Alibaba Cloud Computing Ltd.

TPC Express Benchmark™ Big Bench (TPCx-BB)

Full Disclosure Report

for

Alibaba Cloud MaxCompute

(with 58x Compute Nodes,
9x Storage Nodes
3x Admin Nodes)

using

MaxCompute v3.37

and

Alibaba Group Enterprise Linux Server 7.2 (Paladin)

First Edition

August 18, 2021
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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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### System Configuration

#### Physical Storage/Scale Factor: 57.25

<table>
<thead>
<tr>
<th>Servers:</th>
<th>3x Admin Nodes / 58x Compute Node / 9x Storage Node</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Processors/Cores/Threads</td>
<td>140/3,592/7,184</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3x Master Node</th>
<th>58x Compute Node (Compute)</th>
<th>9x Storage Node (Storage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2x Intel® Xeon® Platinum 8163 CPU @ 2.50GHz</td>
<td>2x Intel(R) Xeon(R) Platinum 8269CY CPU @ 2.50GHz</td>
<td>2x Intel(R) Xeon(R) Platinum 8163 CPU @ 2.50GHz</td>
</tr>
<tr>
<td>512 GiB</td>
<td>768 GiB</td>
<td>256 GiB</td>
</tr>
<tr>
<td>Onboard SATA Controller</td>
<td>Onboard SATA Controller</td>
<td>Onboard SATA Controller</td>
</tr>
<tr>
<td>1x 240 GB SATA 6 Gbps SSD</td>
<td>1x 240 GB SATA 6 Gbps SSD</td>
<td>2x 240 GB SATA 6 Gbps SSD</td>
</tr>
<tr>
<td>1x 3.84 TB NVMe SSD</td>
<td>1x 3.84 TB OCSSD</td>
<td>76x 8 TB SATA 6 Gbps HDD</td>
</tr>
<tr>
<td>Mellanox MT27710 ConnectX-4 Lx</td>
<td>Mellanox MT27710 ConnectX-4 Lx</td>
<td>Mellanox MT27710 ConnectX-4 Lx</td>
</tr>
</tbody>
</table>

| Connectivity: | Network Switch (8x 100 Gbps Up; 48x 25 Gbps Down) |
### Pricing:

1 = Alibaba; 2 = Apple.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.

### Audited by Doug Johnson, InfoSizing

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 | 100000 |
| Streams      | 4      |
| SUT Validation Test | PASS   |

## Performance Run (Run 1)

| Overall Run Start Time | 2021-07-25 10:50:43.451 |
| Overall Run End Time   | 2021-07-25 17:39:23.742 |
| Overall Run Elapsed Time | 24,520.291 |
| Load Test Start Time   | 2021-07-25 10:50:43.452 |
| Load Test End Time     | 2021-07-25 12:06:37.186 |
| Load Test Elapsed Time | 4,553.734     |
| Power Test Start Time  | 2021-07-25 12:06:37.188 |
| Power Test End Time    | 2021-07-25 14:14:07.715 |
| Power Test Elapsed Time | 7,650.527   |
| Throughput Test Start Time | 2021-07-25 14:14:07.715 |
| Throughput Test End Time | 2021-07-25 17:39:23.742 |
| Throughput Test Elapsed Time | 12,316.027 |

**Performance Metric (BBQpm@ 100000)**

46,059.27

## Repeatability Run (Run 2)

| Overall Run Start Time | 2021-07-25 20:12:43.107 |
| Overall Run End Time   | 2021-07-26 02:46:40.529 |
| Overall Run Elapsed Time | 23,637.422 |
| Load Test Start Time   | 2021-07-25 20:12:43.108 |
| Load Test End Time     | 2021-07-25 21:13:40.809 |
| Load Test Elapsed Time | 3,657.701     |
| Power Test Start Time  | 2021-07-25 21:13:40.811 |
| Power Test End Time    | 2021-07-25 23:00:08.340 |
| Power Test Elapsed Time | 6,387.529   |
| Throughput Test Start Time | 2021-07-25 23:00:08.340 |
| Throughput Test End Time | 2021-07-26 02:46:40.528 |
| Throughput Test Elapsed Time | 13,592.188 |

