



**TPC Benchmark™ E
Full Disclosure Report
DELL PowerEdge 6850
Using
Microsoft SQL Server 2005 Enterprise Edition x64 SP2
On
Microsoft Windows Server 2003 Enterprise x64 SP1**

First Edition

Submitted for Review

August 24, 2007

Dell Computer Corp PowerEdge 6850 Server with Microsoft SQL Server 2005 Enterprise Edition x64 SP2 on Microsoft Windows Server 2003 Enterprise x64 SP1

First Printing August 2007

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Abstract

This report documents the methodology and results of the TPC Benchmark E test conducted on a PowerEdge 6850 Server using SQL Server 2005 database in conformance with the requirements of the TPC-E Benchmark Specification. The operating system used for the server was Microsoft Windows Server 2003 Enterprise Edition x64. The operating system on the client was Microsoft Windows Server 2003 Enterprise Edition x64.

All tests were done in compliance with Revision 1.2.0 of the Transaction Processing Council's TPC Benchmark™ E Standard Specification. The standard TPC Benchmark™ E metrics, transactions per second (tpsE), price per tpsE (\$/tpmE) and the availability date are reported and referred to in this document.

The results from the tests are summarized below:

Hardware	Software	Total System Cost	tpsE	\$/tpsE	Availability Date
Dell PowerEdge 6850	Microsoft Windows 2003 Enterprise Ed. x64 SQL Server 2005 Enterprise Ed. x64	\$224,428	220.00	1,020.13	August 24,2007

Additional copies of this Full Disclosure Report can be obtained from either the Transaction Processing Performance Council or Dell at the following address:


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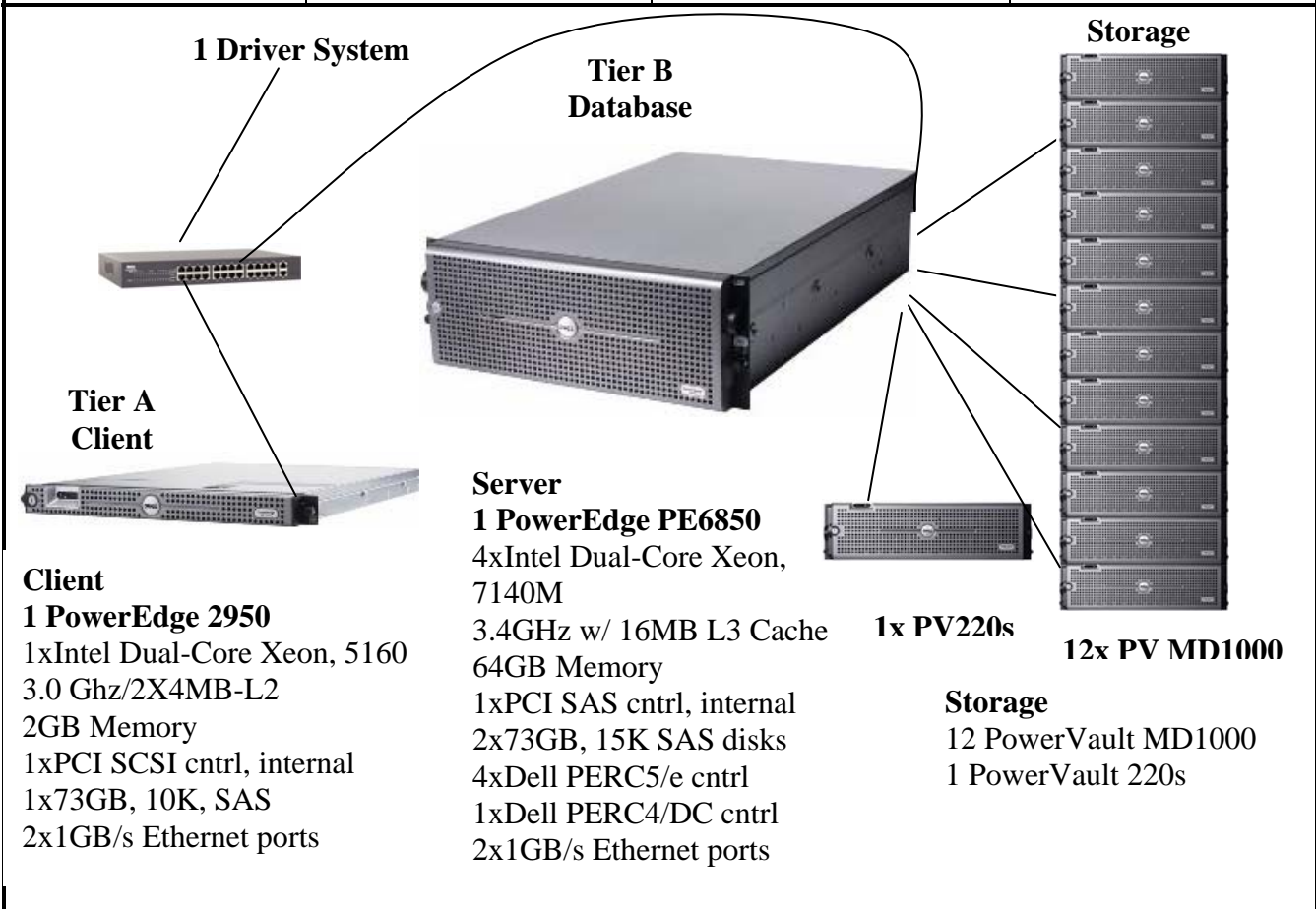
Auditor

In order to verify compliance to the TPC-E benchmark specification, Lorna Livingtree, Performance Metrics, Inc., audited the benchmark configuration, environment and methodology used to produce and validate the test results, and the pricing model used to calculate the price/performance.

