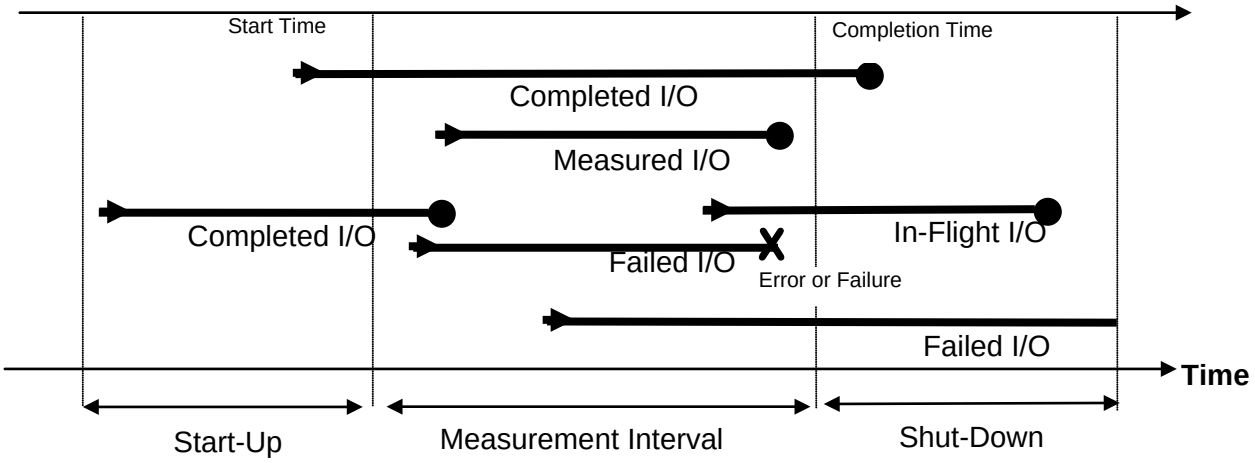
Steady State: The consistent and sustainable throughput of the TSC. During this period the load presented to the TSC by the Workload Generator is constant.

Test: A collection of Test Phases and or Test Runs sharing a common objective.

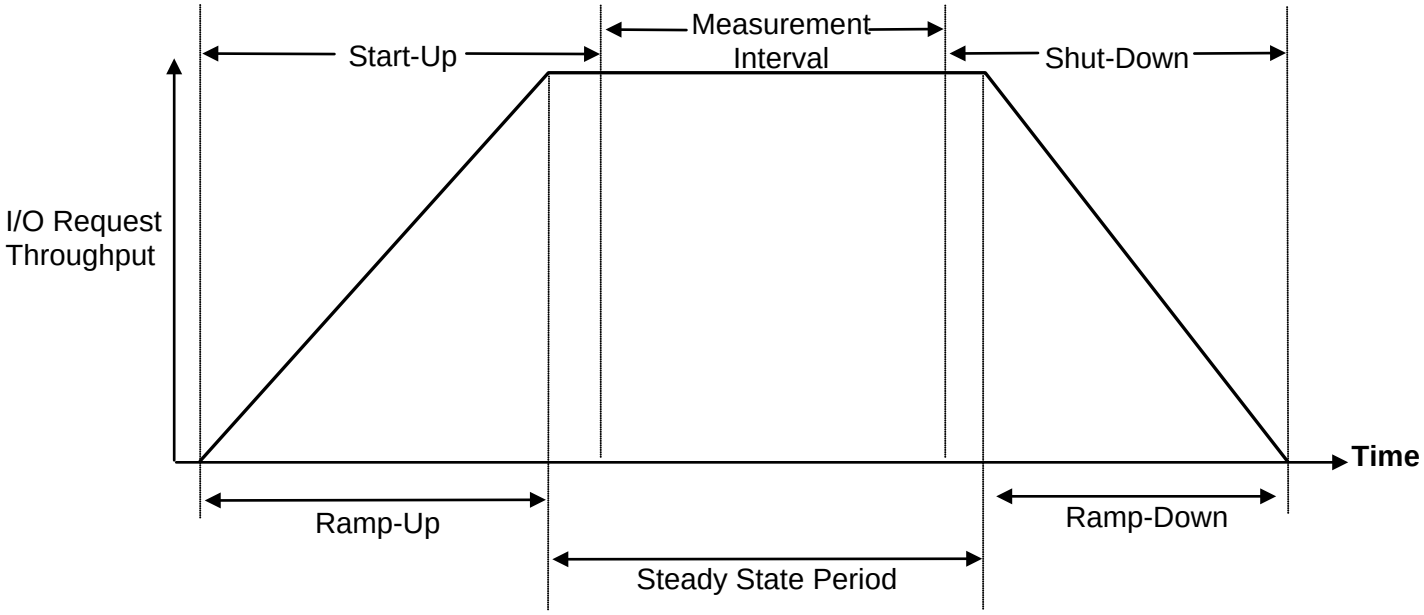
Test Run: The execution of SPC-1 for the purpose of producing or supporting an SPC-1 test result. SPC-1 Test Runs may have a finite and measured Ramp-Up period, Start-Up period, Shut-Down period, and Ramp-Down period as illustrated in the "SPC-1 Test Run Components" below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.

Test Phase: A collection of one or more SPC-1 Test Runs sharing a common objective and intended to be run in a specific sequence.

I/O Completion Types



SPC-1 Test Run Components



APPENDIX B: CUSTOMER TUNABLE PARAMETERS AND OPTIONS

Red Hat Enterprise Linux 6.3 (64-bit)

The I/O scheduler was changed from the default of **cfq** to **noop** on each Host System, which will result in all incoming I/O request to be inserted into a simple, unordered FIFO queue.

Emulex HBAs

Each Emulex HBA had the driver queue-depth changed from a default of 32 to 16 for all HBA ports.

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

1. Initial Installation and Configuration – Customer Support Engineer

The initial installation and configuration of the Hitachi Unified Storage VM is typically done by a customer support engineer. That initial installation and configuration was completed according to the following diagram:

	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Tray-27																								
Tray-26	PG	PG	PG	PG	PG	PG	PG	PG																
Tray-25	5-17	5-18	5-19	5-20	5-21	5-22	5-23	5-24																
Tray-24																								
Tray-23																								
Tray-22	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG
Tray-21	4-25	4-26	4-27	4-28	4-29	4-30	4-31	4-32	5-1	5-2	5-3	5-4	5-5	5-6	5-7	5-8	5-9	5-10	5-11	5-12	5-13	5-14	5-15	5-16
Tray-20																								
Tray-19																								
Tray-18	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG
Tray-17	4-1	4-2	4-3	4-4	4-5	4-6	4-7	4-8	4-9	4-10	4-11	4-12	4-13	4-14	4-15	4-16	4-17	4-18	4-19	4-20	4-21	4-22	4-23	4-24
Tray-16																								
Tray-15																								
Tray-14	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG
Tray-13	3-9	3-10	3-11	3-12	3-13	3-14	3-15	3-16	3-17	3-18	3-19	3-20	3-21	3-22	3-23	3-24	3-25	3-26	3-27	3-28	3-29	3-30	3-31	3-32
Tray-12																								
Tray-11																								
Tray-10	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG
Tray-09	2-17	2-18	2-19	2-20	2-21	2-22	2-23	2-24	2-25	2-26	2-27	2-28	2-29	2-30	2-31	2-32	3-1	3-2	3-3	3-4	3-5	3-6	3-7	3-8
Tray-08																								
Tray-07																								
Tray-06	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG
Tray-05	1-25	1-26	1-27	1-28	1-29	1-30	1-31	1-32	2-1	2-2	2-3	2-4	2-5	2-6	2-7	2-8	2-9	2-10	2-11	2-12	2-13	2-14	2-15	2-16
Tray-04																								
Tray-03																								
Tray-02	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG	PG
Tray-01	1-1	1-2	1-3	1-4	1-5	1-6	1-7	1-8	1-9	1-10	1-11	1-12	1-13	1-14	1-15	1-16	1-17	1-18	1-19	1-20	1-21	1-22	1-23	1-24
Tray-00																								

Each set of four disks represents a physical RAID-10 (2D+2D) Parity Group. Each pair of adjacent Parity Groups is then combined to form a single logical RAID-10 (4D+4D) Parity Group with the logical identifier highlighted in bold red type. Each underlying physical Parity Group is also known as a Free Space, from which Logical Devices will be created.

2. Create Logical Devices

Mount the "Hitachi Command Control Interface Software" CD-ROM on one of the Host Systems. As the root user, unpack the contents of the RMHORC archive, where **/media/HS042_52** is the mount point for the CD-ROM, as follows:

```
cd /
cpio -idmu < /media/HS042_52/LINUX/X64/RMHORC
```

Change to the HORCM directory and execute the installer script as follows:

```
cd /HORCM
./horcminstall.sh
```

Edit the **/etc/horcm.conf** file, replacing the sample contents with the following, where 192.168.100.100 is the IP address of the storage array's service processor:

```
HORCM_MON
localhost      11099          1000          3000

HORCM_CMD
\\.\IPCMD-192.168.100.100-31001
```

Start the Hitachi RAID Manager CLI by executing the following command:

```
/usr/bin/horcmstart.sh
```

Execute the **ldevcreate.sh** RAID Manager CLI script to create 228 Logical Devices.

3. Format Logical Devices

Format the Logical Devices by executing the **ldevformat.sh** RAID Manager CLI script.

4. Map Logical Devices to Host Ports

After the formatting of the Logical Devices is finished, map them to host ports by executing the **lunmap.sh** RAID Manager CLI script.

5. Modify RHEL I/O Scheduler

Change the I/O scheduler from the default of ***cfq*** to ***noop*** on each Host System, which will result in all incoming I/O requests inserted into a simple, unordered FIFO queue. This was done by adding the following parameter in **/boot/grub/grub.conf** file at the end of the kernel line on each Host System.

```
elevator=noop
```

6. Change Emulex HBA Queue Depth

Change the Emulex HBA driver queue depth from a default of 32 to 16 on all HBA Ports by executing the following CLI commands on each Host System:

```
hbacmd setdriverparam <WWPN> I p lun-queue-depth 16
```

The values for **<WWPN>** are available from the output of the following command:

```
hbacmd listhbas local m=lpe12002* | grep 'Port WWN'
```

7. Reboot Host Systems

In order to make the changes in #5 and #6 effective, the Host Systems must be rebooted.

