SPC Benchmark 1™

Full Disclosure Report

Telecommunications Technology Association
Jet-speed™ HHS3124F / HHS2112F (10 Nodes)

SPC-1 V3.8

Submission Identifier: A31019

Submitted For Review: December 4, 2018
First Edition – December 2018

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Benchmark Specification and Glossary

The official SPC Benchmark 1™ (SPC-1™) specification is available on the website of the Storage Performance Council (SPC) at www.spcresults.org.

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

Cheol-Soon Park  
Telecommunications Technology Association  
47, Bundang-ro, Bundang-gu, Seongnam-city,  
Gyeonggi-do, 13591  
Republic of Korea  

December 3, 2018  

I verified the SPC Benchmark 1™ (SPC-1™ Revision3.8) test execution and performance results of the following Tested Storage Product:  

JET-SPEED™ HHS3124F / HHS2112F (10 NODES)  

The results were:  

<table>
<thead>
<tr>
<th>SPC-1 IOPS™</th>
<th>2,410,271</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPC-1 Price-Performance™</td>
<td>$287,014.01/SPC-1 KIOPS™</td>
</tr>
<tr>
<td>SPC-1 IOPS™ Response Time</td>
<td>0.311 ms</td>
</tr>
<tr>
<td>SPC-1 Overall Response Time</td>
<td>0.205 ms</td>
</tr>
<tr>
<td>SPC-1 ASU Capacity</td>
<td>46,789 GB</td>
</tr>
<tr>
<td>SPC-1 Space Effectiveness Ratio</td>
<td>NA</td>
</tr>
<tr>
<td>SPC-1 ASU Price</td>
<td>$14.79/GB</td>
</tr>
<tr>
<td>SPC-1 Total System Price</td>
<td>$691,767.07</td>
</tr>
</tbody>
</table>

In my opinion, these performance results were produced in compliance with the SPC requirements for the benchmark.

The testing was executed using the SPC-1 Toolkit Version 0xe28e08v3.0.2. The audit process was conducted in accordance with the SPC Policies and met the requirements for the benchmark.

A Letter of Good Faith was issued by the Test Sponsor, stating the accuracy and completeness of the documentation and testing data provided in support of the audit of this result.

A Full Disclosure Report for this result was prepared by InfoSizing, reviewed and approved by the Test Sponsor, and can be found at www.spcresults.org under the Submission Identifier A31019.
The independent audit process conducted by InfoSizing included the verifications of the following items:

- The physical capacity of the data repository;
- The total capacity of the Application Storage Unit (ASU);
- The accuracy of the Benchmark Configuration diagram;
- The tuning parameters used to configure the Benchmark Configuration;
- The Workload Generator commands used to execute the testing;
- The validity and integrity of the test result files;
- The compliance of the results from each performance test;
- The compliance of the results from the persistence test;
- The compliance of the submitted pricing model; and
- The differences between the tested and the priced configuration, if any.

The Full Disclosure Report for this result was prepared in accordance with the disclosure requirements set forth in the specification for the benchmark.

The following benchmark requirements, if any, were waived according to the SPC Policies:

- None.

Respectfully Yours,

François Raab, Certified SPC Auditor
LETTER OF GOOD FAITH

December 3, 2018

From: Telecommunications Technology Association

To: Mr. Francois Raab, Certified SPC Auditor
   InfoSizing, Inc.
   20 Kreg Lane
   Manitou Springs, CO 80829

Subject: SPC-1 Letter of Good Faith for the Telecommunications Technology Association JetSpeed™ HHS3124F/2112F

Telecommunications Technology Association is the SPC-1 Test Sponsor for the above listed product. To the best of our knowledge and belief, the required SPC-1 benchmark results and materials we have submitted for that product are complete, accurate, and in full compliance with V3.8 of the SPC-1 benchmark specification.

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

Signed:  

Date:

Cheol-Soon Park  
Vice President,  
Telecommunications Technology Association  

Dec. 3, 2018
### SPC Benchmark 1™

**EXECUTIVE SUMMARY**

**Telecommunications Technology Association**

**Jet-speed HHS3124F / HHS2112F (10 Nodes)**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPC-1 IOPS™</td>
<td>2,410,271</td>
</tr>
<tr>
<td>SPC-1 Price-Performance™</td>
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</tr>
<tr>
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<td>NA</td>
</tr>
<tr>
<td>SPC-1 ASU Price</td>
<td>$14.79/GB</td>
</tr>
<tr>
<td>SPC-1 Total System Price</td>
<td>$691,767.07</td>
</tr>
</tbody>
</table>

| Data Protection Level                       | Protected 1 (RAID 1+0)      |
| Physical Storage Capacity                   | 129,976 GB                  |
| Pricing Currency / Target Country           | U.S. Dollars / Korea        |

**SPC-1 V3.8**

**Submission Identifier:** A31019

**Submitted For Review:** December 4, 2018
EXECUTIVE SUMMARY

SPC Benchmark™ V3.8 FULL DISCLOSURE REPORT
Telecommunications Technology Association
Jet-speed HHS3124F / HHS2112F (10 Nodes)

Submission Identifier: A31019
Submitted for Review: December 4, 2018

Benchmark Configuration Diagram

Host Systems

5 x Uni RB128 servers

1 x Mellanox CX556A-ConnectX-5 2-port 100Gbps IB per server

10 x Infiniband Connections (2 per server)

1 x Mellanox SB7890 36-port IB Switch

20 x Infiniband Connections (2 per Jet-speed node)

Jet-speed HHS3124F / HHS2112F

2 x Jet-speed HHS3124F nodes (each with)
2 x Intel Xeon E5-2630 v4 2.20GHz (node 1)
2 x Intel Xeon E5-2640 v2 2.40GHz (node 2)
64 GB Memory
1 x Mellanox 2-port 100Gbps IB card
2 x PCIe Gen3 Switch cards
1 x SAS/SATA Megaraid controller
2 x 480GB SATA SSD (system)
8 x 1600GB NVMe SSD (node 1)
6 x 1600GB NVMe SSD (node 2)

8 x Jet-speed HHS2112F nodes (each with)
2 x Intel Xeon E5-2630 v3 2.40GHz
64 GB Memory
1 x Mellanox 2-port 100Gbps IB card
2 x PCIe Gen3 Switch cards
1 x SAS/SATA Megaraid controller
2 x 300GB 10Krpm HDD (system, nodes 3, 4, 8)
2 x 146GB 10Krpm HDD (system, nodes 5, 6, 7)
2 x 147GB 15Krpm HDD (system, nodes 9, 10)
8 x 1600GB NVMe SSD

Tested Storage Configuration (TSC)
Tested Storage Product Description

The intelligent Hyper Hybrid Storage HHS3124F/HHS2112F present an ultra-high speed, all-NVMe RAID storage platform. The systems guarantee stability and performance through its own control system and management system using Intel® Xeon® controller.

Data stability and redundancy is secured by implementing a PCIe RAID architecture. Flash SSD performance degradation and breakdown rates that are caused by frequent write operations are innovatively reduced. Especially, the HHS3124F, which supports concurrent use of NVMe Flash SSDs and Tajin Infotech’s NVMe RAM-based SSDs, can activate data cache engine which is configured to improve data I/O performance using the controller’s own cache as well as the NVMe RAM-based SSD.

*Note: NVMe RAM-based SSDs were not used for this SPC-1 result.*

For more details, visit:

http://www.taejin.co.kr/wp/?page_id=11611

Priced Storage Configuration Components

<table>
<thead>
<tr>
<th>5 x Mellanox CX556A-ConnectX-5 2-port 100Gbps IB cards (1 per host)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 x Jet-speed HHS3124F storage nodes, each with:</td>
</tr>
<tr>
<td>2 x Intel Xeon CPU E5-2630 v4 2.20GHz 10-core (node 1)</td>
</tr>
<tr>
<td>2 x Intel Xeon CPU E5-2640 v4 2.40GHz 10-core (node 2)</td>
</tr>
<tr>
<td>4 x 16GB DDR4 Memory</td>
</tr>
<tr>
<td>1 x Mellanox 2-port 100Gbps IB card</td>
</tr>
<tr>
<td>1 x SAS/SATA MegaRAID controller</td>
</tr>
<tr>
<td>2 x PCIe Gen3 switch cards</td>
</tr>
<tr>
<td>2 x 480GB SATA 6Gbps SSD (System)</td>
</tr>
<tr>
<td>8 x 1600GB NVMe SSD 2.5’ SFF (node 1)</td>
</tr>
<tr>
<td>6 x 1600GB NVMe SSD 2.5’ SFF (node 2)</td>
</tr>
<tr>
<td>8 x Jet-speed HHS2112F storage nodes, each with:</td>
</tr>
<tr>
<td>2 x Intel Xeon CPU E5-2630 v3 2.40GHz 8-core</td>
</tr>
<tr>
<td>4 x 16GB DDR4 Memory</td>
</tr>
<tr>
<td>2 x PCIe Gen3 switch cards</td>
</tr>
<tr>
<td>1 x Mellanox 2-port 100Gbps IB card</td>
</tr>
<tr>
<td>1 x SAS/SATA MegaRAID controller</td>
</tr>
<tr>
<td>2 x 300GB SAS 10Krpm HDD (System, nodes 3,4,8)</td>
</tr>
<tr>
<td>2 x 146GB SAS 10Krpm HDD (System, nodes 5,6,7)</td>
</tr>
<tr>
<td>2 x 147GB SAS 15Krpm HDD (System, nodes 9,10)</td>
</tr>
<tr>
<td>8 x 1600GB NVMe SSD 2.5’ SFF</td>
</tr>
<tr>
<td>Mellanox SB7890 100 Gbps 36-port IB Switch</td>
</tr>
</tbody>
</table>
### Storage Configuration Pricing

