
TPC Benchmark® E

Full Disclosure Report

HP ProLiant DL585 G7

using Microsoft SQL Server 2008 R2 Enterprise Edition

on Microsoft Windows Server 2008 R2 Enterprise Edition

First Edition
June 21 , 2010

First Edition June 21 , 2010

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Abstract

Overview

This report documents the methodology and results of the TPC Benchmark® E (TPC-E) test conducted on the using HP ProLiant DL585 G7. The operating system used for the benchmark was Microsoft Windows Server 2008 R2 Enterprise Edition. The report also includes the results of the TPC Benchmark® Energy (TPC-Energy) test conducted on the same system.

TPC Benchmark® E Metrics

The standard TPC Benchmark ® E metrics, tpsE® (transactions per second), price per tpsE ® (three year capital cost per measured tpsE ®), and the availability date are reported as required by the benchmark specification.

TPC Benchmark® Energy Metrics



The standard TPC Benchmark ® Energy metrics, watts per tpsE is optionally reported by the benchmark specification.


Standard and Executive Summary Statements

The following pages contain the Executive Summary of the benchmark results for the system.

Auditor

The benchmark configuration, environment and methodology used to produce and validate the test results, and the pricing model used to calculate the cost per tpsE®, were audited by of Lorna Livingtree of Performance Metrics, Inc. to verify compliance with the relevant TPC specifications.

	HP ProLiant DL585 G7 AMD Opteron 2.3 GHz 12MB L3 C/S with 4 HP ProLiant DL360 G5			TPCE Rev 1.10.0
				TPC Pricing 1.5.0
				TPC Energy 1.1.1
				Report Date
				June 21, 2010
TPC-E Throughput	Price/Performance	Availability Date	Total System Cost	TPC-Energy Metric
1400.14 tpsE	\$330 USD/tpsE	June 21, 2010	\$461,160 USD	6.72 watts/tpsE
Database Server Configuration				
Operating System	Database Manager	Processor/Cores/Thread	Memory	
Microsoft Windows Server 2008 R2 Enterprise Edition	Microsoft SQL Server 2008 R2 Enterprise Edition	AMD 2.3 GHz 12MB L3 4/48/48	256GB	
<p style="text-align: center;">Tier B: Server HP ProLiant DL585G7</p> <p>4 x AMD Opteron Processor 6176 SE 2.30 GHz 256GB Memory 1 x HP NC364T PCI Express Quad Port Gigabit Server Adapter 2 x HP 72GB 3G SAS 15K SFF DP</p> <div style="display: flex; align-items: center; justify-content: center;">  </div> <p style="text-align: center;">Database Log</p> <div style="display: flex; justify-content: space-between;"> <div style="width: 30%;"> <p>Tier A: Clients</p> <p>4 x ProLiant DL360g5 1 x Quad-Core Intel Xeon processor E5420 2.50Ghz 16 x 72GB SAS 10K SFF DP 2 x Onboard 1Gbps Ethernet 2 x HP NC360T PCI-E Dual Port</p> </div> <div style="width: 30%;"> <p>Storage</p> <p>4 x HP 300GB 6G SAS 10K SFF DP (internal) 7 x HP Smart Array P411/512 MB 28 x HP StorageWorks D2700 Disk Enclosure 700 x 72GB 6G SAS 15K SFF DP</p> </div> </div>				
Initial Database Size	Redundancy Level: 1		Storage	
6,210 GB	RAID10:Log/RAID10:Data		702x72GB 15K , 4x300GB 10K	

	HP ProLiant DL585G7 AMD Opteron 2.3 GHz 12MB L3				TPC-E	1.10.0
					TPC-Pricing	1.5.0
					Report date	21-Jun-10
					Availability Date	21-Jun-10
Description	Part Number	Brand	Unit Price	Qty.	Extended Price	3 Yr Maint Price
Server Hardware (Tier B)						
HP DL585R07 CTO Chassis Svr	590480-B21	1	4,036	1	4,036	
HP DL585G7 6176SE FIO 2P Kit	601351-L21	1	3,600	2	7,200	
HP 8GB 2Rx4 PC3-8500R-7 Kit	516423-B21	1	990	32	31,680	
HP 72GB 3G SAS 10K SFF DP ENT HDD	384842-B21	1	259	2	518	
HP Smart Array P411/512 MB with BBWC Controller	462832-B21	1	649	7	4,543	
HP NC364T PCI Express Quad Port Gigabit Server Adapter	412648-B21	1	229	1	229	
HP LE1851w 18.5-Inch wide Monitor	NK033AA#ABA	1	159	1	159	
HP PS/2 Keyboard And Mouse Bundle	RC464AA#ABA	1	39	1	39	
HP 300GB SAS 10K SFF DP ENT HDD	512547-B21	1	499	4	1,996	
HP 3y 4h 24x7 ProLiant DL58x HW Support ,ProLiant Server DL58x	U4545E	1	1,397	1		\$1,397
			Subtotal		\$50,400	\$1,397
Server Software						
SQL Server 2008 R2 Enterprise Edition, Per Processor License	810-07580	2	19,188	4	76,752	
Windows Server 2008 R2 Enterprise Edition	P72-04217	2	2,280	1	2,280	
Microsoft Problem Resolution Services	N/A	2	259	1		259
			Subtotal		\$79,032	259
Storage						
HP StorageWorks D2700 Disk Enclosure	AJ941A	1	3,399	28	95,172	
HP StorageWorks D2700 Disk Enclosure (10% Spares)	AJ941A	1	3,399	3	10,197	
HP 72GB 6G SAS 15K SFF DP ENT HDD	512545-B21	1	349	700	244,300	
HP 72GB 6G SAS 15K SFF DP ENT HDD (10% Spares)	512545-B21	1	349	70	24,430	
HP 5642 Pallet Unassembled Rack	358254 B21	1	865	2	1,730	
			Subtotal		375,829	0
Client Hardware (Tier A)						
HP ProLiant DL360 G5 E5420 2.50GHz Quad Core 2GB Rack Server	457925-001	1	2,499	4	9,996	
HP 72GB 3G SAS 10K SFF DP ENT HDD	384842-B21	1	259	16	4,144	
HP NC360T PCI-E Dual Port Gigabit Server Adapter	412648-B21	1	229	4	916	
HP 3y 4h 24x7 ProLiant DL36x HW Support ,ProLiant DL36x	U4497E	1	698	4		2,792
			Subtotal		15,056	2,792
Client Software						
Microsoft Windows Server 2008 Standard (x64)	P73-04165	2	711	4	2,844	
			Subtotal		2,844	0
Infrastructure						
HP ProCurve 2910al-24G Switch 24-port 10/100/1000 basic Layer 3	J9145A#ABA	1	2,609	2	5,218	
3-year, 4-hour onsite, 24x7 coverage for hardware	U4835E	1	227	2		454
HP 1.2m/4ft CAT5 RJ45 M/M Ethernet Cable	C7533A	1	4	20	74	
			Subtotal		5,292	454
Total Extended Price					\$528,453	\$4,902
HP's Large Configuration Discount *	16.0%	Total Discounts			\$71,452	\$743
Grand Total					\$457,001	\$4,159
Pricing: 1=HP Direct 800-203-6748 2=Microsoft. Note 1: Discount based on HP Direct guidance applies to all lines where pricing = 1. Note 2: All the hardware are available to order. Note 3: The benchmark results were audited by Lorna Livingtree of Performance Metrics.					Three-year Cost of Ownership: USD	\$461,160
					tpsE	1,400.14
					\$ USD/tpsE	\$330
Prices used in TPC benchmarks reflect the actual prices a customer would pay for a one-time purchase of the stated components. Individually negotiated discounts are not permitted. Special prices based on assumptions about past or future purchases are not permitted. All discounts reflect standard pricing policies for the listed components. For complete details, see the pricing sections of the TPC benchmark specifications. If you find that the stated prices are not available according to these terms, please inform at pricing@tpc.org . Thank you.						

Hewlett-Packard Company		HP ProLiant DL585G7			TPC-E Rev. 1.10.0
		2.3 GHz 6MB L2			TPC-Pricing 1.5.0
		C/S with 4 HP ProLiant DL360 G5			TPC-Energy 1.1.1
					Report Date: June 21, 2010
Total System Cost	TPC-E Throughput	Price/Performance	Availability Date	TPC-Energy	
\$461,160	1400.14 tpsE	\$330 USD/tpsE	June 21, 2010	6.72 watts/tpsE	
Numerical Quantities For Reported Energy Configuration: REC Idle Power: 8140 watts Average Power of REC: 9403 watts					
	Secondary Metrics	Additional Numerical Quanties			
	watts / tpsE	Full Load Avg watts	Full Load % of REC	Idle Avg. watts	Idle % of REC
Database Server	0.70	977.16	10.4%	790.73	9.7%
Storage	5.38	7,532.00	80.1%	6,502.56	79.9%
Application Server	0.54	763.04	8.1%	715.53	8.8%
Miscellaneous	0.09	131.23	1.4%	131.57	1.6%
Total REC	6.72	9403	100%	8140	100%
Lowest ambient temperature at air inlet: 21.44 °C					
Items in Priced Configuration not in the Reported Energy Configuration: None					
Items in Reported Energy Configuration not in the Measured Energy Configuration: 1 HP LE1851w 18.5-Inch wide Monitor Part Number NK033AA#ABA					


