NEC

TPC Benchmark™ E
Full Disclosure Report

NEC Express5800/A1080a-E

with Microsoft® SQL Server® 2008 R2 Enterprise Edition
and
Microsoft® Windows Server® 2008 R2 Enterprise Edition
with Service Pack 1

Third Edition
29-June-2011

Abstract

This report documents the compliance of NEC Corporation's TPC Benchmark[TM] E tests on the NEC Express5800/A1080a-E client/server system with version 1.12.0 of the TPC Benchmark[TM] E Standard Specification. Two clients (NEC Express5800/R120b-2) were used as the Tier-A clients.

The operating system and the DBMS used on the server were Microsoft® Windows Server® 2008 R2 Enterprise Edition with Service Pack 1 and Microsoft® SQL Server® 2008 R2 Enterprise Edition. The operating system on the clients was Microsoft® Windows Server® 2008 Standard Edition.

Two standard metrics, transaction-per-second-E(tpsE) and price per tpsE($/tpsE) are reported, in accordance with the TPC Benchmark[TM] E Standard. The independent auditor's report by Doug Johnson appears at the end of this report.

TPC Benchmark[TM] E Metrics

The standard TPC Benchmark[TM] E metrics, tpsE (transactions per second), price per tpsE are reported.
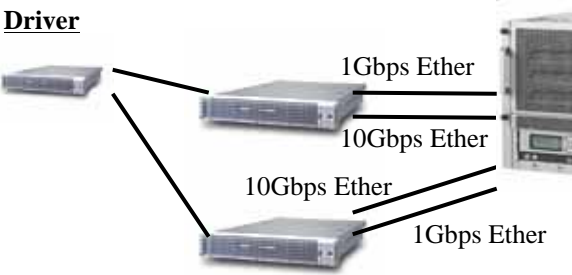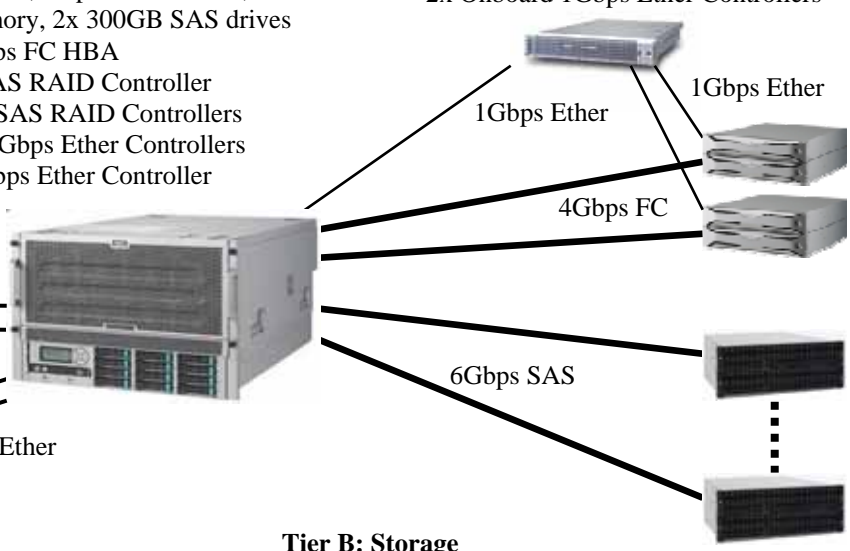
System	Software	Total System Cost	tpsE	$ USD /tpsE	Availability Date
NEC Express5800 /A1080a-E	Microsoft® SQL Server® 2008 R2 Enterprise Edition Microsoft® Windows Server® 2008 R2 Enterpirse Edition with Service Pack 1	$1,207,318 (USD)	4200.61	$287.42	31-August-2011

Executive Summary

The following pages contain executive summary of results for this benchmark.

Auditor

The benchmark configuration, environment and methodology were audited by Doug Johnson of InfoSizing, Inc. to verify compliance with the relevant TPC specifications.

NEC	NEC Express5800/A1080a-E	TPC-E 1.12.0 TPC Pricing 1.6.0
		Report Date : 28-Apr-2011 Revised Date : 29-Jun-2011

TPC-E Throughput	Price/Performance	Availability Date	Total System Cost
4200.61 tpsE	**$287.42** **USD per tpsE**	**31-August-2011**	**$1,207,318USD**

Database Server Configuration

Operating System	Database Manager	Processors/Cores/Threads	Memory
Microsoft® Windows Server® 2008 R2 Enterprise Edition with Service Pack 1	**Microsoft® SQL Server® 2008 R2 Enterprise Edition**	**8 / 80 / 160**	**2048GB**

Tier B: System Console
1x NEC Express5800/R120b-2
1x Intel® Xeon® processor X5675
3.06GHz, 12MB L3 cache,
6 processor cores, 12 threads
8GB Memory
1x 300GB SAS drive
2x Onboard 1Gbps Ether Controllers

Tier B: Server
NEC Express5800/A1080a-E
8x Intel® Xeon® processor E7-8870 2.40GHz,
 30MB L3 cache, 10 processor cores, 20 threads
2048GB Memory, 2x 300GB SAS drives
1x 2port 8Gbps FC HBA
1x Internal SAS RAID Controller
11x External SAS RAID Controllers
2x Onboard 1Gbps Ether Controllers
1x 2port 10Gbps Ether Controller

Driver

1Gbps Ether

1Gbps Ether

4Gbps FC

1Gbps Ether

10Gbps Ether

10Gbps Ether

1Gbps Ether

6Gbps SAS

Tier A: Client
2x NEC Express5800/R120b-2
2x Intel® Xeon® processor X5675 3.06GHz,
12MB L3 cache, 6 processor cores, 12 threads
8GB Memory
1x 300GB SAS drive
2x Onboard 1Gbps Ether Controllers
1x 2port 1Gbps Ether Controller

Tier B: Storage
NEC Storage D3-10
2x NEC Storage D3-10 Controllers
5x NEC Storage D3-10 SAS/SATA Disk Enclosures
76x 147GB 15k rpm SAS drives
Dot Hill Systems Storage
22x Dot Hill 3120 JBODs
399x 64GB SSD SATA drives

Initial Database Size	Redundancy Level : 1	Storage
19,267 GB	**RAID10 : Log / RAID5 : Data**	**76 x 147GB 15K HDD** **399 x 64GB SSD**

NEC

NEC Express5800/A1080a-E

TPC-E 1.12.0
TPC Pricing 1.6.0

Report Date : 28-Apr-2011
Revised Date : 29-Jun-2011

Available Date
31-August-2011

Description	Part Number	Third Party Brand	Pricing	Unit Price	Qty	Extended Price	3-yr Mnt. Price
Server Hardware							
NEC Express5800/A1080a-E							
A1080a-E Base Unit (1x MGM card, 2x power module included)	NE3100-101H	NEC	1	12,499	1	12,499	
Processor Memory Module (PMM) Xeon E7-8870 All Cores Activated	NE3102-011	NEC	1	9,499	8	75,992	
32GB Memory (1067MHz 16GB DIMM x 2)	NE3103-014	NEC	1	2,599	64	166,336	
6Gbps SAS RAID Controller for Embedded HDD/SSD	NE3104-001	NEC	1	499	1	499	
300GB 10krpm 6Gbps SAS HDD	NE3105-104	NEC	1	399	2	798	
2Port 8G FC HBA	NE3108-104	NEC	1	2,499	1	2,499	
MegaRAID SAS 9280-8e	Q24-FR000000001948	NEC	1	795	11	8,745	
LSI MegaRAID FastPath software	Q24-FR000000002102	NEC	1	150	11	1,650	
2port 10GBASE	NE3108-004	NEC	1	999	1	999	
Optical Module for 10G SR	NE3108-005	NEC	1	159	2	318	
Embedded DVD-ROM	NE3100-201	NEC	1	99	1	99	
Power Module	NE3100-301	NEC	1	799	2	1,598	
Power Cable for 200V	NE3107-001	NEC	1	69	4	276	
PDU L6-30P	NE3107-101	NEC	1	599	2	1,198	
Installation	SP-GX00-STIN001	NEC	1	5,000	1	5,000	
Microsoft Windows Server 2008 R2 Enterprise Edition w/25 user CAL	062-03622-000	NEC	1	3,999	1	3,999	
Platinum Warranty (Yr 1,2 & 3)	UPPLT-A1080a8-3Y	NEC	1	6,799	1		6,799
NEC Express5800/R120b-2 (for System Maintenance)							
Model R120b-2 (1x X5675, MEM less, ODD/HDD less)	N8100-1712F	NEC	1	4,850	1	4,850	
CPU kit (X5675)	N8101-487F	NEC	1	2,720	1	2,720	
Additional 4GB Memory Module	N8102-373F	NEC	1	195	2	390	
RAID Controller (256MB, RAID0/1)	N8103-129	NEC	1	410	1	410	
300GB HDD (SAS 10k rpm, 2.5")	N8150-301	NEC	1	365	1	365	
External DVD-ROM (USB)	N8160-85	NEC	1	215	1	215	
3 Years of Upgraded Platinum Warranty for the Express 5800/100 Series	UPPLT-GP100-2U-3Y	NEC	1	840	1		840
NEC AccuSync AS171-BK 17" LCD (+2 spares)	AS171-BK	NEC	3	128	4	512	
					Subtotal	**291,967**	**7,639**
Disk Subsystem							
NEC Storage D3-10							
NEC Storage D3-10 Base Model	850193310	NEC	1	6,834	2	13,668	
3 Years of Platinum Warranty Upgrade for D3-10 Base Model	UPPT850193310	NEC	1	1,025	2		2,050
SAS/SATA Disk Enclosure w/NEC logo	NF5021-SE60E-000	NEC	1	2,749	5	13,745	
3 Years of Platinum Warranty Upgrade for 3Gbps Disk Enclosure	UPPTNF5021SE60E	NEC	1	412	5		2,060
SAS disk drive (15k rpm/147GB) (+10% spares)	NF5021-SM624E	NEC	1	311	84	26,124	
3 Years Platinum Warranty Upgrade SAS Disk Drive(15krpm/147GB/3Gbps)	UPPTNF5021SM624E	NEC	1	51	84		4,284
1 yr of Platinum SW Maintenance for Base SW	UFSD0M-310000AMAS	NEC	1	520	6		3,120
Dot Hill Systems Storage							
3120,2RM,NO DRIVES,AC	D3120X000000DA	DotHill	4	3,467	22	76,274	
DRIVE, 64GB, SLC, SATA, SFF - FRU (+10% spares)	PFRUKF43-01	DotHill	4	1,194	439	524,166	
DD,AMS SFF BLANK, 48 BULK PACK	PFRUKF31-48	DotHill	4	864	2	1,728	
DD,AMS SFF BLANK,FRU,PKG	PFRUKF31-01	DotHill	4	18	33	594	
RACK MOUNT KIT	FHDW018-02	DotHill	4	120	22	2,640	
3120 JBOD, 7x24x4 Onsite	DS3120XPA4D1SW0	DotHill	4	2,046	22		45,012
HP Serial Attached SCSI (SAS) external cable - 6.6 ft (+10% spares)	407339-B21	HP	3	148	13	1,924	
UPS 3kVA	050-02424-000	NEC	1	1,799	24	43,176	
42U Rackframe	050-02378-001	NEC	1	1,799	3	5,397	
10 meter Multimode LC/LC Duplex Fiber Optic cable (+10% spares)	F2F202LL-10M	Belkin	3	39	4	156	
					Subtotal	**709,592**	**56,526**
Server Software							
Microsoft SQL Server 2008 R2 Enterprise Edition	810-08527	Microsoft	2	19,188	8	153,504	259
					Subtotal	**153,504**	**259**

continued on the next page

		TPC-E 1.12.0
		TPC Pricing 1.6.0
NEC	**NEC Express5800/A1080a-E**	Report Date : 28-Apr-2011
		Revised Date : 29-Jun-2011
		Available Date
		31-August-2011

Client Hardware							
NEC Express5800/R120b-2							
Model R120b-2 (1x X5675, MEM less, ODD/HDD less)	N8100-1712F	NEC	1	4,850	2	9,700	
CPU kit (X5675)	N8101-487F	NEC	1	2,720	2	5,440	
Additional 4GB Memory Module	N8102-373F	NEC	1	195	4	780	
300GB HDD (SAS 10k rpm, 2.5")	N8150-301	NEC	1	365	2	730	
RAID Controller (256MB, RAID0/1)	N8103-129	NEC	1	410	2	820	
10GBASE Adapter (SFP+/2ch)	N8104-128	NEC	1	710	2	1,420	
SFP+ Module (10G-SR)	N8104-129	NEC	1	155	2	310	
3 Years of Upgraded Platinum Warranty for the Express 5800/100 Series	UPPLT-GP100-2U-3Y	NEC	1	840	2		1,680
NEC AccuSync AS171-BK 17" LCD (+2 spares)	AS171-BK	NEC	3	128	4	512	
42U Rackframe	050-02378-001	NEC	1	1,799	1	1,799	
Cat5e RJ45 UTP Patch Cable 25ft (+10% spares) for NEC Storage Manager	N001-025-BL	Tripp Lite	3	7	5	35	
Cat5e Crossover Cable 7ft (+2 spares)	N010-007-GY	Tripp Lite	3	5	7	35	
					Subtotal	**21,581**	**1,680**
Client Software							
Windows Server 2008 Standard Edition (x86)*	P73-04165	Microsoft	2	711	3	2,133	(Included)
					Subtotal	**2,133**	**0**
Infrastructure							
3m Multimode Duplex Fiber Cable (+10% spares)	LCLC50G-03M-CDW	Belkin	3	40	4	160	
5-Port 10/100/1000 Gigabit Switch (+2 spares) for NEC Storage Manager	SD2005	Cisco	3	55	3	165	
					Subtotal	**325**	**0**
					TOTAL	1,179,101	66,104
NEC Large Volume Discount**				-10%		-41,456	3,569

Notes:
Pricing: 1-NEC Contact: 1-866-632-3226, 2-Microsoft, 3-CDW, 4-Promark TECHNOLOGY

* Qty of Windpws Server 2008 Standard Edition includes the license of the DB server's mainetenance Console
**10% discount was based on the overall value of the specific components from NEC in this single
quotation except 3-yr Mnt. Price for Disk Subsystem
Discount for similarly sized configurations will be similar to those quoted here but may be vary
based on the components in quotation
Results and methodology audited by Doug Johnson of InfoSizing, Inc. (www.sizing.com)

3-Yr. Cost of Ownership: **$1,207,318**

tpsE Throughput: **4200.61**

$ / tpsE **$287.42**

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 reflects 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 the TPC at pricing@tpc.org. Thank you.