**Performance Metric (BBQpm@ 100000)**

47,385.53
Performance Run Report (Run 1)

***************
TPCx-BB
Result
v1.5.0
***************
INFO: T_LOAD = 4553.734
INFO: T_LD = 0.1 * T_LOAD: 455.3734
INFO: T_PT = 3871.601215828
INFO: T_T_PUT = 12316.027
INFO: T_TT = 3079.00675
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@100000 = 46059.2701226814

Repeatability Run Report (Run 2)

***************
TPCx-BB
Result
v1.5.0
***************
INFO: T_LOAD = 3657.701
INFO: T_LD = 0.1 * T_LOAD: 365.7701
INFO: T_PT = 3468.02375756023
INFO: T_T_PUT = 13592.188
INFO: T_TT = 3398.047
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@100000 = 47385.5399634586

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 v1.5.0.

The test was conducted at a Scale Factor of 100000 with 70 nodes (58x Compute Node, 9x Storage Node) running MaxCompute v3.37 on Alibaba Group Enterprise Linux Server 7.2 (Paladin).

Measured Configuration

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Cluster Node</th>
<th>Virtualization</th>
<th>Operating System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alibaba Cloud Computing Ltd.</td>
<td>3x Admin Nodes</td>
<td>n/a</td>
<td>Alibaba Group Enterprise Linux Server 7.2 (Paladin)</td>
</tr>
<tr>
<td></td>
<td>58x Compute Node</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9x Storage Node</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TPC Express Benchmark© Big Bench Metrics

<table>
<thead>
<tr>
<th>Total System Cost</th>
<th>BBQpm@100000</th>
<th>Price/Performance</th>
<th>Availability Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,664,590 USD</td>
<td>46,059.27</td>
<td>79.57 USD</td>
<td>August 1, 2021</td>
</tr>
</tbody>
</table>
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 Alibaba Cloud Computing Ltd.

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:** 70
- **Total Processors/Cores/Threads:** 140/3,592/7,184
- **Total Memory:** 48,384 GiB
- **Total Number of Storage Devices:** 824
- **Total Storage Capacity:** 5,725,200

**Network:**
- Network Switch (8x 100 Gbps Up; 48x 25 Gbps Down)

**3x Master Nodes each with:**
- 2/48/96 (processors/cores/threads)
- 2x Intel(R) Xeon(R) Platinum 8163 CPU @ 2.50GHz
- 384 GiB
- Onboard SATA Controller
- 1x 240 GB SATA 6 Gbps SSD
- 1x 3.84 TB NVMe SSD
- Mellanox MT27710 ConnectX-4 Lx

**58x Compute Node (Compute):**
- 2/52/104
- 2x Intel(R) Xeon(R) Platinum 8269CY CPU @ 2.50GHz
- 768 GiB
- Onboard SATA Controller
- 1x 240 GB SATA 6 Gbps SSD
- 1x 3.84 TB OCSSD
- Mellanox MT27710 ConnectX-4 Lx

**9x Storage Node (Storage):**
- 2/48/96
- 2x Intel(R) Xeon(R) Platinum 8163 CPU @ 2.50GHz
- 256 GiB
- Onboard SATA Controller
- 2x 240 GB SATA 6 Gbps SSD
- 76x 8 TB SATA 6 Gbps HDD
- Mellanox MT27710 ConnectX-4 Lx

