TPC Benchmark^{TM} E
Full Disclosure Report

for

IBM® System x® 3650 M2

using

Microsoft® SQL Server 2008

Enterprise x64 Edition

and

Microsoft Windows® Server 2008

Enterprise x64 Edition

TPC-E Version 1.7.0

Submitted for Review
July 14, 2009

IBM Corporation

First Edition – July 2009

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Notes

[1] GHz and MHz only measures microprocessor internal clock speed, not application performance. Many factors affect application performance.

[2] When referring to hard disk capacity, GB, or gigabyte, means one thousand million bytes. Total user-accessible capacity may be less.

Abstract

IBM Corporation conducted the TPC Benchmark^{TM} E on the IBM® System x3650 M2 configured as a client/server system. This report documents the full disclosure information required by the TPC Benchmark E Standard Specification, Revision 1.7.0, including the methodology used to achieve the reported results. All testing fully complied with this revision level.
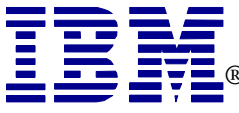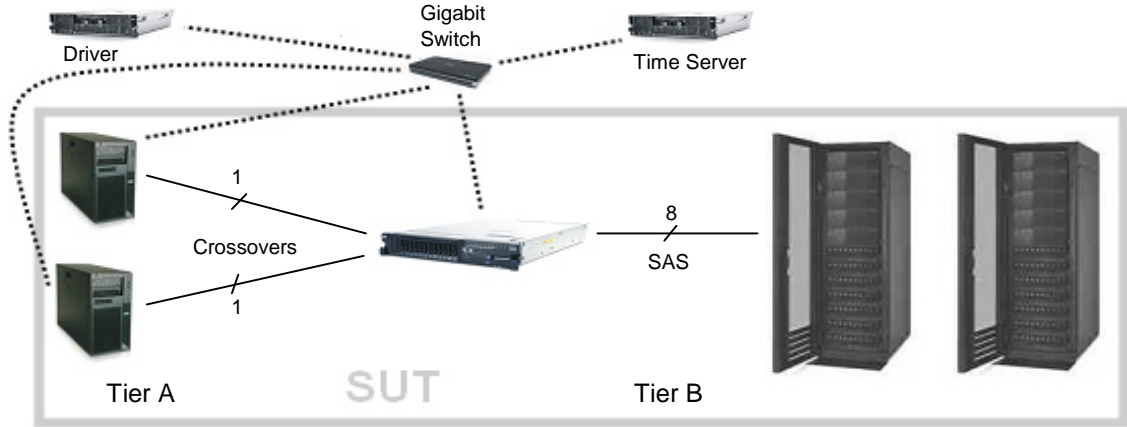
The software used on the IBM System x3650 M2 system included Microsoft® Windows® Server 2008 Enterprise x64 Edition and Microsoft SQL Server 2008 Enterprise x64 Edition.

Standard metrics, transactions per second-E (tpsE), price per tpsE ($/tpsE) and Availability Date, are reported as required by the TPC Benchmark E Standard Specification.

The benchmark results are summarized in the following table:

Hardware	Software	Total System Cost	tpsE	$ USD /tpsE	Total Solution Availability Date
IBM System x3650 M2	Microsoft SQL Server 2008 Enterprise x64 Edition (SP1) Microsoft Windows Server 2008 Enterprise x64 Edition	$260,792 USD	817.15	$319.15 USD	July 31, 2009

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

IBM®	IBM® System x® 3650 M2 Microsoft® SQL Server 2008	TPC-E 1.7.0 TPC Pricing 1.4.0
		Report Date: July 14, 2009

TPC-E Throughput	Price/Performance	Availability Date	Total System Cost
817.15 tpsE	**$319.15 USD per tpsE**	**July 31, 2009**	**$260,792 USD**

Database Server Configuration				

Operating System	Database Manager	Processors/Cores/ Threads	Memory
Microsoft Windows Server 2008 Enterprise x64 Edition	**Microsoft SQL Server 2008 Enterprise x64 Edition (SP1)**	**2/8/16**	**96GB**

Driver — Gigabit Switch — Time Server

1 Crossovers 1

8 SAS

Tier A — SUT — Tier B

2 x IBM x3200 M2
Each contains:
 - 1 x Quad-Core Intel Xeon
   Processor X3360 2.83GHz
   (1 Proc/4 Cores/4 Threads)
 - 2GB Memory
 - 2 x 73GB 15K SAS (RAID-1)
 - Onboard RAID Controller
 - Onboard Gigabit Ethernet
 - 1 x NetXtreme II 1000 Express

IBM System x3650 M2
 - 2 x Intel Xeon Processor
   X5570 2.93GHz
   (2 Procs/8 Cores/16 Threads)
 - 96GB Memory
 - 8 x 300GB 10K SATA (RAID-1)
 - 4 x IBM ServeRAID-MR10M
   SAS Controller
 - 1 x IBM ServeRAID-MR10i
   SAS Controller
 - Onboard Gigabit Ethernet
 - 1 x Ethernet Daughter Card

32 x IBM System Storage
EXP3000 Enclosure
Each contains:
 - 12 x 73GB 15K SAS

= 16 x 24-drive RAID-10
384 Total External Drives

Initial Database Size **3,163 GB**	Redundancy Level: **1** **RAID-10 Log & Data**	Storage **384 x 73.4 GB** **8 x 300 GB**
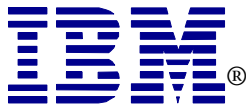
IBM System x3650 M2
Microsoft SQL Server 2008

TPC-E 1.7.0
TPC Pricing 1.4.0

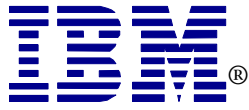Report Date:
July 14, 2009

Availability Date:
July 31, 2009

Description	Part Number	Price Source	Unit Price	Quantity	Extended Price	3-Yr. Maint. Price
Server Hardware						
x3650 M2 with 1 x Intel Xeon Processor X5570 (2.93GHz / 1MB L2 Cache / 8MB L3 Cache) 2x 2GB Memory	794792U	1	4,379	1	4,379	
Dual port 1Gb Ethernet Daughter Card	46M1076	1	89	1	89	
Intel Xeon Processor X5570 (2.93GHz/1MB L2/8MB L3 Cache)	46M1087	1	2,135	1	2,135	
8GB (1X8GB) Dual Rank PC3-8500 CL7 ECC DDR3-1066 LP RDIMM	46C7449	1	1,049	12	12,588	
300GB 10K SFF SATA	43W7666	1	499	8	3,992	
IBM ServeRAID-MR10M SAS/SATA Controller	44E8825	1	899	4	3,596	
IBM Preferred Pro USB Keyboard	40K9584	1	29	1	29	
IBM 3-Button Optical Mouse - Black - USB	40K9201	1	19	1	19	
ServicePac for 3-Year 24x7x4 Support (x3650 M2)	21P2078	1	600	1		600
Acer V173 b Black 17" 5ms LCD Monitor (2 spares)	V173b	3	120	3	360	
				Subtotal	27,187	600
Server Storage						
IBM S2 42U Standard Rack	93074RX	1	1,489	2	2,978	
IBM System Storage EXP3000 Enclosure	1727-01X	1	3,199	32	102,368	
IBM 1M SAS cable	39R6529	1	119	28	3,332	
IBM 3M SAS cable	39R6531	1	135	4	540	
IBM Hot-Swap 3.5 inch 73.4GB 15K SAS HDD	43W7523	1	309	384	118,656	
ServicePac for 3-Year 24x7x4 Support (EXP3000)	41L2768	1	760	32		24,320
ServicePac for 3-Year 24x7x4 Support (Rack)	41L2760	1	300	2		600
				Subtotal	227,874	24,920
Server Software						
Microsoft SQL Server 2008 Enterprise x64 Edition	810-07509	2	24,999	2	49,998	
Microsoft Windows Server 2008 Enterprise x64 Edition	P72-03195	2	3,999	1	3,999	
Microsoft Problem Resolution Services	N/A	2a	245	1		245
				Subtotal	53,997	245
Client Hardware						
x3200 M2 with Intel Xeon X3360 (2.83GHz/12MB L2 Cache) 1GB (2x512GB) PC2-6400 CL6 ECC DDR2 800MHz	436776U	1-S	1,519	2	3,038	
1GB (2x512MB) PC2-6400 CL6 ECC DDR2 800MHz DIMM	46C7443	1-S	115	2	230	
73GB 15K 2.5" SFF Hot-Swap SAS	43X0837	1-S	369	4	1,476	
NetXtreme II 1000 Express Ethernet Adapter	39Y6066	1	169	2	338	
ServicePac for 3-Year 24x7x4 Support (x3200 M2)	51J9054	1	399	2		798
				Subtotal	5,082	798
Client Software						
Microsoft Windows Server 2008 Standard x64 Edition	P73-04190	2	999	2	1,998	
				Subtotal	1,998	0
Infrastructure						
Ethernet Crossover Cable (2 spares)	RCW-717	3	2	4	8	
				Subtotal	8	0
				Total	316,146	26,563
Dollar Volume Discount (See Note 1)		27.11%	1		77,551	
Microsoft Open Program Discount Schedule		7.80%	2		4,366	

