Dell Inc.

TPC Express Benchmark™ Big Bench (TPCx-BB)

Full Disclosure Report

for

Dell PowerEdge R660/R760

(with 1x PowerEdge R660; 10x PowerEdge R760)

using

Cloudera CDP Private Cloud Base v7.1.7

and

Red Hat Enterprise Linux 8.6 (Ootpa)

First Edition

November 3, 2023

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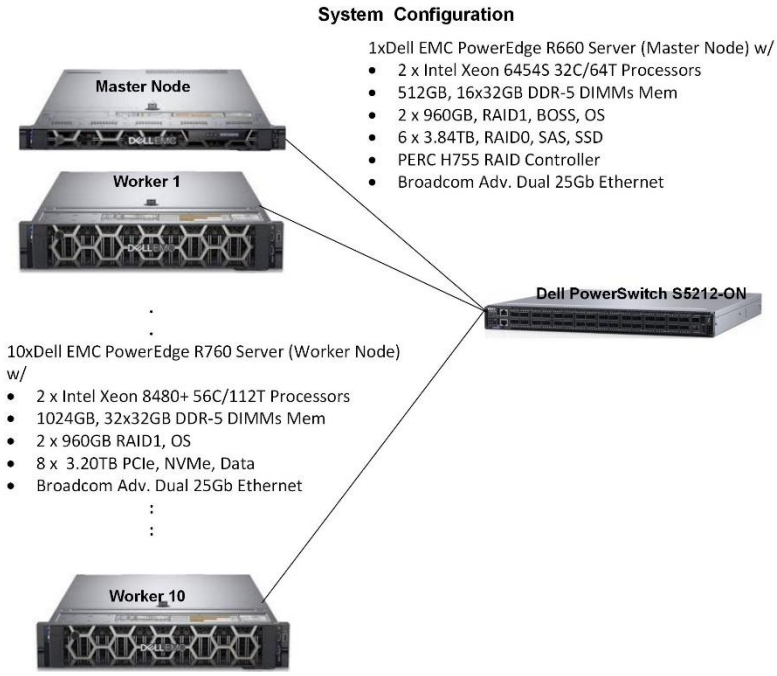
DELL EMC	**Dell PowerEdge R660/R760**	TPCx-BB Rev. v1.6.2 TPC-Pricing Rev. v2.9.0 Report Date: November 3, 2023
Total System Cost	TPCx-BB Performance Metric	Price/Performance
834,667 USD	**4,519.40** BBQpm@10000	**184.69 USD** $/BBQpm@10000

Framework	Operating System	Other Software	Availability Date	Scale Factor	Streams
Cloudera CDP Private Cloud Base v7.1.7	Red Hat Enterprise Linux 8.6 (Ootpa)	None	November 3, 2023	10000	12

System Configuration



Physical Storage/Scale Factor: 30.02	Scale Factor/Physical Memory: 0.93

Servers: Total Processors/Cores/Threads	11x PowerEdge R660 / PowerEdge R760 22/1,184/2,368	
Server Configuration: Processors Memory Storage Controller Storage Device Network Controller	**1x PowerEdge R660 (Admin):** 2x Intel(R) Xeon(R) Gold 6454S 512 GiB PERC H755 2x 960 GB BOSS M.2 SSD 6x 3.84 TB SAS SSD Broadcom Adv. Dual 25 Gb Ethernet	**10x PowerEdge R760 (Worker):** 2x Intel(R) Xeon(R) Platinum 8480+ 1,024 GiB n/a 2x 960 GB BOSS M.2 SSD 8x 3.20 TB NVMe Broadcom Adv. Dual 25 Gb Ethernet
Connectivity:	Dell PowerSwitch S5212-ON	

