DELL EMC

Dell Inc.

TPC Express Benchmark™ IoT Full Disclosure Report for Dell PowerEdge R7415

(with 8x Dell PowerEdge R7415 Servers)

Using

HBase 2.0.0 on Cloudera Distribution for Apache Hadoop Enterprise Edition 6.0

and

Red Hat Enterprise Linux Server Release 7.5

TPCx-IoT Version	V1.0.3
Report Edition	First
Report Submitted	May 24, 2019

First Edition - TBD

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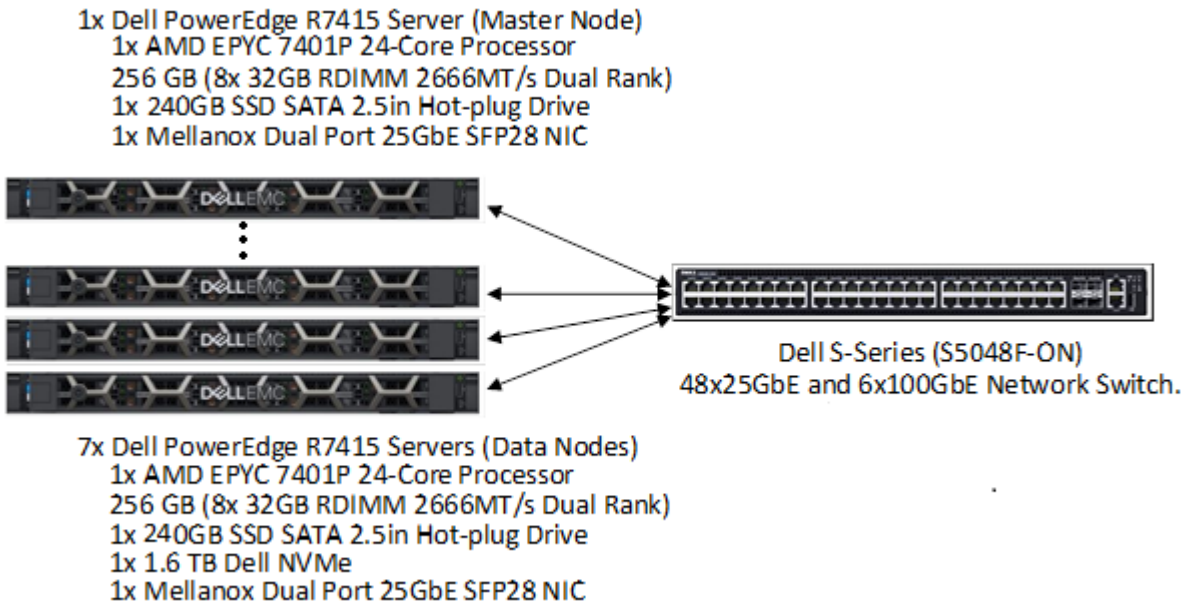
DELL EMC	**Dell PowerEdge R7415**			TPCx-IoT v1.0.3 TPC-Pricing v2.3.0 Report Date: May 24, 2019
Total System Cost	TPCx-IoT Performance Metric			Price/Performance
265,084 USD	**354,811.45 IoTps**			**0.75 USD $/IoTps**
Number of Records	DBMS Software	Operating System	Other Software	Availability Date
600 Millions	HBase 2.0.0 on Cloudera Distribution for Apache Hadoop 6.0	Red Hat Enterprise Linux Server Release 7.5	None	May 24, 2019

System Configuration



Total Number of Servers:		8x Dell PowerEdge R7415
Total Processors/Cores/Threads:		8/192/384
Server Configuration (each)	Processors	1x AMD EPYC 7401P 2.0GHz 24-Core
	Memory	256GB
	Storage Controller	Perc H740P
	Storage Device	1x 240GB SSD SATA (all nodes)
	7x	1x Dell 1.6TB NVMe (Data Nodes)
	Network	1x Mellanox Dual Port 25GbE SFP28 NIC
	Connectivity:	Dell S-Series (S5048F-ON) Network Switch
Total Rack Units:		(8xR7415) + (1xS5048F) = (8x2) + (1x1) = 17RU

