NEC

TPC Benchmark™ E
Full Disclosure Report

NEC Express5800/A2040b

with Microsoft® SQL Server® 2014 Enterprise Edition
and
Microsoft® Windows Server® 2012 Standard Edition

First Edition
18-Feb-2014

NEC Corporation(NEC), the Sponsor of this benchmark test, believes that the information in this document is accurate as of the publication date. The information in this document is subject to change without notice. The Sponsor assumes no responsibility for any errors that may appear in this document. The pricing information in this document is believed to accurately reflect the current prices as of the publication date. However, the Sponsor provides no warranty of the pricing information in this document.

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

All performance data contained in this report were obtained in a rigorously controlled environment. Results obtained in other operating environments may vary significantly. NEC does not warrant or represent that a user can or will achieve similar performance expressed in transactions per second (tpsE) or normalized price/performance ($/tpsE). No warranty of system performance or price/performance is expressed or implied in this report.

Printed in USA, 2014

Abstract

This report documents the compliance of NEC Corporation's TPC Benchmark™ E tests on the NEC Express5800/A2040b client/server system with version 1.12.0 of the TPC Benchmark™ E Standard Specification. Two clients (NEC Express5800/R120d-2M) were used as the Tier-A clients.

The operating system and the DBMS used on the server were Microsoft® Windows Server® 2012 Standard Edition and Microsoft® SQL Server® 2014 Enterprise Edition. The operating system on the clients was Microsoft® Windows Server® 2012 Standard Edition.

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

TPC Benchmark™ E Metrics

The standard TPC Benchmark™ E metrics, tpsE (transactions per second), price per tpsE are reported.

System	Software	Total System Cost	tpsE	$ USD /tpsE	Availability Date
NEC Express5800 /A2040b	Microsoft® SQL Server® 2014 Enterprise Edition Microsoft® Windows Server® 2012 Standard Edition	$1,165,158 (USD)	5,087.17	$229.04	15-Apr-2014

Executive Summary

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

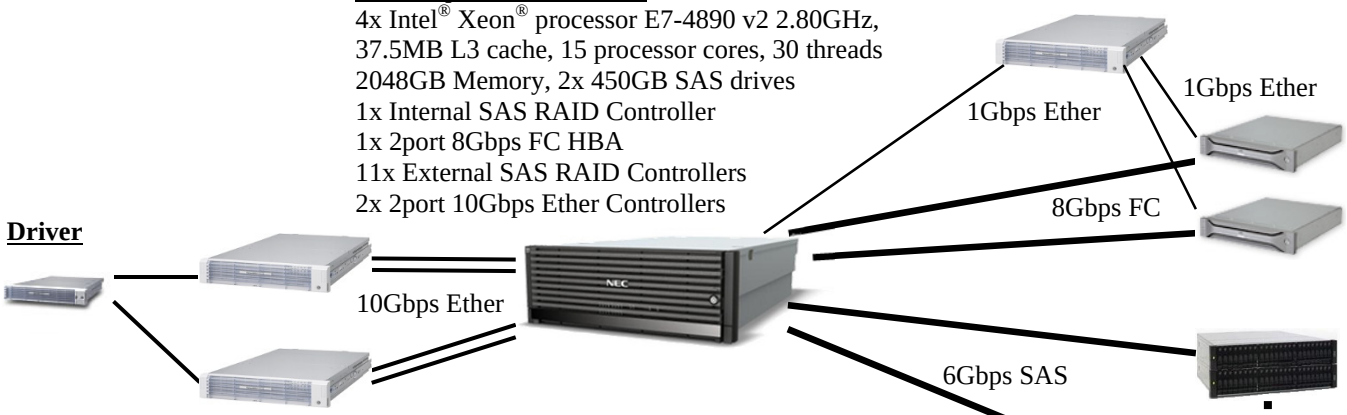
Auditor

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

NEC	NEC Express5800/A2040b		TPC-E 1.12.0 TPC Pricing 1.7.0 Report Date 18-Feb-2014
TPC-E Throughput **5,087.17 tpsE**	Price/Performance **$229.04 USD per tpsE**	Availability Date **15-Apr-2014**	Total System Cost **$1,165,158USD**

Database Server Configuration

Operating System	Database Manager	Processors/Cores/Threads	Memory
Microsoft® Windows Server® 2012 Standard Edition	**Microsoft® SQL Server® 2014 Enterprise Edition**	**4 / 60 / 120**	**2048GB**



Tier B: System Console
1x NEC Express5800/R120d-2M
1x Intel® Xeon® processor E5-2650 2.00GHz, 20MB L3 cache, 8 processor cores, 16 threads
24GB Memory
2x 147GB SAS drives
1x Internal SAS RAID Controller
2x Onboard 1Gbps Ether Controllers

Tier B: Server
NEC Express5800/A2040b
4x Intel® Xeon® processor E7-4890 v2 2.80GHz, 37.5MB L3 cache, 15 processor cores, 30 threads
2048GB Memory, 2x 450GB SAS drives
1x Internal SAS RAID Controller
1x 2port 8Gbps FC HBA
11x External SAS RAID Controllers
2x 2port 10Gbps Ether Controllers

Tier A: Client
2x NEC Express5800/R120d-2M
2x Intel® Xeon® processor E5-2690 2.90GHz, 20MB L3 cache, 8 processor cores, 16 threads
256GB Memory
2x 147GB SAS drives
1x Internal SAS RAID Controller
2x Onboard 1Gbps Ether Controllers
1x 2port 10Gbps Ether Controller

Tier B: Storage
NEC Storage M300
2x NEC Storage M300 Controllers
42x 450GB 10k rpm SAS drives
Dot Hill Systems Storage
11x Dot Hill 4120 JBODs
165x 200GB SSD SAS drives

Initial Database Size	Redundancy Level : 1	Storage
22,572 GB	**RAID10 : Log / RAID5 : Data**	**42 x 450GB 10K HDD 165 x 200GB SSD**

