



**SPC BENCHMARK 1™
FULL DISCLOSURE REPORT**

**SUN MICROSYSTEMS, INC.
SUN STORAGE TEK® 6140 ARRAY**

SPC-1 V1.10.1

Submitted for Review: October 16, 2006

Submission Identifier: A00048

Accepted: December 15, 2006

Revised: February 19, 2007



First Edition – October 2006

THE INFORMATION CONTAINED IN THIS DOCUMENT IS DISTRIBUTED ON AN AS IS BASIS WITHOUT ANY WARRANTY EITHER EXPRESS OR IMPLIED. The use of this information or the implementation of any of these techniques is the customer's responsibility and depends on the customer's ability to evaluate and integrate them into the customer's operational environment. While each item has been reviewed by Sun Microsystems, Inc. for accuracy in a specific situation, there is no guarantee that the same or similar results will be obtained elsewhere. Customers attempting to adapt these techniques to their own environment do so at their own risk.

This publication was produced in the United States. Sun Microsystems, Inc. may not offer the products, services, or features discussed in this document in other countries, and the information is subject to change with notice. Consult your local Sun Microsystems, Inc. representative for information on products and services available in your area.

© Copyright Sun Microsystems, Inc. 2006. All rights reserved.

Permission is hereby granted to reproduce this document in whole or in part, provided the copyright notice as printed above is set forth in full text on the title page of each item reproduced.

Trademarks

SPC Benchmark 1, SPC-1 IOPS, and SPC-1 LRT are trademarks of the Storage Performance Council. Sun, Sun Microsystems, the Sun logo, Sun StorageTek, and Solaris are trademarks or registered trademarks of Sun Microsystems, Inc. in the United States and other countries. UNIX is a registered trademark of The Open Group in the United States and other countries. All other brands, trademarks, and product names are the property of their respective owners.

Table of Contents

Audit Certification	vii
Audit Certification (<i>cont.</i>)	viii
Letter of Good Faith	ix
Executive Summary	10
Test Sponsor and Contact Information	10
Revision Information and Key Dates	10
Tested Storage Product (TSP) Description	10
Summary of Results	11
Storage Capacities and Relationships	11
Response Time – Throughput Curve	12
Response Time – Throughput Data	12
Tested Storage Configuration Pricing (<i>Priced Storage Configuration</i>)	13
Differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration	13
Benchmark Configuration/Tested Storage Configuration Diagram	14
Benchmark Configuration/Tested Storage Configuration Components	14
Configuration Information	15
Benchmark Configuration (BC)/Tested Storage Configuration (TSC) Diagram	15
Storage Network Configuration	15
Host System Configuration	16
Customer Tunable Parameters and Options	16
Tested Storage Configuration (TSC) Description	16
SPC-1 Workload Generator Storage Configuration	17
SPC-1 Data Repository	18
Storage Capacities and Relationships	18
SPC-1 Storage Capacities	18
SPC-1 Storage Hierarchy Ratios	18
SPC-1 Storage Capacities and Relationships Illustration	19
Logical Volume Capacity and ASU Mapping	19
SPC-1 Benchmark Execution Results	20
SPC-1 Tests, Test Phases, and Test Runs	20
Primary Metrics Test – Sustainability Test Phase	21
SPC-1 Workload Generator Input Parameters	21
Sustainability Test Results File	21
Sustainability – Data Rate Distribution Data (<i>MB/second</i>).....	22

Sustainability – Data Rate Distribution Graph	23
Sustainability – I/O Request Throughput Distribution Data	24
Sustainability – I/O Request Throughput Distribution Graph	25
Sustainability – Average Response Time (ms) Distribution Data	25
Sustainability – Average Response Time (ms) Distribution Data	26
Sustainability – Average Response Time (ms) Distribution Graph	27
Sustainability – Response Time Frequency Distribution Data	28
Sustainability – Response Time Frequency Distribution Graph	28
Sustainability – Measured Intensity Multiplier and Coefficient of Variation.....	29
Primary Metrics Test – IOPS Test Phase.....	30
SPC-1 Workload Generator Input Parameters	30
IOPS Test Results File.....	30
IOPS Test Run – I/O Request Throughput Distribution Data	31
IOPS Test Run – I/O Request Throughput Distribution Graph.....	31
IOPS Test Run – Average Response Time (ms) Distribution Data	32
IOPS Test Run – Average Response Time (ms) Distribution Graph	32
IOPS Test Run – Response Time Frequency Distribution Data	33
IOPS Test Run –Response Time Frequency Distribution Graph.....	33
IOPS Test Run – I/O Request Information.....	34
IOPS Test Run – Measured Intensity Multiplier and Coefficient of Variation	34
Primary Metrics Test – Response Time Ramp Test Phase	35
SPC-1 Workload Generator Input Parameters	35
Response Time Ramp Test Results File.....	35
Response Time Ramp Distribution (IOPS) Data.....	36
Response Time Ramp Distribution (IOPS) Graph	37
SPC-1 LRT™ Average Response Time (ms) Distribution Data.....	38
SPC-1 LRT™ Average Response Time (ms) Distribution Graph	38
SPC-1 LRT™ (10%) – Measured Intensity Multiplier and Coefficient of Variation	39
Repeatability Test	40
SPC-1 Workload Generator Input Parameters	40
Repeatability Test Results File	41
Repeatability 1 LRT – I/O Request Throughput Distribution Data.....	42
Repeatability 1 LRT – I/O Request Throughput Distribution Graph	42
Repeatability 1 LRT –Average Response Time (ms) Distribution Data	43
Repeatability 1 LRT –Average Response Time (ms) Distribution Graph.....	43
Repeatability 1 IOPS – I/O Request Throughput Distribution Data	44
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph.....	44
Repeatability 1 IOPS –Average Response Time (ms) Distribution Data	45
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph	45

Repeatability 2 LRT – I/O Request Throughput Distribution Data.....	46
Repeatability 2 LRT – I/O Request Throughput Distribution Graph	46
Repeatability 2 LRT –Average Response Time (ms) Distribution Data	47
Repeatability 2 LRT –Average Response Time (ms) Distribution Graph.....	47
Repeatability 2 IOPS – I/O Request Throughput Distribution Data	48
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph.....	48
Repeatability 2 IOPS –Average Response Time (ms) Distribution Data.....	49
Repeatability 2 IOPS –Average Response Time (ms) Distribution Graph	49
Repeatability 1 (LRT) Measured Intensity Multiplier and Coefficient of Variation.....	50
Repeatability 1 (IOPS) Measured Intensity Multiplier and Coefficient of Variation	50
Repeatability 2 (LRT) Measured Intensity Multiplier and Coefficient of Variation.....	50
Repeatability 2 (IOPS) Measured Intensity Multiplier and Coefficient of Variation	51
Data Persistence Test.....	52
SPC-1 Workload Generator Input Parameters	52
Data Persistence Test Results File	52
Data Persistence Test Results.....	53
Priced Storage Configuration Availability Date.....	54
Pricing Information.....	54
Anomalies or Irregularities	54
Appendix A: SPC-1 Glossary	55
“Decimal” (<i>powers of ten</i>) Measurement Units.....	55
“Binary” (<i>powers of two</i>) Measurement Units.....	55
SPC-1 Data Repository Definitions.....	55
SPC-1 Data Protection Levels	56
SPC-1 Test Execution Definitions	56
I/O Completion Types	58
SPC-1 Test Run Components.....	58
Appendix B: Customer Tunable Parameters and Options.....	59
Solaris Parameters.....	59
Host Bus Adapter (HBA) Options	59
LUN Parameters	59
Appendix C: Tested Storage Configuration (TSC) Creation	60
Create RAID 1 LUNs	60
spc1-6140-cfg.txt.....	60
LUN discovery via Solaris 10.....	71
config-6140-spc1.sh	71

Appendix D: SPC-1 Workload Generator Storage Commands and Parameters 74

Appendix E: SPC-1 Workload Generator Input Parameters 75

runspc16140.sh.....75

runspc16140-P2.sh.....76

AUDIT CERTIFICATION



Leah Schoeb
Sun Microsystems, Inc.
5300 Riata Park Court AUS08
Austin, TX 78721

October 16, 2006

The SPC Benchmark 1™ results listed below for the Sun StorageTek® 6140 Array were produced in compliance with the SPC Benchmark 1™ V1.10.1 Remote Audit requirements.

SPC Benchmark 1™ V1.10.1 Results	
Tested Storage Configuration (TSC) Name:	
Sun StorageTek® 6140 Array	
Metric	Reported Result
SPC-1 IOPS™	17,395.53
SPC-1 Price-Performance	\$4.91/SPC-1 IOPS™
Total ASU Capacity	1,963,269 GB
Data Protection Level	Mirroring
Total TSC Price (including three-year maintenance)	\$85,424

The following SPC Benchmark 1™ Remote Audit requirements were reviewed and found compliant with V1.10.1 of the SPC Benchmark 1™ specification:

- A Letter of Good Faith, signed by a senior executive.
- The following Data Repository storage items were verified using information supplied by Sun Microsystems, Inc.:
 - ✓ 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.
- An appropriate diagram of the Benchmark Configuration (BC)/Tested Storage Configuration (TSC).
- Listings and commands to configure the Benchmark Configuration/Tested Storage Configuration, including customer tunable parameters.

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

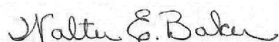
AUDIT CERTIFICATION (CONT.)

Sun StorageTek® 6140 Array
SPC-1 Audit Certification

Page 2

- Commands and parameters used to configure the SPC-1 Workload Generator.
- The following Host System requirements were reviewed using documentation supplied by Sun Microsystems, Inc.:
 - ✓ The type of Host System including the number of processors and main memory.
 - ✓ The presence and version number of the Workload Generator on the Host System.
 - ✓ The TSC boundary within the Host System.
- The Test Results Files and resultant Summary Results Files received from Sun Microsystems, Inc. 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
- The difference documented between the Tested Storage Configuration (TSC) used for the benchmark and Priced Storage Configuration would have no performance impact if the TSC was configured identical to the Priced Storage Configuration.
- The final version of the pricing spreadsheet 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.

Respectfully,



Walter E. Baker
SPC Auditor

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

LETTER OF GOOD FAITH

Sun Microsystems, Inc.
Mailstop UMPK17-302
17 Network Circle
Menlo Park, CA 95025



Date: 10/11/06

From: Paul Giroux

To: Walter Baker

Subject: SPC-1 Letter of Good Faith for the Sun StorageTek® 6140

Sun Microsystems Inc. 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 V1.10.1 of the SPC-1 benchmark specification.

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

Signed:

A handwritten signature in cursive script, reading "Paul Giroux Oct 12/06", written over a horizontal line.

Paul Giroux
Vice President, Business & Marketing Operations, Storage Group

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	Sun Microsystems, Inc. – http://www.sun.com Leah Schoeb – leah.schoeb@sun.com 5300 Riata Park Court AUS08 Austin, TX 78721 Phone: (512) 401-1227 FAX: (512) 266-2523
Test Sponsor Alternate Contact	Sun Microsystems, Inc. – http://www.sun.com Jason Schaffer – jason.schaffer@sun.com 500 Eldorado Blvd. Broomfield, CO 80021 Phone: (303) 272-4743 FAX: (512) 266-2523
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	V1.10.1
SPC-1 Workload Generator revision number	V2.00.04a
Date Results were first used publicly	October 16, 2006
Date the FDR was submitted to the SPC	October 16, 2006
Date revised FDR was submitted to the SPC: Revised Total Price and SPC-1 Price-Performance	February 19, 2007
Date the TSP is available for shipment to customers	August 10, 2006
Date the TSP completed audit certification	October 16, 2006

Tested Storage Product (TSP) Description

The Sun StorageTek® 6140 Array is one of the first products in the Sun StorageTek modular storage family. The StorageTek modular storage family is designed for customers seeking to support business-critical applications and for Service Providers looking for a cost-effective, easy-to-use enterprise-class platform with the ability to confidently handle large data sets. Through common storage modules, common array management, and common data services, Sun's new modular storage helps customers preserve the investments they've made in people, processes and infrastructure.

The Sun StorageTek® 6140 Array is a ROHS-compliant, 4 gigabits-per-second (Gb/sec) Fibre Channel (FC) array designed for both direct attached and SAN attached storage. The system features a fully redundant architecture with drive intermixing (FC or SATA-2 disk drives), 8 x 4 Gb FC ports, 4 GB cache, application-oriented management, switched drive connectivity and a maximum capacity of 112 disk drives.

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: Sun StorageTek® 6140 Array	
Metric	Reported Result
SPC-1 IOPS™	17,395.53
SPC-1 Price-Performance	\$4.93/SPC-1 IOPS™
Total ASU Capacity	1,963.269 GB
Data Protection Level	Mirroring
Total TSC Price (including three-year maintenance)	\$85,823

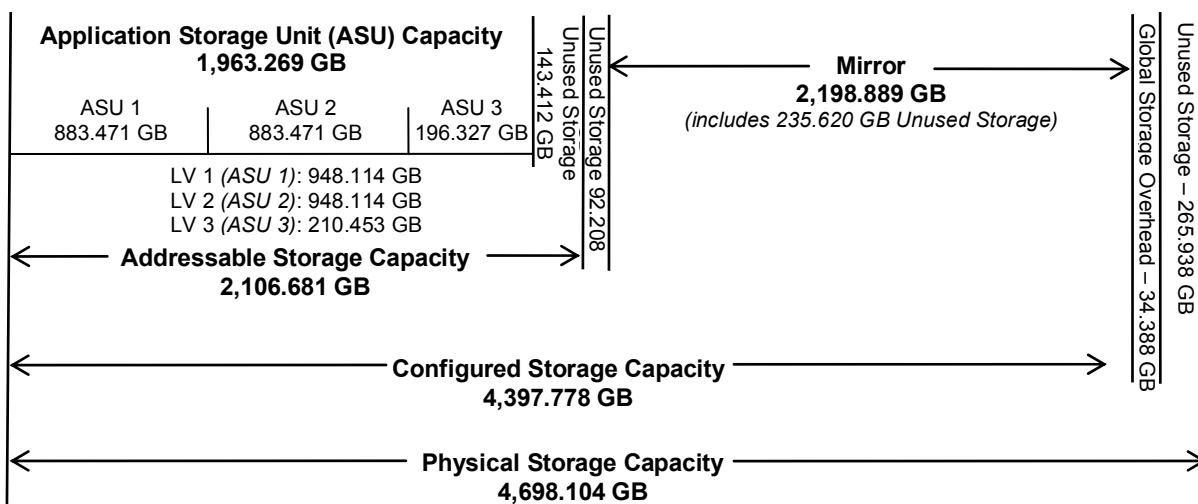
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

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

A Data Protection Level of Mirroring configures two or more identical copies of user data.

Storage Capacities and Relationships

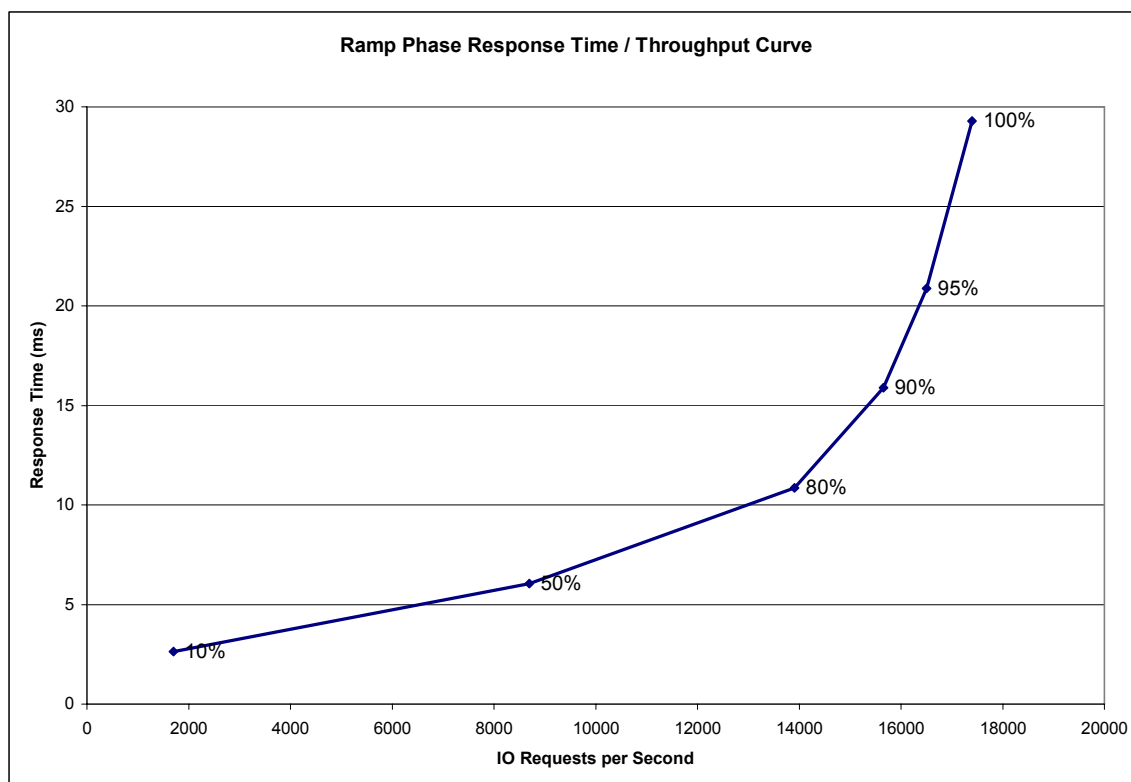
The following diagram documents the various storage capacities, used in this benchmark, and their relationships.