Numerical Quantities Summary				
Reported Throughput : 4200.61 tpsE	**Configured Customers : 2,400,000**			
Response Times (in seconds)	**Minimum**	**Average**	**90th %tile**	**Maximum**
Broker Volume	0.00	0.04	0.08	2.47
Customer Position	0.00	0.03	0.06	2.66
Market Feed	0.00	0.02	0.05	7.69
Market Watch	0.00	0.04	0.09	2.67
Security Detail	0.00	0.01	0.03	2.63
Trade Lookup	0.00	0.11	0.19	14.42
Trade Order	0.00	0.06	0.13	2.70
Trade Result	0.00	0.07	0.16	2.82
Trade Status	0.00	0.02	0.04	2.63
Trade Update	0.01	0.12	0.20	14.42
Data Maintenance	0.00	0.02		0.26
Transaction Mix		**Transaction Count**	**Mix %**	
Broker Volume		14,819,500	4.900%	
Customer Position		39,316,948	13.000%	
Market Feed		3,024,472	1.000%	
Market Watch		54,438,677	18.000%	
Security Detail		42,341,596	14.000%	
Trade Lookup		24,194,374	8.000%	
Trade Order		30,545,932	10.100%	
Trade Result		30,244,395	10.000%	
Trade Status		57,463,560	19.000%	
Trade Update		6,048,548	2.000%	
Data Maintenance		120		
Test Duration and Timings				
Ramp-up Time		1:10:00		
Measurement Interval		2:00:00		
Business Recovery Time		2:47:24		
Total Number of Transactions Completed in Measurement Interval		302,438,002		

PREAMBLE

Introduction

TPC Benchmark^{TM} 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.

Comment: While separated from the main text for readability, comments are a part of the standard and must be enforced.

Clause 1 : General Items

Order and Titles

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

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

Executive Summary Statement

The TPC Executive Summary Statement must be included near the beginning of the Report. An example of the Executive Summary Statement is presented in Appendix B. The latest version of the required format is available from the TPC Administrator.

The TPC Executive Summary Statement is included at the beginning of this report.

Benchmark Sponsor

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

This benchmark test was sponsored by NEC Corporation.

Configuration Diagrams

Diagrams of both Measured and Priced Configurations must be reported in the Report, accompanied by a description of the differences. This includes, but is not limited to:

- *Number and type of processors, number of cores and number of threads.*
- *Size of allocated memory, and any specific mapping/partitioning of memory unique to the test.*
- *Number and type of disk units (and controllers, if applicable).*
- *Number of channels or bus connections to disk units, including their protocol type.*
- *Number of LAN (e.g. Ethernet) connections, including routers, workstations, etc., that were physically used in the test or incorporated into the pricing structure.*
- *Type and the run-time execution location of software components (e.g. DBMS, client, processes, transaction monitors, software drivers, etc.).*

Measured Configuration

The following figure represents the measured configuration.

Figure1.1: NEC Express5800/A1080a-E, Measured Configuration Diagram

Tier B: System Console
1x NEC Express5800/R120b-2
1x Intel® Xeon® processor X5675
3.06GHz, 12MB L3 cache,
6 processor cores, 12 threads
8GB Memory,
1x 300GB SAS drive
2x Onboard 1Gbps Ether Controllers

Tier B: Server
NEC Express5800/A1080a-E
8x Intel® Xeon® processor E7-8870 2.40GHz,
 30MB L3 cache, 10 processor cores, 20 threads
2048GB Memory, 2x 300GB SAS drives
1x 2port 8Gbps FC HBA
1x Internal SAS RAID Controller
11x External SAS RAID Controllers
2x Onboard 1Gbps Ether Controllers
1x 2port 10Gbps Ether Controller

Driver

1Gbps Ether

1Gbps Ether

4Gbps FC

1Gbps Ether

10Gbps Ether

10Gbps Ether

1Gbps Ether

6Gbps SAS

6Gbps SAS

Tier A: Client
2x NEC Express5800/R120b-2
2x Intel® Xeon® processor X5675 3.06GHz,
12MB L3 cache, 6 processor cores, 12 threads
8GB Memory
1x 300GB SAS drive
2x Onboard 1Gbps Ether Controllers
1x 2port 1Gbps Ether Controller

Tier B: Storage
NEC Storage D3-10
2x NEC Storage D3-10 Controllers
7x NEC Storage D3-10 SAS/SATA Disk Enclosures
100x 147GB 15k rpm SAS drives
Dot Hill Systems Storage
22x Dot Hill 3120 JBODs
399x 64GB SSD SATA drives
NEC Disk Expansion Unit
12x NEC Disk Expansion Units
144x 147GB 15k rpm SAS drives

Priced Configuration

The following figure represents the priced configuration.

Figure1.2: NEC Express5800/A1080a-E, Priced Configuration Diagram

Tier B: System Console
1x NEC Express5800/R120b-2
1x Intel® Xeon® processor X5675
3.06GHz, 12MB L3 cache,
6 processor cores, 12 threads
8GB Memory
1x 300GB SAS drive
2x Onboard 1Gbps Ether Controllers

Tier B: Server
NEC Express5800/A1080a-E
8x Intel® Xeon® processor E7-8870 2.40GHz,
 30MB L3 cache, 10 processor cores, 20 threads
2048GB Memory, 2x 300GB SAS drives
1x 2port 8Gbps FC HBA
1x Internal SAS RAID Controller
11x External SAS RAID Controllers
2x Onboard 1Gbps Ether Controllers
1x 2port 10Gbps Ether Controller

Driver

1Gbps Ether

1Gbps Ether

4Gbps FC

1Gbps Ether

10Gbps Ether

10Gbps Ether

1Gbps Ether

6Gbps SAS

Tier A: Client
2x NEC Express5800/R120b-2
2x Intel® Xeon® processor X5675 3.06GHz,
12MB L3 cache, 6 processor cores, 12 threads
8GB Memory
1x 300GB SAS drive
2x Onboard 1Gbps Ether Controllers
1x 2port 1Gbps Ether Controller

Tier B: Storage
NEC Storage D3-10
2x NEC Storage D3-10 Controllers
5x NEC Storage D3-10 SAS/SATA Disk Enclosures
76x 147GB 15k rpm SAS drives
Dot Hill Systems Storage
22x Dot Hill 3120 JBODs
399x 64GB SSD SATA drives

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). 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. This includes, but is not limited to:

- · *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.*

Driver

The driver is not included in the priced configuration or SUT. In this benchmark, the NEC Express5800/R120b-2 was used. The driver machine was configured with IP addresses of 10.10.1.250 and 10.10.2.250.

Tier-A installation / configuration

The NEC Express5800/R120b-2 has 2x Intel® Xeon® processor X5675, 8GB of Memory, 1x 300GB SAS drive. The 1x 2port 10Gbps Ether Controller is installed to the PCI-Express slot of the NEC Express5800/R120b-2. Tier-A consists of 2x NEC Express5800/R120b-2, all of which have the same hardware configuration. Each Tier-A machine is connected to the database server with a 10GbE cable and a GbE cable, and to the driver system with a GbE cable.

Figure1.3: Rear view of each Client (NEC Express5800/R120b-2)
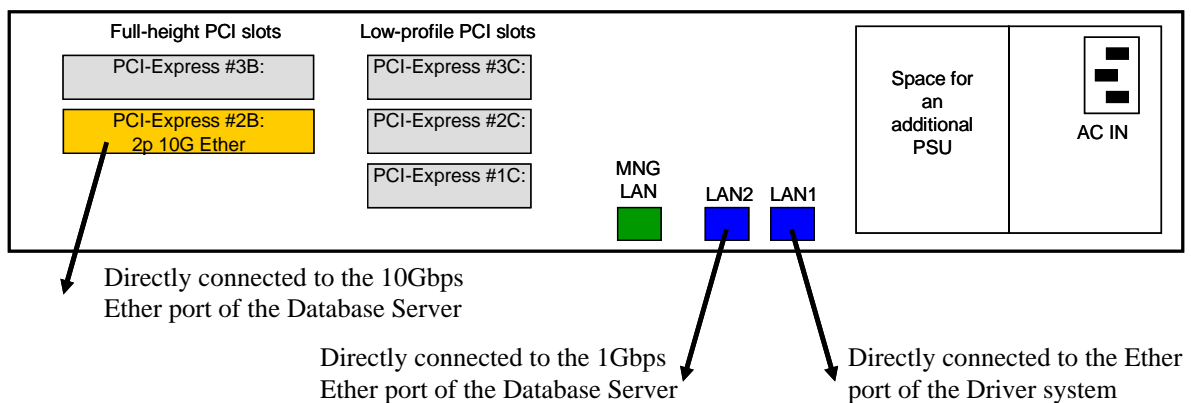
Tier-B installation / configuration

Tier-B hardware consists of one NEC Express5800/A1080a-E as the database server, two NEC Storage D3-10 and twenty-two Dot Hill 3120 as the Database Array and one NEC Express5800/R120b-2 as the System Console of the NEC Express5800/A1080a-E and the NEC Storage D3-10.

The System Console (NEC Express5800/R120b-2) has 1x Intel® Xeon® processor X5675, 8GB of Memory, 1x 300GB SAS drive. The machine is directly connected to the Management LAN port of the Database Server, and connected to D3-10 controllers via 1Gbps Ether switch.

Figure1.4: Rear view of the System Console (NEC Express5800/R120b-2)
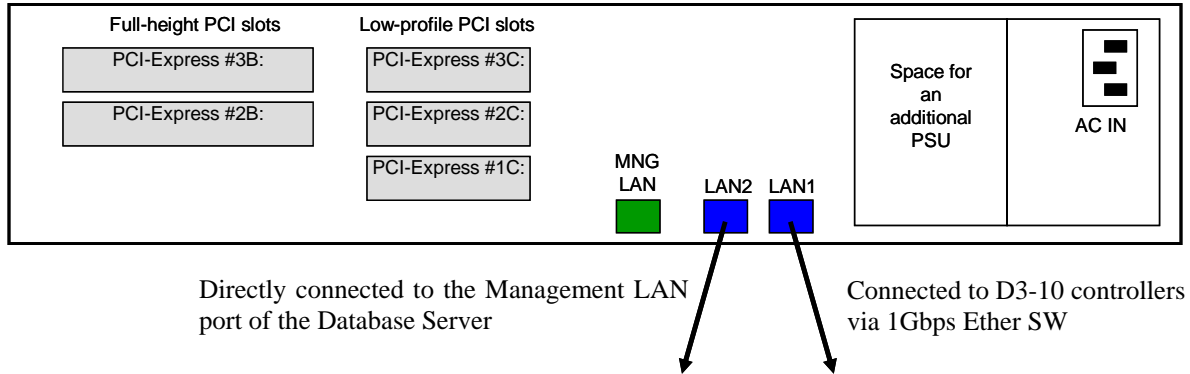
The NEC Express5800/A1080a-E has 8x Intel® Xeon® processor E7-8870 2.40GHz, 30MB L3 cache, 128x 16GB DIMMs, 2x Onboard 1Gbps Ether Controllers, 1x Internal SAS RAID Controller and 2x 300GB SAS drive with Microsoft® Windows Server® 2008 R2 Enterprise Edition with Service Pack 1.

The 1x 2port 8Gbps FC HBA, 11x External SAS RAID Controllers and 1x 2port 10Gbps Ether Controller are installed to the PCI-Express slots of the NEC Express5800/A1080a-E. The FC HBA and External SAS RAID Controllers are connected to the Database Array as follows:

Management LAN	to the system console
Onboard LAN1	to 1Gbps Ether port of client #1
Onboard LAN2	to 1Gbps Ether port of client #2
PCI-Express #2: External SAS RAID Controller	to 3120 JBOD
PCI-Express #3: External SAS RAID Controller	to 3120 JBOD
PCI-Express #4: External SAS RAID Controller	to 3120 JBOD
PCI-Express #5: External SAS RAID Controller	to 3120 JBOD
PCI-Express #6: External SAS RAID Controller	to 3120 JBOD
PCI-Express #7: 2port 10Gbps Ether Controller	#0 to 10Gbps Ether port of client #1
	#1 to 10Gbps Ether port of client #2
PCI-Express #8: External SAS RAID Controller	to 3120 JBOD
PCI-Express #9: External SAS RAID Controller	to 3120 JBOD
PCI-Express #10: External SAS RAID Controller	to 3120 JBOD
PCI-Express #11: 2port 8Gbps FC HBA	#0 to D3-10 Controller
	#1 to D3-10 Controller
PCI-Express #12: External SAS RAID Controller	to 3120 JBOD
PCI-Express #13: External SAS RAID Controller	to 3120 JBOD
PCI-Express #14: External SAS RAID Controller	to 3120 JBOD

Figure1.5: Rear view of the Server (NEC Express5800/A1080a-E)