Description	Part Number	Key	Unit Price	Qty	Extended Price	3 yr. Maint. Price
HARDWARE COMPONENTS						
PowerEdge R760 Server	210-BDZY	1	190,294.88	10	1,902,948.80	
No Trusted Platform Module	461-AADZ	1	0.00	10		
2.5" Chassis with 8 Universal Drive Slots (SAS/SATA/NVME), Front PERC 11, 2 CPU	404-BBFB	1	0.00	10		
Intel® Xeon® Platinum 8480+ 2.0G, 56C/112T, 16GT/s, 105M Cache, Turbo, HT (350W) DDR5-4800	379-BEXV	1	0.00	10		
Intel® Xeon® Platinum 8480+ 2.0G, 56C/112T, 16GT/s, 105M Cache, Turbo, HT (350W) DDR5-4800	379-BDCO, 379-BEXV	1	0.00	10		
No HBM	379-BFFD	1	0.00	10		
Heatsink for 2 CPU configuration (CPU greater than 165W)	412-ABCP	1	0.00	10		
Performance Optimized	370-AAIP	1	0.00	10		
4800MT/s RDIMMs	370-AHCL	1	0.00	10		
32GB RDIMM, 4800MT/s Dual Rank	370-AGZP	1	0.00	320		
C7, Unconfigured RAID for HDDs or SSDs (Mixed Drive Types Allowed)	780-BCDS	1	0.00	10		
DELLPLUS NO	692-BBBB	1	0.00	10		
3.2TB, Enterprise, NVMe, Mixed Use, U2, G4, P5620 with carrier	400-BOXP	1	0.00	80		
Performance BIOS Setting	384-BBBL	1	0.00	10		
UEFI BIOS Boot Mode with GPT Partition	800-BBDM	1	0.00	10		
No Energy Star	387-BBEY	1	0.00	10		
High Performance Fan x6	750-ADRE	1	0.00	10		
Dual, Hot-Plug, Fully Redundant Power Supply (1+1), 1400W, Mixed Mode	450-AJHG	1	0.00	10		
NEMA 5-15P to C13 Wall Plug, 125 Volt, 15 AMP, 10 Feet (3m), Power Cord, North America	450-AALV	1	0.00	20		
Riser Config 2, 2x8 FH Slots (Gen4), 4x8 FH Slots (Gen5), 2x16 LP Slots (Gen4)	330-BBXY	1	0.00	10		
Motherboard supports ALL CPUs (required for CPUs 250W and above)	329-BHJS	1	0.00	10		
iDRAC9 Datacenter 16G with OpenManage Enterprise Advanced Plus	528-CTID, 528-CTZH	1	0.00	10		
Broadcom 57414 Dual Port 10/25GbE SFP28, OCP NIC 3.0	540-BCOC	1	0.00	10		
LOM Blank	540-BDOW	1	0.00	10		
No Cables Required, No GPU Blanks	470-AEYU	1	0.00	10		
PowerEdge 2U Standard Bezel	321-BHMY, 325-BEVI	1	0.00	10		
BOSS-N1 controller card + with 2 SED M.2 960GB (RAID 1)	403-BCVY, 470-AFMF	1	0.00	10		
No Quick Sync	350-BBYX	1	0.00	10		
iDRAC9 Legacy Password for OCP cards	379-BETF	1	0.00	10		
iDRAC Service Module (ISM), NOT Installed	379-BCQX	1	0.00	10		
iDRAC Group Manager, Disabled	379-BCQY	1	0.00	10		
No Operating System	611-BBBF	1	0.00	10		
No Media Required	605-BBFN	1	0.00	10		
ReadyRails Sliding Rails With Cable Management Arm	770-BDRQ, 770-BEKK	1	0.00	10		
Fan Foam, HDD 2U	750-ACOM	1	0.00	10		
Keyboard and Optical Mouse, USB, Black, English	570-AAKV, 580-ADJC	1	0.00	10		
No Systems Documentation, No OpenManage DVD Kit	631-AACK	1	0.00	10		
PowerEdge R760 Shipping	340-DCEP	1	0.00	10		
PowerEdge R760 Shipping Material	340-DJQY	1	0.00	10		
PowerEdge R760 No CCC, No CE, and No BIS Marking	343-BBSU	1	0.00	10		
Basic Next Business Day 36 Months, 36 Month(s)	709-BBFM	1	249.00	10		2,490.00
No Installation	900-9997	1	$0.00	1		
Prosupport Plus and 4Hr Mission Critical, 36 Month(s)	865-BBMY	1	13,692.86	10		136,928.60
ProDeploy Dell Server R Series 1U/2U	854-0555	1	$0.00	10		
Red Hat Enterprise Linux, Non Factory Install, Requires License & Subscription Selection	605-BBFL	1	$0.00	10		

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Description	Part Number	Key	Unit Price	Qty	Extended Price	3 yr. Maint. Price
PowerEdge R660 Server	210-BEQQ	1	$99282.12	1	$99,282.12	
Trusted Platform Module 2.0 V3	461-AAIG	1	$99.00	1		
2.5" Chassis with up to 10 Hard Drives (SAS/SATA), 2CPU, PERC11	321-BHRW	1	$580.00	1		
Intel® Xeon® Gold 6454S 2.2G, 32C/64T, 16GT/s, 60M Cache, Turbo, HT (270W) DDR5-4800	338-CHSY	1	$7800.00	1		
Intel® Xeon® Gold 6454S 2.2G, 32C/64T, 16GT/s, 60M Cache, Turbo, HT (270W) DDR5-4800	338-CHSY, 379-BDCO	1	$7800.00	1		
No HBM	379-BFFD	1	$0.00	1		
Heatsink for 2 CPU configuration (CPU more than or equal to 250W)	412-ABCG	1	$332.00	1		
Performance Optimized	370-AAIP	1	$0.00	1		
4800MT/s RDIMMs	370-AHCL	1	$0.00	1		
32GB RDIMM, 4800MT/s Dual Rank	370-AGZP	1	$30080.00	16		
C7, Unconfigured RAID for HDDs or SSDs (Mixed Drive Types Allowed)	780-BCDS	1	$0.00	1		
PERC H755 with rear load Brackets	405-AAZB, 750-ADRI	1	$3349.00	1		
3.84TB SSD SAS, Read Intensive, up to 24Gbps FIPS-140 512e 2.5in Hot-Plug, AG Drive	345-BENR	1	$35568.12	6		
Power Saving BIOS Setting	384-BBBH	1	$0.00	1		
UEFI BIOS Boot Mode with GPT Partition	800-BBDM	1	$0.00	1		
No Energy Star	387-BBEY	1	$0.00	1		
4 Very High Performance Fans	384-BCUJ	1	$289.00	1		
Dual, Fully Redundant(1+1), Hot-Plug Power Supply,1100W MM(100-240Vac) Titanium	450-AKLF	1	$1429.00	1		
NEMA 5-15P to C13 Wall Plug, 125 Volt, 15 AMP, 10 Feet (3m), Power Cord, North America	450-AALV	1	$0.00	2		
Riser Config 3, Full Height, 2x16 FH Slots (Gen5)	330-BBYZ	1	$818.00	1		
Motherboard supports ALL CPUs and is required for CPUs 250W and above	329-BHFX	1	$450.00	1		
Server Secured Component Verification	528-COYT	1	$99.00	1		
iDRAC9 Datacenter 16G with OpenManage Enterprise Advanced Plus	528-CTID, 528-CTZH	1	$1188.00	1		
Broadcom 57414 Dual Port 10/25GbE SFP28, OCP NIC 3.0	540-BCOC	1	$709.00	1		
LOM Blank	540-BDMK	1	$0.00	1		
Standard Bezel	325-BEVE, 350-BCKC	1	$98.00	1		
BOSS-N1 controller card + with 2 SED M.2 960GB (RAID 1)	403-BCVY, 470-AFMG	1	$2768.00	1		
No Quick Sync	350-BBXM	1	$0.00	1		
iDRAC9 Factory Generated Password for OCP cards	379-BETG	1	$0.00	1		
iDRAC Service Module (ISM), NOT Installed	379-BCQX	1	$0.00	1		
iDRAC Group Manager, Disabled	379-BCQY	1	$0.00	1		
No Operating System	611-BBBF	1	$0.00	1		
No Media Required	605-BBFN	1	$0.00	1		
ReadyRails Sliding Rails With Cable Management Arm	770-BDMT, 770-BECD	1	$218.00	1		
Keyboard and Optical Mouse, USB, Black, English	570-AAKV, 580-ADJC	1	$12.00	1		
No Systems Documentation, No OpenManage DVD Kit	631-AACK	1	$0.00	1		
PowerEdge R660 Shipping	340-DBXZ	1	$49.00	1		
PowerEdge R660 Shipping Material, 10x2.5", 8x2.5" Smart Flow or 16xEDSFF	340-DBYC	1	$99.00	1		
PowerEdge R660 CE, CCC and BIS Marking on 2.5" Chassis	343-BBTS, 343-BBUB	1	$0.00	1		
Basic Next Business Day 36 Months, 36 Month(s)	709-BBFM	1	$249.00	1		$249.00
No Installation	900-9997	1	$0.00	1		
Prosupport Plus and 4Hr Mission Critical, 36 Month(s)	865-BBMY	1	$7123.18	1		$7,123.18
Red Hat Enterprise Linux, Non Factory Install, Requires License & Subscription Selection	605-BBFL	1	$0.00	1		

