TPC Express Benchmark™ HS
Full Disclosure Report

Supermicro Cluster
(with 16x AS-1114S-WN10RT Servers; 1x AS-1114S-WTRT Servers)

Running

CDP Private Cloud Base Edition 7.1.6

on

SUSE Linux Enterprise Server 12 SP5

TPCx-HS Version 2.0.3
Report Edition First
Report Submitted September 16, 2021
First Edition - September 2021

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All performance data contained in this report was obtained in a rigorously controlled environment. Results obtained in other operating environments may vary significantly. No warranty of system performance or price/performance is expressed or implied in this report.

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Abstract

This document contains the methodology and results of the TPC Express Benchmark™ HS (TPCx-HS) test conducted in conformance with the requirements of the TPCx-HS Standard Specification, Revision 2.0.3.

The benchmark results are summarized below.

<table>
<thead>
<tr>
<th>Measured Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Name</td>
</tr>
<tr>
<td>Supermicro</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TPC Express Benchmark™ HS Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total System Cost</td>
</tr>
<tr>
<td>$885,866</td>
</tr>
</tbody>
</table>

Executive Summary

The Executive Summary follows on the next several pages.
Supermicro Cluster

**TPC Pricing**

$20,225.26 / HSph@100TB

<table>
<thead>
<tr>
<th>Availability Date</th>
<th>TPCx-HS Performance</th>
<th>Price/Performance</th>
<th>Total System Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Currently Available</td>
<td>43.80 HSp@100TB</td>
<td>$20,225.26 / HSph@100TB</td>
<td>$885,866 USD</td>
</tr>
</tbody>
</table>

### System Under Test Configuration Overview

**Scale Factor** | Hadoop Software | Operating System | Other Software
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>CDP Private Cloud Base Edition 7.1.6</td>
<td>SUSE Linux Enterprise Server 12 SP5</td>
<td>None</td>
</tr>
</tbody>
</table>

**Physical Storage/Scale Factor:** 4.48

**Scale Factor/Physical Memory:** 23.53

**Total Number of Servers:**

- 17 (16x AS-1114S-WN10RT; 1x AS-1114S-WRT)  
- 17/544/1,088

**Server Configuration:**

- **Processors:** Per AS-1114S-WN10RT  
  1x AMD EPYC 75F3
  256 GiB

- **Memory:**
  1x 1 TB NVMe (12 nodes)  
  1x 960 GB NVMe (4 nodes)  
  7x 3.84 TB NVMe (all nodes)

- **Storage Device:**  
  1x Mellanox Dual-port ConnectX-5 Ex 100 GbE (12 nodes)  
  1x Mellanox Dual-port ConnectX-5 100 GbE (4 nodes)  
  1x Broadcom Dual-port 10 GbE (all nodes)

- **Network:**
  1x SSE-C3632R 32-port 100 GbE  
  1x E1031 48-port 1/10 GbE

- **Connectivity:**
  16x(1U)+1x(1U)+1x(1U)+1x(1U) = 16U+1U+1U+1U = 19U

**Report Date:** Sep. 16, 2021
## HARDWARE

### Data Nodes
- **H12SSW-NTR, CSE-116TS-R706WB5-N10,RoHS**
  - **AS-1114S-WN10RT**
  - **Qty**: 1
  - **Unit Price**: $1,477.00
  - **Extended Price**: $23,632.00
- **32GB DDR4-3200 2Rx4 ECC REG DIMM**
  - **MEM-DR432L-HL01-ER32**
  - **Qty**: 1
  - **Unit Price**: $1,338.00
  - **Extended Price**: $21,404.00
- **Kioxia CM6 3.84TB NVMe PCIe 4x4 2.5" 15mm SIE 1DWPD**
  - **HDS-TUN-KCM6RU1L3T84**
  - **Qty**: 1
  - **Unit Price**: $859.00
  - **Extended Price**: $9,620.00
- **Mellanox ConnectX-5 EN network card 100GbE dual-port**
  - **AOC-MCK536A-CDAT**
  - **Qty**: 1
  - **Unit Price**: $849.00
  - **Extended Price**: $9,620.00
- **Micron 7300 PRO 960GB,PCIe NVMe,M.2 22x80mm,3D TLC,1DWPD**
  - **HDS-MMN-MTFDHBA960TDF1AW**
  - **Qty**: 1
  - **Unit Price**: $178.50
  - **Extended Price**: $714.00

