

# TPC Express Benchmark™ HS Full Disclosure Report

## Dell PowerEdge R6415

(with 17x Dell PowerEdge R6415 Servers)

Running

Cloudera Enterprise Edition 6.0

on

Red Hat Enterprise Linux Server Release 7.5

TPCx-HS Version  
Report Edition  
Report Submitted

v2.0.3  
First  
January 23, 2019

**First Edition - January 2019**

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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 v2.0.3.






The benchmark results are summarized below.


Measured Configuration			
Company Name	Cluster Node	Hadoop Software	Operating System
Dell	Dell PowerEdge R6415	Cloudera Enterprise Edition 6.0	Red Hat Enterprise Linux Server Release 7.5


TPC Express Benchmark™ HS Metrics			
Total System Cost	HSph@10TB	Price/Performance	Availability Date
\$472,071	17.19	\$27,461.96	January 23, 2019


# Executive Summary

The [Executive Summary](#) follows on the next several pages.

	<h1 style="text-align: center;">Dell PowerEdge R6415</h1>		TPCx-HS v2.0.3
			TPC Pricing v2.4.0
			Report Date Jan. 23, 2019
Availability Date <b>January 23, 2019</b>	TPCx-HS Performance <b>17.19 HSph@10TB</b>	Price/Performance <b>\$27,461.96 \$/ HSph@10TB</b>	Total System Cost <b>\$472,071 USD</b>
System Under Test Configuration Overview			
Scale Factor  10	Hadoop Software  Cloudera Enterprise Edition 6.0	Operating System  Red Hat Enterprise Linux Server Release 7.5	Other Software  N/A
<div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>...</p> <p><b>16x Dell PowerEdge R6415 Servers (Data Nodes)</b></p> <ul style="list-style-type: none"> <li>• 1x AMD EPYC 7551P 32-Core Processor</li> <li>• 256 GB (8x 32GB RDIMM 2666MT/s Dual Rank)</li> <li>• 1x 960GB SSD SATA 2.5in Hot-plug Drive</li> <li>• 1x Mellanox Dual Port 25GbE SFP28 NIC</li> <li>• 3x Dell 1.6TB, NVMe, 2.5 SFF Drive</li> </ul> <p>...</p>  <p>...</p>  <p><b>1x Dell PowerEdge R6415 Server (Master Node)</b></p> <ul style="list-style-type: none"> <li>• 1x AMD EPYC 7551P 32-Core Processor</li> <li>• 256 GB (8x 32GB RDIMM 2666MT/s Dual Rank)</li> <li>• 1x 960GB SSD SATA 2.5in Hot-plug Drive</li> <li>• 1x Mellanox Dual Port 25GbE SFP28 NIC</li> </ul> </div> <div style="text-align: center;">  <p><b>Dell S-Series (S5148F-ON) 48x25GbE and 6x100GbE Network Switch.</b></p> </div> </div>			
Physical Storage/Scale Factor: 9.31		Scale Factor/Physical Memory: 2.35	
Total Number of Servers:		17x Dell PowerEdge R6415	
Total Processors/Cores/Threads:		17/544/1,088	
Server Configuration:		Per Dell PowerEdge R6415	
Processors		1x AMD EPYC 7551P 32-Core	
Memory		256 GiB	
Storage Controller		Perc H740P	
Storage Device		1x 960 GB SSD SATA (all nodes)	
Network		3x Dell 1.6TB NVMe (Data Nodes)	
		1x Mellanox Dual Port 25GbE SFP28 NIC	
Connectivity:		Dell S-Series (S5148F-ON) Network Switch	
Total Rack Units:		(17xR6415) + (1xS5148F) = (17x1) + (1x1) = 18RU	

