TPC Benchmark™ E

Full Disclosure Report for

PRIMEQUEST 1800E

Using

**Microsoft SQL Server 2008 R2
Datacenter Edition**

Using

**Microsoft Windows Server 2008 R2
Datacenter Edition**

TPC-E Version 1.12.0

Submitted for Review

October 26, 2010

First Edition October 2010

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 2008 R2 Datacenter Edition.

The TPC Benchmark™ E tests were run on a PRIMEQUEST 1800E system using the Microsoft Windows Server 2008 R2 Datacenter Edition operating system.

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

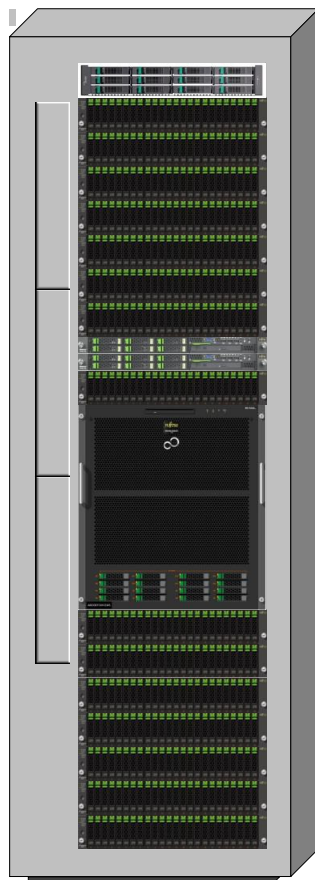| Hardware	Software	Total System Cost	tpsE	$ USD/tpsE	Availability Date
Fujitsu PRIMEQUEST 1800E	Microsoft SQL Server 2008 R2 Datacenter Edition Microsoft Windows Server 2008 R2 Datacenter Edition	$ 1,075,507 USD	3,800.00	$ 283.03 USD	October 1, 2010

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.

	PRIMEQUEST 1800E	TPC-E 1.12.0 TPC Pricing 1.5.0
FUJITSU		Report Date October 26, 2010

TPC-E Throughput **3,800.00 tpsE**	Price/Performance **$ 283.03 USD per tpsE**	Availability Date **October 1, 2010**	Total System Cost **$ 1,075,507**

Database Server Configuration			
Operating System **Microsoft Windows Server 2008 R2 Datacenter Edition**	Database Manager **Microsoft SQL Server 2008 R2 Datacenter Edition**	Processors/Cores/Threads **8/64/128**	Memory **1024 GB**

Tier A (2x)
PRIMERGY RX200 S6
2x Intel Xeon E5640 2.66 GHz
12 GB Memory
1x 73 GB 15K SAS Drive
2x onboard LAN 1 Gb/s
2x Dual Port LAN 1 Gb/s

Tier B
PRIMEQUEST 1800E
8x Intel Xeon X7560 2.26 GHz
1024 GB Memory
2x 146 GB 15K SAS Drives
6x 300 GB 10K SAS Drives
8x onboard LAN 1 Gb/s
15x SAS RAID Controller
1x ETERNUS JX40

Storage
1x PRIMECENTER Rack
14x ETERNUS JX40
336x 64 GB SSD Drives
1x FibreCAT SX40
7x 750 GB 7.2K SATA Drives

Initial Database Size **15,248 GB**	Redundancy Level 1 **RAID-5 data and RAID-10 log**	Storage **336 x 64 GB SSD** **7 x 750 GB 7.2K HDD** **6 x 300 GB 10K HDD**

Description	Part Number	Price Source	Unit Price USD	Qty	Extended Price USD	3-yr. Maint. Price USD
Database Server Hardware						
PRIMEQUEST 1800E		1	261,260.00	1	261,260.00	
PRIMEQUEST 1800E Base Cabinet	MCD3AC211U			1		
System Board	MC-3HSB21			4		
CPU Module (2.26GHz/24M, 8core)	MC-3BAA11			8		
32GB Memory Module (8GB DIMM x4)	MC-3CA611			32		
146GB Hard Disk Drive (15,000rpm)	MC-5DS621			2		
I/O Unit	MC-3HUX11			2		
SAS Disk Unit	MC-5HSC11			1		
SAS RAID Controller Card	MC-0JSR11			15		
FSCJX40_FTS:ETJXS11BG_107478-01		1	2,611.20	1	2,611.20	
ETERNUS JX40	FTS:ETJXS11BG					
JX40 SAS 6G Disk 300GB 10k 2.5"	FTS:ETJSA3MBG	1	399.6	6	2,397.60	
(3-yr. Maint. see below)						
PYRX800 Warranty Uplift, 36 Months, Enhanced Plus Level, 24x7x365 Phone Support (Sev1 - Live Transfer), 24x7x365 Onsite and Parts (Sev1 Resp. Time - 4 Hours), Incl. Holidays, Prepaid billing	PYR800-U004361-0NA	1	8,708.00	1		8,708.00
				Subtotal	266,268.80	8,708.00
Server Storage						
FSCPCTR_S26361-K826-V214_106605-01		1	2,584.00	1	2,584.00	
PRIMECENTER Rack 46U, 1100mm deep	S26361-K826-V214			1		
Dummy panel, plastics, 2U + assembly	S26361-F2735-E131			3		
Socket strip 3phase 3x 8 sockets	S26361-F2262-L31	1	157.25	1	157.25	
PYPCTR Warranty Uplift, 36 Months, Enhanced Plus Level, 24x7x365 Phone Support (Sev1 - Live Transfer), 24x7x365 Onsite and Parts (Sev1 Resp. Time - 4 Hours), Incl. Holidays, Prepaid billing	PYPCTR-U004361-0NA	1	720.00	1		720.00
FSCJX40_FTS:ETJXS11BG_106605-02		1	2,611.20	14	36,556.80	
ETERNUS JX40	FTS:ETJXS11BG			14		
PRIMERGY Rackinstallation SX/DX ex works	D:FCSX-INPSR			14		
SSD SATA 3G 64GB SLC HOT PLUG 2.5" EP	S26361-F3298-L64	1	1,131.35	336	380,133.60	
PYJX40 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	609.00	15		9,135.00
PYJX40 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	15		18,270.00
PYJX40 during normal business hours, Primergy storage installation, One Time billing	PYJX40-N043005-0NA	1	450.00	15		6,750.00
FSCSX40_S26361-K1122-V200_106605-03		1	3,100.80	1	3,100.80	
FibreCAT SX40 SAS Disk Subsystem	S26361-K1122-V200			1		
HD SATA 3Gb/s 750GB 7.2k hot p 3.5" SX40	S26361-F3245-E750			7		
Rack installation ex works, SX10, 1U Nod	S26361-F1647-E302			1		
PYSX40 Warranty Uplift, 36 Months, Enhanced Plus Level, 24x7x365 Phone Support (Sev1 - Live Transfer), 24x7x365 Onsite and Parts (Sev1 Resp. Time - 4 Hours), Incl. Holidays, Prepaid billing	PYSX40-U004361-0NA	1	1,827.00	1		1,827.00
PYSX40 during normal business hours, Primergy storage installation, One Time billing	PYSX40-N043005-0NA	1	450.00	1		450.00
SAS Cable 6Gb 1x SFF 8088-1x SFF 8088 2m	D:KBSAS6G-1S-1S-2M	1	85.00	14	1,190.00	
SAS CBL EXT 2m 8088-8470	S26361-F3246-L203	1	62.90	1	62.90	
				Subtotal	423,785.35	37,152.00