Directly connected to
the Ether port of the System Console

PCI-Express #1 : Int SAS RAID

MNG LAN

LAN2 LAN1

PCI-Express #2 : Ext SAS RAID

PCI-Express #3 : Ext SAS RAID

PCI-Express #4 : Ext SAS RAID

PCI-Express #5 : Ext SAS RAID

PCI-Express #6 : Ext SAS RAID

PCI-Express #7 : 2p 10G Ether

PCI-Express #8 : Ext SAS RAID

PCI-Express #9 : Ext SAS RAID

PCI-Express #10: Ext SAS RAID

PCI-Express #11: 2p 8G FC

PCI-Express #12: Ext SAS RAID

PCI-Express #13: Ext SAS RAID

PCI-Express #14: Ext SAS RAID

AC IN

AC IN

AC IN

AC IN

Directly connected to
the 1Gbps Ether port
of Client#1

Directly connected to
the 1Gbps Ether port
of Client#2

Directly connected to
the 10Gbps Ether port
of Client#1

Directly connected to
the 10Gbps Ether port
of Client#2

Figure1.6: Overview of the whole system connections
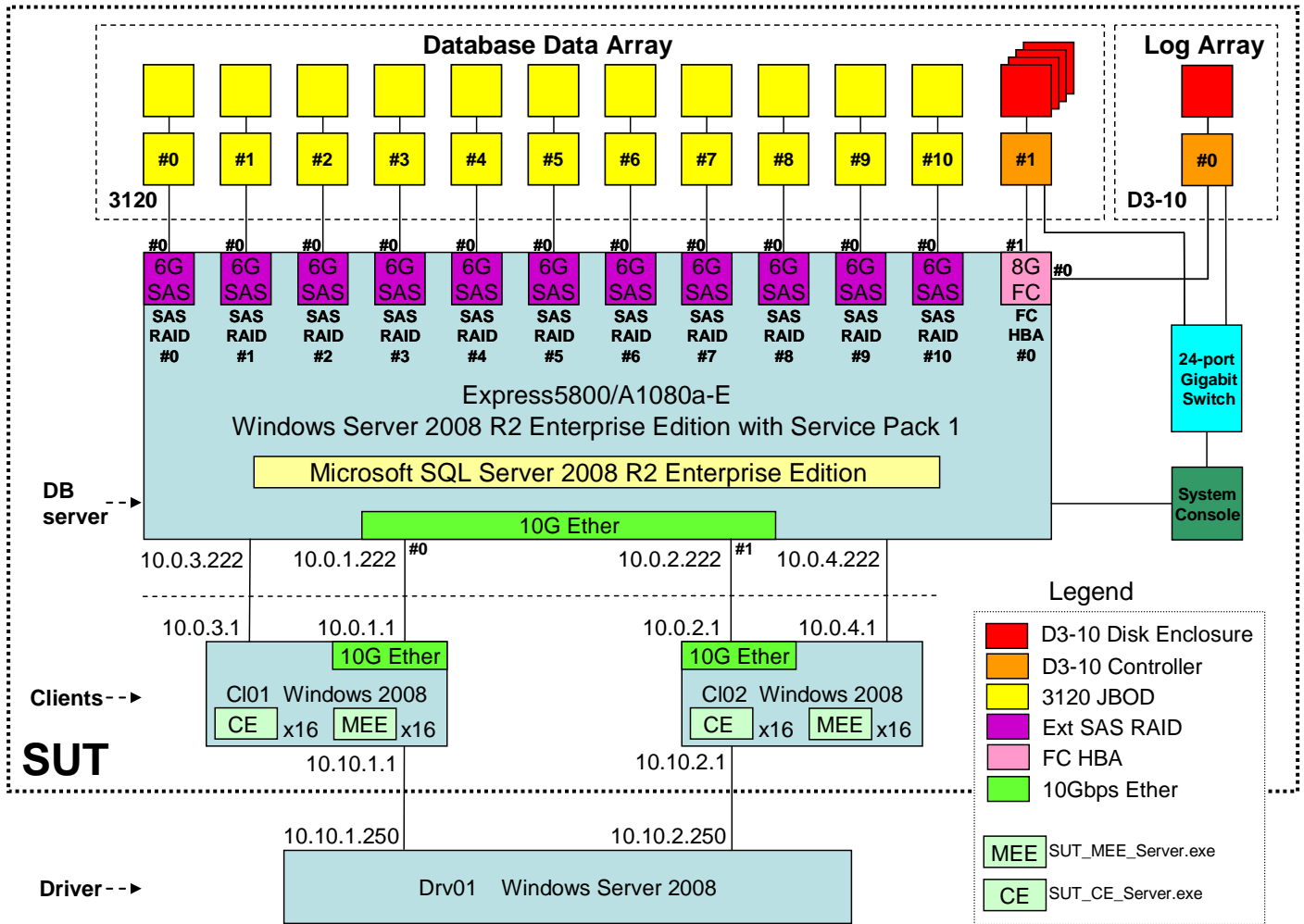
Connect NEC Storage D3-10 controllers to disk enclosures and Dot Hill 3120 JBODs

The Database Array consists of two types of disk array system. One is Database Data Array and the other is Log Array.

Database Data Array has one NEC Storage D3-10 controller, four NEC Storage D3-10 disk enclosures and twenty-two Dot Hill 3120 JBODs. The D3-10 controller is connected to the 8Gbps FC HBA of the Database Server. The 3120 JBODs are connected to the 6Gbps SAS of the Database Server.

Log Array has one NEC Storage D3-10 controller and one NEC Storage D3-10 disk enclosure. The controller is connected to the 8Gbps FC HBA of the Database Server.

See Figure 1.7 to check the connection diagram of the NEC Storage D3-10 controller and the disk enclosure for Log Array.

Figure1.7: Connection diagram of the NEC Storage D3-10 for Log Array

DP-out DP-In   DP-out DP-In

DP1 DP0   LAN MNT   DP1 DP0   LAN MNT
        HP1 HP0   PWR.   HP1 HP0   PWR.

controller subunit#1   controller subunit#0

Directly connected to the 8Gbps HBA
of the Database Server directly

Connected to the System
Console via 1Gbps Ether SW
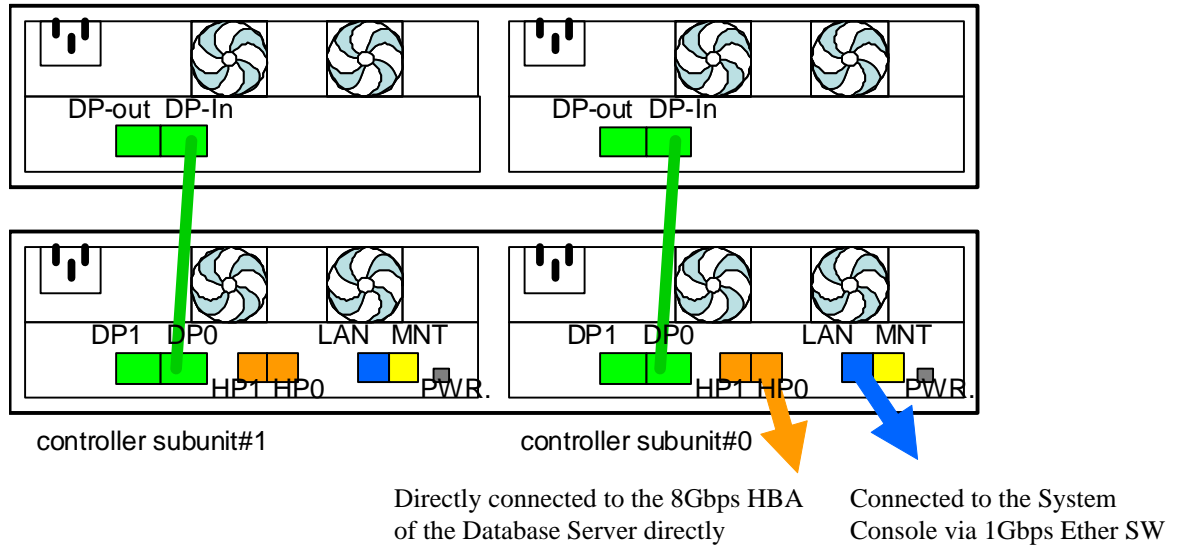
See Figure 1.8 to check the connection diagram of the NEC Storage D3-10 controller and the disk enclosures for Database Data Array.

Figure1.8: Connection diagram of the NEC Storage D3-10 for Database Data Array

DP-out DP-In   DP-out DP-In   DP-out DP-In   DP-out DP-In

DP-out DP-In   DP-out DP-In   DP-out DP-In   DP-out DP-In

DP1 DP0   LAN MNT   DP1 DP0   LAN MNT
        HP1 HP0   PWR.   HP1 HP0   PWR.

controller subunit#1   controller subunit#0

Directly connected to the 8Gbps HBA
of the Database Server

Connected to the System
Console via 1Gbps Ether SW
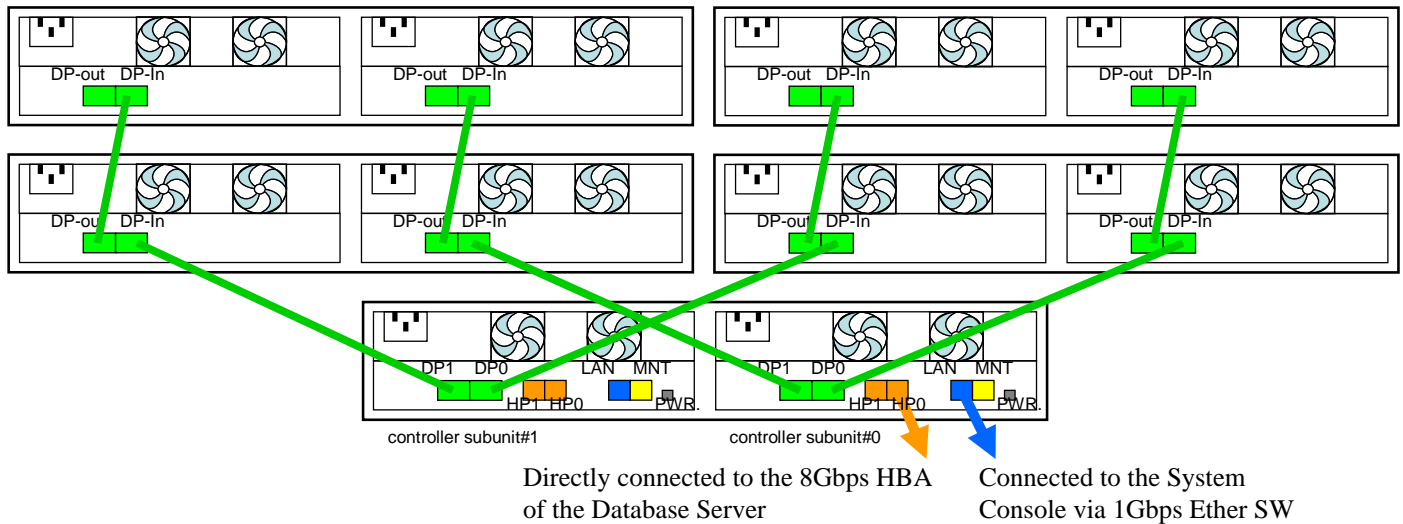
See Figure 1.9 to check the connection diagram of the Dot Hill 3120 JBODs for Database Data Array.

Figure1.9: Connection diagram of the Dot Hill 3120 for Database Data Array
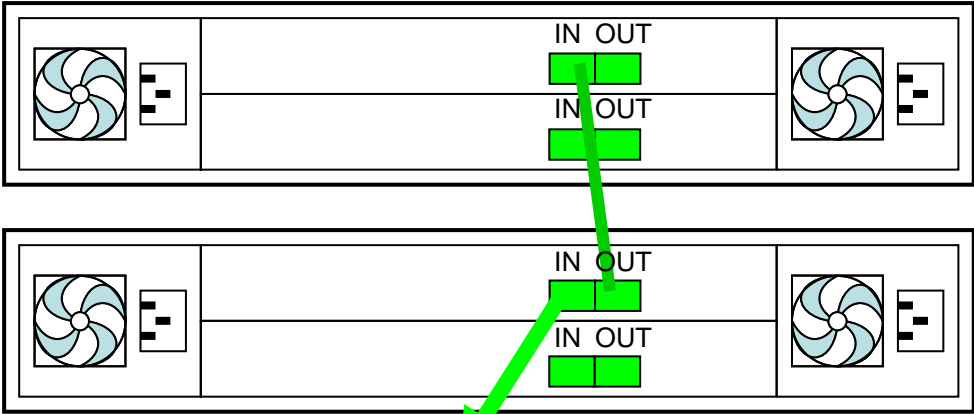
Directly connected to the 6Gbps SAS
of the Database Server

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.*

Driver

The driver is not included in the priced configuration or SUT. In this benchmark, the driver machine runs Microsoft® Windows Server® 2008 Standard Edition. Proprietary driver was installed on the machine.

Tier-A

OS Installation

Step.1: Install "Windows Server® 2008"

1. Put an OS install medium into the DVD drive of the NEC Express5800/R120b-2.

2. Power on the NEC Express5800/R120b-2 with a DVD Drive, then "Windows Setup" boots from the OS install medium.

3. Continue normal Windows installation.

Step.2: Install driver

1. After Windows installation completes, put the EXPRESSBUILDER DVD medium into the DVD drive of the NEC Express5800/R120b-2.

2. A dialog below is displayed.

3. Select "Setup Windows" -> "Update the system".

4. When "Update the system" is finished, remove the EXPRESSBUILDER DVD medium from the DVD drive and reboot the NEC Express5800/R120b-2.

OS Configuration

Assign IP addresses to Ethernet cards.

Step.1: **Connection to the Database server**

> **"Local Area Connection"** is used for this connection. Assign IP address "10.0.x.1".
>
> "x" represents the Client number.

> **"Local Area Connection 3"** is used for this connection. Assign IP address "10.0.y.1".
>
> "y" represents the number that adds two to the Client number.

Step.2: **Connection to the Driver system**

> **"Local Area Connection 2"** is used for this connection. Assign IP address "10.10.x.1".
>
> "x" represents the Client number.

SQL Server® Installation (only Client #1)

Install Microsoft® SQL Server® 2008 R2 Express. The SQL Server® installation procedure on the client #1 is the same as described in Tier-B portion of this clause.

Benchmark module Installation

After the OS is installed, install the vc2008SP1redist_x86.exe, SUT_CE_Server.exe and SUT_MEE_Server.exe.

Tier-B

Tier-B hardware consists of one NEC Express5800/A1080a-E as the database server, two NEC Storage D3-10 controller, seven NEC Storage D3-10 enclosures and twenty-two Dot Hill 3120 JBODs as the Database Array and one NEC Express5800/R120b-2 as the System Console of the NEC Express5800/A1080a-E and the NEC Storage D3-10.

<u>**Tier-B : The System Console**</u>

OS Installation

The OS installation procedure on the System Console, NEC Express5800/R120b-2, is the same as described in Tier-A portion of this clause.

OS Configuration

Assign IP addresses to Ethernet connections.

Step.1: **Connection to D3-10 controllers**

"Local Area Connection" is used for this. Assign IP address "192.168.11.251".

Step.2: **Connection to the Management LAN port of the Database Server**

"Local Area Connection 2" is used for this. Assign IP address "192.168.1.6".

<u>**Tier-B : The Database Server**</u>

Power up the database server, NEC Express5800/A1080a-E

The System Console is directly connected to the Management LAN port of the database server, NEC Express5800/A1080a-E. Following steps are executed on the System Console.

Step.1: Start up "Internet Explorer".

Step.2: Enter "http://192.168.1.100/" as Address and log on to Management Firmware with User Name and Password.
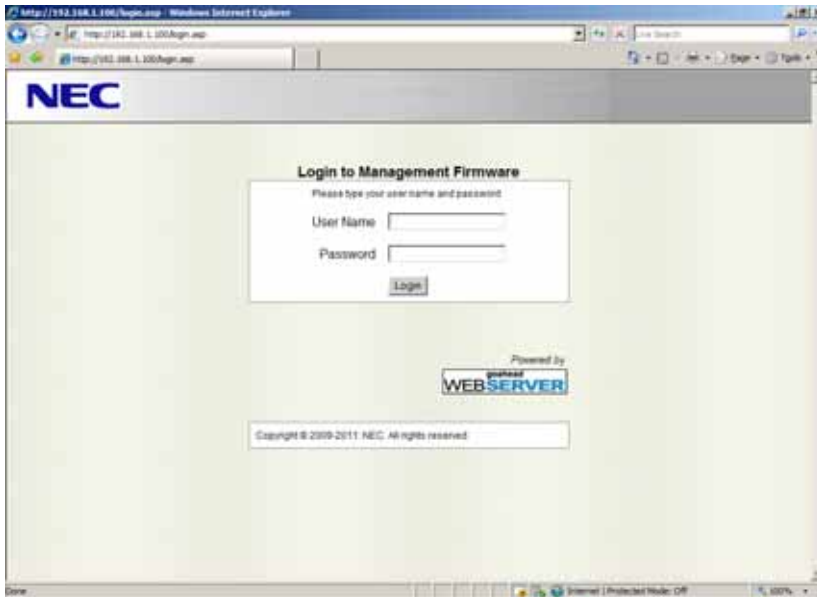
(The IP address, User Name and Password of Management Firmware are to be provided by NEC.)

