TPC Benchmark™ E
Full Disclosure Report
for
IBM® System x3950 M2
using
Microsoft® SQL Server 2008
Enterprise x64 Edition
and
Microsoft Windows® Server 2008
Datacenter x64 Edition

TPC-E Version 1.5.1

Submitted for Review
July 2, 2008

IBM Corporation

First Edition – July 2008

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Notes

[1] GHz and MHz only measures microprocessor internal clock speed, not application performance. Many factors affect application performance.
[2] When referring to hard disk capacity, GB, or gigabyte, means one thousand million bytes. Total user-accessible capacity may be less.

Abstract

IBM Corporation conducted the TPC Benchmark™ E on the IBM® System x3950 M2 configured as a client/server system with attached IBM System Storage™ DS4800. This report documents the full disclosure information required by the TPC Benchmark E Standard Specification, Revision 1.5.1, including the methodology used to achieve the reported results. All testing fully complied with this revision level.

The software used on the IBM System x3950 M2 system includes Microsoft® Windows® Server 2008 Datacenter x64 Edition operating system and Microsoft SQL Server 2008 Enterprise x64 Edition.

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

The benchmark results are summarized in the following table.

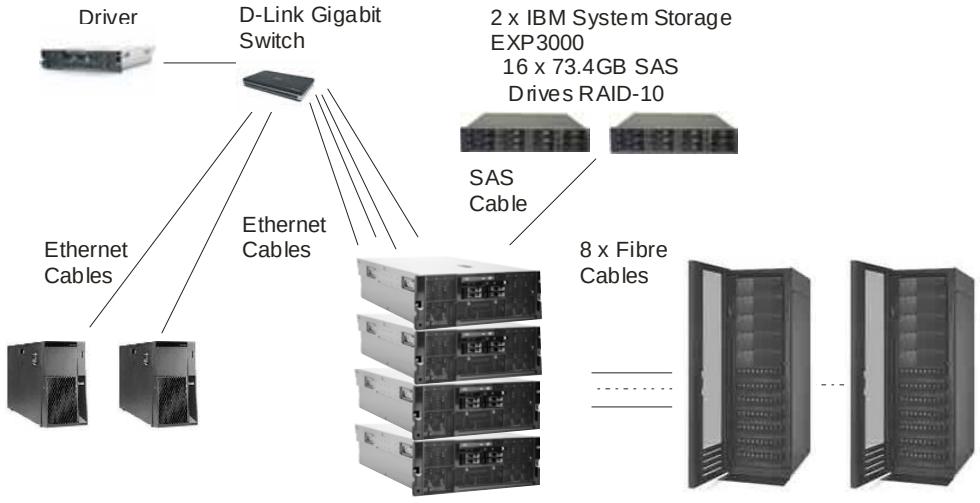
Hardware	Software	Total System Cost	tpsE	$ USD /tpsE	Total Solution Availability Date
IBM System x3950 M2	**Microsoft SQL Server 2008 Enterprise x64 Edition** **Microsoft Windows Server 2008 Datacenter x64 Edition**	**$1,639,064 USD**	**1250.00**	**$ 1,311.26 USD**	**August 30, 2008**

The benchmark implementation and results were audited by Doug Johnson for InfoSizing (www.sizing.com). The auditor's attestation letter is contained in Section 9 of this report.

IBM®	**IBM® System x™ 3950 M2** **Microsoft® SQL Server 2008**		TPC-E Revision 1.5.1 TPC Pricing 1.3.0 Report Date: July 2, 2008
TPC-E Throughput **1250.00 tpsE**	Price/Performance **$ 1,311.26 USD per tpsE**	Availability Date **August 30, 2008**	Total System Cost **$ 1,639,064 USD**

Database Server Configuration

Operating System	Database Manager	Processors/Cores/ Threads	Memory
Microsoft Windows Server 2008 Datacenter x64 Edition	**Microsoft SQL Server 2008 Enterprise x64 Edition**	**16/64/64**	**512GB**



Tier A - Clients

2 x IBM System x3500
Each contains:
1 x Quad-Core Intel Xeon Processor E5440 2.83GHz (1 Processor, 4 Cores, 4 Threads)
2GB of Memory
2 x 73.4GB SAS Drive (RAID-1 for OS, Onboard RAID Controller, Onboard Dual-Port 1 Gigabit Ethernet Controller)

Tier B - Database Server

IBM System x3950 M2
16 x Quad-Core Intel Xeon Processor X7350 2.93GHz (16 Processors, 64 Cores, 64 Threads)
512GB of Memory
4 x QLogic 8Gb FC Dual-Port HBA
1 x IBM ServeRAID-MR10M SAS Controller
4 x Intel PRO/1000 PT Dual-Port Ethernet Adapter

4 x IBM System Storage DS4800
48 x IBM System Storage EXP810 Enclosure
Each EXP810 contains:
16 x 15K rpm drives for a total of 768 drives arrayed as:
32 x 24-Disk (73.4GB) RAID-5

Initial Database Size	Redundancy Level: 1	Storage
4,839 GB	**RAID-10 Log + RAID-5 Data**	**784 x 73.4 GB Drives**

IBM System x3950 M2
Microsoft SQL Server 2008

TPC-E Revision 1.5.1
TPC Pricing Spec 1.3.0

Report Date:
July 2, 2008

Availability Date:
August 30, 2008

Description	Part Number	Price Source	Unit Price	Quantity	Extended Price	3-Yr. Maint. Price
Server Hardware						
IBM System x3950 M2 (2 x Intel Xeon Processor X7350 (2.93GHz/2x4MB L2 Cache) with 4 Memory Cards and 8 x 1GB DIMM	7141-4SU	1	17,779	4	71,116	
Intel Xeon Processor X7350 (2.93GHz/2x4MB L2)	44E4243	1	3,339	8	26,712	
8GB (2x4GB) PC2-5300 CL5 ECC DDR2 SDRAM	41Y2768	1	849	64	54,336	
Scalability Upgrade Option - 4-Chassis Cable Kit	44E4250	2	319	1	319	
73GB 15K 2.5" Hot-Swap SAS SFF	43X0837	1	369	2	738	
QLogic 8Gb FC Dual-Port HBA for IBM System x	42D0510	2*	2,499	4	9,996	
IBM ServeRAID-MR10M SAS/SATA Controller	43W4339	1	1,049	1	1,049	
Intel PRO/1000 PT Daul Port Server Adapter	39Y6126	1	269	4	1,076	
IBM T115 15-inch TFT Display	494215U	1	209	1	209	
IBM Preferred Pro USB Keyboard	40K9584	1	29	1	29	
IBM 3-Button Optical Mouse - Black - USB	40K9201	1	19	1	19	
ServicePac for 3-Year 24x7x4 Support (x3950 M2)	96P2688	1	3,390	4		13,560
ServicePac for 3-Year 24x7x4 Support (Display)	10N3110	1	90	1		90
				Subtotal	165,599	13,650
Server Storage						
4 Gbps SW SFP Transceiver 4 Pack	22R4897	1	550	18	9,900	
IBM 1m LC-LC Fibre Channel Cable	39M5696	1	79	80	6,320	
IBM 5m LC-LC Fibre Channel Cable	39M5697	1	129	24	3,096	
IBM S2 42U Standard Rack	93074RX	1	1,489	5	7,445	
IBM System Storage EXP3000 Enclosure	1727-01X	1	3,199	2	6,398	
IBM 1M SAS cable	39R6529	1	119	1	119	
IBM 3M SAS cable	39R6531	1	135	1	135	
IBM Hot-Swap 3.5 inch 73.4GB 15K SAS HDD	43W7523	1	329	16	5,264	
ServicePac for 3-Year 24x7x4 Support (EXP3000)	41L2768	1	760	2		1,520
ServicePac for 3-Year 24x7x4 Support (Rack)	41L2760	1	300	5		1,500
IBM System Storage DS4800 Disk Upgrade to 8GB Cache	1815-82A	1	53,995	4	215,980	
IBM System Storage DS4000 EXP810 Storage Exp. Unit	1812-81A	1	6,000	48	288,000	
73.4GB 15K 4Gbps FC E-DDM Hot-Swap HDD	40K6816	1	1,301	768	999,168	
ServicePac for 3-Year 24x7x4 Support (EXP810)	10N3651	1	960	48		46,080
ServicePac for 3-Year 24x7x4 Support (DS4800)	41C5953	1	3,200	4		12,800
				Subtotal	1,541,825	61,900
Server Software						
Microsoft SQL Server 2008 Enterprise x64 Edition	810-07578	3*	13,969	1	13,969	
Microsoft SQL Server 2008 Client Access License	359-01912	3	163	1225	199,675	
Microsoft Windows Server 2008 DataCenter x64 Ed. 16P	P71-04279	3	2,999	16	47,984	
Microsoft Problem Resolution Services	N/A	3	245	1		245
				Subtotal	261,628	245
Client Hardware						
x3500 with Intel Xeon E5440 (2.83GHz/12MB), 1GB Memory	7977M2U	1	3,109	2	6,218	
2GB (2x1GB) PC2-5300 CL5 ECC DDR2	39M5785	1	169	2	338	
73GB 15K 3.5" Hot-Swap SAS	43W7523	1	329	4	1,316	
ServicePac for 3-Year 24x7x4 Support (x3500)	21P2084	1	689	2		1,378
				Subtotal	7,872	1,378
Client Software						
Microsoft Windows Server 2003 R2 Standard x86 Edition	P73-01972	3	999	2	1,998	
				Subtotal	1,998	0
Infrastructure						
D-Link DGS-2208 10/20/100/1000/2000Mbps Switch (2 spares)	DGS-2208	4	55	4	220	
Ethernet Cable (2 spares)	A3L791-10-BLK	4	5	22	110	
				Subtotal	330	
				Total	1,979,252	77,173
Compsat Technology Large Purchase Discount (See Note 1.)	21.86%	1			-389,503	
Microsoft Open Program Discount Schedule	10.57%	3			-27,858	

Pricing: 1 - Compsat Technology; 2 - IBM - 1-888-SHOP-IBM, ext. 5821;
3 - Microsoft; 4 - newegg.com

* This component is not immediately orderable. See the FDR for more information.

Note 1: Discount applies to all line items where Pricing=1; pricing is for these or similar quantities.
Discount for similarly sized configurations will be similar to those quoted here but may vary based on the components in the price quotation

Three-Year Cost of Ownership USD: $1,639,064

TPC-E Throughput: 1,250.00

$ USD/tpsE: $1,311.26

Implementation and results audited by Doug Johnson for InfoSizing, Inc. (www.sizing.com)

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

IBM System x3950 M2
Microsoft SQL Server 2008

TPC-E Revision 1.5.1
TPC Pricing Spec 1.3.0

Report Date:
July 2, 2008

Availability Date:
August 30, 2008

Reported Throughput: 1250.00 tpsE	**Configured Customers: 625,000**

Response Time (in seconds)	**Minimum**	**Average**	**90Th Percentile**	**Maximum**
Broker-Volume	0.01	0.04	0.06	2.95
Customer-Position	0.00	0.02	0.04	1.06
Market-Feed	0.00	0.02	0.05	0.55
Market-Watch	0.00	0.03	0.06	10.82
Security-Detail	0.00	0.01	0.02	0.88
Trade-Lookup	0.00	0.43	0.63	2.34
Trade-Order	0.00	0.05	0.09	1.15
Trade-Result	0.00	0.05	0.10	1.91
Trade-Status	0.00	0.01	0.03	0.93
Trade-Update	0.01	0.51	0.69	12.22
Data-Maintenance	0.00	0.11	N/A	0.88

Transaction Mix	**Transaction Count**	**Mix %**
Broker-Volume	4,468,877	4.900
Customer-Position	11,856,084	13.000
Market-Feed	911,879	1.000
Market-Watch	16,415,825	18.000
Security-Detail	12,768,001	14.000
Trade-Lookup	7,295,476	8.000
Trade-Order	9,211,421	10.100
Trade-Result	9,118,771	9.999
Trade-Status	17,327,950	19.000
Trade-Update	1,823,841	2.000
Data-Maintenance	120	N/A

Test Duration and Timings	
Ramp-up Time	00:44:00
Measurement Interval	02:00:00
Business Recovery Time	01:41:10
Total Number of Transactions Completed in Measurement Interval	91,198,125

Table of Contents

Clause 0 – Preamble

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

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

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

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

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

The benchmark defines:

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

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

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

the associated price-per-tpsE, and the **Availability Date** of the **Priced Configuration** (See Clause 6.7.3 for more detail).

Although this specification defines the implementation in terms of a relational data model, the database may be implemented using any commercially available **Database Management System** (**DBMS**), **Database Server**, file system, or other data repository that provides a functionally equivalent implementation. The terms "table", "row", and "column" are used in this document only as examples of logical data structures.

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

Restrictions and Limitations
Despite the fact that this benchmark offers a rich environment that represents many OLTP applications, this benchmark does not reflect the entire range of OLTP requirements. In addition, the extent to which a customer can achieve the **Results reported** by a vendor is highly dependent on how closely TPC-E approximates the customer application. The relative performance of systems derived from this benchmark does not necessarily hold for other workloads or environments. Extrapolations to any other environment are not recommended.

Benchmark **Results** are highly dependent upon workload, specific application requirements, and systems design and implementation. Relative system performance will vary because of these and other factors. Therefore, TPC-E should not be used as a substitute for specific customer application benchmarking when critical capacity planning and/or product evaluation decisions are contemplated.

Benchmark **Sponsors** are permitted various possible implementation designs, insofar as they adhere to the model described and pictorially illustrated in this specification. A **Full Disclosure Report (FDR)** of the implementation details, as specified in Clause 9.1, must be made available along with the **reported Results**.

Clause 1 – Introduction

Benchmark Sponsor

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

This benchmark was sponsored by IBM Corporation.

Configuration Diagrams

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

The measured and priced configurations were the same in this benchmark. The configuration diagram is provided on the following page.

The TPC-E Driver used for these TPC Benchmark E tests is a Microsoft proprietary Driver. The Driver software needed to implement the Driving & Reporting is run on an IBM eServer® xSeries® 3850 M2 machine that is not part of the SUT. The Driver communicates with Tier A over an Ethernet network using the Driver machine's onboard 1Gb Ethernet card.

Tier A is on two IBM System x3500 servers, each with one Quad-Core Intel® Xeon® Processor E5440 (2.83GHz with 12MB L2 cache), 2GB of memory, two internal 73GB SAS drives in a RAID-1 array for the operating system, which is Microsoft Windows Server 2003 R2 Standard x86 Edition. Tier A communicates with Tier B and the Driver over an Ethernet network using the IBM System x3500's onboard 1Gb Ethernet card.

Tier B is on an IBM System x3950 M2. The x3950 M2 has:

- Sixteen Quad-Core Intel Xeon Processor X7350 (2.93GHz with 2 x 4MB L2 cache)
- 512GB of memory
- Two 73GB 15K rpm 2.5-inch Hot-Swap SAS SFF internal drives in a RAID-1 array for the operating system, which is Microsoft Windows Server 2008 Datacenter x64 Edition with Microsoft SQL Server 2008 Enterprise x64 Edition
- Four QLogic 8Gb Fibre Channel Dual-Port HBA for IBM System x cards
- One IBM ServeRAID-MR10M SAS Controller
- Four Intel PRO/1000 PT Dual-Port Server Adapters
- The x3950 M2 has an onboard dual-port 1Gb Ethernet card, but for the measurements this was disabled in BIOS.

Each port of the QLogic 8Gb Fibre Channel HBAs has one Fibre Channel cable connection. The cable from the HBA is connected directly to controller A or B of the IBM System Storage DS4800 controller. Each DS4800 is connected to 12 IBM System Storage EXP810 disk enclosures. Each EXP810 disk enclosure has sixteen 15Krpm drives. The 768 drives are organized as thirty-two 24-Disk RAID-5 arrays for the database data.

Each array is seen as one LUN by the operating system on the x3950 M2. In Windows Disk Manager each of the LUNs from the RAID-5 arrays is configured to have a RAW partition for the fixed and scaling tables and another RAW partition for the growing tables. The rest of the space on the LUN is an NTFS partition used for DB backups and the temp DB.

Tier B communicates with Tier A over an Ethernet network using the Intel Pro/1000 PT Dual-Port Server Adapters. One Ethernet cable comes out of each Intel Pro/1000 PT Adapter and runs to a D-Link 8-port Ethernet switch that also has the Ethernet cables from the Tier A and Driver machines.

Measured and Priced Configuration

The measured and priced configurations were identical as shown in Figure 1-1.

