



TPC Benchmark® E

Full Disclosure Report

HP ProLiant BL685c G7 Blade Server
using Microsoft SQL Server 2008 R2 Enterprise Edition
on Microsoft Windows Server 2008 R2 Enterprise Edition

First Edition
June 21, 2010

First Edition June 21, 2010

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Abstract

Overview

This report documents the methodology and results of the TPC Benchmark® E (TPC-E) test conducted on the HP ProLiant BL685c G7 Blade Server using Microsoft SQL Server 2008 R2 Enterprise Edition. The operating system used for the benchmark was Microsoft Windows Server 2008 R2 Enterprise Edition.

TPC Benchmark® E Metrics



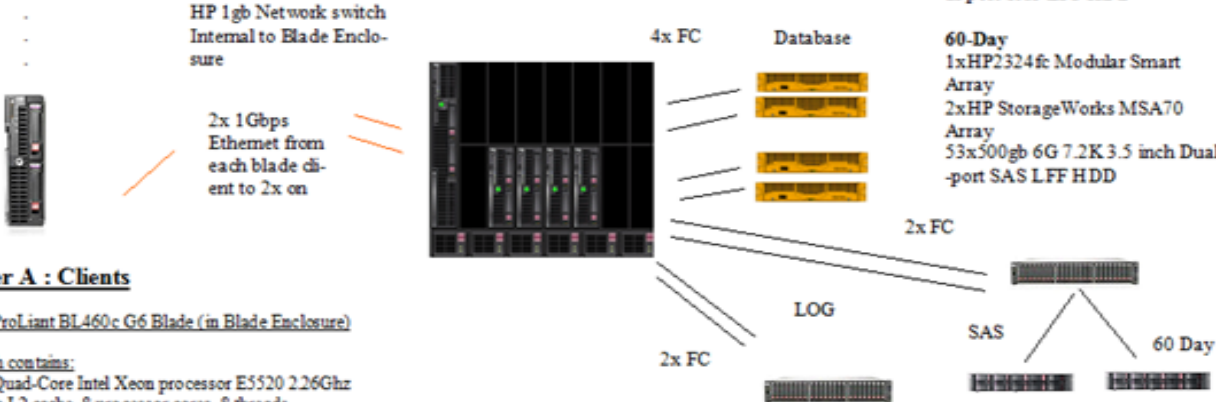
The standard TPC Benchmark ® E metrics, TpsE® (transactions per second), price per TpsE ® (three year capital cost per measured TpsE ®), and the availability date are reported as required by the benchmark specification.


Standard and Executive Summary Statements

The following pages contain the Executive Summary of the benchmark results for the HP ProLiant BL685c G7 Blade Server system.

Auditor

The benchmark configuration, environment and methodology used to produce and validate the test results, and the pricing model used to calculate the cost per TpsE®, were audited by Francois Raab of InfoSizing, 125 West Monroe Street, Colorado Springs, CO 80907 to verify compliance with the relevant TPC specifications.

	HP ProLiant BL685c G7 Blade Server		TPCE Rev 1.11.0
			TPC Pricing 1.5.0
			Report Date June 21,2010
TPC-E Throughput	Price/Performance	Availability Date	Total System Cost
1,464.12	\$302.49 USD/TpsE	June 21, 2010	\$442,879 USD
Database Server Configuration			
Operating System	Database Manager	Processor/Cores/Thread	Memory
Microsoft Windows Server 2008 R2 Enterprise Edition	Microsoft SQL Server 2008 R2 Enterprise Edition	4/48/48	512 Gbyte
<div> <div>  <p>Tier B: Server <u>HP ProLiant BL685c G7</u> 4 x 12-Core AMD Processor 6174 (Magny-Cours) @2.2 GHz 512GB Memory Onboard P410i SmartArray RAID Controller 2 x 72GB SAS Drive (Boot) (RAID1) 4 x 10Gbps Ethernet NIC (internal)</p> </div> <div> <p>Storage: <u>Database:</u> 4 x Violin Memory Appliances 1.728TB each (usable) <u>Log:</u> 1x HP 2324fc Modular Smart Array 24 x 72GB 3G 15K 3.5 inch Dual-port SAS LFF HDD <u>60-Day</u> 1xHP2324fc Modular Smart Array 2xHP StorageWorks MSA70 Array 53x500gb 6G 7.2K 3.5 inch Dual-port SAS LFF HDD</p> </div> <div>  <p>HP 1gb Network switch Internal to Blade Enclosure</p> <p>2x 1Gbps Ethernet from each blade client to 2x on</p> <p>Tier A : Clients <u>4x ProLiant BL460c G6 Blade (in Blade Enclosure)</u> <u>Each contains:</u> 2x Quad-Core Intel Xeon processor E5520 2.26Ghz 3Mb L2 cache, 8 processor cores, 8 threads 8GB of Memory Onboard P410i SmartArray RAID Controller 2 x 146GB SAS drive (Boot) (RAID1) 2x Onboard 1Gbps Ethernet Controllers</p> </div> </div> <p style="text-align: center;">Priced Configuration</p>			
Initial Database Size 6228 GB	Redundancy Level : 1 RAID10 : Log/ RAID3 : Data		Storage 4 x 1.728TB Violin Mem Appl 24 x 72GB Log 53 x 500gb 60-day

	HP ProLiant BL685c G7				TPC-E	1.11.0
					TPC-Pricing	1.5.0
					Report date	21-Jun-10
					Availability Date	21-Jun-10
Description	Part Number	Brand	Unit Price	Qty.	Extended Price	3 Yr Maint Price
Server Hardware (Tier B)						
HP BL685c G7 CTO Blade (support included under client hardware)	518878-B21	1	4,191	1	4,191	
HP BL685c G7 O6174 12C 2P Kit	518871-B21	1	2,999	1	2,999	
HP BL685c G7 O6174 12C 2P FIO Kit	518871-L21	1	2,999	1	2,999	
HP 16GB (1x16GB) Quad Rank x4 PC3-8500 (DDR3-1066) Registered CAS-7 Memory Kit	593915-B21	1	1,549	32	49,568	
HP 72GB 3G SAS 10K SFF DP ENT HDD	384842-B21	1	259	2	518	
QLogic QMH2562 8Gb FC HBA for HP BladeSystem c-Class	451871-B21	1	849	1	849	
HP LE1851w 18.5-Inch wide Monitor	NK033AA#ABA	1	159	1	159	
HP PS/2 Keyboard And Mouse Bundle	RC464AA#ABA	1	39	1	39	
			Subtotal		\$61,322	\$0
Server Software						
SQL Server 2008 R2 Enterprise Edition, Per Processor License	810-07580	2	19,188	4	76,752	
Windows Server 2008 Enterprise Edition R2	P72-03868	2	2,280	1	2,280	
Microsoft Problem Resolution Services	N/A	2	259	1		259
			Subtotal		\$79,032	259
Storage						
V-3200 Chassis with PCIe 20 Gbit/s Interface 2.6TB Flash (21 x VIMM-128GSLC)	V-3202	4	50,250	4	201,000	
Violin Network Head-Quad 4/8 Gbit/s Fiber Channel Interfaces	V-IF-8GFCx4	4	8,040	2	16,080	
Violin Standard Warranty includes 3 years of 4h 24 x7 support	VS-SW	4	0	1		0
HP StorageWorks 2324fc G2 Dual Controller Modular Smart Array (SFF)	AJ797A	1	8,900	1	8,900	
HP 3y 4h 24x7 MSA2000 Array HWSupp ,MSA2000 Dual Controller	UJ675E	1	1,513	1		1,513
HP 72GB 3G SAS 15K SFF (2.5-inch) Dual Port Enterprise 3yr Warranty Hard Drive	418371-B21	1	349	24	8,376	
HP StorageWorks 2324fc G2 Dual Controller Modular Smart Array (SFF)	AJ797A	1	8,900	1	8,900	
HP 3y 4h 24x7 MSA2000 Array HWSupp ,MSA2000 Dual Controller (includes disks)	UJ675E	1	1,513	1		1,513
HP StorageWorks MSA70 Array (60-day)	418800-B21	1	3,199	2	6,398	
3-year, 4-hour, 24x7 MSA70 hardware support (includes disks) (60-day)	UF303E	1	2,198	2		4,396
HP 500GB 6G SAS 7.2K SFF (2.5-inch) Dual Port Midline Hard Dr (60-day)	507610-B21	1	419	53	22,207	
			Subtotal		271,861	7,422
Client Hardware (Tier A)						
HP BLc7000 Blade Enclosure 3 Inch LCD display	507019-B21	1	4,837	1	4,837	
Single Phase Power option for Blade Enclosure	413379-B21	1	175	1	175	
HP BLc 6x Active Cool 200 FIO Fan Option	517520-B21	1	894	1	894	
HP 2400W High Efficiency Power Supply	499243-B21	1	349	6	2,094	
HP GbE2c Layer 2/3 Ethernet Blade Switch	438030-B21	1	1,799	2	3,598	
HP ProLiant BL460C G6 E5520 2.26Ghz Quad Core Blade Server	507782-B21	1	2,489	4	9,956	
HP E5520 BL460c G6 FIO Kit	507799-B21	1	599	4	2,396	
HP 4GB 2Rx4 PC3-10600R-9 Memory Kit	500658-B21	1	230	8	1,840	
HP 146GB 15k 2.5 dual Port HP SAS Drive	418367-B21	1	269	8	2,152	
HP 1year 4h 24x7 B Series Blades HW Support 16 Blades	UB329E	1	612	3		1,836
			Subtotal		27,942	1,836
Client Software						
Microsoft Windows Server 2008 Standard (x64) R2		2	711	4	2,844	
			Subtotal		2,844	0
Infrastructure						
HP 5642 Pallet Unassembled Rack	358254-B21	1	865	2	1,730	
HP Brocade 8/12c SAN Switch for BladeSystem c-Class	AJ820A	1	6,374	2	12,748	
HP 8Gb Shortwave B-series Fibre Channel 1 Pack SFP+ Transceiver	AJ716A	1	249	10	2,490	
2 m LC-LC Multi-Mode Fibre Channel Cable	221692-B21	1	75	8	600	
2 m LC-LC Multi-Mode Fibre Channel Cable (spares)	221692-B21	1	75	2	150	
CAT 6 7 Foot Gray Patch Cable	CB242-7G	3	2	2	3	
CAT 6 7 Foot Gray Patch Cable (Spares)	CB242-7G	3	2	2	3	
			Subtotal		17,724	0
Total Extended Price					\$460,725	\$9,517
Total Discounts					\$25,882	\$1,481
Grand Total					\$434,843	\$8,036
Pricing: 1=HP Direct 800-203-6748 2=Microsoft, 3=deepsurplus.com 4=Violin Memory Systems Note 1: Discount based on HP Direct guidance applies to all lines where pricing = 1. Note 2: All the hardware are available to order. The benchmark results were audited by Francois Raab of Infosizing Inc (www.infosizing.com).					Three-year Cost of Ownership: USD tpsE \$ USD/tpsE	
						\$442,879 1,464.12 \$302.49
Prices used in TPC benchmarks reflect the actual prices a customer would pay for a one-time purchase of the stated components. Individually negotiated discounts are not permitted. Special prices based on assumptions about past or future purchases are not permitted. All discounts reflect standard pricing policies for the listed components. For complete details, see the pricing sections of the TPC benchmark specifications. If you find that the stated prices are not available according to these terms, please inform at pricing@tpc.org. Thank you.						