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Description	Part Number	Key	Unit Price	Qty	Extended Price	3 yr. Maint. Price
Dell Networking PowerSwitch S5212-ON	210-APHW, 343-BBRX	1	$20548.00	1	$20,548.00	
S52XX User Manual	343-BBLP	1	$0.00	1		
OS10 Enterprise,S5212F-ON	634-BRXD	1	$0.00	1		
Power Cord, 125V, 15A, 10 Feet, NEMA 5-15/C13, Qty 2	450-AAFH, 450-AAFH	1	$0.00	1		
Dell NW Dual Tray, 4-post, S5212F-ON	770-BDGQ	1	$0.00	1		
3 Years ProSupport with Next Business Day Onsite Service	818-3530, 818-3543, 818-3544, 818-3562, 975-3461, 989-3439, 997-6306	1	$2930.98	1		$2,930.98
3 Years ProSupport OS10 Enterprise Software Support-Maintenance	848-8544	1	$524.79	1		$524.79
Dell Networking, Cable, SFP28 to SFP28, 25GbE, Passive Copper Twinax Direct Attach Cable, 2 Meter	470-ACET	1	$0.00	11		
Dell 24 Monitor	210-AIWG	1	$169.99	1	$169.99	
DELL EMC NETSHELTER SX 24U RACK - 600MM	A7522217	1	$1,405.00	1	$1,405.00	
HARDWARE COMPONENTS				**Subtotal**	$2,040,210.31	$150,246.55
SOFTWARE COMPONENTS						
Cloudera SEL Data Platform Private Cloud Base Edition, Annual Subscription per compute node, Business Level Support	AB242979	1	$15,000	1	$15,000.00	
Cloudera SEL Data Platform Private Cloud Base Edition, Annual Subscription per storage node, Business Level Support	AB352445	1	$15,230	10	$152,295.00	
RHEL, 1-2SKT, Physical Node, 1YR Premium Sub,up to 4 Virtual Guest, Digitally Fulfilled	528-CHFJ	1	1,299.00	33	$42,867.00	
SOFTWARE COMPONENTS				**Subtotal**	$210,162.00	$0.00
Total					**$2,250,372.31**	**$150,246.55**
Large Purchase Discount (65%)*					-1,462,742.00	-97,660.26

Pricing:1 = Dell

(1) 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.

Audited by Doug Johnson of InfoSizing

Three-Year Cost of Ownership	**$834,667**
BBQpm@10000	**4,519.40**
$/BBQpm@10000	**$ 184.69**

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. Thank you.

Numerical Quantities

Scale Factor	10000
Streams	12
SUT Validation Test	PASS

Performance Run (Run 2)

Overall Run Start Time	2023-10-31 14:32:11.646
Overall Run End Time	2023-11-01 04:29:26.163
Overall Run Elapsed Time	50,234.517
Load Test Start Time	2023-10-31 14:32:11.647
Load Test End Time	2023-10-31 14:49:29.757
Load Test Elapsed Time	1,038.110
Power Test Start Time	2023-10-31 14:49:29.758
Power Test End Time	2023-10-31 17:18:35.554
Power Test Elapsed Time	8,945.796
Throughput Test Start Time	2023-10-31 17:18:35.554
Throughput Test End Time	2023-11-01 04:29:26.163
Throughput Test Elapsed Time	40,250.609
Performance Metric (BBQpm@ 10000)	4,519.40

Repeatability Run (Run 1)

Overall Run Start Time	2023-10-31 00:14:02.656
Overall Run End Time	2023-10-31 14:12:24.884
Overall Run Elapsed Time	50,302.228
Load Test Start Time	2023-10-31 00:14:02.657
Load Test End Time	2023-10-31 00:31:09.831
Load Test Elapsed Time	1,027.174
Power Test Start Time	2023-10-31 00:31:09.833
Power Test End Time	2023-10-31 03:01:22.239
Power Test Elapsed Time	9,012.406
Throughput Test Start Time	2023-10-31 03:01:22.240
Throughput Test End Time	2023-10-31 14:12:24.884
Throughput Test Elapsed Time	40,262.644
Performance Metric (BBQpm@ 10000)	4,521.78