 invent	HP DL585 G7 AMD Opteron 2.3 GHz 12MB L3		TPCE Rev 1.10.0 TPC Pricing 1.5.0		
			Report Date June 21, 2010		
			Availability Date June 21, 2010		
Numerical Quantities Summary					
Reported Throughput	1400.14 tpsE	Configured Customers:		730,000	
Response Times (in seconds)		Minimum	Average	90 th %tile	Maximum
Broker Volume		0.01	0.06	0.10	6.96
Customer Position		0.00	0.03	0.06	8.07
Market Feed		0.00	0.04	0.07	26.18
Market Watch		0.00	0.03	0.07	6.95
Security Detail		0.00	0.02	0.03	7.04
Trade Lookup		0.00	0.57	0.75	7.71
Trade Order		0.00	0.08	0.14	10.27
Trade Result		0.00	0.09	0.16	10.00
Trade Status		0.00	0.02	0.05	6.92
Trade Update		0.01	0.63	0.77	7.57
Data Maintenance		0.01	0.09		0.56
Transaction Mix		Transaction Count		Mix %	
Broker Volume		4,939,630		4.900%	
Customer Position		13,104,688		13.000%	
Market Feed		1,008,115		1.000%	
Market Watch		18,145,594		18.000%	
Security Detail		14,112,771		14.000%	
Trade Lookup		8,063,896		7.999%	
Trade Order		10,181,475		10.100%	
Trade Result		10,081,046		10.000%	
Trade Status		19,153,307		19.000%	
Trade Update		2,015,927		2.000%	
Data Maintenance		120			
Ramp-up Time		01:09:00			
Measurement Interval		2:00:00			
Business Recovery Time		1:03:03			
Total Number of Transactions Completed in Measurement Interval		100,806,449			

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Preface

Document Structure

This is the full disclosure report for a benchmark test of the using Microsoft SQL Server 2008 R2 Enterprise Edition. It meets the requirements of the TPC Benchmark® E Standard Specification, Revision 1.10.0 dated Sept 2009 TPC Benchmark® E was developed by the Transaction Processing Performance Council (TPC). It is the intent of this group to develop a suite of benchmarks to measure the performance of computer systems executing a wide range of applications. Hewlett-Packard Company and Microsoft, Inc. are active participants in the TPC.

The requirements for this Full Disclosure Report are in Clause 9 of TPC Benchmark® E Specification.

TPC Benchmark® E Overview

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.

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.

Clause 1: General Items

1.1 Orders 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 of the sections in this report correspond with those specified in the TPC-E specification.

1.2 Pricing

The FDR must follow all reporting rules specified in the effective version of the TPC Pricing Specification, located at www.tpc.org. (9.1.1.2)

The pricing rules for this FDR follow the current standard at the time of publication, TPC Pricing Specification 1.5.0.

1.3 Executive Summary Statement

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

The Executive Summary statement is included after the preamble of this Full Disclosure Report, as well as a separate document.

1.4 Supporting Files

A directory structure for the supporting files must be followed. (9.1.1.3)

The accompanying support files are in the proper structure as defined by the specification.

1.5 Auditor

*The name of the **Auditor** who certified the result must be included after the Price Spreadsheet. (9.2.2.2)*

This Benchmark, Executive Summary, and Full Disclosure Report were audited by Lorna Livingtree of Performance Metrics, Inc.. The attestation letter is included in this FDR.

1.6 Configuration Diagrams

*Diagrams of both **Measured** and **Priced Configurations** must be **reported** in the **Report**, accompanied by a description of the differences. (9.3.1.2, 9.3.1.3)*

The Benchmarked and Priced configurations of the driver, SUT Server, and DBMS server are the same and illustrated in Figure 1.1.

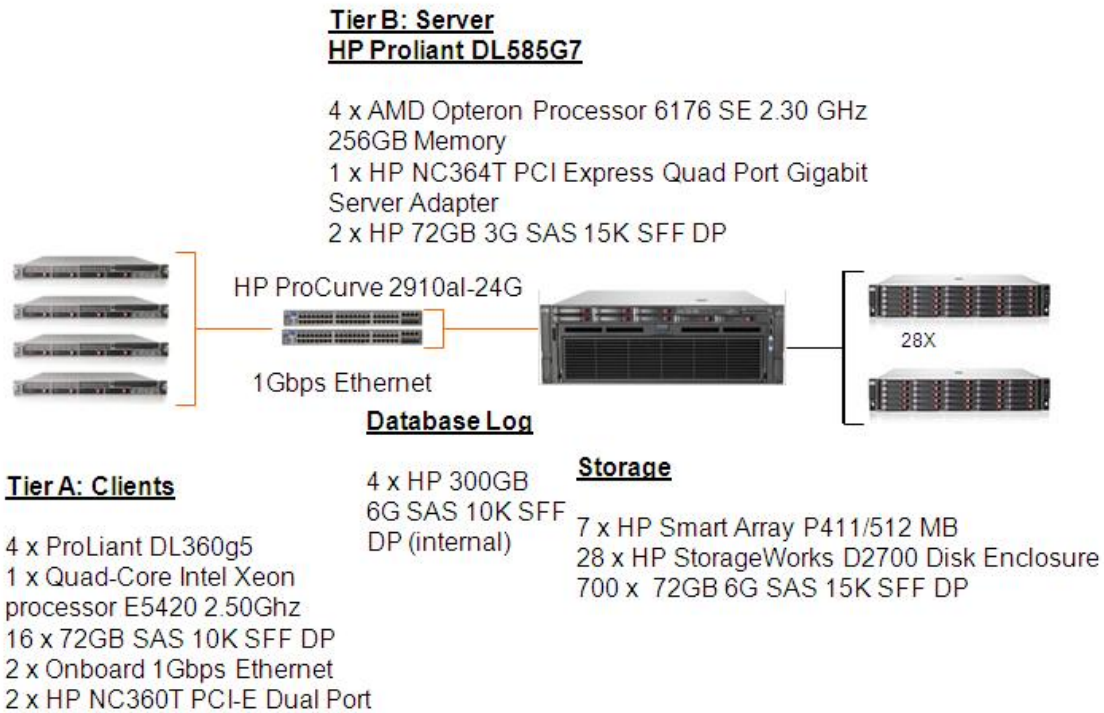


Figure 1.1 Benchmarked and Priced Configuration

1.7 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.

A description of any firmware updates or patches to the hardware.

A description of any GUI configuration used to configure the system hardware.

A description of exactly how the hardware is combined to create the complete system. For example, if the **SUT** description lists a base chassis with 1 processor, a processor update package of 3 processors, a NIC controller and 3 disk controllers, a description of where and how the processors, NIC and disk controllers are placed within the base chassis must be **reported** in the **Report**.

A description of how the hardware components are connected. The description can assume the reader is knowledgeable of computer systems and the TPC-E specification. For example, only a description that Controller 1 in slot A is connected to Disk Tower 5 is required. The reader is assumed to be knowledgeable enough to determine what type of cable is required based upon the component descriptions and how to plug the cable into the components.

The HP Proliant DL585 G7, in the benchmarked configuration, consists of a single cabinet with 4 sockets. Each socket has 1 processor installed, along with 32 x 8 GB DIMMs. The various HBA's, NICS, and other IO cards are installed in the various chassis as defined in the file **HWConfig.pdf** in the \SupportingFiles\Introduction\Tier "Introduction" directory. Additionally, the **DiskConfig.pdf** file in the *Supporting Files* directory shows how the SmartArray/MSA disk subsystem was configured.

1.8 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. This includes, but is not limited to:*

A description of any updates or patches to the software.

A description of any changes to the software.

A description of any GUI configurations used to configure the software.

The file **Win2008Setup.pdf** in the \Supporting Files\Introduction\TierB directory outlines the steps taken to configure the OS and DBMS. The file **DiskDriverCfg.pdf** in *RaidDriver* outlines the steps to configure the disk driver used for the Smart Array Controllers. The file **PerfDriver.reg** is the registry entry for the initial performance driver settings. The file **SQL2008Setup.doc** in \Supporting Files\Introduction\TierB likewise outlines the steps taken to setup the DBMS. Other supporting files (registry, configuration) are also included in the respective directories.

Clause 2: Database Design, Scaling & Population Items

2.1 Physical Database Organization

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

The database tables and indices were organized into two SQL Server filegroups as shown in Table 2.1 below. The tables that grew during the run, defined as *growing tables* in the TPC-E specification, were placed in a file group called Growing, while the tables that do not grow during the run, designated as *fixed and scaling*, and were placed in a filegroup called Fixed.

Directory **Clause2** in *Supporting Files* contains the scripts used to create the data base filegroups, tables, constraints, and indices. In addition, files to create TEMPDB files before the build and remove them after the build are included, as well as a script to remove the LOAD_FG files and filegroup after the build and before the initial backup.

Fixed		Growing
Account_Permission	Security	Cash_Transaction
Address	Watch_Item	Holding
Company	Watch_List	Holding_History
Company_Competitor	Charge	Holding_Summary
Customer	Commission_Rate	Settlement
Customer_Account	Exchange	Trade
Customer_TaxRate	Industry	Trade_History
Daily_Market	Sector	Trade_Request
Financial	Status_Type	
Last_Trade	TaxRate	
News_Item	Trade_Type	
News_Xref	Zip_Code	
Broker		

Table 2.1 – FileGroup Table Assignments

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 was done for this benchmark.

2.3 Replication, Duplication

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

Additional and/or duplicated columns in any table must be reported in the Report along with a statement on the impact on performance. (9.3.2.4)

No replication or duplication was done for this benchmark.

2.4 Cardinality of Tables

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

The TPC-E database was configured using 730,000 customers. Table 2.2 below shows the cardinality of each table.

