Cisco Systems, Inc.

TPC Express Benchmark™ IoT (TPCx-IoT)

Full Disclosure Report

for

Cisco UCS Mini Blade Server Chassis

(with 4 Cisco UCS B200M4 Servers)

using

HBase 1.2.1 on Cloudera Distribution for Apache Hadoop

5.10.0

and

Red Hat Enterprise Linux Server Release 7.2

First Edition

November 20, 2017

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Benchmark results are highly dependent upon workload, specific application requirements, and system design and implementation. Relative system performance will vary as a result of these and other factors. Therefore, the TPC Express Benchmark ™ IoT should not be used as a substitute for a specific customer application benchmark when critical capacity planning and/or product evaluation decisions are contemplated.

All performance data contained in this report was obtained in a rigorously controlled environment. Results obtained in other operating environments may vary significantly. No warranty of system performance or price/performance is expressed or implied in this report.

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CISCO		**Cisco UCS Mini**		TPCx-IoT Rev 1.0.1 TPC-Pricing Rev 2.1.1 Report Date: November 20, 2017
Total System Cost		TPCx-IoT Performance Metric		Price/Performance
133,662 USD		**142,493.85** IoTps		**0.94 USD** $/IoTps
Number of Records	DBMS Software	Operating System	Other Software	Availability Date
300 Million	HBase 1.2.1 On Cloudera Distribution for Apache Hadoop 5.10.0	Red Hat Enterprise Linux Server Release 7.2	None	November 20, 2017

System Configuration

SUT Chassis Front View

10 GigE

SUT Chassis Back View

Cisco UCS Mini Blade 5108 Chassis with
1 x Cisco UCS B200 M4 server (Name Node/HBase Master Node)
Server Configuration:
2 x Intel Xeon E5-2680 V4
256 GB Memory
1 x 3.8 TB Samsung SATA 6G SSDs
3 x Cisco UCS B200 M4 servers (HBase Region Servers)
Server Configuration:
2 x Intel Xeon E5-2680 V4
256 GB Memory
2 x 3.8 TB Samsung SATA 6G SSDs

Servers:	4 x Cisco UCS B200 M4 Servers
Total Processors/Cores/Threads:	8/112/224

Server Configuration (each)

Processors	2 x Intel Xeon CPU E5-2680 v4, 2.4GHz
Memory	256 GB
Storage Controller	1 x Cisco 12 Gbps RAID Controller
Storage Device	2 x 3.8 TB Samsung SATA 6G SSD (Worker Servers) 1 x 3.8 TB Samsung SATA 6G SSD (Master Server)
Network	1 x Cisco VIC 1340 Dual Port 40Gb QSFP CNA MLOM
Total Rack Units	1 x 5108 Blade Chassis = 6 RU

Cisco UCS Mini	TPCx-IoT Rev 1.0.1 TPC-Pricing Rev 2.1.1
	Report Date: November 20, 2017

Description	Part Number	Brand	Source	Unit Price	Qty	Extended Price	3 Year Maint. Price
Cisco Unified Computing System	UCS-MINI-Z0001	Cisco	1	$0.00	1	$0.00	
UCS 5108 Blade Server AC2 Chassis, 0 PSU/8 fans/0 FEX	UCSB-5108-AC2	Cisco	1	$5,999.00	1	$5,999.00	
Fan module for UCS 5108	N20-FAN5	Cisco	1	$0.00	8	$0.00	
Single phase AC power module for UCS 5108	N01-UAC1	Cisco	1	$0.00	1	$0.00	
Blade slot blanking panel for UCS 5108/single slot	N20-CBLKB1	Cisco	1	$0.00	4	$0.00	
6324 Fabric Interconnect License for 40G Scalability Port	UCS-6324-40G	Cisco	1	$5,548.00	2	$11,096.00	
Accessory kit for UCS 5108 Blade Server Chassis	N20-CAK	Cisco	1	$0.00	1	$0.00	
UCS 5108 Packaging for chassis with half width blades.	UCSB-5108-PKG-HW	Cisco	1	$0.00	1	$0.00	
UCS 5108 Blade Chassis FW Package 3.2(1)	N20-FW015	Cisco	1	$0.00	1	$0.00	
UCS B200 M4 w/o CPU, mem, drive bays, HDD, mezz	UCSB-B200-M4	Cisco	1	$2,995.00	4	$11,980.00	
2.40 GHz E5-2680 v4/120W 14C/35MB Cache/DDR4 2400MHz	UCS-CPU-E52680E	Cisco	1	$5,259.00	8	$42,072.00	
32GB DDR4-2400-MHz RDIMM/PC4-19200/dual rank/x4/1.2v	UCS-MR-1X322RV-A	Cisco	1	$1,735.00	32	$55,520.00	
Cisco FlexStorage 12G SAS RAID controller with Drive bays	UCSB-MRAID12G	Cisco	1	$749.00	4	$2,996.00	
3.8TB 2.5 inch Enterprise Value 6G SATA SSD	UCS-SD38TBMS4-EV	Cisco	1	$9,600.00	7	$67,200.00	
Cisco UCS VIC 1340 modular LOM for blade servers	UCSB-MLOM-40G-03	Cisco	1	$1,499.00	4	$5,996.00	
Cisco M4 - v4 CPU asset tab ID label (Auto-Expand)	UCS-M4-V4-LBL	Cisco	1	$0.00	4	$0.00	
CPU Heat Sink for UCS B200 M4/B420 M4 (Rear)	UCSB-HS-EP-M4-R	Cisco	1	$0.00	4	$0.00	
CPU Heat Sink for UCS B200 M4/B420 M4 (Front)	UCSB-HS-EP-M4-F	Cisco	1	$0.00	4	$0.00	