	HP ProLiant BL685c G7 Blade Server	TPCE Rev 1.11.0 TPC Pricing 1.5.0	
		Report Date June 21, 2010	
		Availability Date June 21, 2010	
Numerical Quantities Summary			
Reported Throughput	1,464.12	Configured Customers: 800,000	
Response Times (in seconds)	Minimum Average 90 th %tile Maximum		
Broker Volume	0.00	0.04	0.06 0.90
Customer Position	0.00	0.03	0.04 1.02
Market Feed	0.00	0.02	0.04 1.61
Market Watch	0.00	0.03	0.06 0.96
Security Detail	0.00	0.01	0.02 1.27
Trade Lookup	0.00	0.11	0.16 1.74
Trade Order	0.00	0.06	0.08 1.64
Trade Result	0.00	0.08	0.11 2.75
Trade Status	0.00	0.02	0.03 1.04
Trade Update	0.01	0.13	0.18 2.94
Data Maintenance	0.00	0.03	0.34
Transaction Mix		Transaction Count	Mix %
Broker Volume		5,165,673	4.900%
Customer Position		13,704,694	13.000%
Market Feed		1,054,173	1.000%
Market Watch		18,975,612	18.000%
Security Detail		14,759,361	14.000%
Trade Lookup		8,433,494	8.000%
Trade Order		10,647,612	10.100%
Trade Result		10,541,668	10.000%
Trade Status		20,030,234	19.000%
Trade Update		2,108,431	2.000%
Data Maintenance		120	
Ramp-up Time		54:06	
Measurement Interval		2:00:00	
Business Recovery Time		00:58:50	
Total Number of Transactions Completed in Measurement Interval		105,420,952	

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Preface

Document Structure

This is the full disclosure report for a benchmark test of the HP ProLiant BL685c G7 Blade Server Microsoft SQL Server 2008 R2 Enterprise Edition. It meets the requirements of the TPC Benchmark ® E Standard Specification, Revision 1.11.0 dated April 22, 2010. TPC Benchmark® E was developed by the Transaction Processing Performance Council (TPC). It is the intent of this group to develop a suite of benchmarks to measure the performance of computer systems executing a wide range of applications. Hewlett-Packard Company and Microsoft, Inc. are active participants in the TPC.

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

TPC Benchmark® E Overview

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

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

The TPC-E operations are modeled as follows:

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

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

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

Clause 1: General Items

1.1 Orders and Titles

*The order and titles of sections in the **Report** and **Supporting Files** must correspond with the order and titles of sections from the TPC-E Standard Specification (i.e., this document). The intent is to make it as easy as possible for readers to compare and contrast material in different **Reports**. (9.1.1.1)*

The order and titles of the sections in this report correspond with those specified in the TPC-E specification.

1.2 Pricing

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

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

1.3 Executive Summary Statement

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

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

1.4 Supporting Files

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

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

1.5 Auditor

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

This Benchmark, Executive Summary, and Full Disclosure Report were audited by InfoSizing of 125 West Monroe Street. The attestation letter is included in this FDR.

1.6 Configuration Diagrams

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

The Benchmarked configuration of the driver, SUT Server, and DBMS server are illustrated in Figure 1.1. The Priced Configuration is shown in Figure 1.2. Following Figure 1.2 is a detailed description of the differences.