		<h1 style="margin: 0;">Dell PowerEdge R6415</h1>		TPCx-HS	v2.0.3		
				TPC Pricing	v2.4.0		
				Report Date	Jan. 23, 2019		
Description		Part Number	Source	Unit Price	Qty	Extended Price	3 Yr. Maint. Price
<b>HARDWARE COMPONENTS</b>							
<b>PowerEdge R6415 Server</b>							
PowerEdge R6415/R7415 Motherboard	210-ANJO	1		\$28,553.00	16	\$456,848.00	
No Trusted Platform Module	384-BBSR	1		\$0.00	16	\$0.00	
2.5" Chassis with up to 10 Hard Drives, including up to 8 SAS/SATA or 9 NVME Drives	461-AADZ	1		\$0.00	16	\$0.00	
PowerEdge R6415 Shipping	321-BDFY	1		\$0.00	16	\$0.00	
PowerEdge R6415 x4 or x10 Drive Shipping Material	340-BTFM	1		\$0.00	16	\$0.00	
AMD EPYC™ 7551P 2.00GHz/2.55GHz, 32C/64T, 64M Cache (180W) DDR4-2666	343-BBGL	1		\$0.00	16	\$0.00	
Standard Heatsink	338-BNCU	1		\$0.00	16	\$0.00	
2666MT/s RDIMMs	412-AALH	1		\$0.00	16	\$0.00	
Performance Optimized	370-ADNU	1		\$0.00	16	\$0.00	
Unconfigured RAID	370-AAIP	1		\$0.00	16	\$0.00	
PERC H740P RAID Controller, 8GB NV Cache, Mini card	780-BCDS	1		\$0.00	16	\$0.00	
Red Hat Enterprise Linux Non Factory Install,x64,Req Lic&Sub Selection	405-AAMS	1		\$0.00	16	\$0.00	
iDRAC9,Enterprise	421-4727	1		\$0.00	16	\$0.00	
iDRAC Group Manager, Disabled	385-BBKT	1		\$0.00	16	\$0.00	
iDRAC,Factory Generated Password	379-BCQY	1		\$0.00	16	\$0.00	
Riser Config 1, 2 x 16 LP	379-BCSF	1		\$0.00	16	\$0.00	
On-Board LOM	330-BBIV	1		\$0.00	16	\$0.00	
No Internal Optical Drive	542-BBBP	1		\$0.00	16	\$0.00	
Dual, Hot Plug, Redundant Power Supply (1+1), 550W	429-AAIQ	1		\$0.00	16	\$0.00	
No Bezel	450-AGZB	1		\$0.00	16	\$0.00	
Dell EMC Luggage Tag	350-BBBW	1		\$0.00	16	\$0.00	
No Quick Sync	350-BBME	1		\$0.00	16	\$0.00	
Performance BIOS Settings	350-BBKR	1		\$0.00	16	\$0.00	
UEFI BIOS Boot Mode with GPT Partition	384-BBBL	1		\$0.00	16	\$0.00	
ReadyRails Sliding Rails With Cable Management Arm	800-BBDM	1		\$0.00	16	\$0.00	
No Systems Documentation, No OpenManage DVD Kit	770-BCKT	1		\$0.00	16	\$0.00	
Dell Hardware Limited Warranty Plus On-Site Service	631-AACK	1		\$0.00	16	\$0.00	
ProSupport Mission Critical: 7x24 HW / SW Technical Support and Assistance, 3 Years	816-0779	1		\$0.00	16	\$0.00	\$0.00
ProSupport Mission Critical: 4-Hour 7x24 On-Site Service with Emergency Dispatch, 3 Years	816-0796	1		\$1,438.00	16	\$23,008.00	\$23,008.00