Server Software						
SQL Server 2008 R2 Datacenter Edition Per Processor License	810-00445	2	38,524.00	8	308,192.00	
Windows Server 2008 R2 Datacenter Edition Per Processor License	P71-06367	2	2,310.00	8	18,480.00	
Microsoft Problem Resolution Services	n/a	2	259.00	1		259.00
				Subtotal	326,672.00	259.00
Tier A Client Hardware						
FSCR2S6_S26361-K1342-V101_106605-05		1	4,414.90	2	8,829.80	
PY RX200 S6, 6HD-bays 2.5"	S26361-K1342-V101			2		
Intel Xeon E5640 4C/8T 2.66 GHz 12 MB	S26361-F4419-E266			4		
SP 6GB 3x2 DDR3 1333 MHz PC3-10600 rg s	S26361-F3604-E533			4		
DVD-RW supermulti slimline SATA	S26361-F3269-E2			2		
HD SAS 6G 73GB 15K HOT PLUG 2.5" EP	S26361-F4006-E573			2		
RAID 0/1 SAS based on LSI MegaRAID 4Port	S26361-F3257-E4			2		
Eth Ctrl 2x1Gbit PCIe PRO/1000PT Cu lp	S26361-F3228-E201			4		
Rack installation ex works, SX10, 1U Nod	S26361-F1647-E302			2		
RMK-P_1-2U servers (new)	S26361-F2735-E110			2		
Power Supply Module 450W gold hp	S26113-F570-E1			2		
PYRX200 S6 Warranty Uplift, 36 Months, Enhanced Plus Level, 24x7x365 Phone Support (Sev1 - Live Transfer), 24x7x365 Onsite and Parts (Sev1 Resp. Time - 4 Hours), Incl. Holidays, Prepaid billing	PYR2S6-U004361-0NA	1	550.00	2		1,100.00
PYRX200 S6 during normal business hours, Primergy installation, Low-end Server, w/o OS, One Time billing	PYR2S6-N039005-0NA	1	200.00	2		400.00
				Subtotal	8,829.80	1,500.00
Tier A Client Software						
Windows Server 2008 R2 Standard x64 Edition	P73-04980	2	711.00	2	1,422.00	
Infrastructure or Connectivity						
DISPLAY A19-5 ECO (incl. 2 spares)	S26361-K1339-V140	1	125.80	5	629.00	
KB400 USB US (incl. 2 spares)	S26381-K550-L402	1	15.30	5	76.50	
Mini Optical Mouse (incl. 2 spares)	S26381-K452-L100	1	11.05	5	55.25	
LAN-CAT 5 Enhanced, l=3m	S26361-F3417-L3	1	18.70	8	149.60	
				Total	1,027,888.30	47,619.00

Notes:		**Three-Year Cost of Ownership USD**	$1,075,507
Price Source: 1=Fujitsu 1-408-746-7802 http://www.fujitsu.com/us/, 2=Microsoft Corporation		**TPC-E Throughput**	3,800.00
		$ USD/tpsE	$283.03

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

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 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.

TPC-E 1.12.0
TPC Rev 1.5.0

PRIMEQUEST 1800E

Report Date
October 26, 2010

Availability Date
October 1, 2010

Numerical Quantities Summary				
Reported Throughput:	**3800.00 tpsE**	**Configured Customers:**		**1,900,000**
Response Times (in seconds)	**Minimum**	**Average**	**90th%tile**	**Maximum**
Broker Volume	0.00	0.06	0.10	0.44
Customer Position	0.00	0.05	0.07	2.31
Market Feed	0.00	0.03	0.05	2.25
Market Watch	0.00	0.05	0.09	0.53
Security Detail	0.00	0.02	0.04	0.71
Trade Lookup	0.00	0.13	0.19	0.96
Trade Order	0.00	0.10	0.14	1.69
Trade Result	0.00	0.13	0.18	1.72
Trade Status	0.00	0.03	0.04	1.56
Trade Update	0.01	0.14	0.20	0.89
Data Maintenance	0.00	0.06	N/A	0.37
Transaction Mix		**Transaction Count**		**Mix %**
Broker Volume		13,430,877		4.900%
Customer Position		35,633,507		13.000%
Market Feed		2,741,163		1.000%
Market Watch		49,338,805		18.000%
Security Detail		38,374,736		14.000%
Trade Lookup		21,928,616		8.000%
Trade Order		27,685,008		10.100%
Trade Result		27,411,324		10.000%
Trade Status		52,079,935		19.000%
Trade Update		5,481,999		2.000%
Data Maintenance		120		N/A
Test Duration and Timings				
Ramp-up Time (hh:mm:ss)		00:23:13		
Measurement Interval (hh:mm:ss)		02:00:00		
Business Recovery Time (hh:mm:ss)		00:52:52		
Total Number of Transactions Completed in Measurement Interval		274,105,970		

Table of Contents

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 anytime, 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
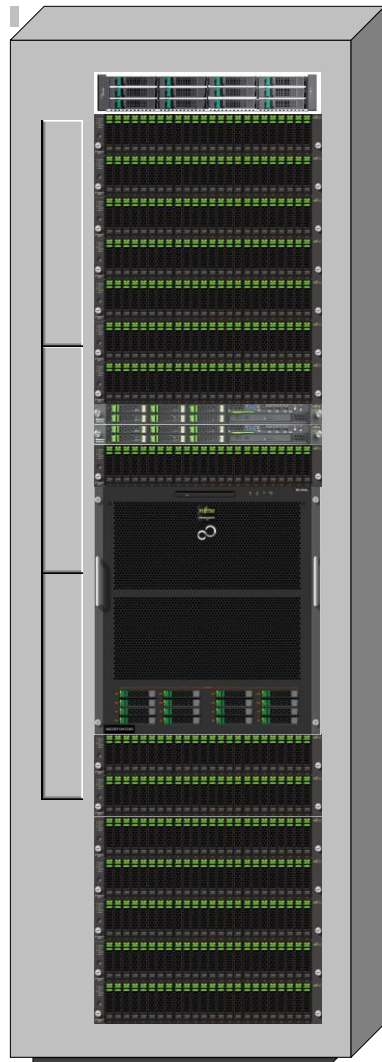
Tier A (2x)
PRIMERGY RX200 S6
2x Intel Xeon E5640 2.66 GHz
12 GB Memory
1x 73 GB 15K SAS Drive
2x onboard LAN 1 Gb/s
2x Dual Port LAN 1 Gb/s