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	1,700.48	8,698.24	13,904.91	15,652.90	16,499.34	17,395.53
Average Response Time (ms):						
All ASUs	2.64	6.05	10.87	15.90	20.88	29.29
ASU-1	3.18	6.67	11.58	16.45	21.21	29.49
ASU-2	3.10	7.78	16.19	23.29	29.57	39.55
ASU-3	1.30	3.98	7.02	11.51	16.37	24.37
Reads	4.77	9.33	16.90	22.82	28.12	37.25
Writes	1.26	3.91	6.94	11.39	16.16	24.10

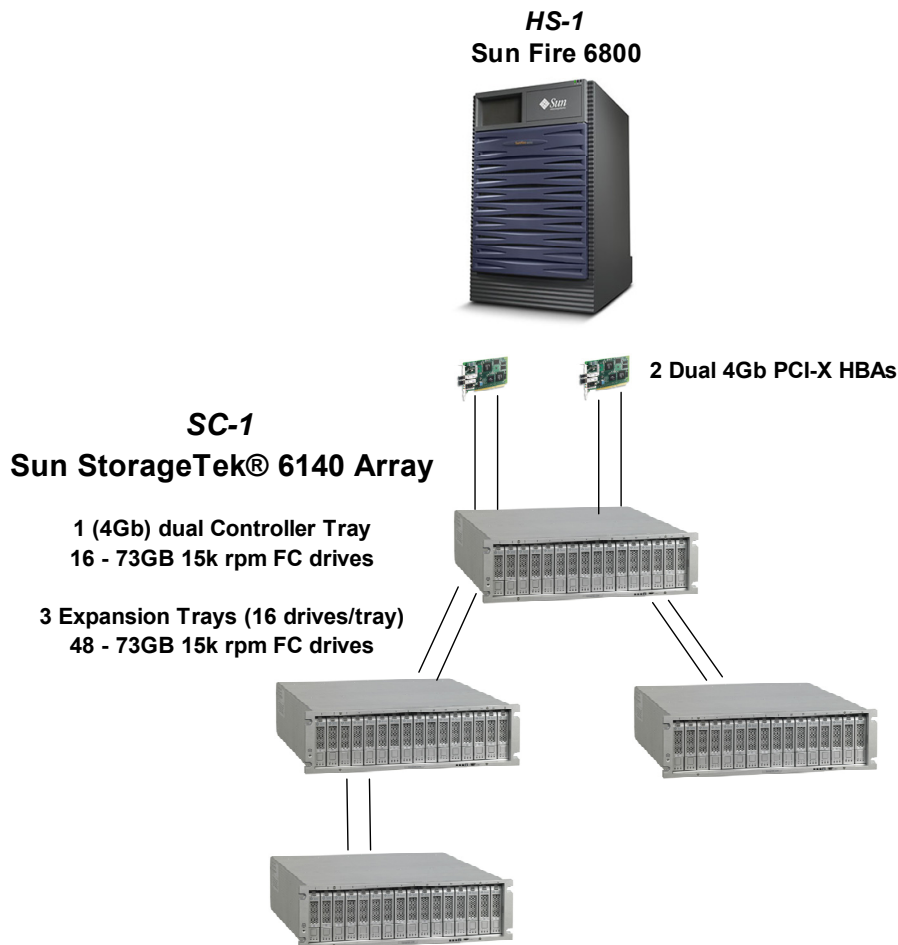
Tested Storage Configuration Pricing (*Priced Storage Configuration*)

XTC6140R11A2B1168	Dual Controller with 1x1x16x73G15K	1	\$48,895	\$48,895	39%	\$29,826
	- 2 Controllers w/ 2GB cache each					
	- 16 73GB 15k rpm drives					
	- All required cables included					
XTCCSM2R01A0B1168	FC Expansion tray 0x1x16x73G15K	3	\$26,395	\$79,185	39%	\$48,303
	- 16 73GB 15k rpm drives					
	- All required cables included					
SG-XPCI2FC-QF4	4Gb PCI-X Dual FC Host Based Adapter	2	\$2,530	\$5,060	39%	\$3,087
W9D-ST6140-4-3G	Controller unit upgrade 3 year Gold Service Maintenance	1	\$2,988	\$2,988		\$2,988
	- 7/24 coverage					
	- 4 hr response time					
	- 4 hour resolution					
W9D-ST6140-4-3G	Expansion unit upgrade 3 year Gold Service Maintenance	1	\$1,620	\$1,620		\$1,620
	- 7/24 coverage					
	- 4 hr response time					
	- 4 hour resolution					
Total				\$137,748		\$85,823

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

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

Benchmark Configuration/Tested Storage Configuration Diagram



Benchmark Configuration/Tested Storage Configuration Components

Host System:	Tested Storage Configuration (TSC):
UID=HS-1 SunFire 6800	2 – 4 Gb dual port FC PCI-X HBAs
12 – 1.2 GHz dual core UltraSPARC-IV processors 64 KB L1 cache per core, 2 MB L2 shared per dual core 32 MB L3 shared per dual core	UID=SC-1: Sun StorageTek® 6140 Array 1 Dual Controller 2 GB cache per controller (4 GB total)
48 GB main memory	4 host connections (<i>front end</i>) 2 drive connections (<i>backend</i>)
Solaris 10 FCS	3 – FC Expansion Trays
PCI-X	64 – 73 GB 15K RPM disk drives
WG	

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 9.2.4.4.1

A one page Benchmark Configuration (BC)/Tested Storage Configuration (TSC) diagram shall be included in the Executive Summary...

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC) is illustrated on page 14 (*Benchmark Configuration/Tested Storage Configuration Diagram*).

Storage Network Configuration

Clause 9.2.4.4.1

...

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 9.2.4.4.2.*

Clause 9.2.4.4.2

If a storage network was configured as a part of the Tested Storage Configuration and the Benchmark Configuration diagram described in Clause 9.2.4.4.1 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 Configuration

Clause 9.2.4.4.3

The FDR shall minimally contain, for each Host System running the Workload Generator, a listing of the following:

1. Number and type of CPUs.
2. Main memory capacity.
3. Cache memory capacity.
4. Number and type of disk controllers or Host Bus Adapters.

The details of the Host System configuration may be found on page 14 (*Benchmark Configuration/ Tested Storage Configuration Diagram*).

Customer Tunable Parameters and Options

Clause 9.2.4.5.1

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 59 contains the customer tunable parameters and options that have been altered from their default values for this benchmark.

Tested Storage Configuration (TSC) Description

Clause 9.2.4.5.2

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 60 contains the detailed information that describes how to create and configure the logical TSC.

SPC-1 Workload Generator Storage Configuration

Clause 9.2.4.5.3

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 74.

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 55 contains definitions of terms specific to the SPC-1 Data Repository.

Storage Capacities and Relationships

Clause 9.2.4.6.1

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

SPC-1 Storage Capacities		
Storage Hierarchy Component	Units	Capacity
Total ASU Capacity	Gigabytes (GB)	1,963.269
Addressable Storage Capacity	Gigabytes (GB)	2,106.681
Configured Storage Capacity	Gigabytes (GB)	4,397.778
Physical Storage Capacity	Gigabytes (GB)	4,698.104
Data Protection (Mirroring)	Gigabytes (GB)	2,198.889
Required Storage	Gigabytes (GB)	0.000
Global Storage Overhead	Gigabytes (GB)	34.388
Total Unused Storage	Gigabytes (GB)	737.178

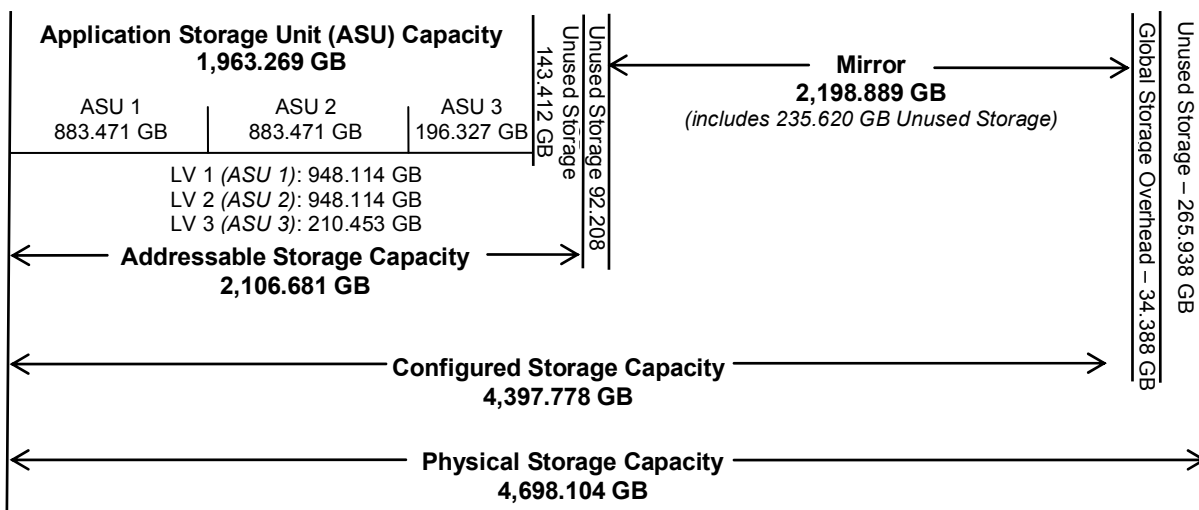
SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	Configured Storage Capacity	Physical Storage Capacity
Total ASU Capacity	93.19%	44.64%	41.79%
Required for Data Protection (Mirroring)		50.00%	46.80%
Addressable Storage Capacity		47.90%	44.84%
Required Storage		0.00%	0.00%
Configured Storage Capacity			93.61%
Global Storage Overhead			0.73%
Unused Storage:			
Addressable	13.62%		
Configured		4.19%	
Physical			5.66%

The Physical Storage Capacity consisted of 4,698.104 GB distributed over 64 disk drives each with a formatted capacity of 73.431 GB. There was 265.940 GB (5.66%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 34.388 GB (0.73%) of Physical Storage Capacity. There was 184.415 GB (4.19%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 93.19% of the Addressable Storage Capacity resulting in 286.825 GB (13.62%) of Unused Storage within the Addressable Storage Capacity.

SPC-1 Storage Capacities and Relationships Illustration

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



Logical Volume Capacity and ASU Mapping

Clause 9.2.4.6.2

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 (883.471 GB)	ASU-2 (883.471 GB)	ASU-3 (196.327GB)
1 Logical Volume 948.114 GB per Logical Volume (883.471 GB used per Logical Volume)	1 Logical Volume 948.114 GB per Logical Volume (883.471 GB used per Logical Volume)	1 Logical Volume 210.453 GB per Logical Volume (196.327 GB used per Logical Volume)

The Data Protection Level used for all Logical Volumes was Mirroring as described on page 11. 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. “SPC-1 Test Execution Definitions” on page 56 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 three (3) 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 9.2.4.7.1

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

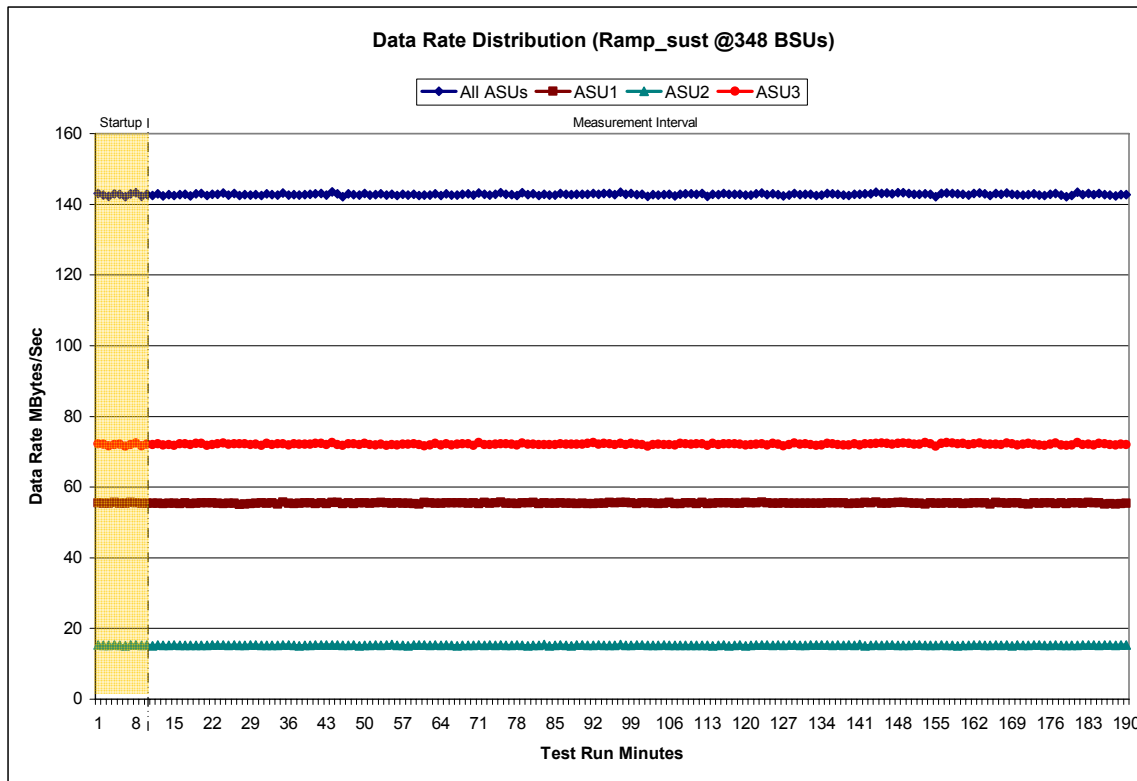
The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in “Appendix E: SPC-1 Workload Generator Input Parameters” on Page 75.

Sustainability Test Results File

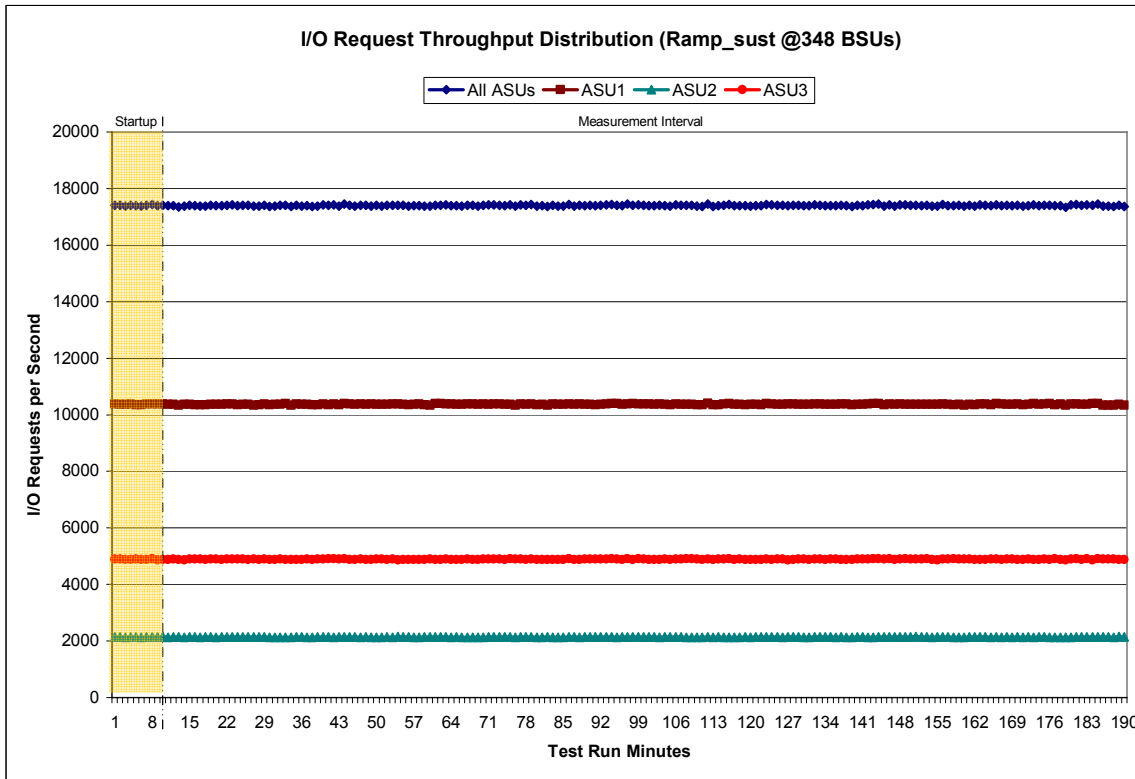
A link to the test results file generated from the Sustainability Test Run is listed below.