	PowerEdge™ 6850 Server		TPC-E 1.2.0 TPC Pricing 1.2
			Report Date: August 24, 2007
TPC-E Throughput	Price/Performance	Availability Date	Total System Cost
220.00 tpsE	\$1,020.13 USD per tpsE	August 24, 2007	\$ 224,428 USD

Database Server Configuration

Operating System	Database Manager	Processors/Cores/ Threads	Memory
Microsoft Windows Server 2003 Enterprise x64 Edition™ SP1	SQL Server 2005 Enterprise x64 Edition™ SP2	4/8/16	64GB



Initial Database Size	Redundancy Level: 1	Storage
856 GB	RAID - 10	70 x 36GB SAS 14 x 36GB SCSI 86 x 73GB SAS 14 x 146GB SAS



PowerEdge 6850

TPC-E 1.2.0 TPC Pricing 1.2

Report Date
August 24, 2007
Revision Date
August 24, 2007
Availability Date
August 24, 2007

Description	Part Number	Price Source	Unit Price	Qty	Extended Price	3 yr. Maint. Price
Server Hardware						
PE6850,DC XEON 7140M,3.4GHz/16MB,800FSB	222-5582	1	5,341.00	1	\$5,341.00	\$320.00
- includes Dual on-board NICs	430-8991	1	0.00	0	\$0.00	
QUAD XEON 7140M,3.4GHz/16MB,800 FSB	311-6774	1	6,499.00	1	\$6,499.00	
64GB (16x4GB)	311-5709	1	12,508.00	1	\$12,508.00	
PERC5M,Integrated	341-3360	1	\$299.00	1	\$299.00	
PERC5/E SAS RAID, 2X4 EXTERNAL	341-3023	1	\$799.00	4	\$3,196.00	
PERC4/DC SCSI RAID, 2X4 EXTERNAL	341-1285	1	\$799.00	1	\$799.00	
73GB,3GBPS,SAS,3.5IN,10K	341-3028	1	\$299.00	2	\$598.00	
DELL E157FP,15 IN,15.0 VIS	320-5090	1	\$189.00	1	\$189.00	
				Subtotal	\$29,429.00	\$320.00
Server Storage						
PV MD1000,RACK,3U,15 BAY,LBZL	222-2299	1	2,680.00	12	\$32,160.00	\$19,776.00
TWO ENCL MGT MODULES, SAS/SATA	420-5927	1	\$345.83	12	\$4,149.96	
PV 220R Enclosure	222-2910	1	\$2,255.00	1	\$1,648.00	\$1,648.00
36GB,3GBPS,SAS,3.5IN,15K	341-2816	1	\$249.00	70	\$17,430.00	
36GB,SCSI,U320,15K	340-9371	1	\$249.00	14	\$3,486.00	
73GB,3GBPS,SAS,3.5IN,15K	341-2818	1	\$299.00	84	\$25,116.00	
146GB,3GBPS,SAS,3.5IN,15K	341-2819	1	\$399.00	14	\$5,586.00	
RACK-111/24U/Dell	A0213544	1	\$479.95	1	\$479.95	
				Subtotal	\$90,055.91	\$21,424.00
Server Software						
SQL Server 2005 Enterprise x64 Edition **	810-04793	2	\$23,432.00	4	\$93,728.00	
Windows Server 2003 Enterprise x64 Server **	P72-00274	2	\$2,334.00	1	\$2,334.00	
Professional Support (1 Incident)			\$245.00	1		\$245.00
				Subtotal	\$96,062.00	\$245.00
Client Hardware						
PE2950,XEON 5160,3.0GHz/4MB,1333 FSB	222-3190	1	1,882.00	1	\$1,882.00	\$320.00
- includes Dual on-board NICs	430-1764	1	0.00	0	\$0.00	
No second processor	311-1193	1	0.00	1	\$0.00	
2GB (4x512MB)	311-6153	1	518.00	1	\$518.00	
73GB,3GBPS,SAS,3.5IN,10K	341-3028	1	\$299.00	2	\$598.00	
DELL E157FP,15 IN,15.0 VIS	320-5090	1	\$189.00	1	\$189.00	
				Subtotal	\$3,187.00	\$320.00
Client Software						
Windows Server 2003 Enterprise x64 Server **	P72-00274	2	\$2,334.00	1	\$2,334.00	
				Subtotal	\$2,334.00	\$0.00
Infrastructure						
PowerConnect 2216, 16port Switch	222-2259	1	\$69.00	1	\$69.00	
2x4M, Cable, PERC4/39160	310-0679	1	\$99.00	1	\$99.00	
2M SAS Cable, MD1000	310-7083	1	\$40.00	16	\$640.00	
				Subtotal	\$808.00	\$0.00
				Other Discounts*	(\$19,756.79)	
				Total	\$221,875.91	\$22,309.00

Notes:						
*All hardware items from Dell(1) are discounted 16% based on total cost.				Three-Year Cost of Ownership:	\$224,428	USD
** All Microsoft maintenance is covered by the maint. costs of Microsoft SQL Server				TPC-E Throughput:	220.00	tpsE
Price Source: 1=Dell, 2=Microsoft, NIO = Not Immediately Orderable				Price/Performance:	\$1,020.13	tpsE/USD
Pricing may be verified by calling 1-800-BUY-DELL and referencing quote # 382816819 as a complex quote.						
Audited by Lorna Livingtree, Performance Metrics Inc.						

Prices used in TPC benchmarks reflect the actual prices a customer would pay for a one-time purchase of the stated components. Individually negotiated discounts are not permitted. Special prices based on assumptions about past or future purchases are not permitted. All discounts reflect standard pricing policies for the listed components. For complete details, see the pricing sections of the TPC benchmark specifications. If you find that the stated prices are not available according to these items, please inform the TPC at pricing@tpc.org.

Numerical Quantities Summary				
Reported Throughput: 220.00 tpsE		Configured Customers: 110,000		
Response Times (in seconds)	Minimum	Average	90th%tile	Maximum
Broker-Volume	0.01	0.09	0.14	0.33
Customer-Position	0.00	0.03	0.06	0.71
Market-Feed	0.00	0.04	0.08	0.45
Market-Watch	0.00	0.05	0.11	0.67
Security-Detail	0.00	0.02	0.03	3.23
Trade-Lookup	0.00	0.47	0.67	1.24
Trade-Order	0.01	0.09	0.14	0.78
Trade-Result	0.00	0.10	0.16	5.14
Trade-Status	0.00	0.04	0.06	0.70
Trade-Update	0.03	0.56	0.72	1.27
Data-Maintenance	0.01	0.15		3.44
Transaction Mix		Transaction Count		Mix %
Broker-Volume		779,106		4.900
Customer-Position		2,067,409		13.002
Market-Feed		158,998		1.000
Market-Watch		2,862,166		18.000
Security-Detail		2,226,217		14.000
Trade-Lookup		1,272,088		8.000
Trade-Order		1,606,021		10.100
Trade-Result		1,589,964		9.999
Trade-Status		3,021,209		19.000
Trade-Update		317,993		2.000
Data-Maintenance		120		
Test Duration and Timings				
Ramp-up Time (hh:mm:ss)		00:12:00		
Measurement Interval (hh:mm:ss)		02:00:00		
Business Recovery Time (hh:mm:ss)		00:43:25		
Total number of Transactions Completed in Measurement Interval		15,901,171		

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Introduction

Document Structure

The TPC Benchmark™ E Standard Specification requires test sponsors to publish, submit to the TPC, and make available to the public, a full disclosure report (FDR) for any result to be considered compliant with the specification. The required contents of the full disclosure report are specified in Clause 9. This report is submitted to satisfy the specification's requirement for full disclosure. It documents the compliance of the benchmark implementation and execution reported for the Dell PE6850 server using Microsoft SQL Server 2005 Enterprise Edition SP2 (x64) on Microsoft Windows Server 2003 Enterprise Edition (x64).