Step.3: Click "Power On".
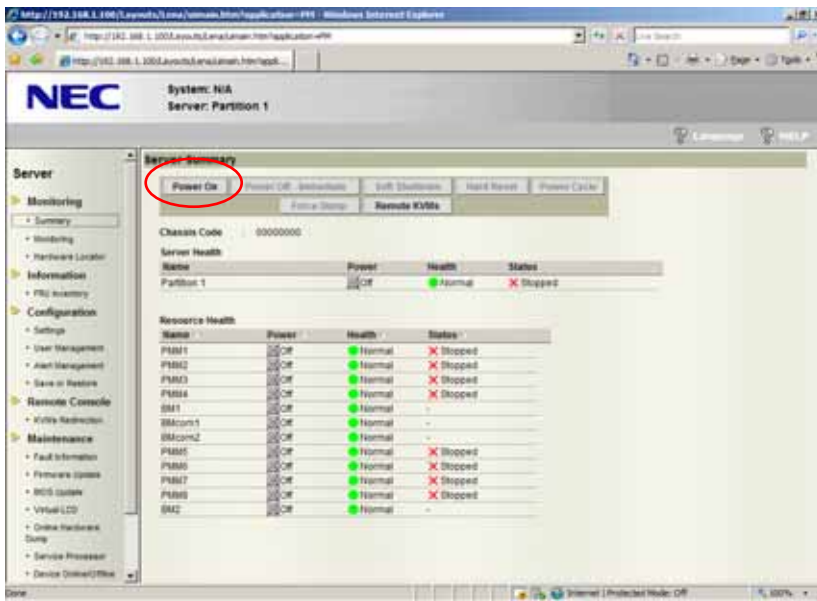
Step.4: Then the database server is booting up OS automatically.

OS Installation

The database server has already had its OS, Microsoft® Windows Server® 2008 R2 Enterprise Edition with Service Pack 1 installed.

OS Configuration

To configure the OS of the Database Server, follow the procedures below.

Disable "Windows Firewall"

To connect the Database Server to the Clients, disable "Windows Firewall".

1. Launch "Administrator Tools" -> "Windows Firewall with Advanced Security".
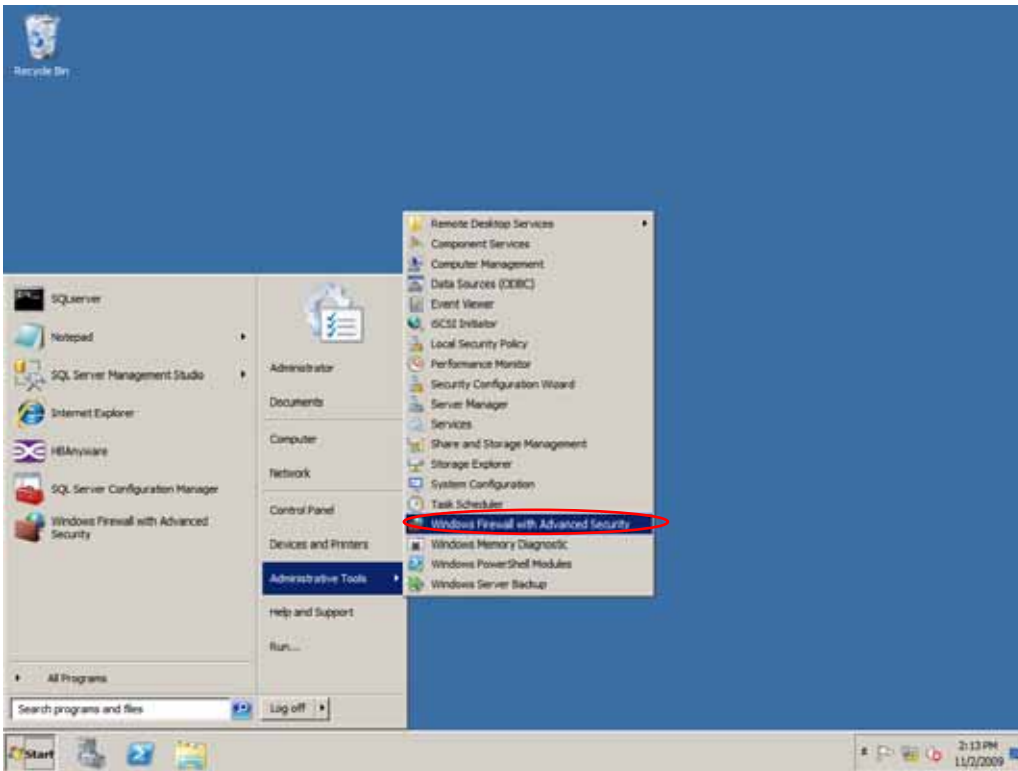
2. Click "Properties".
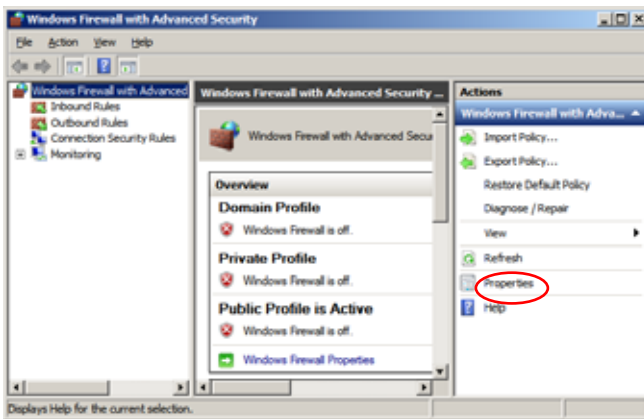
3. Change the "Firewall state" from On to Off.
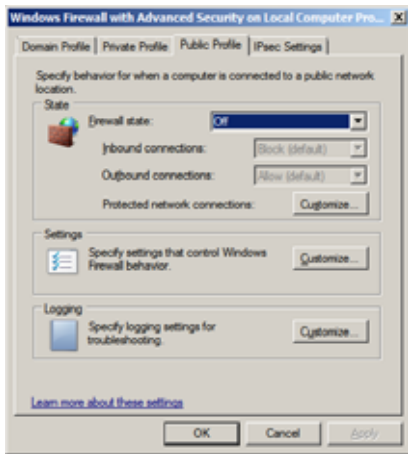
Configure "Lock pages in memory"

1. Run configuration tool "gpedit.msc" from "Run..." of the Start menu.

2. Select "Local Computer Policy" -> "Computer configuration" -> "Windows Settings" -> "Security Settings" -> "Local Policies" -> "User Rights Assignment" in the left window.
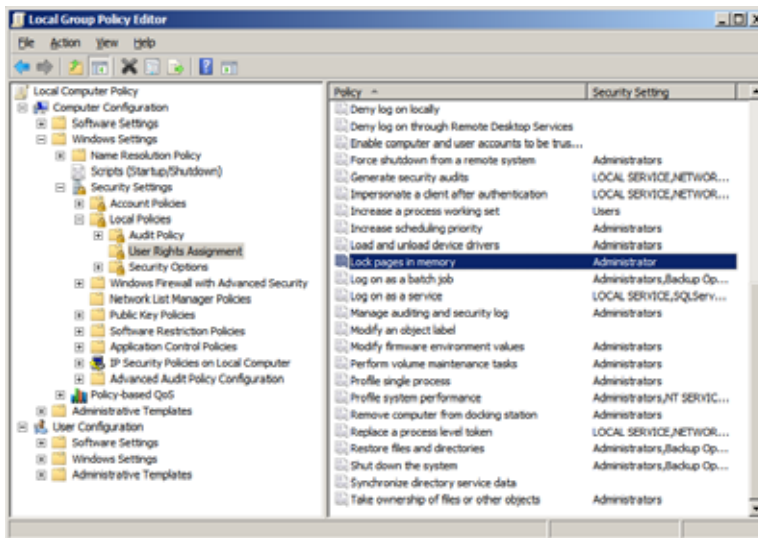
3. Double-click "Lock pages in memory" in the right window to open dialog, then add Administrator into this policy.

4. Logoff to reflect new configuration.

Configure "Registry"

To enable "code in large page" configuration controlled by the OS, and add registry key. OS will load sqlbinary in large pages.

1. Start "regedit.exe" from "Run…" of the Start Menu.

2. Select "HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT\CurrentVersion\Image File Execution Options"

3. Add a key "sqlservr.exe" and select this key.

4. Right click it, then open menu.

5. And Select "New" -> "DWORD(32-bit) Value".

6. Configure as follows.

   Name: UseLargePages

   Value: 1
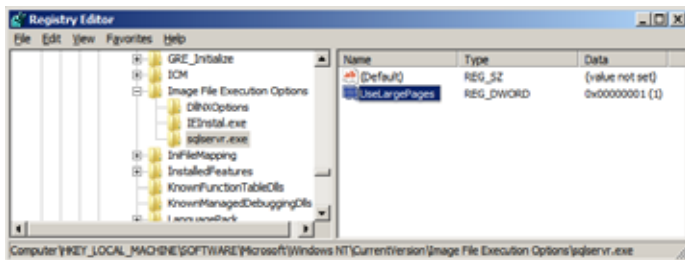
7. Reboot OS to reflect new configuration.

RAID Configuration for the Database Array

Step by Step instruction is shown in D3-10StorageSetup.doc and 3120StorageSetup.doc (included in the Supporting Files).

Configure Partitions for Database Server

Step.1: Create Partitions

Use "Disk Management" to create partitions as shown sydskmap_[01..07].png (included in the Supporting Files).

Step.2: Create Junction Points

Create junction points using mkmp.cmd (included in the Supporting Files).

Step.3: Assign Mount Points

Assign mount points using diskpart command. Execute "diskpart /s mount.txt" from the command line. (the script file "mount.txt" is included in the Supporting Files).

SQL Server® Installation

Install Microsoft® SQL Server® 2008 R2 Enterprise Edition. Here are the notes for the installation.

Step.1: **"Server Configuration"**

Change the "Startup Type" from Automatic to Manual.
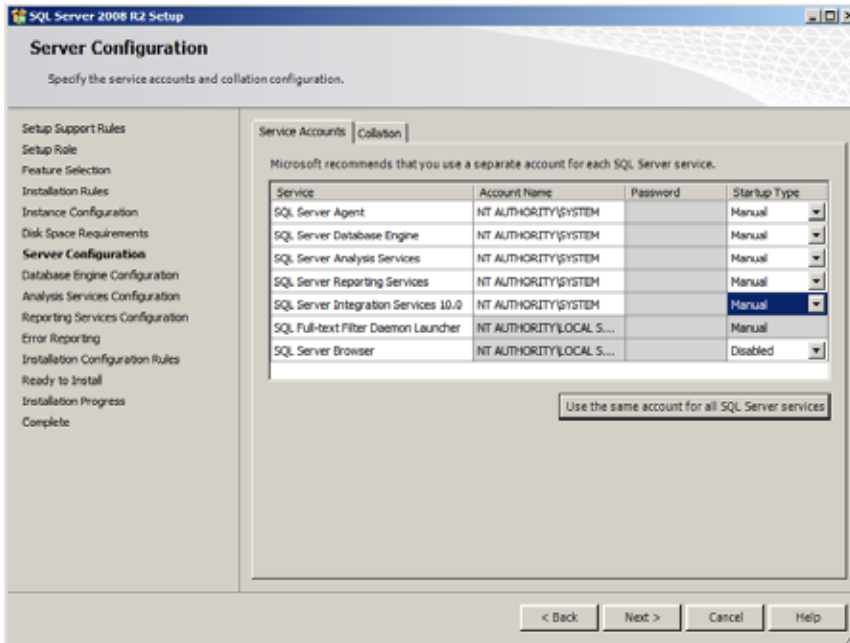
Select "Collation" tab.

Change the "Database Engine Collation" to Laten1_General_BIN.
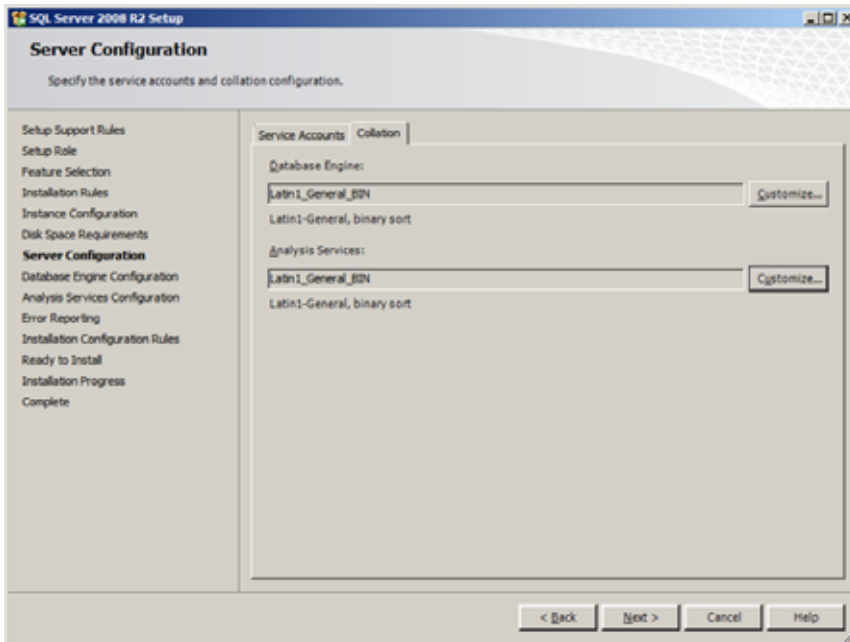
SQL Server® Configuration

Step.1: **Startup Parameter**

Start Microsoft® SQL Server® 2008 R2 from the command line using startSQL.cmd (included in the Supporting Files).