Performance Run Report (Run 2)

****
TPCx-BB
Result
v1.6.2
****
INFO: T_LOAD = 1038.11
INFO: T_LD = 0.1 * T_LOAD: 103.810999999999
INFO: T_PT = 4485.916413649
INFO: T_T_PUT = 40250.609
INFO: T_TT = 3354.21741666666
INFO: === Checking validity of the final result ===
INFO: OK: All required BigBench phases were performed.
INFO: OK: All 30 queries were running in the power test.
INFO: OK: All 30 queries were running in the first throughput test.
INFO: OK: Pretend mode was inactive. All commands were executed.
INFO: === Final result ===
INFO: VALID BBQpm@10000 = 4519.40675345921

Repeatability Run Report (Run 1)

****
TPCx-BB
Result
v1.6.2
****
INFO: T_LOAD = 1027.174
INFO: T_LD = 0.1 * T_LOAD: 102.7174
INFO: T_PT = 4482.26977803591
INFO: T_T_PUT = 40262.644
INFO: T_TT = 3355.22033333333
INFO: === Checking validity of the final result ===
INFO: OK: All required BigBench phases were performed.
INFO: OK: All 30 queries were running in the power test.
INFO: OK: All 30 queries were running in the first throughput test.
INFO: OK: Pretend mode was inactive. All commands were executed.
INFO: === Final result ===
INFO: VALID BBQpm@10000 = 4521.78062131844

Summary details of the run reports are shown above. For the complete run reports, see the Support Files Archive.

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Abstract

This document contains the methodology and results of the TPC Express Benchmark™ Big Bench (TPCx-BB) test conducted in conformance with the requirements of the TPCx-BB Standard Specification, Revision v1.6.2.

The test was conducted at a Scale Factor of 10000 with 11 nodes (1x PowerEdge R660, 10x PowerEdge R760) running Cloudera CDP Private Cloud Base v7.1.7 on Red Hat Enterprise Linux 8.6 (Ootpa).

Measured Configuration

Company Name	Cluster Node	Virtualization	Operating System
Dell Inc.	1x PowerEdge R660 10x PowerEdge R760	n/a	Red Hat Enterprise Linux 8.6 (Ootpa)

TPC Express Benchmark© Big Bench Metrics

Total System Cost	BBQpm@10000	Price/Performance	Availability Date
834,667 USD	4,519.40	184.69 USD	November 3, 2023

Preface

TPC Express Benchmark™ Big Bench Overview

Big data analytics is a growing field of research and business. The significant decrease in the overall cost of hardware, the emergence of Open Source based analytics frameworks, along with the greater depth of data mining capabilities allows new types of data sources to be correlated with traditional data sources. For example, online retailers used to record only successful transactions on their website, whereas modern systems are capable of recording every interaction. The former allowed for simple shopping basket analysis techniques, while the current level of detail in monitoring makes detailed user modeling possible. The growing demands on data management systems and the new forms of analysis have led to the development of a new type of ***Big Data Analytics Systems (BDAS)****.*

Similar to the advent of ***Database Management Systems****, there is a vastly growing ecosystem of diverse approaches to enabling Big Data Analytics Systems. This leads to a dilemma for customers of* ***BDAS****, as there are no realistic and proven measures to compare different* ***BDAS*** *solutions. To address this, TPC has developed TPCx-BB (BigBench), which is an express benchmark for comparing* ***BDAS*** *solutions. The TPCx-BB Benchmark was developed to cover essential functional and business aspects of big data use cases. The benchmark allows for an objective measurement of* ***BDAS*** *System under Test, and provides the industry with verifiable performance, price/performance, and availability metrics.*

The TPCx-BB kit is available from the TPC website (see www.tpc.org for more information). Users must sign-up and agree to the TPCx-BB End User Licensing Agreement (EULA) to download the kit. All related work (such as collaterals, papers, derivatives) must acknowledge the TPC and include the TPCx-BB copyright. The TPCx-BB kit includes: TPCx-BB Specification document (this document), TPCx-BB Users Guide documentation, shell scripts to set up the benchmark environment, Java code to execute the benchmark workload, Data Generator, ***Query*** *files, and Benchmark Driver.*

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-BB models and represents a Big Data Analytics System such as Hadoop ecosystem or 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 components used by the SUT.*
- *Configuration parameters and options for Operating System and file system components used by the SUT.*
- *Configuration parameters and options for any other software components (e.g compiler optimization options) used by the SUT.*

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.

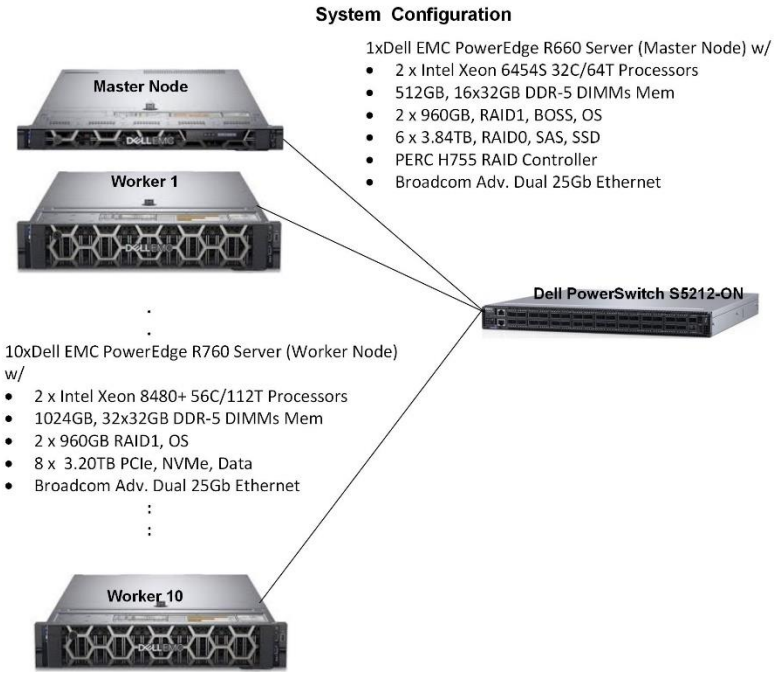
The Supporting Files Archive contains the parameters and options used to configure the components involved in this benchmark.