<table>
<thead>
<tr>
<th>Description</th>
<th>Qty</th>
<th>Unit Price</th>
<th>Ext. Price</th>
<th>Disc.</th>
<th>Disc. Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>HHS2112F All NVMe Storage (2U / 12 disk bays Dual Intel Xeon E5-2600v3/v4 Family, 16x DIMM Slots, 800W redundant PSU 80Plus platinum)</td>
<td>8</td>
<td>50,379.73</td>
<td>403,037.82</td>
<td>50%</td>
<td>201,518.91</td>
</tr>
<tr>
<td>HHS3124F All NVMe Storage (3U / 24 disk bays Dual Intel Xeon E5-2600v3/v4 Family, 16x DIMM Slots, 1000W redundant PSU 80Plus platinum)</td>
<td>2</td>
<td>91,777.78</td>
<td>183,555.56</td>
<td>50%</td>
<td>91,777.78</td>
</tr>
<tr>
<td>DDR4 16GB PC4-17000 ECC/REG (16GB PC4-17000 DDR Rdimm Ecc Reg RX8 CL17 1.2V)</td>
<td>8</td>
<td>179.64</td>
<td>1,437.12</td>
<td>0%</td>
<td>1,437.12</td>
</tr>
<tr>
<td>DDR4 16GB PC4-19200 ECC/REG (16GB PC4-19200 DDR Rdimm Ecc Reg RX8 CL17 1.2V)</td>
<td>8</td>
<td>179.64</td>
<td>1,437.12</td>
<td>0%</td>
<td>1,437.12</td>
</tr>
<tr>
<td>100G IB EDR HBC CARD CX556A - ConnectX-5 (ConnectX-5 Ex VPI Adapter Card EDR IB and 4-port QSFP28 PCIe4.0 x16 Tall Bracket ROHS R6)</td>
<td>15</td>
<td>951.00</td>
<td>14,265.00</td>
<td>0%</td>
<td>14,265.00</td>
</tr>
<tr>
<td>Raid Controller SAS Megaraid 9361-8i (up to 8 SATA or SAS drives via direct connection or up to 240 drives with SAS expander)</td>
<td>10</td>
<td>931.61</td>
<td>9,316.10</td>
<td>0%</td>
<td>9,316.10</td>
</tr>
<tr>
<td>SSD 480GB 2.5&quot; 6Gb SATA3</td>
<td>4</td>
<td>281.64</td>
<td>1,126.56</td>
<td>0%</td>
<td>1,126.56</td>
</tr>
<tr>
<td>HDD 300GB 2.5&quot; 10K RPM 6Gb SAS</td>
<td>4</td>
<td>55.00</td>
<td>220.00</td>
<td>0%</td>
<td>220.00</td>
</tr>
<tr>
<td>HDD 300GB 2.5&quot; 10K RPM 6Gb SAS</td>
<td>2</td>
<td>55.00</td>
<td>110.00</td>
<td>0%</td>
<td>110.00</td>
</tr>
<tr>
<td>HDD 146GB 2.5&quot; 10K RPM 6Gb SAS</td>
<td>6</td>
<td>40.07</td>
<td>240.42</td>
<td>0%</td>
<td>240.42</td>
</tr>
<tr>
<td>HDD 147GB 2.5&quot; 15K RPM 6Gb SAS</td>
<td>4</td>
<td>42.10</td>
<td>168.40</td>
<td>0%</td>
<td>168.40</td>
</tr>
<tr>
<td>NVMe SSD 1.6TB, HGST, SN200, 2.5&quot; SFF</td>
<td>8</td>
<td>1306.62</td>
<td>10,452.96</td>
<td>0%</td>
<td>10,452.96</td>
</tr>
<tr>
<td>NVMe SSD 1.6TB, Samsung PM1725A, 2.5&quot; SFF</td>
<td>14</td>
<td>1306.62</td>
<td>18,292.68</td>
<td>0%</td>
<td>18,292.68</td>
</tr>
<tr>
<td>NVMe SSD 1.6TB, Intel, DCP4600 2.5&quot; SFF</td>
<td>56</td>
<td>1306.62</td>
<td>73,170.73</td>
<td>0%</td>
<td>73,170.73</td>
</tr>
<tr>
<td>Board PCIe Switching GEN3 x8 4Port for HHS2112F, HHS3124F</td>
<td>20</td>
<td>0.03895</td>
<td>0.7799</td>
<td>50%</td>
<td>50,389.50</td>
</tr>
<tr>
<td>MSB7890ES2F 100G IB SWITCH By Mellanox (36-port Non-blocking Externally-managed EDR)</td>
<td>1</td>
<td>124,328.08</td>
<td>124,328.08</td>
<td>0%</td>
<td>124,328.08</td>
</tr>
<tr>
<td>MCP1600-E002 IB EDR Cable</td>
<td>30</td>
<td>136.76</td>
<td>4102.79</td>
<td>0%</td>
<td>4102.79</td>
</tr>
<tr>
<td>4U Rack Cabinet</td>
<td>1</td>
<td>776.59</td>
<td>776.59</td>
<td>0%</td>
<td>776.59</td>
</tr>
<tr>
<td>Gluesys AnyStore Enterprise, AnyManager SW (NAS O/S, RAID 0/1/10/5/6, Protocol NFS/CIFS/APP, NVMe Option, UI Mgmt. etc.)</td>
<td>10</td>
<td>20,000.00</td>
<td>200,000.00</td>
<td>50%</td>
<td>100,000.00</td>
</tr>
</tbody>
</table>

### Hardware & Software Subtotal
601,537.07

### Support & Maintenance

<table>
<thead>
<tr>
<th>Description</th>
<th>Qty</th>
<th>Unit Price</th>
<th>Ext. Price</th>
<th>Disc.</th>
<th>Disc. Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premium Package 3-Year Support &amp; Maintenance</td>
<td>10</td>
<td>18,046.00</td>
<td>180,460.00</td>
<td>50%</td>
<td>90,230.00</td>
</tr>
</tbody>
</table>

### Support & Maintenance Subtotal
90,230.00

### SPC-1 Total System Price
691,767.07

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPC-1 IOPS™</td>
<td>2,410,271</td>
</tr>
<tr>
<td>SPC-1 Price-Performance™ ($/SPC-1 KIOPS™)</td>
<td>287.01</td>
</tr>
<tr>
<td>SPC-1 ASU Capacity (GB)</td>
<td>46,789</td>
</tr>
<tr>
<td>SPC-1 ASU Price ($/GB)</td>
<td>14.79</td>
</tr>
</tbody>
</table>

**Third-Party Reseller:** TTA is the sponsor of this result but does not directly sell the products and components of the Priced Storage Configuration (PSC). The above reflects the pricing quoted by the vendor and third-party reseller Taejin Infotech Co., Ltd. See Appendix B of the Full Disclosure Report for a copy of the third-party reseller’s quotation.
Discount Details: The discounts shown are based on the storage capacity purchased and are generally available.

Warranty: The 3-year maintenance and support included in the above pricing meets or exceeds a 24x7 coverage with a 4-hour response time.

Availability Date: Currently available.
### Contact Information

**Test Sponsor Primary Contact**  
TTA – [http://tta.or.kr/eng/index.jsp](http://tta.or.kr/eng/index.jsp)  
Hyojin (Kailynne) Kim – hjkim16@tta.or.kr

**SPC Auditor**  
InfoSizing – [www.sizing.com](http://www.sizing.com)  
Francois Raab – francois@sizing.com

### Revision Information

<table>
<thead>
<tr>
<th>SPC Benchmark 1™ Revision</th>
<th>V3.8.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPC-1 Workload Generator Revision</td>
<td>0xe28e08v3.0.2</td>
</tr>
<tr>
<td>Publication Revision History</td>
<td>First Edition</td>
</tr>
</tbody>
</table>
Benchmark Configuration and Tested Storage Configuration

The following diagram illustrates the Benchmark Configuration (BC), including the Tested Storage Configuration (TSC) and the Host System(s).