Step.2: **sp_configure**

name	minimum	maximum	config_value	run_value
access check cache bucket count	0	65536	0	0
access check cache quota	0	2147483647	0	0
Ad Hoc Distributed Queries	0	1	0	0
affinity I/O mask	-2147483648	2147483647	0	0
affinity mask	-2147483648	2147483647	-1	-1
affinity64 I/O mask	-2147483648	2147483647	0	0
affinity64 mask	-2147483648	2147483647	268435455	268435455
Agent XPs	0	1	1	1
allow updates	0	1	0	0
awe enabled	0	1	0	0
backup compression default	0	1	1	1
blocked process threshold (s)	0	86400	0	0
c2 audit mode	0	1	0	0
clr enabled	0	1	0	0
common criteria compliance enabled	0	1	0	0
cost threshold for parallelism	0	32767	5	5
cross db ownership chaining	0	1	0	0
cursor threshold	-1	2147483647	-1	-1
Database Mail XPs	0	1	0	0
default full-text language	0	2147483647	1033	1033
default language	0	9999	0	0
default trace enabled	0	1	0	0
disallow results from triggers	0	1	0	0
EKM provider enabled	0	1	0	0
filestream access level	0	2	0	0
fill factor (%)	0	100	0	0
ft crawl bandwidth (max)	0	32767	100	100
ft crawl bandwidth (min)	0	32767	0	0
ft notify bandwidth (max)	0	32767	100	100
ft notify bandwidth (min)	0	32767	0	0
in-doubt xact resolution	0	2	0	0
index create memory (KB)	704	2147483647	0	0
lightweight pooling	0	1	1	1
locks	5000	2147483647	0	0
max degree of parallelism	0	1024	1	1
max full-text crawl range	0	256	4	4
max server memory (MB)	16	2147483647	1945600	1945600

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max text repl size (B)	-1	2147483647	65536	65536
max worker threads	128	32767	4096	4096
media retention	0	365	0	0
min memory per query (KB)	512	2147483647	1024	1024
min server memory (MB)	0	2147483647	0	16
nested triggers	0	1	1	1
network packet size (B)	512	32767	4096	4096
Ole Automation Procedures	0	1	0	0
open objects	0	2147483647	0	0
optimize for ad hoc workloads	0	1	0	0
PH timeout (s)	1	3600	60	60
precompute rank	0	1	0	0
priority boost	0	1	1	1
query governor cost limit	0	2147483647	0	0
query wait (s)	-1	2147483647	-1	-1
recovery interval (min)	0	32767	32767	32767
remote access	0	1	1	1
remote admin connections	0	1	0	0
remote login timeout (s)	0	2147483647	0	0
remote proc trans	0	1	0	0
remote query timeout (s)	0	2147483647	0	0
Replication XPs	0	1	0	0
scan for startup procs	0	1	0	0
server trigger recursion	0	1	1	1
set working set size	0	1	0	0
show advanced options	0	1	1	1
SMO and DMO XPs	0	1	1	1
SQL Mail XPs	0	1	0	0
transform noise words	0	1	0	0
two digit year cutoff	1753	9999	2049	2049
user connections	0	32767	0	0
user options	0	32767	0	0
xp_cmdshell	0	1	0	0

Step.3: **Configure cpu affinity**

Run 160cpu-affinity.sql to configure the affinity of cpu (the sql file "160cpu-affinity.sql" is included in the Supporting Files).

Step.4: **Configure tempdb**

Run tempdb.sql to increase the size of the temporary database (the sql file "tempdb.sql" is included in the Supporting Files).

Step.5: **Configure softNUMA node**

1. Run "SoftNUMA-node-cpumask.reg" to add node keys and configure CPUmask for each node (the reg file "SoftNUMA-node-cpumask.reg" is included in the Supporting Files).

2. Run "SoftNUMA-ports.reg" to configure TCP/IP ports for softNUMA nodes (the reg file "SoftNUMA-ports.reg" is included in the Supporting Files).

Clause 2 : Database Design, Scaling & Population Related Items

Database Creation

A description of the steps taken to create the database for the Reported Throughput must be reported in the Report. Any and all scripts or step by step GUI instructions are reported in the Supporting Files (see Clause 9.4.2). The description, scripts and GUI instructions must be sufficient such that a reader knowledgeable of database software environments and the TPC-E specification could recreate the database.

The database has been created for 2,400,000 customers. The SQL Server® scripts and setup command files are included in the Supporting Files\Clause2 folder. Three file groups are used for tables and indices. One filegroup called "growing_fg" and one filegroup called "scaling_fg" and the other filegroup called "fixed_fg". "growing_fg" uses all the V:\Device\Growing_* disk partitions. "scaling_fg" uses all the V:\Device\Scaling_* disk partitions. "fixed_fg" uses V:\Device\Data_01\TPCE_Fixed.ndf. The database log uses the V:\Device\TPCE_Log partition.

Table Organization

The physical organization of tables and User-Defined Objects, within the database, must be reported in the Report.

Physical space was allocated to Microsoft® SQL Server® 2008 R2 on the server disks as detailed in Table 2.2.

Disclosure of 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.

Partitioning was not used on any tables in this benchmark.

Replication of Tables

Replication of tables, if used, must be reported in the Report (see Clause 2.3.4).

No tables were replicated in this benchmark.

Additional and/or Duplicated Attributes in any Table

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

No duplications or additional attributes were used in this benchmark.

Initial Cardinality of Tables

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

The TPC-E database was originally built with 2,400,000 customers.

Table 2.1: Number of Rows for Server

Table Name	Rows Loaded
Scaling Tables	
ACCOUNT PERMISSION	17,040,108
ADDRESS	3,600,004
BROKER	24,000
COMPANY	1,200,000

COMPANY COMPETITOR	3,600,000
CUSTOMER	2,400,000
CUSTOMER ACCOUNT	12,000,000
CUSTOMER TAXRATE	4,800,000
DAILY MARKET	2,145,420,000
FINANCIAL	24,000,000
LAST TRADE	1,644,000
NEWS ITEM	2,400,000
NEWS XREF	2,400,000
SECURITY	1,644,000
WATCH ITEM	239,964,184
WATCH LIST	2,400,000
Growing Tables	
CASH TRANSACTION	38,154,316,860
HOLDING	2,123,445,459
HOLDING HISTORY	55,579,497,927
HOLDING SUMMARY	119,360,046
SETTLEMENT	41,472,000,000
TRADE	41,472,000,000
TRADE HISTORY	99,532,602,851
TRADE REQUEST	0
Fixed Tables	
CHARGE	15
COMMISSION RATE	240
EXCHANGE	4
INDUSTRY	102
SECTOR	12
STATUS TYPE	5
TAX RATE	320
TRADE TYPE	5
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.

Table 2.2 and 2.3 depict the distribution of the database over the disks of the measured and priced system.
Figure 1.1 and 1.2 show the disk configuration for measured and priced systems.

Table 2.2: Data Distribution for the Measured Configuration

Disk#	Controller#	Card#	Card Type	Drives Enclosure model RAID level	Partition Filesystem	Size	Use
0	0	0-0	FC HBA	8x147GB, 15K, SAS D3-10 Base model RAID10 / 8x147GB, 15K, SAS D3-10 Disk Enclosure RAID10	V: (NTFS) V:\Device\TPCE_Log\ (RAW)	10GB 1055GB	Log
1	1	0-1	FC HBA	12x147GB, 15K, SAS D3-10 Base model RAID6	V:\Device\Backup13 (NTFS)	1274GB	Backup_13
2				12x147GB, 15K, SAS D3-10 Disk Enclosure RAID6	V:\Device\Backup14 (NTFS)	1274GB	Backup_14
3				12x147GB, 15K, SAS D3-10 Disk Enclosure RAID6	(NTFS)	1274GB	
4				12x147GB, 15K, SAS D3-10 Disk Enclosure RAID6	(NTFS)	1274GB	
5				12x147GB, 15K, SAS D3-10 Disk Enclosure RAID6	(NTFS)	1274GB	
6				12x147GB, 15K, SAS D3-10 Disk Enclosure RAID6	(NTFS)	1274GB	
7				12x147GB, 15K, SAS D3-10 Disk Enclosure RAID6	(NTFS)	1274GB	
8		internal	SAS RAID	2x300GB, 10K, SAS internal RAID1	System Reserve C: (NTFS)	100MB 278.78GB	OS
9		1-0	SAS RAID	12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup02 (NTFS)	1498.40GB	Backup_02
10				12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup01 (NTFS)	1498.40GB	Backup_01
11		1-1		18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_01\ (RAW) V:\Device\Scaling_01\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_01 Scaling_01
12				18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_02\ (RAW) V:\Device\Scaling_02\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_02 Scaling_02
13		2-0	SAS RAID	12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup04 (NTFS)	1498.40GB	Backup_04
14				12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup03 (NTFS)	1498.40GB	Backup_03
15		2-1		18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_04\ (RAW) V:\Device\Scaling_04\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_04 Scaling_04
16				18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_03\ (RAW) V:\Device\Scaling_03\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_03 Scaling_03

Table 2.2: Data Distribution for the Measured Configuration (Cont)

17		3-0	SAS RAID	12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup06 (NTFS)	1498.40GB	Backup_06
18				12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup05 (NTFS)	1498.40GB	Backup_05
19		3-1		18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_05\ (RAW) V:\Device\Scaling_05\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_05 Scaling_05
20				18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_06\ (RAW) V:\Device\Scaling_06\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_06 Scaling_06
21		4-0	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_07\ (RAW) V:\Device\Scaling_07\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_07 Scaling_07
22				18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_08\ (RAW) V:\Device\Scaling_08\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_08 Scaling_08
23		4-1		12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup07 (NTFS)	1498.40GB	Backup_07
24				12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup08 (NTFS)	1498.40GB	Backup_08
25		5-0	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_09\ (RAW) V:\Device\Scaling_09\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_09 Scaling_09
26				18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_10\ (RAW) V:\Device\Scaling_10\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_10 Scaling_10
27		5-1		12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup09 (NTFS)	1498.40GB	Backup_09
28				12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup10 (NTFS)	1498.40GB	Backup_10
29		6-0	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_21\ (RAW) V:\Device\Scaling_21\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_21 Scaling_21
30				20x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_22\ (RAW) V:\Device\Scaling_22\ (RAW) (NTFS)	975.05GB 29.93GB 118.39GB	Growing_22 Scaling_22
31		7-1		12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup12 (NTFS)	1498.40GB	Backup_09
32				18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_11\ (RAW) V:\Device\Scaling_11\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_11 Scaling_11
33		7-0	SAS RAID	19x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_12\ (RAW) V:\Device\Scaling_12\ (RAW) V:\Device\Data_01 (NTFS) V:\Device\TPCE_TempLog (NTFS) V:\Device\TPCE_TempDB (NTFS)	975.05GB 29.93GB 59.27GB	Growing_12 Scaling_12 Data_01 TPCE_TempLog TPCE_TempDB
34		7-1		12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup11 (NTFS)	1498.40GB	Backup_11

Table 2.2: Data Distribution for the Measured Configuration (Cont)

35		8-0	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_13\ (RAW) V:\Device\Scaling_13\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_13 Scaling_13
36				18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_14\ (RAW) V:\Device\Scaling_14\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_14 Scaling_14
37		9-0	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_15\ (RAW) V:\Device\Scaling_15\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_15 Scaling_15
38				18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_16\ (RAW) V:\Device\Scaling_16\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_16 Scaling_16
39		10-0	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_17\ (RAW) V:\Device\Scaling_17\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_17 Scaling_17
40				18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_18\ (RAW) V:\Device\Scaling_18\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_18 Scaling_18
41		11-0	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_19\ (RAW) V:\Device\Scaling_19\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_19 Scaling_19
42				18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_20\ (RAW) V:\Device\Scaling_20\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_20 Scaling_20

Table 2.3: Data Distribution for the Priced Configuration

Disk#	Controller#	Card#	Card Type	Drives Enclosure model RAID level	Partition Filesystem	Size	Use
0	0	0-0	FC HBA	8x147GB, 15K, SAS D3-10 Base model RAID10 8x147GB, 15K, SAS D3-10 Disk Enclosure RAID10	V: (NTFS) V:\Device\TPCE_Log\ (RAW)	10GB 1055GB	Log
1				12x147GB, 15K, SAS D3-10 Base model RAID6	(NTFS)	1274GB	60days space
2				12x147GB, 15K, SAS D3-10 Disk Enclosure RAID6	(NTFS)	1274GB	60days space
3	1	0-1	FC HBA	12x147GB, 15K, SAS D3-10 Disk Enclosure RAID6	(NTFS)	1274GB	60days space
4				12x147GB, 15K, SAS D3-10 Disk Enclosure RAID6	(NTFS)	1274GB	60days space
5				12x147GB, 15K, SAS D3-10 Disk Enclosure RAID6	(NTFS)	1274GB	60days space
8		internal	SAS RAID	2x300GB, 10K, SAS internal RAID1	System Reserve C: (NTFS)	100MB 278.78GB	OS
11		1-1	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_01\ (RAW) V:\Device\Scaling_01\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_01 Scaling_01
12			SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_02\ (RAW) V:\Device\Scaling_02\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_02 Scaling_02
15		2-1	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_04\ (RAW) V:\Device\Scaling_04\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_04 Scaling_04
16			SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_03\ (RAW) V:\Device\Scaling_03\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_03 Scaling_03
19		3-1	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_05\ (RAW) V:\Device\Scaling_05\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_05 Scaling_05
20			SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_06\ (RAW) V:\Device\Scaling_06\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_06 Scaling_06
21		4-0	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_07\ (RAW) V:\Device\Scaling_07\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_07 Scaling_07
22			SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_08\ (RAW) V:\Device\Scaling_08\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_08 Scaling_08
25		5-0	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_09\ (RAW) V:\Device\Scaling_09\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_09 Scaling_09
26			SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_10\ (RAW) V:\Device\Scaling_10\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_10 Scaling_10

29		6-0	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_21\ (RAW) V:\Device\Scaling_21\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_21 Scaling_21
30				20x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_22\ (RAW) V:\Device\Scaling_22\ (RAW) (NTFS)	975.05GB 29.93GB 118.39GB	Growing_22 Scaling_22
32		7-0	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_11\ (RAW) V:\Device\Scaling_11\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_11 Scaling_11
33				19x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_12\ (RAW) V:\Device\Scaling_12\ (RAW) V:\Device\Data_01 (NTFS) V:\Device\TPCE_TempLog (NTFS) V:\Device\TPCE_TempDB (NTFS)	975.05GB 29.93GB 59.27GB	Growing_12 Scaling_12 Data_01 TPCE_TempLog TPCE_TempDB
35		8-0	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_13\ (RAW) V:\Device\Scaling_13\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_13 Scaling_13
36				18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_14\ (RAW) V:\Device\Scaling_14\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_14 Scaling_14
37		9-0	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_15\ (RAW) V:\Device\Scaling_15\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_15 Scaling_15
38				18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_16\ (RAW) V:\Device\Scaling_16\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_16 Scaling_16
39		10-0	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_17\ (RAW) V:\Device\Scaling_17\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_17 Scaling_17
40				18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_18\ (RAW) V:\Device\Scaling_18\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_18 Scaling_18
41		11-0	SAS RAID	18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_19\ (RAW) V:\Device\Scaling_19\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_19 Scaling_19
42				18x64GB, SSD, SATA 3120 JBOD RAID5	V:\Device\Growing_20\ (RAW) V:\Device\Scaling_20\ (RAW) (NTFS)	975.05GB 29.93GB 145MB	Growing_20 Scaling_20

Type of Database

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).*
- · *The methodology used to load the database must be reported in the Report.*

Microsoft® SQL Server® 2008 R2, a relational database, was used in this benchmark. Microsoft® SQL Server® 2008 R2 stored procedures were used and invoked through library function calls embedded in C++ code.