8. Initialize LVM Physical Volumes

Verify that the **lsscsi** package is installed and that the ***lsscsi*** command is available. Execute the **pvcreate.sh** script on one of the Host Systems to initialize all LUNs and make

them visible to LVM as Physical Volumes. The other Host System will automatically detect the configuration changes.

If the **lsscsi** package is not installed, the package can be found on the RHEL Server 6.3 x86_64 installation media at ***/Packages/lsscsi-0.23-2.el6.x86_64.rpm*** and installed using the ***rpm -i*** command.

9. Create LVM Volume Groups

Execute the **vgcreate.sh** script on one of the Host Systems to create three Volume Groups, one each for ASU-1, ASU-2, and ASU-3. The other Host System will automatically detect the configuration changes.

The script first generates a sorted LUN mapping table that lists the storage array **CU:LDEV** identifier **(LDEV ID)** along with the Linux device name. It then creates the three Volume Groups using the Linux device names taken from the LUN mapping table, where the **LDEV ID**s 01:00 - 01:4B are the Physical Volumes for the ASU-1 Volume Group, 02:00 - 02:4B are the Physical Volumes for the ASU-2 Volume Group, and 03:00 - 03:4B are the Physical Volumes for the ASU-3 Volume Group. The default Physical Extent (PE) size of 4 MiB is used.

10. Create LVM Logical Volumes

Execute the **lvcreate.sh** script, on one of the Host Systems, to create a total of 9 Logical Volumes according to the following:

4 Logical Volumes for ASU-1, each using the parameters

- ***-l 1409952*** *(number of logical extents)*
- ***-i 76*** *(number of stripes)*
- ***-I 4M*** *(stripe size in MiB)*
- ***-n*** *(name of the Logical Volume)*

4 Logical Volumes for ASU-2, each using the parameters

- ***-l 1409952*** *(number of logical extents)*
- ***-i 76*** *(number of stripes)*
- ***-I 4M*** *(stripe size in MiB)*
- ***-n*** *(name of the Logical Volume)*

1 Logical Volume for ASU-3, using the parameters

- ***-l 1253240*** *(number of logical extents)*
- ***-i 76*** *(number of stripes)*
- ***-I 4M*** *(stripe size in MiB)*
- ***-n*** *(name of the Logical Volume)*

The LVM software on the other Host System will automatically detect the configuration changes.

11. Verify LVM Logical Volume Availability

On each Host System, verify that the LVM Logical Volumes are available by executing the following CLI command:

lvs | grep lvasu

The expected output is shown below

```
lvasu11 vgasu1  -wi-a---   5.38t
lvasu12 vgasu1  -wi-a---   5.38t
lvasu13 vgasu1  -wi-a---   5.38t
lvasu14 vgasu1  -wi-a---   5.38t
lvasu21 vgasu2  -wi-a---   5.38t
lvasu22 vgasu2  -wi-a---   5.38t
lvasu23 vgasu2  -wi-a---   5.38t
lvasu24 vgasu2  -wi-a---   5.38t
lvasu31 vgasu3  -wi-a---   4.78t
```

If any Logical Volumes are missing the ***"a"*** attribute and are hence not available, issue the following command for each of them:

lvchange -ay /dev/<VGNAME>/<LVNAME>

The value for ***<VGNAME>*** is the name of the Volume Group in column #2 of the ***lvs*** command output. The value for ***<LVNAME>*** is the name of the Logical Volume in column #1 of the ***lvs*** command output