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:	11
Total Processors/Cores/Threads:	22/1,184/2,368
Total Memory:	10,752
Total Number of Storage Devices:	108
Total Storage Capacity:	300,160
Network:	Dell PowerSwitch S5212-ON

	1x PowerEdge R660 (Admin):	**10x PowerEdge R760 (Worker):**
Processors/Cores/Threads:	2/64/128	2/64/224
Processor Model:	2x Intel(R) Xeon(R) Gold 6454S	2x Intel(R) Xeon(R) Platinum 8480+
Memory:	512 GiB	1,024 GiB
Storage Controller:	PERC H755	n/a
Storage Devices:	2x 960 GB BOSS M.2 SSD 6x 3.84 TB SAS SSD	2x 960 GB BOSS M.2 SSD 8x 3.20 TB NVMe
Network Controller:	Broadcom Adv. Dual 25 Gb Ethernet	Broadcom Adv. Dual 25 Gb Ethernet

The distribution of software components over server nodes is detailed in section 2.1.

Priced Configuration

There are no differences between the priced and measured configurations.

Clause 2: Software Components and Dataset Distribution

2.1 Roles and Dataset Distribution

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

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

Table 1.4: Software Components and Dataset Distribution

Server	Role(s)	Count	Virtual	Host Names	HW/SW Configuration	Storage Setup
Worker	HDFS Gateway HDFS DataNode Hive Gateway Hive on Tez Gateway Spark Gateway Tez Getway YARN NodeManager	10	N	worker-[1-10] alias n{1-10]	Dell PowerEdge R760 Processor: 2xIntel Xeon 8480+ 56-Core Processor Memory : 1024 GB,32x32GB,2R,DDR-5 Storage: 8x 3.2TB NVMe(Data) + 2x960GB BOSS (OS) Network: Broadcom Adv. Dual 25 GbE OS: Red Hat Enterprise Linux 8.6 Cloudera Private Cloud Base (CDP) 7.1.7	OS: 2x960GB BOSS,NVMe RAID1 Intermediate Shuffle Temp Data Distributed FS: 8x3.2B NVMe
Admin	HDFS Gateway HDFS Namenode HDFS Secondary Namenode Hive Gateway Hive Metastore Server Hive on Tez Gateway Hive on Tez Hive Server2 CMS Alert Publisher CMS Event Server CMS Host Monitor CMS Service Monitor YARN Queue Manager Store YARN Queue Manager Webapp Spark Gateway Spark History Server Tez Getway YARN JobHistory Server YARN ResourceManager Zookeeper Server	1	N	infra alias nn	Dell PowerEdge R660 Processor: 2xIntel Xeon 6454S 32-Core Processor Memory : 512 GB Storage: 6x3.84GB SSD + 2x960GB BOSS (OS) Network: Broadcom Adv. Dual 25 GbE OS: Red Hat Enterprise Linux 8.6 Cloudera Private Cloud Base (CDP) 7.1.7	OS, Metadata/Temp Data: 2x960GB BOSS,NVMe RAID1

2.2 Distributed File System Implementation

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

Cloudera CDP Private Cloud Base v7.1.7 (fully HDFS compatible at the API level).

2.3 Engine Implementation

The Engine implementation and corresponding version must be disclosed.

Component	Version
Hive	3.1.3
HDFS	3.1.1
YARN	3.1.1
Spark2	2.4.7
MapReduce2	3.1.1
Tez	0.9,1

2.4 Frameworks

Frameworks and Engine used in the benchmark should be disclosed.

Framework	Version
PvC Base	7.1.7
Hive	3.1.3
HDFS	3.1.1
YARN	3.1.1
Spark2	2.4.7
MapReduce2	3.1.1

2.5 Applied Patches

Any additional vendor supported patches applied to the SUT should be disclosed.

No additional patches were applied.

Clause 3: Workload Related Items

3.1 Hardware & Software Tunable

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

The Supporting Files Archive contains all configuration scripts.

3.2 Kit Version

Version number of the TPCx-BB kit must be included in the Report.

TPCx-BB Kit Version
v1.6.2

3.3 Run Report

The run report generated by TPCx-BB benchmark kit must be included in the Report.