DELL EMC

Dell PowerEdge R7415

TPCx-IoT v1.0.3

TPC-Pricing v2.3.0

Report Date: May 24, 2019

Description	Part Number	Key	Unit Price	Qty	Extended Price	3 yr. Maint. Price
HARDWARE COMPONENTS						
PowerEdge R7415 Server	210-ANKR	1	$23,619.00	7	$165,333.00	
PowerEdge R6415/R7415 Motherboard	384-BBSR	1	0.00	7	0.00	
No Trusted Platform Module	461-AADZ	1	0.00	7	0.00	
Chassis with up to 24 x 2.5" Drives including Maximum of 8 SAS/SATAor up to 23 NVMe Drives	321-BDEL	1	0.00	7	0.00	
PowerEdge R7415 Shipping	340-BVTK	1	0.00	7	0.00	
PowerEdge R7415 x4 or x10 Drive Shipping Material	343-BBGJ	1	0.00	7	0.00	
AMD EPYC™ 7401P 2.0GHz/2.8GHz, 24C/48T, 64M Cache (155W/170W) DDR4-2400/2666	338-BNCT	1	0.00	7	0.00	
Standard Heatsink	322-BBBL	1	0.00	7	0.00	
2666MT/s RDIMMs	370-ADNU	1	0.00	7	0.00	
Performance Optimized	370-AAIP	1	0.00	7	0.00	
Unconfigured RAID	780-BCDS	1	0.00	7	0.00	
PERC H740P RAID Controller, 8GB NV Cache, Mini card	405-AAMS	1	0.00	7	0.00	
Red Hat Enterprise Linux Non Factory Install,x64,Req Lic&Sub Selection	421-4727	1	$0.00	3	$0.00	
iDRAC9,Enterprise	385-BBKT	1	0.00	7	0.00	
iDRAC Group Manager, Disabled	379-BCQY	1	0.00	7	0.00	
iDRAC,Factory Generated Password	379-BCSF	1	0.00	7	0.00	
Riser Config 1, 2 x 16 LP	330-BBJH	1	0.00	7	0.00	
On-Board LOM	542-BBBP	1	0.00	7	0.00	
No Internal Optical Drive	429-AAIQ	1	0.00	7	0.00	
Dual, Hot-plug, Redundant Power Supply (1+1) 495W for x24 chassis	450-AGZB	1	0.00	7	0.00	
No Bezel	350-BBBW	1	0.00	7	0.00	
Dell EMC Luggage Tag	350-BBMI	1	0.00	7	0.00	
No Quick Sync	350-BBKU	1	0.00	7	0.00	
Performance BIOS Settings	384-BBBL	1	0.00	7	0.00	
UEFI BIOS Boot Mode with GPT Partition	800-BBDM	1	0.00	7	0.00	
ReadyRails Sliding Rails With Cable Management Arm	770-BBBR	1	0.00	7	0.00	
No Systems Documentation, No OpenManage DVD Kit	631-AACK	1	0.00	7	0.00	
US Order	332-1286	1	0.00	7	0.00	
Dell Hardware Limited Warranty Plus On-Site Service	816-3842	1	$200.00	7		1,400.00
ProSupport Mission Critical: 7x24 HW / SW Technical Support and Assistance, 3 Years	816-3859	1	$1,438.00	7		10,066.00
3 Years ProSupport and Mission Critical 4Hr Onsite Service	816-3843	1	$262.00	7		1,834.00
Thank you choosing Dell ProSupport. For tech support, visit //www.dell.com/support or call 1-800- 945-3355	989-3439	1	$0.00	7		0.00