TSC Creation/Configuration Scripts

ldevcreate.sh

```
raidcom add ldev -parity_grp_id 1-1  -ldev_id 03:00 -capacity 135092184
raidcom add ldev -parity_grp_id 1-1  -ldev_id 02:00 -capacity 607914828
raidcom add ldev -parity_grp_id 1-2  -ldev_id 01:00 -capacity 607914828
raidcom add ldev -parity_grp_id 1-3  -ldev_id 03:01 -capacity 135092184
raidcom add ldev -parity_grp_id 1-3  -ldev_id 02:01 -capacity 607914828
raidcom add ldev -parity_grp_id 1-4  -ldev_id 01:01 -capacity 607914828
raidcom add ldev -parity_grp_id 1-5  -ldev_id 03:02 -capacity 135092184
raidcom add ldev -parity_grp_id 1-5  -ldev_id 02:02 -capacity 607914828
raidcom add ldev -parity_grp_id 1-6  -ldev_id 01:02 -capacity 607914828
raidcom add ldev -parity_grp_id 1-7  -ldev_id 03:03 -capacity 135092184
raidcom add ldev -parity_grp_id 1-7  -ldev_id 02:03 -capacity 607914828
raidcom add ldev -parity_grp_id 1-8  -ldev_id 01:03 -capacity 607914828
raidcom add ldev -parity_grp_id 1-9  -ldev_id 03:04 -capacity 135092184
raidcom add ldev -parity_grp_id 1-9  -ldev_id 02:04 -capacity 607914828
raidcom add ldev -parity_grp_id 1-10 -ldev_id 01:04 -capacity 607914828
raidcom add ldev -parity_grp_id 1-11 -ldev_id 03:05 -capacity 135092184
raidcom add ldev -parity_grp_id 1-11 -ldev_id 02:05 -capacity 607914828
raidcom add ldev -parity_grp_id 1-12 -ldev_id 01:05 -capacity 607914828
raidcom add ldev -parity_grp_id 1-13 -ldev_id 03:06 -capacity 135092184
raidcom add ldev -parity_grp_id 1-13 -ldev_id 02:06 -capacity 607914828
raidcom add ldev -parity_grp_id 1-14 -ldev_id 01:06 -capacity 607914828
raidcom add ldev -parity_grp_id 1-15 -ldev_id 03:07 -capacity 135092184
raidcom add ldev -parity_grp_id 1-15 -ldev_id 02:07 -capacity 607914828
raidcom add ldev -parity_grp_id 1-16 -ldev_id 01:07 -capacity 607914828
raidcom add ldev -parity_grp_id 1-17 -ldev_id 03:08 -capacity 135092184
raidcom add ldev -parity_grp_id 1-17 -ldev_id 02:08 -capacity 607914828
raidcom add ldev -parity_grp_id 1-18 -ldev_id 01:08 -capacity 607914828
raidcom add ldev -parity_grp_id 1-19 -ldev_id 03:09 -capacity 135092184
```

```
raidcom add ldev -parity_grp_id 1-19 -ldev_id 02:09 -capacity 607914828
raidcom add ldev -parity_grp_id 1-20 -ldev_id 01:09 -capacity 607914828
raidcom add ldev -parity_grp_id 1-21 -ldev_id 03:0A -capacity 135092184
raidcom add ldev -parity_grp_id 1-21 -ldev_id 02:0A -capacity 607914828
raidcom add ldev -parity_grp_id 1-22 -ldev_id 01:0A -capacity 607914828
raidcom add ldev -parity_grp_id 1-23 -ldev_id 03:0B -capacity 135092184
raidcom add ldev -parity_grp_id 1-23 -ldev_id 02:0B -capacity 607914828
raidcom add ldev -parity_grp_id 1-24 -ldev_id 01:0B -capacity 607914828
raidcom add ldev -parity_grp_id 1-25 -ldev_id 03:0C -capacity 135092184
raidcom add ldev -parity_grp_id 1-25 -ldev_id 02:0C -capacity 607914828
raidcom add ldev -parity_grp_id 1-26 -ldev_id 01:0C -capacity 607914828
raidcom add ldev -parity_grp_id 1-27 -ldev_id 03:0D -capacity 135092184
raidcom add ldev -parity_grp_id 1-27 -ldev_id 02:0D -capacity 607914828
raidcom add ldev -parity_grp_id 1-28 -ldev_id 01:0D -capacity 607914828
raidcom add ldev -parity_grp_id 1-29 -ldev_id 03:0E -capacity 135092184
raidcom add ldev -parity_grp_id 1-29 -ldev_id 02:0E -capacity 607914828
raidcom add ldev -parity_grp_id 1-30 -ldev_id 01:0E -capacity 607914828
raidcom add ldev -parity_grp_id 1-31 -ldev_id 03:0F -capacity 135092184
raidcom add ldev -parity_grp_id 1-31 -ldev_id 02:0F -capacity 607914828
raidcom add ldev -parity_grp_id 1-32 -ldev_id 01:0F -capacity 607914828
raidcom add ldev -parity_grp_id 2-1  -ldev_id 03:10 -capacity 135092184
raidcom add ldev -parity_grp_id 2-1  -ldev_id 02:10 -capacity 607914828
raidcom add ldev -parity_grp_id 2-2  -ldev_id 01:10 -capacity 607914828
raidcom add ldev -parity_grp_id 2-3  -ldev_id 03:11 -capacity 135092184
raidcom add ldev -parity_grp_id 2-3  -ldev_id 02:11 -capacity 607914828
raidcom add ldev -parity_grp_id 2-4  -ldev_id 01:11 -capacity 607914828
raidcom add ldev -parity_grp_id 2-5  -ldev_id 03:12 -capacity 135092184
raidcom add ldev -parity_grp_id 2-5  -ldev_id 02:12 -capacity 607914828
raidcom add ldev -parity_grp_id 2-6  -ldev_id 01:12 -capacity 607914828
raidcom add ldev -parity_grp_id 2-7  -ldev_id 03:13 -capacity 135092184
raidcom add ldev -parity_grp_id 2-7  -ldev_id 02:13 -capacity 607914828
raidcom add ldev -parity_grp_id 2-8  -ldev_id 01:13 -capacity 607914828
raidcom add ldev -parity_grp_id 2-9  -ldev_id 03:14 -capacity 135092184
raidcom add ldev -parity_grp_id 2-9  -ldev_id 02:14 -capacity 607914828
raidcom add ldev -parity_grp_id 2-10 -ldev_id 01:14 -capacity 607914828
raidcom add ldev -parity_grp_id 2-11 -ldev_id 03:15 -capacity 135092184
raidcom add ldev -parity_grp_id 2-11 -ldev_id 02:15 -capacity 607914828
raidcom add ldev -parity_grp_id 2-12 -ldev_id 01:15 -capacity 607914828
raidcom add ldev -parity_grp_id 2-13 -ldev_id 03:16 -capacity 135092184
raidcom add ldev -parity_grp_id 2-13 -ldev_id 02:16 -capacity 607914828
raidcom add ldev -parity_grp_id 2-14 -ldev_id 01:16 -capacity 607914828
raidcom add ldev -parity_grp_id 2-15 -ldev_id 03:17 -capacity 135092184
raidcom add ldev -parity_grp_id 2-15 -ldev_id 02:17 -capacity 607914828
raidcom add ldev -parity_grp_id 2-16 -ldev_id 01:17 -capacity 607914828
raidcom add ldev -parity_grp_id 2-17 -ldev_id 03:18 -capacity 135092184
raidcom add ldev -parity_grp_id 2-17 -ldev_id 02:18 -capacity 607914828
raidcom add ldev -parity_grp_id 2-18 -ldev_id 01:18 -capacity 607914828
raidcom add ldev -parity_grp_id 2-19 -ldev_id 03:19 -capacity 135092184
raidcom add ldev -parity_grp_id 2-19 -ldev_id 02:19 -capacity 607914828
raidcom add ldev -parity_grp_id 2-20 -ldev_id 01:19 -capacity 607914828
raidcom add ldev -parity_grp_id 2-21 -ldev_id 03:1A -capacity 135092184
raidcom add ldev -parity_grp_id 2-21 -ldev_id 02:1A -capacity 607914828
raidcom add ldev -parity_grp_id 2-22 -ldev_id 01:1A -capacity 607914828
raidcom add ldev -parity_grp_id 2-23 -ldev_id 03:1B -capacity 135092184
raidcom add ldev -parity_grp_id 2-23 -ldev_id 02:1B -capacity 607914828
raidcom add ldev -parity_grp_id 2-24 -ldev_id 01:1B -capacity 607914828
raidcom add ldev -parity_grp_id 2-25 -ldev_id 03:1C -capacity 135092184
raidcom add ldev -parity_grp_id 2-25 -ldev_id 02:1C -capacity 607914828
raidcom add ldev -parity_grp_id 2-26 -ldev_id 01:1C -capacity 607914828
raidcom add ldev -parity_grp_id 2-27 -ldev_id 03:1D -capacity 135092184
raidcom add ldev -parity_grp_id 2-27 -ldev_id 02:1D -capacity 607914828
raidcom add ldev -parity_grp_id 2-28 -ldev_id 01:1D -capacity 607914828
raidcom add ldev -parity_grp_id 2-29 -ldev_id 03:1E -capacity 135092184
```

```
raidcom add ldev -parity_grp_id 2-29 -ldev_id 02:1E -capacity 607914828
raidcom add ldev -parity_grp_id 2-30 -ldev_id 01:1E -capacity 607914828
raidcom add ldev -parity_grp_id 2-31 -ldev_id 03:1F -capacity 135092184
raidcom add ldev -parity_grp_id 2-31 -ldev_id 02:1F -capacity 607914828
raidcom add ldev -parity_grp_id 2-32 -ldev_id 01:1F -capacity 607914828
raidcom add ldev -parity_grp_id 3-1  -ldev_id 03:20 -capacity 135092184
raidcom add ldev -parity_grp_id 3-1  -ldev_id 02:20 -capacity 607914828
raidcom add ldev -parity_grp_id 3-2  -ldev_id 01:20 -capacity 607914828
raidcom add ldev -parity_grp_id 3-3  -ldev_id 03:21 -capacity 135092184
raidcom add ldev -parity_grp_id 3-3  -ldev_id 02:21 -capacity 607914828
raidcom add ldev -parity_grp_id 3-4  -ldev_id 01:21 -capacity 607914828
raidcom add ldev -parity_grp_id 3-5  -ldev_id 03:22 -capacity 135092184
raidcom add ldev -parity_grp_id 3-5  -ldev_id 02:22 -capacity 607914828
raidcom add ldev -parity_grp_id 3-6  -ldev_id 01:22 -capacity 607914828
raidcom add ldev -parity_grp_id 3-7  -ldev_id 03:23 -capacity 135092184
raidcom add ldev -parity_grp_id 3-7  -ldev_id 02:23 -capacity 607914828
raidcom add ldev -parity_grp_id 3-8  -ldev_id 01:23 -capacity 607914828
raidcom add ldev -parity_grp_id 3-9  -ldev_id 03:24 -capacity 135092184
raidcom add ldev -parity_grp_id 3-9  -ldev_id 02:24 -capacity 607914828
raidcom add ldev -parity_grp_id 3-10 -ldev_id 01:24 -capacity 607914828
raidcom add ldev -parity_grp_id 3-11 -ldev_id 03:25 -capacity 135092184
raidcom add ldev -parity_grp_id 3-11 -ldev_id 02:25 -capacity 607914828
raidcom add ldev -parity_grp_id 3-12 -ldev_id 01:25 -capacity 607914828
