

**TPC Benchmark™ E**  
**Full Disclosure Report**  
**for**  
**IBM® BladeCenter® HS21 XM**  
**using**  
**Microsoft® SQL Server 2005**  
**Enterprise x64 Edition SP2**  
**and**  
**Microsoft Windows® Server 2003**  
**R2 Enterprise x64 Edition**

**TPC-E Version 1.2.0**

**Submitted for Review**  
**August 10, 2007**

**IBM Corporation**

## **First Edition – August 2007**

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### **Notes**

<sup>1</sup> GHz and MHz only measures microprocessor internal clock speed, not application performance. Many factors affect application performance.

<sup>2</sup> 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® BladeCenter® HS21 XM 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 1.2.0, including the methodology used to achieve the reported results. All testing fully complied with this revision level.


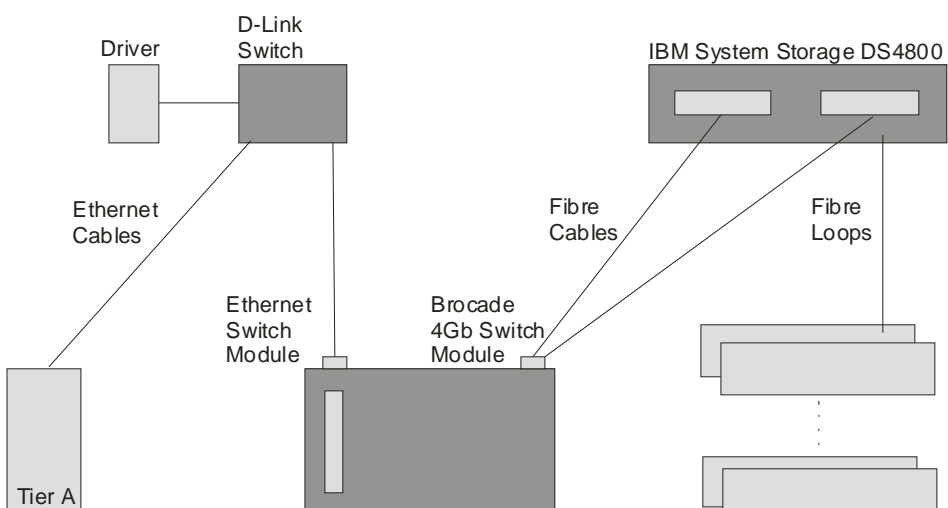
The software used on the IBM BladeCenter HS21 XM system includes Microsoft® Windows® Server 2003 R2 Enterprise x64 Edition operating system and Microsoft SQL Server 2005 Enterprise x64 Edition SP2.

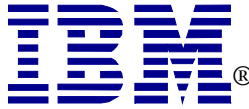
Standard metrics, transactions per second-E (tpsE), price per tpsE (\$/tpsE) and Availability Date, are reported as required by the TPC Benchmark E Standard Specification.

The benchmark results are summarized in the following table.

Hardware	Software	Total System Cost	tpsE	\$ USD /tpsE	Total Solution Availability Date
IBM BladeCenter HS21 XM	Microsoft SQL Server 2005 Enterprise x64 Edition SP2 Microsoft Windows Server 2003 R2 Enterprise x64 Edition	\$ 321,824	169.59	\$ 1,897.66	August 10, 2007

The benchmark implementation and results were audited by Lorna Livingtree for InfoSizing ([www.sizing.com](http://www.sizing.com)). The auditor's attestation letter is contained in Section 9 of this report.

	<b>IBM® BladeCenter® HS21 XM</b>		TPC-E Revision 1.2.0
	<b>Microsoft® SQL Server 2005</b>		TPC Pricing 1.2.0
			Report Date: August 10, 2007
TPC-E Throughput <b>169.59 tpsE</b>	Price/Performance <b>\$ 1,897.66 USD per tpsE</b>	Availability Date <b>August 10, 2007</b>	Total System Cost <b>\$ 321,824 USD</b>
<b>Database Server Configuration</b>			
Operating System <b>Microsoft Windows Server 2003 R2 Enterprise x64 Edition</b>	Database Manager <b>Microsoft SQL Server 2005 Enterprise x64 Edition SP2</b>	Processors/Cores/ Threads <b>2/4/4</b>	Memory <b>32GB</b>
			
<b>IBM System x3500</b> 1 x Dual-Core Intel Xeon Processor 5160 3.0GHz (1 Processor, 2 Cores, 2 Threads) 1GB of Memory 2 x 73.4GB SAS Drive (RAID-1 for OS, Onboard RAID Controller, Onboard Dual-Port 1 Gigabit Ethernet Controller)	<b>IBM BladeCenter H</b> 1 x IBM BladeCenter HS21 XM 2 x Dual-Core Intel Xeon Processor 5160 3.0GHz (2 Processors, 4 Cores, 4 Threads) 32GB of Memory 1 x QLogic 4Gb Expansion Card Onboard Dual-Port 1 Gigabit Ethernet Controller	<b>IBM System Storage DS4800</b> 12 x IBM System Storage EXP810 Enclosure Each Contains: 16 x 36.4GB 15K rpm Drives (Total of 192 Drives arrayed as: 1 x 2-Disk RAID-1 1 x 30-Disk RAID-10 10 x 16-Disk RAID-5)	
Initial Database Size <b>654 GB</b>	Redundancy Level: 1 <b>RAID-10 Log + RAID-5 Data</b>		Storage <b>192 x 36.4 GB 15K</b>



# IBM BladeCenter HS21 XM Microsoft SQL Server 2005

TPC-E Revision 1.2.0  
TPC Pricing Spec 1.2.0

Report Date:  
August 10, 2007

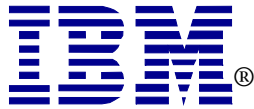
Availability Date:  
August 10, 2007

Description	Part Number	Price Source	Unit Price	Quantity	Extended Price	3-Yr. Maint. Price
<b>Server Hardware</b>						
IBM BladeCenter H Chassis	8852-4XU	1	3,849	1	3,849	
IBM KVM/ Advanced Management Module						
Server Connectivity Module for IBM BladeCenter	39Y9324	1	999	1	999	
IBM BladeCenter HS21 - 1 x Dual Core Intel Xeon 5160 1GB (2x512MB) PC2-5300 DDR2 SDRAM (Chipkill)	7995-L6U	1	3,339	1	3,339	
Intel Xeon Processor 5160 3.00GHz/4MB L2, 1333MHz FSB	42C0567	1	1,899	1	1,899	
8GB (2x4GB) PC2-5300 CL5 ECC DDR2 SDRAM (Chipkill)	39M5797	1	5,999	4	23,996	
QLLogic 4Gb SFF Fibre Channel Expansion Card	26R0890	1	799	1	799	
IBM T115 15-inch TFT Display	494215U	1	259	1	259	
IBM Preferred Pro USB Keyboard	40K9584	1	29	1	29	
IBM 3-Button Optical Mouse - Black - USB	40K9201	1	19	1	19	
NEC Black 1.44MB 3.5" External USB Floppy Drive (2 spares)	UF0002S-102	5	22	3	66	
ServicePac for 3-Year 24x7x4 Support (BC Chassis)	30L9185	1	750	1		750
ServicePac for 3-Year 24x7x4 Support (HS21)	69P9519	1	400	1		400
ServicePac for 3-Year 24x7x4 Support (Display)	30L9183	1	90	1		90
				<b>Subtotal</b>	<b>35,254</b>	<b>1,240</b>
<b>Server Storage</b>						
IBM Short Wave SFP Module (4 Pack)	22R0483	1	550	5	2,750	
IBM 1m LC-LC Fibre Channel Cable	39M5696	1	79	24	1,896	
IBM 5m LC-LC Fibre Channel Cable	39M5697	1	129	2	258	
Brocade 4Gb 10-port SAN Switch Module for IBM BladeCenter	32R1813	1	8,999	1	8,999	
IBM S2 42U Standard Rack	93074RX	1	1,489	2	2,978	
IBM UPS 750TLV	21301TX	1	545	1	545	
ServicePac for 3-Year 24x7x4 Support (Rack)	41L2760	1	300	2		600
IBM System Storage DS4800 Disk Upgrade to 8GB Cache	1815-82A	2a	53,995	1	53,995	
IBM System Storage DS4000 EXP810 Storage Exp. Unit	1812-81H	2a	6,000	12	72,000	
36.4GB 15K 4Gbps FC E-DDM Hot-Swap HDD	40K6812	2a	892	192	171,264	
ServicePac for 3-Year 24x7x4 Support (EXP810)	10N3651	2b	960	12		11,520
ServicePac for 3-Year 24x7x4 Support (DS4800)	41C5953	2b	3,200	1		3,200
				<b>Subtotal</b>	<b>314,685</b>	<b>15,320</b>
<b>Server Software</b>						
Microsoft SQL Server 2005 Enterprise x64 Edition	810-03150	3a	23,911	2	47,822	
Microsoft Windows Server 2003 R2 Enterprise x64 Edition	P72-01684	3b	2,334	1	2,334	
Microsoft Problem Resolution Services		3	245.00	1		245
				<b>Subtotal</b>	<b>50,156</b>	<b>245</b>
<b>Client Hardware</b>						
x3500 with 3.0GHz/2x2MB Xeon 5160, 1GB (2x512) Memory	797792U	1	3,399	1	3,399	
73GB 15K Hot Swap SAS	40K1043	1	349	2	698	
ServicePac for 3-Year 24x7x4 Support (x3500)	21P2084	1	689	1		689
				<b>Subtotal</b>	<b>4,097</b>	<b>689</b>
<b>Client Software</b>						
Microsoft Windows Server 2003 R2 Standard Edition	P73-01972	3c	719	1	719	
				<b>Subtotal</b>	<b>719</b>	<b>0</b>
<b>Infrastructure</b>						
D-Link DGS 1008TLEthernet Switch (2 spares)	DGS1008TL	4	206	3	618	
Ethernet Cable (2 spares)	A3L791-10-BLK	5	4	6	24	
				<b>Subtotal</b>	<b>642</b>	
				<b>Total</b>	<b>405,553</b>	<b>17,494</b>
IBM Large Purchase Discount 17.35% (See Note 1.)		1			-10,279	
Compsat Technology Large Purchase Discount 29.15% (See Note 2.)		2			-90,944	