Table	Rows
ACCOUNT_PERMISSION	5183437
ADDRESS	1095004
BROKER	7300
COMPANY	365000
COMPANY_COMPETITOR	1095000
CUSTOMER	730000
CUSTOMER_ACCOUNT	3650000
CUSTOMER_TAXRATE	1460000
DAILY_MARKET	652565250
FINANCIAL	7300000
LAST_TRADE	500050
NEWS_ITEM	730000
NEWS_XREF	730000
SECURITY	500050
WATCH_ITEM	73050375
WATCH_LIST	730000
CASH_TRANSACTION	11605264057
HOLDING	645856655
HOLDING_HISTORY	16905350179
HOLDING_SUMMARY	36307033
SETTLEMENT	12614400000
TRADE	12614400000
TRADE_HISTORY	30274580266
TRADE_REQUEST	0
CHARGE	15
COMMISSION_RATE	240
EXCHANGE	4
INDUSTRY	102
SECTOR	12
STATUS_TYPE	5
TAXRATE	320
TRADE_TYPE	5
ZIP_CODE	14741

Table 2.2 Initial Cardinality of Tables

2.5 Disk Configuration

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

Table 2.3 shows the configuration of the HP SmartArray P411 700 Drives configured for data connected to 7 HP SmartArray P411 controllers in 28 x D2700 enclosures, and 4 4 Drives configured for the log connected to 1 HP Smart Array P410i controllers in internal bay. All 28 x D2700 were configured as RAID1+0 arrays across all disks in each enclosure, including the log.

Each data array was partitioned with partitions: Growing, Fixed, and Backup (see the layout below). Access to all the partitions was by using mount points, no drive letters were used except for the log and the boot/utility drives.

SA #, Type	Cab, Bay, Chassis, Slot	Disk #	Drives Enclosure RAID Lvl	Path Filesystem Partition	Size	Use
1, P410i	Internal,1-6,0,0	1	2x72 SCSI, Internal RAID1	C:, NTFS	72GB	Win2008 Boot, PageFile, Utility, Scripts Mount Point Root, DB Root File
		2	4x300 SCSI, Internal RAID1	F:, RAW	558.7GB	Database log
2, P411	1-4,1-100,1,1	3	100x72 SAS D2700 RAID1+0	C:\e-fix\fx1\ (RAW) C:\e-grow\gw1\ (RAW) C:\e-fix\fx2\ (RAW) C:\e-grow\gw2\ (RAW) C:\e-fix\fx3\ (RAW) C:\e-grow\gw3\ (RAW) C:\e-fix\fx4\ (RAW) C:\e-grow\gw4\ (RAW) C:\e-fix\fx5\ (RAW)	6.15 GB 205.7 GB 6.15 GB 205.7 GB 6.15 GB 205.7 GB 6.15 GB 205.7 GB 6.15 GB	Fixed FG Grow FG Fixed FG Grow FG Fixed FG Grow FG Fixed FG Grow FG Fixed FG
		4	100x72 SAS D2700 RAID1+0	C:\e-grow\gw5\ (RAW) C:\e-fix\fx6\ (RAW) C:\e-grow\gw6\ (RAW) C:\e-back\back01\ (NTFS) C:\e-back\back02\ (NTFS) C:\e-back\back03\ (NTFS) C:\e-back\back04\ (NTFS) C:\e-back\back05\ (NTFS) C:\e-back\back06\ (NTFS)	205.7 GB 6.15 GB 205.7 GB 247.5 GB 247.5 GB 247.5 GB 247.5 GB 247.5 GB 247.5 GB	Grow FG Fixed FG Grow FG Backup Backup Backup Backup Backup Backup

Table 2.3 Disk/Partition Configuration

SA #, Type	Cab, Bay, Chassis, Slot	Disk #	Drives Enclosure RAID Lvl	Path Filesystem Partition	Size	Use
3, P411	5-8,1-100,1,2	5	50x72 SAS D2700 RAID1+0	C:\e-fix\fx1\ (RAW)	6.15 GB	Fixed FG
				C:\e-grow\gw1\ (RAW)	205.7 GB	Grow FG
				C:\e-fix\fx2\ (RAW)	6.15 GB	Fixed FG
				C:\e-grow\gw2\ (RAW)	205.7 GB	Grow FG
				C:\e-fix\fx3\ (RAW)	6.15 GB	Fixed FG
				C:\e-grow\gw3\ (RAW)	205.7 GB	Grow FG
				C:\e-fix\fx4\ (RAW)	6.15 GB	Fixed FG
	6	50x72 SAS D2700 RAID1+0	C:\e-grow\gw4\ (RAW)	205.7 GB	Grow FG	
			C:\e-fix\fx5\ (RAW)	6.15 GB	Fixed FG	
			C:\e-grow\gw5\ (RAW)	205.7 GB	Grow FG	
			C:\e-fix\fx6\ (RAW)	6.15 GB	Fixed FG	
			C:\e-grow\gw6\ (RAW)	205.7 GB	Grow FG	
			C:\e-back\back01\ (NTFS)	247.5 GB	Backup	
			C:\e-back\back02\ (NTFS)	247.5 GB	Backup	
4, P411	9-12,1-100,1,3	7	50x72 SAS D2700 RAID1+0	C:\e-fix\fx1\ (RAW)	6.15 GB	Fixed FG
				C:\e-grow\gw1\ (RAW)	205.7 GB	Grow FG
				C:\e-fix\fx2\ (RAW)	6.15 GB	Fixed FG
				C:\e-grow\gw2\ (RAW)	205.7 GB	Grow FG
				C:\e-fix\fx3\ (RAW)	6.15 GB	Fixed FG
				C:\e-grow\gw3\ (RAW)	205.7 GB	Grow FG
				C:\e-fix\fx4\ (RAW)	6.15 GB	Fixed FG
	8	50x72 SAS D2700 RAID1+0	C:\e-grow\gw4\ (RAW)	205.7 GB	Grow FG	
			C:\e-fix\fx5\ (RAW)	6.15 GB	Fixed FG	
			C:\e-grow\gw5\ (RAW)	205.7 GB	Grow FG	
			C:\e-fix\fx6\ (RAW)	6.15 GB	Fixed FG	
			C:\e-grow\gw6\ (RAW)	205.7 GB	Grow FG	
			C:\e-back\back01\ (NTFS)	247.5 GB	Backup	
			C:\e-back\back02\ (NTFS)	247.5 GB	Backup	
C:\e-back\back03\ (NTFS)	247.5 GB	Backup				
C:\e-back\back04\ (NTFS)	247.5 GB	Backup				
C:\e-back\back05\ (NTFS)	247.5 GB	Backup				
C:\e-back\back06\ (NTFS)	247.5 GB	Backup				

Table 2.3 Disk/Partition Configuration (continued)

SA #, Type	Cab, Bay, Chassis, Slot	Disk #	Drives Enclosure RAID Lvl	Path Filesystem Partition	Size	Use
5, P411	13-16,1- 100,1,4	9	50x72 SAS D2700 RAID1+0	C:\e-fix\fx1\ (RAW)	6.15 GB	Fixed FG
				C:\e-grow\gw1\ (RAW)	205.7 GB	Grow FG
				C:\e-fix\fx2\ (RAW)	6.15 GB	Fixed FG
				C:\e-grow\gw2\ (RAW)	205.7 GB	Grow FG
				C:\e-fix\fx3\ (RAW)	6.15 GB	Fixed FG
				C:\e-grow\gw3\ (RAW)	205.7 GB	Grow FG
				C:\e-fix\fx4\ (RAW)	6.15 GB	Fixed FG
	10	50x72 SAS D2700 RAID1+0	C:\e-grow\gw4\ (RAW)	205.7 GB	Grow FG	
			C:\e-fix\fx5\ (RAW)	6.15 GB	Fixed FG	
			C:\e-grow\gw5\ (RAW)	205.7 GB	Grow FG	
			C:\e-fix\fx6\ (RAW)	6.15 GB	Fixed FG	
			C:\e-grow\gw6\ (RAW)	205.7 GB	Grow FG	
			C:\e-back\back01\ (NTFS)	247.5 GB	Backup	
			C:\e-back\back02\ (NTFS)	247.5 GB	Backup	
6, P411	17-20,1- 100,1,5	11	50x72 SAS D2700 RAID1+0	C:\e-back\back03\ (NTFS)	247.5 GB	Backup
				C:\e-back\back04\ (NTFS)	247.5 GB	Backup
				C:\e-back\back05\ (NTFS)	247.5 GB	Backup
				C:\e-back\back06\ (NTFS)	247.5 GB	Backup
				C:\e-fix\fx1\ (RAW)	6.15 GB	Fixed FG
				C:\e-grow\gw1\ (RAW)	205.7 GB	Grow FG
				C:\e-fix\fx2\ (RAW)	6.15 GB	Fixed FG
	12	50x72 SAS D2700 RAID1+0	C:\e-grow\gw2\ (RAW)	205.7 GB	Grow FG	
			C:\e-fix\fx3\ (RAW)	6.15 GB	Fixed FG	
			C:\e-grow\gw3\ (RAW)	205.7 GB	Grow FG	
			C:\e-fix\fx4\ (RAW)	6.15 GB	Fixed FG	
			C:\e-grow\gw4\ (RAW)	205.7 GB	Grow FG	
			C:\e-fix\fx5\ (RAW)	6.15 GB	Fixed FG	
			C:\e-grow\gw5\ (RAW)	205.7 GB	Grow FG	
C:\e-fix\fx6\ (RAW)	6.15 GB	Fixed FG				
C:\e-grow\gw6\ (RAW)	205.7 GB	Grow FG				
C:\e-back\back01\ (NTFS)	247.5 GB	Backup				
C:\e-back\back02\ (NTFS)	247.5 GB	Backup				
C:\e-back\back03\ (NTFS)	247.5 GB	Backup				
C:\e-back\back04\ (NTFS)	247.5 GB	Backup				
C:\e-back\back05\ (NTFS)	247.5 GB	Backup				
C:\e-back\back06\ (NTFS)	247.5 GB	Backup				