Benchmark Overview

The Transaction Processing Performance Council (TPC) developed The TPC Benchmark™ E Standard Specification Revision 1.2.0.

TPC Benchmark™ E (TPC-E) is an Online 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 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 benchmark simulates the OLTP workload of a brokerage firm. The focus of the benchmark is the central database that exercises 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.

Clause 1: General Items

1.1: 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 specification.

1.2: 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.

1.3: Test Sponsor

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

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

1.4: 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 System Under Test (SUT) is depicted in the next diagram. The difference between the priced and measured system was as shown in Table 1

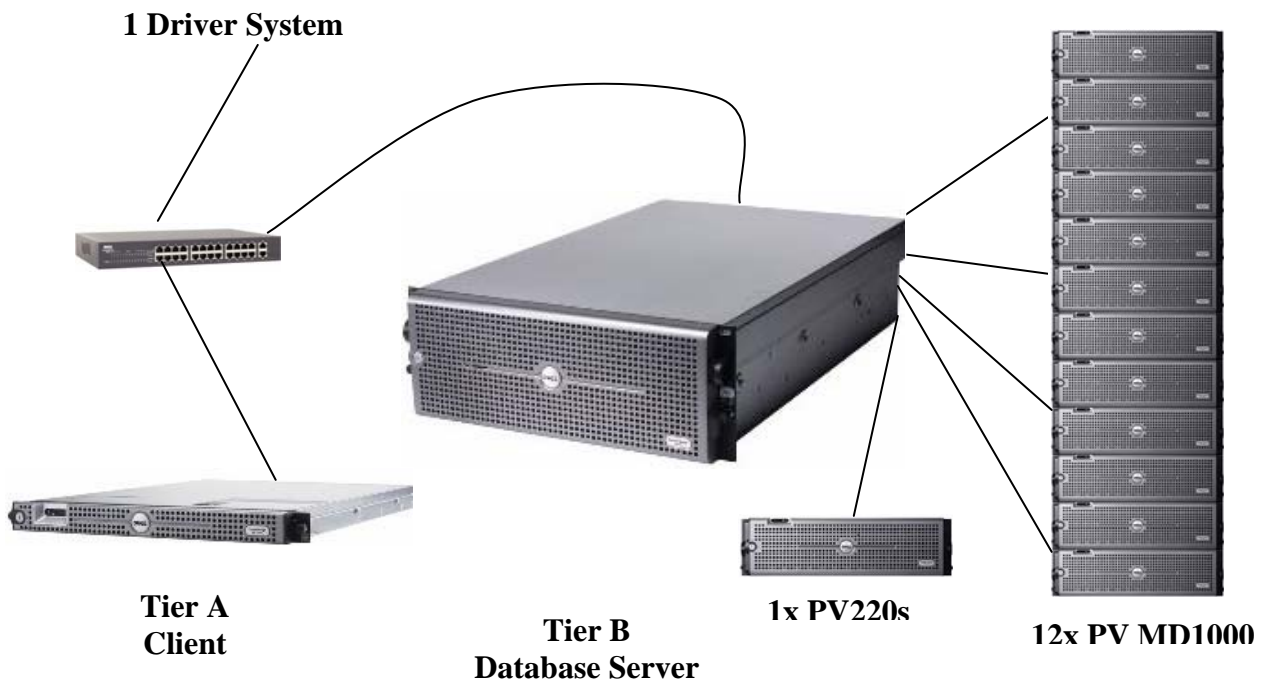
Table 1: Difference between priced and measured configuration

	Priced	Measured
Client Server	PE2950	PE2850
- FSB	1333MHz	800MHz
- Processors	Intel Dual-core Xeon 3.0 GHz/2x4MB-L2	Intel Dual-core Xeon 2.8GHz/2x2MB-L2
- Memory	2GB	2GB
- OS drives	1x73GB	1x73GB

Measured Configuration

The measured and priced configurations have different client systems.

Figure 1: Measured Configuration



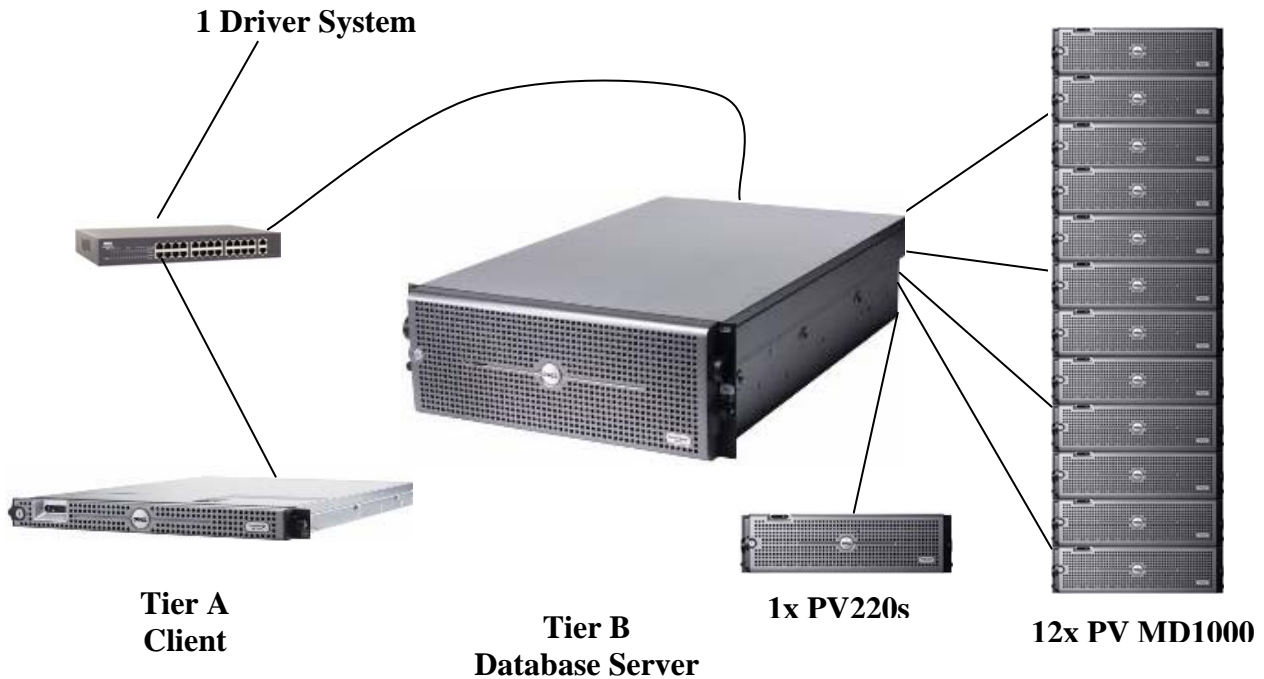
1 PowerEdge 2850
 1xIntel Dual-Core Xeon,
 2.8Ghz/2x2MB-L2
 800MHz FSB
 2GB Memory
 1xPCI SCSI cntrl, internal
 1x73GB,U320,15K,SCSI
 2x1GB/s Ethernet ports