Pricing: 1 - IBM - 1-800-656-0833 x35330; 2 - Microsoft; 3 - newegg.com			
Note 1: Discount applies to all line items where Pricing=1; pricing is for these or similar quantities.	**Three-Year Cost of Ownership USD:**		$260,792
Discounts for similarly sized configurations will be similar to what is quoted here, but may vary based	**TPC-E Throughput:**		817.15
on the components in the price quotation	**$ USD/tpsE:**		$319.15
S: One or more components of the measured configuration have been substituted in the priced			
configuration. See the FDR for details.			
* These components are not immediately orderable. See the FDR for more information.			

Implementation and results 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 specifications. If you find that stated prices are not available according to these terms, please inform the TPC at pricing@tpc.org. Thank you.

IBM®	IBM System x3650 M2 Microsoft SQL Server 2008	TPC-E 1.7.0 TPC Pricing 1.4.0
		Report Date: July 14, 2009
		Availability Date: July 31, 2009

Numerical Quantities Summary				
Reported Throughput: 817.15 tpsE		**Configured Customers: 409,000**		
Response Time (in seconds)	**Minimum**	**Average**	**90Th Percentile**	**Maximum**
Broker-Volume	0.00	0.03	0.06	1.12
Customer-Position	0.00	0.03	0.06	4.76
Market-Feed	0.00	0.04	0.14	4.74
Market-Watch	0.00	0.02	0.05	0.90
Security-Detail	0.00	0.02	0.03	0.95
Trade-Lookup	0.00	0.60	0.78	9.07
Trade-Order	0.00	0.09	0.14	1.41
Trade-Result	0.00	0.09	0.16	10.51
Trade-Status	0.00	0.03	0.06	0.71
Trade-Update	0.01	0.71	0.83	10.45
Data-Maintenance	0.01	0.14	N/A	0.75

Transaction Mix	Transaction Count	Mix %
Broker-Volume	2,882,455	4.900
Customer-Position	7,647,504	13.000
Market-Feed	588,349	1.000
Market-Watch	10,588,263	17.999
Security-Detail	8,235,913	14.000
Trade-Lookup	4,705,699	7.999
Trade-Order	5,941,471	10.100
Trade-Result	5,883,500	10.001
Trade-Status	11,176,988	19.000
Trade-Update	1,176,487	2.000
Data-Maintenance	120	N/A

Test Duration and Timings	
Ramp-up Time (hh:mm:ss)	00:20:19
Measurement Interval (hh:mm:ss)	02:00:00
Business Recovery Time (hh:mm:ss)	00:19:41
Total Number of Transactions Completed in Measurement Interval	58,826,629

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 modeled 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 modeled 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. 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.

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.

Clause 1 – Introduction

Benchmark Sponsor

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

This benchmark was sponsored by IBM Corporation.

Configuration Diagrams

Diagrams of both the measured and priced configurations must be reported, accompanied by a description of the differences. A description of the steps taken to configure all of the hardware and software must be reported.

Measured and Priced Configuration

The measured and priced configurations are shown in Figure 1-1.

Figure 1-1. Measured and Priced Configuration

2 x IBM x3200 M2
Each contains:
- 1 x Quad-Core Intel Xeon
  Processor X3360 2.83GHz
  (1 Proc/4 Cores/4 Threads)
- 2GB Memory
- 2 x 73GB 15K SAS (RAID-1)
- Onboard RAID Controller
- Onboard Gigabit Ethernet
- 1 x NetXtreme II 1000 Express

IBM System x3650 M2
- 2 x Intel Xeon Processor
  X5570 2.93GHz
  (2 Procs/8 Cores/16 Threads)
- 96GB Memory
- 8 x 300GB 10K SATA (RAID-1)
- 4 x IBM ServeRAID-MR10M
  SAS Controller
- 1 x IBM ServeRAID-MR10i
  SAS Controller
- Onboard Gigabit Ethernet
- 1 x Ethernet Daughter Card

32 x IBM System Storage
EXP3000 Enclosure
Each contains:
- 12 x 73GB 15K SAS

= 16 x 24-drive RAID-10
384 Total External Drives

The measured and priced configurations differed in only the specific model of the Tier A clients used. Both the measured and priced configurations used IBM System x3200 M2 systems, machine type 4367.

The measured configuration used model 4367-72U. This specific model is no longer offered by IBM. The priced configuration used model 4367-76U. The models are identical except as follows:

- Measured model 4367-72U includes 2GB of PC2-5300 CL5 ECC DDR2 667MHz memory. The measurements were conducted with 2GB of this memory in each Tier A client.
- Priced model 4367-76U includes 1GB of PC2-6400 CL6 ECC DDR2 800MHz memory. An additional 1GB of this memory was priced for each client, bringing each of them up to 2GB.
- Measured model 4367-72U uses 3.5" SAS drives. A pair of 3.5" 73GB 15K SAS drives, per client, was therefore used for the measurements.
- Priced model 4367-76U uses 2.5" SFF SAS drives. A pair of 2.5" SFF 73GB 15K SAS drives, per client, was priced.

Disk stats were collected on the Tier A clients as the benchmark was running in steady state. These stats showed that the Tier A clients were doing less than one disk IO per second, on average.

Hardware and Software Configuration Steps

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

Detailed instructions for installing and configuring the SUT, hardware and software, are included in the supporting files:

- Information specific to the Tier A clients can be found in: SupportingFiles\Introduction\TierA\TierA_x3200M2_Setup.pdf
- Information specific to the Tier B database server and storage can be found in: SupportingFiles\Introduction\TierB\TierB_x3650M2_Setup.pdf

Clause 2- Database Design, Scaling, and Population

Database Creation and Table Definitions

A description of the steps taken to create the database for the Reported Throughput must be reported in the Report.

The database was created and populated using the Microsoft TPC-E benchmark kit. Instructions for doing so are included in the supporting files. See SupportingFiles\Clause2\MSTPCE Database Setup Reference.pdf.