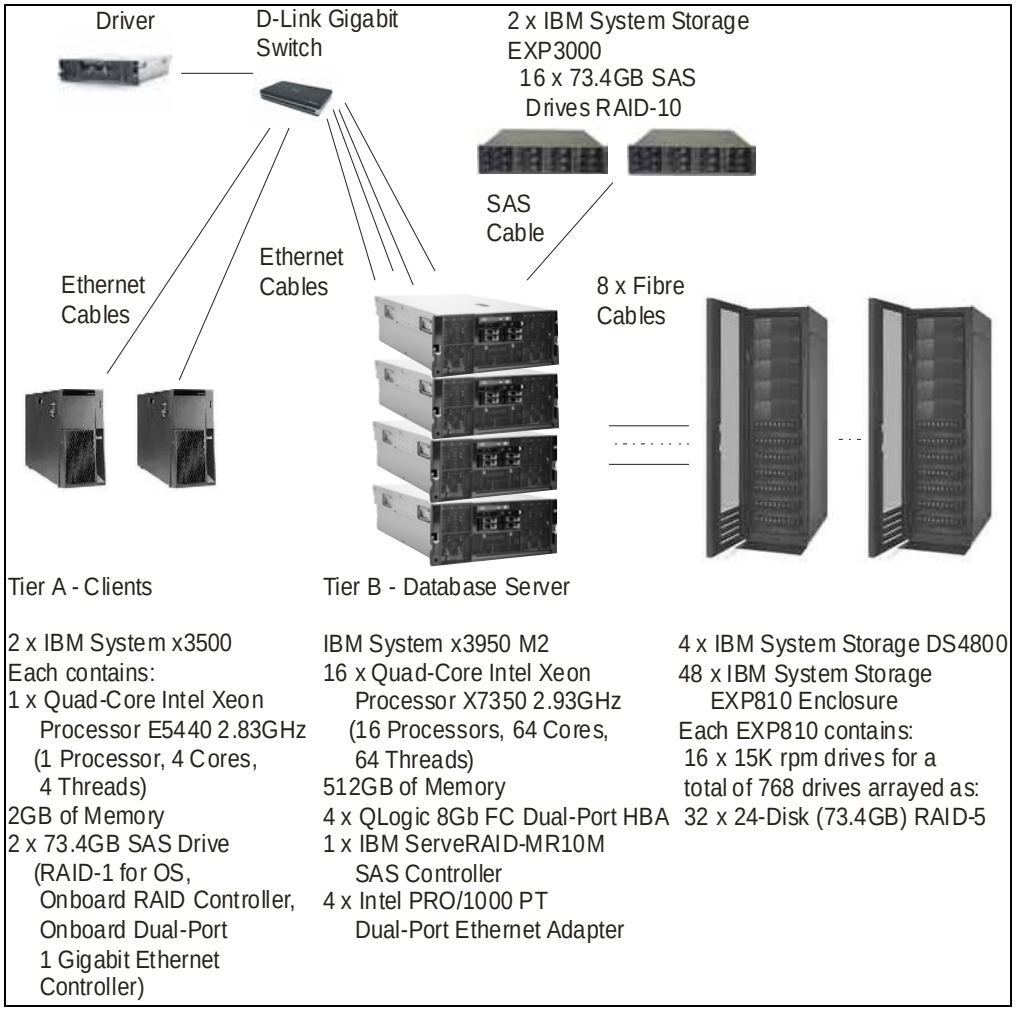


Figure 1-1. Measured and Priced Configuration

Hardware and Software Configuration Steps

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

Driver

The Driver is not part of the priced configuration/System Under Test. For this result an IBM eServer xSeries 3850 M2 machine running Microsoft Windows Server 2003 R2 Standard x86 Edition was used. The Microsoft Benchcraft proprietary driver was installed on the machine. An Ethernet cable was run from the machine's onboard Ethernet controller to the D-Link switch.

Tier A

The IBM System x3500 comes with one Quad-Core Intel Xeon E5440 Processor and 1GB of memory. Remove the 2 X 512MB DIMMs and replace them with the 2 X 1GB DIMMs. Insert two 73.4GB SAS drives. Temporarily, attach a USB floppy driver to the IBM System x3500. Power on the IBM System

x3500. During POST press Ctrl-A when prompted to drop into the IBM ServeRAID Config Utility to configure the drives. Select “Array Configuration Utility.” Initialize both drives.

Create the array using:

- RAID-1
- Read caching: Y
- Quick Initialization

Once the RAID array has been created, escape to the main menu and select “Serial Select Utility” – “Controller Configuration,” and “Disable Array background consistency check.” Then exit the tool; the IBM System x3500 will restart. Boot from the installation CD for Microsoft Windows Server 2003 Standard x86 Edition. Press F6 when prompted to load the Driver for the SAS RAID controller from diskette. The driver can be downloaded from www.ibm.com. During the operating system install, select the per seat 9999 option.

Once the operating system is installed, install the onboard Broadcom Ethernet card’s device driver using the Broadcom-provided executable, which is run from a USB memory stick. The executable can be downloaded from www.ibm.com. When the Ethernet card’s device driver is installed, set a static IP address 192.168.50.224 for one port and 192.168.122.10 for the other port on the first IBM System x3500. On the second IBM System x3500 set a static IP address 192.168.50.225 for one port and 192.168.122.20 for the other port of the dual-port onboard Ethernet card. Connect an Ethernet cable from the 190.168.50.224 and 192.168.50.225 ports. The other end of the Ethernet cable will be connected to a second D-Link switch which has Ethernet connections to the Driver and IBM System Storage DS4800. Connect Ethernet cables to the 192.168.122.10 and 192.168.122.20 ports. The other end of each of the Ethernet cables connects to the first D-Link switch, which has connections to the Tier B machines. Install the Microsoft SQL Server Workstation components (client), SUT_CE_Server.exe and SUT_MEE_Server.exe.

External storage subsystem

Before powering on the EXP810 enclosures and the DS4800s, load all 48 EXP810s with the 73.4GB 15K rpm drives. Set the speed switch on the front of the EXP810 to 4Gb. Each DS4800 will connect to 12 EXP810s. Each EXP810 has 16 drives.

The IBM System Storage DS4800 comes with eight 4Gb IBM short wave SFP modules. The IBM System Storage EXP810 comes with two 4Gb IBM short wave SFP modules. Move the SFP modules to the appropriate places as indicated in the diagram below, and use the additional SFP modules that were purchased separately to fill all the necessary spots according to the diagram. Then cable the configuration as directed by the diagram below, which shows how to cable one DS4800 to the first three EXP810s. The cabling pattern is repeated for the remaining three sets of three EXP810s for that DS4800. So the second set would start with a cable from channel 2, port 2 on the top contoller of the DS4800; this cable would go to port 1B on the left of the fourth EXP810.

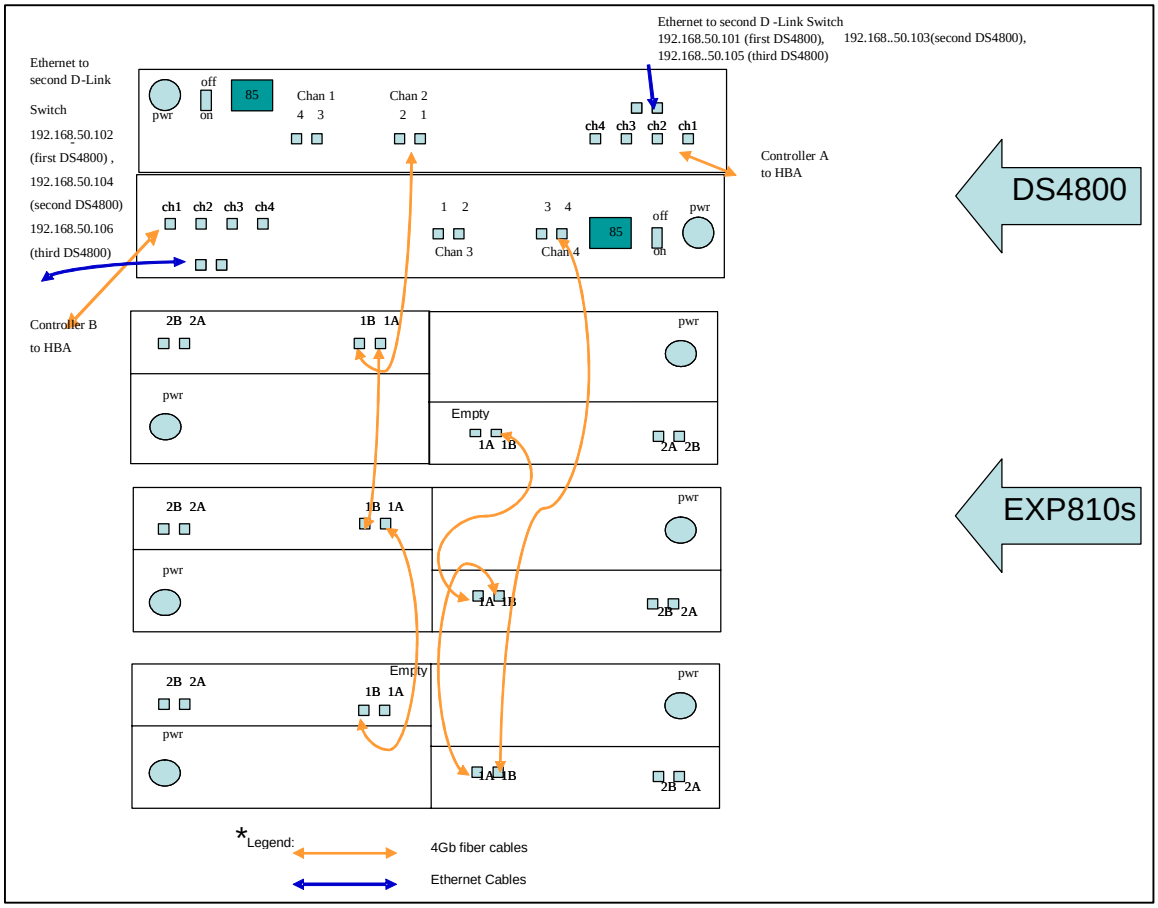


Figure 1-2. Cabling Diagram for the IBM System Storage DS4800 and IBM System Storage EXP810

Run an Ethernet cable from the top and bottom controllers in each DS4800 to the the second D-Link switch.

Download IBM Storage Manager 10 Client from www.ibm.com and install it on the Driver. During the installation, do not start the monitor service.

The default IP addresses for the controllers on the DS4800 are 192.168.128.101and 192.168.129. 102.

Perform the following steps for both controllers in each DS4800:

1. Hook up a standard serial cable to the DS4800 controller from another machine.
2. On the other machine, Hyperterminal into the DS4800 controller:
    a. Speed: 38400
    b. Other settings: 8, none, 1, none
    c. Press CTRL-BRK, ESC to get the command prompt.
3. Enter the Default password = infiniti
4. Select **sysWipe** to clear all RAID configuration information, which can travel with drives.
    a. **Wait for sysWipe to complete on both sides**. sysWipe runs in the background and takes some time to complete, but it tells you when it's done. Wait for the message that sysWipe has completed.
    b. After sysWipe is finished on both controllers, power cycle the controller.
5. **safeSysWipe** returns quickly.
6. Relog into the controller, and use:

a. **netCfgShow** to see the current Ethernet configuration
b. **netCfgSet** to change the Ethernet configuration.
    i. Set the hostname and IP to suit your needs. (We used IP addresss 192.168.50.101 for the top controller and 192.168.50.102 for the bottom controller on the first DS4800; IP address 192.168.50.103 for the top controller and 192.168.50.104 for the bottom controller on the second DS4800; IP address 192.168.50.105 for the top controller and 192.168.50.106 for the bottom controller on the third DS4800; and IP address 192.168.50.107 for the top controller and 192.168.50.108 for the bottom controller on the fourth DS4800)

After completing those steps on all of the DS4800s, start the IBM Storage Manager 10 Client on the Driver and discover all the devices. In IBM Storage Manager 10 Client, do the following:

1. Double click the DS4800 icon to open a window for that DS4800.
2. In the new window, synchronize the date/time on all the devices – right click on the DS4800 Icon – Set Controller Clocks.
3. In the new window, disable any premium features – right click on the DS4800 Icon – Premium Features – Disable.
4. For each DS4800, from the Enterprise Management Window: right click Tools – Load Configuration – "xxxDS4800.cfg" (provided in the SupportingFiles). This loads the RAID array configurations: Eight 24-drive RAID-5 arrays for the database data.
5. From the Enterprise Management Window: right click Tools – Execute Script – Load – ds4800_setup.script (provided in the SupportingFiles)
6. From Tools: right click Verify and Execute the ds4800_setup.script. This script sets the no FUA bit, and makes it so that Microsoft Windows only sees one copy of each of the LUNs.

The external storage subsystem is now ready.

IBM EXP3000

Before powering on two EXP3000 enclosures, load each enclosure with eight 73.4GB SAS drives. Connect these two EXP3000s with one SAS cable, from the "out" port of top EXP3000 to the "in" port of bottom EXP3000. The two EXP3000s are ready to be used now.

IBM System x3950 M2

The IBM x3950 M2 supports up to four nodes. In this benchmark four nodes were used. Each node comes with two Quad-Core Intel Xeon X7350 processors, eight 1GB DIMMs, four memory cards and an onboard dual-port Broadcom Ethernet card. Open each node, and perform these steps:

1. Install two more Quad-Core Intel Xeon X7350 Processors.
2. Remove the eight 1GB DIMMs and install thirty-two 4GB DIMMs.
3. Install the Intel Pro/1000 PT Dual Port Server Adapter in PCI-E slot 7.
4. Run an Ethernet cable from the first port of Ethernet Adapter to the first D-Link switch, which has connections to the Tier A machines.
5. Connect four nodes with six scalability cables as shown in the following digram.

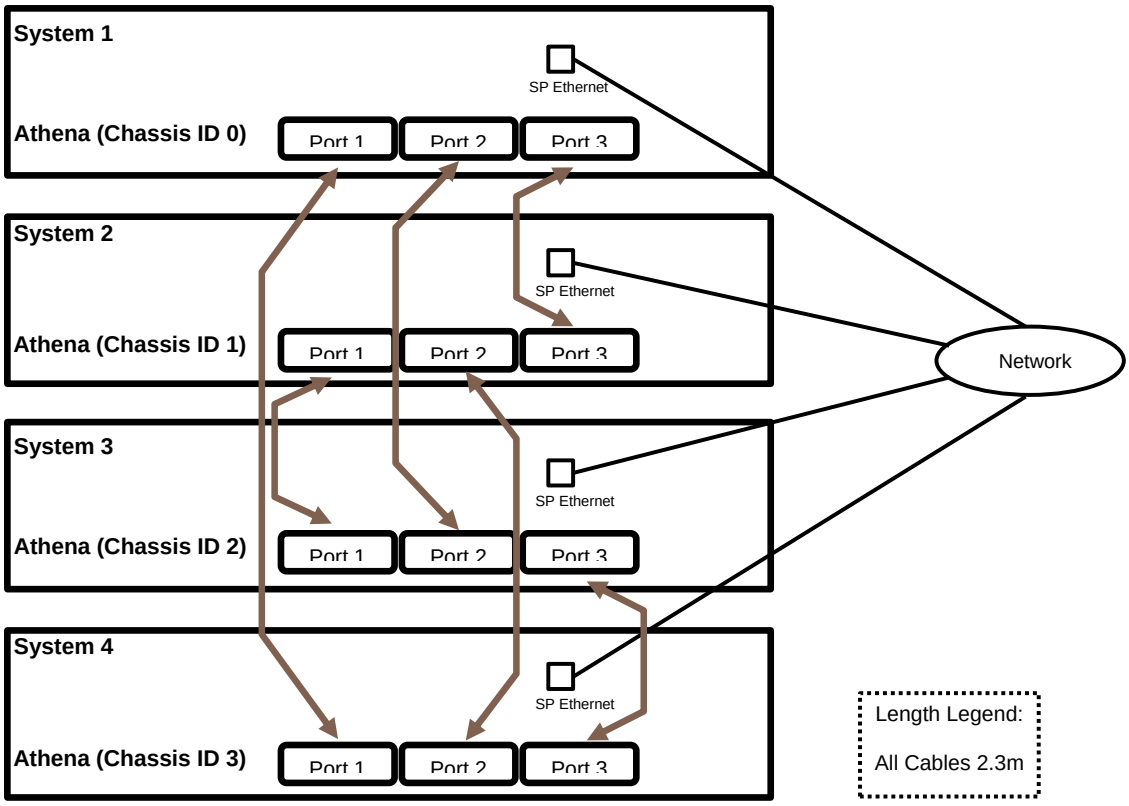


Figure 1-3. Cabling Diagram for the IBM System x3950 M2 Four Chassis

6. Run an Ethernet cable from RSA II port to the third D-Link switch which has the connections to the driver.
7. Insert the two 73GB 15K rpm 2.5" Hot-Swap SAS SFF drives in the front of the first node.
8. Plug the power cords into the back of four nodes.
9. Press the power switch on the front of the first node.

