SPC Benchmark 1™
Full Disclosure Report

Huawei Technologies Co., Ltd.
Huawei OceanStor™ S5800T

SPC-1 V1.13

Submitted for Review: November 15, 2012
Submission Identifier: A00124
First Edition – November 2012

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AUDIT CERTIFICATION

Eric He
Huawei Technologies Co., Ltd.
Tianhe Road 88#,
Chengdu, Sichuan, P.R. China 610711

November 13, 2012

The SPC Benchmark 1™ Reported Data listed below for the Huawei OceanStor™ S5800T™ was produced in compliance with the SPC Benchmark 1™ v1.13 Remote Audit requirements.

<table>
<thead>
<tr>
<th>Metric</th>
<th>Reported Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPC-1 IOPS™</td>
<td>150,286.25</td>
</tr>
<tr>
<td>SPC-1 Price-Performance</td>
<td>$3.15/SPC-1 IOPS™</td>
</tr>
<tr>
<td>Total ASU Capacity</td>
<td>50,496.366 GB</td>
</tr>
<tr>
<td>Data Protection Level</td>
<td>Protected (Mirroring)</td>
</tr>
<tr>
<td>Total TSC Price (including three-year maintenance)</td>
<td>$475,060.00</td>
</tr>
</tbody>
</table>

The following SPC Benchmark 1™ Remote Audit requirements were reviewed and found compliant with 1.13 of the SPC Benchmark 1™ specification:
- A Letter of Good Faith, signed by a senior executive.
- The following Data Repository storage items were verified by information supplied by Huawei Technologies Co., Ltd.:
  - Physical Storage Capacity and requirements.
  - Configured Storage Capacity and requirements.
  - Addressable Storage Capacity and requirements.
  - Capacity of each Logical Volume and requirements.
  - Capacity of each Application Storage Unit (ASU) and requirements.
- The total Application Storage Unit (ASU) Capacity was filled with random data, using an auditor approved tool, prior to execution of the SPC-1 Tests.
- An appropriate diagram of the Benchmark Configuration (BC)/Tested Storage Configuration (TSC).
AUDIT CERTIFICATION (CONT.)

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

Audit Notes:
There were no audit notes or exceptions.

Respectfully,

Walter G. Baker
SPC Auditor

Storage Performance Council
643 East Island Road, Suite 103
Redwood City, CA 94062
AuditService@storageperformance.org
650.555.0384
LETTER OF GOOD FAITH

Date: November 7, 2012

From: Huawei Technologies Co., Ltd.

To: Walter E. Bakor, SPC Auditor
    Gradient Systems, Inc.
    543 Bair Island Road, Suite 103
    Redwood City, CA 94063

Subject: SPC-1 Letter of Good Faith for the Huawei OceanStor S5800T

Huawei Technologies Co., Ltd. is the SPC-1 Test Sponsor for the above listed product. To the best of our knowledge and belief, the required SPC-1 benchmark results and materials we have submitted for that product are complete, accurate, and in full compliance with V1.13 of the SPC-1 benchmark specification.

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

Signed:

Fan Ruigui
President of Storage Product Line

Date: 2012.11.7
EXECUTIVE SUMMARY

Test Sponsor and Contact Information

| Test Sponsor Primary Contact | Huawei Technologies Co., Ltd. – http://www.huawei.com/en/  
| Eric He – eric.heji@huawei.com  
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| Chengdu, Sichuan, P.R. China 611711  
| Phone: 86 28 62905595  
| FAX: 86 28 62905793 |
| Test Sponsor Alternate Contact | Huawei Technologies Co., Ltd. – http://www.huawei.com/en/  
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| FAX: 86 28 62905793 |
| Walter E. Baker – AuditService@StoragePerformance.org  
| 643 Bair Island Road, Suite 103  
| Redwood City, CA 94063  
| Phone: (650) 556-9384  
| FAX: (650) 556-9385 |

Revision Information and Key Dates

| Revision Information and Key Dates | |
| SPC-1 Specification revision number | V1.13 |
| SPC-1 Workload Generator revision number | V2.3.0 |
| Date Results were first used publicly | November 15, 2012 |
| Date the FDR was submitted to the SPC | November 15, 2012 |
| Date the Priced Storage Configuration is available for shipment to customers | currently available |
| Date the TSC completed audit certification | November 13, 2012 |

Tested Storage Product (TSP) Description

Huawei OceanStor T series unified storage system (T series) is a new-generation storage product for mid-range and high-end storage applications. It boasts integration of block-level and file-level data storage, support for a variety of storage protocols, and GUI-based central storage management. Delivering leading performance, enhanced efficiency, maximized return on investment, and all-in-one solutions, the T series is ideally applicable to scenarios such as large-database OLTP/OLAP, high-performance computing, digital media, Internet applications, central storage, backup, disaster recovery, and data migration.
Summary of Results

<table>
<thead>
<tr>
<th>SPC-1 Reported Data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tested Storage Product (TSP) Name:</strong> Huawei OceanStor™ S5800T</td>
</tr>
<tr>
<td><strong>Metric</strong></td>
</tr>
<tr>
<td>SPC-1 IOPSTS™</td>
</tr>
<tr>
<td>SPC-1 Price-Performance™</td>
</tr>
<tr>
<td>Total ASU Capacity</td>
</tr>
<tr>
<td>Data Protection Level</td>
</tr>
<tr>
<td>Total Price</td>
</tr>
<tr>
<td>Currency Used</td>
</tr>
<tr>
<td>Target Country for availability, sales and support</td>
</tr>
</tbody>
</table>

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

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

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

A Data Protection Level of **Protected 1** using **Mirroring** configures two or more identical copies of user data.

Total Price includes the cost of the Priced Storage Configuration plus three years of hardware maintenance and software support as detailed on page 14.

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

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

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

<table>
<thead>
<tr>
<th>Application Storage Unit (ASU) Capacity</th>
<th>50,465.866 GB</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASU 1</td>
<td>22,709.640 GB</td>
</tr>
<tr>
<td>ASU 2</td>
<td>22,709.640 GB</td>
</tr>
<tr>
<td>ASU 3</td>
<td>5,046.587 GB</td>
</tr>
</tbody>
</table>

ASU1: 20 Logical Volumes, 1,135.482 GB/Volume  
ASU2: 20 Logical Volumes, 1,135.482 GB/Volume  
ASU3: 4 Logical Volumes, 1,261.647 GB/Volume

<table>
<thead>
<tr>
<th>Addressable Storage Capacity</th>
<th>50,465.866 GB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configured Storage Capacity</td>
<td>129,077.726 GB</td>
</tr>
<tr>
<td>Physical Storage Capacity</td>
<td>129,603.054 GB</td>
</tr>
</tbody>
</table>

Data Protection (Mirroring)  
64,538.863 GB  
(includes 14,072.997 GB of Unused Capacity)

Unused – 14,072.997 GB

Global Storage Overhead – 327.768 GB

Unused – 197.568 GB

Unused – 14,072.997 GB

SPC-1 Storage Capacity Utilization

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Utilization</td>
<td>38.94%</td>
</tr>
<tr>
<td>Protected Application Utilization</td>
<td>77.88%</td>
</tr>
<tr>
<td>Unused Storage Ratio</td>
<td>21.87%</td>
</tr>
</tbody>
</table>

Application Utilization: Total ASU Capacity (50,465.866 GB) divided by Physical Storage Capacity (129,603.054 GB)

Protected Application Utilization: Total ASU Capacity (50,465.866 GB) plus total Data Protection Capacity (64,538.863 GB) minus unused Data Protection Capacity (14,072.997 GB) divided by Physical Storage Capacity (129,603.054 GB)

Unused Storage Ratio: Total Unused Capacity (28,343.563 GB) divided by Physical Storage Capacity (129,603.054 GB) and may not exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 21-22.
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 IOPSTM 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

<table>
<thead>
<tr>
<th>I/O Request Throughput</th>
<th>10% Load</th>
<th>50% Load</th>
<th>80% Load</th>
<th>90% Load</th>
<th>95% Load</th>
<th>100% Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Response Time (ms):</td>
<td>14,994.14</td>
<td>75,086.00</td>
<td>120,196.06</td>
<td>135,195.89</td>
<td>142,677.38</td>
<td>150,286.25</td>
</tr>
<tr>
<td>All ASUs</td>
<td>2.77</td>
<td>3.88</td>
<td>5.60</td>
<td>6.38</td>
<td>6.90</td>
<td>7.38</td>
</tr>
<tr>
<td>ASU-1</td>
<td>3.67</td>
<td>5.02</td>
<td>7.03</td>
<td>7.94</td>
<td>8.51</td>
<td>9.03</td>
</tr>
<tr>
<td>ASU-2</td>
<td>3.30</td>
<td>5.31</td>
<td>8.47</td>
<td>10.06</td>
<td>11.14</td>
<td>12.29</td>
</tr>
<tr>
<td>ASU-3</td>
<td>0.62</td>
<td>0.83</td>
<td>1.31</td>
<td>1.45</td>
<td>1.63</td>
<td>1.73</td>
</tr>
<tr>
<td>Reads</td>
<td>6.21</td>
<td>8.68</td>
<td>12.32</td>
<td>14.07</td>
<td>15.13</td>
<td>16.21</td>
</tr>
<tr>
<td>Writes</td>
<td>0.53</td>
<td>0.75</td>
<td>1.22</td>
<td>1.36</td>
<td>1.54</td>
<td>1.63</td>
</tr>
</tbody>
</table>
Differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration

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

Priced Storage Configuration Pricing

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Quantity</th>
<th>Unit Price</th>
<th>Total Price</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Control module</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPEB1C0200-S56-2C96G-BASE</td>
<td>SPEB1C0200-56 Controller Enclosure (Dual Controller, AC, 96GB Cache, w/ th UPS Cache Protected Module, w/ th Front-End &amp; Back-End Port, w/ th HS Storage Array Control System Software)</td>
<td>1</td>
<td>43,757.00</td>
<td>43,757.00</td>
</tr>
<tr>
<td><strong>Hard Disk Drives</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAS300-15K-2</td>
<td>300GB 15K RPM SAS Disk Unit (3.5&quot;)</td>
<td>384</td>
<td>418.00</td>
<td>160,512.00</td>
</tr>
<tr>
<td>SAS600-15K-2</td>
<td>600GB 15K RPM SAS Disk Unit (3.5&quot;)</td>
<td>24</td>
<td>669.00</td>
<td>16,056.00</td>
</tr>
<tr>
<td><strong>Disk Enclosure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAE1243SU4-AC</td>
<td>DAE1243SU4-03 Disk Enclosure (4U, 3.5&quot;, AC, SAS Expansion Module, w/ th Disk Unit, w/ th HS SAS in Band Management Software)</td>
<td>17</td>
<td>3,006.00</td>
<td>51,102.00</td>
</tr>
<tr>
<td><strong>IO Interface</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPU4F8</td>
<td>4*8Gbps Fibre Channel I/O modules (Total 4 ports)</td>
<td>2</td>
<td>1,219.00</td>
<td>2,438.00</td>
</tr>
<tr>
<td>LPU2S6</td>
<td>2*24Gbps SAS-wide I/O modules (Total 2 ports)</td>
<td>8</td>
<td>1,034.00</td>
<td>8,272.00</td>
</tr>
<tr>
<td><strong>Accessory</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS-OP-D-LC-M-3</td>
<td>Patchcord, DLC/PC-DLC/PC, Multimode, 2mm Parallel, 3m</td>
<td>8</td>
<td>11.00</td>
<td>88.00</td>
</tr>
<tr>
<td>MINI-SAS-3</td>
<td>Purchased Cable, MiniSAS Cable, Key246, 3m</td>
<td>1</td>
<td>67.00</td>
<td>67.00</td>
</tr>
<tr>
<td>MINI-SAS-6</td>
<td>Purchased Cable, MiniSAS Cable, Key246, 3m</td>
<td>4</td>
<td>91.00</td>
<td>364.00</td>
</tr>
<tr>
<td><strong>Storage management software</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIC-UltraPath02-V1R5</td>
<td>OceanStor HS UltraPath Software are License</td>
<td>1</td>
<td>1,938.00</td>
<td>1,938.00</td>
</tr>
<tr>
<td>LIC-S5B-ISM02-BLOCK</td>
<td>HS Integrated Storage Manager-Device Management License for OceanStor Block S5800T</td>
<td>1</td>
<td>4,136.00</td>
<td>4,136.00</td>
</tr>
<tr>
<td><strong>Third Party</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N8GHBA000</td>
<td>QLOGIC QLE2562 HBA Card, PCIe, 8Gbps DualPort, Fiber Channel Multimode LC Optic Interface, English Manual, Driver CD</td>
<td>4</td>
<td>1,698.00</td>
<td>6,792.00</td>
</tr>
<tr>
<td><strong>Total of Product</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maintenance Support Service</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hi-Care Premier On-Site Service (3 years)</td>
<td></td>
<td>1</td>
<td>179,568.00</td>
<td>179,568.00</td>
</tr>
<tr>
<td><strong>Total of Service (3 years)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Price</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Hi-Care Premier On-Site Service include: 7'24 Technical Assistance Center Access. Access to all new software updates and Online Support. 24'7'4 Hours Onsite Hardware Replacement
The above pricing includes hardware maintenance and software support for three years, 7 days per week, 24 hours per day. The hardware maintenance and software support provides the following:

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

Huawei Technologies Co., Ltd. only sells its products to third-party resellers, who in turn, sell those products to U.S. customers. The above pricing, which also includes the required three-year maintenance and support, was obtained from one of those third-party resellers. See page 75 (“Appendix F: Third-Party Quotation”) for a copy of the third-party reseller quotation.
Priced Storage Configuration Diagram

4 - Qlogic dual-port QLE 2562 FC HBAs

Huawei OceanStor™ S5800T

dual controllers – Active-Active
48 GB cache per controller (96 GB total)
1 – FC 4-port I/O module per controller
(8Gbps, 2 modules total)
4 – 2x24 Gbps SAS-wide I/O modules per controller (8 modules total)

17 - disk enclosures
24 - disk drives per enclosure

408 - 15K RPM SAS disk drives
24 - 600GB 15K RPM SAS disk drives
384 - 300GB 15K RPM SAS disk drives

Priced Storage Configuration Components

<table>
<thead>
<tr>
<th>Priced Storage Configuration:</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 – Qlogic dual-port QLE2562 FC HBAs</td>
</tr>
<tr>
<td>Huawei OceanStor™ S5800T</td>
</tr>
<tr>
<td>dual controllers – Active-Active</td>
</tr>
<tr>
<td>48 GB cache per controller (96 GB total)</td>
</tr>
<tr>
<td>1 – FC 4-port I/O module per controller (8 Gbps, 2 modules total)</td>
</tr>
<tr>
<td>4 – 8 Gbps front-end connections per controller (8 total, 8 used)</td>
</tr>
<tr>
<td>4 – 2x24 Gbps SAS-wide I/O modules per controller (8 total) (2 ports per modules)</td>
</tr>
<tr>
<td>8 –2x24 Gbps SAS backend connections per controller (16 total, 8 used)</td>
</tr>
<tr>
<td>17 – Disk Enclosures</td>
</tr>
<tr>
<td>24 – 3.5” HD slots per enclosure</td>
</tr>
<tr>
<td>24 – disk drives in each enclosures</td>
</tr>
<tr>
<td>408 – 15K RPM SAS disk drives</td>
</tr>
<tr>
<td>384 – 300 GB disk drives</td>
</tr>
<tr>
<td>24 – 600 GB disk drives</td>
</tr>
</tbody>
</table>
In each of the following sections of this document, the appropriate Full Disclosure Report requirement, from the SPC-1 benchmark specification, is stated in italics followed by the information to fulfill the stated requirement.

