DELL EMC

Dell Inc.

TPC Express Benchmark™ HS
Full Disclosure Report

PowerEdge R7515

(with 9x PowerEdge R7515 Servers; 1x PowerEdge R6525 Servers)

Running

Cloudera Enterprise Edition 6.3

on

Red Hat Enterprise Linux Server 7.6

TPCx-HS Version	2.0.3
Report Edition	First
Report Submitted	September 17, 2019

First Edition - September 2019

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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.

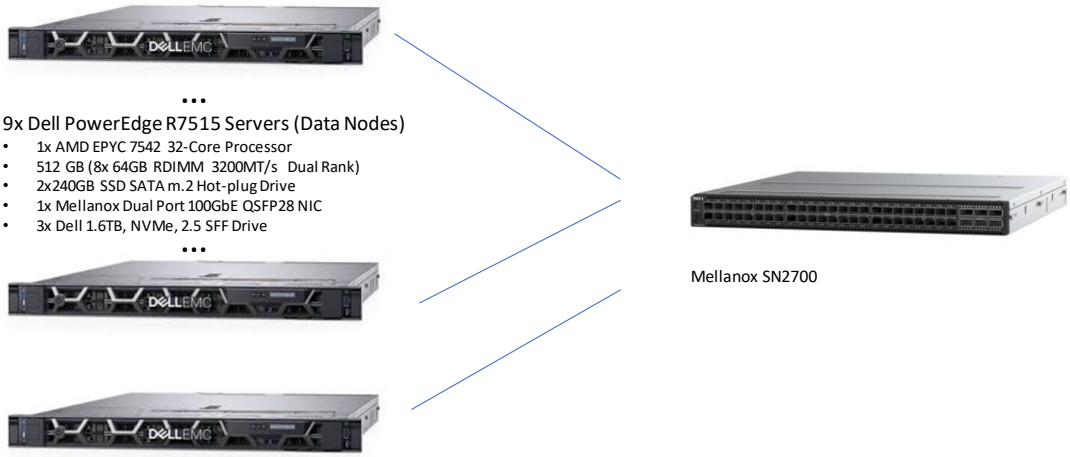
Measured Configuration			
Company Name	Cluster Node	Hadoop Software	Operating System
Dell	PowerEdge R7515	Cloudera Enterprise Edition 6.3	Red Hat Enterprise Linux Server 7.6

TPC Express Benchmark™ HS Metrics			
Total System Cost	HSph@1TB	Price/Performance	Availability Date
$447,883	9.81	$45,655.76	October 15, 2019

Executive Summary

The Executive Summary follows on the next several pages.

DELL EMC	PowerEdge R7515		TPCx-HS 2.0.3 TPC Pricing 2.4.0 Report Date Sep. 17, 2019
Availability Date **October 15, 2019**	TPCx-HS Performance **9.81 HSph@1TB**	Price/Performance **$45,655.76 $ / HSph@1TB**	Total System Cost **$447,883 USD**
System Under Test Configuration Overview			
Scale Factor 1	Hadoop Software Cloudera Enterprise Edition 6.3	Operating System Red Hat Enterprise Linux Server 7.6	Other Software N/A



Physical Storage/Scale Factor: 48.00	Scale Factor/Physical Memory: 0.20
Total Number of Servers: Total Processors/Cores/Threads:	10 (9x PowerEdge R7515; 1x PowerEdge R6525) 11/352/704

Server Configuration:	Per PowerEdge R7515	Per PowerEdge R6525
Processors	1x AMD EPYC 7542 32-Core Processor	2x AMD EPYC 7502 32-Core Processor
Memory	512 GiB	512 GiB
Storage Controller	Perc H740P	Perc H740P
Storage Device	2x 240GB SATA SSD m.2 3x Dell 1.6TB NVMe	2x 240GB SATA SSD m.2
Network	Mellanox Dual Port 100GbE	Broadcom Adv. Dual 25Gb
Connectivity: Total Rack Units:	Mellanox SN2700 (32-port, 100Gbe) (9xR7515)+(1xR6525)+(1xMSN2700) = 18 + 1 + 1 = 20RU	

DELL EMC	PowerEdge R7515	TPCx-HS	2.0.3
		TPC Pricing	2.4.0
		Report Date	Sep. 17, 2019