Thank you choosing Dell ProSupport. For tech support, visit //www.dell.com/support or call 1-800- 945-3355	816-0784	1		\$262.00	16	\$4,192.00	\$4,192.00
On-Site Installation Declined	989-3439	1		\$0.00	16	\$0.00	\$0.00
32GB RDIMM 2666MT/s Dual Rank	900-9997	1		\$0.00	16	\$0.00	\$0.00
960GB SSD SATA 6Gbps 512e 2.5in Hot Plug S4510 Drive	370-ADNF	1		\$0.00	128	\$0.00	\$0.00
Dell 1.6TB, NVMe, Mixed Use Express Flash, 2.5 SFF Drive, U.2, PM1725a with Carrier	400-BDNJ	1		\$0.00	16	\$0.00	\$0.00
Mellanox ConnectX-4 Lx Dual Port 25GbE SFP28 Network Adapter, Low Profile	400-AUMP	1		\$0.00	48	\$0.00	\$0.00
C13 to C14, PDU Style, 12 AMP, 6.5 Feet (2m) Power Cord, North America	406-BBLD	1		\$0.00	16	\$0.00	\$0.00
Dell EMC S5148F-ON Switch,48x 25GbE,6x 100GbE QSFP28, IO to PSU,2 PSU,OS10	492-BBDI	1		\$0.00	32	\$0.00	\$0.00
OS10 Enterprise S5148F-ON	210-ANCK	1		\$25,701.00	1	\$25,701.00	\$25,701.00
Dell Networking, Cable, SFP28 to SFP28, 25GbE, Passive Copper Twinax Direct Attach Cable, 2 Meter	634-BMIF	1		\$0.00	1	\$0.00	\$0.00
Dell EMC S5148 Series User Guide	470-ACET	1		\$0.00	17	\$0.00	\$0.00
Force10, Power Cord, 125V, 15A, 10 Feet, NEMA 5-15/C13, S-Series	343-BBFV	1		\$0.00	1	\$0.00	\$0.00
Dell Hardware Limited Warranty 1 Year	450-AAFH	1		\$0.00	1	\$0.00	\$0.00
Thank you choosing Dell ProSupport. For tech support, visit //www.dell.com/support or call 1-800- 945-3355	814-8268	1		\$0.00	1	\$0.00	\$0.00
Dell Limited Hardware Warranty Extended Year(s)	989-3439	1		\$0.00	1	\$0.00	\$0.00
Mission Critical Package: 4-Hour 7X24 On-Site Service with Emergency Dispatch, 2 Year Extended	975-3461	1		\$0.00	1	\$0.00	\$0.00
ProSupport: 7x24 HW / SW Tech Support and Assistance, 3 Year	814-8278	1		\$423.00	1	\$423.00	\$423.00
Info 3rd Party Software Warranty provided by Vendor	814-8288	1		\$5,956.00	1	\$5,956.00	\$5,956.00
Mission Critical Package: 4-Hour 7X24 On-Site Service with Emergency Dispatch, 1 Year	997-6306	1		\$0.00	1	\$0.00	\$0.00
On-Site Installation Declined	814-8277	1		\$111.00	1	\$111.00	\$111.00
APC NetShelter SX 24U 600mm x 1070mm Deep Enclosure	900-9997	1		\$0.00	1	\$0.00	\$0.00
Rack PDU, Basic, Zero U, 15A, 120V, 5-15 input, (14) 5-15 output	A7067508	1		\$1,079.99	1	\$1,079.99	\$1,079.99
Logitech MK120 Keyboard and Mouse	A7541364	1		\$174.99	1	\$174.99	\$174.99
Dell 24 Monitor	A6999510	1		\$15.99	1	\$15.99	\$15.99
	210-AIWG	1		\$139.99	1	\$139.99	\$139.99
<b>Subtotal</b>						<b>\$483,959.96</b>	<b>\$33,690.00</b>