**CONFIGURATION INFORMATION**

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

*Clause 9.4.3.4.1*

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

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC) is illustrated on page 18 *(Benchmark Configuration / Tested Storage Configuration Diagram)*.

**Storage Network Configuration**

*Clause 9.4.3.4.1*

...

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

*Clause 9.4.3.4.2*

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

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

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

*Clause 9.4.3.4.3*

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

The Host System(s) and TSC table of components may be found on page 18 *(Host Systems and Tested Storage Configuration Components)*.
Benchmark Configuration/Tested Storage Configuration Diagram

2 – Huawei Tecal RH5485 Rack Servers
4 - QLogic dual-port QLE 2562 FC HBAs
(2 HBAs per server)

Huawei OceanStor™ S5800T

dual controllers – Active-Active
48 GB cache per controller (96 GB total)
1 – FC 4-port I/O module per controller
(8 Gbps, 2 modules total)
4 – 2x24 Gbps SAS-wide I/O modules per controller (8 modules total)
17 - disk enclosures
24 - disk drives per enclosure
408 - 15K RPM SAS disk drives
24 - 600GB 15K RPM SAS disk drives
384 - 300GB 15K RPM SAS disk drives

Host Systems: and Tested Storage Configuration Components

<table>
<thead>
<tr>
<th>Host Systems:</th>
<th>Tested Storage Configuration (TSC):</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 – Huawei Tecal RH5485 Rack Servers</td>
<td>4 – QLogic dual-ported QLE2562 FC HBAs</td>
</tr>
<tr>
<td>each server with:</td>
<td></td>
</tr>
<tr>
<td>4 – Intel Xeon E7530 1.87 GHz CPUs</td>
<td></td>
</tr>
<tr>
<td>128 GB main memory</td>
<td></td>
</tr>
<tr>
<td>Red Hat Enterprise Linux 5.5 x86_64</td>
<td></td>
</tr>
<tr>
<td>LVM version 2.02.56(1)</td>
<td></td>
</tr>
<tr>
<td>PCIe</td>
<td></td>
</tr>
<tr>
<td>Huawei OceanStor™ S5800T</td>
<td></td>
</tr>
<tr>
<td>dual controllers – Active-Active</td>
<td></td>
</tr>
<tr>
<td>48 GB cache per controller (96 GB total)</td>
<td></td>
</tr>
<tr>
<td>1 – FC 4-port I/O module per controller (8 Gbps, 2 modules total)</td>
<td></td>
</tr>
<tr>
<td>4 – 8Gbps front-end connections per controller (8 total, 8 used)</td>
<td></td>
</tr>
<tr>
<td>4 – 2x24 Gbps SAS-wide I/O modules per controller (8 modules total, 2 ports per modules)</td>
<td></td>
</tr>
<tr>
<td>8 – 2x24 Gbps SAS-wide backend connections per controller (16 total and 8 used)</td>
<td></td>
</tr>
<tr>
<td>17 – Disk Enclosures</td>
<td></td>
</tr>
<tr>
<td>24 – 3.5&quot; HD slots per enclosure</td>
<td></td>
</tr>
<tr>
<td>24 – disk drives per enclosure</td>
<td></td>
</tr>
<tr>
<td>408 – 15K RPM SAS disk drives</td>
<td></td>
</tr>
<tr>
<td>384 – 300 GB disk drives</td>
<td></td>
</tr>
<tr>
<td>24 – 600 GB disk drives</td>
<td></td>
</tr>
</tbody>
</table>
Customer Tunable Parameters and Options

Clause 9.4.3.5.1
All Benchmark Configuration (BC) components with customer tunable parameter and options that have been altered from their default values must be listed in the FDR. The FDR entry for each of those components must include both the name of the component and the altered value of the parameter or option. If the parameter name is not self-explanatory to a knowledgeable practitioner, a brief description of the parameter's use must also be included in the FDR entry.

“Appendix B: Customer Tunable Parameters and Options” on page 61 contains the customer tunable parameters and options that have been altered from their default values for this benchmark.

Tested Storage Configuration (TSC) Description

Clause 9.4.3.5.2
The FDR must include sufficient information to recreate the logical representation of the TSC. In addition to customer tunable parameters and options (Clause 4.2.4.5.3), that information must include, at a minimum:

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

“Appendix C: Tested Storage Configuration (TSC) Creation” on page 62 contains the detailed information that describes how to create and configure the logical TSC.

SPC-1 Workload Generator Storage Configuration

Clause 9.4.3.5.3
The FDR must include all SPC-1 Workload Generator storage configuration commands and parameters.

The SPC-1 Workload Generator storage configuration commands and parameters for this measurement appear in “Appendix D: SPC-1 Workload Generator Storage Commands and Parameters” on page 69.
ASU Pre-Fill

Clause 5.3.3

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

The configuration file used to complete the required ASU pre-fill appears in “Appendix D: SPC-1 Workload Generator Storage Commands and Parameters” on page 69.
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 57 contains definitions of terms specific to the SPC-1 Data Repository.

Storage Capacities and Relationships

Clause 9.4.3.6.1

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

SPC-1 Storage Capacities

The Physical Storage Capacity consisted of 129,603.054 GB distributed over 384 disk drives, each with a formatted capacity of 300.00 GB and 24 disk drives, each with a formatted capacity of 600.127 GB. There was 197.568 GB (0.15%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 327.760 GB (0.25%) of the Physical Storage Capacity. There was 28,145.994 GB (21.81%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 100% of the Addressable Storage Capacity resulting in 0.00 GB (0.00%) of Unused Storage within the Addressable Storage Capacity. The Data Protection (Mirroring) capacity was 64,538.863 GB of which 50,465.866 GB was utilized. The total Unused Storage capacity was 28,343.563 GB.

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

<table>
<thead>
<tr>
<th>Storage Hierarchy Component</th>
<th>Units</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total ASU Capacity</td>
<td>Gigabytes (GB)</td>
<td>50,465.866</td>
</tr>
<tr>
<td>Addressable Storage Capacity</td>
<td>Gigabytes (GB)</td>
<td>50,465.866</td>
</tr>
<tr>
<td>Configured Storage Capacity</td>
<td>Gigabytes (GB)</td>
<td>129,077.726</td>
</tr>
<tr>
<td>Physical Storage Capacity</td>
<td>Gigabytes (GB)</td>
<td>129,603.054</td>
</tr>
<tr>
<td>Data Protection (Mirroring)</td>
<td>Gigabytes (GB)</td>
<td>64,538.863</td>
</tr>
<tr>
<td>Required Storage</td>
<td>Gigabytes (GB)</td>
<td>0.000</td>
</tr>
<tr>
<td>Global Storage Overhead</td>
<td>Gigabytes (GB)</td>
<td>327.760</td>
</tr>
<tr>
<td>Total Unused Storage</td>
<td>Gigabytes (GB)</td>
<td>28,343.563</td>
</tr>
</tbody>
</table>
### SPC-1 Storage Capacities and Relationships Illustration

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

![Diagram illustrating storage capacities](image)

### SPC-1 Storage Hierarchy Ratios

<table>
<thead>
<tr>
<th></th>
<th>Addressable Storage Capacity</th>
<th>Configured Storage Capacity</th>
<th>Physical Storage Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total ASU Capacity</td>
<td>100.00%</td>
<td>39.10%</td>
<td>38.94%</td>
</tr>
<tr>
<td>Required for Data Protection <em>(Mirroring)</em></td>
<td>50.00%</td>
<td>49.80%</td>
<td></td>
</tr>
<tr>
<td>Addressable Storage Capacity</td>
<td>39.10%</td>
<td>38.94%</td>
<td></td>
</tr>
<tr>
<td>Required Storage</td>
<td>0.00%</td>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td>Configured Storage Capacity</td>
<td>99.59%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global Storage Overhead</td>
<td></td>
<td>0.25%</td>
<td></td>
</tr>
<tr>
<td>Unused Storage:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Addressable</td>
<td>0.00%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Configured</td>
<td>21.81%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical</td>
<td></td>
<td>0.15%</td>
<td></td>
</tr>
</tbody>
</table>
Storage Capacity Utilization

Clause 9.4.3.6.2
The FDR will include a table illustrating the storage capacity utilization values defined for Application Utilization (Clause 2.8.1), Protected Application Utilization (Clause 2.8.2), and Unused Storage Ratio (Clause 2.8.3).

Clause 2.8.1
Application Utilization is defined as Total ASU Capacity divided by Physical Storage Capacity.

Clause 2.8.2
Protected Application Utilization is defined as (Total ASU Capacity plus total Data Protection Capacity minus unused Data Protection Capacity) divided by Physical Storage Capacity.

Clause 2.8.3
Unused Storage Ratio is defined as Total Unused Capacity divided by Physical Storage Capacity and may not exceed 45%.

<table>
<thead>
<tr>
<th>SPC-1 Storage Capacity Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Utilization</td>
</tr>
<tr>
<td>Protected Application Utilization</td>
</tr>
<tr>
<td>Unused Storage Ratio</td>
</tr>
</tbody>
</table>

Logical Volume Capacity and ASU Mapping

Clause 9.4.3.6.3
A table illustrating the capacity of each ASU and the mapping of Logical Volumes to ASUs shall be provided in the FDR. ... Logical Volumes shall be sequenced in the table from top to bottom per its position in the contiguous address space of each ASU. The capacity of each Logical Volume shall be stated. ... In conjunction with this table, the Test Sponsor shall provide a complete description of the type of data protection (see Clause 2.4.5) used on each Logical Volume.

<table>
<thead>
<tr>
<th>Logical Volume Capacity and Mapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASU-1 (22,709.640 GB)</td>
</tr>
<tr>
<td>20 Logical Volumes 1,135.482 per Logical Volume (1,135.482 GB used per Logical Volume)</td>
</tr>
</tbody>
</table>

The Data Protection Level used for all Logical Volumes was Protected 1 using 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. “Protected 1: The single point of failure of any storage device in the configuration will not result in permanent loss of access to or integrity of the SPC-1 Data Repository.

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

SPC-1 Test Execution Definitions” on page 58 contains definitions of terms specific to the SPC-1 Tests, Test Phases, and Test Runs.

Clause 5.4.3

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

SPC-1 Tests, Test Phases, and Test Runs

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

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

- **Repeatability Test**
  - Repeatability Test Phase 1
    - 10% of IOPS Test Run (LRT)
    - IOPS Test Run
  - Repeatability Test Phase 2
    - 10% of IOPS Test Run (LRT)
    - IOPS Test Run

- **Data Persistence Test**
  - Data Persistence Test Run 1
  - Data Persistence Test Run 2

Each Test is an atomic unit that must be executed from start to finish before any other Test, Test Phase, or Test Run may be executed.
The results from each Test, Test Phase, and Test Run are listed below along with a more detailed explanation of each component.
Primary Metrics Test – Sustainability Test Phase

Clause 5.4.4.1.1
The Sustainability Test Phase has exactly one Test Run and shall demonstrate the maximum sustainable I/O Request Throughput within at least a continuous eight (8) hour Measurement Interval. This Test Phase also serves to insure that the TSC has reached Steady State prior to reporting the final maximum I/O Request Throughput result (SPC-1 IOPS™).

Clause 5.4.4.1.2
The computed I/O Request Throughput of the Sustainability Test must be within 5% of the reported SPC-1 IOPS™ result.

Clause 5.4.4.1.4
The Average Response Time, as defined in Clause 5.1.1, will be computed and reported for the Sustainability Test Run and cannot exceed 30 milliseconds. If the Average Response time exceeds that 30-milliseconds constraint, the measurement is invalid.

Clause 9.4.3.7.1
For the Sustainability Test Phase the FDR shall contain:
1. A Data Rate Distribution graph and data table.
2. I/O Request Throughput Distribution graph and data table.
3. A Response Time Frequency Distribution graph and table.
4. An Average Response Time Distribution graph and table.
5. The human readable Test Run Results File produced by the Workload Generator (may be included in an appendix).
6. A listing or screen image of all input parameters supplied to the Workload Generator (may be included in an appendix).
7. The Measured Intensity Multiplier for each I/O stream.
8. The variability of the Measured Intensity Multiplier, as defined in Clause 5.3.13.3.