raidcom add ldev -parity_grp_id 3-13 -ldev_id 03:26 -capacity 135092184
raidcom add ldev -parity_grp_id 3-13 -ldev_id 02:26 -capacity 607914828
raidcom add ldev -parity_grp_id 3-14 -ldev_id 01:26 -capacity 607914828
raidcom add ldev -parity_grp_id 3-15 -ldev_id 03:27 -capacity 135092184
raidcom add ldev -parity_grp_id 3-15 -ldev_id 02:27 -capacity 607914828
raidcom add ldev -parity_grp_id 3-16 -ldev_id 01:27 -capacity 607914828
raidcom add ldev -parity_grp_id 3-17 -ldev_id 03:28 -capacity 135092184
raidcom add ldev -parity_grp_id 3-17 -ldev_id 02:28 -capacity 607914828
raidcom add ldev -parity_grp_id 3-18 -ldev_id 01:28 -capacity 607914828
raidcom add ldev -parity_grp_id 3-19 -ldev_id 03:29 -capacity 135092184
raidcom add ldev -parity_grp_id 3-19 -ldev_id 02:29 -capacity 607914828
raidcom add ldev -parity_grp_id 3-20 -ldev_id 01:29 -capacity 607914828
raidcom add ldev -parity_grp_id 3-21 -ldev_id 03:2A -capacity 135092184
raidcom add ldev -parity_grp_id 3-21 -ldev_id 02:2A -capacity 607914828
raidcom add ldev -parity_grp_id 3-22 -ldev_id 01:2A -capacity 607914828
raidcom add ldev -parity_grp_id 3-23 -ldev_id 03:2B -capacity 135092184
raidcom add ldev -parity_grp_id 3-23 -ldev_id 02:2B -capacity 607914828
raidcom add ldev -parity_grp_id 3-24 -ldev_id 01:2B -capacity 607914828
raidcom add ldev -parity_grp_id 3-25 -ldev_id 03:2C -capacity 135092184
raidcom add ldev -parity_grp_id 3-25 -ldev_id 02:2C -capacity 607914828
raidcom add ldev -parity_grp_id 3-26 -ldev_id 01:2C -capacity 607914828
raidcom add ldev -parity_grp_id 3-27 -ldev_id 03:2D -capacity 135092184
raidcom add ldev -parity_grp_id 3-27 -ldev_id 02:2D -capacity 607914828
raidcom add ldev -parity_grp_id 3-28 -ldev_id 01:2D -capacity 607914828
raidcom add ldev -parity_grp_id 3-29 -ldev_id 03:2E -capacity 135092184
raidcom add ldev -parity_grp_id 3-29 -ldev_id 02:2E -capacity 607914828
raidcom add ldev -parity_grp_id 3-30 -ldev_id 01:2E -capacity 607914828
raidcom add ldev -parity_grp_id 3-31 -ldev_id 03:2F -capacity 135092184
raidcom add ldev -parity_grp_id 3-31 -ldev_id 02:2F -capacity 607914828
raidcom add ldev -parity_grp_id 3-32 -ldev_id 01:2F -capacity 607914828
raidcom add ldev -parity_grp_id 4-1  -ldev_id 03:30 -capacity 135092184
raidcom add ldev -parity_grp_id 4-1  -ldev_id 02:30 -capacity 607914828
raidcom add ldev -parity_grp_id 4-2  -ldev_id 01:30 -capacity 607914828
raidcom add ldev -parity_grp_id 4-3  -ldev_id 03:31 -capacity 135092184
raidcom add ldev -parity_grp_id 4-3  -ldev_id 02:31 -capacity 607914828
raidcom add ldev -parity_grp_id 4-4  -ldev_id 01:31 -capacity 607914828
raidcom add ldev -parity_grp_id 4-5  -ldev_id 03:32 -capacity 135092184
raidcom add ldev -parity_grp_id 4-5  -ldev_id 02:32 -capacity 607914828
raidcom add ldev -parity_grp_id 4-6  -ldev_id 01:32 -capacity 607914828
raidcom add ldev -parity_grp_id 4-7  -ldev_id 03:33 -capacity 135092184
```

```
raidcom add ldev -parity_grp_id 4-7  -ldev_id 02:33 -capacity 607914828
raidcom add ldev -parity_grp_id 4-8  -ldev_id 01:33 -capacity 607914828
raidcom add ldev -parity_grp_id 4-9  -ldev_id 03:34 -capacity 135092184
raidcom add ldev -parity_grp_id 4-9  -ldev_id 02:34 -capacity 607914828
raidcom add ldev -parity_grp_id 4-10 -ldev_id 01:34 -capacity 607914828
raidcom add ldev -parity_grp_id 4-11 -ldev_id 03:35 -capacity 135092184
raidcom add ldev -parity_grp_id 4-11 -ldev_id 02:35 -capacity 607914828
raidcom add ldev -parity_grp_id 4-12 -ldev_id 01:35 -capacity 607914828
raidcom add ldev -parity_grp_id 4-13 -ldev_id 03:36 -capacity 135092184
raidcom add ldev -parity_grp_id 4-13 -ldev_id 02:36 -capacity 607914828
raidcom add ldev -parity_grp_id 4-14 -ldev_id 01:36 -capacity 607914828
raidcom add ldev -parity_grp_id 4-15 -ldev_id 03:37 -capacity 135092184
raidcom add ldev -parity_grp_id 4-15 -ldev_id 02:37 -capacity 607914828
raidcom add ldev -parity_grp_id 4-16 -ldev_id 01:37 -capacity 607914828
raidcom add ldev -parity_grp_id 4-17 -ldev_id 03:38 -capacity 135092184
raidcom add ldev -parity_grp_id 4-17 -ldev_id 02:38 -capacity 607914828
raidcom add ldev -parity_grp_id 4-18 -ldev_id 01:38 -capacity 607914828
raidcom add ldev -parity_grp_id 4-19 -ldev_id 03:39 -capacity 135092184
raidcom add ldev -parity_grp_id 4-19 -ldev_id 02:39 -capacity 607914828
raidcom add ldev -parity_grp_id 4-20 -ldev_id 01:39 -capacity 607914828
raidcom add ldev -parity_grp_id 4-21 -ldev_id 03:3A -capacity 135092184
raidcom add ldev -parity_grp_id 4-21 -ldev_id 02:3A -capacity 607914828
raidcom add ldev -parity_grp_id 4-22 -ldev_id 01:3A -capacity 607914828
raidcom add ldev -parity_grp_id 4-23 -ldev_id 03:3B -capacity 135092184
raidcom add ldev -parity_grp_id 4-23 -ldev_id 02:3B -capacity 607914828
raidcom add ldev -parity_grp_id 4-24 -ldev_id 01:3B -capacity 607914828
raidcom add ldev -parity_grp_id 4-25 -ldev_id 03:3C -capacity 135092184
raidcom add ldev -parity_grp_id 4-25 -ldev_id 02:3C -capacity 607914828
raidcom add ldev -parity_grp_id 4-26 -ldev_id 01:3C -capacity 607914828
raidcom add ldev -parity_grp_id 4-27 -ldev_id 03:3D -capacity 135092184
raidcom add ldev -parity_grp_id 4-27 -ldev_id 02:3D -capacity 607914828
raidcom add ldev -parity_grp_id 4-28 -ldev_id 01:3D -capacity 607914828
raidcom add ldev -parity_grp_id 4-29 -ldev_id 03:3E -capacity 135092184
raidcom add ldev -parity_grp_id 4-29 -ldev_id 02:3E -capacity 607914828
raidcom add ldev -parity_grp_id 4-30 -ldev_id 01:3E -capacity 607914828
raidcom add ldev -parity_grp_id 4-31 -ldev_id 03:3F -capacity 135092184
raidcom add ldev -parity_grp_id 4-31 -ldev_id 02:3F -capacity 607914828
raidcom add ldev -parity_grp_id 4-32 -ldev_id 01:3F -capacity 607914828
raidcom add ldev -parity_grp_id 5-1  -ldev_id 03:40 -capacity 135092184
raidcom add ldev -parity_grp_id 5-1  -ldev_id 02:40 -capacity 607914828
raidcom add ldev -parity_grp_id 5-2  -ldev_id 01:40 -capacity 607914828
raidcom add ldev -parity_grp_id 5-3  -ldev_id 03:41 -capacity 135092184
raidcom add ldev -parity_grp_id 5-3  -ldev_id 02:41 -capacity 607914828
raidcom add ldev -parity_grp_id 5-4  -ldev_id 01:41 -capacity 607914828
raidcom add ldev -parity_grp_id 5-5  -ldev_id 03:42 -capacity 135092184
raidcom add ldev -parity_grp_id 5-5  -ldev_id 02:42 -capacity 607914828
raidcom add ldev -parity_grp_id 5-6  -ldev_id 01:42 -capacity 607914828
raidcom add ldev -parity_grp_id 5-7  -ldev_id 03:43 -capacity 135092184
raidcom add ldev -parity_grp_id 5-7  -ldev_id 02:43 -capacity 607914828
raidcom add ldev -parity_grp_id 5-8  -ldev_id 01:43 -capacity 607914828
raidcom add ldev -parity_grp_id 5-9  -ldev_id 03:44 -capacity 135092184
raidcom add ldev -parity_grp_id 5-9  -ldev_id 02:44 -capacity 607914828
raidcom add ldev -parity_grp_id 5-10 -ldev_id 01:44 -capacity 607914828
raidcom add ldev -parity_grp_id 5-11 -ldev_id 03:45 -capacity 135092184
raidcom add ldev -parity_grp_id 5-11 -ldev_id 02:45 -capacity 607914828
raidcom add ldev -parity_grp_id 5-12 -ldev_id 01:45 -capacity 607914828
raidcom add ldev -parity_grp_id 5-13 -ldev_id 03:46 -capacity 135092184
raidcom add ldev -parity_grp_id 5-13 -ldev_id 02:46 -capacity 607914828
raidcom add ldev -parity_grp_id 5-14 -ldev_id 01:46 -capacity 607914828
raidcom add ldev -parity_grp_id 5-15 -ldev_id 03:47 -capacity 135092184
raidcom add ldev -parity_grp_id 5-15 -ldev_id 02:47 -capacity 607914828
raidcom add ldev -parity_grp_id 5-16 -ldev_id 01:47 -capacity 607914828
raidcom add ldev -parity_grp_id 5-17 -ldev_id 03:48 -capacity 135092184
```

```
raidcom add ldev -parity_grp_id 5-17 -ldev_id 02:48 -capacity 607914828
raidcom add ldev -parity_grp_id 5-18 -ldev_id 01:48 -capacity 607914828
raidcom add ldev -parity_grp_id 5-19 -ldev_id 03:49 -capacity 135092184
raidcom add ldev -parity_grp_id 5-19 -ldev_id 02:49 -capacity 607914828
raidcom add ldev -parity_grp_id 5-20 -ldev_id 01:49 -capacity 607914828
raidcom add ldev -parity_grp_id 5-21 -ldev_id 03:4A -capacity 135092184
raidcom add ldev -parity_grp_id 5-21 -ldev_id 02:4A -capacity 607914828
raidcom add ldev -parity_grp_id 5-22 -ldev_id 01:4A -capacity 607914828
raidcom add ldev -parity_grp_id 5-23 -ldev_id 03:4B -capacity 135092184
raidcom add ldev -parity_grp_id 5-23 -ldev_id 02:4B -capacity 607914828
raidcom add ldev -parity_grp_id 5-24 -ldev_id 01:4B -capacity 607914828
```