### Master Node
- **H12SSW-NT, CSV-116TS-R504WBP**
  - **AS-1114S-WTRT**
  - **Qty**: 1
  - **Unit Price**: $1,304.00
  - **Extended Price**: $1,304.00
- **32GB DDR4-3200 2Rx4 ECC REG DIMM**
  - **MEM-DR432L-HL01-ER32**
  - **Qty**: 1
  - **Unit Price**: $1,338.00
  - **Extended Price**: $1,338.00
- **Kioxia XG6 1TB NVMe M.2 22x80mm**
  - **HDS-TMN0-KXG60ZNV1T02**
  - **Qty**: 1
  - **Unit Price**: $190.00
  - **Extended Price**: $380.00
- **Mellanox ConnectX-5 EN network card 100GbE dual-port**
  - **AOC-MCK536A-CDAT**
  - **Qty**: 1
  - **Unit Price**: $1,060.00
  - **Extended Price**: $1,060.00
- **Milan 75F3 DP/UP 32C/64T 2.95G 256M 280W SP3**
  - **PSE-MLN75F3-0313**
  - **Qty**: 1
  - **Unit Price**: $4,834.00
  - **Extended Price**: $4,834.00
- **Out of Band Firmware Management License-BIOS Flash /Setting**
  - **SFT-OOB-LIC**
  - **Qty**: 1
  - **Unit Price**: $15.00
  - **Extended Price**: $15.00
- **ASSEMBLY FEE**
  - **MC0037**
  - **Qty**: 1
  - **Unit Price**: $25.00
  - **Extended Price**: $25.00
- **0% 3 YRS LABOR, 3 YRS PARTS, 1 YR CRS UNDER LIMITED WRNTY**
  - **EWCSC**
  - **Qty**: 1
  - **Unit Price**: (included)
  - **Extended Price**: (included)

### Network and Cables
- **E1031 48-port 1/10G Ethernet ToR switch**
  - **SSE-G3648BR**
  - **Qty**: 1
  - **Unit Price**: $1,675.00
  - **Extended Price**: $1,675.00
- **Cumulus-Linux SW 1G perpetual license with 3 yr Cumulus**
  - **SFT-CLSPL1G-3Y**
  - **Qty**: 1
  - **Unit Price**: $1,475.00
  - **Extended Price**: $1,475.00

### Infrastructure
- **42U Enclosure system**
  - **SRK-42SE-11**
  - **Qty**: 1
  - **Unit Price**: $1,516.30
  - **Extended Price**: $1,516.30
  - **AP7911B**
  - **Qty**: 1
  - **Unit Price**: $1,025.00
  - **Extended Price**: $1,025.00
- **PWCD,US,IEC60320 C14 TO C13,4FT,16AWG,RoHS/REACH**
  - **CBL-PWCD-0373-IS**
  - **Qty**: 1
  - **Unit Price**: $6.50
  - **Extended Price**: $6.50

### Spares, Accessories
- **LONCENTV - 12 inch IPS 1920x1080p HDMI Monitor**
  - **N/A**
  - **Qty**: 1
  - **Unit Price**: $99.99
  - **Extended Price**: $99.99
- **Logitech MK200 Media Keyboard and Mouse Combo**
  - **920-002714**
  - **Qty**: 1
  - **Unit Price**: $41.50
  - **Extended Price**: $41.50