SPC-1 Workload Generator Input Parameters
The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in “Appendix E: SPC-1 Workload Generator Input Parameters” on Page 72.

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

Sustainability Test Results File
Sustainability – Data Rate Distribution Data \((MB/second)\)

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

[Sustainability Data Rate Table](#)

Sustainability – Data Rate Distribution Graph

![Data Rate Distribution Graph](#)
Sustainability – I/O Request Throughput Distribution Data
The Sustainability I/O Request Throughput table of data is not embedded in this document due to its size. The table is available via the following URL:

Sustainability I/O Request Throughput Table

Sustainability – I/O Request Throughput Distribution Graph

I/O Request Throughput Distribution (Ramp_sust @3005 BSUs)

All ASUs

ASU1

ASU2

ASU3

Measurement Interval

Test Run Minutes

I/O Requests per Second
Sustainability – Average Response Time (ms) Distribution Data

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

[Sustainability Average Response Time Table](#)

Sustainability – Average Response Time (ms) Distribution Graph

---

Average Response Time Distribution (Ramp_sust @3005 BSUs)

- **Measurement Interval**
- **Test Run Minutes**
- **Average Response Time (ms)**

- **All ASUs**
- **ASU1**
- **ASU2**
- **ASU3**
### Sustainability – Response Time Frequency Distribution Data

<table>
<thead>
<tr>
<th>Response Time (ms)</th>
<th>0-0.25</th>
<th>&gt;0.25-0.5</th>
<th>&gt;0.5-0.75</th>
<th>&gt;0.75-1.0</th>
<th>&gt;1.0-1.25</th>
<th>&gt;1.25-1.5</th>
<th>&gt;1.5-1.75</th>
<th>&gt;1.75-2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read</td>
<td>125,021,188</td>
<td>35,693,116</td>
<td>6,760,345</td>
<td>5,876,921</td>
<td>8,013,464</td>
<td>8,248,977</td>
<td>7,288,186</td>
<td>7,528,579</td>
</tr>
<tr>
<td>Write</td>
<td>13,762</td>
<td>82,921,592</td>
<td>360,695,905</td>
<td>474,286,631</td>
<td>498,336,175</td>
<td>352,005,221</td>
<td>217,086,643</td>
<td>158,148,399</td>
</tr>
<tr>
<td>All ASUs</td>
<td>125,034,950</td>
<td>118,614,708</td>
<td>367,456,250</td>
<td>480,163,552</td>
<td>506,349,639</td>
<td>360,254,198</td>
<td>224,374,829</td>
<td>165,676,978</td>
</tr>
<tr>
<td>ASU1</td>
<td>102,632,696</td>
<td>67,903,351</td>
<td>167,363,456</td>
<td>212,900,726</td>
<td>223,347,789</td>
<td>158,548,893</td>
<td>98,803,246</td>
<td>73,448,796</td>
</tr>
<tr>
<td>ASU2</td>
<td>22,396,582</td>
<td>15,188,462</td>
<td>38,718,765</td>
<td>49,723,788</td>
<td>52,377,769</td>
<td>37,213,994</td>
<td>23,159,024</td>
<td>17,130,768</td>
</tr>
<tr>
<td>ASU3</td>
<td>5,672</td>
<td>35,522,895</td>
<td>161,374,029</td>
<td>217,539,038</td>
<td>230,624,081</td>
<td>164,491,311</td>
<td>102,412,559</td>
<td>75,097,414</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Response Time (ms)</th>
<th>&gt;2.0-2.5</th>
<th>&gt;2.5-3.0</th>
<th>&gt;3.0-3.5</th>
<th>&gt;3.5-4.0</th>
<th>&gt;4.0-4.5</th>
<th>&gt;4.5-5.0</th>
<th>&gt;5.0-6.0</th>
<th>&gt;6.0-7.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read</td>
<td>18,066,015</td>
<td>16,340,842</td>
<td>22,764,154</td>
<td>23,849,552</td>
<td>35,093,732</td>
<td>36,771,868</td>
<td>100,416,650</td>
<td>118,814,138</td>
</tr>
<tr>
<td>Write</td>
<td>226,359,910</td>
<td>86,509,588</td>
<td>58,838,794</td>
<td>27,836,555</td>
<td>21,743,469</td>
<td>12,042,273</td>
<td>15,510,107</td>
<td>7,326,494</td>
</tr>
<tr>
<td>All ASUs</td>
<td>244,425,925</td>
<td>102,850,430</td>
<td>81,602,948</td>
<td>51,686,107</td>
<td>56,837,201</td>
<td>48,814,141</td>
<td>115,926,757</td>
<td>126,140,632</td>
</tr>
<tr>
<td>ASU1</td>
<td>111,749,032</td>
<td>51,175,597</td>
<td>45,666,948</td>
<td>33,946,460</td>
<td>42,026,920</td>
<td>39,441,435</td>
<td>99,263,293</td>
<td>110,503,003</td>
</tr>
<tr>
<td>ASU2</td>
<td>25,446,600</td>
<td>10,525,570</td>
<td>7,969,669</td>
<td>4,530,287</td>
<td>4,504,733</td>
<td>3,648,360</td>
<td>9,256,577</td>
<td>12,102,299</td>
</tr>
<tr>
<td>ASU3</td>
<td>107,228,293</td>
<td>41,149,263</td>
<td>27,936,331</td>
<td>13,209,360</td>
<td>10,305,548</td>
<td>5,724,346</td>
<td>7,406,887</td>
<td>3,553,330</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Response Time (ms)</th>
<th>&gt;7.0-8.0</th>
<th>&gt;8.0-9.0</th>
<th>&gt;9.0-10.0</th>
<th>&gt;10.0-15.0</th>
<th>&gt;15.0-20.0</th>
<th>&gt;20.0-25.0</th>
<th>&gt;25.0-30.0</th>
<th>&gt;30.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read</td>
<td>121,887,879</td>
<td>109,239,754</td>
<td>91,092,785</td>
<td>258,321,001</td>
<td>129,595,157</td>
<td>87,211,455</td>
<td>64,939,300</td>
<td>267,754,022</td>
</tr>
<tr>
<td>Write</td>
<td>3,621,552</td>
<td>2,248,266</td>
<td>1,590,462</td>
<td>4,425,564</td>
<td>1,861,289</td>
<td>1,302,557</td>
<td>982,747</td>
<td>4,670,231</td>
</tr>
<tr>
<td>All ASUs</td>
<td>125,709,431</td>
<td>111,488,020</td>
<td>92,683,247</td>
<td>262,746,565</td>
<td>131,456,446</td>
<td>88,514,012</td>
<td>65,922,047</td>
<td>272,424,253</td>
</tr>
<tr>
<td>ASU1</td>
<td>109,367,914</td>
<td>94,978,942</td>
<td>77,790,734</td>
<td>220,311,583</td>
<td>110,624,658</td>
<td>73,671,077</td>
<td>54,144,953</td>
<td>199,334,418</td>
</tr>
<tr>
<td>ASU2</td>
<td>14,474,052</td>
<td>15,388,620</td>
<td>14,086,493</td>
<td>40,078,383</td>
<td>19,695,315</td>
<td>13,968,704</td>
<td>11,092,613</td>
<td>69,538,851</td>
</tr>
<tr>
<td>ASU3</td>
<td>1,867,465</td>
<td>1,120,458</td>
<td>806,020</td>
<td>2,356,599</td>
<td>1,136,473</td>
<td>856,231</td>
<td>684,481</td>
<td>3,550,984</td>
</tr>
</tbody>
</table>

### Sustainability – Response Time Frequency Distribution Graph

![Response Time Frequency Distribution Graph](image-url)

**Response Time Frequency Distribution (Ramp_sust @3005 BSUs)**

- **Read**
- **Write**
- **All ASUs**

- **Number of Occurrences**
- **Response Time in Milliseconds**
Sustainability – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

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

Clauses 5.1.10 and 5.3.15.2

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

Clause 5.3.15.3

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

<table>
<thead>
<tr>
<th></th>
<th>ASU1-1</th>
<th>ASU1-2</th>
<th>ASU1-3</th>
<th>ASU1-4</th>
<th>ASU2-1</th>
<th>ASU2-2</th>
<th>ASU2-3</th>
<th>ASU3-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM</td>
<td>0.0350</td>
<td>0.2810</td>
<td>0.0700</td>
<td>0.2100</td>
<td>0.0180</td>
<td>0.0700</td>
<td>0.0350</td>
<td>0.2810</td>
</tr>
<tr>
<td>MIM</td>
<td>0.0350</td>
<td>0.2810</td>
<td>0.0700</td>
<td>0.2100</td>
<td>0.0180</td>
<td>0.0700</td>
<td>0.0350</td>
<td>0.2810</td>
</tr>
<tr>
<td>COV</td>
<td>0.002</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.003</td>
<td>0.001</td>
<td>0.002</td>
<td>0.001</td>
</tr>
</tbody>
</table>
Primary Metrics Test – IOPS Test Phase

Clause 5.4.4.2
The IOPS Test Phase consists of one Test Run at the 100% load point with a Measurement Interval of ten (10) minutes. The IOPS Test Phase immediately follows the Sustainability Test Phase without any interruption or manual intervention.

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

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

Clause 9.4.3.7.2
For the IOPS Test Phase the FDR shall contain:
   1. I/O Request Throughput Distribution (data and graph).
   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 72.

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

<table>
<thead>
<tr>
<th>Start-Up/Ramp-Up</th>
<th>Start</th>
<th>Stop</th>
<th>Interval</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement Interval</td>
<td>19:52:08</td>
<td>19:55:09</td>
<td>0:03:01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>19:55:09</td>
<td>20:05:09</td>
<td>3:12</td>
<td>0:10:00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>60 second intervals</th>
<th>All ASUs</th>
<th>ASU1</th>
<th>ASU2</th>
<th>ASU3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>150,557.70</td>
<td>89,751.77</td>
<td>18,516.57</td>
<td>42,289.37</td>
</tr>
<tr>
<td>1</td>
<td>150,252.78</td>
<td>89,590.60</td>
<td>18,462.13</td>
<td>42,200.05</td>
</tr>
<tr>
<td>2</td>
<td>150,176.40</td>
<td>89,455.87</td>
<td>18,511.78</td>
<td>42,208.75</td>
</tr>
<tr>
<td>3</td>
<td>150,291.82</td>
<td>89,598.18</td>
<td>18,492.65</td>
<td>42,200.98</td>
</tr>
<tr>
<td>4</td>
<td>150,370.88</td>
<td>89,602.07</td>
<td>18,486.95</td>
<td>42,281.87</td>
</tr>
<tr>
<td>5</td>
<td>150,250.82</td>
<td>89,502.12</td>
<td>18,504.38</td>
<td>42,244.32</td>
</tr>
<tr>
<td>6</td>
<td>150,239.52</td>
<td>89,521.20</td>
<td>18,494.27</td>
<td>42,224.05</td>
</tr>
<tr>
<td>7</td>
<td>150,366.32</td>
<td>89,582.90</td>
<td>18,485.53</td>
<td>42,297.88</td>
</tr>
<tr>
<td>8</td>
<td>150,237.50</td>
<td>89,555.15</td>
<td>18,465.58</td>
<td>42,216.77</td>
</tr>
<tr>
<td>9</td>
<td>150,241.58</td>
<td>89,591.23</td>
<td>18,452.47</td>
<td>42,197.88</td>
</tr>
<tr>
<td>10</td>
<td>150,327.35</td>
<td>89,579.50</td>
<td>18,503.77</td>
<td>42,244.08</td>
</tr>
<tr>
<td>11</td>
<td>150,281.38</td>
<td>89,584.35</td>
<td>18,462.75</td>
<td>42,234.28</td>
</tr>
<tr>
<td>12</td>
<td>150,255.33</td>
<td>89,519.53</td>
<td>18,488.43</td>
<td>42,247.37</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>150,286.25</strong></td>
<td><strong>89,563.62</strong></td>
<td><strong>18,483.68</strong></td>
<td><strong>42,238.95</strong></td>
</tr>
</tbody>
</table>

IOPS Test Run – I/O Request Throughput Distribution Graph
IOPS Test Run – Average Response Time (ms) Distribution Data

<table>
<thead>
<tr>
<th>3,005 BSUs</th>
<th>Start</th>
<th>Stop</th>
<th>Interval</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 second intervals</td>
<td>All ASUs</td>
<td>ASU1</td>
<td>ASU2</td>
<td>ASU3</td>
</tr>
<tr>
<td>0</td>
<td>7.47</td>
<td>9.07</td>
<td>12.36</td>
<td>1.95</td>
</tr>
<tr>
<td>1</td>
<td>7.50</td>
<td>9.18</td>
<td>12.33</td>
<td>1.80</td>
</tr>
<tr>
<td>2</td>
<td>7.76</td>
<td>9.37</td>
<td>12.77</td>
<td>2.14</td>
</tr>
<tr>
<td>3</td>
<td>7.49</td>
<td>9.19</td>
<td>12.23</td>
<td>1.78</td>
</tr>
<tr>
<td>4</td>
<td>7.44</td>
<td>9.07</td>
<td>12.51</td>
<td>1.77</td>
</tr>
<tr>
<td>5</td>
<td>7.37</td>
<td>9.06</td>
<td>12.20</td>
<td>1.70</td>
</tr>
<tr>
<td>6</td>
<td>7.34</td>
<td>8.99</td>
<td>12.20</td>
<td>1.72</td>
</tr>
<tr>
<td>7</td>
<td>7.32</td>
<td>8.96</td>
<td>12.30</td>
<td>1.69</td>
</tr>
<tr>
<td>8</td>
<td>7.41</td>
<td>9.07</td>
<td>12.40</td>
<td>1.73</td>
</tr>
<tr>
<td>9</td>
<td>7.41</td>
<td>9.06</td>
<td>12.31</td>
<td>1.77</td>
</tr>
<tr>
<td>10</td>
<td>7.34</td>
<td>8.99</td>
<td>12.27</td>
<td>1.69</td>
</tr>
<tr>
<td>11</td>
<td>7.40</td>
<td>9.05</td>
<td>12.23</td>
<td>1.77</td>
</tr>
<tr>
<td>12</td>
<td>7.28</td>
<td>8.89</td>
<td>12.25</td>
<td>1.69</td>
</tr>
<tr>
<td>Average</td>
<td>7.38</td>
<td>9.03</td>
<td>12.29</td>
<td>1.73</td>
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</table>