The methodology used to load the database used the flat files option on the EGenLoader command line. This generates flat files then a bulk insert of the data into the tables. For a more detailed description, refer to MSTPCE Database Setup Reference.pdf (included in the Supporting Files).

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 3.2.1.6) must be reported in the Report.

The vendor-supplied code is functionally equivalent to the Pseudo-code.

Database Footprint Requirements

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

The database footprint requirements were met.

Clause 4: SUT, Driver, and Network Related Items

Network configurations and Driver system

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

There is no difference between the measured and priced configurations in the network configuration. The network configuration of the measured configuration is provided as Figure 1.1, 1.2 and 1.6.

Clause 5: EGen Related Items

EGen Version

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

EGen v1.12.0 was used in this benchmark.

EGen Code

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

All required TPC-provided EGen code was used in this benchmark.

EGen Modifications

If the Test Sponsor modified EGen, a statement EGen has been modified must be reported in the Report. All formal waivers from the TPC documenting the allowed changes to EGen must also be reported in the Report (see Clause 5.3.7.1). If any of the changes to EGen do not have a formal waiver that must also be reported in the Report.

EGen has not been modified in this benchmark.

EGenLoader Extensions

If the Test Sponsor extended EGenLoader (as described in Appendix A.6), the use of the extended EGenLoader and the audit of the extension code by an Auditor must be reported in the Report (see Clause 5.7.4).

No extensions were made to the EGenLoader for this benchmark.

Clause 6 : Performance Metrics and Response Time Related Items

EGenDriver Items

The number of EGenDriverMEE and EGenDriverCE instances used in the benchmark must be reported in the Report (see Clause 6.2.5).

The number of EGenDriverMEE instances is thirty-two. The number of EGenDriverCE instances is thirty-two.

Measured Throughput

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

Measured tpsE

4,200.61 tpsE

Trade-Result Throughput vs. Elapsed Wall Clock Time

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

Figure 6.1: Test Run Graph

Steady State

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.

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

1. Looked at the Test Run Graph and verified that tpsE was steady prior to commencing the Measurement Interval.
2. Calculated 60 minute average tpsE during the Steady State moving the time window 10 minutes each time. Then confirmed that the minimum 60 minute average tpsE was not less than 98% of the Reported Throughput, and that the maximum 60 minute average tpsE was not greater than 102% of the Reported Throughput.
3. Calculated 10 minute average tpsE during the Steady State moving the window 1 minute each time. Then confirmed that the minimum 10 minute average tpsE was not less than 80% of the Reported Throughput, and that the maximum 10 minute average tpsE was not greater than 120% of the Reported Throughput.

Work Performed During Steady State

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

A checkpoint in Microsoft® SQL Server® 2008 R2 wrote to disk all updated memory pages that had not been yet actually written to disk. SQL Server® 2008 R2 recovery interval parameter was set to the maximum allowable value to perform checkpoint at specific intervals. Checkpoints were issued at specified duration (420 seconds) and specified intervals (448 seconds).

Transaction Averages

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

Table 6.1: Transaction Averages

Input Parameter	Value	Actual Pct	Required Range
Customer-Position			
by_tax_id	1	50.02%	48% to 52%
get_history	1	50.00%	48% to 52%
Market-Watch			
Securities chosen by	Watch list	60.00%	57% to 63%
	Account ID	35.01%	33% to 37%
	Industry	5.00%	4.5% to 5.5%
Security-Detail			
access_lob	1	1.00%	0.9% to 1.1%
Trade-Lookup			
frame_to_execute	1	29.99%	28.5% to 31.5%
	2	30.00%	28.5% to 31.5%
	3	30.01%	28.5% to 31.5%
	4	10.00%	9.5% to 10.5%
Trade-Order			
Transactions requested by a third party		9.99%	9.5% to 10.5%
Security chosen by company name and issue		40.00%	38% to 42%
type_is_margin	1	8.01%	7.5% to 8.5%
roll_it_back	1	0.99%	0.94% to 1.04%
is_lifo	1	35.00%	33% to 37%
trade_qty	100	25.00%	24% to 26%
	200	24.99%	24% to 26%
	400	25.00%	24% to 26%
	800	25.00%	24% to 26%
trade_type	TMB	30.00%	29.7% to 30.3%
	TMS	30.01%	29.7% to 30.3%
	TLB	20.00%	19.8% to 20.2%
	TLS	9.99%	9.9% to 10.1%
	TSL	10.00%	9.9% to 10.1%
Trade-Update			
frame_to_execute	1	32.98%	31% to 35%
	2	32.99%	31% to 35%
	3	34.02%	32% to 36%

Clause 7 : Transaction and System Properties Related Items

Transaction System Properties (ACID)

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

The TPC Benchmark™ E Standard Specification defines a set of transaction processing system properties that a system under test (SUT) must support during the execution of the benchmark. Those properties are Atomicity, Consistency, Isolation and Durability (ACID). This section quotes the specification definition of each of those properties and describes the tests done as specified and monitored by the auditor, to demonstrate compliance. See also file MSTPCE ACID Procedures.pdf in the SupportingFiles directory. The ACID scripts and outputs are located in the directory SupportingFiles\Clause7\.

Redundancy Level

The Test Sponsor must report in the Report the Redundancy Level (see Clause 7.6.3.4) and describe the Data Accessibility test(s) used to demonstrate compliance.

Redundancy Level 1 was used for the Database Array.

## Durability Test for Data Accessibility

A Data Accessibility Graph for each run demonstrating a Redundancy Level must be reported in the Report (see Clause 7.6.4.2).

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 7.6.2) and satisfy those requirements for at least 5 minutes.
3. It was verified that the measured throughput was at least 95% of the reported throughput prior to inducing each failure.
4. Induce the failure described for the redundancy level being demonstrated. In this case fail a disk in one of the Database Data Array, fail a disk in the Database Log Array, and fail a controller module in the Database Log Array controller. Transactions should continue processing since the Database Log Array uses RAID10, the Database Data Array uses RAID5 and the Database Log Array controller has a mirrored cache module.
5. Begin the necessary recovery process, with replacing the failed Database Log Array controller, the failed drives in the Database Log Array and the Database Data Array.
6. Continue running the Driver for 20 minutes.
7. Terminate the run gracefully from the Driver.
8. Retrieve the new number of completed trades in the database by running: *select count(*) as count2 from SETTLEMENT*
9. 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.
10. 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
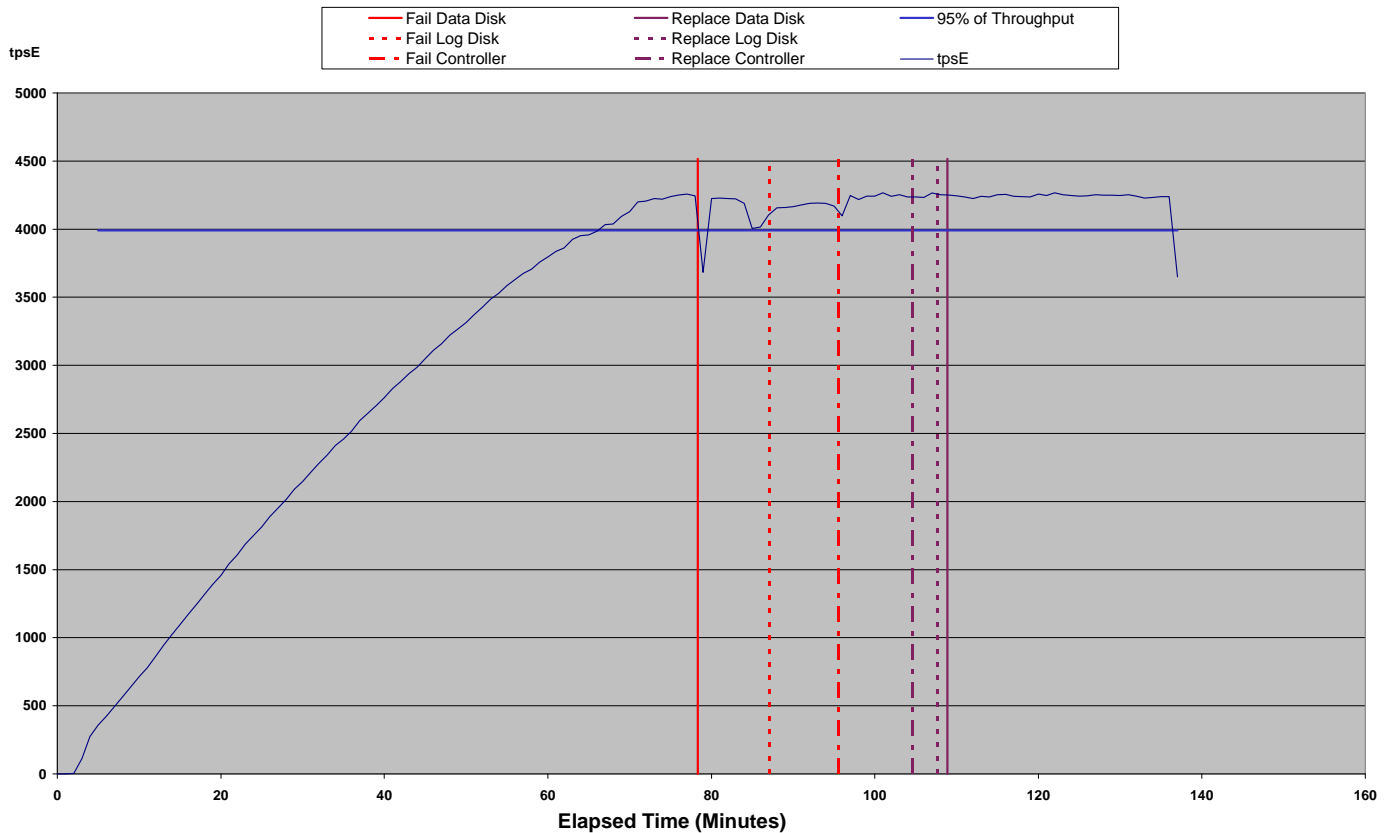
Durability Test for Business Recovery

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

The Business Recovery Time must be reported on the Executive Summary Statement and in the Report. If the failures described in Clauses 7.5.3.1, 7.5.3.2 and 7.5.3.3 were not combined into one Durability test (usually powering off the Database Server during the run), then the Business Recovery Time for the failure described for instantaneous interruption is the Business Recovery Time that must be reported in the Executive Summary Statement. All the Business Recovery Times for each test requiring Business Recovery must be reported in the Report.

The Business Recovery Time Graph (see Clause 7.5.8.3) must be reported in the Report for all Business Recovery tests.

The tests for "Loss of Processing," "Loss of Vulnerable Storage Component," and "Loss of External power to the SUT" were combined.

Note: Twenty-four UPSs have been priced for NEC Storage D3-10 for the Database Log Array and Dot Hill Systems Storage.

The following steps were successfully performed.
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 7.5.5.1) and satisfy those requirements for at least 20 minutes.
3. Removing power cords from the database server, NEC Express5800/A1080a-E.
4. Stop the Driver.
5. Re-power and restart the database server, NEC Express5800/A1080a-E.
6. On the NEC Express5800/A1080a-E when Windows has started, start up Microsoft® SQL Server® 2008 R2. Then database recovery starts automatically. Microsoft® SQL Server® 2008 R2 records timestamps out to the errorlog

when the recovery procedure has begun. The timestamp defines the time when Database Recovery starts (as defined in Clause 7.5.6.2).

7. Wait for Microsoft® SQL Server® 2008 R2 to finish recovering the database. The timestamp in the errorlog of the message indicating that the recovery of database tpce is complete is considered the end of the Database Recovery (as defined in Clause 7.5.6.3).
8. Once the SUT will accept Transactions, start submitting Transactions and note this time as the start of Application Recovery (as defined in Clause 7.5.6.6). Ramp up to a Durability Throughput Requirements (as defined in Clause 7.5.5.1) and satisfy those requirements for at least 20 minutes.
9. Note the time of the beginning of that 20-minute window as the end of Application Recovery (as defined in Clause 7.5.6.7).
10. Terminate the Driver gracefully.
11. Verify that no errors were reported by the Driver during steps 7 through 10.
12. Retrieve the new number of completed trades in the database by running: *select count(*) as count2 from SETTLEMENT*
13. 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 8. 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.
14. Verify consistency conditions as specified in Clause 7.3.3.

The database recovery time was 01:41:24. The application recovery time was 01:06:00. The Business Recovery Time, which is the sum of the database recovery time and the application recovery time, was 02:47:24.