		<h1 style="margin: 0;">Dell PowerEdge R6415</h1>		TPCx-HS	v2.0.3		
				TPC Pricing	v2.4.0		
				Report Date	Jan. 23, 2019		
Description		Part Number	Source	Unit Price	Qty	Extended Price	3 Yr. Maint. Price
<b>PowerEdge R6415 Server</b>		210-ANJO	1	\$18,416.00	1	\$18,416.00	
PowerEdge R6415/R7415 Motherboard		384-BBSR	1	\$0.00	1	\$0.00	
No Trusted Platform Module		461-AADZ	1	\$0.00	1	\$0.00	
2.5" Chassis with up to 10 Hard Drives, including up to 8 SAS/SATA or 9 NVME Drives		321-BDFY	1	\$0.00	1	\$0.00	
PowerEdge R6415 Shipping		340-BTFM	1	\$0.00	1	\$0.00	
PowerEdge R6415 x4 or x10 Drive Shipping Material		343-BBGL	1	\$0.00	1	\$0.00	
AMD EPYC™ 7511P 2.00GHz/2.55GHz, 32C/64T, 64M Cache (180W) DDR4-2666		338-BNCU	1	\$0.00	1	\$0.00	
Standard Heatsink		412-AALH	1	\$0.00	1	\$0.00	
2666MT/s RDIMMs		370-ADNU	1	\$0.00	1	\$0.00	
Performance Optimized		370-AAIP	1	\$0.00	1	\$0.00	
Unconfigured RAID		780-BCDS	1	\$0.00	1	\$0.00	
PERC H740P RAID Controller, 8GB NV Cache, Mini card		405-AAMS	1	\$0.00	1	\$0.00	
Red Hat Enterprise Linux Non Factory Install,x64,Req Lic&Sub Selection		421-4727	1	\$0.00	1	\$0.00	
iDRAC9,Enterprise		385-BBKT	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	
Riser Config 1, 2 x 16 LP		330-BBIV	1	\$0.00	1	\$0.00	
On-Board LOM		542-BBBP	1	\$0.00	1	\$0.00	
No Internal Optical Drive		429-AAIQ	1	\$0.00	1	\$0.00	
Dual, Hot Plug, Redundant Power Supply (1+1), 550W		450-AGZB	1	\$0.00	1	\$0.00	
No Bezel		350-BBBW	1	\$0.00	1	\$0.00	
Dell EMC Luggage Tag		350-BBME	1	\$0.00	1	\$0.00	
No Quick Sync		350-BBKR	1	\$0.00	1	\$0.00	
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	\$0.00	1	\$0.00	
No Systems Documentation, No OpenManage DVD Kit		631-AACK	1	\$0.00	1	\$0.00	
Dell Hardware Limited Warranty Plus On-Site Service		816-0779	1	\$0.00	1	\$0.00	\$0.00
ProSupport Mission Critical: 7x24 HW / SW Technical Support and Assistance, 3 Years		816-0796	1	\$1,438.00	1	\$1,438.00	\$1,438.00
ProSupport Mission Critical: 4-Hour 7x24 On-Site Service with Emergency Dispatch, 3 Years		816-0784	1	\$262.00	1	\$262.00	\$262.00
Thank you choosing Dell ProSupport. For tech support, visit //www.dell.com/support or call 1-800- 945-3355		989-3439	1	\$0.00	1	\$0.00	\$0.00
On-Site Installation Declined		900-9997	1	\$0.00	1	\$0.00	\$0.00
32GB RDIMM 2666MT/s Dual Rank		370-ADNF	1	\$0.00	8	\$0.00	\$0.00
960GB SSD SATA 6Gbps 512e 2.5in Hot Plug S4510 Drive		400-BDNJ	1	\$0.00	1	\$0.00	\$0.00
Mellanox ConnectX-4 Lx Dual Port 25GbE SFP28 Network Adapter, Low Profile		406-BBLD	1	\$0.00	1	\$0.00	\$0.00
C13 to C14, PDU Style, 12 AMP, 6.5 Feet (2m) Power Cord, North America		492-BBDI	1	\$0.00	2	\$0.00	\$0.00
<b>Sub Total</b>						\$18,416.00	\$1,700.00
<b>HARDWARE COMPONENTS</b>						<b>Subtotal</b>	<b>\$502,375.96</b>
<b>SOFTWARE COMPONENTS</b>							
SEL Cloudera Basic Gold Node , Node License, 24x7, 3YR		CEBN-GOLD-I	1	\$7,386.00	17	\$125,562.00	\$125,562.00
Red Hat Enterprise Linux, Non Factory Install, x64, Reqs Lic & Sub Selection		421-4727	1	\$0.00	17	\$0.00	\$0.00
Red Hat Linux Registration Document, No Subscription		340-AVFG	1	\$0.00	17	\$0.00	\$0.00
Red Hat Enterprise Linux,1-25KT,3yr Premium Subscription,1 Virtual Guest		421-5721	1	\$3,702.00	17	\$62,934.00	\$62,934.00
<b>SOFTWARE COMPONENTS</b>						<b>Subtotal</b>	<b>\$0.00</b>
<b>Total</b>						<b>\$502,375.96</b>	<b>\$223,886.00</b>
Large Purchase Discount (35%)*						-\$175,831.59	-\$78,360.10
<p>Pricing: 1 = Dell; 1S = One or more components of the Measured Configuration have been substituted in the Priced Configuration. See the FDR for details.                  * Discount applies to all line items where Key = 1. Discount based upon total system cost as purchased by a regular customer.</p>				<p><b>Three-Year Cost of Ownership: \$472,071</b></p> <p><b>HSPH@10TB: 17.19</b></p> <p><b>\$/HSPH@10TB: \$27,461.96</b></p>			
<p><b>Audited by Doug Johnson, InfoSizing</b></p> <p><i>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.</i></p>							