Description	Part Number	Brand	Price Source	Unit Price	Qty	Extended Price	3 yr. Maint. Price
Server Hardware							
NEC Express5800/A2040b							
Express5800/A2040b (with MGMx2, Fan (full), Rack Mount Kit, SUV Cable, Cover for PCI Hot-plug)	NE3400-040F	NEC	1*	14,990	1	14,990	
Xeon E7-4890 v2 Processor Kit	NE3301-H001F	NEC	1*	18,500	4	74,000	
Memory Riser Card (A2040b/A2020b/A2010b)	NE3402-H001	NEC	1*	530	8	4,240	
64GB Memory (2 x 32GB DIMM)	NE3302-H012F	NEC	1*	3,350	32	107,200	
RAID Controller (1GB, RAID 0/1/5/6)	NE3303-168	NEC	1*	930	1	930	
450GB HDD(10Krpm, SAS)	NE3350-322	NEC	1*	390	2	780	
Fibre Channel Controller (2 port)	NE3390-154	NEC	1*	1,620	1	1,620	
External RAID Controller (1GB, RAID 0/1/5/6)	NE3303-H001	NEC	1*	1,180	11	12,980	
10GBASE Adapter (SFP+/2ch)	NE3304-128	NEC	1*	740	2	1,480	
SFP+ Module (10G-SR)	NE3304-129	NEC	1*	150	4	600	
Internal DVD Super Multi Drive	NE3351-107	NEC	1*	120	1	120	
Power Supply Unit (1000W)	NE3381-88	NEC	1*	620	4	2,480	
CBL,AC PWR,2.5M C14 TO C13	Q24-RH000000007079	NEC	1	4	4	16	
Front Bezel (A2040b/A2020b/A2010b)	NE3446-H001	NEC	1*	100	1	100	
Cable Arm (70mm)	NE3343-H001	NEC	1*	290	1	290	
Installation	INST-CXA20-202040	NEC	1*	5,000	1	5,000	
Windows Server Standard 2012 x64 English 2CPU/2VM	Q24-HL000000059843	NEC	1	882	1	882	
Windows Server Standard 2012 64-bit English 2CPU/2VM Additional License	Q24-HL000000059844	NEC	1	882	1	882	
Platinum Warranty (Yr 1,2 & 3)	Q24-DN000000068496	NEC	1*	7,250	1		7,250
Express5800/R120d-2M (as system maintenance console)							
Express5800/R120d-2M, No CPU, no RAM, no ODD, no HDD, no PSU, no bezel	N8100-1793F	NEC	1	1,920	1	1,920	
Xeon E5-2650 Processor Kit, E5-2650, 2GHz, 8C/16T, 95W	N8101-549F	NEC	1	1,880	1	1,880	
8GB DDR3-1600 REG Memory Kit, 2x 4GB, DDR3L-1600, Registered	N8102-469F	NEC	1	175	3	525	
RAID Controller (512MB, RAID 0/1)	N8103-149	NEC	1	350	1	350	
146.5GB HDD, SAS2.0(6Gbps), 15,000rpm, 2.5-inch, HotPlug, new tray	N8150-303	NEC	1	270	2	540	
External DVD-ROM (USB)	N8160-85	NEC	1	215	1	215	
800W Hot Plug Power Supply, 80 PLUS Platinum	N8181-87F	NEC	1	265	1	265	
6 ft Universal Power cord - IEC320 C13 to NEMA 5-15P	307-00012-000	NEC	1	4	1	4	
3 Year Upgrade to Platinum Warranty for R120d-2M GP Server	Q24-DN000000012023	NEC	1	1,799	1		1,799
AccuSync AS171-BK 17" LCD Display (+2 spares)	AS171-BK	NEC	3	137	3	411	
					Subtotal	**234,700**	**9,049**
Disk Subsystem							
NEC Storage M300							
M300 2.5 Inch Disk Array Unit including M300 Storage BaseProduct software (w/o Controller Cards)	NF5331-SB01E	NEC	1	12,293	2	24,586	
3 Years Upgraded Platinum Warranty for M300 Disk Array Unit (2.5' w/o Controller Cards)	Q24-DN000000009192	NEC	1	3,319	2		6,638
M300 Controller Card Kit (2x 8Gb FC 4Port Card)	NF5331-SF02WE	NEC	1	8,452	2	16,904	
3 Years Upgraded Platinum Warranty for M300 Controller Card 8Gb FC 8Port	Q24-DN000000009197	NEC	1	2,282	2		4,564
M300 Extended Cache Memory (From 8GB to 16GB)	NF5331-SC01E	NEC	1	1,195	2	2,390	
3 Years Upgraded Platinum Warranty for M300 Cache Memory Extension 8GB->16GB	Q24-DN000000009212	NEC	1	325	2		650
MSeries SAS Disk Drive(2.5", 10krpm/450GB, 6Gbps) (+10% spares)	NF5321-SM767E	NEC	1	445	47	20,915	
3 Years Upgrade Platinum Warranty for M-Series SAS Disk Drive(2.5' 10Krpm/450GB, 6Gbps)	Q24-DN000000006757	NEC	1	300	2		600
CRU FC CABLE 5M x2 (M#LCLC-5MQ) 5M (+2 spares)	Q24-RH000000063466	NEC	1	54	4	216	
3 Years Upgrade Platinum Software Maintenance for M300 StorageBaseProduct	Q24-DN000000010477	NEC	1	3,146	2		6,292
Dot Hill Systems Storage							
4120 2JM NO DRIVES AC V2 DH	D4120C000000BA	DotHill	4	3,500	11	38,500	
12G SAS 200GB SSD eMLC (+10% spares)	PFRUKRXSXN145-01	DotHill	4	1,800	182	327,600	
AMS SFF BLANK BB FRU PKG	PFRUKF31-01	DotHill	4	18	99	1,782	
1YR UPG ONSITE 7X24X4 SFF JBOD 1YR AME	DS-7X24X-SJ-1Y-A-U	DotHill	4	1,771	33		58,443
UPS 3kVA	050-02424-000	NEC	1	1,799	2	3,598	
19" Rack frame, 42U rack - Black	050-02378-001	NEC	1	1,799	1	1,799	
					Subtotal	**438,290**	**77,187**
Server Software							
Microsoft SQL Server 2014 Enterprise Edition 2 core License	TBD*	Microsoft	2*	13,473	30	404,175	**259**
					Subtotal	**404,175**	**259**

continued on the next page

Client Hardware							
Express5800/R120d-2M							
Express5800/R120d-2M, No CPU, no RAM, no ODD, no HDD, no PSU, no bezel	N8100-1793F	NEC	1	1,920	2	3,840	
Xeon E5-2690 Processor Kit, E5-2690, 2.90GHz, 8C/16T, 135W	N8101-552F	NEC	1	3,510	4	14,040	
Processor Heat Sink For 2nd CPU for R120d-2M	N8101-553F	NEC	1	125	2	250	
32GB DDR3-1600 REG Memory Kit, 2x 16GB, DDR3L-1600, Registered	N8102-471F	NEC	1	500	16	8,000	
RAID Controller (512MB, RAID 0/1)	N8103-149	NEC	1	350	2	700	
146.5GB HDD, SAS2.0(6Gbps), 15,000rpm, 2.5-inch, HotPlug, new tray	N8150-303	NEC	1	270	4	1,080	
10GBASE Adapter (SFP+/2ch), PCIe (x8), FH/LP, SR	N8104-128	NEC	1	550	2	1,100	
SFP+ Module (10G-SR)	N8104-129	NEC	1	110	4	440	
800W Hot Plug Power Supply, 80 PLUS Platinum	N8181-87F	NEC	1	265	2	530	
6 ft Universal Power cord - IEC320 C13 to NEMA 5-15P	307-00012-000	NEC	1	4	2	8	
3 Year upgrades to Platinum Warranty for R120d-2M GP Server	Q24-DN000000012023	NEC	1	1,799	2		3,598
14ft Cat5e / Cat5 350MHz Snagless Patch Cable RJ45 M/M Blue 14' (+2 spares)	N001-014-BL	Tripp Lite	3	6	8	48	
10ft Cat5E 350 MHz Snagless Patch Cable - Red (+2 spares)	15203	C2G	3	5	4	20	
					Subtotal	**30,056**	**3,598**
Client Software							
Windows Server 2012 Standard[1]	P73-05761	Microsoft	2	735	3	2,205	(Included)
					Subtotal	**2,205**	**0**
Infrastructure							
3M 10Gb MMF Fiber 50/125 OM3 LSZH Patch Cable LC/LC Aqua 10ft (+2 spares)	N820-03M	Tripp Lite	3	26	6	156	
SE2500 - switch - 5 ports - unmanaged - desktop (+2 spares)	SE2500	Linksys	3	54	4	216	
					Subtotal	**372**	**0**
					TOTAL	**1,109,798**	**90,093**
NEC Large Volume Discount[2]				-10%		-33,469	-1,265

Notes:

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

* These components are not immediately Orderable. See the FDR for more information.

1, Qty of Windows Server 2012 Standard Edition includes the license of the DB server's system maintenance Console.