Changes and customizations were made to some of the kit files. First, the filegroups the database was loaded onto were changed in number from four filegroups to two. Second, several scripts were modified to customize the load to the specific hardware configuration of this SUT.

The default kit files create the database on four filegroups: customer_fg, misc_fg, broker_fg, and market_fg. That was changed so that only two filegroups were used, fixed_fg and growing_fg. The modified files are included as part of SupportingFiles\Clause2:

- All of the items in the following files should be changed to fixed_fg:
    - Utility\Create_TID_Ranges_Table.sql
    - DDL\Create_Tables_Scaling.sql
    - DDL\Create_Tables_Fixed.sql
    - DDL\Create_NC_Indexes_Scaling.sql
    - DDL\Create_NC_Indexes_Fixed.sql
    - DDL\Create_Clustered_Indexes_Scaling.sql
    - DDL\Create_Clustered_Indexes_Fixed.sql
- DDL\Create_Tables_Growing.sql
    - BROKER goes to fixed_fg
    - The rest go to growing_fg
- DDL\Create_NC_Indexes_Growing.sql
    - BROKER goes to fixed_fg (NC1 and NC2)
    - The rest go to growing_fg
- DDL\Create_Clustered_Indexes_Growing.sql
    - BROKER goes to fixed_fg
    - The rest go to growing_fg
- DDL\Create_Tables_Scaling_Flat.sql
    - NEWS_ITEM_TEMP goes to growing_fg
    - The rest go to fixed_fg

The files that were customized for this specific SUT hardware are included in the folder SupportingFiles\Clause2\409000.Cust\Database:

- Tempdb.sql creates a larger temporary database for SQL Server
- Shrinktempdb.sql shrinks it back down
- Backupdev.sql creates devices for SQL Server to backup the database to
- Dropbackupdev.sql removes those devices
- Backup_Database.sql backs up the tpce database to the specified device names
- Restore_Database.sql restores the tpce database from the specified device names
- Create_Database.sql maps the database filegroups and log to physical storage
- Flatfile.txt tells the database loader where to store the database flatfiles during the load
- Remove_Database.sql drops the current tpce database

Database Physical Organization

The physical organization of tables and indexes within the database must be reported in the Report.

The following tables and related indexes were on the growing_fg filegroup:

- CASH_TRANSACTION
- SETTLEMENT
- TRADE
- TRADE_HISTORY
- TRADE_REQUEST
- HOLDING
- HOLDING_HISTORY
- HOLDING_SUMMARY

The remaining tables and their related indexes were all on the fixed_fg filegroup.

Horizontal/Vertical Partitioning

While there are few restrictions placed upon horizontal or vertical partitioning of tables and rows in the TPC-E benchmark, any such partitioning must be reported.

Partitioning was not used for this benchmark.

Replication

Replication of tables, if used, must be reported in the Report.

Replication was not used for this benchmark.

Table Attributes

Additional and/or duplicated attributes in any table must be reported in the Report along with a statement on the impact on performance (see Clause 2.3.5).

No additional attributes were used for this benchmark.

Cardinality of Tables

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

The database was built with 409,000 customers. The cardinality is shown in Table 2-1.

Table 2-1. Initial Cardinality of Tables

Table Name	Rows
ACCOUNT_PERMISSION	2,903,913
ADDRESS	613,504
BROKER	4,090
CASH_TRANSACTION	6,502,138,468
CHARGE	15
COMMISSION_RATE	240
COMPANY	204,500
COMPANY_COMPETITOR	613,500
CUSTOMER	409,000
CUSTOMER_ACCOUNT	2,045,000
CUSTOMER_TAXRATE	818,000
DAILY_MARKET	365,615,325
EXCHANGE	4
FINANCIAL	4,090,000
HOLDING	361,908,202
HOLDING_HISTORY	9,471,641,807
HOLDING_SUMMARY	20,347,942
INDUSTRY	102
LAST_TRADE	280,165
NEWS_ITEM	409,000
NEWS_XREF	409,000
SECTOR	12
SECURITY	280,165
SETTLEMENT	7,067,520,000
STATUS_TYPE	5
TAXRATE	320
TRADE	7,067,520,000
TRADE_HISTORY	16,962,062,151
TRADE_REQUEST	0
TRADE_TYPE	5
WATCH_ITEM	40,931,680
WATCH_LIST	409,000
ZIP_CODE	14,741

Distribution of Tables and Logs

The distribution of tables, partitions and logs across all media must be explicitly depicted for the measured and priced configurations.

The database storage was the same for the measured and priced configurations.

There were eight 300GB 2.5" SFF 10K SATA drives in the database server, all accessed by a ServeRAID-MR10i internal SAS/SATA controller. The OS was loaded onto a RAID-1 array located on two of these drives. The database log was stored on a RAID-10 array located on the other six of these drives.

The database data was stored on external SAS storage. This storage was accessed by four IBM ServeRAID-MR10M SAS/SATA controllers, filling the four PCI-E slots in the database server. Each of these controllers was connected to eight IBM System Storage EXP3000 enclosures, which held twelve 3.5" 73GB 15K SAS drives each. In total, thirty-two EXP3000 enclosures and 384 external drives were connected to the server. Sixteen data arrays were each configured as 24-drive RAID-10. Each data array was broken into three partitions: one for fixed_fg (RAW), one for growing_fg (RAW), and one for backup, tempdb, and flatfiles (NTFS).

Adapter write caching was disabled for all controllers and arrays.

Further details on the storage configuration are available in the supporting files. See the files in the directory SupportingFiles\Introduction\TierB.

Table 2-2 depicts the database configuration of the measured and priced systems to meet the 8-hour steady state requirement.

Table 2-2. Data Distribution for the Measured and Priced Configuration

Disk #	Controller #	Slot #	Drives Enclosure RAID level	Partition (File System)	Size	Use
0	1	1	24 X 73.4GB SAS EXP3000 RAID-10	c:\mp\fx1 (RAW) c:\mp\gw1 (RAW) c:\mp\bk1 (NTFS)	5.96GB 249.80GB 548.77GB	Fixed 1 Growing 1 Backup1
1	1	1	24 X 73.4GB SAS EXP3000 RAID-10	c:\mp\fx2 (RAW) c:\mp\gw2 (RAW) c:\mp\bk2 (NTFS)	5.96GB 249.80GB 548.77GB	Fixed 2 Growing 2 Backup2
2	1	1	24 X 73.4GB SAS EXP3000 RAID-10	c:\mp\fx3 (RAW) c:\mp\gw3 (RAW) c:\mp\bk3 (NTFS)	5.96GB 249.80GB 548.77GB	Fixed 3 Growing 3 Backup3
3	1	1	24 X 73.4GB SAS EXP3000 RAID-10	c:\mp\fx4 (RAW) c:\mp\gw4 (RAW) c:\mp\bk4 (NTFS)	5.96GB 249.80GB 548.77GB	Fixed 4 Growing 4 Backup4
4	2	2	24 X 73.4GB SAS EXP3000 RAID-10	c:\mp\fx5 (RAW) c:\mp\gw5 (RAW) c:\mp\bk5 (NTFS)	5.96GB 249.80GB 548.77GB	Fixed 5 Growing 5 Backup5
5	2	2	24 X 73.4GB SAS EXP3000 RAID-10	c:\mp\fx6 (RAW) c:\mp\gw6 (RAW) c:\mp\bk6 (NTFS)	5.96GB 249.80GB 548.77GB	Fixed 6 Growing 6 Backup6
6	2	2	24 X 73.4GB SAS EXP3000 RAID-10	c:\mp\fx7 (RAW) c:\mp\gw7 (RAW) c:\mp\bk7 (NTFS)	5.96GB 249.80GB 548.77GB	Fixed 7 Growing 7 Backup7
7	2	2	24 X 73.4GB SAS EXP3000 RAID-10	c:\mp\fx8 (RAW) c:\mp\gw8 (RAW) c:\mp\bk8 (NTFS)	5.96GB 249.80GB 548.77GB	Fixed 8 Growing 8 Backup8