Press F1 while the first node is going through POST. This causes the server to drop into BIOS Setup. In BIOS Setup change the following from their default values:

1. Set the correct date and time.
2. In Devices in I/O Ports, disable "Planar Ethernet" and "Display Onboard MAC Address During Boot."
3. In Start Options, set the Startup Sequence to CD-ROM, Diskette Drive 0, Hard Disk 0, Disabled.
4. Still in Start Options, disable Planar Ethernet PXE/DHCP.
5. In Advanced Setup – Memory Settings – ensure that the Memory Array Setting is High Performance Memory Array.
6. In Advanced Setup – CPU Options - disable nearly everything (PowerExecutive Power Capping, Processor Performance States, Adjacent sector Prefetch, Processor Hardware Prefetcher, Processor Execute Disable Bit, Intel Virtualization Technology, Processor IP Prefetcher, Processor DCU Prefetcher, C1E). Leave the Clustering Technology in Logical Mode.
7. In Advanced Setup – Advanced PCI Settings – disable PCI ROM Control Execution for the seven PCI-E slots.
8. In RSA II Setting – select statics IP and set IP address as 10.10.10.10 with Subnet Mask 255.255.255.0. Make sure you save the change on RSA II before leaving RSAII setting.

Save the BIOS changes and shutdown the first node. Power on the other node then repeat the above steps with a new IP address 10.10.10.20 for second node, 10.10.10.30 for third node and 10.10.10.40 for fourth node. Again save the BIOS changes and shutdown the node.

Login the driver machine which has IP address 10.10.10.99. Then open a web browser with http://10.10.10.10. This is an userid/password protected page. By default, type in USERID/PASSW0RD for userid/password. In the main page select "partition configure" at the bottom of the left pane. In the new page, you will see a drawing of four machines connected by six lines. Select the first node as the primary node and the other nodes as the member of partition group. Then click the "partition configuration" with "auto" or "create". If it was created successfully then the drawing will change color from no color to a blue color. If it becomes red then means something was not set properly. Either you didn't shutdown the node or the scalability cable was not connected properly.

Now you have four nodes connected together. From now on start/stop any node will start/stop all nodes.

Power on the x3950 M2. During POST on the x3950 M2, when the LSI banner is displayed, press Ctrl-C. The SAS Configuration Utility will be displayed. Create a RAID-1 array from the two internal SAS drives.

1. SAS1078
2. RAID Properties
3. Create IM Volume
4. Arrow over to the RAID Disk column, use the space bar to toggle from No to Yes for both internal SAS drives
5. D to overwrite existing data
6. 7006MB, C to create
7. Create and Save new array
8. Save changes and exit the menu
9. RAID Properties
10. Manage Array
11. Synchronize Array, Y start array synchronization and exit this menu
12. Exit the configuration utility and reboot the x3950 M2.

Insert the Microsoft Windows Server 2008 Enterprise x64 Edition DVD in the first node's DVD/CDROM drive. Boot the x3950 M2 from the DVD.

1. Select Boot section 0
2. Language to install – English
3. Time and currency formtat – English (United States)
4. Keyboard or input method – U.S. [Next]
5. [Install Now]
6. Enter Product Key
7. Deselect "Automatically activate Windows when I'm online." [Next]
8. Windows Server 2008 Enterprise (Full Installation) x64 [Next]
9. Check "I accept the license terms" [Next]
10. Custom (advanced) install not upgrade
11. Where do you want to install Windows?
12. Disk 0 Unallocated Space 68.0GB
13. Drive Options (advanced)
14. New 69618 MB [Apply]
15. Disk 0 Partition 1 68.0GB Primary
16. [Next]

17. Installing Windows… That's all the information we need right now. Your computer will restart several times during installation.
18. Before the first reboot remove the DVD. There are two reboots.
19. After the second reboot the following message is displayed "The user's password must be changed before logging on the first time" [OK]
20. Set a new secure password for the Administrator
21. The "Initial Configuration Tasks" window is displayed. On the Date and Time tab set the Time Zone to GMT-05:00 Eastern Time (US & Canada) [OK]
22. Internet Time tab [Change settings…], uncheck "Synchonize with an internet time server [OK] [OK]
23. Configure networking – Windows saw the Intel Pro/1000 Daul-port Server Adapter and installed a default driver, we upgraded them to v9.12.17.0 which can be downloaded from Intel website.
24. Check the radio button "Use the following IP address"; enter IP address 192.168.122.100 with a subnet mask of 255.255.255.0 [OK] [Close]; close the Networks folder.
25. Repeat steps 23/24 for other three Adapters with IP address 192.168.122.110, 192.168.122.120 and 192.168.122.130.
26. Provide computer name and domain – Computer description – TPC-E Athena Win2008 [Change] computer name – Athena_4x2 [OK]. A message is displayed that says the server must be restarted for the change to take effect so save open files. [OK]. Still in "System Properties" "Computer Name" tab click the "Advanced" tab.
27. On the "Advanced" tab - Performance – [Settings…] – Visual Effects tab – check radio button for "Adjust for best performance". On the "Advanced" leave the radio button for background services checked.
28. Data Execution Prevention tab the default is DEP for all programs and services except those I select" [OK]. Close the Performance Options Window.
29. Startup and Recovery – [Settings…] – change the time to display a list of operating systems to 10 seconds instead of the default 30 seconds. In the System Failure section uncheck "Automatically restart". Change "Write debugging information" to "(none)". [OK]
30. In the System Properties Window change from the "Advanced" tab to the "Remote" tab.
31. Check the radio button to "Allow connections from computers running any version of Remote Desktop".
32. A warning about enabling Remote Desk making the server less secure is displayed. [OK] [Close]
33. A message saying the computer must be restarted to apply these change is displayed. [Restart later]
34. Back in Initial Configuration Tasks window. "2 Update This Server" – "Enable automatic updating and feedback – [Manually configure settings]
35. Manually Configure Settings window – Windows automatic updating [Change Setting…] – check the radio button for "Never check for updates" – [OK]
36. Windows Error Reporting – [Change Setting…] – check the button "I don't want to participate, and don't ask me again" – [OK]
37. Customer Experience Improvement Program – check the button "No, I don't want to participate" – [OK] [Close]
38. Download and install updates – leave as no checking for updates
39. Windows Firewall – Change settings – Advanced tabe – Network Connections – uncheck. General tab – check the button "Off" – [Apply] [OK]
40. gpedit.msc (Global Policy Manager) – Computer Configuration – Windows Settings – Security Settings – Account Policies – Password Policy – Password must meet complexity requirements – disable – Maximum Password age – change from 42 to 0, which means your password never expires.

41. Still in gpedit.msc – Computer Configuration – Administrative Templates – System – right panel – Display shutdown event tracker – disable
42. Still in gpedit.msc – Computer Configuration – Windows Setting – Security Settings – Local Policies – User rights assignment – lock pages in memory add Administrators group.
43. Back on the initial settings page – check "do not show again."
44. Restart, after restart change the Administrator's password to a simple password.
45. Personal Settings – Screen Saver – Screen Save – (none) – Change power settings… - select the "High Performance" power plan – Choose when to turn off the display – Never – [Save Changes]
46. Sounds – Sound scheme – No Sounds – uncheck "Play Windows Startup Sound" [OK]
47. Move some icons onto my tool bar (e.g., Windows Explorer, command window, calculator, notepad).
48. Server Manager – Services – change the following services to Manual – Cryptographic Services, DHCP Client, Print Spooler, Remote Registry, Windows Update, Windows Error Reporting Service.
49. Check that HKLM\SYSTEM\CurrentControlSet\Services\Lanman Server\Parameters – Size = 3.
50. Change HKLM\SYSTEM\CurrentControlSet\Control\Session Manager\Memory Management – Large System Cache from 1 to 0, and Disable Paging Executive from 0 to 1.
51. Update my hosts file in c:\windows\system32\drivers\etc.

SQL Server Installation

Install Microsoft SQL Server 2008 Enterprise x64 Edition.

1. Install prerequisites such as Microsoft Office 2003 Web Components.
2. Install – Server components, tools, Book online and samples.
3. SQL Server 2008 Setup – accept the license terms [Next].
4. Setup Support Files [Install].
5. SQL Server Installation Center – New Installation – System Configuration Check – Execution completed – Passed: 7 Failed: 0, Warning 0 Skipped 0 [Next].
6. Feature Selection – check Database Engine Services.
7. Shared Features – check Client Tools and SQL Server Book online [Next].
8. Instance Configuration – check Default instance, MSSQLServer, C:\Program Files\Microsoft SQL Server [Next].
9. Service Accounts – SQL Server Agent left as manual, change SQL Server (MSSQL..) from automatic to manual, change SQL Server Browser from Disabled to Manual, select Administrator as the account and apply it to all [Next].
10. Collation – check Windows Collation designator and sort order, Collation designation – Latin1_General, check Binary sort order [OK].
11. Database Engine Configuration – Account Provisioning tab – check Mixed Mode, Built-in SQL Server system administrator account, enter sa password and confirm the password. Specify SQL Server administrators – [Add Current User] – IBMSERVA\Administrator.
12. Select the defaults on Data Directories and FILESTREAMING tabs [Next].
13. Error and Usage Reporting – uncheck "Send error reports to Microsoft or your corporate report server" and "Send anonymous feature usage data to Microsoft," [Next].
14. Ready to Install [Next].
15. Shows progress, when finished [Next].
16. Installation complete so [Close].

SQL Server softNUMA node configuration

- To do so edit the registry:
    - `HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Microsoft SQL Server\100\NodeConfiguration`
    - Add keys named "Node0", "Node1".

    - Under each of those keys, add a DWORD value called “CPUMask” and set it to the CPU mask of the node.
        - For example:
            - `Node0 -> CPUMask = 0xFFFF0000`
            - `Node1 -> CPUMask = 0x0000FFFF`
            - `Node2 -> CPUMASK = 0xFFFF00000000`
            - `Node3 -> CPUMASK = 0xFFFF000000000000`

- Now configure the TCP/IP ports so that one listens for each softNUMA node
    - Open the SQL Server Configuration Manager
    - Expand the SQL Server Network Configuration
    - Select “Protocols for MSSQLSERVER”
        - Shared Memory and TCP/IP should be enabled; the rest disabled
        - Open TCP/IP, Protocol tab
            - Enabled = yes
            - KeepAlive = 30000
            - Listen All = Yes
        - IP Addresses Tab
            - IPx (IP1, IP2, IP3, etc.) should all be disabled (they are only used if ListenAll = No)
            - IPAll
                - TCP Port. This is where you set the port->softNUMA node affinities. In this benchmark we use
                - `1433,1434[0x1],1436[0x2]`,1438[0x4],1440[0x8]

Connect x3950 M2 to External Storage

Power off the x3950 M2. Install four QLogic 8Gb Fibre Channel Dual-Port HBA for IBM System x in PCI-E slots 2, 9, 16 and 23.

Run a 4Gb Fibre cable from each port of the QLogic 8Gb HBAs to a controller of the DS4800. The dual-port HBA in PCI-E slot 2 were connected to controllers A and B of the first DS4800 and dual-port HBA in PCI-E slot 9 were connected to controllers A and B of the second DS4800. The dual-port HBA in PCI-E slot 16 was connected to controllers A and B of the third DS4800 and the dual-port HBA in PCI-E slot 23 was connected to controllers A and B of the fourth DS4800.

Power on the x3950 M2. Download SANsurfer FC HBA Manager and the latest firmware and driver (v9.1.7.16) for QLogic 8Gb Fibre Channel HBA (QLE2562) from QLogic.com. You can upgrade the firmware through GUI management tool. Then open Device Manager and under the Storage Controllers find the HBAs. Update the driver for each HBA. Reboot the x3950 M2.

regedit.exe – under the key -

Computer\HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Enum\SCSI\Disk&Ven_IBM&Prod_1815____FAST

There is a list of keys such as 5&dc982ed000005. For each of these keys, add a key “Classpnp” under the “Device Parameters” key. Under the new Classpnp, add a DWORD IdlePrioritySupported with a value of 0. This disables I/O prioritization.

Connect x3950 M2 to IBM EXP3000

Power off the x3950 M2. Install IBM ServeRAID-MR10M SAS controller in PCI-E slot 12, which is at the second node. Then run a SAS cable from one port of IBM ServeRAID-MR10M SAS controller to the “in” port of the top IBM EXP3000 enclosure, which connects to another EXP3000 with another SAS cable.

Power on the x3950 M2. Download MegaRAID Storage Manager, and the latest firmware and driver for IBM ServeRAID-MR10M from the IBM Web site. Install MegaRAID Storage Manager on the x3950 M2.

Use MegaRAID Storage Manager to flash the firmware. Open Device Manager and under the Storage Controllers, find the SAS controller. Update the driver for the SAS controller. Reboot the x3950 M2.

Use MegaRAID Storage Manager to configure the log file. In MegaRAID Storage Manager, right click on the adapter (IBM ServeRAID-MR10M SAS controller) to select Configuration → Configuration Wizard.

1. Select "Manual Configuration" from a pop-up window; then click "Next."
2. In the new window, you will see two enclosures each with eight drives at the left pane. Select one drive from each enclosure; then click "Add." These two drives will be moved to the right pane as a new array. Click "Accept" to accept it.
3. Return to the left pane to select another two drives from each enclosure and accept it after they are moved to the right pane. Repeat this procedure eight times until all drives have been moved to the right pane. It should have eight arrays; each has two drives now. Click "Next."
4. In the new window, select all eight new arrays at the same time.
5. Then at the Virtual Disk Properties, change the setting as following:
    a. RAID Level: RAID-10
    b. Volume Name: Log
    c. Read Policy: Adaptive Read Ahead
    d. Default Write Policy: Write Through
    e. Disk Cache Policy: Enabled
6. Click "Accept," then "Next," then "Finish" to complete the configuration.

A log file that has 549312MB size with RAID-10 is now ready to be used.

Mount Points and Disk Partitions

1. In a command window, create mount points:
    - c:
    - cd \
    - mkmp.cmd (mkmp.cmd provided in the SupportingFiles)

2. Open Windows Disk Manager.

3. If the Wizard prompts you to initialize disks, do so; don't upgrade the disks.

4. From a command prompt, run diskpart.exe /s dblog.txt (dblog.txt provided in the SupportingFiles).

5. From a command prompt, run diskpart.exe /s datadisks.txt (datadisks.txt provided in the SupportingFiles).

6. From a command prompt, run formats.cmd (formats.cmd provided in the SupportingFiles).

7. Close Windows Disk Manager: the disk partitions for the database have been created.

SQL Server Configuration

Start Microsoft SQL Server from the command line using sqlservr –c –T3502.

Run runconfig.sql to set the SQL Server sp_configure settings (the file is included in the SupportingFiles). Run tempdb.sql to increase the size of the temporary database, which is used during database load (the file is included in the SupportingFiles).

Shut down SQL Server. Start Microsoft SQL Server 2008 – Configuration Tools – SQL Server Configuration Manager - SQL Server Network Configuration - Protocols for MSSSQLSERVER – check Shared Memory, Named Pipes and TCP/IP are enabled.

Clause 2 –Database Design, Scaling and Population Related Items

Database Creation and Table Definitions

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

Create a folder 625,000.cust\database. In the folder, create a create_database.sql script to create a TPC-E database with two filegroups. One filegroup called fixed_fg for the fixed and scaling TPC-E tables and the other filegroup called growing_fg for all growing TPC-E tables. fixed_fg uses all the c:\mp\fx* disk partitions. growing_fg uses all the c:\mp\gw* disk partitions. The database log is on E:. Modify the files provided by Microsoft:

- Create_Tables_Fixed.sql
- Create_Tables_Growing.sql
- Create_Tables_Scaling.sql
- Create_Tables_Scaling_Flat.sql
- Create_Clustered_Indexes_Fixed.sql
- Create_Clustered_Indexes_Growing.sql
- Create_Clustered_Indexes_Scaling.sql
- Create_NC_Indexes_Fixed.sql
- Create_NC_Indexes_Growing.sql
- Create_NC_Indexes_Scaling.sql

by replacing misc_fg, market_fg, broker_fg and customer_fg with fixed_fg or growing_fg.