### HARDWARE Subtotals
- **HARDWARE Subtotals**
  - **Total**: $275,085.87
  - **Extended**: $10,407.17

(continued next page)
## Executive Summary

**Supermicro Cluster**

<table>
<thead>
<tr>
<th>Description</th>
<th>Part Number</th>
<th>Source</th>
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<th>Unit Price</th>
<th>Extended Price</th>
<th>3 Yr. Maint. Price</th>
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<tr>
<td>SOFTWARE</td>
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<td></td>
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<tr>
<td>SUSE Linux Enterprise Server, x86 &amp; x86-64, 1-2 Sockets or 1-2 Virtual Machines, Priority Subscription, 3 Year 874-006883</td>
<td>SFT-NV-SU2P3YBAC</td>
<td>17</td>
<td>$2,916.00</td>
<td>$49,572.00</td>
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<td>Cloudera Data Platform Private Cloud Base Edition - Annual Subscription per Node for up to 16 Cores/128 GB RAM for compute and up to 48 TB for storage. Business Level Support.</td>
<td>SMC-CDP-PVBASE-BUS</td>
<td>51</td>
<td>$9,600.00</td>
<td>$489,600.00</td>
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<td></td>
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<tr>
<td>COMPUTE: price per CCU per year for compute in excess of 16 cores/128 GB RAM per Node, where 1 CCU = 1 core + 8 GB RAM</td>
<td>SMC-CDP-COMPUTE</td>
<td>816</td>
<td>75</td>
<td>$61,200.00</td>
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**Software Subtotals**

<table>
<thead>
<tr>
<th>Software Subtotals</th>
<th>$600,372.00</th>
<th>$0.00</th>
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</thead>
</table>

**Pricing:** 1 = Supermicro; 2 = APC; 3 = Amazon

* Discount applies to all line items where Key = 1. Discount based upon total system cost as purchased by a regular customer.

**Audited by Doug Johnson, InfoSizing**

Three-Year Cost of Ownership:  $885,866

HSph@100TB:  43.80

$ / HSph@100TB:  $20,225.26

* Prices used in TPC benchmarks reflect the actual prices a customer would pay for a one-time purchase of the stated Line Items. Individually negotiated discounts are not permitted. Special prices based on assumptions about past or future purchases are not permitted. All discounts reflect standard pricing policies for the listed Line Items. For complete details, see the pricing section of the TPC Benchmark Standard. If you find that the stated prices are not available according to these terms, please inform the TPC at pricing@tpc.org. Thank you.
## Numerical Quantities

### Performance Run – Run 1

<table>
<thead>
<tr>
<th>Scale Factor</th>
<th>100TB</th>
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<tr>
<td>Run Start Time</td>
<td>2021-09-02 08:33:35.000</td>
</tr>
<tr>
<td>Run End Time</td>
<td>2021-09-02 10:50:30.000</td>
</tr>
<tr>
<td>Run Elapsed Time</td>
<td>8,218.000</td>
</tr>
<tr>
<td>HSGen Start Time</td>
<td>2021-09-02 08:33:36.000</td>
</tr>
<tr>
<td>HSGen End Time</td>
<td>2021-09-02 09:00:39.000</td>
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<tr>
<td>HSGen Elapsed Time</td>
<td>1,624.553</td>
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<tr>
<td>HSSort Start Time</td>
<td>2021-09-02 09:00:50.000</td>
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<tr>
<td>HSSort End Time</td>
<td>2021-09-02 10:37:49.000</td>
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<tr>
<td>HSSort Elapsed Time</td>
<td>5,820.704</td>
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<tr>
<td>HSValidate Start Time</td>
<td>2021-09-02 10:38:00.000</td>
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<tr>
<td>HSValidate End Time</td>
<td>2021-09-02 10:50:30.000</td>
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<tr>
<td>HSValidate Elapsed Time</td>
<td>751.080</td>
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</table>

