DELL EMC

Dell Inc.

TPC Express Benchmark™ AI
Full Disclosure Report

PowerEdge R6625

with 1x PowerEdge R6625; 3x PowerEdge R6625
using

Cloudera SEL Data Platform Private Cloud Base Edition

running on

Red Hat Enterprise Linux 8.6

TPCx-AI Version	1.0.2
Report Edition	First
Report Submitted	November 10, 2022

First Edition - November 2022

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Abstract

Dell conducted the TPC Express Benchmark™ AI (TPCx-AI) on the PowerEdge R6625. The software used included Cloudera SEL Data Platform Private Cloud Base Edition. This report provides full disclosure of the results. All testing was conducted in conformance with the requirements of the TPCx-AI Standard Specification, Revision 1.0.2.

Configuration Overview

Test Sponsor	Node(s)	Operating System
Dell	1x PowerEdge R6625 (Primary) 3x PowerEdge R6625 (Worker)	Red Hat Enterprise Linux 8.6

Metrics Overview

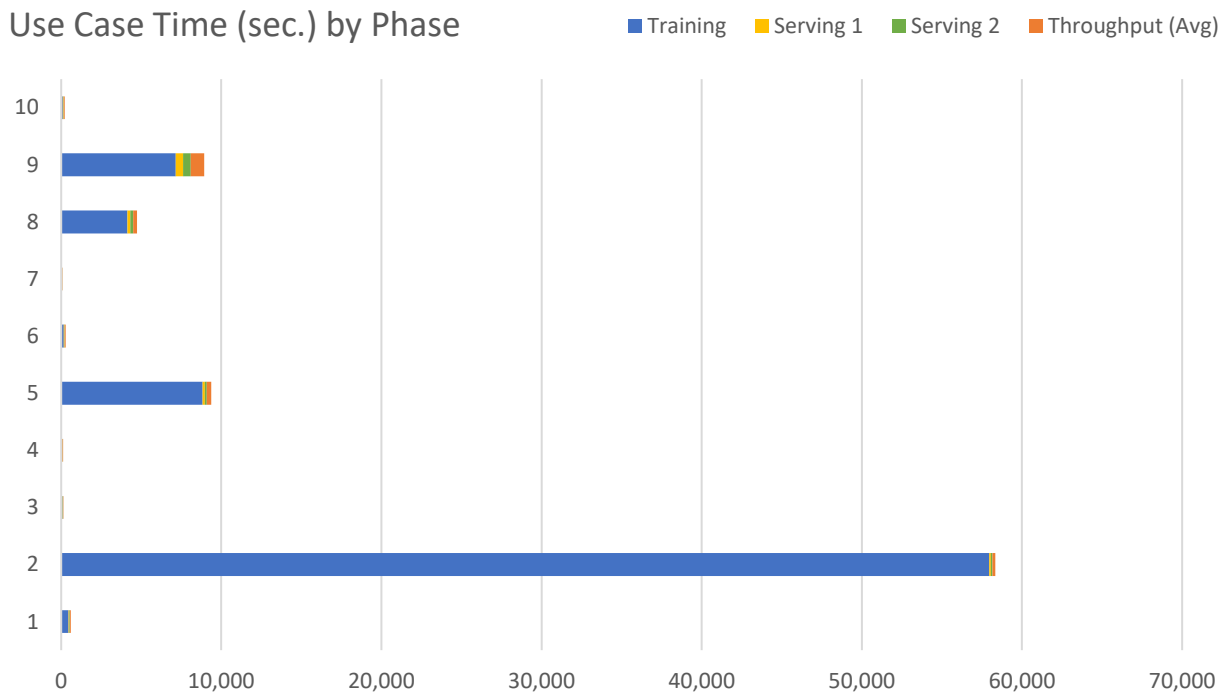
Total System Cost	Performance	Price/Performance	Availability Date
$309,091 USD	972.07 AIUCpm@300	317.98 USD $/AIUCpm@300	February 22, 2023

Executive Summary

The Executive Summary follows on the next several pages.

DELL EMC	PowerEdge R6625		TPCx-AI 1.0.2 TPC Pricing 2.8.0 Report Date Nov. 10, 2022
TPCx-AI Performance **972.07 AIUCpm@300**	Total System Cost **$309,091 USD**	Price/Performance **$317.98 USD/AIUCpm@300**	Availability Date **February 22, 2023**

Framework	Operating System	Other Software	Scale Factor	Streams
Cloudera SEL Data Platform Private Cloud Base Edition	Red Hat Enterprise Linux 8.6	N/A	300	6



Physical Storage / Scale Factor	Scale Factor / Physical Memory	Main Data Redundancy Model
262.40	0.11	Replication 3, RAID 1

Servers: Total Processors/Cores/Threads	4 8 / 256 / 512

Server Type	1x PowerEdge R6625 (Primary)	3x PowerEdge R6625 (Worker)
Processors	2x AMD EPYC 9354 32-Core Processor GHz	2x AMD EPYC 9354 32-Core Processor GHz
Memory	384 GiB	768 GiB
Storage Controller	1x PERC H965i	1x PERC H965i
Storage Device	2x 240 GB M.2 SSD; 2x 3.84 TB NVMe	2x 240 GB M.2 SSD; 6x 3.84 TB NVMe
Network Controller	1x Mellanox ConnectX-4, 25GbE, 2-port	1x Mellanox ConnectX-4, 25GbE, 2-port
Connectivity	1x Mellanox SN2400 100/25 GbE (Switch)	

DELL EMC	PowerEdge R6625	TPCx-AI	1.0.2
		TPC Pricing	2.8.0
		Report Date	Nov. 10, 2022