2, 10% discount was based on the overall value of the specific components from NEC in this single quotation except for 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 Francois Raab of InfoSizing, Inc. (www.sizing.com)

3-Yr. Cost of Ownership:	**$1,165,158**
tpsE Throughput:	**5087.17**
$ / tpsE	**$229.04**

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 :	**5,087.17 tpsE**	**Configured Customers :**		**2,750,000**
Response Times (in seconds)	**Minimum**	**Average**	**90th %tile**	**Maximum**
Broker Volume	0.00	0.04	0.07	0.55
Customer Position	0.00	0.03	0.06	0.88
Market Feed	0.00	0.02	0.04	4.79
Market Watch	0.00	0.02	0.04	0.99
Security Detail	0.00	0.01	0.03	0.92
Trade Lookup	0.00	0.07	0.11	0.61
Trade Order	0.00	0.06	0.11	0.83
Trade Result	0.00	0.06	0.13	4.84
Trade Status	0.00	0.02	0.03	0.98
Trade Update	0.01	0.08	0.12	0.66
Data Maintenance	0.00	0.01		0.14
Transaction Mix		**Transaction Count**		**Mix %**
Broker Volume		17,949,416		4.900%
Customer Position		47,621,088		13.000%
Market Feed		3,662,807		1.000%
Market Watch		65,935,916		18.000%
Security Detail		51,284,358		14.000%
Trade Lookup		29,304,844		8.000%
Trade Order		36,997,903		10.100%
Trade Result		36,627,658		9.999%
Trade Status		69,599,809		19.000%
Trade Update		7,326,398		2.000%
Data Maintenance		120		
Test Duration and Timings				
Ramp-up Time				0:57:13
Measurement Interval				2:00:00
Business Recovery Time				1:21:09
Total Number of Transactions Completed in Measurement Interval				366,310,197

PREAMBLE

Introduction

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

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

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

Goal of the TPC-E Benchmark

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

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

The benchmark defines:

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

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

The Performance Metric reported by TPC-E is a "business throughput" measure of the number of completed Trade-Result transactions processed per second (see Clause 6.7.1). Multiple Transactions are used to simulate the business activity of processing a trade, and each Transaction is subject to a Response Time constraint. The Performance Metric for the benchmark is expressed in transactions-per-second-E (tpsE). To be compliant with the TPC-E standard, all references to tpsE Results must include the tpsE rate, the associated price-per-tpsE, and the Availability Date of the Priced Configuration (See Clause 6.7.3 for more detail).

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

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

Restrictions and Limitations

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

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

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

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

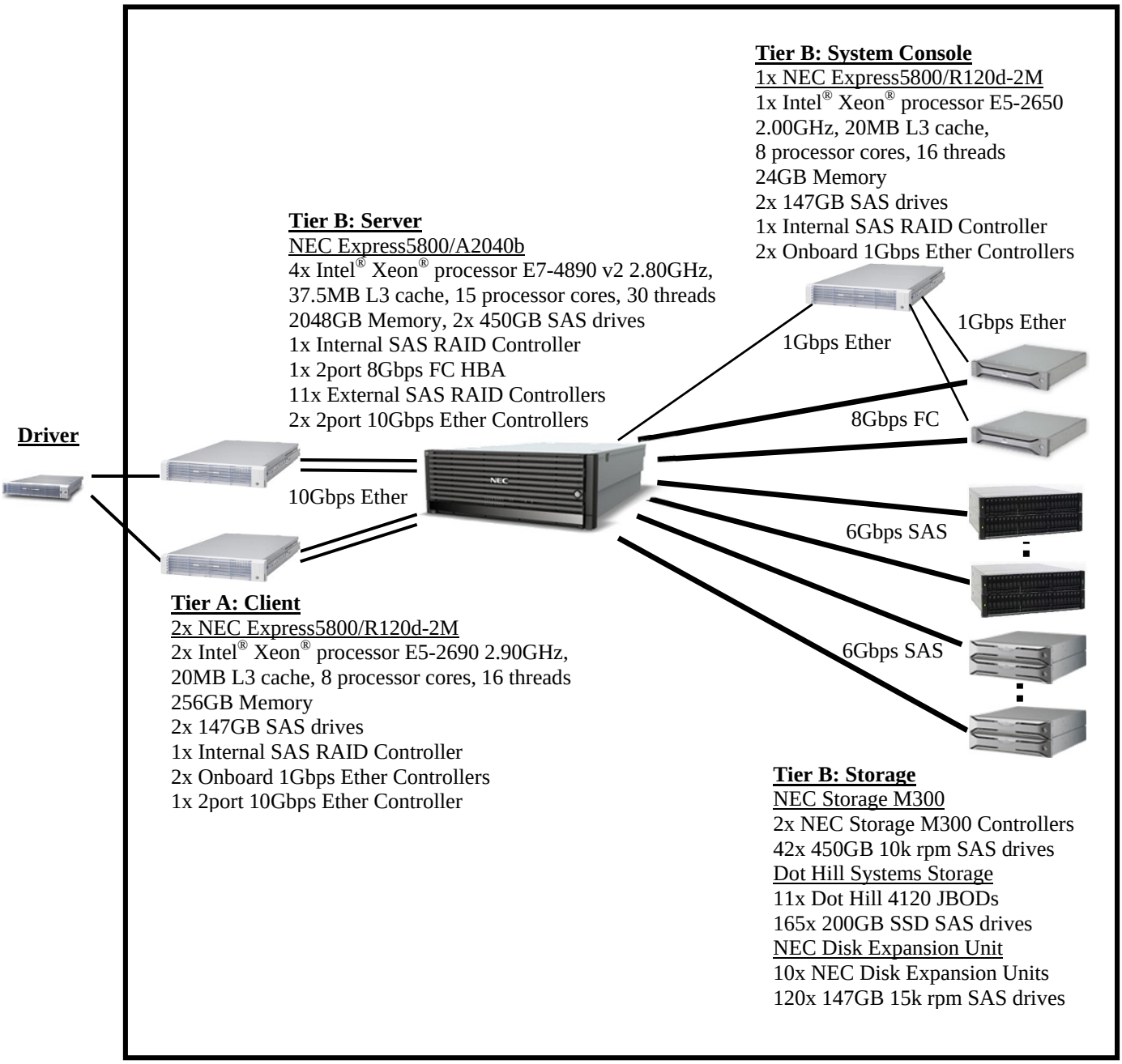
Diagrams of both Measured and Priced Configurations must be reported in the Report, accompanied by a description of the differences. This includes, but is not limited to:

- *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.

