TPC Benchmark™ E

Full Disclosure Report for

FUJITSU Server PRIMERGY RX2540 M2

Using

**Microsoft SQL Server 2016
Enterprise Edition**

Using

**Microsoft Windows Server 2012 R2
Standard Edition**

TPC-E Version 1.14.0

Submitted for Review

March 31, 2016

First Edition March 2016

Fujitsu believes that the information in this document is accurate as of the publication date. The information in this document is subject to change without notice. We assume no responsibility for any errors that may appear in this document. The pricing information in this document is believed to accurately reflect the current prices as of the publication date. However, we provide no warranty of the pricing information in this document.

Benchmark results are highly dependent upon workload, specific application requirements, system design and implementation. Relative system performance will vary as a result of these and other factors. Therefore, TPC Benchmark™ E 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 were obtained in a rigorously controlled environment. Results obtained in other operating environments may vary significantly. We do not warrant or represent that a user can or will achieve similar performance expressed in transactions per second (tpsE) or normalized price/performance ($/tpsE). No warranty of system performance or price/performance is expressed or implied in this report.

Abstract

This report documents the TPC Benchmark™ E results achieved by Fujitsu using Microsoft SQL Server 2016 Enterprise Edition.

The TPC Benchmark™ E tests were run on a FUJITSU Server PRIMERGY RX2540 M2 system using the Microsoft Windows Server 2012 R2 Standard Edition operating system.

The results, summarized below, show the number of TPC Benchmark™ E transactions per second (tpsE) and the price per tpsE ($/tpsE).

Hardware	Software	Total System Cost	tpsE	$ USD/tpsE	Availability Date
FUJITSU Server PRIMERGY RX2540 M2	**Microsoft SQL Server 2016 Enterprise Edition** **Microsoft Windows Server 2012 R2 Standard Edition**	**$ 528,618 USD**	**4,734.87**	**$ 111.65 USD**	**July 31, 2016**

The benchmark implementation and results were audited by Doug Johnson for InfoSizing Inc. (www.sizing.com). The auditor's attestation letter is contained in Section 8 of this report.

FUJITSU	FUJITSU Server PRIMERGY RX2540 M2	TPC-E 1.14.0 TPC Pricing 2.0.0
		Report Date March 31, 2016

TPC-E Throughput **4,734.87 tpsE**	Price/Performance **$ 111.65 USD per tpsE**	Availability Date **July 31, 2016**	Total System Cost **$ 528,618 USD**

Database Server Configuration

Operating System **Microsoft Windows Server 2012 R2 Standard Edition**	Database Manager **Microsoft SQL Server 2016 Enterprise Edition**	Processors/Cores/Threads **2/44/88**	Memory **1024 GB**

SUT

Tier A
PRIMERGY RX2530 M1
2x Intel Xeon E5-2697 v3 2.60 GHz
64 GB Memory
2x 300 GB 15k rpm SAS Drive
2x Onboard LAN 10 Gb/s
1x Dual Port LAN 1 Gb/s
1x SAS RAID controller

Tier B
PRIMERGY RX2540 M2
2x Intel Xeon E5-2699 v4 2.20 GHz
1024 GB Memory
2x 300 GB 15k rpm SAS Drives
4x 600 GB 15k rpm SAS Drives
2x onboard LAN 10 Gb/s
6x SAS RAID Controller

Storage
1x PRIMECENTER Rack
5x ETERNUS JX40 S2
80x 400 GB SSD Drives

Initial Database Size **19,552 GB**	Redundancy Level 1 **RAID-5 data and RAID-10 log**	Storage **80 x 400 GB SSD** **4 x 600 GB 15k rpm HDD**

	FUJITSU Server				**TPC-E 1.14.0**	
FUJITSU	**PRIMERGY RX2540 M2**				**TPC Pricing 2.0.0**	
					Report Date	
					March 31, 2016	
					Availability Date	
					July 31, 2016	

Description	Part Number	Price Source	Unit Price	Qty	Extended Price	3-yr. Maint. Price
Database Server (Tier B) Hardware			$		$	$
PRIMERGY RX2540 M2						
PY RX2540 M2 8x 2.5' expandable	S26361-K1566-V401	1	1,124.00	1	1,124.00	
Config 4: 8x 2,5" HDD	S26361-F2495-E440	1	161.00	1	161.00	
Modular PSU 800W platinum hp	S26113-F574-E13	1	322.00	2	644.00	
Cable powercord rack, 4m, grey	T26139-Y1968-E100	1	12.00	2	24.00	
Intel Xeon E5-2699v4 22C/44T 2.20 GHz	S26361-F3933-E199	1	6,885.00	2	13,770.00	
Cooler Kit 2nd CPU	S26361-F3849-E100	1	33.00	1	33.00	
64GB (1x64GB) 4Rx4 DDR4-2400 LR ECC	S26361-F3935-E516	1	4,977.00	16	79,632.00	
Performance Mode Installation	S26361-F3694-E2	1	7.00	2	14.00	
PLAN EM 2x10Gb T OCI14000-LOM interface	S26361-F5302-E210	1	611.00	1	611.00	
DVD-RW supermulti ultraslim SATA	S26361-F3778-E1	1	102.00	1	102.00	
HD SAS 12G 300GB 15K HOT PL 2.5' EP	S26361-F5531-E530	1	520.00	2	1,040.00	
HD SAS 12G 600GB 15K HOT PL 2.5' EP	S26361-F5531-E560	1	969.00	4	3,876.00	
PRAID EP420i	S26361-F5243-E2	1	461.00	1	461.00	
PRAID EP420e LP	S26361-F3847-E202	1	702.00	5	3,510.00	
Rack Mount Kit F1 CMA QRL LV	S26361-F2735-E175	1	102.00	1	102.00	
Mounting of RMK in symmetrical racks	S26361-F4530-E10	1	7.00	1	7.00	
region-kit America	S26361-F1452-E130	1	12.00	1	12.00	
PY RX2540 Series during normal business hours, Primery Installation, Midrange Server, w/o OS, One Time billing	PYR254-N038005-0NA	1	350.00	1		350.00
PY RX2540 Series Warranty Uplift, 36 Months, Enhanced Plus Level, 24x7 4hr Onsite, Prepaid billing	PYR254-U004121-0NA	1	913.00	1		913.00
				Subtotal (*)	105,123.00	1,263.00
Storage						
PRIMECENTER RACK						
PRIMECENTER M1 Rack 724S 24U-1050x700	S26361-K827-V220	1	2,285.00	1	2,285.00	
Dummy panel, plastics, 1U + assembly	S26361-F4530-L131	1	17.00	3	51.00	
Dummy panel, plastics, 2U + assembly	S26361-F4530-L132	1	23.00	6	138.00	
Socket strip 8x IEC320 + IEC309 plug 32A	S26361-F2262-L45	1	311.00	1	311.00	
PY PRIMECENTER during normal business hours, PRIMERGY Installation, Racks, One Time billing	PYPCTR-N076005-0NA	1	265.00	1		265.00
PY PRIMECENTER Warranty Uplift, 36 Months, Enhanced Plus Level, 24x7 4hr Onsite, Prepaid billing (PYPCTR-U004361-0NA)	PYPCTR-U004361-0NA	1	540.00	1		540.00
ETERNUS JX40 S2			1			
ETERNUS JX40 S2 Enclosure w 1x IOM	FTS:ETJEADU		2,234.00	5	11,170.00	
JX40 S2 MLC SSD 400GB	FTS:ETJ4SA4	1	2,032.00	80	162,560.00	
MiniSAS-HD cable1.1m	FTS:ETJ4KM11-L	1	73.00	5	365.00	
PY JX40 Warranty Uplift, 12 Months, Enhanced Plus Level, 24x7x365 Phone Support (Sev1 - Live Transfer), 24x7x365 Onsite and Parts (Sev1 Resp. Time - 4 Hours), Incl. Holidays, Prepaid billing	PYJX40-U004121-0NA	1	639.00	5		3,195.00
PY JX40 Post Warranty, 24 Months, Enhanced Plus Level, 24x7x365 Phone Support (Sev1 - Live Transfer), 24x7x365 Onsite and Parts (Sev1 Resp. Time - 4 Hours), Incl. Holidays, Prepaid billing	PYJX40-P004241-0NA	1	1,218.00	5		6,090.00
PY JX40 during normal business hours, Primergy storage installation, One Time billing	PYJX40-N043005-0NA	1	450.00	5		2,250.00
				Subtotal(*)	176,880.00	12,340.00
Database Server (Tier B) Software						
SQL Server 2016 Enterprise Edition 2 Core License	7JQ-00256	2	13,472.50	22	296,395.00	
Microsoft Windows Server 2012 R2 Standard Edition 2 Processor License	P73-06284	2	735.00	1	735.00	
Microsoft Problem Resolution Services	n/a	2	259.00	1		259.00
				Subtotal	297,130.00	259.00

	FUJITSU Server	**TPC-E 1.14.0**
	PRIMERGY RX2540 M2	**TPC Pricing 2.0.0**
FUJITSU		Report Date
		March 31, 2016
		Availability Date
		July 31, 2016