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

<table>
<thead>
<tr>
<th>Response Time (ms)</th>
<th>0-0.25</th>
<th>&gt;0.25-0.5</th>
<th>&gt;0.5-0.75</th>
<th>&gt;0.75-1.0</th>
<th>&gt;1.0-1.25</th>
<th>&gt;1.25-1.5</th>
<th>&gt;1.5-1.75</th>
<th>&gt;1.75-2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read</td>
<td>2,700,620</td>
<td>831,534</td>
<td>162,447</td>
<td>124,563</td>
<td>167,619</td>
<td>171,577</td>
<td>152,165</td>
<td>154,175</td>
</tr>
<tr>
<td>Write</td>
<td>249</td>
<td>1,658,225</td>
<td>7,391,229</td>
<td>9,684,722</td>
<td>10,299,451</td>
<td>7,392,613</td>
<td>4,592,048</td>
<td>3,291,431</td>
</tr>
<tr>
<td>All ASUs</td>
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<td>2,489,759</td>
<td>7,553,676</td>
<td>9,809,285</td>
<td>10,467,070</td>
<td>7,564,190</td>
<td>4,744,213</td>
<td>3,445,606</td>
</tr>
<tr>
<td>ASU1</td>
<td>2,242,905</td>
<td>1,464,856</td>
<td>3,454,415</td>
<td>4,351,947</td>
<td>4,618,296</td>
<td>3,330,887</td>
<td>2,088,207</td>
<td>1,526,238</td>
</tr>
<tr>
<td>ASU2</td>
<td>457,863</td>
<td>317,272</td>
<td>796,685</td>
<td>1,016,989</td>
<td>1,082,010</td>
<td>780,839</td>
<td>491,129</td>
<td>355,018</td>
</tr>
<tr>
<td>ASU3</td>
<td>101</td>
<td>707,631</td>
<td>3,302,576</td>
<td>4,440,349</td>
<td>4,766,764</td>
<td>3,452,464</td>
<td>2,164,877</td>
<td>1,564,350</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Response Time (ms)</th>
<th>&gt;2.0-2.5</th>
<th>&gt;2.5-3.0</th>
<th>&gt;3.0-3.5</th>
<th>&gt;3.5-4.0</th>
<th>&gt;4.0-4.5</th>
<th>&gt;4.5-5.0</th>
<th>&gt;5.0-6.0</th>
<th>&gt;6.0-7.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read</td>
<td>377,574</td>
<td>478,407</td>
<td>497,433</td>
<td>737,653</td>
<td>769,502</td>
<td>2,104,257</td>
<td>2,492,304</td>
<td></td>
</tr>
<tr>
<td>Write</td>
<td>4,805,635</td>
<td>1,269,383</td>
<td>608,887</td>
<td>477,125</td>
<td>270,489</td>
<td>347,755</td>
<td>163,724</td>
<td></td>
</tr>
<tr>
<td>All ASUs</td>
<td>5,183,209</td>
<td>1,106,320</td>
<td>1,214,778</td>
<td>1,039,991</td>
<td>2,452,012</td>
<td>2,656,028</td>
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<td></td>
</tr>
<tr>
<td>ASU1</td>
<td>2,369,690</td>
<td>973,883</td>
<td>718,755</td>
<td>892,479</td>
<td>832,749</td>
<td>2,088,463</td>
<td>2,319,911</td>
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</tr>
<tr>
<td>ASU2</td>
<td>538,169</td>
<td>169,876</td>
<td>97,447</td>
<td>96,464</td>
<td>78,691</td>
<td>197,230</td>
<td>257,189</td>
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</tr>
<tr>
<td>ASU3</td>
<td>2,275,350</td>
<td>604,031</td>
<td>290,118</td>
<td>225,835</td>
<td>128,551</td>
<td>166,319</td>
<td>78,928</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Response Time (ms)</th>
<th>&gt;7.0-8.0</th>
<th>&gt;8.0-9.0</th>
<th>&gt;9.0-10.0</th>
<th>&gt;10.0-15.0</th>
<th>&gt;15.0-20.0</th>
<th>&gt;20.0-25.0</th>
<th>&gt;25.0-30.0</th>
<th>&gt;30.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read</td>
<td>2,557,525</td>
<td>5,244,910</td>
<td>2,658,537</td>
<td>1,799,602</td>
<td>1,340,934</td>
<td>5,520,928</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Write</td>
<td>86,030</td>
<td>38,646</td>
<td>50,459</td>
<td>32,670</td>
<td>21,466</td>
<td>111,740</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All ASUs</td>
<td>2,643,555</td>
<td>1,923,990</td>
<td>2,708,996</td>
<td>1,832,727</td>
<td>1,362,400</td>
<td>5,632,668</td>
<td></td>
<td></td>
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<tr>
<td>ASU1</td>
<td>2,293,725</td>
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<td>1,605,778</td>
<td>1,520,857</td>
<td>1,116,525</td>
<td>4,110,905</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASU2</td>
<td>307,761</td>
<td>298,811</td>
<td>407,246</td>
<td>290,811</td>
<td>231,048</td>
<td>1,441,404</td>
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<td></td>
</tr>
<tr>
<td>ASU3</td>
<td>42,069</td>
<td>59,729</td>
<td>29,309</td>
<td>20,604</td>
<td>14,827</td>
<td>80,359</td>
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</tr>
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</table>

IOPS Test Run – Response Time Frequency Distribution Graph
IOPS Test Run – I/O Request Information

<table>
<thead>
<tr>
<th></th>
<th>I/O Requests Completed in the Measurement Interval</th>
<th>I/O Requests Completed with Response Time = or &lt; 30 ms</th>
<th>I/O Requests Completed with Response Time &gt; 30 ms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>90,170,721</td>
<td>84,538,053</td>
<td>5,632,668</td>
</tr>
</tbody>
</table>

IOPS Test Run – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

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

Clauses 5.1.10 and 5.3.15.2

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

Clause 5.3.15.3

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

<table>
<thead>
<tr>
<th></th>
<th>ASU1-1</th>
<th>ASU1-2</th>
<th>ASU1-3</th>
<th>ASU1-4</th>
<th>ASU2-1</th>
<th>ASU2-2</th>
<th>ASU2-3</th>
<th>ASU3-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM</td>
<td>0.0350</td>
<td>0.2810</td>
<td>0.0700</td>
<td>0.2100</td>
<td>0.0180</td>
<td>0.0700</td>
<td>0.0350</td>
<td>0.2810</td>
</tr>
<tr>
<td>MIM</td>
<td>0.0350</td>
<td>0.2810</td>
<td>0.0700</td>
<td>0.2099</td>
<td>0.0180</td>
<td>0.0700</td>
<td>0.0350</td>
<td>0.2811</td>
</tr>
<tr>
<td>COV</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.002</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
</tbody>
</table>
Primary Metrics Test – Response Time Ramp Test Phase

Clause 5.4.4.3
The Response Time Ramp Test Phase consists of five Test Runs, one each at 95%, 90%, 80%, 50%, and 10% of the load point (100%) used to generate the SPC-1 IOPSTM 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 13.

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

Clause 9.4.3.7.3
The following content shall appear in the FDR for the Response Time Ramp Phase:

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

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in “Appendix E: SPC-1 Workload Generator Input Parameters” on Page 72.

Response Time Ramp Test Results File

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

- 95% Load Level
- 90% Load Level
- 80% Load Level
- 50% Load Level
- 10% Load Level
Response Time Ramp Distribution (IOPS) Data

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

### 100% Load Level - 3005 BSUs

<table>
<thead>
<tr>
<th>Start-Up/Ramp-Up</th>
<th>Measurement Interval</th>
<th>Start</th>
<th>Stop</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20:55:09</td>
<td>20:55:09</td>
<td>0-2</td>
<td>0:05:00</td>
</tr>
</tbody>
</table>

### 95% Load Level - 2854 BSUs

<table>
<thead>
<tr>
<th>Start-Up/Ramp-Up</th>
<th>Measurement Interval</th>
<th>Start</th>
<th>Stop</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20:00:49</td>
<td>20:00:49</td>
<td>3-12</td>
<td>0:10:00</td>
</tr>
</tbody>
</table>

### 90% Load Level - 2505 BSUs

<table>
<thead>
<tr>
<th>Start-Up/Ramp-Up</th>
<th>Measurement Interval</th>
<th>Start</th>
<th>Stop</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20:00:49</td>
<td>20:00:49</td>
<td>3-12</td>
<td>0:10:00</td>
</tr>
</tbody>
</table>

### 80% Load Level - 2204 BSUs

<table>
<thead>
<tr>
<th>Start-Up/Ramp-Up</th>
<th>Measurement Interval</th>
<th>Start</th>
<th>Stop</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20:00:49</td>
<td>20:00:49</td>
<td>3-12</td>
<td>0:10:00</td>
</tr>
</tbody>
</table>

### 50% Load Level - 1502 BSUs

<table>
<thead>
<tr>
<th>Start-Up/Ramp-Up</th>
<th>Measurement Interval</th>
<th>Start</th>
<th>Stop</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20:00:49</td>
<td>20:00:49</td>
<td>3-12</td>
<td>0:10:00</td>
</tr>
</tbody>
</table>

### 10% Load Level - 300 BSUs

<table>
<thead>
<tr>
<th>Start-Up/Ramp-Up</th>
<th>Measurement Interval</th>
<th>Start</th>
<th>Stop</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20:00:49</td>
<td>20:00:49</td>
<td>3-12</td>
<td>0:10:00</td>
</tr>
</tbody>
</table>
Response Time Ramp Distribution (IOPS) Graph

![Response Time Ramp Distribution Graph](image-url)
SPC-1 LRT™ Average Response Time (ms) Distribution Data

<table>
<thead>
<tr>
<th>300 BSUs</th>
<th>Start</th>
<th>Stop</th>
<th>Interval</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start-Up/Ramp-Up</td>
<td>21:00:12</td>
<td>21:03:13</td>
<td>0-2</td>
<td>0:03:01</td>
</tr>
<tr>
<td>Measurement Interval</td>
<td>21:03:13</td>
<td>21:13:13</td>
<td>3-12</td>
<td>0:10:00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>60 second intervals</th>
<th>All ASUs</th>
<th>ASU1</th>
<th>ASU2</th>
<th>ASU3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2.70</td>
<td>3.65</td>
<td>3.29</td>
<td>0.43</td>
</tr>
<tr>
<td>1</td>
<td>2.87</td>
<td>3.79</td>
<td>3.43</td>
<td>0.69</td>
</tr>
<tr>
<td>2</td>
<td>2.69</td>
<td>3.60</td>
<td>3.22</td>
<td>0.52</td>
</tr>
<tr>
<td>3</td>
<td>2.75</td>
<td>3.66</td>
<td>3.27</td>
<td>0.59</td>
</tr>
<tr>
<td>4</td>
<td>2.77</td>
<td>3.69</td>
<td>3.28</td>
<td>0.58</td>
</tr>
<tr>
<td>5</td>
<td>2.74</td>
<td>3.65</td>
<td>3.22</td>
<td>0.60</td>
</tr>
<tr>
<td>6</td>
<td>2.75</td>
<td>3.67</td>
<td>3.24</td>
<td>0.60</td>
</tr>
<tr>
<td>7</td>
<td>2.75</td>
<td>3.65</td>
<td>3.27</td>
<td>0.61</td>
</tr>
<tr>
<td>8</td>
<td>2.94</td>
<td>3.84</td>
<td>3.46</td>
<td>0.80</td>
</tr>
<tr>
<td>9</td>
<td>2.74</td>
<td>3.63</td>
<td>3.32</td>
<td>0.59</td>
</tr>
<tr>
<td>10</td>
<td>2.72</td>
<td>3.61</td>
<td>3.27</td>
<td>0.59</td>
</tr>
<tr>
<td>11</td>
<td>2.82</td>
<td>3.71</td>
<td>3.37</td>
<td>0.68</td>
</tr>
<tr>
<td>12</td>
<td>2.73</td>
<td>3.62</td>
<td>3.29</td>
<td>0.58</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>2.77</td>
<td>3.67</td>
<td>3.30</td>
<td>0.62</td>
</tr>
</tbody>
</table>

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

Average Response Time Distribution (Ramp_10 @300 BSUs)
SPC-1 LRT™ (10%) – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

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

*Clauses 5.1.10 and 5.3.15.2*

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

*Clause 5.3.15.3*

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

<table>
<thead>
<tr>
<th></th>
<th>ASU1-1</th>
<th>ASU1-2</th>
<th>ASU1-3</th>
<th>ASU1-4</th>
<th>ASU2-1</th>
<th>ASU2-2</th>
<th>ASU2-3</th>
<th>ASU3-1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IM</strong></td>
<td>0.0350</td>
<td>0.2810</td>
<td>0.0700</td>
<td>0.2100</td>
<td>0.0180</td>
<td>0.0700</td>
<td>0.0350</td>
<td>0.2810</td>
</tr>
<tr>
<td><strong>MIM</strong></td>
<td>0.0350</td>
<td>0.2810</td>
<td>0.0701</td>
<td>0.2100</td>
<td>0.0180</td>
<td>0.0699</td>
<td>0.0351</td>
<td>0.2810</td>
</tr>
<tr>
<td><strong>COV</strong></td>
<td>0.006</td>
<td>0.002</td>
<td>0.005</td>
<td>0.003</td>
<td>0.007</td>
<td>0.003</td>
<td>0.006</td>
<td>0.001</td>
</tr>
</tbody>
</table>
Repeatability Test

Clause 5.4.5
The Repeatability Test demonstrates the repeatability and reproducibility of the SPC-1 IOPS™ primary metric and the SPC-1 LRT™ metric generated in earlier Test Runs.