Description	Part Number	Source	List Price	Qty	Extended Price	1-Yr. Maintenance
Hardware						
PowerEdge R6625 Server - Primary Node	210-ATCF	1	$67,602.00	1	$67,602.00	
2.5 Chassis	379-BDTF	1	0	1		
NVMe Backplane	379-BDSX	1	0	1		
Trusted Platform Module 2.0 V3	461-AAIG	1	0	1		
C03-03 : 8x U.2 G4 RAID - Low Z (FPERC 12)	321-BIIN	1	0	1		
MOD,PRC,9354,2.7,GOA,32C,XXX,QB	338-CGMZ	1	0	1		
MOD,PRC,9354,2.7,GOA,32C,XXX,QB	338-CGMZ	1	0	1		
Performance Optimized	370-AAIP	1	0	1		
4800MT/s RDIMMs	370-AHCL	1	0	1		
16GB RDIMM, 4800MT/s Single Rank	370-AGZO	1	0	24		
C31, No RAID with NVMe and front PERC	379-BEGI	1	0	1		
PERC H965i with floating brackets for lowz	405-ABDN	1	0	1		
Front PERC Mechanical Parts,rear load	750-ACFQ	1	0	1		
No Hard Drive	400-ABHL	1	0	1		
3.84TB Enterprise NVMe Read Intensive AG Drive U.2 Gen4 wit	400-BKGL	1	0	2		
Performance BIOS Settings	384-BBBL	1	0	1		
UEFI BIOS Boot Mode with GPTPartition	800-BBDM	1	0	1		
High Performance Fan for CPUgreater than or equal to 180W(2	750-ADJI	1	0	1		
Dual, Hot-plug, Fully Redundant Power Supply (1+1), 1400W, N	450-AIQX	1	0	2		
Power Cord - C13, 3M, 125V, 15A (North America, Guam, North	450-AALV	1	0	1		
Riser Config 2, 1 x 16 LP PCIe slot (CPU1), 2 x 16 LP PCIeslot (CP	330-BBNR	1	0	1		
PowerEdge R6625 Motherboard	384-BCWP	1	0	1		
Broadcom 5720 Dual Port 1GbE Optional LOM	540-BDKD	1	0	1		
Mellanox Technologies MT27710 Family [ConnectX-4 Lx], 25 G	540-BBVV	1	0	1		
iDRAC9,Enterprise 15G	385-BBOT	1	0	1		
Dell EMC Luggage Tag (x8 or x10 chassis)	350-BBXP	1	0	1		
Standard Bezel	325-BCHH	1	0	1		
No Quick Sync	350-BBXM	1	0	1		
iDRAC,Factory Generated Password	379-BCSF	1	0	1		
Red Hat Enterprise Linux 8.6 (Ootpa), kernel 4.18.0-372.9.1.el8	605-BBFL	1	0	1		
ReadyRails Sliding Rails Without Cable Management Arm or St	770-BECD	1	0	1		
Cable Management Arm	770-BDMT	1	0	1		
BOSS-S2 controller card + with 2 M.2 240GB (RAID 1)	403-BCMG	1	0	1		
No Systems Documentation, NoOpenManage DVD Kit	631-AACK	1	0	1		
PowerEdge R6625 Shipping Material 4	340-COXQ	1	0	1		
PowerEdge R6625 CCC Marking, No CE Marking	389-DTIQ	1	0	1		
US Order	332-1286	1	0	1		
Dell Hardware Limited Warranty Plus On-Site Service	828-3901	1	$200.00	1		$200.00
ProSupport Mission Critical:4-Hour 7x24 On-Site Service with En	828-3855	1	$940.00	1		$940.00
ProSupport Mission Critical:7x24 HW / SW Technical Support an	828-3847	1	$1,816.00	1		$1,816.00

(continued on the next page)

DELL EMC	PowerEdge R6625	TPCx-AI	1.0.2
		TPC Pricing	2.8.0
		Report Date	Nov. 10, 2022

(continued from the previous page)