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 Recover Time Graph
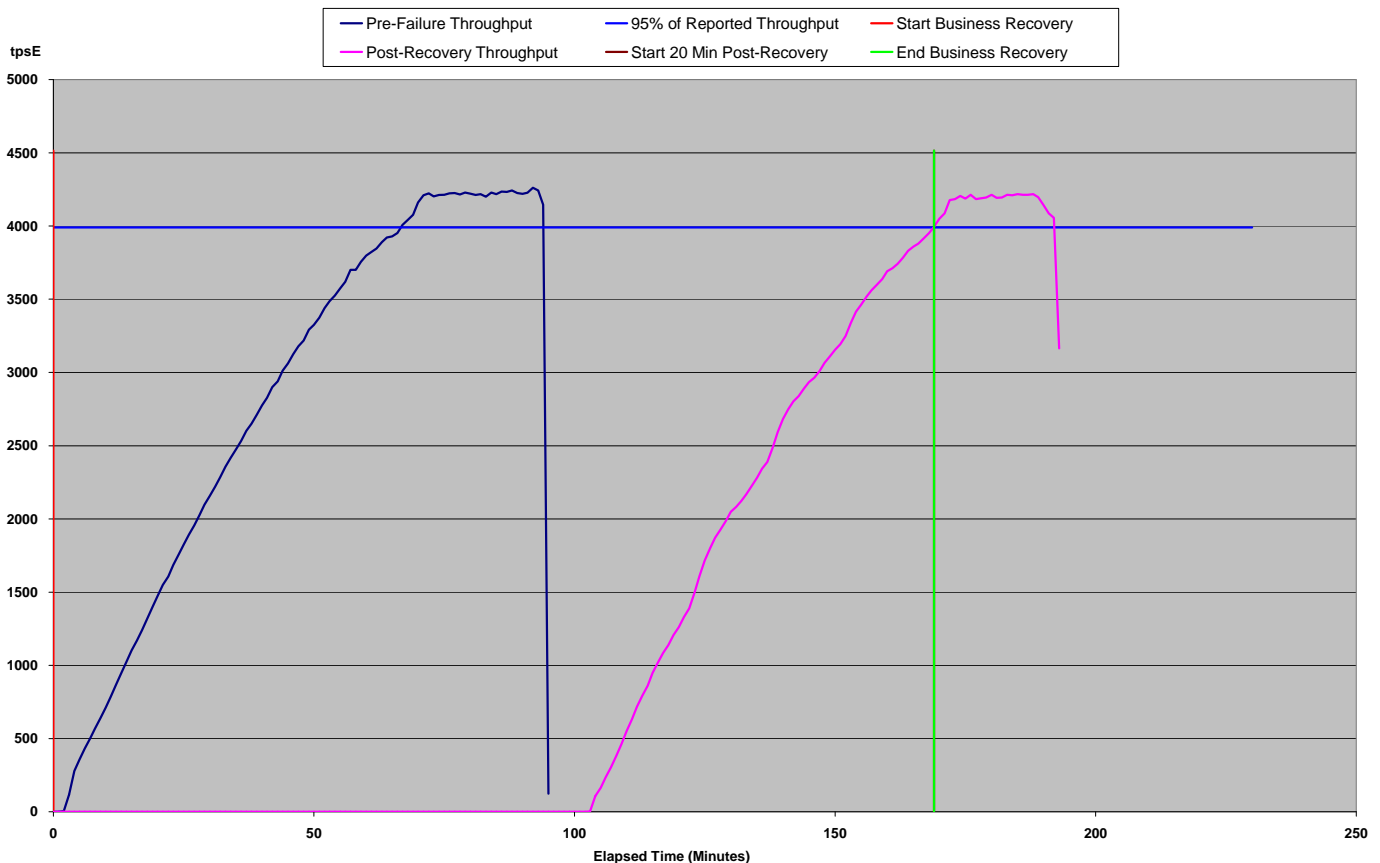
Clause 8 : Pricing Related Items

60-Day Space

Details of the 60-Day Space computations (see Clause 6.6.6.6) along with proof that the database is configured to sustain a Business Day of growth (see Clause 6.6.6.1) must be reported in the Report.

TPC-E Disk Space Requirements

Customers Used	2,400,000	Performance	4200.61 tpsE				
Growing File Group	**Initial Rows**	**Data (KB)**	**Index size (KB)**	**Extra 5% (KB)**	**Total + 5% (KB)**	**After run (KB)**	**Growth (KB)**
CASH_TRANSACTION	38,154,316,860	3,963,417,848	8,361,920		3,971,779,768	3,982,489,736	10,709,968
HOLDING	2,123,445,459	141,944,736	90,045,960		231,990,696	235,597,240	3,606,544
HOLDING_HISTORY	55,579,497,927	2,021,073,040	1,168,182,040		3,189,255,080	3,201,143,936	11,888,856
HOLDING_SUMMARY	119,360,046	5,231,240	24,592		5,255,832	5,255,832	0
SETTLEMENT	41,472,000,000	1,977,545,984	4,175,416		1,981,721,400	1,987,690,064	5,968,664
TRADE	41,472,000,000	4,950,934,024	2,496,292,520		7,447,226,544	7,474,146,688	26,920,144
TRADE_HISTORY	99,532,602,851	2,993,462,112	7,811,088		3,001,273,200	3,012,184,720	10,911,520
TRADE_REQUEST	0	8	8		16	354,784	354,768
Scaling File Group							
ACCOUNT_PERMISSION	17,040,108	938,344	6,224	47,228	991,796	944,688	120
ADDRESS	3,600,004	207,712	1,728	10,472	219,912	209,496	56
BROKER	24,000	1,752	2,048	190	3,990	3,800	0
COMPANY	1,200,000	255,968	71,688	16,383	344,039	327,672	16
COMPANY_COMPETITOR	3,600,000	96,680	78,720	8,770	184,170	175,400	0
CUSTOMER	2,400,000	393,344	104,528	24,894	522,766	497,888	16
CUSTOMER_ACCOUNT	12,000,000	1,087,416	232,288	65,985	1,385,689	1,319,704	0
CUSTOMER_TAXRATE	4,800,000	100,088	1,728	5,091	106,907	101,976	160
DAILY_MARKET	2,145,420,000	100,581,192	294,456	5,043,782	105,919,430	100,877,232	1,584
FINANCIAL	24,000,000	2,704,600	8,848	135,672	2,849,120	2,713,800	352
LAST_TRADE	1,644,000	102,504	1,728	5,212	109,444	104,232	0
NEWS_ITEM	2,400,000	260,203,968	4,184	13,010,408	273,218,560	260,208,152	0
NEWS_XREF	2,400,000	59,856	1,728	3,079	64,663	61,584	0
SECURITY	1,644,000	227,816	60,072	14,394	302,282	287,888	0
WATCH_ITEM	239,964,184	6,733,288	25,784	337,954	7,097,026	6,759,392	320
WATCH_LIST	2,400,000	59,840	48,896	5,437	114,173	108,736	0
Fixed File Group							
CHARGE	15	8	8	1	17	16	0
COMMISSION_RATE	240	16	16	2	34	32	0
EXCHANGE	4	8	8	1	17	16	0
INDUSTRY	102	8	24	2	34	32	0
SECTOR	12	8	24	2	34	32	0
STATUS_TYPE	5	8	8	1	17	16	0
TAXRATE	320	24	16	2	42	56	16
TRADE_TYPE	5	8	1,032	52	1,092	1,040	0
ZIP_CODE	14,741	488	16	25	529	504	0
TOTALS (KB)		**16,427,363,936**	**3,775,839,344**	**18,735,037**	**20,221,938,317**		
Initial Database Size (MB)		**19,729,691**	**19,267 GB**	**18.82 TB**			

Db/Filegroups	LUN Count	Partition Size(KB)	MB allocated	MB Loaded	MB Loaded+5%	Ending size	8 Hours
Growing_FG	22	10,255,172,567	220,325,973	19,363,772	19,363,772	19,432,483	19,503,161
Scaling_FG	22	26,675,773	573,112	365,917	384,213	365,920	365,922
Fixed_FG	1	512,000	500	1.69	2	2	2
Settlements	**59,635,570**						

		Number of disks	399
		Disk Capacity (MB)	60,543
		RAID5 Overhead	6%
Initial Growing Space (MB)	19,363,772	**Total Space (MB)**	22,824,711

Final Growing Space (MB)	19,432,483	**Number of disks**	60	**Initial Log size (MB)**	40,279
Delta (MB)	68,711	**Disk Capacity (MB)**	135,893	**Final Log size (MB)**	383,698
Data Space per TR (MB)	0.001152188	**RAID6 Overhead**	20%	**Log Growth (MB)**	343,418
1 Day Data Growth (MB)	139,389	**Total Space (MB)**	6,522,864	**Log Growth/TR (MB)**	0.0057586157
60 Day Space (MB)	**28,093,025**	**Total Space (MB)**	29,347,575	**1 Day log space (MB)**	**696,663**

Log Disks: 16
Disk Capacity (MB): 136,320
RAID10 overhead: 50%
Tempdb Log: -
Log Space (MB): **1,090,560**

Auditor's Attestation Letter

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

INFO SIZING

TPC CERTIFIED AUDITOR

Manabu Miyazaki
NEC Corporation
1-10 Nisshincho
Fuchu-City, Tokyo 183-8501, Japan

April 27, 2011

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

Platform: NEC Express 5800/A1080a-E (8 processors)
Operating System: Microsoft Windows Server 2008 R2 Enterprise Edition
Database Manager: Microsoft SQL Server 2008 R2 Enterprise Edition

The results were:

CPU's Speed	Memory	Disks	Trade-Result 90% Response Time	tpsE
Tier B, Server: NEC Express 5800/A1080a-E (8 processors)				
8 x Intel Xeon E7-8870 (2.40GHz)	2048 GB (30MB L3)	76 x 147 GB 15K HDD 399 x 64 GB SSD	0.16 Seconds	4200.61
Tier A, Two Clients: NEC Express 5800/R120b-2				
2 x Intel Xeon X5675 (3.06 GHz)	8 GB (12MB L3)	1 x 300 GB 10K SAS	n/a	n/a

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

The following verification items were given special attention:

• All EGen components were verified to be v1.12.0.

• The transactions were correctly implemented.

• The database was properly scaled and populated for 2,400,000 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 2:47:24 was correctly measured.
- The 60 day storage requirement was correctly computed.
- The system pricing was verified for major components and maintenance.

Additional Audit Notes:

    None.

Respectfully Yours,

Doug Johnson, Auditor   François Raab, President

Clause 9 : Supporting Files

Supporting Files Index Table

An index for all files required by Clause 9.4 Supporting Files must be provided in the Report. The Supporting Files index is presented in a tabular format where the columns specify the following:

- · *The first column denotes the clause in the TPC Specification*
- · *The second column provides a short description of the file contents.*
- · *The third column contains the path name for the file starting at the SupportingFiles directory.*

If there are no Supporting Files provided then the description column must indicate that there is no supporting file and the path name column must be left blank.

Clause	Description	path	filename
Introduction	Disk Configuration	SupportingFiles/Introduction/Hardware/	3120StorageSetup.doc D3-10StorageSetup.doc mkmp.cmd mount.txt StorageDiagram.doc sydskmap_[01..07].png
	TierB(server) cofiguration	SupportingFiles/Introduction/Hardware/	TierB_A1080a-E_R120b-2_setup.doc
	TierA(client) setup	SupportingFiles/Introduction/Hardware/	TierA_R120b-2_setup.doc
	Database Tunable Parameters	SupportingFiles/Introduction/Software/	160cpu-affinity.sql Remove_Addon_Files.sql SoftNUMA-node-cpumask.reg SoftNUMA-ports.reg sp_configure.out startSQL.cmd tempdb.sql
	OS Tunable Parameters	SupportingFiles/Introduction/Software/	syostune.doc syhwTierB.out syhwTierA_[1..2].out
	Tier A Scripts	SupportingFiles/Introduction/Software/	ce[1..32].cmd me[1..32].cmd

Clause2	Table creation scripts	SupportingFiles/Clause2/DDL/	BulkInsert_[1..88].sql Convert_NI_ITEM_Data.sql Create_Check_Constraints_Fixed.sql Create_Check_Constraints_Growing.sql Create_Check_Constraints_Scaling.sql Create_FK_Constraints.sql Create_Tables_Fixed.sql Create_Tables_Growing.sql Create_Tables_Scaling.sql Create_Tables_Scaling_Flat.sql Create_TPCE_Types.sql Drop_FK_Constraints.sql Drop_Tables_Fixed.sql Drop_Tables_Growing.sql Drop_Tables_Scaling.sql
	Index creation scripts	SupportingFiles/Clause2/DDL/	Create_Indexes_Fixed_Tables.sql Create_Indexes_Growing_Tables.sql Create_Indexes_Scaling_Tables.sql
	Load Transaction Frames	SupportingFiles/Clause2/DML/	BrokerVolume.sql CustomerPosition.sql DataMaintenance.sql MarketFeed.sql MarketWatch.sql SecurityDetail.sql TradeLookup.sql TradeOrder.sql TradeResult.sql TradeStatus.sql TradeUpdate.sql
	Create Database	SupportingFiles/Clause2/	Backup_Database.sql Backup_Devices.sql Checkpoint_TPCE_Database.SQL Count_Customers.sql Create_Database.sql Create_DM_Audit_Table.sql Create_TID_Ranges_Tables.sql Create_Timer_Table.sql Create_TL_TU_Warnings_Table.sql Create_TPCE_VERSIONS_Table.sql Database_Options_1.sql Database_Options_2.sql Drop_and_Create_TPCE_INFO.sql End_Load_Timer.sql Get_Next_T_ID.sql Install_Load_Timer_Proc.sql Load_TPCE_Info.sql MSTPCE Database Setup Reference.pdf Output_TPCE_VERSIONS_Table.SQL Remove_Database.sql Restore_Database.sql SQL_Server_Configuration.sql tempdb.sql Trade_Cleanup.sql Version.sql
	Database Space Scripts	SupportingFiles/Clause2/Audit_Scripts/Space/	SPFiles.sql SPLog.sql SPUsed.sql
	Database Audit Scripts	SupportingFiles/Clause2/Audit_Scripts/Database/	Create_DB_Audit_Tables.SQL DB_Check.sql DB_FK_Constraints.sql DB_Primary_Key_Check.SQL DB_Tables.sql Drop_DB_Audit_Tables.SQL Insert_Duplicates_Tests.sql Referential_Integrity_Tests.sql

	Output	SupportingFiles/Clause2/Outputs	2400000Customers_Load_Timer.log
			BrokerVolume.log
			BuildSteps.log
			BulkInsert_[1..88].out
			Check_Constraints_Fixed.log
			Check_Constraints_Growing.log
			Check_Constraints_Scaling.log
			Convert_NI_ITEM_Data.log
			Create_DM_Audit_Table.log
			Create_Indexes_Fixed_Tables.log
			Create_Indexes_Growing_Tables.log
			Create_Indexes_Scaling_Tables.log
			Create_TID_Ranges_Table.log
			Create_TL_TU_Warnings_Table.log
			Create_TPCE_VERSIONS_Table.log
			CreateDB.log
			CustomerPosition.log
			Database_Options_1.log
			Database_Options_2.log
			DataMaintenance.log
			Drop_Fixed_Tables.log
			Drop_FK_Constraints.log
			Drop_Growing_Tables.log
			Drop_Scaling_Tables.log
			FK_Constraints.log
			Get_Next_T_ID.log
			Load_Timer.log
			Load_Timer_Proc.log
			Load_TPCE_Info.log
			MarketFeed.log
			MarketWatch.log
			RemoveDB.log
			SecurityDetail.log
			SQL_Server_Configuration.log
			Tables_Fixed.log
			Tables_Growing.log
			Tables_Scaling.log
			TPCE_Types.log
			TPCE_VERSIONS.log
			TradeLookup.log
			TradeOrder.log
			TradeResult.log
			TradeStatus.log
			TradeUpdate.log
			Version.log