### Repeatability Run – Run 2

<table>
<thead>
<tr>
<th>Scale Factor</th>
<th>100TB</th>
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</thead>
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<tr>
<td>Run Start Time</td>
<td>2021-09-02 10:55:36.000</td>
</tr>
<tr>
<td>Run End Time</td>
<td>2021-09-02 13:12:19.000</td>
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<tr>
<td>Run Elapsed Time</td>
<td>8,206.000</td>
</tr>
<tr>
<td>HSGen Start Time</td>
<td>2021-09-02 10:55:37.000</td>
</tr>
<tr>
<td>HSGen End Time</td>
<td>2021-09-02 11:22:53.000</td>
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<tr>
<td>HSGen Elapsed Time</td>
<td>1,637.588</td>
</tr>
<tr>
<td>HSSort Start Time</td>
<td>2021-09-02 11:23:04.000</td>
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<tr>
<td>HSSort End Time</td>
<td>2021-09-02 12:59:42.000</td>
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<tr>
<td>HSSort Elapsed Time</td>
<td>5,799.461</td>
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<tr>
<td>HSValidate Start Time</td>
<td>2021-09-02 12:59:53.000</td>
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<tr>
<td>HSValidate End Time</td>
<td>2021-09-02 13:12:19.000</td>
</tr>
<tr>
<td>HSValidate Elapsed Time</td>
<td>747.356</td>
</tr>
</tbody>
</table>
Run Report for Performance Run – Run 1

TPCx-HS Performance Metric (HSph@SF) Report

Test Run 1 Details
Total Time = 8218
Total Size = 1000000000000
Scale-Factor = 100

TPCx-HS Performance Metric (HSph@SF): 43.8077

Run Report for Repeatability Run – Run 2

TPCx-HS Performance Metric (HSph@SF) Report

Test Run 2 Details
Total Time = 8206
Total Size = 1000000000000
Scale-Factor = 100

TPCx-HS Performance Metric (HSph@SF): 43.8711
# Supermicro Cluster

**TPCx-HS 2.0.3**
**TPC Pricing 2.7.0**

<table>
<thead>
<tr>
<th>Date</th>
<th>Edition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 16, 2021</td>
<td>First</td>
<td>Initial Publication</td>
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Report Date: Sep. 16, 2021
Table of Contents

Abstract........................................................................................................................................... 3
Executive Summary ........................................................................................................................... 3
Table of Contents ............................................................................................................................. 10
Clause 0 – Preamble ......................................................................................................................... 11
  0.1 TPC Express Benchmark™ HS Overview ........................................................................... 11
Clause 1 – General Items ................................................................................................................ 12
  1.1 Test Sponsor .......................................................................................................................... 12
  1.2 Parameter Settings ............................................................................................................... 12
  1.3 Configuration Diagrams ....................................................................................................... 12
    1.3.1 Measured Configuration .............................................................................................. 13
    1.3.2 Priced Configuration ................................................................................................. 13
  1.4 Dataset Distribution ............................................................................................................ 14
  1.5 Software Components Distribution .................................................................................... 14
Clause 2 – Workload Related Items ............................................................................................. 15
  2.1 Hardware & Software Tunables ......................................................................................... 15
  2.2 Run Report .......................................................................................................................... 15
  2.3 Benchmark Kit Identification ............................................................................................ 15
  2.4 Benchmark Kit Changes ..................................................................................................... 16
Clause 3 – SUT Related Items ....................................................................................................... 17
  3.1 Data Storage Ratio .............................................................................................................. 17
  3.2 Memory Ratio ...................................................................................................................... 17
Clause 4 – Metrics Related Items ............................................................................................... 18
  4.1 HSGen Time ....................................................................................................................... 18
  4.2 HSSort Time ....................................................................................................................... 18
  4.3 HSVValidate Time .............................................................................................................. 18
  4.4 HSDataCheck Times .......................................................................................................... 18
  4.5 Performance & Price-Performance ..................................................................................... 18
Auditor’s Information & Letter of Attestation ............................................................................... 19
Supporting Files Index .................................................................................................................. 22
Third-Party Price Quotes .............................................................................................................. 23
  APC ............................................................................................................................................ 23
  Amazon ................................................................................................................................. 24
Clause 0 – Preamble

0.1 TPC Express Benchmark™ HS Overview

The TPC Express Benchmark™ HS (TPCx-HS) was developed to provide an objective measure of hardware, operating system and commercial Apache Hadoop File System API compatible software distributions, and to provide the industry with verifiable performance, price-performance and availability metrics. The benchmark models a continuous system availability of 24 hours a day, 7 days a week.

