



*Cisco Systems, Inc.*

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TPC Express Benchmark™ HS (TPCx-HS)  
Full Disclosure Report  
for  
Cisco UCS Integrated Infrastructure for Big Data  
(with 32 Cisco UCS C240M4 Servers)  
using  
IBM Open Platform (IBM IOP) 4.1  
and  
Red Hat Enterprise Linux Server Release 6.7

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**First Edition**

**July 7, 2016**

**Revised August 1, 2016**

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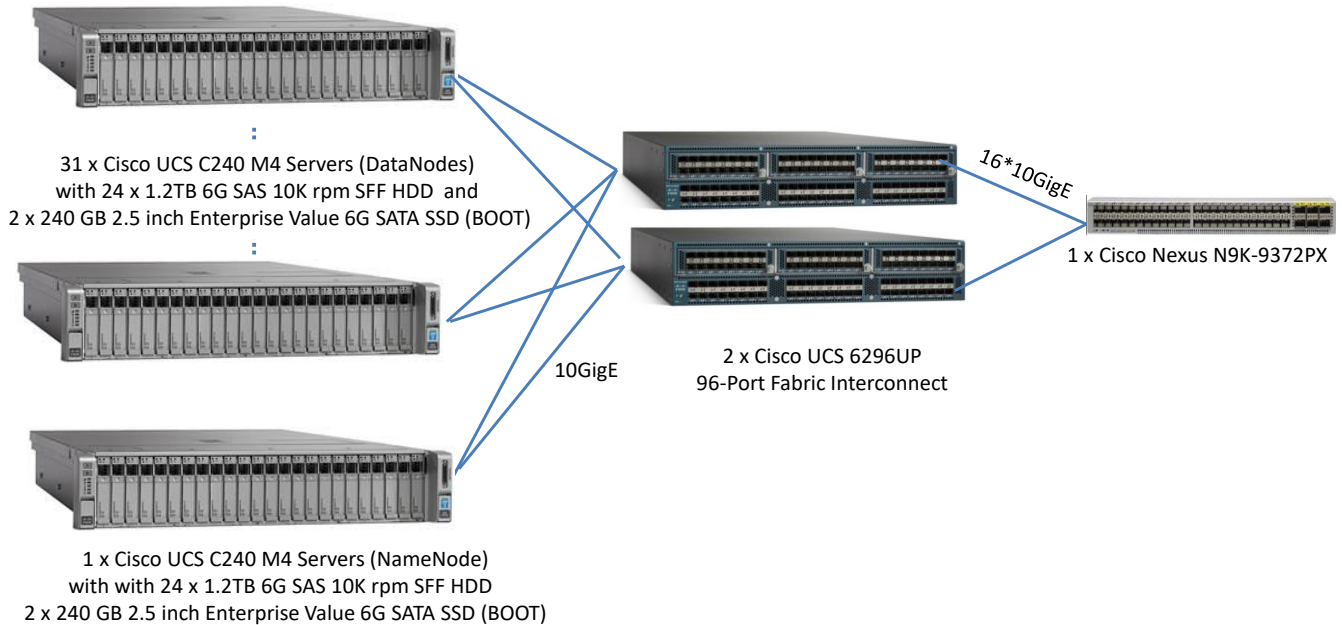
## Cisco UCS Integrated Infrastructure for Big Data

TPCx-HS Rev. 1.4.0  
TPC-Pricing Rev. 2.1.0

Report Date: **July 7, 2016**  
Revised: **August 1, 2016**

Total System Cost		TPCx-HS Performance Metric		Price/Performance	
<b>842,308 USD</b>		<b>22.26</b> HSph @ 100TB		<b>37,839.54 USD</b> \$/HSph @ 100TB	
Scale Factor	Apache Hadoop Compatible Software	Operating System	Other Software	Availability Date	
100TB	IBM Open Platform (IBM IOP) 4.1	Red Hat Enterprise Linux Server Release 6.7	None	July 7, 2016	

