Alibaba Cloud

Alibaba Cloud Computing Ltd.

TPC Benchmark™ DS

Full Disclosure Report

for

Alibaba Cloud AnalyticDB (ADB)

(with 16 Alibaba Cloud Elastic Compute Units)

using

Alibaba Cloud AnalyticDB 2.7

and

Alibaba Group Enterprise Linux Server release 7.2 (Paladin)

First Edition

April 26, 2019

First Edition – April, 2019

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Abstract

This document contains the methodology and results of the TPC Benchmark™ DS (TPC-DS) test conducted in conformance with the requirements of the TPC-DS Standard Specification, Revision 2.10.1.

The test was conducted at a Scale Factor of 10000GB with 16 Alibaba Cloud Elastic Compute Units running Alibaba Cloud AnalyticDB version 2.7 on CentOS Linux Release 7.4.

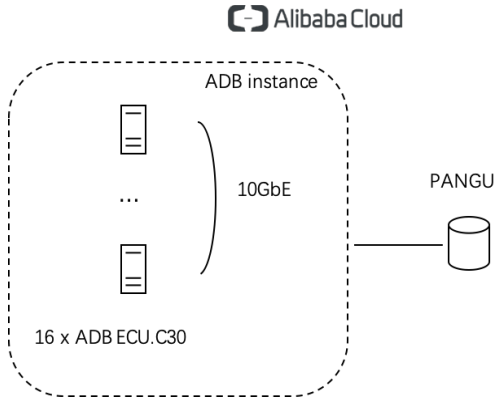
Measured Configuration

Company Name	Cluster Node	Database Software	Operation System
Alibaba Cloud Computing Ltd.	Alibaba Cloud Elastic Compute Units	Alibaba Cloud AnalyticDB 2.7	Alibaba Group Enterprise Linux Server release 7.2 (Paladin)

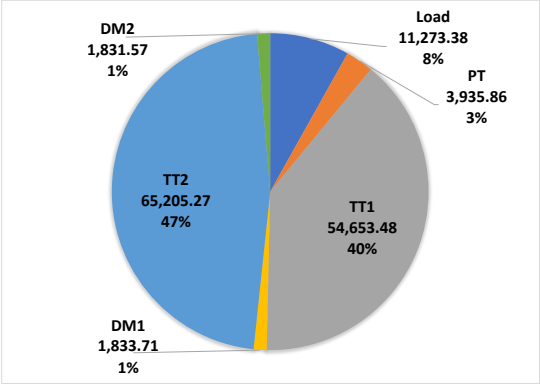
TPC Benchmark™ DS Metrics

Total System Cost (RMB)	TPC-DS Throughput (QphDS@10000GB)	Price/Performance (RMB/QphDS@10000GB)	Availability Date
¥3,172,347	**2,684,357**	**¥1.19**	**As of Publication**

Alibaba Cloud	**Alibaba Cloud AnalyticDB**		TPC-DS: 2.10.1 TPC-Pricing: 2.4.0 Report Date: Apr. 26, 2019	
Total System Cost	TPC-DS Throughput	Price/Performance	System Availability Date	
¥3,172,347 RMB	**2,684,357** QphDS@10000GB	**¥1.19** RMB/QphDS@10000GB	**As of Publication**	
Dataset Size[1]	Database Manager	Operation System	Other Software	Cluster
10,000 GB	Alibaba Cloud AnalyticDB 2.7	Alibaba Group Enterprise Linux Server 7.2 (Paladin)	N/A	Yes



Benchmarked Configuration



Elapsed Time

Load includes backup = No	RAID = No
System Configuration:	**Alibaba Cloud AnalyticDB Cluster**
Servers:	16 x ECU C30
Total Processors/Cores/Threads:	1,024 virtual cores (threads)
Total Memory:	6,144 GB
Total Storage[2]:	120,992 GB (including PANGU)
Storage Ratio[3]:	12.10
Server Configuration:	**Per node (ECU C30)**
Processors/Cores/Threads:	64 virtual cores (threads)
Memory:	384 GB
Network:	10Gbps
Storage Device:	2,242 GB SSD
Object Storage Service Configuration:	**PANGU Storage**
Storage Capacity:	8 TB x 10 = 80,000 GB

1. Dataset Size includes only raw data (i.e., no temp, index, redundant storage space, etc.).
2. Total Storage = 2,442 * 16 (ECU SSD) + 8,192 * 10 (PANGU) = 120,992 GB
3. Storage Ratio = Total Storage / SF = 120,992 GB / 10,000 GB

Alibaba Cloud	**Alibaba Cloud AnalyticDB**	TPC-DS: 2.10.1 TPC-Pricing: 2.4.0 Report Date: Apr.26, 2019

Description	Part Number	Src	Unit Price (RMB)	Qty	Ext. Price (RMB)	3-Year Maint. (RMB)
Licence Compute and Software Services						
AnalyticDB (South China 1 Region) (3-Year Pre-Pay)		1	3,168,000.00	1	3,168,000.00	included
- ECU Instance C30 (included in AnalyticDB)	C30	1		16		included
- PANGU cloud storage						
(SATA clound disks 8,000 GB, included in AnalyticDB)		1		10		included
Licence Computer and Software Services Sub-Total					**3,168,000.00**	**0.00**
Other Components						
Lenovo MIIX 210 Laptop (Includes spares)		2	1,449.00	3	4,347.00	
Other Components Sub-Total					**4,347.00**	**0.00**

1 = Alibaba Cloud, 2 = Tmall.com	**3-Year Cost of Ownership**	**3,172,347.00**
All prices are based on 3-year pre-paid subscriptions.	**QphDS@10000GB**	**2,684,357**
Audited by Francois Raab, InfoSizing	**RMB/QphDS@10000GB**	**1.19**

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.

Alibaba Cloud	Alibaba Cloud AnalyticDB	TPC-DS: 2.10.1 TPC-Pricing: 2.4.0 Report Date: Apr.26, 2019

Metrics Details:

Name	Value	Unit
Scale Factor (SF)	10000	GB
Streams	4	Stream
Queries (Q)	396	Queries
T_load	11,273.4	Second
T_ld	0.1253	Hour
T_pt	4.3733	Hour
T_tt1	14,033.6	Second
T_tt2	16,524.3	Second
T_dm1	1,833.8	Second
T_dm2	1,831.6	Second
T_tt	8.4884	Hour
T_dm	1.0182	Hour

Load Step	Start	End	(sec.)	(hh:mm:ss)
Build	04/25/19 01:54:20.74	04/25/19 04:47:32.67	10,391.93	2:53:12
Audit	04/25/19 04:47:32.68	04/25/19 04:59:34.59	721.91	0:12:02
Finish	04/25/19 04:59:34.60	04/25/19 05:14:16.05	881.45	0:14:41
Reported	**04/25/19 01:54:20.74**	**04/25/19 05:14:16.05**	**11,273.38**	**3:07:53**