Even though the modeled application is simple, the results are highly relevant to hardware and software dealing with Big Data systems in general. TPCx-HS stresses both hardware and software including Hadoop run-time, Hadoop File-system API compatible systems and MapReduce layers. This workload can be used to assess a broad range of system topologies and implementation of Hadoop clusters. TPCx-HS can be used to assess a broad range of system topologies and implementation methodologies in a technically rigorous and directly comparable and vendor-neutral manner.

The TPCx-HS kit is available from the TPC (See www.tpc.org/tpcx-hs for more information). Users must sign-up and agree to the TPCx-HS User Licensing Agreement (ULA) to download the kit. Re-distribution of the kit is prohibited. All related work (such as collaterals, papers, derivatives) must acknowledge the TPC and include TPCx-HS copyright. The TPCx-HS Kit includes: TPCx-HS Specification document, TPCx-HS Users Guide documentation, shell scripts to set up the benchmark environment and Java code to execute the benchmark load.

The purpose of TPC benchmarks is to provide relevant, objective performance data to industry users. To achieve that purpose, TPC benchmark specifications require that benchmark tests be implemented with systems, products, technologies and pricing that:

• Are generally available to users;
• Are relevant to the market segment that the individual TPC benchmark models or represents (e.g., TPCx-HS models and represents Hadoop run-time and Hadoop File-system API compatible systems);
• Would plausibly be implemented by a significant number of users in the market segment the benchmark models or represents.

The use of new systems, products, technologies (hardware or software) and pricing is encouraged so long as they meet the requirements above. Specifically prohibited are benchmark systems, products, technologies or pricing (hereafter referred to as "implementations") whose primary purpose is performance optimization of TPC benchmark results without any corresponding applicability to real-world applications and environments. In other words, all "benchmark special" implementations that improve benchmark results but not real-world performance or pricing, are prohibited.

The rules for pricing are included in the TPC Pricing Specification and rules for energy measurement are included in the TPC Energy Specification. Further information is available at www.tpc.org.
Clause 1 – General Items

1.1 Test Sponsor
A statement identifying the benchmark sponsor(s) and other participating companies must be provided.

This benchmark was sponsored by Super Micro Computer, Inc..

1.2 Parameter Settings
Settings must be provided for all customer-tunable parameters and options which have been changed from the defaults found in actual products, including by not limited to:

- Configuration parameters and options for server, storage, network and other hardware component incorporated into the pricing structure;
- Configuration parameters and options for operating system and file system component incorporated into the pricing structure;
- Configuration parameters and options for any other software component incorporated into the pricing structure;
- Compiler optimization options.

Comment 1: In the event that some parameters and options are set multiple times, it must be easily discernible by an interested reader when the parameter or option was modified and what new value it received each time.

Comment 2: This requirement can be satisfied by providing a full list of all parameters and options, as long as all those that have been modified from their default values have been clearly identified and these parameters and options are only set once.

The supporting files contain the parameters and options used to configure the components involved in this benchmark.

1.3 Configuration Diagrams
Diagrams of both measured and priced configurations must be provided, accompanied by a description of the differences. This includes, but is not limited to:

- Total number of nodes used;
- Total number and type of processors used/total number of cores used/total number of threads used (including sizes of L2 and L3 caches);
- Size of allocated memory, and any specific mapping/partitioning of memory unique to the test;
- Number and type of disk units (and controllers, if applicable);
- Number of channels or bus connections to disk units, including their protocol type;
- Number of LAN (e.g., Ethernet) connections and speed for switches and other hardware components physically used in the test or are incorporated into the pricing structure;
- Type and the run-time execution location of software components.
1.3.1 Measured Configuration

The measured configuration consisted of:

- **Total Nodes:** 17 (16x AS-1114S-WN10RT; 1x AS-1114S-WRTT)
- **Total Processors/Cores/Threads:** 17/544/1,088
- **Total Memory:** 4.25 TiB
- **Total Number of Storage Drives/Devices:** 130
- **Total Storage Capacity:** 447.92 TB

Server node details:

**16x AS-1114S-WN10RT Servers, each with:**
- Processors/Cores/Threads: 1/32/64
- Processor Model: AMD EPYC 75F3
- Memory: 256 GiB
- Drives:
  - 1x 1 TB NVMe (12 nodes)
  - 1x 960 GB NVMe (4 nodes)
  - 7x 3.84 TB NVMe (all nodes)
- Network:
  - 1x Mellanox Dual-port ConnectX-5 Ex 100 GbE (12 nodes)
  - 1x Mellanox Dual-port ConnectX-5 100 GbE (4 nodes)
  - 1x Broadcom Dual-port 10 GbE (all nodes)

**1x AS-1114S-WRTT Servers, each with:**
- Processors/Cores/Threads: 1/32/64
- Processor Model: AMD EPYC 75F3
- Memory: 256 GiB
- Drives:
  - 2x 1 TB NVMe
- Network:
  - 1x Mellanox Dual-port ConnectX-5 Ex 100 GbE
  - 1x Broadcom Dual-port 10 GbE

Network connectivity detail:

- 1x SSE-C3632R 32-port 100 GbE
- 1x E1031 48-port 1/10 GbE

The distribution of software components over server nodes is detailed in section 1.5.

1.3.2 Priced Configuration

There are no differences between the priced configuration and the measured configuration.
1.4 Dataset Distribution

The distribution of dataset across all media must be explicitly described.

Table 1-1 describes the distribution of the dataset across all media in the system.

<table>
<thead>
<tr>
<th>Server Node</th>
<th>Controller</th>
<th>Disk Drive</th>
<th>Description of Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NVMe</td>
<td>nvme7n1</td>
<td>Operating System, Root, Swap, Hadoop Master</td>
</tr>
<tr>
<td>2-3</td>
<td>NVMe</td>
<td>nvme7n1</td>
<td>Operating System, Root, Swap, Hadoop Master</td>
</tr>
<tr>
<td></td>
<td></td>
<td>nvme0n1, nvme1n1, nvme2n1,</td>
<td>Data, Temp</td>
</tr>
<tr>
<td></td>
<td></td>
<td>nvme3n1, nvme4n1, nvme5n1,</td>
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<td></td>
<td>nvme6n1</td>
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<td>4-17</td>
<td>NVMe</td>
<td>nvme7n1</td>
<td>Operating System, Root, Swap, Hadoop Master</td>
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<td>nvme0n1, nvme1n1, nvme2n1,</td>
<td>Data, Temp</td>
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<td>nvme6n1</td>
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</tbody>
</table>

Table 1-1 Dataset Distribution

1.5 Software Components Distribution

The distribution of various software components across the system must be explicitly described.

Table 1-2 Describes the distribution of the software components across the system.

<table>
<thead>
<tr>
<th>Node</th>
<th>Resource Manager</th>
<th>Node Manager</th>
<th>NameNode</th>
<th>DataNode</th>
<th>QuorumPeer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>2-3</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>4-17</td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Table 1-2 Software Component Distribution

Distributed file system implementation and corresponding Hadoop File System API version must be disclosed.

CDP Private Cloud Base Edition 7.1.6 (fully HDFS compatible at the API level).

Map/Reduce implementation and corresponding version must be disclosed.

CDP Private Cloud Base Edition 7.1.6 (compatible equivalent to Hadoop 3.1.1.7.1.6.0-297).
Clause 2 – Workload Related Items

2.1 Hardware & Software Tunables

*Script or text used to set for all hardware and software tunable parameters must be reported.*

The Supporting File Archive contains all configuration scripts.

2.2 Run Report

*The run report generated by TPCx-HS benchmark kit must be reported.*

The Supporting File Archive contains the full run report. Following are extracts from the run report that lists the performance summary for both runs.

```
Run Report for Run 1 – Performance Run
===================================================================
TPCx-HS Performance Metric (HSph@SF) Report

Test Run 1 Details
Total Time = 8218
Total Size = 1000000000000
Scale-Factor = 100

TPCx-HS Performance Metric (HSph@SF): 43.8077

===================================================================

Run Report for Run 2 – Repeatability Run
===================================================================
TPCx-HS Performance Metric (HSph@SF) Report

Test Run 2 Details
Total Time = 8206
Total Size = 1000000000000
Scale-Factor = 100

TPCx-HS Performance Metric (HSph@SF): 43.8711

===================================================================
```