Application Server (Tier A) Hardware						
PRIMERGY RX2530 M1		1				
PY RX2530 M1 4x 2.5" expandable	S26361-K1492-V301	1	1,249.00	1	1,249.00	
Modular PSU 450W platinum hp	S26113-F575-E13	1	275.00	2	550.00	
Cable powercord rack, 4m, grey	T26139-Y1968-E100	1	13.00	2	26.00	
Cool-safe Advanced Thermal Design	S26361-F3776-E101	1	4.00	1	4.00	
Intel Xeon E5-2697v3 14C/28T 2.60 GHz	S26361-F3849-E197	1	4,145.00	2	8,290.00	
Cooler Kit 2nd CPU	S26361-F3849-E100	1	35.00	1	35.00	
8GB (1x8GB) 2Rx8 DDR4-2133 R ECC	S26361-F3843-E515	1	252.00	8	2,016.00	
Performance Mode Installation	S26361-F3694-E2	1	7.00	2	14.00	
DVD ROM Ulltraslim	S26361-F3718-E2	1	104.00	1	104.00	
HD SAS 12G 300GB 15K HOT PL 2.5' EP	S26361-F5531-E530	1	554.00	2	1,108.00	
PRAID EP400i	S26361-F5243-E1	1	514.00	1	514.00	
PLAN EM 2x10Gb T OCl14000-LOM interface	S26361-F5302-E210	1	189.00	1	189.00	
PLAN CP 2x1Gbit Cu Intel I350-T2 LP	S26361-F4610-E202	1	268.00	1	268.00	
Rack Mount Kit F1-CMA Slim Line	S26361-F2735-E400	1	92.00	1	92.00	
Mounting of RMK in symmetrical racks	S26361-F4530-E10	1	7.00	1	7.00	
region-kit America	S26361-F1452-E130	1	13.00	1	13.00	
PY RX2530 M1 during normal business hours, Primergy Installation, Midrange Server, w /o OS, One Time billing	PYR253-N038005-0NA	1	350.00	2		700.00
PY RX2530 M1 Warranty Uplift, 36 Months, Enhanced Plus Level, 24x7 4hr Onsite, Prepaid billing	PYR253_S26361-K1492-V301	1	931.00	2		1,862.00
				Subtotal(*)	14,479.00	2,562.00
Application Server (Tier A) Software						
Microsoft Window s Server 2012 Standard Edition 2 Processor License	P73-06284	2	735.00	1	735.00	
				Subtotal	735.00	
Miscellaneous						
Display E24T-7 LED, Cross Trade (incl 2spares)	S26361-K1543-V140	1	332.00	3	996.00	
Infrastructure or Connectivity						
KB900 Keyboard USB USA (incl 2 spares)	S26381-K560-L402	1	27.00	3	81.00	
Mouse MC200 (incl 2 spares)	S26381-K463-L100	1	16.00	3	48.00	
StarTech.com 7 ft Blue Shielded Snagless 10Gb RJ45 STP Cat6a Patch Cable (incl 2 spares)	C6ASPAT7BL	3	12.99	4	51.96	
				Subtotal(*)	1,176.96	0.00
				Total	595,523.96	16,424.00
Dollar Volume Discount (see Notes)		28%	1		83,329.96	
					512,194.00	

Notes:	**Three-Year Cost of Ownership USD**	$528,618.00
Price Source: 1=Fujitsu, 2=Microsoft Corporation, 3=w w w .cdw .com	**TPC-E Throughput**	4734.87
Discount applies to all subtotal marked w ith(*) .	**$ USD/tpsE**	$111.65

Pricing is for these or similar quantities.Discounts for similary sized configurations w ill be similar to w hat is quoted here, but may vary based on the specific components priced.

The benchmark results and test methodology w ere audited by Doug Johnson for InfoSizing Inc. (w w w .sizing.com)

Prices used in TPC benchmarks reflect the actual prices a customer w ould 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 section of the TPC benchmark pricing specifications. If you find that the stated prices are not available according to these terms, please inform the TPC at pricing@tpc.org. Thank you.

	FUJITSU Server PRIMERGY RX2540 M2	TPC-E 1.14.0 TPC Pricing 2.0.0
		Report Date March 31, 2016
		Availability Date July 31, 2016

Numerical Quantities Summary				
Reported Throughput:	4,734.87 tpsE	**Configured Customers:**		2,380,000
Response Times (in seconds)	**Minimum**	**Average**	**90th%tile**	**Maximum**
Broker Volume	0.01	0.01	0.02	0.39
Customer Position	0.01	0.01	0.02	0.62
Market Feed	0.01	0.01	0.02	0.38
Market Watch	0.01	0.01	0.01	0.21
Security Detail	0.01	0.01	0.01	0.21
Trade Lookup	0.01	0.04	0.07	0.30
Trade Order	0.01	0.03	0.09	0.89
Trade Result	0.01	0.02	0.04	0.88
Trade Status	0.01	0.01	0.01	0.21
Trade Update	0.01	0.05	0.08	0.29
Data Maintenance	0.01	0.01	N/A	0.03
Transaction Mix			**Transaction Count**	**Mix %**
Broker Volume			16,703,128	4.900%
Customer Position			44,314,631	13.000%
Market Feed			3,409,116	1.000%
Market Watch			61,358,668	18.000%
Security Detail			47,723,132	14.000%
Trade Lookup			27,270,209	8.000%
Trade Order			34,428,841	10.100%
Trade Result			34,091,105	10.001%
Trade Status			64,767,475	19.000%
Trade Update			6,817,573	2.000%
Data Maintenance			120	N/A
Test Duration and Timings				
Ramp-up Time (hh:mm:ss)			0:18:39	
Measurement Interval (hh:mm:ss)			2:00:00	
Business Recovery Time (hh:mm:ss)			0:20:04	
Total Number of Transactions Completed in Measurement Interval			340,883,878	

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Clause 0: Preamble

Introduction

TPC Benchmark™ E (TPC-E) is an On-Line Transaction Processing (OLTP) workload. It is a mixture of read-only and update intensive transactions that simulate the activities found in complex OLTP application environments. The database schema, data population, transactions, and implementation rules have been designed to be broadly representative of modern OLTP systems. The benchmark exercises a breadth of system components associated with such environments, which are characterized by:

- The simultaneous execution of multiple transaction types that span a breadth of complexity; Moderate system and application execution time;
- A balanced mixture of disk input/output and processor usage; Transaction integrity (ACID properties);
- A mixture of uniform and non-uniform data access through primary and secondary keys;
- Databases consisting of many tables with a wide variety of sizes, attributes, and relationships with realistic content;
- Contention on data access and update.

The TPC-E operations are modelled as follows: The database is continuously available 24 hours a day, 7 days a week, for data processing from multiple Sessions and data modifications against all tables, except possibly during infrequent (e.g., once a month) maintenance Sessions. Due to the worldwide nature of the application modelled by the TPC-E benchmark, any of the transactions may be executed against the database at any time, especially in relation to each other.

Goal of the TPC-E Benchmark

The TPC-E benchmark simulates the OLTP workload of a brokerage firm. The focus of the benchmark is the central database that executes transactions related to the firm's customer accounts. In keeping with the goal of measuring the performance characteristics of the database system, the benchmark does not attempt to measure the complex flow of data between multiple application systems that would exist in a real environment.

The mixture and variety of transactions being executed on the benchmark system is designed to capture the characteristic components of a complex system. Different transaction types are defined to simulate the interactions of the firm with its customers as well as its business partners. Different transaction types have varying run-time requirements.

The benchmark defines:

- Two types of transactions to simulate Consumer-to-Business as well as Business-to-Business activities
- Several transactions for each transaction type
- Different execution profiles for each transaction type
- A specific run-time mix for all defined transactions

For example, the database will simultaneously execute transactions generated by systems that interact with customers along with transactions that are generated by systems that interact with financial markets as well as administrative systems. The benchmark system will interact with a set of driver systems that simulate the various sources of transactions without requiring the benchmark to implement the complex environment.

The Performance Metric reported by TPC-E is a "business throughput" measure of the number of completed Trade-Result transactions processed per second (see Clause 6.7.1). Multiple Transactions are used to simulate the business activity of processing a trade, and each Transaction is subject to a Response Time constraint. The Performance Metric for the benchmark is expressed in transactions-per-second-E (tpsE). To be compliant with the TPC-E standard, all references to tpsE Results must include the tpsE rate, the associated price-per-tpsE, and the Availability Date of the Priced Configuration (See Clause 6.7.3 for more detail).

Although this specification defines the implementation in terms of a relational data model, the database may be implemented using any commercially available Database Management System (DBMS), Database Server, file

system, or other data repository that provides a functionally equivalent implementation. The terms "table", "row", and "column" are used in this document only as examples of logical data structures.

TPC-E uses terminology and metrics that are similar to other benchmarks, originated by the TPC and others. Such similarity in terminology does not imply that TPC-E Results are comparable to other benchmarks. The only benchmark Results comparable to TPC-E are other TPC-E Results that conform to a comparable version of the TPC-E specification.

Restrictions and Limitations

Despite the fact that this benchmark offers a rich environment that represents many OLTP applications, this benchmark does not reflect the entire range of OLTP requirements. In addition, the extent to which a customer can achieve the Results reported by a vendor is highly dependent on how closely TPC-E approximates the customer application. The relative performance of systems derived from this benchmark does not necessarily hold for other workloads or environments. Extrapolations to any other environment are not recommended.
Benchmark Results are highly dependent upon workload, specific application requirements, and systems design and implementation. Relative system performance will vary because of these and other factors. Therefore, TPC-E should not be used as a substitute for specific customer application benchmarking when critical capacity planning and/or product evaluation decisions are contemplated.
Benchmark Sponsors are permitted various possible implementation designs, insofar as they adhere to the model described and pictorially illustrated in this specification. A Full Disclosure Report (FDR) of the implementation details, as specified in Clause 9.1, must be made available along with the reported Results.