Description	Part Number	Source	List Price	Qty	Extended Price	1-Yr. Maintenance
PowerEdge R6625 Server - Worker Nodes	210-ATCF	1	$103,571.00	3	$310,713.00	
2.5 Chassis	379-BDTF	1	0	3		
NVMe Backplane	379-BDSX	1	0	3		
Trusted Platform Module 2.0 V3	461-AAIG	1	0	3		
C03-03 : 8x U.2 G4 RAID - Low Z (FPERC 12)	321-BIIN	1	0	3		
MOD,PRC,9354,2.7,GOA,32C,XXX,QB	338-CGMZ	1	0	3		
MOD,PRC,9354,2.7,GOA,32C,XXX,QB	338-CGMZ	1	0	3		
Performance Optimized	370-AAIP	1	0	3		
4800MT/s RDIMMs	370-AHCL	1	0	3		
32GB RDIMM, 4800MT/s Dual Rank	370-AGZP	1	0	72		
C31, No RAID with NVMe and front PERC	379-BEGI	1	0	3		
PERC H965i with floating brackets for lowz	405-ABDN	1	0	3		
Front PERC Mechanical Parts,rear load	750-ACFQ	1	0	3		
No Hard Drive	400-ABHL	1	0	3		
3.84TB Enterprise NVMe Read Intensive AG Drive U.2 Gen4 wit	400-BKGL	1	0	18		
Performance BIOS Settings	384-BBBL	1	0	3		
UEFI BIOS Boot Mode with GPTPartition	800-BBDM	1	0	3		
High Performance Fan for CPUgreater than or equal to 180W(2	750-ADJI	1	0	3		
Dual, Hot-plug, Fully Redundant Power Supply (1+1), 1400W, M	450-AIQX	1	0	3		
Power Cord - C13, 3M, 125V, 15A (North America, Guam, North	450-AALV	1	0	6		
Riser Config 2, 1 x 16 LP PCIe slot (CPU1), 2 x 16 LP PCIeslot (CP	330-BBNR	1	0	3		
PowerEdge R6625 Motherboard	384-BCWP	1	0	3		
Broadcom 5720 Dual Port 1GbE Optional LOM	540-BDKD	1	0	3		
Mellanox Technologies MT27710 Family [ConnectX-4 Lx], 25 G	540-BBVV	1	0	3		
iDRAC9,Enterprise 15G	385-BBOT	1	0	3		
Dell EMC Luggage Tag (x8 or x10 chassis)	350-BBXP	1	0	3		
Standard Bezel	325-BCHH	1	0	3		
No Quick Sync	350-BBXM	1	0	3		
iDRAC,Factory Generated Password	379-BCSF	1	0	3		
Red Hat Enterprise Linux 8.6 (Ootpa), kernel 4.18.0-372.9.1.el8	605-BBFL	1	0	3		
ReadyRails Sliding Rails Without Cable Management Arm or St	770-BECD	1	0	3		
Cable Management Arm	770-BDMT	1	0	3		
BOSS-S2 controller card + with 2 M.2 240GB (RAID 1)	403-BCMG	1	0	3		
No Systems Documentation, NoOpenManage DVD Kit	631-AACK	1	0	3		
PowerEdge R6625 Shipping Material 4	340-COXQ	1	0	3		
PowerEdge R6625 CCC Marking, No CE Marking	389-DTIQ	1	0	3		
US Order	332-1286	1	0	3		
Dell Hardware Limited Warranty Plus On-Site Service	828-3901	1	$200.00	3		$600.00
ProSupport Mission Critical:4-Hour 7x24 On-Site Service with En	828-3855	1	$940.00	3		$2,820.00
ProSupport Mission Critical:7x24 HW / SW Technical Support an	828-3847	1	$1,816.00	3		$5,448.00
Keyboard and Optical Mouse, USB, Black, English	570-AAKV, 580-ADJC	1	$12.00	1	$12.00	
Dell 24 Monitor	210-AIWG	1	$169.99	1	$169.99	
Mellanox MSN2410-CB2F 25GbE/100GbE Switch	920-9N112-00F7-0X2	2	$14,242.00	1	$14,242.00	
NVIDIA ENT Business Critical Support Services for SN2000 - 12 M	780-C20N0Z+P2CMI12	2	$1,140.00	1		$1,140.00
				Subtotal	$392,738.99	$12,964.00
Software						
Cloudera SEL Data Platform Private Cloud Base Edition Annual S	AB352445	1	$15,384.62	4		$61,538.48
				Subtotal	$0.00	$61,538.48
Large Purchase Discount (35%)*					-$132,473.95	-$25,676.87
				Total	$260,265.04	$48,825.61

Pricing: 1 = Dell; 2 = Nvidia

* Discount applies to all line items where Key = 1. Discount based upon total system cost as purchased by a regular customer.

Audited by Doug Johnson, InfoSizing

Total System Cost (USD):	**$309,091**
AIUCpm@300:	**972.07**
$/AIUCpm@300:	**$317.98**

Prices used in TPC benchmarks reflect the actual prices a customer would pay for a one-time purchase of the stated Line Items. Individually negotiated discounts are not permitted. Special prices based on assumptions about past or future purchases are not permitted. All discounts reflect standard pricing policies for the listed Line Items. For complete details, see the pricing section of the TPC Benchmark Standard. If you find that the stated prices are not available according to these terms, please inform the TPC at pricing@tpc.org. Thank you.

DELL EMC	PowerEdge R6625	TPCx-AI	1.0.2
		TPC Pricing	2.8.0
		Report Date	Nov. 10, 2022

Numerical Quantities

AIUCpm@300	**972.07**	T_{Load}	607.47
Scale Factor	300	T_{LD}	607.47
Streams	6	T_{PTT}	657.72
		T_{PST1}	53.79
Kit Version	1.0.2	T_{PST2}	53.47
Execution Status	Pass	T_{PST}	53.79
Accuracy Status	Pass	T_{TT}	54.70