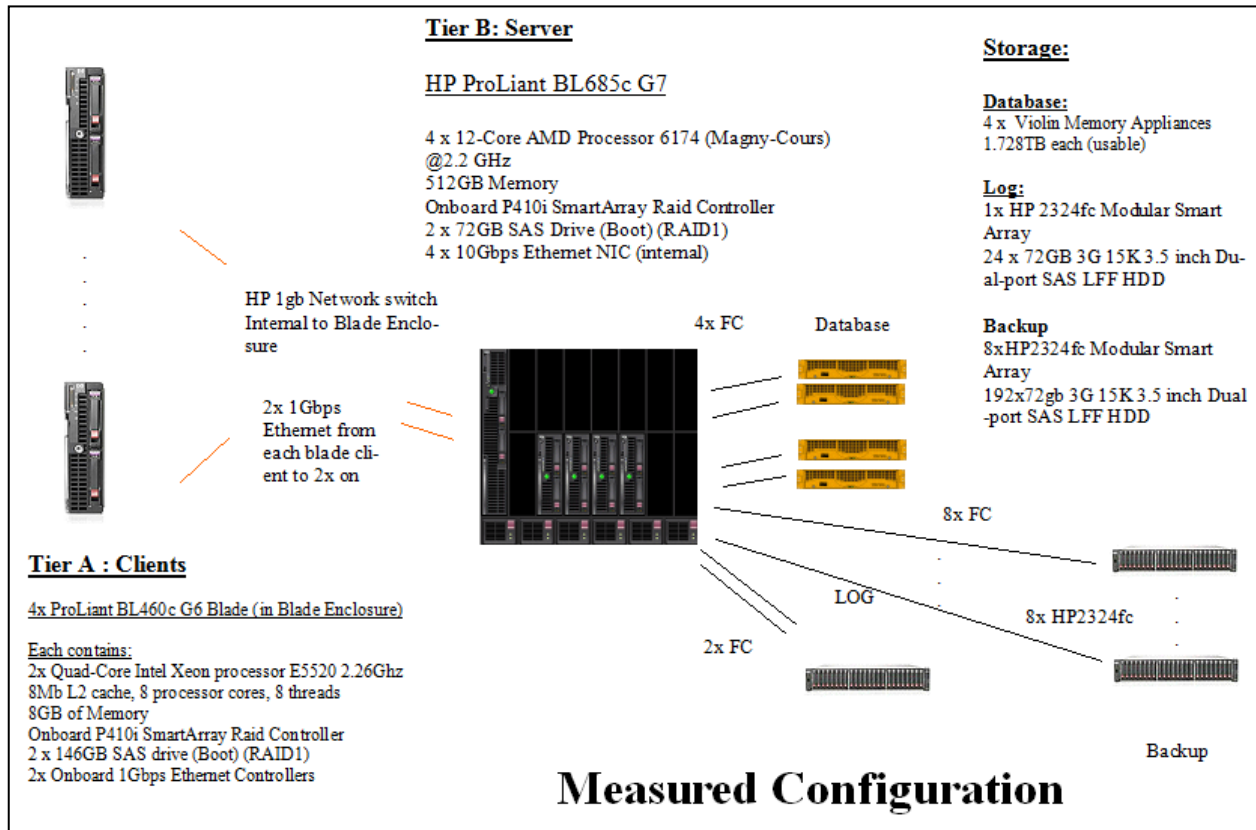


Figure 1.1 Benchmarked Configuration

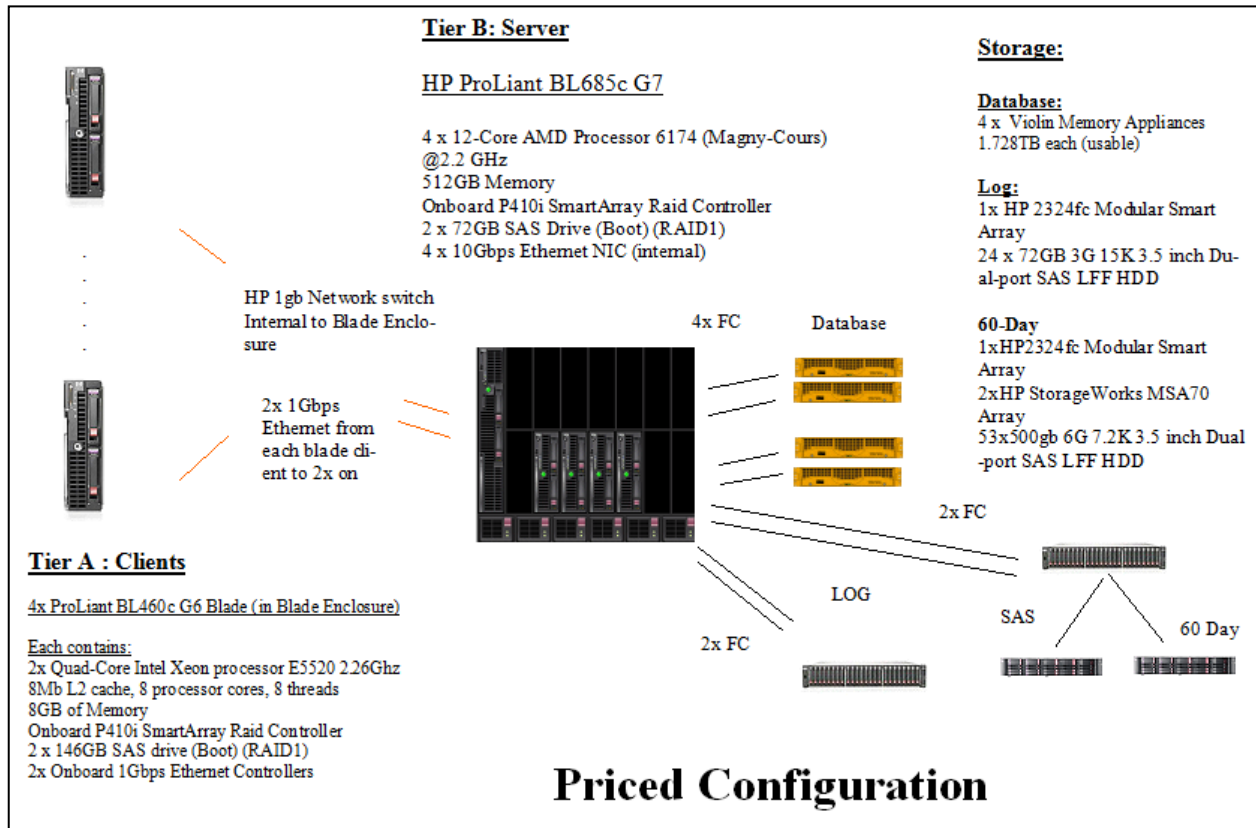


Figure 1.2 Priced Configuration

The benchmarked and priced configurations differed in that 500GB drives and associated enclosures and hardware were priced to meet 60-day space requirements. The reported performance was measured with attached HP2312fc arrays connected to 72GB disk drives and configured for backup only. Each array was configured as 2 12disk RAID5 LUNs. A second measurement, resulting in performance increase of 0.6 TpsE, was performed to meet the requirements for pricing additional storage to hold part of the 60-day space. This was measured with an attached HP 2324fc array connected to 12 500GB disk drives. In both cases, the additional storage was not used to contain any part of the active database during runs.

1.7 Hardware Configuration

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

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

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

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

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

The Microsoft SQL Server 2008 R2 Enterprise Edition on HP ProLiant BL685c G7 Blade Server, in the benchmarked configuration, consists of a single mainboard with 4 AMD Opteron Processor 6174 processors. The 512 GB of memory was also installed on the mainboard. The 10gb NIC hardware is built on to the mainboard, while the Qlogic Fiber Channel Adapters were installed as a mezzanine card. Details of this are in the file **HWConfig.pdf** in the *SupportingFiles* “Introduction” directory. Additionally, the **DiskConfig.pdf** file in the *DiskConfig* directory in *SupportingFiles* file shows how the Log disc subsystem was configured. The Violin configuration was performed by a representative of the vendor, and this configuration service is part of the purchase price of those arrays.

1.8 Software Configuration

*A description of the steps taken to configure all software must be **reported** in the **Report**. Any and all configuration scripts or step by step GUI instructions are **reported** in the **Supporting Files** (see Clause 9.4.1.2). The description, scripts and GUI instructions must be sufficient such that a reader knowledgeable of computer systems and the TPC-E specification could recreate the software environment. This includes, but is not limited to:*

A description of any updates or patches to the software.

A description of any changes to the software.

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

The file **Win2008R2Setup.pdf** in the *SupportingFiles\Introduction\SWSetup\OSSetup* directory outlines the steps taken to configure the OS and DBMS. The file **SQL2008R2Setup.doc** in *DBMSSetup* likewise outlines the steps taken to setup the DBMS. Other supporting files (registry, configuration) are also included in the respective directories.

Clause 2: Database Design, Scaling & Population Items

2.1 Physical Database Organization

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

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

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

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

Table 2.1 – FileGroup Table Assignments

2.2 Table and Row Partitioning

*While few restrictions are placed upon horizontal or vertical partitioning of tables and rows in the TPC-E benchmark (see Clause 2.3.3), any such partitioning must be **reported** in the **Report**.(9.3.2.2)*

No partitioning was done for this benchmark.

2.3 Replication, Duplication

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

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

No replication or duplication was done for this benchmark.

2.4 Cardinality of Tables

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

The TPC-E database was configured using 800,000 customers. Table 2.2 below shows the cardinality of each table.

Table	Rows
Account_Permission	5679775
Address	1200004
Broker	8000
Company	400000
Company_Competitor	1200000
Customer	800000
Customer_Account	4000000
Customer_Taxrate	1600000
Daily Market	715140000
Financial	8000000
Last_Trade	548000
News_Item	800000
News_Xref	800000
Security	548000
Watch_Item	80054495
Watch_List	800000
Cash_Transaction	12718084996
Holding	707739258
Holding_History	18526540227
Holding_Summary	39788095
Settlement	13824000000
Trade	13824000000
Trade_History	33177541373
Trade_Request	0
Charge	15
Commission_Rate	240
Exchange	4
Industry	102
Sector	12
Status_Type	5
Tax_Rate	320
Trade_Type	5
Zip_Code	14741

Table 2.2 Initial Cardinality of Tables

2.5 Disc Configuration

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

Table 2.3 shows the configuration of the various data storage hardware to Qlogic Fiber Channel Adapters. The Fiber Adapter Mezzanine card provides the electronics, the output of which is carried through the Blade backplane to the two HP Brocade 8/12c SAN Switch for Blade System c-Class switches. The Qlogic Mezz card provides two 8gb fiber ports, one to each of the two switches. All data transfers were through these two ports. Fibers were run to the various fiber storage units, balancing the load between the two ports. The switches were not zoned or configured, only left at the default settings (all ports visible).