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

<table>
<thead>
<tr>
<th>Server</th>
<th>Role(s)</th>
<th>Count</th>
<th>Virtual</th>
<th>Host Names</th>
<th>HW/SW Configuration</th>
<th>Storage Setup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxcompute Master Node1</td>
<td>Pangu master</td>
<td>1</td>
<td>N</td>
<td>s54a04374.cloud.eoi66</td>
<td>2 * Intel Xeon Platinum 8163 @ 2.50GHz</td>
<td>OS: 1 * 240GB SATA 6Gbps SSD Data Drive: 1 * 3.84TB NVMe SSD</td>
</tr>
<tr>
<td></td>
<td>Fuxi Master</td>
<td></td>
<td></td>
<td></td>
<td>1 * 240GB SATA 6Gbps SSD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nuwa</td>
<td></td>
<td></td>
<td></td>
<td>1 * 3.84TB NVMe SSD</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 * 25Gb</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>OS: Linux 3.10.0-327.ali2014.alioc7.x86_64</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Apsara: 1.11_u32</td>
<td></td>
</tr>
<tr>
<td>Maxcompute Master Node2</td>
<td>Pangu master</td>
<td>1</td>
<td>N</td>
<td>s54c06379.cloud.eoi66</td>
<td>2 * Intel Xeon Platinum 8163 @ 2.50GHz</td>
<td>OS: 1 * 240GB SATA 6Gbps SSD Data Drive: 1 * 3.84TB NVMe SSD</td>
</tr>
<tr>
<td></td>
<td>Fuxi Master</td>
<td></td>
<td></td>
<td></td>
<td>1 * 240GB SATA 6Gbps SSD</td>
<td></td>
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<td></td>
<td>Nuwa</td>
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<td>1 * 3.84TB NVMe SSD</td>
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<td></td>
<td>2 * 25Gb</td>
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<td></td>
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<td></td>
<td>OS: Linux 3.10.0-327.ali2014.alioc7.x86_64</td>
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<td></td>
<td>Apsara: 1.11_u32</td>
<td></td>
</tr>
<tr>
<td>Maxcompute Master Node3</td>
<td>Pangu master</td>
<td>1</td>
<td>N</td>
<td>s54d06393.cloud.eoi66</td>
<td>2 * Intel Xeon Platinum 8163 @ 2.50GHz</td>
<td>OS: 1 * 240GB SATA 6Gbps SSD Data Drive: 1 * 3.84TB NVMe SSD</td>
</tr>
<tr>
<td></td>
<td>Fuxi Master</td>
<td></td>
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<td>1 * 240GB SATA 6Gbps SSD</td>
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<td></td>
<td>Nuwa</td>
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<td>1 * 3.84TB NVMe SSD</td>
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<td></td>
<td>2 * 25Gb</td>
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<td>OS: Linux 3.10.0-327.ali2014.alioc7.x86_64</td>
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<td></td>
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<td></td>
<td>Apsara: 1.11_u32</td>
<td></td>
</tr>
<tr>
<td>Maxcompute Compute Nodes</td>
<td>Fuxi tubo</td>
<td>58</td>
<td>N</td>
<td></td>
<td>2 * Intel Xeon Platinum 8269CY @ 2.50GHz</td>
<td>OS: 1 * 240GB SATA 6Gbps SSD Data Drive: 1 * 3.84TB OCSSD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>768GB Memory</td>
<td></td>
</tr>
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<td></td>
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<td></td>
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<td></td>
<td>1 * 240GB SATA 6Gbps SSD</td>
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<td></td>
<td></td>
<td></td>
<td>1 * 3.84TB OCSSD</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>2 * 25Gb</td>
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<td>OS: Linux 3.10.0-327.ali2016.alioc7.x86_64</td>
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<td></td>
<td></td>
<td></td>
<td>Apsara: 1.11_u32</td>
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</tr>
<tr>
<td>Maxcompute Storage Nodes</td>
<td>Pangu ChunkServer</td>
<td>9</td>
<td>N</td>
<td></td>
<td>2 * Intel Xeon Platinum 8163 @ 2.50GHz</td>
<td>OS: 2 * 240GB SATA 6Gbps SSD Data Drive: 76 * 8TB SATA 6Gbps HD</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>256GB Memory</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>2 * 240GB SATA 6Gbps SSD</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>76 * 8TB SATA 6Gbps HDD</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>OS: Linux 3.10.0-327.ali2010.rc7.alioc7.x86_64</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Apsara: 1.11_u32</td>
<td></td>
</tr>
</tbody>
</table>