Tier B
PRIMEQUEST 1800E
8x Intel Xeon X7560 2.26 GHz
1024 GB Memory
2x 146 GB 15K SAS Drives
6x 300 GB 10K SAS Drives
8x onboard LAN 1 Gb/s
15x SAS RAID Controller
1x ETERNUS JX40

Storage
1x PRIMECENTER Rack
14x ETERNUS JX40
336x 64 GB SSD Drives
1x FibreCAT SX40
7x 750 GB 7.2K SATA Drives

Figure 1-2: Measured Configuration
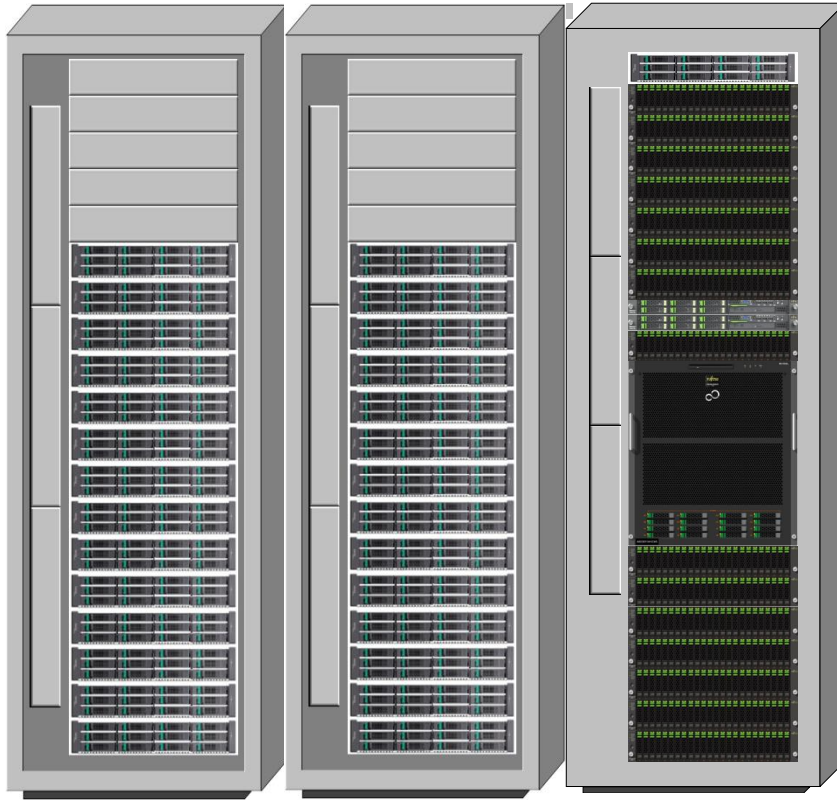
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14x ETERNUS JX40
336x 64 GB SSD Drives
1x FibreCAT SX40
7x 750 GB 7.2K SATA Drives
14x FibreCAT SX40
12x 73 GB 15K SAS Drives
14x FibreCAT SX40
12x 146 GB 15K SAS Drives

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 systems Fujitsu PRIMERGY RX200 S5 are not part of the System Under Test (SUT) and priced configuration. Two systems were connected, each with one Tier A system, using onboard LAN controller and 2x 1 Gb/s Ethernet. There are two LAN segments for these connections per driver – Tier A connection.

Tier A
Two identical systems are used as Tier A. The Tier A server is a Fujitsu PRIMERGY RX200 S6 with two Intel Xeon E5640 Quad-Core Processor and 12 GB of memory. One SAS 73 GB 15K disk drive is connected to the onboard controller. Two 1 Gb/s dual port Ethernet LAN cards are plugged in the PCI-E slots. Each of these four ports are directly connected with one of the 8 1 Gb/s Ethernet onboard LAN ports of Tier B using a LAN crossover cable. There are four LAN segments for these connections per Tier A. The two onboard 1 Gb/s LAN ports are used for driver connection.

Tier B

The Tier B or database server is a Fujitsu PRIMEQUEST 1800E with eight Intel Xeon X7560 Eight-Core Processors and 1024 GB memory. Two of the four 2.5" disk bays are used with 2x SAS 146 GB 15K disk drives and onboard SAS controller. These drives are configured with software RAID1 for OS and database. An ETERNUS JX40 and 6x SAS 300GB 10K disk drives RAID 10 are used for database log. These drives are connected to a (1) LSI MegaRAID SAS9280-8e with 512MB cache. Fourteen (14) RAID controllers LSI MegaRAID SAS9280-8e with 512MB cache are used to connect the external disk drives to the server. The controller cache of all 15 RAID controllers is configured with Write Through. 8 of the 16 onboard 1 Gb/s Ethernet LAN ports are connected to the two Tier A systems as described above. The remaining 8x 1 Gb/s Ethernet ports are not used.

Storage

14 Fujitsu ETERNUS JX40 are used, each with 24x 64GB SSD 2.5" RAID5 and 1 Fujitsu FibreCAT SX40 with 7x 750GB 7.2K HDD 3.5" RAID 5. The enclosures are connected to the LSI MegaRAID SAS9280-8e. 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. Information about changes to the software, settings and BenchCraft can be found in the SupportingFiles directory Introduction - Software.

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 1,900,000 customers. The SQL Server scripts and setup command files are included in the SupportingFiles\Clause2 folder. One file group is used for all tables and indices. The distribution is shown in table 2-1. For creating the database additional storage was assigned to the database (see Figure 1-2 Measured Configuration) and removed at the end before backing up the database.