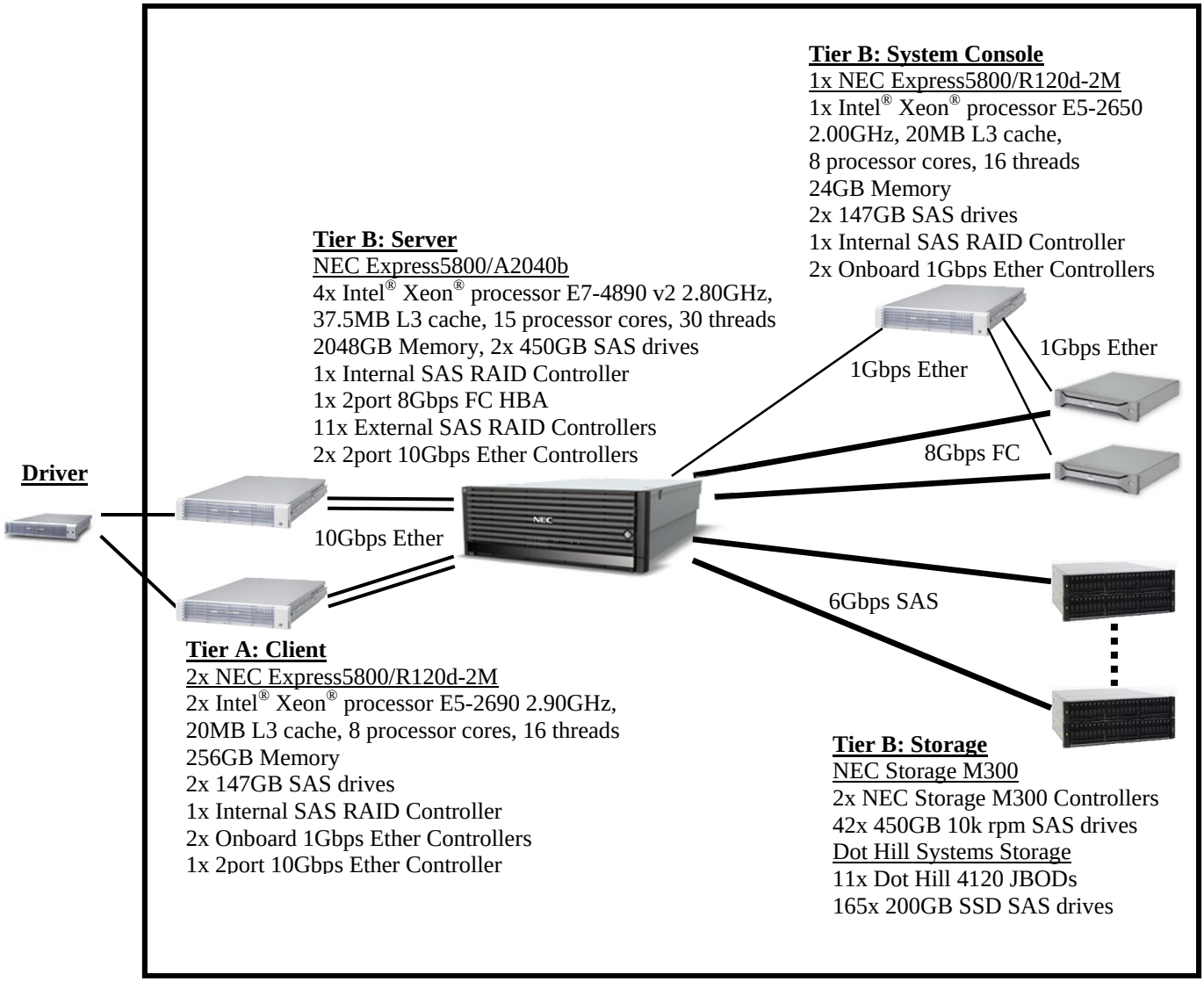
Figure1.1: NEC Express5800/A2040b, Measured Configuration Diagram



Priced Configuration

The following figure represents the priced configuration. There are differences between the measured and priced configuration at the NEC Disk Expansion Units and SAS drives used only for database backup. These NEC Disk Expansion Units and SAS drives were not used during the Test Run and not included in the priced configuration.

Figure1.2: NEC Express5800/A2040b, Priced Configuration Diagram



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.*

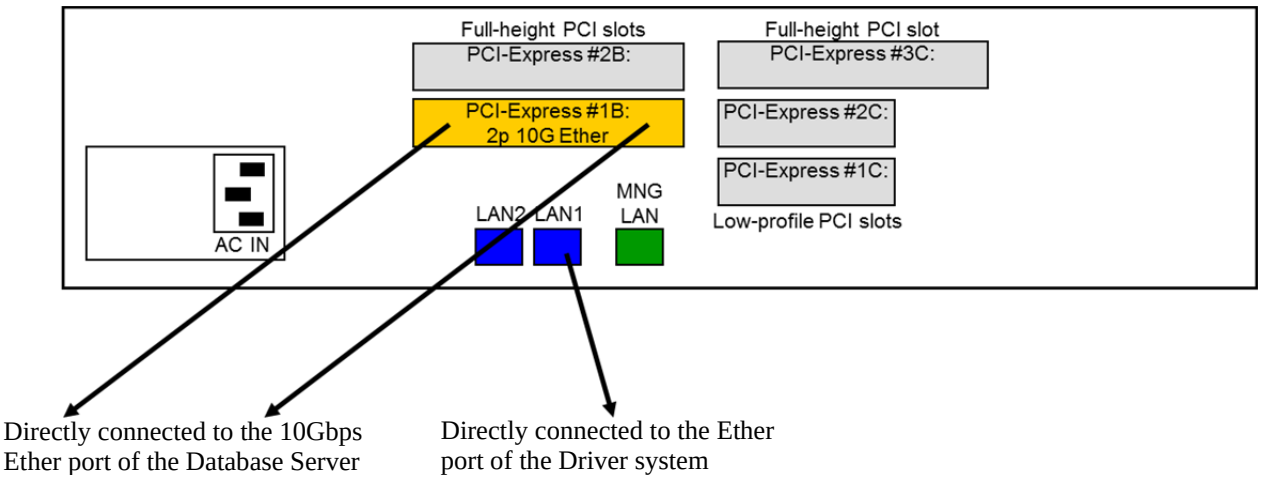
Driver

The driver is not included in the priced configuration or SUT. In this benchmark, two NEC Express5800/R120a-2 were used.

Tier-A installation / configuration

The NEC Express5800/R120d-2M has 2x Intel® Xeon® processor E5-2690, 2.90GHz, 20MB L3 cache, 256GB of Memory, 1x Internal SAS RAID Controller and 2x 147GB SAS drives, RAID1-protected, with Microsoft® Windows Server® 2012 Standard Edition. 1x 2port 10Gbps Ether Controller is installed to the PCI-Express slot of the NEC Express5800/R120d-2M. Tier-A consists of 2x NEC Express5800/R120d-2M, all of which have the same hardware configuration. Each Tier-A machine is connected to the database server with two 10GbE cables and to the driver system with a GbE cable.

Figure1.3: Rear view of each Client (NEC Express5800/R120d-2M)

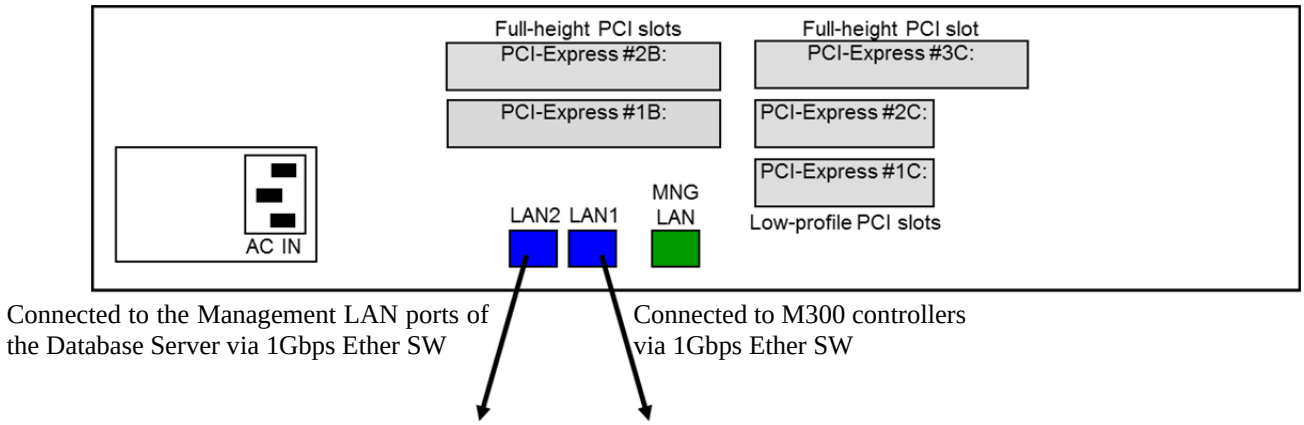


Tier-B installation / configuration

Tier-B hardware consists of one NEC Express5800/A2040b as the database server, two NEC Storage M300 and eleven Dot Hill 4120 as the Database Array and one NEC Express5800/R120d-2M as the System Console of the NEC Express5800/A2040b and the NEC Storage M300.

The System Console (NEC Express5800/R120d-2M) has 1x Intel® Xeon® processor E5-2650, 2.00GHz, 20MB L3 cache, 24GB of Memory, 1x Internal SAS RAID Controller and 2x 147GB SAS drives, RAID1-protected, with Microsoft® Windows Server® 2012 Standard Edition. The machine is connected to the Management LAN ports of the Database Server via 1Gbps Ether switch, and connected to M300 controllers via 1Gbps Ether switch.