2.2 Distributed File System Implementation

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

MaxCompute v3.37.
2.3 Engine Implementation

*The Engine implementation and corresponding version must be disclosed.*

<table>
<thead>
<tr>
<th>Component</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>MaxCompute</td>
<td>3.37</td>
</tr>
</tbody>
</table>

2.4 Frameworks

*Frameworks and Engine used in the benchmark should be disclosed.*

<table>
<thead>
<tr>
<th>Framework</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>MaxCompute</td>
<td>3.37</td>
</tr>
</tbody>
</table>

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.*

<table>
<thead>
<tr>
<th>TPCx-BB Kit Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>v1.5.0</td>
</tr>
</tbody>
</table>

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 (Performance Run)**

```
**************
TPCx-BB
Result
v1.5.0
**************
INFO: T_LOAD = 4553.734
INFO: T_LD = 0.1 * T_LOAD: 455.3734
INFO: T_PT = 3871.6012115828
INFO: T_T_PUT = 12316.027
INFO: T_TT = 3079.00675
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@100000 = 46059.2701226814
```

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

```
**************
TPCx-BB
Result
v1.5.0
**************
INFO: T_LOAD = 3657.701
INFO: T_LD = 0.1 * T_LOAD: 365.7701
INFO: T_PT = 3468.02375756023
INFO: T_T_PUT = 13592.188
INFO: T_TT = 3398.047
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@100000 = 47385.53999634586
```
### 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.