On-Site Installation Declined	900-9997	1	$0.00	7		0.00
32GB RDIMM 2666MT/s Dual Rank	370-ADNF	1	$0.00	56	$0.00	
240GB SSD SATA Mixed Use 6Gbps 512e 2.5in Hot Plug S4610 Drive	400-BDSS		$0.00	7	$0.00	
Dell 1.6TB, NVMe, Mixed Use Express Flash, 2.5 SFF Drive, U.2, PM1725a with Carrier	400-AWLD	1	$0.00	7	$0.00	
Mellanox ConnectX-4 Lx Dual Port 25GbE SFP28 Network Adapter, Low Profile	406-BBLD	1	$0.00	7	$0.00	
C13 to C14, PDU Style, 12 AMP, 6.5 Feet (2m) Power Cord, North America	492-BBDI	1	$0.00	14	$0.00	
Dell EMC S5048F-ON Switch,48x 25GbE,6x 100GbE QSFP28, IO to PSU,2 PSU,OS10	210-ANRH	1	$25,129.00	1	25,129.00	
QSFP28, IO to PSU airflow, 2x PSU, OS9Software, Rights to use L3 on OS9, S5048-ON	634-BQCB	1	$0.00	1	$0.00	
Dell Networking, Cable, SFP28 to SFP28, 25GbE, Passive Copper Twinax Direct Attach Cable, 2 Meter	470-ACET	1	$0.00	7	$0.00	
Dell EMC S5048 Series User Guide	343-BBGU	1	$0.00	1	$0.00	
US No Canada Ship Charge	332-1286	1	$0.00	1	$0.00	
Force10, Power Cord, 125V, 15A, 10 Feet, NEMA 5-15/C13, S-Series	450-AAFH	1	$0.00	2	$0.00	
Dell Hardware Limited Warranty 1 Year	815-5868	1	$422.00	1		422.00
ProSupport Mission Critical Package: 4-Hour 7x24 On-Site Service withEmergency Dispatch, 1 Year	815-5876	1	$111.00	1		111.00
ProSupport Mission Critical Package: 4-Hour 7x24 On-Site Service withEmergency Dispatch, Extended to 2 Years	815-5877	1	$423.00	1		423.00
ProSupport Mission Critical:7x24 HW/SW Technical Support andAssistance, 3 Years	815-5887	1	$5,956.00	1		5,956.00
Dell Limited Hardware Warranty Extended Year(s)	975-3461	1	$0.00	1		0.00
Thank you choosing Dell ProSupport. For tech support, visit //www.dell.com/support or call 1-800- 945-3355	989-3439	1	$0.00	7		0.00
Info 3rd Party Software Warranty provided by Vendor	997-6306	1	$0.00	1		0.00
On-Site Installation Declined	900-9997	1	$0.00	1		0.00
APC NetShelter SX 24U 600mm x 1070mm Deep Enclosure	A7067508	1	$1,079.99	1	1,079.99	
Rack PDU, Basic, Zero U, 15A, 120V, 5-15 input, (14) 5-15 output	A7541364	1	$174.99	1	174.99	
Logitech MK120 Keyboard and Mouse	A6999510	1	$15.99	1	15.99	
Dell 24 Monitor	210-AIWG	1	$0.00	1	0.00	
Subtotal					**$191,732.97**	**$20,212.00**