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 1,900,000 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	13490342	1
ADDRESS	2850004	1
BROKER	19000	1
CASH_TRANSACTION	30205369151	1
CHARGE	15	1
COMMISSION_RATE	240	1
COMPANY	950000	1
COMPANY_COMPETITOR	2850000	1
CUSTOMER	1900000	1
CUSTOMER_ACCOUNT	9500000	1
CUSTOMER_TAXRATE	3800000	1
DAILY_MARKET	1698457500	1
EXCHANGE	4	1
FINANCIAL	19000000	1
HOLDING	1680816025	1
HOLDING_HISTORY	44000459125	1
HOLDING_SUMMARY	94488562	1
INDUSTRY	102	1
LAST_TRADE	1301500	1
NEWS_ITEM	1900000	1
NEWS_XREF	1900000	1
SECTOR	12	1
SECURITY	1301500	1
SETTLEMENT	32832000000	1
STATUS_TYPE	5	1
TAXRATE	320	1
TRADE	32832000000	1
TRADE_HISTORY	78796796253	1
TRADE_REQUEST	0	1
TRADE_TYPE	5	1
WATCH_ITEM	190008342	1
WATCH_LIST	1900000	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	Windows Crtl#	Windows Disk#
Crtl 0	0 – onboard	2x146GB 15K SAS,SW-RAID1	C:\	136 GB	OS, DB	0	0,1
Crtl 1	1 – onboard	6x300GB 10K SAS, RAID10	L:\	837 GB	DB Log	5	14
Crtl 2 Port 0	2 – JX40	24x64GB SSD, RAID5	C:\jp\tpce01	1360 GB	Filegroup1	7	19
Crtl 2 Port 1	3 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help01	1635 GB	DB setup Backup		20
	4 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help02	814 GB	DB setup Backup		21
Crtl 3 Port 0	5 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce02	1360 GB	Filegroup1	6	15
Crtl 3 Port 1	6 – SX40	7x750GB, 7.2K SATA, RAID5	C:\jp\addsize	4188 GB	DB Data		16
	7 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help04	814 GB	DB setup Backup		17
	8 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help04	814 GB	DB setup Backup		18
Crtl 4 Port 0	9 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce03	1360 GB	Filegroup1	13	37
Crtl 4 Port 1	10 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help05	1635 GB	DB setup Backup		38
	11 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help06	814 GB	DB setup Backup		39
Crtl 5 Port 0	12 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce04	1360 GB	Filegroup1	8	22
Crtl 5 Port 1	13 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help07	1635 GB	DB setup Backup		23
	14 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help08	814 GB	DB setup Backup		24
Crtl 6 Port 0	15 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce05	1360 GB	Filegroup1	12	34
Crtl 6 Port 1	16 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help09	1635 GB	DB setup Backup		35
	17 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help10	814 GB	DB setup Backup		36
Crtl 7 Port 0	18 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce06	1360 GB	Filegroup1	14	40
Crtl 7 Port 1	19 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help11	1635 GB	DB setup Backup		41
	20 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help12	814 GB	DB setup Backup		42
Crtl 8 Port 0	21 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce07	1360 GB	Filegroup1	3	8
Crtl 8 Port 1	22 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help13	1635 GB	DB setup Backup		9
	23 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help14	814 GB	DB setup Backup		10

HBA - Port	Disk	Drives	Partition	Size	Use	Windows Crtl#	Windows Disk#
Crtl 9 Port 0	24 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce08	1360 GB	Filegroup1	2	5
Crtl 9 Port 1	25 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help15	1635 GB	DB setup Backup		6
	26 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help16	814 GB	DB setup Backup		7
Crtl 10 Port 0	27 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce09	1360 GB	Filegroup1	1	2
Crtl 10 Port 1	28 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help17	1635 GB	DB setup Backup		3
	29 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help18	814 GB	DB setup Backup		4
Crtl 11 Port 0	30 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce10	1360 GB	Filegroup1	15	43
Crtl 11 Port 1	31 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help19	1635 GB	DB setup Backup		44
	32 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help20	814 GB	DB setup Backup		45
Crtl 12 Port 0	33 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce11	1360 GB	Filegroup1	11	31
Crtl 12 Port 1	34 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help21	1635 GB	DB setup Backup		32
	35 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help22	814 GB	DB setup Backup		33
Crtl 13 Port 0	36 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce12	1360 GB	Filegroup1	10	28
Crtl 13 Port 1	37 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help23	1635 GB	DB setup Backup		29
	38 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help24	814 GB	DB setup Backup		30
Crtl 14 Port 0	39 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce13	1360 GB	Filegroup1	9	25
Crtl 14 Port 1	40 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help25	1635 GB	DB setup Backup		26
	41 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help26	814 GB	DB setup Backup		27
Crtl 15 Port 0	42 – JX40	24x64GB, SSD, RAID5	C:\jp\tpce14	1360 GB	Filegroup1	4	11
Crtl 15 Port 1	43 – SX40	12x146GB, 15K SAS, RAID0	C:\jp\help27	1635 GB	DB setup Backup		13
	44 – SX40	12x73GB, 15K SAS, RAID0	C:\jp\help28	814 GB	DB setup Backup		14

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 2008 R2 Datacenter 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 PRIMEQUEST 1800E has 16x onboard Ethernet 1 Gb/s ports. Eight ports are disabled and 8x Ethernet 1 Gb/s ports are connected with two Tier A systems.
Each of the two Tier A systems PRIMERGY RX200 S6 has an onboard Ethernet controller with two 1 Gb/s ports used for driver system connection. Each Tier A system was extended with two dual-port 1 Gb/s Ethernet controller cards. All of these four ports were directly connected with four of the eight onboard ports of Tier B using different LAN segments. The second Tier A system is connected to the other four ports of Tier B.

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 1.12.0.

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).

There were no modifications to the EGen. EGenLoader was not extended for this benchmark.

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).