<table>
<thead>
<tr>
<th>Type</th>
<th>Query</th>
<th>Power</th>
<th>Stream 1</th>
<th>Stream 2</th>
<th>Stream 3</th>
<th>Stream 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>49.832</td>
<td>63.381</td>
<td>47.941</td>
<td>151.966</td>
<td>56.732</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>51.919</td>
<td>638.046</td>
<td>270.011</td>
<td>512.389</td>
<td>145.370</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>55.495</td>
<td>52.381</td>
<td>223.356</td>
<td>59.509</td>
<td>67.616</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>31.011</td>
<td>296.005</td>
<td>36.848</td>
<td>72.148</td>
<td>67.033</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>32.626</td>
<td>32.838</td>
<td>137.781</td>
<td>164.304</td>
<td>32.942</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>43.851</td>
<td>220.991</td>
<td>109.408</td>
<td>200.803</td>
<td>53.646</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>28.277</td>
<td>34.729</td>
<td>44.908</td>
<td>46.197</td>
<td>230.905</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>42.867</td>
<td>96.341</td>
<td>87.839</td>
<td>48.083</td>
<td>101.507</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>125.668</td>
<td>116.268</td>
<td>584.072</td>
<td>157.788</td>
<td>115.741</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>42.756</td>
<td>57.214</td>
<td>150.013</td>
<td>66.313</td>
<td>37.220</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>280.459</td>
<td>279.513</td>
<td>287.472</td>
<td>424.734</td>
<td>355.789</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>355.796</td>
<td>348.969</td>
<td>319.213</td>
<td>272.379</td>
<td>393.932</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>27.679</td>
<td>32.161</td>
<td>25.285</td>
<td>26.600</td>
<td>34.571</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>59.697</td>
<td>91.617</td>
<td>185.288</td>
<td>175.639</td>
<td>161.690</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>58.433</td>
<td>54.511</td>
<td>122.603</td>
<td>65.603</td>
<td>72.711</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>272.662</td>
<td>598.340</td>
<td>396.297</td>
<td>286.027</td>
<td>520.726</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>229.344</td>
<td>246.557</td>
<td>324.777</td>
<td>239.093</td>
<td>245.611</td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>100.079</td>
<td>558.357</td>
<td>267.596</td>
<td>408.100</td>
<td>93.723</td>
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<tr>
<td></td>
<td>2</td>
<td>652.291</td>
<td>1,055.789</td>
<td>1,084.737</td>
<td>921.003</td>
<td>890.984</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>314.446</td>
<td>559.232</td>
<td>495.371</td>
<td>628.885</td>
<td>574.635</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>411.225</td>
<td>463.559</td>
<td>631.493</td>
<td>431.292</td>
<td>2,096.173</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>617.663</td>
<td>793.845</td>
<td>811.049</td>
<td>849.074</td>
<td>1,007.826</td>
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<tr>
<td></td>
<td>8</td>
<td>181.181</td>
<td>304.903</td>
<td>365.933</td>
<td>252.119</td>
<td>331.530</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>110.320</td>
<td>83.178</td>
<td>157.884</td>
<td>102.341</td>
<td>212.528</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>1,002.061</td>
<td>2,325.037</td>
<td>585.203</td>
<td>2,279.878</td>
<td>870.044</td>
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<td></td>
<td>10</td>
<td>189.245</td>
<td>213.204</td>
<td>399.328</td>
<td>229.697</td>
<td>195.658</td>
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<tr>
<td></td>
<td>18</td>
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<td>1,988.943</td>
<td>3,050.600</td>
<td>2,047.447</td>
<td>1,588.164</td>
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<tr>
<td></td>
<td>19</td>
<td>343.731</td>
<td>448.940</td>
<td>494.302</td>
<td>409.210</td>
<td>343.663</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>54.079</td>
<td>100.059</td>
<td>75.495</td>
<td>216.720</td>
<td>64.583</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>130.551</td>
<td>161.104</td>
<td>142.746</td>
<td>145.193</td>
<td>316.804</td>
</tr>
</tbody>
</table>
3.5 Validation Test Output

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

<table>
<thead>
<tr>
<th>Query Number</th>
<th>Query Execution</th>
<th>Output Validation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PASS</td>
<td>PASS</td>
</tr>
<tr>
<td>2</td>
<td>PASS</td>
<td>PASS</td>
</tr>
<tr>
<td>3</td>
<td>PASS</td>
<td>PASS</td>
</tr>
<tr>
<td>4</td>
<td>PASS</td>
<td>PASS</td>
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<tr>
<td>5</td>
<td>PASS</td>
<td>PASS</td>
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<tr>
<td>6</td>
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<td>PASS</td>
</tr>
<tr>
<td>7</td>
<td>PASS</td>
<td>PASS</td>
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<tr>
<td>8</td>
<td>PASS</td>
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<td>9</td>
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<tr>
<td>10</td>
<td>PASS</td>
<td>PASS</td>
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<tr>
<td>11</td>
<td>PASS</td>
<td>PASS</td>
</tr>
<tr>
<td>12</td>
<td>PASS</td>
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<td>13</td>
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<tr>
<td>14</td>
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<tr>
<td>15</td>
<td>PASS</td>
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</tr>
<tr>
<td>16</td>
<td>PASS</td>
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<tr>
<td>17</td>
<td>PASS</td>
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<td>18</td>
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<td>25</td>
<td>PASS</td>
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<tr>
<td>26</td>
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<td>PASS</td>
</tr>
<tr>
<td>27</td>
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</tr>
<tr>
<td>28</td>
<td>PASS</td>
<td>PASS</td>
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<tr>
<td>29</td>
<td>PASS</td>
<td>PASS</td>
</tr>
<tr>
<td>30</td>
<td>PASS</td>
<td>PASS</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Nodes</th>
<th>Disks</th>
<th>Size (GB)</th>
<th>Total (GB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>61</td>
<td>1</td>
<td>240</td>
<td>14,640</td>
</tr>
<tr>
<td>61</td>
<td>1</td>
<td>3,840</td>
<td>234,240</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>240</td>
<td>4,320</td>
</tr>
<tr>
<td>9</td>
<td>76</td>
<td>8,000</td>
<td>5,472,000</td>
</tr>
</tbody>
</table>