Pricing: 1 - IBM - 1-888-SHOP-IBM, ext. 5821; 2 - Compsat Technology discounts 2a = 30%, 2b = 12%; 3 - Microsoft discounts 3a = 4%; 3b = 42%; 3c = 28%; 4 - www.superwarehouse.com; 5 - newegg.com Note 1: Discount based on IBM Direct guidance applies to all line items where Pricing=1. Note 2: Discount applies to all line items where Pricing=2a, 2b and 2c. Pricing is for this system or one of similar size.	<b>Three-Year Cost of Ownership USD:</b> \$321,824
	<b>TPC-E Throughput:</b> 169.59
	<b>\$ USD/tpsE:</b> \$1,897.66

Implementation and results audited by Lorna Livingtree for InfoSizing (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 BladeCenter HS21 XM  
Microsoft SQL Server 2005**

TPC-E Revision 1.2.0  
TPC Pricing Spec 1.2.0

Report Date:  
August 10, 2007

Availability Date:  
August 10, 2007

<b>Reported Throughput: 169.59 tpsE</b>		<b>Configured Customers: 85,000</b>		
<b>Response Time (in seconds)</b>	<b>Minimum</b>	<b>Average</b>	<b>90<sup>th</sup> Percentile</b>	<b>Maximum</b>
<b>Broker-Volume</b>	0.01	0.04	0.07	0.24
<b>Customer-Position</b>	0.00	0.04	0.07	0.48
<b>Market-Feed</b>	0.00	0.04	0.07	0.22
<b>Market-Watch</b>	0.00	0.03	0.06	0.56
<b>Security-Detail</b>	0.00	0.02	0.04	0.47
<b>Trade-Lookup</b>	0.01	0.47	0.63	1.00
<b>Trade-Order</b>	0.00	0.13	0.17	0.53
<b>Trade-Result</b>	0.00	0.13	0.19	4.38
<b>Trade-Status</b>	0.00	0.03	0.05	0.50
<b>Trade-Update</b>	0.02	0.56	0.68	1.03
<b>Data-Maintenance</b>	0.01	0.09	N/A	0.65
<b>Transaction Mix</b>		<b>Transaction Count</b>	<b>Mix %</b>	
<b>Broker-Volume</b>		598,355	4.900	
<b>Customer-Position</b>		1,587,365	13.000	
<b>Market-Feed</b>		122,111	1.000	
<b>Market-Watch</b>		2,197,965	18.001	
<b>Security-Detail</b>		1,709,530	14.001	
<b>Trade-Lookup</b>		976,643	7.998	
<b>Trade-Order</b>		1,233,329	10.101	
<b>Trade-Result</b>		1,221,093	10.000	
<b>Trade-Status</b>		2,319,897	18.999	
<b>Trade-Update</b>		244,162	2.000	
<b>Data-Maintenance</b>		120	N/A	
<b>Test Duration and Timings</b>				
<b>Ramp-up Time</b>			01:10:00	
<b>Measurement Interval</b>			02:00:00	
<b>Business Recovery Time</b>			03:48:08	
<b>Total Number of Transactions Completed in Measurement Interval</b>			12,210,450	

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# 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 are the same. The configuration diagram for the measured and priced system is provided on the following pages.

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 System x226 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 an IBM System x3500 with one Dual-Core Intel® Xeon® Processor 5160 (3.0GHz with 1 x 4MB L2 Cache) processor, 2GB of memory, two onboard 73.4GB SAS drives in a RAID-1 array for the operating system, which is Microsoft Windows Server 2003 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 BladeCenter HS21 XM blade inside an IBM BladeCenter H chassis. The IBM BladeCenter HS21 XM blade has two Dual-Core Intel Xeon Processor 5160 (3.0GHz with 1 x 4MB L2 Cache), 32GB of memory, no onboard drives, a QLogic 4Gb Fibre Channel expansion card. The QLogic 4Gb Fibre Channel expansion card is connected via the IBM BladeCenter backplane to a legacy Brocade switch module in the back of the IBM BladeCenter chassis. The switch module has two Fibre Channel cables connections. One cable is connected to controller A of an IBM System Storage DS4800 controller. The other cable is connected to controller B of an IBM System Storage DS4800 controller. The DS4800 is connected to 12 IBM System Storage EXP810 disk enclosures. Each EXP810 disk enclosure has sixteen 36.4GB 15Krpm drives. The 192 drives are organized as:

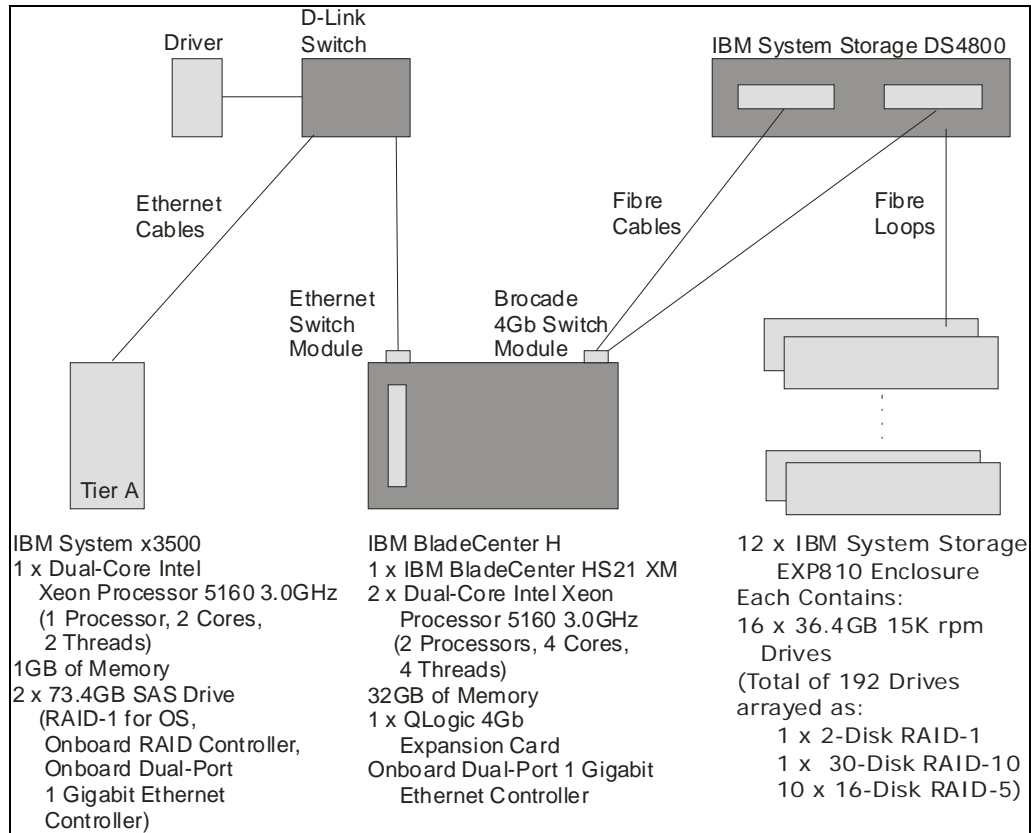
- One 2-disk RAID-1 array for the IBM BladeCenter HS21 XM's operating system, which is Microsoft Windows Server 2003 Enterprise x64 Edition (SP2) with Microsoft SQL Server 2005 Enterprise x64 Edition SP2.
- One 30-disk RAID-10 array for the database log
- Ten 16-disk RAID-5 arrays for the database data

Each array is seen as one LUN by the operating system on the HS21 XM blade. In Windows Disk Manager each of the LUNs from the RAID-5 arrays is configured to have a RAW partition for the broker tables and another RAW partition for all the other TPC-E tables (customer, market and dimension all in one file group called customer). The rest of the space on the LUN is an NTFS partition used for DB backups or the temp DB, or is not used at all.

Tier B communicates with Tier A over an Ethernet network using the HS21 XM blade's onboard 1Gb Ethernet card with TOE (TCP/IP Offload Engine) enabled. This onboard 1GB Ethernet card is connected via the HS21 XM's backplane to a legacy Ethernet switch module in the back of the IBM BladeCenter chassis. One Ethernet cable comes out of the switch module 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 are the same.



**Figure 1-2. 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 System x226 machine running Microsoft Windows Server 2003 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. The driver machine was configured with an IP address of 192.168.200.13.