ldevformat.sh

```
raidcom initialize ldev -ldev_id 01:00 -operation fmt
raidcom initialize ldev -ldev_id 02:00 -operation fmt
raidcom initialize ldev -ldev_id 03:00 -operation fmt
raidcom initialize ldev -ldev_id 01:01 -operation fmt
raidcom initialize ldev -ldev_id 02:01 -operation fmt
raidcom initialize ldev -ldev_id 03:01 -operation fmt
raidcom initialize ldev -ldev_id 01:02 -operation fmt
raidcom initialize ldev -ldev_id 02:02 -operation fmt
raidcom initialize ldev -ldev_id 03:02 -operation fmt
raidcom initialize ldev -ldev_id 01:03 -operation fmt
raidcom initialize ldev -ldev_id 02:03 -operation fmt
raidcom initialize ldev -ldev_id 03:03 -operation fmt
raidcom initialize ldev -ldev_id 01:04 -operation fmt
raidcom initialize ldev -ldev_id 02:04 -operation fmt
raidcom initialize ldev -ldev_id 03:04 -operation fmt
raidcom initialize ldev -ldev_id 01:05 -operation fmt
raidcom initialize ldev -ldev_id 02:05 -operation fmt
raidcom initialize ldev -ldev_id 03:05 -operation fmt
raidcom initialize ldev -ldev_id 01:06 -operation fmt
raidcom initialize ldev -ldev_id 02:06 -operation fmt
raidcom initialize ldev -ldev_id 03:06 -operation fmt
raidcom initialize ldev -ldev_id 01:07 -operation fmt
raidcom initialize ldev -ldev_id 02:07 -operation fmt
raidcom initialize ldev -ldev_id 03:07 -operation fmt
raidcom initialize ldev -ldev_id 01:08 -operation fmt
raidcom initialize ldev -ldev_id 02:08 -operation fmt
raidcom initialize ldev -ldev_id 03:08 -operation fmt
raidcom initialize ldev -ldev_id 01:09 -operation fmt
raidcom initialize ldev -ldev_id 02:09 -operation fmt
raidcom initialize ldev -ldev_id 03:09 -operation fmt
raidcom initialize ldev -ldev_id 01:0A -operation fmt
raidcom initialize ldev -ldev_id 02:0A -operation fmt
raidcom initialize ldev -ldev_id 03:0A -operation fmt
raidcom initialize ldev -ldev_id 01:0B -operation fmt
raidcom initialize ldev -ldev_id 02:0B -operation fmt
raidcom initialize ldev -ldev_id 03:0B -operation fmt
raidcom initialize ldev -ldev_id 01:0C -operation fmt
raidcom initialize ldev -ldev_id 02:0C -operation fmt
raidcom initialize ldev -ldev_id 03:0C -operation fmt
raidcom initialize ldev -ldev_id 01:0D -operation fmt
raidcom initialize ldev -ldev_id 02:0D -operation fmt
raidcom initialize ldev -ldev_id 03:0D -operation fmt
raidcom initialize ldev -ldev_id 01:0E -operation fmt
raidcom initialize ldev -ldev_id 02:0E -operation fmt
raidcom initialize ldev -ldev_id 03:0E -operation fmt
raidcom initialize ldev -ldev_id 01:0F -operation fmt
raidcom initialize ldev -ldev_id 02:0F -operation fmt
raidcom initialize ldev -ldev_id 03:0F -operation fmt
```

```
raidcom initialize ldev -ldev_id 01:10 -operation fmt
raidcom initialize ldev -ldev_id 02:10 -operation fmt
raidcom initialize ldev -ldev_id 03:10 -operation fmt
raidcom initialize ldev -ldev_id 01:11 -operation fmt
raidcom initialize ldev -ldev_id 02:11 -operation fmt
raidcom initialize ldev -ldev_id 03:11 -operation fmt
raidcom initialize ldev -ldev_id 01:12 -operation fmt
raidcom initialize ldev -ldev_id 02:12 -operation fmt
raidcom initialize ldev -ldev_id 03:12 -operation fmt
raidcom initialize ldev -ldev_id 01:13 -operation fmt
raidcom initialize ldev -ldev_id 02:13 -operation fmt
raidcom initialize ldev -ldev_id 03:13 -operation fmt
raidcom initialize ldev -ldev_id 01:14 -operation fmt
raidcom initialize ldev -ldev_id 02:14 -operation fmt
raidcom initialize ldev -ldev_id 03:14 -operation fmt
raidcom initialize ldev -ldev_id 01:15 -operation fmt
raidcom initialize ldev -ldev_id 02:15 -operation fmt
raidcom initialize ldev -ldev_id 03:15 -operation fmt
raidcom initialize ldev -ldev_id 01:16 -operation fmt
raidcom initialize ldev -ldev_id 02:16 -operation fmt
raidcom initialize ldev -ldev_id 03:16 -operation fmt
raidcom initialize ldev -ldev_id 01:17 -operation fmt
raidcom initialize ldev -ldev_id 02:17 -operation fmt
raidcom initialize ldev -ldev_id 03:17 -operation fmt
raidcom initialize ldev -ldev_id 01:18 -operation fmt
raidcom initialize ldev -ldev_id 02:18 -operation fmt
raidcom initialize ldev -ldev_id 03:18 -operation fmt
raidcom initialize ldev -ldev_id 01:19 -operation fmt
raidcom initialize ldev -ldev_id 02:19 -operation fmt
raidcom initialize ldev -ldev_id 03:19 -operation fmt
raidcom initialize ldev -ldev_id 01:1A -operation fmt
raidcom initialize ldev -ldev_id 02:1A -operation fmt
raidcom initialize ldev -ldev_id 03:1A -operation fmt
raidcom initialize ldev -ldev_id 01:1B -operation fmt
raidcom initialize ldev -ldev_id 02:1B -operation fmt
raidcom initialize ldev -ldev_id 03:1B -operation fmt
raidcom initialize ldev -ldev_id 01:1C -operation fmt
raidcom initialize ldev -ldev_id 02:1C -operation fmt
raidcom initialize ldev -ldev_id 03:1C -operation fmt
raidcom initialize ldev -ldev_id 01:1D -operation fmt
raidcom initialize ldev -ldev_id 02:1D -operation fmt
raidcom initialize ldev -ldev_id 03:1D -operation fmt
raidcom initialize ldev -ldev_id 01:1E -operation fmt
raidcom initialize ldev -ldev_id 02:1E -operation fmt
raidcom initialize ldev -ldev_id 03:1E -operation fmt
raidcom initialize ldev -ldev_id 01:1F -operation fmt
raidcom initialize ldev -ldev_id 02:1F -operation fmt
raidcom initialize ldev -ldev_id 03:1F -operation fmt

raidcom initialize ldev -ldev_id 01:20 -operation fmt
raidcom initialize ldev -ldev_id 02:20 -operation fmt
raidcom initialize ldev -ldev_id 03:20 -operation fmt
raidcom initialize ldev -ldev_id 01:21 -operation fmt
raidcom initialize ldev -ldev_id 02:21 -operation fmt
raidcom initialize ldev -ldev_id 03:21 -operation fmt
raidcom initialize ldev -ldev_id 01:22 -operation fmt
raidcom initialize ldev -ldev_id 02:22 -operation fmt
raidcom initialize ldev -ldev_id 03:22 -operation fmt
raidcom initialize ldev -ldev_id 01:23 -operation fmt
raidcom initialize ldev -ldev_id 02:23 -operation fmt
raidcom initialize ldev -ldev_id 03:23 -operation fmt
raidcom initialize ldev -ldev_id 01:24 -operation fmt
```

```
raidcom initialize ldev -ldev_id 02:24 -operation fmt
raidcom initialize ldev -ldev_id 03:24 -operation fmt
raidcom initialize ldev -ldev_id 01:25 -operation fmt
raidcom initialize ldev -ldev_id 02:25 -operation fmt
raidcom initialize ldev -ldev_id 03:25 -operation fmt
raidcom initialize ldev -ldev_id 01:26 -operation fmt
raidcom initialize ldev -ldev_id 02:26 -operation fmt
raidcom initialize ldev -ldev_id 03:26 -operation fmt
raidcom initialize ldev -ldev_id 01:27 -operation fmt
raidcom initialize ldev -ldev_id 02:27 -operation fmt
raidcom initialize ldev -ldev_id 03:27 -operation fmt
raidcom initialize ldev -ldev_id 01:28 -operation fmt
raidcom initialize ldev -ldev_id 02:28 -operation fmt
raidcom initialize ldev -ldev_id 03:28 -operation fmt
raidcom initialize ldev -ldev_id 01:29 -operation fmt
raidcom initialize ldev -ldev_id 02:29 -operation fmt
raidcom initialize ldev -ldev_id 03:29 -operation fmt
raidcom initialize ldev -ldev_id 01:2A -operation fmt
raidcom initialize ldev -ldev_id 02:2A -operation fmt
raidcom initialize ldev -ldev_id 03:2A -operation fmt
raidcom initialize ldev -ldev_id 01:2B -operation fmt
raidcom initialize ldev -ldev_id 02:2B -operation fmt
raidcom initialize ldev -ldev_id 03:2B -operation fmt
raidcom initialize ldev -ldev_id 01:2C -operation fmt
raidcom initialize ldev -ldev_id 02:2C -operation fmt
raidcom initialize ldev -ldev_id 03:2C -operation fmt
raidcom initialize ldev -ldev_id 01:2D -operation fmt
raidcom initialize ldev -ldev_id 02:2D -operation fmt
raidcom initialize ldev -ldev_id 03:2D -operation fmt
raidcom initialize ldev -ldev_id 01:2E -operation fmt
raidcom initialize ldev -ldev_id 02:2E -operation fmt
raidcom initialize ldev -ldev_id 03:2E -operation fmt
raidcom initialize ldev -ldev_id 01:2F -operation fmt
raidcom initialize ldev -ldev_id 02:2F -operation fmt
raidcom initialize ldev -ldev_id 03:2F -operation fmt

raidcom initialize ldev -ldev_id 01:30 -operation fmt
raidcom initialize ldev -ldev_id 02:30 -operation fmt
raidcom initialize ldev -ldev_id 03:30 -operation fmt
raidcom initialize ldev -ldev_id 01:31 -operation fmt
raidcom initialize ldev -ldev_id 02:31 -operation fmt
raidcom initialize ldev -ldev_id 03:31 -operation fmt
raidcom initialize ldev -ldev_id 01:32 -operation fmt
raidcom initialize ldev -ldev_id 02:32 -operation fmt
raidcom initialize ldev -ldev_id 03:32 -operation fmt
raidcom initialize ldev -ldev_id 01:33 -operation fmt
raidcom initialize ldev -ldev_id 02:33 -operation fmt
raidcom initialize ldev -ldev_id 03:33 -operation fmt
raidcom initialize ldev -ldev_id 01:34 -operation fmt
raidcom initialize ldev -ldev_id 02:34 -operation fmt
raidcom initialize ldev -ldev_id 03:34 -operation fmt
raidcom initialize ldev -ldev_id 01:35 -operation fmt
raidcom initialize ldev -ldev_id 02:35 -operation fmt
raidcom initialize ldev -ldev_id 03:35 -operation fmt
raidcom initialize ldev -ldev_id 01:36 -operation fmt
raidcom initialize ldev -ldev_id 02:36 -operation fmt
raidcom initialize ldev -ldev_id 03:36 -operation fmt
raidcom initialize ldev -ldev_id 01:37 -operation fmt
raidcom initialize ldev -ldev_id 02:37 -operation fmt
raidcom initialize ldev -ldev_id 03:37 -operation fmt
raidcom initialize ldev -ldev_id 01:38 -operation fmt
raidcom initialize ldev -ldev_id 02:38 -operation fmt
raidcom initialize ldev -ldev_id 03:38 -operation fmt
```

```
raidcom initialize ldev -ldev_id 01:39 -operation fmt
raidcom initialize ldev -ldev_id 02:39 -operation fmt
raidcom initialize ldev -ldev_id 03:39 -operation fmt
raidcom initialize ldev -ldev_id 01:3A -operation fmt
raidcom initialize ldev -ldev_id 02:3A -operation fmt
raidcom initialize ldev -ldev_id 03:3A -operation fmt
raidcom initialize ldev -ldev_id 01:3B -operation fmt
raidcom initialize ldev -ldev_id 02:3B -operation fmt
raidcom initialize ldev -ldev_id 03:3B -operation fmt
raidcom initialize ldev -ldev_id 01:3C -operation fmt
raidcom initialize ldev -ldev_id 02:3C -operation fmt
raidcom initialize ldev -ldev_id 03:3C -operation fmt
raidcom initialize ldev -ldev_id 01:3D -operation fmt
raidcom initialize ldev -ldev_id 02:3D -operation fmt
raidcom initialize ldev -ldev_id 03:3D -operation fmt
raidcom initialize ldev -ldev_id 01:3E -operation fmt
raidcom initialize ldev -ldev_id 02:3E -operation fmt
raidcom initialize ldev -ldev_id 03:3E -operation fmt
raidcom initialize ldev -ldev_id 01:3F -operation fmt
raidcom initialize ldev -ldev_id 02:3F -operation fmt
raidcom initialize ldev -ldev_id 03:3F -operation fmt

raidcom initialize ldev -ldev_id 01:40 -operation fmt
raidcom initialize ldev -ldev_id 02:40 -operation fmt
raidcom initialize ldev -ldev_id 03:40 -operation fmt
raidcom initialize ldev -ldev_id 01:41 -operation fmt
raidcom initialize ldev -ldev_id 02:41 -operation fmt
raidcom initialize ldev -ldev_id 03:41 -operation fmt
raidcom initialize ldev -ldev_id 01:42 -operation fmt
raidcom initialize ldev -ldev_id 02:42 -operation fmt
raidcom initialize ldev -ldev_id 03:42 -operation fmt
raidcom initialize ldev -ldev_id 01:43 -operation fmt
raidcom initialize ldev -ldev_id 02:43 -operation fmt
raidcom initialize ldev -ldev_id 03:43 -operation fmt
raidcom initialize ldev -ldev_id 01:44 -operation fmt
raidcom initialize ldev -ldev_id 02:44 -operation fmt
raidcom initialize ldev -ldev_id 03:44 -operation fmt
raidcom initialize ldev -ldev_id 01:45 -operation fmt
raidcom initialize ldev -ldev_id 02:45 -operation fmt
raidcom initialize ldev -ldev_id 03:45 -operation fmt
raidcom initialize ldev -ldev_id 01:46 -operation fmt
raidcom initialize ldev -ldev_id 02:46 -operation fmt
raidcom initialize ldev -ldev_id 03:46 -operation fmt
raidcom initialize ldev -ldev_id 01:47 -operation fmt
raidcom initialize ldev -ldev_id 02:47 -operation fmt
raidcom initialize ldev -ldev_id 03:47 -operation fmt
raidcom initialize ldev -ldev_id 01:48 -operation fmt
raidcom initialize ldev -ldev_id 02:48 -operation fmt
raidcom initialize ldev -ldev_id 03:48 -operation fmt
raidcom initialize ldev -ldev_id 01:49 -operation fmt
raidcom initialize ldev -ldev_id 02:49 -operation fmt
raidcom initialize ldev -ldev_id 03:49 -operation fmt
raidcom initialize ldev -ldev_id 01:4A -operation fmt
raidcom initialize ldev -ldev_id 02:4A -operation fmt
raidcom initialize ldev -ldev_id 03:4A -operation fmt
raidcom initialize ldev -ldev_id 01:4B -operation fmt
raidcom initialize ldev -ldev_id 02:4B -operation fmt
raidcom initialize ldev -ldev_id 03:4B -operation fmt
```