Test	Start	End	(sec.)	(hh:mm:ss)
Power	04/25/19 05:27:07.34	04/25/19 06:32:43.20	3,935.86	1:05:36
Thruput-1	04/25/19 06:32:43.26	04/25/19 10:26:36.80	14,033.54	3:53:54
Thruput-2	04/25/19 10:57:26.22	04/25/19 15:32:50.48	16,524.26	4:35:24
DM-1	04/25/19 10:26:52.45	04/25/19 10:57:26.16	1,833.71	0:30:34
DM-2	04/25/19 15:33:13.04	04/25/19 16:03:44.62	1,831.58	0:30:32

Stream	Start	End	(sec.)	(hh:mm:ss)
Pt - 0	04/25/19 05:27:07.34	04/25/19 06:32:43.20	3,935.86	1:05:36
Tt1 - 1	04/25/19 06:32:43.26	04/25/19 10:21:57.57	13,754.31	3:49:14
Tt1 - 2	04/25/19 06:32:43.26	04/25/19 10:26:36.80	14,033.54	3:53:54
Tt1 - 3	04/25/19 06:32:43.26	04/25/19 10:17:56.03	13,512.77	3:45:13
Tt1 - 4	04/25/19 06:32:43.26	04/25/19 10:15:16.12	13,352.86	3:42:33
Tt2 - 5	04/25/19 10:57:26.22	04/25/19 15:23:24.13	15,957.91	4:25:58
Tt2 - 6	04/25/19 10:57:26.22	04/25/19 15:31:02.76	16,416.55	4:33:37
Tt2 - 7	04/25/19 10:57:26.22	04/25/19 15:32:50.48	16,524.26	4:35:24
Tt2 - 8	04/25/19 10:57:26.22	04/25/19 15:29:12.77	16,306.55	4:31:47
DMt1 - 1	04/25/19 10:26:52.45	04/25/19 10:42:07.75	915.31	0:15:15
DMt1 - 2	04/25/19 10:42:07.76	04/25/19 10:57:26.16	918.40	0:15:18
DMt2 - 3	04/25/19 15:33:13.04	04/25/19 15:48:10.12	897.08	0:14:57
DMt2 - 4	04/25/19 15:48:10.13	04/25/19 16:03:44.62	934.49	0:15:34

Timing Intervals for Queries (in Seconds)