1 PowerEdge PE6850
 4xIntel Dual-Core Xeon , 7140M
 3.4GHz w/ 16MB L3 Cache
 64GB Memory
 1xPCI SAS cntrl, internal
 2x73GB,15K SAS disks
 4xDell PERC5/e cntrl
 1xDell PERC4/DC cntrl
 2x1GB/s Ethernet ports

Storage
 12 PowerVault MD1000
 1 PowerVault 220s

Priced Configuration

Figure 2: Priced Configuration



1 PowerEdge 2950
 1xIntel Dual-Core Xeon,
 3.0Ghz/2x4MB-L2
 1333MHz FSB
 2GB Memory
 1xPCI SCSI cntrl, internal
 1x73GB,U320,15K,SCSI
 2x1GB/s Ethernet ports

1 PowerEdge PE6850
 4xIntel Dual-Core Xeon , 7140M
 3.4GHz w/ 16MB L3 Cache
 64GB Memory
 1xPCI SAS cntrl, internal
 2x73GB,15K SAS disks
 4xDell PERC5/e cntrl
 1xDell PERC4/DC cntrl
 2x1GB/s Ethernet ports

Storage
 12 PowerVault MD1000
 1 PowerVault 220s

1.5: Hardware configuration

A description of the steps taken to configure all of the hardware must be reported in the Report. Any and all configuration scripts or step by step GUI instructions are reported in the Supporting Files (see Clause 9.4.1.1). The description, scripts and GUI instructions must be sufficient such that a reader knowledgeable of computer systems and the TPC-E specification could recreate the hardware environment. (9.3.1.4)

The file **PE6850_HardwareConfiguration.pdf** in the *SupportingFiles* Directory (“Introduction”) contains the hardware configuration used in running these TPC-E tests. The directory also contains the storage subsystem configuration in the file **Storage_Hardware_config.pdf** in the *DiskSubsystem* directory.

The hardware configuration used in this TPC-E test is a Dell PowerEdge 6850 server (tier B) driven by one Dell PowerEdge 2850 (tierA) client. The clients and server are networked together via a Dell PowerConnect 2216 10/100/1000 BaseT switch. One Dell PowerEdge 1600 server was the driver system that emulated 190 users executing the standard TPC-E workload. The driver system is connected to the client via the Dell Powerconnect network switch. Microsoft Windows 2003 Enterprise Server x64 SP1 was the operating system used on both the server and the client system. Microsoft SQL Server 2005 Enterprise Edition x64 was the database management system on the server machine.

The PowerEdge 6850 motherboard uses the Intel 8501 chipset and can hold up to four dual-core Intel Xeon MP processors (3.4 GHz with 16MB L3 cache each). The system has 4 PCI-e and 3 PCI-x I/O slots. The measured configuration used 64Gbytes of DDR RAM, which was achieved by using 16 4096Mbyte DIMMs.

The PowerEdge 6850 has an integrated LSI SCSI controller to which was attached two 73GB disk drives containing the operating system. In addition, 4 Dell PERC5/e controllers were installed in 4 PCI-e slots and connected to 12 MD 1000 disk pods, which can hold 15 disks each. Each of the 4 controllers managed 3 RAID 10 LUNs. Each LUN had 14 physical drives. The total number of physical drives used for the database was 168 SAS disks. The last controller, Dell PERC4-DC was connected to one PV220 disk pod with a split backplane enclosing 14 36Gb SCSI drives mirrored using RAID10, configured for transaction log data. There were 2 empty PCI-X slots. Hyperthreading was enabled on this server.

The PE2950 client server has a single Intel Dual-core Xeon processor with 2x4MB of L2 cache and a FSB rated at 1333MHz. The system had 2 Gbytes of RAM, two 73 GB hard disk, 2 intergrated Ethernet ports. The client connected to the driver machine and the DB server through a powerconnect switch. Hyperthreading was enabled on this server.

1.6: Software Configuration

A description of the steps taken to configure all software must be reported in the Report. Any and all configuration scripts or step by step GUI instructions are reported in the Supporting Files (see Clause 9.4.1.2). The description, scripts and GUI instructions must be sufficient such that a reader knowledgeable of computer systems and the TPC-E specification could recreate the software environment. (9.3.1.5)

The file **SoftwareConfiguration.pdf** in the *SupportingFiles* Directory (“Introduction”) contains the configuration and system parameters used in running these tests.

Clause 2: Database Design Scaling and Population

2.1: Physical Database Organization

The physical organization of tables and indices, within the database, must be reported in the Report. (9.3.2.1)

The **SupportingFiles/Clause2** folder contains the SQL definitions of all the required filegroups, tables and indexes.

The database tables and their indexes were divided into 3 file groups : Broker, Customer, market as shown in the table below :

Table 2: Physical database organization

Broker File Group	Customer File Group	Market File Group
BROKER	ACCOUNT_PERMISSION	COMPANY
CASH_TRANSACTION	CUSTOMER	COMPANY_COMPETITOR
CHARGE	CUSTOMER_ACCOUNT	DAILY_MARKET
COMMISSION_RATE	CUSTOMER_TAXRATE	EXCHANGE
SETTLEMENT	HOLDING	FINANCIAL
TRADE	HOLDING_HISTORY	INDUSTRY
TRADE_HISTORY	HOLDING_SUMMARY	LAST_TRADE
TRADE_REQUEST	WATCH_ITEM	NEWS_ITEM
TRADE_TYPE	WATCH_LIST	NEWS_XREF
ADDRESS		SECTOR
TAXRATE		SECURITY
ZIP_CODE		STATUS_TYPE

2.2: Table and Row 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)

No partitioning implemented in this configuration.

2.3: Replications, Duplications and Additions

Replication of tables, if used, must be reported in the Report (9.3.2.3)

No replication implemented in this configuration.

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)

No additional or duplicated attributes.