Two Tier A systems were used and configured to drive 8 EGenDriverMEE and 8 EGenDriverCE instances each. The total numbers are 16 EGenDriverMEE and 16 EGenDriverCE instances.
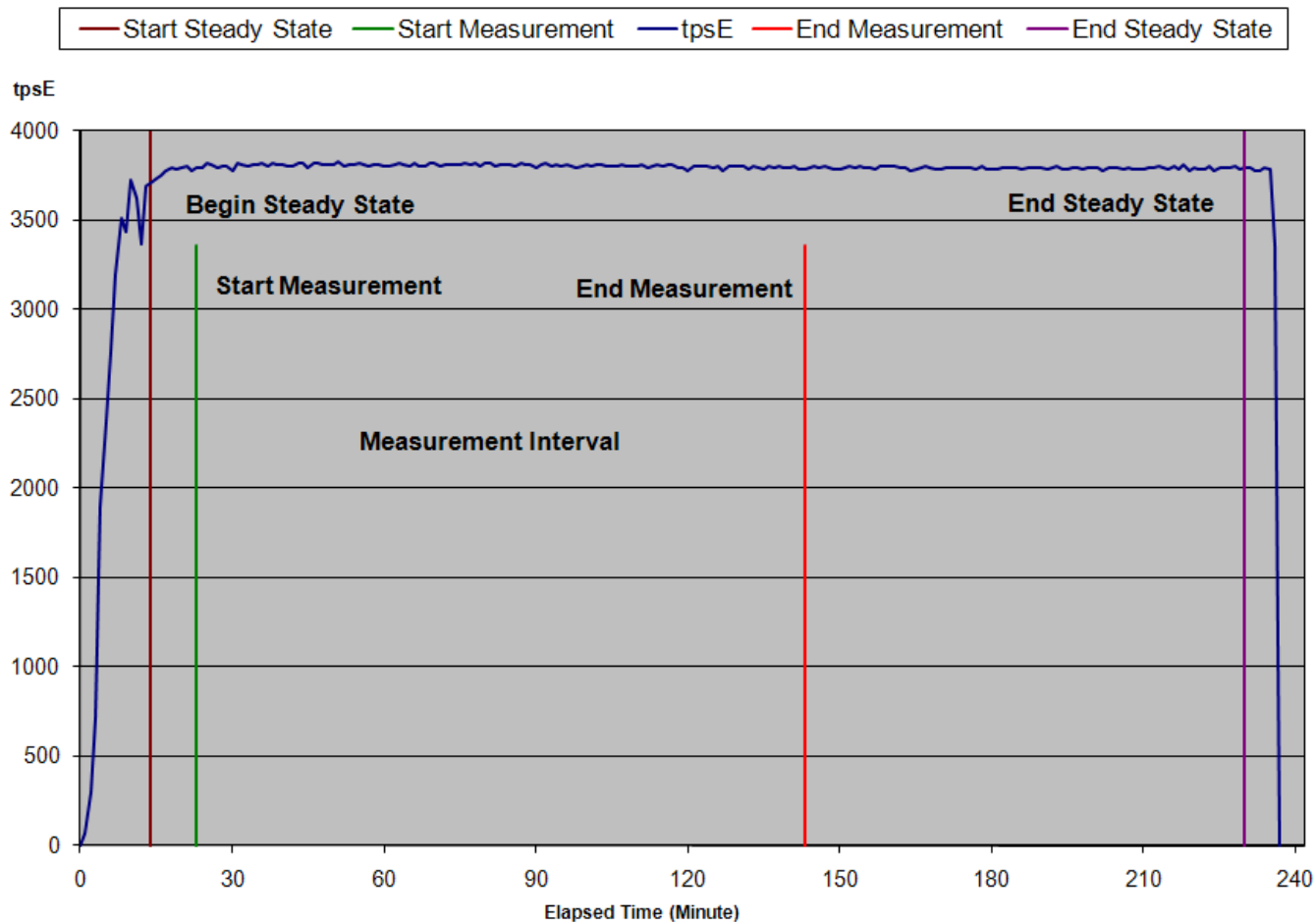
Measured Throughput

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

The measured throughput was 3807.12 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.
4. Two completed full checkpoints.

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 (420 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%	50.00%	Ok
	Get History	48.00%	52.00%	50.00%	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%	29.98%	Ok
	Frame 2	28.50%	31.50%	29.99%	Ok
	Frame 3	28.50%	31.50%	30.02%	Ok
	Frame 4	9.50%	10.50%	10.00%	Ok
	Overall				Ok
Trade Update	Frame 1	31.00%	35.00%	33.00%	Ok
	Frame 2	31.00%	35.00%	33.00%	Ok
	Frame 3	32.00%	36.00%	34.00%	Ok
	Overall				Ok
Trade Order	By Non-Owner	9.50%	10.50%	9.99%	Ok
	By Company Name	38.00%	42.00%	40.00%	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%	25.02%	Ok
	Trade Qty 400	24.00%	26.00%	25.00%	Ok
	Trade Qty 800	24.00%	26.00%	24.99%	Ok
	Market Buy	29.70%	30.30%	29.99%	Ok
	Market Sell	29.70%	30.30%	30.01%	Ok
	Limit Buy	19.80%	20.20%	20.00%	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.
3. Induce the failure described for the redundancy level being demonstrated. In this case fail a disk in a database data array. The transactions continue since RAID5 used for at least 5 minutes above 95% of reported throughput.
4. Induce the failure described for the redundancy level being demonstrated. In this case fail a disk in the database log array. The transactions continue since RAID10 is used for at least 5 minutes.
5. Begin the necessary recovery process, by replacing the failed drives in the database data array and start the rebuild process.
6. Begin the necessary recovery process, by replacing the failed drives in the database log array and start the rebuild.
7. Continue running the Driver for at least 20 minutes with throughput above 95% of reported throughput.
8. Terminate the run gracefully from the Driver.
9. Wait until rebuild process has finished.
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 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
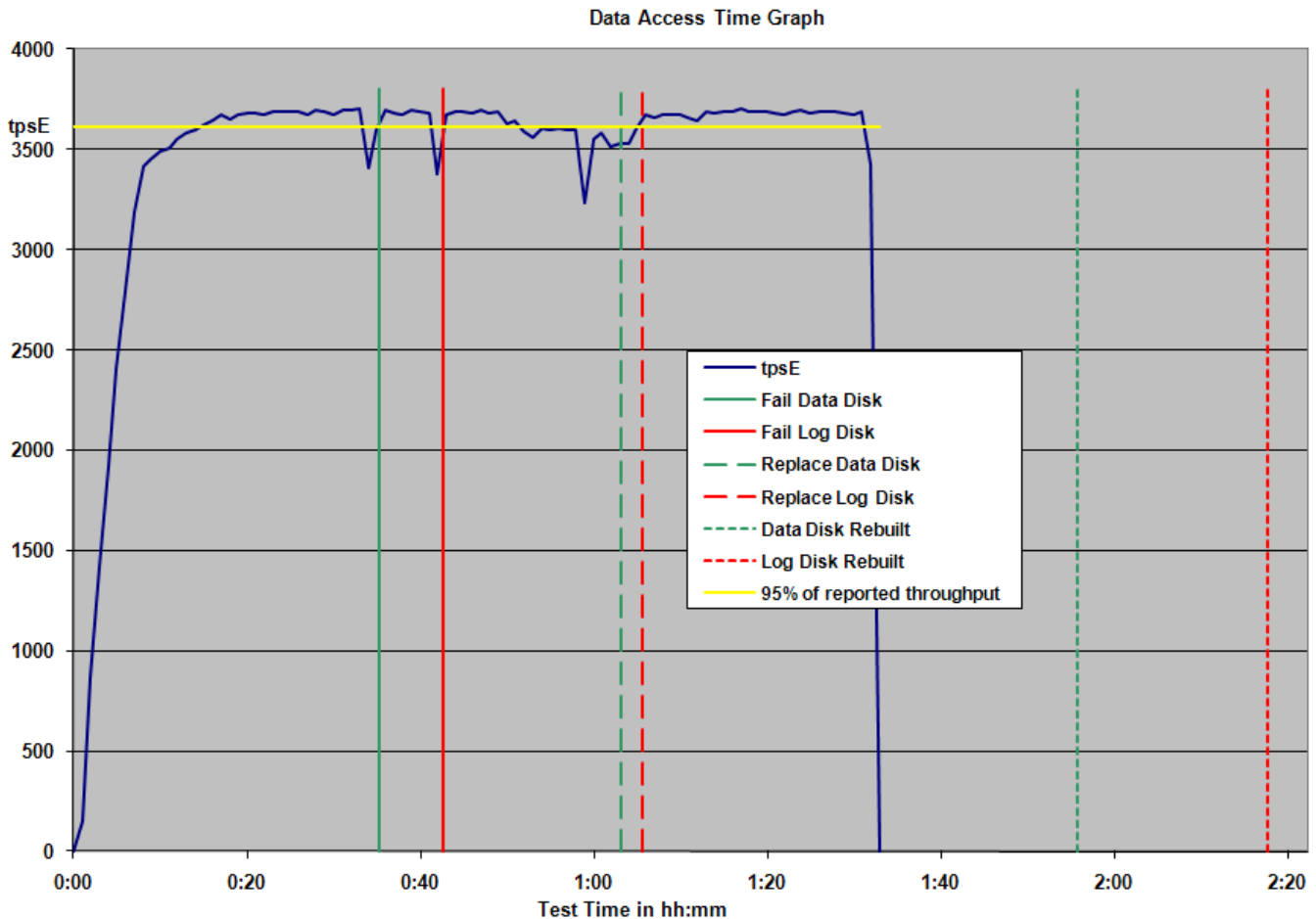
Business Recovery