The main data storage was via the Violin Memory Appliances. The capacity of the flash memory can be configured to vary, balancing it with total write IO. The units used were configured to present 1727.88 GB to the host. Each unit was divided into 2 halves, accommodating 8 files for each of the two DB filegroups, plus a small partition for Tempdb files.

The SQL Log consisted of 1 HP StorageWorks 2312fc G2 Modular Smart Array containing 24 HP 72GB 3G SAS 15K SFF Dual Port Disk Drives. The log drives were created as two RAID1+0 sets of 6x2 drives each, and software striped in the operating system. A small partition was created on the array for the main TEMPDB log and data file, with extra TEMPDB files spread on the Violin units as noted.

Each data array was partitioned with 3 partitions: Growing, Fixed, and Temp. The first two contained the database files, and the third contained multiple TEMPDB files. The first 2 partitions were RAW, the 3rd was configured as NTFS.

Access to all the partitions was by using mount points, no drive letters were used except for the log, main TEMPDB and the boot/utility drives.

Adapter #	Slot #	Disk #	Drives Enclosure RAID Lvl	Path Filesystem Partition	Size	Use
P410i	Built In	1 (Measured)	2x72 SCSI, Built In RAID1	C:, NTFS	72 GB	Win2008 Boot, Pagefile
Qlogic Fiber Adapter	1 (via Blade Fiber Switch)	1 (Measured)	Violin Proprietary RAID3	C:\mnt\growing\1 (RAW) C:\mnt\fixed\1 (RAW) C:\mnt\temp\1 (NTFS) C:\mnt\growing\2 (RAW) C:\mnt\fixed\2 (RAW) C:\mnt\temp\2 (NTFS)	834GB 20GB 9.77GB 834GB 20GB 9.77GB	Growing FG Growing FG Tempdb Files Growing FG Growing FG Tempdb Files
		2 (Measured)	Violin Proprietary RAID3	C:\mnt\growing\3 (RAW) C:\mnt\fixed\3 (RAW) C:\mnt\temp\3 (NTFS) C:\mnt\growing\4 (RAW) C:\mnt\fixed\4 (RAW) C:\mnt\temp\4 (NTFS)	834GB 20GB 9.77GB 834GB 20GB 9.77GB	Growing FG Growing FG Tempdb Files Growing FG Growing FG Tempdb Files
		3-10 (Measured)	8x12x72GB SAS HP2324fc RAID5	C:\mnt\backup\1-8	8x750.98GB	Backup
		11 (Software Striped) (Measured+ Priced)	12x73 SAS HP2324fc RAID1+0 (Lun 0)	T: L: (RAW) C:\mnt\backup\LOG_EX TRA	24.41GB 175.58GB 209.57GB	Tempdb SQL Log Scratch (avail for 8 hour log space)
		3(Priced)	12x500GB SAS HP2324fc RAID5	Priced 60-day Space (1/2 of configured LUNS)	5118GB	60-day space
		4(Priced)	12x500GB SAS HP2324fc RAID5	Priced 60-day Space (1/2 of configured LUNS)	5118GB	60-day space
		5(Priced)	5x500GB SAS HP2324fc RAID5	Priced 60-day Space (1/2 of configured LUNS)	1706GB	60-day space

Table 2.3 Disc/Partition Configuration

Adapter #	Slot #	Disk #	Drives Enclosure RAID Lvl	Path Filesystem Partition	Size	Use
Qlogic Fiber Adapter	2 (via Blade Fiber Switch)	1	Violin Proprietary RAID3	C:\mnt\growing\5 (RAW) C:\mnt\fixed\5 (RAW) C:\mnt\temp\5 (NTFS) C:\mnt\growing\6 (RAW) C:\mnt\fixed\6 (RAW) C:\mnt\temp\6 (NTFS)	834GB 20GB 9.77GB 834GB 20GB 9.77GB	Growing FG Growing FG Tempdb Files Growing FG Growing FG Tempdb Files
		2	Violin Proprietary RAID3	C:\mnt\growing\7 (RAW) C:\mnt\fixed\7 (RAW) C:\mnt\temp\7 (NTFS) C:\mnt\growing\8 (RAW) C:\mnt\fixed\8 (RAW) C:\mnt\temp\8 (NTFS)	834GB 20GB 9.77GB 834GB 20GB 9.77GB	Growing FG Growing FG Tempdb Files Growing FG Growing FG Tempdb Files
		3-10 (Measured)	8x12x72GB SAS HP2324fc RAID5	C:\mnt\backup\9-16	8x750.98GB	Backup
		11 (Software Striped) (Measured+Priced)	12x73 SAS HP2324fc RAID1+0 (Lun 1)	T: L: (RAW) C:\mnt\backup\LOG_EXTRA	24.41GB 175.58GB 209.57GB	Tempdb SQL Log Scratch (avail for 8 hour log space)
		3(Priced)	12x500GB SAS HP2324fc RAID5	Priced 60-day Space (1/2 of configured LUNS)	5118GB	60-day space
		4(Priced)	12x500GB SAS HP2324fc RAID5	Priced 60-day Space (1/2 of configured LUNS)	5118GB	60-day space

Table 2.3 Disc/Partition Configuration (continued)

2.6 Database Interface

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

*The **Database Interface** (e.g., embedded, call level) and access language (e.g., SQL, COBOL read/write) used to implement the TPC-E **Transactions**. If more than one interface / access language is used to implement TPC-E, each interface / access language must be described and a list of which interface /access language is used with which **Transaction** type must be **reported**.(9.3.2.7)*

*The data model implemented by the **DBMS** (e.g., relational, network, hierarchical).(9.3.2.7)*

*The methodology used to load the database must be **reported** in the **Report**. (9.3.2.8)*

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

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

The methodology used to load the database is contained in the file **TPCESetup.pdf** in the CLAUSE2 directory in *SupportingFiles* directory.

Clause 3: Transaction Related Items

3.1 Code Functionality

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

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

3.2 Database Footprint

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

Database footprint requirements were met.

Clause 4: SUT, Driver and Network Related Items

4.1 Network Configuration

*The **Network** configurations of both the measured and **Priced Configurations** must be described and **reported** in the **Report**. This includes the mandatory **Network** between the **Driver** and **Tier A**) and any optional **Database Server** interface networks (9.3.4.1)*

The network configuration for both the priced and reported configurations are the same. All network connections were through two HP GbE2c Layer 2/3 Ethernet Blade Switches, using the Blade infrastructure. The 4driver machines (+ the Benchcraft master driver machine) were networked via one of their built in 1Gbps ports. The DBMS server used 2 of it's 4 onboard 10Gbps NICS for data base traffic during the measured run, and another dual port NIC for management access, all of which are standard with the system.

Clause 5: Egen Related Items

5.1 Egen Version

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

Egen Version used for this test was 1.11.0

5.2 Egen Code

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

All required TPC provided Egen code was used in this benchmark.

5.3 Egen Modifications

*If the **Test Sponsor** modified EGen, a statement EGen has been modified must be **reported** in the **Report**. All formal waivers from the TPC documenting the allowed changes to EGen must also be **reported** in the **Report**. If any of the changes to EGen do not have a formal waiver that must also be **reported** in the **Report**.*

No modifications to Egen were done for this report.

5.4 Egen Loader Extensions

*If the **Test Sponsor** extended EGenLoader the use of the extended EGenLoader and the audit of the extension code by an **Auditor** must be **reported** in the **Report** (9.3.5.4)*

Egen Loader was not extended for this report.