Description	Part Number	Source	Unit Price	Qty	Extended Price	3 Yr. Maint. Price
HARDWARE COMPONENTS						
PowerEdge R7515		1	$41,778.17	9	$376,003.53	
PowerEdge R7515 Server	210-ASVQ	1	$0.00	1	$0.00	
PowerEdge R6515/R7515 Motherboard, with 2 x	384-BCEL	1	$0.00	1	$0.00	
No Trusted Platform Module	461-AADZ	1	$0.00	1	$0.00	
PowerEdge R7515 Shipping	340-CODN,	1	$0.00	1	$0.00	
PowerEdge R7515 Shipping Material,DAO w/CC Cert Marking	343-BBNT	1	$0.00	1	$0.00	
Standard Heatsink	412-AASE	1	$0.00	1	$0.00	
3200MT/s RDIMMs	370-AEVR	1	$0.00	1	$0.00	
Performance Optimized	370-AAIP	1	$0.00	1	$0.00	
No Media Required	605-BBFN	1	$0.00	1	$0.00	
iDRAC9, Express X5	385-BBOU	1	$0.00	1	$0.00	
iDRAC Group Manager, Disabled	379-BCQY	1	$0.00	1	$0.00	
iDRAC,Factory Generated Password	379-BCSF	1	$0.00	1	$0.00	
Single, Hot-plug Power Supply (1+0), 495W	450-ADWP	1	$0.00	1	$0.00	
NEMA 5-15P to C13 Wall Plug, 125 Volt, 15 AMP,	450-AALV	1	$0.00	1	$0.00	
PowerEdge 2U Standard Bezel	350-BBWP	1	$0.00	1	$0.00	
No Quick Sync	350-BBKU	1	$0.00	1	$0.00	
Performance BIOS Setting	384-BBBL	1	$0.00	1	$0.00	
ReadyRails Sliding Rails With Cable Management Arm	770-BBBR	1	$0.00	1	$0.00	
No Systems Documentation, No OpenManage DVD Kit	631-AACK	1	$0.00	1	$0.00	
US Order	332-1286	1	$0.00	1	$0.00	
Basic Deployment Dell Server R Series 1U/2U	804-6747	1	$0.00	1	$0.00	
Chassis with up to 24x2.5" Drives	379-BDTF	1	$0.00	1	$0.00	
No Internal Optical Drive for x10 or greater HDD Chassis	429-AAIQ	1	$0.00	1	$0.00	
Riser Config 2, 2 x 16 FH + 2 x 16 LP PCIe slot	330-BBNL	1	$0.00	1	$0.00	
NVMe Backplane	379-BDSX	1	$0.00	1	$0.00	
No Additional Mid Fan	384-BBSO	1	$0.00	1	$0.00	
2.5" Chassis with up to 24 NVMe Drives	321-BERW	1	$0.00	1	$0.00	
AMD EPYC 7542 2.90GHz, 2C/64T, 128M Cache (225W) DDR4-3200	338-BTYY	1	$0.00	1	$0.00	
64GB RDIMM, 3200MT/s, Dual Rank	370-AEVP	1	$0.00	8	$0.00	
C30, No RAID for NVME chassis	780-BCDO	1	$0.00	1	$0.00	
No Hard Drive	400-ABHL	1	$0.00	1	$0.00	
Dell 1.6TB, NVMe, Mixed Use Express Flash, 2.5 SFF Drive, U.2, PM1725b with Carrier	400-BEFC	1	$0.00	3	$0.00	
Mellanox ConnectX-5 EX Dual Port 40/100GbE	540-BCIU	1	$0.00	1	$0.00	
BOSS controller card + with 2 M.2 Sticks 240G	403-BCHM	1	$0.00	1	$0.00	
No Controller	405-AACD	1	$0.00	1	$0.00	
UEFI BIOS Boot Mode with GPT Partition	800-BBDM	1	$0.00	1	$0.00	
Keyboard and Optical Mouse, USB, Black, English	570-AAKV,	1	$12.00	3	$36.00	
3 Years ProSupport Plus Mission Critical 4Hr Onsite Service	827-1296,	1	$5,299.00	9		$47,691.00
Dell 24 Monitor - E2417H	E2417H	1	$169.99	3	$509.97	
Mellanox MSN2700-CS2F, 32 Port QSFP 100Gbe	MSN2700-		$35,913.00	1	$35,913.00	
1m (3ft) Dell DAC-Q28-100G-1M Compatible 100G QSFP28 Passive Direct Attach Copper Twinax Cable	Q28-PC01		$29.00	11	$319.00	
3m (10ft) Dell DAC-Q28-4SFP28-25G-3M Compatible 100G QSFP28 to 4x25G SFP28 Passive Direct Attach Copper Breakout Cable	Q-		$93.00	3	$279.00	
C13 to C14, PDU Style, 12 AMP, 2 Feet (.6m) Power Cord, North America	492-BBDI	1	$20.00	22	$440.00	
APC NetShelter SX 24U 600mm x 1070mm Deep Enclosure	A7545498	1	$1,129.99	1	$1,129.99	
Rack PDU, Basic, Zero U, 15A, 120V, 5-15 input, (14) 5-15 output	A7541364	1	$174.99	1	$174.99	
Subtotal					$414,805.48	$47,691.00

