Super Micro Computer, Inc.

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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The pricing information in this document is believed to accurately reflect the current prices as of the publication date. However, the Sponsor provides no warranty of the pricing information in this document.

Benchmark results are highly dependent upon workload, specific application requirements, and system design and implementation. Relative system performance will vary because of these and other factors. Therefore, the TPC Express Benchmark™ V should not be used as a substitute for a specific customer application benchmark when critical capacity planning and/or product evaluation decisions are contemplated.

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.

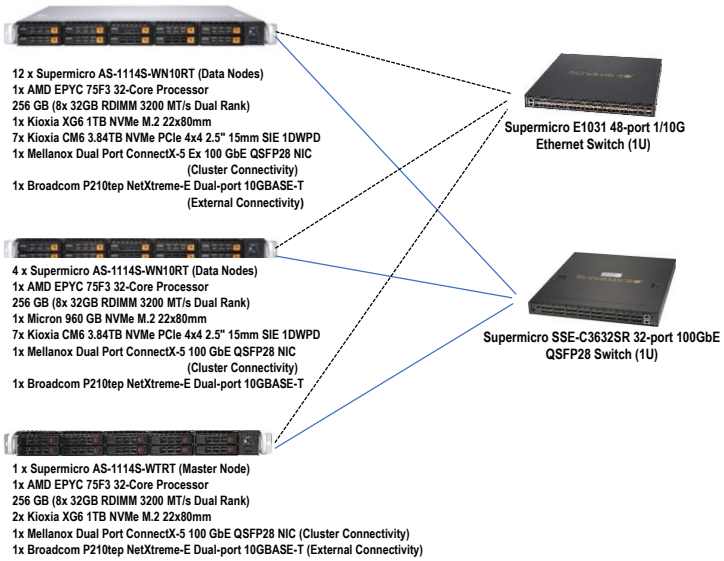
Measured Configuration			
Company Name	Cluster Node	Hadoop Software	Operating System
Supermicro	AS-1114S-WN10RT	CDP Private Cloud Base Edition 7.1.6	SUSE Linux Enterprise Server 12 SP5

TPC Express Benchmark™ HS Metrics			
Total System Cost	HSph@10TB	Price/Performance	Availability Date
$885,866	43.47	$20,378.79	Currently Available

Executive Summary

The Executive Summary follows on the next several pages.

SUPERMICRO	**Supermicro Cluster**		TPCx-HS 2.0.3 TPC Pricing 2.7.0 Report Date Sep. 16, 2021
Availability Date **Currently Available**	TPCx-HS Performance **43.47 HSph@10TB**	Price/Performance **$20,378.79 $ / HSph@10TB**	Total System Cost **$885,866 USD**
System Under Test Configuration Overview			
Scale Factor 10	Hadoop Software CDP Private Cloud Base Edition 7.1.6	Operating System SUSE Linux Enterprise Server 12 SP5	Other Software None



Physical Storage/Scale Factor: 44.79		Scale Factor/Physical Memory: 2.35
Total Number of Servers: Total Processors/Cores/Threads:		17 (16x AS-1114S-WN10RT; 1x AS-1114S-WTRT) 17/544/1,088
Server Configuration: Processors Memory Storage Device Network	Per AS-1114S-WN10RT 1x AMD EPYC 75F3 256 GiB 1x 1 TB NVMe (12 nodes) 1x 960 GB NVMe (4 nodes) 7x 3.84 TB NVMe (all nodes) 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)	Per AS-1114S-WTRT 1x AMD EPYC 75F3 256 GiB 2x 1 TB NVMe 1x Mellanox Dual-port 100 GbE 1x Broadcom Dual-port 10 GbE
Connectivity: Total Rack Units:	1x SSE-C3632R 32-port 100 GbE; 1x E1031 48-port 1/10 GbE 16x(1U)+1x(1U)+1x(1U)+1x(1U) = 16U+1U+1U+1U = 19U	