5.5 Egen Loader Make Files

*The make/project files used to compile/link EGenLoader and EGenValidate must be **reported** in the **Supporting Files**. The compiler/linker options and flags used to compile/link EGen Objects for the SUT must be **reported** in the **Supporting Files**. (9.3.5.5)*

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

Clause 6: Performance Metrics and Response Time Related Items

6.1 EgenDriver and MEE instances

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

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

6.2 Measured Throughput

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

Measured TpsE for this run was 1,464.12

Test Run Graph and Steady State Measurement

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

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

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

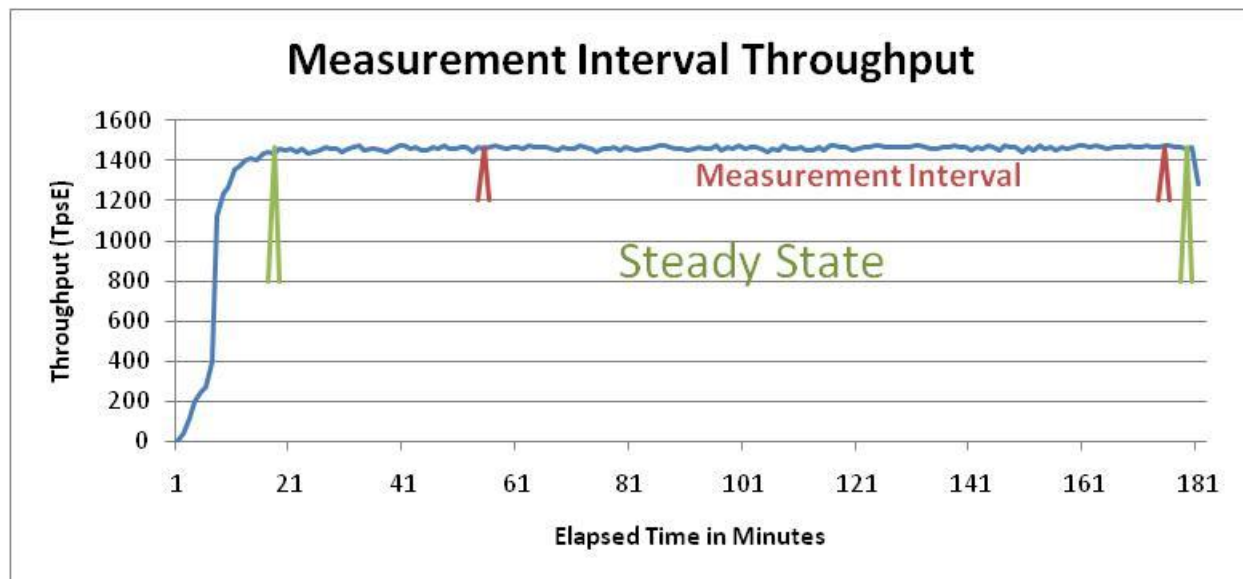


Figure 6.1 Test Run Time/Steady State Measurement Run Data

6.4 Work Measurement

A description of how the work normally performed during a Test Run, actually occurred during the Measurement Interval must be reported in the Report (for example checkpointing, writing Undo/Redo Log records, etc). (9.3.6.5)

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

Checkpoints were performed to flush all dirty pages from memory, and write a record of this fact to the transaction log. This was accomplished by setting the SQL Recovery Interval to 32767, which effectively tells SQL to not checkpoint automatically. Near the beginning of the test run, a script was started that did manual checkpoints, specifying an interval of 440 seconds. SQL Server was run with run flag 3502, which caused it to display messages when checkpoints were started and ended. This was used to verify the checkpoints were done in the time intervals as required by the TPC-E specification.

6.5 Transaction Reporting

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

Table 6.2 shows the Averages for the Test Run.

Transaction	Over- all	Parameter	Value	Range Check	Acceptable Range	
					Min	Max
Customer Position	OK	By Tax ID	50.01%	OK	48.00%	52.00%
		Get History	50.00%	OK	48.00%	52.00%
Trade Lookup	OK	Frame 1	30.00%	OK	28.50%	31.50%
		Frame 2	29.97%	OK	28.50%	31.50%
		Frame 3	30.02%	OK	28.50%	31.50%
		Frame 4	10.00%	OK	9.50%	10.50%
Market Watch	OK	By Watch List	59.99%	OK	57.00%	63.00%
		By Customer Acct	35.01%	OK	33.00%	37.00%
		By Industry	5.00%	OK	4.50%	5.50%
Trade Update	OK	Frame 1	33.04%	OK	31.00%	35.00%
		Frame 2	32.95%	OK	31.00%	35.00%
		Frame 3	34.00%	OK	32.00%	36.00%
Security Detail	OK	Access LOB	1.00%	OK	0.90%	1.10%
Trade Order	OK	By Non-Owner	10.00%	OK	9.50%	10.50%
		By Company Name	39.99%	OK	38.00%	42.00%
		Buy on Margin	8.00%	OK	7.50%	8.50%
		Rollback	0.99%	OK	0.94%	1.04%
		LIFO	34.99%	OK	33.00%	37.00%
		Trade by Qty 100	24.98%	OK	24.00%	26.00%
		Trade by Qty 200	25.02%	OK	24.00%	26.00%
		Trade by Qty 400	25.00%	OK	24.00%	26.00%
		Trade by Qty 800	25.00%	OK	24.00%	26.00%
		Market Buy	29.99%	OK	29.70%	30.30%
		Market Sell	30.01%	OK	29.70%	30.30%
		Limit Buy	20.02%	OK	19.80%	20.20%
		Limit Sell	10.00%	OK	9.90%	10.10%
		Stop Loss	9.99%	OK	9.90%	10.10%

Table 6.2 Average Transaction Parameters

Clause 7: Transaction and System Properties

7.1 ACID Tests

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

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

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

7.2 Redundancy Level and Data Accessibility Test 1

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

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

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

Data Accessibility was done in two parts. The first was to fail a Violin Intelligent Memory Module one of the Violin Memory Appliances, and the 2nd (separate) run was done for the HP 2324fc Log Array disk and controller.

The Data Accessibility Test for the Violin Memory Appliance was performed according to the following steps

1. The rows in the Settlement table were counted to establish the initial count of trades present.
2. A run was started using the same profile and configuration as the test run (reported result) and ramped up to at least 95% of the Reported Throughput.
3. After ≥ 5 minutes of running at at least 95% of the Reported Throughput, a command was issued to remove power from a Violin Intelligent Memory Module (VIMM). The use of this command was to prevent damage to the VIMM. The auditor verified that the effect of the command meets the requirement for instantaneous failure of the component.
4. The benchmark was allowed to run for over 5 more minutes at steady state with the RAID group degraded, all at $\geq 95\%$ of Reported Throughput.
5. The VIMM was then physically removed from the Violin Memory Appliance and re-inserted to trigger recovery of the failed VIMM.
6. The VIMM processor automatically booted, and recovery of the RAID Group was started automatically.
7. The run continued for 20 minutes at a reduced throughput due to the RAID rebuild.
8. The benchmark was terminated gracefully, and the various reports were run. No errors were reported at any time in this process.
9. The rows in the Settlement table were counted again to establish the final number of trades present in the data base.
10. The initial count was subtracted from the final count and was verified against the reported number of Trade-Result transactions
11. After the VIMM RAID Group finished rebuilding, the recovery was considered complete.
12. The Consistency scripts were run to verify the data base was logically consistent.

The auditor verified that the method used to fail the VIMM complied with the requirements for instantaneous failure.