Disk #	Controller #	Slot #	Drives Enclosure RAID level	Partition (File System)	Size	Use
8	3	3	24 X 73.4GB SAS EXP3000 RAID-10	c:\mp\fx9(RAW) c:\mp\gw9 (RAW) c:\mp\bk9 (NTFS)	5.96GB 249.80GB 548.77GB	Fixed 9 Growing 9 Backup9
9	3	3	24 X 73.4GB SAS EXP3000 RAID-10	c:\mp\fx10 (RAW) c:\mp\gw10 (RAW) c:\mp\bk10 (NTFS)	5.96GB 249.80GB 548.77GB	Fixed 10 Growing 10 Backup10
10	3	3	24 X 73.4GB SAS EXP3000 RAID-10	c:\mp\fx11 (RAW) c:\mp\gw11 (RAW) c:\mp\bk11 (NTFS)	5.96GB 249.80GB 548.77GB	Fixed 11 Growing 11 Backup11
11	3	3	24 X 73.4GB SAS EXP3000 RAID-10	c:\mp\fx12 (RAW) c:\mp\gw12 (RAW) c:\mp\bk12 (NTFS)	5.96GB 249.80GB 548.77GB	Fixed 12 Growing 12 Backup12
12	4	4	24 X 73.4GB SAS EXP3000 RAID-10	c:\mp\fx13 (RAW) c:\mp\gw13 (RAW) c:\mp\bk13 (NTFS)	5.96GB 249.80GB 548.77GB	Fixed 13 Growing 13 Backup13
13	4	4	24 X 73.4GB SAS EXP3000 RAID-10	c:\mp\fx14 (RAW) c:\mp\gw14 (RAW) c:\mp\bk14 (NTFS)	5.96GB 249.80GB 548.77GB	Fixed 14 Growing 14 Backup14
14	4	4	24 X 73.4GB SAS EXP3000 RAID-10	c:\mp\fx15 (RAW) c:\mp\gw15 (RAW) c:\mp\bk15 (NTFS)	5.96GB 249.80GB 548.77GB	Fixed 15 Growing 15 Backup15
15	4	4	24 X 73.4GB SAS EXP3000 RAID-10	c:\mp\fx16 (RAW) c:\mp\gw16 (RAW) c:\mp\bk16 (NTFS)	5.96GB 249.80GB 548.77GB	Fixed 16 Growing 16 Backup16
16	internal	N/A	2 X 300GB SATA internal RAID-1	C: (NTFS) F: (NTFS)	67.06GB 211.40GB	OS MDF
17	Internal	N/A	6 x 300GB SATA Internal RAID-10	E: (RAW)	292.97GB	Log

Database Interface and Model Implemented

*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).*

Microsoft SQL Server 2008 Enterprise x64 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.

Database Load Methodology

The methodology used to load the database must be reported in the Report.

The database was loaded using the flat files option on the EGenLoader command line. This will generate flat files first, then bulk insert the data into the tables. A further description is provided in SupportingFiles\Clause2\MSTPCE Database Setup Reference.pdf.

Clause 3 – Transaction Related Items

Vendor-Supplied Code

A statement that vendor-supplied code is functionally equivalent to Pseudo-code in the specification (see Clause 3.2.1.5) must be reported.

The stored procedure code for the transactions was functionally equivalent to the pseudo-code. The stored procedures can be seen in SupportingFiles\Clause3\StoredProcedures.

The code to interface the stored procedures can be seen in:

- SupportingFiles\Clause3\BaseServer
- SupportingFiles\Clause3\TransactionsSP
- SupportingFiles\Clause3\TxnHarness

Database Footprint of Transactions

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

The database footprint requirements were met.

Clause 4 – SUT, Driver, and Network

Network Configuration

The Network configurations of both the measured and priced configurations must be described and reported. This includes the mandatory Network between the Driver and Tier A (see Clause 4.2.2) and any optional Database Server interface networks (see Clause 4.1.3.12).

The network configurations of the measured and priced configurations were the same. Refer to Figure 1-1 for a diagram of the network connections.

The Tier A clients and Tier B database server were connected by two Ethernet crossover cables. Each client was configured with one NetXtreme II 1000 Express Ethernet Adapter. A crossover cable was connected from that adapter on each client to one of the two onboard Ethernet ports on the database server. These two gigabit networks handled all of the network traffic between Tier A and Tier B while a measurement was underway.

Another network connected the driver, the database server, the clients, and a time server. This network was connected via a gigabit Ethernet switch. On each client, this network was connected to the onboard Ethernet port. On the database server, this network was connected to one of the two Ethernet ports on the Dual-port 1Gb Ethernet daughter card. This network fulfills the mandatory network between the driver and Tier A. It also allows the driver, clients, and database server to synchronize and verify their times with the time server.

Clause 5 – EGen

EGen Version

The version of EGen used in the benchmark must be reported (see Clause 5.3.1).

EGen v1.7.0 was used in the benchmark.

EGen Code and Modifications

A statement that all required TPC-provided EGen code was used in the benchmark must be reported. 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. If any of the changes to EGen do not have a formal waiver, that must also be reported. If the Test Sponsor extended EGenLoader, the use of the extended EGenLoader and the audit of the extension code by an Auditor must be reported (see Clause 5.7.3).

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

EGen was not modified for use in this benchmark.

EGenLoader was not extended for this benchmark.

EGen Files

The make/project files used to compile/link EGenLoader and EGenValidate must be reported in the Supporting Files. The compiler/linker options and flags used to compile/link EGen objects for the SUT must be reported in the Supporting Files.

See the supporting files directory SupportingFiles\Clause3\prj for the files related to EGenLoader and EGenValidate.

See the supporting files directory SupportingFiles\Clause3\SUT_CE_Server for the files related to the SUT_CE_Server.

See the supporting files directory SupportingFiles\Clause3\SUT_MEE_Server for the files related to the SUT_MEE_Server.

Clause 6 – Performance Metrics and Response Time

EGen Instances

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

There were four EGenDriverCEs with a total of 740 EGenDriverCE instances used in the benchmark.