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

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

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

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

Clause 9.4.3.7.4
The following content shall appear in the FDR for each Test Run in the two Repeatability Test Phases:
1. A table containing the results of the Repeatability Test.
2. An I/O Request Throughput Distribution graph and table.
3. An Average Response Time Distribution graph and table.
4. The human readable Test Run Results File produced by the Workload Generator.
5. A listing or screen image of all input parameters supplied to the Workload Generator.

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in “Appendix E: SPC-1 Workload Generator Input Parameters” on Page 72.
Repeatability Test Results File

The values for the SPC-1 IOPSTM, SPC-1 LRTTM, and the Repeatability Test measurements are listed in the tables below.

<table>
<thead>
<tr>
<th></th>
<th>SPC-1 IOPSTM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Metrics</td>
<td>150,286.25</td>
</tr>
<tr>
<td>Repeatability Test Phase 1</td>
<td>150,235.28</td>
</tr>
<tr>
<td>Repeatability Test Phase 2</td>
<td>150,275.09</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>SPC-1 LRTTM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Metrics</td>
<td>2.77 ms</td>
</tr>
<tr>
<td>Repeatability Test Phase 1</td>
<td>2.75 ms</td>
</tr>
<tr>
<td>Repeatability Test Phase 2</td>
<td>2.69 ms</td>
</tr>
</tbody>
</table>

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

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

- Repeatability Test Phase 1, Test Run 1 (LRT)
- Repeatability Test Phase 1, Test Run 2 (IOPS)
- Repeatability Test Phase 2, Test Run 1 (LRT)
- Repeatability Test Phase 2, Test Run 2 (IOPS)
Repeatability 1 LRT – I/O Request Throughput Distribution Data

<table>
<thead>
<tr>
<th>300 BSUs</th>
<th>Start-Up/Ramp-Up</th>
<th>Measurement Interval</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Start</td>
<td>Stop</td>
<td>Interval</td>
</tr>
<tr>
<td></td>
<td>21:13:50</td>
<td>21:16:50</td>
<td>0-2</td>
</tr>
<tr>
<td></td>
<td>21:16:50</td>
<td>21:26:50</td>
<td>3-12</td>
</tr>
</tbody>
</table>

60 second intervals

<table>
<thead>
<tr>
<th></th>
<th>All ASUs</th>
<th>ASU1</th>
<th>ASU2</th>
<th>ASU3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>15,002.77</td>
<td>8,937.40</td>
<td>1,838.95</td>
<td>4,226.42</td>
</tr>
<tr>
<td>1</td>
<td>15,009.03</td>
<td>8,947.32</td>
<td>1,838.63</td>
<td>4,223.08</td>
</tr>
<tr>
<td>2</td>
<td>14,999.03</td>
<td>8,927.97</td>
<td>1,845.13</td>
<td>4,225.93</td>
</tr>
<tr>
<td>3</td>
<td>14,983.80</td>
<td>8,938.47</td>
<td>1,838.57</td>
<td>4,206.77</td>
</tr>
<tr>
<td>4</td>
<td>15,006.17</td>
<td>8,949.65</td>
<td>1,848.23</td>
<td>4,208.28</td>
</tr>
<tr>
<td>5</td>
<td>14,998.38</td>
<td>8,942.17</td>
<td>1,848.72</td>
<td>4,207.50</td>
</tr>
<tr>
<td>6</td>
<td>14,993.17</td>
<td>8,940.75</td>
<td>1,841.12</td>
<td>4,211.30</td>
</tr>
<tr>
<td>7</td>
<td>14,977.58</td>
<td>8,916.35</td>
<td>1,844.57</td>
<td>4,216.67</td>
</tr>
<tr>
<td>8</td>
<td>14,966.43</td>
<td>8,916.28</td>
<td>1,844.78</td>
<td>4,205.37</td>
</tr>
<tr>
<td>9</td>
<td>14,997.65</td>
<td>8,943.82</td>
<td>1,839.37</td>
<td>4,214.47</td>
</tr>
<tr>
<td>10</td>
<td>14,975.60</td>
<td>8,918.92</td>
<td>1,841.45</td>
<td>4,215.23</td>
</tr>
<tr>
<td>11</td>
<td>14,988.90</td>
<td>8,932.43</td>
<td>1,846.30</td>
<td>4,210.17</td>
</tr>
<tr>
<td>12</td>
<td>15,006.13</td>
<td>8,932.07</td>
<td>1,854.63</td>
<td>4,219.43</td>
</tr>
</tbody>
</table>

Average 14,989.38 8,933.09 1,844.77 4,211.52

Repeatability 1 LRT – I/O Request Throughput Distribution Graph
Repeatability 1 LRT –Average Response Time (ms) Distribution Data

<table>
<thead>
<tr>
<th>300 BSUs</th>
<th>Start</th>
<th>Stop</th>
<th>Interval</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start-Up/Ramp-Up</td>
<td>21:13:50</td>
<td>21:16:50</td>
<td>0-2</td>
<td>0:03:00</td>
</tr>
<tr>
<td>Measurement Interval</td>
<td>21:16:50</td>
<td>21:26:50</td>
<td>3-12</td>
<td>0:10:00</td>
</tr>
<tr>
<td>60 second intervals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>2.88</td>
<td>3.81</td>
<td>3.46</td>
<td>0.67</td>
</tr>
<tr>
<td>1</td>
<td>2.75</td>
<td>3.65</td>
<td>3.31</td>
<td>0.62</td>
</tr>
<tr>
<td>2</td>
<td>2.75</td>
<td>3.65</td>
<td>3.32</td>
<td>0.59</td>
</tr>
<tr>
<td>3</td>
<td>2.75</td>
<td>3.64</td>
<td>3.31</td>
<td>0.59</td>
</tr>
<tr>
<td>4</td>
<td>2.75</td>
<td>3.65</td>
<td>3.27</td>
<td>0.60</td>
</tr>
<tr>
<td>5</td>
<td>2.76</td>
<td>3.65</td>
<td>3.32</td>
<td>0.60</td>
</tr>
<tr>
<td>6</td>
<td>2.73</td>
<td>3.63</td>
<td>3.29</td>
<td>0.59</td>
</tr>
<tr>
<td>7</td>
<td>2.72</td>
<td>3.61</td>
<td>3.29</td>
<td>0.59</td>
</tr>
<tr>
<td>8</td>
<td>2.72</td>
<td>3.61</td>
<td>3.30</td>
<td>0.58</td>
</tr>
<tr>
<td>9</td>
<td>2.74</td>
<td>3.64</td>
<td>3.30</td>
<td>0.60</td>
</tr>
<tr>
<td>10</td>
<td>2.90</td>
<td>3.80</td>
<td>3.46</td>
<td>0.77</td>
</tr>
<tr>
<td>11</td>
<td>2.72</td>
<td>3.61</td>
<td>3.25</td>
<td>0.60</td>
</tr>
<tr>
<td>12</td>
<td>2.71</td>
<td>3.60</td>
<td>3.26</td>
<td>0.59</td>
</tr>
<tr>
<td>Average</td>
<td>2.75</td>
<td>3.64</td>
<td>3.30</td>
<td>0.61</td>
</tr>
</tbody>
</table>

Repeatability 1 LRT –Average Response Time (ms) Distribution Graph
### Repeatability 1 IOPS – I/O Request Throughput Distribution Data

<table>
<thead>
<tr>
<th>3005 BSUs</th>
<th>Start</th>
<th>Stop</th>
<th>Interval</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start-Up/Ramp-Up</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All ASUs</td>
<td>150,327.95</td>
<td>89,577.80</td>
<td>18,498.67</td>
<td>42,251.48</td>
</tr>
<tr>
<td>ASU1</td>
<td>150,288.22</td>
<td>89,526.98</td>
<td>18,526.13</td>
<td>42,235.10</td>
</tr>
<tr>
<td>ASU2</td>
<td>150,272.35</td>
<td>89,597.83</td>
<td>18,490.68</td>
<td>42,183.83</td>
</tr>
<tr>
<td>ASU3</td>
<td>150,300.60</td>
<td>89,565.88</td>
<td>18,472.57</td>
<td>42,262.15</td>
</tr>
<tr>
<td>60 second intervals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>150,229.98</td>
<td>89,503.27</td>
<td>18,479.07</td>
<td>42,247.65</td>
</tr>
<tr>
<td>1</td>
<td>150,249.32</td>
<td>89,505.00</td>
<td>18,494.62</td>
<td>42,249.70</td>
</tr>
<tr>
<td>2</td>
<td>150,215.60</td>
<td>89,528.98</td>
<td>18,471.47</td>
<td>42,215.15</td>
</tr>
<tr>
<td>3</td>
<td>150,195.67</td>
<td>89,538.42</td>
<td>18,487.83</td>
<td>42,169.42</td>
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<tr>
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<td>150,273.97</td>
<td>89,603.38</td>
<td>18,459.57</td>
<td>42,211.02</td>
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<td>42,199.87</td>
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<td>150,248.13</td>
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<td>18,461.87</td>
<td>42,237.03</td>
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<tr>
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<td>89,589.08</td>
<td>18,468.27</td>
<td>42,218.43</td>
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<tr>
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<td>89,544.03</td>
<td>18,473.81</td>
<td>42,217.45</td>
</tr>
</tbody>
</table>

### Repeatability 1 IOPS – I/O Request Throughput Distribution Graph

![I/O Request Throughput Distribution Graph](image-url)
Repeatability Test

SPC-1 BENCHMARK EXECUTION RESULTS

REPEATABILITY TEST

SPC BENCHMARK 1™ V1.13 FULL DISCLOSURE REPORT Submission Identifier: A00124
Huawei OceanStor™ S5800T

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

<table>
<thead>
<tr>
<th>3005 BSUs</th>
<th>Start</th>
<th>Stop</th>
<th>Interval</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21:27:31</td>
<td>21:30:32</td>
<td>0-2</td>
<td>0:03:01</td>
</tr>
<tr>
<td></td>
<td>21:30:32</td>
<td>21:40:32</td>
<td>3-12</td>
<td>0:10:00</td>
</tr>
</tbody>
</table>

60 second intervals

<table>
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<tr>
<th>All ASUs</th>
<th>ASU1</th>
<th>ASU2</th>
<th>ASU3</th>
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<tbody>
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<tr>
<td>12</td>
<td>7.34</td>
<td>9.03</td>
<td>12.08</td>
</tr>
</tbody>
</table>

Average 7.31 8.97 12.20 1.65

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

Average Response Time Distribution (Repeat1_iops @3005 BSUs)

![Graph showing the average response time distribution over test run minutes for all ASUs and individual ASUs over 3005 BSUs.](image-url)
### Repeatability 2 LRT – I/O Request Throughput Distribution Data

<table>
<thead>
<tr>
<th>300 BSUs</th>
<th>Start</th>
<th>Stop</th>
<th>Interval</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
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<td>21:44:10</td>
<td>0-2</td>
<td>0:03:00</td>
</tr>
<tr>
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<td>21:54:10</td>
<td>3-12</td>
<td>0:10:00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>60 second intervals</th>
<th>All ASUs</th>
<th>ASU1</th>
<th>ASU2</th>
<th>ASU3</th>
</tr>
</thead>
<tbody>
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<td>1,841.27</td>
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<td>1,838.43</td>
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<td>1,853.82</td>
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<tr>
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<td>1,856.83</td>
<td>4,211.82</td>
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<td>1,845.45</td>
<td>4,220.80</td>
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<tr>
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<td>8,930.80</td>
<td>1,844.45</td>
<td>4,218.27</td>
</tr>
<tr>
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<td>15,017.57</td>
<td>8,947.43</td>
<td>1,847.15</td>
<td>4,222.98</td>
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<tr>
<td>10</td>
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<td>1,844.68</td>
<td>4,210.68</td>
</tr>
<tr>
<td>12</td>
<td>14,994.60</td>
<td>8,930.85</td>
<td>1,844.42</td>
<td>4,219.33</td>
</tr>
</tbody>
</table>

Average: 15,003.62 8,939.25 1,848.41 4,215.97

### Repeatability 2 LRT – I/O Request Throughput Distribution Graph

![I/O Request Throughput Distribution (Repeat2_lrt @300 BSUs)](image-url)
Repeatability 2 LRT –Average Response Time (ms) Distribution Data

<table>
<thead>
<tr>
<th>300 BSUs</th>
<th>Start-Up/Ramp-Up</th>
<th>Measurement Interval</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Start</td>
<td>Stop</td>
<td>Interval</td>
</tr>
<tr>
<td></td>
<td>21:41:10</td>
<td>21:44:10</td>
<td>0-2</td>
</tr>
<tr>
<td></td>
<td>21:44:10</td>
<td>21:54:10</td>
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</tr>
<tr>
<td>60 second intervals</td>
<td>All ASUs</td>
<td>ASU1</td>
<td>ASU2</td>
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<tr>
<td>Average</td>
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</table>

Repeatability 2 LRT –Average Response Time (ms) Distribution Graph
Repeatability 2 IOPS – I/O Request Throughput Distribution Data