Cisco ONE Data Center Compute Opt Out Option	C1UCS-OPT-OUT	Cisco	1	$0.00	4	$0.00	
2500W Platinum AC Hot Plug Power Supply - DV	UCSB-PSU-2500ACDV	Cisco	1	$936.00	4	$3,744.00	
NEMA 6-20 to IEC-C19 13ft US	CAB-US620P-C19-US	Cisco	1	$0.00	4	$0.00	
UCS 6324 In-Chassis FI with 4 UP, 1x40G Exp Port, 16 10Gb	UCS-FI-M-6324	Cisco	1	$22,000.00	2	$44,000.00	
UCS Manager v3.2(1)	N10-MGT015	Cisco	1	$0.00	1	$0.00	
3Y SMARTNET 24x7x4 UCS B200 M4 Blade Server Support	CON-SNTP-B200M4	Cisco	1	$1,221.00	4		$4,884
Cisco R42612 standard rack w/side panels	RACK2-UCS2	Cisco	1	$6,341.00	1		
3Y Support 24x7x4 UCS6324 In-Chs w/4UP 1x40G Exp Prt	CON-SNTP-FI6324U	Cisco	1	$1,077.00	2		$2,154
Red Hat Enterprise Linux Server, 3Y 24x7	CON-ISV1-EL2S2V3A	Cisco	1	$3,897.00	4	$3,897.00	Inc.
Cloudera Enterprise Edition, 3Y 24x7	UCS-BD-CEBN-GD=	Cisco	1	$14,057.00	4	$56,228.00	Inc.
3Y Support 24x7x4 UCS 5108 Mini Chassis SNTC for TrblShtg	CON-OSPT-SP5108AC	Cisco	1	$891.00	1		$891
					Total	$328,760.00	$7,929
Large Purchase Discount [1]	61% for products and 35% for service	Cisco	1			($200,543.60)	-$2,775
Acer V206HQL-LED monitor - 20" (Inc 2 spares)	UM.1V6AA.A02	CDW	2	$78.99	3	$236.97	
Logitech USB Corded Keyboard/Mouse Combo MK120 (Inc 2 spares)	920-002565	CDW	2	$17.99	3	$53.97	

Pricing:1 = Cisco, 2 = CDW.com

(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.

Three-Year Cost of Ownership **$133,662**

IoTps **142,493.85**

$/IoTps **0.94**

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 futur 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.

Measurement Results for Performance Run

Number of Records	300 Millions
Warm Up Run Start Time	2017-11-10 15:50:40
Warm Up Run End Time	2017-11-10 16:34:35
Warm Up Run Elapsed Time in Seconds	2,634.47
Measured Run Start Time	2017-11-10 16:34:35
Measured Run End Time	2017-11-10 17:09:41
Measured Run Elapsed Time in Seconds	2,105.35

Measurement Results for Repeatability Run

Number of Records	300 Millions
Warm Up Run Start Time	2017-11-10 17:17:40
Warm Up Run End Time	2017-11-10 17:58:26
Warm Up Run Elapsed Time in Seconds	2,446.22
Measured Run Start Time	2017-11-10 17:58:26
Measured Run End Time	2017-11-10 18:32:58
Measured Run Elapsed Time in Seconds	2,071.26

Run Report for Performance Run

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TPCx-IoT Performance Metric (IoTps) Report

Total Time in Seconds = 2,105.35

Total Number of Records = 300 Millions

TPCx-IoT Performance Metric (IoTps): 142,493.85

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Run Report for Repeatability Run

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TPCx-IoT Performance Metric (IoTps) Report

Total Time in Seconds = 2,071.26

Total Number of Records = 300 Millions

TPCx-IoT Performance Metric(IoTps): 144,839.65

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Table of Contents

Abstract

This document contains the methodology and results of the TPC Express Benchmark™ IoT (TPCx-IoT) test conducted in conformance with the requirements of the TPCx-IoT Standard Specification, Revision 1.0.1.

The test was conducted for a Scale Factor of 300 Million records with 4 Cisco UCS CB200M4 Servers running HBase 1.2.1 on Cloudera Distribution for Apache Hadoop Edition 5.10.0 on Red Hat Enterprise Linux Server Release 7.2.

This benchmark was approved by a Peer Review Board consisting of members of the TPCx-IoT sub-committee.