### System Configuration



Physical Storage/Scale Factor: 9.37

Scale Factor/Physical Memory: 12.50

Servers:	32 x Cisco UCS C240M4 Server
Total Processors/Cores/Threads	64/896 /1,792
Server Configuration:	Per node:
Processors	2 x Intel® Xeon® Processor E5-2680 v4, 2.40 GHz, 35 MB L3
Memory	256GB
Storage Controller	1 x Cisco 12G SAS Modular Raid Controller
Storage Device	24 x 1.2TB 12G SAS 10KrpmSFF HDD 2 x 240GB 2.5in. Enterprise Value 6G SATA SSD (boot disk)
Network	1 x Cisco UCS VIC 1227 MLOM - Dual Port 10Gb SFP+
Connectivity:	2 x Cisco UCS 6296UP 96-Port Fabric Interconnect 1 x Cisco Nexus N9K-9372PX
Total Rack Units:	(32*2RU)+(2*2RU)+(1*1RU) = 69RU



## Cisco UCS Integrated Infrastructure for Big Data

TPCx-HS Rev. 1.4.0  
TPC-Pricing Rev. 2.1.0

Report Date: July 7, 2016  
Revised: August 1, 2016

Description	Part Number	Source	Unit Price	Qty	Extended Price	3 Year Maint. Price
Cisco UCS Integrated Infrastructure for Big Data Performance Optimized B	UCS-SL-CPA4-P1	1	\$685,107.18	1	\$ 685,107.18	
UCS C240M4SX	UCS-SPBD-C240M4-P1	1	-	16	-	
2.40 GHz E5-2680 v4/120W 14C/35MB Cache/DDR4 2400MHz	UCS-CPU-E52680E	1	-	32	-	
16GB DDR4-2133-MHz RDIMM/PC4-17000/dual rank/x4/1.2v	UCS-MR-1X162RU-A	1	-	256	-	
1.2 TB 12G SAS 10K RPM SFF HDD	UCS-HD12TB10K12G	1	-	384	-	
240 GB 2.5 inch Enterprise Value 6G SATA SSD (boot)	UCS-SD240GBKS4-EB	1	-	32	-	
Right PCI Riser Bd (Riser 1) 2onbd SATA bootdrvs+ 2PCI slts	UCSC-PCI-1C-240M4	1	-	16	-	
Cisco UCS VIC1227 VIC MLOM - Dual Port 10Gb SFP+	UCSC-MLOM-CSC-02	1	-	16	-	
1200W / 800W V2 AC Power Supply for 2U C-Series Servers	UCSC-PSU2V2-1200W	1	-	32	-	
Power Cord, 125V AC 13A NEMA 5-15 Plug, North America	CAB-9K12A-NA	1	-	32	-	
Ball Bearing Rail Kit for C220 M4 and C240 M4 rack servers	UCSC-RAILB-M4	1	-	16	-	
Supercap cable 250mm	UCSC-SCCBL240	1	-	16	-	
Heat sink for UCS C240 M4 rack servers	UCSC-HS-C240M4	1	-	32	-	
Cisco 12G SAS Modular Raid Controller	UCSC-MRAID12G	1	-	16	-	
Cisco 12Gbps SAS 2GB FBWC Cache module (Raid 0/1/5/6)	UCSC-MRAID12G-2GB	1	-	16	-	
(Not sold standalone) UCS 6296UP 2RU FI w /18p LIC, 16xCables	UCS-SA-BD-FI96	1	-	2	-	
UCS 6296UP Power Supply/100-240V AC	UCS-PSU-6296UP-AC	1	-	4	-	
Power Cord, 125V AC 13A NEMA 5-15 Plug, North America	CAB-9K12A-NA	1	-	4	-	
10GBASE-CU SFP+ Cable 3 Meter	SFP-H10GB-CU3M	1	-	32	-	
UCS Manager v3.1	N10-MGT014	1	-	2	-	
UCS 6296UP Chassis Accessory Kit	UCS-ACC-6296UP	1	-	2	-	
UCS 6296UP Fan Module	UCS-FAN-6296UP	1	-	8	-	
UCS 6200 Series Expansion Module Blank	UCS-BLKE-6200	1	-	6	-	
UCS C240M4SX	UCS-SPBD-C240M4-P1	1	\$ 40,663.00	16	\$ 650,608.00	
2.40 GHz E5-2680 v4/120W 14C/35MB Cache/DDR4 2400MHz	UCS-CPU-E52680E	1	-	32	-	
16GB DDR4-2133-MHz RDIMM/PC4-17000/dual rank/x4/1.2v	UCS-MR-1X162RU-A	1	-	256	-	
1.2 TB 12G SAS 10K RPM SFF HDD	UCS-HD12TB10K12G	1	-	384	-	
240 GB 2.5 inch Enterprise Value 6G SATA SSD (boot)	UCS-SD240GBKS4-EB	1	-	32	-	
Right PCI Riser Bd (Riser 1) 2onbd SATA bootdrvs+ 2PCI slts	UCSC-PCI-1C-240M4	1	-	16	-	
Cisco UCS VIC1227 VIC MLOM - Dual Port 10Gb SFP+	UCSC-MLOM-CSC-02	1	-	16	-	
1200W / 800W V2 AC Power Supply for 2U C-Series Servers	UCSC-PSU2V2-1200W	1	-	32	-	
Power Cord, 125V AC 13A NEMA 5-15 Plug, North America	CAB-9K12A-NA	1	-	32	-	
Ball Bearing Rail Kit for C220 M4 and C240 M4 rack servers	UCSC-RAILB-M4	1	-	16	-	
Supercap cable 250mm	UCSC-SCCBL240	1	-	16	-	
Heat sink for UCS C240 M4 rack servers	UCSC-HS-C240M4	1	-	32	-	
Cisco 12G SAS Modular Raid Controller	UCSC-MRAID12G	1	-	16	-	
Cisco 12Gbps SAS 2GB FBWC Cache module (Raid 0/1/5/6)	UCSC-MRAID12G-2GB	1	-	16	-	