### Tier A

The IBM System x3500 comes with one Dual-Core Intel Xeon 5160 Processor and two 512MB 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. Pick "Array Configuration Utility." Initialize both drives. Create the array using:

- RAID-1
- Read caching: Y

- Quick Initialization

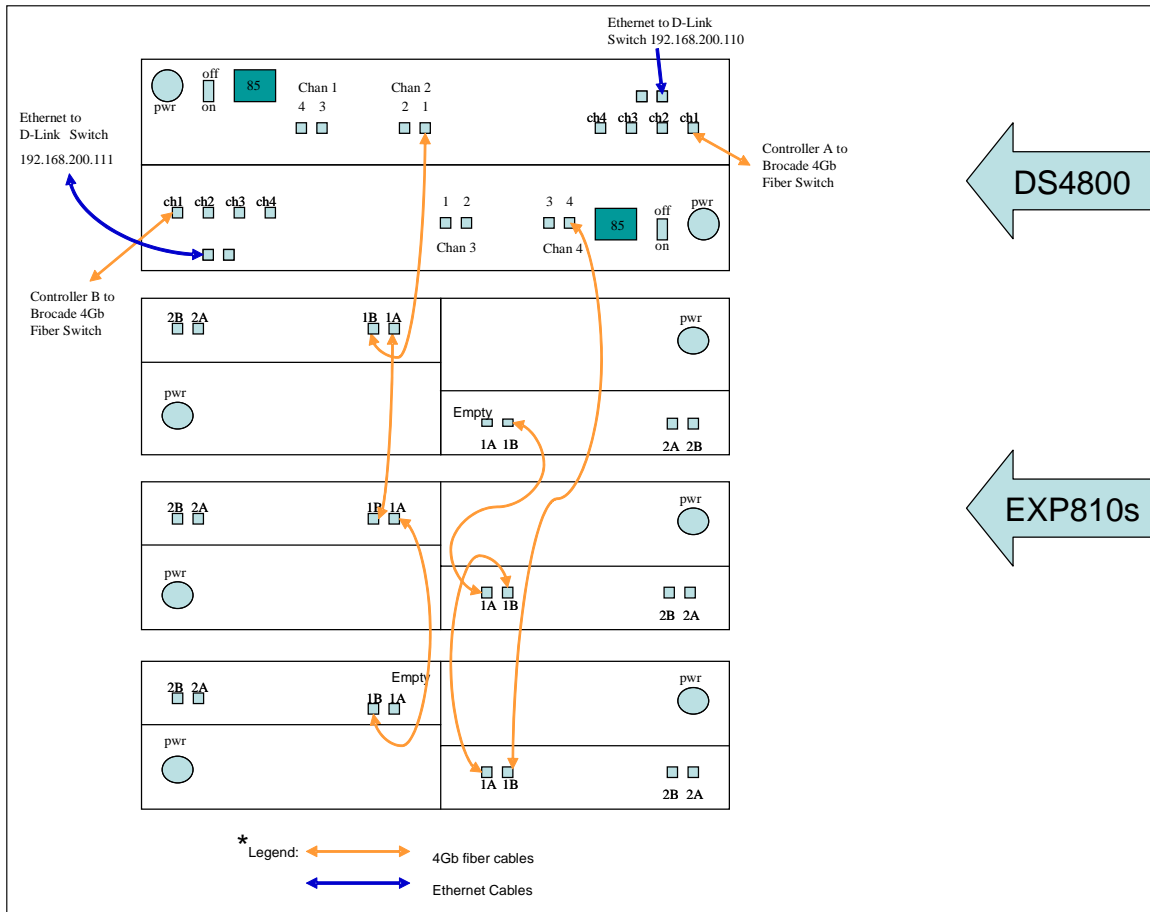
Once the RAID array has been created, escape to the main menu and select “Serial Select Utility” – “Controller Configuration,” and “Disable Array background consistency check.” Then exit the tool; the IBM System x3500 will restart. Boot from the installation CD for Microsoft Windows Server 2003 Standard 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](http://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](http://www.ibm.com). When the Ethernet card’s device driver is installed, set a static IP address 192.168.200.7 for one port and 192.168.70.7 for the other port of the dual-port onboard Ethernet card. Connect a crossover cable from the 190.168.70.7 port. The other end of the crossover cable will be connected to the Ethernet port on the IBM BladeCenter H Management Module. Connect an Ethernet cable to the 192.168.200.7 port. The other end of the Ethernet cable connects to the D-Link switch. 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 DS4800, load all 12 EXP810s with the 36.4GB 15K rpm drives. Set the speed switch on the front of the EXP810 to 4Gb.

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 the DS4800 to the first three EXP810s. The cabling pattern is repeated for the remaining three sets of three EXP810s. So set two would start with a cable from channel 2, port 2 on the top controller of the DS4800; this cable would go to port 1B on the left of the fourth EXP810.



**Figure 1-2. IBM System Storage DS4800 and IBM System Storage EXP810 cabling diagram**

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

Download IBM Storage Manager 9 Client from [www.ibm.com](http://www.ibm.com) and install it on the x3500 (Tier A machine). During the installation, do not start the monitor service.

The default IP addresses for the controllers on the DS4800 are 192.168.128.101/102 and 192.168.129.101/102.

Perform the following steps for both controllers in the 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 address 192.168.200.110 for the top controller and 192.168.200.111 for the bottom controller.)

After completing those steps on all of the DS4800s, start the IBM Storage Manager 9 Client on the x3500 and discover all the devices. In IBM Storage Manager 9 Client, do the following:

1. Doubleclick the DS4800 icon to open a window for that DS4800.
2. In the new window, sync 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. From the Enterprise Management Window: right click Tools – Execute Script – Load – ds4800\_setup.script (provided in the supportingFiles)
5. 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.
6. From the Enterprise Management Window: right click Tools – Load Configuration – “storage system files.cfg” (provided in the supportingFiles). This loads the RAID array configurations. 2-drive RAID-1 array for the OS, 30-drive RAID-10 array for the database log. Ten 16-drive RAID-5 arrays for the database data.

The external storage subsystem is now ready.

### **IBM BladeCenter**

The BladeCenter chassis comes with a management module. Run a crossover cable from the Management Module Ethernet port to the second port of the onboard Dual-Port Ethernet controller in the IBM System x3500, which is the Tier A machine.

Looking from the back of the BladeCenter chassis:

1. Put the Brocade 4Gb SAN switch module in I/O module bay 3 (after removing the blank from that I/O module bay). I/O module bay 3 is on the top right beside the Management Module.
2. Remove the blank in I/O module bay 1, which is on the top left. Insert the Server Connectivity Module for BladeCenter in I/O module bay 1. Run an Ethernet cable from the Server Connectivity Module to the D-Link 8-port switch.
3. Run two 4Gb Fibre cables from the Brocade 4Gb SAN switch module to the DS4800. One Fibre cable plugs into the input for controller A (top controller) on the DS4800. The other Fibre cable plugs into the input for controller B (bottom controller) on the DS4800. Since we are only using one Brocade 4Gb SAN switch module in the BladeCenter, we are only using the first port on the QLogic 4Gb SFF Fibre Channel Expansion Card in the BladeCenter HS21 XM blade.

**Note:** To use the second port on the QLogic 4Gb SFF Fibre Channel Expansion Card, another Brocade 4Gb SAN switch module would have to be inserted into I/O module bay 4; then the Fibre cable that goes from the top Brocade switch module to the input to controller B of the DS4800 could be moved to the bottom Brocade switch module. This would give added redundancy but at the cost of a second Brocade switch module.

On the x3500 (Tier A machine), which is connected via a crossover cable to the BladeCenter H Management Module, open a browser to <http://192.168.70.125>. This is the default IP address of the BladeCenter H Management Module. Log on to the Management Module using the default user ID of USERID and the default password of PASSWORD. The “o” in password is a zero. Under I/O Module Tasks – Admin/Power/Restart – I/O Module Advance Setup – ensure that external ports are enabled for I/O Module 1 and I/O Module 3. This means that the BladeCenter HS21 XM that is connected to the Ethernet Switch and Fibre switch in I/O mModules 1 and 3 can communicate through the switches to devices outside the BladeCenter chassis.

### **IBM BladeCenter HS21 XM**

The IBM BladeCenter HS21 XM comes with one Dual-Core Intel Xeon 5160 processor, two 512MB DIMMs, a SAS disk and a USB disk and an onboard dual-port Broadcom Ethernet card. Open the IBM BladeCenter HS21 XM, and perform these steps:

1. Install the second Dual-Core Intel Xeon 5160 Processor
2. Remove the two 512MB DIMMs and install eight 4GB DIMMs.
3. Remove the SAS disk.
4. Remove the USB disk.
5. Close the HS21 XM, and insert it in the first blade bay in the BladeCenter chassis.
6. At the top of the blade, press the switch to select the blade as the active blade, and press the switch beside it to set this blade as the blade talking to the media tray.
7. Press the power switch on the HS21 XM blade to start it.

The latest firmware for the Broadcom Ethernet card that is onboard the HS21 XM and the x3500 can be downloaded from [www.ibm.com](http://www.ibm.com). A bootable diskette containing the firmware can be made. Attach a USB floppy drive to the IBM BladeCenter's media tray. Insert the bootable diskette containing the Broadcom firmware in the diskette drive. Boot the HS21 XM from the diskette. At the DOS prompt, run UPDATE 7995. Remove the diskette, and reboot the HS21 XM.

Press F1 while the IBM BladeCenter HS21 XM 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. Use flat memory model
3. Disable Power Executive Power Capping
4. Enable Adjacent Sector Prefetch
5. Disable Hardware Prefetch
6. Disable CP1 Power State
7. Enable HPET timer
8. Disable planar SAS
9. Change PCI Device Boot Priority from Planar SAS to Daughter Card Slot 1
10. Disable USB Disk

Save the BIOS changes and restart the HS21 XM.

During POST on the HS21 XM, when the QLogic banner is displayed, press Cctrl-Q. Change the following settings in Fast!UTIL:

1. Loop Reset Delay from 5 to 8
2. Connection Options from 2 to 1 (point-to-point)
3. Disable Fibre Channel Tape Support
4. Selectable boot enabled on first port and Operating System LUN selected
5. Selectable boot disabled on second port, BIOS disabled for second port
6. Execution Throttle set to 255
7. LUNs per Target from 128 to 0
8. Enable Target Reset from Yes to No
9. Login Retry Count from 8 to 30
10. Port Down Retry Count from 30 to 70
11. Link Down Timeout from 30 to 60
12. Interrupt Delay Timer from 0 to 10



### 13. Operation Mode from 0 to 5

Save the settings and restart the HS21 XM.

Put the Microsoft Windows Server 2003 Enterprise x64 Edition with SP1 CD in the DVD/CDROM drive in the BladeCenter's media tray. Boot the HS21 XM from the CD. Press F6 when prompted by the Windows installation program to load the QLogic driver from diskette. The driver can be downloaded from [www.ibm.com](http://www.ibm.com). During the operating system installation, select the per seat 9999 option.

Install Service Pack 2 for Microsoft Windows Server 2003 Enterprise x64 Edition.