Run the Microsoft file TPCE_Setup.cmd to start the database load (the file is included in the SupportingFiles). When prompted, fill in 625,000 for the number of customers to be loaded. TPCE_Setup.cmd calls files that are included in the SupportingFiles to create and load the TPC-E database.

Database Physical Organization

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

Physical space was allocated to Microsoft SQL Server 2008 on the server disks as detailed in Table 2-2.

Horizontal/Vertical Partitioning

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

Partitioning was not used in this benchmark. However, the TPC-E tables were distributed over multiple disk arrays by SQL Server because the file groups were spread over 32 disk arrays.

Replication

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

Replication was not used in this benchmark.

Table Attributes

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

No additional attributes were used in this benchmark.

Cardinality of Tables

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

The database was built with 625,000 customers. Table 2-1 is on the following page.

Table Name	Rows
ACCOUNT_PERMISSION	4,437,353
ADDRESS	937,504
BROKER	6,250
CASH_TRANSACTION	9,935,989,568
CHARGE	15
COMMISSION_RATE	240
COMPANY	312,500
COMPANY_COMPETITOR	937,500
CUSTOMER	625,000
CUSTOMER_ACCOUNT	3,125,000
CUSTOMER_TAXRATE	1,250,000
DAILY_MARKET	558,703,125
EXCHANGE	4
FINANCIAL	6,250,000
HOLDING	553,044,807
HOLDING_HISTORY	14,473,766,084
HOLDING_SUMMARY	31,087,057
INDUSTRY	102
LAST_TRADE	428,125
NEWS_ITEM	625,000
NEWS_XREF	625,000
SECTOR	12
SECURITY	428,125
SETTLEMENT	10,800,000,000
STATUS_TYPE	5
TAXRATE	320
TRADE	10,800,000,000
TRADE_HISTORY	25,920,063,458
TRADE_REQUEST	0
TRADE_TYPE	5
WATCH_ITEM	62,523,423
WATCH_LIST	625,000
ZIP_CODE	14,741

Table 2-1. Initial Cardinality of Tables

Distribution of Tables and Logs

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

The x3950 M2 has 28 PCI-E slots. Four Qlogic 8Gb Fibre Channel Dual-Port HBA for IBM System x were put in PCI-E slots 2 , 9, 16 and 23. Four IBM System Storage DS4800s were used in this benchmark. The DS4800 has two controllers: the top controller A and the bottom controller B.

The dual-port HBA in PCI-E slot 2 were connected to controllers A and B of the first DS4800 and Dual-port HBA in PCI-E slot 9 were connected to controllers A and B of the second DS4800. The HBA in PCI-E slot 16 were connected to controllers A and B of the third DS4800 while the last HBA in PCI-E slot 23 were connected to the controllers A and B of the fourth DS4800.

All the drives used in this benchmark are 73.4GB 15K rpm 4Gbps Fibre Channel drives. Figure 2-2 depicts the database configuration of the measured and priced systems to meet the 8-hour steady state requirement.

One IBM ServeRAID-MR10M SAS Controller was put in PCI-E slot 12, to connect two IBM System Storage EXP3000 with a SAS cable. Each EXP3000 has 8 73.4GB SAS drives. Total 16 drives were used as the log file with RAID-10 and write-through policy.

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

Disk #	Controller #	Slot #	Drives Enclosure model RAID level	Partition/file system	Size	Use
2	1A	2	24 X 73.4GB Fibre EXP810 Enclosure RAID- 5	c:\mp\fx1 (RAW) c:\mp\gw1 (RAW) c:\mp\bk1: (NTFS)	6.37GB 183.42GB 976.56GB	Fixed 1 Growing 1 Backup1
3	1A	2	24 X 73.4GB Fibre EXP810 Enclosure RAID- 5	c:\mp\fx2 (RAW) c:\mp\gw2 (RAW) c:\mp\bk2: (NTFS)	6.37GB 183.42GB 976.56GB	Fixed 2 Growing 2 Backup2
4	1A	2	24 X 73.4GB Fibre EXP810 Enclosure RAID- 5	c:\mp\fx3 (RAW) c:\mp\gw3 (RAW) c:\mp\bk3: (NTFS)	6.37GB 183.42GB 976.56GB	Fixed 3 Growing 3 Backup3
5	1A	2	24 X 73.4GB Fibre EXP810 Enclosure RAID- 5	c:\mp\fx4 (RAW) c:\mp\gw4 (RAW) c:\mp\bk4: (NTFS)	6.37GB 183.42GB 976.56GB	Fixed 4 Growing 4 Backup4
6	1B	2	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx5 (RAW) c:\mp\gw5 (RAW) c:\mp\bk5: (NTFS)	6.37GB 183.42GB 976.56GB	Fixed 5 Growing 5 Backup5

7	1B	2	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx6 (RAW) c:\mp\gw6 (RAW) c:\mp\bk6: (NTFS)	6.37GB 183.42GB 976.56GB	Fixed 6 Growing 6 Backup6
8	1B	2	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx7 (RAW) c:\mp\gw7 (RAW) c:\mp\bk7: (NTFS)	6.37GB 183.42GB 976.56GB	Fixed 7 Growing 7 Backup7
9	1B	2	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx8 (RAW) c:\mp\gw8 (RAW) c:\mp\bk8: (NTFS)	6.37GB 183.42GB 976.56GB	Fixed 8 Growing 8 Backup8
10	2A	9	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx9(RAW) c:\mp\gw9 (RAW) c:\mp\bk9: (NTFS)	6.37GB 183.42GB 976.56GB	Fixed 9 Growing 9 Backup9
11	2A	9	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx10(RAW) c:\mp\gw10(RAW) c:\mp\bk10(NTFS)	6.37GB 183.42GB 976.56GB	Fixed 10 Growing 10 Backup10
12	2A	9	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx11(RAW) c:\mp\gw11(RAW) c:\mp\bk11(NTFS)	6.37GB 183.42GB 976.56GB	Fixed 11 Growing 11 Backup11
13	2A	9	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx12(RAW) c:\mp\gw12(RAW) c:\mp\bk12(NTFS)	6.37GB 183.42GB 976.56GB	Fixed 12 Growing 12 Backup12
14	2B	9	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx13(RAW) c:\mp\gw13(RAW) c:\mp\bk13(NTFS)	6.37GB 183.42GB 976.56GB	Fixed 13 Growing 13 Backup13
15	2B	9	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx14(RAW) c:\mp\gw14(RAW) c:\mp\bk14(NTFS)	6.37GB 183.42GB 976.56GB	Fixed 14 Growing 14 Backup14
16	2B	9	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx15(RAW) c:\mp\gw15(RAW) c:\mp\bk15(NTFS)	6.37GB 183.42GB 976.56GB	Fixed 15 Growing 15 Backup15

17	2B	9	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx16(RAW) c:\mp\gw16(RAW) c:\mp\bk16(NTFS)	6.37GB 183.42GB 976.56GB	Fixed 16 Growing 16 Backup16
18	3A	16	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx17(RAW) c:\mp\gw17(RAW) c:\mp\bk17(NTFS)	6.37GB 183.42GB 976.56GB	Fixed 17 Growing 17 Backup17
19	3A	16	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx18(RAW) c:\mp\gw18(RAW) c:\mp\bk18(NTFS)	6.37GB 183.42GB 976.56GB	Fixed 18 Growing 18 Backup18
20	3A	16	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx19(RAW) c:\mp\gw19(RAW) c:\mp\bk19(NTFS)	6.37GB 183.42GB 976.56GB	Fixed 19 Growing 19 Backup19
21	3A	16	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx20(RAW) c:\mp\gw20(RAW) c:\mp\bk20(NTFS)	6.37GB 183.42GB 976.56GB	Fixed 20 Growing 20 Backup20
22	3B	16	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx21 (RAW) c:\mp\gw21(RAW) c:\mp\bk21(NTFS)	6.37GB 183.42GB 976.56GB	Fixed 21 Growing 21 Backup21
23	3B	16	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx22 (RAW) c:\mp\gw22(RAW) c:\mp\bk22(NTFS)	6.37GB 183.42GB 976.56GB	Fixed 22 Growing 22 Backup22
24	3B	16	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx23 (RAW) c:\mp\gw23(RAW) c:\mp\bk23(NTFS)	6.37GB 183.42GB 976.56GB	Fixed 23 Growing 23 Backup23
25	3B	16	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx24 (RAW) c:\mp\gw24(RAW) c:\mp\bk24(NTFS)	6.37GB 183.42GB 976.56GB	Fixed 24 Growing 24 Backup24
26	4A	23	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx25(RAW) c:\mp\gw25(RAW) c:\mp\bk25(NTFS)	6.37GB 183.42GB 1371.11GB	Fixed 25 Growing 25 Backup25

27	4A	23	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx26(RAW) c:\mp\gw26(RAW) c:\mp\bk26(NTFS)	6.37GB 183.42GB 1371.11GB	Fixed 26 Growing 26 Backup26
28	4A	23	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx27(RAW) c:\mp\gw27(RAW) c:\mp\bk27(NTFS)	6.37GB 183.42GB 1371.11GB	Fixed 27 Growing 27 Backup27
29	4A	23	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx28(RAW) c:\mp\gw28(RAW) c:\mp\bk28(NTFS)	6.37GB 183.42GB 1371.11GB	Fixed 28 Growing 28 Backup28
30	4B	23	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx29 (RAW) c:\mp\gw29(RAW) c:\mp\bk29(NTFS)	6.37GB 183.42GB 1371.11GB	Fixed 29 Growing 29 Backup29
31	4B	23	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx30 (RAW) c:\mp\gw30(RAW) c:\mp\bk30(NTFS)	6.37GB 183.42GB 1371.11GB	Fixed30 Growing 30 Backup30
32	4B	23	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx31 (RAW) c:\mp\gw31(RAW) c:\mp\bk31(NTFS)	6.37GB 183.42GB 1371.11GB	Fixed 31 Growing 31 Backup31
33	4B	23	24 X 73.4GB Fibre EXP810 Enclosure RAID-5	c:\mp\fx32 (RAW) c:\mp\gw32(RAW) c:\mp\bk32(NTFS)	6.37GB 183.42GB 1371.11GB	Fixed 32 Growing 32 Backup32
1	LSI SAS Controller	12	16 X 73.4GB SAS EXP3000Enclosure RAID-10	E: (RAW)	390.64GB	DB Log
0	onboard LSI	N/A	2 X 73GB SAS onboard x3950 M2 RAID-1	C: (NTFS)	67.99GB	OS

Database Interface and Model Implemented

*A statement must be provided in the **Report** that describes:*

- *The **Database Interface** (e.g., embedded, call level) and access language (e.g., SQL, COBOL read/write) used to implement the TPC-E **Transactions**. If more than one interface / access language is used to implement TPC-E, each interface / access language must be described and a list of which interface /access language is used with which **Transaction** type must be **reported**.*
- *The data model implemented by the **DBMS** (e.g., relational, network, hierarchical).*

Microsoft SQL Server 2008 Enterprise x64 Edition is a relational database. The interface used was Microsoft SQL Server stored procedures accessed with Remote Procedure Calls embedded in C++ code using the Microsoft ODBC interface.

Database Load Methodology

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

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

Clause 3 – Transaction Related Items

Vendor-Supplied Code

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

The SQL in the stored procedures for the transactions is functionally equivalent to the pseudo-code.

Database Footprint of Transactions

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

The database footprint requirements are met by the stored procedure code for the transactions.

Clause 4 – SUT, Driver and Network Related Items

EGen Instances

The number of EGenDriverMEE and EGenDriverCE instances used in the benchmark must be reported (see Clause 4.1.3).

A total of 868 EGenDriverCE instances was used in the benchmark. Four EGenDriverMEE instances were used in the benchmark.

Network Configuration

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

The Network configurations of both the measured and priced configurations were the same. The Driver machine used one of the ports on the onboard dual-port Gigabit Ethernet card. The port's IP address was 192.168.122.99. The port was connected to the first D-Link switch via an Ethernet cable. Other Ethernet cables ran from the first D-Link Switch to a port on the onboard dual-port Gigabit Ethernet card in the IBM System x3500 machines that were used as the Tier A machines. That port on one x3500 was configured with the IP address 192.168.122.10, and 192.168.122.20 on the other x3500. The network connection between the port with IP address 192.168.122.99 othe Driver and the ports with IP addresses 192.168.122.10 nd 192.168.122.20 on the Tier A machines was the mandatory network.

There was also a network connection between the Tier A machines and the Tier B machine. The Tier B machine was the x3950 M2. The port on the Intel Pro/1000 PT Adapter in the x3950 M2 was configured with IP address 192.168.122.100/110/120/130 and was connected via an Ethernet cable to the first D-Link switch.

Tier A used ODBC calls to Tier B.

Clause 5 – EGen Related Items

EGen Version

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

EGen v1.5.1 was used in the benchmark.

EGen Code and Modifications

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

All required TPC-provided EGen code was used in the benchmark. EGen was not modified for use in this benchmark. EGenLoader was not extended for this benchmark.

Clause 6 – Performance Metrics and Response Time Related Items

Measured Throughput

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

Measured tpsE: 1250.00 tpsE
Price per tpsE: $ 1,311.26 USD per tpsE

Throughput vs. Elapsed Time for Trade-Result Transaction

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

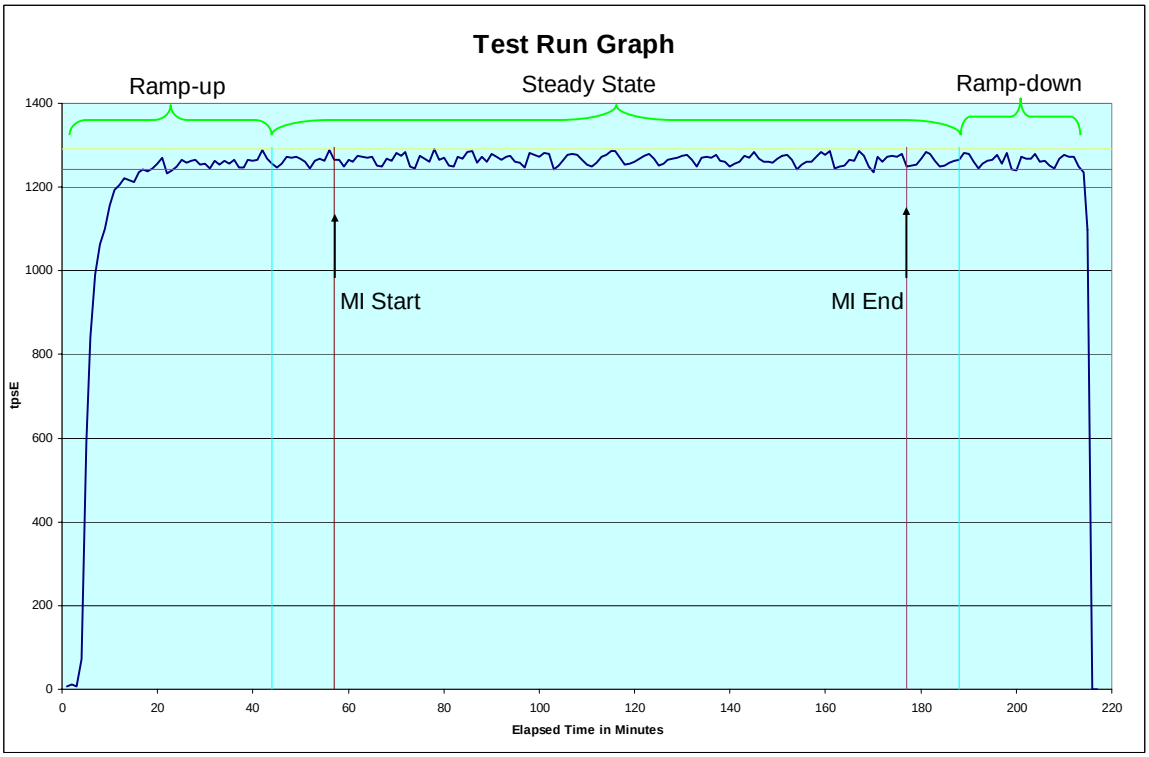


Figure 6-1. Test Run Graph

Steady State Methodology

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

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

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

2. Calculated 60-minute average tpsE during the Steady State moving the time window 10 minutes each time. Then confirmed that the minimum 60-minute average tpsE was not less than 98% of the Reported Throughput, and that the maximum 60-minute average tpsE was not greater than 102% of the Reported Throughput.
3. Calculated 10-minute average tpsE during the Steady State moving the window 1 minute each time. Then confirmed that the minimum 10-minute average tpsE was not less than 80% of the Reported Throughput, and the maximum 10-minute average tpsE was not greater than 120% of the Reported Throughput.