Test Times

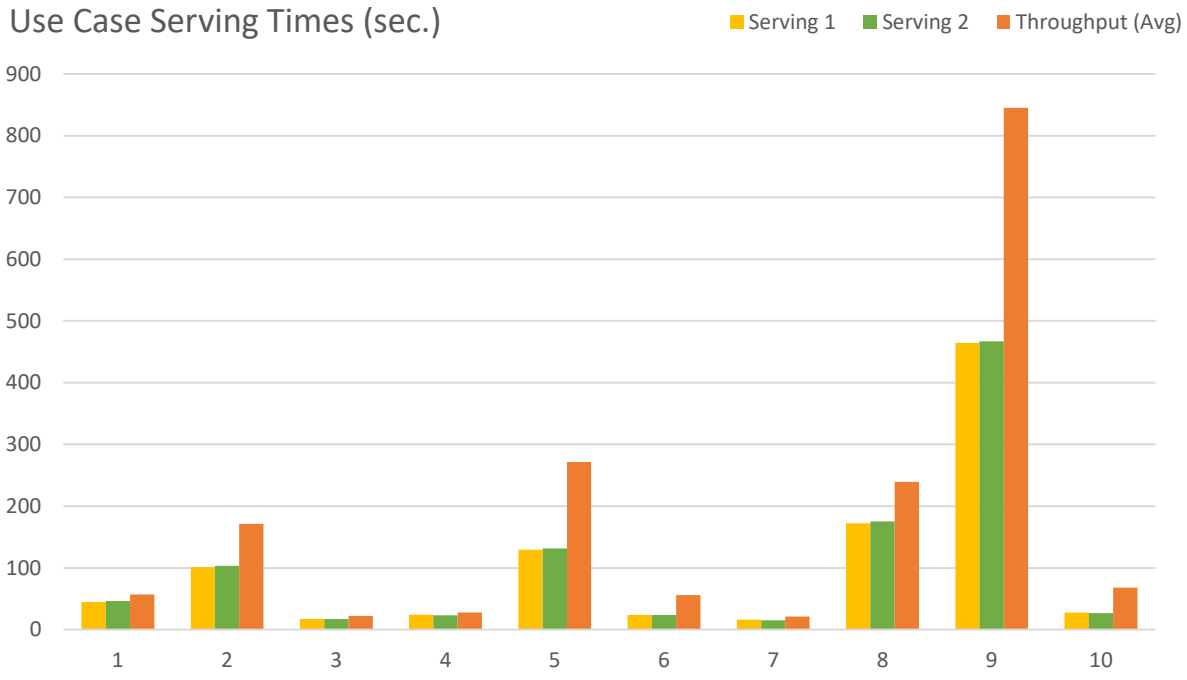
Overall Run Start Time	2022-10-30 22:34:44.957
Overall Run End Time	2022-10-31 22:40:05.160
Overall Run Elapsed Time	86,720.203
Load Test Start Time	2022-10-30 22:54:34.570
Load Test End Time	2022-10-30 23:04:44.092
Load Test Elapsed Time	609.522
Power Training Start Time	2022-10-30 23:04:44.093
Power Training End Time	2022-10-31 21:01:30.458
Power Training Elapsed Time	79,006.365
Power Serving 1 Start Time	2022-10-31 21:01:30.459
Power Serving 1 End Time	2022-10-31 21:18:41.324
Power Serving 1 Elapsed Time	1,030.865
Power Serving 2 Start Time	2022-10-31 21:18:41.325
Power Serving 2 End Time	2022-10-31 21:35:59.832
Power Serving 2 Elapsed Time	1,038.507
Scoring Start Time	2022-10-31 21:40:00.781
Scoring End Time	2022-10-31 21:45:12.338
Scoring Elapsed Time	311.557
Throughput Start Time	2022-10-31 21:45:12.342
Throughput End Time	2022-10-31 22:40:05.159
Throughput Elapsed Time	3,292.817

DELL EMC	PowerEdge R6625	TPCx-AI 1.0.2 TPC Pricing 2.8.0 Report Date Nov. 10, 2022

Numerical Quantities (continued)

Use Case Times & Accuracy

Use Case	Training (sec)	Serving 1 (sec)	Serving 2 (sec)	Throughput (avg)	Accuracy
UC01	456.989	45.045	46.162	56.930	0.000
UC02	57,955.108	101.124	103.028	171.167	0.154
UC03	90.870	17.251	17.079	22.418	4.389
UC04	40.589	24.092	23.203	27.492	0.705
UC05	8,836.639	129.379	131.566	271.719	0.023
UC06	174.807	23.509	23.450	55.848	0.216
UC07	30.085	15.968	15.115	21.101	1.429
UC08	4,143.933	172.495	175.113	239.194	0.759
UC09	7,154.498	464.190	466.875	845.173	1.000
UC10	112.558	27.563	26.602	68.054	0.816



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Clause 0 – Preamble

0.1 TPC Express Benchmark™ AI Overview

Artificial intelligence (AI) has become a key transformational technology of our times. Advances in neural networks and other machine learning techniques have made it possible to use AI on a variety of use cases. From the public sector to aerospace, defense and academia, new and improved ways to use AI techniques are changing the way we harness data and analytics. This along with advances in compute, interconnect and memory technologies have made possible to solve complicated challenges that will ultimately benefit customers in production datacenter and cloud environments.

Abundant volumes of rich data from text, images, audio and video are the essential starting point for creating a benchmark that would represent the myriad of use cases and customers. TPC Express Benchmark™ AI (TPCx-AI) is created in keeping with the TPC tradition of emulating real world AI scenarios and data science use cases. Unlike most other AI benchmarks, the TPCx-AI uses a diverse dataset and is able to scale across a wide range of scale factors. TPCx-AI may later expand with additional use cases and add additional flexibility for a greater variety of implementations.

The benchmark defines and provides a means to evaluate the System Under Test (SUT) performance as a general-purpose data science system that:

- Generates and processes large volumes of data.
- Trains preprocessed data to produce realistic machine learning models.
- Conducts accurate insights for real-world customer scenarios based on the generated models.
- Can scale to large scale distributed configurations.
- Allows for flexibility in configuration changes to meet the demands of the dynamic AI landscape.

The benchmark models real-life examples of companies and public-sector organizations that use a range of analytics techniques, both AI and more traditional machine learning approaches, as well as the potential application of these techniques in situations like those in which they have already been successfully deployed. In addition, the benchmark measures end to end time to provide insights for individual use cases, as well as throughput metrics to simulate multiuser environments for a given hardware, operating system, and data processing system configuration under a controlled, complex, multi-user AI or machine learning data science workload.