There were four EGenDriverMEEs with a dynamic number of instances used in the benchmark.
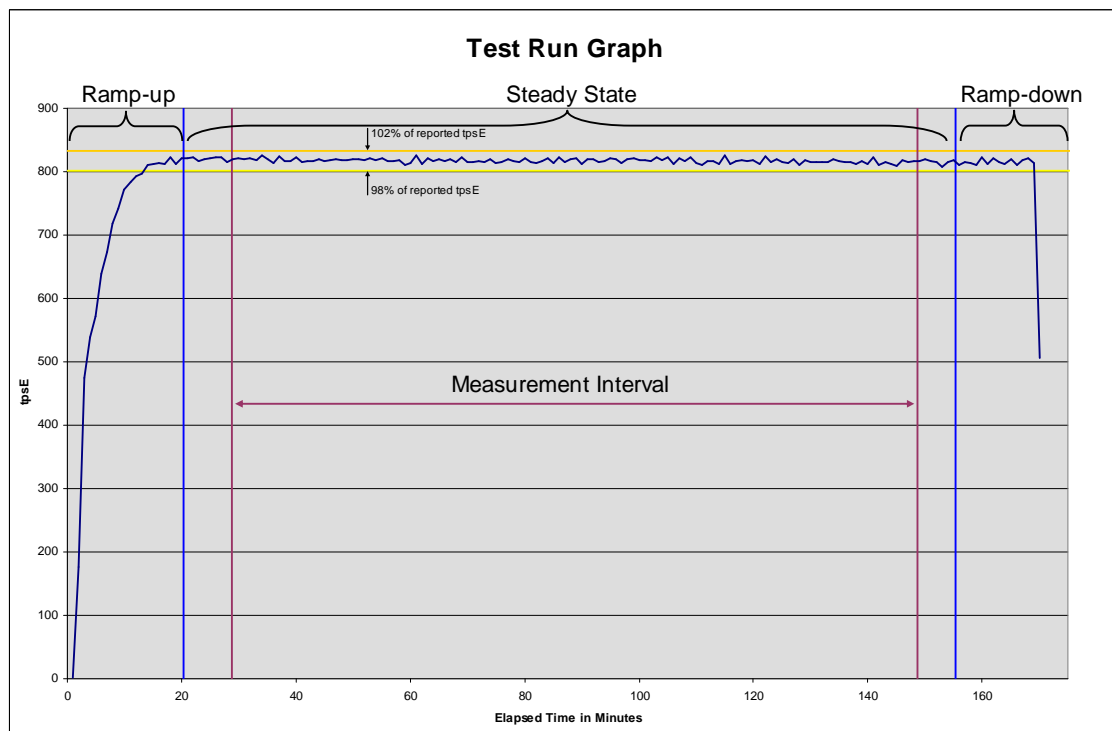
Measured Throughput

The Measured Throughput must be reported (see Clause 6.7.1.2).

The measured throughput was 817.15 tpsE.

Throughput vs. Elapsed Time for Trade-Result Transaction

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

Figure 6-1. Test Run Graph

Steady State Methodology

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

During the run, observation of the tpsE as the benchmark ran was used to determine Steady State. After the run, Steady State was confirmed by:

1. Looking at the Test Run Graph and verifying that tpsE was steady prior to commencing the Measurement Interval.

2. Calculating the average tpsE over 60-minute windows during Steady State, with the start of each window 10 minutes apart. Then it was 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. Calculating the average tpsE over 10-minute windows during the Steady State, with the start of each window 1 minute apart. Then it was confirmed that the minimum 10-minute average tpsE was not less than 80% of the Reported Throughput, and 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 (e.g., checkpointing, writing Undo/Redo Log records).

Checkpoints were run continuously every 7½ minutes during the entire run.

Data-Maintenance was run every 60 seconds.

Transaction Statistics

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

Table 6-1 contains the transaction statistics.

Table 6-1. Transaction Statistics

Input Parameter	Value	Actual Percentage	Required Range
Customer-Position			
By Tax ID	1	50.00%	48% to 52%
Get History	1	49.99%	48% to 52%
Market-Watch			
Securities chosen by	Watch List	59.99%	57% to 63%
	Account ID	35.03%	33% to 37%
	Industry	4.98%	4.5% to 5.5%
Security-Detail			
Access LOB	1	1.00%	0.9% to 1.1%
Trade-Lookup			
Frame to execute	1	29.91%	28.5% to 31.5%
	2	30.02%	28.5% to 31.5%
	3	30.06%	28.5% to 31.5%
	4	10.01%	9.5% to 10.5%
Trade-Order			
Transactions requested by a third party		10.00%	9.5% to 10.5%
By Company Name		40.00%	38% to 42%
Buy On Margin	1	8.02%	7.5% to 8.5%
Rollback	1	0.99%	0.94% to 1.04%
LIFO	1	34.97%	33% to 37%
Trade Quantity	100	25.00%	24% to 26%
	200	24.99%	24% to 26%
	400	25.02%	24% to 26%
	800	24.98%	24% to 26%
Trade Type	Market Buy	30.01%	29.7% to 30.3%
	Market Sell	29.99%	29.7% to 30.3%
	Limit Buy	20.00%	19.8% to 20.2%
	Limit Sell	10.00%	9.9% to 10.1%
	Stop Loss	10.00%	9.9% to 10.1%
Trade-Update			
Frame to execute	1	32.99%	31% to 35%
	2	33.02%	31% to 35%
	3	34.00%	32% to 36%

Clause 7 – Transaction and System Properties

The ACID (Atomicity, Consistency, Isolation, and Durability) properties of transaction processing systems must be supported by the System Under Test during the running of this benchmark. It is the intent of this section to define the ACID properties informally and to specify a series of tests that must be performed to demonstrate that these properties are met.

Atomicity Requirements

The system under test must guarantee that database transactions are atomic; the system will either perform all individual operations on the data, or will assure that no partially completed operations leave any effects on the data.

All ACID tests were conducted according to specification. The following steps were performed to verify the Atomicity of the Trade-Order transactions:

- *Perform a market Trade-Order Transaction with the roll_it_back flag set to false. Verify that the appropriate rows have been inserted in the TRADE and TRADE_HISTORY tables.*
- *Perform a market Trade-Order Transaction with the roll_it_back flag set to true. Verify that no rows associated with the rolled back Trade-Order have been added to the TRADE and TRADE_HISTORY tables.*

The procedure for running the atomicity tests is documented in the file SupportingFiles\Clause7\MSTPCE ACID Procedures.pdf

The atomicity scripts and outputs are located in the directory SupportingFiles\Clause7\Atomicity

Consistency Requirements

Consistency is the property of the application that requires any execution of a database transaction to take the database from one consistent state to another. A TPC-E database when first populated by EGenLoader must meet these consistency conditions. The three consistency conditions must be tested after initial database population and after any Business Recovery tests.

Entries in the BROKER and TRADE tables must satisfy the relationship:
B_NUM_TRADES = count(*)
For each broker defined by:
(B_ID = CA_B_ID) and (CA_ID = T_CA_ID) and (T_ST_ID = 'CMPT')

Entries in the BROKER and TRADE tables must satisfy the relationship:
B_COMM_TOTAL = SUM(T_COMM)
For each broker defined by:
(B_ID = CA_B_ID) and (CA_ID = T_CA_ID) and (T_ST_ID = 'CMPT')

Entries in the HOLDING_SUMMARY and HOLDING tables must satisfy the relationship:
HS_QTY = sum(H_QTY)
For each holding summary defined by:
(HS_CA_ID = H_CA_ID) and (HS_S_SYMB = H_S_SYMB)

Consistency conditions 1, 2, and 3 were tested using a batch file to issue queries to the database after the database was loaded and after the Business Recovery Test. The results of the queries demonstrated that the database was consistent for all three tests.

The procedure for running the consistency tests is documented in the file SupportingFiles\Clause7\MSTPCE ACID Procedures.pdf

The consistency scripts and outputs are located in the directory SupportingFiles\Clause7\Consistency

Isolation Requirements

Systems that implement Transaction isolation using a locking and/or versioning scheme must demonstrate compliance with the isolation requirements by executing the tests described in Clause 7.4.2.

Isolation tests 1 through 4 were successfully done following the procedure documented in the file SupportingFiles\Clause7\MSTPCE ACID Procedures.pdf

The isolation scripts and outputs are located in the directory SupportingFiles\Clause7\Isolation

Durability Requirements

The tested system must guarantee durability: the ability to preserve the effects of committed transactions and ensure database consistency after recovery from any one of the failures listed in Clauses 7.5.2.2, 7.5.2.3 and 7.5.2.4.