## Cisco UCS Integrated Infrastructure for Big Data

TPCx-HS Rev. 1.4.0  
TPC-Pricing Rev. 2.1.0

Report Date: July 7, 2016  
Revised: August 1, 2016

Description	Part Number	Source	Unit Price	Qty	Extended Price	3 Year Maint. Price
Cisco Nexus 9372PX Switch	N9K-C9372PX	1	\$ 22,500.00	1	\$ 22,500.00	
Cisco SNTP Cisco Nexus 9372PX Switch, 36 24x7	CON-SNTP-9372PX	1	\$ 5,256.00	1		\$ 5,256.00
Nexus 9500 or 9300 Base NX-OS Software Rel 6.1(2)I3(3A)	N9KDK9-612I3.3A	1	-	1	-	
Nexus 3K/9K Fixed Accessory Kit	N3K-C3064-ACC-KIT	1	-	1	-	
Nexus 2K/3K/9K Single Fan, port side exhaust airflow	NXA-FAN-30CFM-F	1	-	4	-	
Power Cord, 250VAC 10A CEE 7/7 Plug, EU	CAB-9K10A-EU	1	-	2	-	
Nexus 9300 650W AC PS, Port-side Exhaust	N9K-PAC-650W-B	1	-	2	-	
2rd Gen FI License to connect C-direct only	UCS-L-6200-10G-C	1	\$ 925.00	60	\$ 55,500.00	
10GBASE-CU SFP+ Cable 3 Meter	SFP-H10GB-CU3M	1	\$100	64	\$6,400	
Cisco Smart Net 24X7X4 3Y UCS C240 M4S BD SP Server	CON-OSP-C240V4SP	1	\$ 1,284.99	32		\$41,120
Cisco R42610 standard rack w/side panels	RACK-UCS2	1	\$ 3,429.00	2	\$ 6,858.00	
Cisco Smart Net 24X7X4 3Y UCS 6296UP 2RU Fabric Int/2 PSU/4 Fans	CON-SNTP-FI6296UP	1	\$ 5,781.00	2		\$11,562
Red Hat Enterprise Linux Server, 3Y 24x7	CON-ISV1-RH2SUG3A	1	\$ 2,397.00	32	\$ 76,704.00	
<b>Total</b>					<b>\$1,503,677.18</b>	<b>\$ 57,937.68</b>
Large Purchase Discount 1	61% for products and 35% for service	1			\$ (917,243.08)	\$(20,278.19)
Acer V206HQLAbd - LED monitor - 20" (Inc 2 spares)	UM.1V6AA.A02	2	79.99	3	\$ 239.97	
Logitech USB Corded Keyboard/Mouse Combo MK120 (Inc 2 spares)	920-002565	2	17.99	3	\$ 53.97	
IBM Elite Support for Apache Hadoop	IBM-D1G8TLL	3	6810	32	\$ 217,920.00	