Measured Configuration

Company Name	Cluster Node	Virtualization	Operating System
Cisco Systems, Inc.	Cisco UCS B200 M4 Server	Not Used	Red Hat Enterprise Linux Server Release 7.2

TPC Express Benchmark© IoT Metrics

Total System Cost	IoTps	Price/Performance	Availability Date
133,662 USD	142,493.85	0.94 USD	November 20, 2017

Preface

TPC Express Benchmark™ IoT Overview

TPC Express Benchmark™ 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 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 Cisco Systems, Inc.

1.2 Parameter Settings

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

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

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

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

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

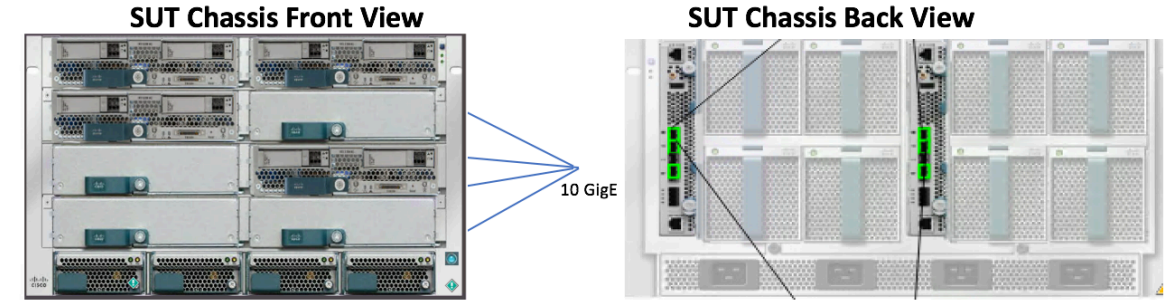
1.3 Configuration Diagrams

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



Cisco UCS Mini Blade 5108 Chassis with
1 x Cisco UCS B200 M4 server (Name Node/HBase Master Node)
Server Configuration:
2 x Intel Xeon E5-2680 V4
256 GB Memory
1 x 3.8 TB Samsung SATA 6G SSDs
3 x Cisco UCS B200 M4 servers (HBase Region Servers)
Server Configuration:
2 x Intel Xeon E5-2680 V4
256 GB Memory
2 x 3.8 TB Samsung SATA 6G SSDs

The measured configuration consisted of

- Total Nodes: 4
- Total Processor Cores/Threads: 8/112/224
- Total Memory: 1.02 TB
- Total Number of Storage Devices: 7
- Total Storage Capacity: 26.6 TB

Server nodes details:

- 4 x Cisco UCS B200M4 Servers with:
  - Processors/Cores/Threads: 2/28/56
  - Processor Model: 2 x Intel® Xeon® CPU E5-2680 v4, 2.4 GHz
  - Memory: 256 GB
  - Controller:
    - 1 x Cisco Flex Storage 12G SAS RAID controller with Drive bays
  - Drives:
    - 2 x 3.8 TB 6G SATA SSD (for all Worker Servers)
    - 1 x 3.8 TB 6G SATA SSD (for Master Server)

- Network: 1 x Cisco VIC 1340 Dual Port 40Gb QSFP CNA MLOM Network connectivity

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	Cisco 12 Gbps RAID Controller	1 (SSD)	Operating System, swap, Hadoop Master, root, Temp
2-4	Cisco 12 Gbps RAID Controller	1-2 (SSD)	Operating System, swap, root, 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
2-4		X		X		X	X

NoSQL Database version must be disclosed.

HBase -1.2.0 on Cloudera Distribution for Apache Hadoop 5.10.0

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 Run – Performance Run

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Total Time for Warmup Run in Seconds = 2,634.47

Total Time in Seconds = 2,105.35

Total Number of Records = 300,000,000

TPC-IoT Performance Metric (IoTps): 142,493.85

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Run Report for Run – Repeatability Run

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TPC-IoT Performance Metric (IoTps) Report

Total Time for Warmup Run in Seconds = 2,446.22

Total Time in Seconds = 2,071.26

Total Number of Records = 300,000,000

TPC-IoT Performance Metric (IoTps): 144,839.65

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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 1.0.1

```
e8ca6b78270482d955565f13803eb96e  TPC-IoT-master.sh
94815829685f7df4eba8ed3abeb4b778  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

	Run1	Run2
Total Run Time	2,105.35	2,071.26

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.

	Run1	Run2
IoTps	142,493.85	144,839.65

$/IoTps	0.94 USD

3.3 System Configuration Information

Storage System Software	Operating System	Other Software	System Availability Date
	Red Hat Enterprise Linux Server Release 7.2	-	November 20, 2017

Cloudera 5.10.0	
Component	**Package Version**
Apache Hadoop	hadoop-2.6.0+cdh5.10.0+2102
HBase	hbase-1.2.0+cdh5.10.0+236
Zookeeper	zookeeper-3.4.5+cdh5.10.0+104

Supporting File Index

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

Clause	Description	Archive File Pathname
Clause 1	Parameters and option used to configure and tune the SUT	SupportingFilesArchive/Clause1
Clause 2	Configuration Scripts and Run Report	SupportingFilesArchive/Clause2
Clause 3	System Configuration Details	SupportingFilesArchive/Clause3

Third Party Price Quotes