Total Storage (GB) 5,725,200
Scale Factor 100000
Data Storage Ratio 57.25

4.5 Scale Factor to Memory Ratio

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

<table>
<thead>
<tr>
<th>Nodes</th>
<th>Memory (GB)</th>
<th>Total (GB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>512</td>
<td>1,536</td>
</tr>
<tr>
<td>58</td>
<td>768</td>
<td>44,544</td>
</tr>
<tr>
<td>9</td>
<td>256</td>
<td>2,304</td>
</tr>
</tbody>
</table>

Scale Factor 100000
Total Memory (GB) 48,384
SF / Memory Ratio 2.07
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.

<table>
<thead>
<tr>
<th>Performance Run</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBQpm@100000 46,059.27</td>
</tr>
</tbody>
</table>

5.2 Repeatability Run Metric

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

<table>
<thead>
<tr>
<th>Repeatability Run</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBQpm@100000 47,385.53</td>
</tr>
</tbody>
</table>

5.3 Price-Performance Metric

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

<table>
<thead>
<tr>
<th>Price / Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$BBQpm@100000 79.57</td>
</tr>
</tbody>
</table>

5.4 Scale Factor

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

<table>
<thead>
<tr>
<th>Scale Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>100000</td>
</tr>
</tbody>
</table>

5.5 Stream Count

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

<table>
<thead>
<tr>
<th>Streams</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Run</th>
<th>Elapsed Time</th>
<th>Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run 1</td>
<td>00 06:48:40.291</td>
<td>24,520.291</td>
</tr>
<tr>
<td>Run 2</td>
<td>00 06:33:57.422</td>
<td>23,637.422</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Test</th>
<th>Performance Run</th>
<th>Repeatability Run</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load Test</td>
<td>4,553.734</td>
<td>3,657.701</td>
</tr>
<tr>
<td>Power Test</td>
<td>7,650.527</td>
<td>6,387.529</td>
</tr>
<tr>
<td>Throughput Test</td>
<td>12,316.027</td>
<td>13,592.188</td>
</tr>
</tbody>
</table>
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.
I verified the TPC Express Benchmark™ BB v1.5.0 performance of the following configuration:

Platform: Alibaba Cloud MaxCompute
(w/ 3x Master Nodes, 58x Compute Nodes, 9 Storage Nodes)
Operating System: Alibaba Group Enterprise Linux Server 7.2 (Paladin)
Framework: MaxCompute v3.37

The results were:

**Performance Metric** 46,059.27 BBQpm@100000
Run Elapsed Time 00 06:48:40.291 (24,520.291 Seconds)

**Cluster** 3x Master Nodes, 58x Compute Nodes, 9x Storage Nodes

| CPUs          | 2x Intel® Xeon® Platinum 8163 (2.50 GHz, 24-core, 33 MB L3)  
|              | (Master, Storage nodes) |
|              | 2x Intel® Xeon® Platinum 8269CY (2.50 GHz, 18-core, 35.75 MB L3)  
|              | (Compute nodes) |
| Memory Storage | 512GiB (Master nodes), 768GiB (Compute nodes), 256GiB (Storage 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 v1.5.0
- 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 (100000GB) was confirmed to be valid for publication
• All validation queries executed successfully and produced compliant results
• 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,

[Signature]

Doug Johnson, TPC Auditor
Third Party Price Quotes

Apple.com

Customize your 13-inch MacBook Pro - Space Gray

Apple M1 chip with 8-core CPU, 8-core GPU, and 16-core Neural Engine
8GB unified memory
256GB SSD storage
13-inch Retina display with True Tone
Backlit Magic Keyboard - US English
Touch Bar and Touch ID
Two Thunderbolt / USB 4 ports

Learn more about the Apple M1 chip

Delivery:
In Stock
Free Shipping
Get delivery dates

Pickup:
Check availability

$1,299.00 or $108.25/mo. for 12 mo.*
The following index outlines the information included in the supporting files archive.