2.4: Initial 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 110,000 customers. The cardinality of the tables is as shown in table 2.2 below:

Table 3: Table Cardinality

Table	Cardinality after database load
Account_Permission	780759
Address	165004
Broker	1100
Cash_Transaction	1748724883
Charge	15
Commission_Rate	240
Company	55000
Company_Competitor	165000
Customer	110000
Customer_Account	550000
Customer_Taxrate	220000
Daily_Market	98331750
Exchange	4
Financial	1100000
Holding	97359557
Holding_History	2547382360
Holding_Summary	5474881
Industry	102
Last_Trade	75350
News_Item	110000
News_Xref	110000
Sector	12
Security	75350
Settlement	1900800000
Status_Type	5
Taxrate	320
Trade	1900800000
Trade_History	4561916535
Trade_Request	0
Trade_Type	5
Watch_Item	11000534
Watch_List	110000
Zip_Code	14741

2.5: Disk Configuration Data

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

The Storage subsystem was configured as shown in Table 4. All database files were located on RAW file systems. Backup devices were setup up on NTFS filesystems. Junction points were used to map to the NTFS partitions that contained the backup devices. The OS (C:)drive was formatted for NTFS.

Table 4: Disk Configuration

HBA#	Slot#	Disk#	Drives Enclosure model RAID level	OS Partition	Size	Use
0	internal	1	2x73GB,15K,SAS MD1000 RAID10	C:\	68.35GB	OS
1	7	0	14x36GB,15K,SCSI PV220S RAID10	Z:\	120GBGB	Logs
					117.06GB	Free
2	3	2	14x36GB,15K,SAS MD1000 RAID10	E:\	133.62GB	Broker1
					100.00GB	Free
		3	14x73GB,15K,SAS MD1000 RAID10	W:\	133.62GB	Broker10
				M:\	80.00GB	Customer1
				Q:\	19.99GB	Market1
				C:\..\back1 ¹	194.14GB	Backup1
			46.49GB	Free		
		4	14x36GB,15K,SAS MD1000 RAID10	F:\	133.62GB	Broker2
	100.00GB			Free		
3	1	8	14x36GB,15K,SAS MD1000 RAID10	I:\	133.62GB	Broker5
					100.00GB	Free
		9	14x36GB,15K,SAS MD1000 RAID10	V:\	133.62GB	Broker9
				O:\	80.00GB	Customer3
				S:\	19.99GB	Market3
		10	14x36GB,15K,SAS MD1000 RAID10	J:\	133.62GB	Broker6
	100.00GB			Free		
4	4	11	14x73GB,15K,SAS MD1000 RAID10	K:\	133.62GB	Broker7
				U:\	146.49GB	Tempdb
				C:\..\back5 ⁵	194.14GB	Backup5
		12	14x146GB,15K,SAS MD1000 RAID10	Y:\	133.62GB	Broker12
				P:\	80.00GB	Customer4
				T:\	19.99GB	Market4
				C:\..\back6 ⁶	194.14GB	Backup6
			520.74GB	Free		
13	14x73GB,15K,SAS MD1000	L:\	133.62GB	Broker8		
		C:\..\back7 ⁷	194.14GB	Backup7		

			RAID10		146.49GB	Free
5	5	5	14x73GB,15K,SAS MD1000 RAID10	G:\	133.62GB	Broker3
				C:\..\back2 ²	194.14GB	Backup2
					146.49GB	Free
		6	14x73GB,15K,SAS MD1000 RAID10	X:\	133.62GB	Broker11
				N:\	80.00GB	Customer2
				R:\	19.99GB	Market2
				C:\..\back3 ³	194.14GB	Backup3
		7	14x73GB,15K,SAS MD1000 RAID10		46.49GB	Free
				H:\	133.62GB	Broker4
				C:\..\back4 ⁴	194.14GB	Backup4
			146.49GB	Free		

C:\..\back1² - C:\backup\back1\
C:\..\back2² - C:\backup\back2\
C:\..\back3² - C:\backup\back3\
C:\..\back4² - C:\backup\back4\
C:\..\back5² - C:\backup\back5\
C:\..\back6² - C:\backup\back6\
C:\..\back7² - C:\backup\back7\

2.6: Database Interface

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)

This test deployed Microsoft SQL Server 2005 which is a relational database.

The client software interfaced to SQL Server via Stored Procedures invoked through ODBC calls driven by the C++ application code.

The methodology used to load the database is described in **Clause2** of the *SupportingFiles* directory (***MSTPCE Database Setup Reference.pdf***)

Clause 3: Transaction Items

3.1: Code Functionality

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.

3.2: Database 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

4.1: EGenDriver Items

The number of EGenDriverMEE and EGenDriverCE instances used in the benchmark must be reported in the Report (9.3.4.1)

There was 1 instance of EGenDriverMEE and 1 instance of EGenDriverCE

4.2: 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)

Figure 1 and Figure 2 show the network connections of the configuration. The PE6850 server has an inbuilt network Ethernet controller with 2 1000MB/s ports. One of the ports is used to connect to the client (tier A) system via a Dell PowerConnect switch. The Client system also has an inbuilt network controller with 2 1000MB/s ports. One of these ports is connected to the driver system via the PowerConnect switch and satisfies the requirement for a mandatory network between tier A and the driver system.

Clause 5: EGen Items

5.1: EGen Version

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

The EGen version used was 1.2.0

5.2: 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.

5.3: 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)

There were no modifications to the EGen.

5.4: EGen Loader Extension Code

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 was no use and no implementation of the EGenloader extension code.

Clause 6: Performance Metrics and Response time

6.1: Measured Throughput (tpsE)

The Measured Throughput must be reported (9.3.6.1)