Supermicro Cluster

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Description	Part Number	Source	Qty	Unit Price	Extended Price	3 Yr. Maint. Price
HARDWARE						
Data Nodes						
H12SSW-NTR, CSE-116TS-R706WBP5-N10,RoHS	AS-1114S-WN10RT	1	16	$1,477.00	$23,632.00	
32GB DDR4-3200 2Rx4 ECC REG DIMM	MEM-DR432L-HL01-ER32	1	128	$184.60	$23,628.80	
Kioxia CM6 3.84TB NVMe PCIe 4x4 2.5" 15mm SIE 1DWPD	HDS-TUN-KCM6XRUL3T84	1	112	$859.00	$96,208.00	
Mellanox ConnectX-5 EN network card 100GbE dual-port	AOC-MCX516A-CDAT	1	12	$1,060.00	$12,720.00	
MCX516A-CCAT PCIe 2-port 100GbE QSFP28 Gen3.0 x16 CX-5	AOC-MCX516A-CCAT	1	4	$849.00	$3,396.00	
Milan 75F3 DP/UP 32C/64T 2.95G 256M 280W SP3	PSE-MLN75F3-0313	1	16	$4,834.00	$77,344.00	
Kioxia XG6 1TB NVMe M.2 22x80mm	HDS-TMN0-KXG60ZNV1T02	1	12	$190.00	$2,280.00	
Micron 7300 PRO 960GB,PCIe NVMe,M.2 22x80mm,3D TLC,1DWPD	HDS-MMN-MTFDHBA960TDF1AW	1	4	$178.50	$714.00	
Out of Band Firmware Management License-BIOS Flash /Setting	SFT-OOB-LIC	1	16	$15.00	$240.00	
ASSEMBLY FEE	MC0037	1	16	$25.00	$400.00	
0% 3 YRS LABOR, 3 YRS PARTS, 1 YR CRS UNDER LIMITED WRNTY	EWCSC	1	16	(included)		(included)
On Site 4hrs 24x7x365 Support 3 Years with Extended Wrnty	OS4HR3	1	16	$516.28		$8,260.42
Master Node						
H12SSW-NT, CSV-116TS-R504WBP	AS -1114S-WTRT	1	1	$1,304.00	$1,304.00	
32GB DDR4-3200 2Rx4 ECC REG DIMM	MEM-DR432L-HL01-ER32	1	8	$184.60	$1,476.80	
Kioxia XG6 1TB NVMe M.2 22x80mm	HDS-TMN0-KXG60ZNV1T02	1	2	$190.00	$380.00	
Mellanox ConnectX-5 EN network card 100GbE dual-port	AOC-MCX516A-CDAT	1	1	$1,060.00	$1,060.00	
Milan 75F3 DP/UP 32C/64T 2.95G 256M 280W SP3	PSE-MLN75F3-0313	1	1	$4,834.00	$4,834.00	
Out of Band Firmware Management License-BIOS Flash /Setting	SFT-OOB-LIC	1	1	$15.00	$15.00	
ASSEMBLY FEE	MC0037	1	1	$25.00	$25.00	