Pricing: 1 = Cisco, 2 = CDW.com, 3 = IBM <sup>(1)</sup> All discounts are based on US list prices and for similar quantities and configurations. The discounts are based on the overall specific components pricing from respective vendors in this single quotation. Discounts for similarly sized configurations will be similar to those quoted here, but may vary based on the components in the configuration.	<b>Three-Year Cost of Ownership</b> <b>\$842,308</b>  <b>HSph@100TB</b> <b>22.26</b>  <b>\$/HSph@100TB</b> <b>\$37,839.54</b>
<b>Audited by Doug Johnson of InfoSizing</b>	

Prices used in TPC benchmarks reflect the actual prices a customer would pay for a one-time purchase of the stated components. 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 components. For complete details, see the pricing sections of the TPC benchmark specifications. If you find that the stated prices are not available according to these terms, please inform at [pricing@tpc.org](mailto:pricing@tpc.org). Thank you.



## Cisco UCS Integrated Infrastructure for Big Data

TPCx-HS Rev. 1.4.0  
TPC-Pricing Rev. 2.1.0

Report Date: July 7, 2016  
Revised: August 1, 2016

### Performance Run

Scale Factor	100TB
Run Start Time	2016-06-25 11:21:03
Run End Time	2016-06-25 15:50:32
Run Elapsed Time	16,171.000
HSGen Start Time	2016-06-25 11:21:04
HSGen End Time	2016-06-25 12:26:11
HSGen Elapsed Time	3,908.233
HSSort Start Time	2016-06-25 12:26:13
HSSort End Time	2016-06-25 15:21:42
HSSort Elapsed Time	10,529.997
HSValidate Start Time	2016-06-25 15:21:46
HSValidate End Time	2016-06-25 15:50:32
HSValidate Elapsed Time	1,727.825

### Repeatability Run

Scale Factor	100TB
Run Start Time	2016-06-25 16:00:42
Run End Time	2016-06-25 20:29:26
Run Elapsed Time	16,126.000
HSGen Start Time	2016-06-25 16:00:43
HSGen End Time	2016-06-25 17:06:02
HSGen Elapsed Time	3,920.592
HSSort Start Time	2016-06-25 17:06:05
HSSort End Time	2016-06-25 20:00:17
HSSort Elapsed Time	10,453.239
HSValidate Start Time	2016-06-25 20:00:20
HSValidate End Time	2016-06-25 20:29:26
HSValidate Elapsed Time	1,747.406



# Cisco UCS Integrated Infrastructure for Big Data

TPCx-HS Rev. 1.4.0  
TPC-Pricing Rev. 2.1.0

Report Date: July 7, 2016  
Revised: August 1, 2016

## Run Report for Performance Run - Run 1

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

Test Run 1 Details	Total Time =	16171
	Total Size =	1000000000000
	Scale-Factor =	100

TPCx-HS Performance Metric (HSph@SF): 22.2622

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## Run Report for Repeatability Run - Run 2

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

Test Run 2 Details	Total Time =	16126
	Total Size =	1000000000000
	Scale-Factor =	100

TPCx-HS Performance Metric (HSph@SF): 22.3244

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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 1.4.0.