Clause 1: Overview

Order and Titles

The order and titles of sections in the Report and Supporting Files must correspond with the order and titles of sections from the TPC-E Standard Specification (i.e., this document). The intent is to make it as easy as possible for readers to compare and contrast material in different Reports (9.1.1.1).

The order and titles in this report correspond to those in the TPC-E specification.

Executive Summary Statement

The TPC Executive Summary Statement must be included near the beginning of the Report (9.2).

The Executive summary has been included near the beginning of this FDR.

Benchmark Sponsor

A statement identifying the benchmark sponsor(s) and other participating companies must be provided (9.3.1.1).

Fujitsu is the sponsor of this TPC Benchmark™ E result.

Configuration Diagram

Diagrams of both measured and Priced Configurations must be reported in the Report, accompanied by a description of the differences (9.3.1.2).

The measured and priced configurations are shown in the following figures. There are differences between both configurations at additional storage used for database setup and backup in the measured configuration. This storage is not used during measurement and not required for pricing.

Figure 1-1: Priced Configuration

Tier A
PRIMERGY RX2530 M1
2x Intel Xeon E5-2697 v3 2.60 GHz
64 GB Memory
2x 300 GB 15k rpm SAS Drive
2x Onboard LAN 10 Gb/s
1x Dual Port LAN 1 Gb/s
1x SAS RAID controller

Tier B
PRIMERGY RX2540 M2
2x Intel Xeon E5-2699 v4 2.20 GHz
1024 GB Memory
2x 300 GB 15k rpm SAS Drives
4x 600 GB 15k rpm SAS Drives
2x onboard LAN 10 Gb/s
6x SAS RAID Controller

Storage
1x PRIMECENTER Rack
5x ETERNUS JX40 S2
80x 400 GB SSD Drives

Figure 1-2: Measured Configuration

Tier A
PRIMERGY RX2530 M1
2x Intel Xeon E5-2697 v3 2.60 GHz
64 GB Memory
2x 300 GB 15k rpm SAS Drive
2x Onboard LAN 10 Gb/s
1x Dual Port LAN 1 Gb/s
1x SAS RAID controller

Tier B
PRIMERGY RX2540 M2
2x Intel Xeon E5-2699 v4 2.20 GHz
1024 GB Memory
2x 300 GB 15k rpm SAS Drives
4x 600 GB 15k rpm SAS Drives
2x onboard LAN 10 Gb/s
6x SAS RAID Controller

Storage
1x PRIMECENTER Rack
5x ETERNUS JX40 S2
80x 400 GB SSD Drives

Hardware Configuration

A description of the steps taken to configure all the hardware must be reported in the Report (9.3.1.4).

Driver
The driver system is not part of the System Under Test (SUT) and priced configuration. This system was connected with Tier A system, using onboard LAN with 2 x 10 Gb/s Ethernet. There are two LAN segments for these connections.

Tier A
The Tier A server is a Fujitsu PRIMERGY RX2530 M1 system with two Intel Xeon E5-2697 v3 Fourteen-Core Processor and 64 GB of memory. Two SAS 300 GB 15k rpm disk drives are connected with RAID controller 12 Gb/s SAS3.0 (PRAID EP400i) and configured with RAID1 for OS. One dual port 1 Gb/s Ethernet LAN card is plugged in the PCI-E slot. These two 1 Gb/s LAN ports are used for driver connection. There are two onboard 10 Gb/s LAN ports. Each of the two ports is directly connected with one of the 10 Gb/s Ethernet onboard LAN ports of Tier B using a LAN crossover cable.

Tier B
The Tier B or database server is a Fujitsu PRIMERGY RX2540 M2 with two Intel Xeon E5-2699 v4 Twenty-two-Core Processors and 1024 GB memory. Six of the eight onboard 3.5" disk bays are used with 2x SAS 300 GB 15k rpm; 4x SAS 600 GB 15k rpm disk drives and SAS/SATA RAID Controller 12 Gb/s SAS3.0 (PRAID EP420i). Two drives are configured with RAID1 for OS and database. The four drives with 600 GB are configured with RAID10 for database log. Five RAID Controllers 12G SAS3.0 (PRAID EP420e) are used to connect the external disk drives to the server. The controller cache of all 6 RAID controllers is configured with Write Through. The two onboard 10 Gb/s Ethernet LAN ports are connected to the Tier A system as described above.

Storage
5 Fujitsu ETERNUS JX40 S2 are used, each with 16x 400GB SSD 2.5" RAID5. The enclosures are connected to the RAID Controllers 12G SAS3.0 (PRAID EP420e). For details see table 2-2 Disk Configuration. The disk configuration can be done with the ServerView RAID Manager, which is shipped on ServerStart DVD together with the Server.

Software Configuration

A description of the steps taken to configure all the software must be reported in the Report (9.3.1.5).

The default installation of the operating system was executed on Tier A and B as well as the installation of the database SW on Tier B and the database client connectivity on Tier A. Information about changes to the software, settings and BenchCraft can be found in the SupportingFiles directory Introduction - Software.

Windows Server 2012 R2 Update (KB2919355) is required for SQL Server 2016 and checked during installation (e.g. see https://www.microsoft.com/en-US/download/details.aspx?id=42335). In addition KB815436 has been used (e.g. see https://support.microsoft.com/en-us/kb/815436)

Clause 2: Database Design, Scaling and Population

Database Creation

A description of the steps taken to create the database for the Reported Throughput must be reported in the Report (9.3.2).
The physical organization of tables and indices, within the database, must be reported in the Report. (9.3.2.1)

The database has been created for 2,380,000 customers. The SQL Server scripts and setup command files are included in the SupportingFiles\Clause2 folder. Two file groups are used for the tables and indices. The distribution is shown in table 2-1.

Partitioning

While few restrictions are placed upon horizontal or vertical partitioning of tables and rows in the TPC-E benchmark (see Clause 2.3.3), any such partitioning must be reported in the Report. (9.3.2.2)

There is no partitioning implemented in this configuration.

Replication and Duplicated Attributes

Replication of tables, if used, must be reported in the Report (9.3.2.3).
Additional and/or duplicated attributes in any table must be reported in the Report along with a statement on the impact on performance (9.3.2.4).

There is no replication implemented in this configuration.
No duplications or additional attributes were used.

Cardinality of Tables

The cardinality (e.g. the number of rows) of each table, as it existed after database load (see Clause 2.6), must be reported in the Report (9.3.2.5).

The database was configured for 2,380,000 customers. The cardinality of the tables after database load is as shown in the following table 2-1.

Table 2-1: Table Cardinality and File Groups

Table	Cardinality after database load	File Group
ACCOUNT_PERMISSION	16898148	1
ADDRESS	3570004	1
BROKER	23800	1
CASH_TRANSACTION	37836400750	2
CHARGE	15	1
COMMISSION_RATE	240	1
COMPANY	1190000	1
COMPANY_COMPETITOR	3570000	1
CUSTOMER	2380000	1
CUSTOMER_ACCOUNT	11900000	1
CUSTOMER_TAXRATE	4760000	1
DAILY_MARKET	2127541500	1
EXCHANGE	4	1
FINANCIAL	23800000	1
HOLDING	2105466800	2
HOLDING_HISTORY	55116496853	2
HOLDING_SUMMARY	118363996	2
INDUSTRY	102	1
LAST_TRADE	1630300	1
NEWS_ITEM	2380000	1
NEWS_XREF	2380000	1
SECTOR	12	1
SECURITY	1630300	1
SETTLEMENT	41126400000	2
STATUS_TYPE	5	1
TAXRATE	320	1
TRADE	41126400000	2
TRADE_HISTORY	98703307649	2
TRADE_REQUEST	0	2
TRADE_TYPE	5	1
WATCH_ITEM	238024179	1
WATCH_LIST	2380000	1
ZIP_CODE	14741	1

Distribution of Tables, Partitions and Logs

The distribution of tables, partitions and logs across all media must be explicitly depicted for the measured and Priced Configurations (9.3.2.6).

Table 2-2: Disk Configuration

HBA - Port	Disk#	Drives	Partition	Size	Use
Crtl 0 onboard	1	2x300GB 15K SAS, RAID1	C:\	278 GB	OS, DB
	0	4x600GB 15K SAS, RAID10	L:\	1116 GB	DB Log
Crtl 1 Port 0 JX40 S2	2	16x400GB SSD, RAID5	C:\jp\tpce011 C:\jp\tpce012	122 GB 5459 GB	Filegroup1 Filegroup2
	3	8x1200GB HDD, RAID5	C:\jp\help01	7821 GB	DB Setup,Backup
Crtl 1 Port 1 JX40 S2	4	15x400GB SSD, RAID5	C:\jp\temp01	5208 GB	DB Setup
Crtl 2 Port 0 JX40 S2	5	16x400GB SSD, RAID5	C:\jp\tpce021 C:\jp\tpce022	122 GB 5459 GB	Filegroup1 Filegroup2
	6	8x1200GB HDD, RAID5	C:\jp\help02	7821 GB	DB Setup,Backup
Crtl 2 Port 1 JX40 S2	7	15x400GB SSD, RAID5	C:\jp\temp02	5208 GB	DB Setup
Crtl 3 Port 0 JX40 S2	8	16x400GB SSD, RAID5	C:\jp\tpce031 C:\jp\tpce032	122 GB 5459 GB	Filegroup1 Filegroup2
	9	8x1200GB HDD, RAID5	C:\jp\help03	7821 GB	DB Setup,Backup
Crtl 3 Port 1 JX40 S2	10	15x400GB SSD, RAID5	C:\jp\temp03	5208 GB	DB Setup
Crtl 4 Port 0 JX40 S2	11	16x400GB SSD, RAID5	C:\jp\tpce041 C:\jp\tpce042	122 GB 5459 GB	Filegroup1 Filegroup2
	12	8x1200GB HDD, RAID5	C:\jp\help04	7821 GB	DB Setup,Backup
Crtl 4 Port 1 JX40 S2	13	15x400GB SSD, RAID5	C:\jp\temp04	5208 GB	DB Setup
Crtl 5 Port 0 JX40 S2	14	16x400GB SSD, RAID5	C:\jp\tpce051 C:\jp\tpce052	122 GB 5459 GB	Filegroup1 Filegroup2
	15	8x1200GB HDD, RAID5	C:\jp\help05	7821 GB	DB Setup,Backup
Crtl 5 Port 1 JX40 S2	16	15x400GB SSD, RAID5	C:\jp\temp05	5208 GB	DB Setup