DELL EMC	**Dell PowerEdge R7415**	TPCx-IoT v1.0.3 TPC-Pricing v2.3.0 Report Date: May 24, 2019

Description	Part Number	Key	Unit Price	Qty	Extended Price	3 yr. Maint. Price	
PowerEdge R7415 Server	210-ANKR	1	$20,360.00	1	$20,360.00		
PowerEdge R6415/R7415 Motherboard	384-BBSR	1	$0.00	1	$0.00		
No Trusted Platform Module	461-AADZ	1	$0.00	1	$0.00		
2.5" Chassis with up to 10 Hard Drives, including up to 8 SAS/SATA or 9 NVME Drives	321-BDEL	1	$0.00	1	$0.00		
PowerEdge R7415 Shipping	340-BVTK	1	$0.00	1	$0.00		
PowerEdge R7415 x4 or x10 Drive Shipping Material	343-BBGJ	1	$0.00	1	$0.00		
AMD EPYC™ 7401P 2.0GHz/2.8GHz, 24C/48T, 64M Cache (155W/170W) DDR4-2400/2666	338-BNCT	1	$0.00	1	$0.00		
Standard Heatsink	322-BBBL	1	$0.00	1	$0.00		
2666MT/s RDIMMs	370-ADNU	1	$0.00	1	$0.00		
Performance Optimized	370-AAIP	1	$0.00	1	$0.00		
Unconfigured RAID	780-BCDS	1	$0.00	1	$0.00		
PERC H740P RAID Controller, 8GB NV Cache, Mini card	405-AAMS	1	$0.00	1	$0.00		
Red Hat Enterprise Linux Non Factory Install,x64,Req Lic&Sub Selection	421-4727	1	$0.00	3	$0.00		
iDRAC9,Enterprise	385-BBKT	1	$0.00	1	$0.00		
iDRAC Group Manager, Disabled	379-BCQY	1	$0.00	1	$0.00		
iDRAC,Factory Generated Password	379-BCSF	1	$0.00	1	$0.00		
Riser Config 1, 2 x 16 LP	330-BBJH	1	$0.00	1	$0.00		
On-Board LOM	542-BBBP	1	$0.00	1	$0.00		
No Internal Optical Drive	429-AAIQ	1	$0.00	1	$0.00		
Dual, Hot-plug, Redundant Power Supply (1+1) 750W for x24 chassis	450-AGUL	1	$0.00	1	$0.00		
No Bezel	325-BCHU	1	$0.00	1	$0.00		
Dell EMC Luggage Tag	350-BBMI	1	$0.00	1	$0.00		
No Quick Sync	350-BBKU	1	$0.00	1	$0.00		
Performance BIOS Settings	384-BBBL	1	$0.00	1	$0.00		
UEFI BIOS Boot Mode with GPT Partition	800-BBDM	1	$0.00	1	$0.00		
ReadyRails Sliding Rails With Cable Management Arm	770-BBBR	1	$0.00	1	$0.00		
No Systems Documentation, No OpenManage DVD Kit	631-AACK	1	$0.00	1	$0.00		
US Order	332-1286	1	$0.00	1	$0.00		
Dell Hardware Limited Warranty Plus On-Site Service	816-3842	1	$200.00	1			$200.00
ProSupport Mission Critical: 7x24 HW / SW Technical Support and Assistance, 3 Years	816-3859	1	$262.00	1			$262.00
3 Years ProSupport and Mission Critical 4Hr Onsite Service	816-3843	1	$1,438.00	1			$1,438.00
Thank you choosing Dell ProSupport. For tech support, visit //www.dell.com/support or call 1-800- 945-3355	989-3439	1	$0.00	1			$0.00
On-Site Installation Declined	900-9997	1	$0.00	1			$0.00
32GB RDIMM 2666MT/s Dual Rank	370-ADNF	1	$0.00	8	$0.00		
240GB SSD SATA Boot 6Gbps 512n 2.5in Hot-plug Drive, 1 DWPD, 219 TBW	400-BDSS		$0.00	1	$0.00		
Mellanox ConnectX-4 Lx Dual Port 25GbE SFP28 Network Adapter, Low Profile	406-BBLD	1	$0.00	1	$0.00		
C13 to C14, PDU Style, 12 AMP, 6.5 Feet (2m) Power Cord, North America	492-BBDI	1	$0.00	2	$0.00		
Sub Total						$20,360.00	$1,900.00
HARDWARE COMPONENTS					**Subtotal**	$212,092.97	$22,112.00
SOFTWARE COMPONENTS							
Cloudera Enterprise Operational DB Edition, Node License, 24x7, 1YR	CE0DN-GOLD	1	$6,000.00	24			$144,000.00
Red Hat Enterprise Linux,1-2SKT,3yr Premium Subscription,1 Virtual Guest	421-5721	1	$3,702	8			$29,616.00
SOFTWARE COMPONENTS					**Subtotal**	$0.00	$173,616.00
Total						**$212,092.97**	**$195,728.00**
Large Purchase Discount (35%)*						-74,232.54	-68,504.80
Pricing: 1 Dell EMC * Discount based upon total system cost as purchased by a regular customer.					**Three-Year Cost Ownership:**		**$265,084**
					IoTps:		**354,811.45**
					$/IoTps:		**0.75**

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 the TPC at pricing@tpc.org.