The test was conducted at a Scale Factor of 100TB with 32 Cisco UCS C240M4 Servers running IBM Open Platform (IBM IOP) 4.1 on Red Hat Enterprise Linux Server Release 6.7.

## Measured Configuration

Company Name	Cluster Node	Virtualization	Operating System
Cisco Systems, Inc.	Cisco UCS C240M4 Server	n/a	Red Hat Enterprise Linux Server Release 6.7

## TPC Express Benchmark©HS Metrics

Total System Cost	HSph@100TB	Price/Performance	Availability Date
842,308 USD	22.26	37,839.54 USD	July 7, 2016

# Preface

## TPC Express Benchmark™ HS Overview

*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. The 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. The 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-H 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 Cisco Systems, 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.*

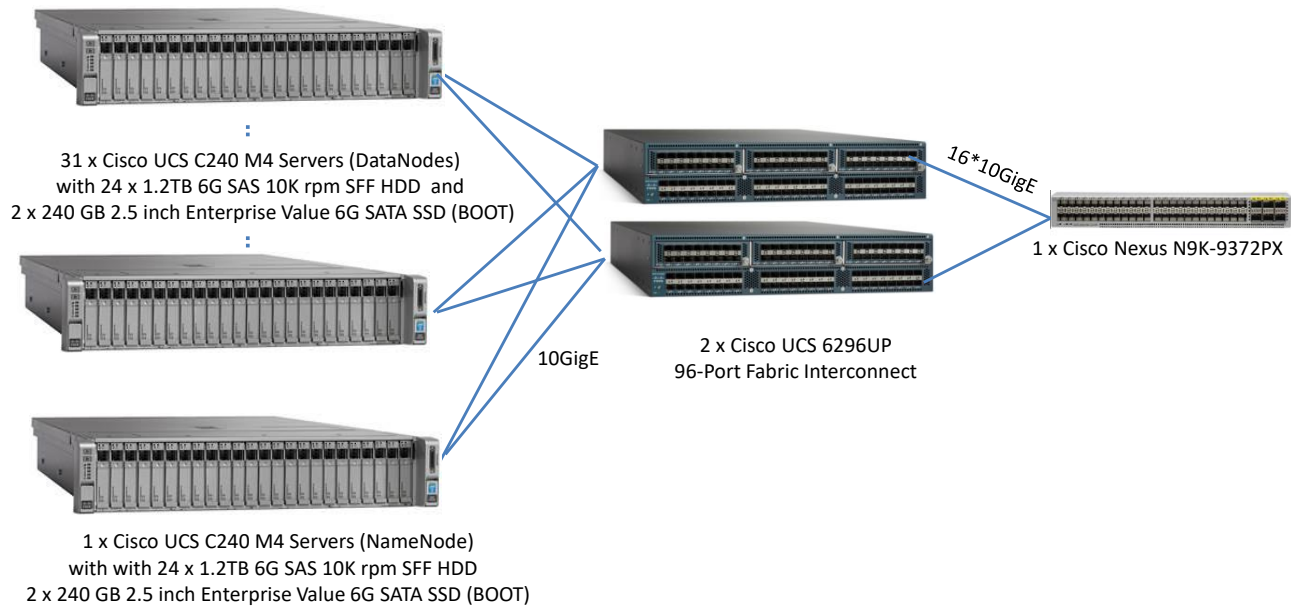
The supporting files contain the parameters and options used to configure the components involved in this benchmark.