Figure1.4: Rear view of the System Console (NEC Express5800/R120d-2M)



The NEC Express5800/A2040b has 4x Intel® Xeon® processor E7-4890 v2, 2.80GHz, 37.5MB L3 cache, 2048GB of Memory, 1x Internal SAS RAID Controller and 2x 450GB SAS drives, RAID1-protected, with Microsoft® Windows Server® 2012 Standard Edition. 1x 2port 8Gbps FC HBA, 11x External SAS RAID Controllers and 2x 2port 10Gbps Ether Controllers are installed to the PCI-Express slots of the NEC Express5800/A2040b. The FC HBA, External SAS RAID Controllers and Ether Controllers are connected to the Database Array as follows:

MGB1 Management LAN	to the system console via 1Gbps Ether SW
MGB2 Management LAN	to the system console via 1Gbps Ether SW
PCI-Express #2: External SAS RAID Controller	to 4120 JBOD
PCI-Express #3: External SAS RAID Controller	to 4120 JBOD
PCI-Express #4: 2port 10Gbps Ether Controller	#0 to 10Gbps Ether port of client #2
	#1 to 10Gbps Ether port of client #1
PCI-Express #5: 2port 10Gbps Ether Controller	#0 to 10Gbps Ether port of client #2
	#1 to 10Gbps Ether port of client #1
PCI-Express #6: External SAS RAID Controller	to 4120 JBOD
PCI-Express #7: External SAS RAID Controller	to 4120 JBOD
PCI-Express #8: External SAS RAID Controller	to 4120 JBOD
PCI-Express #10: External SAS RAID Controller	to 4120 JBOD
PCI-Express #11: External SAS RAID Controller	to 4120 JBOD
PCI-Express #12: External SAS RAID Controller	to 4120 JBOD
PCI-Express #13: 2port 8Gbps FC HBA	#0 to M300 Controller
	#1 to M300 Controller
PCI-Express #14: External SAS RAID Controller	to 4120 JBOD
PCI-Express #15: External SAS RAID Controller	to 4120 JBOD

Figure1.5: Rear view of the Server (NEC Express5800/A2040b)

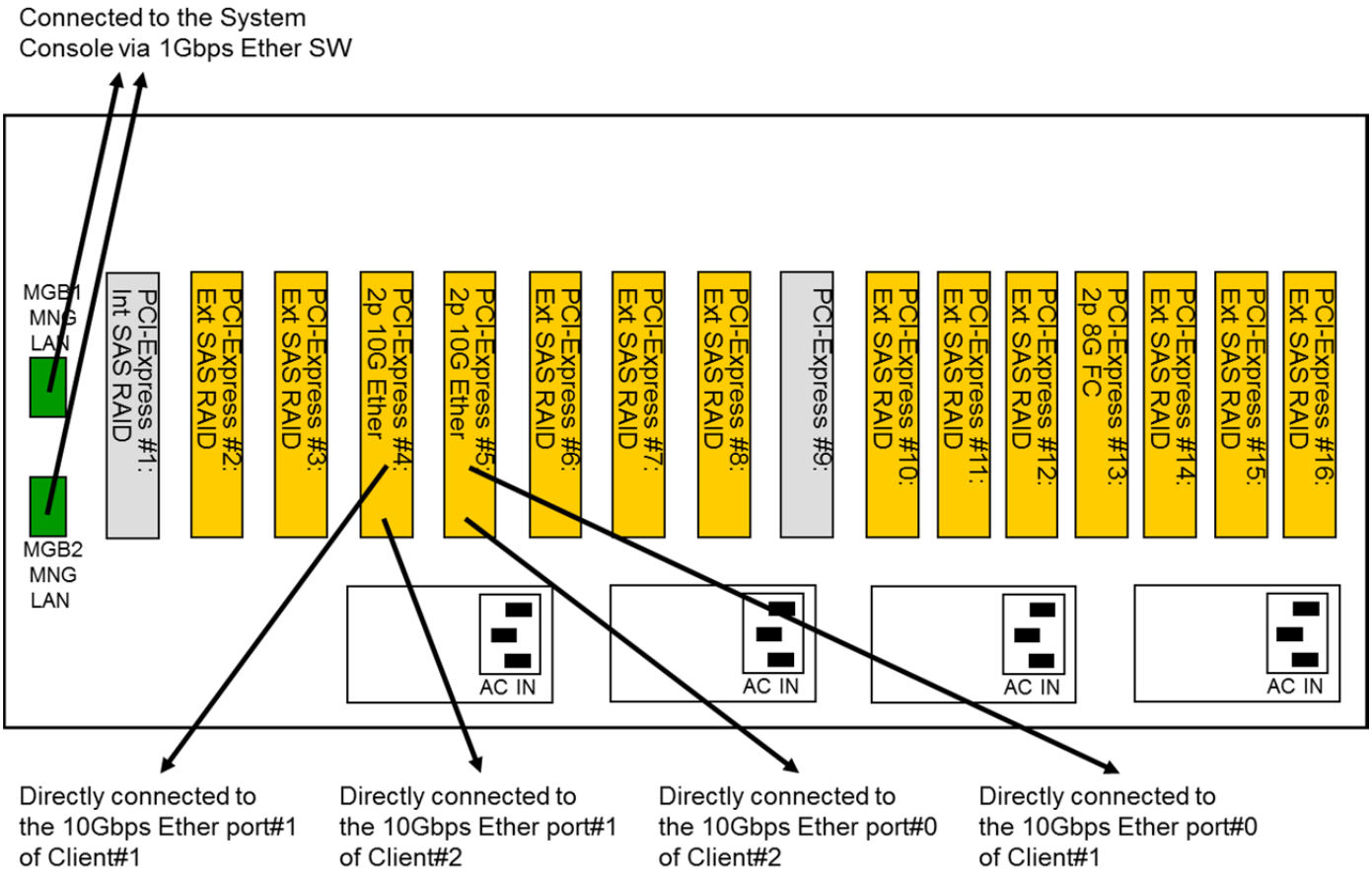
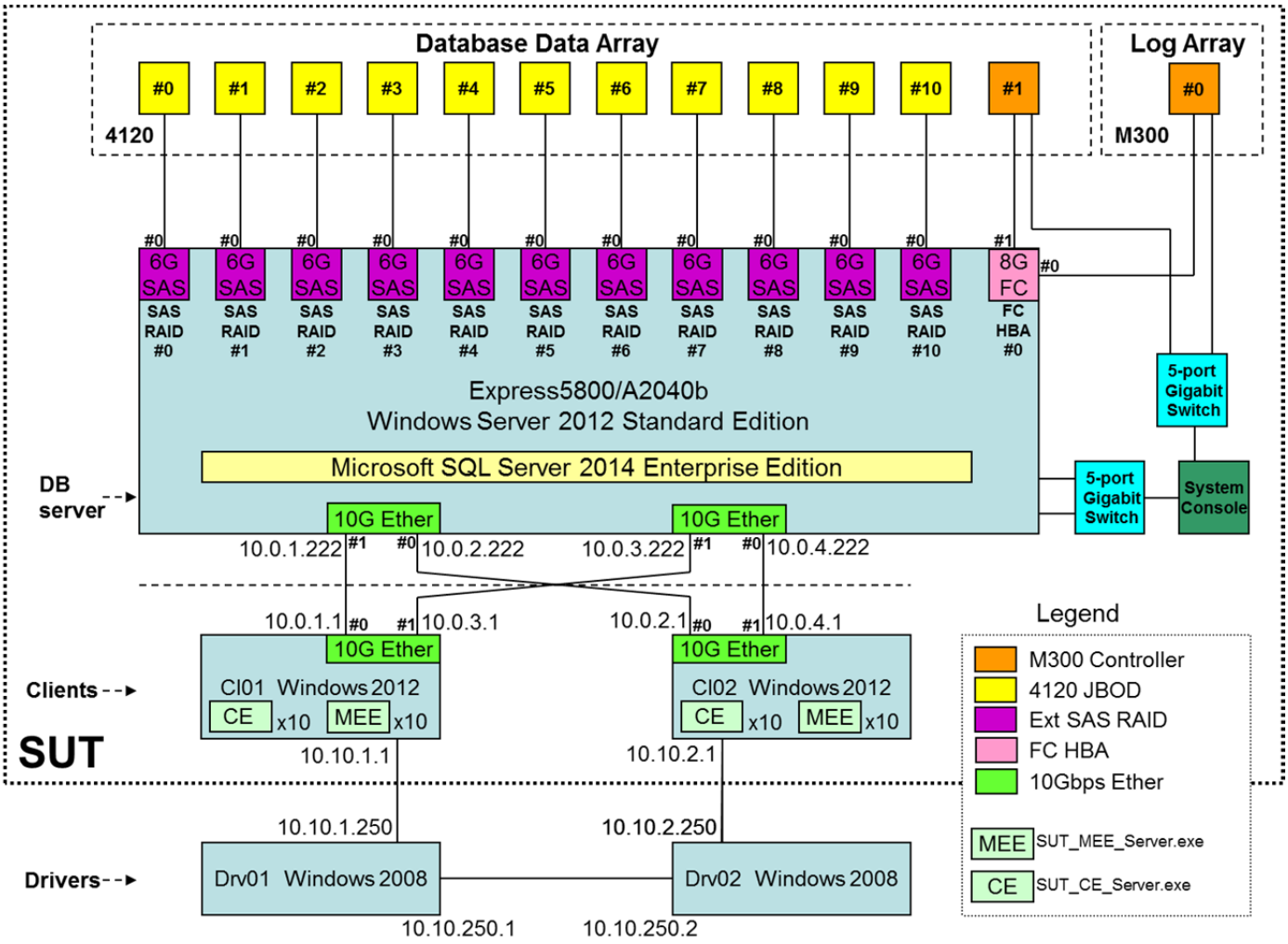