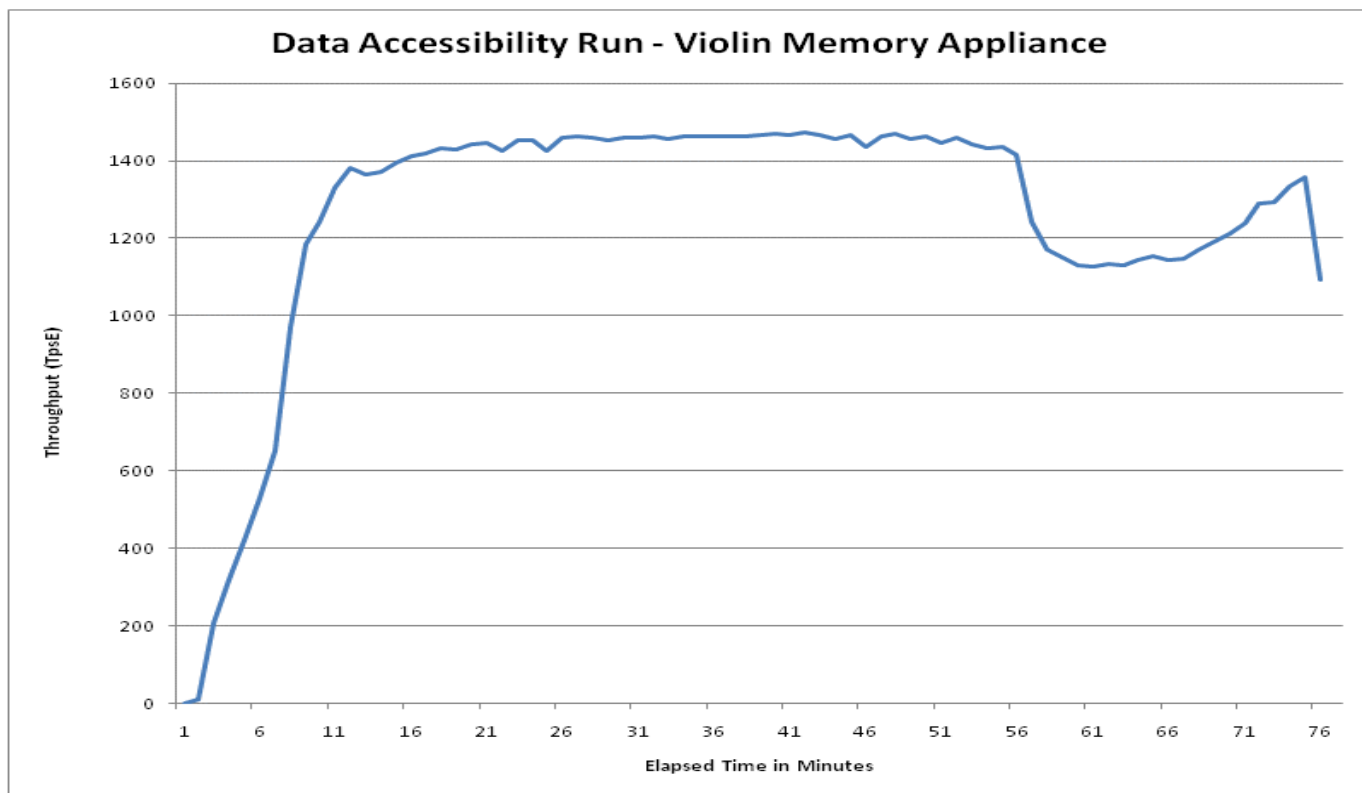


Figure 7.1a Data Accessibility Test Run Graph – Violin Memory Appliance

7.3 Redundancy Level and Data Accessibility Test 2

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

The Data Assessability Test for the SQL Log array (HP 2324fc) was performed according to the following steps

1. The rows in the Settlement table were counted to establish the initial count of trades present.
2. A run was started using the same profile and configuration as the test run (reported result) and ramped up to 95% of the Reported Throughput.
3. After ≥ 5 minutes of running at at least 95% of the Reported Throughput, a disk was pulled from the array. $\geq 95\%$ throughput was maintained
4. After running more than 5 minutes, a log controller was pulled. $\geq 95\%$ throughput was maintained.
5. The benchmark was allowed to run for at least 5 more minutes at steady state at $\geq 95\%$ of Reported Throughput.
6. After running more than 5 minutes, the log controller was re-inserted.
7. After running more than 5 more minutes, the disc was inserted, and the commands were entered in the array's Telnet interface to clear the disk metadata and add it as a spare, at which time the rebuild started.
8. The run continued for 20 minutes, all the time maintaining $\geq 95\%$ throughput.
9. The benchmark was terminated gracefully, and the various reports were run. No errors were reported at any time in this process.
10. The rows in the Settlement table were counted again to establish the final number of trades present in the data base.
11. The initial count was subtracted from the final count and was verified against the reported number of Trade-Result transactions
12. The rebuild finished shortly after the run termination.
13. The Consistency scripts were run to verify the data base was logically consistent.

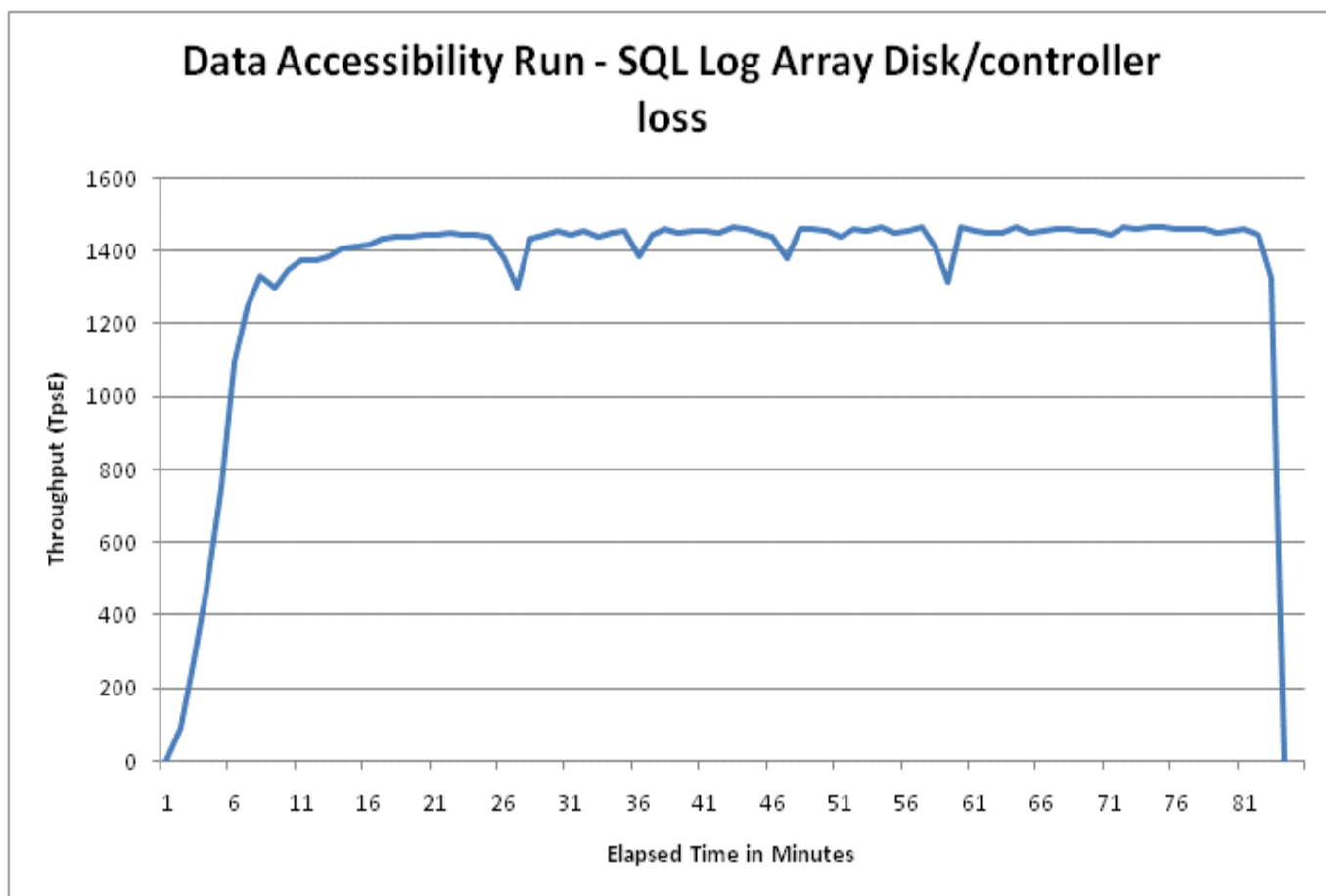


Figure 7.1b Data Accessibility Test Run Graph – SQL Log Array

7.4 Business Recovery Tests

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

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

1. The rows in the Settlement table were counted to establish the initial count of trades present.
2. A run was started using the same profile and configuration as the test run (reported result) and ramped up to 95% of the Reported Throughput.
3. Primary power to both Tier A servers and Tier B server was removed (ie, the plug was pulled), as well as the SQL log enclosure.
4. Drivers noted transaction failures almost immediately, and the driver environment was terminated while the servers were booting back up.
5. Power was restored to Tier A and Tier B servers, and the machines rebooted.
6. After the OS was running, SQL Server was started, which automatically started transaction recovery of the primary TPCE data base. This process reads the transaction log and reapplies all committed transactions and rollback any incomplete transactions. At the end of this process, the database on disc will be logically consistent.
7. Business Recovery when the TPCE database is opened by Microsoft SQL Server 2008 R2 Enterprise Edition. After SQL finished recovery of TPCE and reported that the data base was available, the Trade-Cleanup Transaction was executed.
8. The benchmark was started and ramped up as before to 95% of the Reported Throughput.
9. The benchmark was allowed to run at $\geq 95\%$ for 20 minutes.
10. The driver environment was terminated gracefully. No errors were reported.
11. The rows in the Settlement table were counted again to determine the final number of trades present.
12. The initial count was subtracted from the final count was calculated, and this number was verified to be greater than or equal to the number of Trade-Result transacts as logged during the run.
13. The Consistency scripts were run to verify the data base was logically consistent.
14. The beginning of the first window of time where $\geq 95\%$ for 20 minutes was noted, which marked the end of the Business Recovery interval.