lunmap.sh

```
raidcom add lun -port CL1-A -ldev_id 01:00
```

```
raidcom add lun -port CL1-A -ldev_id 02:00
raidcom add lun -port CL1-A -ldev_id 03:00
raidcom add lun -port CL1-B -ldev_id 01:01
raidcom add lun -port CL1-B -ldev_id 02:01
raidcom add lun -port CL1-B -ldev_id 03:01
raidcom add lun -port CL1-C -ldev_id 01:02
raidcom add lun -port CL1-C -ldev_id 02:02
raidcom add lun -port CL1-C -ldev_id 03:02
raidcom add lun -port CL1-D -ldev_id 01:03
raidcom add lun -port CL1-D -ldev_id 02:03
raidcom add lun -port CL1-D -ldev_id 03:03
raidcom add lun -port CL2-A -ldev_id 01:04
raidcom add lun -port CL2-A -ldev_id 02:04
raidcom add lun -port CL2-A -ldev_id 03:04
raidcom add lun -port CL2-B -ldev_id 01:05
raidcom add lun -port CL2-B -ldev_id 02:05
raidcom add lun -port CL2-B -ldev_id 03:05
raidcom add lun -port CL2-C -ldev_id 01:06
raidcom add lun -port CL2-C -ldev_id 02:06
raidcom add lun -port CL2-C -ldev_id 03:06
raidcom add lun -port CL2-D -ldev_id 01:07
raidcom add lun -port CL2-D -ldev_id 02:07
raidcom add lun -port CL2-D -ldev_id 03:07
raidcom add lun -port CL3-A -ldev_id 01:08
raidcom add lun -port CL3-A -ldev_id 02:08
raidcom add lun -port CL3-A -ldev_id 03:08
raidcom add lun -port CL3-B -ldev_id 01:09
raidcom add lun -port CL3-B -ldev_id 02:09
raidcom add lun -port CL3-B -ldev_id 03:09
raidcom add lun -port CL3-C -ldev_id 01:0A
raidcom add lun -port CL3-C -ldev_id 02:0A
raidcom add lun -port CL3-C -ldev_id 03:0A
raidcom add lun -port CL3-D -ldev_id 01:0B
raidcom add lun -port CL3-D -ldev_id 02:0B
raidcom add lun -port CL3-D -ldev_id 03:0B
raidcom add lun -port CL4-A -ldev_id 01:0C
raidcom add lun -port CL4-A -ldev_id 02:0C
raidcom add lun -port CL4-A -ldev_id 03:0C
raidcom add lun -port CL4-B -ldev_id 01:0D
raidcom add lun -port CL4-B -ldev_id 02:0D
raidcom add lun -port CL4-B -ldev_id 03:0D
raidcom add lun -port CL4-C -ldev_id 01:0E
raidcom add lun -port CL4-C -ldev_id 02:0E
raidcom add lun -port CL4-C -ldev_id 03:0E
raidcom add lun -port CL4-D -ldev_id 01:0F
raidcom add lun -port CL4-D -ldev_id 02:0F
raidcom add lun -port CL4-D -ldev_id 03:0F

raidcom add lun -port CL1-A -ldev_id 01:10
raidcom add lun -port CL1-A -ldev_id 02:10
raidcom add lun -port CL1-A -ldev_id 03:10
raidcom add lun -port CL1-B -ldev_id 01:11
raidcom add lun -port CL1-B -ldev_id 02:11
raidcom add lun -port CL1-B -ldev_id 03:11
raidcom add lun -port CL1-C -ldev_id 01:12
raidcom add lun -port CL1-C -ldev_id 02:12
raidcom add lun -port CL1-C -ldev_id 03:12
raidcom add lun -port CL1-D -ldev_id 01:13
raidcom add lun -port CL1-D -ldev_id 02:13
raidcom add lun -port CL1-D -ldev_id 03:13
raidcom add lun -port CL2-A -ldev_id 01:14
raidcom add lun -port CL2-A -ldev_id 02:14
raidcom add lun -port CL2-A -ldev_id 03:14
```

```
raidcom add lun -port CL2-B -ldev_id 01:15
raidcom add lun -port CL2-B -ldev_id 02:15
raidcom add lun -port CL2-B -ldev_id 03:15
raidcom add lun -port CL2-C -ldev_id 01:16
raidcom add lun -port CL2-C -ldev_id 02:16
raidcom add lun -port CL2-C -ldev_id 03:16
raidcom add lun -port CL2-D -ldev_id 01:17
raidcom add lun -port CL2-D -ldev_id 02:17
raidcom add lun -port CL2-D -ldev_id 03:17
raidcom add lun -port CL3-A -ldev_id 01:18
raidcom add lun -port CL3-A -ldev_id 02:18
raidcom add lun -port CL3-A -ldev_id 03:18
raidcom add lun -port CL3-B -ldev_id 01:19
raidcom add lun -port CL3-B -ldev_id 02:19
raidcom add lun -port CL3-B -ldev_id 03:19
raidcom add lun -port CL3-C -ldev_id 01:1A
raidcom add lun -port CL3-C -ldev_id 02:1A
raidcom add lun -port CL3-C -ldev_id 03:1A
raidcom add lun -port CL3-D -ldev_id 01:1B
raidcom add lun -port CL3-D -ldev_id 02:1B
raidcom add lun -port CL3-D -ldev_id 03:1B
raidcom add lun -port CL4-A -ldev_id 01:1C
raidcom add lun -port CL4-A -ldev_id 02:1C
raidcom add lun -port CL4-A -ldev_id 03:1C
raidcom add lun -port CL4-B -ldev_id 01:1D
raidcom add lun -port CL4-B -ldev_id 02:1D
raidcom add lun -port CL4-B -ldev_id 03:1D
raidcom add lun -port CL4-C -ldev_id 01:1E
raidcom add lun -port CL4-C -ldev_id 02:1E
raidcom add lun -port CL4-C -ldev_id 03:1E
raidcom add lun -port CL4-D -ldev_id 01:1F
raidcom add lun -port CL4-D -ldev_id 02:1F
raidcom add lun -port CL4-D -ldev_id 03:1F

raidcom add lun -port CL1-A -ldev_id 01:20
raidcom add lun -port CL1-A -ldev_id 02:20
raidcom add lun -port CL1-A -ldev_id 03:20
raidcom add lun -port CL1-B -ldev_id 01:21
raidcom add lun -port CL1-B -ldev_id 02:21
raidcom add lun -port CL1-B -ldev_id 03:21
raidcom add lun -port CL1-C -ldev_id 01:22
raidcom add lun -port CL1-C -ldev_id 02:22
raidcom add lun -port CL1-C -ldev_id 03:22
raidcom add lun -port CL1-D -ldev_id 01:23
raidcom add lun -port CL1-D -ldev_id 02:23
raidcom add lun -port CL1-D -ldev_id 03:23
raidcom add lun -port CL2-A -ldev_id 01:24
raidcom add lun -port CL2-A -ldev_id 02:24
raidcom add lun -port CL2-A -ldev_id 03:24
raidcom add lun -port CL2-B -ldev_id 01:25
raidcom add lun -port CL2-B -ldev_id 02:25
raidcom add lun -port CL2-B -ldev_id 03:25
raidcom add lun -port CL2-C -ldev_id 01:26
raidcom add lun -port CL2-C -ldev_id 02:26
raidcom add lun -port CL2-C -ldev_id 03:26
raidcom add lun -port CL2-D -ldev_id 01:27
raidcom add lun -port CL2-D -ldev_id 02:27
raidcom add lun -port CL2-D -ldev_id 03:27
raidcom add lun -port CL3-A -ldev_id 01:28
raidcom add lun -port CL3-A -ldev_id 02:28
raidcom add lun -port CL3-A -ldev_id 03:28
raidcom add lun -port CL3-B -ldev_id 01:29
raidcom add lun -port CL3-B -ldev_id 02:29
```

```
raidcom add lun -port CL3-B -ldev_id 03:29
raidcom add lun -port CL3-C -ldev_id 01:2A
raidcom add lun -port CL3-C -ldev_id 02:2A
raidcom add lun -port CL3-C -ldev_id 03:2A
raidcom add lun -port CL3-D -ldev_id 01:2B
raidcom add lun -port CL3-D -ldev_id 02:2B
raidcom add lun -port CL3-D -ldev_id 03:2B
raidcom add lun -port CL4-A -ldev_id 01:2C
raidcom add lun -port CL4-A -ldev_id 02:2C
raidcom add lun -port CL4-A -ldev_id 03:2C
raidcom add lun -port CL4-B -ldev_id 01:2D
raidcom add lun -port CL4-B -ldev_id 02:2D
raidcom add lun -port CL4-B -ldev_id 03:2D
raidcom add lun -port CL4-C -ldev_id 01:2E
raidcom add lun -port CL4-C -ldev_id 02:2E
raidcom add lun -port CL4-C -ldev_id 03:2E
raidcom add lun -port CL4-D -ldev_id 01:2F
raidcom add lun -port CL4-D -ldev_id 02:2F
raidcom add lun -port CL4-D -ldev_id 03:2F

raidcom add lun -port CL1-A -ldev_id 01:30
raidcom add lun -port CL1-A -ldev_id 02:30
raidcom add lun -port CL1-A -ldev_id 03:30
raidcom add lun -port CL1-B -ldev_id 01:31
raidcom add lun -port CL1-B -ldev_id 02:31
raidcom add lun -port CL1-B -ldev_id 03:31
raidcom add lun -port CL1-C -ldev_id 01:32
raidcom add lun -port CL1-C -ldev_id 02:32
raidcom add lun -port CL1-C -ldev_id 03:32
raidcom add lun -port CL1-D -ldev_id 01:33
raidcom add lun -port CL1-D -ldev_id 02:33
raidcom add lun -port CL1-D -ldev_id 03:33
raidcom add lun -port CL2-A -ldev_id 01:34
raidcom add lun -port CL2-A -ldev_id 02:34
raidcom add lun -port CL2-A -ldev_id 03:34
raidcom add lun -port CL2-B -ldev_id 01:35
raidcom add lun -port CL2-B -ldev_id 02:35
raidcom add lun -port CL2-B -ldev_id 03:35
raidcom add lun -port CL2-C -ldev_id 01:36
raidcom add lun -port CL2-C -ldev_id 02:36
raidcom add lun -port CL2-C -ldev_id 03:36
raidcom add lun -port CL2-D -ldev_id 01:37
raidcom add lun -port CL2-D -ldev_id 02:37
raidcom add lun -port CL2-D -ldev_id 03:37
raidcom add lun -port CL3-A -ldev_id 01:38
raidcom add lun -port CL3-A -ldev_id 02:38
raidcom add lun -port CL3-A -ldev_id 03:38
raidcom add lun -port CL3-B -ldev_id 01:39
raidcom add lun -port CL3-B -ldev_id 02:39
raidcom add lun -port CL3-B -ldev_id 03:39
raidcom add lun -port CL3-C -ldev_id 01:3A
raidcom add lun -port CL3-C -ldev_id 02:3A
raidcom add lun -port CL3-C -ldev_id 03:3A
raidcom add lun -port CL3-D -ldev_id 01:3B
raidcom add lun -port CL3-D -ldev_id 02:3B
raidcom add lun -port CL3-D -ldev_id 03:3B
raidcom add lun -port CL4-A -ldev_id 01:3C
raidcom add lun -port CL4-A -ldev_id 02:3C
raidcom add lun -port CL4-A -ldev_id 03:3C
raidcom add lun -port CL4-B -ldev_id 01:3D
raidcom add lun -port CL4-B -ldev_id 02:3D
raidcom add lun -port CL4-B -ldev_id 03:3D
raidcom add lun -port CL4-C -ldev_id 01:3E
```

```
raidcom add lun -port CL4-C -ldev_id 02:3E
raidcom add lun -port CL4-C -ldev_id 03:3E
raidcom add lun -port CL4-D -ldev_id 01:3F
raidcom add lun -port CL4-D -ldev_id 02:3F
raidcom add lun -port CL4-D -ldev_id 03:3F

raidcom add lun -port CL1-A -ldev_id 01:40
raidcom add lun -port CL1-A -ldev_id 02:40
raidcom add lun -port CL1-A -ldev_id 03:40
raidcom add lun -port CL1-B -ldev_id 01:41
raidcom add lun -port CL1-B -ldev_id 02:41
raidcom add lun -port CL1-B -ldev_id 03:41
raidcom add lun -port CL1-C -ldev_id 01:42
raidcom add lun -port CL1-C -ldev_id 02:42
raidcom add lun -port CL1-C -ldev_id 03:42
raidcom add lun -port CL1-D -ldev_id 01:43
raidcom add lun -port CL1-D -ldev_id 02:43
raidcom add lun -port CL1-D -ldev_id 03:43
raidcom add lun -port CL2-A -ldev_id 01:44
raidcom add lun -port CL2-A -ldev_id 02:44
raidcom add lun -port CL2-A -ldev_id 03:44
raidcom add lun -port CL2-B -ldev_id 01:45
raidcom add lun -port CL2-B -ldev_id 02:45
raidcom add lun -port CL2-B -ldev_id 03:45
raidcom add lun -port CL2-C -ldev_id 01:46
raidcom add lun -port CL2-C -ldev_id 02:46
raidcom add lun -port CL2-C -ldev_id 03:46
raidcom add lun -port CL2-D -ldev_id 01:47
raidcom add lun -port CL2-D -ldev_id 02:47
raidcom add lun -port CL2-D -ldev_id 03:47
raidcom add lun -port CL3-A -ldev_id 01:48
raidcom add lun -port CL3-A -ldev_id 02:48
raidcom add lun -port CL3-A -ldev_id 03:48
raidcom add lun -port CL3-B -ldev_id 01:49
raidcom add lun -port CL3-B -ldev_id 02:49
raidcom add lun -port CL3-B -ldev_id 03:49
raidcom add lun -port CL3-C -ldev_id 01:4A
raidcom add lun -port CL3-C -ldev_id 02:4A
raidcom add lun -port CL3-C -ldev_id 03:4A
raidcom add lun -port CL3-D -ldev_id 01:4B
raidcom add lun -port CL3-D -ldev_id 02:4B
raidcom add lun -port CL3-D -ldev_id 03:4B
```