DELL EMC	**Dell PowerEdge R7415**	TPCx-IoT v1.0.3 TPC-Pricing v2.3.0 Report Date: May 24, 2019

Measurement Results for Performance Run

Total Number of Records	600 Millions
Warmup Run - Start Time	2019-02-10 21:21:37
Warmup Run - End Time	2019-02-10 22:08:45
Warmup Run Elapsed Time in Seconds	2,826.715
Measured Run Start Time	2019-02-10 22:08:45
Measured Run End Time	2019-02-10 22:36:57
Total Time In Seconds	1,691.039

Measurement Results for Repeatability Run

Total Number of Records	600 Millions
Warmup Run Start Time	2019-02-10 22:49:56
Warmup Run End Time	2019-02-10 23:33:25
Warmup Run Elapsed Time in Seconds	2,608.359
Measured Run Start Time	2019-02-10 23:33:25
Measured Run End Time	2019-02-11 00:01:22
Total Time In Seconds	1,676.257

Run Report for Performance Run

```
================================================
TPCx-IoT Performance Metric (IoTps) Report

Total Time For Warmup Run In Seconds = 2,826.72
Total Time In Seconds = 1,691.04
Total Number of Records = 600 Millions

TPCx-IoT Performance Metric (IoTps): 354,811.45

================================================
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Run Report for Repeatability Run

```
================================================
TPCx-IoT Performance Metric (IoTps) Report

Total Time For Warmup Run In Seconds = 2,608.36
Total Time In Seconds = 1,676.26
Total Number of Records = 600 Millions

TPCx-IoT Performance Metric (IoTps): 357,940.34

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Table of Contents

ABSTRACT **9**

PREFACE **10**

CLAUSE 1: GENERAL ITEMS **11**

1.1 TEST SPONSOR 11
1.2 PARAMETER SETTINGS 11
1.3 CONFIGURATION DIAGRAMS 11
1.4 DATASET DISTRIBUTION 13
1.5 SOFTWARE COMPONENTS DISTRIBUTION 13

CLAUSE 2: WORKLOAD RELATED ITEMS **14**

2.1 HARDWARE & SOFTWARE TUNABLE 14
2.2 RUN REPORT 14
2.3 BENCHMARK KIT IDENTIFICATION 15
2.4 BENCHMARK KIT CHANGES 15

CLAUSE 3: SCALE FACTORS AND METRICS **16**

3.1 TOTAL RUN TIME 16
3.2 PERFORMANCE AND PRICE PERFORMANCE 16
3.3 SYSTEM CONFIGURATION INFORMATION 16

SUPPORTING FILE INDEX **17**

Abstract

This document contains the methodology and results of the TPC Express BenchmarkTM IoT (TPCx-IoT) test conducted in conformance with the requirements of the TPCx-IoT Standard Specification, Revision 1.0.3.

The test was conducted for a Scale Factor of 600 Millions records with 8 Dell R7415 Servers running HBase 2.0.0 on Cloudera Distribution for Apache Hadoop Edition 6.0.0 on Red Hat Enterprise Linux Server Release 7.5.

This benchmark is now submitted for the Peer Review Board consisting of members of the TPCx-IoT sub-committee.

Measured Configuration

Company Name	Cluster Node	Virtualization	Operating System
Dell Inc.	Dell R7415 Server	Not Used	Red Hat Enterprise Linux Server Release 7.5

TPC Express Benchmark© IoT Metrics

Total System Cost	IoTps	Price/Performance	Availability Date
265,084 USD	354,811.45	0.75 USD	May 24, 2019

Preface

TPC Express Benchmark^{TM} IoT Overview

TPC Express BenchmarkTM IoT (TPCx-IoT) was developed to provide an objective measure of hardware, operating system and commercial NoSQL database 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 IoT Gateway systems in general. The TPCx-IoT stresses both hardware and software including database APIs and network connections to the database. This workload can be used to assess a broad range of NoSQL databases. The TPCx-IoT can be used to assess a range of NoSQL implementations in a technically rigorous and directly comparable and vendor-neutral manner. The metric effectively represents the total number of records that can be inserted into a NoSQL database per second while running queries against the database.

The TPCx-IoT kit is available from the TPC (See www.tpc.org/tpcx-iot for more information). Users must sign- up and agree to the TPCx-IoT 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-IoT copyright. The TPCx-IoT Kit includes: TPCx-IoT Specification document, TPCx-IoT 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- IoT models and represents a NoSQL database mimicking an IoT gateway system)*

• *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.