Storage Network Configuration

The Tested Storage Configuration (TSC) involved ten storage nodes of two types (two HHS3124F nodes and eight HHS2112F nodes), driven by five Uni RB128 host systems. Each host had two connections to a Mellanox SB7890 InfiniBand (IB) Switch. Each of the ten Jet-speed storage nodes had two connections to the Mellanox SB7890 IB Switch. All connections operated at 100Gbps.
Host System and Tested Storage Configuration Components

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

<table>
<thead>
<tr>
<th>Host Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 x Uni RB128 x86 Servers</td>
</tr>
<tr>
<td>2 x Intel Xeon E5-2699 v4 2.20 GHz 22-core</td>
</tr>
<tr>
<td>12 x 32GB DDR4 Memory</td>
</tr>
<tr>
<td>CentOS 7.4 (64-bit)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Priced Storage Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 x Mellanox CX556A-ConnectX-5 2-port 100Gbps IB cards (1 per host)</td>
</tr>
<tr>
<td>2 x Jet-speed HHS3124F storage nodes, each with:</td>
</tr>
<tr>
<td>2 x Intel Xeon CPU E5-2630 v4 2.20GHz 10-core (node 1)</td>
</tr>
<tr>
<td>2 x Intel Xeon CPU E5-2640 v4 2.40GHz 10-core (node 2)</td>
</tr>
<tr>
<td>4 x 16GB DDR4 Memory</td>
</tr>
<tr>
<td>1 x Mellanox 2-port 100Gbps IB card</td>
</tr>
<tr>
<td>1 x SAS/SATA MegaRAID controller</td>
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<tr>
<td>2 x PCIe Gen3 switch cards</td>
</tr>
<tr>
<td>2 x 480GB SATA 6Gbps SSD (System)</td>
</tr>
<tr>
<td>8 x 1600GB NVMe SSD 2.5’ SFF (node 1)</td>
</tr>
<tr>
<td>6 x 1600GB NVMe SSD 2.5’ SFF (node 2)</td>
</tr>
<tr>
<td>8 x Jet-speed HHS2112F storage nodes, each with:</td>
</tr>
<tr>
<td>2 x Intel Xeon CPU E5-2630 v3 2.40GHz 8-core</td>
</tr>
<tr>
<td>4 x 16GB DDR4 Memory</td>
</tr>
<tr>
<td>2 x PCIe Gen3 switch cards</td>
</tr>
<tr>
<td>1 x Mellanox 2-port 100Gbps IB card</td>
</tr>
<tr>
<td>1 x SAS/SATA MegaRAID controller</td>
</tr>
<tr>
<td>2 x 300GB SAS 10Krpm HDD (System, nodes 3,4,8)</td>
</tr>
<tr>
<td>2 x 146GB SAS 10Krpm HDD (System, nodes 5,6,7)</td>
</tr>
<tr>
<td>2 x 147GB SAS 15Krpm HDD (System, nodes 9,10)</td>
</tr>
<tr>
<td>8 x 1600GB NVMe SSD 2.5’ SFF</td>
</tr>
<tr>
<td>Mellanox SB7890 100 Gbps 36-port IB Switch</td>
</tr>
</tbody>
</table>

Differences Between Tested and Priced Storage Configurations

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

Component Changes in Revised Full Disclosure Report

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

<table>
<thead>
<tr>
<th>Original Component</th>
<th>Revised Component</th>
<th>Description of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>n/a</td>
<td>n/a</td>
<td>Initial submission</td>
</tr>
</tbody>
</table>
Benchmark Configuration Creation Process

Customer Tuning Parameters and Options
All the customer tuning parameters and options that have been altered from their default values for this benchmark are included in Appendix C and in the Supporting Files (see Appendix A).

Tested Storage Configuration Creation
A detailed description of how the logical representation of the TSC was created is included in Appendix D and in the Supporting Files (see Appendix A).

Tested Storage Configuration Inventory
An inventory of the components in the TSC, as seen by the Benchmark Configuration, is included in Appendix E and in the Supporting Files (see Appendix A).

Workload Generator Storage Configuration
The SPC-1 Workload Generator storage configuration commands and parameters used to invoke the execution of the tests are included in Appendix F and in the Supporting Files (see Appendix A).

Logical Volume Capacity and ASU Mapping
The following table details the capacity of each ASU and how they are mapped to logical volumes (LV).

<table>
<thead>
<tr>
<th>LV per ASU</th>
<th>LV Capacity</th>
<th>Used per LV</th>
<th>Total per ASU</th>
<th>% ASU Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASU-1</td>
<td>9</td>
<td>2,339.49</td>
<td>2,339.49</td>
<td>21,055.41</td>
</tr>
<tr>
<td>ASU-2</td>
<td>9</td>
<td>2,339.49</td>
<td>2,339.49</td>
<td>21,055.41</td>
</tr>
<tr>
<td>ASU-3</td>
<td>1</td>
<td>4,678.33</td>
<td>4,678.33</td>
<td>4,678.33</td>
</tr>
<tr>
<td><strong>SPC-1 ASU Capacity</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>46,789.15</strong></td>
</tr>
</tbody>
</table>
Physical Storage Capacity and Utilization

The following table details the Physical Capacity of the storage devices and the Physical Capacity Utilization (percentage of Total Physical Capacity used) in support of hosting the ASUs.

<table>
<thead>
<tr>
<th>Devices</th>
<th>Count</th>
<th>Physical Capacity</th>
<th>Total Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,600GB NVMe SSD</td>
<td>78</td>
<td>1,600.00</td>
<td>124,800.00</td>
</tr>
<tr>
<td>480GB SSD (system)</td>
<td>4</td>
<td>479.60</td>
<td>1,918.40</td>
</tr>
<tr>
<td>300GB HDD (system)</td>
<td>6</td>
<td>299.00</td>
<td>1,794.00</td>
</tr>
<tr>
<td>146GB HDD (system)</td>
<td>6</td>
<td>146.30</td>
<td>877.80</td>
</tr>
<tr>
<td>147GB HDD (system)</td>
<td>4</td>
<td>146.46</td>
<td>585.84</td>
</tr>
<tr>
<td><strong>Total Physical Storage Capacity</strong></td>
<td></td>
<td><strong>129,976.04</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Physical Capacity Utilization</strong></td>
<td></td>
<td><strong>36.00%</strong></td>
<td></td>
</tr>
</tbody>
</table>

Data Protection

The data protection level used for all logical volumes was Protected 1, which was accomplished on the NVMe storage nodes by combining pairs of nearby NVMe SSDs in RAID 1 volumes and creating a RAID 0 volume over all of the RAID 1 volumes.
**BENCHMARK EXECUTION RESULTS**

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

**Benchmark Execution Overview**

**Workload Generator Input Parameters**

The SPC-1 Workload Generator commands and input parameters for the Test Phases are presented in the Supporting Files (see Appendix A).

**Primary Metrics Test Phases**

The benchmark execution consists of the Primary Metrics Test Phases, including the Test Phases SUSTAIN, RAMPD_100 to RAMPD_10, RAMPU_50 to RAMPU_100, RAMP_0, REPEAT_1 and REPEAT_2.

Each Test Phase starts with a transition period followed by a Measurement Interval.

**Measurement Intervals by Test Phase Graph**

The following graph presents the average IOPS and the average Response Times measured over the Measurement Interval (MI) of each Test Phase.

![Measurement Intervals by Test Phase Graph](image_url)

**Exception and Waiver**

None.
SUSTAIN Test Phase

SUSTAIN – Results File

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

- SPC1_METRICS_0_Raw_Results.xlsx

SUSTAIN – Execution Times

<table>
<thead>
<tr>
<th>Interval</th>
<th>Start Time</th>
<th>End Time</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement Interval</td>
<td>14-Nov-18 21:35:25</td>
<td>15-Nov-18 05:35:26</td>
<td>8:00:01</td>
</tr>
</tbody>
</table>

SUSTAIN – Throughput Graph

![Throughput Graph (SUSTAIN @ 2,410,000 IOPS)](image-url)
SUSTAIN – Response Time Graph

![Response Time Graph (SUSTAIN @ 2,410,000 IOPS)]

SUSTAIN – Data Rate Graph

![Data Rate Graph (SUSTAIN @ 2,410,000 IOPS)]
**SUSTAIN – Response Time Frequency Graph**

![Response Time Frequency Graph](image)

**SUSTAIN – Intensity Multiplier**

The following table lists the targeted intensity multiplier (Defined), the measured intensity multiplier (Measured) for each I/O STREAM, its coefficient of variation (Variation) and the percentage of difference (Difference) between Target and Measured.