Disk# 4, 7, 10, 13 and 16 are only used for database setup
Disk# 3, 6, 9, 12 and 15 are used for database setup and database backup

Database Interface, Data Model and Load Methodology

A statement must be provided in the Report that describes:
The Database Interface (e.g., embedded, call level) and access language (e.g., SQL, COBOL read/write) used to implement the TPC-E Transactions. If more than one interface / access language is used to implement TPC-E, each interface / access language must be described and a list of which interface /access language is used with which Transaction type must be reported.
The data model implemented by the DBMS (e.g., relational, network, hierarchical) (9.3.2.7).
The methodology used to load the database must be reported in the Report (9.3.2.8).

Microsoft SQL Server 2016 Enterprise Edition is a relational database. The interface used was Microsoft SQL Server stored procedures accessed with Remote Procedure Calls embedded in C++ code using the Microsoft ODBC interface.
The methodology used to load the database is described in Clause2 of the SupportingFiles directory.

Clause 3: Transactions

Vendor-Supplied Code

A statement that vendor-supplied code is functionally equivalent to Pseudo-code in the specification (see Clause 3.2.1.6) must be reported in the Report (9.3.3.1).

The vendor supplied code is functionally equivalent to the pseudo-code.

Database Footprint Requirements

A statement that the database footprint requirements (as described in Clause 3.3) were met must be reported in the Report (9.3.3.2).

Database footprint requirements were met as described in the specification.

Clause 4: SUT, Driver and Network

Network Configuration

The Network configurations of both the measured and Priced Configurations must be described and reported in the Report. This includes the mandatory Network between the Driver and Tier A (see Clause 4.2.2) and any optional Database Server interface networks (9.3.4.2):

Figures 1-1 and 1-2 show the configuration of the measured and priced configurations. Both are identical in case of the network configuration. Tier B system PRIMERGY RX2540 M2 has an onboard Ethernet controller with two 10 Gb/s ports. Tier A system PRIMERGY RX2530 M1 has an onboard Ethernet controller with two 10 Gb/s ports. These two ports were directly connected with the two onboard ports of Tier B using different LAN segments. Tier A system was extended with one dual-port 1 Gb/s Ethernet controller card used for driver system connection..

Clause 5: EGen

EGen Version

The version of EGen used in the benchmark must be reported (9.3.5.1).

The EGen version used was 1.14.0.

EGen Code

A statement that all required TPC-provided EGen code was used in the benchmark must be reported (9.3.5.2).

All the required TPC-provided code was used in the benchmark.

EGen Modifications

If the Test Sponsor modified EGen, a statement EGen has been modified must be reported in the Report. All formal waivers from the TPC documenting the allowed changes to EGen must also be reported in the Report (see Clause 5.3.7.1). If any of the changes to EGen do not have a formal waiver that must also be reported (9.3.5.3).
If the Test Sponsor extended EGenLoader (as described in Appendix A.6), the use of the extended EGenLoader and the audit of the extension code by an Auditor must be reported (9.3.5.4).

Clause 6: Performance Metrics and Response time

EGen Driver

The number of EGenDriverMEE and EGenDriverCE instances used in the benchmark must be reported in the Report (see Clause 6.2.5) (9.3.1.1).

One Tier A system was used and configured to drive 16 EGenDriverMEE and 16 EGenDriverCE instances.
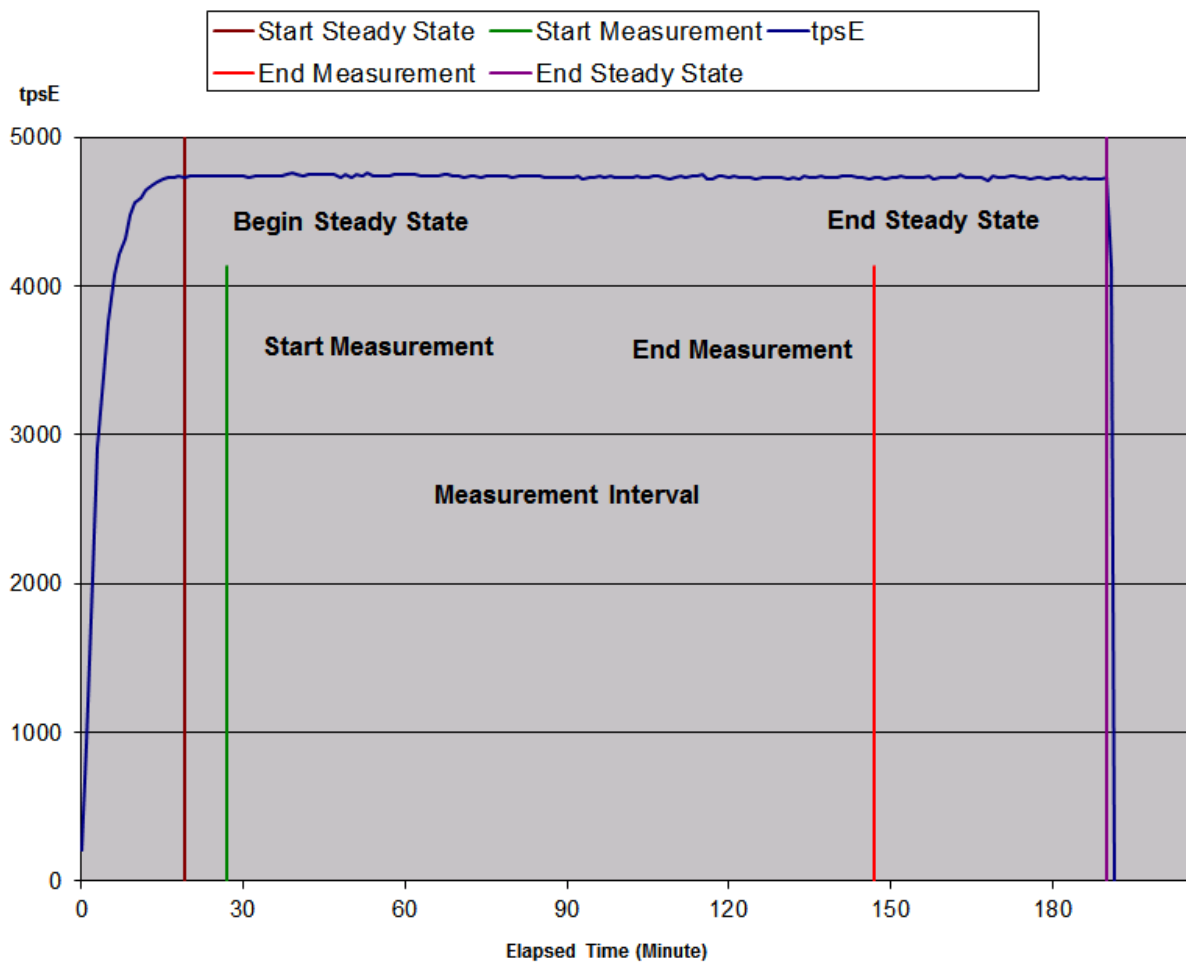
Measured Throughput

The Measured Throughput must be reported in the Report (see Clause 6.7.1.2) (9.3.6.2).

The measured throughput was 4734.87 tpsE.

Test Run Graph

A Test Run Graph of throughput versus elapsed wall clock time must be reported in the Report for the Trade-Result Transaction (see Clause 6.7.2) (9.3.6.3).

Figure 6-1: Test Run Graph

Steady State

The method used to determine that the SUT had reached a Steady State prior to commencing the Measurement Interval must be reported in the Report (9.3.6.4).

During the run the tpsE throughput was observed to determine steady state. After the run steady state was confirmed by:
1. Looked at the Test Run Graph and verified that tpsE was steady prior to commencing the Measurement Interval.
2. Calculated 60 minute average tpsE during the Steady State moving the time window 10 minutes each time. Then confirmed that the minimum 60 minute average tpsE was not less than 98% of the Reported Throughput, and that the maximum 60 minute average tpsE was not greater than 102% of the Reported Throughput.
3. Calculated 10 minute average tpsE during the Steady State moving the window 1 minute each time. Then confirmed that the minimum 10 minute average tpsE was not less than 80% of the Reported Throughput, and that the maximum 10 minute average tpsE was not greater than 120% of the Reported Throughput.

Work Performed During Steady State

A description of how the work normally performed during a Test Run, actually occurred during the Measurement Interval must be reported in the Report (for example checkpointing, writing Undo/Redo Log records, etc.) (9.3.6.5).