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 00:38:24 (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 00:14:28 (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 00:52:52 (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
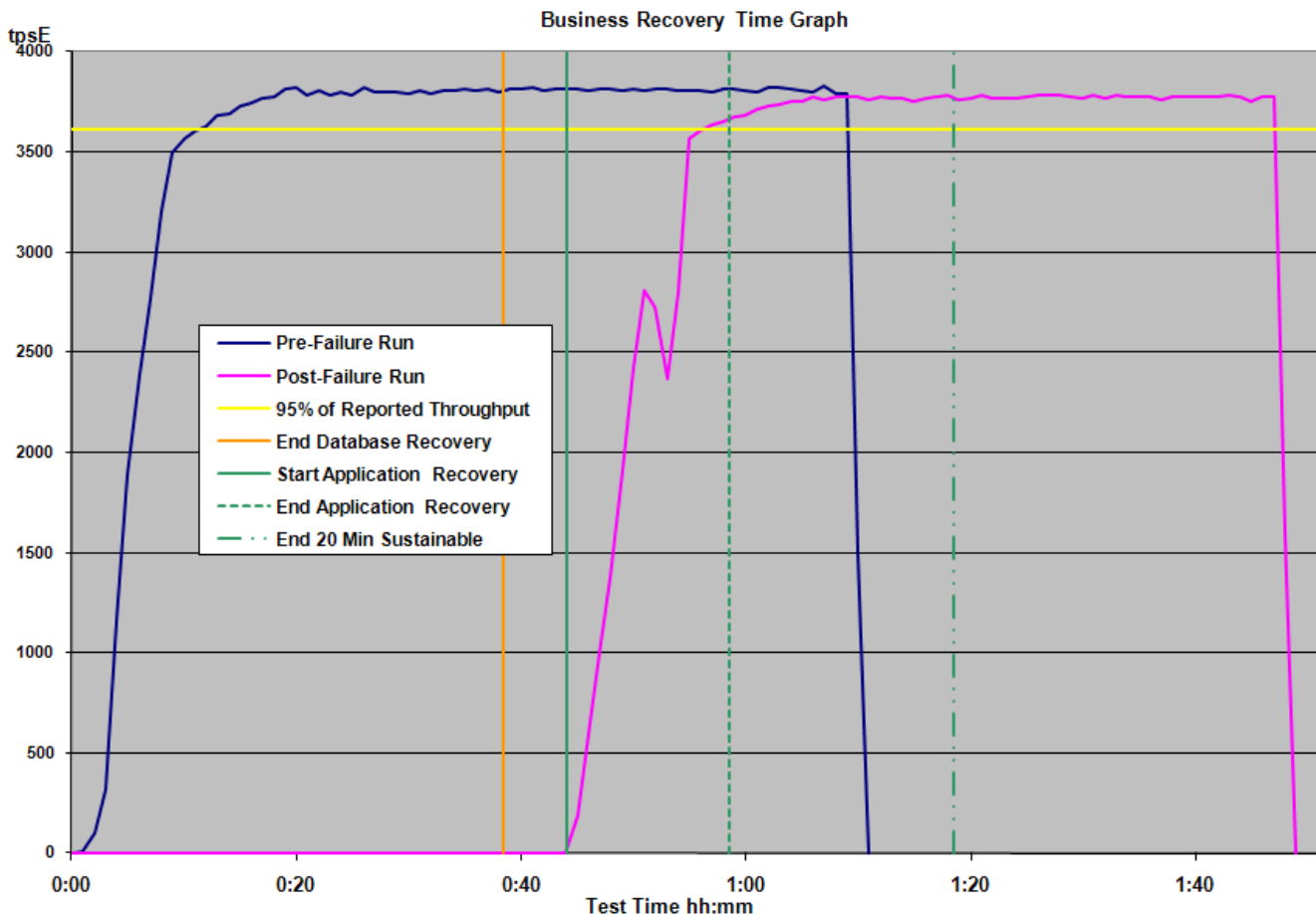
Clause 8: Pricing Related Items