<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>Defined</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>Measured</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>Variation</td>
<td>0.0004</td>
<td>0.0001</td>
<td>0.0003</td>
<td>0.0002</td>
<td>0.0006</td>
<td>0.0003</td>
<td>0.0004</td>
<td>0.0001</td>
</tr>
<tr>
<td>Difference</td>
<td>0.006%</td>
<td>0.003%</td>
<td>0.004%</td>
<td>0.002%</td>
<td>0.001%</td>
<td>0.004%</td>
<td>0.003%</td>
<td>0.002%</td>
</tr>
</tbody>
</table>
RAMPD_100 Test Phase

**RAMPD_100 – Results File**

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

- SPC1_METRICS_0_Raw_Results.xlsx

**RAMPD_100 – Execution Times**

<table>
<thead>
<tr>
<th>Interval</th>
<th>Start Time</th>
<th>End Time</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transition Period</td>
<td>15-Nov-18 05:36:25</td>
<td>15-Nov-18 05:41:26</td>
<td>0:05:01</td>
</tr>
<tr>
<td>Measurement Interval</td>
<td>15-Nov-18 05:41:26</td>
<td>15-Nov-18 05:51:26</td>
<td>0:10:00</td>
</tr>
</tbody>
</table>

**RAMPD_100 – Throughput Graph**

![Throughput Graph](image)
RAMPD_100 – Response Time Graph

![Response Time Graph (RAMPD_100 @ 2,410,000 IOPS)](image)

RAMPD_100 – Data Rate Graph

![Data Rate Graph (RAMPD_100 @ 2,410,000 IOPS)](image)
**RAMPD_100 – Response Time Frequency Graph**

![Response Time Frequency Graph]

**RAMPD_100 – Intensity Multiplier**

The following table lists the targeted intensity multiplier (Defined), the measured intensity multiplier (Measured) for each I/O STREAM, its coefficient of variation (Variation) and the percentage of difference (Difference) between Target and Measured.

<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>Defined</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>Measured</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>Variation</td>
<td>0.0003</td>
<td>0.0001</td>
<td>0.0003</td>
<td>0.0001</td>
<td>0.0006</td>
<td>0.0003</td>
<td>0.0004</td>
<td>0.0001</td>
</tr>
<tr>
<td>Difference</td>
<td>0.008%</td>
<td>0.001%</td>
<td>0.005%</td>
<td>0.003%</td>
<td>0.046%</td>
<td>0.000%</td>
<td>0.010%</td>
<td>0.000%</td>
</tr>
</tbody>
</table>

**RAMPD_100 – I/O Request Summary**

<table>
<thead>
<tr>
<th>I/O Requests Completed in the Measurement Interval</th>
<th>1,446,176,219</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/O Requests Completed with Response Time &lt;= 30 ms</td>
<td>1,446,170,555</td>
</tr>
<tr>
<td>I/O Requests Completed with Response Time &gt; 30 ms</td>
<td>5,664</td>
</tr>
</tbody>
</table>
Response Time Ramp Test

Response Time Ramp Test – Results File

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

- SPC1_METRICS_0_Raw_Results.xlsx

Response Time Ramp Test – Phases

The Response Time Ramp Test is comprised of 11 Test Phases, including six Ramp-Down Phases (executed at 100%, 95%, 90%, 80%, 50%, and 10% of the Business Scaling Unit) and five Ramp-Up Phases (executed at 50%, 80%, 90%, 95%, and 100% of the Business Scaling Unit).

Response Time Ramp Test – Average Throughput Graph

![Average Throughput Graph (Response Time Ramp Test)](image-url)
**Response Time Ramp Test – Average Response Time Graph**

![Average Response Time Graph](image1)

**Response Time Ramp Test – RAMPD_10 Response Time Graph**

![Response Time Graph](image2)
Repeatability Test

Repeatability Test Results File

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

- SPC1_METRICS_0_Raw_Results.xlsx

Repeatability Test Results

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

<table>
<thead>
<tr>
<th>Test Phase</th>
<th>100% IOPS</th>
<th>10% IOPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAMPD</td>
<td>2,410,271.3</td>
<td>241,011.0</td>
</tr>
<tr>
<td>REPEAT_1</td>
<td>2,410,246.6</td>
<td>241,014.7</td>
</tr>
<tr>
<td>REPEAT_2</td>
<td>2,410,270.6</td>
<td>241,042.6</td>
</tr>
</tbody>
</table>

REPEAT_1_100 – Throughput Graph
REPEAT_1_100 – Response Time Graph

REPEAT_2_100 – Throughput Graph
REPEAT_2_100 – Response Time Graph

The following tables lists the targeted intensity multiplier (Defined), the measured intensity multiplier (Measured) for each I/O STREAM, its coefficient of variation (Variation) and the percent of difference (Difference) between Target and Measured.

**REPEAT_1_100 Test Phase**

<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>Defined</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>Measured</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>Variation</td>
<td>0.0004</td>
<td>0.0001</td>
<td>0.0003</td>
<td>0.0001</td>
<td>0.0004</td>
<td>0.0004</td>
<td>0.0004</td>
<td>0.0001</td>
</tr>
<tr>
<td>Difference</td>
<td>0.019%</td>
<td>0.000%</td>
<td>0.006%</td>
<td>0.005%</td>
<td>0.007%</td>
<td>0.000%</td>
<td>0.019%</td>
<td>0.002%</td>
</tr>
</tbody>
</table>

**REPEAT_2_100 Test Phase**

<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>Defined</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>Measured</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>Variation</td>
<td>0.0004</td>
<td>0.0002</td>
<td>0.0005</td>
<td>0.0002</td>
<td>0.0004</td>
<td>0.0004</td>
<td>0.0006</td>
<td>0.0002</td>
</tr>
<tr>
<td>Difference</td>
<td>0.012%</td>
<td>0.008%</td>
<td>0.003%</td>
<td>0.002%</td>
<td>0.012%</td>
<td>0.027%</td>
<td>0.015%</td>
<td>0.003%</td>
</tr>
</tbody>
</table>
Space Optimization Reporting

**Description of Techniques Used**

No space optimization was used for this SPC-1 result.

**Physical Free Space Measurements**

The following table lists the Physical Free Space as measured at each of the required points during test execution. If space optimization techniques were not used, “NA” is reported.

<table>
<thead>
<tr>
<th>Physical Free Space Measurement</th>
<th>Free Space (GB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>After Logical Volume Creation</td>
<td>NA</td>
</tr>
<tr>
<td>After ASU Pre-Fill</td>
<td>NA</td>
</tr>
<tr>
<td>After Repeatability Test Phase</td>
<td>NA</td>
</tr>
</tbody>
</table>

**Space Optimization Metrics**

The following table lists the required space optimization metrics. If space optimization techniques were not used, “NA” is reported.

<table>
<thead>
<tr>
<th>Space Optimization Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPC-1 Space Optimization Ratio</td>
<td>NA</td>
</tr>
<tr>
<td>SPC-1 Space Effectiveness Ratio</td>
<td>NA</td>
</tr>
</tbody>
</table>
Data Persistence Test

Data Persistence Test Results File

The results files generated during the execution of the Data Persistence Test is included in the Supporting Files (see Appendix A) as follows:

- SPC1_PERSIST_1_0_Raw_Results.xlsx
- SPC1_PERSIST_2_0_Raw_Results.xlsx

Data Persistence Test Execution

The Data Persistence Test was executed using the following sequence of steps:

- The PERSIST_1_0 Test Phase was executed to completion.
- The Benchmark Configuration was taken through an orderly shutdown process and powered off.
- The Benchmark Configuration was powered on and taken through an orderly startup process.
- The PERSIST_2_0 Test Phase was executed to completion.

Data Persistence Test Results

<table>
<thead>
<tr>
<th>Data Persistence Test Phase: Persist1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Logical Blocks Written</td>
<td>478,651,585</td>
</tr>
<tr>
<td>Total Number of Logical Blocks Verified</td>
<td>233,295,120</td>
</tr>
<tr>
<td>Total Number of Logical Blocks Overwritten</td>
<td>245,356,465</td>
</tr>
<tr>
<td>Total Number of Logical Blocks that Failed Verification</td>
<td>0</td>
</tr>
<tr>
<td>Time Duration for Writing Test Logical Blocks (sec.)</td>
<td>601</td>
</tr>
<tr>
<td>Size in bytes of each Logical Block</td>
<td>8,192</td>
</tr>
<tr>
<td>Number of Failed I/O Requests in the process of the Test</td>
<td>0</td>
</tr>
</tbody>
</table>

Committed Data Persistence Implementation

The persistency of committed data is implemented at the disk level, where data loss is prevented through the use of RAID 1 arrays. At the controller level, the cache is set-up in write-through mode and needs not to be protected to ensure persistence of committed data.
## APPENDIX A: SUPPORTING FILES

The following table details the content of the Supporting Files provided as part of this Full Disclosure Report.