The purpose of TPC benchmarks is to provide relevant, objective performance data to industry users. To achieve that purpose, TPC benchmark specifications require benchmark runs 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-AI models and represents complex, high data volume, decision support environments).
- Would plausibly be implemented.

The TPCx-AI kit is available from the TPC website (see www.tpc.org/tpcx-ai/ for more information). Users must sign up and agree to the TPCx-AI 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-AI copyright. The TPCx-AI kit includes: TPCx-AI Specification document (this document), TPCx-AI Users Guide (README.md) documentation, scripts to set up the benchmark environment, code to execute the benchmark workload, Data Generator, use case related files, and Benchmark Driver.

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.

Further information is available at www.tpc.org.

Clause 1 – General Items

1.1 Test Sponsor

This benchmark was sponsored by Dell Inc..

1.2 Parameter Settings

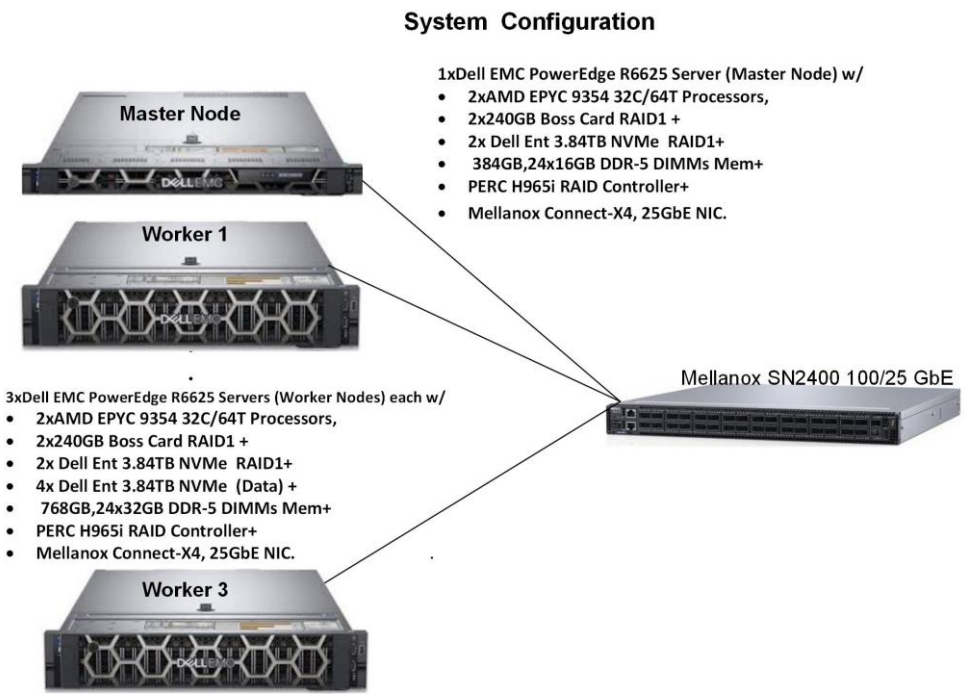
The Supporting Files Archive contains the parameters and options used to configure the components involved in this benchmark.

1.3 Configuration Diagrams

The measured configuration diagram is shown below. In addition, any differences between the measured and the priced configurations are described.

1.3.1 Measured Configuration

Nodes:	4		
Processors/Cores/Threads:	8/256/512	Storage Devices:	28
Total Memory:	2,688 GiB	Storage Capacity:	78,720 GB



	Primary	Worker
Server	1x PowerEdge R6625:	3x PowerEdge R6625:
Procs/Cores/Threads:	2/32/64	2/32/64
Processor Model:	2x AMD EPYC 9354 32-Core Processor	2x AMD EPYC 9354 32-Core Processor
Memory:	384 GiB	768 GiB
Storage Controller:	1x PERC H965i	1x PERC H965i
Storage Devices:	2x 240 GB M.2 SSD 2x 3.84 TB NVMe	2x 240 GB M.2 SSD 6x 3.84 TB NVMe
Network Controller:	1x Mellanox ConnectX-4, 25GbE, 2-port	1x Mellanox ConnectX-4, 25GbE, 2-port
Network:	1x Mellanox SN2400 100/25 GbE (Switch)	

The distribution of software components over server nodes is detailed in Clause 2.

1.3.2 Differences Between the Measured and the Priced Configurations

There are no differences between the measured configuration and the priced configuration.

Clause 2 – SW Components & Data Distribution

2.1 Roles and Dataset Distribution

Table 2-1 describes the distribution of the dataset across all media in the SUT.

Server	Host Name	SW Services	Storage	Contents
1x PowerEdge R6625	genoa-namenode	Core Configuration Gateway Core Configuration Storage Operations HDFS Balancer HDFS NameNode HDFS SecondaryNameNode Hive Gateway Hive Metastore Server Hive on Tez Gateway Hive on Tez HiveServer2 Cloudera Management Service Alert Publisher Cloudera Management Service Event Server Cloudera Management Service Host Monitor Cloudera Management Service Service Monitor YARN Queue Manager Store YARN Queue Manager Webapp Spark Gateway Spark History Server Tez Gateway YARN JobHistory Server YARN ResourceManager ZooKeeper Server	2x 240 GB M.2 SSD 2x 3.84 TB NVMe	OS Kit Metadata
3x PowerEdge R6625	genoa-datanode[1-3]	Core Configuration Gateway HDFS DataNode Hive Gateway Hive on Tez Gateway Spark Gateway Tez Gateway YARN NodeManager	2x 240 GB M.2 SSD 2x 3.84 TB NVMe 4x 3.84 TB NVMe	OS Kit Metadata Distributed FS

Table 2-1 Software Components and Dataset Distribution

2.2 File System Implementation

A distributed file system provided by Red Hat Enterprise Linux 8.6 / Cloudera SEL Data Platform Private Cloud Base Edition was used for data generation and the Load Test. The data set was not relocated after generation and before the Load Test.