0% 3 YRS LABOR, 3 YRS PARTS, 1 YR CRS UNDER LIMITED WRNTY	EWCSC	1	1	(included)		(included)
On Site 4hrs 24x7x365 Support 3 Years with Extended Wrnty	OS4HR3	1	1	$454.36		$454.36
Network and Cables						
E1031 48-port 1/10G Ethernet ToR switch	SSE-G3648BR	1	1	$1,675.00	$1,675.00	
Cumulus-Linux SW 1G perpetual license with 3 yr Cumulus	SFT-CLSPL1G-3Y	1	1	$1,475.00	$1,475.00	
On Site 4hrs 24x7x365 Support 3 Years with Extended Wrnty	OS4HR3	1	1	$315.00		$315.00
32-port 100GbE QSFP28,B2F,2x800W R0872-F0004-01,HF	SSE-C3632SR	1	1	$7,375.00	$7,375.00	
Cumulus-Linux Software 100G Perpetual License with 3 yr SnS	SFT-CLSNWPL-100G-3Y	1	1	$6,399.00	$6,399.00	
On Site 4hrs 24x7x365 Support 3 Years with Extended Wrnty	OS4HR3	1	1	$1,377.40		$1,377.40
ETHERNET,QSFP28,100GbE,PASSIVE,LSZH,3m,Molex,RoHS	CBL-NTWK-0943-SQ28C30M	1	17	$139.50	$2,371.50	
ETHERNET,CAT6,RJ45,SNAGLESS,YELLOW,15FT (4.6M),28AWG,Ro	CBL-C6-YL15FT-P	1	17	$10.80	$183.60	
ETHERNET,CAT6,RJ45,SNAGLESS,GREEN,UTP,15FT(4.5M),28AWG,RoHS	CBL-C6-GN15FT-P	1	17	$10.80	$183.60	
Infrastructure						
42U Enclosure system	SRK-42SE-11	1	1	$1,516.30	$1,516.30	
Rack PDU, Switched, 2U, 30A, 208V, (16)C13	AP7911B	2	3	$1,025.00	$3,075.00	
PWCD,US,IEC60320 C14 TO C13,4FT,16AWG,RoHS/REACH	CBL-PWCD-0373-IS	1	38	$6.50	$247.00	
LONCEVON - 12 inch IPS 1920x1080p HDMI Monitor	N/A	3	3	$99.99	$299.97	
Logitech MK200 Media Keyboard and Mouse Combo	920-002714	3	3	$41.50	$124.50	
Spares, Accessories						
ETHERNET,QSFP28,100GbE,PASSIVE,LSZH,3m,Molex,RoHS	CBL-NTWK-0943-SQ28C30M	1	3	$139.50	$418.50	
ETHERNET,CAT6,RJ45,SNAGLESS,YELLOW,15FT (4.6M),28AWG,Ro	CBL-C6-YL15FT-P	1	3	$10.80	$32.40	
ETHERNET,CAT6,RJ45,SNAGLESS,GREEN,UTP,15FT(4.5M),28AWG,RoHS	CBL-C6-GN15FT-P	1	3	$10.80	$32.40	
PWCD,US,IEC60320 C14 TO C13,4FT,16AWG,RoHS/REACH	CBL-PWCD-0373-IS	1	3	$6.50	$19.50	
HARDWARE Subtotals					**$275,085.87**	**$10,407.17**