<table>
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<tr>
<th>3005 BSUs</th>
<th>Start</th>
<th>Stop</th>
<th>Interval</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start-Up/Ramp-Up</td>
<td>21:54:51</td>
<td>21:57:52</td>
<td>0-2</td>
<td>0:03:01</td>
</tr>
<tr>
<td>Measurement Interval</td>
<td>21:57:52</td>
<td>22:07:52</td>
<td>3-12</td>
<td>0:10:00</td>
</tr>
</tbody>
</table>

60 second intervals

<table>
<thead>
<tr>
<th></th>
<th>All ASUs</th>
<th>ASU1</th>
<th>ASU2</th>
<th>ASU3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>150,406.07</td>
<td>89,661.38</td>
<td>18,508.85</td>
<td>42,235.83</td>
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<td>150,292.85</td>
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<td>18,487.93</td>
<td>42,184.52</td>
</tr>
<tr>
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<td>89,511.82</td>
<td>18,456.15</td>
<td>42,251.20</td>
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<tr>
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<td>89,596.87</td>
<td>18,469.58</td>
<td>42,226.83</td>
</tr>
<tr>
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<td>89,480.07</td>
<td>18,480.57</td>
<td>42,246.43</td>
</tr>
<tr>
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Repeatability 2 IOPS – I/O Request Throughput Distribution Graph

I/O Request Throughput Distribution (Repeat2_iops @3005 BSUs)
Repeatability 2 IOPS – Average Response Time (ms) Distribution Data

<table>
<thead>
<tr>
<th>3005 BSUs</th>
<th>Start</th>
<th>Stop</th>
<th>Interval</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start-Up/Ramp-Up</td>
<td>21:54:51</td>
<td>21:57:52</td>
<td>0-2</td>
<td>0:03:01</td>
</tr>
<tr>
<td>Measurement Interval</td>
<td>21:57:52</td>
<td>22:07:52</td>
<td>3-12</td>
<td>0:10:00</td>
</tr>
<tr>
<td>All ASUs</td>
<td>60 second intervals</td>
<td>Average</td>
<td>7.31</td>
<td>8.98</td>
</tr>
<tr>
<td>ASU1</td>
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<td>12</td>
<td>7.29</td>
<td>8.97</td>
<td>12.08</td>
</tr>
</tbody>
</table>

Average Response Time Distribution (Repeat2_iops @3005 BSUs)

- All ASUs
- ASU1
- ASU2
- ASU3

Repeatability 2 IOPS – Average Response Time (ms) Distribution Graph
Repeatability 1 (LRT)
Measured Intensity Multiplier and Coefficient of Variation

**Clause 3.4.3**

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

**Clauses 5.1.10 and 5.3.15.2**

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

**Clause 5.3.15.3**

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

<table>
<thead>
<tr>
<th></th>
<th>ASU1-1</th>
<th>ASU1-2</th>
<th>ASU1-3</th>
<th>ASU1-4</th>
<th>ASU2-1</th>
<th>ASU2-2</th>
<th>ASU2-3</th>
<th>ASU3-1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IM</strong></td>
<td>0.0350</td>
<td>0.2810</td>
<td>0.0700</td>
<td>0.2100</td>
<td>0.0180</td>
<td>0.0700</td>
<td>0.0350</td>
<td>0.2810</td>
</tr>
<tr>
<td><strong>MIM</strong></td>
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<td>0.2810</td>
<td>0.0700</td>
<td>0.2100</td>
<td>0.0180</td>
<td>0.0700</td>
<td>0.0350</td>
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<td>0.002</td>
<td>0.006</td>
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<td>0.004</td>
<td>0.004</td>
<td>0.001</td>
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</table>

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

<table>
<thead>
<tr>
<th></th>
<th>ASU1-1</th>
<th>ASU1-2</th>
<th>ASU1-3</th>
<th>ASU1-4</th>
<th>ASU2-1</th>
<th>ASU2-2</th>
<th>ASU2-3</th>
<th>ASU3-1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IM</strong></td>
<td>0.0350</td>
<td>0.2810</td>
<td>0.0700</td>
<td>0.2100</td>
<td>0.0180</td>
<td>0.0700</td>
<td>0.0350</td>
<td>0.2810</td>
</tr>
<tr>
<td><strong>MIM</strong></td>
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<td>0.2811</td>
<td>0.0701</td>
<td>0.2100</td>
<td>0.0180</td>
<td>0.0700</td>
<td>0.0350</td>
<td>0.2810</td>
</tr>
<tr>
<td><strong>COV</strong></td>
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<td>0.001</td>
<td>0.003</td>
<td>0.001</td>
<td>0.002</td>
<td>0.001</td>
</tr>
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</table>

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

<table>
<thead>
<tr>
<th></th>
<th>ASU1-1</th>
<th>ASU1-2</th>
<th>ASU1-3</th>
<th>ASU1-4</th>
<th>ASU2-1</th>
<th>ASU2-2</th>
<th>ASU2-3</th>
<th>ASU3-1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IM</strong></td>
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<td>0.2810</td>
<td>0.0701</td>
<td>0.2098</td>
<td>0.0181</td>
<td>0.0701</td>
<td>0.0350</td>
<td>0.2810</td>
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<tr>
<td><strong>MIM</strong></td>
<td>0.0349</td>
<td>0.2810</td>
<td>0.0701</td>
<td>0.2098</td>
<td>0.0181</td>
<td>0.0701</td>
<td>0.0350</td>
<td>0.2810</td>
</tr>
<tr>
<td><strong>COV</strong></td>
<td>0.004</td>
<td>0.002</td>
<td>0.005</td>
<td>0.002</td>
<td>0.005</td>
<td>0.004</td>
<td>0.003</td>
<td>0.002</td>
</tr>
</tbody>
</table>
### Repeatability 2 (IOPS)
Measured Intensity Multiplier and Coefficient of Variation

<table>
<thead>
<tr>
<th></th>
<th>ASU1-1</th>
<th>ASU1-2</th>
<th>ASU1-3</th>
<th>ASU1-4</th>
<th>ASU2-1</th>
<th>ASU2-2</th>
<th>ASU2-3</th>
<th>ASU3-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM</td>
<td>0.0350</td>
<td>0.2810</td>
<td>0.0700</td>
<td>0.2100</td>
<td>0.0180</td>
<td>0.0700</td>
<td>0.0350</td>
<td>0.2810</td>
</tr>
<tr>
<td>MIM</td>
<td>0.0350</td>
<td>0.2810</td>
<td>0.0700</td>
<td>0.2099</td>
<td>0.0180</td>
<td>0.0700</td>
<td>0.0350</td>
<td>0.2811</td>
</tr>
<tr>
<td>COV</td>
<td>0.001</td>
<td>0.000</td>
<td>0.001</td>
<td>0.001</td>
<td>0.002</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
</tbody>
</table>
Data Persistence Test

Clause 6
The Data Persistence Test demonstrates the Tested Storage Configuration (TSC):

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

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

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

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

Clause 9.4.3.8
The following content shall appear in this section of the FDR:

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

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in “Appendix E: SPC-1 Workload Generator Input Parameters” on Page 72.

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

<table>
<thead>
<tr>
<th>Data Persistence Test Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Persistence Test Run Number: 1</td>
</tr>
<tr>
<td>Total Number of Logical Blocks Written</td>
</tr>
<tr>
<td>Total Number of Logical Blocks Verified</td>
</tr>
<tr>
<td>Total Number of Logical Blocks that Failed Verification</td>
</tr>
<tr>
<td>Time Duration for Writing Test Logical Blocks</td>
</tr>
<tr>
<td>Size in bytes of each Logical Block</td>
</tr>
<tr>
<td>Number of Failed I/O Requests in the process of the Test</td>
</tr>
</tbody>
</table>

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

*Clause 9.4.3.9*

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

The Huawei OceanStor™ S5800T as documented in this Full Disclosure Report is currently available for customer purchase and shipment.

**PRICING INFORMATION**

*Clause 9.4.3.3.6*

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

Pricing information may be found in the Priced Storage Configuration Pricing section on page 14.

**TESTED STORAGE CONFIGURATION (TSC) AND PRICED STORAGE CONFIGURATION DIFFERENCES**

*Clause 9.4.3.3.8*

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

A list of all differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration may be found in the Executive Summary portion of this document on page 14.

**ANOMALIES OR IRREGULARITIES**

*Clause 9.4.3.10*

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

There were no anomalies or irregularities encountered during the SPC-1 Remote Audit of the Huawei OceanStor™ S5800T.
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**

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

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

**SPC-1 Test Execution Definitions**

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

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

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

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

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

**Failed I/O Request:** Any I/O Request issued by the Workload Generator that could not be completed or was signaled as failed by System Software. A Failed I/O Request has no Completion Time (see “I/O Completion Types” below).
**I/O Request Throughput:** The total number of Measured I/O requests in an SPC-1 Test Run divided by the duration of the Measurement Interval in seconds.

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

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

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

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

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

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

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

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

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

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

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

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

**Test Run:** The execution of SPC-1 for the purpose of producing or supporting an SPC-1 test result. SPC-1 Test Runs may have a finite and measured Ramp-Up period, Start-Up period, Shut-Down period, and Ramp-Down period as illustrated in the “SPC-1 Test Run Components” below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.
**Test Phase:** A collection of one or more SPC-1 Test Runs sharing a common objective and intended to be run in a specific sequence.

**I/O Completion Types**

![Diagram of I/O Completion Types]

**SPC-1 Test Run Components**

![Diagram of SPC-1 Test Run Components]
Red Hat Enterprise Linux 5.5 (64-bit)

Change the I/O scheduler from \texttt{cfq} to \texttt{noop} on each Host System, which will result in all incoming I/O requests inserted into a simple, unordered FIFO queue. This was done by execution of the \texttt{scheduler.sh} script as documented in “Appendix C: Tested Storage Configuration (TSC) Creation”.
APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

Step 1 Create Host Group and Host

Execute the following commands in OceanStor S5800T’s CLI to create one host group HostGroup001, and add Host001 and Host002 to the host group, then add 4 host FC ports WWNs to Host001 and add the other 4 FC ports WWNs to Host002.

The \texttt{-t} parameter is used in the command \texttt{addhost} to define the host operating system type, and \texttt{-t 0} means Linux. The \texttt{-type} parameter of command \texttt{addhostport} means port type, and \texttt{type 1} means FC host port.

\begin{verbatim}
createhostgroup -n HostGroup001
addhost -group 1 -n Host001 -t 0
addhost -group 1 -n Host002 -t 0
addhostport -host 0 -type 1 -wwn 21000024ff2087b6 -n FCInitiator001
addhostport -host 0 -type 1 -wwn 21000024ff2087b7 -n FCInitiator002
addhostport -host 0 -type 1 -wwn 21000024ff2088e2 -n FCInitiator003
addhostport -host 0 -type 1 -wwn 21000024ff2088e3 -n FCInitiator004
addhostport -host 1 -type 1 -wwn 21000024ff2c9498 -n FCInitiator005
addhostport -host 1 -type 1 -wwn 21000024ff28ea72 -n FCInitiator006
addhostport -host 1 -type 1 -wwn 21000024ff2c9499 -n FCInitiator007
addhostport -host 1 -type 1 -wwn 21000024ff28ea73 -n FCInitiator008
\end{verbatim}

Step 2 Create RAID Groups and LUNs

Execute the \texttt{mklun.sh} script on the Host System, which has \texttt{expect} installed. The script will create 34 RAID Groups, 34 LUNs (one LUN per RAID Group) and map the LUNs to HostGroup001.

\textit{Note:} \texttt{Expect} is a Unix automation and testing tool, written by Don Libes as an extension to the \texttt{Tcl} scripting language, for interactive applications such as \texttt{telnet}, \texttt{ftp}, \texttt{passwd}, \texttt{fsck}, \texttt{rlogin}, \texttt{tip}, \texttt{ssh}, and others. It uses Unix pseudo terminals to wrap up subprocesses transparently, allowing the automation of arbitrary applications that are accessed over a terminal. \texttt{Expect} is an open source tool can be downloaded at the following location: \url{http://www.nist.gov/el/msid/expect.cfm}

The \texttt{createlun} commands create one LUN per RAID Group and use all of the available capacity for the LUN. The \texttt{addhostmap} command maps a LUN to a host or a host group.

RAID Groups 0-31 each contain six 300 GB disk drives. Four of the disk drives in RAID Group 0 are vault disk drives, each of which as 23 GiB reserved to store “dirty” data in case of a power failure. RAID Groups 32 and 33 each contain six 600 GB disk drives.

The RAID-Disk mapping is illustrated below.
Step 3  Change the low and high water level of storage

Execute the following command, using the OceanStor S5800T’s CLI to change the low water level to 40 and the high water level to 50.

```
chgcachewaterlevel -low 40
chgcachewaterlevel -high 50
```

Step 4  Create Volumes on the Host System

Execute the `mkvolume.sh` script on the Host System to create 44 logical volumes.

1. Create Physical Volumes

   Invoke `pvcreate` on each block device, creating 34 physical volumes
2. Create Volume Groups

Create \texttt{vg0} using: /dev/sdc, /dev/sdd, /dev/sde, /dev/sdf, /dev/sdh, /dev/sdi, /dev/sdj, /dev/sdk, /dev/sdl, /dev/sdm, /dev/ sdn, /dev/ sdo, /dev/sdp, /dev/sdq, /dev/sdr, /dev/sds, /dev/sdt, /dev/sdu, /dev/sdv, /dev/sdw, /dev/sdx, /dev/sdy, /dev/sdz, /dev/sdaa, /dev/sdab, /dev/sdac, /dev/sdad, /dev/sdae, /dev/sdaf, /dev/sdag, /dev/sdah

Create \texttt{vg1} using: /dev/sdai, /dev/sdaj

3. Create Logical Volumes

- Create 20 logical volumes on \texttt{vg0} for ASU-1, each with a capacity of 1,057.5 GiB.
- Create 20 logical volumes on \texttt{vg0} for ASU-2, each with a capacity of 1,057.5 GiB.
- Create 4 logical volumes on \texttt{vg1} for ASU-3, each with a capacity of 1,175 GiB.