Query	Stream 0	Stream 1	Stream 2	Stream 3	Stream 4	Min	25%tile	Median	75%tile	Max	Stream 5	Stream 6	Stream 7	Stream 8	Min	25%tile	Median	75%tile	Max
1	3.1	8.5	9.4	16.7	20.8	8.5	9.2	13.1	17.7	20.8	24.3	17.5	10.5	27.4	10.5	15.8	20.9	25.1	27.4
2	37.4	65.6	419.0	54.8	73.1	54.8	62.9	69.4	159.6	419.0	79.3	487.5	205.6	110.9	79.3	103.0	158.3	276.1	487.5
3	14.1	36.4	132.4	496.6	35.8	35.8	36.3	84.4	223.5	496.6	24.8	267.2	81.8	45.3	24.8	40.2	63.6	128.2	267.2
4	414.5	948.7	777.5	783.5	1,055.1	777.5	782.0	866.1	975.3	1,055.1	707.0	982.8	664.1	708.5	664.1	696.3	707.8	777.1	982.8
5	19.5	54.3	112.6	47.5	37.5	37.5	45.0	50.9	68.9	112.6	33.3	38.2	73.9	56.7	33.3	37.0	47.5	61.0	73.9
6	1.9	4.2	109.0	9.6	86.0	4.2	8.3	47.8	91.8	109.0	15.6	3.9	172.1	17.4	3.9	12.7	16.5	56.1	172.1
7	12.9	54.8	188.2	44.2	83.5	44.2	52.2	69.2	109.7	188.2	105.0	56.6	54.9	396.4	54.9	56.2	80.8	177.9	396.4
8	6.8	33.1	8.9	46.6	8.0	8.0	8.7	21.0	36.5	46.6	11.3	23.8	23.6	42.3	11.3	20.5	23.7	28.4	42.3
9	23.7	258.9	34.2	34.9	46.0	34.2	34.7	40.5	99.2	258.9	123.8	56.7	62.6	43.9	43.9	53.5	59.7	77.9	123.8
10	11.3	28.9	52.5	11.3	20.0	11.3	17.8	24.5	34.8	52.5	19.9	29.3	108.6	35.5	19.9	27.0	32.4	53.8	108.6
11	228.8	408.0	1,244.7	539.3	303.3	303.3	381.8	473.7	715.7	1,244.7	523.4	652.4	917.0	533.5	523.4	531.0	593.0	718.6	917.0
12	0.9	3.1	2.0	5.8	6.1	2.0	2.8	4.5	5.9	6.1	3.6	9.6	4.2	52.9	3.6	4.1	6.9	20.4	52.9
13	28.9	166.2	68.6	257.4	68.5	68.5	68.6	117.4	189.0	257.4	201.5	76.7	260.8	111.6	76.7	102.9	156.6	216.3	260.8
14	618.8	1,373.2	1,170.6	966.0	1,036.0	966.0	1,018.5	1,103.3	1,221.3	1,373.2	1,357.2	1,137.4	1,384.0	1,145.2	1,137.4	1,143.3	1,251.2	1,363.9	1,384.0
15	3.8	111.1	11.2	7.1	8.7	7.1	8.3	10.0	36.2	111.1	5.2	5.8	30.5	11.8	5.2	5.7	8.8	16.5	30.5
16	51.2	136.3	196.0	370.4	109.3	109.3	129.6	166.2	239.6	370.4	129.1	62.1	60.5	397.4	60.5	61.7	95.6	196.2	397.4
17	8.8	21.0	36.3	72.0	33.7	21.0	30.5	35.0	45.2	72.0	19.2	53.8	42.7	90.0	19.2	36.8	48.3	62.9	90.0
18	8.4	56.2	8.8	18.6	29.0	8.8	16.2	23.8	35.8	56.2	44.3	66.0	407.9	78.7	44.3	60.6	72.4	161.0	407.9
19	10.2	27.5	278.4	6.5	18.7	6.5	15.7	23.1	90.2	278.4	5.7	14.0	73.1	252.1	5.7	11.9	43.6	117.9	252.1
20	1.4	34.0	19.4	4.1	13.3	4.1	11.0	16.4	23.1	34.0	37.7	26.4	267.6	3.0	3.0	20.6	32.1	95.2	267.6
21	0.7	16.5	109.3	5.3	5.6	5.3	5.5	11.1	39.7	109.3	2.7	2.0	32.4	183.5	2.0	2.5	17.6	70.2	183.5
22	3.5	12.9	8.7	38.4	4.4	4.4	7.6	10.8	19.3	38.4	12.7	468.1	3.4	39.5	3.4	10.4	26.1	146.7	468.1
23	666.9	1,275.3	2,356.1	1,921.2	2,236.5	1,275.3	1,759.7	2,078.9	2,266.4	2,356.1	2,298.8	1,332.7	2,838.5	2,205.2	1,332.7	1,987.1	2,252.0	2,433.7	2,838.5
24	93.1	376.8	231.1	413.8	466.0	231.1	340.4	395.3	426.9	466.0	403.6	430.9	233.3	343.3	233.3	315.8	373.5	410.4	430.9
25	6.3	45.7	16.4	18.1	40.6	16.4	17.7	29.4	41.9	45.7	23.4	31.3	31.9	63.2	23.4	29.3	31.6	39.7	63.2
26	7.2	57.7	221.5	30.2	32.2	30.2	31.7	45.0	98.7	221.5	32.9	88.1	35.0	95.8	32.9	34.5	61.6	90.0	95.8
27	8.6	61.9	54.9	399.3	23.8	23.8	47.1	58.4	146.3	399.3	33.8	36.3	15.7	31.7	15.7	27.7	32.8	34.4	36.3
28	32.0	51.9	51.7	146.3	97.8	51.7	51.9	74.9	109.9	146.3	121.3	43.7	83.2	98.4	43.7	73.3	90.8	104.1	121.3
29	17.6	152.8	39.1	244.5	62.7	39.1	56.8	107.8	175.7	244.5	117.9	448.5	89.9	367.6	89.9	110.9	242.8	387.8	448.5
30	2.9	9.0	8.4	9.8	5.8	5.8	7.8	8.7	9.2	9.8	6.1	4.4	6.5	11.7	4.4	5.7	6.3	7.8	11.7
31	18.4	55.9	141.1	55.0	54.3	54.3	54.8	55.5	77.2	141.1	30.5	41.7	66.9	57.1	30.5	38.9	49.4	59.6	66.9
32	15.5	73.6	93.4	92.0	62.4	62.4	70.8	82.8	92.4	93.4	126.8	83.7	69.9	57.2	57.2	66.7	76.8	94.5	126.8
33	2.9	5.9	7.4	10.9	7.0	5.9	6.7	7.2	8.3	10.9	6.1	13.7	6.6	11.8	6.1	6.5	9.2	12.3	13.7
34	9.6	34.1	14.4	28.7	16.9	14.4	16.3	22.8	30.1	34.1	77.3	104.9	77.5	47.1	47.1	69.8	77.4	84.4	104.9
35	21.1	94.0	85.0	61.9	38.4	38.4	56.0	73.5	87.3	94.0	199.8	202.7	309.5	132.3	132.3	182.9	201.3	229.4	309.5
36	10.1	181.7	88.9	66.0	39.6	39.6	59.4	77.5	112.1	181.7	82.9	68.0	115.2	62.3	62.3	66.6	75.5	91.0	115.2
37	5.3	28.6	16.0	19.3	78.1	16.0	18.5	24.0	41.0	78.1	21.9	38.4	63.8	48.8	21.9	34.3	43.6	52.6	63.8
38	72.4	180.5	220.9	169.4	214.2	169.4	177.7	197.4	215.9	220.9	267.5	189.1	201.8	195.2	189.1	193.7	198.5	218.2	267.5
39	2.8	2.1	12.1	2.9	2.8	2.1	2.6	2.9	5.2	12.1	8.6	4.8	5.4	28.6	4.8	5.3	7.0	13.6	28.6
40	4.4	10.0	10.0	35.3	30.1	10.0	10.0	20.1	31.4	35.3	7.9	24.5	38.6	20.3	7.9	17.2	22.4	28.0	38.6
41	0.3	138.5	0.4	0.9	4.5	0.4	0.8	2.7	38.0	138.5	171.5	6.5	0.7	3.3	0.7	2.7	4.9	47.8	171.5
42	0.9	1.7	3.9	2.3	4.5	1.7	2.2	3.1	4.1	4.5	55.0	385.9	7.5	119.4	7.5	43.1	87.2	186.0	385.9
43	14.2	42.2	43.6	121.4	61.5	42.2	43.3	52.6	76.5	121.4	120.2	33.5	67.9	81.1	33.5	59.3	74.5	90.9	120.2
44	1.8	1.9	6.8	7.0	22.6	1.9	5.6	6.9	10.9	22.6	4.8	79.6	169.2	27.2	4.8	21.6	53.4	102.0	169.2
45	3.1	12.4	7.0	11.7	12.8	7.0	10.5	12.1	12.5	12.8	13.4	5.8	5.8	15.2	5.8	5.8	9.6	13.9	15.2
46	14.8	60.2	13.4	51.5	28.5	13.4	24.7	40.0	53.7	60.2	557.2	257.5	261.0	377.9	257.5	260.1	319.5	422.7	557.2
47	82.8	161.1	83.4	226.2	252.3	83.4	141.7	193.7	232.7	252.3	172.8	253.6	320.1	195.6	172.8	189.9	224.6	270.2	320.1
48	27.7	67.8	29.1	302.3	112.4	29.1	58.1	90.1	159.9	302.3	104.0	621.5	88.4	65.8	65.8	82.8	96.2	233.4	621.5
49	8.8	32.2	74.5	15.0	15.8	15.0	15.6	24.0	42.8	74.5	241.8	59.7	28.4	25.3	25.3	27.6	44.1	105.2	241.8