<table>
<thead>
<tr>
<th>File Name</th>
<th>Description</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>/SPC1_RESULTS</td>
<td>Data reduction worksheets</td>
<td>root</td>
</tr>
<tr>
<td>SPC1_INIT_0_Raw_Results.xlsx</td>
<td>Raw results for INIT Test Phase</td>
<td>/SPC1_RESULTS</td>
</tr>
<tr>
<td>SPC1_METRICS_0_Quick_Look.xlsx</td>
<td>Quick Look Test Run Overview</td>
<td>/SPC1_RESULTS</td>
</tr>
<tr>
<td>SPC1_METRICS_0_Raw_Results.xlsx</td>
<td>Raw results for Primary Metrics Test</td>
<td>/SPC1_RESULTS</td>
</tr>
<tr>
<td>SPC1_METRICS_0_Summary_Results.xlsx</td>
<td>Primary Metrics Summary</td>
<td>/SPC1_RESULTS</td>
</tr>
<tr>
<td>SPC1_PERSIST_1_0_Raw_Results.xlsx</td>
<td>Raw results for PERSIST1 Test Phase</td>
<td>/SPC1_RESULTS</td>
</tr>
<tr>
<td>SPC1_PERSIST_2_0_Raw_Results.xlsx</td>
<td>Raw results for PERSIST2 Test Phase</td>
<td>/SPC1_RESULTS</td>
</tr>
<tr>
<td>SPC1_Run_Set_Overview.xlsx</td>
<td>Run Set Overview Worksheet</td>
<td>/SPC1_RESULTS</td>
</tr>
<tr>
<td>SPC1_VERIFY_0_Raw_Results.xlsx</td>
<td>Raw results for first VERIFY Test Phase</td>
<td>/SPC1_RESULTS</td>
</tr>
<tr>
<td>SPC1_VERIFY_1_Raw_Results.xlsx</td>
<td>Raw results for second VERIFY Test Phase</td>
<td>/SPC1_RESULTS</td>
</tr>
<tr>
<td>/C_Tuning</td>
<td>Tuning parameters and options</td>
<td>root</td>
</tr>
<tr>
<td>rc.local</td>
<td>Set tuning parameters</td>
<td>/C_Tuning</td>
</tr>
<tr>
<td>/D_Creation</td>
<td>Storage configuration creation</td>
<td>root</td>
</tr>
<tr>
<td>create_nvmet_md.sh</td>
<td>Create the NVMe over Fabric setup</td>
<td>/D_Creation</td>
</tr>
<tr>
<td>lvcreate.sh</td>
<td>Create the Logical Volumes</td>
<td>/D_Creation</td>
</tr>
<tr>
<td>mdcreate.sh</td>
<td>Create RAID volumes</td>
<td>/D_Creation</td>
</tr>
<tr>
<td>mdfrozen.sh</td>
<td>Stop RAID re-sync activity</td>
<td>/D_Creation</td>
</tr>
<tr>
<td>parted.sh</td>
<td>Create partitions on the NVMe devices</td>
<td>/D_Creation</td>
</tr>
<tr>
<td>rm_parted.sh</td>
<td>Remove pre-existing partitions</td>
<td>/D_Creation</td>
</tr>
<tr>
<td>/E_Inventory</td>
<td>Configuration inventory</td>
<td>root</td>
</tr>
<tr>
<td>inventory_start.out</td>
<td>Storage inventory before INIT</td>
<td>/E_Inventory</td>
</tr>
<tr>
<td>inventory_end.out</td>
<td>Storage inventory after restart</td>
<td>/E_Inventory</td>
</tr>
<tr>
<td>/F_Generator</td>
<td>Workload generator</td>
<td>root</td>
</tr>
<tr>
<td>hst1_linear.asu</td>
<td>Defining LUNs hosting the ASUs</td>
<td>/F_generator</td>
</tr>
<tr>
<td>5host.HST</td>
<td>Host configuration file</td>
<td>/F_generator</td>
</tr>
<tr>
<td>spc1.sh</td>
<td>Executing all test phases</td>
<td>/F_generator</td>
</tr>
</tbody>
</table>
# APPENDIX B: THIRD PARTY QUOTATION

## Quotation

<table>
<thead>
<tr>
<th>Date</th>
<th>NO.</th>
<th>Project Description</th>
<th>Q'ty</th>
<th>Unit Price</th>
<th>Amount (US$)</th>
<th>DC %</th>
<th>Final Amount (US$)</th>
<th>Remark</th>
</tr>
</thead>
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<td>10-Nov-2018</td>
<td>TIQ2018-1110001</td>
<td>For SPC-1 Test with HHS3124F &amp; HHS2112F</td>
<td>C.C.</td>
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<td>Tqing Infotech Co., Ltd.</td>
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<td>Hyungjung Ahn</td>
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<td>Total Amount: 691,767.07 (US$)</td>
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<th>Item Description</th>
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<th>Amount (US$)</th>
<th>DC %</th>
<th>Final Amount (US$)</th>
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<td>HHS2112F All NVMe Storage</td>
<td>8</td>
<td>50,379.73</td>
<td>403,073.82</td>
<td>50%</td>
<td>201,518.91</td>
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<td>2U/12 disk bays</td>
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<td>Dual Intel Xeon E5-2600v4 X4 Family, 16x DIMM Slots,</td>
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<td>800W redundant PSU 800plus platinum</td>
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<td>HHS3124F All NVMe Storage</td>
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<td>3U/24 disk bays</td>
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<td>Dual Intel Xeon E5-2600v4 X4 Family, 16x DIMM Slots,</td>
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<td>28</td>
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<td>16GB PC17000 DDR Rddm Ecc Reg R8B CL17.12</td>
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<td>Detail Specification</td>
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<td>16GB PC17000 DDR Rddm Ecc Reg R8B CL17.12</td>
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<td>951.00</td>
<td>14,265.00</td>
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<td>ConnectX-5 Evi VP Adapter Card EDR IB and 1000Base Dual-port GIIFP8 PX4.0 x8 16 Slot Bracket ROHS R8 Intelligent RDMA-enabled network adapter card with advanced application offload capabilities for High-Performance Computing, Web2.0, Cloud and Storage platforms</td>
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<td>6</td>
<td>Raid Controller SAS/SATA Megaraid 9361-1</td>
<td>10</td>
<td>931.81</td>
<td>9,316.10</td>
<td>0%</td>
<td>9,316.10</td>
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<td></td>
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<td></td>
<td>Connect up to 8 SATA or SAS drives via direct connection inside the box or up to 240 drives leveraging SAS expander technology</td>
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<tr>
<td></td>
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<td></td>
<td>Fit into rack-mounted servers with low-profile form factor and side-mounted SAS connectors</td>
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<td></td>
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<td>Support critical, high-bandwidth applications with PCIe x8 connectivity</td>
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<td></td>
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<td>Balance protection and performance for critical applications with RAID levels 0, 1, 4, 5, 6, 10, 50, and 60</td>
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<td>Detail Specification</td>
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<td>SM063 400GB SATA-6Gbps 2.5INCH MLC INTERNAL SOLID STATE DRIVE, BRAND NEW WITH STANDARD MPG WARRANTY</td>
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<td>Capacity: 480GB</td>
<td>INTERFACE: SATA-6Gbps</td>
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<td>Drive Dimensions: 2.5 INCH</td>
<td>NAND FLASH MEMORY TYPE: MULTI-LEVEL CELL (MLC)</td>
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<td>Power Consumption: 3.0 watt (read) 2.4 watt (write)</td>
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<tr>
<td>8</td>
<td>3200GB SAS 2.5&quot;10K RPM</td>
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<td>55.00</td>
<td>220.00</td>
<td>0%</td>
<td>220.00</td>
<td>Results (Hitachi)</td>
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<td>Detail Specification</td>
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<td>Hitachi GST Ultrastar C10K300 MLC1O3D30C3S10000 3000GB 10000 RPM 64MB Cache SAS 6Gb/s 2.5&quot; Enterprise Internal Hard Drive Bare Drive</td>
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<td></td>
<td></td>
<td>+ 10000 RPM + 64MB Cache + SAS 6Gb/s + 3 years limited</td>
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<td>9</td>
<td>146GB SAS 2.5&quot;10K RPM</td>
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<td>40.07</td>
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<td>0%</td>
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<td>Seagate Savvio 10K LST SFF6003S146GB 10000 RPM 16MB Cache SAS 6Gb/s 2.5&quot; Enterprise</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Hard Drive Bare Drive</td>
<td>+ 10000 RPM + 16MB Cache + SAS 6Gb/s</td>
<td>ideal for Servers</td>
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### APPENDIX C

#### Tuning Parameters and Options

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<tr>
<td>Total</td>
<td>1,225,683.26</td>
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<td>691,767.07</td>
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Notes:
1. Payment: L/C or T/T
2. Shipment: F.O.B. Incheon
APPENDIX C: TUNING PARAMETERS AND OPTIONS

The following scripts, listed below, were used to set tuning parameters and options:

- The script `rc.local` was used to set `aio-max-nr` to the value of `max_user_watches` and to set `ulimit` to 1000.