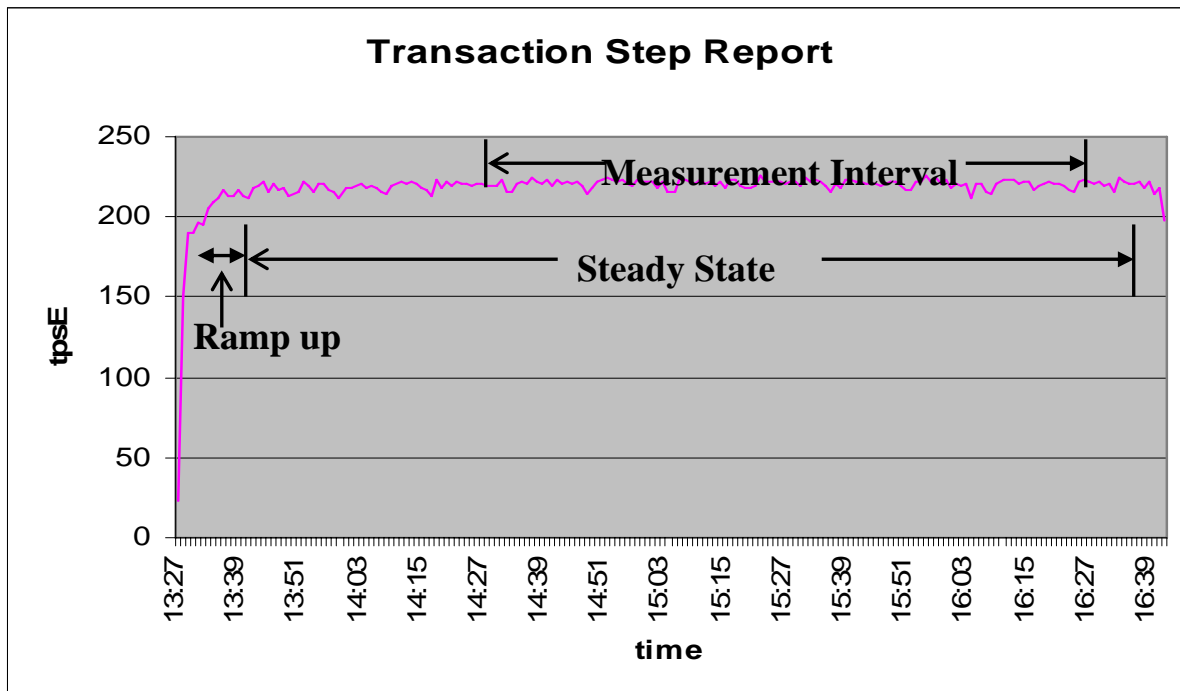
The measured tpsE was 220.83

6.2: Test Run times

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). (9.3.6.2)

The transaction step report for the performance run was evaluated and drawn as shown in Figure 3.

Figure 3: Steady State graph



6.3: Steady State Measurement

The method used to determine that the SUT had reached a Steady State prior to commencing the Measurement Interval must be reported. (9.3.6.3)

It can be seen that after ramp-up a steady state was maintained through the measurement interval and until the run was stopped.

A 1 hour window sliding by 10 mins in steady state was evaluated and was found to vary by 1.32%. A 10 min window sliding by 1 min was found to vary by 2.65%.

6.4: Work Measurements during Test Run

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.). (9.3.6.4)

The driver generated the required transactions and their input data. This data was timestamped. Response for the requested transaction was verified and time-stamped in the driver log files. Log file contents are consolidated for the reports.

The driver engine accessed the application processes running on the client system via an Ethernet network connection. The client application processes handled all requests to the database on the server. The applications communicated with the database server over an Ethernet connection using SQL Server ODBC library and RPC calls.

To perform checkpoints at specific intervals, the SQL Server recovery interval was set to 32767. Continuous checkpoints every 7.5 minutes were performed during steady state before and during the measurement interval by the driver engine. 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 during the test run.

6.5: Transaction Averages

The recorded averages over the Measurement Interval for each of the Transaction input parameters specified by clause 6.4.1 must be reported. (9.3.6.5)

The transaction averages were recorded as shown in Table 5.

Table 5: Transaction Averages

Transaction	Overall	Parameter	Value	Range Check	Acceptable Range	
					Min	Max
Customer Position	Ok	By Tax ID	49.98%	Ok	48.00%	52.00%
		Get history	50.04%	Ok	48.00%	52.00%
Trade Lookup	Ok	Frame 1	30.08%	Ok	28.50%	31.50%
		Frame 2	29.94%	Ok	28.50%	31.50%
		Frame 3	29.99%	Ok	28.50%	31.50%
		Frame 4	9.99%	Ok	9.50%	10.50%
Market Watch	Ok	By Watch List	60.03%	Ok	57.00%	63.00%
		By Customer Account	34.97%	Ok	33.00%	37.00%
		By Industry	5.00%	Ok	4.50%	5.50%
Trade Update	Ok	Frame 1	33.11%	Ok	31.00%	35.00%
		Frame 2	32.92%	Ok	31.00%	35.00%
		Frame 3	33.97%	Ok	32.00%	36.00%
Security Detail	Ok	Access LOB	0.99%	Ok	0.90%	1.10%

Trade Order	Ok	By Non-Owner	9.97%	Ok	9.50%	10.50%
		By Company Name	40.04%	Ok	38.00%	42.00%
		Buy on Margin	8.02%	Ok	7.50%	8.50%
		Rollback	0.99%	Ok	0.94%	1.04%
		LIFO	35.07%	Ok	33.00%	37.00%
		Trade Quantity 100	24.99%	Ok	24.00%	26.00%
		Trade Quantity 200	25.03%	Ok	24.00%	26.00%
		Trade Quantity 400	25.00%	Ok	24.00%	26.00%
		Trade Quantity 800	24.98%	Ok	24.00%	26.00%
		Market Buy	29.97%	Ok	29.70%	30.30%
		Market Sell	29.97%	Ok	29.70%	30.30%
		Limit buy	20.03%	Ok	19.80%	20.20%
		Limit sell	10.01%	Ok	9.90%	10.10%
		Stop Loss	10.02%	Ok	9.90%	10.10%

Clause 7: Transaction and System Properties

7.1 : Transaction Properties (ACID)

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 benchmark specification requires that a system under test (SUT) must support a set of properties during the execution of the benchmark. Those properties are ACID and Redundancy.

This section defines each of these properties, describes the steps taken to ensure that they were present during the test and describes a series of tests done to demonstrate compliance with the specification. See file ***MSTPCE ACID Procedures.pdf*** in the *SupportingFiles* directory (Clause 7).

7.2: Redundancy Level

The Test Sponsor must report in the Report the Redundancy Level (see Clause 7.5.7.1) and describe the test(s) used to demonstrate compliance. (9.3.7.2)

Redundancy level 1 was used for all storage systems.

7.3: Data Accessibility Tests

A description of the Data Accessibility tests run and the Redundancy Level they were demonstrating must be reported. (9.3.7.3)