Figure1.6: Overview of the whole system connections



Connect NEC Storage M300 controllers and Dot Hill 4120 JBODs

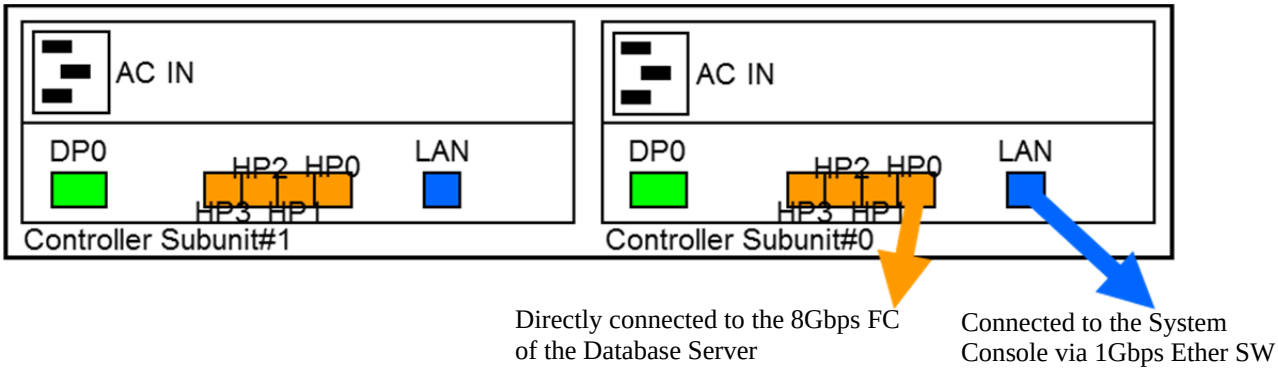
The Database Array consists of two types of disk array system. One is Database Data Array and the other is Log Array.

Database Data Array has one NEC Storage M300 controller and eleven Dot Hill 4120 JBODs. The M300 controller is connected to the 8Gbps FC of the Database Server. The 4120 JBODs are connected to the 6Gbps SAS of the Database Server.

Log Array has one NEC Storage M300 controller. The controller is connected to the 8Gbps FC of the Database Server.

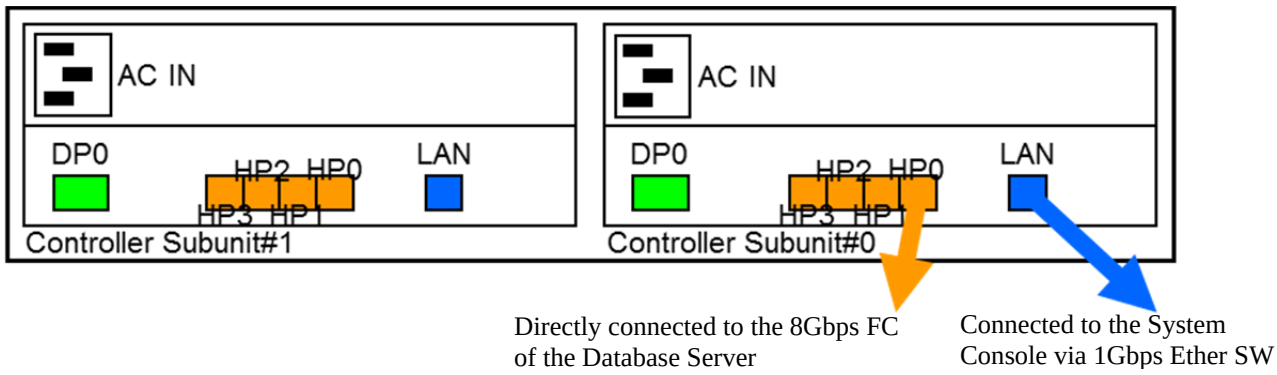
See Figure 1.7 to check the connection diagram of the NEC Storage M300 controller for Log Array.

Figure1.7: Connection diagram of the NEC Storage M300 for Log Array



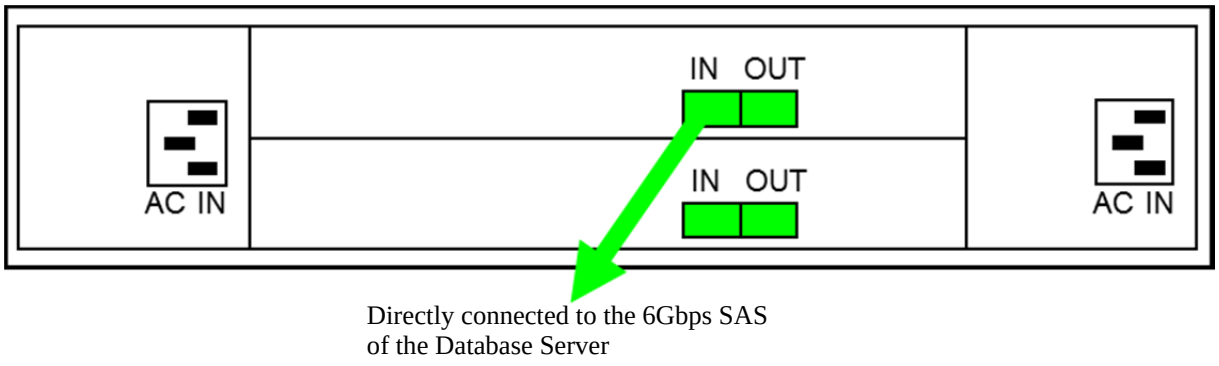
See Figure 1.8 to check the connection diagram of the NEC Storage M300 controller for Database Data Array.