50	28.4	73.4	76.7	233.5	110.3	73.4	75.9	93.5	141.1	233.5	168.5	191.0	36.8	207.9	36.8	135.6	179.8	195.2	207.9
51	22.0	61.9	91.8	127.2	414.3	61.9	84.3	109.5	199.0	414.3	94.7	92.6	64.7	103.2	64.7	85.6	93.7	96.8	103.2
52	1.3	1.8	32.1	2.5	2.8	1.8	2.3	2.7	10.1	32.1	67.9	2.3	5.3	2.0	2.0	2.2	3.8	21.0	67.9
53	3.7	9.9	14.2	13.3	18.2	9.9	12.5	13.8	15.2	18.2	151.0	45.1	82.3	31.8	31.8	41.8	63.7	99.5	151.0
54	4.4	20.8	16.1	38.2	32.8	16.1	19.6	26.8	34.2	38.2	37.1	243.1	16.1	341.9	16.1	31.9	140.1	267.8	341.9
55	0.9	5.2	63.4	33.3	198.4	5.2	26.3	48.4	97.2	198.4	520.0	2.1	181.8	56.2	2.1	42.7	119.0	266.4	520.0
56	2.5	10.3	4.5	21.2	6.7	4.5	6.2	8.5	13.0	21.2	17.2	8.7	3.3	13.1	3.3	7.4	10.9	14.1	17.2
57	37.4	222.9	69.7	117.3	61.0	61.0	67.5	93.5	143.7	222.9	143.1	81.6	49.2	108.0	49.2	73.5	94.8	116.8	143.1
58	1.5	4.8	4.7	40.2	1.3	1.3	3.9	4.8	13.7	40.2	305.1	174.7	4.8	4.4	4.4	4.7	89.8	207.3	305.1
59	24.3	71.9	54.9	309.2	52.7	52.7	54.4	63.4	131.2	309.2	82.1	115.1	110.5	178.6	82.1	103.4	112.8	131.0	178.6
60	3.5	7.5	5.4	14.7	46.3	5.4	7.0	11.1	22.6	46.3	6.9	8.2	8.6	5.3	5.3	6.5	7.6	8.3	8.6
61	5.2	317.6	230.0	18.7	9.6	9.6	16.4	124.4	251.9	317.6	341.9	169.5	13.4	425.0	13.4	130.5	255.7	362.7	425.0
62	10.5	44.4	29.6	28.3	29.6	28.3	29.3	29.6	33.3	44.4	68.0	87.9	268.7	93.4	68.0	82.9	90.7	137.2	268.7
63	3.9	329.7	136.0	14.4	18.5	14.4	17.5	77.3	184.4	329.7	15.5	107.5	108.6	43.4	15.5	36.4	75.5	107.8	108.6
64	42.1	365.0	88.5	135.9	144.9	88.5	124.1	140.4	199.9	365.0	178.7	200.4	202.8	150.4	150.4	171.6	189.6	201.0	202.8
65	28.6	305.8	65.5	73.1	163.7	65.5	71.2	118.4	199.2	305.8	115.5	99.6	150.6	104.4	99.6	103.2	110.0	124.3	150.6
66	5.8	14.8	6.2	15.0	14.9	6.2	12.7	14.9	14.9	15.0	38.8	32.1	47.8	81.9	32.1	37.1	43.3	56.3	81.9
67	257.2	1,207.4	1,142.0	756.9	1,060.5	756.9	984.6	1,101.3	1,158.4	1,207.4	582.1	681.5	654.2	612.1	582.1	604.6	633.2	661.0	681.5
68	17.5	74.2	39.3	52.5	66.2	39.3	49.2	59.4	68.2	74.2	234.9	271.1	264.6	278.1	234.9	257.2	267.9	272.9	278.1
69	7.6	20.5	17.7	171.1	41.2	17.7	19.8	30.9	73.7	171.1	28.3	8.8	343.8	41.2	8.8	23.4	34.8	116.9	343.8
70	36.8	313.3	181.6	133.9	151.8	133.9	147.3	166.7	214.5	313.3	56.9	127.4	306.0	176.8	56.9	109.8	152.1	209.1	306.0
71	3.1	38.0	29.8	14.1	112.3	14.1	25.9	33.9	56.6	112.3	121.2	8.1	8.9	13.1	8.1	8.7	11.0	40.1	121.2
72	39.2	107.5	161.5	86.0	228.6	86.0	102.1	134.5	178.3	228.6	148.3	372.0	161.5	155.9	148.3	154.0	158.7	214.1	372.0
73	6.9	36.0	24.4	29.4	44.7	24.4	28.2	32.7	38.2	44.7	27.1	28.7	22.9	40.1	22.9	26.1	27.9	31.6	40.1
74	150.7	221.3	149.7	477.5	501.1	149.7	203.4	349.4	483.4	501.1	337.2	492.3	228.6	525.9	228.6	310.1	414.8	500.7	525.9
75	67.7	93.3	62.5	104.6	81.4	62.5	76.7	87.4	96.1	104.6	201.1	150.4	183.0	348.3	150.4	174.9	192.1	237.9	348.3
76	20.6	61.9	49.1	59.7	52.3	49.1	51.5	56.0	60.3	61.9	31.5	38.8	168.6	221.0	31.5	37.0	103.7	181.7	221.0
77	2.9	17.4	258.5	16.4	299.7	16.4	17.2	138.0	268.8	299.7	15.1	10.2	179.1	18.3	10.2	13.9	16.7	58.5	179.1
78	102.2	777.6	457.8	359.6	676.0	359.6	433.3	566.9	701.4	777.6	579.2	475.2	467.7	429.2	429.2	458.1	471.5	501.2	579.2
79	14.8	36.4	47.9	48.0	60.6	36.4	45.0	48.0	51.2	60.6	187.0	139.3	350.5	46.8	46.8	116.2	163.2	227.9	350.5
80	13.8	32.0	35.3	33.1	24.1	24.1	30.0	32.6	33.7	35.3	41.1	127.4	76.9	23.1	23.1	36.6	59.0	89.5	127.4
81	4.8	12.9	13.3	8.9	12.2	8.9	11.4	12.6	13.0	13.3	11.7	4.2	266.9	16.1	4.2	9.8	13.9	78.8	266.9
82	12.7	279.1	75.0	48.1	34.1	34.1	44.6	61.6	126.0	279.1	35.7	43.4	57.6	104.5	35.7	41.5	50.5	69.3	104.5
83	0.6	3.0	8.4	5.9	123.5	3.0	5.2	7.2	37.2	123.5	3.7	80.3	2.2	32.3	2.2	3.3	18.0	44.3	80.3
84	2.6	4.3	62.6	19.4	20.4	4.3	15.6	19.9	31.0	62.6	9.9	16.9	17.5	6.9	6.9	9.2	13.4	17.1	17.5
85	21.6	77.4	118.5	53.9	48.8	48.8	52.6	65.7	87.7	118.5	247.6	35.7	50.5	115.5	35.7	46.8	83.0	148.5	247.6
86	6.9	44.2	22.8	13.1	17.9	13.1	16.7	20.4	28.2	44.2	65.3	23.6	38.7	561.3	23.6	34.9	52.0	189.3	561.3
87	75.4	148.0	384.6	433.9	198.3	148.0	185.7	291.5	396.9	433.9	124.4	129.7	177.7	138.2	124.4	128.4	134.0	148.1	177.7
88	20.7	233.1	35.1	42.7	290.0	35.1	40.8	137.9	247.3	290.0	195.5	203.9	123.4	139.8	123.4	135.7	167.7	197.6	203.9
89	5.4	89.4	5.0	16.2	22.5	5.0	13.4	19.4	39.2	89.4	22.6	386.0	50.6	276.8	22.6	43.6	163.7	304.1	386.0
90	2.0	17.9	22.7	10.6	3.5	3.5	8.8	14.3	19.1	22.7	35.5	33.2	6.5	72.2	6.5	26.5	34.4	44.7	72.2
91	1.2	6.5	9.5	128.5	5.8	5.8	6.3	8.0	39.3	128.5	1.6	2.5	2.4	5.1	1.6	2.2	2.5	3.2	5.1
92	9.6	48.4	8.9	72.2	40.5	8.9	32.6	44.5	54.4	72.2	55.7	59.9	84.5	79.2	55.7	58.9	69.6	80.5	84.5
93	30.3	66.8	50.2	187.9	98.3	50.2	62.7	82.6	120.7	187.9	260.0	180.1	82.2	161.2	82.2	141.5	170.7	200.1	260.0
94	16.8	65.5	89.8	44.4	93.2	44.4	60.2	77.7	90.7	93.2	232.6	109.3	32.2	80.3	32.2	68.3	94.8	140.1	232.6
95	16.8	329.4	160.4	115.4	220.5	115.4	149.2	190.5	247.7	329.4	110.8	67.8	40.6	129.2	40.6	61.0	89.3	115.4	129.2
96	6.0	105.6	33.1	37.7	18.0	18.0	29.3	35.4	54.7	105.6	290.7	11.6	17.2	41.4	11.6	15.8	29.3	103.7	290.7
97	53.3	156.4	295.8	285.0	163.5	156.4	161.7	224.3	287.7	295.8	308.0	389.1	131.9	241.2	131.9	213.9	274.6	328.3	389.1
98	3.1	11.6	9.2	14.9	12.3	9.2	11.0	12.0	13.0	14.9	8.1	499.4	271.0	13.9	8.1	12.5	142.5	328.1	499.4
99	21.1	79.2	58.5	99.9	80.9	58.5	74.0	80.1	85.7	99.9	205.7	122.5	122.9	43.1	43.1	102.7	122.7	143.6	205.7