Work Performed during Steady State

A description of how the work normally performed during a Test Run, actually occurred during the Measurement Interval must be reported (e.g., checkpointing, writing Undo/Redo Log records).

Checkpoints were run once every 7 ½ minutes. Data-Maintenance was run every 60 seconds.

Transaction Statistics

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

Table 6-1 contains the transaction statistics.

Input Parameter	Value	Actul Pct	Required Range
Customer-Position			
by_tax_id	1	50.01%	48% to 52%
get_history	1	49.99%	48% to 52%
Market-Watch			
Securities chosen by	Watch list	60.00%	57% to 63%
	Account ID	35.00%	33% to 37%
	Industry	5.00%	4.5% to 5.5%
Security-Detail			
access_lob	1	1.00%	0.9% to 1.1%
Trade-Lookup			
frame_to_execute	1	29.98%	28.5% to 31.5%
	2	30.00%	28.5% to 31.5%
	3	30.02%	28% to 31.5%
	4	10.00%	9.5% to 10.5%
Trade-Order			
Transactions requested by a third party		9.98%	9.5% to 10.5%
Security chosen by company name and issue		40.03%	38% to 42%
type_is_margin	1	7.98%	7.5% to 8.5%
roll_it_back	1	0.99%	0.94% to 1.04% (*)
is_lifo	1	34.99%	33% to 37%
trade_qty	100	25.00%	24% to 26%
	200	25.01%	24% to 26%
	400	25.00%	24% to 26%
	800	24.98%	24% to 26%
trade_type	TMB	29.98%	29.7% to 30.3%
	TMS	30.01%	29.7% to 30.3%
	TLB	20.00%	19.8% to 20.2%
	TLS	10.01%	9.9% to 10.1%
	TSL	10.00%	9.9% to 10.1%
Trade-Update			
frame_to_execute	1	32.95%	31% to 35%
	2	33.05%	31% to 35%
	3	34.00%	32% to 36%

Table 6-1. Transaction Statistics

Clause 7 – Transaction and System Properties Related Items

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

Atomicity Requirements

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

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

Perform a market Trade-Order Transaction with the roll_it_back flag set to false. Verify that the appropriate rows have been inserted in the TRADE and TRADE_HISTORY tables.

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

Execution of Atomicity Tests

1. Open a command prompt.
2. Change to mstpce.1.5.1-1008\ACID\Atomicity directory.
3. Run Atomicity.cmd
4. The output will be in Atomicity_C.out and Atomicity_RB.out

Atomicity.cmd runs a Trade-Order with a commit and notes the new T_ID. Then it does a select on TRADE and TRADE_HISTORY to return the rows in those tables with the new T_ID.

Atomicity.cmd runs a Trade-Order with a roll back and notes the new T_ID. Then it does a select on TRADE and TRADE_HISTORY to return the rows in those tables with the new T_ID. No rows should be returned.

Consistency Requirements

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

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

The specific procedure was:

1. Open a command prompt.
2. Change to the MSTPCE.1.5.1-1008\ACID\Consistency directory.
3. Run Consistency.cmd

4. The output will be in Consistency.out

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

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

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

Isolation Requirements

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

Execution of Isolation Test #1 (P3 Test in Read-Write)

The isolation tests require that you use the SQL Server Management Studio. You are required to copy values from one session to another and the Management Studio facilitates this. The instructions below assume that you are using the Management Studio.

1. Open the SQL Server Management Studio.
2. Open MSTPCE.1.5.1-1008\ACID\Isolation\Scripts\Isolation1_S1.sql in the Management Studio. When prompted, connect to the database server.
3. Ctrl-T to convert results to text.
4. Open MSTPCE.1.5.1-1008\ACID\Isolation\Scripts\Isolation1_S2.sql in the Management Studio. When prompted, connect to the database server.
5. Ctrl-T to convert results to text.
6. Open MSTPCE.1.5.1-1008\ACID\Isolation\Scripts\Isolation1_S3.sql in the Management Studio. When prompted, connect to the database server.
7. Ctrl-T to convert results to text.
8. Open MSTPCE.1.5.1-1008\ACID\Isolation\Scripts\Isolation1_S4.sql in the Management Studio. When prompted, connect to the database server.
9. Ctrl-T to convert results to text.
10. Execute Isolation1_S1.
11. Scroll to the bottom of the Results window and record the "Trade ID Returned."
12. Copy the Customer Account Used to the @acct_id variable near the top of Isolation1_S2.
13. Copy the Symbol Used to the @symbol variable near the top of Isolation1_S2.
14. Execute Isolation1_S2.
15. Scroll to the bottom of the Results window and record the "Trade ID Returned."
16. Copy the Trade ID Used in the Isolation1_S1 results window to the @trade_id variable near the top of Isolation1_S3.
17. Copy the Trade ID Used in the Isolation1_S2 results window to the @trade_id variable near the top of Isolation1_S4.
18. Execute Isolation1_S3 and then immediately execute Isolation1_S4. Note that the SQL code and the instrumented stored procedure will do the appropriate pausing as required in the specification.

Verification of Isolation Test #1 (P3 Test in Read-Write)

1. Record the "Holding Summary After First Execution of Trade Result Frame 1": value of HS_QTY. This is found near the top of the results window of Isolation1_S3. Verify that this is set to 0.
2. Record the "Holding Summary After Second Execution of Trade Result Frame 1": value of HS_QTY. This is found near the top of the results window of Isolation1_S3. Verify that this is set to 0.
3. Record the "Holding Summary After Trade Result Frame 1": value of HS_QTY. This is found near the top of the results window of Isolation1_S4. Verify that this is set to 0.
4. The Trade-Result in S4 completed, and the Trade-Result in S3 was selected as a deadlock victim.

Execution of Isolation Test #2 (P2 Test in Read-Write)

The isolation tests require that you use the SQL Server Management Studio. You are required to copy values from one session to another and the Management Studio facilitates this. The instructions below assume that you are using the Management Studio.

1. Open the SQL Server Management Studio.

2. Open MSTPCE.1.5.1-1008\ACID\Isolation\Scripts\Isolation2_S1.sql in the Management Studio. When prompted, connect to the database server.
3. Ctrl-T to convert results to text.
4. Open MSTPCE.1.5.1-1008\ACID\Isolation\Scripts\Isolation2_S2.sql in the Management Studio. When prompted, connect to the database server.
5. Ctrl-T to convert results to text.
6. Open MSTPCE.1.5.1-1008\ACID\Isolation\Scripts\Isolation2_S3.sql in the Management Studio. When prompted, connect to the database server.
7. Ctrl-T to convert results to text.
8. Open MSTPCE.1.5.1-1008\ACID\Isolation\Scripts\Isolation2_S4.sql in the Management Studio. When prompted, connect to the database server.
9. Ctrl-T to convert results to text.
10. Execute Isolation2_S1.
11. Scroll to the bottom of the Results window of Isolation2_S1 and record the "Holding Summary Quantity" and the "Trade ID Returned."
12. Copy the Customer Account Used from the Results window of Isolation2_S1 to the @acct_id variable near the top of Isolation2_S2.
13. Copy the Symbol Used from the Results window of Isolation2_S1 to the @symbol variable near the top of Isolation2_S2.
14. Execute Isolation2_S2.
15. Scroll to the bottom of the Results window of Isolation2_S2 and record the Trade ID Returned.
16. Copy the Trade ID Used in the Isolation2_S1 results window to the @trade_id variable near the top of Isolation2_S3.
17. Copy the Trade ID Used in the Isolation2_S2 results window to the @trade_id variable near the top of Isolation2_S4.
18. Execute Isolation2_S3 and then immediately execute Isolation2_S4. Note that the SQL code and the instrumented stored procedure will do the appropriate pausing as required in the specification

Verification of Isolation Test #2 (P2 Test in Read-Write)

1. Record the "Holding Summary After First Execution of Trade Result Frame 1": value of HS_QTY. This is found near the top of the results window of Isolation2_S3.
2. Record the "Holding Summary After Second Execution of Trade Result Frame 1": value of HS_QTY. This is found near the top of the results window of Isolation2_S3. This value should match the value returned in step 1 above.
3. Record the "Holding Summary After Trade Result Frame 1": value of HS_QTY. This is found near the top of the results window of Isolation2_S4. This value should match the value returned in step 1 above.
4. The Trade-Result in S4 ran to completion. The Trade-Result in S3 was selected as a deadlock victim.

Execution of Isolation Test #3 (P1 Test in Read-Write)

The isolation tests require that you use the SQL Server Management Studio. You are required to copy values from one session to another and the Management Studio facilitates this. The instructions below assume that you are using the Management Studio.

1. Open the SQL Server Management Studio.
2. Open MSTPCE.1.5.1-1008\ACID\Isolation\Scripts\Isolation3_S1.sql in the Management Studio. When prompted, connect to the database server.
3. Ctrl-T to convert results to text.
4. Open MSTPCE.1.5.1-1008\ACID\Isolation\Scripts\Isolation3_S2.sql in the Management Studio. When prompted, connect to the database server.
5. Ctrl-T to convert results to text.
6. Open MSTPCE.1.5.1-1008\ACID\Isolation\Scripts\Isolation3_S3.sql in the Management Studio. When prompted, connect to the database server.
7. Ctrl-T to convert results to text.

8. Execute Isolation3_S1. This script will initiate the Customer Position and execute two Trade Orders for the remainder of this isolation test to access.
9. Scroll to the bottom of the Results window of Isolation3_S1 and record the "Customer ID Used" and the "Customer Account Balance."
10. Copy the first Trade ID Returned from Isolation3_S1 to the top of Isoaltion3_S2.sql.
11. Copy the Customer Account Used from Isolation3_S1 to the top of Isoaltion3_S2.sql.
12. Copy the second Trade ID Returned from Isolation3_S1 to the top of Isoaltion3_S3.sql.
13. Copy the Customer Account Used from Isolation3_S1 to the top of Isoaltion3_S3.sql.
14. Execute Isolation3_S2, then immediately execute Isolation3_S3. Note that the SQL code and the instrumented stored procedure will do the appropriate pausing as required in the specification.
15. Scroll to the bottom of the Results window of Isolation3_S2 and record the Customer Account Balance and the Settlement Amount.
16. Scroll to the bottom of the Results window of Isolation3_S3 and record the Customer Account Balance and the Settlement Amount.

Verification of Isolation Test #3 (P1 Test in Read-Write)

1. Record the Customer Account Balance from the bottom of the Results window of Isolation3_S1.
2. Record the Customer Account Balance and the Settlement Amount from the bottom of the Results window of Isolation3_S2.
3. Record the Customer Account Balance and the Settlement Amount from the bottom of the Results window of Isolation3_S3.
4. Since the Trade Result in Isolation3_S3 blocks until Isolation3_S2 completes, you may verify the results as follows:
    a. CA_BAL (from Isolation3_S1) + Settlement Amount (from Isolation3_S2) + Settlement Amount (from Isolation3_S3) = Customer Account Balance (from Isoaltion3_S3)

Execution of Isolation Test #4 (P1 Test in Read-Only)

The isolation tests require that you use the SQL Server Management Studio. You are required to copy values from one session to another and the Management Studio facilitates this. The instructions below assume that you are using the Management Studio.

1. Open the SQL Server Management Studio.
2. Open MSTPCE.1.5.1-1008\ACID\Isolation\Scripts\Isolation4_S1.sql in the Management Studio. When prompted, connect to the database server.
3. Ctrl-T to convert results to text.
4. Open MSTPCE.1.5.1-1008\ACID\Isolation\Scripts\Isolation4_S2.sql in the Management Studio. When prompted, connect to the database server.
5. Ctrl-T to convert results to text.
6. Open MSTPCE.1.5.1-1008\ACID\Isolation\Scripts\Isolation4_S3.sql in the Management Studio. When prompted, connect to the database server.
7. Ctrl-T to convert results to text.
8. Execute Isolation4_S1. This script will initiate the Customer Position and execute a Trade Order for the remainder of this isolation test to access.
9. Scroll to the bottom of the Results window of Isolation4_S1 and record the "Customer ID Used," "Customer Account Used," "Customer Account Balance," and the "Trade ID Returned."
10. Copy the "Customer Account Used" from the Results window of Isolation4_S1 to the @acct_id variable near the top of Isolation4_S2.
11. Copy the "Trade ID Returned" from the Results window of Isolation4_S1 to the @trade_id variable near the top of Isolation4_S2.
12. Copy the "Customer ID" from the Results window of Isolation4_S1 to the @cust_id variable near the top of Isolation4_S3.
13. Copy the "Customer Account Used" from the Results window of Isolation4_S1 to the @acct_id variable near the top of Isolation4_S3.

14. Execut Isolation4_S2 and after a few seconds to make sure Isolation4_S2 has started execute Isolation4_S3.

Verification of Isolation Test #4 (P1 Test in Read-Only)

1. Record the Customer Account Balance from the bottom of the Results window of Isolation4_S1.
2. Record the Customer Account Balance and the Settlement Amount from the bottom of the Results window of Isolation4_S2.
3. Record the Customer Account Balance from the bottom of the Results window of Isolation4_S3.
4. Since the Customer Position in Isolation4_S3 blocks until Isolation4_S2 completes, you may verify the results as follows:
    a. CA_BAL (from Isolation4_S1) + Settlement Amount (from Isolation4_S2) = Customer Account Balance (from Isoaltion4_S3)

Durability Requirements

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

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

Durability Test for Data Accessibility

This benchmark result used Redundancy Level 1.

To prove Redundancy Level 1, the following steps were successfully performed. The test for Redundancy Level 1 is the test for Permanent Irrecoverable Failure of any single Durable Medium.

1. Determine the current number of completed trades in the database by running: *select count(*) as count1 from SETTLEMENT*
2. Start submitting Transactions and ramp up to the Durability Throughput Requirements (as defined in Clause 7.5.3) and satisfy those requirements for at least 5 minutes.
3. Induce the failure described for the redundancy level being demonstrated. In this case fail a disk in a database data array. Then wait 20 minutes or so to allow Durability Throughput Requirements to be met again, and then fail a disk in the database log array. Transactions should continue processing since the database log array has mirrored drives and the database data array uses RAID-5.
4. Begin the necessary recovery process, by replacing the failed drives in the database log array and the database data array. A rebuild on each replaced drive should start automatically.
5. Continue running the Driver for 20 minutes.
6. Terminate the run gracefully from the Driver.
7. Retrieve the new number of completed trades in the database by running: *select count(*) as count2 from SETTLEMENT*
8. Compare the number of executed Trade-Result Transactions on the Driver to (count2 – count1). Verify that (count2 - count1) is equal to the number of successful Trade-Result Transaction records in the Driver log file.
9. Allow recovery process to complete as needed.