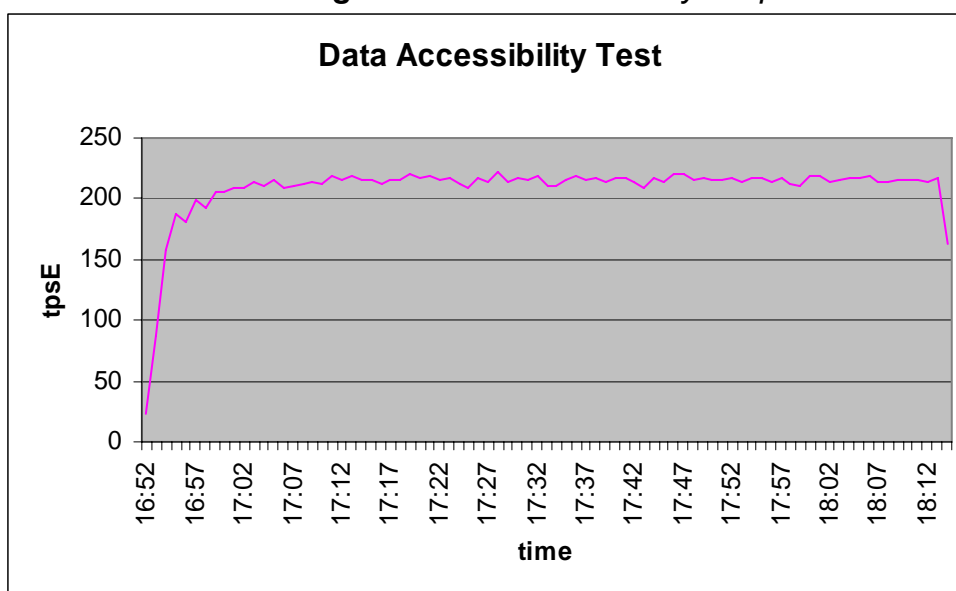
1. The Trade_Request table was truncated using the Trade_Cleanup.sql script.
2. The rows in the Settlement table were counted to determine the initial count of completed trades present in the database (count-before).
3. A performance run was started with the same number of configured customers and driver load used for the measurement interval.
4. The test ramped up, and executed at or above 95% of the Reported Throughput for 30 mins.
5. After 30mins, a log disk drive was pulled from the disk pod.
6. The driver continued running normally for 15 mins.
7. After an additional 15mins, a data disk drive was pulled from the disk pod.
8. The drivers continued running normally with no errors logged in the SQL errorlog and OS logs.
9. After an additional 30mins the driver was stopped gracefully.
10. A transaction report for the test was generated and the number of Trade_Result transactions recorded during the run was noted.
11. The faulty log and data disk drives were replaced by spare disks of similar characteristics.

12. The Database was allowed to recover normally
13. Step 2 was repeated to determine the total number of completed trades present in the database (count-after)
14. count-after minus count-before was verified to be equal to the number of successful Trade-Result transaction records in the driver log file.
15. Consistency tests were run to ensure that the database was in a consistent state.

7.4: Data Accessibility Test Graph

A Data Accessibility Graph for each run demonstrating a Redundancy Level must be reported (9.3.7.4)

Figure 4: Data Accessibility Graph



7.5: Business Recovery Tests

The Test Sponsor must describe in the Report the test(s) used to demonstrate Business Recovery. (9.3.7.5)

Power to the SUT was removed as a way of demonstrating recovery from a system crash:

1. The Trade_Cleanup.sql script was run to truncate the Trade_Request table
2. The rows in the Settlement table were counted to determine the initial count of completed trades present in the database (count-before).
3. A performance run (Run1) with the same number of configured customers and driver load was started and ramped up to steady state.
4. The test ran at 95% and above of reported throughput for 15mins.
5. Power to tier A and tier B systems was pulled.
6. After transaction failures were noted by the drivers, the drivers were stopped
7. Power to the SUT was returned.
8. Database recovery started. That marked the beginning of business recovery.

9. Database recovery was completed successfully
10. A performance run (Run2) was started.
11. The test ramped-up to steady state.
12. Business recovery ends when the test attains at least 95% of reported throughput and maintains that rate or above thereafter.
13. The test was allowed to run in steady-state for 30mins.
14. The drivers were stopped gracefully.
15. Transaction reports for Run1 and Run2 were generated and the count of Trade_Results transactions for both runs were noted and summed.
16. Step 2 was repeated to determine the total number of completed trades present in the database (count-after)
17. count-after minus count-before was verified to be equal to the number of successful Trade-Result transaction (sum of Run1 and Run2) records in the driver log file.
18. Consistency tests were run to ensure that the database was in a consistent state.

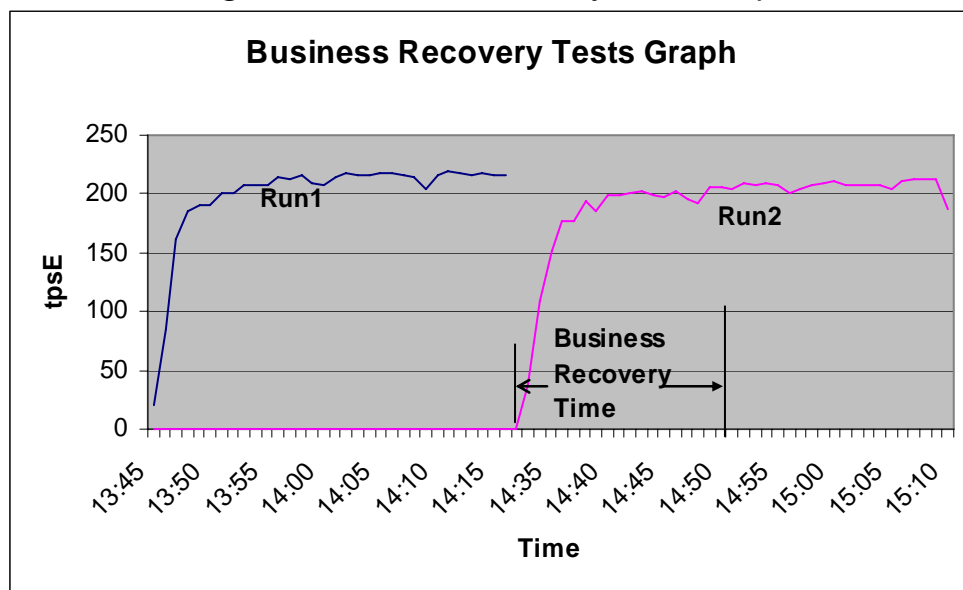
7.6: Business Recovery Time

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 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)

A Business Recovery Graph (see clause 7.5.7.4) must be reported in the Report for all Business Recovery Tests. (9.3.7.7)

The Business Recovery Time was determined to be 43mins 25s. This is also recorded in the Executive Summary.