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

- **Run1 Report Summary (Repeatability Run)**

  ****
  TPCx-BB
  Result
  v1.6.2
  ****
  INFO: T_LOAD = 1027.174
  INFO: T_LD = 0.1 * T_LOAD: 102.7174
  INFO: T_PT = 4482.26977803591
  INFO: T_T_PUT = 40262.644
  INFO: T_TT = 3355.22033333333
  INFO: === Checking validity of the final result ===
  INFO: OK: All required BigBench phases were performed.
  INFO: OK: All 30 queries were running in the power test.
  INFO: OK: All 30 queries were running in the first throughput test.
  INFO: OK: Pretend mode was inactive. All commands were executed.
  INFO: === Final result ===
  INFO: VALID BBQpm@10000 = 4521.78062131844

- **Run2 Report Summary (Performance Run)**

  ****
  TPCx-BB
  Result
  v1.6.2
  ****
  INFO: T_LOAD = 1038.11
  INFO: T_LD = 0.1 * T_LOAD: 103.810999999999
  INFO: T_PT = 4485.916413649
  INFO: T_T_PUT = 40250.609
  INFO: T_TT = 3354.21741666666
  INFO: === Checking validity of the final result ===
  INFO: OK: All required BigBench phases were performed.
  INFO: OK: All 30 queries were running in the power test.
  INFO: OK: All 30 queries were running in the first throughput test.
  INFO: OK: Pretend mode was inactive. All commands were executed.
  INFO: === Final result ===
  INFO: VALID BBQpm@10000 = 4519.40675345921

3.4 Query Elapsed Times

Elapsed times of all power and throughput Queries needs to be reported from the Performance Run, grouped respectively as Structured, semi-structured and unstructured buckets.

Type	Query	Power	Stream 1	Stream 2	Stream 3	Stream 4	Stream 5	Stream 6
Structured	1	92.296	314.782	416.419	367.263	370.241	326.070	363.320
	6	190.268	1,144.843	1,102.268	1,122.208	1,076.002	1,150.433	1,051.211
	7	49.372	157.969	149.983	137.703	176.667	217.536	157.354
	9	29.693	117.463	123.520	130.305	100.340	28.756	113.434
	11	33.107	94.553	110.353	107.763	115.222	116.369	88.117
	13	111.625	713.776	623.857	683.862	712.246	582.538	698.502
	14	31.783	109.775	96.169	93.512	103.083	91.236	70.812
	15	32.849	173.224	93.819	119.375	134.537	33.217	120.489
	16	110.551	255.993	392.117	445.765	338.440	282.775	308.727
	17	40.281	150.962	166.838	142.202	149.749	123.753	146.992
	20	193.863	589.833	743.400	639.144	750.604	651.614	591.058
	21	102.167	457.365	440.706	391.368	502.896	167.732	421.945
	22	31.445	97.639	33.957	87.671	90.246	82.288	105.708
	23	96.295	269.269	296.244	293.398	306.427	264.858	319.120
	24	47.795	157.501	221.234	167.582	178.464	145.553	224.141
	25	212.869	723.057	725.597	740.152	750.447	745.930	907.892
	26	227.331	677.511	862.435	652.903	706.183	627.015	637.996
	29	360.746	1,249.700	1,266.325	1,032.997	1,258.465	1,220.055	1,458.508
Semi-structured	2	1,620.255	7,602.471	7,346.373	7,575.483	7,531.706	7,762.290	7,492.440
	3	418.958	2,940.513	3,234.151	2,713.007	3,027.509	2,788.332	2,730.379
	4	631.843	4,478.377	4,465.596	4,800.800	3,579.972	4,615.728	5,233.625
	5	760.242	3,472.819	3,799.132	3,473.792	3,993.246	3,688.699	3,124.037
	8	574.493	1,923.763	2,024.711	2,221.256	1,816.247	1,730.945	1,858.032
	12	355.390	1,465.293	1,317.741	1,539.696	1,493.918	1,410.914	1,320.284
	30	1,193.370	6,030.759	6,404.396	6,233.243	7,149.742	7,146.470	6,485.802
Unstructured	10	348.922	895.632	863.648	801.115	740.967	913.292	881.103
	18	803.242	2,241.417	2,125.263	2,325.593	2,236.604	2,399.931	2,121.967
	19	122.595	388.828	319.230	318.464	436.618	388.048	415.736
	27	32.084	97.570	101.259	67.349	67.683	94.738	68.705
	28	90.037	244.392	355.032	283.968	265.221	312.777	314.117

Type	Query	Stream 7	Stream 8	Stream 9	Stream 10	Stream 11	Stream 12
Structured	1	356.077	156.850	345.065	388.080	339.072	324.195
	6	1,080.800	927.252	576.472	1,066.055	1,069.308	818.625
	7	182.398	175.580	186.269	164.319	133.991	155.621
	9	130.193	64.705	79.231	140.158	106.290	120.905
	11	103.811	166.932	115.645	104.601	91.395	153.867
	13	704.728	589.095	587.781	687.336	600.823	616.049
	14	40.484	103.328	103.642	113.462	85.548	112.717
	15	116.112	87.913	115.606	88.358	85.497	135.870
	16	288.685	383.496	309.247	231.386	318.442	352.170
	17	51.228	138.216	168.113	119.674	147.321	130.233
	20	520.634	267.426	637.237	648.918	682.405	632.094
	21	285.783	376.907	483.372	417.945	479.092	479.540
	22	71.104	87.135	111.433	124.580	78.561	108.315
	23	286.623	98.060	306.873	319.650	244.869	258.574
	24	171.379	196.689	180.776	169.164	203.019	162.025
	25	853.335	965.290	928.811	812.678	717.383	928.610
	26	652.632	729.719	848.198	780.390	645.788	723.599
	29	1,246.193	1,297.549	1,162.481	1,210.935	1,176.965	1,260.299
Semi-structured	2	6,843.361	7,787.007	7,573.731	6,535.369	8,138.448	7,173.968
	3	2,852.492	2,862.478	3,251.396	2,111.044	3,484.241	2,901.025
	4	5,323.050	4,591.090	4,298.458	4,721.520	3,154.800	5,251.327
	5	3,846.135	3,766.756	2,935.109	4,092.849	3,646.481	3,788.852
	8	2,172.940	1,939.221	2,204.805	2,059.035	2,103.109	1,894.325
	12	1,058.142	1,438.200	1,383.963	1,475.957	1,408.603	1,399.770
	30	6,974.965	7,384.614	7,013.896	6,938.822	7,171.581	6,307.628
Unstructured	10	690.805	866.386	748.492	971.415	788.821	818.341
	18	2,158.320	2,112.070	2,221.959	2,098.657	2,099.518	2,097.147
	19	387.820	364.017	379.372	395.048	350.753	418.449
	27	102.754	95.131	77.410	85.972	78.264	77.279
	28	314.545	231.480	312.820	275.446	270.148	230.150

3.5 Validation Test Output

Output report from successful SUT Validation test must be included in the Report.