Following is a graph of the measured throughput versus elapsed time that must be reported for the run portions of the Data Accessibility tests:

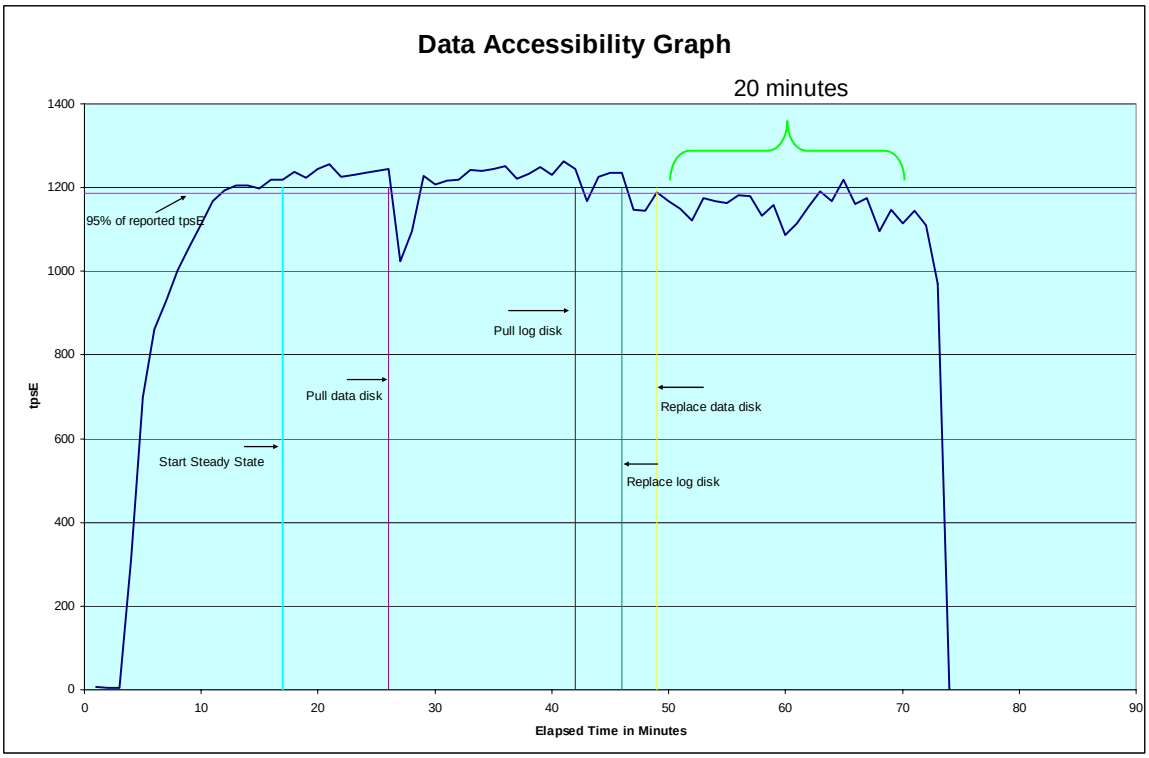


Figure 7-1. Data Accessibility Graph

Durability Test Procedure for Catastrophic Failures

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

The following steps were successfully performed to meet the Durability Throughput Requirements of Clause 7.5.3:

1. Determine the current number of completed trades in the database by running: *select count(*) as count1 from SETTLEMENT*
2. Start submitting Transactions and ramp up to the Durability Throughput Requirements (as defined in Clause 7.5.3) and satisfy those requirements for at least 20 minutes.
3. Induce all of the Catastrophic failures, in Clause 7.5.2.2, 7.5.2.3 and 7.5.2.4, by pulling the power cords from the x3950 M2.
4. Stop the Driver.
5. Re-power and restart the x3950 M2.
6. On the x3950 M2 when Windows has started run StartSQLdashX.bat to start SQL Server and database recovery. SQL Server writes timestamps out to the errorlog when it is started. This timestamp can be used as the time when Business Recovery starts (see Clause 7.5.6.4).
7. Once the SUT will accept Transactions, start submitting Transactions and ramp up to a Durability Throughput Requirements (as defined in Clause 7.5.3) and satisfy those requirements for at least 20 minutes.
8. Note this time as the end of Business Recovery (see Clause 7.5.6.7).
9. Terminate the Driver gracefully.
10. Verify that no errors were reported by the Driver during steps 7 through 9.
11. Retrieve the new number of completed trades in the database by running: *select count(*) as count2 from SETTLEMENT*

12. Compare the number of completed Trade-Result Transactions on the Driver to (count2 – count1). Verify that (count2 - count1) is greater than or equal to the aggregate number of successful Trade-Result Transaction records in the Driver log file for the runs performed in step 2 and step 7. If there is an inequality, the SETTLEMENT table must contain additional records and the difference must be less than or equal to the maximum number of Transactions that can be simultaneously in-flight from the Driver to the SUT. This number is specific to the implementation of the Driver and configuration settings at the time of the crash.
13. Verify consistency conditions as specified in Clause 7.3.1.1.

The Business Recovery Time was 01:41:10.

Following is a graph of the measured throughput versus elapsed time that must be reported for the run portions of the Business Recover Time test:

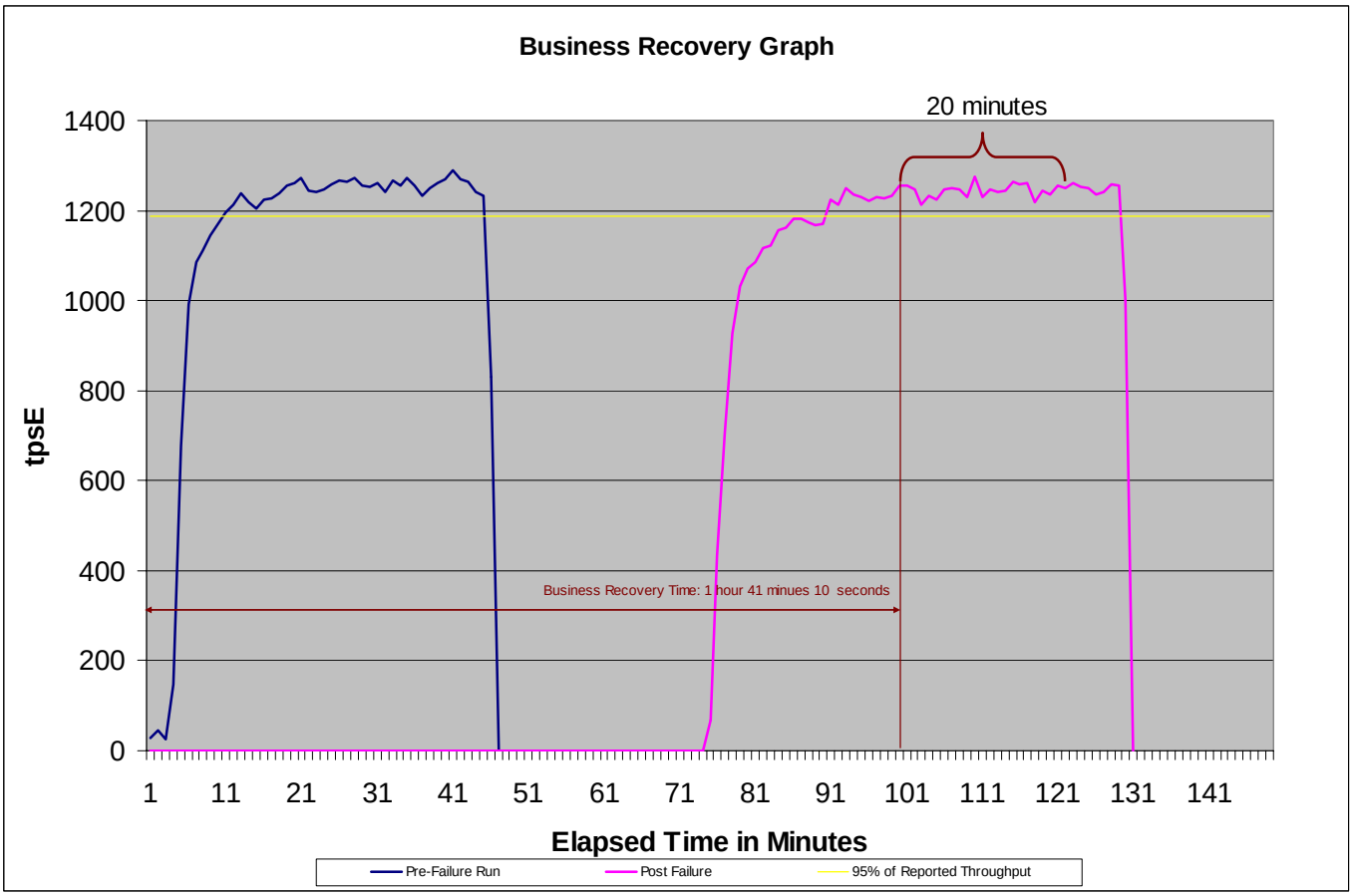


Figure 7-2. Business Recovery Time Graph

Clause 8 – Pricing Related Items

60-Day Space

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

Table 8-1 Disk Space Requirements

Customers Used	**625,000**	**Performance**	**1266.49**	**TpsE**		**Reported**	**1250**	**TpsE**	
Broker File Group	**Initial Rows**	**Data (KB)**	**Index size (KB)**	**Extra 5% (KB)**	**Total + 5% (KB)**	**After run (KB)**	**Growth (KB)**	**Bus. Day Growth (KB)**	**Req. Add. (KB)**
BROKER	6,250	352	672	51	1,075	1,408	384	884	884
CASH_TRANSACTION	9,935,989,568	985,577,208	2,079,664	49,382,844	1,037,039,716	1,015,039,280	27,382,408	62,969,288	62,969,288
CHARGE	15	8	8	1	17	16	-	-	1
COMMISSION_RATE	240	16	16	2	34	32	-	-	2
SETTLEMENT	10,800,000,000	530,002,000	1,117,936	26,555,997	557,675,933	556,499,624	25,379,688	58,363,782	58,363,782
TRADE	10,800,000,000	1,199,520,232	644,708,968	92,211,460	1,936,440,660	1,866,861,120	22,631,920	52,044,944	52,044,944
TRADE_HISTORY	25,920,063,458	743,227,768	1,938,496	37,258,313	782,424,577	748,108,264	2,942,000	6,765,499	6,765,499
TRADE_REQUEST	-	8	8	1	17	27,976	27,960	64,298	64,298
TRADE_TYPE	5	8	1,032	52	1,092	1,040	-	-	52
Customer File Group									-
ACCOUNT_PERMISSION	4,437,353	443,856	2,944	22,340	469,140	446,800	-	-	22,340
CUSTOMER	625,000	105,904	27,888	6,690	140,482	133,808	16	37	6,690
CUSTOMER_ACCOUNT	3,125,000	290,240	345,992	31,812	668,044	636,232	-	-	31,812
CUSTOMER_TAXRATE	1,250,000	26,104	776	1,344	28,224	27,024	144	332	1,344
HOLDING	553,044,807	29,611,104	22,001,624	2,580,636	54,193,364	72,802,152	21,189,424	48,727,743	48,727,743
HOLDING_HISTORY	14,473,766,084	526,318,888	274,292,312	40,030,560	840,641,760	803,814,008	3,202,808	7,365,260	7,365,260
HOLDING_SUMMARY	31,087,057	1,065,248	4,608	53,493	1,123,349	2,142,544	1,072,688	2,466,781	2,466,781
WATCH_ITEM	62,523,423	1,733,112	6,944	87,003	1,827,059	1,740,336	280	644	87,003
WATCH_LIST	625,000	15,616	13,432	1,452	30,500	29,048	-	-	1,452
Market File Group									
COMPANY	312,500	68,024	19,560	4,379	91,963	87,584	-	-	4,379
COMPANY_COMPETITOR	937,500	25,216	21,272	2,324	48,812	46,488	-	-	2,324
DAILY_MARKET	558,703,125	28,839,616	12,308,928	2,057,427	43,205,971	41,149,960	1,416	3,257	2,057,427
EXCHANGE	4	8	8	1	17	16	-	-	1
FINANCIAL	6,250,000	735,416	2,736	36,908	775,060	738,464	312	718	36,908
INDUSTRY	102	8	40	2	50	48	-	-	2
LAST_TRADE	428,125	20,072	784	1,043	21,899	40,968	20,112	46,251	46,251
NEWS_ITEM	625,000	67,763,704	1,752	3,388,273	71,153,729	67,765,456	-	-	3,388,273
NEWS_XREF	625,000	15,592	784	819	17,195	16,376	-	-	819
SECTOR	12	8	24	2	34	32	-	-	2
SECURITY	428,125	67,496	30,256	4,888	102,640	97,776	24	56	4,888
STATUS_TYPE	5	8	8	1	17	16	-	-	1
Misc File Group									
ADDRESS	937,504	54,144	776	2,746	57,666	54,960	40	92	2,746
TAXRATE	320	24	16	2	42	56	16	37	37
ZIP_CODE	14,741	488	176	33	697	664	-	-	33
TOTALS (KB)		**4,115,527,496**	**958,930,440**	**253,722,897**	**5,328,180,833**				
Initial Database Size (MB)		**4,955,525**	**4,839 GB**						

Db/Filegroups	**LUN Count**	**Partition Size(KB)**	**MB allocated**	**MB Loaded**	**MB Required**	
	0	-	-	-	-	OK
growing_fg	32	192,307,200	6,009,600	4,845,182	5,078,353	OK
	0	-	-	-	-	OK
fixed_fg	32	6,656,000	208,000	110,344	115,906	OK
Settlements	**15,861,239**					

Initial Growing Space (MB)	4,845,182							
Final Growing Space (MB)	4,946,577	**Data LUNS**	32	**Initial Log size (MB)**	7,065	**Log LUNS**	1	
Delta (MB)	101,395	**Disks per LUN**	24	**Final Log size (MB)**	164,309	**Log Disks**	16	
Data Space per Trade (MB)	0.006392654	**Disk Capacity (MB)**	69,495	**Log Growth (MB)**	157,243	**Disk Capacity (MB)**	69,495	
1 Day Data Growth (MB)	230,136	**RAID5 overhead**	96%	**Log Growth/trade (MB)**	0.009913683868	**RAID10 overhead**	50%	
60 Day Space (MB)	**18,763,657**	**Total Space (MB)**	**51,147,899**	**1 Day log space (MB)**	**356,893**	**Log Space (MB)**	**555,958**	
			OK					OK

Table 8-1. Ordering and Pricing Information

Description	Part Number	Order Date	Availability Date	Order Method	Price Verification
Qlogic FC Dual-Port HBA for IBM System x	42D0510	7-8-08	7-15-08	See Note 1	See Note 2
Microsoft SQL Server 2008 Enterprise x64 Edition	N/A	8-30-08	8-30-08	See Note 3	See Note 3

Note 1: IBM – 1-888-746-7426, ext. 5821

Note 2: This component is not immediately orderable. For price verification before order date, call 1-888-746-7426, ext. 5821.

Note 3: This component is not immediately orderable. For price verification before order date, refer to the price quote at the end of this FDR.

Auditor's Attestation Letter

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

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

INFO SIZING

TPC TRANSACTION PROCESSING PERFORMANCE COUNCIL CERTIFIED AUDITOR

Benchmark Sponsor: Celia Schreiber, Manager
Modular Systems and Blade Performance Analysis and Benchmarking
IBM Systems and Technology Group
3039 Cornwallis Road
RTP, NC 27709

July 2, 2008

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

Platform: IBM System x3950 M2
Operating system: Microsoft Windows Server 2008 Datacenter x64 Edition
Database Manager: Microsoft SQL Server 2008 Enterprise x64 Edition

The results were:

CPU's Speed	Memory	Disks	Trade-Result 90% Response Time	tpsE
Tier B, Server: IBM System x3950 M2				
16 x Intel Xeon X7350 (2.93GHz)	512 GB (2 x 4 MB L2)	768 x 73.4 GB 15K 4Gbps FC 16 x 73.4 GB 15K SAS	0.10 Seconds	1250.00
Tier A, Two Clients: IBM System x3500				
1 x Intel Xeon E5440 (2.83 GHz)	2 GB	2 x 73 GB 15K Hot Swap SAS	n/a	n/a

In my opinion, these performance results were produced in compliance with the TPC requirements for the benchmark.

The following 12 verification items were given special attention:

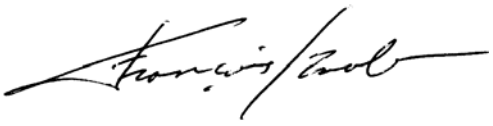
- All EGen components were verified to be v1.5.1.
- The transactions were correctly implemented.
- The database was properly scaled and populated for 625,000 customers.

- The mandatory network between the driver and the SUT was configured.
- The ACID properties were met.
- Input data was generated according to the specified percentages.
- The reported response times were correctly measured.
- All 90% response times were under the specified maximums.
- The measurement interval was representative of steady state conditions.
- The reported measurement interval was 120 minutes.
- The 60 day storage requirement was correctly computed.
- The system pricing was verified for major components and maintenance.

Additional Audit Notes:

None.

Respectfully Yours,



Doug Johnson, Auditor

François Raab, President

Supporting Files Index Table

The **Supporting Files Index** file can be found in the *SupportingFiles* directory (SupportingFiles.doc).