The Microsoft SQL Server recovery interval parameter was set to the maximum allowable value to perform checkpoint at specific intervals. Checkpoints were automatically issued at specified intervals (449 seconds) and specified duration (440 seconds). SQL Server was started with trace flag 3502, which caused it to log the occurrence of the checkpoints. This information was used to verify that the checkpoints occurred at the appropriate times and duration during steady state.

Transaction Input Parameter Averages

The recorded averages over the Measurement Interval for each of the Transaction input parameters specified by clause 6.4.1 must be reported (9.3.6.6).

Table 6-2: Transaction Input Parameter Averages.

Transaction	Parameter	Range Min	Range Max	Value	Check
Customer Position	By Tax ID	48.00%	52.00%	50.01%	Ok
	Get History	48.00%	52.00%	50.01%	Ok
	Overall				Ok
Market Watch	By Watch List	57.00%	63.00%	60.00%	Ok
	By Customer Account	33.00%	37.00%	35.00%	Ok
	By Industry	4.50%	5.50%	5.00%	Ok
	Overall				Ok
Security Detail	Access LOB	0.90%	1.10%	1.00%	Ok
	Overall				Ok
Trade Lookup	Frame 1	28.50%	31.50%	29.99%	Ok
	Frame 2	28.50%	31.50%	29.99%	Ok
	Frame 3	28.50%	31.50%	30.01%	Ok
	Frame 4	9.50%	10.50%	10.01%	Ok
	Overall				Ok
Trade Update	Frame 1	31.00%	35.00%	33.03%	Ok
	Frame 2	31.00%	35.00%	33.01%	Ok
	Frame 3	32.00%	36.00%	33.96%	Ok
	Overall				Ok
Trade Order	By Non-Owner	9.50%	10.50%	9.99%	Ok
	By Company Name	38.00%	42.00%	40.01%	Ok
	Buy On Margin	7.50%	8.50%	8.00%	Ok
	Rollback	0.94%	1.04%	0.99%	Ok
	LIFO	33.00%	37.00%	35.00%	Ok
	Trade Qty 100	24.00%	26.00%	24.99%	Ok
	Trade Qty 200	24.00%	26.00%	25.00%	Ok
	Trade Qty 400	24.00%	26.00%	25.02%	Ok
	Trade Qty 800	24.00%	26.00%	25.00%	Ok
	Market Buy	29.70%	30.30%	30.02%	Ok
	Market Sell	29.70%	30.30%	30.00%	Ok
	Limit Buy	19.80%	20.20%	19.99%	Ok
	Limit Sell	9.90%	10.10%	10.00%	Ok
	Stop Loss	9.90%	10.10%	10.00%	Ok
	Overall				Ok

Clause 7: Transaction and System Properties

ACID Tests

The results of the ACID tests must be reported in the Report along with a description of how the ACID requirements were met, and how the ACID tests were run (9.3.7.1).

The TPC Benchmark™ E Standard Specification defines a set of transaction processing system properties that a system under test (SUT) must support during the execution of the benchmark. Those properties are Atomicity, Consistency, Isolation and Durability (ACID). This section quotes the specification definition of each of those properties and describes the tests done as specified and monitored by the auditor, to demonstrate compliance. See also file MSTPCE ACID Procedures.pdf in the SupportingFiles directory.

Redundancy Level and Data Accessibility

The Test Sponsor must report in the Report the Redundancy Level (see Clause 7.5.7.1) and describe the Data Accessibility test(s) used to demonstrate compliance (9.3.7.2).
*A Data Accessibility Graph for each run demonstrating a Redundancy Level must be reported in the Report (see Clause 7.5.7.2) (9.3.7.3).*

Redundancy Level 1 was used for the storage system. To prove Redundancy Level 1, the following steps were successfully performed on a database data and log disk. The test for Redundancy Level 1 is the test for Permanent Irrecoverable Failure of any single Durable Medium. The different steps and the various states of the two disks are reported by ServerView RAID and written to the system event (see SupportingFiles).

1. Determine the current number of completed trades in the database by counting the rows in SETTLEMENT.
2. Start submitting Transactions and ramp up to the Durability Throughput Requirements (as defined in Clause 7.5.3) and satisfy those requirements for at least 5 minutes with a throughput above 95% of reported throughput.
3. Induce the failure described for the redundancy level being demonstrated. In this case fail a disk in the database tempdb array. Since RAID1 is used, the transactions continue. Run for at least 5 minutes with throughput above 95% of reported throughput.
4. Induce the failure described for the redundancy level being demonstrated. In this case fail a disk in a database log array. Since RAID10 is used, the transactions continue. Run for at least 5 minutes with throughput above 95% of reported throughput.
5. Induce the failure described for the redundancy level being demonstrated. In this case fail a disk in the database data array. Since RAID5 is used, the transactions continue. Run for at least 5 minutes.
6. Begin the necessary recovery process, by replacing the failed drives in the database data array and start the rebuild process.
7. Begin the necessary recovery process, by replacing the failed drives in the database log array and start the rebuild.
8. Continue running the Driver for at least 20.
9. Terminate the run gracefully from the Driver.
10. Wait until rebuild process has finished.
11. Determine the current number of completed trades in the database by counting the rows in SETTLEMENT.
12. Run the evaluation of Trade-Result Transactions executed and compare it with the difference of the SETTLEMENT rows counted.

The Graph in Figure 7-1 show the measured throughput versus time and the different test stated.

Figure 7-1: Redundancy Level and Data Accessibility Graph

Data Access Time Graph
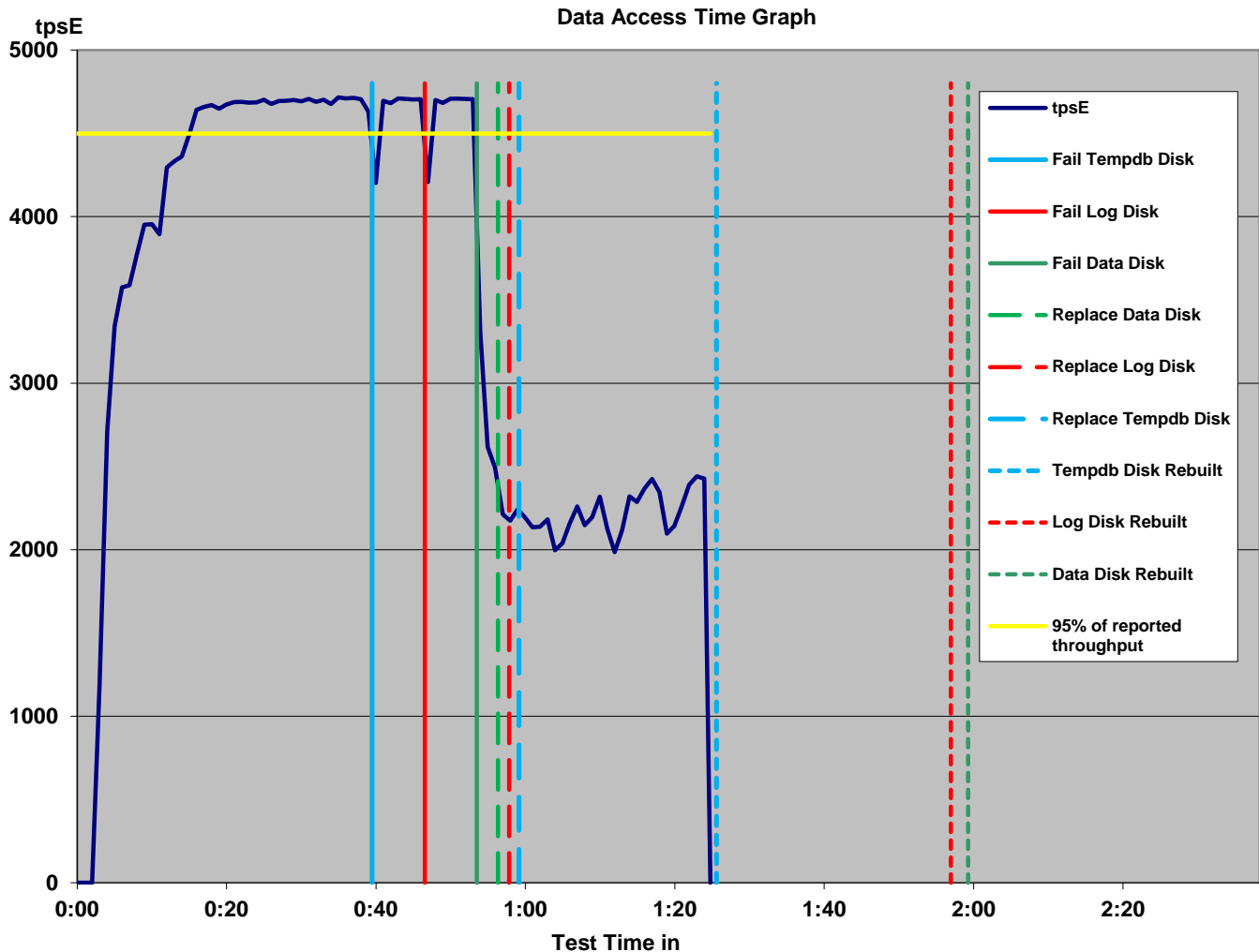
Business Recovery

The Test Sponsor must describe in the Report the test(s) used to demonstrate Business Recovery (9.3.4.7). The Business Recovery Time must be reported on the Executive Summary Statement and in the Report. If the failures described in Clauses 7.5.2.2, 7.5.2.3 and 7.5.2.4 were not combined into one Durability test (usually powering off the Database Server during the run), then the Business Recovery Time for the failure described for instantaneous interruption is the Business Recovery Time that must be reported in the Executive Summary Statement. All the Business Recovery Times for each test requiring Business Recovery must be reported in the Report (9.3.7.6). 9.3.7.6 The Business Recovery Time Graph (see Clause 7.5.7.4) must be reported in the Report for all Business Recovery tests (9.3.7.7).