4. Scan Logical Volumes

Scan the logical volumes on the second Host System.

Step 5 Change the schedule on each block device

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

Referenced Scripts

\texttt{mklun.sh}

```bash
#!/bin/bash
stor=129.27.228.169
stor_user=admin
stor_pswd=Admin@storage
export LANG=C
echo "creating LUN ..."
expect <<__END_CREATE_LUN
spawn ssh $stor_user@$stor
expect {
  "assword" {
    send "$stor_pswd\r"
  }
  "yes/no" {
    send "yes\r"
    expect "assword"
    send "$stor_pswd\r"
  }
}
expect ">
set timeout 60
set lunid 0
```

SPC BENCHMARK 1™ V1.13 FULL DISCLOSURE REPORT Submission Identifier: A00124
Huawei OceanStor™ S5800T
set rgid 0

{
    foreach diskset {0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23} {
        set disk_list ""
        foreach disk [split \$diskset ,] {
            set list_unit [string map [list : ,\$disk:] \$enclosure]
            append disk_list \$list_unit
        }
        send "createrg -n ASU-\$rgid -l 10 -num 2 -list \$disk_list\r"
        expect {
            "(y/n)" {
                send "y\r"
            } ">" {
                send "\r"
            }
        }
        expect ">"
        send "showrg -rg \$rgid\r"
        expect ">"
        if [ expr \$lunid%2 ] {
            set ctrl b
        } else {
            set ctrl a
        }
        if { \$lunid >= 12 && \$lunid <= 41 } {
            send "createlun -rg \$rgid -n ASU-\$lunid -susize 512 -pretype 1 -value 4 -c \$ctrl\r"
        } else {
            send "createlun -rg \$rgid -n ASU-\$lunid -susize 512 -pretype 0 -c \$ctrl\r"
        }
        expect ">"
        sleep 1
        send "showlun -lun \$lunid\r"
        expect ">"
        send "addhostmap -group 1 -devlun \$lunid\r"
        expect ">"
        send "showhostmap -map [expr \$lunid + 1048576]\r"
        expect ">"
        incr lunid
        incr rgid
    }
}
send "exit\r"
expect "(y/n):" 
send "y\r"
expect EOF
__END_CREATE_LUN
mkvolume.sh

```
pvcreate /dev/sdc
pvcreate /dev/sdd
pvcreate /dev/sde
pvcreate /dev/sdf
pvcreate /dev/sdg
pvcreate /dev/sdh
pvcreate /dev/sdi
pvcreate /dev/sdj
pvcreate /dev/sdk
pvcreate /dev/sdl
pvcreate /dev/sdm
pvcreate /dev/sdn
pvcreate /dev/sdo
pvcreate /dev/sdp
pvcreate /dev/sdq
pvcreate /dev/sdr
pvcreate /dev/sds
pvcreate /dev/sdt
pvcreate /dev/sdu
pvcreate /dev/sdv
pvcreate /dev/sdw
pvcreate /dev/sdx
pvcreate /dev/sdy
pvcreate /dev/sdz
pvcreate /dev/sdaz
pvcreate /dev/sdab
pvcreate /dev/sdac
pvcreate /dev/sdad
pvcreate /dev/sdae
pvcreate /dev/sdaf
pvcreate /dev/sdah
pvcreate /dev/sdai
pvcreate /dev/sdaj

vgcreate vg0 /dev/sdc /dev/sdd /dev/sde /dev/sdf /dev/sdg /dev/sdh /dev/sdi /dev/sdj
/dev/sdk /dev/sdl /dev/sdm /dev/sdn /dev/sdo /dev/sdp /dev/sdq /dev/sdr /dev/sds
/dev/sdt /dev/sdu /dev/sdv /dev/sdw /dev/sdx /dev/sdy /dev/sdz /dev/sdaz /dev/sdab
/dev/sdac /dev/sdad /dev/sdae /dev/sdaf /dev/sdah
vgcreate vg1 /dev/sdai /dev/sdaj
```

```bash
lvcreate -n asu11 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu12 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu13 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu14 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu15 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu16 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu17 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu18 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu19 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu110 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu111 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu112 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu113 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu114 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu115 -i 32 -I 512 -L 1057.5g vg0
```

SPC BENCHMARK 1™ V1.13 FULL DISCLOSURE REPORT
Huawei Technologies Co., Ltd.
Huawei OceanStor™ SS800T
Submission Identifier: A00124
Submitted for Review: NOVEMBER 15, 2012
lvcreate -n asu119 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu120 -i 32 -I 512 -L 1057.5g vg0

lvcreate -n asu21 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu22 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu23 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu24 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu25 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu26 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu27 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu28 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu29 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu210 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu211 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu212 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu213 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu214 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu215 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu216 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu217 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu218 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu219 -i 32 -I 512 -L 1057.5g vg0
lvcreate -n asu220 -i 32 -I 512 -L 1057.5g vg0

lvcreate -n asu31 -i 2 -I 512 -L 1175g vg1
lvcreate -n asu32 -i 2 -I 512 -L 1175g vg1
lvcreate -n asu33 -i 2 -I 512 -L 1175g vg1
lvcreate -n asu34 -i 2 -I 512 -L 1175g vg1

for host in host1
121 do
dest 122 ssh $host pvscan
123 ssh $host vgscan
124 ssh $host lvscan
125 ssh $host lvchange -ay /dev/vg0/asu11
126 ssh $host lvchange -ay /dev/vg0/asu12
127 ssh $host lvchange -ay /dev/vg0/asu13
128 ssh $host lvchange -ay /dev/vg0/asu14
129 ssh $host lvchange -ay /dev/vg0/asu15
130 ssh $host lvchange -ay /dev/vg0/asu16
131 ssh $host lvchange -ay /dev/vg0/asu17
132 ssh $host lvchange -ay /dev/vg0/asu18
133 ssh $host lvchange -ay /dev/vg0/asu19
134 ssh $host lvchange -ay /dev/vg0/asu10
135 ssh $host lvchange -ay /dev/vg0/asu111
136 ssh $host lvchange -ay /dev/vg0/asu112
137 ssh $host lvchange -ay /dev/vg0/asu113
138 ssh $host lvchange -ay /dev/vg0/asu114
139 ssh $host lvchange -ay /dev/vg0/asu115
140 ssh $host lvchange -ay /dev/vg0/asu116
141 ssh $host lvchange -ay /dev/vg0/asu117
142 ssh $host lvchange -ay /dev/vg0/asu118
143 ssh $host lvchange -ay /dev/vg0/asu119
144 ssh $host lvchange -ay /dev/vg0/asu120
145
146 ssh $host lvchange -ay /dev/vg0/asu21
147 ssh $host lvchange -ay /dev/vg0/asu22
148 ssh $host lvchange -ay /dev/vg0/asu23
149 ssh $host lvchange -ay /dev/vg0/asu24
150 ssh $host lvchange -ay /dev/vg0/asu25
151 ssh $host lvchange -ay /dev/vg0/asu26
152 ssh $host lvchange -ay /dev/vg0/asu27
153 ssh $host lvchange -ay /dev/vg0/asu28
154 ssh $host lvchange -ay /dev/vg0/asu29
155 ssh $host lvchange -ay /dev/vg0/asu210
156 ssh $host lvchange -ay /dev/vg0/asu211
157 ssh $host lvchange -ay /dev/vg0/asu212
158 ssh $host lvchange -ay /dev/vg0/asu213
159 ssh $host lvchange -ay /dev/vg0/asu214
160 ssh $host lvchange -ay /dev/vg0/asu215
161 ssh $host lvchange -ay /dev/vg0/asu216
162 ssh $host lvchange -ay /dev/vg0/asu217
163 ssh $host lvchange -ay /dev/vg0/asu218
164 ssh $host lvchange -ay /dev/vg0/asu219
165 ssh $host lvchange -ay /dev/vg0/asu220
166
167 ssh $host lvchange -ay /dev/vg1/asu31
168 ssh $host lvchange -ay /dev/vg1/asu32
169 ssh $host lvchange -ay /dev/vg1/asu33
170 ssh $host lvchange -ay /dev/vg1/asu34
171 done

scheduler.sh

echo noop > /sys/block/sdc/queue/scheduler
echo noop > /sys/block/sdd/queue/scheduler
echo noop > /sys/block/sde/queue/scheduler
echo noop > /sys/block/sdf/queue/scheduler
echo noop > /sys/block/sdg/queue/scheduler
echo noop > /sys/block/sdh/queue/scheduler
echo noop > /sys/block/sdi/queue/scheduler
echo noop > /sys/block/sdj/queue/scheduler
echo noop > /sys/block/sdk/queue/scheduler
echo noop > /sys/block/sdl/queue/scheduler
echo noop > /sys/block/sdm/queue/scheduler
echo noop > /sys/block/sdn/queue/scheduler
echo noop > /sys/block/sdo/queue/scheduler
echo noop > /sys/block/sdp/queue/scheduler
echo noop > /sys/block/sdq/queue/scheduler
echo noop > /sys/block/sdr/queue/scheduler
echo noop > /sys/block/sds/queue/scheduler
echo noop > /sys/block/sdt/queue/scheduler
echo noop > /sys/block/sdu/queue/scheduler
echo noop > /sys/block/sdv/queue/scheduler
echo noop > /sys/block/sdw/queue/scheduler
echo noop > /sys/block/sdx/queue/scheduler
echo noop > /sys/block/sdy/queue/scheduler
echo noop > /sys/block/sdz/queue/scheduler
echo noop > /sys/block/sdaa/queue/scheduler
echo noop > /sys/block/sdab/queue/scheduler
echo noop > /sys/block/sdac/queue/scheduler
echo noop > /sys/block/sdad/queue/scheduler
echo noop > /sys/block/sdae/queue/scheduler
echo noop > /sys/block/sdaf/queue/scheduler
echo noop > /sys/block/sdag/queue/scheduler
echo noop > /sys/block/sdah/queue/scheduler
echo noop > /sys/block/sdai/queue/scheduler
echo noop > /sys/block/sdaj/queue/scheduler

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

ASU Pre-Fill

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

```
pattern=/root/S5800T/random
hd=default,vdbench=/root/vdbench,user=root,shell=ssh
hd=hd1,system=host1
hd=hd2,system=host2
sd=default,threads=1
  sd=sd1,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu11,size=1135481978880
  sd=sd2,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu12,size=1135481978880
  sd=sd3,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu13,size=1135481978880
  sd=sd4,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu14,size=1135481978880
  sd=sd5,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu15,size=1135481978880
  sd=sd6,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu16,size=1135481978880
  sd=sd7,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu17,size=1135481978880
  sd=sd8,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu18,size=1135481978880
  sd=sd9,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu19,size=1135481978880
  sd=sd10,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu110,size=1135481978880
  sd=sd11,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu111,size=1135481978880
  sd=sd12,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu112,size=1135481978880
  sd=sd13,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu113,size=1135481978880
  sd=sd14,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu114,size=1135481978880
  sd=sd15,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu115,size=1135481978880
  sd=sd16,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu116,size=1135481978880
  sd=sd17,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu117,size=1135481978880
  sd=sd18,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu118,size=1135481978880
  sd=sd19,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu119,size=1135481978880
  sd=sd20,hd=hd1,openflags=o_direct,lun=/dev/vg0/asu120,size=1135481978880
  sd=sd21,hd=hd1,openflags=o_direct,lun=/dev/vg0/azu121,size=1135481978880
  sd=sd22,hd=hd1,openflags=o_direct,lun=/dev/vg0/azu122,size=1135481978880
  sd=sd23,hd=hd1,openflags=o_direct,lun=/dev/vg0/azu123,size=1135481978880
  sd=sd24,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu21,size=1135481978880
  sd=sd25,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu22,size=1135481978880
  sd=sd26,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu23,size=1135481978880
  sd=sd27,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu24,size=1135481978880
  sd=sd28,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu25,size=1135481978880
  sd=sd29,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu26,size=1135481978880
  sd=sd30,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu27,size=1135481978880
  sd=sd31,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu28,size=1135481978880
  sd=sd32,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu29,size=1135481978880
  sd=sd33,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu30,size=1135481978880
  sd=sd34,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu31,size=1135481978880
  sd=sd35,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu32,size=1135481978880
  sd=sd36,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu33,size=1135481978880
  sd=sd37,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu34,size=1135481978880
  sd=sd38,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu35,size=1135481978880
  sd=sd39,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu36,size=1135481978880
  sd=sd40,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu37,size=1135481978880
  sd=sd41,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu38,size=1135481978880
  sd=sd42,hd=hd2,openflags=o_direct,lun=/dev/vg0/azu39,size=1135481978880
  sd=sd43,hd=hd2,openflags=o_direct,lun=/dev/vg1/azu33,size=1261646643200
  sd=sd44,hd=hd2,openflags=o_direct,lun=/dev/vg1/azu34,size=1261646643200
wd=wd1,rd=*.*.rdpct=0,seekpct=-1,xfersize=512K
rd=prefssd,wd=wd1,iorate=max,elapsed=360000, interval=10
```
Primary Metrics and Repeatability Tests