<table>
<thead>
<tr>
<th>Description</th>
<th>Archive File Pathname</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clause 1 - General Items</strong></td>
<td></td>
</tr>
<tr>
<td>The Supporting Files Archive contains the parameters and options used to configure the components involved in this benchmark</td>
<td>Support-Files-for-Alibaba-Maxcompute-58nodes-100TB/Performance-Run-logs-20210725-175133-sql-sf100000</td>
</tr>
<tr>
<td>Validation Run Files</td>
<td>Support-Files-for-Alibaba-Maxcompute-58nodes-100TB/Validation-Run-logs-20210725-084511-sql-sf100000</td>
</tr>
<tr>
<td>Performance Run Files</td>
<td>Support-Files-for-Alibaba-Maxcompute-58nodes-100TB/Performance-Run-logs-20210725-175133-sql-sf100000</td>
</tr>
<tr>
<td>Repeatability Run Files</td>
<td>Support-Files-for-Alibaba-Maxcompute-58nodes-100TB/Repeatability-Run-logs-20210726-030803-sql-sf100000</td>
</tr>
<tr>
<td><strong>Clause 3 - Workload Related Items</strong></td>
<td></td>
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<tr>
<td>Query Parameters used in the benchmark execution Settings</td>
<td>Support-Files-for-Alibaba-Maxcompute-58nodes-100TB/Performance-Run-logs-20210725-175133-sql-sf100000/bigBench-configs/sql/conf/queryParameters.sql</td>
</tr>
<tr>
<td>Load Test script</td>
<td>Support-Files-for-Alibaba-Maxcompute-58nodes-100TB/Performance-Run-logs-20210725-175133-sql-sf100000/bigBench-configs/sql/queries/clusterLocalSettings.conf</td>
</tr>
<tr>
<td><strong>Clause 4 - SUT Related Items</strong></td>
<td></td>
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<tr>
<td>Data Redundancy report</td>
<td>Support-Files-for-Alibaba-Maxcompute-58nodes-100TB/pangu_redundant_info_20210726-030925.txt</td>
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<tr>
<td>Benchmark execution script</td>
<td>Support-Files-for-Alibaba-Maxcompute-58nodes-100TB/TPCxBB_FullBenchmark_sequence_run.sh</td>
</tr>
<tr>
<td>Hardware and Software Report from a representative master node</td>
<td>Support-Files-for-Alibaba-Maxcompute-58nodes-100TB/envInfo-s54a04374.cloud.eo166/envInfo.log</td>
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<tr>
<td>Hardware and Software Report from a representative compute node</td>
<td>Support-Files-for-Alibaba-Maxcompute-58nodes-100TB/envInfo-s37a09328.cloud.eo166/envInfo.log</td>
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<td>Hardware and Software Report from a representative storage node</td>
<td>Support-Files-for-Alibaba-Maxcompute-58nodes-100TB/envInfo-s39e12451.cloud.eo166/envInfo.log</td>
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<tr>
<td><strong>Clause 5 - Metric and Scale Factor Related Items</strong></td>
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<td><strong>Clause 6 – Other</strong></td>
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<tr>
<td>compute Nodes</td>
<td>Support-Files-for-Alibaba-Maxcompute-58nodes-100TB/nodelist.txt</td>
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<tr>
<td>storage Nodes</td>
<td>Support-Files-for-Alibaba-Maxcompute-58nodes-100TB/storage-nodelist.txt</td>
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