Table 2.3 Disk/Partition Configuration (continued)

SA #, Type	Cab, Bay, Chassis, Slot	Disk #	Drives Enclosure RAID Lvl	Path Filesystem Partition	Size	Use
7, P411	21-24,1-100,1,6	13	50x72 SAS D2700 RAID1+0	C:\e-fix\fx1\ (RAW) C:\e-grow\gw1\ (RAW) C:\e-fix\fx2\ (RAW) C:\e-grow\gw2\ (RAW) C:\e-fix\fx3\ (RAW) C:\e-grow\gw3\ (RAW) C:\e-fix\fx4\ (RAW) C:\e-grow\gw4\ (RAW) C:\e-fix\fx5\ (RAW)	6.15 GB 205.7 GB 6.15 GB 205.7 GB 6.15 GB 205.7 GB 6.15 GB 205.7 GB 6.15 GB	Fixed FG Grow FG Fixed FG Grow FG Fixed FG Grow FG Fixed FG Grow FG Fixed FG
		14	50x72 SAS D2700 RAID1+0	C:\e-grow\gw5\ (RAW) C:\e-fix\fx6\ (RAW) C:\e-grow\gw6\ (RAW) C:\e-back\back01\ (NTFS) C:\e-back\back02\ (NTFS) C:\e-back\back03\ (NTFS) C:\e-back\back04\ (NTFS) C:\e-back\back05\ (NTFS) C:\e-back\back06\ (NTFS)	205.7 GB 6.15 GB 205.7 GB 247.5 GB 247.5 GB 247.5 GB 247.5 GB 247.5 GB 247.5 GB	Grow FG Fixed FG Grow FG Backup Backup Backup Backup Backup Backup
8, P411	25-28,1-100,1,7	15	50x72 SAS D2700 RAID1+0	C:\e-fix\fx1\ (RAW) C:\e-grow\gw1\ (RAW) C:\e-fix\fx2\ (RAW) C:\e-grow\gw2\ (RAW) C:\e-fix\fx3\ (RAW) C:\e-grow\gw3\ (RAW) C:\e-fix\fx4\ (RAW) C:\e-grow\gw4\ (RAW) C:\e-fix\fx5\ (RAW) C:\e-grow\gw5\ (RAW)	6.15 GB 205.7 GB 6.15 GB 205.7 GB 6.15 GB 205.7 GB 6.15 GB 205.7 GB 6.15 GB 205.7 GB	Fixed FG Grow FG Fixed FG Grow FG Fixed FG Grow FG Fixed FG Grow FG Fixed FG Grow FG
		16	50x72 SAS D2700 RAID1+0	C:\e-fix\fx6\ (RAW) C:\e-grow\gw6\ (RAW) C:\e-back\back01\ (NTFS) C:\e-back\back02\ (NTFS) C:\e-back\back03\ (NTFS) C:\e-back\back04\ (NTFS) C:\e-back\back05\ (NTFS) C:\e-back\back06\ (NTFS)	6.15 GB 205.7 GB 247.5 GB 247.5 GB 247.5 GB 247.5 GB 247.5 GB 247.5 GB	Fixed FG Grow FG Backup Backup Backup Backup Backup Backup

Table 2.3 Disk/Partition Configuration

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.(9.3.2.7)

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)*

Client software interfaced to SQL Server through stored procedures invoked by the clients with ODBC calls. The application code was C++.

The data model implemented by Microsoft SQL Server 2008 R2 Enterprise Edition is relational.

The methodology used to load the database is contained in the file **MSTPCE Database Setup Reference.pdf** in the CLAUSE2 directory in *Supporting Files* directory.

Clause 3: Transaction Related Items

3.1 Code Functionality

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

Secondary sponsor-supplied code is functionally equivalent to pseudo-code in the specification.

3.2 Database Footprint

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

Database footprint requirements were met.

Clause 4: SUT, Driver and Network Related Items

4.1 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) and any optional Database Server interface networks (9.3.4.1)

The network configurations for both the priced and reported configurations are the same. All network connections were through two HP ProCurve 2910al-24G switches. The 1 driver machine and the 4 client machines were networked via one of their built in 1Gbps port, and an external HP 360T dual port network card. The DBMS server used a two quad port 1Gbps NIC for data base traffic during the measured run, both of which are priced. Figures 1.1 shows configuration of the network.

Clause 5: Egen Related Items

5.1 Egen Version

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

Egen Version used for this test was 1.10.0

5.2 Egen Code

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

All required TPC provided Egen code was used in this 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 if any of the changes to EGen do not have a formal waiver that must also be reported in the Report.

No modifications to Egen were done for this report.

5.4 Egen Loader Extensions

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 in the Report (9.3.5.4)

Egen Loader was not extended for this report.

5.5 Egen Loader Make 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.(9.3.5.5)

The Visual C++ project files are included in the **EgenMakeFiles** directory in the **Clause5** directory in the *Supporting Files* directory.

Clause 6: Performance Metrics and Response Time Related Items

6.1 EgenDriver and MEE instances

The number of EGenDriverMEE and EGenDriverCE instances used in the benchmark must be reported in the Report (9.3.6.1)

24 instances of both the EgenDriverMEE and EgenDriverCE were used in this report.

6.2 Measured Throughput

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

Measured tpsE for this run was 1,400.14 tpsE.

Test Run Graph and Steady State Measurement

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

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

After initial ramp-up, throughput and response time were observed until both were constant, generally to within less than a percent of the reported throughput. Throughput and response time were determined by examining the data after the run was terminated. The data was reported over every 60 second window during the test run. Ramp up and steady state can be seen from the graph below.

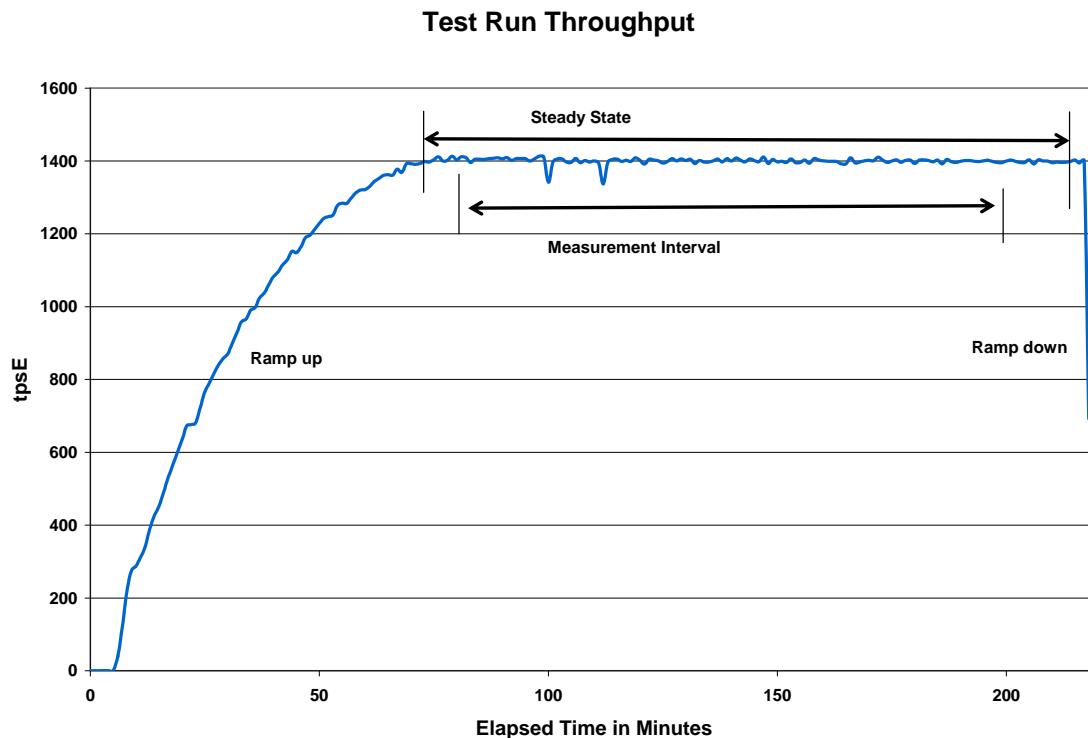


Figure 6.1 Test Run Time/Steady State Measurement Run Data

6.4 Work Measurement

*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 check-pointing, writing **Undo/Redo Log** records, etc). (9.3.6.5)*

During the run, the Customer Emulator engines (Driver Engines) generated transactions via the audited stored procedures as per the TPC-E specification. Each transaction was time-stamped, response time verified, and the transactions logged into individual log files. Communication was done between the Driver Engine Customer Emulators and Market Emulators to the SUT Server emulators, which in turn generated commands via ODBC connections to Microsoft SQL Server 2008 R2 Enterprise Edition. Satisfying these ODBC requests constitute the primary load on the server during the run.

Checkpoints were performed to flush all dirty pages from memory, and write a record of this fact to the transaction log. This was accomplished by setting the SQL Recovery Interval to 32767, which effectively tells SQL to not checkpoint automatically. Near the beginning of the test run, a script was started that did manual checkpoints, specifying an interval of 435 seconds. SQL Server was run with run flag 3502, which caused it to display messages when checkpoints were started and ended. This was used to verify the checkpoints were done in the time intervals as required by the TPC-E specification.

6.5 Transaction Reporting

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

Table 6.2 shows the Averages for the Test Run.