[Sustainability Test Results File](#)

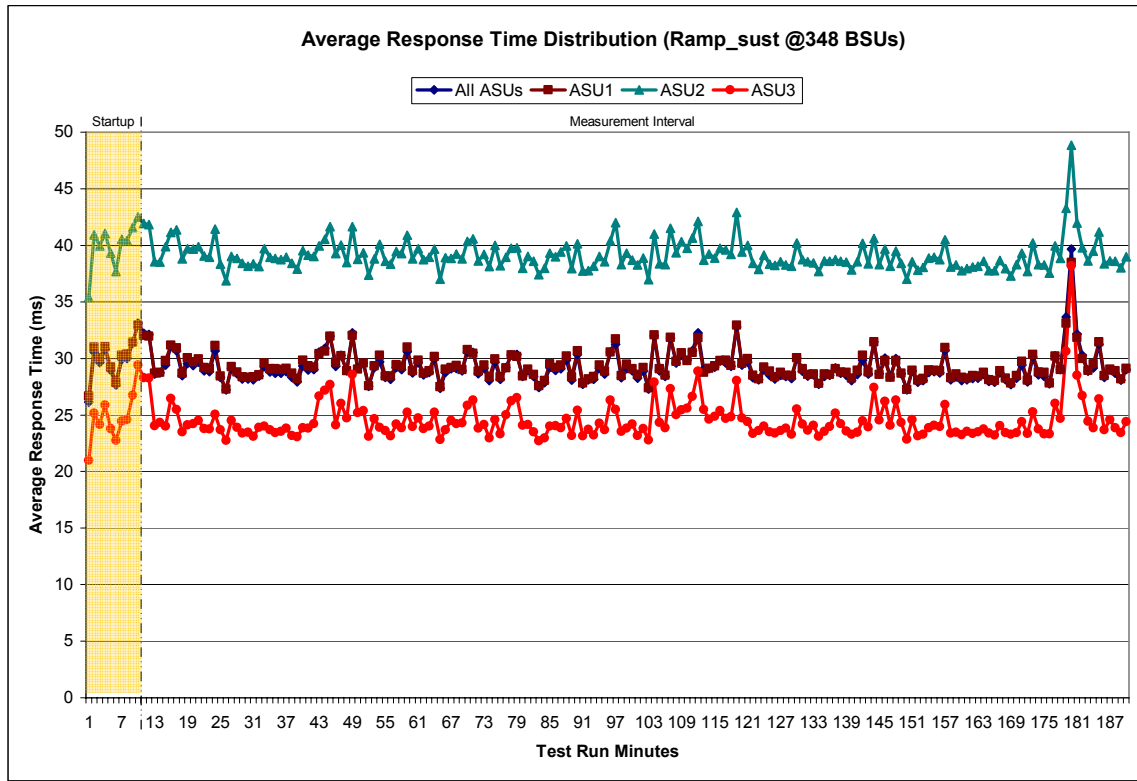
Sustainability – Data Rate Distribution Graph



Sustainability – I/O Request Throughput Distribution Graph



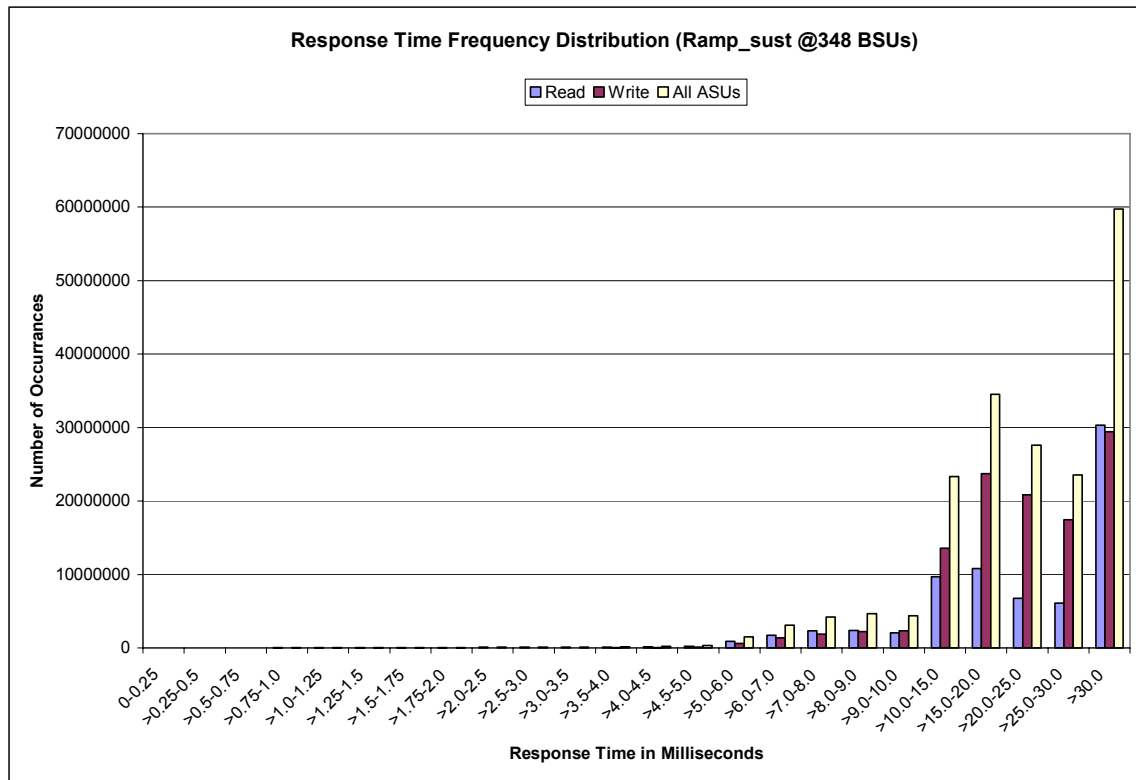
Sustainability – Average Response Time (ms) Distribution Graph



Sustainability – Response Time Frequency Distribution Data

Response Time Frequency Distribution								
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	62	9,302	26,044	40,567	46,538	48,026	48,259	49,968
Write	-	-	82	752	1,989	3,084	3,816	4,024
All ASUs	62	9,302	26,126	41,319	48,527	51,110	52,075	53,992
ASU1	59	8,571	24,158	38,090	44,173	46,073	46,649	48,421
ASU2	3	731	1,958	3,044	3,726	3,915	4,036	4,186
ASU3	-	-	10	185	628	1,122	1,390	1,385
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	101,083	99,163	100,339	115,156	154,504	228,621	895,838	1,710,964
Write	9,906	14,796	25,827	46,102	75,547	127,863	625,912	1,381,294
All ASUs	110,989	113,959	126,166	161,258	230,051	356,484	1,521,750	3,092,258
ASU1	98,584	99,364	105,570	129,347	181,064	275,484	1,129,807	2,202,425
ASU2	8,933	9,227	10,986	14,377	20,039	30,585	131,366	287,156
ASU3	3,472	5,368	9,610	17,534	28,948	50,415	260,577	602,677
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	2,309,182	2,398,617	2,054,835	9,715,471	10,799,334	6,770,270	6,073,892	30,314,029
Write	1,908,233	2,236,216	2,311,391	13,596,668	23,738,657	20,823,831	17,472,290	29,405,600
All ASUs	4,217,415	4,634,833	4,366,226	23,312,139	34,537,991	27,594,101	23,546,182	59,719,629
ASU1	2,941,666	3,137,591	2,863,417	14,719,375	20,003,012	15,120,015	12,772,918	35,959,742
ASU2	426,383	495,525	467,344	2,533,078	3,836,128	2,959,889	2,578,113	9,283,902
ASU3	849,366	1,001,717	1,035,465	6,059,686	10,698,851	9,514,197	8,195,151	14,475,985

Sustainability – Response Time Frequency Distribution Graph



Sustainability – Measured Intensity Multiplier and Coefficient of Variation

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
<i>IM</i>	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
<i>MIM</i>	0.0350	0.2809	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
<i>COV</i>	0.005	0.002	0.003	0.002	0.008	0.004	0.005	0.002

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 5.1.0 and 5.3.13.2

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 5.3.13.3

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

Primary Metrics Test – IOPS Test Phase

Clause 5.4.2.2

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 9.2.4.7.2

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 75.

IOPS Test Results File

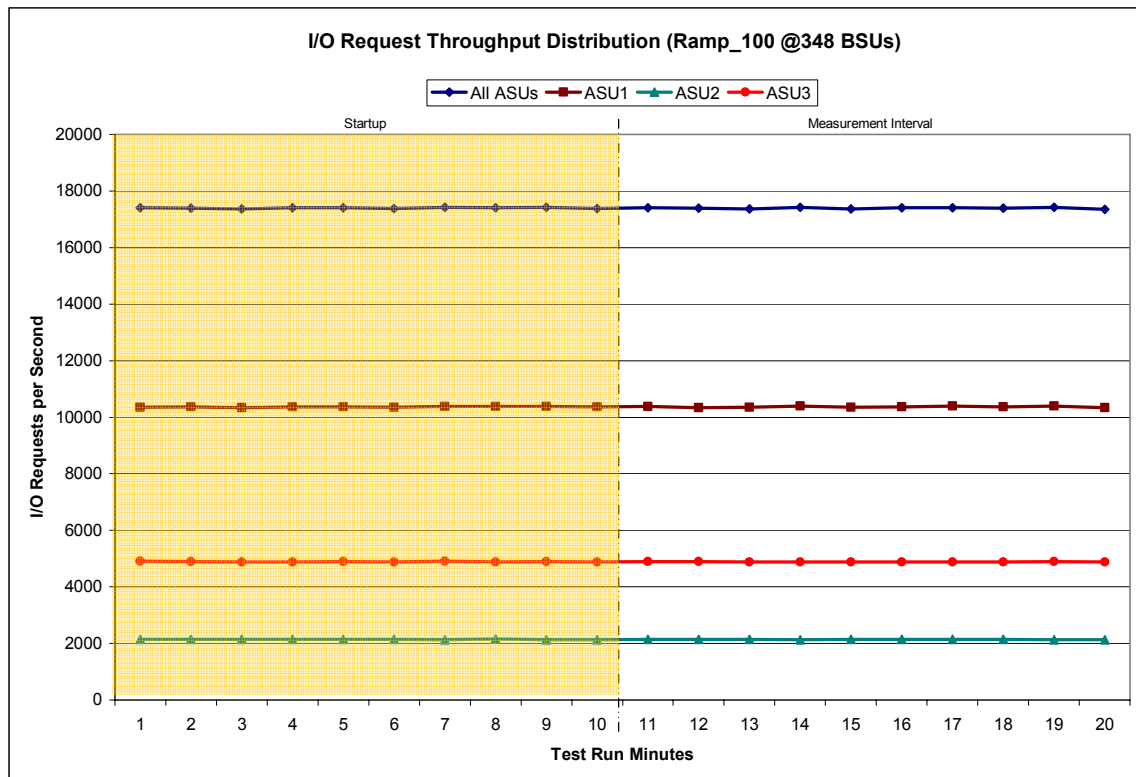
A link to the test results file generated from the IOPS Test Run is listed below.

[IOPS Test Results File](#)

IOPS Test Run – I/O Request Throughput Distribution Data

348 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:31:34	19:41:35	0-9	0:10:01
Measurement Interval	19:41:35	19:51:35	10-19	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	17,405.02	10,351.93	2,146.83	4,906.25
1	17,399.23	10,365.68	2,141.92	4,891.63
2	17,364.00	10,340.67	2,141.05	4,882.28
3	17,401.30	10,371.15	2,148.93	4,881.22
4	17,406.47	10,366.03	2,143.42	4,897.02
5	17,379.45	10,350.65	2,144.40	4,884.40
6	17,429.45	10,385.00	2,136.88	4,907.57
7	17,403.88	10,374.87	2,154.60	4,874.42
8	17,420.82	10,387.57	2,134.67	4,898.58
9	17,383.08	10,372.27	2,135.07	4,875.75
10	17,409.93	10,374.85	2,138.88	4,896.20
11	17,388.22	10,343.20	2,145.10	4,899.92
12	17,369.47	10,346.17	2,140.53	4,882.77
13	17,424.33	10,400.42	2,136.58	4,887.33
14	17,371.15	10,347.60	2,139.52	4,884.03
15	17,409.82	10,374.32	2,148.13	4,887.37
16	17,412.43	10,390.87	2,140.93	4,880.63
17	17,396.40	10,370.78	2,140.78	4,884.83
18	17,419.47	10,394.70	2,135.88	4,888.88
19	17,354.07	10,343.35	2,132.65	4,878.07
Average	17,395.53	10,368.63	2,139.90	4,887.00

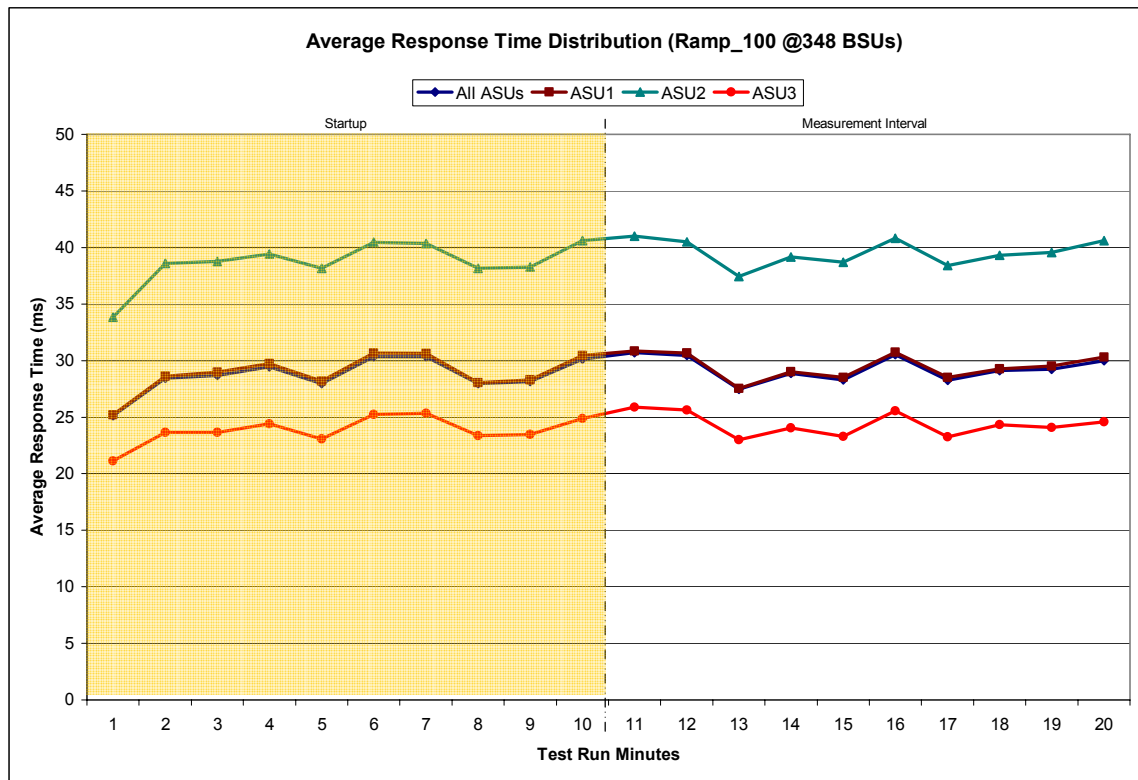
IOPS Test Run – I/O Request Throughput Distribution Graph



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

348 BSUs Start-Up/Ramp-Up Measurement Interval	Start 19:31:34	Stop 19:41:35	Interval 0-9	Duration 0:10:01
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	25.13	25.21	33.85	21.13
1	28.44	28.61	38.57	23.65
2	28.69	28.98	38.76	23.65
3	29.43	29.72	39.41	24.42
4	27.99	28.20	38.15	23.09
5	30.35	30.66	40.46	25.24
6	30.35	30.65	40.35	25.36
7	27.98	28.05	38.15	23.35
8	28.16	28.30	38.26	23.45
9	30.13	30.45	40.60	24.86
10	30.69	30.83	41.00	25.87
11	30.46	30.67	40.48	25.64
12	27.48	27.52	37.42	23.01
13	28.87	29.01	39.15	24.05
14	28.29	28.49	38.70	23.29
15	30.53	30.74	40.84	25.56
16	28.27	28.53	38.40	23.26
17	29.12	29.26	39.32	24.33
18	29.23	29.53	39.57	24.07
19	29.97	30.32	40.61	24.58
Average	29.29	29.49	39.55	24.37