After installing the operating system, install the onboard Broadcom Ethernet card's device driver using the Broadcom-provided executable, which is run from a USB memory stick inserted into the BladeCenter's media tray. The executable can be downloaded from [www.ibm.com](http://www.ibm.com). After installing the Ethernet card's device driver, set a static IP address (192.168.200.101) for the HS21 XM.

Now customize the operating system as follows:

- 1) Control Panel Settings:
  - a) System
    - i) Advanced
      - (1) Performance
        - (a) Visual effects: Adjust for best performance
        - (b) Advanced
          - (i) Set for Background services & system cache
          - (ii) Check page file settings
      - (2) Startup & Recovery
        - (a) No administrative alert
        - (b) No auto restart
        - (c) No debugging information
        - (d) If desired, lower the default 30 second boot.ini selection timeout
      - (3) Error Reporting
        - (a) Disable, but notify when errors occur
    - ii) Auto Updates
      - (1) Disable
    - iii) Remote
      - (1) Disable Remote Assistance
      - (2) Enable Remote Desktop (if you plan to use it)
  - b) Display
    - i) Ensure video performance troubleshooting slider all the way to the right
    - ii) Turn screen saver off
    - iii) Select "Always On" for power management. (If desired, set the monitor to be turned off after 30 minutes or so.)
  - c) Sounds
    - i) "no sounds" sound scheme
  - d) Internet Settings
    - i) Use blank homepage
  - e) Folder options:
    - i) Don't automatically search for network folder and printers
    - ii) Show all files
    - iii) Don't hide file extensions
    - iv) Don't hide protected OS files
    - v) Ensure that offline files are disabled
  - f) Date and Time

- i) Disable syncing time with Internet time server

#### Regedit

- 1) HKLM\System\CurrentControlSet\Control\Session Manager\I/O System\
  - a) CountOperations (DWORD=0) [turns off some perf monitoring]
- 2) HKLM\System\CurrentControlSet\Control\Session Manager\Memory Management\
  - a) DontVerifyRandomDrivers (DWORD=1)
  - b) LargeSystemCache (DWORD=0)
  - c) DisablePagingExecutive (DWORD = 1)
    - i) 0 = kernel can be paged out
    - ii) 1 = kernel can not be paged out
- 3) HKLM\System\CurrentControlSet\Services\TCPIP\Parameters\
  - a) MaxUserPort (DWORD = 40,000 Decimal, or higher)
- 4) HKLM\System\CurrentControlSet\Services\lanmanserver\parameters\Size (DWORD = 3)

Stop unneeded services and make them manual startup rather than automatic startup:

1. Automatic Updates
2. Computer Browser
3. Cryptographic Services
4. DHCP Client
5. DNS Client
6. Error Reporting Service
7. Help and Support
8. IPSEC Services
9. Print Spooler
10. Remote Registry Service
11. Wireless Configuration

Disable Windows 2003 Shutdown Event Tracker and Autoplay:

1. Go into Group Policy Object Editor (Start -> Run -> gpedit.msc)
2. Browse to Computer Configuration -> Administrative Templates -> System
3. In the right window pane, double click on "Display Shutdown Event Tracker"
4. You'll see the disable choice- select it and you are DONE!
5. Now in the right window pane, double click on "Turn off Autoplay"
6. **Enable** for "All Drives" (which disables Autoplay)

#### SQL Server Installation

Install Microsoft SQL Server 2005 Enterprise x64 Edition, apply Service Packs 1 and 2 for SQL Server. Select the binary sort order.

#### Mount Points and Disk Partitions

1. In a command window, create mount points:
  - c:
  - cd \
  - md mp
  - cd mp
  - md b1
  - md b2
  - md b3
  - md b4
  - md b5
  - md b6
  - md b7
  - md b8

- md b9
  - md b10
  - md c1
  - md c2
  - md c3
  - md c4
  - md c5
  - md c6
  - md c7
  - md c8
  - md c9
  - md c10
2. Open Windows Disk Manager.
  3. If the Wizard prompts you to initialize disks do so, don't upgrade the disks.
  4. Create an extended partition on disks 1 through 11.
  5. On disk 1:
    - Create a logical partition with size 400000MB, assign drive letter E:, do not format the partition.
    - Create a logical partition using up the rest of the disk space, assign drive letter F: and this partition should be NTFS formatted.
  6. On disks 2 through 11:
    - Create a logical partition with size 75000MB, assign mount point c:\mp\b\* to the partition. Where \* is 1 for disk 2, 2 for disk 3 and so on. The partition should not be formatted.
    - Create a logical partition with size 25000MB, assign mount point c:\mp\c\* to the partition. Where \* is 1 for disk 2, 2 for disk 3 and so on. The partition should not be formatted.
    - Create a logical partition using up the rest of the disk space, assign drive letter G: through P: as you go from disk 2 to disk 11, this partition should be NTFS formatted.
  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 StartSQLMorgan.bat (the file is included in the supporting files).

Run runconfig.sql to set the SQL Server sp\_configure settings (the file is included in the supporting files).  
 Run growTempDB.sql to increase the size of the temporary database which is used during database load (the file is included in the supporting files).

## **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 85000.cust\database. In the folder create a create\_database.sql script to create a TPCE database with two filegroups. One filegroup called broker\_fg for the Broker related TPC-E tables and the other filegroup called customer\_fg for all the other TPC-E tables. broker\_fg uses all the c:\mp\b\* disk partitions. customer\_fg uses all the c:\mp\c\* disk partitions. The database log is on E:. Modify the Microsoft provided files:

- Create\_Tables\_Fixed.sql
- Create\_Tables\_Scaling.sql
- Create\_Clustered\_Indexes\_Fixed.sql
- Create\_Clustered\_Indexes\_Scaling.sql
- Create\_NC\_Indexes\_Fixed.sql
- Create\_NC\_Indexes\_Scaling.sql

by replacing misc\_fg and market\_fg with customer\_fg.

Run the Microsoft provided file TPCE\_Setup.cmd to start the database load (the file is included in the supporting files). Fill in 85000 for the number of customers to be loaded when prompted. TPCE\_Setup.cmd calls files that are included in the supporting files 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 2005 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 ten 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 **Error! Reference source not found.**).*

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 85,000 customers.

**Table 2-1. Initial Cardinality of Tables**

Table Name	Rows
ACCOUNT_PERMISSION	603,413
ADDRESS	127,504
BROKER	850
CASH_TRANSACTION	1,351,304,762
CHARGE	15
COMMISSION_RATE	240
COMPANY	42,500
COMPANY_COMPETITOR	127,500
CUSTOMER	85,00
CUSTOMER_ACCOUNT	425,000
CUSTOMER_TAXRATE	170,000
DAILY_MARKET	75,983,625
EXCHANGE	4
FINANCIAL	850,000
HOLDING	75,285,552
HOLDING_HISTORY	1,968,360,153
HOLDING_SUMMARY	4,229,765
INDUSTRY	102
LAST_TRADE	58,225
NEWS_ITEM	85,000
NEWS_XREF	85,000
SECTOR	12
SECURITY	58,225
SETTLEMENT	1,468,800,000
STATUS_TYPE	5
TAXRATE	320
TRADE	1,468,800,000
TRADE_HISTORY	3,525,148,661
TRADE_REQUEST	0
TRADE_TYPE	5
WATCH_ITEM	8,471,094
WATCH_LIST	85,000
ZIP_CODE	14,741

## Distribution of Tables and Logs

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

The IBM BladeCenter HS21 XM only has slots for one QLogic 4Gb SFF Fibre Channel Expansion card. That card has two ports. We are only using one of the ports. That port is connected to a single IBM System Storage DS4800, which has two controllers - the top controller A and the bottom controller B. All the drives are 36.4GB 15K rpm 4Gb Fibre Channel drives. Figure 2-2 depicts the database configuration of the measured and priced systems to meet the 8-hour steady state requirement.

**Table 2-2. Data Distribution for the Benchmarked and Priced Configuration**

Disk #	Controller #	Slot #	Drives Enclosure model RAID level	Partition/file system	Size	Use
0	A	N/A	2 X 36.4GB EXP810 Enclosure RAID 1	C: (NTFS)	33.39GB	OS Drive
1	A	N/A	30 X 36.4GB EXP810 Enclosure RAID 10	E: (RAW) F: (NTFS)	400,000MB 110.38GB	DB Log Not used
2	A	N/A	16 X 36.4GB EXP810 Enclosure RAID 5	c:\mp\b5 (RAW) c:\mp\c5 (RAW) K: (NTFS)	75,000MB 25,000MB 403.34GB	Broker 5 Customer 5 Not used
3	A	N/A	16 X 36.4GB EXP810 Enclosure RAID 5	c:\mp\b1 (RAW) c:\mp\c1 (RAW) G: (NTFS)	75,000MB 25,000MB 403.34GB	Broker 1 Customer 1 MDF File and extra Temp DB file
4	A	N/A	16 X 36.4GB EXP810 Enclosure RAID 5	c:\mp\b2 (RAW) c:\mp\c2 (RAW) H: (NTFS)	75,000MB 25,000MB 403.34GB	Broker 2 Customer 2 Backup 1
5	A	N/A	16 X 36.4GB EXP810 Enclosure RAID 5	c:\mp\b3 (RAW) c:\mp\c3 (RAW) I: (NTFS)	75,000MB 25,000MB 403.34GB	Broker 3 Customer 3 Backup 2
6	A	N/A	16 X 36.4GB EXP810 Enclosure	c:\mp\b4 (RAW)	75,000MB	Broker 4

			RAID 5	c:\mp\c4 (RAW) J: (NTFS)	25,000MB 403.34GB	Customer 4 Backup 3
7	B	N/A	16 X 36.4GB EXP810 Enclosure RAID 5	c:\mp\b6 (RAW) c:\mp\c6 (RAW) L: (NTFS)	75,000MB 25,000MB 403.34GB	Broker 6 Customer 6 Not used
8	B	N/A	16 X 36.4GB EXP810 Enclosure RAID 5	c:\mp\b7 (RAW) c:\mp\c7 (RAW) M: (NTFS)	75,000MB 25,000MB 403.34GB	Broker 7 Customer 7 Not Used
9	B	N/A	16 X 36.4GB EXP810 Enclosure RAID 5	c:\mp\b8 (RAW) c:\mp\c8 (RAW) N: (NTFS)	75,000MB 25,000MB 403.34GB	Broker 8 Customer 8 Backup 8
10	B	N/A	16 X 36.4GB EXP810 Enclosure RAID 5	c:\mp\b9 (RAW) c:\mp\c9 (RAW) O: (NTFS)	75,000MB 25,000MB 403.34GB	Broker 9 Customer 9 Backup 5
11	B	N/A	16 X 36.4GB EXP810 Enclosure RAID 5	c:\mp\b10 (RAW) c:\mp\c10 (RAW) P: (NTFS)	75,000MB 25,000MB 403.34GB	Broker 10 Customer 10 Backup 6

## 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 2005 Enterprise 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 `-l ODBC` option on the EGenLoader command line. This direct loads into a Microsoft SQL Server Database. 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).*

One EGenDriverCE with 150 threads was used in the benchmark. One EGenDriverMEE with a dynamic number of threads that reaches a steady number of threads during the benchmark was used.