Figure1.8: Connection diagram of the NEC Storage M300 for Database Data Array



See Figure 1.9 to check the connection diagram of the Dot Hill 4120 JBODs for Database Data Array.

Figure1.9: Connection diagram of the Dot Hill 4120 for Database Data Array



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: Prepare "Windows Server® 2012, NEC Driver Set"

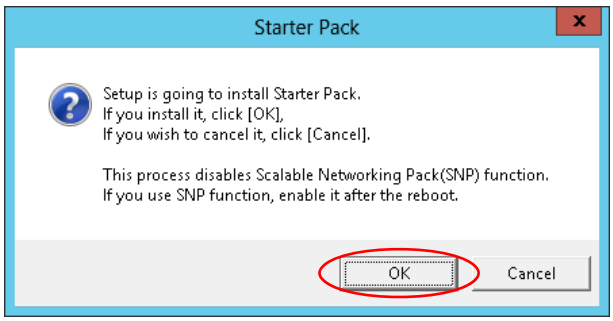
1. Download "Windows Server® 2012, NEC Driver Set" for NEC Express5800/R120d-2M from "http://www.58support.nec.co.jp/global/download/w2012/driverset/Global-WS2012-S1_100.html".
2. Unzip the download file and copy to a DVD medium.

Step.2: Install "Windows Server® 2012"

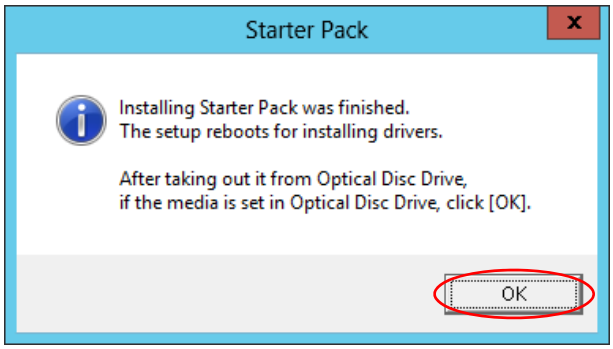
1. Put an OS install medium into the DVD drive of the NEC Express5800/R120d-2M.
2. Power on the NEC Express5800/R120d-2M with a DVD Drive, then "Windows Setup" boots from the OS install medium.
3. Continue normal Windows installation.

Step.3: Install driver

1. After Windows installation completes, put the "Windows Server® 2012, NEC Driver Set" DVD medium into the DVD drive of the NEC Express5800/R120d-2M.
2. Run the setup program, "\winnt\bin\pkgsetup.vbs"
3. Click "OK".



4. Remove the "Windows Server® 2012, NEC Driver Set" DVD medium from the DVD drive and click "OK" to reboot the NEC Express/R120d-2M.



OS Configuration

Assign IP Address

Assign IP addresses to Ethernet cards.

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

"PCI1B" is used for this connection. Assign IP address "10.0.x.1".

"x" represents the Client number.

"PCI1B 2" 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**

"LAN1" is used for this connection. Assign IP address "10.10.x.1".

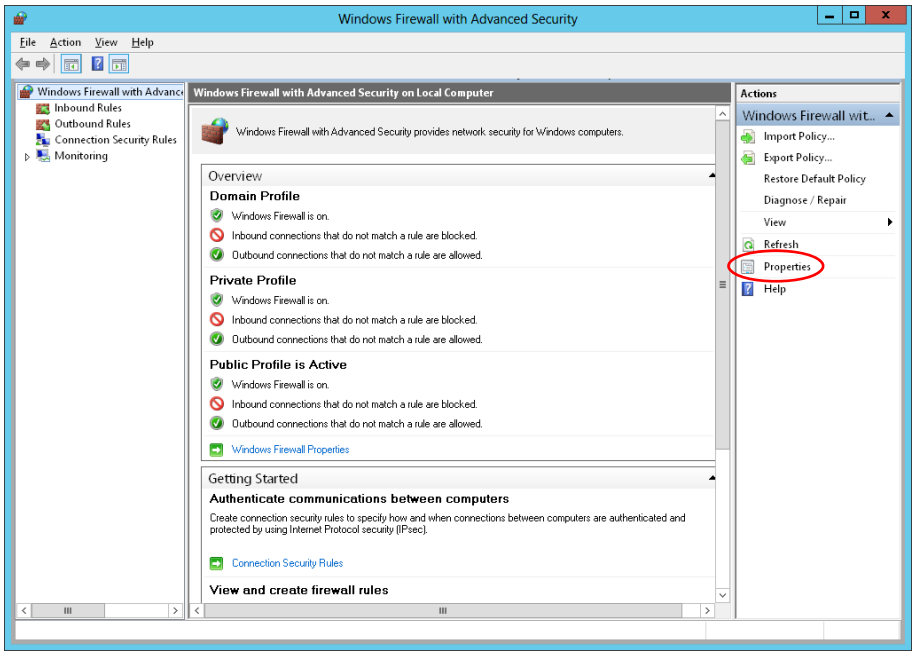
"x" represents the Client number.

Disable "Windows Firewall"

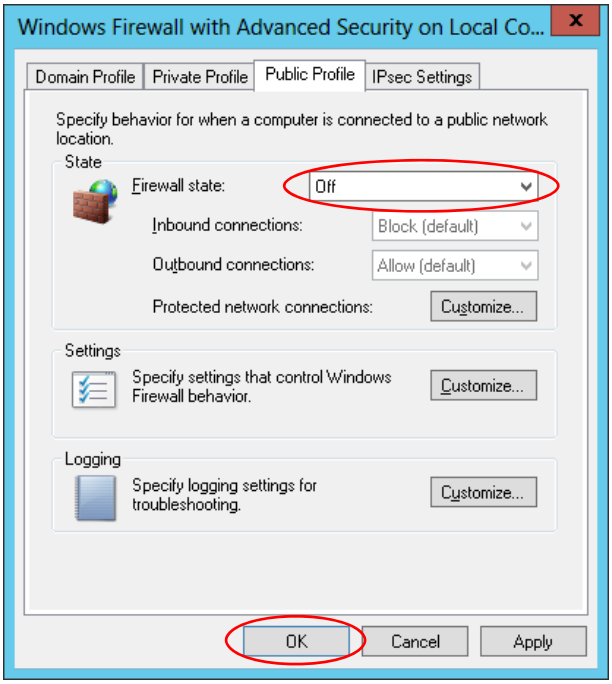
To connect the Database Server from the Clients, disable "Windows Firewall".

1. Run the configuration tool, "WF.msc".

2. Click “Properties”.



3. Select “Off” as Firewall state and click “OK”.



SQL Server® Installation (only Client #1)

Install Microsoft® SQL Server® 2012 with Service Pack 1 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 vcredist_x86.exe, SUT_CE_Server.exe and SUT_MEE_Server.exe.

Tier-B

Tier-B hardware consists of one NEC Express5800/A2040b as the database server, two NEC Storage M300 controllers & eleven Dot Hill 4120 JBODs as the Database Array and one NEC Express5800/R120d-2M as the System Console of the NEC Express5800/A2040b & the NEC Storage M300.

Tier-B : The System Console

OS Installation

The OS installation procedure on the System Console, NEC Express5800/R120d-2M, is the same as described in Tier-A portion of this clause.

OS Configuration

Assign IP addresses to Ethernet connections.

Step.1: **Connection to M300 controllers**

"LAN1" is used for this. Assign IP address "192.168.11.223".

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

"LAN2" is used for this. Assign IP address "192.168.1.2".

Tier-B : The Database Server

OS Installation

The database server has already had its OS, Microsoft® Windows Server® 2012 Standard Edition installed.