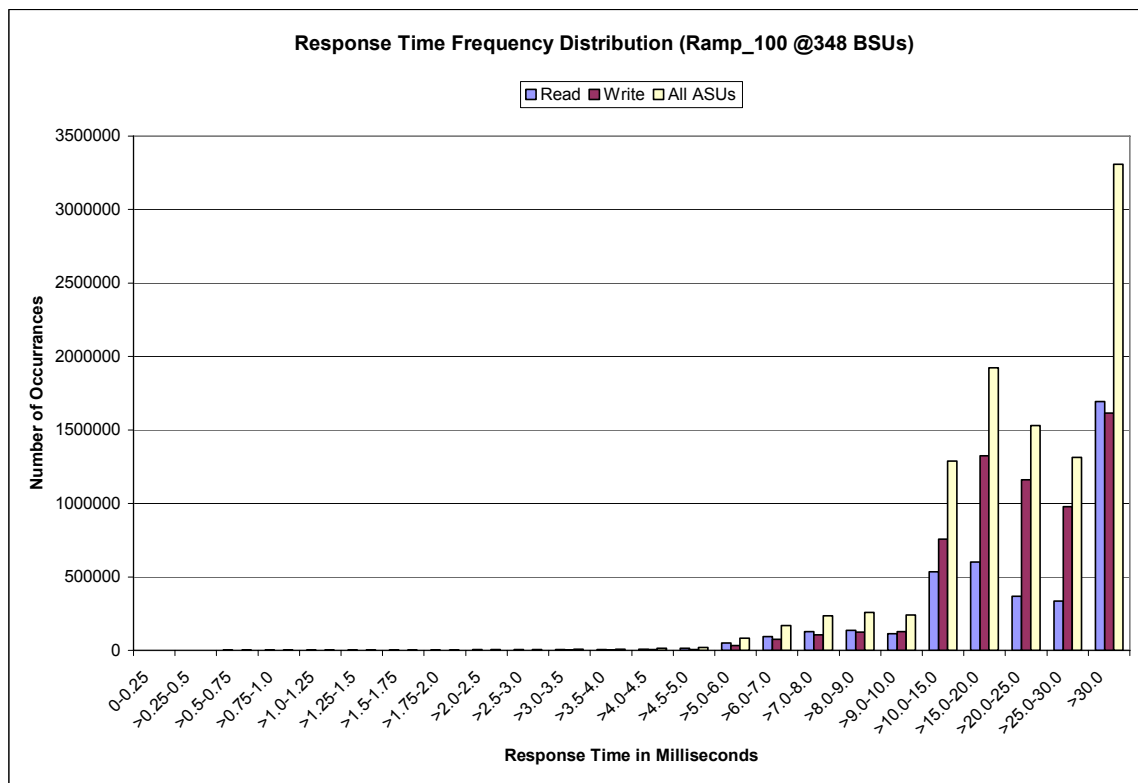
IOPS Test Run – Average Response Time (ms) Distribution Graph



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	4	593	1,698	2,562	2,888	2,969	3,077	3,132
Write	0	0	3	31	63	196	188	198
All ASUs	4	593	1,701	2,593	2,951	3,165	3,265	3,330
ASU1	3	544	1,579	2,418	2,721	2,888	2,958	3,019
ASU2	1	49	122	166	209	211	233	247
ASU3	0	0	0	9	21	66	74	64
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	6,236	6,100	6,143	6,797	8,740	12,668	49,280	95,134
Write	568	782	1,441	2,594	4,305	6,677	33,663	75,274
All ASUs	6,804	6,882	7,584	9,391	13,045	19,345	82,943	170,408
ASU1	6,096	6,075	6,428	7,595	10,253	15,104	61,824	121,730
ASU2	509	522	635	808	1,115	1,605	7,125	15,662
ASU3	199	285	521	988	1,677	2,636	13,994	33,016
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	128,536	134,726	114,300	534,151	600,777	369,646	335,009	1,692,071
Write	106,648	123,319	128,079	755,318	1,323,647	1,161,037	978,593	1,616,901
All ASUs	235,184	258,045	242,379	1,289,469	1,924,424	1,530,683	1,313,602	3,308,972
ASU1	163,989	175,377	159,249	810,471	1,111,319	833,844	711,628	2,003,744
ASU2	23,538	27,372	25,617	139,890	212,738	163,647	143,665	518,152
ASU3	47,657	55,296	57,513	339,108	600,367	533,192	458,309	787,076

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
10,436,762	7,127,790	3,308,972

IOPS Test Run – 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	0.0701	0.2100	0.0179	0.0701	0.0350	0.2809
COV	0.006	0.002	0.003	0.002	0.006	0.003	0.004	0.002

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 5.1.0 and 5.3.13.2

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 5.3.13.3

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

Primary Metrics Test – Response Time Ramp Test Phase

Clause 5.4.2.3

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 12.

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 9.2.4.7.3

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 75.

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](#)

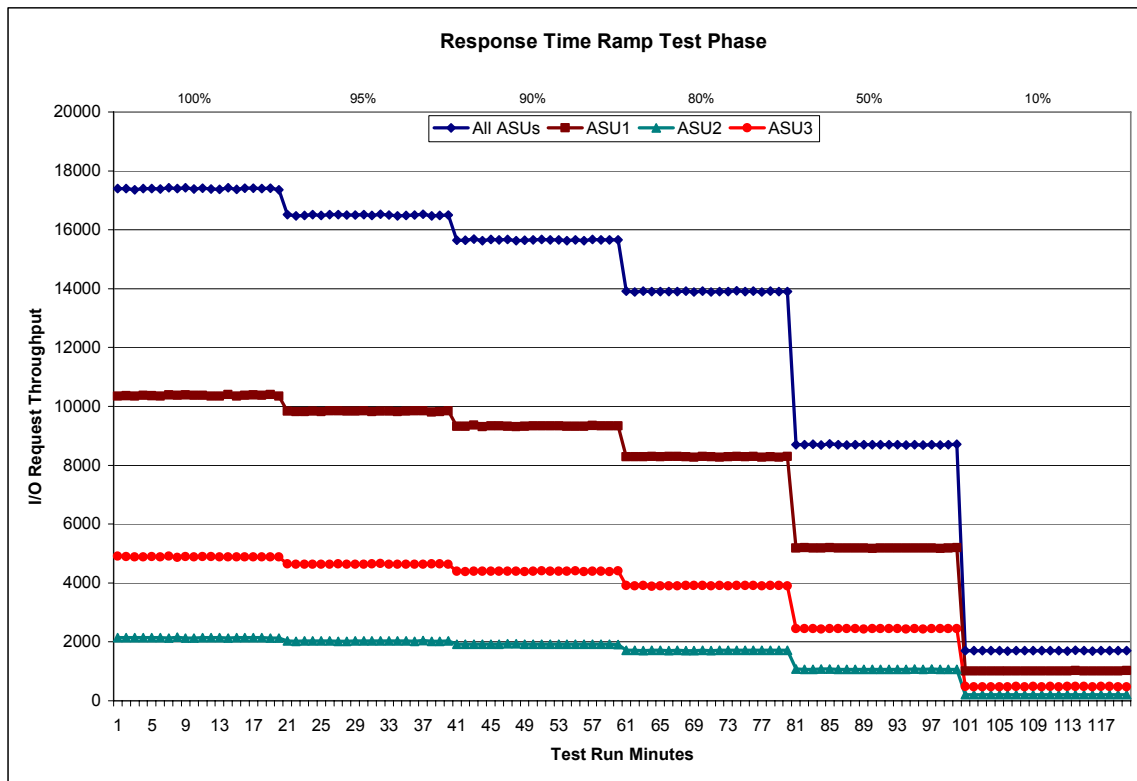
[90% Load Level](#)

[80% Load Level](#)

[50% Load Level](#)

[10% Load Level](#)

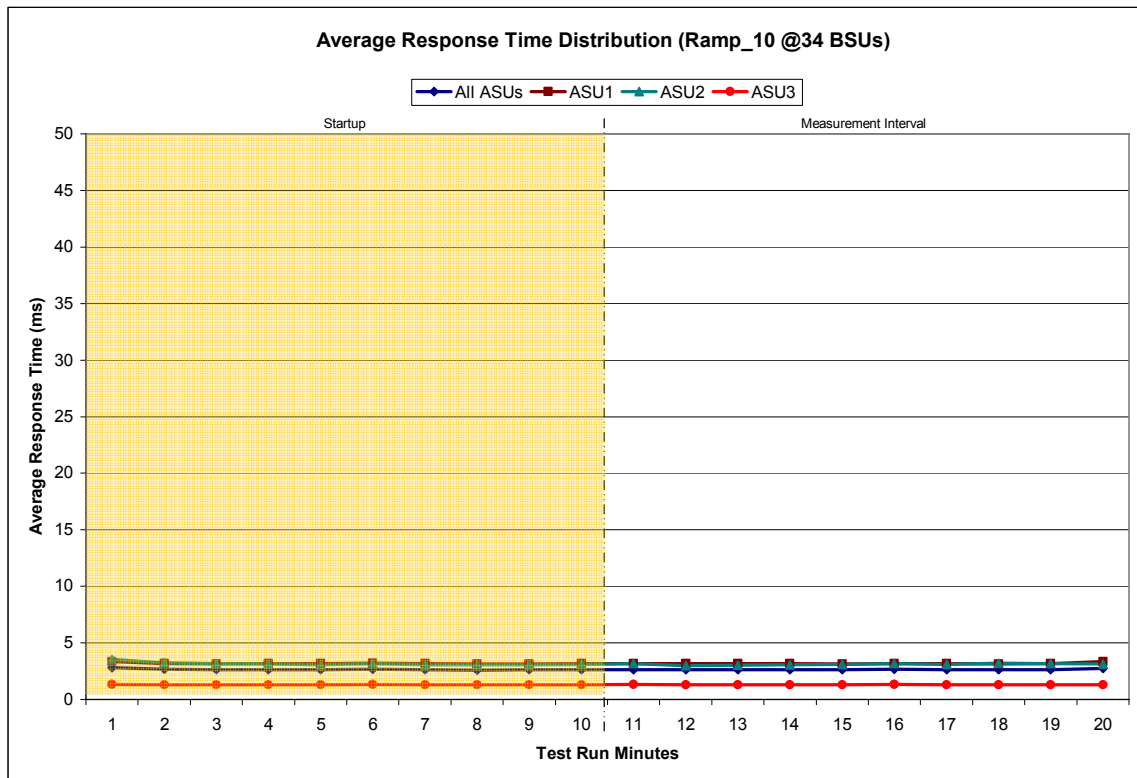
Response Time Ramp Distribution (IOPS) Graph



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

34 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	21:12:05	21:22:05	0-9	0:10:00
<i>Measurement Interval</i>	21:22:05	21:32:05	10-19	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	2.81	3.36	3.52	1.33
1	2.66	3.17	3.26	1.30
2	2.62	3.14	3.15	1.28
3	2.64	3.16	3.13	1.31
4	2.63	3.17	3.08	1.29
5	2.67	3.20	3.18	1.32
6	2.62	3.17	3.04	1.29
7	2.61	3.13	3.07	1.29
8	2.61	3.14	3.05	1.30
9	2.62	3.15	3.08	1.30
10	2.64	3.17	3.16	1.32
11	2.62	3.15	3.00	1.31
12	2.61	3.15	3.01	1.30
13	2.63	3.17	3.05	1.30
14	2.61	3.14	3.08	1.30
15	2.66	3.18	3.16	1.34
16	2.64	3.17	3.09	1.31
17	2.63	3.15	3.20	1.29
18	2.64	3.17	3.15	1.29
19	2.74	3.33	3.14	1.28
Average	2.64	3.18	3.10	1.30

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



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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
<i>IM</i>	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
<i>MIM</i>	0.0349	0.2816	0.0700	0.2097	0.0180	0.0698	0.0351	0.2809
<i>COV</i>	0.018	0.006	0.012	0.007	0.015	0.010	0.018	0.005

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 5.1.0 and 5.3.13.2

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 5.3.13.3

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

Repeatability Test

Clause 5.4.5

The Repeatability Test demonstrates the repeatability and reproducibility of the SPC-1 IOPS™ primary metric and 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%.

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 9.2.4.7.4

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 75.

Repeatability Test Results File

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

	SPC-1 IOPS™	SPC-1 LRT™
Primary Metrics	17,395.53	2.64
Repeatability Test Phase 1	17,395.33	2.62
Repeatability Test Phase 2	17,398.22	2.64

A link to the test result file generated from each Repeatability Test Run list 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 \(LRT\)](#)

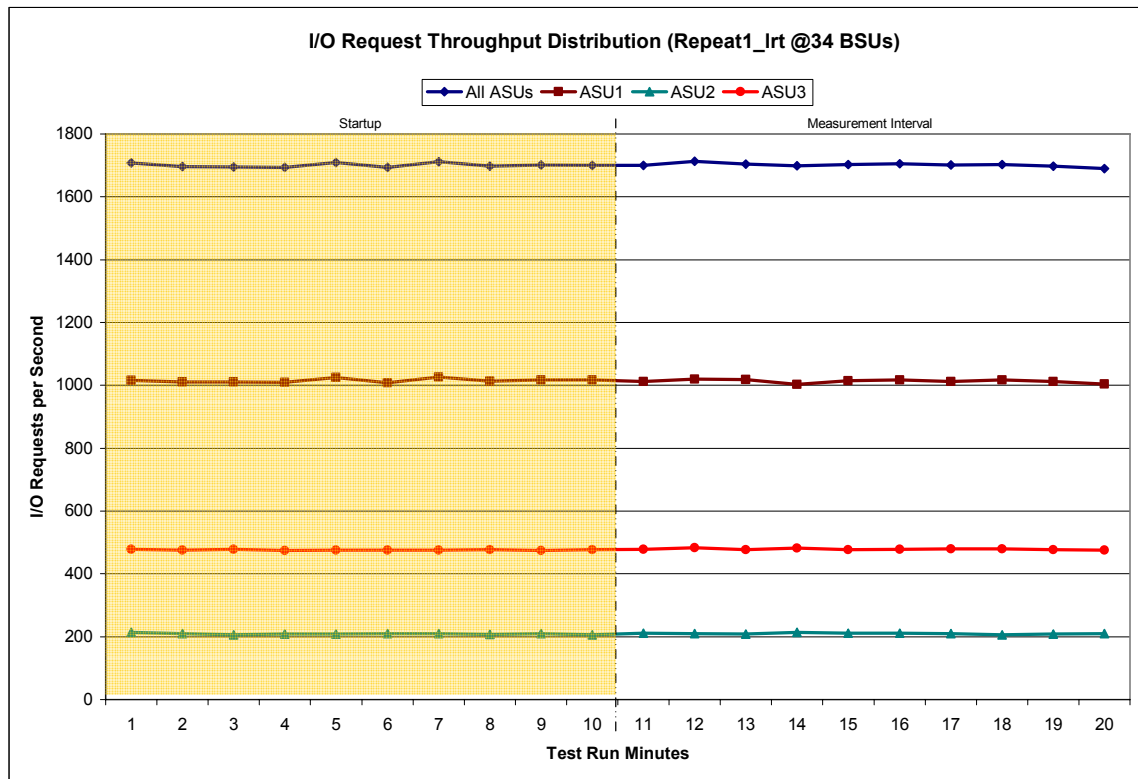
[Repeatability Test Phase 2, Test Run 2 \(IOPS\)](#)

Repeatability 1 LRT – I/O Request Throughput Distribution Data

34 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	21:32:37	21:42:37	0-9	0:10:00
<i>Measurement Interval</i>	21:42:37	21:52:37	10-19	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	1,707.90	1,016.10	213.23	478.57
1	1,696.13	1,011.18	209.50	475.45
2	1,694.55	1,010.37	206.17	478.02
3	1,693.10	1,009.68	208.98	474.43
4	1,709.40	1,025.12	209.23	475.05
5	1,694.20	1,008.22	209.83	476.15
6	1,711.37	1,026.38	209.72	475.27
7	1,697.68	1,013.72	207.42	476.55
8	1,701.38	1,016.80	209.73	474.85
9	1,700.75	1,017.45	206.40	476.90
10	1,700.60	1,011.63	211.03	477.93
11	1,713.25	1,019.37	210.55	483.33
12	1,704.17	1,018.15	208.82	477.20
13	1,699.27	1,003.52	213.38	482.37
14	1,702.70	1,014.33	211.53	476.83
15	1,705.88	1,016.83	210.77	478.28
16	1,702.10	1,012.12	210.07	479.92
17	1,702.78	1,016.70	206.07	480.02
18	1,697.68	1,012.13	208.97	476.58
19	1,689.47	1,004.15	209.68	475.63
Average	1,701.79	1,012.89	210.09	478.81