Query Number	Query Execution	Output Validation
1	PASS	PASS
2	PASS	PASS
3	PASS	PASS
4	PASS	PASS
5	PASS	PASS
6	PASS	PASS
7	PASS	PASS
8	PASS	PASS
9	PASS	PASS
10	PASS	PASS
11	PASS	PASS
12	PASS	PASS
13	PASS	PASS
14	PASS	PASS
15	PASS	PASS
16	PASS	PASS
17	PASS	PASS
18	PASS	PASS
19	PASS	PASS
20	PASS	PASS
21	PASS	PASS
22	PASS	PASS
23	PASS	PASS
24	PASS	PASS
25	PASS	PASS
26	PASS	PASS
27	PASS	PASS
28	PASS	PASS
29	PASS	PASS
30	PASS	PASS

3.6 Global Framework Parameters

Global Framework parameter settings files must be included in the Report.

The Supporting File Archive contains the global framework parameter settings files.

3.7 Kit Modifications

Test Sponsor kit modifications files must be included in the Report.

The following files were modified by the Test Sponsor to facilitate system, platform and Framework differences.

- bigBench-configs/conf/userSettings.conf
- bigBench-configs/hive/conf/engineSettings.conf
- bigBench-configs/hive/queries/q01/engineLocalSettings.conf
- bigBench-configs/hive/queries/q01/engineLocalSettings.sql
- bigBench-configs/hive/queries/q02/engineLocalSettings.sql
- bigBench-configs/hive/queries/q03/engineLocalSettings.sql
- bigBench-configs/hive/queries/q04/engineLocalSettings.sql
- bigBench-configs/hive/queries/q05/engineLocalSettings.sql
- bigBench-configs/hive/queries/q06/engineLocalSettings.sql
- bigBench-configs/hive/queries/q07/engineLocalSettings.sql
- bigBench-configs/hive/queries/q08/engineLocalSettings.sql
- bigBench-configs/hive/queries/q09/engineLocalSettings.sql
- bigBench-configs/hive/queries/q10/engineLocalSettings.sql
- bigBench-configs/hive/queries/q11/engineLocalSettings.sql
- bigBench-configs/hive/queries/q12/engineLocalSettings.sql
- bigBench-configs/hive/queries/q13/engineLocalSettings.sql
- bigBench-configs/hive/queries/q14/engineLocalSettings.sql
- bigBench-configs/hive/queries/q15/engineLocalSettings.sql
- bigBench-configs/hive/queries/q16/engineLocalSettings.sql
- bigBench-configs/hive/queries/q17/engineLocalSettings.sql
- bigBench-configs/hive/queries/q18/engineLocalSettings.sql
- bigBench-configs/hive/queries/q19/engineLocalSettings.sql
- bigBench-configs/hive/queries/q20/engineLocalSettings.sql
- bigBench-configs/hive/queries/q21/engineLocalSettings.sql
- bigBench-configs/hive/queries/q22/engineLocalSettings.sql
- bigBench-configs/hive/queries/q23/engineLocalSettings.sql
- bigBench-configs/hive/queries/q24/engineLocalSettings.sql
- bigBench-configs/hive/queries/q25/engineLocalSettings.sql
- bigBench-configs/hive/queries/q26/engineLocalSettings.sql
- bigBench-configs/hive/queries/q27/engineLocalSettings.sql
- bigBench-configs/hive/queries/q28/engineLocalSettings.sql
- bigBench-configs/hive/queries/q29/engineLocalSettings.sql
- bigBench-configs/hive/queries/q30/engineLocalSettings.sql

Clause 4: SUT Related Items

4.1 Specialized Hardware/Software

Specialized Hardware/Software used in the SUT must be included.

No specialized hardware or software was used.

4.2 Framework Configuration Files

All Framework configuration files from SUT, for the performance run.

All Framework configuration files are included in the Supporting Files Archive.

4.3 SUT Environment Information

SUT environment info in form of envinfo.log from a representative worker node form every role in the server.

All envinfo.log files are include in the Supporting Files Archive.

4.4 Data Storage to Scale Factor Ratio

The data storage ratio must be disclosed.

Nodes	Disks	Size (GB)	Total (GB)
11	2	960	21,120
1	6	3,840	23,040
10	8	3,200	256,000

Total Storage (GB)	300,160
Scale Factor	10000
Data Storage Ratio	30.02

4.5 Scale Factor to Memory Ratio

The Scale Factor to memory ratio must be disclosed.

Nodes	Memory (GiB)	Total (GiB)
1	512	512
10	1,024	10,240

Scale Factor	10000
Total Memory (GiB)	10,752
SF / Memory Ratio	0.93

Clause 5: Metrics and Scale Factors

5.1 Performance Run Metric

The Reported Performance Metric (BBQpm@SF for the Performance Run) must be disclosed in the Report.

Performance Run
BBQpm@10000 4,519.40

5.2 Repeatability Run Metric

The Performance Metric (BBQpm@SF) for the Repeatability Run must be disclosed in the Report..

Repeatability Run
BBQpm@10000 4,521.78

5.3 Price-Performance Metric

The Reported Performance Metric (BBQpm@SF for the Performance Run) must be disclosed in the Report.