(continued next page)

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TPCx-HS	2.0.3
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(continued from previous page)

Description	Part Number	Source	Qty	Unit Price	Extended Price	3 Yr. Maint. Price
SOFTWARE						
SUSE Linux Enterprise Server, x86 & x86-64, 1-2 Sockets or 1-2 Virtual Machines, Priority Subscription, 3 Year 874-006883	SFT-NV-SU2P3YBAC	1	17	$2,916.00	$49,572.00	
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. BusinessLevel Support.	SMC-CDP-PVCBASE-BUS	1	51	$9,600.00	$489,600.00	
COMPUTE: price per CCU per year for compute in excess of 16 cores/128GB RAM per Node, where 1 CCU = 1 core + 8 GB RAM	SMC-CDP-COMPUTE	1	816	75	$61,200.00	
SOFTWARE Subtotals					**$600,372.00**	**$0.00**

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@10TB:	**43.47**
$ / HSph@10TB:	**$20,378.79**

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.

Supermicro Cluster

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Numerical Quantities

Performance Run – Run 1

Scale Factor	10TB
Run Start Time	2021-08-27 22:06:16.000
Run End Time	2021-08-27 22:20:01.000
Run Elapsed Time	828.000
HSGen Start Time	2021-08-27 22:06:16.000
HSGen End Time	2021-08-27 22:09:09.000
HSGen Elapsed Time	174.209
HSSort Start Time	2021-08-27 22:09:16.000
HSSort End Time	2021-08-27 22:18:28.000
HSSort Elapsed Time	552.925
HSValidate Start Time	2021-08-27 22:18:35.000
HSValidate End Time	2021-08-27 22:20:01.000
HSValidate Elapsed Time	87.167

Repeatability Run – Run 2

Scale Factor	10TB
Run Start Time	2021-08-27 22:30:06.000
Run End Time	2021-08-27 22:43:51.000
Run Elapsed Time	828.000
HSGen Start Time	2021-08-27 22:30:07.000
HSGen End Time	2021-08-27 22:32:59.000
HSGen Elapsed Time	173.059
HSSort Start Time	2021-08-27 22:33:05.000
HSSort End Time	2021-08-27 22:42:17.000
HSSort Elapsed Time	552.500
HSValidate Start Time	2021-08-27 22:42:24.000
HSValidate End Time	2021-08-27 22:43:51.000
HSValidate Elapsed Time	88.403

Run Reports

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

Test Run 1 Details	Total Time =	828
	Total Size =	100000000000
	Scale-Factor =	10

TPCx-HS Performance Metric (HSph@SF): 43.4782

==========

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

Test Run 2 Details	Total Time =	828
	Total Size =	100000000000
	Scale-Factor =	10

TPCx-HS Performance Metric (HSph@SF): 43.4782

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Supermicro Cluster

TPCx-HS	2.0.3
TPC Pricing	2.7.0
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Revision History

Date	Edition	Description
September 16, 2021	First	Initial Publication

Table of Contents

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

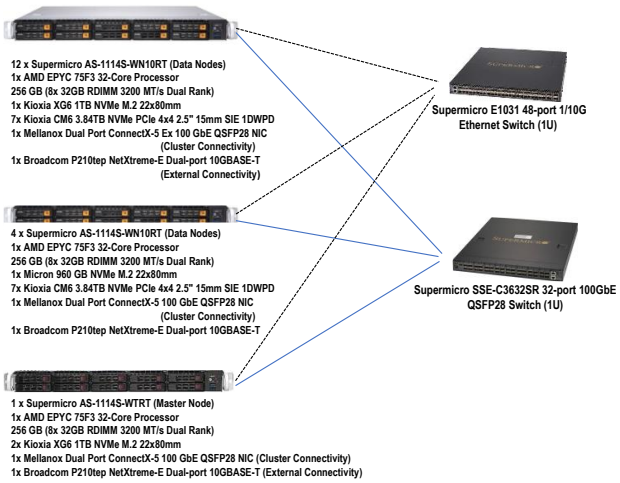

Figure 1-1 Measured Configuration

The measured configuration consisted of:

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

Server node details:

16x AS-1114S-WN10RT Servers, each with:	1x AS-1114S-WTRT 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)
	• 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.

Server Node	Controller	Disk Drive	Description of Content
1	NVMe	nvme7n1	Operating System, Root, Swap, Hadoop Master
2-3	NVMe	nvme7n1	Operating System, Root, Swap, Hadoop Master
2-3	NVMe	nvme0n1, nvme1n1, nvme2n1, nvme3n1, nvme4n1, nvme5n1, nvme6n1	Data, Temp
4-17	NVMe	nvme7n1	Operating System, Root, Swap, Hadoop Master
4-17	NVMe	nvme0n1, nvme1n1, nvme2n1, nvme3n1, nvme4n1, nvme5n1, nvme6n1	Data, Temp

Table 1-1Dataset 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.

	Map/Reduce		HDFS		ZooKeeper
Node	Resource Manager	Node Manager	NameNode	DataNode	QuorumPeer
1	X		X		X
2-3		X		X	
4-17		X		X	

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 =                828
                        Total Size =       100000000000
                        Scale-Factor =               10

TPCx-HS Performance Metric (HSph@SF):          43.4782

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


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

Test Run 2 Details      Total Time =                828
                        Total Size =       100000000000
                        Scale-Factor =               10

TPCx-HS Performance Metric (HSph@SF):          43.4782

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

2.3 Benchmark Kit Identification

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

Kit Version 2.0.3

File	MD5
BigData_cluster_validate_suite.sh	57f7cd68251a9aba0feb6648630ff5da
HSDataCheck.sh	bcf0b946a49d1249c9da174b5d9805f1
TPCx-HS-master_MR2.jar	492cbc51a1a60c28b43d96c79d08683d
TPCx-HS-master.sh	c619a0819571ecd00cd75d2b76ba8c64

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.