- *Permanent irrecoverable failure of any single durable medium.*
- *Instantaneous interruption (system crash/system hang) in processing that requires system reboot to recover.*
- *Failure of all or part of memory (loss of contents).*
- *Loss of all external power to the SUT for an indefinite time period (power failure). This must include at least all portions of the SUT that participate in the database portions of Transactions.*

Durability Test for Data Accessibility

This benchmark result used Redundancy Level 1. The test for Redundancy Level 1 is the test for permanent irrecoverable failure of any single durable medium.

To prove Redundancy Level 1, the following steps were successfully performed:

1. Determined the current number of completed trades in the database by running *select count(*) as count1 from SETTLEMENT.*

2. Started a run, using the profile from the measured run, with checkpoints, and let it get to steady state for at least 5 minutes with a score at least 95% of the reported throughput.

3. Induced the first failure, which in this case was failing a drive in a database data array by physically removing it from its enclosure. Since the database data arrays are RAID protected, transaction processing continued.

4. Let the performance get back to steady state, again over 95% of the reported throughput, for at least 5 minutes.

5. Induced the second failure, which in this case was failing a drive in the database log array by physically removing it from its enclosure. Since the database log array is RAID protected, transaction processing continued.

6. After a few minutes passed, a new drive was inserted into the log enclosure to replace the failed log drive. The log array rebuilding process was started.

7. After a few minutes passed, a new drive was inserted into the data enclosure to replace the failed data drive. The data array rebuilding process commenced automatically.

8. Continued running the benchmark for at least 20 minutes.

9. Terminated the run gracefully.

10. Retrieved the new number of completed trades in the database by running *select count(*) as count2 from SETTLEMENT.*

11. Verified that (count2 – count1), which is the number of completed trades done during the run, equaled the number of successful Trade-Result transactions reported by the Driver.

12. Allowed the recovery process to complete.

Figure 7-1 is a graph of the measured throughput versus elapsed time for the data accessibility run. The timings of the induced failures as well as the recovery process are indicated.

Figure 7-1. Data Accessibility Graph
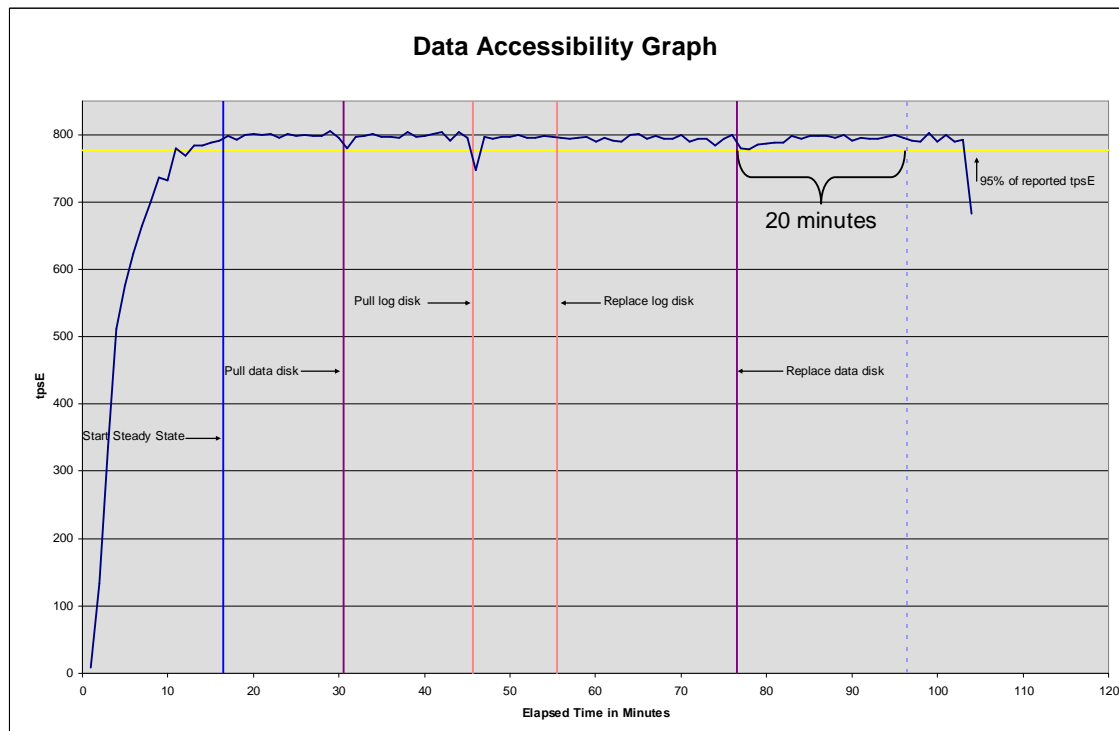
The files related to this data accessibility test are located in SupportingFiles\Clause7\Durability\DataAccessibility

Durability Test for Business Recovery

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

The following steps were successfully performed to test Business Recovery:

1. Determined the current number of completed trades in the database by running *select count(*) as count1 from SETTLEMENT*.

2. Started a run, using the profile from the measured run, with checkpoints, and let it get to steady state for at least 20 minutes with a score at least 95% of the reported throughput.

3. Pulled the power cords from the x3650 M2 database server.

4. Stopped the driver.

5. Plugged in and restarted the database server.

6. Started SQL Server on the database server. It automatically began recovery of the tpce database. The timestamp in the SQL Server ERRORLOG of the first message related to database tpce is considered the start of the database recovery time.

7. Waited for SQL Server to finish recovering the database. The timestamp in the SQL Server ERRORLOG of the message indicating that the recovery of database tpce is complete is considered the end of the database recovery time.

8. Started a run, using the profile from the measured run, with checkpoints. The time when the first transaction is submitted to the database is considered the start of the application recovery time.

9. Let the run proceed until it ran for at least 20 minutes with a score at least 95% of the reported throughput. The time of the beginning of that 20-minute window is considered the end of the application recovery time.

10. Terminated the run gracefully.

11. Verified that no errors were reported during steps 8 through 10.

12. Retrieved the new number of completed trades in the database by running *select count(*) as count2 from SETTLEMENT*.

13. Verified that (count2 – count1), which is the number of completed trades done during the run, was greater than or equal to the combined number of successful Trade-Result transactions reported by the Driver for both runs. In the case of an inequality, verified that the difference is less than or equal to the maximum number of transactions that could be in-flight from the Driver to the SUT.

14. Verified database consistency.

Figure 7-2 is a graph of the measured throughput versus elapsed time for the business recovery runs.

The database recovery time was 00:08:40. The application recovery time was 00:11:01. The Business Recovery Time, which is the sum of the database recovery time and the application recovery time, was 00:19:41.