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

```
host=master
slaves=(slave1,slave2,slave3,slave4,slave5,slave6,slave7,slave8,slave9,slave10,slave11,slave12,slave13,slave14,slave15,slave16,slave17,slave18,slave19,slave20,slave21,slave22,slave23,slave24,slave25,slave26,slave27,slave28,slave29,slave30,slave31,slave32,slave33,slave34,slave35,slave36,slave37,slave38,slave39,slave40)

sd=asu1_1,lun=/dev/vg0/asu11 ,size=1135481978880
sd=asu1_2,lun=/dev/vg0/asu12 ,size=1135481978880
sd=asu1_3,lun=/dev/vg0/asu13 ,size=1135481978880
sd=asu1_4,lun=/dev/vg0/asu14 ,size=1135481978880
sd=asu1_5,lun=/dev/vg0/asu15 ,size=1135481978880
sd=asu1_6,lun=/dev/vg0/asu16 ,size=1135481978880
sd=asu1_7,lun=/dev/vg0/asu17 ,size=1135481978880
sd=asu1_8,lun=/dev/vg0/asu18 ,size=1135481978880
sd=asu1_9,lun=/dev/vg0/asu19 ,size=1135481978880
sd=asu1_10,lun=/dev/vg0/asu110,size=1135481978880
sd=asu1_11,lun=/dev/vg0/asu111,size=1135481978880
sd=asu1_12,lun=/dev/vg0/asu112,size=1135481978880
sd=asu1_13,lun=/dev/vg0/asu113,size=1135481978880
sd=asu1_14,lun=/dev/vg0/asu114,size=1135481978880
sd=asu1_15,lun=/dev/vg0/asu115,size=1135481978880
sd=asu1_16,lun=/dev/vg0/asu116,size=1135481978880
sd=asu1_17,lun=/dev/vg0/asu117,size=1135481978880
sd=asu1_18,lun=/dev/vg0/asu118,size=1135481978880
sd=asu1_19,lun=/dev/vg0/asu119,size=1135481978880
sd=asu1_20,lun=/dev/vg0/asu120,size=1135481978880

sd=asu2_1,lun=/dev/vg0/asu21 ,size= 1135481978880
sd=asu2_2,lun=/dev/vg0/asu22 ,size= 1135481978880
sd=asu2_3,lun=/dev/vg0/asu23 ,size= 1135481978880
sd=asu2_4,lun=/dev/vg0/asu24 ,size= 1135481978880
sd=asu2_5,lun=/dev/vg0/asu25 ,size= 1135481978880
sd=asu2_6,lun=/dev/vg0/asu26 ,size= 1135481978880
sd=asu2_7,lun=/dev/vg0/asu27 ,size= 1135481978880
sd=asu2_8,lun=/dev/vg0/asu28 ,size= 1135481978880
sd=asu2_9,lun=/dev/vg0/asu29 ,size= 1135481978880
sd=asu2_10,lun=/dev/vg0/asu210,size=1135481978880
sd=asu2_11,lun=/dev/vg0/asu211,size=1135481978880
sd=asu2_12,lun=/dev/vg0/asu212,size=1135481978880
sd=asu2_13,lun=/dev/vg0/asu213,size=1135481978880
sd=asu2_14,lun=/dev/vg0/asu214,size=1135481978880
sd=asu2_15,lun=/dev/vg0/asu215,size=1135481978880
sd=asu2_16,lun=/dev/vg0/asu216,size=1135481978880
sd=asu2_17,lun=/dev/vg0/asu217,size=1135481978880
sd=asu2_18,lun=/dev/vg0/asu218,size=1135481978880
sd=asu2_19,lun=/dev/vg0/asu219,size=1135481978880
sd=asu2_20,lun=/dev/vg0/asu220,size=1135481978880

sd=asu3_1,lun=/dev/vg1/asu31 ,size=1261646643200
sd=asu3_2,lun=/dev/vg1/asu32 ,size=1261646643200
sd=asu3_3,lun=/dev/vg1/asu33 ,size=1261646643200
sd=asu3_4,lun=/dev/vg1/asu34 ,size=1261646643200
```
SPC-1 Persistence Test

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

```
sd=asu1_1,lun=/dev/vg0/asu1, size=1135481978880
sd=asu1_2,lun=/dev/vg0/asu2, size=1135481978880
sd=asu1_3,lun=/dev/vg0/asu3, size=1135481978880
sd=asu1_4,lun=/dev/vg0/asu4, size=1135481978880
sd=asu1_5,lun=/dev/vg0/asu5, size=1135481978880
sd=asu1_6,lun=/dev/vg0/asu6, size=1135481978880
sd=asu1_7,lun=/dev/vg0/asu7, size=1135481978880
sd=asu1_8,lun=/dev/vg0/asu8, size=1135481978880
sd=asu1_9,lun=/dev/vg0/asu9, size=1135481978880
sd=asu1_10,lun=/dev/vg0/asu10, size=1135481978880
sd=asu1_11,lun=/dev/vg0/asu11, size=1135481978880
sd=asu1_12,lun=/dev/vg0/asu12, size=1135481978880
sd=asu1_13,lun=/dev/vg0/asu13, size=1135481978880
sd=asu1_14,lun=/dev/vg0/asu14, size=1135481978880
sd=asu1_15,lun=/dev/vg0/asu15, size=1135481978880
sd=asu1_16,lun=/dev/vg0/asu16, size=1135481978880
sd=asu1_17,lun=/dev/vg0/asu17, size=1135481978880
sd=asu1_18,lun=/dev/vg0/asu18, size=1135481978880
sd=asu1_19,lun=/dev/vg0/asu19, size=1135481978880
sd=asu1_20,lun=/dev/vg0/asu20, size=1135481978880

sd=asu2_1,lun=/dev/vg0/asu21, size=1135481978880
sd=asu2_2,lun=/dev/vg0/asu22, size=1135481978880
sd=asu2_3,lun=/dev/vg0/asu23, size=1135481978880
sd=asu2_4,lun=/dev/vg0/asu24, size=1135481978880
sd=asu2_5,lun=/dev/vg0/asu25, size=1135481978880
sd=asu2_6,lun=/dev/vg0/asu26, size=1135481978880
sd=asu2_7,lun=/dev/vg0/asu27, size=1135481978880
sd=asu2_8,lun=/dev/vg0/asu28, size=1135481978880
sd=asu2_9,lun=/dev/vg0/asu29, size=1135481978880
sd=asu2_10,lun=/dev/vg0/asu30, size=1135481978880
sd=asu2_11,lun=/dev/vg0/asu31, size=1135481978880
sd=asu2_12,lun=/dev/vg0/asu32, size=1135481978880
sd=asu2_13,lun=/dev/vg0/asu33, size=1135481978880
sd=asu2_14,lun=/dev/vg0/asu34, size=1135481978880

sd=asu3_1,lun=/dev/vg1/asu31, size=1261646643200
sd=asu3_2,lun=/dev/vg1/asu32, size=1261646643200
sd=asu3_3,lun=/dev/vg1/asu33, size=1261646643200
sd=asu3_4,lun=/dev/vg1/asu34, size=1261646643200
```
APPENDIX E: SPC-1 WORKLOAD GENERATOR INPUT PARAMETERS

ASU Pre-Fill, Primary Metrics Test, Repeatability Test, Persistence Test Run 1, TSC power off/power on and Persistence Test Run 2

The following script was used to execute the required ASU pre-fill, Primary Metrics Test (Sustainability Test Phase, IOPS Test Phase, and Response Time Ramp Test Phase), Repeatability Test (Repeatability Test Phase 1 and Repeatability Test Phase 2), and Persistence Test Run 1 in an uninterrupted sequence. The script pauses until the required TSC power off/power on cycle is completed then executes Persistence Test Run 2.

The script also included the appropriate commands to capture the detailed TSC profile listings required for a Remote Audit.

```java
JAVA="/usr/java/jre1.7.0_06/bin/java -Xms4096m -Xmx4096m -Xss256k"
EXEDIR=/root/S5800T

expect shstorage.tcl > profile1_storage.log
date > profile1_volume.log
pvdisplay >> profile1_volume.log
ergdisplay >> profile1_volume.log
lvdisplay >> profile1_volume.log
date >> profile1_volume.log

../vdbench/vdbench -f prefilling.cfg -o prefilling

N=1
for host in host2 host1
do
    ssh $host rm -rf $EXEDIR/output
    ssh $host rm -rf $EXEDIR/config
    ssh $host mkdir $EXEDIR/output
    ssh $host mkdir $EXEDIR/config
    for((i=1;i<=20;i++))
do
        echo "start slave$N on $host"
        echo "master=host2" > $EXEDIR/config/slave$N.cfg
        echo "host=slave$N" >> $EXEDIR/config/slave$N.cfg
        echo "sd=asu1_1,lun=/dev/vg0/asu11 ,size=1135481978880 " >> $EXEDIR/config/slave$N.cfg
        echo "sd=asu1_2,lun=/dev/vg0/asu12 ,size=1135481978880 " >> $EXEDIR/config/slave$N.cfg
        echo "sd=asu1_3,lun=/dev/vg0/asu13 ,size=1135481978880 " >> $EXEDIR/config/slave$N.cfg
        echo "sd=asu1_4,lun=/dev/vg0/asu14 ,size=1135481978880 " >> $EXEDIR/config/slave$N.cfg
        echo "sd=asu1_5,lun=/dev/vg0/asu15 ,size=1135481978880 " >> $EXEDIR/config/slave$N.cfg
        echo "sd=asu1_6,lun=/dev/vg0/asu16 ,size=1135481978880 " >> $EXEDIR/config/slave$N.cfg
        echo "sd=asu1_7,lun=/dev/vg0/asu17 ,size=1135481978880 " >> $EXEDIR/config/slave$N.cfg
        echo "sd=asu1_8,lun=/dev/vg0/asu18 ,size=1135481978880 " >> $EXEDIR/config/slave$N.cfg
        echo "sd=asu1_9,lun=/dev/vg0/asu19 ,size=1135481978880 " >> $EXEDIR/config/slave$N.cfg
        echo "sd=asu1_10,lun=/dev/vg0/asu110,size=1135481978880" >> $EXEDIR/config/slave$N.cfg
```

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Huawei Technologies Co., Ltd.
Huawei OceanStor™ S5800T

Submission Identifier: A00124
Submitted for Review: NOVEMBER 15, 2012
echo "sd=asu1_11,lun=/dev/vg0/asu111,size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu1_12,lun=/dev/vg0/asu112,size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu1_13,lun=/dev/vg0/asu113,size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu1_14,lun=/dev/vg0/asu114,size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu1_15,lun=/dev/vg0/asu115,size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu1_16,lun=/dev/vg0/asu116,size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu1_17,lun=/dev/vg0/asu117,size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu1_18,lun=/dev/vg0/asu118,size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu1_19,lun=/dev/vg0/asu119,size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu1_20,lun=/dev/vg0/asu120,size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_1,lun=/dev/vg0/asu21 ,size= 1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_2,lun=/dev/vg0/asu22 ,size= 1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_3,lun=/dev/vg0/asu23 ,size= 1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_4,lun=/dev/vg0/asu24 ,size= 1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_5,lun=/dev/vg0/asu25 ,size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_6,lun=/dev/vg0/asu26 ,size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_7,lun=/dev/vg0/asu27 ,size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_8,lun=/dev/vg0/asu28 ,size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_9,lun=/dev/vg0/asu29 ,size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_10,lun=/dev/vg0/asu210, size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_11,lun=/dev/vg0/asu211, size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_12,lun=/dev/vg0/asu212, size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_13,lun=/dev/vg0/asu213, size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_14,lun=/dev/vg0/asu214, size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_15,lun=/dev/vg0/asu215, size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_16,lun=/dev/vg0/asu216, size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_17,lun=/dev/vg0/asu217, size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_18,lun=/dev/vg0/asu218, size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_19,lun=/dev/vg0/asu219, size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu2_20,lun=/dev/vg0/asu220, size=1135481978880" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu3_1,lun=/dev/vg1/asu31 ,size=1261646643200" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu3_2,lun=/dev/vg1/asu32 ,size=1261646643200" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu3_3,lun=/dev/vg1/asu33 ,size=1261646643200" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu3_4,lun=/dev/vg1/asu34 ,size=1261646643200" >> $EXEDIR/config/slave$N.cfg
echo "sd=asu3_6,lun=/dev/vg1/asu36 ,size=1261646643200" >> $EXEDIR/config/slave$N.cfg

scp $EXEDIR/config/slave$N.cfg $host:$EXEDIR/config/slave$N.cfg
ssh $host "$JAVA -cp $EXEDIR/../spc1 spc1 -f $EXEDIR/config/slave$N.cfg -o $EXEDIR/output/slave$N" > /dev/null &
N=$[N+1]
done
done

rm -rf spc1.cfg
cp metrics.cfg spc1.cfg
$JAVA -cp ../spc1 metrics -b 3005 -t 28800
$JAVA -cp ../spc1 repeat1 -b 3005
$JAVA -cp ../spc1 repeat2 -b 3005

for host in host1 host2
do
    ssh $host killall java
done

rm -rf spc1.cfg
cp persist.cfg spc1.cfg
$JAVA -cp ../spc1 persist1 -b 2255
echo "Power cycle TSC, then Enter to continue"
read

expect shstorage.tcl > profile2_storage.log
date > profile2_volume.log
pvdisplay >> profile2_volume.log
vgdisplay >> profile2_volume.log
lvdisplay >> profile2_volume.log
date >> profile2_volume.log

$JAVA -cp ../spc1 persist2
## APPENDIX F: THIRD-PARTY QUOTATION

### Even Enterprises Quotation

**Issued To:**
- **Company:**
- **First Name:**
- **Last Name:**
- **City:**
- **State:**
- **Business Phone:**
- **Email:**

**DATE ISSUED:** November 12, 2012

**PAYMENT TERMS:** Credit Card / Net 30 (upon approval)

**Salesperson:** Eslam Even

**Prices subject to change without notice**

**Prices Valid for 90 days**

**Confidential**

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**SPC Benchmark 1™ V1.13**

**FULL DISCLOSURE REPORT**

**Huawei Technologies Co., Ltd.**

**Huawei OceanStor™ S5800T**

**Submission Identifier:** A00124

**Submitted for Review:** November 15, 2012
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Notes: Hi-Care Premier On-Site Service include: 7*24 Technical Assistance Center Access. Access to all new software updates and Online Support. 24*7*4 Hours Onsite Hardware Replacement.