pvcreate.sh

```
#!/bin/bash

for disk in `lsscsi | grep HITACHI | awk '{ print $6 }'`
do
     pvcreate $disk
done
```

vgcreate.sh

```
#!/bin/bash

lunmap=lunmap.txt

# Generate a mapping of the Storage Array LDEV ID to Linux SCSI Device name
cat /dev/null > $lunmap
for disk in `lsscsi | grep HITACHI | awk '{ print $6 }'`
do
     lun=`scsi_id --page=0x83 --whitelisted --device=$disk | tail -c 5`
     cu=`echo $lun | cut -c 1-2`
     ldev=`echo $lun | cut -c 3-4`
     echo -e $cu":"$ldev"\t"$disk >> $lunmap
done
sort -o $lunmap $lunmap

# Build the list of PVs for ASU-1, ASU-2, ASU-3 with the following assumptions:
#   LDEVs where CU=01 -> ASU-1
#   LDEVs where CU=02 -> ASU-2
#   LDEVs where CU=03 -> ASU-3
asu1pvs=`cat $lunmap | grep "^01" | awk '{ print $2 }'`
asu2pvs=`cat $lunmap | grep "^02" | awk '{ print $2 }'`
asu3pvs=`cat $lunmap | grep "^03" | awk '{ print $2 }'`

# Create LVM Volume Groups
vgcreate vgasu1 $asu1pvs
vgcreate vgasu2 $asu2pvs
vgcreate vgasu3 $asu3pvs
```

lvcreate.sh

```
#!/bin/bash

lvcreate -l 1409952 -i 76 -I 4M -n lvasu11 vgasu1
lvcreate -l 1409952 -i 76 -I 4M -n lvasu12 vgasu1
lvcreate -l 1409952 -i 76 -I 4M -n lvasu13 vgasu1
lvcreate -l 1409952 -i 76 -I 4M -n lvasu14 vgasu1
lvcreate -l 1409952 -i 76 -I 4M -n lvasu21 vgasu2
lvcreate -l 1409952 -i 76 -I 4M -n lvasu22 vgasu2
lvcreate -l 1409952 -i 76 -I 4M -n lvasu23 vgasu2
lvcreate -l 1409952 -i 76 -I 4M -n lvasu24 vgasu2
lvcreate -l 1253240 -i 76 -I 4M -n lvasu31 vgasu3
```

APPENDIX D: SPC-1 WORKLOAD GENERATOR STORAGE COMMANDS AND PARAMETERS

ASU Pre-Fill

The content of command and parameter file, used in this benchmark to execute the required ASU pre-fill, is listed below.

```
compratio=1

sd=sd1,lun=/dev/vgasu1/lvasu11,size=5913767313408,threads=8,openflags=o_direct
sd=sd2,lun=/dev/vgasu1/lvasu12,size=5913767313408,threads=8,openflags=o_direct
sd=sd3,lun=/dev/vgasu1/lvasu13,size=5913767313408,threads=8,openflags=o_direct
sd=sd4,lun=/dev/vgasu1/lvasu14,size=5913767313408,threads=8,openflags=o_direct
sd=sd5,lun=/dev/vgasu2/lvasu21,size=5913767313408,threads=8,openflags=o_direct
sd=sd6,lun=/dev/vgasu2/lvasu22,size=5913767313408,threads=8,openflags=o_direct
sd=sd7,lun=/dev/vgasu2/lvasu23,size=5913767313408,threads=8,openflags=o_direct
sd=sd8,lun=/dev/vgasu2/lvasu24,size=5913767313408,threads=8,openflags=o_direct
sd=sd9,lun=/dev/vgasu3/lvasu31,size=5256469544960,threads=8,openflags=o_direct

wd=wd1,sd=sd1,rdpct=0,seek=-1,xfersize=512k
wd=wd2,sd=sd2,rdpct=0,seek=-1,xfersize=512k
wd=wd3,sd=sd3,rdpct=0,seek=-1,xfersize=512k
wd=wd4,sd=sd4,rdpct=0,seek=-1,xfersize=512k
wd=wd5,sd=sd5,rdpct=0,seek=-1,xfersize=512k
wd=wd6,sd=sd6,rdpct=0,seek=-1,xfersize=512k
wd=wd7,sd=sd7,rdpct=0,seek=-1,xfersize=512k
wd=wd8,sd=sd8,rdpct=0,seek=-1,xfersize=512k
wd=wd9,sd=sd9,rdpct=0,seek=-1,xfersize=512k

rd=asu_prefill,wd=wd*,iorate=max,elapsed=100h,interval=10
```

Primary Metrics Test, and Repeatability Tests

The content of SPC-1 Workload Generator command and parameter file, used in this benchmark to execute the Primary Metrics and Repeatability Tests, is listed below.

```
host=master
slaves=(cb38_1,cb38_2,cb38_3,cb38_4,cb38_5,cb38_6,cb38_7,cb38_8,cb38_9,cb38_10,cb38_
11,cb38_12,cb38_13,cb38_14,cb38_15,cb38_16,cb38_17,cb38_18,cb39_1,cb39_2,cb39_3,cb39
_4,cb39_5,cb39_6,cb39_7,cb39_8,cb39_9,cb39_10,cb39_11,cb39_12,cb39_13,cb39_14,cb39_1
5,cb39_16,cb39_17,cb39_18,cb39_19)

javaparms="-Xms1536m -Xmx2048m -Xss256k"

sd=asu1_1,lun=/dev/vgasu1/lvasu11,size=5913767313408
sd=asu1_2,lun=/dev/vgasu1/lvasu12,size=5913767313408
sd=asu1_3,lun=/dev/vgasu1/lvasu13,size=5913767313408
sd=asu1_4,lun=/dev/vgasu1/lvasu14,size=5913767313408

sd=asu2_1,lun=/dev/vgasu2/lvasu21,size=5913767313408
sd=asu2_2,lun=/dev/vgasu2/lvasu22,size=5913767313408
sd=asu2_3,lun=/dev/vgasu2/lvasu23,size=5913767313408
sd=asu2_4,lun=/dev/vgasu2/lvasu24,size=5913767313408

sd=asu3_1,lun=/dev/vgasu3/lvasu31,size=5256469544960
```