	<h1>Dell PowerEdge R6415</h1>	TPCx-HS	v2.0.3
		TPC Pricing	v2.4.0
		Report Date	Jan. 23, 2019
<h2>Numerical Quantities</h2>			
<h3>Performance Run – Run 1</h3>			
Scale Factor			10TB
Run Start Time	2018-12-12 22:13:32.000		
Run End Time	2018-12-12 22:48:23.000		
Run Elapsed Time			2,094.000
HSGen Start Time	2018-12-12 22:13:33.000		
HSGen End Time	2018-12-12 22:22:26.000		
HSGen Elapsed Time			534.793
HSSort Start Time	2018-12-12 22:22:29.000		
HSSort End Time	2018-12-12 22:45:00.000		
HSSort Elapsed Time			1,351.870
HSValidate Start Time	2018-12-12 22:45:04.000		
HSValidate End Time	2018-12-12 22:48:23.000		
HSValidate Elapsed Time			201.125
<h3>Repeatability Run – Run 2</h3>			
Scale Factor			10TB
Run Start Time	2018-12-12 22:49:29.000		
Run End Time	2018-12-12 23:24:15.000		
Run Elapsed Time			2,089.000
HSGen Start Time	2018-12-12 22:49:31.000		
HSGen End Time	2018-12-12 22:58:27.000		
HSGen Elapsed Time			537.405
HSSort Start Time	2018-12-12 22:58:30.000		
HSSort End Time	2018-12-12 23:20:59.000		
HSSort Elapsed Time			1,350.761
HSValidate Start Time	2018-12-12 23:21:03.000		
HSValidate End Time	2018-12-12 23:24:15.000		
HSValidate Elapsed Time			194.029