Timing Intervals for Refresh Functions (in Seconds)

DM Fx	R-Run 1	R-Run 2	R-Run 3	R-Run 4	Min	25%tile	Median	75%tile	Max
LF_CR	27.1	26.1	24.1	27.1	24.1	25.6	26.6	27.1	27.1
LF_CS	114.3	112.5	111.8	110.8	110.8	111.6	112.2	113.0	114.3
LF_I	17.9	17.8	17.8	17.6	17.6	17.8	17.8	17.8	17.9
LF_SR	54.9	48.4	47.6	48.2	47.6	48.1	48.3	50.0	54.9
LF_SS	120.0	121.8	120.1	119.1	119.1	119.8	120.1	120.5	121.8
LF_WR	24.5	22.9	21.0	22.7	21.0	22.3	22.8	23.3	24.5
LF_WS	70.9	76.5	75.7	73.8	70.9	73.1	74.8	75.9	76.5
DF_CS	60.1	54.1	54.6	55.1	54.1	54.5	54.9	56.4	60.1
DF_SS	117.4	109.3	102.0	107.5	102.0	106.1	108.4	111.3	117.4
DF_WS	24.1	25.6	24.7	25.8	24.1	24.6	25.2	25.7	25.8
DF_I	4.7	4.1	3.9	4.0	3.9	4.0	4.1	4.3	4.7

Preface

TPC Benchmark™ DS Overview

The TPC Benchmark™ DS (TPC-DS) is a decision support benchmark that models several generally applicable aspects of a decision support system, including queries and data maintenance. The benchmark provides are presentative evaluation of performance as a general-purpose decision support system.

This benchmark illustrates decision support systems that:

- Examine large volumes of data;
- Give answers to real-world business questions;
- Execute queries of various operational requirements and complexities (e.g., ad-hoc, reporting, iterative OLAP, data mining);
- Are characterized by high CPU and IO load;
- Are periodically synchronized with source OLTP databases through database maintenance functions.
- Run on “Big Data” solutions, such as RDBMS as well as Hadoop/Spark based systems.

A benchmark result measures query response time in single user mode, query throughput in multi user mode and data maintenance performance for a given hardware, operating system, and data processing system configuration under a controlled, complex, multi-user decision support 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 tests be implemented with systems, products, technologies and pricing that:

a) Are generally available to users;
b) Are relevant to the market segment that the individual TPC benchmark models or represents (e.g., TPC-DS models and represents complex, high data volume, decision support environments);
c) Would plausibly be implemented by a significant number of users in the market segment modeled or represented by the benchmark.

In keeping with these requirements, the TPC-DS database must be implemented using commercially available data processing software, and its queries must be executed via SQL interface. 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, which improve benchmark results but not real-world performance or pricing, are prohibited.

TPC benchmark results are expected to be accurate representations of system performance. Therefore, there are specific guidelines that are expected to be followed when measuring those results. The approach or methodology to be used in the measurements are either explicitly described in the specification or left to the discretion of the test sponsor.

When not described in the specification, the methodologies and approaches used must meet the following requirements:

- The approach is an accepted engineering practice or standard;
- The approach does not enhance the result;
- Equipment used in measuring the results is calibrated according to established quality standards;
- Fidelity and candor is maintained in reporting any anomalies in the results, even if not specified in the benchmark requirements.

Further information is available at http://www.tpc.org/

General Items

0.1 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.

0.2 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:

- *Database Tuning Options*
- *Optimizer/Query execution options*
- *Query processing tool/language configuration parameters*
- *Recovery/commit options*
- *Consistency/locking options*
- *Operating system and configuration parameters*
- *Configuration parameters and options for any other software component incorporated into the pricing structure*
- *Compiler optimization options*

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

Default ADB configuration parameters and options are used.

0.3 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:

- *Number and type of processors*
- *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, including routers, workstations, terminals, etc., that were physically used in the test or are incorporated into the pricing structure.*
- *Type and the run-time execution location of software components (e.g., DBMS, query processing tools/languages, middle-ware components, software drivers, etc.).*

Measured Configuration

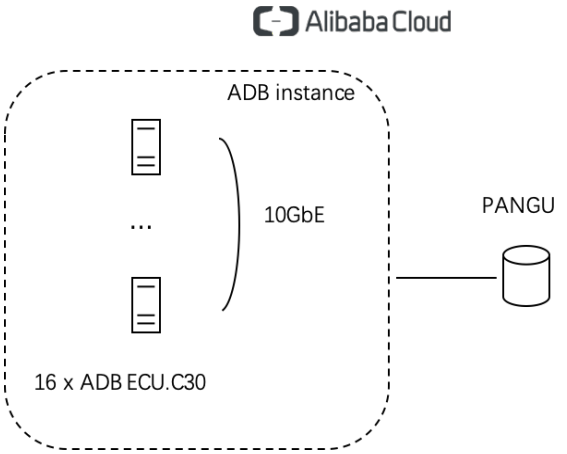


Figure 0.3: Measured Configuration

The measured configuration consisted of 16 ECUs:

ECU details (16 ECUs):

- ECU Instance Type: C30
- Processors: 64 virtual cores (threads)
- Memory: 384 GB
- Storage:
  - x 2,442 GB SSD Cloud Disk (data disk)
- Network:
  - Bandwidth (Gbit/s): 10.0

PANGU Storage details:

- Storage Class: Cloud Storage
- Storage Capacity: Storage: 8 TB SATA * 10.

AnalyticDB System Components Configuration

	ADB		
	Coordinator	WriteNode	ReadNode
ECU 1-2	x	x	x
ECU 3-16		x	x

Priced Configuration

There are no differences between the priced and measured configurations.

Clause 2: Logical Database Design Related Items

2.1 Database Definition Statements

Listings must be provided for the DDL scripts and must include all table definition statements and all other statements used to set up the test and qualification databases.

The Supporting File Archive contains the table definitions and all other statements used to set up the test and qualification databases.

2.2 Physical Organization

The physical organization of tables and indices within the test and qualification databases must be disclosed. If the column ordering of any table is different from that specified in Clause2.3 or 2.4, it must be noted.

Horizontal partitioning is used as described in 2.3.

Column clustering is used on store_sales, store_returns, catalog_sales, catalog_returns, web_sales, web_returns and inventory tables and the clustering columns are ss_sold_date_sk, sr_returned_date_sk, cs_sold_date_sk, cr_returned_date_sk, ws_sold_date_sk, wr_returned_date_sk and inv_date_sk. The clustering granularity is by day.

2.3 Horizontal Partitioning

If any directives to DDLs are used to horizontally partition tables and rows in the test and qualification databases, these directives, DDLs, and other details necessary to replicate the partitioning behavior must be disclosed.