## 1.3 Configuration Diagrams

*7.4.4 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.*

## Measured Configuration



The measured configuration consisted of:

- Total Nodes: 32
- Total Processors/Cores/Threads: 64/896 /1,792
- Total Memory: 8TB
- Total Number of Storage Drives/Devices: 832
- Total Storage Capacity: 936.96TB

Server nodes details:

- 32 x Cisco UCS C240M4 Servers, each with:
  - Processors/Cores/Threads: 2/28 /56
  - Processor Model: 2 x Intel® Xeon® Processor E5-2680 v4, 2.40 GHz, 35 MB L3
  - Memory: 256GB
  - Controller: 1 x Cisco 12G SAS Modular Raid Controller
  - Drives:
    - 24 x 1.2TB 12G SAS 10Krpm SFF HDD
    - 2 x 240GB 2.5in. Enterprise Value 6G SATA SSD (boot disk)
  - Network: 1 x Cisco UCS VIC 1227 MLOM - Dual Port 10Gb SFP+

Network connectivity detail:

- 2 x Cisco UCS 6296UP 96-Port Fabric Interconnect
- 1 x Cisco Nexus N9K-9372PX

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

## Priced Configuration

There are no differences between the priced and measured configurations.

## 1.4 Dataset Distribution

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

Table 1.4 describes the distribution of the dataset across all media in the system.

**Table 1.4: Dataset Distribution**

Server Node	Controller	Disk Drive	Description of Content
1-32	MegaRAID 3108	1-24 (HDD)	Data, Temp
1-32	Intel Chipset Embedded SATA RAID	0 (2 SSD, RAID-1)	Operating system, root, swap, Hadoop Master

## 1.5 Software Components Distribution

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

Table 1.5 describes the distribution of the software components across the system.

**Table 1.5: Software Component Distribution**

Node	Map/Reduce		HDFS		ZooKeeper
	Resource Manager	Node Manager	NameNode	DataNode	QuorumPeer
1	X		X		X
2		X		X	X
3		X		X	X
4-32		X		X	

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

IBM Open Platform (IBM IOP) 4.1 (fully HDFS compatible at the API level).

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

IBM Open Platform (IBM IOP) 4.1 (compatible equivalent to Hadoop 2.7.1).

# Clause 2: Workload Related Items

## 2.1 Hardware & Software Tunable

*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

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

Test Run 1 Details	Total Time =	16171
	Total Size =	1000000000000
	Scale-Factor =	100

TPCx-HS Performance Metric (HSph@SF): 22.2622

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### Run Report for Run 2 - Repeatability Run

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

Test Run 1 Details	Total Time =	16126
	Total Size =	1000000000000
	Scale-Factor =	100

TPCx-HS Performance Metric (HSph@SF): 22.3244

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## 2.3 Benchmark Kit Identification

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

Kit Version	1.4.0
File	MD5
BigData_cluster_validate_suite.sh	58c13ddb98a2d1228f2df10f4a087a71
TPCx-HS-master.jar	a7310f65339708afe92af0029960a2cc
TPCx-HS-master.sh	f716204449c12247f57b1ed3a5e03703

## 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.

**Table 3.1: Storage Device Capacity**

Qty	Capacity (GB)	Total (GB)
768	1,200	921,600
64	240	15,360
<b>Total Storage (TB)</b>		<b>936.96</b>

Scale Factor = 100TB

**Data Storage Ratio** = (Storage / SF) = **9.37**

## 3.2 Memory Ratio

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

Total Configured Memory = 8TB

**Scale Factor to Memory Ratio** = (SF / Memory) = **12.50**



# Clause 4: Scale Factors and Metrics

## 4.1 HSGen Time

The HSGen time must be disclosed for Run1 and Run2.

	Run1	Run2
HSGen	3,908.233	3,920.592

## 4.2 HSSort Time

The HSSort time must be disclosed for Run1 and Run2.

	Run1	Run2
HSSort	10,529.997	10,453.239

## 4.3 HSValidate Time

The HSValidate time must be disclosed for Run1 and Run2.

	Run1	Run2
HSValidate	1,727.825	1,747.406

## 4.4 HSDataCheck Times

Both HSDataCheck times must be disclosed for Run1 and Run2.