The script described above are included in the Supporting Files (see Appendix A) and listed below.

**rc.local**

```bash
#!/bin/bash
# THIS FILE IS ADDED FOR COMPATIBILITY PURPOSES
#
# It is highly advisable to create own systemd services or udev rules
# to run scripts during boot instead of using this file.
#
# In contrast to previous versions due to parallel execution during boot
# this script will NOT be run after all other services.
#
# Please note that you must run 'chmod +x /etc/rc.d/rc.local' to ensure
# that this script will be executed during boot.

touch /var/lock/subsys/local
cat /proc/sys/fs/epoll/max_user_watches >> /proc/sys/fs/aio-max-nr
ulimit -n 1000
```
APPENDIX D: STORAGE CONFIGURATION CREATION

Environment
First, the following shell scripts are executed on each of the storage nodes.

- `parted.sh`
- `mdcreate.sh`
- `rm_parted.sh`
- `mdfrozen.sh`
- `create_nvmet_md.sh`

Step 1 - Create Partitions, RAID volumes
The `parted.sh` shell scripts listed below, performs the following actions:

- Create 2 partitions on each NVMe device

The `mdcreate.sh` shell scripts listed below, performs the following actions:

- On each node, create 8 RAID 1 volumes using 2 partitions across 2 nearby NVMe devices (only 6 volumes were created on nodes with only 6 NVMe SSDs)
- Collects RAID configuration information for use during reboot
- Invoke the `rm_parted.sh` script to remove any pre-existing partitions from the RAID volumes
- Invoke the `mdfrozen.sh` script to stop RAID re-sync activity

The command files described above are included in the Supporting Files (see Appendix A) and listed below.

`parted.sh`

```bash
#!/bin/sh
devs=$(ls /dev/nvme?n?)
for dev in $devs
do
    parted -a optimal -s $dev mklabel gpt mkpart primary 1 50% mkpart primary 50% 100%; parted -s $dev unit s print
done
sleep 2
lsblk
sleep 2
/root/mgmt_script/set_kernel_parameters.sh
```
**mdcreate.sh**

```bash
#!/bin/sh

(echo "y") | mdadm -C /dev/md1 -l 1 -n 2 -c 512 /dev/nvme0n1p1 /dev/nvme1n1p1 --forcedevice
(echo "y") | mdadm -C /dev/md2 -l 1 -n 2 -c 512 /dev/nvme1n1p2 /dev/nvme0n1p2 --forcedevice

(echo "y") | mdadm -C /dev/md3 -l 1 -n 2 -c 512 /dev/nvme2n1p1 /dev/nvme3n1p1 --forcedevice
(echo "y") | mdadm -C /dev/md4 -l 1 -n 2 -c 512 /dev/nvme3n1p2 /dev/nvme2n1p2 --forcedevice

(echo "y") | mdadm -C /dev/md5 -l 1 -n 2 -c 512 /dev/nvme4n1p1 /dev/nvme5n1p1 --forcedevice
(echo "y") | mdadm -C /dev/md6 -l 1 -n 2 -c 512 /dev/nvme5n1p2 /dev/nvme4n1p2 --forcedevice

(echo "y") | mdadm -C /dev/md7 -l 1 -n 2 -c 512 /dev/nvme6n1p1 /dev/nvme7n1p1 --forcedevice
(echo "y") | mdadm -C /dev/md8 -l 1 -n 2 -c 512 /dev/nvme7n1p2 /dev/nvme6n1p2 --forcedevice

mdadm --verbose --detail --scan > /etc/mdadm.conf
/root/mgmt_script/rm_parted.sh
sleep 2
/root/mgmt_script/mdfrozen.sh
```

**rm_parted.sh**

```bash
#!/bin/sh

parted -s /dev/md1 rm 1 rm 2
parted -s /dev/md2 rm 1 rm 2
parted -s /dev/md3 rm 1 rm 2
parted -s /dev/md4 rm 1 rm 2
parted -s /dev/md5 rm 1 rm 2
parted -s /dev/md6 rm 1 rm 2
parted -s /dev/md7 rm 1 rm 2
parted -s /dev/md8 rm 1 rm 2

lsblk
```

**mdfrozen.sh**

```bash
#!/bin/sh

cmd=$1
devs=$(ls /dev/md? | awk '/ / {print $3}')

for dev in $devs;
do
echo frozen >> /sys/block/$dev/md/sync_action
done

sleep 2

cat /proc/mdstat
```
Step 2 – Set-Up NVMe Over Fabric

The `create_nvmet_md.sh` command file, listed below, includes all the CLI commands to perform the following actions:

- Create an NVMe subsystem
- Create an NVMe namespace for each RAID volume
- Set the NVMe device paths
- Enable the namespace
- Create NVMe_oF connections

The command file described above is included in the Supporting Files (see Appendix A) and listed below.

```
#!/bin/sh
nvmetcli clear

mkdir /sys/kernel/config/nvmet/subsystems/nvme
mv /sys/kernel/config/nvmet/subsystems/nvme-ib0

mkdir /sys/kernel/config/nvmet/ports/1
mv /sys/kernel/config/nvmet/ports/1

ln -s /sys/kernel/config/nvmet/subsystems/nvme-ib0
```

---

### `create_nvmet_md.sh`

```bash
#!/bin/sh

nvmetcli clear

mkdir /sys/kernel/config/nvmet/subsystems/nvme-
ib0

echo 1 > /sys/kernel/config/nvmet/subsystems/nvme-
ib0/attr_allow_any_host

mkdir /sys/kernel/config/nvmet/subsystems/nvme-
ib0/namespaces/1

echo > /dev/md1 > /sys/kernel/config/nvmet/subsystems/nvme-
ib0/namespaces/1/device_path

mkdir /sys/kernel/config/nvmet/subsystems/nvme-
ib0/namespaces/1/enable

echo 1 > /sys/kernel/config/nvmet/subsystems/nvme-
ib0/namespaces/1/enable

mkdir /sys/kernel/config/nvmet/subsystems/nvme-
ib0/namespaces/2

echo > /dev/md2 > /sys/kernel/config/nvmet/subsystems/nvme-
ib0/namespaces/2/device_path

mkdir /sys/kernel/config/nvmet/subsystems/nvme-
ib0/namespaces/2/enable

echo 1 > /sys/kernel/config/nvmet/subsystems/nvme-
ib0/namespaces/2/enable

mkdir /sys/kernel/config/nvmet/subsystems/nvme-
ib0/namespaces/3

echo > /dev/md3 > /sys/kernel/config/nvmet/subsystems/nvme-
ib0/namespaces/3/device_path

mkdir /sys/kernel/config/nvmet/subsystems/nvme-
ib0/namespaces/3/enable

echo 1 > /sys/kernel/config/nvmet/subsystems/nvme-
ib0/namespaces/3/enable

mkdir /sys/kernel/config/nvmet/subsystems/nvme-
ib0/namespaces/4

echo > /dev/md4 > /sys/kernel/config/nvmet/subsystems/nvme-
ib0/namespaces/4/device_path

mkdir /sys/kernel/config/nvmet/subsystems/nvme-
ib0/namespaces/4/enable

echo 1 > /sys/kernel/config/nvmet/subsystems/nvme-
ib0/namespaces/4/enable

mkdir /sys/kernel/config/nvmet/ports/1

mv /sys/kernel/config/nvmet/ports/1

ln -s /sys/kernel/config/nvmet/subsystems/nvme-ib0
```