# Dell PowerEdge R6415

TPCx-HS	v2.0.3
TPC Pricing	v2.4.0
Report Date	Jan. 23, 2019

## Run Reports

### Run Report for Performance Run – Run 1

#### TPCx-HS Performance Metric (HSph@SF) Report

Test Run 1 Details	Total Time =	2094
	Total Size =	100000000000
	Scale-Factor =	10

TPCx-HS Performance Metric (HSph@SF): 17.1939


### Run Report for Repeatability Run – Run 2

#### TPCx-HS Performance Metric (HSph@SF) Report

Test Run 2 Details	Total Time =	2089
	Total Size =	100000000000
	Scale-Factor =	10

TPCx-HS Performance Metric (HSph@SF): 17.2354



	<b>Dell PowerEdge R6415</b>	TPCx-HS v2.0.3 TPC Pricing v2.4.0 Report Date Jan. 23, 2019
<b>Revision History</b>		
Date January 23, 2019	Edition First	Description Initial Publication

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## 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](http://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](http://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

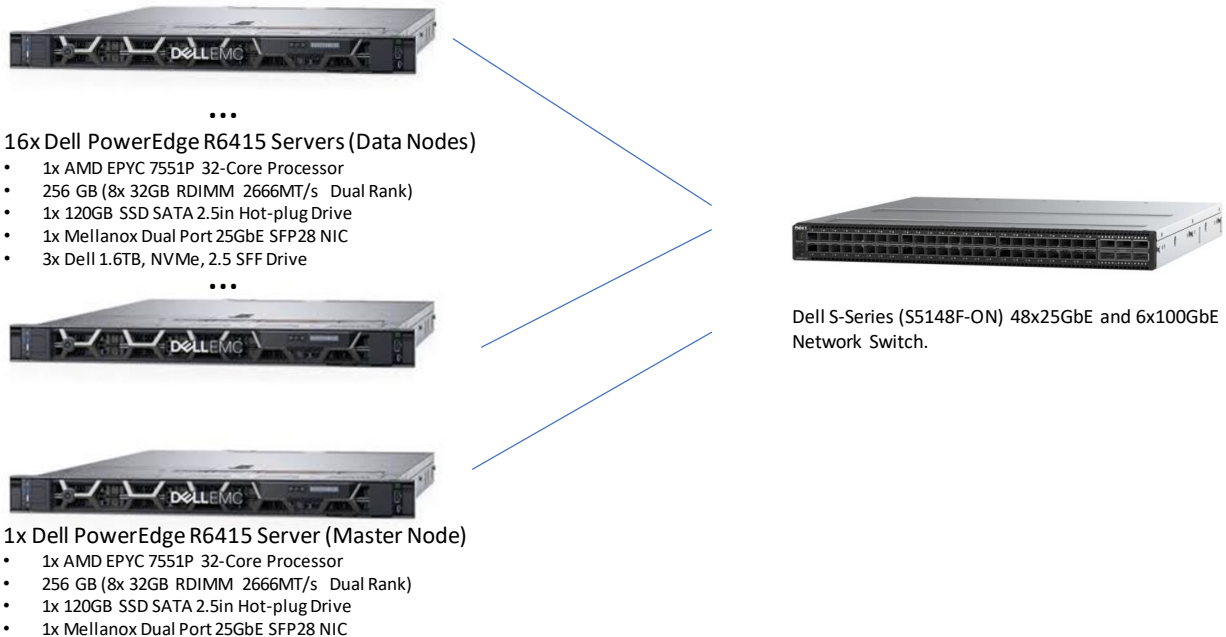


Figure 1-1 Measured Configuration

The measured configuration consisted of:

- Total Nodes: 17 (17x Dell PowerEdge R6415)
- Total Processors/Cores/Threads: 17/544/1,088
- Total Memory: 4.25TiB
- Total Number of Storage Drives/Devices: 65
- Total Storage Capacity: 93.12TB

Server node details:

- 17x Dell PowerEdge R6415 Servers, each with:
  - Processors/Cores/Threads: 1/32/64
  - Processor Model: AMD EPYC 7551P 32-Core
  - Memory: 256 GiB
  - Controller: Perc H740P
  - Drives:
    - 1x 120 GB SSD SATA (all nodes)
    - 3x Dell 1.6TB NVMe (Data Nodes)
  - Network: 1x Mellanox Dual Port 25GbE SFP28 NIC

Network connectivity detail:

- Dell S-Series (S5148F-ON) Network Switch

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

### 1.3.2 Priced Configuration

All nodes in the measured configuration used 1x Intel® SSD DC S3520 Series 120GB drive as a system disk. All nodes in the priced configuration use 1x Intel® SSD D3-S4510 Series 960GB drive as a substitute. The substitution was allowed under TPC Pricing rules based on the following data.

Characteristic	<u>Priced</u> SSD 960GB S4510 Series	<u>Measured</u> SSD 120GB S3520 Series
Dell Part number	400-BDNJ	400-ASEG
Interface	SATA III 6 Gb/s	SATA III 6 Gb/s
Lithography type	3D NAND TLC	3D NAND MLC
Latency Read	36 us	40us
Latency write	37 us	42us
Sequential Read (up to)	560 MB/s	450 MB/s
Sequential write (up to)	510 MB/s	380 MB /s
Form Factor	2.5"	2.5"
Launch Date	Q3'18	2016
Random I/O Read (upto)	95K IOPS	67.5K IOPS
Random I/O Write (upto)	36K IOPS	17K IOPS

## 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	Perc H740p	sda	Operating System, Root, Swap, Hadoop Master
2-3	Perc H740p	sda	Operating System, Root, Swap, Hadoop Master
2-3	NVMe	nvme0n1, nvme1n1, nvme2n1	Data, Temp
4-17	Perc H740p	Sda	Operating System, Root, Swap, Hadoop Master
4-17	NVMe	nvme0n1, nvme1n1, nvme2n1	Data, Temp

*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.