Business Recovery Time was 58 Minutes and 50 Seconds. This is also reported in the Executive Summary.

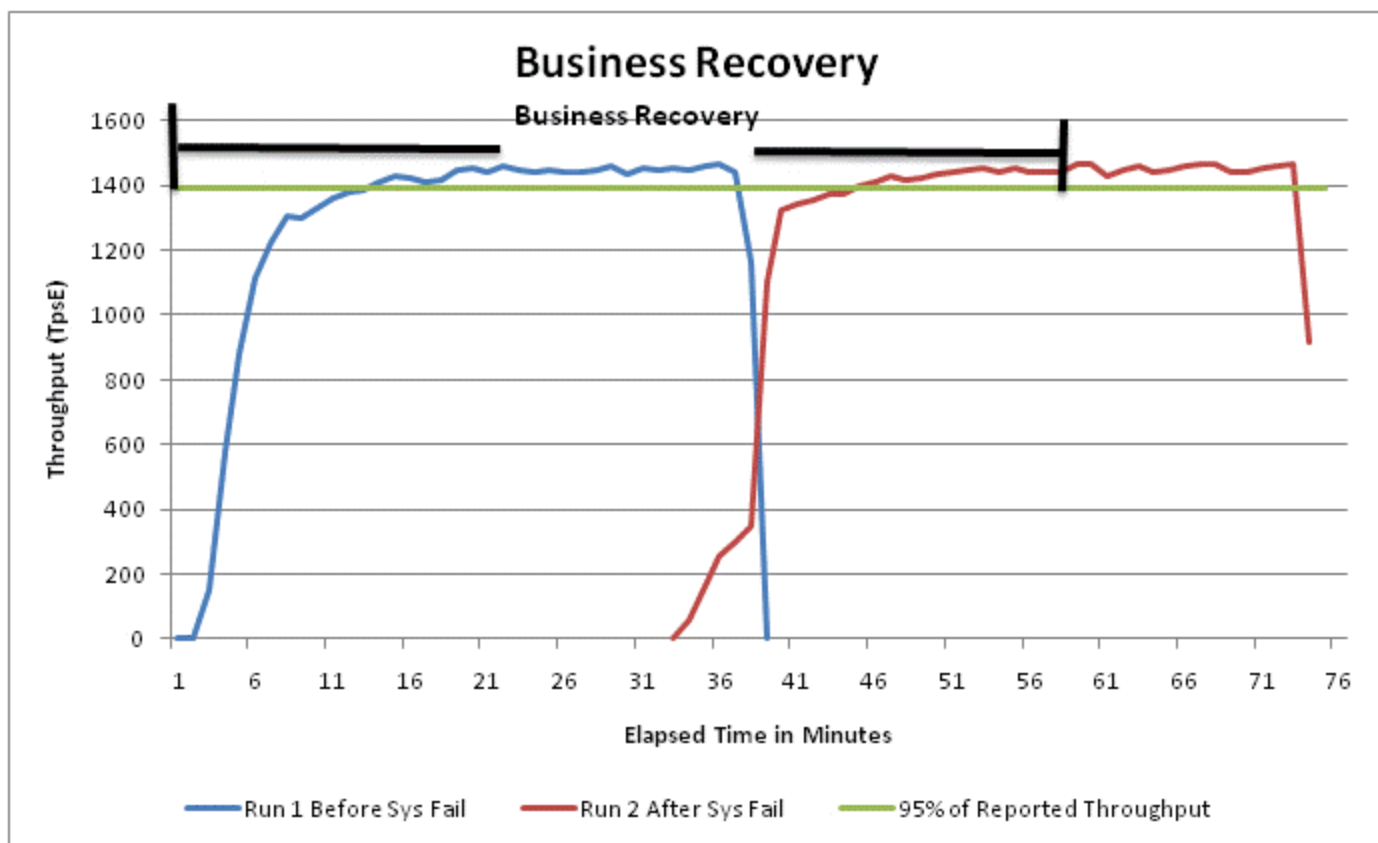


Figure 7.2 The Business Recovery Tests Graph

Clause 8: Pricing Related Items

8.1 60-Day Space

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

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

TPC-E Disk Space Requirements									
Customers Used	800,000	Performance	1,464.12 TpsE						
Broker File Group	Initial Rows	Data (KB)	Index size (KB)	Extra 5% (KB)	Total + 5% (KB)	After run (KB)	Growth (KB)	1 Day Growth (KB)	Req. Add. (KB)
BROKER	8,000	888	760	82	1,730	1,648	-	-	82
CASH_TRANSACTION	12,723,197,728	1,271,117,144	4,773,680	63,794,541	1,339,685,365	1,300,695,240	24,804,416	68,666,758	68,666,758
CHARGE	15	8	8	1	17	16	-	-	1
COMMISSION_RATE	240	16	16	2	34	32	-	-	2
SETTLEMENT	13,829,557,317	686,866,592	2,712,912	34,478,975	724,058,479	713,097,976	23,518,472	65,106,843	65,106,843
TRADE	13,829,646,094	1,540,169,360	820,315,920	118,024,264	2,478,509,544	2,384,372,632	23,887,352	66,128,024	66,128,024
TRADE_HISTORY	33,191,092,378	952,333,512	2,484,768	47,740,914	1,002,559,194	957,543,368	2,725,088	7,543,938	7,543,938
TRADE_REQUEST	-	-	-	-	-	201,456	201,456	557,697	557,697
TRADE_TYPE	5	8	1,032	52	1,092	1,040	-	-	52
Customer File Group									
ACCOUNT_PERMISSION	5,679,775	483,648	3,280	24,346	511,274	487,168	240	665	24,346
CUSTOMER	800,000	135,584	35,280	8,543	179,407	170,888	24	67	8,543
CUSTOMER_ACCOUNT	4,000,000	600,248	79,088	33,967	713,303	679,352	16	45	33,967
CUSTOMER_TAXRATE	1,600,000	33,488	848	1,717	36,053	34,456	120	333	1,717
HOLDING	707,883,095	46,495,376	43,968,776	4,523,208	94,987,360	113,654,992	23,190,840	64,199,850	64,199,850
HOLDING_HISTORY	18,534,033,172	668,266,016	352,435,944	51,035,098	1,071,737,058	1,065,678,888	44,976,928	124,510,886	124,510,886
HOLDING_SUMMARY	39,788,439	2,608,288	14,720	131,150	2,754,158	2,623,040	32	89	89
WATCH_ITEM	80,054,495	2,227,248	8,872	111,806	2,347,926	2,236,392	272	753	111,806
WATCH_LIST	800,000	20,000	16,928	1,846	38,774	36,928	-	-	1,846
Market File Group									
COMPANY	400,000	87,144	24,648	5,590	117,382	111,808	16	45	5,590
COMPANY_COMPETITOR	1,200,000	32,312	26,640	2,948	61,900	58,952	-	-	2,948
DAILY_MARKET	715,140,000	36,984,104	130,744	1,855,742	38,970,590	37,116,064	1,216	3,367	1,855,742
EXCHANGE	4	8	8	1	17	16	-	-	1
FINANCIAL	8,000,000	941,416	3,424	47,242	992,082	945,096	256	709	47,242
INDUSTRY	102	8	24	2	34	32	-	-	2
LAST_TRADE	548,000	51,192	928	2,606	54,726	52,120	-	-	2,606
NEWS_ITEM	800,000	94,026,680	1,696	4,701,419	98,729,795	94,028,416	40	111	4,701,419
NEWS_XREF	800,000	20,000	848	1,042	21,890	20,848	-	-	1,042
SECTOR	12	8	24	2	34	32	-	-	2
SECURITY	548,000	86,520	20,376	5,345	112,241	106,896	-	-	5,345
STATUS_TYPE	5	8	8	1	17	16	-	-	1
Misc File Group									
ADDRESS	1,200,004	69,304	848	3,508	73,660	70,192	40	111	3,508
TAXRATE	320	32	16	2	50	56	8	23	23
ZIP_CODE	14,741	488	72	28	588	560	-	-	28
TOTALS (KB)		5,303,656,648	1,227,063,136	326,535,989	6,857,255,773				
Initial Database Size (MB)		6,377,656	6,228 GB						
Db/Filegroups	LUN Count	Partition Size(KB)	MB allocated	MB Loaded	MB Required				
fixed_fg	8	20,971,520	163,840	132,966	139,614	OK			
growing_fg	8	874,512,384	6,832,128	6,244,690	6,632,107	OK			
					MB Available				
Settlements	15,231,814				224,248				
Initial Growing Space (MB)	6,244,690								
Final Growing Space (MB)	6,384,636	Data LUNS	4	1	Initial Log size (MB)	110,398	Log LUNS	2	
Delta (MB)	139,946	Disks per LUN	12	5	Final Log size (MB)	292,744	Log Disks	12	
Data Space per Trade (MB)	0.00918774	Disk Capacity (MB)	476,160	476,160	Log Growth (MB)	182,346	Disk Capacity (MB)	69,898	
1 Day Data Growth (MB)	387,416	RAID5 Overhead	8.4%	20.0%	Log Growth/trade (MB)	0.01197139	RAID10 Overhead	50%	
60-Day Overflow (MB)	22,633,302	Total Space (MB)	20,935,803	1,904,640	1 Day log space (MB)	504,793	Log Space (MB)	788,784	
			22,840,443	OK					