The tests for "Instantaneous interrupt," "Failure of all or part of memory," and "Loss of external power to the SUT" were combined by power off Tier A and B.

1. Determine the current number of completed trades in the database by counting the rows in SETTLEMENT.
2. Start submitting transactions and ramp up to the Durability Throughput Requirements (as defined in Clause 7.5.3) and satisfy those requirements for at least 20 minutes.
3. Induce the failures by power off Tier B.
4. On the driver side the number of MEE connections is captured and after transaction failures is noted by the drivers, terminate the run and collect the data for Pre-Failure Run.

5. Re-power and restart Tier B.
6. When restarting the database on Tier B, it automatically starts the recovery and records timestamps. The Database Recovery Time was 00:08:04 (hh:mm.ss).
7. After recovery has completed Trade-Cleanup has been executed. A new run started again submitting transactions and ramp up to the Durability Throughput Requirements (as defined in Clause 7.5.3) and satisfy those requirements for at least 20 minutes. The Application Recovery Time was 00:12:00 (hh:mm:ss).
8. Terminate the run gracefully from the Driver and collect the data for Post-Failure Run.
9. Verify that there are no errors in the Post-Failure run and check the consistency of the database as specified in Clause 7.3.1.1.
10. Determine the current number of completed trades in the database by counting the rows in SETTLEMENT.
11. Run the evaluation of Trade-Result Transactions executed in both runs and compare it with the difference of the SETTLEMENT rows counted. The difference must be less than or equal to the maximum number of Transactions which can be simultaneously in-flight from the Driver to the SUT.

The Business Recovery Time (per Clause 7.5.7 Step15) was 00:20:04 (hh:mm:ss).

The Graph in Figure 7-2 shows the measured throughput versus time and the Business Recovery.

Figure 7-2: Business Recovery Graph
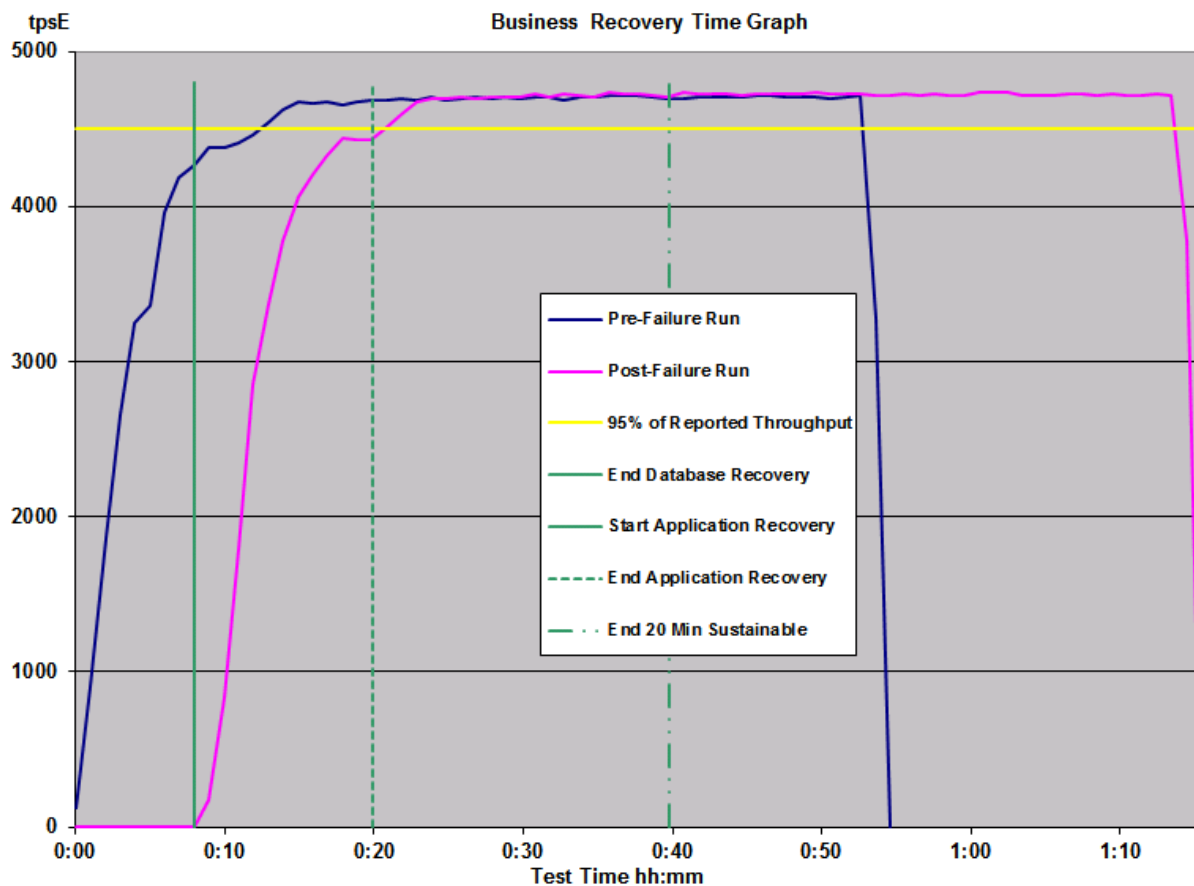
Clause 8: Pricing Related Items

60-Day Space

Details of the 60-Day Space computations along with proof that the database is configured to sustain a Business Day of growth must be reported (9.3.8.1).

Table 8-1: Space Requirements

TPC-E Disk Space Requirements									
Customers Used	2,380,000								
Performance	4734.87 TpsE		settlements after 8 hours (Busines Day)			136,364,256			
					initinal size	grow size			
Table	**Initial Rows**	**Data (KB)**	**Index size (KB)**	**Extra 5% (KB)**	**Total + 5% (KB)**	**After run (KB)**	**Growth (KB)**	**1 Day Growth (KB)**	**Req. Add. (KB)**
ACCOUNT_PERMISSION	16,898,148	930,488	4,872	46,768	982,128	935,472	112	287	46,768
ADDRESS	3,570,004	205,968	776	10,337	217,081	206,776	32	82	10,337
BROKER	23,800	1,736	1,776	176	3,688	3,512	0	0	176
CASH_TRANSACTION	37,840,126,761	3,930,892,752	8,292,456	196,959,260	4,136,144,468	3,948,398,888	9,213,680	23,562,126	23,562,126
CHARGE	15	8	8	1	17	16	0	0	1
COMMISSION_RATE	240	16	16	2	34	32	0	0	2
COMPANY	1,190,000	253,816	75,352	16,458	345,626	329,192	24	62	16,458
COMPANY_COMPETITOR	3,570,000	95,864	86,704	9,128	191,696	182,568	0	0	9,128
CUSTOMER	2,380,000	390,024	113,584	25,180	528,788	503,656	48	123	25,180
CUSTOMER_ACCOUNT	11,900,000	1,078,328	262,928	67,063	1,408,319	1,341,256	0	0	67,063
CUSTOMER_TAXRATE	4,760,000	99,264	760	5,001	105,025	100,160	136	348	5,001
DAILY_MARKET	2,127,541,500	99,740,968	290,824	5,001,590	105,033,382	100,033,056	1,264	3,233	5,001,590
EXCHANGE	4	8	8	1	17	16	0	0	1
FINANCIAL	23,800,000	2,682,056	7,432	134,474	2,823,962	2,689,816	328	839	134,474
HOLDING	2,105,571,425	140,988,920	96,215,384	11,860,215	249,064,519	240,351,040	3,146,736	8,047,142	8,047,142
HOLDING_HISTORY	55,121,955,085	2,004,416,736	1,339,262,016	167,183,938	3,510,862,690	3,354,804,296	11,125,544	28,451,332	28,451,332
HOLDING_SUMMARY	118,364,277	5,187,440	19,264	260,335	5,467,039	5,206,704	0	0	0
INDUSTRY	102	8	24	2	34	32	0	0	2
LAST_TRADE	1,630,300	101,648	768	5,121	107,537	102,416	0	0	5,121
NEWS_ITEM	2,380,000	258,035,424	2,480	12,901,895	270,939,799	258,037,928	24	62	12,901,895
NEWS_XREF	2,380,000	59,304	736	3,002	63,042	60,040	0	0	3,002
SECTOR	12	8	24	2	34	32	0	0	2
SECURITY	1,630,300	225,888	62,400	14,414	302,702	288,328	40	103	14,414
SETTLEMENT	41,130,448,807	1,961,473,592	4,136,792	98,280,519	2,063,890,903	1,970,750,816	5,140,432	13,145,617	13,145,617
STATUS_TYPE	5	8	8	1	17	16	0	0	1
TAXRATE	320	24	16	2	42	64	24	62	62
TRADE	41,130,731,812	4,910,212,856	2,751,899,152	383,105,600	8,045,217,608	7,670,494,240	8,382,232	21,435,866	21,435,866
TRADE_HISTORY	98,713,704,142	2,969,249,272	7,746,064	148,849,767	3,125,845,103	2,986,178,720	9,183,384	23,484,650	23,484,650
TRADE_REQUEST	0	0	0	0	0	885,792	885,792	2,265,235	2,265,235
TRADE_TYPE	5	8	1,032	52	1,092	1,040	0	0	52
WATCH_ITEM	238,024,179	6,678,472	24,656	335,156	7,038,284	6,703,416	288	737	335,156
WATCH_LIST	2,380,000	59,304	53,576	5,644	118,524	112,880	0	0	5,644
ZIP_CODE	14,741	488	48	27	563	536	0	0	27