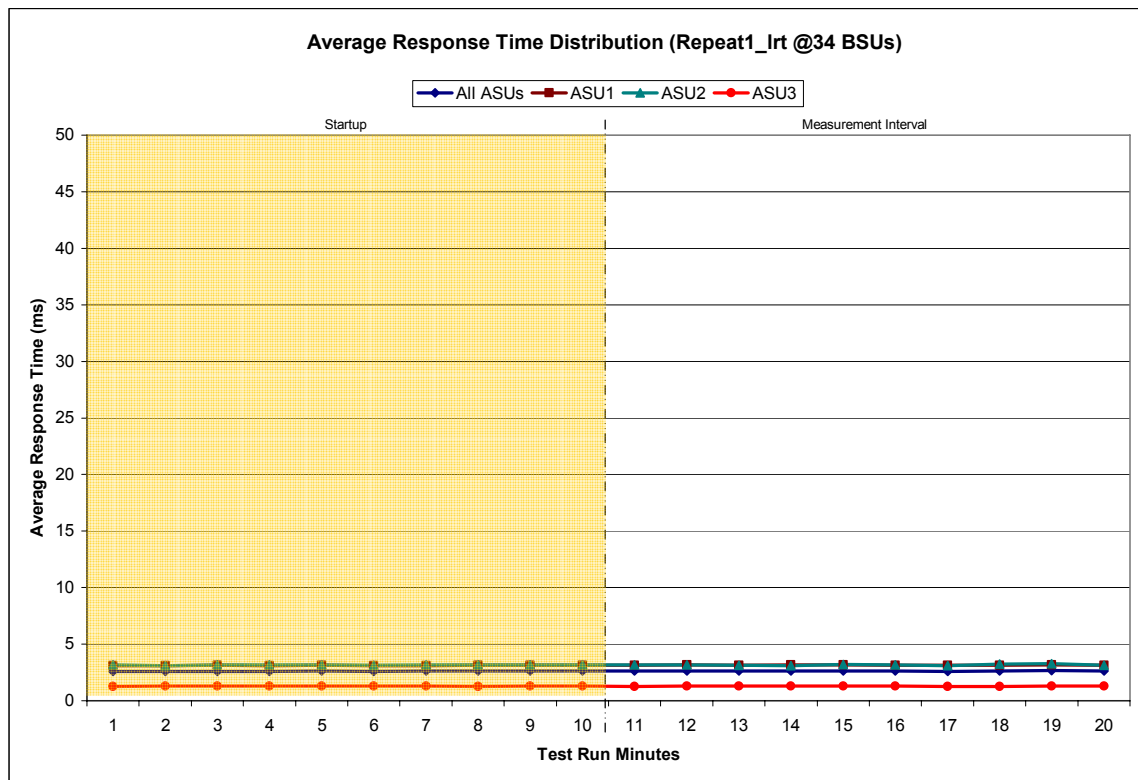
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



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

34 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	21:32:37	21:42:37	0-9	0:10:00
<i>Measurement Interval</i>	21:42:37	21:52:37	10-19	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	2.59	3.09	3.16	1.27
1	2.60	3.11	3.11	1.29
2	2.61	3.12	3.16	1.29
3	2.60	3.11	3.15	1.28
4	2.63	3.13	3.16	1.30
5	2.60	3.11	3.13	1.28
6	2.61	3.11	3.16	1.29
7	2.62	3.14	3.17	1.28
8	2.61	3.12	3.16	1.30
9	2.62	3.13	3.18	1.28
10	2.62	3.15	3.17	1.27
11	2.64	3.17	3.16	1.29
12	2.61	3.13	3.14	1.28
13	2.62	3.16	3.09	1.28
14	2.64	3.15	3.20	1.30
15	2.62	3.13	3.18	1.30
16	2.60	3.12	3.11	1.28
17	2.63	3.14	3.26	1.27
18	2.65	3.17	3.26	1.29
19	2.62	3.14	3.12	1.28
Average	2.62	3.15	3.17	1.28

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

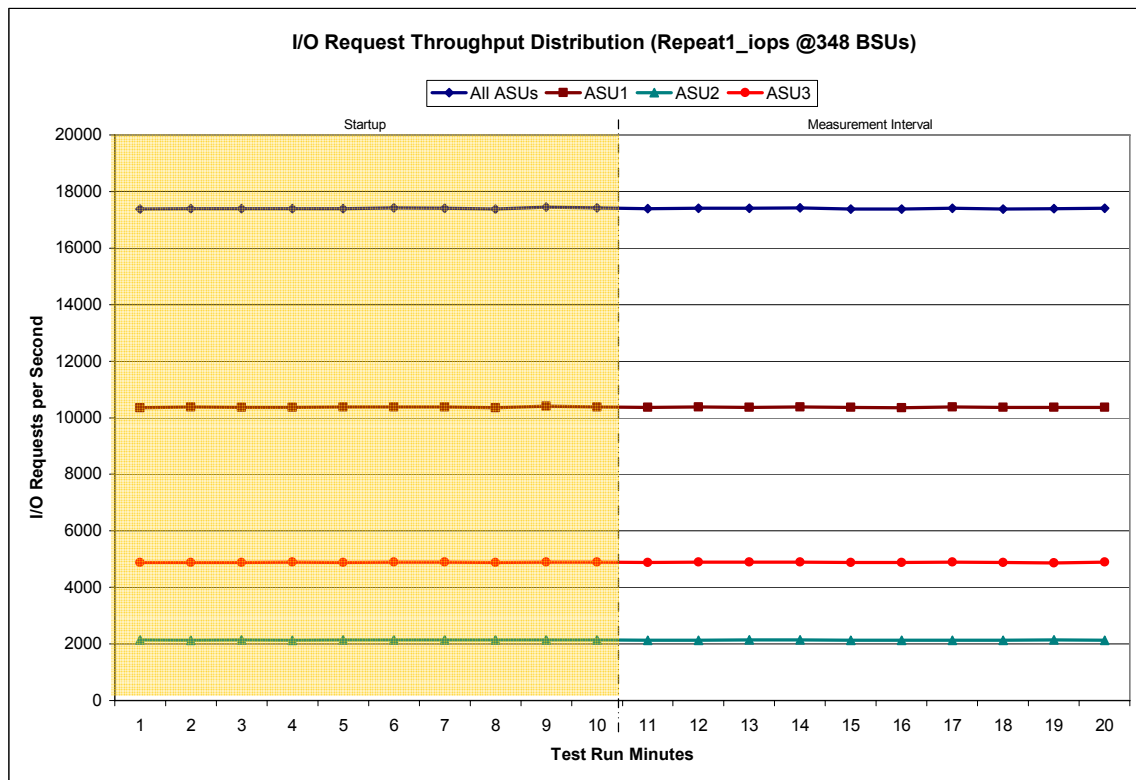


Repeatability 1 IOPS – I/O Request Throughput Distribution Data

348 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:52:45	22:02:46	0-9	0:10:01
Measurement Interval	22:02:46	22:12:46	10-19	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	17,381.17	10,351.33	2,141.93	4,887.90
1	17,396.77	10,387.45	2,132.67	4,876.65
2	17,397.45	10,367.70	2,143.52	4,886.23
3	17,387.28	10,364.60	2,134.22	4,888.47
4	17,395.10	10,375.87	2,140.48	4,878.75
5	17,423.85	10,380.25	2,141.02	4,902.58
6	17,414.62	10,379.18	2,141.65	4,893.78
7	17,377.68	10,354.88	2,143.98	4,878.82
8	17,445.07	10,410.05	2,146.60	4,888.42
9	17,417.67	10,384.35	2,142.42	4,890.90
10	17,387.17	10,367.90	2,133.62	4,885.65
11	17,414.33	10,383.35	2,133.67	4,897.32
12	17,406.92	10,369.58	2,148.88	4,888.45
13	17,417.08	10,375.08	2,148.60	4,893.40
14	17,379.07	10,361.18	2,132.53	4,885.35
15	17,374.37	10,352.83	2,133.95	4,887.58
16	17,404.20	10,376.55	2,138.07	4,889.58
17	17,379.95	10,370.00	2,135.37	4,874.58
18	17,386.97	10,366.22	2,151.93	4,868.82
19	17,403.22	10,372.18	2,133.87	4,897.17
Average	17,395.33	10,369.49	2,139.05	4,886.79

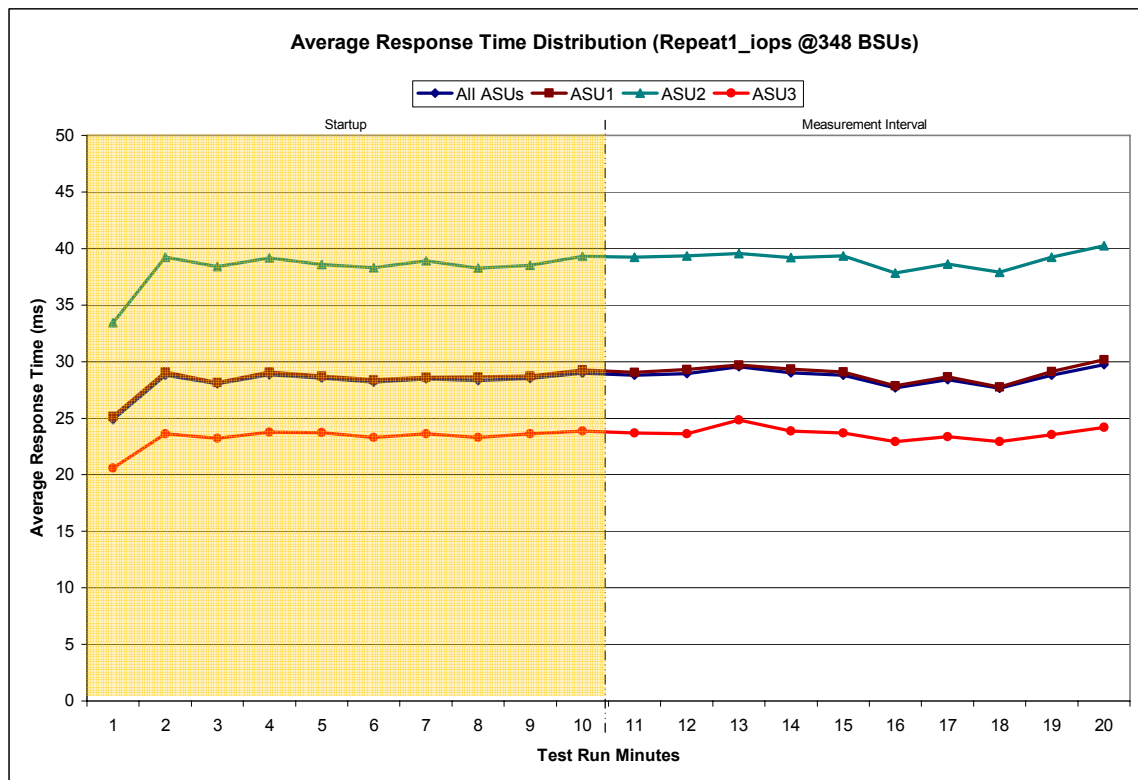
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

348 BSUs Start-Up/Ramp-Up Measurement Interval	Start 21:52:45 22:02:46	Stop 22:02:46 22:12:46	Interval 0-9 10-19	Duration 0:10:01 0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	24.88	25.15	33.43	20.58
1	28.79	29.07	39.24	23.61
2	28.03	28.16	38.40	23.22
3	28.83	29.09	39.17	23.76
4	28.54	28.72	38.59	23.74
5	28.19	28.41	38.31	23.31
6	28.47	28.61	38.91	23.62
7	28.34	28.67	38.27	23.28
8	28.50	28.73	38.52	23.61
9	28.99	29.27	39.31	23.87
10	28.79	29.05	39.24	23.68
11	28.93	29.29	39.33	23.63
12	29.54	29.69	39.54	24.82
13	29.01	29.33	39.20	23.85
14	28.82	29.07	39.33	23.69
15	27.69	27.84	37.84	22.95
16	28.39	28.64	38.61	23.38
17	27.64	27.74	37.90	22.94
18	28.81	29.13	39.25	23.54
19	29.72	30.18	40.25	24.17
Average	28.73	29.00	39.05	23.66

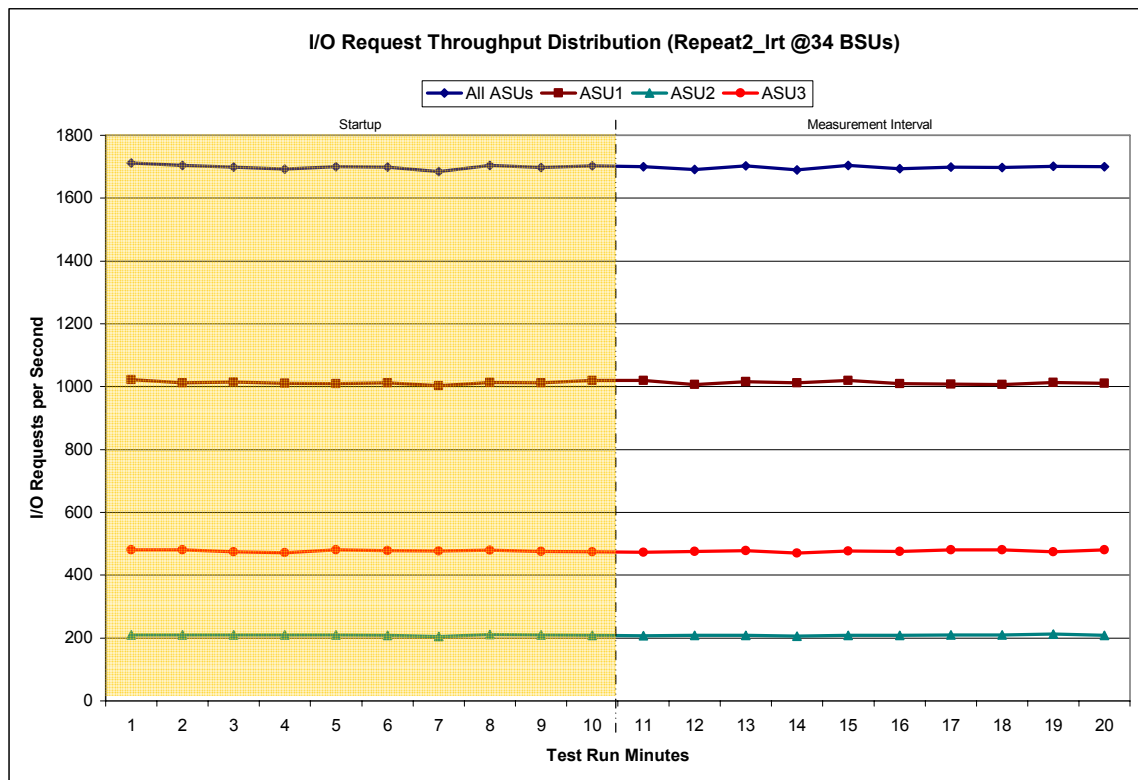
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

34 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:13:17	22:23:17	0-9	0:10:00
Measurement Interval	22:23:17	22:33:17	10-19	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	1,712.10	1,022.08	209.73	480.28
1	1,703.87	1,012.52	210.25	481.10
2	1,699.40	1,014.32	210.15	474.93
3	1,692.98	1,010.93	209.87	472.18
4	1,700.77	1,010.05	210.23	480.48
5	1,699.27	1,012.40	208.63	478.23
6	1,684.95	1,003.62	204.88	476.45
7	1,703.80	1,012.93	210.90	479.97
8	1,697.20	1,012.35	209.62	475.23
9	1,702.55	1,019.63	208.87	474.05
10	1,699.83	1,019.30	207.78	472.75
11	1,691.75	1,007.43	208.95	475.37
12	1,703.18	1,016.00	209.15	478.03
13	1,689.88	1,012.52	206.47	470.90
14	1,704.45	1,019.60	208.27	476.58
15	1,693.68	1,009.73	208.15	475.80
16	1,699.53	1,008.73	209.72	481.08
17	1,698.25	1,007.55	209.52	481.18
18	1,701.72	1,013.78	213.17	474.77
19	1,699.58	1,010.28	208.83	480.47
Average	1,698.19	1,012.49	209.00	476.69

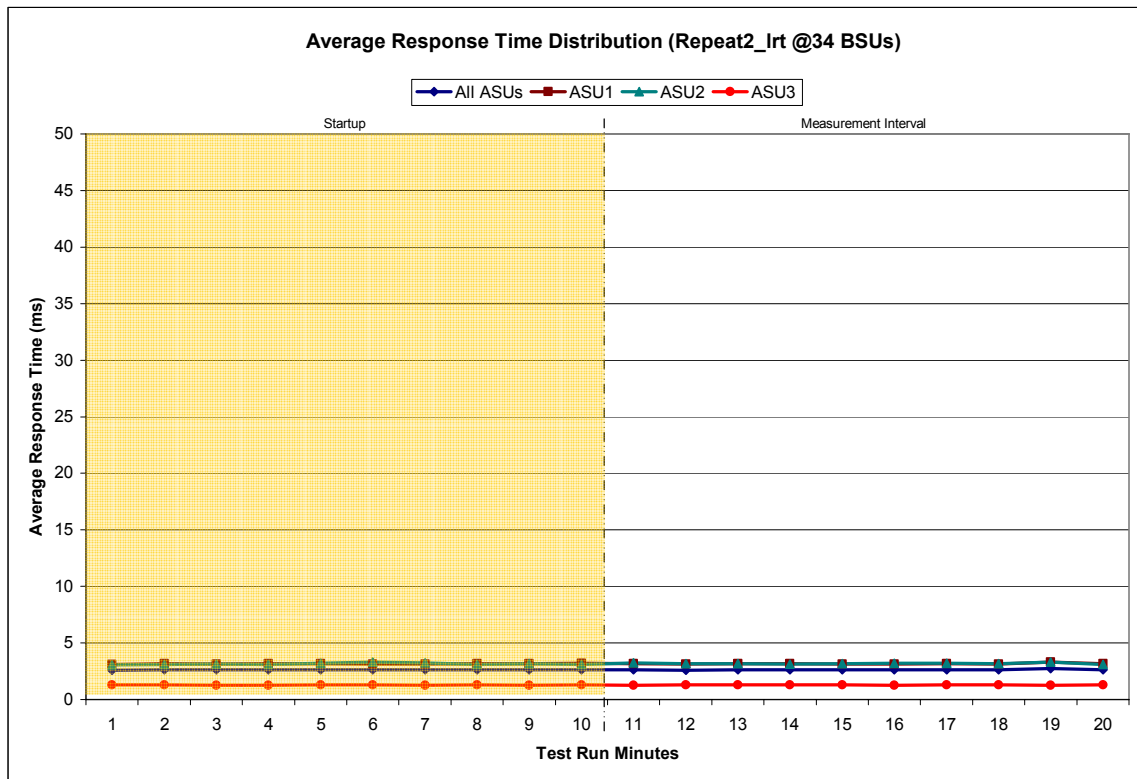
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