Quantity	Capacity	Total (TB)
12	1 TB	12.00
4	960 GB	3.84
112	3.84 TB	430.08
2	1 TB	2.00
Total Storage (TB)		**447.92**

Table 3-1 Storage Device Capacities

Scale Factor = 10

Data Storage Ratio = (Total Storage (TB) / SF) = **44.79**

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)) = **2.35**

Clause 4 – Metrics Related Items

4.1 HSGen Time

The HSGen time must be disclosed for Run1 and Run2.

	Run 1	Run 2
HSGen	174.209	173.059

Table 4-1 HSGen Times

4.2 HSSort Time

The HSSort time must be disclosed for Run1 and Run2.

	Run 1	Run 2
HSSort	552.925	552.500

Table 4-2 HSSort Times

4.3 HSValidate Time

The HSValidate time must be disclosed for Run1 and Run2.

	Run 1	Run 2
HSValidate	87.167	88.403

Table 4-3 HSValidate Times

4.4 HSDataCheck Times

Both HSDataCheck times must be disclosed for Run1 and Run2.

	Run 1	Run 2
HSDataCheck (pre-sort)	7.000	6.000
HSDataCheck (post-sort)	7.000	7.000

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.

	Run 1	Run 2
HSph@10TB	43.47	43.47

Table 4-5 Performance Metrics

Run 1 Price-Performance: 20,378.79 $/ HSph@10TB

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.

InfoSizing
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TPC
Certified Auditor

Srini Bala
Super Micro Computer, Inc.
980 Rock Avenue,
San Jose, CA 95131
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September 14, 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 Linus Enterprise Server 12 SP5
Apache Hadoop Compatible Software:	CDP Private Cloud Base Edition 7.1.6

The results were:

Performance Metric	**43.47 HSph@10TB**
Run Elapsed Time	828.00 Seconds

Cluster	**16x AS-1114S-WN10RT, 1x AS-1114S-WTRT with:**		
CPUs	1x AMD® EPYC 75F3 32-Core Processor (all nodes)		
Memory	256 GiB (all nodes)		
Storage	***Qty***	***Size***	***Type***
	2	1 TB	NVMe (master node)
	1	1 TB	NVMe (12 data nodes)
	1	960 GB	NVMe (4 data nodes)
	7	3.84 TB	NVMe (all data nodes)

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

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- The generated dataset was properly scaled to 10 TB
- The generated dataset and the sorted dataset were erasure coded with a policy of RS-6-3-1024k
- 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