Transaction	Over-all	Parameter	Value	Range Check	Acceptable Range	
					Min	Max
Customer Position	OK	By Tax ID	50.01%	Ok	48.00%	52.00%
		Get History	50.02%	Ok	48.00%	52.00%
Trade Lookup	OK	Frame 1	30.02%	Ok	28.50%	31.50%
		Frame 2	30.00%	Ok	28.50%	31.50%
		Frame 3	29.98%	Ok	28.50%	31.50%
		Frame 4	10.00%	Ok	9.50%	10.50%
Market Watch	OK	By Watch List	60.01%	Ok	57.00%	63.00%
		By Customer Acct	35.00%	Ok	33.00%	37.00%
		By Industry	4.99%	Ok	4.50%	5.50%
Trade Update	OK	Frame 1	33.00%	Ok	31.00%	35.00%
		Frame 2	32.99%	Ok	31.00%	35.00%
		Frame 3	34.01%	Ok	32.00%	36.00%
Security Detail	OK	Access LOB	1.00%	Ok	0.90%	1.10%
Trade Order	OK	By Non-Owner	9.98%	Ok	9.50%	10.50%
		By Company Name	39.99%	Ok	38.00%	42.00%
		Buy on Margin	7.99%	Ok	7.50%	8.50%
		Rollback	0.99%	Ok	0.94%	1.04%
		LIFO	35.02%	Ok	33.00%	37.00%
		Trade by Qty 100	24.99%	Ok	24.00%	26.00%
		Trade by Qty 200	24.99%	Ok	24.00%	26.00%
		Trade by Qty 400	25.00%	Ok	24.00%	26.00%
		Trade by Qty 800	25.02%	Ok	24.00%	26.00%
		Market Buy	30.01%	Ok	29.70%	30.30%
		Market Sell	30.01%	Ok	29.70%	30.30%
		Limit Buy	20.00%	Ok	19.80%	20.20%
		Limit Sell	10.00%	Ok	9.90%	10.10%
		Stop Loss	9.98%	Ok	9.90%	10.10%

Table 6.2 Average Transaction Parameters

Clause 7: Transaction and System Properties

7.1 ACID Tests

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

The Atomicity, Consistency, Isolation, and Durability tests are specified by the TPC-E specification. These requirements are translated into audited procedures which are executed either on a fresh database (Isolation, Atomicity), or after a test run (Consistency). Instructions for running these tests are included in the file *MSTPCE ACID Procedures.pdf*. This file, along with results of these tests is contained in the *Supporting Files* directory under *Clause7*.

Durability test consisted of Data Accessibility and Business Recovery tests. The procedures for each are outlined below.

7.2 Redundancy Level and Data Accessibility Tests

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

Redundancy level 1 was used for all tests and the measured run.

The Data Accessibility Test was performed according to the following steps

1. The rows in the Settlement table were counted to establish the initial count of trades present.
2. A run was started using the same profile and configuration as the test run (reported result) and ramped up to 95% of the Reported Throughput.
3. After more 5 minutes of running at $\geq 95\%$ of the Reported Throughput, a data disk in the RAID10 data arrays was pulled, and a few seconds later, a log disk in the RAID10 log array was pulled.
4. The benchmark was allowed to run for 5 more minutes at steady state, all at $\geq 95\%$ of Reported Throughput.
5. After the 5 minutes, the disks were replaced by different disks of the same size and a rebuild of the volumes started automatically by the Smart Array controllers.
6. The run continued for more than 20 minutes at $\geq 95\%$ of the Reported Throughput.
7. The benchmark was terminated gracefully, and the various reports were run. No errors were reported at any time in this process.
8. The rows in the Settlement table were counted again to establish the final number of trades present in the data base.
9. The initial count was subtracted from the final count and was verified against the reported number of Trade-Result transactions
10. After the two disks were rebuilt, the recovery was considered complete.

7.3 Data Accessibility Graph

A *Data Accessibility Graph* for each run demonstrating a *Redundancy Level* must be *reported in the Report*. (9.3.7.3)

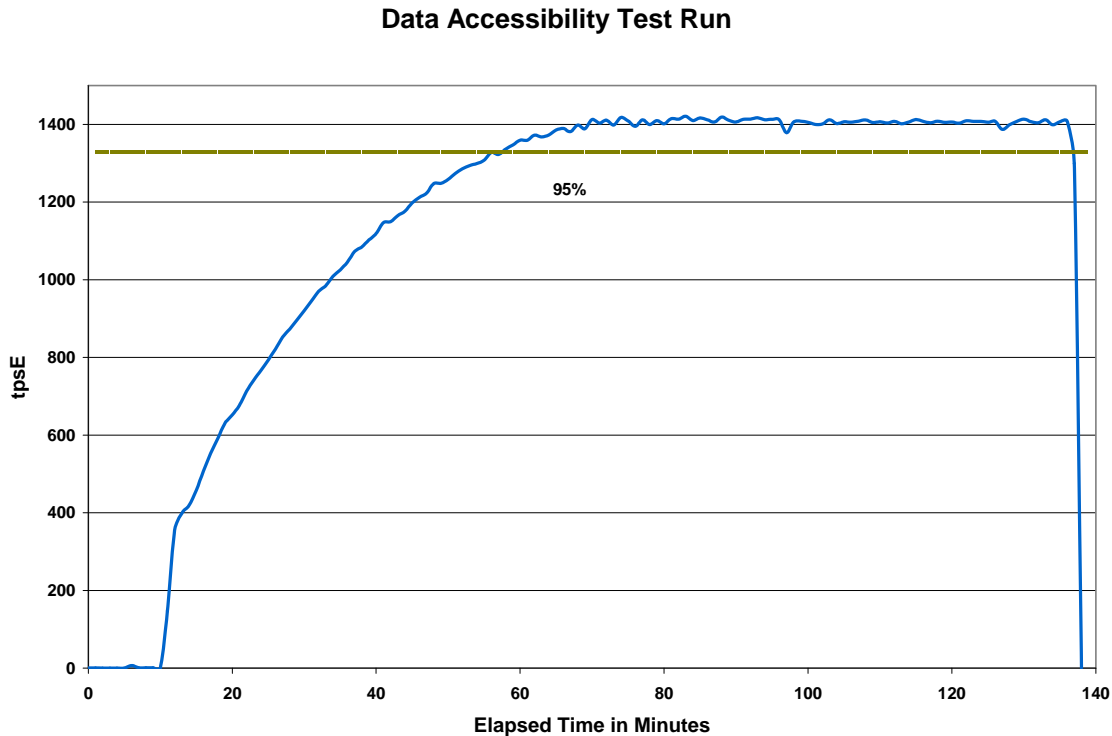


Figure 7.1 Data Accessibility Test Run Graph

7.4 Business Recovery Tests

The *Test Sponsor* must describe in the *Report* the test(s) used to demonstrate *Business Recovery*. (9.3.7.4)

This test measures the time it takes to recover to 95% of the reported throughput after a system power loss.

1. The rows in the Settlement table were counted to establish the initial count of trades present.
2. A run was started using the same profile and configuration as the test run (reported result) and ramped up to 95% of the Reported Throughput.
3. Primary power to Tier B server was removed (i.e., the plug was pulled).
4. Drivers noted transaction failures almost immediately, and the driver environment was terminated while the servers were booting back up.
5. Power was restored to Tier B server, and the machines rebooted.
6. After the OS was running, SQL Server was started, which automatically started transaction recovery of the primary TPCE data base. This process reads the transaction log and reapplies all committed transactions and rollback any incomplete transactions. At the end of this process, the database on disk will be logically consistent.
7. Business Recovery starts with the first line of output produced by Microsoft SQL Server 2008 R2 Enterprise Edition.

8. After SQL finished recovery of TPCE and reported that the data base was available, the Trade-Cleanup Transaction was executed.
9. The benchmark was started and ramped up as before to 95% of the Reported Throughput.
10. The benchmark was allowed to run at $\geq 95\%$ for 20 minutes.
11. The driver environment was terminated gracefully. No errors were reported.
12. The rows in the Settlement table were counted again to determine the final number of trades present.
13. The initial count was subtracted from the final count was calculated, and this number was verified to be greater than or equal to the number of Trade-Result transacts as logged during the run.
14. The Consistency scripts were run to verify the data base was logically consistent.
15. The beginning of the first window of time where $\geq 95\%$ for 20 minutes was noted, which marked the end of the Business Recovery interval.

Business Recovery Time was 1 hour 3 minutes and 3 seconds. This is also reported in the Executive Summary.