8.1 Attestation Letter



Benchmark Sponsor: Jason Goertz
Senior Performance Engineer
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c/o Microsoft Corporation
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Redmond, WA 98052

June 18, 2010

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

Platform: **HP ProLiant BL685c G7 Blade Server**
Database Manager: **Microsoft SQL Server 2008 R2 Enterprise Edition**
Operating system: **Microsoft Windows Server 2008 R2 Enterprise x64 Edition**

The results were:

CPU's Speed	Memory	Disks	Trade-Result 90% Response Time	tpsE
Tier B, Server: <u>HP ProLiant BL685c G7 Blade Server</u>				
4 x AMD 6174 (2.2GHz, 12-core)	512 GB (2 x 6MB L3)	2 x 72 GB SAS (int.) 4 x 1.726TB Violin Memory Appliances 24 x 72 GB 15K SAS 53 x 500GB 7.5K SAS	0.11 Seconds	1,464.12
Tier A, Clients: 4 x <u>HP ProLiant BL450cG6 Blade</u>				
2 x Intel Xeon E5520 (2.26 GHz, 4-core)	8 GB (8 MB L2)	2x 146 GB SAS	n/a	n/a

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

The following verification items were given special attention:

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- All EGen components were verified to be v1.11.0.
- The transactions were correctly implemented.
- The database was properly scaled and populated for 800,000 customers.
- The mandatory network between the driver and the SUT was configured.
- The ACID properties were met.
- Input data was generated according to the specified percentages.
- The reported response times were correctly measured.
- All 90% response times were under the specified maximums.
- The measurement interval was representative of steady state conditions.
- The reported measurement interval was 120 minutes.
- The implementation used Redundancy Level 1.
- The Business Recovery Time of 0:58:50 was correctly measured.
- The 60 day storage requirement was correctly computed and configured.
- The system pricing was verified for major components and maintenance.

Additional Audit Note:

The connectivity of the 500GB disk drives used for the required 59 days of database growth was verified during a separate run from the one used to report performance. This other run produced a performance of 0.6 tpsE greater than the reported performance.

Respectfully Yours,



François Raab, President

Clause 9: Supporting Files

9.1 Supporting Files

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

Appendix A: Third Party Pricing Quotes/Pricing

Microsoft

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

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

Microsoft

June 16, 2010

Hewlett-Packard
Jason Goertz
One Microsoft Way
Redmond, WA 98077

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

All pricing shown is in US Dollars (\$).

Part Number	Description	Unit Price	Quantity	Price
810-07580	SQL Server 2008 R2 Enterprise Edition <i>Per Processor License Open Program - Level C Unit Price reflects a 33% discount from the retail unit price of \$28,749.</i>	\$19,188	4	\$76,752
P72-04217	Windows Server 2008 R2 Enterprise Edition <i>Server License with 25 CALs Open Program - Level C Unit Price reflects a 43% discount from the retail unit price of \$3,999.</i>	\$2,280	1	\$2,280
P73-04980	Windows Server 2008 R2 Standard Edition <i>Server License with 5 CALs Open Program - Level C Unit Price reflects a 31% discount from the retail unit price of \$1,029.</i>	\$711	4	\$2,844
N/A	Microsoft Problem Resolution Services <i>Professional Support (1 Incident).</i>	\$259	1	\$259

All Microsoft products listed above are currently orderable and available through Microsoft's normal distribution channels. A list of Microsoft's resellers can be found at the Microsoft Product Information Center at <http://www.microsoft.com/products/info/render.aspx?view=22&type=how>

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

This quote is valid for the next 90 days.

Reference ID: TPCE_g3wOpiq6ZAtgdnQQtWbatNjU7f+RiCyr_V1.0.0.



Sales Quote

Violin Memory, Inc.
 27 Garcia Ave.
 Mountain View, CA 94043
 E. Casey Roche III
 Ph: 1-888-9VIOLIN (984-6546) x10
 Fax: 1 732-218-6077
[Email: casey@violin-memory.com](mailto:casey@violin-memory.com)
www.violin-memory.com

To: Jason Goertz
 1 Microsoft Way
 Redmond, WA 98052
 425-882-8080
b-jasgoe@microsoft.com

Date: June 17, 2010
 Quote #: ECR-001
 Expiration: Valid for
 Date: 30 days

Project: BL685c-TPC-E-8M

Payment Terms: Net 30 days

Qty	Prod Code	Description	List Price	Discount	Extended Price
Violin Silicon Storage Shelf					
4	V-3202	V-3200 Chassis with PCIe 20 Gbit/s Interface 2.6TB Flash (21 x VIMM-128GSLC) Redundant AC supplies PCIe8 Interface Card and Cable	\$ 75,000.00	33%	\$ 201,000.00
Storage Interface					
2	V-IF-8GFCx4	Violin Network Head: Quad 4/8 Gbit/s Fiber Channel Interfaces	\$ 12,000.00	33%	\$ 16,080.00
Maintenance					
1	VS-SW	Violin Standard Warranty 3 Years Hardware: 24/7 support with 4-hour response. No specific software version requirements	0%	0%	\$ -
Subtotal					\$ 217,080.00
Sales Tax					-
Total					\$ 217,080.00
Shipping, Handling and Insurance					\$ -
Sales Tax					0.000%
Total					\$ 217,080.00

Availability: Within 8 weeks after receipt of order.

Shipping: FOB NJ, Shipping by 5 day ground within USA

Availability: Within 8 weeks after receipt of order.

Shipping: FOB NJ, Shipping by 5 day ground within USA

Shipping Details [Contact] (email), [phone]
 [Address]

Thank You For Your Business!

33 Wood Avenue South, 3rd Floor, Iselin, NJ 08830 Ph: 1-888-9VIOLIN (984-6546) Email: sales@violin-memory.com www.violin-memory.com



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[As low as \\$1.16](#)
 - [7ft Black Cat 6 Patch Cable, Molded](#)
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7ft Green Cat 6 Patch Cable, Molded

As low as \$1.16



Quantity	Price
1 - 2	\$1.70
3 - 4	\$1.67
5 - 7	\$1.63
8 - 11	\$1.61
12 - 15	\$1.59
16 - 19	\$1.58
20 - 29	\$1.57
30 - 39	\$1.55
40 - 49	\$1.54
50 - 99	\$1.52
100 - 199	\$1.34
200 - 299	\$1.31
300 - 499	\$1.27
500 - 999	\$1.19
1000 +	\$1.16

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Meets or exceeds the ANSI/TIA/EIA-568-B.2-1 standard for CAT 6 CMR, communication riser cable, and certified by UL, Underwriters Laboratories on each end and boots to protect the tab of the RJ45 connector from being snagged. Packaged individually in labeled bags.

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Mfg: Abergetty

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