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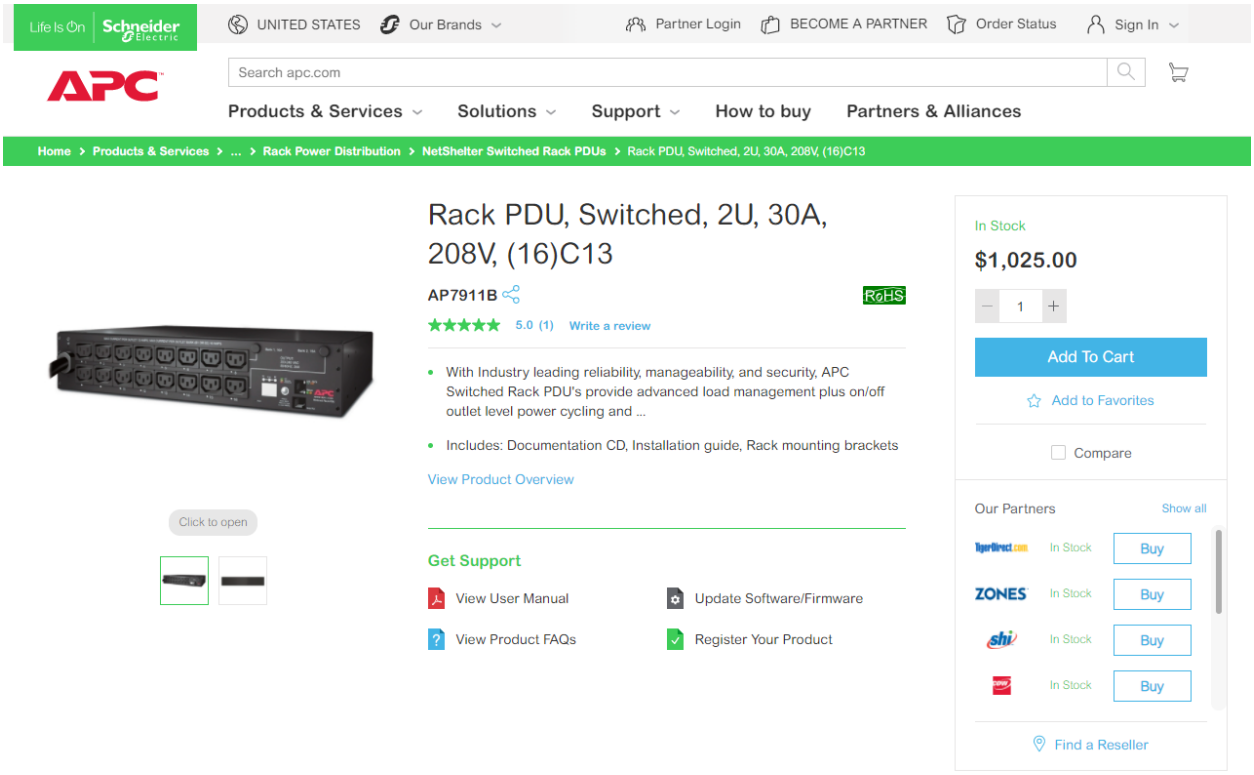
Supporting Files Index

Clause	Description	Archive File Pathname
Clause 1	Parameters and options used to configure the system	SupportingFiles/Clause1
Clause 2	Configuration scripts and Run Report	SupportingFiles/Clause2
Clause 3	System configuration details	SupportingFiles/Clause3