Further information is available atwww.tpc.org

Clause 1: General Items

1.1 Test Sponsor

A statement identifying the benchmark sponsor(s) and other participating companies must be provided.

This benchmark was sponsored by Dell Inc.

1.2 Parameter Settings

Settings must be provided for all customer-tunable parameters and options which have been changed from the defaults found in actual products, including by not limited to:

- *Configuration parameters and options for server, storage, network and other hardware component incorporated into the pricing structure;*
- *Configuration parameters and options for operating system and file system component incorporated into the pricing structure;*
- *Configuration parameters and options for any other software component incorporated into the pricing structure;*
- *Compiler optimization options.*

Comment 1: In the event that some parameters and options are set multiple times, it must be easily discernible by an interested reader when the parameter or option was modified and what new value it received each time.

Comment 2: This requirement can be satisfied by providing a full list of all parameters and options, as long as all those that have been modified from their default values have been clearly identified and these parameters and options are only set once.

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

1.3 Configuration Diagrams

Diagrams of both measured and priced configurations must be provided, accompanied by a description of the differences. This includes, but is not limited to:

- *Total number of nodes used;*
- *Total number and type of processors used/total number of cores used/total number of threads used (including sizes of L2 and L3 caches);*
- *Size of allocated memory, and any specific mapping/partitioning of memory unique to the test;*

- *Number and type of disk units (and controllers,) if applicable;*
- *Number of channels or bus connections to disk units, including their protocol type;*
- *Number of LAN (e.g., Ethernet) connections and speed for switches and other hardware components physically used in the test or are incorporated into the pricing structure;*
- *Type and the run-time execution location of software components.*

Measured Configuration:

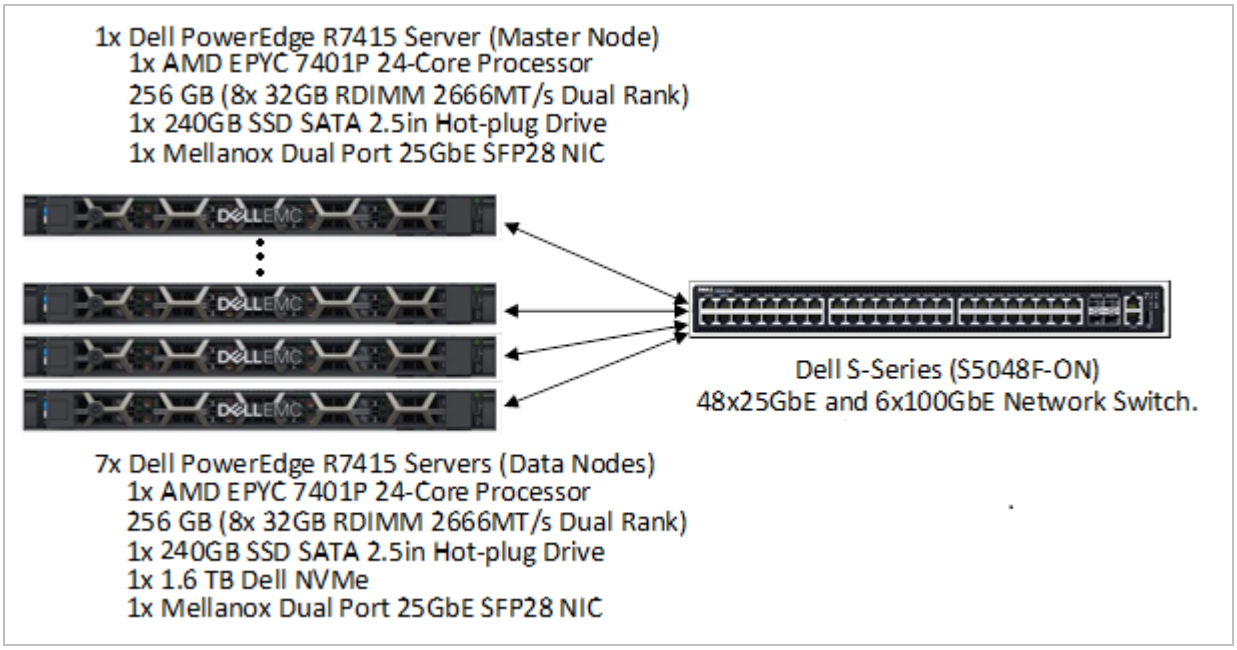

Figure 1-1 Measured Configuration

The measured configuration consisted of

- Total Nodes: 8
- Total Processor/Cores/Threads: 8/192/384
- Total Memory: 2.048TB
- Total Number of Storage Devices: 15
- Total Storage Capacity: 13.12TB