Clause3	Transaction Frames	SupportingFiles/Clause3/	BrokerVolume.sql
			CustomerPosition.sql
			DataMaintenance.sql
			MarketFeed.sql
			MarketWatch.sql
			SecurityDetail.sql
			Trade_Cleanup.sql
			TradeLookup.sql
			TradeOrder.sql
			TradeResult.sql
			TradeStatus.sql
			TradeUpdate.sql
	SUT_CE_Server	SupportingFiles/Clause3/SUT_CE_Server/	CEServer.cpp
			CEServer.h
			CEServerMain.cpp
			PortDefinitions.h
			stdafx.cpp
			stdafx.h
			SUT_CE_Server.vcproj
			SUT_CE_Server.vcxproj
			SUTServer.sln
			SUTStructs.h
	SUT_MEE_Server	SupportingFiles/Clause3/SUT_MEE_Server/	MEEServer.cpp
			MEEServer.h
			MEEServerMain.cpp
			stdafx.cpp
			stdafx.h
			SUT_MEE_Server.vcproj
			SUT_MEE_Server.vcxproj
Clause4			
Clause5	EGen modifications		
	EGenLoader extensions		
	EGenDriver Configuration	SupportingFiles/Clause5/	2400Kcust.xml
	EGenLoader Parameters	SupportingFiles/Clause5/	BuildSteps.log
			EGenLoaderFrom1To27000.log
			EGenLoaderFrom27001To55000.log
			EGenLoaderFrom55001To82000.log
			EGenLoaderFrom82001To109000.log
			EGenLoaderFrom109001To136000.log
			EGenLoaderFrom136001To164000.log
			EGenLoaderFrom164001To191000.log
			EGenLoaderFrom191001To218000.log
			EGenLoaderFrom218001To245000.log
			EGenLoaderFrom245001To273000.log
			EGenLoaderFrom273001To300000.log
			EGenLoaderFrom300001To327000.log
			EGenLoaderFrom327001To355000.log
			EGenLoaderFrom355001To382000.log
			EGenLoaderFrom382001To409000.log
			EGenLoaderFrom409001To436000.log
			EGenLoaderFrom436001To464000.log
			EGenLoaderFrom464001To491000.log
			EGenLoaderFrom491001To518000.log
			EGenLoaderFrom518001To545000.log
			EGenLoaderFrom545001To573000.log
			EGenLoaderFrom573001To600000.log
			EGenLoaderFrom600001To627000.log
			EGenLoaderFrom627001To655000.log
			EGenLoaderFrom655001To682000.log
			EGenLoaderFrom682001To709000.log
			EGenLoaderFrom709001To736000.log
			EGenLoaderFrom736001To764000.log
			EGenLoaderFrom764001To791000.log
			EGenLoaderFrom791001To818000.log
			EGenLoaderFrom818001To845000.log
			EGenLoaderFrom845001To873000.log
			EGenLoaderFrom873001To900000.log
			EGenLoaderFrom900001To927000.log
			EGenLoaderFrom927001To955000.log
			EGenLoaderFrom955001To982000.log
			EGenLoaderFrom982001To1009000.log
			EGenLoaderFrom1009001To1036000.log
			EGenLoaderFrom1036001To1064000.log

			EGenLoaderFrom1064001To1091000.log
			EGenLoaderFrom1091001To1118000.log
			EGenLoaderFrom1118001To1145000.log
			EGenLoaderFrom1145001To1173000.log
			EGenLoaderFrom1173001To1200000.log
			EGenLoaderFrom1200001To1227000.log
			EGenLoaderFrom1227001To1255000.log
			EGenLoaderFrom1255001To1282000.log
			EGenLoaderFrom1282001To1309000.log
			EGenLoaderFrom1309001To1336000.log
			EGenLoaderFrom1336001To1364000.log
			EGenLoaderFrom1364001To1391000.log
			EGenLoaderFrom1391001To1418000.log
			EGenLoaderFrom1418001To1445000.log
			EGenLoaderFrom1445001To1473000.log
			EGenLoaderFrom1473001To1500000.log
			EGenLoaderFrom1500001To1527000.log
			EGenLoaderFrom1527001To1555000.log
			EGenLoaderFrom1555001To1582000.log
			EGenLoaderFrom1582001To1609000.log
			EGenLoaderFrom1609001To1636000.log
			EGenLoaderFrom1636001To1664000.log
			EGenLoaderFrom1664001To1691000.log
			EGenLoaderFrom1691001To1718000.log
			EGenLoaderFrom1718001To1745000.log
			EGenLoaderFrom1745001To1773000.log
			EGenLoaderFrom1773001To1800000.log
			EGenLoaderFrom1800001To1827000.log
			EGenLoaderFrom1827001To1855000.log
			EGenLoaderFrom1855001To1882000.log
			EGenLoaderFrom1882001To1909000.log
			EGenLoaderFrom1909001To1936000.log
			EGenLoaderFrom1936001To1964000.log
			EGenLoaderFrom1964001To1991000.log
			EGenLoaderFrom1991001To2018000.log
			EGenLoaderFrom2018001To2045000.log
			EGenLoaderFrom2045001To2073000.log
			EGenLoaderFrom2073001To2100000.log
			EGenLoaderFrom2100001To2127000.log
			EGenLoaderFrom2127001To2155000.log
			EGenLoaderFrom2155001To2182000.log
			EGenLoaderFrom2182001To2209000.log
			EGenLoaderFrom2209001To2236000.log
			EGenLoaderFrom2236001To2264000.log
			EGenLoaderFrom2264001To2291000.log
			EGenLoaderFrom2291001To2318000.log
			EGenLoaderFrom2318001To2345000.log
			EGenLoaderFrom2345001To2373000.log
			EGenLoaderFrom2373001To2400000.log
	EGenLogger Output	SupportingFiles/Clause5/	EGENLOG.xlt
Clause6	EGenValidate Output	SupportingFiles/Clause6/	EGenValidate.out

Clause7	ACID Procedure document	SupportingFiles/Clause7/	MSTPCE ACID Procedures.pdf
	ACID procedures	SupportingFiles/Clause7/AcidProcs/	AcidProc.cmd AcidProc.out Remove_AcidProcs.cmd
		SupportingFiles/Clause7/AcidProcs/Scripts/	AcidProc.vbs CustomerPosition_Iso3.sql CustomerPosition_Iso4.sql Remove_AcidProcs.vbs TradeOrder_C.sql TradeOrder_Iso1_1.sql TradeOrder_Iso1_2.sql TradeOrder_Iso2.sql TradeOrder_Iso3.sql TradeOrder_Iso4.sql TradeOrder_RB.sql TradeResult_Iso1_1.sql TradeResult_Iso1_2.sql TradeResult_Iso2_1.sql TradeResult_Iso2_2.sql TradeResult_Iso3.sql TradeResult_Iso4.sql
	Atomicity Scripts	SupportingFiles/Clause7/Atomicity/	Atomicity.cmd
		SupportingFiles/Clause7/Atomicity/Scripts/	atom.vbs Atomicity_C.sql Atomicity_RB.sql
	Atomicity Output	SupportingFiles/Clause7/Atomicity/	Atomicity_C.out Atomicity_RB.out
	Consistency Scripts	SupportingFiles/Clause7/Consistency/	Consistency.cmd
		SupportingFiles/Clause7/Consistency/Scripts/	Consistency.sql Consistency.vbs
	Consistency Output	SupportingFiles/Clause7/Consistency/	Consistency1.out
	Isolation Scripts	SupportingFiles/Clause7/Isolation/Scripts/	Isolation1_S1.sql Isolation1_S2.sql Isolation1_S3.sql Isolation1_S4.sql Isolation2_S1.sql Isolation2_S2.sql Isolation2_S3.sql Isolation2_S4.sql Isolation3_S1.sql Isolation3_S2.sql Isolation3_S3.sql Isolation4_S1.sql Isolation4_S2.sql Isolation4_S3.sql
	Isolation Output	SupportingFiles/Clause7/Isolation/	Iso1S1.out Iso1S2.out Iso1S3.out Iso1S4.out Iso2S1.out Iso2S2.out Iso2S3.out Iso2S4.out Iso3S1.out Iso3S2.out Iso3S3.out Iso4S1.out Iso4S2.out Iso4S3.out

	Durability Business Recovery	SupportingFiles/Clause7/Durability/BusinessRecovery/	BusinessRecoveryTimeGraph.xls Consistency2.out count1.sql count1BR.out count2.sql count2BR.out dblgBRpart1.out dblgBRpart2.out dblgRecovery.out DsymTierBoslg.out Part1Step.xlt Part1TxnReport20min.xlt Part1TxnReportAll.xlt Part2Step.xlt Part2TxnReport20min.xlt Part2TxnReportAll.xlt
	Durability Data Accessibility	SupportingFiles/Clause7/Durability/DataAccessibility/	count1.sql count1DA.out count2.sql count2DA.out DataAccessibility_wholeRun_TxnReportE.xlt DataAccessibilityGraph.xls DBlgDataAccessibility.out loss_and_replace_data_disk.txt loss_log_disk_and_cont.png replace_log_cont_disk.png
Clause8	60-Day Space Calculations	SupportingFiles/Clause8/	tpce_space.xls

Appendix A : Price Quotation

Microsoft Corporation
One Microsoft Way
Redmond, WA 98052-6399

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

Microsoft

March 1, 2011

NEC Corporation
Keiichi Yamada
1-10 Nisshin-cho, Fuchu-shi
Tokyo, Japan 1838501

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
810-08527	**SQL Server 2008 R2 Enterprise Edition** *Per Processor License* *Open Program - Level C* *Unit Price reflects a 20% discount from the retail unit price of $23,848.*	$19,188	8	$153,504
P73-04165	**Windows Server 2008 Standard Edition** *Server License with 5 CALs* *Open Program - Level C* *Unit Price reflects a 29% discount from the retail unit price of $999.*	$711	3	$2,133
N/A	**Microsoft Problem Resolution Services** *Professional Support* *(1 Incident).*	$259	1	$259

SQL Server 2008 R2 Enterprise Edition and Windows Server 2008 Standard Edition are currently orderable and available through Microsoft's normal distribution channels. A list of Microsoft's resellers can be found in the Microsoft Product Information Center at
http://www.microsoft.com/products/info/render.aspx?view=22&type=how

Defect support is included in the purchase price. Additional support is available from Microsoft PSS on an incident by incident basis at $259 call.

This quote is valid for the next 90 days.

Reference ID: TPCE_qhtplylGYLKTVUKfhkhIjhiIhqjPkqf85757.DOC.

CDW   800.800.4239

Shopping Cart   ❓ NEED HELP? ⊢⊣

Quantity	Product	CDW	Availability	Price	Ext. Price
8	NEC AccuSync AS171-BK 17" LCD	1994501	In Stock	$127.99	$1,023.92
13	HP Serial Attached SCSI (SAS) external cable - 6.6 ft	1137212	In Stock	$147.99	$1,923.87
4	Belkin 10 meter Multimode LC/LC 62.5/125 Duplex Fiber Optic cable	405050	In Stock	$38.99	$155.96
5	Tripp Lite 25' Blue Cat5e or Cat5 Snagless RJ45 UTP Patch Cable 25ft	324500	In Stock	$6.99	$34.95
7	Tripp Lite 7' Gray Cat5e or Cat5 Snagless Crossover Cable, 7ft, cross over	1321339	In Stock	$4.99	$34.93
4	CDW 3m Multimode Duplex Fiber Cable, 10G Aqua LC/LC MMF 50/125	1452903	In Stock	$39.99	$159.96
3	Cisco SD2005 5-port 10/100/1000 Gigabit Switch	507647	In Stock	$54.99	$164.97
				Sub-Total	$3,498.56

Customers Who Bought Products in Your Cart Also Bought...

NEC AccuSync AS191 19" LCD	Kensington Keyboard For Life - K64370 - USB & PS/2	InFocus IN1100 Projector	Logitech Optical Wheel Mouse S8F-96
Only $154.99	Only $11.99	Only $975.00	Only $10.99

Items Related to Products in Your Cart

APC Rack PDU, Switched, 1U, 20A, 120V	Cables to Go Cat6 550 MHz Snagless Patch Cable - patch cable - 35 ft	Cisco 10GBASE-SR Module	Logitech ClearChat Stereo - headset
Only $544.99	Only $16.99	Only $1,331.99	Only $19.99

http://www.cdw.com/shop/cart/default.aspx?printable=1   4/27/2011

QUOTE

PROMARK TECHNOLOGY, INC.
10900 PUMP HOUSE ROAD
SUITE B
ANNAPOLIS JUNCTION, MD 20701
T: (240) 280-8030   F: (301) 725-7869

Quote #:	0074184
Date:	4/15/2011
Salesperson:	Troy Richards
Customer PO#:	

Quote To:
NEC CORPORATION
KEIICHI YAMADA
C/O NEC CORPORATION OF AMERICA
10850 GOLD CENTER DRIVE
Rancho Cordova, CA 95670
Confirm To:
Keiichi Yamada

Ship To:
NEC CORPORATION
10850 Gold Center Drive
c/o NEC Corporation of America
Rancho Cordova, CA 95670

Qty	Part Number	Description	List Price	Unit Price	Ext. Price
22	D3120X000000DA	3120,2RM,NO DRIVES,AC	7,075.00	3,467.00	76,274.00
439	PFRUKF43-01	DRIVE, 64GB, SLC, SATA, SFF - FRU	2,411.00	1,194.00	524,166.00
2	PFRUKF31-48	DD,AMS SFF BLANK, 48 BULK PACK	1,800.00	864.00	1,728.00
33	PFRUKF31-01	DD,AMS SFF BLANK,FRU,PKG	37.50	18.00	594.00
22	FHDW018-02	RACK MOUNT KIT,SHELF,LONG,ALL HW 25""-36""	245.00	120.00	2,640.00
22	DS3120XPA4D1SW0	3120 7x24 WARR ONSITE SPARES	0.00	2,046.00	45,012.00

QUOTE VALID FOR 60 DAYS

Prices subject to change - We shall not be liable for any loss of profits, business, goodwill, data, interruption of business, nor for incidental or consequential merchantability or fitness of purpose, damages related to this agreement. Minimum 15% restocking fee with original packaging.

SubTotal:	650,414.00
Shipping:	0.00
Sales Tax:	0.00
Order Total:	$650,414.00

If shipping and handling charges are not quoted, standard charges are FOB Shipping Point.

Page: 1