Clause	Description	Pathname
Introduction	Disk Configuration	SupportingFiles/Introduction/Hardware/1stDS4800.cfg SupportingFiles/Introduction/Hardware/2ndDS4800.cfg SupportingFiles/Introduction/Hardware/3rdDS4800.cfg SupportingFiles/Introduction/Hardware/4thDS4800.cfg SupportingFiles/Introduction/Hardware/dataDisks.txt SupportingFiles/Introduction/Hardware/dblog.txt SupportingFiles/Introduction/Hardware/DS4800_EXP810diagram.ppt SupportingFiles/Introduction/Hardware/DS4800_setup.script SupportingFiles/Introduction/Hardware/formats.cmd SupportingFiles/Introduction/Hardware/input.txt SupportingFiles/Introduction/Hardware/Logcfg.txt SupportingFiles/Introduction/Hardware/mkmp.cmd SupportingFiles/Introduction/Hardware/StorageSetup.doc
	Tier B/x3950 M2 Configuration	SupportingFiles/Introduction/Hardware/TierB_x3950M2_setup.txt
	TierA/x3500 setup	SupportingFiles/Introduction/Hardware/TierA_x3500_setup.txt
	Database Tunable Parameters	SupportingFiles/Introduction/software/runconfig.sql SupportingFiles/Introduction/software/startSQL.bat SupportingFiles/Introduction/software/stopSQL.bat
	Checkpoint Scripts	SupportingFiles/Introduction/software/runregularcheckpoints.bat SupportingFiles/Introduction/software/checkpoint.bat SupportingFiles/Introduction/software/checkpoint.sql
	Tier A Scripts	SupportingFiles/Introduction/software/StartTpce_vclient10.bat SupportingFiles/Introduction/software/StartTpce_vclient20.bat
	OS Tunable Parameters	SupportingFiles/Introduction/software/TierB_OSTune.doc SupportingFiles/Introduction/software/x3950M2_TierB_SysInfo.txt SupportingFiles/Introduction/software/vclient10_TierA_sysinfo.txt SupportingFiles/Introduction/software/vclient20_TierA_sysinfo.txt

Clause 2	Table creation scripts	SupportingFiles/Clause2/DDL/BulkInsert_1.sql SupportingFiles/Clause2/DDL/BulkInsert_2.sql SupportingFiles/Clause2/DDL/BulkInsert_3.sql SupportingFiles/Clause2/DDL/BulkInsert_4.sql SupportingFiles/Clause2/DDL/BulkInsert_5.sql SupportingFiles/Clause2/DDL/BulkInsert_6.sql SupportingFiles/Clause2/DDL/BulkInsert_7.sql SupportingFiles/Clause2/DDL/BulkInsert_8.sql SupportingFiles/Clause2/DDL/BulkInsert_9.sql SupportingFiles/Clause2/DDL/BulkInsert_10.sql SupportingFiles/Clause2/DDL/BulkInsert_11.sql SupportingFiles/Clause2/DDL/BulkInsert_12.sql SupportingFiles/Clause2/DDL/BulkInsert_13.sql SupportingFiles/Clause2/DDL/BulkInsert_14.sql SupportingFiles/Clause2/DDL/BulkInsert_15.sql SupportingFiles/Clause2/DDL/BulkInsert_16.sql SupportingFiles/Clause2/DDL/BulkInsert_17.sql SupportingFiles/Clause2/DDL/BulkInsert_18.sql SupportingFiles/Clause2/DDL/BulkInsert_19.sql SupportingFiles/Clause2/DDL/BulkInsert_20.sql SupportingFiles/Clause2/DDL/BulkInsert_21.sql SupportingFiles/Clause2/DDL/BulkInsert_22.sql SupportingFiles/Clause2/DDL/BulkInsert_23.sql SupportingFiles/Clause2/DDL/BulkInsert_24.sql SupportingFiles/Clause2/DDL/BulkInsert_25.sql SupportingFiles/Clause2/DDL/BulkInsert_26.sql SupportingFiles/Clause2/DDL/BulkInsert_27.sql SupportingFiles/Clause2/DDL/BulkInsert_28.sql SupportingFiles/Clause2/DDL/BulkInsert_29.sql SupportingFiles/Clause2/DDL/BulkInsert_30.sql SupportingFiles/Clause2/DDL/Convert_NI_ITEM_Data.sql SupportingFiles/Clause2/DDL/Create_Check_Constraints_Fixed.sql SupportingFiles/Clause2/DDL/Create_Check_Constraints_Growing.sql SupportingFiles/Clause2/DDL/Create_Check_Constraints_Scaling.sql SupportingFiles/Clause2/DDL/Create_FK_Constraints.sql SupportingFiles/Clause2/DDL/Create_Tables_Fixed.sql SupportingFiles/Clause2/DDL/Create_Tables _Growing.sql SupportingFiles/Clause2/DDL/Create_Tables _Scaling.sql SupportingFiles/Clause2/DDL/Create_Tables _Scaling_Flat.sql SupportingFiles/Clause2/DDL/Create_TPCE_Types.sql SupportingFiles/Clause2/DDL/Drop_FK_Constraints.sql SupportingFiles/Clause2/DDL/Drop_Tables_Fixed.sql SupportingFiles/Clause2/DDL/Drop_Tables_Growing.sql SupportingFiles/Clause2/DDL/Drop_Tables_Scaling.sql
	Index creation scripts	SupportingFiles/Clause2/DDL/Create_Clustered_Indexes_Fixed.sql SupportingFiles/Clause2/DDL/Create_Clustered_Indexes_Growing.sql SupportingFiles/Clause2/DDL/Create_Clustered_Indexes_Scaling.sql SupportingFiles/Clause2/DDL/Create_NC_Indexes_Fixed.sql SupportingFiles/Clause2/DDL/Create_NC_Indexes_Growing.sql SupportingFiles/Clause2/DDL/Create_NC_Indexes_Scaling.sql

	Load Transaction Frames	SupportingFiles/Clause2/DML/BrokerVolume.sql SupportingFiles/Clause2/DML/CustomerPosition.sql SupportingFiles/Clause2/DML/DataMaintenance.sql SupportingFiles/Clause2/Utility/Get_Next_T_ID.sql SupportingFiles/Clause2/DML/MarketFeed.sql SupportingFiles/Clause2/DML/MarketWatch.sql SupportingFiles/Clause2/DML/SecurityDetail.sql SupportingFiles/Clause2/Utility/Trade_Cleanup.sql SupportingFiles/Clause2/DML/TradeLookup.sql SupportingFiles/Clause2/DML/TradeOrder.sql SupportingFiles/Clause2/DML/TradeResult.sql SupportingFiles/Clause2/DML/TradeStatus.sql SupportingFiles/Clause2/DML/TradeUpdate.sql
	Create Database	SupportingFiles/Clause2/misc/Backup_database.sql SupportingFiles/Clause2/misc/backupdev.sql SupportingFiles/Clause2/Utility/Count_Customers.sql SupportingFiles/Clause2/misc/countSettlement.sql SupportingFiles/Clause2/misc/create_database.sql SupportingFiles/Clause2/Utility/Create_DM_Audit_Table.sql SupportingFiles/Clause2/Utility/Create_TID_Ranges_Tables.sql SupportingFiles/Clause2/Utility/Create_Timer_Table.sql SupportingFiles/Clause2/Utility/Database_Options_1.sql SupportingFiles/Clause2/Utility/Database_Options_2.sql SupportingFiles/Clause2/Utility/Drop_and_Create_TPCE_INFO.sql SupportingFiles/Clause2/Utility/End_Load_Timer.sql SupportingFiles/Clause2/Utility/Install_Load_Timer_Proc.sql SupportingFiles/Clause2/Utility/Load_TPCE_Info.sql SupportingFiles/Clause2/MSTPCE Database Setup Reference.pdf SupportingFiles/Clause2/misc/remove_database.sql SupportingFiles/Clause2/misc/restore.sql SupportingFiles/Clause2/misc/runconfig.sql SupportingFiles/Clause2/misc/selectDM_Audit_Table.sql SupportingFiles/Clause2/Utility/SQL_Server_Configuration.sql SupportingFiles/Clause2/misc/StartSQL.bat SupportingFiles/Clause2/misc/tempdb.sql SupportingFiles/Clause2/TPCE_Setup.cmd SupportingFiles/Clause2/Utility/Version.sql
	Database Space Scripts	SupportingFiles/Clause2/audit_scripts/Space/SPFiles.sql SupportingFiles/Clause2/audit_scripts/Space/SPLog.sql SupportingFiles/Clause2/audit_scripts/Space/SPUsed.sql
	Database Audit Scripts	SupportingFiles/Clause2/audit_scripts/database/Create_DB_Audit_Tables.sql SupportingFiles/Clause2/audit_scripts/database/DB_Check.sql SupportingFiles/Clause2/audit_scripts/database/DB_Primary_Key_Check.sql SupportingFiles/Clause2/audit_scripts/database/DB_Tables.sql SupportingFiles/Clause2/audit_scripts/database/Drop_DB_Audit_Tables.sql SupportingFiles/Clause2/audit_scripts/database/Insert_Duplicates_Tests.sql SupportingFiles/Clause2/Audit_Scripts/Database/Referential_Integrity_Tests.sql

Clause 3	Transaction Frames	SupportingFiles/Clause3/BrokerVolume.sql SupportingFiles/Clause3/CustomerPosition.sql SupportingFiles/Clause3/DataMaintenance.sql SupportingFiles/Clause3/Get_Next_T_ID.sql SupportingFiles/Clause3/MarketFeed.sql SupportingFiles/Clause3/MarketWatch.sql SupportingFiles/Clause3/SecurityDetail.sql SupportingFiles/Clause3/Trade_Cleanup.sql SupportingFiles/Clause3/TradeLookup.sql SupportingFiles/Clause3/TradeOrder.sql SupportingFiles/Clause3/TradeResult.sql SupportingFiles/Clause3/TradeStatus.sql SupportingFiles/Clause3/TradeUpdate.sql
	BaseServer	SupportingFiles/Clause3/BaseServer/BaseServer.cpp SupportingFiles/Clause3/BaseServer/BaseServer.h SupportingFiles/Clause3/BaseServer/BaseServer.vcproj SupportingFiles/Clause3/BaseServer/stdafx.cpp SupportingFiles/Clause3/BaseServer/stdafx.h SupportingFiles/Clause3/BaseServer/SUTServersLocals.h
	SUT_CE_Server	SupportingFiles/Clause3/SUT_CE_Server/CEServer.cpp SupportingFiles/Clause3/SUT_CE_Server/CEServer.h SupportingFiles/Clause3/SUT_CE_Server/CEServerMain.cpp SupportingFiles/Clause3/SUT_CE_Server/PortDefinitions.h SupportingFiles/Clause3/SUT_CE_Server/stdafx.cpp SupportingFiles/Clause3/SUT_CE_Server/stdafx.h SupportingFiles/Clause3/SUT_CE_Server/SUT_CE_Server.vcproj SupportingFiles/Clause3/SUT_CE_Server/SUTServer.sln SupportingFiles/Clause3/SUT_CE_Server/SUTServer.suo SupportingFiles/Clause3/SUT_CE_Server/SUTStructs.h
	SUT_MEE_Server	SupportingFiles/Clause3/SUT_MEE_Server/MEEServer.cpp SupportingFiles/Clause3/SUT_MEE_Server/MEEServer.h SupportingFiles/Clause3/SUT_MEE_Server/MEEServerMain.cpp SupportingFiles/Clause3/SUT_MEE_Server/stdafx.cpp SupportingFiles/Clause3/SUT_MEE_Server/stdafx.h SupportingFiles/Clause3/SUT_MEE_Server/SUT_MEE_Server.vcproj

	TransactionsSP	SupportingFiles/Clause3/TransactionsSP/BrokerVolumeDB_SP.cpp SupportingFiles/Clause3/TransactionsSP/BrokerVolumeDB_SP.h SupportingFiles/Clause3/TransactionsSP/CheckpointDB_SP.cpp SupportingFiles/Clause3/TransactionsSP/CheckpointDB_SP.h SupportingFiles/Clause3/TransactionsSP/CustomerPositionDB_SP.cpp SupportingFiles/Clause3/TransactionsSP/CustomerPositionDB_SP.h SupportingFiles/Clause3/TransactionsSP/DataMaintenanceDB_SP.cpp SupportingFiles/Clause3/TransactionsSP/DataMaintenanceDB_SP.h SupportingFiles/Clause3/TransactionsSP/MarketFeedDB_SP.cpp SupportingFiles/Clause3/TransactionsSP/MarketFeedDB_SP.h SupportingFiles/Clause3/TransactionsSP/MarketWatchDB_SP.cpp SupportingFiles/Clause3/TransactionsSP/MarketWatchDB_SP.h SupportingFiles/Clause3/TransactionsSP/SecurityDetailDB_SP.cpp SupportingFiles/Clause3/TransactionsSP/SecurityDetailDB_SP.h SupportingFiles/Clause3/TransactionsSP/stdafx.cpp SupportingFiles/Clause3/TransactionsSP/stdafx.h SupportingFiles/Clause3/TransactionsSP/TradeLookupDB_SP.cpp SupportingFiles/Clause3/TransactionsSP/TradeLookupDB_SP.h SupportingFiles/Clause3/TransactionsSP/TradeOrderDB_SP.cpp SupportingFiles/Clause3/TransactionsSP/TradeOrderDB_SP.h SupportingFiles/Clause3/TransactionsSP/TradeResultDB_SP.cpp SupportingFiles/Clause3/TransactionsSP/TradeResultDB_SP.h SupportingFiles/Clause3/TransactionsSP/TradeStatusDB_SP.cpp SupportingFiles/Clause3/TransactionsSP/TradeStatusDB_SP.h SupportingFiles/Clause3/TransactionsSP/TradeUpdateDB_SP.cpp SupportingFiles/Clause3/TransactionsSP/TradeUpdateDB_SP.h SupportingFiles/Clause3/TransactionsSP/TransactionsSP.vcproj SupportingFiles/Clause3/TransactionsSP/TxnHarnessDBBase.cpp SupportingFiles/Clause3/TransactionsSP/TxnHarnessDBBase.h SupportingFiles/Clause3/TransactionsSP/TxnHarnessDBConn.cpp SupportingFiles/Clause3/TransactionsSP/TxnHarnessDBConn.h
	TxnHarness	SupportingFiles/Clause3/TxnHarness/TxnHarness.vcproj SupportingFiles/Clause3/TxnHarness/TxnHarness_stdafx.cpp SupportingFiles/Clause3/TxnHarness/TxnHarness_stdafx.h SupportingFiles/Clause3/TxnHarness/TxnHarnessSendToMarket.cpp SupportingFiles/Clause3/TxnHarness/TxnHarnessSendToMarket.h
Clause 4	No Requirements	
Clause 5	No EGen modifications	
	No EGenLoader extensions	
	EGenDriver Configuration	SupportingFiles/Clause5/625Kcust_4MEEs_v1.5.1_2clients_4.xml

	EGenLoader Parameters	SupportingFiles/Clause5/EGenLoaderFlags.txt SupportingFiles/Clause5/EGenLoaderFrom1To21000.log SupportingFiles/Clause5/EGenLoaderFrom21001To42000.log SupportingFiles/Clause5/EGenLoaderFrom42001To63000.log SupportingFiles/Clause5/EGenLoaderFrom63001To83000.log SupportingFiles/Clause5/EGenLoaderFrom83001To104000.log SupportingFiles/Clause5/EGenLoaderFrom104001To125000.log SupportingFiles/Clause5/EGenLoaderFrom125001To146000.log SupportingFiles/Clause5/EGenLoaderFrom146001To167000.log SupportingFiles/Clause5/EGenLoaderFrom167001To188000.log SupportingFiles/Clause5/EGenLoaderFrom188001To208000.log SupportingFiles/Clause5/EGenLoaderFrom208001To229000.log SupportingFiles/Clause5/EGenLoaderFrom229001To250000.log SupportingFiles/Clause5/EGenLoaderFrom250001To271000.log SupportingFiles/Clause5/EGenLoaderFrom271001To292000.log SupportingFiles/Clause5/EGenLoaderFrom292001To313000.log SupportingFiles/Clause5/EGenLoaderFrom313001To333000.log SupportingFiles/Clause5/EGenLoaderFrom333001To354000.log SupportingFiles/Clause5/EGenLoaderFrom354001To375000.log SupportingFiles/Clause5/EGenLoaderFrom375001To396000.log SupportingFiles/Clause5/EGenLoaderFrom396001To417000.log SupportingFiles/Clause5/EGenLoaderFrom417001To438000.log SupportingFiles/Clause5/EGenLoaderFrom438001To458000.log SupportingFiles/Clause5/EGenLoaderFrom458001To479000.log SupportingFiles/Clause5/EGenLoaderFrom479001To500000.log SupportingFiles/Clause5/EGenLoaderFrom500001To521000.log SupportingFiles/Clause5/EGenLoaderFrom521001To542000.log SupportingFiles/Clause5/EGenLoaderFrom542001To563000.log SupportingFiles/Clause5/EGenLoaderFrom563001To583000.log SupportingFiles/Clause5/EGenLoaderFrom583001To604000.log SupportingFiles/Clause5/EGenLoaderFrom604001To625000.log
Clause 6	EGenValidate Output	SupportingFiles/Clause6/EGenValidate.txt