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

Table	Initial Rows	Data (KB)	Index size (KB)	Extra 5% (KB)	initinal size Total + 5% (KB)	grow size After run (KB)	Growth (KB)
				TPC-E Disk Space Requirements			
Customers Used	1,900,000						
Performance	3800.00	TpsE	settlements after 8 hours (Busines Day)			109,440,000	
ACCOUNT_PERMISSION	13490342	743056	6424	37474	786954	749584	104
ADDRESS	2850004	164592	2520	8356	175468	167184	72
BROKER	19000	1392	1592	149	3133	2984	0
CASH_TRANSACTION	30205369151	3133816768	6607808	157021229	3297445805	3149892080	9467504
CHARGE	15	8	8	1	17	16	0
COMMISSION_RATE	240	16	16	2	34	32	0
COMPANY	950000	202728	59240	13098	275066	262000	32
COMPANY_COMPETITOR	2850000	76744	64640	7069	148453	141384	0
CUSTOMER	1900000	311608	85368	19849	416825	396992	16
CUSTOMER_ACCOUNT	9500000	861088	186288			1047376	0
CUSTOMER_TAXRATE	3800000	79456	2368	4091	85915	82000	176
DAILY_MARKET	1698457500	79572480	233864	3990317	83796661	79808032	1688
EXCHANGE	4	8	8	1	17	16	0
FINANCIAL	19000000	2141344	8432	107489	2257265	2150192	416
HOLDING	1680816025	112282800	71213392	9174810	192671002	186690032	3193840
HOLDING_HISTORY	44000459125	1600017216	924808488	126241285	2651066989	2535458600	10632896
HOLDING_SUMMARY	94488562	4137512	17496	207750	4362758	4155008	0
INDUSTRY	102	8	24	2	34	32	0
LAST_TRADE	1301500	81368	2432	4190	87990	83800	0
NEWS_ITEM	1900000	206116032	6440			206122472	0
NEWS_XREF	1900000	47600	2288	2494	52382	49888	0
SECTOR	12	8	24	2	34	32	0
SECURITY	1301500	180376	49656	11502	241534	230056	24
SETTLEMENT	32832000000	1565556456	3307816	78443214	1647307486	1574147144	5282872
STATUS_TYPE	5	8	8	1	17	16	0
TAXRATE	320	24	16	2	42	56	16
TRADE	32832000000	3919203336	1975147040	294717519	6189067895	5916666864	22316488
TRADE_HISTORY	78796796253	2369828952	6179952	118800445	2494809349	2385653384	9644480
TRADE_REQUEST	0	8	56	3	67	329736	329672
TRADE_TYPE	5	8	1032	52	1092	1040	0
WATCH_ITEM	190008342	5325744	21832	267379	5614955	5347912	336
WATCH_LIST	1900000	47576	40728	4415	92719	88304	0
ZIP_CODE	14741	488	96	29	613	584	0

		Initial Database Size			Settlements	52,772,831
		15,614,115 (MB)			Grown Database Size	
		15,248 (GB)			15,673,559 (MB)	

DB filegroups	partition size (MB)	file size (MB)	alloc total (MB)	loaded (MB)	loaded +5% (MB)	after run (MB)	Business Day (MB)
14	1,392,512	1,390,000	19,495,168	15,614,115	16,394,821	15,673,559	15,737,390
		Number of disks	336				
		Disk Capacity (MB)	60,544				
		RAID5 Overhead	4%				

Initial Growing Space (MB)	15,324,341	Total Space (MB)	19,495,168				
Final Growing Space (MB)	15,383,782	Number of disks	7	Initial Log Size (MB)	15,709	Log units	1
Delta (MB)	59,441	Disk Capacity (MB)	714,880	Final Log Size (MB)	363,729	Disks per unit	6
Data Space per Trade (MB	0.001126	RAID5 Overhead	14%	Log Growth (MB)	348,021	Disk Capacity (MB)	285,568
1 Day Data Growth (MB)	123,269	Total Space (MB)	4,289,280	Log Space per Trade	0.006595	RAID10 Overhead	50.0%
60 Day Space (MB)	23,010,241	Total Space (MB)	23,784,448	1 Day Log Space (MB	721,723	Log Space (MB)	856,704

Attestation Letter

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

INFO S SIZING

TPC CERTIFIED AUDITOR

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

October 20, 2010

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

Platform:	PRIMEQUEST 1800E
Operating System:	Microsoft Windows Server 2008 R2 Datacenter Edition
Database Manager:	Microsoft SQL Server 2008 R2 Datacenter Edition

The results were:

CPU's Speed	Memory	Disks	Trade-Result 90% Response Time	tpsE
Tier B, Server: PRIMEQUEST 1800E				
8 x Intel Xeon X7560 (2.26GHz)	1024 GB (8 x 24 MB L3)	336 x 64GB SSD 7 x 750GB 7.2K SATA 6 x 300GB 10K SAS	0.18 Seconds	3800.00 (3807.12)
Tier A, Two Clients: PRIMERGY RX200 S6				
2 x Intel Xeon E5640 (2.66 GHz)	12 GB (2 x 12 MB L3)	1 x 73 GB 15K SAS	n/a	n/a

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 v1.12.0.

* The transactions were correctly implemented.

* The database was properly scaled and populated for 1,900,000 customers.

* The mandatory network between the driver and the SUT was configured.

* The ACID properties were met.

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- 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 representative of steady state conditions.

- The reported measurement interval was 120 minutes.

- The implementation used Redundancy Level 1.

- The Business Recovery Time of 00:52:52 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_TierA1.txt SysInfo_TierA2.txt SysInfo_TierB.txt
	Disk Configuration	SupportingFiles/Introduction/Hardware/	DiskConfiguration.doc flatfilelocations.txt makehelpdirff.cmd Readme.txt Remove_Addon_Files.sql tempdb28.sql
	Parameter OS Tunables Database Setup	SupportingFiles/Introduction/Software/	CountOperations.reg MemoryMamagement.reg MSTPCE Database Setup Reference.docx set128CPU.sql SQL_IP.reg SQL_Nodes.reg SQL_Server_Configuration.ver sqlservr_LargePages.reg
	Startup Scripts Tier A	SupportingFiles/Introduction/Software/	start_all_PQ1800E-1.cmd start_all_PQ1800E.cmd start_CE1_PQ1800E.cmd start_CE2_PQ1800E.cmd … start_CE16_PQ1800E.cmd start_MEE1_PQ1800E.cmd start_MEE2_PQ1800E.cmd … start_MEE16_PQ1800E.cmd
	Startup Scripts Tier B	SupportingFiles/Introduction/Software/	sqlstartR2.cmd
Clause 2	Create Database	SupportingFiles/Cause2	Backup_Database.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 SQL_Server_Configuration.sql tempdb28.sql

			TPCE_Setup.cmd Trade_Cleanup.cmd Trade_Cleanup.sql Version.sql
	Create Database output	SupportingFiles/Cause2/DB_setup	1900000Customers_Load_Timer2.log 1050000Customers_Load_Timer3.log 1050000Customers_Load_Timer.log Backup_Database.log BrokerVolume.log BulkInsert_1.out … BulkInsert_112.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_Build_Steps1.log DB_Build_Steps2.log DB_Build_Steps3.log DB_Check.log DB_FK_Constraints.log DB_Primary_Key_Check.log DB_RI_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 EGenLoaderFrom1To17000.log EGenLoaderFrom17001To34000.log …. EGenLoaderFrom1883001To1900000.log ERRORLOG.txt FK_Constraints.log Get_Next_T_ID.log Insert_Duplicates_Tests.log Load_Timer.log Load_Timer_Proc.log Load_TPCE_Info.log MarketFeed.log MarketWatch.log Referential_Integrity_Tests.log Remove_Addon_Files.sql RemoveDB.log SecurityDetail.log spfiles.ver spfiles_setup.ver splog.ver spused.ver spused_setup.ver SQL_Server_Configuration.log Tables_Fixed.log Tables_Growing.log Tables_Scaling.log TPCE_Types.log TPCE_VERSIONS1.log TPCE_VERSIONS2.log TPCE_VERSIONS3.log