All tables are partitioned. The partition columns for the tables are:
call_center: cc_call_center_sk
catalog_page: cc_catalog_page_sk
customer: c_customer_sk
customer_address: ca_address_sk
customer_demographics: cd_demo_sk
date_dim: d_date_sk
household_demographics: hd_demo_sk
income_band: ib_income_band_sk
item: i_item_sk
promotion: p_promo_sk
reason: r_reason_sk
ship_mode: sm_ship_mode_sk
store: s_store_sk
time_dim: t_time_sk
warehouse: w_warehouse_sk
web_page: wp_web_page_sk
web_site: web_site_sk
catalog_sales: cs_item_sk
catalog_returns: cr_item_sk
inventory: inv_item_sk
store_returns: sr_item_sk
store_sales: ss_item_sk
web_returns: wr_item_sk
web_sales: ws_item_sk

2.4 Replication

Any replication of physical objects must be disclosed and must conform to the requirements of Clause 2.5.3.

No physical object was replicated.

Clause 3: Scaling and Database Population

3.1 Initial Cardinality of Tables

The cardinality (e.g., the number of rows) of each table of the test database, as it existed at the completion of the database load (see Clause 7.1.2) must be disclosed.

Table 3.1 lists the cardinality of each table as they existed upon completion of the build.

Table 3.1 Initial Number of Rows

Table Name	Row Count
call_center	54
catalog_page	40,000
catalog_returns	1,440,033,112
catalog_sales	14,399,964,710
customer	65,000,000
customer_address	32,500,000
customer_demographics	1,920,800
date_dim	73,049
household_demographics	7,200
income_band	20
inventory	1,311,525,000
item	402,000
promotion	2,000
reason	70
ship_mode	20
store	1,500
store_returns	2,879,765,003
store_sales	28,799,942,425
time_dim	86,400
warehouse	25
web_page	4,002
web_returns	720,020,485
web_sales	7,199,963,324
web_site	78

3.2 Distribution of Tables and Logs Across Media

The distribution of tables and logs across all media must be explicitly described using a format similar to that shown in the following example for both the tested and priced systems.

Table 3.2 Distribution of Tables and Logs

Server Node	Disk Type	Disk drive	Description of Content
Coordinator (1-2)	Local SSD Disk	/dev/nvme0n1p2	event log and transaction log
WriteNode (1-16)	Local SSD Disk	/dev/nvme0n1p2	event log
ReadNode (1-16)	Local SSD Disk	/dev/nvme0n1p2	event log, temp files, cache of table data
PANGU	Virtual Disk	/apsarapangu/	table data and replica of table data

All the base Tables were stored on PANGU.

Table size on PANGU:

176.2KB pangu://localcluster/adb/tpcds_10t/call_center
39.2KB pangu://localcluster/adb/tpcds_10t/catalog_page
305.5GB pangu://localcluster/adb/tpcds_10t/catalog_returns
3.5TB pangu://localcluster/adb/tpcds_10t/catalog_sales
18.2GB pangu://localcluster/adb/tpcds_10t/customer
8.8GB pangu://localcluster/adb/tpcds_10t/customer_address
200.8KB pangu://localcluster/adb/tpcds_10t/customer_demographics
83.6KB pangu://localcluster/adb/tpcds_10t/date_dim
15.7KB pangu://localcluster/adb/tpcds_10t/household_demographics
21.0KB pangu://localcluster/adb/tpcds_10t/income_band
61.0GB pangu://localcluster/adb/tpcds_10t/inventory
335.4KB pangu://localcluster/adb/tpcds_10t/item
45.8KB pangu://localcluster/adb/tpcds_10t/promotion
31.0KB pangu://localcluster/adb/tpcds_10t/reason
41.6KB pangu://localcluster/adb/tpcds_10t/ship_mode
1.0KB pangu://localcluster/adb/tpcds_10t/store
484.4GB pangu://localcluster/adb/tpcds_10t/store_returns
5.2TB pangu://localcluster/adb/tpcds_10t/store_sales
38.7KB pangu://localcluster/adb/tpcds_10t/time_dim
73.0KB pangu://localcluster/adb/tpcds_10t/warehouse
36.2KB pangu://localcluster/adb/tpcds_10t/web_page
148.6GB pangu://localcluster/adb/tpcds_10t/web_returns
1.8TB pangu://localcluster/adb/tpcds_10t/web_sales
175.3KB pangu://localcluster/adb/tpcds_10t/web_site

3.3 Mapping of Database Partitions/Replications

The mapping of database partitions/replications must be explicitly described.

Neither database partitions nor replications were mapped to specific devices.

3.4 Implementation of RAID

Implementations may use some form of RAID. The RAID level used must be disclosed for each device. If RAID is used in an implementation, the logical intent of its use must be disclosed

The database table data was stored in PANGU which maintains three replicas. PANGU's Service Level Agreement (SLA) guaranties high availability to be 99.999999999%.

3.5 DBGEN Modifications

The version number (i.e., the major revision number, the minor revision number, and third tier number) of dsdgen must be disclosed. Any modifications to the dsdgen source code (see Appendix B:) must be disclosed. In the event that a program other than dsdgen was used to populate the database, it must be disclosed in its entirety.

Dsdgen version v2.10.0rc2 was used. No changes were made to the dsdgen tool.

3.6 Database Load time

The database load time for the test database (see Clause 7.4.3.7) must be disclosed.

The database load time was 11,273.38 seconds.

3.7 Data Storage Ratio

The data storage ratio must be disclosed. It is computed by dividing the total data storage of the priced configuration (expressed in GB) by SF corresponding to the scale factor chosen for the test database as defined in Clause 3.1. The ratio must be reported to the nearest 1/100th, rounded up. For example, a system configured with 96 disks of 2.1 GB capacity for a 100GB test database has a data storage ratio of 2.02.

The data storage ratio is (39,072 + 81,920) / 10,000 = 12.10

Total Storage Capacity (Local node) = 16 (ECU) * 2,442GB = 39,072 GB

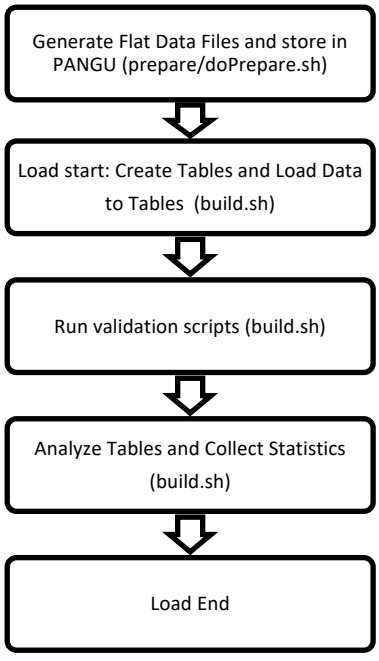
Total Storage Capacity (PANGU) = 80TB = 81,920 GB

3.8 Database Load Mechanism Details and Illustration

The details of the database load must be disclosed, including a block diagram illustrating the overall process. Disclosure of the load procedure includes all steps, scripts, input and configuration files required to completely reproduce the test and qualification databases.

The database was built as shown in Figure 3.8. All of the related source code and scripts are included in the Supporting Files.

Figure 3.8: Block Diagram of database build process:



The final database load time is calculated as (load end time – load start time – duration of validation scripts).

3.9 Qualification Database Configuration

Any differences between the configuration of the qualification database and the test database must be disclosed.

The qualification database was built using the same scripts as the test database with the following exceptions:

- The Scale factor is adjusted to 1 GB

All of the related source code and scripts are included in the Supporting Files.