Server nodes details:

- 8x Dell PowerEdge R7415 Servers, each with:
  - Processors/Cores/Threads: 1/24/48
  - Processor Model: 1x AMD EPYC™ 7401P 2.0GHz 24-core
  - Memory: 256GB (8 x 32GB RDIMM 2666MT/s Dual Rank)
  - Drives: 1x 240GB SSD SATA (for all Servers)
    1x Dell 1.6TB NVMe (for all Data Node Servers)
  - Network: 1x Mellanox Dual Port 25GbE SFP28 NIC

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	Perc HP740p	1 (SSD)	Operating System, Swap, Hadoop Master, Root, Temp
2-8	Perc HP740p	1 (SSD)	Operating System, Swap, Root, Temp
2-8	NVMe	NVMe0n1	Data, Temp

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

	HDFS		HBase		YARN		Zoo Keeper
Node	NameNode	DataNode	Master	Region Server	Resource Manager	Node Manager	
1	X		X		X		X
2-5		X		X		X	X
6-8		X		X		X	

NoSQL Database version must be disclosed.

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-IoT 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 Performance Run

```
================================================
TPCx-IoT Performance Metric (IoTps) Report

Total Time For Warmup Run In Seconds = 2,826.72
Total Time In Seconds = 1,691.04
Total Number of Records = 600 Millions

TPCx-IoT Performance Metric (IoTps): 354,811.45

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

Run Report for Repeatability Run

```
================================================
TPCx-IoT Performance Metric (IoTps) Report

Total Time For Warmup Run In Seconds = 2,608.36
Total Time In Seconds = 1,676.26
Total Number of Records = 600 Millions

TPCx-IoT Performance Metric (IoTps): 357,940.34

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

2.3 Benchmark Kit Identification

Version number of TPCx-IoT kit and checksum for the jar file and master Programs must be reported.

Kit Version **1.0.3**

```
24d1e8079cfdd240f266041bca0333b5  ./TPC-IoT-master.sh
68379f9375c7b584fc3253dfe9c4f7a6  ./tpcx-iot/lib/core-0.13.0-SNAPSHOT.jar
7bebf1e17d5c2b380df575fad160d7f8  ./IoT_cluster_validate_suite.sh
```

2.4 Benchmark Kit changes

No Modifications were made to the TPC provided kit.

Clause 3: Scale Factors and Metrics

3.1 Total Run Time

	Run 1	Run 2
Total Run Time	1,691.04	1,676.26

3.2 Performance and Price Performance

The performance metric (IoTps) must be disclosed for Run1 and Run2. Price-performance metric ($/IoTps) must be disclosed for the performance run.

	Run 1	Run 2
IoTps	354,811.45	357,940.34

$/IoTps	**$0.75**

3.3 System Configuration Information

Storage System Software	Operating System	Other Software	System Availability Date
	Red Hat Enterprise Linux Server Release 7.5		TDB

Cloudera 6.0.0	
Component	**Package Version**
Apache Hadoop	hadoop-3.0.0+cdh6.0.0
HBase	hbase-2.0.0+cdh6.0.0
YARN	yarn-3.0.0+cdh6.0.0
Zookeeper	zookeeper-3.4.5+cdh6.0.0

Supporting File Index

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

Storage System Software	Operating System	System Availability Date
Clause 1	Parameters and options used to configure and tune the SUT	Supporting Files Archive/Clause1
Clause 2	Configuration Scripts and Run Report	Supporting Files Archive/Clause2
Clause 3	System Configuration Details	Supporting Files Archive/Clause3