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DELL EMC	PowerEdge R7515	TPCx-HS	2.0.3
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PowerEdge R6525 Server						
PowerEdge R6525 Server	210-ATCF	1	$749.00	1	$749.00	
BOSS controller card + with 2 M.2 sticks 240G (RAID 1), LP	403-BCHM	1	$879.00	1	$879.00	
PowerEdge R6525 Motherboard, with 2 x 1Gb Onboard LOM (BCM5720)	384-BCGI	1	$0.00	1	$0.00	
Very High Performance Fan for 10 x 2.5" or 10 x 2.5" + 2 x 2.5" chassis	384-BCGH	1	$399.00	1	$399.00	
Chassis with up to 10 x 2.5" Hot Plug Hard Drives (2CPU & XGMI)	321-BEUP	1	$370.00	1	$370.00	
No Trusted Platform Module	461-AADZ	1	$0.00	1	$0.00	
PowerEdge R6525 Shipping Label, FCC2, PSU, 800W, w/o BIS	343-BBOL	1	$0.00	1	$0.00	
PowerEdge R6525 x4 or x10 Drive Shipping Material	340-COGL	1	$99.00	1	$99.00	
AMD EPYC 7502 2.00GHz/2.55GHz, 32C/64T, 64M Cache (180W) DDR4-2666	338-BSWD	1	$5,599.00	2	$11,198.00	
Heatsink for 1st CPU, greater than or equal to 180W	412-AASH	1	$0.00	1	$0.00	
Heatsink for 2nd CPU, greater than or equal to 180W	412-AASJ	1	$0.00	1	$0.00	
3200MT/s RDIMMs	370-AEVR	1	$0.00	1	$0.00	
64GB RDIMM, 3200MT/s Dual Rank	370-AEVP	1	$2,439.00	8	$19,512.00	
Performance Optimized	370-AAIP	1	$0.00	1	$0.00	
Unconfigured RAID	780-BCDS	1	$0.00	1	$0.00	
PERC H745 for Chassis up to 10 drives	405-AAUZ	1	$1,199.00	1	$1,199.00	
No Media Required	421-5736	1	$0.00	1	$0.00	
iDRAC9,Enterprise	385-BBKT	1	$489.00	1	$489.00	
iDRAC Group Manager, Disabled	379-BCQY	1	$0.00	1	$0.00	
iDRAC, Factory Generated Password	379-BCSF	1	$0.00	1	$0.00	
Riser Config 2, 1 x 16 LP PCIe slot (CPU1), 2 x 16 LP PCIe slot (CPU2)	330-BBNR	1	$349.00	1	$349.00	
No Internal Optical Drive	429-ABBF	1	$0.00	1	$0.00	
Dual, Hot-plug, Redundant Power Supply (1+1), 1400W	450-AIQZ	1	$1,699.00	1	$1,699.00	
No Bezel	350-BBBW	1	$0.00	1	$0.00	
Dell EMC Luggage Tag (x8 or x10 chassis)	350-BBXP	1	$0.00	1	$0.00	
No Quick Sync	350-BBXM	1	$49.00	1	$49.00	
Performance BIOS Settings	384-BBBL	1	$0.00	1	$0.00	
UEFI BIOS Boot Mode with GPT Partition	800-BBDM	1	$0.00	1	$0.00	
ReadyRails Sliding Rails With Cable Management Arm	770-BCKT	1	$189.00	1	$189.00	
No Systems Documentation, No OpenManage DVD Kit	631-AACK	1	$0.00	2	$0.00	
US Order	332-1286	1	$0.00	1	$0.00	
ProSupport and 4Hr Mission Critical, 36 Month(s)	[865-BBNB]	1	$4,661.00	1		$4,661.00
No Installation	[900-9997]	1	$0.00	1	$0.00	
NEMA 5-15P to C13 Wall Plug, 125 Volt, 15 AMP, 10 Feet (3m), Power Cord, North America	450-AALV	1	$0.00	2	$0.00	
Sub Total					$37,180.00	$4,661.00
HARDWARE COMPONENTS				**Subtotal**	$451,985.48	$52,352.00
SOFTWARE COMPONENTS						
Cloudera Enterprise Data Engineering (CDH 6.3), 3yr Node License	CEDEN-	1	$14,769.24	10	$147,692.40	
Red Hat Linux Registration Document, No Subscription	340-AVFG	1	$0.00	10	$0.00	
Enterprise Linux OS, Non Factory Installed, Requires Subscription Selection	605-BBFL	1	$0.00	10	$0.00	
Red Hat Enterprise Linux, 1-2SKT, Physical Node, 3YR Premium Subscription, with up to 1 Virtual Guest	605-BBHO	1	$3,702.00	10	$37,020.00	
SOFTWARE COMPONENTS				**Subtotal**	$184,712.40	$0.00
Total					**$636,697.88**	**$52,352.00**
Large Purchase Discount (35%)*					-222,844.26	-18,323.20