2.3 Execution Engine, Frameworks, Driver & Libraries

Cloudera SEL Data Platform Private Cloud Base Edition consisted of the following components.

Component	Version
HDFS	3.1.1
YARN	3.1.1
MapReduce2	3.1.1
Spark	2.4.7

Table 2-2 Software Components

For a detailed listing of installed libraries, please see the envInfo logs in the Supporting Files.

2.4 Applied Patches

No additional vendor-supported patches were applied to the SUT.

Clause 3 – Workload Related Items

3.1 Hardware & Software Tuning

The Supporting Files archive contains all hardware and software configuration scripts.

3.2 Kit Version & Modifications

Table 3-1 shows the version of the TPCx-AI used to produce this result along with any kit flies that were modified to facilitate system, platform, and framework differences.

TPCx-AI Kit Version	1.0.2
Modified File	Description of Changes
None – See Auditor's Note	N/A

Table 3-1 Kit Version & Modifications

3.3 Use Case Elapsed Times

Below are the elapsed times for each use case. Use cases are grouped based on whether they use Deep Learning or Machine Learning techniques.

Type	UC ID	P1	P2	T1	T2	T3	T4	T5	T6
Deep Learning	2	101.124	103.028	108.337	169.135	258.027	127.289	194.804	169.410
	5	129.379	131.566	159.859	158.846	166.837	826.732	162.543	155.498
	9	464.189	466.875	539.458	2,433.186	501.385	553.850	521.678	521.480
Machine Learning	1	45.045	46.162	54.590	49.508	53.218	55.613	74.112	54.538
	3	17.251	17.079	17.847	18.180	18.299	17.391	18.610	44.181
	4	24.092	23.203	29.302	31.517	26.940	26.735	24.519	25.939
	6	23.509	23.450	213.971	20.645	23.798	21.155	30.900	24.619
	7	15.968	15.115	15.941	14.952	44.498	15.790	17.130	18.293
	8	172.495	175.113	359.074	171.698	183.710	174.743	273.476	272.460
	10	27.563	26.602	60.808	214.334	29.970	26.734	33.818	42.662

Table 3-2 Use Case Elapsed Times

3.4 SUT Validation Test Output

Validation Run Report

AIUCpm@1	14.76	T_{Load}	259.25
Scale Factor	1	T_{LD}	259.25
Streams	6	T_{PTT}	96.86
		T_{PST1}	23.10
Kit Version	1.0.2	T_{PST2}	23.25
Execution Status	Pass	T_{PST}	23.25
Accuracy Status	Pass	T_{TT}	4.68

Test Times

Overall Run Start Time	2022-10-30 19:27:53.457
Overall Run End Time	2022-10-30 22:13:33.805
Overall Run Elapsed Time	9,940.348
Load Test Start Time	2022-10-30 19:30:51.561
Load Test End Time	2022-10-30 19:35:12.853
Load Test Elapsed Time	261.292
Power Training Start Time	2022-10-30 19:35:12.854
Power Training End Time	2022-10-30 21:50:43.368
Power Training Elapsed Time	8,130.514
Power Serving 1 Start Time	2022-10-30 21:50:43.371
Power Serving 1 End Time	2022-10-30 21:55:09.119
Power Serving 1 Elapsed Time	265.748
Power Serving 2 Start Time	2022-10-30 21:55:09.121
Power Serving 2 End Time	2022-10-30 21:59:37.489
Power Serving 2 Elapsed Time	268.368
Scoring Start Time	2022-10-30 22:03:37.793
Scoring End Time	2022-10-30 22:08:42.397
Scoring Elapsed Time	304.604
Throughput Start Time	2022-10-30 22:08:42.400
Throughput End Time	2022-10-30 22:13:33.804
Throughput Elapsed Time	291.404

(continued on next page)

Validation Run Report (continued)

Accuracy Metrics

Use Case	Metric Name	Metric	Criteria	Threshold	Status
1	N/A	0.000	N/A	0.00	Pass
2	word_error_rate	0.483	<=	0.50	Pass
3	mean_squared_log_error	5.352	<=	5.40	Pass
4	f1_score	0.697	>=	0.65	Pass
5	mean_squared_log_error	0.118	<=	0.50	Pass
6	matthews_corrcoef	0.224	>=	0.19	Pass
7	median_absolute_error	1.715	<=	1.80	Pass
8	accuracy_score	0.701	>=	0.65	Pass
9	accuracy_score	1.000	>=	0.90	Pass
10	accuracy_score	0.817	>=	0.70	Pass

3.5 Configuration Parameters

The Supporting Files archive contains all Global Benchmark Parameter and Use Case Specific Parameter settings.

Clause 4 – SUT Related Items

4.1 Specialized Hardware/Software

No Specialized Hardware/Software was used in the SUT.

4.2 Configuration Files

The Supporting Files archive contains all configuration files.

4.3 SUT Environment Information

All envInfo.log files are included in the Supporting Files archive.

4.4 Data Storage to Scale Factor Ratio

The details of the Data Storage Ratio are provided below.

Node Count	Disks	Size (GB)	Total (GB)
4	2	240	1,920
1	2	3,840	7,680
3	6	3,840	69,120

Total Storage (GB)	78,720
Scale Factor	300
Data Storage Ratio	262.40

4.5 Scale Factor to Memory Ratio

The details of the Memory to Scale Factor Ratio are provided below.