### 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 192.168.200.13. The port was connected to a D-Link switch via an Ethernet cable. Another Ethernet cable ran from the D-Link Switch to a port on the onboard dual-port Gigabit Ethernet card in the IBM System x3500 machine that was used as the Tier A machine. That port was configured with the IP address 192.168.200.7. The network connection between the port with IP address 192.168.200.13 on the Driver and the port with IP address 192.168.200.7 on the Tier A machine was the mandatory network.

There was also a network connection between the Tier A machine and the Tier B machine. The Tier B machine was the IBM BladeCenter HS21 XM. One of the ports on the HS21 XM's onboard dual-port Ethernet card was configured with IP address 192.168.200.101 and was connected via the BladeCenter backplane to the Ethernet switch module in the back of the BladeCenter. This switch module had an Ethernet cable that ran to the 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 v1.2.0 was used in the benchmark.

### **EGen Code and Modifications**

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

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

## 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: 169.59 tpsE  
Price per tpsE: \$ 1,897.66 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).*

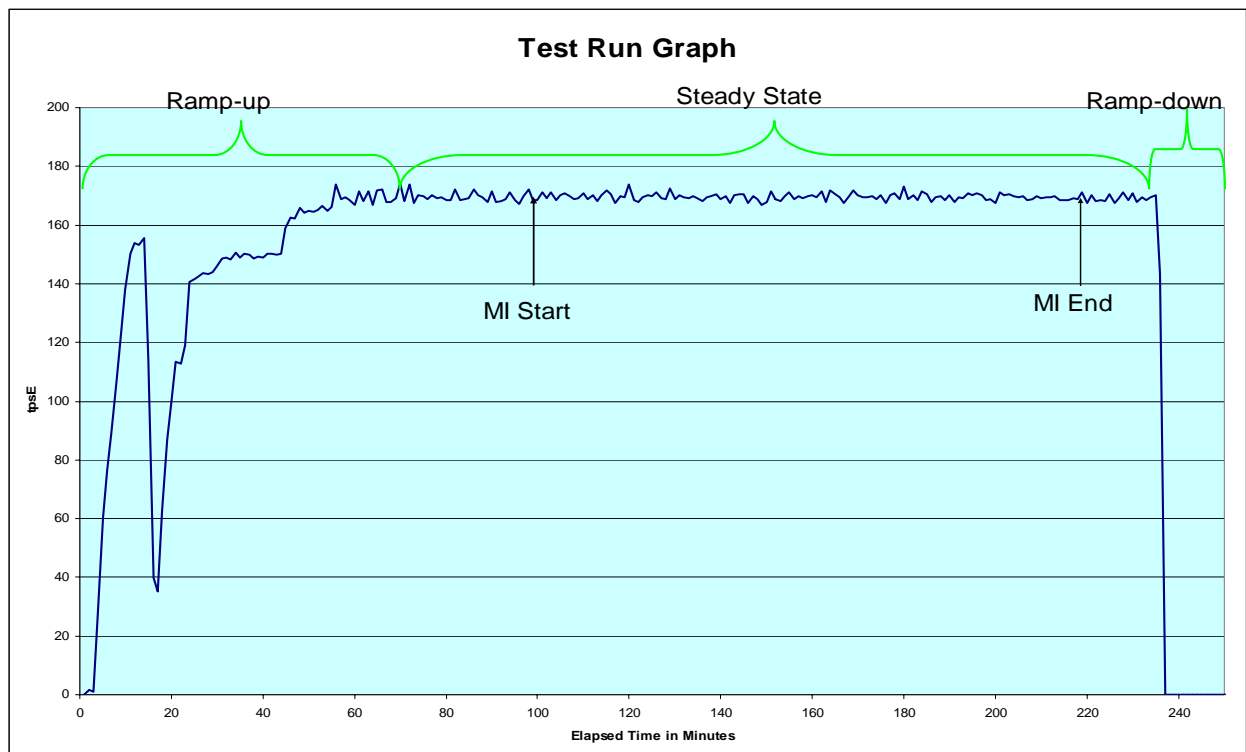


Figure 6-1. Test Run Graph

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

## **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 seven and a half minutes.

## **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. Transaction Statistics**

Input Parameter	Value	Actul Pct	Required Range
<b>Customer-Position</b>			
by_tax_id	1	50.03%	48% to 52%
get_history	1	50.00%	48% to 52%
<b>Market-Watch</b>			
Securities chosen by	Watch list	59.99%	57% to 63%
	Account ID	34.98%	33% to 37%
	Industry	5.02%	4.5% to 5.5%
<b>Security-Detail</b>			
access_lob	1	1.02%	0.9% to 1.1%
<b>Trade-Lookup</b>			
frame_to_execute	1	29.99%	28.5% to 31.5%
	2	29.98%	28.5% to 31.5%
	3	30.01%	28% to 31.5%
	4	10.02%	9.5% to 10.5%
<b>Trade-Order</b>			
Transactions requested by a third party		9.96%	9.5% to 10.5%
Security chosen by company name and issue		39.97%	38% to 42%
type_is_margin	1	7.97%	7.5% to 8.5%
roll_it_back	1	0.99%	0.94% to 1.04% (*)
is_lifo	1	35.02%	33% to 37%
trade_qty	100	25.08%	24% to 26%
	200	25.01%	24% to 26%
	400	24.94%	24% to 26%
	800	24.97%	24% to 26%
trade_type	TMB	29.98%	29.7% to 30.3%
	TMS	30.05%	29.7% to 30.3%
	TLB	19.99%	19.8% to 20.2%
	TLS	9.97%	9.9% to 10.1%
	TSL	10.01%	9.9% to 10.1%
<b>Trade-Update</b>			
frame_to_execute	1	33.14%	31% to 35%
	2	33.09%	31% to 35%
	3	33.77%	32% to 36%

## 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.1.2.0\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 one through three 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.1.2.0\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.100\ACID\Isolation\Scripts\Isolation1\_S1.sql in the Management Studio. When prompted, connect to you database server.
3. Click on **Query/Results To/Results to Text** in the menu bar.
4. Open MSTPCE.100\ACID\Isolation\Scripts\Isolation1\_S2.sql in the Management Studio. When prompted, connect to you database server.
5. Click on **Query/Results To/Results to Text** in the menu bar.
6. Open MSTPCE.100\ACID\Isolation\Scripts\Isolation1\_S3.sql in the Management Studio. When prompted, connect to you database server.
7. Click on **Query/Results To/Results to Text** in the menu bar.
8. Open MSTPCE.100\ACID\Isolation\Scripts\Isolation1\_S4.sql in the Management Studio. When prompted, connect to you database server.
9. Click on **Query/Results To/Results to Text** in the menu bar.
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, 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.100\ACID\Isolation\Scripts\Isolation2\_S1.sql in the Management Studio. When prompted, connect to you database server.
3. Click on **Query/Results To/Results to Text** in the menu bar.
4. Open MSTPCE.100\ACID\Isolation\Scripts\Isolation2\_S2.sql in the Management Studio. When prompted, connect to you database server.
5. Click on **Query/Results To/Results to Text** in the menu bar.
6. Open MSTPCE.100\ACID\Isolation\Scripts\Isolation2\_S3.sql in the Management Studio. When prompted, connect to you database server.
7. Click on **Query/Results To/Results to Text** in the menu bar.
8. Open MSTPCE.100\ACID\Isolation\Scripts\Isolation2\_S4.sql in the Management Studio. When prompted, connect to you database server.
9. Click on **Query/Results To/Results to Text** in the menu bar.
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, 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 number 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 number 1 above.
4. The Trade-Result in S3 should run to completion. The Trade-Result in S4 may be 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.100\ACID\Isolation\Scripts\Isolation3\_S1.sql in the Management Studio. When prompted, connect to you database server.
3. Click on **Query/Results To/Results to Text** in the menu bar.
4. Open MSTPCE.100\ACID\Isolation\Scripts\Isolation3\_S2.sql in the Management Studio. When prompted, connect to you database server.
5. Click on **Query/Results To/Results to Text** in the menu bar.
6. Open MSTPCE.100\ACID\Isolation\Scripts\Isolation3\_S3.sql in the Management Studio. When prompted, connect to you database server.
7. Click on **Query/Results To/Results to Text** in the menu bar.

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, 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)
5. Note, this verification deviates from the specification since the current specification does not take into account that the Trade Result in S3 WILL block waiting on the Trade Result in S2.