34 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:13:17	22:23:17	0-9	0:10:00
Measurement Interval	22:23:17	22:33:17	10-19	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	2.58	3.10	3.07	1.28
1	2.62	3.16	3.10	1.28
2	2.62	3.15	3.13	1.28
3	2.62	3.16	3.08	1.27
4	2.64	3.15	3.20	1.31
5	2.63	3.13	3.30	1.29
6	2.63	3.14	3.24	1.28
7	2.62	3.15	3.10	1.28
8	2.63	3.15	3.16	1.27
9	2.65	3.19	3.10	1.28
10	2.64	3.15	3.24	1.27
11	2.61	3.11	3.18	1.29
12	2.65	3.17	3.17	1.30
13	2.63	3.15	3.12	1.29
14	2.62	3.13	3.16	1.30
15	2.62	3.14	3.19	1.27
16	2.64	3.17	3.19	1.29
17	2.62	3.14	3.18	1.28
18	2.75	3.32	3.31	1.27
19	2.63	3.18	3.08	1.28
Average	2.64	3.17	3.18	1.29

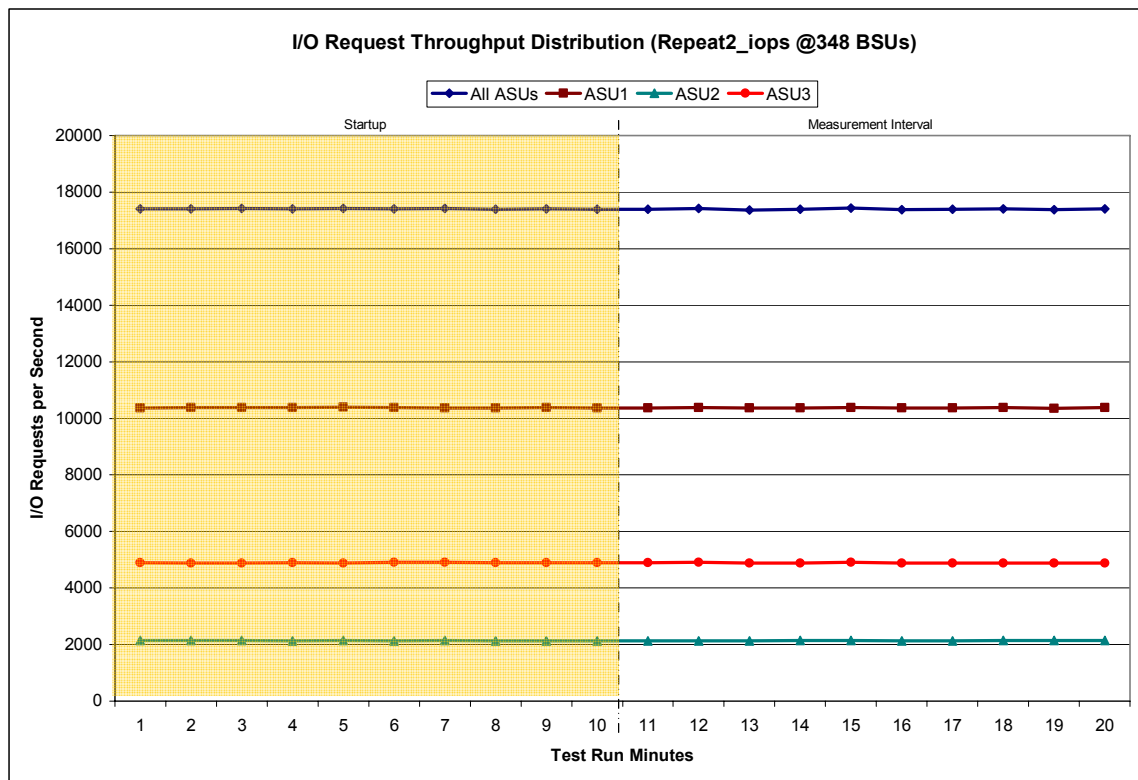
Repeatability 2 LRT –Average Response Time (ms) Distribution Graph



Repeatability 2 IOPS – I/O Request Throughput Distribution Data

348 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	22:33:24	22:43:25	0-9	0:10:01
<i>Measurement Interval</i>	22:43:25	22:53:25	10-19	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	17,401.60	10,365.83	2,146.17	4,889.60
1	17,410.53	10,382.67	2,139.48	4,888.38
2	17,419.42	10,387.72	2,145.55	4,886.15
3	17,405.68	10,378.27	2,131.75	4,895.67
4	17,427.97	10,403.17	2,138.97	4,885.83
5	17,414.72	10,383.02	2,128.05	4,903.65
6	17,419.42	10,365.78	2,144.32	4,909.32
7	17,399.55	10,364.60	2,135.73	4,899.22
8	17,413.38	10,378.85	2,134.32	4,900.22
9	17,390.87	10,369.28	2,131.02	4,890.57
10	17,399.33	10,372.18	2,137.85	4,889.30
11	17,426.12	10,386.43	2,132.15	4,907.53
12	17,368.43	10,360.12	2,127.13	4,881.18
13	17,399.40	10,368.88	2,142.85	4,887.67
14	17,432.82	10,387.47	2,141.55	4,903.80
15	17,380.22	10,371.43	2,133.53	4,875.25
16	17,387.80	10,372.30	2,132.35	4,883.15
17	17,406.95	10,376.62	2,145.42	4,884.92
18	17,374.72	10,351.27	2,139.57	4,883.88
19	17,406.43	10,379.17	2,146.80	4,880.47
Average	17,398.22	10,372.59	2,137.92	4,887.72

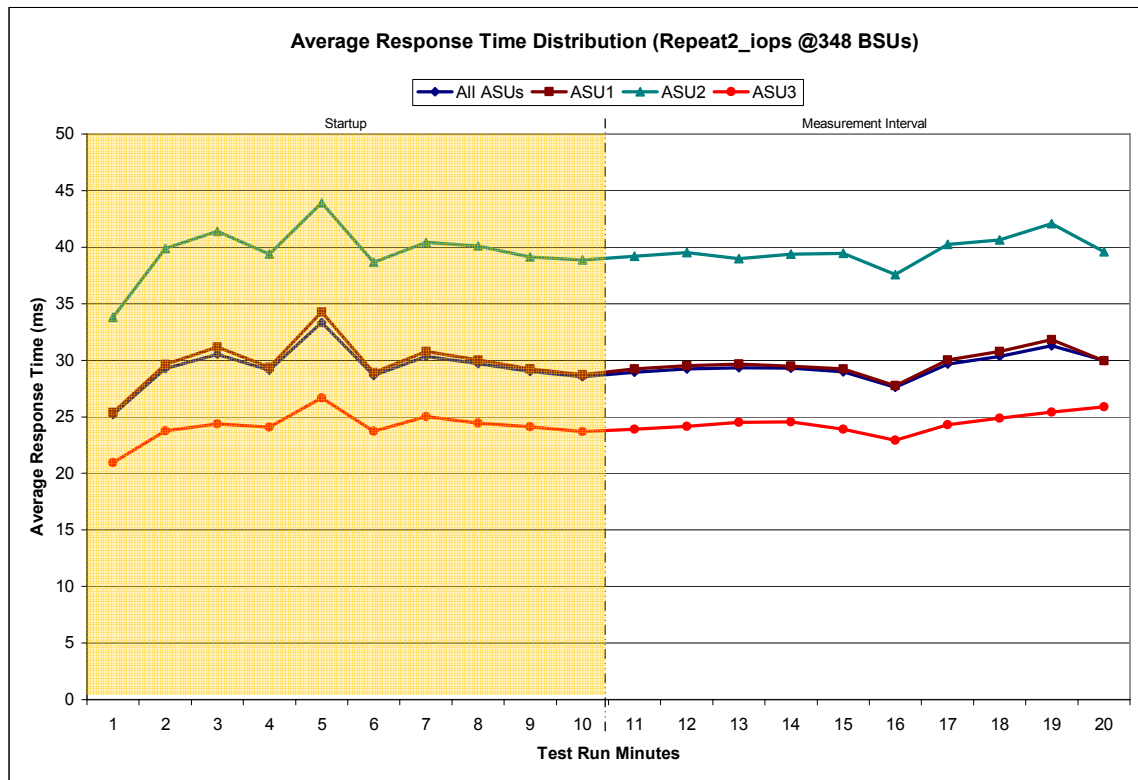
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

348 BSUs Start-Up/Ramp-Up Measurement Interval	Start 22:33:24	Stop 22:43:25	Interval 0-9	Duration 0:10:01
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	25.18	25.39	33.81	20.96
1	29.25	29.63	39.89	23.77
2	30.52	31.16	41.41	24.36
3	29.12	29.39	39.37	24.08
4	33.33	34.28	43.93	26.67
5	28.65	28.92	38.68	23.73
6	30.34	30.77	40.44	25.02
7	29.70	30.03	40.11	24.46
8	29.00	29.21	39.14	24.13
9	28.56	28.74	38.87	23.69
10	28.95	29.21	39.20	23.91
11	29.24	29.52	39.53	24.17
12	29.36	29.66	39.00	24.51
13	29.31	29.47	39.38	24.56
14	28.99	29.25	39.46	23.89
15	27.62	27.76	37.58	22.94
16	29.67	30.03	40.23	24.30
17	30.33	30.77	40.63	24.88
18	31.27	31.81	42.07	25.41
19	30.00	29.95	39.61	25.87
Average	29.47	29.74	39.67	24.44

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



Repeatability 1 (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	0.2797	0.0703	0.2101	0.0182	0.0700	0.0353	0.2810
COV	0.009	0.004	0.010	0.007	0.024	0.010	0.022	0.004

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 5.1.0 and 5.3.13.2

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 5.3.13.3

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

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	0.0351	0.2809	0.0699	0.2102	0.0179	0.0699	0.0351	0.2809
COV	0.004	0.001	0.003	0.001	0.009	0.004	0.005	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	0.0350	0.2812	0.0699	0.2102	0.0181	0.0696	0.0354	0.2807
COV	0.019	0.007	0.013	0.006	0.018	0.005	0.016	0.007

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
<i>IM</i>	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
MIM	0.0349	0.2813	0.0699	0.2100	0.0180	0.0700	0.0349	0.2809
COV	0.005	0.001	0.003	0.001	0.008	0.005	0.003	0.001

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 IOP™ 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 Benchmark Configuration 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 9.2.4.8

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.*

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 75.

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	41,756,720
Total Number of Logical Blocks Verified	38,074,832
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 9.2.4.9

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 must be the date at which all components are committed to be available.

The FDR shall state: "The Priced Storage Configuration, as documented in this Full Disclosure Report will be available for shipment to customers on MMMM DD, YYYY." Where Priced Storage Configuration is the TSC Configuration Name as described in Clause 9.2.4.3.3 and MMMM is the alphanumeric month, DD is the numeric day, and YYYY is the numeric year of the date that the Priced Storage Configuration, as documented, is available for shipment to customers as described above.

The Sun StorageTek® 6140 Array, as documented in this Full Disclosure Report became available on August 10, 2006 for customer purchase and shipment.

PRICING INFORMATION

Clause 9.2.4.11

A statement of the respective calculations for pricing must be included.

Clause 9.2.4.11.3

A list of all differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration must be included.

Pricing information may found in the Tested Storage Configuration Pricing section on page 13. 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 13.

ANOMALIES OR IRREGULARITIES

Clause 9.2.4.10

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 Remote Audit of the Sun StorageTek® 6140 Array.

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 gibibyte (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

RAID5: User data is distributed across the disks in the array. Check data corresponding to user data is distributed across multiple disks in the form of bit-by-bit parity.

Mirroring: Two or more identical copies of user data are maintained on separate disks.

Other Protection Level: Any data protection other than **RAID5** or **Mirroring**.

Unprotected: There is no data protection provided.

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.

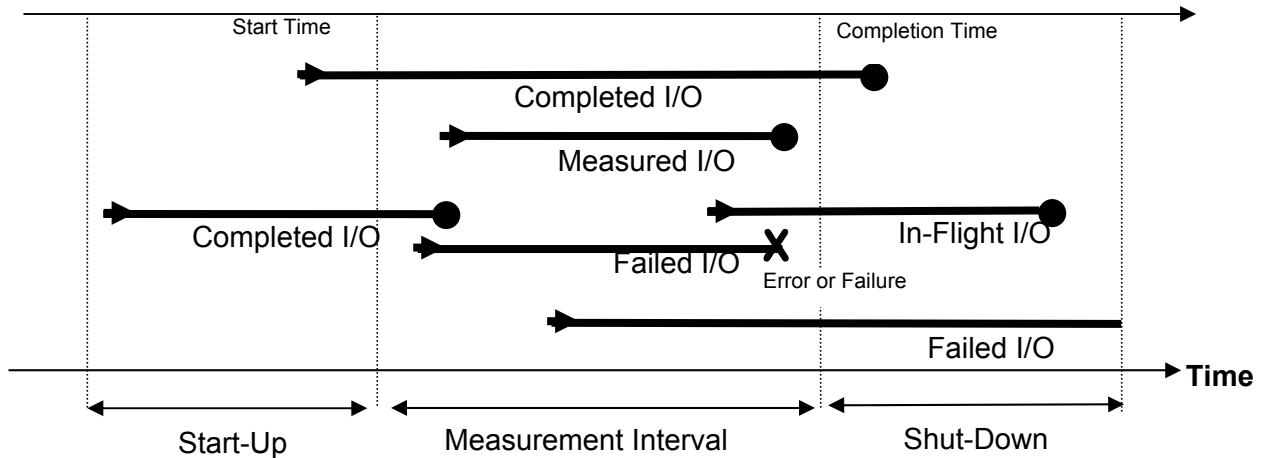
Test: A collection of Test Phases and or Test Runs sharing a common objective.

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

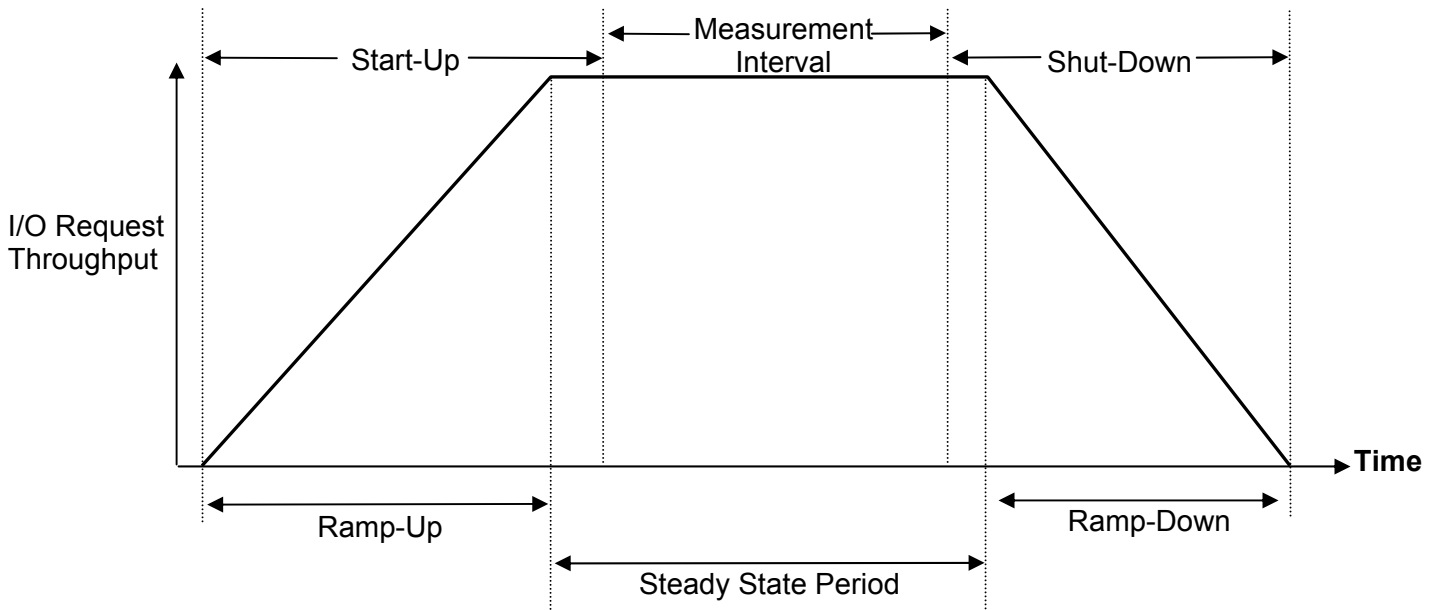
period, Shut-Down period, and Ramp-Down period as illustrated in the “SPC-1 Test Run Components” below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.