Figure 5: Business Recovery Tests Graph



Clause 8: Pricing

8.1: 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. (9.3.8.1)

Table 6: Space Requirements

Space calculations
for TPC-E

Customers: 110,000
TpsE: 220.00
TradeResult
count: 2,234,244

Table	Rows	Data(KB)	Index(KB)	Total	Total + 5%	Rows After
ACCOUNT_PERMISSION	780759	78112	440	78,552	82,480	780759
ADDRESS	165004	9552	144	9,696	10,181	165004
BROKER	1100	120	144	264	277	1100
CASH_TRANSACTION	1749673927	173452704	671832	174,124,536	182,830,763	1751729180
CHARGE	15	8	8	16	17	15
COMMISSION_RATE	240	16	16	32	34	240
COMPANY	55000	11944	3200	15,144	15,901	55000
COMPANY_COMPETITOR	165000	4416	3544	7,960	8,358	165000
CUSTOMER	110000	18640	4712	23,352	24,520	110000
CUSTOMER_ACCOUNT	550000	51096	60616	111,712	117,298	550000
CUSTOMER_TAXRATE	220000	4664	72	4,736	4,973	220000
DAILY_MARKET	98331750	5008120	2095136	7,103,256	7,458,419	98331750
EXCHANGE	4	8	8	16	17	4
FINANCIAL	1100000	129528	464	129,992	136,492	1100000
HOLDING	97384291	6651400	3813184	10,464,584	10,987,813	97441377
HOLDING_HISTORY	2548774652	92716400	48365672	141,082,072	148,136,176	2551786936
HOLDING_SUMMARY	5474910	352528	1944	354,472	372,196	5474982
INDUSTRY	102	8	40	48	50	102
LAST_TRADE	75350	6928	64	6,992	7,342	75350
NEWS_ITEM	110000	12115280	176	12,115,456	12,721,229	110000
NEWS_XREF	110000	2752	48	2,800	2,940	110000
SECTOR	12	8	24	32	34	12
SECURITY	75350	11784	5032	16,816	17,657	75350
SETTLEMENT	1901831776	94855840	382288	95,238,128	100,000,034	1904066020
STATUS_TYPE	5	8	8	16	17	5

TAXRATE	320	40	16	56	59	320
TRADE	1901844584	211994664	113035040	325,029,704	341,281,189	1904091764
TRADE_HISTORY	4564397307	131014832	341992	131,356,824	137,924,665	4569791528
TRADE_REQUEST	12808	1520	2656	4,176	4,385	12936
TRADE_TYPE	5	8	1032	1,040	1,092	5
WATCH_ITEM	11000535	297176	1136	298,312	313,228	11000535
WATCH_LIST	110000	2752	2184	4,936	5,183	110000
ZIP_CODE	14741	488	16	504	529	14741
Totals in KB		728793344	168792888	897586232	942465543.6	

Database File Groups	Allocated size MB	Required size MB	Diff
Customer_fg	327,600	150,653	176,947
Broker_fg	1,638,000	721,529	916,471
Market_fg	3,488,427	18,945	3,469,482

Growing Space	14,925,448	KB
per Trade Results	6.68	KB
Data Growth	42,326,460	KB
60 Day Space	3,437,173,811	KB
60 Day Space	3,278	GB
Log space before in MB	14,839	12.469769
Log space after in MB	38,470	32.32774
per Trade Results	0.011	
Log Growth	67,014	MB
Total 8 hours log space	81,853	MB
Total 8 hours log space	79.93	GB

	Count	Formatted size GB	Total GB Configured	Total Needed
Data Disks configured	70	33.37	2,336	
	86	67.75	5,827	
	14	135.49	1,897	
RAID 10 overhead 50%			(5,030)	
Data Disks space total			5,030	3,278
Log Disks configured	14	36	504	
RAID 10 overhead 50%			(252)	
Log Disk space total			252	80

8.2: Attestation Letter

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

This configuration and benchmark test was audited by a TPC certified auditor Lorna Livingtree as shown by the attestation letter shown below:



Aug 24, 2007

Mr. Nicholas Wakou
Dell Computer Corporation
One Dell Way
Round Rock, TX 78682

I have verified the TPC Benchmark™ E for the following configuration:

Platform: Dell PE 6850
Database Manager: Microsoft SQL Server 2005 Enterprise Edition
Operating System: Microsoft Windows Sever 2003 Enterprise Edition (64bit)

Server (Tier B): PE6850			
CPU's	Memory	Disks (total)	tpsE
4 Intel @ 3.4 GHz	64 GB	14 @ 146 GB 84 @ 36 GB 86 @ 73 GB	220.00
Clients (Tier A):PE2850			
1 Intel @ 3.0 GHz	2GB	2 @ 73 GB	Na

In my opinion, these performance results were produced in compliance with the TPC requirements for the benchmark. The following attributes of the benchmark were given special attention:

- All EGen components were verified to be version 1.2.0.
- The database files were properly sized and populated for 110,000 customers.
- The transaction components were properly implemented.

- The required network between the driver and the transaction harness was configured.
- The ACID properties were successfully demonstrated.
- The database was verified to have no Trade-Request rows prior to the start of the test run.
- The test run met all the requirements for timing, mix, and response times.
- Input data was generated according to the specified percentages.
- One and only one Data-Maintenance process was running during the test run.
- There were no inactive load units during the test run.
- Eight hours of mirrored log space was present on the measured system.
- Eight hours of growth space was present on the measured system.
- The data for the 60 day space calculation was verified.
- There were 190 user contexts present on the system.
- The steady state portion of the test was 120 minutes.
- One checkpoint was taken after steady state and before the measured interval.
- Checkpoint interval was verified to be equal to or less than 7.5 minutes.
- The system pricing was checked for major components and maintenance.
- Third party quotes were verified for compliance.
- The FDR was reviewed and verified as required.

Auditor Notes:

During the measured interval, there was one user context that was repeatedly constructed and destructed. This thread was demonstrated to be the checkpoint thread and displayed a steady 7 minutes 30 seconds between each new occurrence.

Sincerely,

A handwritten signature in cursive script that reads "Lorna Livingtree".

Lorna Livingtree
Auditor

Clause 9: Supporting Files

9.1: Supporting Files

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)

APPENDIX A: 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

August 21, 2007

Dell
Nicholas Wakou
One Dell way
Round Rock, TX 78682

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
810-03134	SQL Server 2005 Enterprise Edition <i>Per Processor License</i> <i>Discount Schedule: Open Program - Level C</i> <i>Unit Price reflects a 6% discount from the retail unit price of \$24,999.</i>	\$23,432	4	\$93,728
P72-01684	Windows Server 2003 R2 Enterprise x64 Edition <i>Server License Only - No CALs</i> <i>Discount Schedule: Open Program - No Level</i> <i>Unit Price reflects a 42% discount from the retail unit price of \$3,999.</i>	\$2,334	2	\$4,668
N/A	Microsoft Problem Resolution Services <i>Professional Support</i> <i>(1 Incident)</i>	\$245	1	\$245

All products are currently orderable through Microsoft's normal distribution channels. A list of Microsoft's resellers can be found at <http://www.microsoft.com/products/info/render.aspx?view=22&type=mpn&content=22/licensing>

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.

If we can be of any further assistance, please contact Jamie Reding at (425) 703-0510 or jamiere@microsoft.com.

Reference ID: PEniwa0708210000005580.

Please include this Reference ID in any correspondence regarding this price quote.