#### **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.100\ACID\Isolation\Scripts\Isolation4\_S1.sql in the Management Studio. When prompted, connect to you database server.
3. Click on **Query/Results To/Results to Text** in the menu bar.
4. Open MSTPCE.100\ACID\Isolation\Scripts\Isolation4\_S2.sql in the Management Studio. When prompted, connect to you database server.
5. Click on **Query/Results To/Results to Text** in the menu bar.
6. Open MSTPCE.100\ACID\Isolation\Scripts\Isolation4\_S3.sql in the Management Studio. When prompted, connect to you database server.
7. Click on **Query/Results To/Results to Text** in the menu bar.
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)
5. Note, this verification deviates from the specification since the current specification does not take into account that the Customer Position in S3 WILL block waiting on the Trade Result in S2.

## **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.*

- v Permanent irrecoverable failure of any single durable medium*
- v Instantaneous interruption (system crash/system hang) in processing that requires system reboot to recover*
- v Failure of all or part of memory (loss of contents)*
- v 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, and 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:

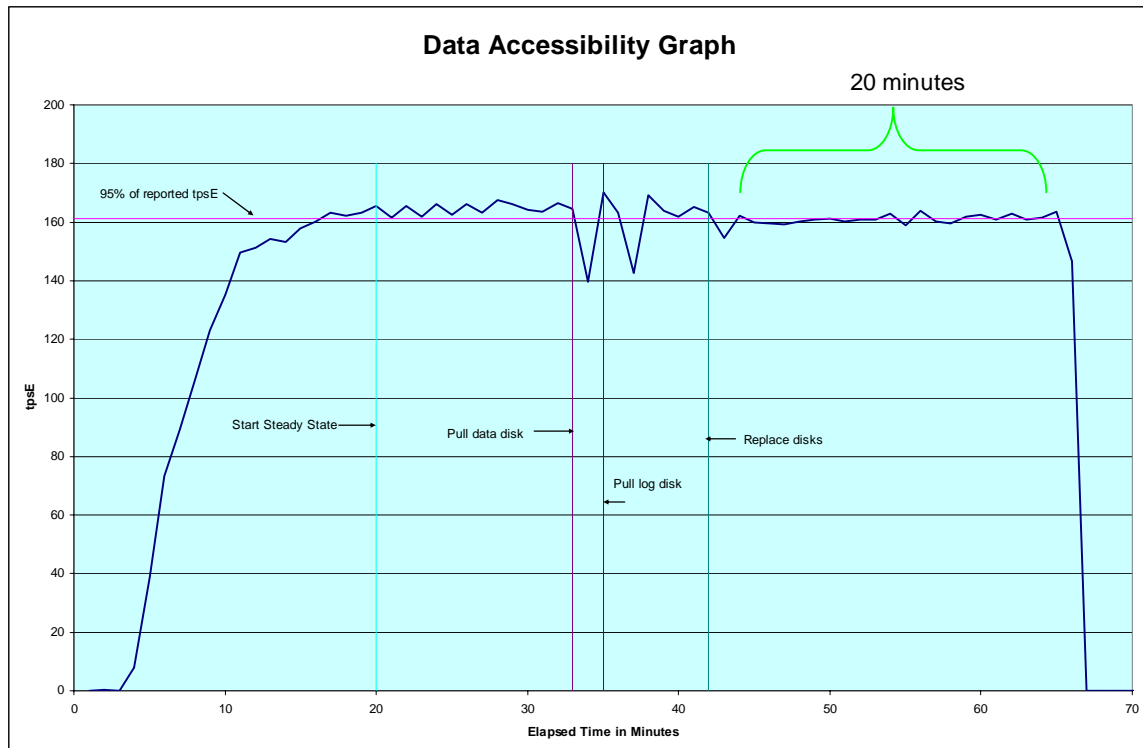


Figure 7-1. Data Accessibility Graph

### 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.

**Note:** A UPS has been priced for the SUT.

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 out the IBM BladeCenter HS21 XM from the IBM BladeCenter. At the same time remove the power cord from the back of the x3500 to fail the Tier A machine at the same time as the Tier B machine.
4. Stop the Driver.
5. Re-insert and restart the IBM BladeCenter HS21 XM. Re-power and restart the x3500.
6. On the HS21 when Windows has started run StartSQLMorgan.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 7.5.6.6).

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 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 which 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 03:48:08

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:

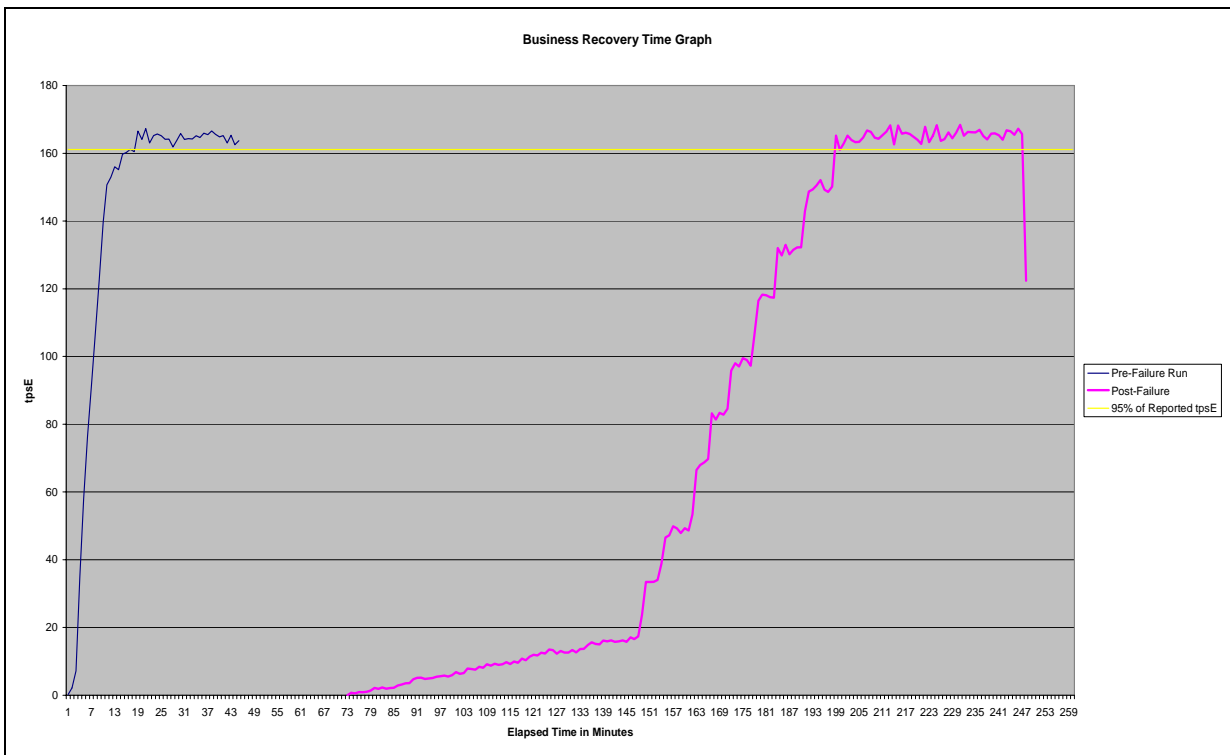


Figure 7-2. Business Recovery Time Graph

# 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.

### TPC-E Disk Space Requirements

Customers Used **85,000** Performance **169.59 TpsE**

Broker File Group	Initial Rows	Data (KB)	Index size (KB)	Extra 5% (KB)	Total + 5% (KB)	After run (KB)	Growth (KB)
BROKER	850	48	112	8	168	216	56
CASH_TRANSACTION	1,351,304,762	132,500,512	280,160	6,639,034	139,419,706	136,674,008	3,893,336
CHARGE	15	8	8	1	17	16	-
COMMISSION_RATE	240	16	16	2	34	32	-
SETTLEMENT	1,468,800,000	72,080,368	152,592	3,611,648	75,844,608	75,823,616	3,590,656
TRADE	1,468,800,000	161,646,024	86,507,720	12,407,687	260,561,431	254,555,184	6,401,440
TRADE_HISTORY	3,525,148,661	101,079,552	263,592	5,067,157	106,410,301	101,763,408	420,264
TRADE_REQUEST	-	-	-	-	-	3,728	3,728
TRADE_TYPE	5	8	1,032	52	1,092	1,040	-
<b>Customer File Group</b>							
ACCOUNT_PERMISSION	603,413	60,352	384	3,037	63,773	60,736	-
CUSTOMER	85,000	14,400	3,808	910	19,118	18,224	16
CUSTOMER_ACCOUNT	425,000	39,464	47,024	4,324	90,812	86,512	24
CUSTOMER_TAXRATE	170,000	3,552	112	183	3,847	3,840	176
HOLDING	75,285,552	3,972,528	2,934,184	345,336	7,252,048	9,972,584	3,065,872
HOLDING_HISTORY	1,968,360,153	71,576,752	37,302,328	5,443,954	114,323,034	109,335,208	456,128
HOLDING_SUMMARY	4,229,765	141,560	584	7,107	149,251	284,688	142,544
WATCH_ITEM	8,471,094	228,336	888	11,461	240,685	229,528	304
WATCH_LIST	85,000	2,112	1,792	195	4,099	3,904	-
<b>Market File Group</b>							
COMPANY	42,500	9,192	2,568	588	12,348	11,776	16
COMPANY_COMPETITOR	127,500	3,424	2,880	315	6,619	6,304	-
DAILY_MARKET	75,983,625	3,865,240	1,614,920	274,008	5,754,168	5,481,760	1,600
EXCHANGE	4	8	8	1	17	16	-
FINANCIAL	850,000	100,016	360	5,019	105,395	100,704	328
INDUSTRY	102	8	40	2	50	48	-
LAST_TRADE	58,225	2,688	96	139	2,923	5,528	2,744
NEWS_ITEM	85,000	9,361,848	192	468,102	9,830,142	9,362,064	24
NEWS_XREF	85,000	2,112	96	110	2,318	2,208	-
SECTOR	12	8	24	2	34	32	-
SECURITY	58,225	9,072	4,024	655	13,751	13,112	16
STATUS_TYPE	5	8	8	1	17	16	-
<b>Misc File Group</b>							
ADDRESS	127,504	7,360	120	374	7,854	7,496	16
TAXRATE	320	24	16	2	42	56	16
ZIP_CODE	14,741	488	88	29	605	576	-
<b>TOTALS (KB)</b>		<b>556,707,088</b>	<b>129,121,776</b>	<b>34,291,443</b>	<b>720,120,307</b>		
<b>Initial Database Size (MB)</b>		<b>669,755</b>	<b>654 GB</b>				
<b>Db/Filegroups</b>							
Db/Filegroups	LUN Count	Partition Size(KB)	MB allocated	MB Loaded	MB Loaded+5%	Ending size	8 Hours
misc_fg	0	-	-	-	-	-	-
broker_fg	10	69,632,000	680,000	541,515	568,591	555,490	571,852
market_fg	0	-	-	-	-	-	-
customer_fg	10	20,480,000	200,000	128,239	134,651	131,823	136,019
<b>Settlements</b>	<b>2,249,867</b>						
<b>Initial Growing Space (MB)</b>	<b>654,725</b>						
<b>Final Growing Space (MB)</b>	<b>672,278</b>	<b>Data LUNS</b>	<b>10</b>	<b>Initial Log size (MB)</b>	<b>1,616</b>	<b>Log LUNS</b>	<b>1</b>
<b>Delta (MB)</b>	<b>17,553</b>	<b>Disks per LUN</b>	<b>16</b>	<b>Final Log size (MB)</b>	<b>26,267</b>	<b>Log Disks</b>	<b>30</b>
<b>Data Space per Trade (MB)</b>	<b>0.007801663</b>	<b>Disk Capacity (MB)</b>	<b>34,714</b>	<b>Log Growth (MB)</b>	<b>24,650</b>	<b>Disk Capacity (MB)</b>	<b>34,714</b>
<b>1 Day Data Growth (MB)</b>	<b>38,105</b>	<b>RAID5 overhead</b>	<b>86%</b>	<b>Log Growth/trade (MB)</b>	<b>0.010956401725</b>	<b>RAID10 overhead</b>	<b>50%</b>
<b>60 Day Space (MB)</b>	<b>2,956,044</b>	<b>Total Space (MB)</b>	<b>4,778,109</b>	<b>1 Day log space (MB)</b>	<b>53,513</b>	<b>Log Space (MB)</b>	<b>520,706</b>