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

Solaris Parameters

The following parameters were added to the Solaris `/etc/system` file for the configured Host System.

```
set vxio:vol_default_iodelay = 10
set vxio:vol_maxkiocount = 32768
set vxio:vol_maxioctl = 131072
set vxio:vol_maxio = 8192
set vxio:vol_maxspecialio = 10240
set maxpgio = 65536
set fastscan = 65536
set ufs:ufs_HW = 20971520
set ufs:ufs_LW = 15728640
set autoup = 1024
set tune_t_fsflushr = 1
set sq_max_size = 100
set sdd:sdd_max_throttle=256
set maxphys = 8388608
set sd:sd_max_throttle=256
```

Host Bus Adapter (HBA) Options

The following HBA options were changed in the `/kernel/drv/qlc.conf` file.

Option	Default	New Value
Execution Throttle	32	256
Login Retry Count	4	30
Enable Adapter Hard loop ID	0	1
Reset Delay	5	8
Port Down Retry Count	8	70
Link Down Timeout	0	60

LUN Parameters

The following parameters are set during the execution of the `sscs` command, which is documented in Appendix.

Automatic Cache Read Ahead: **off** (default is **on**)

Cache Read Ahead Multiplier: **0** (default is **1**)

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

Create RAID 1 LUNs

The ST6140 is configured with eight RAID 1 storage groups with one LUN per group. The configuration file **spc1-6140-cfg.txt** is used to configure the ST6140 via the **sscs** command. The **sscs** command is accessed via the “SUNWsesscs package” found in the CD that ships with the ST6140.

```
sscs import -f spc1-6140-cfg.txt array sbm-6140a
```

The above command performs the following:

- Probes ST6140 to ensure configuration file compatibility
- Creates eight RAID 1 LUNs
- Presents all LUNs to the attached host
 - Read Ahead is disabled
 - Disk Scrubbing is disabled

*Note: **sbm-6140a**, in the above command, is the hostname assigned to the ST6140.*

The configuration file, **spc1-6140-cfg.txt** is listed below.

spc1-6140-cfg.txt

```
<?xml version="1.0" encoding="UTF-8"?>
<raidbaseview>
<raidsystem>
<name>sbm-6140a</name>
<unique_id>60%3A0A%3A0B%3A80%3A00%3A11%3AA9%3A2E%3A00%3A00%3A00%3A00%3A44%3A75%3A7E%
3ABA</unique_id>
<status>ok</status>
<manufacturer>SUN</manufacturer>
<model>6140</model>
<firmware_version>06.16.81.10</firmware_version>
<nvsram_version></nvsram_version>
<cache_size></cache_size>
<network>
<ip1>172.20.106.207</ip1>
<ip2>172.20.106.206</ip2>
<gateway1>172.20.106.248</gateway1>
<gateway2>172.20.106.248</gateway2>
<netmask1>255.255.255.0</netmask1>
<netmask2>255.255.255.0</netmask2>
</network>
<array_param>
<cache_block_size>16KB</cache_block_size>
<cache_flush_threshold>80</cache_flush_threshold>
<cache_flush_amount>80</cache_flush_amount>
<default_host_port_type>SOLARIS_MPXIO</default_host_port_type>
<default_media_scan>0</default_media_scan>
<default_failover_alert_delay>300</default_failover_alert_delay>
</array_param>
<premium_features>
<premium_name>Snapshot</premium_name>
<premium_name>ReplicationSet</premium_name>
<premium_name>VolumeCopy</premium_name>
<premium_name>StorageDomain</premium_name>
```

```
</premium_features>
<pools>
<pool>
<pool_name>spc1-pool</pool_name>
<pool_desc>>null</pool_desc>
<pool_profile_name>SPC1</pool_profile_name>
<pool_total_capacity>123.725GB</pool_total_capacity>
<pool_avail_capacity>123.725GB</pool_avail_capacity>
</pool>
<pool>
<pool_name>Default</pool_name>
<pool_desc>>null</pool_desc>
<pool_profile_name>Default</pool_profile_name>
<pool_total_capacity>0.000GB</pool_total_capacity>
<pool_avail_capacity>0.000GB</pool_avail_capacity>
</pool>
</pools>
<total_trays>4</total_trays>
<tray>
<idx>85</idx>
<type>FC</type>
<num_drive_slots>16</num_drive_slots>
<active_drives>85.15 85.14 85.13 85.12 85.11 85.10 85.9 85.8 85.7 85.6 85.5 85.4
85.3 85.2 85.1 85.16 </active_drives>
<disk_capacity>68.366GB</disk_capacity>
<hot_spare_drives></hot_spare_drives>
</tray>
<tray>
<idx>3</idx>
<type>FC</type>
<num_drive_slots>16</num_drive_slots>
<active_drives>3.15 3.14 3.13 3.12 3.11 3.10 3.9 3.8 3.7 3.6 3.5 3.4 3.3 3.2 3.1
3.16 </active_drives>
<disk_capacity>68.366GB</disk_capacity>
<hot_spare_drives></hot_spare_drives>
</tray>
<tray>
<idx>0</idx>
<type>FC</type>
<num_drive_slots>16</num_drive_slots>
<active_drives>0.15 0.14 0.13 0.12 0.11 0.10 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1
0.16 </active_drives>
<disk_capacity>68.366GB</disk_capacity>
<hot_spare_drives></hot_spare_drives>
</tray>
<tray>
<idx>2</idx>
<type>FC</type>
<num_drive_slots>16</num_drive_slots>
<active_drives>2.15 2.14 2.13 2.12 2.11 2.10 2.9 2.8 2.7 2.6 2.5 2.4 2.3 2.2 2.1
2.16 </active_drives>
<disk_capacity>68.366GB</disk_capacity>
<hot_spare_drives></hot_spare_drives>
</tray>
<vdisk>
<vdisk_idx>2</vdisk_idx>
<vdisk_id>60%3A0A%3A0B%3A80%3A00%3A11%3AA9%3A2E%3A00%3A00%3A22%3A52%3A45%3A08%3A98%3
ABB</vdisk_id>
<vdisk_status>Good</vdisk_status>
<raid_level>RAID+1</raid_level>
<physical_drives>
<tray>
<idx>85</idx>
```

```
<active_drives>15</active_drives>
<active_drives>14</active_drives>
<active_drives>13</active_drives>
<active_drives>12</active_drives>
<active_drives>11</active_drives>
<active_drives>10</active_drives>
<active_drives>9</active_drives>
<active_drives>16</active_drives>
</tray>
<tray>
<idx>3</idx>
</tray>
<tray>
<idx>0</idx>
</tray>
<tray>
<idx>2</idx>
</tray>
</physical_drives>
<number_of_drives>8</number_of_drives>
<total_volumes>1</total_volumes>
<volume>
<volume_name>2</volume_name>
<volume_id>60%3A0A%3A0B%3A80%3A00%3A11%3AA9%3A2E%3A00%3A00%3A22%3A51%3A45%3A08%3A4F%
3ABE</volume_id>
<volume_size>274877906944</volume_size>
<volume_type>Standard</volume_type>
<assignment>A</assignment>
<vol_write_cache>true</vol_write_cache>
<vol_write_cache_with_mirroring>true</vol_write_cache_with_mirroring>
<vol_write_cache_without_batteries>>false</vol_write_cache_without_batteries>
<vol_disk_scrubbing>>false</vol_disk_scrubbing>
<vol_disk_scrubbing_with_redundancy>>false</vol_disk_scrubbing_with_redundancy>
<vol_mod_priority>1</vol_mod_priority>
<pool_name>-</pool_name>
<mapping>
<partition_name>Default_Group</partition_name>
<lun>1</lun>
</mapping>
</volume>
</vdisk>
<vdisk>
<vdisk_idx>1</vdisk_idx>
<vdisk_id>60%3A0A%3A0B%3A80%3A00%3A11%3AA9%3A2E%3A00%3A00%3A22%3A50%3A45%3A08%3A98%3
A99</vdisk_id>
<vdisk_status>Good</vdisk_status>
<raid_level>RAID+1</raid_level>
<physical_drives>
<tray>
<idx>85</idx>
<active_drives>8</active_drives>
<active_drives>7</active_drives>
<active_drives>6</active_drives>
<active_drives>5</active_drives>
<active_drives>4</active_drives>
<active_drives>3</active_drives>
<active_drives>2</active_drives>
<active_drives>1</active_drives>
</tray>
<tray>
<idx>3</idx>
</tray>
<tray>
```

```
<idx>0</idx>
</tray>
<tray>
<idx>2</idx>
</tray>
</physical_drives>
<number_of_drives>8</number_of_drives>
<total_volumes>1</total_volumes>
<volume>
<volume_name>1</volume_name>
<volume_id>60%3A0A%3A0B%3A80%3A00%3A11%3AA9%3A2E%3A00%3A00%3A22%3A4F%3A45%3A08%3A4F%
3A9C</volume_id>
<volume_size>274877906944</volume_size>
<volume_type>Standard</volume_type>
<assignment>A</assignment>
<vol_write_cache>true</vol_write_cache>
<vol_write_cache_with_mirroring>true</vol_write_cache_with_mirroring>
<vol_write_cache_without_batteries>>false</vol_write_cache_without_batteries>
<vol_disk_scrubbing>false</vol_disk_scrubbing>
<vol_disk_scrubbing_with_redundancy>>false</vol_disk_scrubbing_with_redundancy>
<vol_mod_priority>1</vol_mod_priority>
<pool_name>-</pool_name>
<mapping>
<partition_name>Default_Group</partition_name>
<lun>0</lun>
</mapping>
</volume>
</vdisk>
<vdisk>
<vdisk_idx>6</vdisk_idx>
<vdisk_id>60%3A0A%3A0B%3A80%3A00%3A11%3A7D%3AEC%3A00%3A00%3A23%3A71%3A45%3A08%3A99%3
A50</vdisk_id>
<vdisk_status>Good</vdisk_status>
<raid_level>RAID+1</raid_level>
<physical_drives>
<tray>
<idx>85</idx>
</tray>
<tray>
<idx>3</idx>
</tray>
<tray>
<idx>0</idx>
</tray>
<tray>
<idx>2</idx>
<active_drives>15</active_drives>
<active_drives>14</active_drives>
<active_drives>13</active_drives>
<active_drives>12</active_drives>
<active_drives>11</active_drives>
<active_drives>10</active_drives>
<active_drives>9</active_drives>
<active_drives>16</active_drives>
</tray>
</physical_drives>
<number_of_drives>8</number_of_drives>
<total_volumes>1</total_volumes>
<volume>
<volume_name>6</volume_name>
<volume_id>60%3A0A%3A0B%3A80%3A00%3A11%3A7D%3AEC%3A00%3A00%3A23%3A70%3A45%3A08%3A51%
3A37</volume_id>
<volume_size>274877906944</volume_size>
```

```
<volume_type>Standard</volume_type>
<assignment>B</assignment>
<vol_write_cache>true</vol_write_cache>
<vol_write_cache_with_mirroring>true</vol_write_cache_with_mirroring>
<vol_write_cache_without_batteries>false</vol_write_cache_without_batteries>
<vol_disk_scrubbing>false</vol_disk_scrubbing>
<vol_disk_scrubbing_with_redundancy>false</vol_disk_scrubbing_with_redundancy>
<vol_mod_priority>1</vol_mod_priority>
<pool_name>-</pool_name>
<mapping>
<partition_name>Default_Group</partition_name>
<lun>5</lun>
</mapping>
</volume>
</vdisk>
<vdisk>
<vdisk_idx>5</vdisk_idx>
<vdisk_id>60%3A0A%3A0B%3A80%3A00%3A11%3A7D%3AEC%3A00%3A00%3A23%3A6F%3A45%3A08%3A99%3A25</vdisk_id>
<vdisk_status>Good</vdisk_status>
<raid_level>RAID+1</raid_level>
<physical_drives>
<tray>
<idx>85</idx>
</tray>
<tray>
<idx>3</idx>
</tray>
<tray>
<idx>0</idx>
</tray>
<tray>
<idx>2</idx>
<active_drives>8</active_drives>
<active_drives>7</active_drives>
<active_drives>6</active_drives>
<active_drives>5</active_drives>
<active_drives>4</active_drives>
<active_drives>3</active_drives>
<active_drives>2</active_drives>
<active_drives>1</active_drives>
</tray>
</physical_drives>
<number_of_drives>8</number_of_drives>
<total_volumes>1</total_volumes>
<volume>
<volume_name>5</volume_name>
<volume_id>60%3A0A%3A0B%3A80%3A00%3A11%3A7D%3AEC%3A00%3A00%3A23%3A6E%3A45%3A08%3A51%3A0B</volume_id>
<volume_size>274877906944</volume_size>
<volume_type>Standard</volume_type>
<assignment>B</assignment>
<vol_write_cache>true</vol_write_cache>
<vol_write_cache_with_mirroring>true</vol_write_cache_with_mirroring>
<vol_write_cache_without_batteries>false</vol_write_cache_without_batteries>
<vol_disk_scrubbing>false</vol_disk_scrubbing>
<vol_disk_scrubbing_with_redundancy>false</vol_disk_scrubbing_with_redundancy>
<vol_mod_priority>1</vol_mod_priority>
<pool_name>-</pool_name>
<mapping>
<partition_name>Default_Group</partition_name>
<lun>4</lun>
</mapping>
```



```
</volume>
</vdisk>
<vdisk>
<vdisk_idx>4</vdisk_idx>
<vdisk_id>60%3A0A%3A0B%3A80%3A00%3A11%3AA9%3A2E%3A00%3A00%3A22%3A56%3A45%3A08%3A98%3
AF7</vdisk_id>
<vdisk_status>Good</vdisk_status>
<raid_level>RAID+1</raid_level>
<physical_drives>
<tray>
<idx>85</idx>
</tray>
<tray>
<idx>3</idx>
</tray>
<tray>
<idx>0</idx>
<active_drives>15</active_drives>
<active_drives>14</active_drives>
<active_drives>13</active_drives>
<active_drives>12</active_drives>
<active_drives>11</active_drives>
<active_drives>10</active_drives>
<active_drives>9</active_drives>
<active_drives>16</active_drives>
</tray>
<tray>
<idx>2</idx>
</tray>
</physical_drives>
<number_of_drives>8</number_of_drives>
<total_volumes>1</total_volumes>
<volume>
<volume_name>4</volume_name>
<volume_id>60%3A0A%3A0B%3A80%3A00%3A11%3AA9%3A2E%3A00%3A00%3A22%3A55%3A45%3A08%3A4F%
3AF8</volume_id>
<volume_size>274877906944</volume_size>
<volume_type>Standard</volume_type>
<assignment>A</assignment>
<vol_write_cache>true</vol_write_cache>
<vol_write_cache_with_mirroring>true</vol_write_cache_with_mirroring>
<vol_write_cache_without_batteries>false</vol_write_cache_without_batteries>
<vol_disk_scrubbing>false</vol_disk_scrubbing>
<vol_disk_scrubbing_with_redundancy>false</vol_disk_scrubbing_with_redundancy>
<vol_mod_priority>1</vol_mod_priority>
<pool_name>-</pool_name>
<mapping>
<partition_name>Default_Group</partition_name>
<lun>3</lun>
</mapping>
</volume>
</vdisk>
<vdisk>
<vdisk_idx>3</vdisk_idx>
<vdisk_id>60%3A0A%3A0B%3A80%3A00%3A11%3AA9%3A2E%3A00%3A00%3A22%3A54%3A45%3A08%3A98%3
AD6</vdisk_id>
<vdisk_status>Good</vdisk_status>
<raid_level>RAID+1</raid_level>
<physical_drives>
<tray>
<idx>85</idx>
</tray>
<tray>
```

```
<idx>3</idx>
</tray>
<tray>
<idx>0</idx>
<active_drives>8</active_drives>
<active_drives>7</active_drives>
<active_drives>6</active_drives>
<active_drives>5</active_drives>
<active_drives>4</active_drives>
<active_drives>3</active_drives>
<active_drives>2</active_drives>
<active_drives>1</active_drives>
</tray>
<tray>
<idx>2</idx>
</tray>
</physical_drives>
<number_of_drives>8</number_of_drives>
<total_volumes>1</total_volumes>
<volume>
<volume_name>3</volume_name>
<volume_id>60%3A0A%3A0B%3A80%3A00%3A11%3AA9%3A2E%3A00%3A00%3A22%3A53%3A45%3A08%3A4F%
3AD8</volume_id>
<volume_size>274877906944</volume_size>
<volume_type>Standard</volume_type>
<assignment>A</assignment>
<vol_write_cache>true</vol_write_cache>
<vol_write_cache_with_mirroring>true</vol_write_cache_with_mirroring>
<vol_write_cache_without_batteries>false</vol_write_cache_without_batteries>
<vol_disk_scrubbing>false</vol_disk_scrubbing>
<vol_disk_scrubbing_with_redundancy>false</vol_disk_scrubbing_with_redundancy>
<vol_mod_priority>1</vol_mod_priority>
<pool_name>-</pool_name>
<mapping>
<partition_name>Default_Group</partition_name>
<lun>2</lun>
</mapping>
</volume>
</vdisk>
<vdisk>
<vdisk_idx>8</vdisk_idx>
<vdisk_id>60%3A0A%3A0B%3A80%3A00%3A11%3A7D%3AEC%3A00%3A00%3A23%3A75%3A45%3A08%3A99%3
AB0</vdisk_id>
<vdisk_status>Good</vdisk_status>
<raid_level>RAID+1</raid_level>
<physical_drives>
<tray>
<idx>85</idx>
</tray>
<tray>
<idx>3</idx>
<active_drives>15</active_drives>
<active_drives>14</active_drives>
<active_drives>13</active_drives>
<active_drives>12</active_drives>
<active_drives>11</active_drives>
<active_drives>10</active_drives>
<active_drives>9</active_drives>
<active_drives>16</active_drives>
</tray>
<tray>
<idx>0</idx>
</tray>
```

```
<tray>
<idx>2</idx>
</tray>
</physical_drives>
<number_of_drives>8</number_of_drives>
<total_volumes>1</total_volumes>
<volume>
<volume_name>8</volume_name>
<volume_id>60%3A0A%3A0B%3A80%3A00%3A11%3A7D%3AEC%3A00%3A00%3A23%3A74%3A45%3A08%3A51%
3A95</volume_id>
<volume_size>274877906944</volume_size>
<volume_type>Standard</volume_type>
<assignment>B</assignment>
<vol_write_cache>true</vol_write_cache>
<vol_write_cache_with_mirroring>true</vol_write_cache_with_mirroring>
<vol_write_cache_without_batteries>false</vol_write_cache_without_batteries>
<vol_disk_scrubbing>false</vol_disk_scrubbing>
<vol_disk_scrubbing_with_redundancy>false</vol_disk_scrubbing_with_redundancy>
<vol_mod_priority>1</vol_mod_priority>
<pool_name>-</pool_name>
<mapping>
<partition_name>Default_Group</partition_name>
<lun>7</lun>
</mapping>
</volume>
</vdisk>
<vdisk>
<vdisk_idx>7</vdisk_idx>
<vdisk_id>60%3A0A%3A0B%3A80%3A00%3A11%3A7D%3AEC%3A00%3A00%3A23%3A73%3A45%3A08%3A99%3
A7F</vdisk_id>
<vdisk_status>Good</vdisk_status>
<raid_level>RAID+1</raid_level>
<physical_drives>
<tray>
<idx>85</idx>
</tray>
<tray>
<idx>3</idx>
<active_drives>8</active_drives>
<active_drives>7</active_drives>
<active_drives>6</active_drives>
<active_drives>5</active_drives>
<active_drives>4</active_drives>
<active_drives>3</active_drives>
<active_drives>2</active_drives>
<active_drives>1</active_drives>
</tray>
<tray>
<idx>0</idx>
</tray>
<tray>
<idx>2</idx>
</tray>
</physical_drives>
<number_of_drives>8</number_of_drives>
<total_volumes>1</total_volumes>
<volume>
<volume_name>7</volume_name>
<volume_id>60%3A0A%3A0B%3A80%3A00%3A11%3A7D%3AEC%3A00%3A00%3A23%3A72%3A45%3A08%3A51%
3A65</volume_id>
<volume_size>274877906944</volume_size>
<volume_type>Standard</volume_type>
<assignment>B</assignment>
```

```
<vol_write_cache>true</vol_write_cache>
<vol_write_cache_with_mirroring>true</vol_write_cache_with_mirroring>
<vol_write_cache_without_batteries>false</vol_write_cache_without_batteries>
<vol_disk_scrubbing>false</vol_disk_scrubbing>
<vol_disk_scrubbing_with_redundancy>false</vol_disk_scrubbing_with_redundancy>
<vol_mod_priority>1</vol_mod_priority>
<pool_name>-</pool_name>
<mapping>
<partition_name>Default_Group</partition_name>
<lun>6</lun>
</mapping>
</volume>
</vdisk>
<partitions>
<partition>
<mapped_via_type>Default_Group</mapped_via_type>
</partition>
</partitions>
<profiles>
<profile>
<profile_name>Oracle_OLTP_HA</profile_name>
<profile_desc>Pre-configured+Oracle+OLTP+HA+profile</profile_desc>
<raid_level>RAID+1</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>512K</segment_size>
<read_ahead>On</read_ahead>
<drive_type>FC</drive_type>
<factory_profile>yes</factory_profile>
</profile>
<profile>
<profile_name>Oracle_DSS</profile_name>
<profile_desc>Pre-configured+Oracle+DSS+profile</profile_desc>
<raid_level>RAID+5</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>512K</segment_size>
<read_ahead>On</read_ahead>
<drive_type>FC</drive_type>
<factory_profile>yes</factory_profile>
</profile>
<profile>
<profile_name>spc1-asul</profile_name>
<profile_desc>-</profile_desc>
<raid_level>RAID+1</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>128K</segment_size>
<read_ahead>Off</read_ahead>
<drive_type>ANY</drive_type>
<factory_profile>no</factory_profile>
</profile>
<profile>
<profile_name>High_Performance_Computing</profile_name>
<profile_desc>Pre-configured+High+Performance+Computing+profile</profile_desc>
<raid_level>RAID+5</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>512K</segment_size>
<read_ahead>On</read_ahead>
<drive_type>FC</drive_type>
<factory_profile>yes</factory_profile>
</profile>
<profile>
<profile_name>SPC1</profile_name>
<profile_desc>-</profile_desc>
<raid_level>RAID+1</raid_level>
```

```
<optimal_num_drives>0</optimal_num_drives>
<segment_size>512K</segment_size>
<read_ahead>Off</read_ahead>
<drive_type>ANY</drive_type>
<factory_profile>no</factory_profile>
</profile>
<profile>
<profile_name>Random_1</profile_name>
<profile_desc>Pre-configured+Random+1+profile</profile_desc>
<raid_level>RAID+1</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>512K</segment_size>
<read_ahead>On</read_ahead>
<drive_type>FC</drive_type>
<factory_profile>yes</factory_profile>
</profile>
<profile>
<profile_name>Sequential</profile_name>
<profile_desc>Pre-configured+Random+Sequential+profile</profile_desc>
<raid_level>RAID+5</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>512K</segment_size>
<read_ahead>On</read_ahead>
<drive_type>FC</drive_type>
<factory_profile>yes</factory_profile>
</profile>
<profile>
<profile_name>Sybase_OLTP_HA</profile_name>
<profile_desc>Pre-configured+Sybase+OLTP+HA+profile</profile_desc>
<raid_level>RAID+1</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>512K</segment_size>
<read_ahead>On</read_ahead>
<drive_type>FC</drive_type>
<factory_profile>yes</factory_profile>
</profile>
<profile>
<profile_name>Sybase_DSS</profile_name>
<profile_desc>Pre-configured+Sybase+DSS+profile</profile_desc>
<raid_level>RAID+5</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>512K</segment_size>
<read_ahead>On</read_ahead>
<drive_type>FC</drive_type>
<factory_profile>yes</factory_profile>
</profile>
<profile>
<profile_name>Mail_Spooling</profile_name>
<profile_desc>Pre-configured+Mail+Spooling+profile</profile_desc>
<raid_level>RAID+1</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>512K</segment_size>
<read_ahead>On</read_ahead>
<drive_type>FC</drive_type>
<factory_profile>yes</factory_profile>
</profile>
<profile>
<profile_name>Oracle_OLTP</profile_name>
<profile_desc>Pre-configured+Oracle+OLTP+profile</profile_desc>
<raid_level>RAID+5</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>512K</segment_size>
<read_ahead>On</read_ahead>
```

```
<drive_type>FC</drive_type>
<factory_profile>yes</factory_profile>
</profile>
<profile>
<profile_name>Sybase_OLTP</profile_name>
<profile_desc>Pre-configured+Sybase+OLTP+profile</profile_desc>
<raid_level>RAID+5</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>512K</segment_size>
<read_ahead>On</read_ahead>
<drive_type>FC</drive_type>
<factory_profile>yes</factory_profile>
</profile>
<profile>
<profile_name>Default</profile_name>
<profile_desc>Pre-configured+Default+profile</profile_desc>
<raid_level>RAID+5</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>512K</segment_size>
<read_ahead>On</read_ahead>
<drive_type>FC</drive_type>
<factory_profile>yes</factory_profile>
</profile>
<profile>
<profile_name>NFS_Mirroring</profile_name>
<profile_desc>Pre-configured+NFS+Mirroring+profile</profile_desc>
<raid_level>RAID+1</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>512K</segment_size>
<read_ahead>On</read_ahead>
<drive_type>FC</drive_type>
<factory_profile>yes</factory_profile>
</profile>
<profile>
<profile_name>spc1-asu3</profile_name>
<profile_desc>-</profile_desc>
<raid_level>RAID+1</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>256K</segment_size>
<read_ahead>Off</read_ahead>
<drive_type>ANY</drive_type>
<factory_profile>no</factory_profile>
</profile>
<profile>
<profile_name>NFS_Striping</profile_name>
<profile_desc>Pre-configured+NFS+Striping+profile</profile_desc>
<raid_level>RAID+5</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>512K</segment_size>
<read_ahead>On</read_ahead>
<drive_type>FC</drive_type>
<factory_profile>yes</factory_profile>
</profile>
<profile>
<profile_name>spc1-asu2</profile_name>
<profile_desc>-</profile_desc>
<raid_level>RAID+1</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>512K</segment_size>
<read_ahead>Off</read_ahead>
<drive_type>ANY</drive_type>
<factory_profile>no</factory_profile>
</profile>
```

```
<profile>
<profile_name>High_Capacity_Computing</profile_name>
<profile_desc>Pre-configured+High+Capacity+Computing+profile</profile_desc>
<raid_level>RAID+5</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>512K</segment_size>
<read_ahead>On</read_ahead>
<drive_type>SATA</drive_type>
<factory_profile>yes</factory_profile>
</profile>
</profiles>
</raidsystem>
</raidbaseview>
```