Figure 7-2. Business Recovery Time Graph
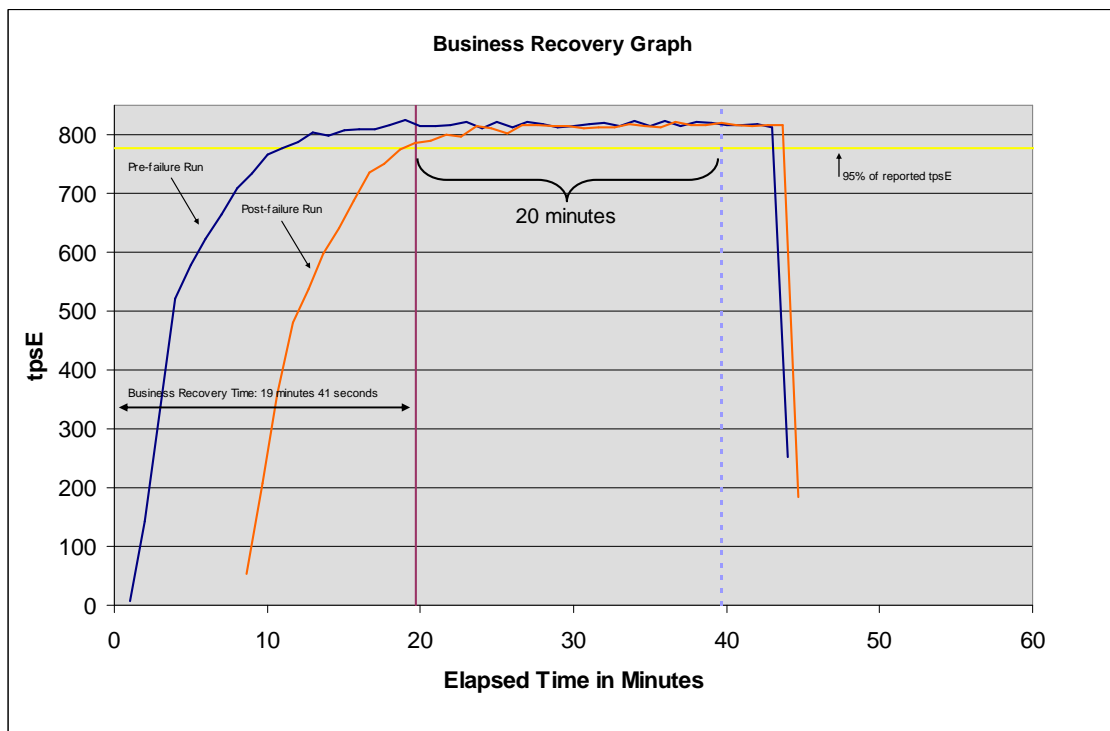
The files related to this business recovery test are located in SupportingFiles\Clause7\Durability\BusinessRecovery

Clause 8 – Pricing

60-Day Space

Details of the 60-Day Space computations (see Clause 8.2.2) along with proof that the database is configured to sustain a Business Day of growth (see Clause 6.6.6.1) must be reported.

Table 8-1. Disk Space Requirements

TPC-E Disk Space Requirements

Customers Used	409,000	Performance	817.15 TpsE		Reported	817.15 TpsE			
	Initial Rows	Data (KB)	Index size (KB)	Extra 5% (KB)	Total + 5% (KB)	After run (KB)	Growth (KB)	Bus. Day Growth (KB)	Req. Add. (KB)
BROKER	4,090	232	408	32	672	880	240	697	697
CASH_TRANSACTION	6,502,138,468	644,240,024	1,358,216	32,279,912	677,878,152	659,902,800	14,304,560	41,492,473	41,492,473
CHARGE	15	8	8	1	17	16	-	-	1
COMMISSION_RATE	240	16	16	2	34	32	-	-	2
SETTLEMENT	7,067,520,000	346,833,472	731,344	17,378,241	364,943,057	360,647,312	13,082,496	37,947,697	37,947,697
TRADE	7,067,520,000	783,795,216	420,095,480	60,194,535	1,264,085,231	1,217,505,144	13,614,448	39,490,702	39,490,702
TRADE_HISTORY	16,962,062,151	486,367,440	1,268,368	24,381,790	512,017,598	489,155,696	1,519,888	4,408,658	4,408,658
TRADE_REQUEST	-	-	-	-	-	16,072	16,072	46,620	46,620
TRADE_TYPE	5	8	1,032	52	1,092	1,040	-	-	52
									-
ACCOUNT_PERMISSION	2,903,913	247,200	1,600	12,440	261,240	249,056	256	743	12,440
CUSTOMER	409,000	69,288	18,048	4,367	91,703	87,384	48	140	4,367
CUSTOMER_ACCOUNT	2,045,000	189,904	225,720	20,781	436,405	415,624	-	-	20,781
CUSTOMER_TAXRATE	818,000	17,072	392	873	18,337	17,584	120	349	873
HOLDING	361,908,202	19,289,848	14,304,312	1,679,708	35,273,868	44,760,888	11,166,728	32,390,731	32,390,731
HOLDING_HISTORY	9,471,641,807	344,423,400	179,495,400	26,195,940	550,114,740	525,506,840	1,588,040	4,606,343	4,606,343
HOLDING_SUMMARY	20,347,942	692,048	2,832	34,744	729,624	1,391,680	696,800	2,021,171	2,021,171
WATCH_ITEM	40,931,680	1,124,640	4,352	56,450	1,185,442	1,129,240	248	720	56,450
WATCH_LIST	409,000	10,192	8,536	936	19,664	18,728	-	-	936
COMPANY	204,500	44,496	12,400	2,845	59,741	56,896	-	-	2,845
COMPANY_COMPETITOR	613,500	16,496	13,592	1,504	31,592	30,088	-	-	1,504
DAILY_MARKET	365,615,325	18,787,528	7,964,448	1,337,599	28,089,575	26,753,160	1,184	3,435	1,337,599
EXCHANGE	4	8	8	1	17	16	-	-	1
FINANCIAL	4,090,000	481,224	1,664	24,144	507,032	483,160	272	789	24,144
INDUSTRY	102	8	40	2	50	48	-	-	2
LAST_TRADE	280,165	13,040	400	672	14,112	26,520	13,080	37,941	37,941
NEWS_ITEM	409,000	44,343,224	784	2,217,200	46,561,208	44,344,032	24	70	2,217,200
NEWS_XREF	409,000	10,184	400	529	11,113	10,584	-	-	529
SECTOR	12	8	24	2	34	32	-	-	2
SECURITY	280,165	44,072	19,232	3,165	66,469	63,304	-	-	3,165
STATUS_TYPE	5	8	8	1	17	16	-	-	1
ADDRESS	613,504	35,392	400	1,790	37,582	35,824	32	93	1,790
TAXRATE	320	24	16	2	42	56	16	47	47
ZIP_CODE	14,741	488	128	31	647	616	-	-	31
TOTALS (KB)		**2,691,076,208**	**625,529,608**	**165,830,291**	**3,482,436,107**				
Initial Database Size (MB)		**3,238,873**		**3,163 GB**					

Db/Filegroups	LUN Count	Partition Size(KB)	MB allocated	MB Loaded	MB Required	
	0	-	-	-	-	OK
growing_fg	16	261,939,200	4,092,800	3,166,892	3,325,490	OK
	0	-	-	-	-	OK
fixed_fg	16	6,246,400	97,600	71,981	75,617	OK
Settlements	8,113,336					

Initial Growing Space (MB)	3,166,892					
Final Growing Space (MB)	3,221,569	Data LUNS	16	Initial Log Size (MB)	3,183	Log LUNS	1
Delta (MB)	54,677	Disks per LUN	24	Final Log Size (MB)	85,327	Log Disks	6
Data Space per Trade (MB)	0.006739125	Disk Capacity (MB)	68,664	Log Growth (MB)	82,144	Disk Capacity (MB)	285,148
1 Day Data Growth (MB)	158,598	RAID Overhead	50%	Log Growth/Trade (MB)	0.010124540556	RAID Overhead	50%
60 Day Space (MB)	12,754,755	Total Space (MB)	13,183,488	1 Day Log Space (MB)	238,270	Log Space (MB)	855,444

OK   OK

The 60-day space calculations are included in SupportingFiles\Clause8\ tpce_space.xls

Availability Date

The committed delivery date for general availability (availability date) of products used in the price calculations must be reported. When the priced system includes products with different availability dates, the reported availability for the priced system must be the date at which all components are committed to be available.