2.3 Benchmark Kit Identification

*Version number of TPCx-HS kit and checksum for HSGen, HSSort and HSValidate Programs must be reported.*

<table>
<thead>
<tr>
<th>Kit Version</th>
<th>2.0.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>File</td>
<td>MD5</td>
</tr>
<tr>
<td>BigData_cluster_validate_suite.sh</td>
<td>57f7cd68251a9aba0feb6648630ff5da</td>
</tr>
<tr>
<td>HSDataCheck.sh</td>
<td>bcf0b946a49d1249c9da174b5d9805f1</td>
</tr>
<tr>
<td>TPCx-HS-master_MR2.jar</td>
<td>492cbc51a1a60c28b43d96c79d08683d</td>
</tr>
<tr>
<td>TPCx-HS-master.sh</td>
<td>c619a0819571edc00cd75d2b76ba8c64</td>
</tr>
</tbody>
</table>
2.4 Benchmark Kit Changes
The required data protection was provided by HDFS Erasure Coding rather than the default three-way data replication. A policy of RS-6-3-1024k was used. Therefore, each block group consisted of 6 data blocks and 3 parity blocks. Each block within a given block group was placed on a different node thus ensuring the required data protection.

To collect the necessary data for auditing, the HSDataCheck.sh script was modified. In accordance with the TPCx-HS Standard Specification, this change received prior approval from the TPCx-HS subcommittee.
Clause 3 – SUT Related Items

3.1 Data Storage Ratio

*The data storage ratio must be disclosed.*

Table 3-1 describes the details of the storage devices configured on the system and their capacity.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Capacity</th>
<th>Total (TB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>1 TB</td>
<td>12.00</td>
</tr>
<tr>
<td>4</td>
<td>960 GB</td>
<td>3.84</td>
</tr>
<tr>
<td>112</td>
<td>3.84 TB</td>
<td>430.08</td>
</tr>
<tr>
<td>2</td>
<td>1 TB</td>
<td>2.00</td>
</tr>
<tr>
<td><strong>Total Storage (TB)</strong></td>
<td><strong>447.92</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Table 3-1 Storage Device Capacities*

Scale Factor = 100

**Data Storage Ratio** = (Total Storage (TB) / SF) = 4.48

3.2 Memory Ratio

*The Scale Factor to memory ratio must be disclosed.*

Total Configured Memory (TiB) = 4.25

**Scale Factor to Memory Ratio** = (SF / Total Memory(TiB)) = 23.53
Clause 4 – Metrics Related Items

4.1 HSGen Time
The HSGen time must be disclosed for Run1 and Run2.

<table>
<thead>
<tr>
<th></th>
<th>Run 1</th>
<th>Run 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSGen</td>
<td>1,624.553</td>
<td>1,637.588</td>
</tr>
</tbody>
</table>

Table 4-1 HSGen Times

4.2 HSSort Time
The HSSort time must be disclosed for Run1 and Run2.

<table>
<thead>
<tr>
<th></th>
<th>Run 1</th>
<th>Run 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSSort</td>
<td>5,820.704</td>
<td>5,799.461</td>
</tr>
</tbody>
</table>

Table 4-2 HSSort Times

4.3 HSV Validate Time
The HSV Validate time must be disclosed for Run1 and Run2.

<table>
<thead>
<tr>
<th></th>
<th>Run 1</th>
<th>Run 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSV Validate</td>
<td>751.080</td>
<td>747.356</td>
</tr>
</tbody>
</table>

Table 4-3 HSV Validate Times

4.4 HSDataCheck Times
Both HSDataCheck times must be disclosed for Run1 and Run2.

<table>
<thead>
<tr>
<th></th>
<th>Run 1</th>
<th>Run 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSDataCheck (pre-sort)</td>
<td>11.000</td>
<td>11.000</td>
</tr>
<tr>
<td>HSDataCheck (post-sort)</td>
<td>11.000</td>
<td>11.000</td>
</tr>
</tbody>
</table>

Table 4-4 HSDataCheck Times

4.5 Performance & Price-Performance
The performance metric (HSph@SF) must be disclosed for Run 1 and Run 2. Price-performance metric ($/HSph@SF) must be disclosed for the performance run.