Nodes	Memory (GiB)	Total (GiB)
1	384	384
3	768	2,304

Scale Factor	300
Total Memory (GiB)	2,688
SF / Memory Ratio	0.11

4.6 Output of Tests

The Supporting Files archive contains the output files of all tests.

4.7 Additional Sponsor Files

The Supporting Files archive contains any additional files that were used.

4.8 Model Optimizations

The Supporting Files archive contains any model optimization files that were used.

Clause 5 – Metrics and Scale Factor

5.1 Reported Performance Metrics

Metric Overview

TPCx-AI Performance Metric	972.07	AIUCpm@300
TPCx-AI Price/Performance Metric	317.98	$/AIUCpm@300
TPCx-AI Scale Factor	300	
TPCx-AI Stream Count	6	

Test Times

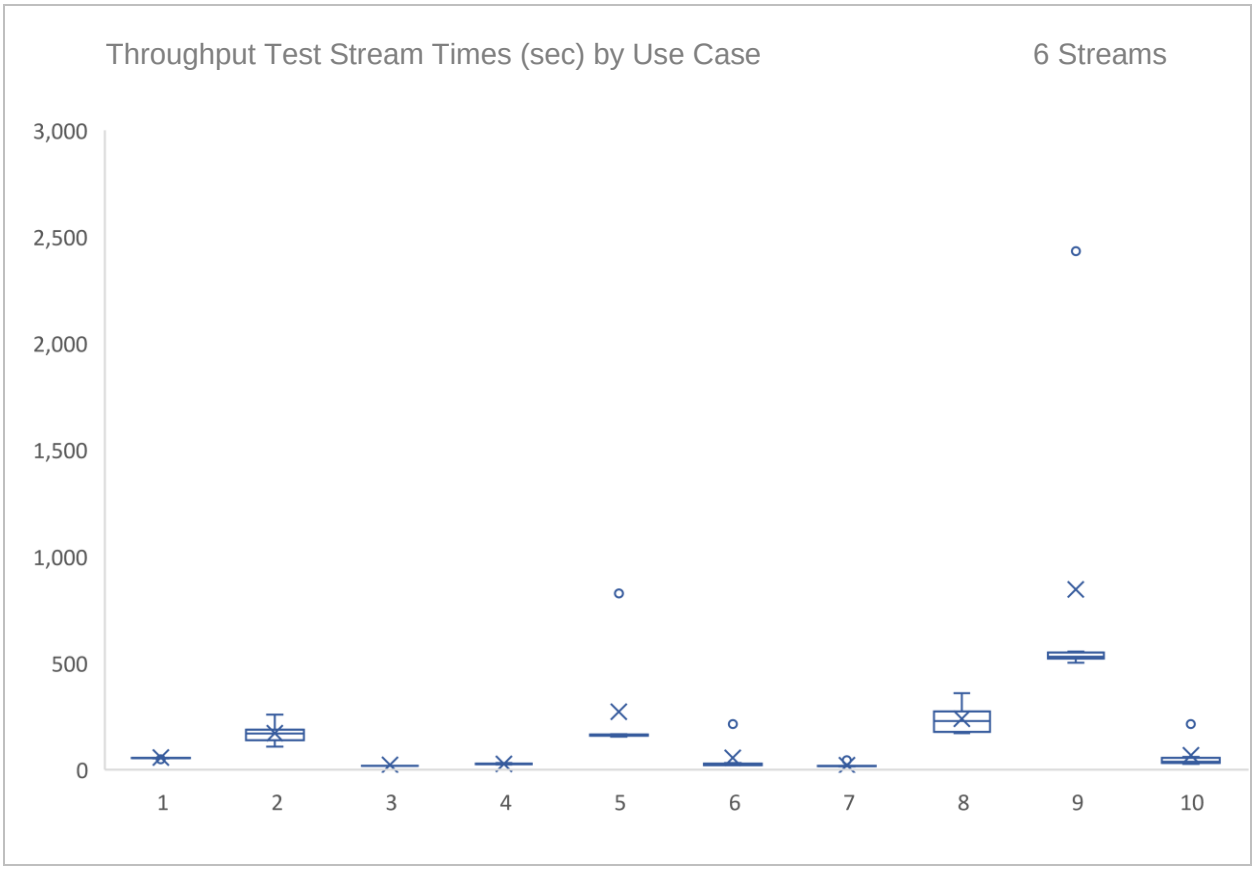
Overall Run Start Time	2022-10-30 22:34:44.957
Overall Run End Time	2022-10-31 22:40:05.160
Overall Run Elapsed Time	86,720.203
Load Test Start Time	2022-10-30 22:54:34.570
Load Test End Time	2022-10-30 23:04:44.092
Load Test Elapsed Time	609.522
Power Training Start Time	2022-10-30 23:04:44.093
Power Training End Time	2022-10-31 21:01:30.458
Power Training Elapsed Time	79,006.365
Power Serving 1 Start Time	2022-10-31 21:01:30.459
Power Serving 1 End Time	2022-10-31 21:18:41.324
Power Serving 1 Elapsed Time	1,030.865
Power Serving 2 Start Time	2022-10-31 21:18:41.325
Power Serving 2 End Time	2022-10-31 21:35:59.832
Power Serving 2 Elapsed Time	1,038.507
Scoring Start Time	2022-10-31 21:40:00.781
Scoring End Time	2022-10-31 21:45:12.338
Scoring Elapsed Time	311.557
Throughput Start Time	2022-10-31 21:45:12.342
Throughput End Time	2022-10-31 22:40:05.159
Throughput Elapsed Time	3,292.817