Pricing: 1 = Dell

* 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: $447,883

HSph@1TB: 9.81

$ / HSph@1TB: $45,655.76

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.

DELL EMC	PowerEdge R7515	TPCx-HS	2.0.3
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		Report Date	Sep. 17, 2019

Numerical Quantities

Performance Run – Run 2

Scale Factor	1TB
Run Start Time	2019-09-10 06:04:28.000
Run End Time	2019-09-10 06:10:32.000
Run Elapsed Time	367.000
HSGen Start Time	2019-09-10 06:04:29.000
HSGen End Time	2019-09-10 06:05:32.000
HSGen Elapsed Time	65.236
HSSort Start Time	2019-09-10 06:05:36.000
HSSort End Time	2019-09-10 06:09:56.000
HSSort Elapsed Time	259.864
HSValidate Start Time	2019-09-10 06:10:00.000
HSValidate End Time	2019-09-10 06:10:32.000
HSValidate Elapsed Time	32.710

Repeatability Run – Run 1

Scale Factor	1TB
Run Start Time	2019-09-10 05:56:26.000
Run End Time	2019-09-10 06:02:21.000
Run Elapsed Time	359.000
HSGen Start Time	2019-09-10 05:56:27.000
HSGen End Time	2019-09-10 05:57:33.000
HSGen Elapsed Time	67.205
HSSort Start Time	2019-09-10 05:57:37.000
HSSort End Time	2019-09-10 06:01:46.000
HSSort Elapsed Time	249.576
HSValidate Start Time	2019-09-10 06:01:50.000
HSValidate End Time	2019-09-10 06:02:21.000
HSValidate Elapsed Time	31.840

DELL EMC	PowerEdge R7515	TPCx-HS 2.0.3 TPC Pricing 2.4.0 Report Date Sep. 17, 2019

Run Reports

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

Test Run 2 Details	Total Time =	367
	Total Size =	10000000000
	Scale-Factor =	1

TPCx-HS Performance Metric (HSph@SF): 9.8135

==========

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

Test Run 1 Details	Total Time =	359
	Total Size =	10000000000
	Scale-Factor =	1

TPCx-HS Performance Metric (HSph@SF): 10.0300

==========

DELL EMC	PowerEdge R7515	TPCx-HS 2.0.3 TPC Pricing 2.4.0 Report Date Sep. 17, 2019

Revision History

Date	Edition	Description
September 17, 2019	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 asses 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 Dell 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

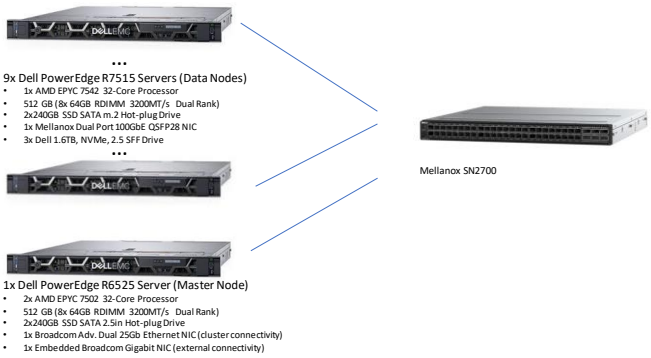

Figure 1-1 Measured Configuration

The measured configuration consisted of:

- Total Nodes: 10 (9x PowerEdge R7515; 1x PowerEdge R6525)
- Total Processors/Cores/Threads: 11/352/704
- Total Memory: 5.00TiB
- Total Number of Storage Drives/Devices: 47
- Total Storage Capacity: 48.00TB

Server node details:

- 9x PowerEdge R7515 Servers, each with:
  - Processors/Cores/Threads: 1/32/64
  - Processor Model: AMD EPYC 7542 32-Core Processor
  - Memory: 512 GiB
  - Controller: Perc H740P
  - Drives:
    - 2x 240GB SATA SSD m.2
    - 3x Dell 1.6TB NVMe
  - Network: Mellanox Dual Port 100GbE
- 1x PowerEdge R6525 Servers, each with:
  - Processors/Cores/Threads: 2/64/128
  - Processor Model: AMD EPYC 7502 32-Core Processor
  - Memory: 512 GiB
  - Controller: Perc H740P
  - Drives:
    - 2x 240GB SATA SSD m.2
  - Network: Mellanox Dual Port 100GbE

Network connectivity detail:

- Mellanox SN2700 (32-port, 100Gbe)

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
10	Boss controller card	sda	Operating System, Root, Swap, Hadoop Master
1-2	Boss controller card	sda	Operating System, Root, Swap, Hadoop Master
1-2	NVMe	nvme0n1,nvme1n1	Data, Temp
3-9	Boss controller card	sda	Operating System, Root, Swap, Hadoop Master
3-9	NVMe	nvme0n1,nvme1n1	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	Spark
Node	Resource Manager	Node Manager	NameNode	DataNode	QuorumPeer	HistoryServer
10	X		X		X	X
1-2		X		X	X	
3-9		X		X		

Table 1-2 Software Component Distribution

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

Cloudera Enterprise Edition 6.3 (fully HDFS compatible at the API level).

Map/Reduce implementation and corresponding version must be disclosed.

Cloudera Enterprise Edition 6.3 (compatible equivalent to Hadoop 3.0.0).

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

Test Run 1 Details      Total Time =                  359
                        Total Size =          10000000000
                        Scale-Factor =                1

TPCx-HS Performance Metric (HSph@SF):           10.0300

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


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

Test Run 2 Details      Total Time =                  367
                        Total Size =          10000000000
                        Scale-Factor =                1

TPCx-HS Performance Metric (HSph@SF):            9.8135

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

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

HSDataCheck.sh was modified at the auditor's direction to collect fsck data.

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)
20	240 GB	4.80
27	1.6 TB	43.20
Total Storage (TB)		**48.00**

Table 3-1 Storage Device Capacities

Scale Factor = 1

Data Storage Ratio = (Total Storage (TB) / SF) = **48.00**

3.2 Memory Ratio

The Scale Factor to memory ratio must be disclosed.

Total Configured Memory (TiB) = 5.00

Scale Factor to Memory Ratio = (SF / Total Memory(TiB)) = **0.20**

Clause 4 – Metrics Related Items

4.1 HSGen Time

The HSGen time must be disclosed for Run1 and Run2.

	Run 1	Run 2
HSGen	67.205	65.236

Table 4-1 HSGen Times

4.2 HSSort Time

The HSSort time must be disclosed for Run1 and Run2.

	Run 1	Run 2
HSSort	249.576	259.864

Table 4-2 HSSort Times

4.3 HSValidate Time

The HSValidate time must be disclosed for Run1 and Run2.

	Run 1	Run 2
HSValidate	31.840	32.710

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)	4.000	4.000
HSDataCheck (post-sort)	4.000	4.000

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@1TB	10.03	9.81

Table 4-5 Performance Metrics

Run 2 Price-Performance: 45,655.76 $/ HSph@1TB

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.

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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
The Right Metric For Sizing IT

TPC
Certified Auditor

Cindy Stap
Senior Manager
Solution Performance Analysis
1 Dell Way PS2-39
Round Rock, TX 78682

September 16, 2019

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

Platform:	Dell PowerEdge R7515 (9x PowerEdge R7515, 1x PowerEdge R6525)
Operating System:	Red Hat Enterprise Linux Server 7.6
Apache Hadoop Compatible Software:	Cloudera Enterprise Edition 6.3 (using MapReduce)

The results were:

Performance Metric	**9.81 HSph@1TB**
Run Elapsed Time	367.00 Seconds

Cluster	**9x Dell PowerEdge R7515 (data nodes), 1x PowerEdge R6525 (master node) each node with:**
CPUs	1x AMD EPYC 7542 (2.90 GHz, 32-core, 16 MB L3) (Data nodes) 2x AMD EPYC 7502 (2.50 GHz, 32-core, 16 MB L3) (Master node)
Memory	512 GiB (all nodes)
Storage	***Qty*** ***Size*** ***Type*** 2 240GB SATA SSD m.2 (All nodes) 3 1.6TB NVMe (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
- The generated dataset was properly scaled to 1TB

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- The generated dataset and the sorted dataset were replicated 3-ways
- 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

None.