LUN discovery via Solaris 10

The script **config-6140-spc1.sh** is used on the host to discover and configure the LUNs in Solaris. It performs the following.

- Probes server and adds labels to all new LUN's
- Creates a prtvtoc output file (**prtvtoc.txt**)
- Creates a disk list text file (**disklist.txt**)
- Creates a Solaris Raid 0 config file using all eight LUNs (**md.tab**)
- Creates a Solaris Raid 0 volume with three soft partitions for ASU,1,2,and 3

The **config-6140-spc1.sh** script is listed below.

config-6140-spc1.sh

```
#!/bin/ksh
#
# Label all new drives
#
clear
echo " "
echo " "
echo "Removing old Disk links and Meta devices"
echo " "
echo " "
sleep 2
metaclear -f d1 d2 d3 d10

# Probe server and remove all old device links
devfsadm -C
echo " "
echo " "
echo " Configuring new disks"
echo " "
echo " Configuring `ls /dev/rdisk/c26*d0s2 | wc -l ` disks"
sleep 5
echo " "
ls /dev/rdisk/c26*d0s2 > disks
echo " "
echo " Starting to Label all new disks"
sleep 5
cat disks | sed 's/s2\@/s2/g' > disk1
rm disks
```

```
C_disks=disk1
#
for f in `cat $C_disks`
do
format $f << EOFF
ty
0
y
label
y
quit
EOFF
done
echo " Finished Configuring `ls /dev/rdisk/c26*d0s2 | wc -l ` disks"
sleep 5
clear
####
# Create prtvtoc.txt file
touch prtvtoc.txt
for x in `cat disk1`
do
prtvtoc $x >> prtvtoc.txt
done
#
# Create all meta devices
format > formatD << EOFF
EOFF
# Stop here for some tweaks
#
#
touch d10
echo "d10 1 8 \\" >> d10
grep -i csm200 formatD | awk '{print $2}' >> d10
echo "-i 100m" >>d10
echo " " >>d10
echo "d1 -p d10 883g " >>d10
echo "d2 -p d10 883g " >>d10
echo "d3 -p d10 196g" >>d10
#
echo " "
echo " Creating new md.tab file"
sleep 5
echo " "
#
# Create md.tab file
# Clean up md.tab file
cat d10 | sed 's/d0/d0s2 \\/g' >md.tab
##
# Copy new md.tab file to /etc/lvm
cp /etc/lvm/md.tab /etc/lvm/md.tab.old
mv md.tab /etc/lvm/md.tab

echo " New md.tab file has been created"
sleep 5
echo " Starting to create new metadvicees."
sleep 5
# create metadvice
metainit d10
echo " "
metainit d3
echo " "
metainit d1
echo " "
```



```
metainit d2
sleep 5
## Display results
clear
# Remove config file
metastat
mv disk1 disklist.txt
rm d10 formatD
```

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

The contents of the SPC-1 Workload Generator command and parameter file used for the Primary Metrics, Repeatability, and Persistence Tests is listed below.

```
sd=asu1_1, lun=/dev/md/rdisk/d1, size=883.471g  
sd=asu2_1, lun=/dev/md/rdisk/d2, size=883.471g  
sd=asu3_1, lun=/dev/md/rdisk/d3, size=196.327g
```

APPENDIX E: SPC-1 WORKLOAD GENERATOR INPUT PARAMETERS

The following script, **runspc1640.sh**, was used to execute the Primary Metrics and Repeatability Tests, as well as, Persistence Test Run 1.

runspc16140.sh

```
#!/usr/bin/ksh
script=runspc16140.sh
output=2ndRun
basedir=/spc/output/spc1/SE6140/bigdog/SUN-FW-Audit
outdir=$basedir/$output
mkdir -p $outdir
cp $script $outdir
#cp $script $outdir/$script-P2
#
mailx -s $script-Started -r Javier.Chavez@sun.com
Javier.Chavez@sun.com,leah.schoeb@sun.com < $script
bsu=348
STEP=1
startup=600
while [[ $bsu -le 348 ]]
do
  Outdir=$outdir/${bsu}
  mkdir -p $Outdir
  cp $script $Outdir
  cp SPC1.cfg $Outdir
  cp /etc/lvm/md.tab $Outdir
  #
  java -Xmx2048m -Xss1024k metrics -b $bsu -s $startup
  sleep 15
  java -Xmx2048m -Xss1024k repeat1 -b $bsu -s $startup
  sleep 15
  java -Xmx2048m -Xss1024k repeat2 -b $bsu -s $startup
  sleep 15
  java -Xmx2048m persist1 -b $bsu
  sleep 15
  #java -Xmx2048m persist2
  sleep 15
  mv metrics $Outdir
  mv repeatability1 $Outdir
  mv repeatability2 $Outdir
  mv persistence1 $Outdir
  #mv persistence2 $Outdir
  #mv asu* $Outdir
  #mv SPCOut $Outdir
  mailx -s spc1-6140-finished-$bsu -r Javier.Chavez@sun.com
  theman@sun.com,leah.schoeb@sun.com < $Outdir/metrics/summary.html
  bsu=`expr $bsu + $STEP`
  echo "All done .... sleeping for 5 minutes"
  sleep 300
done
```

The following script, **runspc1640-P2.sh**, was used to execute Persistence Test Run 2.

runspc16140-P2.sh

```
#!/usr/bin/ksh
script=runspc16140.sh
output=2ndRun
basedir=/spc/output/spc1/SE6140/bigdog/SUN-FW-Audit
outdir=$basedir/$output
#mkdir -p $outdir
#cp $script $outdir
#cp $script $outdir/$script-P2
#
mailx -s $script-Started -r Javier.Chavez@sun.com
Javier.Chavez@sun.com,leah.schoeb@sun.com < $script
bsu=348
STEP=1
startup=600
while [[ $bsu -le 348 ]]
do
  Outdir=$outdir/${bsu}
  #mkdir -p $Outdir
  cp $script $Outdir/$script-P2
  #cp SPC1.cfg $Outdir
  #cp /etc/lvm/md.tab $Outdir
  #
  #java -Xmx2048m -Xss1024k metrics -b $bsu -s $startup
  #sleep 15
  #java -Xmx2048m -Xss1024k repeat1 -b $bsu -s $startup
  #sleep 15
  #java -Xmx2048m -Xss1024k repeat2 -b $bsu -s $startup
  #sleep 15
  #java -Xmx2048m persist1 -b $bsu
  #sleep 15
  java -Xmx2048m persist2
  sleep 15
  #mv metrics $Outdir
  #mv repeatability1 $Outdir
  #mv repeatability2 $Outdir
  #mv persistence1 $Outdir
  mv persistence2 $Outdir
  mv asu* $Outdir
  mv SPCOut $Outdir
  mailx -s spc1-6140-finished-$bsu -r Javier.Chavez@sun.com
  theman@sun.com,leah.schoeb@sun.com < $Outdir/metrics/summary.html
  bsu=`expr $bsu + $STEP`
  echo "All done .... sleeping for 5 minutes"
  sleep 300
done
```