---

SPC Benchmark 1™ V3.8 FULL DISCLOSURE REPORT Submission Identifier: A31019
Telecommunications Technology Association Submitted for Review: December 4, 2018
Jet-speed HHS3124F / HHS2112F (10 Nodes)
mkdir /sys/kernel/config/nvmet/subsystems/nvme-ib1/namespaces/6
echo -n /dev/md6 > /sys/kernel/config/nvmet/subsystems/nvme-ib1/namespaces/6/device_path
echo 1 > /sys/kernel/config/nvmet/subsystems/nvme-ib1/namespaces/6/enable

dir /sys/kernel/config/nvmet/subsystems/nvme-ib1/namespaces/7
echo -n /dev/md7 > /sys/kernel/config/nvmet/subsystems/nvme-ib1/namespaces/7/device_path
echo 1 > /sys/kernel/config/nvmet/subsystems/nvme-ib1/namespaces/7/enable

dir /sys/kernel/config/nvmet/subsystems/nvme-ib1/namespaces/8
echo -n /dev/md8 > /sys/kernel/config/nvmet/subsystems/nvme-ib1/namespaces/8/device_path
echo 1 > /sys/kernel/config/nvmet/subsystems/nvme-ib1/namespaces/8/enable

dir /sys/kernel/config/nvmet/ports/2
echo 4420 > /sys/kernel/config/nvmet/ports/2/addr_trsvcid
echo 1.1.2.201 > /sys/kernel/config/nvmet/ports/2/addr_traddr
echo rdma > /sys/kernel/config/nvmet/ports/2/addr_trtype
echo ipv4 > /sys/kernel/config/nvmet/ports/2/addr_adrfam

ln -s /sys/kernel/config/nvmet/subsystems/nvme-ib1 /sys/kernel/config/nvmet/ports/2/subsystems/nvme-ib1

sleep 2
nvmetclicli save
nvmetclicli ls

Step 3 - Create Volumes on the Host Systems

The following CLI commands were executed on the master host to perform the following actions:

- `nvme discover` to query the NVMe-over-Fabrics
- `nvme connect-all` to discover and connect to the Fabric controllers

The `lvcreate.sh` shell scripts listed below, performs the following actions:

- Create physical volumes for each RAID volume
- Create 1 volume group
- Create 9 logical volumes for ASU1
- Create 9 logical volumes for ASU2
- Create 1 logical volume for ASU3

The remaining hosts were connected to the newly created NVMe_oF using the CLI commands described above.

The shell script described above is included in the Supporting Files (see Appendix A) and listed below.

```
#!/bin/sh
dev='/dev/nvme*n*'`
```bash
pvcreate $dev
pvs --units G

vgcreate vg1 $dev
vgs --units G

num=$(ls $dev | wc -l)

lvcreate -i$num -5%VG -I512 vg1 -n asu1_1 $dev
lvcreate -i$num -5%VG -I512 vg1 -n asu1_2 $dev
lvcreate -i$num -5%VG -I512 vg1 -n asu1_3 $dev
lvcreate -i$num -5%VG -I512 vg1 -n asu1_4 $dev
lvcreate -i$num -5%VG -I512 vg1 -n asu1_5 $dev
lvcreate -i$num -5%VG -I512 vg1 -n asu1_6 $dev
lvcreate -i$num -5%VG -I512 vg1 -n asu1_7 $dev
lvcreate -i$num -5%VG -I512 vg1 -n asu1_8 $dev
lvcreate -i$num -5%VG -I512 vg1 -n asu1_9 $dev

lvcreate -i$num -5%VG -I512 vg1 -n asu2_1 $dev
lvcreate -i$num -5%VG -I512 vg1 -n asu2_2 $dev
lvcreate -i$num -5%VG -I512 vg1 -n asu2_3 $dev
lvcreate -i$num -5%VG -I512 vg1 -n asu2_4 $dev
lvcreate -i$num -5%VG -I512 vg1 -n asu2_5 $dev
lvcreate -i$num -5%VG -I512 vg1 -n asu2_6 $dev
lvcreate -i$num -5%VG -I512 vg1 -n asu2_7 $dev
lvcreate -i$num -5%VG -I512 vg1 -n asu2_8 $dev
lvcreate -i$num -5%VG -I512 vg1 -n asu2_9 $dev

lvcreate -i$num -10%VG -I512 vg1 -n asu3_1 $dev

lvs --units G -v --segment
```
APPENDIX E: CONFIGURATION INVENTORY

An inventory of the Tested Storage Configuration (TSC) was collected during the execution of the `full_run.sh` script. It generated the following log file:

- `inventory_start.out` List of configured volumes before the INIT Phase.
- `inventory_end.out` List of configured volumes after the PERSIST_2 Phase.

The above log files are included in the Supporting Files (see Appendix A).
APPENDIX F: WORKLOAD GENERATOR

The ASUs accessed by the SPC-1 workload generator, are defined using the script `hst1_linear.asu`.

The phases of the benchmark are executed using the script `spc1.sh`. The script pauses before and after the PERSIST_1 test phase. The operator starts the PERSIST_1 test phase by pressing ENTER from the console where the script has been invoked. Once the TSC has been restarted, the PERSIST_2 test phase is executed by pressing ENTER once more.

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

**hst1_linear.asu**

```
-- SPC-1 ASU definition file
-- $:id:
-- Offset = 0
--
-- ASU=1
device=/dev/vg1/asu1_1
device=/dev/vg1/asu1_2
device=/dev/vg1/asu1_3
device=/dev/vg1/asu1_4
device=/dev/vg1/asu1_5
device=/dev/vg1/asu1_6
device=/dev/vg1/asu1_7
device=/dev/vg1/asu1_8
device=/dev/vg1/asu1_9
--
-- ASU=2
device=/dev/vg1/asu2_1
device=/dev/vg1/asu2_2
device=/dev/vg1/asu2_3
device=/dev/vg1/asu2_4
device=/dev/vg1/asu2_5
device=/dev/vg1/asu2_6
device=/dev/vg1/asu2_7
device=/dev/vg1/asu2_8
device=/dev/vg1/asu2_9
--
-- ASU=3
device=/dev/vg1/asu3_1
```

**spc1.sh**