	Run1	Run2
HSDataCheck (pre-Sort)	2.000	3.000
HSDataCheck (post-Sort)	4.000	3.000

## 4.5 Performance & Price-Performance

The performance metric (HSph@SF) must be disclosed for Run1 and Run2. Price-performance metric (\$/HSph@SF) must be disclosed for the performance run.

	Run1	Run2
HSph@100TB	22.26	22.32

\$/HSph@100TB	37,839.54 USD
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# Auditors' Information and Attestation Letter

*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 for InfoSizing

www.sizing.com  
20 Kreg Lane  
Manitou Springs, CO 80829  
719-473-7555.

This benchmark's Full Disclosure Report (FDR) can be downloaded from [www.tpc.org](http://www.tpc.org).

A copy of the auditor's attestation letter is included in the next two pages.

Raghunath Nambiar  
Cisco Systems Inc.  
3800 Zanker Road  
San Jose, CA 95134

July 02, 2016

I verified the TPC Express Benchmark™ HS v1.4.0 performance of the following configuration:

Platform: Cisco UCS Integrated Infrastructure for Big Data (Cisco UCS CPA v4)  
(with 32 Cisco UCS C240M4 Servers)  
Operating System: Red Hat Enterprise Linux Server 6.7  
Apache Hadoop IBM Open Platform (IBM IOP) 4.1  
Compatible Software:

The results were:

**Performance Metric 22.26 HSph@100TB**

Run Elapsed Time 16,171.00 Seconds

**Cluster 32 Cisco UCS C240M4 Servers**

CPU	2 x Intel Xeon Processor E5-2680 v4 (2.40 GHz, 14-core, 35 MB L3)		
Memory	256 GB		
Storage	<b>Qty</b>	<b>Size</b>	<b>Type</b>
	24	1.2 TB	10K rpm SFF HDD
	2	240GB	SATA SSD (boot disk)

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 v1.4.0
- 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 100TB
- 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

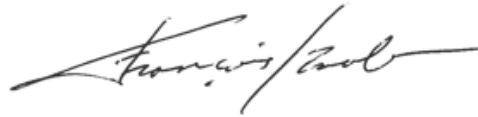
Additional Audit Notes:

Due to a small error in the TPC-provided kit the version in the run report file shows as v1.3.0 rather than v1.4.0. None the less, this is a v1.4.0 result produced with a v1.4.0 compliant kit.

Respectfully Yours,



Doug Johnson, Auditor



François Raab, President

# Supporting File Index

The following index outlines the information included in the supporting files archive.

Clause	Description	Archive File Pathname
Clause 1	Parameters and options used to configure the system	SupportingFilesArchive\Clause1
Clause 2	Configuration scripts & Run report	SupportingFilesArchive\Clause2
Clause 3	System configuration details	SupportingFilesArchive\Clause3

# Third Party Price Quotes

IBM

Date: 6/27/16

Cisco  
Raghunath Nambiar

3800 Zanker Road

San Jose, CA 95134

Here is the information you requested regarding pricing for IBM products to be used in conjunction with your TPC-H benchmark testing.

All pricing shown is in US Dollars (\$).

<b>Part Number</b>	<b>Description</b>	<b>Unit Price</b>	<b>Quantity</b>	<b>Price</b>
DIG8TLL	IBM Elite Support for Apache Hadoop Unlimited Contacts SW Support 12 Months	\$2,580 per Virtual Server (US – SRP)  Retail Discounted Price: \$2,270	1 Virtual Server per 1 Node - for 3 years	\$6,810

This quote is valid for the next 60 days.

IBM IOP Team



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### Logitech MK120 USB Wired Keyboard/Mouse Set – \$4.50 svgs while supplies last

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1

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1

~~\$105.00~~

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- LED monitor
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Acer Two-way freight for depot – extended service agreement – 3 years – pic

0

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Advertised Price