Price / Performance
$BBQpm@10000 184.69

5.4 Scale Factor

The Scale Factor used for the Result must be disclosed in the Report.

Scale Factor
10000

5.5 Stream Count

The number of streams in the throughput run used for the Result must be disclosed in the Report.

Streams
12

5.6 Elapsed Run Times

The total elapsed time for the execution of the Performance Run and Repeatability Run must be disclosed in the Report.

Run	Elapsed Time	Seconds
Run 1	00 13:58:22.228	50,302.228
Run 2	00 13:57:14.517	50,234.517

5.7 Elapsed Test Times

The total time for each of the three tests must be disclosed for the Performance Run and the Repeatability Run.

Test	Performance Run	Repeatability Run
Load Test	1,038.110	1,027.174
Power Test	8,945.796	9,012.406
Throughput Test	40,250.609	40,262.644

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, InfoSizing.

www.sizing.com
63 Lourdes Drive
Leominster, MA 01453
978-343-6562.

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

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

InfoSizing
The Right Metric For Sizing IT

TPC
Certified Auditor

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

November 3, 2023

I verified the TPC Express Benchmark™ BB v1.6.2 performance of the following configuration:

Platform:	Dell PowerEdge R660/760 (with 1x R660, 10x R760)
Operating System:	Red Hat Enterprise Linux 8.6 (Ootpa)
Apache Hadoop Compatible Software:	Cloudera CDP Private Cloud Base v7.1.7

The results were:

Performance Metric	**4,519.40 BBQpm@10000GB**
Run Elapsed Time	00 13:57:14.517 (50,234.517 Seconds)

Cluster	**1x R660 (Admin Node), 10x R760 (Worker Nodes)**		
CPUs	2x Intel® Xeon® Gold 6454S (Admin Node) 2x Intel® Xeon® Platinum 8480+ (Worker Nodes)		
Memory	512 GB (Admin Node) 1,024 GB (Worker Nodes)		
Storage	***Qty***	***Size***	***Type***
	2	960 GB	BOSS M.2 SSD (All Nodes)
	6	3.20 TB	SAS SSD (Admin Node)
	8	3.84 TB	NVMe (Worker 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 v1.6.2.
- No modifications were made to any of the Java code.
- Any and all modifications to shell scripts were reviewed for compliance.
- The tested Scale Factor (10000GB) was confirmed to be valid for publication.
- All validation queries executed successfully and produced compliant results.

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- No errors were reported during the run.
- 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, TPC Auditor

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Third Party Price Quotes

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

Supporting File Index

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

Description	Archive File Pathname
Clause 1 - General Items	
The Supporting Files Archive contains the parameters and options used to configure the components involved in this benchmark	Supporting-Files-xBB-R660_R760-SF10K\
Validation Run Files	Supporting-Files-xBB-R660_R760-SF10K\Validation-run logs
Performance Run Files	Supporting-Files-xBB-R660_R760-SF10K\Performance-run logs
Repeatability Run Files	Supporting-Files-xBB-R660_R760-SF10K\Repeatability-run logs
Clause 3 - Workload Related Items	
Benchmark Generic Parameters	Supporting-Files-xBB-R660_R760-SF10K\ Performance-run logs\bigBench-configs\hive\conf\engineSettings.sql
Query Parameters used in the benchmark execution Settings	Supporting-Files-xBB-R660_R760-SF10K\ Performance-run logs\bigBench-configs\hive\conf\engineSettings.conf
Benchmark Global Framework Parameters Settings	Supporting-Files-xBB-R660_R760-SF10K\ Performance-run logs\bigBench-configs \hive\population\ hiveCreateLoad.sql
Benchmark Global Framework Parameters Settings	Supporting-Files-xBB-R660_R760-SF10K\ Performance-run logs\bigBench-configs\hive\queries\q[01-30]\engineLocalSettings.conf
Load Test script	Supporting-Files-xBB-R660_R760-SF10K\ Performance-run-logs\bigBench-configs\hive\queries\q[01-30]\engineLocalSettings.sql
Queries specific optimization parameters settings	Supporting-Files-xBB-R660_R760-SF10K\ Performance-run logs\bigBench-configs\hive\conf\engineSettings.sql
Queries specific optimization parameters settings	Supporting-Files-xBB-R660_R760-SF10K\ Performance-run logs\bigBench-configs\hive\conf\engineSettings.conf
Clause 4 - SUT Related Items	
Data Redundancy report	Supporting-Files-xBB-R660_R760-SF10K\Performance-run logs\run-logs\data_redundancy_report.log
Benchmark execution script	Supporting-Files-xBB-R660_R760-SF10K\TPCxBB_Benchmarkrun.sh
Benchmark run script	Supporting-Files-xBB-R660_R760-SF10K\ TPCxBB_FullBenchmark_sequence_run
Hardware and Software Report from a representative node	Supporting-Files-xBB-R660_R760-SF10K\ Performance-run logs\run-logs\envInfo-worker-1.rack8-2.dcws.labs\envInfo.log
All Framework configuration files are included in the Supporting Files Archive	Supporting-Files-xBB-R660_R760-SF10K\Performance-run-logs\run-logs\envInfo-worker-1.rack8-2.dcws.labs\hadoop
	Supporting-Files-xBB-R660_R760-SF10K\Performance-run logs\run-logs\envInfo-worker-1.rack8-2.dcws.labs\hive
Clause 5 - Metric and Scale Factor Related Items	
Benchmark Performance Report	Supporting-Files-xBB-R660_R760-SF10K\Performance-run logs\run-logs\BigBenchResult.log
Validation Test Report	Supporting-Files-xBB-R660_R760-SF10K\Validation-run logs\run-logs\BigBenchResult.log