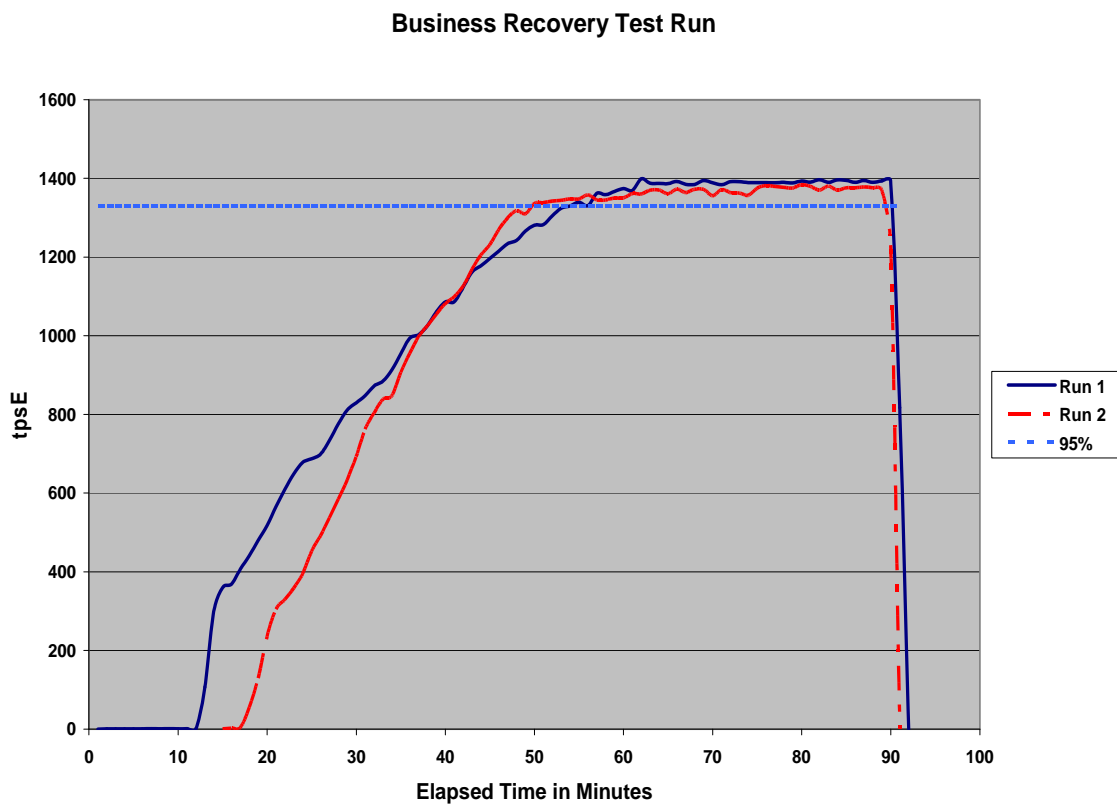


Figure 7.2 The Business Recovery Tests Graph

Clause 8: Pricing Related Items

8.1 60-Day Space

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

Below is the 60 Day Space spreadsheet as prepared by the auditor and verified from the IO configuration.

Table	Rows	Data(KB)	Index(KB)	Total	Total + 5%	Rows After	Data After(KB)	Index After(KB)	Growth
ACCOUNT_PERMISSION	5183437	441328	3232	444,560	466,789	5183437	441480	3384	304
ADDRESS	1095004	63248	1016	64,264	67,477	1095004	63288	1016	40
BROKER	7300	536	712	1,248	1,310	7300	536	712	-
CASH_TRANSACTION	11605264057	1197120408	2525632	1,199,646,040	1,259,628,342	11620020567	1200079200	2535480	2,968,640
CHARGE	15	8	8	16	17	15	8	8	-
COMMISSION_RATE	240	16	16	32	34	240	16	16	-
COMPANY	365000	79496	23240	102,736	107,873	365000	79504	23240	8
COMPANY_COMPETITOR	1095000	29480	25056	54,536	57,263	1095000	29480	25056	-
CUSTOMER	730000	123712	33104	156,816	164,657	730000	123728	33104	16
CUSTOMER_ACCOUNT	3650000	330784	71648	402,432	422,554	3650000	330784	71648	-
CUSTOMER_TAXRATE	1460000	30496	1016	31,512	33,088	1460000	30632	1016	136
DAILY_MARKET	652965250	33726168	119256	33,845,424	35,537,635	652965250	33727352	119488	1,416
EXCHANGE	4	8	8	16	17	4	8	8	-
FINANCIAL	7300000	858992	3312	862,304	905,419	7300000	859192	3440	328
HOLDING	645856655	42986544	27189304	70,175,848	73,684,640	646264549	43963768	27193136	981,056
HOLDING_HISTORY	16905350179	614740168	355319112	970,059,280	1,018,562,244	16926978686	616623648	356614200	3,178,568
HOLDING_SUMMARY	36307033	1578120	6656	1,584,776	1,664,015	36307518	1578120	6656	-
INDUSTRY	102	8	24	32	34	102	8	24	-
LAST_TRADE	500050	31064	1016	32,080	33,684	500050	31064	1016	-
NEWS_ITEM	730000	79145560	1832	79,147,392	83,104,762	730000	79145592	1864	64
NEWS_XREF	730000	18240	1016	19,256	20,219	730000	18240	1016	-
SECTOR	12	8	24	32	34	12	8	24	-
SECURITY	500050	78888	19104	97,992	102,892	500050	78896	19104	8
SETTLEMENT	12614400000	668693680	1410504	670,104,184	703,609,393	12630438808	670442312	1416496	1,754,624
STATUS_TYPE	5	8	8	16	17	5	8	8	-
TAXRATE	320	24	16	40	42	320	24	16	16
TRADE	12614400000	1504029360	755681880	2,259,711,240	2,372,696,802	12630522183	1506069744	761464512	7,823,016
TRADE_HISTORY	30274580266	910513840	2374816	912,888,656	958,533,089	30313103737	913488400	2386728	2,986,472
TRADE_REQUEST	0	8	40	48	50	83375	15040	15952	30,944
TRADE_TYPE	5	8	1032	1,040	1,092	5	8	1032	-
WATCH_ITEM	73050375	2029744	8248	2,037,992	2,139,892	73050375	2029888	8384	280
WATCH_LIST	730000	18248	15896	34,144	35,851	730000	18248	15896	-
ZIP_CODE	14741	488	176	664	697	14741	488	176	-
Totals in KB	85445865100	5056668688	1144837960	6201506648	6511581980		5069268728	1151963856	19725936

Database File Groups	Allocated size MB	Required size MB	Diff	file size
Fixed	258,300	120,316	137,984	# of files
Growing	8,639,400	6,238,681	2,400,719	total in KB (%)
Total	8,897,700	6,358,997		
Total in GB	8.6892	6.2100		

Growing Space	19,723,320	KB		
per Trade Results	1.23	KB		
Data Growth	49,587,462	KB		
60 Day Space	9,176,754,385	KB		
60 Day Space	8,752	GB		
Log space before in MB	12,504	%	2,7785625	size 450000
Log space after in MB	117,541		26.120159	450000
per Trade Results	0.007			
Log Growth	264,080	MB		
Total 8 hours log space	276,583	MB		
Total 8 hours log space	270.10	GB		

Count	Formatted size GB	Total GB Configured	Total Needed
Data Disks configured	0	33.37	-
	700	66.85	46,795
	0	135.49	-
RAID 10 overhead 50%			(23,398)
Data Disks space total			23,398
			8,752
Log Disks configured	4	279.35	1,117
RAID 10 overhead 50%			(559)
Log Disk space total			559
			270

8.1 Attestation Letter



June 19, 2010

Mr. Paul Cao
Senior System Engineer
Hewlett-Packard Company
20555 SH 249
Houston, TX 77070

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

Platform: HP ProLiant DL585 G7
Database Manager: Microsoft SQL Server 2008 R2 Enterprise Edition
Operating System: Microsoft Windows Server 2008 R2 Enterprise Edition
Transaction Monitor: Microsoft COM+

System Under Test:				
CPU's	Memory	Disks (total)		TpsE
4 AMD 12 core @ 2.3 Ghz	Main: 256 GB	702 @ 72 GB 4 @ 300 GB		1,400.14
2 Clients (Tier A): ProLiant DL360 G5				
1 Intel quad core @ 2.50 Ghz	2 GB	4 @ 72 GB	NA	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 1.10.0.
- The database files were properly sized and populated for 730,000 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 on 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.
- The steady state portion of the test was 120 minutes.
- Checkpoint interval was verified to be equal to or less than 7.5 minutes and no two checkpoints lasted longer than 15 minutes.
- The system pricing was checked for major components and maintenance.
- Third party quotes were verified for compliance.
- The FDR, Executive Summary and Supporting Files were reviewed and verified as required.

Auditor Notes: None.

Sincerely,

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

Lorna Livingtree, Certified Auditor

Clause 9: Supporting Files

9.1 Supporting Files

*The **Supporting Files** contain human readable and machine executable (i.e., able to be performed by the appropriate program without modification) scripts that are required to recreate the benchmark **Result**. If there is a choice of using a GUI or a script, then the machine executable script must be provided in the **Supporting Files**. If no corresponding script is available for a GUI, then the **Supporting Files** must contain a detailed step by step description of how to manipulate the GUI.(9.4)*

Appendix A: Third Party Quotes/Pricing

Microsoft

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

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

Microsoft

June 16, 2010

Hewlett-Packard Company
Paul Cao
20555 SH 249
Houston, TX 77070

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
810-07580	SQL Server 2008 R2 Enterprise Edition <i>Per Processor License</i> <i>Open Program - Level C</i> <i>Unit Price reflects a 33% discount from the retail unit price of \$28,749.</i>	\$19,188	4	\$76,752
P72-04217	Windows Server 2008 R2 Enterprise Edition <i>Server License with 25 CALs</i> <i>Open Program - Level C</i> <i>Unit Price reflects a 43% discount from the retail unit price of \$3,999.</i>	\$2,280	1	\$2,280
P73-04165	Windows Server 2008 Standard Edition <i>Server License with 5 CALs</i> <i>Open Program - Level C</i> <i>Unit Price reflects a 29% discount from the retail unit price of \$999.</i>	\$711	4	\$2,844
N/A	Microsoft Problem Resolution Services <i>Professional Support</i> <i>(1 Incident).</i>	\$259	1	\$259

All Microsoft products listed above are currently orderable and available through Microsoft's normal distribution channels. A list of Microsoft's resellers can be found at the Microsoft Product Information Center at <http://www.microsoft.com/products/info/render.aspx?view=22&type=how>. Defect support is included in the purchase price. Additional support is available from Microsoft PSS on an incident by incident basis at \$259 per call.