Clause 4 and 5: Query and Data Maintenance Related Items

4.1 Query Language

The query language used to implement the queries must be identified.

SQL was the query language used to implement the queries.

4.2 Verifying Method of Random Number Generation

The method of verification for the random number generation must be described unless the supplied dsdgen and dsqgen were used.

TPC-supplied dsdgen version 2.10.0rc2 and dsqgen version 2.10.0rc2 were used.

4.3 Generating Values for Substitution Parameters

The method used to generate values for substitution parameters must be disclosed. The version number (i.e., the major revision number, the minor revision number, and third tier number) of dsqgen must be disclosed.

TPC supplied dsqgen version 2.10.0rc2 was used to generate the substitution parameters, as follows:

```
./dsqgen -input $works/queries/query_templates/templates.lst -directory $works/queries/query_templates/ -
dialect adb -scale 10000 -streams 9 -output $works/queries/ -RNGSEED ${seed}
```

4.4 Query Text and Output Data from Qualification Database

The executable query text used for query validation must be disclosed along with the corresponding output data generated during the execution of the query text against the qualification database. If minor modifications have been applied to any functional query definitions or approved variants in order to obtain executable query text, these modifications must be disclosed and justified. The justification for a particular minor query modification can apply collectively to all queries for which it has been used. The output data for the power and Throughput Tests must be made available electronically upon request.

Supporting Files Archive contains the actual query text and query output. Following are the modifications to the query.

The following MQM are used:

- Use vendor-specific syntax of date expressions. (MQM f.1)
  - Q5
  - Q12
  - Q16
  - Q20
  - Q21
  - Q32
  - Q37
  - Q40
  - Q72
  - Q77

    - Q80
    - Q82
    - Q92
    - Q94
    - Q95
    - Q98
- Use column references expression in ORDER BY clause (MQM e.2)
    - Q58
    - Q72

The Supporting Files Archive contains the full set of executable query text template used in the test.

4.5 Query Substitution Parameters and Seeds Used

All the query substitution parameters used during the performance test must be disclosed in tabular format, along with the seeds used to generate these parameters.

The Supporting Files Archive contains the query substitution parameters and seed used in the test.

4.6 Refresh Setting

All query and refresh session initialization parameters, settings and commands must be disclosed.

The Supporting Files Archive contains the query and scripts, along with initialization parameters and settings.

4.7 Source Code of Refresh Functions

The details of how the data maintenance functions were implemented must be disclosed (including source code of any non-commercial program used).

The Supporting Files Archive contains the source code implementing the refresh functions.

4.8 Staging Area

Any object created in the staging area (see Clause 5.1.8 for definition and usage restrictions) used to implement the data maintenance functions must be disclosed. Also, any disk storage used for the staging area must be priced, and any mapping or virtualization of disk storage must be disclosed.

No staging area was used.

Clause 6: Data Persistence Properties Related Items

The results of the data accessibility tests must be disclosed along with a description of how the data accessibility requirements were met.

The data accessibility test was performed by failing the local SSD disk drive used by one ADB ECU, and failing a virtual drive from PANGU. These failures were included during the execution of the first data maintenance test.

- The SSD drive failure was simulated by disabling RW access to the root directory on the local disk.
- The PANGU disk failure was simulated by unmounting a virtual disk from PANGU. After the failures, the test continued to run until completion.

The Supporting Files Archive contains the logs of status before and after the disk failures.

Clause 7: Performance Metrics and Execution Rules Related Items

7.1 System Activity

Any system activity on the SUT that takes place between the conclusion of the load test and the beginning of the performance test must be fully disclosed including listings of scripts or command logs.

The only activity between the end of the load test and the beginning of the performance test was the generation of the executable query text.

7.2 Test Steps

The details of the steps followed to implement the performance test must be disclosed.

The Supporting Files Archive contains the scripts and logs.

7.3 Timing Intervals for Each Query and Refresh Function

The timing intervals defined in Clause 7 must be disclosed.

See the Executive Summary at the beginning of this report.

7.4 Throughput Test Result

For each Throughput Test, the minimum, the 25th percentile, the median, the 75th percentile, and the maximum times for each query shall be reported.

See the Executive Summary at the beginning of this report.

7.5 Time for Each Stream

The start time and finish time for each query stream must be reported.

See the Executive Summary at the beginning of this report.

7.6 Time for Each Refresh Function

The start time and finish time for each data maintenance function in the refresh run must be reported for the Throughput Tests

See the Executive Summary at the beginning of this report.

7.7 Performance Metrics

The computed performance metric, related numerical quantities and the price/performance metric must be reported.

QphDS@10000GB = 2,684,357

See the Executive Summary at the beginning of this report for more detail.

Clause 8: SUT and Driver Implementation Related Items

8.1 Driver

A detailed textual description of how the driver performs its functions, how its various components interact and any product functionalities or environmental settings on which it relies must be provided. All related source code, scripts and configuration files must be disclosed. The information provided should be sufficient for an independent reconstruction of the driver.

The Mysql compatible ADB client was used to submit the queries. It connects to the ADB instance via JDBC. The command is: mysql -h${host} –P${port} -Dtpcds_10t -A -c

The ADB instance accepts SQL queries from the ADB clients and processes the queries. All queries are compiled on the ADB Coordinator and then dispatched to the ADB Read/WriteNodes as distributed tasks. When the tasks finish, their result is collected by the Coordinator which sends the query output to the ADB client.

The Supporting Files Archive contains all the command, scripts and logs.

8.2 Implementation Specific Layer (ISL)

If an implementation specific layer is used, then a detailed description of how it performs its functions, how its various components interact and any product functionalities or environmental setting on which it relies must be provided. All related source code, scripts and configuration files must be disclosed. The information provided should be sufficient for an independent reconstruction of the implementation specific layer.

No Implementation Specific Layer was used.

8.3 Profile-Directed Optimization

If profile-directed optimization as described in Clause 7.2.10 is used, such use must be disclosed. In particular, the procedure and any scripts used to perform the optimization must be disclosed.

Profile-directed optimization was not used.

Clause 9: Pricing Related Items

9.1 Hardware and Software Used

A detailed list of hardware and software used in the priced system must be reported. The rules for pricing are included in the current revision of the TPC Pricing Specification located on the TPC website (http://www.tpc.org)

A detailed list of all licensed services, hardware and software, is provided in the Executive Summary of this report.

9.2 Availability Date

The System Availability Date (see Clause 7.6.5) must be the single availability date reported on the first page of the executive summary. The full disclosure report must report Availability Dates individually for at least each of the categories for which a pricing subtotal must be. All Availability Dates required to be reported must be disclosed to a precision of 1 day, but the precise format is left to the test sponsor.

The total system is available as of the date of this report.

9.3 Country-Specific Pricing

Additional Clause 7 related items may be included in the full disclosure report for each country specific priced configuration.

The configuration is priced in RMB for the China market.

Clause 11: Audit Related Items

Auditor's Information and Attestation Letter

The auditor's agency name, address, phone number, and attestation letter with a brief audit summary report indicating compliance must be included in the full disclosure report. A statement should be included specifying whom to contact in order to obtain further information regarding the audit process.

This benchmark was audited by: Francois Raab, of InfoSizing.