Clause 7	Scripts of ACID procedures	SupportingFiles/Clause7/AcidProcs/AcidProc.cmd SupportingFiles/Clause7/AcidProcs/Scripts/AcidProc.vbs SupportingFiles/Clause7/AcidProcs/Scripts/CustomerPosition_Iso3.sql SupportingFiles/Clause7/AcidProcs/Scripts/CustomerPosition_Iso4.sql SupportingFiles/Clause7/AcidProcs/Scripts/Drop_SPROC.sql SupportingFiles/Clause7/AcidProcs/Scripts/Remove_AcidProcs.vbs SupportingFiles/Clause7/AcidProcs/Scripts/TradeOrder_C.sql SupportingFiles/Clause7/AcidProcs/Scripts/TradeOrder_Iso1_1.sql SupportingFiles/Clause7/AcidProcs/Scripts/TradeOrder_Iso1_2.sql SupportingFiles/Clause7/AcidProcs/Scripts/TradeOrder_Iso2.sql SupportingFiles/Clause7/AcidProcs/Scripts/TradeOrder_Iso3.sql SupportingFiles/Clause7/AcidProcs/Scripts/TradeOrder_Iso4.sql SupportingFiles/Clause7/AcidProcs/Scripts/TradeOrder_RB.sql SupportingFiles/Clause7/AcidProcs/Scripts/TradeResult_Iso1_1.sql SupportingFiles/Clause7/AcidProcs/Scripts/TradeResult_Iso1_2.sql SupportingFiles/Clause7/AcidProcs/Scripts/TradeResult_Iso2_1.sql SupportingFiles/Clause7/AcidProcs/Scripts/TradeResult_Iso2_2.sql SupportingFiles/Clause7/AcidProcs/Scripts/TradeResult_Iso3.sql SupportingFiles/Clause7/AcidProcs/Scripts/TradeResult_Iso4.sql SupportingFiles/Clause7/AcidProcs/Remove_AcidProcs.cmd
	ACID procedures output	SupportingFiles/Clause7/AcidProcs/AcidProc.out
	Atomicity Scripts	SupportingFiles/Clause7/Atomicity/Atomicity.cmd SupportingFiles/Clause7/Atomicity/Scripts/Atomicity_C.sql SupportingFiles/Clause7/Atomicity/Scripts/Atomicity_RB.sql SupportingFiles/Clause7/Atomicity/Scripts/atom.vbs
	Atomicity Output	SupportingFiles/Clause7/Atomicity/Atomicity_C.out SupportingFiles/Clause7/Atomicity/Atomicity_RB.out
	Consistency Scripts	SupportingFiles/Clause7/Consistency/Consistency.cmd SupportingFiles/Clause7/Consistency/Scripts/Consistency.sql SupportingFiles/Clause7/Consistency/Scripts/Consistency.vbs
	Consistency Output	SupportingFiles/Clause7/Consistency/Consistency.after625Kload.out SupportingFiles/Clause7/Consistency/Consistency.afterBusinessRecovery.out SupportingFiles/Clause7/Consistency/Consistency.afterMeasuredRun.out
	Isolation Scripts	SupportingFiles/Clause7/Isolation/Scripts/Isolation1_S1.sql SupportingFiles/Clause7/Isolation/Scripts/Isolation1_S2.sql SupportingFiles/Clause7/Isolation/Scripts/Isolation1_S3.sql SupportingFiles/Clause7/Isolation/Scripts/Isolation1_S4.sql SupportingFiles/Clause7/Isolation/Scripts/Isolation2_S1.sql SupportingFiles/Clause7/Isolation/Scripts/Isolation2_S2.sql SupportingFiles/Clause7/Isolation/Scripts/Isolation2_S3.sql SupportingFiles/Clause7/Isolation/Scripts/Isolation2_S4.sql SupportingFiles/Clause7/Isolation/Scripts/Isolation3_S1.sql SupportingFiles/Clause7/Isolation/Scripts/Isolation3_S2.sql SupportingFiles/Clause7/Isolation/Scripts/Isolation3_S3.sql SupportingFiles/Clause7/Isolation/Scripts/Isolation4_S1.sql SupportingFiles/Clause7/Isolation/Scripts/Isolation4_S2.sql SupportingFiles/Clause7/Isolation/Scripts/Isolation4_S3.sql

	solation Output	SupportingFiles/Clause7/Isolation/Isolation1_S1.rpt SupportingFiles/Clause7/Isolation/Isolation1_S2.rpt SupportingFiles/Clause7/Isolation/Isolation1_S3.rpt SupportingFiles/Clause7/Isolation/Isolation1_S4.rpt SupportingFiles/Clause7/Isolation/Isolation2_S1.rpt SupportingFiles/Clause7/Isolation/Isolation2_S2.rpt SupportingFiles/Clause7/Isolation/Isolation2_S3.rpt SupportingFiles/Clause7/Isolation/Isolation2_S4.rpt SupportingFiles/Clause7/Isolation/Isolation3_S1.rpt SupportingFiles/Clause7/Isolation/Isolation3_S2.rpt SupportingFiles/Clause7/Isolation/Isolation3_S3.rpt SupportingFiles/Clause7/Isolation/Isolation4_S1.rpt SupportingFiles/Clause7/Isolation/Isolation4_S2.rpt SupportingFiles/Clause7/Isolation/Isolation4_S3.rpt
	Durability Business Recovery	SupportingFiles/Clause7/Durability/BusinessRecovery/BusinessRecoveryTime.txt SupportingFiles/Clause7/Durability/BusinessRecovery/BusinessRecoveryTimeGraph.xls SupportingFiles/Clause7/Durability/BusinessRecovery/Consistency.afterBusinessRecovery.out SupportingFiles/Clause7/Durability/BusinessRecovery/CountSettlement.afterBusinessRecovery.txt SupportingFiles/Clause7/Durability/BusinessRecovery/CountSettlement.beforeBusinessRecovery.txt SupportingFiles/Clause7/Durability/BusinessRecovery/countSettlement.sql SupportingFiles/Clause7/Durability/BusinessRecovery/ERRORLOG.BusinessRecoveryPart1.txt SupportingFiles/Clause7/Durability/BusinessRecovery/ERRORLOG.BusinessRecoveryPart2.txt SupportingFiles/Clause7/Durability/BusinessRecovery/TierA_vclient10.SystemEventLog.csv SupportingFiles/Clause7/Durability/BusinessRecovery/TierA_vclient20.SystemEventLog.csv SupportingFiles/Clause7/Durability/BusinessRecovery/TierB_x3950M2.SystemEventLog.csv SupportingFiles/Clause7/Durability/BusinessRecovery/TxnReportE_20minAt95percent_part1.xls SupportingFiles/Clause7/Durability /BusinessRecovery/TxnReportE_20minAt95percent_part2.xls SupportingFiles/Clause7/Durability/BusinessRecovery/ TxnReportE_whole_run_part1.xls SupportingFiles/Clause7/Durability/BusinessRecovery/ TxnReportE_whole_run_part2.xls SupportingFiles/Clause7/Durability/BusinessRecovery/ TxnStepReport_part1.xlt SupportingFiles/Clause7/Durability/BusinessRecovery/ TxnStepReport_part2.xlt
	Durability Data Accessibility	SupportingFiles/Clause7/Durability/DataAccessbility/CountSettlement.afterDataAccessibility.txt SupportingFiles/Clause7/Durability/DataAccessbility/CountSettlement.beforeDataAccessibility.txt SupportingFiles/Clause7/Durability/DataAccessbility/countSettlement.sql SupportingFiles/Clause7/Durability/DataAccessbility/DataAccessibilityGraph.xls SupportingFiles/Clause7/Durability/DataAccessbility/ERRORLOG.DataAccessibility.txt SupportingFiles/Clause7/Durability/DataAccessbility/pulledDataDrive.JPG SupportingFiles/Clause7/Durability/DataAccessbility/pulledLogDrive.JPG SupportingFiles/Clause7/Durability/DataAccessbility/rebuildingDataDrive.JPG SupportingFiles/Clause7/Durability/DataAccessbility/rebuildingLogDrive.JPG SupportingFiles/Clause7/Durability/DataAccessbility/rebuiltDataDrive.JPG SupportingFiles/Clause7/Durability/DataAccessbility/rebuiltLogDrive.JPG SupportingFiles/Clause7/Durability/DataAccessbility/TxnReportE_5min_beforePulledDataDrive.xls SupportingFiles/Clause7/Durability/DataAccessbility/TxnReportE_5min_beforePulledLogDrive.xls SupportingFiles/Clause7/Durability/DataAccessbility/TxnReportE_whole_run.xls
	ACID Procedures Document	SupportingFiles/Clause7/MSTPCE ACID Procedures.pdf
Clause 8	60-Day Space Calculations	SupportingFiles/Clause8/tpce_space.xls

Appendix A – Price Quotes

Protect Your Data - Grow Your Business

To: IBM Corp.
Attention: Chris King
Phone:
Fax:
Email:

From: Alan Powers
Phone: (248)223-1020 x344
Fax: (248)223-1026
Email: apowers@compsat.com

QUOTE # : **16Wx3950M2062408**
DATE: **June 24, 2008**

IBM x3950 M2 Configuration

Part No.	Description	Qty	List Price (per unit) US Dollar	List Price (quantity x unit price) US Dollar	Compsat Discounted Price (per unit) US Dollar	Compsat Discounted Price (quantity x unit price) US Dollar	
x3950 M2 SERVER							
7141-4SU	IBM System x3950 M2 (2 x Intel Xeon Processor X7350 2.93GHz)	4	$ 17,779	$ 71,116	$ 14,579	$ 58,315	
96P2688	ServicePac for 3-Year 24x7x4 Support (x3950 M2)	4	$ 3,390	$ 13,560	$ 2,983	$ 11,933	
44E4243	Intel Xeon Processor X7350 (2.93GHz/2x4MB L2)	8	$ 3,339	$ 26,712	$ 2,938	$ 23,507	
41Y2768	8GB (2x4GB) PC2-5300 CL5 ECC DDR2 SDRAM	64	$ 849	$ 54,336	$ 747	$ 47,816	
43X0837	73GB 15K 2.5" Hot-Swap SAS SFF	2	$ 369	$ 738	$ 325	$ 649	
43W4339	IBM ServeRAID-MR10M SAS/SATA Controller	1	$ 1,049	$ 1,049	$ 923	$ 923	
39Y6126	Intel PRO/1000 PT Dual-Port Server Adapter	4	$ 269	$ 1,076	$ 237	$ 947	
494215U	IBM T115 15-inch TFT Display	1	$ 209	$ 209	$ 184	$ 184	
10N3110	ServicePac for 3-Year 24x7x4 Support (Display)	1	$ 90	$ 90	$ 79	$ 79	
40K9201	IBM 3-Button Optical Mouse - Black - USB	1	$ 19	$ 19	$ 17	$ 17	
40K9584	IBM Preferred Pro USB Keyboard	1	$ 29	$ 29	$ 26	$ 26	
DS4800(s)							
1815-82A	IBM System Storage DS4800 Midrange Disk Subsystem	4	$ 53,995	$ 215,980	$ 37,797	$ 151,186	
41C5953	3 YR onsite repair 24x7x4 hour (DS4800)	4	$ 3,200	$ 12,800	$ 2,816	$ 11,264	
1812-81A	IBM TotalStorage DS4000 EXP810 Storage Exp. Unit	48	$ 6,000	$ 288,000	$ 4,200	$ 201,600	
10N3651	3 YR onsite repair 24x7x4 hour (EXP810)	48	$ 960	$ 46,080	$ 845	$ 40,550	
40K6816	4Gbps FC 73.4GB 15K Hot-Swap HDD	768	$ 1,301	$ 999,168	$ 1,041	$ 799,334	
22R4897	4 Gbps SW SFP Transceiver 4 Pack	18	$ 550	$ 9,900	$ 484	$ 8,712	
39M5696	IBM 1m LC-LC Fibre Channel Cable	80	$ 79	$ 6,320	$ 70	$ 5,562	
39M5697	IBM 5m LC-LC Fibre Channel Cable	24	$ 129	$ 3,096	$ 114	$ 2,724	
EXP3000(s)							
1727-01X	IBM System Storage EXP3000 Enclosure	2	$ 3,199	$ 6,398	$ 2,623	$ 5,246	
41L2768	ServicePac for 3-Year 24x7x4 Support (EXP3000)	2	$ 760	$ 1,520	$ 669	$ 1,338	
39R6529	IBM 1M SAS cable	1	$ 119	$ 119	$ 105	$ 105	
39R6531	IBM 3M SAS cable	1	$ 135	$ 135	$ 119	$ 119	
43W7523	IBM Hot-Swap 3.5 inch 73.4GB 15K SAS HDD	16	$ 329	$ 5,264	$ 290	$ 4,632	
RACK and OPTIONS							
93074RX	IBM S2 42U Standard Rack	5	$ 1,489	$ 7,445	$ 1,310	$ 6,552	
41L2760	ServicePac for 3-Year 24x7x4 Support (Rack)	5	$ 300	$ 1,500	$ 264	$ 1,320	
x3500 SERVER(s)							
7977M2U	x3500 with Intel Xeon E5440 (2.83GHz/12MB), 1GB Memory	2	$ 3,109	$ 6,218	$ 2,549	$ 5,099	
39M5785	2GB (2x1GB) PC2-5300 CL5 ECC DDR2	2	$ 169	$ 338	$ 149	$ 297	
43W7523	73GB 15K 3.5" Hot-Swap SAS	4	$ 329	$ 1,316	$ 290	$ 1,158	
21P2084	ServicePac for 3-Year 24x7x4 Support (x3500)	2	$ 689	$ 1,378	$ 606	$ 1,213	
			TOTAL =	**$ 1,781,909**	**TOTAL =**	**$ 1,392,406**	21.86%

NOTE:
- This quote may include Compsat Technology consulting and configuration charges.
- Mfg. pricing is out of our control and could change without notice.
- Pricing good for 30 Days from date quoted.

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

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

Microsoft

June 26, 2008

IBM Corporation
Chris King
3079 Cornwallis Road
Durham, NC 27709

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

All pricing shown is in US Dollars ($).

Part Number	Description	Unit Price	Quantity	Price
810-07578	**SQL Server 2008 Enterprise x64 Edition** *Server License with 25 CALs* *Discount Schedule: Open Program - Level C* *Unit Price reflects a 40% discount from the retail unit price of $13,969.*	$8,318	1	$8,318
359-01912	**SQL Server 2008 Client Access License** *Discount Schedule: Open Program – No Level* *Unit Price reflects a 4% discount from the retail unit price of $163.*	$156	1,225	$191,100
P71-04279	**Windows Server 2008 Datacenter x64 Edition** *Per Processor License* *Discount Schedule: Open Program – Level C* *Unit Price reflects a 27% discount from the retail unit price of $2,999.*	$2,182	16	$34,912
P73-01972	**Windows Server 2003 R2 Standard Edition** *Server License Only - No CALs* *Discount Schedule: Open Program - No Level* *Unit Price reflects a 28% discount from the retail unit price of $999.*	$719	2	$1,438
N/A	**Microsoft Problem Resolution Services** *Professional Support* *(1 Incident)*	$245	1	$245

Windows Server 2008 and Windows Server 2003 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=mnp&content=22/licensing**

SQL Server 2008 will be orderable and available by August 30, 2008.

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: PEchki0806260000009824.
Please include this Reference ID in any correspondence regarding this price quote.

Shopping Cart

Print

Qty.	Product Description	Savings	Total Price
1	 D-Link DGS-2208 10/100/1000Mbps 8-Port Desktop Green Ethernet Switch - Retail Item #: N82E16833127082 Return Policy: Limited 30-Day Return Policy Select An Optional Extended Warranty Plan	$10.00 Mail-in Rebate	$54.79
1	 BELKIN A3L791-10-BLK 10 ft. Cat 5E Black RJ45 CAT5e Patch Cable - Retail Item #: N82E16812106332 Return Policy: Standard Return Policy		$4.49
		Subtotal:	$59.28
Calculate Shipping Zip Code: UPS Guaranteed 3 Day Service		Shipping:	$0.00
Redeem Gift Certificates Claim Code: Security Code:		Gift Certificates:	$0.00
Apply Promo Code		Promo Code:	$0.00
		Grand Total:*	$59.28

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

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