Accuracy Metrics

Use Case	Metric Name	Metric	Criteria	Threshold	Status
1	N/A	0.000	N/A	0.00	Pass
2	word_error_rate	0.154	<=	0.50	Pass
3	mean_squared_log_error	4.389	<=	5.40	Pass
4	f1_score	0.705	>=	0.65	Pass
5	mean_squared_log_error	0.023	<=	0.50	Pass
6	matthews_corrcoef	0.216	>=	0.19	Pass
7	median_absolute_error	1.429	<=	1.80	Pass
8	accuracy_score	0.759	>=	0.65	Pass
9	accuracy_score	1.000	>=	0.90	Pass
10	accuracy_score	0.816	>=	0.70	Pass

5.2 Throughput Test Stream Times

The following chart shows the minimum, 1st quartile, median, mean (X), 3rd quartile, and maximum stream times by use case for the Throughput Test. Outliers are marked with “o”.



Auditor's Information

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 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

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

November 8, 2022

I verified the TPC Express Benchmark™ AI v1.0.2 performance of the following configuration:

Platform:	1x Dell PowerEdge R6625; 3x Dell PowerEdge 6625
Operating System:	Red Hat Enterprise Linux 8.6
Additional Software:	Cloudera SQL Data Platform Private Cloud Base Edition

The results were:

Performance Metric	**972.07 AIUCpm@300**	
Secondary Metrics	T_{LD}	607.47
	T_{PTT}	657.72
	T_{PST}	53.79
	T_{TT}	54.70

System Under Test	**1x Dell PowerEdge R6625; 3x Dell PowerEdge 6625 with:**		
CPUs	2x AMD EPYC 9354 32-Core Processor (all nodes)		
Memory	384 GiB (Primary Node); 768 GiB (Worker Nodes)		
Storage	***Qty***	***Size***	***Type***
	2	240 GB	M.2 SATA (all nodes)
	2	3.84 TB	NVMe (primary node)
	6	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 v1.0.2.
- All checksums were validated for compliance.
- Any modifications to shell scripts were reviewed for compliance.
- No modifications were made to any of the Java code.
- The generated dataset was properly scaled to 300 GB.

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- The generated dataset used for testing was protected by Replication 3.
- 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:

Two files were erroneously reported as having incorrect checksum. This is due to a minor issue in the TPC-provided kit. The TPCx-AI Subcommittee is aware of this and will correct it in a future release of the kit.

Respectfully Yours,

Doug Johnson, Certified TPC Auditor

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Third-Party Price Quotes

Nvidia

Date: 11/3/2022
Quote # Q-863709
Opportunity # O-313351
Expiration Date 2/1/2023

Advanced Micro Devices (AMD)

Pricing Request Type

NPN Solution Provider
Direct

End Customer
Advanced Micro Devices (AMD)
United States

NVIDIA Salesperson
Martin McNarney
mcnarney@nvidia.com

Qty	Part Number	Reference Part Number	Description	Term (Year)	Unit Price	Discount (%)	Sale Price	Total
1	920-9N112-00F7-0X2	MSN2410-CB2F	Mellanox Spectrum based 25GbE/100GbE 1U Open Ethernet switch with Onyx, 48 SFP28 ports and 8 QSFP28 ports, 2 Power Supplies (AC), x86 CPU, short depth, P2C airflow, Rail Kit		$14,242.00	0.00	$14,242.00	$14,242.00
1	780-C20N0Z +P2CMI12		NVIDIA ENT Business Critical Support Services for SN2000 - 12 Months	1	$1,140.00	0.00	$1,140.00	$1,140.00

Net Total $15,382.00

NOTES

- All pricing is in USD and subject to change. Pricing does not include currency conversion fees, taxes or VAT, and other considerations that may affect the final price that you pay.
- Purchase Order Receipt Date AND Customer Request Date (CRD) must be earlier than Quote expiration date.
- Distributor Purchase Order to NVIDIA:
  - Quote number listed in this document must be included and can only be used for one unique order and may not be used in any other orders.
  - All products, quantities, pricing, reseller and end customer information must align with those on the referenced, valid quote.
  - Reseller, Reseller Contact, End Customer information
  - Must include full company name with no acronyms or abbreviations, address, first and last name of the product end customer contact, and a valid email address with a domain that matches the company name.
- Please reference your NVIDIA Price List for all ordering rules.
- This document serves as a pricing information to the Distributor.
- This quotation is subject to the terms and conditions specified in the applicable signed agreement between NVIDIA and Partner. In the absence of such signed agreement, NVIDIA's Standard Terms & Conditions will apply.
- Accordingly, the products are offered under the applicable terms and conditions, and this quotation is expressly conditional on acceptance of such terms and conditions. No additional or conflicting terms and conditions will apply without NVIDIA's prior, express written consent, and any such additional or conflicting terms and conditions on partner's purchase order, acknowledgement or other business form are hereby rejected by NVIDIA.

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Supporting Files Index

The Supporting Files archive for this disclosure contains the following structure.

Supporting Files Directory	Description
CheckIntegrity/…	Output of CHECK_INTEGRITY test (if the phase is not done as part of the Validation and Performance Test).
PerformanceTest/…	Performance Test output files.
ValidationTest/…	Validation Test output files.

Additional files used by Dell	
Sponsor/ModelOptimization/…	Details of model optimization.
Sponsor/ModifiedKitFiles/…	0 modified file(s). See Auditor's Note.
Sponsor/Tuning/…	All tuning files used.