## **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.

Ms. Celia Schreiber, Manager  
 IBM Modular and Blade Performance Analysis & Benchmarking  
 IBM  
 3039 Cornwallis Rd.  
 RTP, NC 27709

August 10, 2007

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

Platform: IBM BladeCenter HS21 XM  
 Operating system: Microsoft Windows Server 2003 R2 Enterprise x64 Edition  
 Database Manager: Microsoft SQL Server 2005

The results were:

CPU's Speed	Memory	Disks	Trade-Result 90% Response Time	tpsE
<b>Tier B, Server: IBM BladeCenter HS21 XM</b>				
2 x Dual Core Intel Xeon 5160 (3.0GHz)	32 GB (4 MB L2)	192 x 36.4 GB 15K 4Gbps	0.19 Seconds	169.59
<b>Tier A, One Client: IBM x3500</b>				
1 x Xeon 5160 (3.0 GHz)	1 GB (2x2 MB cache)	2x 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 v1.2.0 (see note 1 below.)
- The transactions were correctly implemented.
- The database was properly scaled and populated for 85,000 customers.
- The mandatory network between the driver and the SUT was configured.
- The ACID properties were met (see notes 2 and 3 below.)

- 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:

1. EGen/flat\_in/exchange.txt on the driver system was from an older version of EGen. The older file had an extra column. This had no impact on runtime behavior or performance since the driver only uses this file to get a row count and the number of rows was identical for both versions of the file.
2. During Isolation Test 1 Step 7, Session 3 was the deadlock victim. Therefore not all Frames completed successfully. This did not compromise the demonstration of the required isolation properties.
3. When inducing the required failures during the Business Recovery test, there was a 16 second delay between the failure of the Tier B database server and the failure of the Tier A client machine. This did not compromise the demonstration of the durability properties since the client machine did not participate in the database portion of the transactions.

Respectfully Yours,



Lorna Livingtree, 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/Diskpart.txt SupportingFiles/Introduction/Hardware/DS4800_EXP810diagram.ppt SupportingFiles/Introduction/Hardware/DS4800_setup.script SupportingFiles/Introduction/Hardware/storage system files.cfg SupportingFiles/Introduction/Hardware/StorageSetup.doc
	Tier B/HS21 Configuration	SupportingFiles/Introduction/Hardware/BladeCenter_Setup.txt SupportingFiles/Introduction/Hardware/HS21_bios_settings.txt SupportingFiles/Introduction/Hardware/HS21_QLogicExpansion_setting.txt SupportingFiles/Introduction/Hardware/HS21_setup.txt
	TierA/x3500 setup	SupportingFiles/Introduction/Hardware/TierA_setup.txt
	Database Tunable Parameters	SupportingFiles/Introduction/software/runconfig.sql SupportingFiles/Introduction/software/startsqlmorgan.bat
	Checkpoint scripts	SupportingFiles/Introduction/software/runregularcheckpoints.bat SupportingFiles/Introduction/software/checkpoint.bat SupportingFiles/Introduction/software/checkpoint.sql
	OS Tunable Parameters	SupportingFiles/Introduction/software/OStune.doc SupportingFiles/Introduction/software/HS21_registry.reg SupportingFiles/Introduction/software/HS21_sysinfo.nfo SupportingFiles/Introduction/software/x3500_registry.reg SupportingFiles/Introduction/software/x3500_sysinfo.nfo
Clause 2	Table creation scripts	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_TPCE_Types.sql SupportingFiles/Clause2/DDL/Drop_FK_Constraints.sql SupportingFiles/Clause2/DDL/Drop_Tables_and_Constraints_Fixed.sql SupportingFiles/Clause2/DDL/Drop_Tables_and_Constraints_Growing.sql SupportingFiles/Clause2/DDL/Drop_Tables_and_Constraints_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_Growing.sql SupportingFiles/Clause2/DDL/Create_NC_Indexes_Fixed.sql SupportingFiles/Clause2/DDL/Create_NC_Indexes_Scaling.sql
		SupportingFiles/Clause2/DML/BrokerVolume.sql SupportingFiles/Clause2/DML/CustomerPosition.sql SupportingFiles/Clause2/DML/DataMaintenance.sql

	Load Transaction Frames	SupportingFiles/Clause2/DML/Get_Next_T_ID.sql SupportingFiles/Clause2/DML/MarketFeed.sql SupportingFiles/Clause2/DML/MarketWatch.sql SupportingFiles/Clause2/DML/SecurityDetail.sql SupportingFiles/Clause2/DML/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/backup.sql SupportingFiles/Clause2/backupdev.sql SupportingFiles/Clause2/Count_Customers.sql SupportingFiles/Clause2/create_database.sql SupportingFiles/Clause2/Create_TID_Ranges_Tables.sql SupportingFiles/Clause2/CreateTimerTable.sql SupportingFiles/Clause2/Database_Options_1.sql SupportingFiles/Clause2/Database_Options_2.sql SupportingFiles/Clause2/Drop_and_Create_TPCE_INFO.sql SupportingFiles/Clause2/EndLoadTimer.sql SupportingFiles/Clause2/growTempDB.sql SupportingFiles/Clause2/InstallLoadTimerProc.sql SupportingFiles/Clause2/MSTPCE Database Setup Reference.pdf SupportingFiles/Clause2/remove_database.sql SupportingFiles/Clause2/restore.sql SupportingFiles/Clause2/Set_Statistics.sql SupportingFiles/Clause2/setup_tpce.vbs SupportingFiles/Clause2/SQL_Server_Configuration.sql SupportingFiles/Clause2/SQL_Server_sp_Configure.sql SupportingFiles/Clause2/StartLoadTimber.sql SupportingFiles/Clause2/TPCE_Setup.cmd SupportingFiles/Clause2/VerifyTPCELoad.sql SupportingFiles/Clause2/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/DB_Check.sql SupportingFiles/Clause2/audit_scripts/database/DB_Tables.sql SupportingFiles/Clause2/audit_scripts/database/Duplicate_Tests.sql SupportingFiles/Clause2/Audit_Scripts/Database/RI_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.ncb SupportingFiles/Clause3/SUT_CE_Server/SUTServer.sln SupportingFiles/Clause3/SUT_CE_Server/SUTServer.suo SupportingFiles/Clause3/SUT_CE_Server/SUTStructs.h SupportingFiles/Clause3/SUT_CE_Server/Visual Studio DLL.ism
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/TxnHarnessDB.cpp SupportingFiles/Clause3/TransactionsSP/TxnHarnessDB.h 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/Clause5/85Kcust_msptce022.xml SupportingFiles/Clause5/m51_wholeRun_TxnReportE.xls
	EGenLoader Parameters	SupportingFiles/Clause5/EGenLoaderFlags.txt SupportingFiles/Clause5/EGenLoaderFrom1To21000.log SupportingFiles/Clause5/EGenLoaderFrom21001To42000.log SupportingFiles/Clause5/EGenLoaderFrom42001To63000.log SupportingFiles/Clause5/EGenLoaderFrom63001To85000.log
Clause 6	EGenValidate Output	SupportingFiles/Clause6/m51_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.afterDBLoad.txt SupportingFiles/Clause7/Consistency/consistency.afterBusinessRecovery.txt
	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