<table>
<thead>
<tr>
<th></th>
<th>Run 1</th>
<th>Run 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSph@100TB</td>
<td>43.80</td>
<td>43.87</td>
</tr>
</tbody>
</table>

Table 4-5 Performance Metrics

Run 1 Price-Performance: 20,225.26 $/ HSph@100TB
Auditor’s Information & Letter of Attestation

The auditor’s agency name, address, phone number, and Attestation letter must be included in the full disclosure report. A statement should be included specifying who to contact in order to obtain further information regarding the audit process.

This benchmark was audited by Doug Johnson, InfoSizing.

www.sizing.com
63 Lourdes Drive
Leominster, MA 10453
978-343-6562

This benchmark’s Full Disclosure Report (FDR) can be downloaded from www.tpc.org.

A copy of the auditor’s Letter of Attestation follows.
Sriki Bala  
Super Micro Computer, Inc.  
980 Rock Avenue,  
San Jose, CA 95131  
USA  

September 15, 2021  

I verified the TPC Express Benchmark™ HS v2.0.3 performance of the following configuration:  

Platform: Supermicro Cluster with:  
16x AS-1114S-WN10RT Servers (Data Nodes)  
1x AS-1114S-WTRT Server (Master Node)  

Operating System: SUSE Linux Enterprise Server 12 SPS  
Apache Hadoop: CDP Private Cloud Base Edition 7.1.6  
Compatible Software:  

The results were:  

**Performance Metric** 43.80 HSp@100TB  
Run Elapsed Time 8,218.00 Seconds  

<table>
<thead>
<tr>
<th>Cluster</th>
<th>16x AS-1114S-WN10RT, 1x AS-1114S-WTRT with:</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPUs</td>
<td>1x AMD® EPYC 7F33 32-Core Processor (all nodes)</td>
</tr>
<tr>
<td>Memory</td>
<td>256 GiB (all nodes)</td>
</tr>
<tr>
<td>Storage</td>
<td></td>
</tr>
<tr>
<td>Qty</td>
<td>Size</td>
</tr>
<tr>
<td>2</td>
<td>1 TB</td>
</tr>
<tr>
<td>1</td>
<td>1 TB</td>
</tr>
<tr>
<td>1</td>
<td>960 GB</td>
</tr>
<tr>
<td>7</td>
<td>3.84 TB</td>
</tr>
</tbody>
</table>

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

The following verification items were given special attention:  

- All TPC-provided components were verified to be v2.0.3  
- No modifications were made to any of the Java code  
- Any and all modifications to shell scripts were reviewed for compliance  
- All checksums were validated for compliance
The generated dataset was properly scaled to 100 TB
The generated dataset and the sorted dataset were erasure coded with a policy of RS-6-3-1024
The elapsed times for all phases and runs were correctly measured and reported
The Storage and Memory Ratios were correctly calculated and reported
The system pricing was verified for major components and maintenance
The major pages from the FDR were verified for accuracy

Additional Audit Notes:
None.

Respectfully Yours,

Doug Johnson, Certified TPC Auditor
## Supporting Files Index

<table>
<thead>
<tr>
<th>Clause</th>
<th>Description</th>
<th>Archive File Pathname</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clause 1</td>
<td>Parameters and options used to configure the system</td>
<td>SupportingFiles/Clause1</td>
</tr>
<tr>
<td>Clause 2</td>
<td>Configuration scripts and Run Report</td>
<td>SupportingFiles/Clause2</td>
</tr>
<tr>
<td>Clause 3</td>
<td>System configuration details</td>
<td>SupportingFiles/Clause3</td>
</tr>
</tbody>
</table>
Third-Party Price Quotes

APC

Rack PDU, Switched, 2U, 30A, 208V, (16)C13

$1,025.00

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- Instant access to applications

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