Growing Tables		**Initial Database Size**				Settlements	53,323,569	
		20,021,116 (MB)				**Grown Database Size**		
		19,552 (GB)				20,067,093 (MB)		

	number	partition size (MB)	file size (MB)	alloc total (MB)	loaded (MB)	required (MB)	
filegroup1	5	124,928	575,000	624,640	362,920	381,066	space OK
filegroup2	5	5,590,016	27,250,000	27,950,080	19,658,196	19,775,766	space OK

		Number of disks	80					
		Disk Capacity (MB)	381,024					
		RAID5 Overhead	6%					
Initial Growing Space (MB)	19,658,196	Total Space-1 (MB)	28,576,800					
Final Growing Space (MB)	19,704,170	Number of disks	-	Initial Log Size (MB)	54,775	Log units	1	
Delta (MB)	45,974	Disk Capacity (MB)		Final Log Size (MB)	400,768	Disks per unit	4	
Data Space per Trade (MB)	0.000862	RAID5 Overhead		Log Growth (MB)	345,994	Disk Capacity (MB)	571,808	
1 Day Data Growth (MB)	117,570	Total Space-2 (MB)	-	Log Space per Trade	0.006489	RAID10 Overhead	50.0%	
60 Day Space (MB)	27,075,332	Total Space (MB)	28,576,800	1 Day Log Space (MB	884,809	Log Space (MB)	1,143,616	

Attestation Letter

The Auditor's Attestation Letter, which indicates compliance, must be included in the Report (9.3.8.2).

InfoSizing
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TPC Transaction Processing Performance Council
Certified Auditors

Detlev Seidel
Fujitsu Technology Solutions
Heinz-Nixdorf-Ring 1
33106 Paderborn, Germany

March 29, 2016

I verified the TPC Benchmark™ E v1.14.0 performance of the following configuration:

Platform: Fujitsu Server PRIMERGY RX2540 M2
Operating System: Microsoft Windows Server 2012 R2 Standard Edition
Database Manager: Microsoft SQL Server 2016 Enterprise Edition

The results were:

Performance Metric   **4,734.87 tpsE**
Trade-Result 90th %-tile   0.04 Seconds

Tier B (Server)	**Fujitsu Server PRIMEGY RX2540 M2**		
CPUs	2 x Intel Xeon E5-2699 v4 (2.20 GHz, 22-core, 55 MB L3)		
Memory	1024 GB		
Storage	**Qty**	**Size**	**Type**
	2	300 GB	15K rpm SAS HDD
	4	600 GB	15K rpm SAS HDD
	80	400 GB	SAS SSD

Tier A (Client)	**PRIMERGY RX2530 M1**
CPUs	2 x Intel Xeon E5-2697 v3 (2.60 GHz, 14-core, 35 MB L3)
Memory	64 GB
Storage	2 x 300 GB 15K rpm SAS HDD

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 EGen components were verified to be v1.14.0
- The transaction were correctly implemented
- The database was properly scaled and populated for 2,380,000 customers
- The mandatory network between the driver and the SUT was configured

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- The ACID properties were met
- Input data was generated according to the specified percentages
- The reported response times were correctly measured
- All 90% response times were under the specified maximums
- The measurement interval was 120 minutes
- The implementation used Redundancy Level 1
- The Business Recovery Time of 00:20:04 was correctly measured
- The 60-day storage requirement was correctly computed
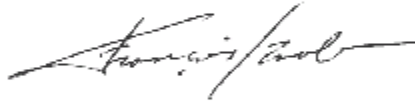- The system pricing was verified for major components and maintenance

Additional Audit Notes:

   None.

Respectfully Yours,

Doug Johnson, Auditor

François Raab, President

Clause 9: Supporting Files

Supporting Files Index table

An index for all files required by Clause 9.4 Supporting Files must be provided in the Report. The Supporting Files index is presented in a tabular format where the columns specify the following:
• The first column denotes the clause in the TPC Specification
• The second column provides a short description of the file contents
• The third column contains the path name for the file starting at the SupportingFiles directory.
If there are no Supporting Files provided then the description column must indicate that there is no supporting file and the path name column must be left blank (9.3.9.1).

Clause	Description	Path	Filename
	overview	SupportingFiles	SupportingFiles.doc
Introduction	System Configuration	SupportingFiles/Introduction/	SysInfo_TierA.txt SysInfo_TierB.txt
	Disk Configuration	SupportingFiles/Introduction/Hardware/	DiskConfiguration.docx flatfilelocations.txt makehelpdir.cmd makehelpdirff.cmd maketpcedir.cmd Readme.txt tempdb05.sql
	Parameter OS Tunables Database Setup	SupportingFiles/Introduction/Software/	CountOperations.reg DiskManagement01.jpg DiskManagement02.jpg DiskManagement03.jpg MemoryManagement.reg MSTPCE Database Setup Reference.doc SQL_IP.reg SQL_LargePages.req SQL_Nodes.reg SQL_Server_Configuration.ver TierA_MSSQL_ConnectTo.reg TierA_W32Time.reg
	Startup Scripts Tier A	SupportingFiles/Introduction/Software/	start_all_RX2540M2-16DR.cmd
	Startup Scripts Tier B	SupportingFiles/Introduction/Software/	Sqlstart2016.cmd
Clause 2	Create Database	SupportingFiles/Clause2	Backup_Database.sql Check_tempdb.sql Checkpoint_TPCE_Database.SQL Count_Customers.sql Create_Database.sql Create_DM_Audit_Table.sql Create_TID_Ranges_Table.sql Create_Timer_Table.sql Create_TL_TU_Warnings_Table.sql Create_TPCE_VERSIONS_Table.sql Database_Options_1.sql Database_Options_2.sql Drop_and_Create_TPCE_INFO.sql End_Load_Timer.sql Get_Next_T_ID.sql Install_Load_Timer_Proc.sql Load_TPCE_Info.sql Output_TPCE_VERSIONS_Table.SQL Remove_Database.sql Restore_Database.sql SpaceUsed_Extended.sql SQL_Server_Configuration.sql TPCE_Setup.cmd Trade_Cleanup.sql Version.sql

| | Create Database output | SupportingFiles/Clause2/DB_setup | 2380000Customers_Load_Timer.log
Backup_Database.log
BrokerVolume.log
Build_Steps.log
BulkInsert_1.out
…
BulkInsert_85.out
Check_Constraints_Fixed.log
Check_Constraints_Growing.log
Check_Constraints_Scaling.log
Convert_NI_ITEM_Data.log
Create_DB_Audit_Tables.log
Create_DM_Audit_Tables.log
Create_Indexes_Fixed_Tables.log
Create_Indexes_Growing_Tables.log
Create_Indexes_Scaling_Tables.log
Create_TID_Ranges_Table.log
Create_TL_TU_Warnings_Table.log
Create_TPCE_VERSIONS_Table.log
CreateDB.log
CustomerPosition.log
Database_Options_1.log
Database_Options_2.log
DataMaintenance.log
DB_Check.log
DB_FK_Constraints.log
DB_Primary_Key_Check.log
DB_Tables.log
Drop_DB_Audit_Tables.log
Drop_Fixed_Tables.log
Drop_FK_Constraints.log
Drop_Growing_Tables.log
Drop_Scaling_Tables.log
EGenLoaderFrom1To28000.log
EGenLoaderFrom28001To56000.log
….
EGenLoaderFrom2352001To2380000.log
ERRORLOG.txt
FK_Constraints.log
Get_Next_T_ID.log
Insert_Duplicates_Tests.log
Install_SpaceUsed_Extended.log
Load_Timer.log
Load_Timer_Proc.log
Load_TPCE_Info.log
MarketFeed.log
MarketWatch.log
Referential_Integrity_Tests.log
RemoveDB.log
SecurityDetail.log
spfiles.log
splog.log
SQL_Server_Configuration.log
Tables_Fixed.log
Tables_Growing.log
Tables_Scaling.log
TPCE_Table_Sizes.log
TPCE_VERSIONS.log
TradeLookup.log
TradeOrder.log
TradeResult.log
TradeStatus.log
TradeUpdate.log
Version.log |
| | Index Creation Scripts | SupportingFiles/Clause2/DDL | BulkInsert_<1..85>.sql
Convert_NI_ITEM_Data.SQL
Create_Check_Constraints_Fixed.sql
Create_Check_Constraints_Growing.sql
Create_Check_Constraints_Scaling.sql
Create_FK_Constraints.sql
Create_Indexes_Fixed_Tables.sql
Create_Indexes_Growing_Tables.sql |