This quote is valid for the next 90 days.

Reference ID: TPCE_g3wOpiq6ZAtgdnQQtWbatNjU7f+RiCyr_V1.0.0.

Appendix B: TPC-Energy Disclosure Report

B.1. TPC-Energy Clause 2-related items (Methodology)

B.1.1. Minimum ambient temperature

The minimum ambient temperature must be disclosed

Minimum Temperature reported by EMSC = 21.44 °C

B.1.2. External electric power source characteristics

The characteristics of the external electric power source must be disclosed. In particular, the voltage, frequency in Hertz, and phase information must be reported.

The external electric power source has the following characteristics: 208V, 60Hz, single phase.

B.1.3. Air-pressure alterations

A statement is required that assures that nothing was done to alter the air-pressure in the measurement environment.

Nothing was done to alter the air-pressure in the measurement environment.

B.1.4. Temperature measurement

A description of where the temperature was measured and how it was determined that this was representative of the lowest ambient temperature is required.

The temperature was measured at the SUT air inlet located at the lowest temperature of the SUT

B.1.5. Cooling method

If a method of cooling other than circulation of ambient air is employed in the REC, a statement describing this method must be included.

No other method of cooling was used.

B.1.6. PTD license

To be compliant with licenses associated with EMS, the following statement must be included in every FDR which contains a TPC-Energy Metric:

The power and temperature characteristics of the MEC were measured using TPC's Energy Measurement Software (EMS). This includes the EMS-PTD, a modified version of the SPEC PTDaemon, which is provided under license from the Standard Performance Evaluation Corporation (SPEC).

B.2. TPC-Energy Clause 3-related items (Metrics)

B.2.1. Primary Metric

The normalized work derived from the Performance Metric (as described in Clause 3.2.1) must be disclosed

6.72 watts / tpsE

The computation for total energy used for each measurement segment that contributes to a Performance Metric must be disclosed. If the energy of the entire Priced Configuration is not derived from direct measurements, the methods for deriving the energy for components that were not measured must be disclosed (See Clause 7.3.3.4)

PMU	Full Load Average Watts Reading	% of Reading Uncertainty	Full Load Energy						Reported Watt - Seconds	Adjusted Watt - Seconds	Reported Seconds	Adjusted Average Watts
			Watts Reading Correction	Wattage Range Setting	% of Range Uncertainty	Wattage Range Correction	Total Wattage Correction	Accuracy Correction Factor				
DB Server PMU-1	974.55	0.10%	+0.97	1500	0.10%	+1.50	+2.47	0.25%	7,017,762	7,035,581	7,200	977.16
DB Server Total	974.55								7,017,762	7,035,581		977.16
Storage PMU-1	2137.48	0.10%	+2.14	6000	0.10%	+6.00	+8.14	0.38%	15,391,999	15,450,597	7,200	2,145.92
Storage PMU-2	3384.25	0.10%	+3.38	6000	0.10%	+6.00	+9.38	0.28%	24,369,962	24,437,537	7,200	3,394.10
Storage PMU-3	1986.72	0.10%	+1.99	3000	0.10%	+3.00	+4.99	0.25%	14,306,382	14,342,291	7,200	1,991.98
Storage Total	7508.45								54,068,343	54,230,426		7,532.00
App Server PMU-1	760.68	0.10%	+0.76	1500	0.10%	+1.50	+2.26	0.30%	5,477,621	5,493,900	7,200	763.04
App Server Total	760.68								5,477,621	5,493,900		763.04
Misc PMU-1	102.52	0.10%	+0.10	600	0.10%	+0.60	+0.70	0.69%	738,232	743,291	7,200	103.23
Monitor Name Plate	28	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	201,600	201,600	7,200	28.00
Misc Total	130.52								939,832	944,891		131.23
REC Total	9,374.20								67,503,557	67,704,798		9,403.44

All monitors power consumption in the Miscellaneous Subsystem were calculated using nameplate values.

The duration of each measurement that produces a Performance Metric must be disclosed

The duration of the measured run was 120 minutes. The idle measurement was 10 minutes.

The average power requirement for each measurement that produces one of these metrics,

	Secondary Metric:	Additional Numerical Quantities				Idle % of REC
	Watts / tpsE	Full Load Avg Watts	Full Load % of REC	Full Load Watt Secs	Idle Avg. Watts	
Database Server	0.70	977.16	10.4%	7,035,581	790.73	9.7%
Storage	5.38	7,532.00	80.1%	54,230,426	6,502.56	79.9%
Application Server	0.54	763.04	8.1%	5,493,900	715.53	8.8%
Miscellaneous	0.09	131.23	1.4%	944,891	131.57	1.6%
Total REC	6.72	9403	100%	67,704,798	8140	100%

Total REC Energy Consumption = 67,704,798 watt-seconds
 SUT Total Work = 10,081,008 transactions

67,704,798 watt-seconds / 10,081,008 = 6.72 watts / tpsE

B.2.2. Secondary Metrics At Reported Performance

If the TPC-Energy Secondary Metrics are reported, the components of the REC that are included in each subsystem must be identified. This can be achieved with separate lists to be included in the FDR or with a specific designation in the price spreadsheet. Every component in the REC that consumes energy must be included in exactly one subsystem.

TPC-Energy secondary metrics are reported.

Description	Part Number	Qty
Server Subsystem		
HP DL585R07 CTO Chassis Svr	590480-B21	1
HP DL585G7 6176SE FIO 2P Kit	601351-L21	2
HP 8GB 2Rx4 PC3-8500R-7 Kit	516423-B21	32
HP 72GB 3G SAS 10K SFF DP ENT HDD	384842-B21	2
HP Smart Array P411/512 MB with BBWC Controller	462832-B21	7
HP NC364T PCI Express Quad Port Gigabit Server Adapter	412648-B21	1
HP LE1851w 18.5-Inch wide Monitor	NK033AA#ABA	1
HP PS/2 Keyboard And Mouse Bundle	RC464AA#ABA	1
HP 300GB SAS 10K SFF DP ENT HDD	512547-B21	4
Storage Subsystem		
HP StorageWorks D2700 Disk Enclosure	AJ941A	28
HP 72GB 6G SAS 15K SFF DP ENT HDD	512545-B21	700
Application Server Subsystem		
HP ProLiant DL360 G5 E5420 2.50GHz Quad Core 2GB Rack Server	457925-001	4
HP 72GB 3G SAS 10K SFF DP ENT HDD	384842-B21	16
HP NC360T PCI-E Dual Port Gigabit Server Adapter	412648-B21	4
HP 3y 4h 24x7 ProLiant DL36x HW Support ,ProLiant DL36x	U4497E	4
Miscellaneous Subsystem		
HP ProCurve 2910al-24G Switch 24-port 10/100/1000 basic Layer 3	J9145A#ABA	2
HP LE1851w 18.5-Inch wide Monitor	NK033AA#ABA	1

For each defined subsystem, the calculations defined for the TPC-Energy Secondary Metrics in Clause 3.3 must be reported, using the Performance Metric of the entire SUT and the energy consumption for each REC subsystem.

	Secondary Metrics	Additional Numerical Quantities				Idle % of REC
	Watts / tpsE	Full Load Avg Watts	Full Load % of REC	Full Load Watt Secs	Idle Avg. Watts	
Database Server	0.70	977.16	10.4%	7,035,581	790.73	9.7%
Storage	5.38	7,532.00	80.1%	54,230,426	6,502.56	79.9%
Application Server	0.54	763.04	8.1%	5,493,900	715.53	8.8%
Miscellaneous	0.09	131.23	1.4%	944,891	131.57	1.6%
Total REC	6.72	9403	100%	67,704,798	8140	100%
			Total SUT Work	10,081,008		
Reported tpsE	1400.14		MI Seconds	7200		

1400.14 tpsE * 7200 seconds MI = 10,081,008 transactions (SUT Total Work)

7,035,581 watt-seconds / 10,081,008 transactions = 0.70 DBServer watts/tpsE

54,230,426 watt-seconds / 10,081,008 transactions = 5.38 Storage watts/tpsE

5,493,900 watt-seconds / 10,081,008 transactions = 0.54 AppServer watts/tpsE

944,891 watt-seconds / 10,081,008 transactions = 0.09 Misc. watts/tpsE

B.2.3. Idle Power reporting

The Idle Power measurement/calculation for the REC must be reported as numerical quantities.

The Idle power measurement for REC = 8140 watts.

If TPC-Energy Secondary Metrics are reported, then the Idle Power measurement/calculation for each subsystem must also be reported as numerical quantities.

PMU	Idle Average Watts Reading	% of Reading Uncertainty	Idle Load Energy					Reported Watt - Seconds	Adjusted Watt - Seconds	Reported Seconds	Adjusted Average Watts	
			Watts Reading Correction	Wattage Range Setting	% of Range Uncertainty	Wattage Range Correction	Total Wattage Correction					Accuracy Correction Factor
DB Server PMU-1	787.12	0.10%	+0.79	1500	0.10%	+1.50	+2.29	0.29%	473,062	474,436	600	790.73
DB Server Total	787.12								473,062	474,436		790.73
Storage PMU-1	1844.05	0.10%	+1.84	6000	0.10%	+6.00	+7.84	0.43%	1,108,273	1,112,988	600	1,854.98
Storage PMU-2	2910.6	0.10%	+2.91	6000	0.10%	+6.00	+8.91	0.31%	1,749,273	1,754,629	600	2,924.38
Storage PMU-3	1720.33	0.00%	+0.00	3000	0.00%	+0.00	+0.00	0.00%	1,033,919	1,033,919	600	1,723.20
Storage Total	6474.98								3,891,466	3,901,535		6,502.56
App Server PMU-1	712.13	0.10%	+0.71	1500	0.10%	+1.50	+2.21	0.31%	427,990	429,320	600	715.53
App Server Total	712.13								427,990	429,320		715.53
Misc PMU-1	102.69	0.10%	+0.10	600	0.10%	+0.60	+0.70	0.68%	61,719	62,141	600	103.57
Monitor Name Plate	28	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	16,800	16,800	600	28.00
Misc Total	130.69								78,519	78,941		131.57
REC Total	8,104.92								4,871,037	4,884,232		8,140.39

The length of time between the conclusion of the performance measurement and the start of the idle measurement must be reported.