			TradeLookup.log TradeOrder.log TradeResult.log TradeStatus.log TradeUpdate.log Version1.log Version2.log Version3.log
	Index Creation Scripts	SupportingFiles/Cause2/DDL	BulkInsert_<1..112>.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.sql Create_Indexes_Growing.sql Create_Indexes_Scaling.sql Create_Tables_Fixed.sql Create_Tables_Growing.sql Create_Tables_Scaling.sql Create_Tables_Scaling_Flat.sql Create_TPCE_Types.sql Drop_FK_Constraints.sql Drop_Tables_Fixed.sql Drop_Tables_Growing.sql Drop_Tables_Scaling.sql
	Database Audit Scripts	SupportingFiles/Cause2/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/Cause2/Audit_Scripts/ Space	SPFiles.sql SPLog.sql SPUsed.sql
Clause3	Transaction Frames	SupportingFiles/Cause3	BrokerVolume.sql CustomerPosition.sql DataMaintenance.sql MarketFeed.sql MarketWatch.sql SecurityDetail.sql TradeLookup.sql TradeOrder.sql TradeResult.sql TradeStatus.sql TradeUpdate.sql
	BaseServer	SupportingFiles/Cause3/BaseServer	BaseServer.cpp BaseServer.h BaseServer.vcproj stdafx.cpp stdafx.h SUTServersLocals.h
	SUT_CE_Server	SupportingFiles/Cause3/SUT_CE_Server	Release\SUT_CE_Server.exe CEServer.cpp CEServer.h CEServerMain.cpp PortDefinitions.h stdafx.cpp stdafx.h SUT_CE_Server.vcproj SUTServer.sln SUTStructs.h
	SUT_MEE_Server	SupportingFiles/Cause3/SUT_MEE_Server	Release\SUT_MEE_Server.exe MEEServer.cpp MEEServer.h MEEServerMain.cpp stdafx.cpp stdafx.h SUT_MEE_Server.vcproj

	TransactionsSP	SupportingFiles/Cause3/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 TxnHarnessDBBase.cpp TxnHarnessDBBase.h TxnHarnessDBConn.cpp TxnHarnessDBConn.h
	TxnHarness	SupportingFiles/Cause3/TxnHarnes	TxnHarness.vcproj TxnHarness_stdafx.cpp TxnHarness_stdafx.h TxnHarnessSendToMarket.cpp TxnHarnessSendToMarket.h
Clause4			
Clause5	EGen Driver Configuration	SupportingFiles/Cause5	PQ1800E_1900KCus_125_101_spiderab_16_16.xml
	EGenLoader Parameter	SupportingFiles/Cause5	BuildSteps1.log BuildSteps2.log BuildSteps3.log EGenLoaderFrom1To17000.log EGenLoaderFrom17001To34000.log …. EGenLoaderFrom1883001To1900000.log
	EGenLogger Output	SupportingFiles/Cause5	TxnReportE-MI.xls
Clause6	EGenValidate	SupportingFiles/Cause6	EGenValidate.txt
Clause7	ACID	SupportingFiles/Cause7	MSTPCE ACID Procedures.docx
	ACID Procedures	SupportingFiles/Cause7/AcidProcs	AcidProc.cmd AcidProc.out Remove_AcidProcs.cmd
	ACID Scripts	SupportingFiles/Cause6/AcidProcs/Scripts	AcidProc.vbs CustomerPosition_Iso3.sql CustomerPosition_Iso4.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/Cause7/Atomicity	Atomicity.cmd Atomicity_C.out Atomicity_RB.out
		SupportingFiles/Cause7/Atomicity/Scripts	atom.vbs Atomicity_C.sql Atomicity_RB.sql
	Consistency	SupportingFiles/Cause7/Consistency	Consistency.cmd Consistency.out
		SupportingFiles/Cause7/Consistency/Scripts	Consistency.sql Consistency.vbs
	Durability Business Recovery	SupportingFiles/Cause7/Durability/BusinessRecovery	BR_BenchCraft_Config.xml BR_Consistency.out BR_Count_Settlement1.ver BR_Count_Settlement2.ver BR_ERRORLOG_1.txt BR_ERRORLOG_2.txt BR_Systemevents_TierA1.txt BR_Systemevents_TierA2.txt 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/Cause7/Durability/DataAccessibility	DA_BenchCraft_Config.xml DA_Count_Settlement1.ver DA_Count_Settlement2.ver DA_ERRORLOG.txt DataAccess_TimeGraph.xls DataAccess_TxnReportE_5min.xlsx DataAccess_TxnReportE_20min.xlsx DataAccess_TxnReportE_all.xlsx SystemEvents_Application.txt
	Isolation	SupportingFiles/Cause7/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/Cause7/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/Cause8	tpce_space.xls

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

October 11, 2010

Fujitsu Technology Solutions
Detlev Seidel
Heinz Nixdorf Ring 1
Paderborn, DE 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
810-00445	**SQL Server 2008 R2 Datacenter Edition** *Per Processor License* *Open Program - Level C* *Unit Price reflects a 33% discount from the retail unit price of $57,498.*	$38,524	8	$308,192
P71-06367	**Windows Server 2008 R2 Datacenter Edition** *Per Processor License* *Open Program - Level C* *Unit Price reflects a 23% discount from the retail unit price of $2,999.*	$2,310	8	$18,480
P73-04980	**Windows Server 2008 R2 Standard Edition** *Server License with 5 CALs* *Open Program - Level C* *Unit Price reflects a 31% discount from the retail unit price of $1,029.*	$711	1	$711
N/A	**Microsoft Problem Resolution Services** *Professional Support* *(1 Incident).*	$259	1	$259

SQL Server 2008 R2 Datacenter Edition, Windows Server 2008 R2 Datacenter Edition, and Windows Server 2008 R2 Standard Edition are currently orderable and available through Microsoft's normal distribution channels. A list of Microsoft's resellers can be found at the Microsoft Product Information Center at
http://www.microsoft.com/products/info/render.aspx?view=22&type=how

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

This quote is valid for the next 90 days.

Reference ID: TPCE_g3wOpiq6ZAtcuc3lVxlLx0NniOh1gu4y_V1.0.0.