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

Cloudera Enterprise Edition 6.0 (fully HDFS compatible at the API level).

*Map/Reduce implementation and corresponding version must be disclosed.*

Cloudera Enterprise Edition 6.0 (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 – Performance Run
=====
TPCx-HS Performance Metric (HSph@SF) Report

Test Run 1 Details      Total Time =                2094
                        Total Size =                100000000000
                        Scale-Factor =                10

TPCx-HS Performance Metric (HSph@SF):                17.1939

=====
```

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

Test Run 2 Details      Total Time =                2089
                        Total Size =                100000000000
                        Scale-Factor =                10

TPCx-HS Performance Metric (HSph@SF):                17.2354

=====
```

### 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
HSDDataCheck.sh                faeff3091759aac98080be4e39f7896a
TPCx-HS-master_MR2.jar         492cbc51a1a60c28b43d96c79d08683d
TPCx-HS-master.sh              c619a0819571ecd00cd75d2b76ba8c64
```

### 2.4 Benchmark Kit Changes

No modifications were made to the TPC-provided kit.



## 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.

Qty	Capacity	Total	Total (TB)
17	960GB	16,320GB	16.32
48	1.6TB	76.8TB	76.8
<b>Total Storage (TB)</b>			<b>93.12</b>

*Table 3-1 Storage Device Capacities*

Scale Factor = 10

**Data Storage Ratio** = (Total Storage (TB) / SF) = **9.31**

### 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	534.793	537.405

Table 4-1 HSGen Times

### 4.2 HSSort Time

The HSSort time must be disclosed for Run1 and Run2.

	Run 1	Run 2
HSSort	1,351.870	1,350.761

Table 4-2 HSSort Times

### 4.3 HSValidate Time

The HSValidate time must be disclosed for Run1 and Run2.

	Run 1	Run 2
HSValidate	201.125	194.029

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)	3.000	3.000
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@10TB	17.19	17.23

Table 4-5 Performance Metrics

Run 1 Price-Performance: 27,461.96 \$/ 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](http://www.tpc.org).

A copy of the auditor's Letter of Attestation follows.



Mr. Nicholas Wakou  
Dell Inc.  
701 E. Parmer Ln. Bldg. 2  
Austin, TX 78753

January 22, 2019

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

Platform: Dell PowerEdge R6415 (with 17x Dell PowerEdge R6415 Servers)  
Operating System: Red Hat Enterprise Linux Server 7.5  
Apache Hadoop Cloudera Enterprise Edition V6.0 (MapReduce)  
Compatible Software:

The results were:

**Performance Metric 17.19 HSph@10TB**  
Run Elapsed Time 2,094.00 Seconds

Cluster	<b>17x Dell PowerEdge R6415 Servers, each node with:</b>		
CPU	1 x AMD EPYC 7551P (2.00 GHz, 32-core, 64 MB L3)		
Memory	256 GB		
Storage	<b>Qty</b>	<b>Size</b>	<b>Type</b>
	1	960GB	SSD SATA (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 10TB
- 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:

The measured configuration included (17) Intel® SSD DC S3520 Series 120GB drives that were substituted by (17) 1x Intel® SSD D3-S4510 Series 960GB drives. Based on the specifications of these disks, it is my opinion that this substitution has no significant effect on performance.

Respectfully Yours,



Doug Johnson, Certified TPC Auditor

63 Lourdes Dr. | Leominster, MA 01453 | 978-343-6562 | [www.sizing.com](http://www.sizing.com)

## 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

All components are directly available through the Test Sponsor, Dell Inc.