Idle measurement was started 2 minutes after all data processing was completed.

The duration of the idle measurement must be reported

Idle measurement duration was 10 minutes.

A statement is required that assures that the system is in a state that is ready to run the Application(s) of the benchmark for the duration of the idle measurement.

The system is in a state that is ready to run the Application(s) of the benchmark for the duration of the idle measurement. This was verified by executing one transaction after the idle measurement interval was completed. The transaction time was compared to the allowed 90th percentile and found to meet the required specifications.

B.2.4. Disclosure requirements when only part of the REC is measured for power

If all PMU's of the REC are not measured for energy use, the FDR must include a description of which PMUs of REC were measured with a power analyzer. The FDR must disclose which PMUs of the REC were computed based on the energy measurements of similar PMUs. A diagram must be included that identifies the portions of the configuration which were measured for energy use and which were calculated. This diagram may be combined with other diagrams required by the TPC Benchmark Standard.

- *The method used to determine which PMUs were measured must be disclosed.*
- *The power values for the each partial-REC measurement for duration of the performance and idle measurements must be disclosed.*
- *The calculation for the power requirements of the entire REC and, if applicable, each subsystem must be disclosed.*

The monitor power consumption in the Miscellaneous Subsystem was calculated using the nameplate value.

B.2.5. Disclosure requirements when component substitution is used

If the TPC Benchmark Standard allows the Priced Configuration to differ from the Measured Configuration, the methods used to assign energy or power characteristics to the substitute components must be disclosed

The Priced Configuration was identical to the Measured Configuration.

PMU	Full Load Energy								Reported Watt - Seconds	Adjusted Watt - Seconds	Reported Seconds	Adjusted Average Watts
	Full Load Average Watts Reading	% of Reading Uncertainty	Watts Reading Correction	Wattage Range Setting	% of Range Uncertainty	Wattage Range Correction	Total Wattage Correction	Accuracy Correction Factor				
DB Server PMU-1	974.55	0.10%	+0.97	1500	0.10%	+1.50	+2.47	0.25%	7,017,762	7,035,581	7,200	977.16
DB Server Total	974.55								7,017,762	7,035,581		977.16
Storage PMU-1	2137.48	0.10%	+2.14	6000	0.10%	+6.00	+8.14	0.38%	15,391,999	15,450,597	7,200	2,145.92
Storage PMU-2	3384.25	0.10%	+3.38	6000	0.10%	+6.00	+9.38	0.28%	24,369,962	24,437,537	7,200	3,394.10
Storage PMU-3	1986.72	0.10%	+1.99	3000	0.10%	+3.00	+4.99	0.25%	14,306,382	14,342,291	7,200	1,991.98
Storage Total	7508.45								54,068,343	54,230,426		7,532.00
App Server PMU-1	760.68	0.10%	+0.76	1500	0.10%	+1.50	+2.26	0.30%	5,477,621	5,493,900	7,200	763.04
App Server Total	760.68								5,477,621	5,493,900		763.04
Misc PMU-1	102.52	0.10%	+0.10	600	0.10%	+0.60	+0.70	0.69%	738,232	743,291	7,200	103.23
Monitor Name Plate	28	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	201,600	201,600	7,200	28.00
Misc Total	130.52								939,832	944,891		131.23
REC Total	9,374.20								67,503,557	67,704,798		9,403.44

The method used to determine which PMUs were measured must be disclosed.

All priced PMUs were measured except for the monitor which the nameplate value was reported.

The power values for the each partial-REC measurement for duration of the performance and idle measurements must be disclosed.

See Chart Above.

B.3. TPC-Energy Clause 4-related items (Drivers /Controller)

A statement indicating the version of EMS used must be included in the FDR, including a statement that no alterations of this code were made for the benchmark, except as specified by Clause 7.3.4.3. This includes levels for the EMS-PTD Manager, EMS-PTD and EMS-controller

EMS version was 1.1.1 and no alterations were made.

Input parameters for the EMS software must be disclosed

Any changes in the EMS components must be documented. Documentation must include a description of the issue, the reason the change was necessary for disclosure of the Result, and the changes made to resolve it. Any change to TPC-Provided Code must be included with the submission as a Supporting File.

No changes to EMS components were made.

B.4. TPC-Energy Clause 6-related items (Instrumentation)

B.4.1. Power Analyzer information

Power Analyzer Specifications and Settings									
PMU	Make	Model	Serial Number	Calibration Date	Wattage (W) Range Setting	Voltage (V) Range Setting	Current (A) Range Setting	% of reading	% of Range
DB Server PMU-1	Yokogawa	WT210	91J713272	8/26/2009	1500	300	5	0.10%	0.10%
Storage PMU-1	Yokogawa	WT210	91GB53023	12/10/2009	6000	300	20	0.10%	0.10%
Storage PMU-2	Yokogawa	WT210	91GB45372	12/10/2009	6000	300	20	0.10%	0.10%
Storage PMU-3	Yokogawa	WT210	91J716746	12/10/2009	3000	300	10	0.10%	0.10%
App Server PMU-1	Yokogawa	WT210	91GC23225	12/10/2009	1500	300	5	0.10%	0.10%
Misc PMU-1	Yokogawa	WT210	91K112851	2/8/2010	600	300	2	0.10%	0.10%

B.4.2. Temperature Sensor information

Make and model.

Accuracy and the source of info

Digi Watchport/H Temperature Probe.

Temperature accuracy from Manufacturer's Datasheet:

+/- 3.6° F (+/- 2° C) at -40° F to 14° F (-40° C to -10° C)

+/- 0.9° F (+/- 0.5° C) at 14° F to 185° F (-10° C to 85° C)

B.5. TPC-Energy Clause 8-related items

B.5.1. Auditor's attestation letter.



June 19, 2010

Mr. Paul Cao
Senior System Engineer
Hewlett-Packard Company
20555 SH 249
Houston, TX 77070

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

Platform: HP ProLiant DL585 G7

Database Manager: Microsoft SQL Server 2008 R2 Enterprise Edition

Operating System: Microsoft Windows Server 2008 R2 Enterprise Edition

Transaction Monitor: Microsoft COM+

System Under Test:				
CPU's	Memory	Disks (total)		TpsE
4 AMD 12 core @ 2.3 Ghz	Main: 256 GB	702 @ 72 GB 4 @ 300 GB		1,400.14
2 Clients (Tier A): ProLiant DL360 G5				
1 Intel quad core @ 2.50 Ghz	2 GB	4 @ 72 GB	NA	NA

In addition to the performance metric, the energy consumption was measured during the performance runs in compliance with the TPC-Energy specification.

- The power analyzers used were verified to be approved and calibrated within one year prior to this measurement.
- The energy measurements met all requirements of the specification unless an exception is noted below.
- The calculations for the TPC-Energy Primary Metric were verified as completed correctly.
- The EMS software was verified to be the correct version and without any changes.
- The executive summary page and the FDR were verified for accuracy.

Auditor's Notes: None.

Sincerely,



Lorna Livingtree, Certified Auditor

B.6. TPC-Energy Supporting Files Index

Clause	Description	Path
7.4.1	PTDM Log Files (XML)	Misc-004.xml
7.4.1	PTDM Log Files (XML)	REC-Temperature-004.xml
7.4.1	PTDM Log Files (XML)	Storage-ArrayOne-004.xml
7.4.1	PTDM Log Files (XML)	Storage-ArrayThree-004.xml
7.4.1	PTDM Log Files (XML)	Storage-ArrayTwo-004.xml
7.4.1	PTDM Log Files (XML)	Clients-004.xml
7.4.1	PTDM Log Files (XML)	DBServer-004.xml
7.4.1	PTDM Log Files (txt)	004.report.idle-Clients.txt
7.4.1	PTDM Log Files (txt)	004.report.idle-DBServer.txt
7.4.1	PTDM Log Files (txt)	004.report.idle-Misc.txt
7.4.1	PTDM Log Files (txt)	004.report.idle-REC-Temperature.txt
7.4.1	PTDM Log Files (txt)	004.report.idle-Storage-ArrayOne.txt
7.4.1	PTDM Log Files (txt)	004.report.idle-Storage-ArrayThree.txt
7.4.1	PTDM Log Files (txt)	004.report.idle-Storage-ArrayTwo.txt
7.4.1	PTDM Log Files (txt)	004.report.perf-Clients.txt
7.4.1	PTDM Log Files (txt)	004.report.perf-DBServer.txt
7.4.1	PTDM Log Files (txt)	004.report.perf-Misc.txt
7.4.1	PTDM Log Files (txt)	004.report.perf-REC-Temperature.txt
7.4.1	PTDM Log Files (txt)	004.report.perf-Storage-ArrayOne.txt
7.4.1	PTDM Log Files (txt)	004.report.perf-Storage-ArrayThree.txt
7.4.1	PTDM Log Files (txt)	004.report.perf-Storage-ArrayTwo.txt
7.4.1	Microsoft Excel Calculation Spreadsheet	DL585G7-TPC-E-TPC-Energy.xlsx