	Isolation 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/Consistency.afterBusinessRecovery.txt SupportingFiles/Clause7/Durability/BusinessRecovery/CountAfter.sql SupportingFiles/Clause7/Durability/BusinessRecovery/CountAfterBusinessRecovery.txt SupportingFiles/Clause7/Durability/BusinessRecovery/CountBefore.sql SupportingFiles/Clause7/Durability/BusinessRecovery/CountBeforeBusinessRecovery.txt SupportingFiles/Clause7/Durability/BusinessRecovery/m53_BusRecoveryPart1_20min_BI_TxnReportE.xls SupportingFiles/Clause7/Durability/BusinessRecovery/m53_BusRecoveryPart1_TxnStepReport.xlt SupportingFiles/Clause7/Durability/BusinessRecovery/m_53BusRecoveryPart1_wholeRun_TxnReportE.xls SupportingFiles/Clause7/Durability/BusinessRecovery/m54_BusRecoveryPart2_20min_BI_TxnReportE.xls SupportingFiles/Clause7/Durability/BusinessRecovery/m54_BusRecoveryPart2_TxnStepReport.xlt SupportingFiles/Clause7/Durability/BusinessRecovery/m54_BusRecoveryPart2_wholeRun_TxnReportE.xls SupportingFiles/Clause7/Durability/BusinessRecovery/m54_BusinessRecoveryTimeGraph.xls SupportingFiles/Clause7/Durability/BusinessRecovery/SQLConsoleLog.BusinessRecoveryPart1.txt SupportingFiles/Clause7/Durability/BusinessRecovery/SQLConsoleLog.BusinessRecoveryPart2.txt SupportingFiles/Clause7/Durability/BusinessRecovery/TierASystemEventLog.Sprucewood1.csv SupportingFiles/Clause7/Durability/BusinessRecovery/TierBSystemEventLog.ibmserverM.csv
	Durability Data Accessibility	SupportingFiles/Clause7/Durability/DataAccessibility/CountAfter.DataAccessibility.txt SupportingFiles/Clause7/Durability/DataAccessibility/CountAfter.sql SupportingFiles/Clause7/Durability/DataAccessibility/CountBefore.DataAccessibility.txt SupportingFiles/Clause7/Durability/DataAccessibility/CountBefore.sql SupportingFiles/Clause7/Durability/DataAccessibility/m52_DataAccessibility_wholeRun_TxnReportE.xls SupportingFiles/Clause7/Durability/DataAccessibility/m52_DataAccessibilityGraph.xls SupportingFiles/Clause7/Durability/DataAccessibility/pulledDrives.bmp SupportingFiles/Clause7/Durability/DataAccessibility/rebuildingDrives.bmp SupportingFiles/Clause7/Durability/DataAccessibility/rebuiltDrives.bmp SupportingFiles/Clause7/Durability/DataAccessibility/SQLConsoleLog.DataAccessibility.txt
	ACID Procedures Document	SupportingFiles/Clause7/MSTPCE ACID Procedures.doc
Clause 8	60-Day Space Calculations	SupportingFiles/Clause8/tpce_space.xls

## Appendix A – Price Quotes

Microsoft Corporation  
One Microsoft Way  
Redmond, WA 98052-6399

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

**Microsoft**

August 8, 2007

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
810-03150	<b>SQL Server 2005 Enterprise Edition</b> <i>Per Processor License</i> <i>Discount Schedule: Open Program - No Level</i> <i>Unit Price reflects a 4% discount from the retail unit price of \$24,999.</i>	\$23,911	2	\$47,822
P73-01972	<b>Windows Server 2003 R2 Standard Edition</b> <i>Server License Only - No CALs</i> <i>Discount Schedule: Open Program - No Level</i> <i>Unit Price reflects a 28% discount from the retail unit price of \$999.</i>	\$719	1	\$719
P72-01684	<b>Windows Server 2003 R2 Enterprise x64 Edition</b> <i>Server License Only - No CALs</i> <i>Discount Schedule: Open Program - No Level</i> <i>Unit Price reflects a 42% discount from the retail unit price of \$3,999.</i>	\$2,334	1	\$2,334
N/A	<b>Microsoft Problem Resolution Services</b> <i>Professional Support</i> <i>(1 Incident)</i>	\$245	1	\$245

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

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

This quote is valid for the next 90 days.

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

Reference ID: PEchki0708080000009630.

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



**Protect Your Data - Grow Your Business**

**To:** Chris King, IBM Corporation  
**Attention:**  
**Phone:**  
**Fax:**  
**Email:**

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

**QUOTE # :** DS4800\_080607  
**DATE:** August 6, 2007

Part No.	Description	Qty	List Price		Compsat Discounted Price	
			(per unit) US Dollar	(quantity x unit price) US Dollar	(per unit) US Dollar	(quantity x unit price) US Dollar
<b>IBM System Storage DS4800</b>						
1815-82A	IBM System Storage DS4800 Midrange Disk Subsystem	1	\$53,995	\$53,995	\$37,797	\$37,797
41C5953	3 YR onsite repair 24x7x4 hour (DS4800)	1	\$3,200	\$3,200	\$2,816	\$2,816
1812-81H	IBM TotalStorage DS4000 EXP810 Storage Exp. Unit	12	\$6,000	\$72,000	\$4,200	\$50,400
10N3651	3 YR onsite repair 24x7x4 hour (EXP810)	12	\$960	\$11,520	\$845	\$10,138
40K6812	4Gbps FC 36.4GB 15K Hot-Swap HDD	192	\$892	\$171,264	\$624	\$119,885
<b>TOTAL =</b>				<b>\$311,979</b>	<b>TOTAL =</b>	<b>\$221,035</b>

29.15%

25330 Telegraph Road / Suite 200 Raleigh Officentre / Southfield, Michigan 48034  
 Phone: 248-223-1020 / Fax: 248-223-1026 / [www.compsat.com](http://www.compsat.com)

**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.



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## NEC

### NEC Black 1.44MB 3.5" External USB Floppy Drive Model UF0002S-102 - OEM

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#### Manufacturer Contact Info

- [Manufacturer Product Page](#)
- Website: <http://www.necdisplay.com>
- Support Phone Number: 1-800-366-5213
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#### Model

Brand	NEC
Model	UF0002S-102

#### Spec

Panel Color	Black
Capacity	1.44MB
Track to Track Access Time	3ms
Rotational Speed	300 rpm
Interface	External USB
Media Type	3.5" Micro Floppy Dis
Features	Completely detached USB

#### Packaging

Package Contents	UF0002S-102 User Manual
------------------	----------------------------

#### Physical Spec

Form Factor	3.5"
Dimensions	5.60" x 4.10" x 0.67"



Home Networking: Switches: Gigabit Ethernet Switches: D-Link

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## D-Link 8 Port Rackmountable Gigabit Switch

Part #: DGS-1008TL

[Email this page](#)

### Purchase Information

Your Price: **\$205.99**  
Status: **Please Call**



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### Summary

Get the blazing speed of Gigabit Ethernet with the D-Link DGS-1008TL, an 8-port 10/100/1000Mbps Switch that delivers power, performance, and reliability in one cost-effective, space-saving design. Increase the speed of your network server and backbone connections, or make Gigabit to the desktop a reality. Power users in the home, office, workgroup, or creative production environment can now move large, bandwidth intensive files faster. Transfer graphics, CGI, CAD, or multimedia files across the network instantly. The versatile and compact 1U height design of the DGS-1008TL enables the device to rack-mounted in a standard 19 inch rack, while conserving valuable rack space.

### Features

**Data Link Protocol:** Ethernet, Fast Ethernet, Gigabit Ethernet

**Switching Protocol:** Store and Forward  
**MAC Address Table:** 8k entries

**Port Quantity:** 8

- Options
- Specs
- Features
- Includes
- Warranty

### Key Specifications

### D-Link 8-Port Gigabit Switch

Manufacturer	D-Link	
Manufacturer Part #	DGS-1008TL	
Device Type	Switch	
Enclosure Type	External	
Memory	RAM	256 KB
	<b>Connectivity Technology</b>	Wired
	<b>Data Link Protocol</b>	Ethernet, Fast Ethernet, Gigabit Ethernet
	<b>Switching Protocol</b>	Store and Forward
	<b>Communication Mode</b>	Half-duplex, full-duplex
<b>Networking</b>	<b>Data Transfer Rate</b>	1000Mbps
	<b>MAC Address Table Size</b>	8k entries
	<b>Status Indicators</b>	Port status, link activity, power
	<b>Features</b>	Flow control, full duplex capability, scalable clustering, layer 2 switching, auto-sensing per device, auto-negotiation, packet filtering
	<b>Compliant Standards</b>	IEEE 802.3, IEEE 802.3U, IEEE 802.3ab, IEEE 802.3x
<b>Interfaces</b>	8 x network - Ethernet 10Base-T/100Base-TX	
<b>Expansion Slots Total (Free)</b>	n/a	
<b>Power</b>	Power supply - internal	
<b>Dimensions (W X D X H)</b>	<b>Unit</b>	17.4 in x 15.3 in x 2.6 in
<b>Weight</b>	6.2 lbs	



[Home](#) > [Categories](#) > [Wired Networking](#) > [Network Cables](#) > [Belkin](#) > Item#: N82E16812106332

## BELKIN

### BELKIN A3L791-10-BLK 10 ft. Cat 5E Black RJ45 CAT5e Patch Cable - Retail

[CUSTOMER REVIEWS](#)
[SPECIFICATIONS](#)


#### Image Viewer



**\$3.99**

**3 Business Day Shipping \$4.99**  
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#### Model

Brand	BELKIN
Model	A3L791-10-BLK

#### Spec

Cat	5E
Length	10 ft.
Color	Black

#### Features

Features	Exceeds the perform: Category 5e. Perfect in conjunctor networks. 50-micron gold plate clean and clear trans This product is guara PowerSum tested
----------	----------------------------------------------------------------------------------------------------------------------------------------------------

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#### Manufacturer Warranty

Beyond any applicable Newegg return policy, this item is warranted independently by the product's Manufacturer. Below is a summary provided for convenience only and may not be accurate or current. [Click here](#) for full details.

#### Manufacturer Contact Info

- [Manufacturer Product Page](#)
- Website: <http://www.belkin.com/index.asp>
- Support Phone Number: 800-223-5546 X 2263
- Support Email: <http://www.belkin.com/support/emailsupport.asp?page=con>
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