SPC-1 Persistence Test

The content of SPC-1 Workload Generator command and parameter file, used in this benchmark to execute the SPC-1 Persistence Test, is listed below.

```
javaparms="-Xms1536m -Xmx2048m -Xss256k"

sd=asu1_1,lun=/dev/vgasu1/lvasu11,size=5913767313408
sd=asu1_2,lun=/dev/vgasu1/lvasu12,size=5913767313408
sd=asu1_3,lun=/dev/vgasu1/lvasu13,size=5913767313408
sd=asu1_4,lun=/dev/vgasu1/lvasu14,size=5913767313408

sd=asu2_1,lun=/dev/vgasu2/lvasu21,size=5913767313408
sd=asu2_2,lun=/dev/vgasu2/lvasu22,size=5913767313408
sd=asu2_3,lun=/dev/vgasu2/lvasu23,size=5913767313408
sd=asu2_4,lun=/dev/vgasu2/lvasu24,size=5913767313408

sd=asu3_1,lun=/dev/vgasu3/lvasu31,size=5256469544960
```

Slave JVMs

Each Slave JVM was invoked with a command and parameter file similar to the example listed below. The only difference in each file was "host" parameter value, which was unique to each Slave JVM, e.g. **cb38_1…cb38_18,cb39_1…cb39_19**.

```
host=cb38_1
master=cb38

javaparms="-Xms1536m -Xmx2048m -Xss256k"

sd=asu1_1,lun=/dev/vgasu1/lvasu11,size=5913767313408
sd=asu1_2,lun=/dev/vgasu1/lvasu12,size=5913767313408
sd=asu1_3,lun=/dev/vgasu1/lvasu13,size=5913767313408
sd=asu1_4,lun=/dev/vgasu1/lvasu14,size=5913767313408

sd=asu2_1,lun=/dev/vgasu2/lvasu21,size=5913767313408
sd=asu2_2,lun=/dev/vgasu2/lvasu22,size=5913767313408
sd=asu2_3,lun=/dev/vgasu2/lvasu23,size=5913767313408
sd=asu2_4,lun=/dev/vgasu2/lvasu24,size=5913767313408

sd=asu3_1,lun=/dev/vgasu3/lvasu31,size=5256469544960
```

APPENDIX E: SPC-1 WORKLOAD GENERATOR INPUT PARAMETERS

ASU Pre-Fill, Primary Metrics Test, Repeatability Test and Persistence Test Run 1

The following 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)*, a reduced level SPC-1 Persistence Test Run 1 and Persistence SPC-2 Persistence Test Run 1 in an uninterrupted sequence.

```
#!/bin/bash

# Environment Variables
export LD_LIBRARY_PATH=/spc/spc1
export LIBPATH=/spc/spc1
export CLASSPATH=/spc/spc1
export PATH=/usr/java64/jre1.7.0_10/bin:$PATH

# Java Settings
XMS=1536m
XMX=2048m
XSS=256k

# Run ASU Prefill Using Vdbench 5.03 RC11
cd /spc/vdbench503rc11
vdbench -f prefill.parm -o prefill-out

# Run SPC-1 Metrics Test (8 Hours)
cd /spc/spc1
cp -p spc1.metrics.cfg spc1.cfg
/spc/spc1/startallslaves.sh
java -Xms$XMS -Xmx$XMX -Xss$XSS metrics -b 3630 -t 28800 -s 300
/spc/spc1/stopallslaves.sh

# Run SPC-1 Repeatability Test 1
/spc/spc1/startallslaves.sh
java -Xms$XMS -Xmx$XMX -Xss$XSS repeat1 -b 3630 -s 300
/spc/spc1/stopallslaves.sh

# Run SPC-1 Repeatability Test 2
/spc/spc1/startallslaves.sh
java -Xms$XMS -Xmx$XMX -Xss$XSS repeat2 -b 3630 -s 300
/spc/spc1/stopallslaves.sh

# Run SPC-1 Persistence Test 1
cp -p spc1.persist.cfg spc1.cfg
java -Xms$XMS -Xmx$XMX -Xss$XSS persist1 -b 3630
```

startallslaves.sh

This script will invoke, **slavestart_cb38.sh** and **slavestart_cb39.sh**, to start all of the Slave JVMs prior to the execution of the Primary Metrics and Repeatability Test Runs.

```
#!/bin/bash

ssh cb38 '/spc/spc1/slavestart_cb38.sh' &
sleep 10
ssh cb39 '/spc/spc1/slavestart_cb39.sh' &
sleep 10
```

stopallslaves.sh

This script will terminate all of the Slave JVMs at the end of each Test Run.

```
#!/bin/bash

ssh cb38 'pkill java'
sleep 10
ssh cb39 'pkill java'
sleep 10
```

slavestart_cb38.sh

```
#!/bin/bash

# Environment Settings
export LD_LIBRARY_PATH=/spc/spc1
export LIBPATH=/spc/spc1
export CLASSPATH=/spc/spc1
export PATH=/usr/java64/jre1.7.0_17/bin:$PATH

DATE=`date +%Y%m%d-%H%M`
SPCDIR=/spc/spc1
OUTDIR=$SPCDIR/slave.`hostname -s`.$DATE

# Java Settings
XMS=1536m
XMX=2048m
XSS=256k

# Create Output Directory
mkdir -p $OUTDIR

# Start Java Slave Processes
cd $SPCDIR
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave01.cfg -o $OUTDIR/slave01
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave02.cfg -o $OUTDIR/slave02
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave03.cfg -o $OUTDIR/slave03
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave04.cfg -o $OUTDIR/slave04
1>/dev/null 2>&1 &
sleep 1
```

```
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave05.cfg -o $OUTDIR/slave05
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave06.cfg -o $OUTDIR/slave06
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave07.cfg -o $OUTDIR/slave07
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave08.cfg -o $OUTDIR/slave08
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave09.cfg -o $OUTDIR/slave09
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave10.cfg -o $OUTDIR/slave10
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave11.cfg -o $OUTDIR/slave11
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave12.cfg -o $OUTDIR/slave12
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave13.cfg -o $OUTDIR/slave13
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave14.cfg -o $OUTDIR/slave14
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave15.cfg -o $OUTDIR/slave15
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave16.cfg -o $OUTDIR/slave16
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave17.cfg -o $OUTDIR/slave17
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave18.cfg -o $OUTDIR/slave18
1>/dev/null 2>&1 &
sleep 1
```

slavestart_cb39.sh

```
#!/bin/bash

# Environment Settings
export LD_LIBRARY_PATH=/spc/spc1
export LIBPATH=/spc/spc1
export CLASSPATH=/spc/spc1
export PATH=/usr/java64/jre1.7.0_17/bin:$PATH

DATE=`date +%Y%m%d-%H%M`
SPCDIR=/spc/spc1
OUTDIR=$SPCDIR/slave.`hostname -s`.$DATE

# Java Settings
XMS=1536m
XMX=2048m
XSS=256k
```

```
# Create Output Directory
mkdir -p $OUTDIR

# Start Java Slave Processes
cd $SPCDIR
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave01.cfg -o $OUTDIR/slave01
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave02.cfg -o $OUTDIR/slave02
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave03.cfg -o $OUTDIR/slave03
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave04.cfg -o $OUTDIR/slave04
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave05.cfg -o $OUTDIR/slave05
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave06.cfg -o $OUTDIR/slave06
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave07.cfg -o $OUTDIR/slave07
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave08.cfg -o $OUTDIR/slave08
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave09.cfg -o $OUTDIR/slave09
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave10.cfg -o $OUTDIR/slave10
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave11.cfg -o $OUTDIR/slave11
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave12.cfg -o $OUTDIR/slave12
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave13.cfg -o $OUTDIR/slave13
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave14.cfg -o $OUTDIR/slave14
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave15.cfg -o $OUTDIR/slave15
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave16.cfg -o $OUTDIR/slave16
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave17.cfg -o $OUTDIR/slave17
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave18.cfg -o $OUTDIR/slave18
1>/dev/null 2>&1 &
sleep 1
nohup java -Xms$XMS -Xmx$XMX -Xss$XSS spc1 -f slave19.cfg -o $OUTDIR/slave19
1>/dev/null 2>&1 &
sleep 1
```

Persistence Test Run 2

The following script was used to execute Persistence Test Run 2.

```
#!/bin/bash

# Environment Variables
export LD_LIBRARY_PATH=/spc/spc1
export LIBPATH=/spc/spc1
export CLASSPATH=/spc/spc1
export PATH=/usr/java64/jre1.7.0_10/bin:$PATH

# Java Settings
XMS=1536m
XMX=2048m
XSS=256k

# Run SPC-1 Persistence Test 2
cd /spc/spc1
java -Xms$XMS -Xmx$XMX -Xss$XSS persist2
```

APPENDIX F: THIRD-PARTY QUOTATIONS

Brocade 360 Switch

01/16/14

BROCADE

TO: Kien Tran

RE: HDS QUOTE

POs should be e-mailed to: HDS-OMDistribution@brocade.com

Product	Description	QTY	HDS PRICE	Total
HD-360-0008	Brocade 360 switch w/ 24 active ports,Full Fabric,24 SWL 8Gb BR SFPs, Fixed Rack Mount	1	$ 4,827.00	$ 4,827.00
(-M)	13 mos maintenance	1	$ 107.00	$ 107.00
HD-360-0008	Brocade 360 switch w/ 24 active ports,Full Fabric,24 SWL 8Gb BR SFPs, Fixed Rack Mount	1	$ 4,827.00	$ 4,827.00
(-M)	3 year support	1	$ 320.00	$ 320.00
				$ -
Total				$ 10,081.00

Yadira Aparicio
Account Manager
Brocade Communications

Emulex LPe12002-M8 HBAs and FC Cables

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Quotation

Quote #	Date
60547	03/20/2013

Sales Rep
Paul Albright
210-691-1715

For	Customer #HS1167	Phones
Kien Tran HITACHI Data Systems 2845 Lafayette Street Accounts Payable Santa Clara CA 95050-2627		Wk 408-327- Cel 561-889-6000 mwk 408-327-4282

PO #	Terms	Ship Date	Ship Via
	NET 30		

	Part	Description	Qty	Price	Extended
1)	*LPE12002-M8*	Emulex LightPulse LPe12002 Fibre Channel Host Bus Adapter LPE12002-M8 2CH 8GB PCIE 3.3/5V FC HBA LOW PROFILE W/STD BRACKET 2 x LC - PCI Express 2.0 - 8Gbps	4	1,380.00	5,520.00
2)	*2-LCLC-Z50RT-003M*	2-LCLC-Z50RT-003M LC-LC, 50/125 OM2 3MM ZIP RISER	20	21.50	430.00

Thank you,
Paul Albright

Quotes are valid for 30 days.
4730 Shavano Oak Suite 215
San Antonio, Texas 78249

Subtotal	5,950.00
TOTAL	**$5,950.00**

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