```
#!/bin/sh
#spc1.sh A B
#A : SPC1 TEST PHASE
#B : SPC1 IOPS
cmd=$1
iops=$2
date=$(date '+%Y-%m-%d_%H:%M:%S')
```

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Jet-speed HHS3124F / HHS2112F (10 Nodes)
date_time=$(date '+%H:%M:%S')
spc_home="/root/spc"
spc_master="/root/spc/5host.HST"
log_home="/root/Logs"
target_ip="10.144.144.201 10.144.144.202 10.144.144.203 10.144.144.204 10.144.144.205 10.144.144.206 10.144.144.207 10.144.144.208 10.144.144.209 10.144.144.210"
host_ip="10.144.144.101 10.144.144.102 10.144.144.103 10.144.144.104 10.144.144.105"
for ip in $target_ip;
do
  ping $ip -c 3
echo ---------------------------------------------------------------
done
for ip in $host_ip;
do
  ping $ip -c 3
echo ---------------------------------------------------------------
done
echo "ready?"
read
mkdir -p $log_home"/$date
log_dir=$log_home"/$date
sys_log_dir=$log_dir"/inventory_start.out"
sys_log_end=$log_dir"/inventory_end.out"
mdadm_log=$log_dir"/mdadm.log"
stat_log_dir=$log_dir"/stat"
parm_log=$log_dir"/parm.log"
mkdir -p $stat_log_dir
cp /root/mgmt_script/spc1.sh $log_dir"/spc1-backup.sh"
cp $spc_home"/5host.HST" $log_dir"/5host.HST"
cp $spc_home"/SPC1_METRICS" $log_dir"/SPC1_METRICS"
echo "1. Get host information."
cat /etc/os-release >> $sys_log
echo -e "" >> $sys_log
uname -r >> $sys_log
echo -e "" >> $sys_log
nvme list >> $sys_log
echo -e "" >> $sys_log
lsblk -b >> $sys_log
echo -e "" >> $sys_log
fdisk -l >> $sys_log
echo -e "" >> $sys_log
#cat /proc/mdstat >> $sys_log
#echo -e "" >> $sys_log
pvs --units G >> $sys_log
echo -e "" >> $sys_log
vgs --units G >> $sys_log
echo -e "" >> $sys_log
lvs --units G -v --segment >> $sys_log
echo -e "" >> $sys_log
echo "2. Get NVMe information.(smartctl)"
for ip in $target_ip;
do
echo ====================$ip================== >> $sys_log
dn=$(ssh root@$ip 'ls /dev/nvme?' | wc -l)
#dn=`expr $dn - 1`
for ((i=0;i<$dn;i++));
do
echo +++++++++++++++++++++/dev/nvme$i++++++++++++++++++ >> $sys_log
  ssh root@$ip smartctl -a /dev/nvme$i >> $sys_log
done
done
echo "3. Get Storage-RAID information."
for ip in $target_ip;
do
echo ====================$ip================== >> $mdadm_log
dn=$(ssh root@$ip 'ls /dev/md?' | wc -l)
for ((i=1;i<=$dn;i++));
do
echo +++++++++++++++++++++/dev/md$i++++++++++++++++++ >> $mdadm_log
  ssh root@$ip mdadm -D /dev/md$i >> $mdadm_log
done
echo +++++++++++++++++++++/etc/mdadm.conf++++++++++++++++++ >> $mdadm_log
  ssh root@$ip cat /etc/mdadm.conf >> $mdadm_log
done
echo "4. Get host disk parameter."
for ip in $host_ip;
do
  devs=$(ssh root@$ip 'ls /dev/nvme?n?' | awk -F '/' '{print $3}')
echo =====================$ip===================== >> $parm_log
  for dev in $devs;
do
    echo ++++++++++++++++++/dev/$dev++++++++++++++++++ >> $parm_log
    #devices configuration setup
    echo -n 'nr_requests : ' >> $parm_log
    ssh root@$ip cat /sys/block/$dev/queue/nr_requests >> $parm_log
    echo -n 'scheduler : ' >> $parm_log
    ssh root@$ip cat /sys/block/$dev/queue/scheduler >> $parm_log
    echo -n 'max_sectors_kb : ' >> $parm_log
    ssh root@$ip cat /sys/block/$dev/queue/max_sectors_kb >> $parm_log
    echo -n 'add_random : ' >> $parm_log
    ssh root@$ip cat /sys/block/$dev/queue/add_random >> $parm_log
    echo -n 'nomerges : ' >> $parm_log
    ssh root@$ip cat /sys/block/$dev/queue/nomerges >> $parm_log
done
  #OS configuration setup
  echo '++++++++++++++++++++++++++++++++++++system parameter+++++++++++++++' >> $parm_log
  echo -n 'aio-max-rr : ' >> $parm_log
  ssh root@$ip cat /proc/sys/fs/aio-max-rr >> $parm_log
  echo 'ulimit -a' >> $parm_log
  ssh root@$ip ulimit -a >> $parm_log
  echo '-----------------------------------------------' >> $parm_log
  ssh root@$ip ulimit -aH >> $parm_log
  echo '-----------------------------------------------' >> $parm_log
  ssh root@$ip ulimit -aH >> $parm_log
done
echo "5. Get storage NVMe parameter."

for ip in $target_ip;
do
devs=$(ssh root@$ip 'ls /dev/nvme?n?' | awk -F '/' '{print $3}')
    echo "=====================$ip====================" >> $parm_log
    for dev in $devs;
do
echo "+++++++++++++/dev/$dev++++++++++++++" >> $parm_log
    #devices configuration setup
    echo -n 'nr_requests : ' >> $parm_log
    ssh root@$ip cat /sys/block/$dev/queue.nr_requests >> $parm_log
    echo -n 'scheduler : ' >> $parm_log
    ssh root@$ip cat /sys/block/$dev/queue/scheduler >> $parm_log
    echo -n 'max_sectors_kb : ' >> $parm_log
    ssh root@$ip cat /sys/block/$dev/queue/max_sectors_kb >> $parm_log
    echo -n 'add_random : ' >> $parm_log
    ssh root@$ip cat /sys/block/$dev/queue/add_random >> $parm_log
    echo -n 'nomerges : ' >> $parm_log
    ssh root@$ip cat /sys/block/$dev/queue/nomerges >> $parm_log
done
#OS configuration setup
    echo '-------------system parameter---------------------' >> $parm_log
    echo -n 'aio-max-nr : ' >> $parm_log
    ssh root@$ip cat /proc/sys/fs/aio-max-nr >> $parm_log
    echo '-------------------------------' >> $parm_log
    echo 'ulimit -a' >> $parm_log
    ssh root@$ip ulimit -a >> $parm_log
    echo '-------------------------------' >> $parm_log
    echo 'ulimit -aH' >> $parm_log
    ssh root@$ip ulimit -aH >> $parm_log
done
done
echo "6. Get storage RAID-Volume parameter."

for ip in $target_ip;
do
devs=$(ssh root@$ip 'ls /dev/rdmad?n?' | awk -F '/' '{print $3}')
    echo "=====================$ip====================" >> $parm_log
    for dev in $devs;
do
echo "+++++++++++++/dev/$dev++++++++++++++" >> $parm_log
    #devices configuration setup
    echo -n 'nr_requests : ' >> $parm_log
    ssh root@$ip cat /sys/block/$dev/queue.nr_requests >> $parm_log
    echo -n 'scheduler : ' >> $parm_log
    ssh root@$ip cat /sys/block/$dev/queue/scheduler >> $parm_log
    echo -n 'max_sectors_kb : ' >> $parm_log
    ssh root@$ip cat /sys/block/$dev/queue/max_sectors_kb >> $parm_log
    echo -n 'add_random : ' >> $parm_log
    ssh root@$ip cat /sys/block/$dev/queue/add_random >> $parm_log
    echo -n 'nomerges : ' >> $parm_log
    ssh root@$ip cat /sys/block/$dev/queue/nomerges >> $parm_log
done
done
echo "7. Start monitoring system."
#storage
for ip in $target_ip;
done
    ssh root@$ip '/root/mgmt_script/kill.sh vmstat'
    ssh root@$ip '/root/mgmt_script/kill.sh iostat'
    ssh root@$ip 'rm -rf /tmp/*stat.log'
    ssh root@$ip 'vmstat -t 10 > /tmp/vmstat.log &'
    ssh root@$ip 'iostat -mtx 10 > /tmp/iostat.log &'

#host
for ip in $host_ip;
done
    ssh root@$ip '/root/mgmt_script/kill.sh vmstat'
    ssh root@$ip '/root/mgmt_script/kill.sh iostat'
    ssh root@$ip 'rm -rf /tmp/*stat.log'
    ssh root@$ip 'vmstat -t 10 > /tmp/vmstat.log &'
    ssh root@$ip 'iostat -mtx 10 > /tmp/iostat.log &'

echo "8. Start SPC-1 Test."
sleep 1
echo -n "3.."
sleep 1
echo -n "2.."
sleep 1
echo -n "1.."
sleep 1
echo "Start!!"
sleep 2

## running spc1
/root/spc/spc1 -run SPC1_INIT -iops 15000 -master $spc_master -output $log_dir
/root/spc/spc1 -run SPC1_VERIFY -iops 100 -master $spc_master -output $log_dir
/root/spc/spc1 -run SPC1_METRICS -iops 241000 -master $spc_master -output $log_dir
sleep 120

echo "9. Get system monitoring logs."
#storage
for ip in $target_ip;
done
    ssh root@$ip '/root/mgmt_script/kill.sh vmstat'
    ssh root@$ip '/root/mgmt_script/kill.sh iostat'
    scp root@$ip:/tmp/vmstat.log $stat_log_dir"/"$ip"_vmstat.log"
    scp root@$ip:/tmp/iostat.log $stat_log_dir"/"$ip"_iostat.log"

#host
for ip in $host_ip;
done
    ssh root@$ip '/root/mgmt_script/kill.sh vmstat'
    ssh root@$ip '/root/mgmt_script/kill.sh iostat'
    scp root@$ip:/tmp/vmstat.log $stat_log_dir"/"$ip"_vmstat.log"
    scp root@$ip:/tmp/iostat.log $stat_log_dir"/"$ip"_iostat.log"

echo "Stop"
read
/root/spc/spc1 -run SPC1_PERSIST_1 -iops 602500 -master $spc_master -output $log_dir
echo "reboot"
read
/root/spc/spc1 -run SPC1_PERSIST_2 -iops 602500 -master $spc_master -output $log_dir

## finish spc1
nvme list >> $sys_log_end

echo -e "==============================================
==========
" >> $sys_log_end
lsblk -b >> $sys_log_end
echo -e "==============================================
==========
" >> $sys_log_end
fdisk -l >> $sys_log_end
echo -e "==============================================
==========
" >> $sys_log_end
#cat /proc/mdstat >> $sys_log_end
#echo -e "==============================================
==========
" >> $sys_log_end
pvs --units G >> $sys_log_end
echo -e "==============================================
==========
" >> $sys_log_end
vgs --units G >> $sys_log_end
echo -e "==============================================
==========
" >> $sys_log_end
lvs --units G -v --segment >> $sys_log_end
echo -e "==============================================
==========
" >> $sys_log_end

for ip in $target_ip;
do
echo ====================$ip================ >> $sys_log_end
dn=$(ssh root@$ip 'ls /dev/nvme?' | wc -l)
#dn=`expr $dn - 1`
for ((i=0;i<=$dn;i++));
do
  echo +++++++++++++++++++++/dev/nvme$i+++++++++++++++++++ >> $sys_log_end
  ssh root@$ip smartctl -a /dev/nvme$i >> $sys_log_end
done
done

for ip in $target_ip
do
echo =====================$ip===================== >> $sys_log_end
  ssh root@$ip 'rm -rf /tmp/*stat.log'
done

for ip in $host_ip
do
echo =====================$ip===================== >> $sys_log_end
  ssh root@$ip 'rm -rf /tmp/*stat.log'
done