			Create_Indexes_Scaling_Tables.sql
			Create_Tables_Fixed.sql
			Create_Tables_Growing.sql
			Create_Tables_Scaling.sql
			Drop_FK_Constraints.sql
			Drop_Tables_Fixed.sql
			Drop_Tables_Growing.sql
			Drop_Tables_Scaling.sql
	Database Audit Scripts	SupportingFiles/Clause2/Audit_Scripts/ Database	Create_DB_Audit_Tables.SQL
			DB_Check.sql
			DB_FK_Constraints.sql
			DB_Primary_Key_Check.SQL
			DB_Tables.sql
			Drop_DB_Audit_Tables.SQL
			Insert_Duplicates_Tests.sql
			Referential_Integrity_Tests.sql
	Database Space Scripts	SupportingFiles/Clause2/Audit_Scripts/ Space	Get_Table_Sizes.sql
			SPFiles.sql
			SPLog.sql
			SPUsed.sql
Clause3	Transaction Frames	SupportingFiles/Clause3	BrokerVolume.sql
			CustomerPosition.sql
			DataMaintenance.sql
			MarketFeed.sql
			MarketWatch.sql
			SecurityDetail.sql
			TradeLookup.sql
			TradeOrder.sql
			TradeResult.sql
			TradeStatus.sql
			TradeUpdate.sql
	BaseServer	SupportingFiles/Clause3/BaseServer	BaseServer.cpp
			BaseServer.h
			BaseServer.vcproj
			stdafx.cpp
			stdafx.h
			SUTServersLocals.h
	SUT_CE_Server	SupportingFiles/Clause3/SUT_CE_Server	Release\SUT_CE_Server.exe
			CEServer.cpp
			CEServer.h
			CEServerMain.cpp
			PortDefinitions.h
			stdafx.cpp
			stdafx.h
			SUT_CE_Server.vcxproj
			SUTServer.sln
			SUTStructs.h
	SUT_MEE_Server	SupportingFiles/Clause3/SUT_MEE_Server	Release\SUT_MEE_Server.exe
			MEEServer.cpp
			MEEServer.h
			MEEServerMain.cpp
			stdafx.cpp
			stdafx.h
			SUT_MEE_Server.vcproj
			SUT_MEE_Server.vcxproj
	TransactionsSP	SupportingFiles/Clause3/TransactionsSP	BrokerVolumeDB_SP.cpp
			BrokerVolumeDB_SP.h
			CheckpointDB_SP.cpp
			CheckpointDB_SP.h
			CustomerPositionDB_SP.cpp
			CustomerPositionDB_SP.h
			DataMaintenanceDB_SP.cpp
			DataMaintenanceDB_SP.h
			MarketFeedDB_SP.cpp
			MarketFeedDB_SP.h
			MarketWatchDB_SP.cpp
			MarketWatchDB_SP.h
			SecurityDetailDB_SP.cpp
			SecurityDetailDB_SP.h
			stdafx.cpp
			stdafx.h

			TradeLookupDB_SP.cpp
			TradeLookupDB_SP.h
			TradeOrderDB_SP.cpp
			TradeOrderDB_SP.h
			TradeResultDB_SP.cpp
			TradeResultDB_SP.h
			TradeStatusDB_SP.cpp
			TradeStatusDB_SP.h
			TradeUpdateDB_SP.cpp
			TradeUpdateDB_SP.h
			TransactionsSP.vcproj
			TransactionsSP.vcxproj
			TxnHarnessDBBase.cpp
			TxnHarnessDBBase.h
			TxnHarnessDBConn.cpp
			TxnHarnessDBConn.h
	TxnHarness	SupportingFiles/Clause3/TxnHarnes	TxnHarness.vcproj
			TxnHarness.vcxproj
			TxnHarness_stdafx.cpp
			TxnHarness_stdafx.h
			TxnHarnessSendToMarket.cpp
			TxnHarnessSendToMarket.h
Clause4			
Clause5	EGen Driver Configuration	SupportingFiles/Clause5	RX2540_2380KCus_4x33+12x35_spiderc-V1.xml
			EGenTxnHarnessStructs.h
	EGenLoader Parameter	SupportingFiles/Clause5	BuildSteps.log
			EGenLoaderFrom1To28000.log
			EGenLoaderFrom28001To56000.log
			….
			EGenLoaderFrom2352001To2380000.log
	EGenLogger Output	SupportingFiles/Clause5	TxnReportE-MI.xls
Clause6	EGenValidate	SupportingFiles/Clause6	EGenValidate.txt
Clause7	ACID	SupportingFiles/Clause7	MSTPCE ACID Procedures.doc
	ACID Procedures	SupportingFiles/Clause7/AcidProcs	AcidProc.cmd
			AcidProc.out
			Remove_AcidProcs.cmd
	ACID Scripts	SupportingFiles/Clause7/AcidProcs/Scripts	AcidProc.vbs
			CustomerPosition_Iso3.sql
			CustomerPosition_Iso4.sql
			Drop_SPROC.sql
			Remove_AcidProcs.vbs
			TradeOrder_C.sql
			TradeOrder_Iso1_1.sql
			TradeOrder_Iso1_2.sql
			TradeOrder_Iso2.sql
			TradeOrder_Iso3.sql
			TradeOrder_Iso4.sql
			TradeOrder_RB.sql
			TradeResult_Iso1_1.sql
			TradeResult_Iso1_2.sql
			TradeResult_Iso2_1.sql
			TradeResult_Iso2_2.sql
			TradeResult_Iso3.sql
			TradeResult_Iso4.sql
	Atomicity	SupportingFiles/Clause7/Atomicity	Atomicity.cmd
			Atomicity_C.out
			Atomicity_RB.out
		SupportingFiles/Clause7/Atomicity/Scripts	atom.vbs
			Atomicity_C.sql
			Atomicity_RB.sql
	Consistency	SupportingFiles/Clause7/Consistency	Consistency.cmd
			Consistency.out
		SupportingFiles/Clause7/Consistency/Scripts	Consistency.sql
			Consistency.vbs
	Durability Business	SupportingFiles/Clause7/Durability/BusinessRecovery	BR_BenchCraft_Config.xml
			BR_Consistency.out

	Recovery		BR_Count_Settlement1.ver BR_Count_Settlement2.ver BR_ERRORLOG1.txt BR_ERRORLOG2.txt BR_ERRORLOG3.txt BR_SQL_Server_Configuration.ver BR_SystemEvents_TierB.txt BusinessRecov_Part1_step60.xlt BusinessRecov_Part1_TxnReportE_20.xls BusinessRecov_Part1_TxnReportE_all.xls BusinessRecov_Part2_step60.xlt BusinessRecov_Part2_TxnReportE_20.xls BusinessRecov_Part2_TxnReportE_all.xls BusinessRecov_TimeGraph.xls
	Durability Data Accessibility	SupportingFiles/Clause7/Durability/Data Accessibility	DA_BenchCraft_Config.xml DA_Count_Settlement1.ver DA_Count_Settlement2.ver DA_ERRORLOG.txt DA_SQL_Server_Configuration.ver DataAccess_TimeGraph.xls DataAccess_TxnReportE_5min1.xls DataAccess_TxnReportE_5min2.xls DataAccess_TxnReportE_5min3.xls DataAccess_TxnReportE_20min.xls DataAccess_TxnReportE_all.xls SystemEvents_Application.txt
	Isolation	SupportingFiles/Clause7/Isolation	Isolation1_S1.rpt Isolation1_S2.rpt Isolation1_S3.rpt Isolation1_S4.rpt Isolation2_S1.rpt Isolation2_S2.rpt Isolation2_S3.rpt Isolation2_S4.rpt Isolation3_S1.rpt Isolation3_S2.rpt Isolation3_S3.rpt Isolation4_S1.rpt Isolation4_S2.rpt Isolation4_S3.rpt
		SupportingFiles/Clause7/Isolation/Scripts	Isolation1_S1.sql Isolation1_S2.sql Isolation1_S3.sql Isolation1_S4.sql Isolation2_S1.sql Isolation2_S2.sql Isolation2_S3.sql Isolation2_S4.sql Isolation3_S1.sql Isolation3_S2.sql Isolation3_S3.sql Isolation4_S1.sql Isolation4_S2.sql Isolation4_S3.sql
Clause8	60-Day Space Calculations	SupportingFiles/Clause8	tpce_space.xlsx

Appendix: Third Party Price Quotations

Microsoft Corporation
One Microsoft Way
Redmond, WA   98052-6399

Tel 425 882 8080
Fax 425 936 7329
http://www.microsoft.com/

Microsoft

March 9, 2016

Fujitsu
Detlev Seidel
Heinz-Nixdorf-Ring-1
Paderborn, Germany 33106

Here is the information you requested regarding pricing for several Microsoft products to be used in conjunction with your TPC-E benchmark testing.

All pricing shown is in US Dollars ($).

Part Number	Description	Unit Price	Quantity	Price
Database Management System				
7JQ-00256	**SQL Server 2016 Enterprise Edition** *2 Core License* *Open Program - Level C*	$13,472.50	22	$296,395.00
Database Server Operating System				
P73-06284	**Windows Server 2012 R2 Standard Edition** *2 Processor License* *Open Program - Level C* *Unit Price reflects a 17% discount from the retail unit price of $882.*	$735.00	1	$735.00
Tier-A Operating System(s)				
P73-06284	**Windows Server 2012 R2 Standard Edition** *2 Processor License* *Open Program - Level C* *Unit Price reflects a 17% discount from the retail unit price of $882.*	$735.00	1	$735.00
Support				
N/A	**Microsoft Problem Resolution Services** *Professional Support* *(1 Incident).*	$259.00	1	$259.00

Windows Server 2012 R2 Standard Edition are currently orderable and available through Microsoft's normal distribution channels. A list of Microsoft's resellers can be found in the Microsoft Product Information Center at
http://www.microsoft.com/products/info/render.aspx?view=22&type=how

SQL Server 2016 Enterprise Edition will be orderable on March 10, 2016 and generally available by July 31, 2016.

Defect support is included in the purchase price. Additional support is available from Microsoft PSS on an incident by incident basis at $259 call.

This quote is valid for the next 90 days.
Reference ID: TPCE_qhtplylGYLKTVUKf89476dhwi_2016_fds.