The total solution as priced will be generally available July 31, 2009.

Supporting Files Index

An index of the files contained in the supporting files is here: SupportingFiles\SupportingFilesIndex.pdf

Auditor's Attestation Letter

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

The auditor's Attestation Letter is on the next two pages.

Celia Schreiber, Manager
IBM System x and BladeCenter Performance Analysis and Benchmarking
IBM Systems and Technology Group
3039 Cornwallis Road
RTP, NC 27709

July 3, 2009

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

Platform: IBM System x3650 M2
Operating System: Microsoft Windows Server 2008 Enterprise x64 Edition
Database Manager: Microsoft SQL Server 2008 Enterprise x64 Edition (SP1)

The results were:

CPU's Speed	Memory	Disks	Trade-Result 90% Response Time	tpsE
Tier B, Server: IBM System x3650 M2				
2 x Intel Xeon X5570 (2.93GHz)	96 GB (8 x 256 KB L2) (2 x 8MB L3)	384 x 73.4 GB 15K SAS 8 x 300 GB SATA	0.16 Seconds	817.15
Tier A, Two Clients: IBM System x3200 M2				
1 x Intel Xeon X3360 (2.83 GHz)	2 GB (2 x 6MB L2)	2 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 v1.7.0.

• The transactions were correctly implemented.

• The database was properly scaled and populated for 409,000 customers.

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

• 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 representative of steady state conditions.

- The reported measurement interval was 120 minutes.

- The implementation used Redundancy Level 1.

- The Business Recovery Time of 00:19:41 was correctly measured.

- The 60 day storage requirement was correctly computed.

- The system pricing was verified for major components and maintenance.

Additional Audit Notes:

The measured system included (2) IBM System x3200 M2 4367-72U Tier-A client systems that were substituted by (2) IBM System x3200 M2 4367-76U Tier-A client systems in the priced configuration. Based on the specifications of these systems and on performance data collected during testing, it is my opinion that this substitution has no significant effect on performance.

Respectfully Yours,

Doug Johnson, Auditor   François Raab, President

Appendix A – Price Quotes

Confirmation number	146218630
Last modified	June 30, 2009 11:16:46 PM MST
Expires	July 30, 2009
Prepared for	Chris King

Your quote details

Part Number / Description		Quantity	List			Approved		
			Component Price	Line / Configuration	Total Price	Component Price	Line / Configuration	Total Price
46C7443	1GB (2x512MB) PC2-6400 CL6 ECC DDR2 800MHz DIMM	2		$115.00	$230.00		$80.00	$160.00
43X0837	IBM Server 73GB SAS 15K 2.5" SFF HS	4		$369.00	$1,476.00		$258.00	$1,032.00
436776U	IBM System x3200 M2	2		$1,519.00	$3,038.00		$1,119.00	$2,238.00
43W7666	300GB 10K SATA 2.5" NHS HDD	8		$499.00	$3,992.00		$349.00	$2,792.00
46M1087	Intel Xeon Processor X5570 4C 2.93GHz 8MB Cache 1333MHz	1		$2,135.00	$2,135.00		$2,079.00	$2,079.00
39Y6066	NetXtreme II 1000 Express Ethernet Adapter	2		$169.00	$338.00		$118.00	$236.00
39R6531	IBM 3m SAS Cable	4		$135.00	$540.00		$94.00	$376.00
46M1076	Dual Port 1Gb Ethernet Daughter Card	1		$89.00	$89.00		$62.00	$62.00
51J9054	3 Year Onsite Repair 24x7 4 Hour Response	2		$399.00	$798.00		$335.00	$670.00
41L2760	3 Year Onsite Repair 24x7 4 Hour Response	2		$300.00	$600.00		$252.00	$504.00
93074RX	NetBAY S2 42U Standard Rack Cabinet	2		$1,489.00	$2,978.00		$1,186.00	$2,372.00
40K9201	IBM 3 Button Optical Mouse - Black - USB	1		$19.00	$19.00		$13.00	$13.00
46C7449	8GB (1x8GB) Dual Rank PC3-10600 CL9 ECC DDR3-1333 LP RDIMM	12		$1,049.00	$12,588.00		$965.00	$11,580.00
39R6529	IBM 1m SAS Cable	28		$119.00	$3,332.00		$83.00	$2,324.00
794792U	IBM System x3650 M2	1		$4,379.00	$4,379.00		$4,064.00	$4,064.00
41L2768	3 Year Onsite Repair 24x7 4 Hour Response	32		$760.00	$24,320.00		$638.00	$20,416.00
44E8825	ServeRAID-MR10M SAS/SATA Controller with Remote Battery Kit	4		$899.00	$3,596.00		$629.00	$2,516.00
43W7523	73GB 15K 3.5" SAS Hot-Swap HDD	384		$309.00	$118,656.00		$216.00	$82,944.00
172701X	IBM System Storage EXP3000	32		$3,199.00	$102,368.00		$2,239.00	$71,648.00
21P2078	3 Year Onsite Repair 24x7 4 Hour Response	1		$600.00	$600.00		$504.00	$504.00
40K9584	IBM Preferred Pro Keyboard USB - US English 103P	1		$29.00	$29.00		$20.00	$20.00

Subtotal	$286,101.00	$208,550.00
Total		$208,550.00
Your savings	$77,551.00	

Shipping & delivery

Shipping method: Standard Shipping

Shipping address
Not available

Comments

Microsoft

June 26, 2009

IBM Corporation
Chris King
3079 Cornwallis Road
Durham, NC 27709

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
810-07509	**SQL Server 2008 Enterprise x64 Edition** *Per Processor License* *Discount Schedule: Open Program - No Level* *Unit Price reflects a 4% discount from the retail unit price of $24,999.*	$23,911	2	$47,822
P73-04190	**Windows Server 2008 Standard Edition (x64)** *Server License with 5 CALs* *Discount Schedule: Open Program - No Level* *Unit Price reflects a 27% discount from the retail unit price of $999.*	$725	2	$1,450
P72-03195	**Windows Server 2008 Enterprise Edition (x64)** *Server License with 25 CALs* *Discount Schedule: Open Program - No Level* *Unit Price reflects a 41% discount from the retail unit price of $3,999.*	$2,357	1	$2,357
N/A	**Microsoft Problem Resolution Services** *Professional Support* *(1 Incident)*	$245	1	$245

A list of Microsoft's resellers can be found at
http://www.microsoft.com/products/info/render.aspx?view=22&type=mnp&content=22/licensing

All products listed above are currently orderable and available.

Defect support is included in the purchase price. Additional support is available from Microsoft PSS on an incident by incident basis at $245 per call.

This quote is valid for the next 90 days.

Reference ID: PEchki0906260000007136.

Shopping Cart

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Qty.	Product Description	Savings	Total Price
1	Acer V173 b Black 17" 5ms LCD Monitor - Retail Item #: N82E16824009136 Return Policy: Monitor Replacement Only Return Policy	-$20.00 Instant	$119.99 $99.99
1	Rosewill RCW-717 3ft. /Network Cable Cat 6 (Crossover) Yellow - Retail Item #: N82E16812119153 Return Policy: Standard Return Policy		$1.29
		Subtotal:	$101.28

Calculate Shipping
Zip Code: UPS Guaranteed 3 Day Service   **Shipping:** $0.00

Redeem Gift Certificates

Claim Code:
Security Code: **Gift Certificates:** $0.00

Apply Promo Code(s):   Promo Code: $0.00

Grand Total:* $101.28

* Above total does not include shipping or taxes. Please input zip code to calculate your grand total.

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