Benchmark sponsor: Liang Lin
Alibaba Cloud Intelligence Business Group
969 West Wen Yi Road
Yu Hang District, Hangzhou
Zhejiang, China

April 26, 2019

I verified the TPC Benchmark™ DS (TPC-DS™ v2.10.1) performance of the following configuration:

Platform:	Alibaba Cloud AnalyticDB (ADB) on Alibaba Cloud ECU
Operating System:	Alibaba Group Enterprise Linux Server 7.2 (Paladin)
Database Manager:	Alibaba Cloud AnalyticDB 2.7

The results were:

Performance Metric	**2,684,357QphDS@10000GB**
Database Load Time	3h 7m 53s

Servers	**Alibaba Cloud Elastic Compute Unit (ECU)**		
16 ECU C30, each with:			
CPUs	64 x Virtual Cores (threads)		
Memory	384 GB		
Storage	***Qty***	***Size***	***Type***
	1	2,242 GB	SSD

Object Storage	**PANGU**		
Storage	***Qty***	***Size***	***Type***
	10	8 TB	Virtual Disk

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:

- The database records were defined with the proper layout and size
- The database population was generated using Dsdgen

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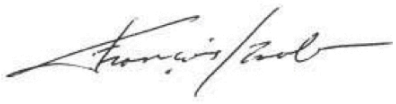
- The database was properly scaled to 10,000GB and populated accordingly
- The database load time was correctly measured and reported
- The query templates were produced using approved minor query modifications and query variants
- The query input variables were generated by Dsqgen
- The execution of the queries against the qualification database produced compliant output
- The tests were driven and sequenced according to the requirements
- The throughput tests involved 4 query streams
- The execution times for queries and data maintenance functions were correctly measured and reported
- The data accessibility test was performed and verified
- The system pricing was verified for major components and maintenance
- The major pages from the FDR were verified for accuracy

Additional Audit Notes:

In the course of the benchmark execution and the independent audit process, a number of issues were raised with the benchmark maintenance subcommittee. These issues were resolved, sometimes resulting in changes to the benchmark specification. While this result was audited against version 2.10.1 of the benchmark, it also takes advantage of some pending changes that are intended for release in the next version of the benchmark.

Respectfully Yours,



François Raab, TPC Certified Auditor

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Supporting Files Index

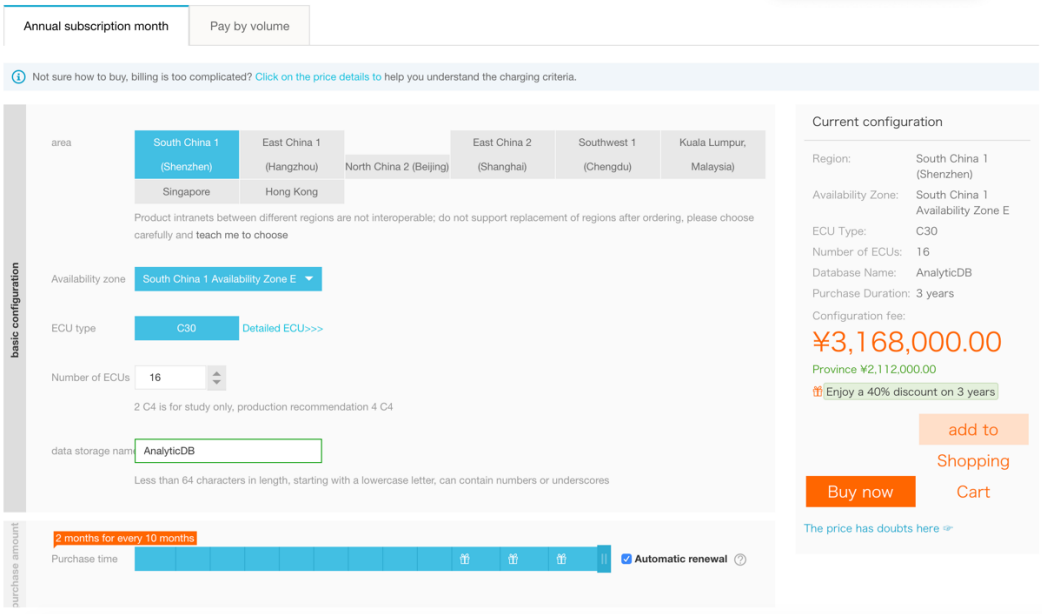
Clause	Description	Archive File Pathname
Clause 3	Database create and load scripts, SQL scripts for validation and log files	SupportingFiles/Clause_3/bulid.sh SupportingFiles/Clause_3/load.sh SupportingFiles/Clause_3/audit/count.sql SupportingFiles/Clause_3/audit/desc.sql SupportingFiles/Clause_3/audit/Validate_Data.sql SupportingFiles/Clause_3/audit/Check_Insert.sql SupportingFiles/Clause_3/audit/Check_RI.sql SupportingFiles/Clause_3/logs/
	Scripts for collecting statistics	SupportingFiles/Clause_3/analyze/anazly_[i].sql
	Tools for data generation and uploading	SupportingFiles/Clause_3/doPrepare.sh SupportingFiles/Clause_3/upload.sh SupportingFiles/Clause_3/upload_dir.sh
Clause 4	The script to execute qualification test and log file	SupportingFiles/Clause_4/run-qualification-test.sh SupportingFiles/Clause_4/logs/qualification_test.log
	SQL for qualification queries	SupportingFiles/Clause_4/query/
	Query templates	SupportingFiles/Clause_4/tpl/query[i].tpl
	Output from executing qualification queries	SupportingFiles/Clause_4/output/
Clause 5	Data maintenance execution scripts and logs files	SupportingFiles/Clause_5/doRefresh.sh SupportingFiles/Clause_5/refresh.sh SupportingFiles/Clause_5/logs/mt_[r]_timing.log SupportingFiles/Clause_5/logs/mt_[r].log
	SQL scripts for DM functions for stream [s]	SupportingFiles/Clause_5/sql/
	Output from executing DM functions	SupportingFiles/Clause_5/output/
Clause 6	Data accessibility test scripts, logs and output files	SupportingFiles/Clause_6/doDATest.sh SupportingFiles/Clause_6/logs/dat.log SupportingFiles/Clause_6/logs/Disk_Status_Good.out SupportingFiles/Clause_6/logs/Disk_Umount.out SupportingFiles/Clause_6/logs/Disk_Status_Failed.out
Clause 7	Performance test scripts and logs	SupportingFiles/Clause_7/run-test.sh SupportingFiles/Clause_7/run-stream.sh SupportingFiles/Clause_7/logs/test.log
	Query text for query [q] in stream [s]	SupportingFiles/Clause_7/stream_[s]/query/query_[q].sql
	Output of query [q] in stream [s]	SupportingFiles/Clause_7/stream_[s]/output/query_[q].out

Appendix A: Provisioning Compute Services

Purchase Page for provisioning the 16-node Alibaba Cloud AnalyticDB with 3-Year Subscription

Original page in Chinese

English version (Chrome translated)



Appendix B: Third Party Price Quotes

Lenovo MIX 210 tablet (Chinese version)

Lenovo MIX 210 tablet (Chrome translated English version)