Third-Party Price Quotes

APC



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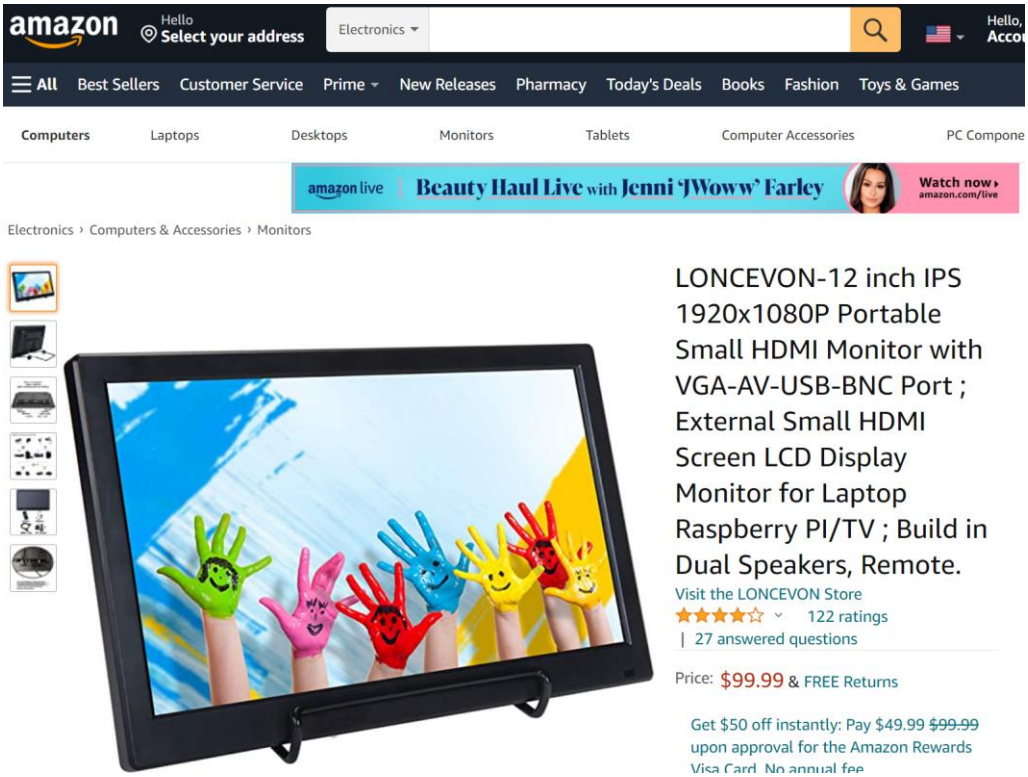
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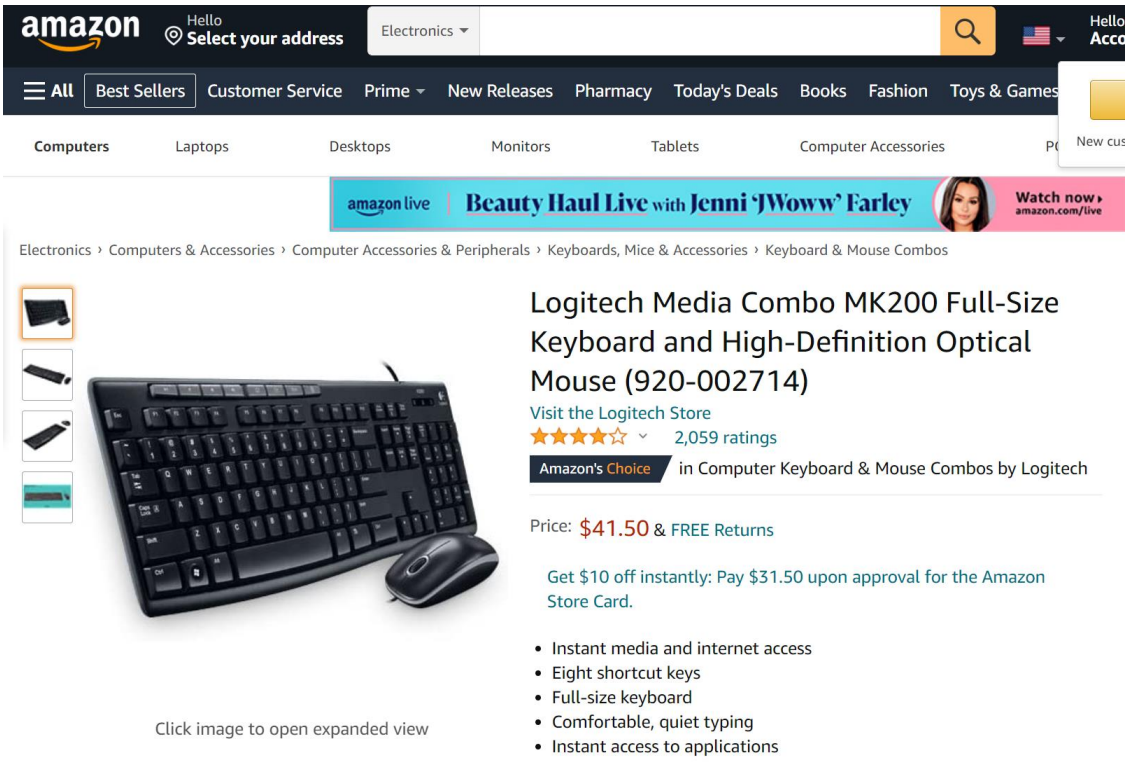
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