OS Configuration

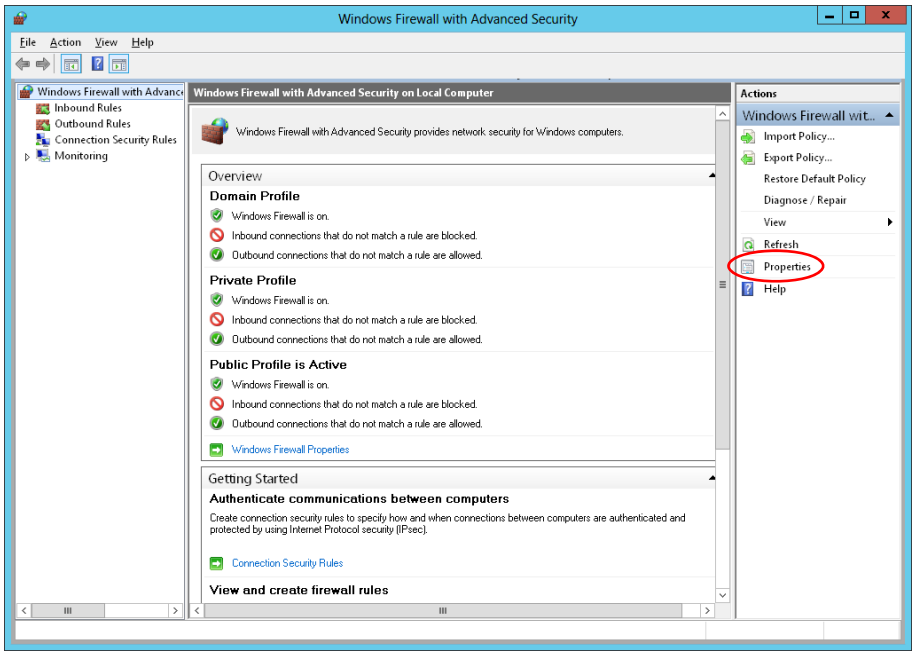
To configure the OS of the Database Server, follow the procedures below.

Disable "Windows Firewall"

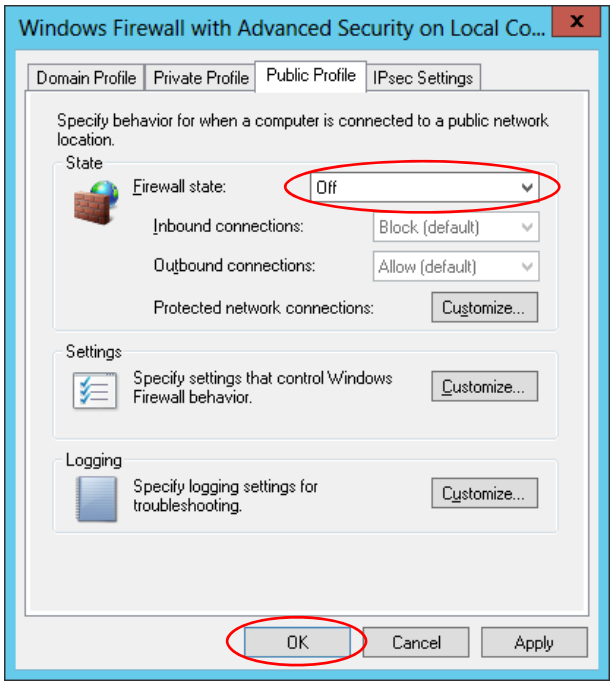
To connect the Database Server from the Clients, disable "Windows Firewall".

1. Run the configuration tool, "WF.msc".

2. Click “Properties”.



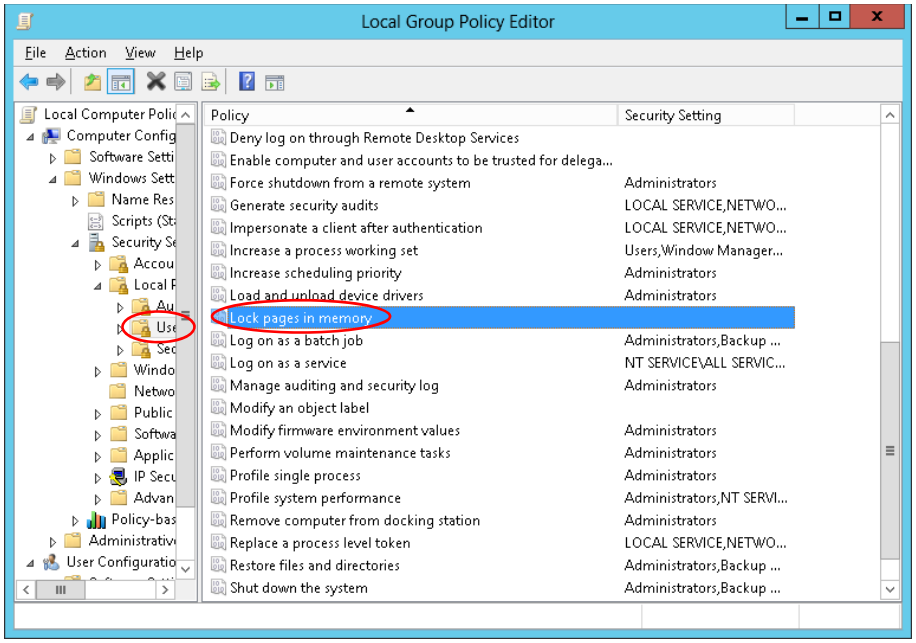
3. Select “Off” as Firewall state and click “OK”.



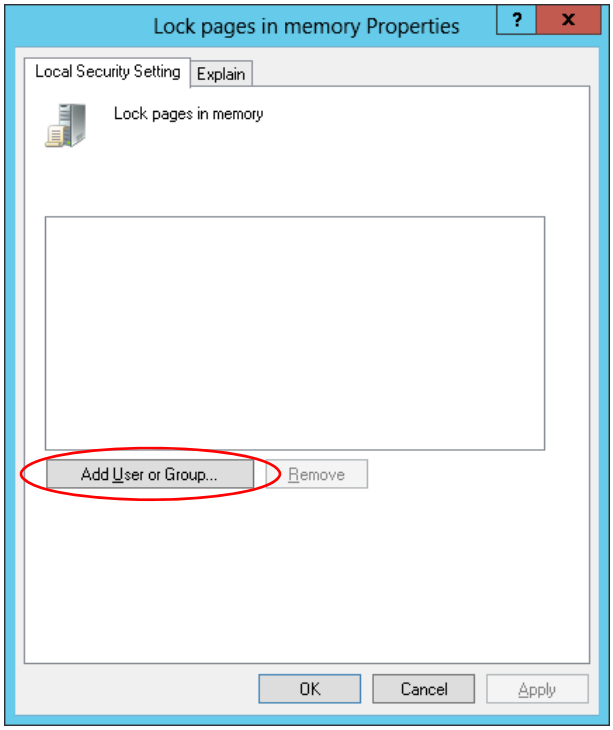
Configure “Lock pages in memory”

1. Run the configuration tool, “gpedit.msc”.

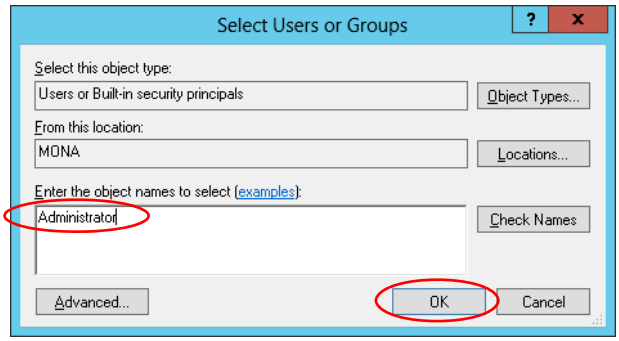
2. Select “Local Computer Policy” -> “Computer Configuration” -> “Windows Settings” -> “Security Settings” -> “Local Policies” -> “User Rights Assignment” in the left window. Then double-click “Lock pages in memory” in the right windows.



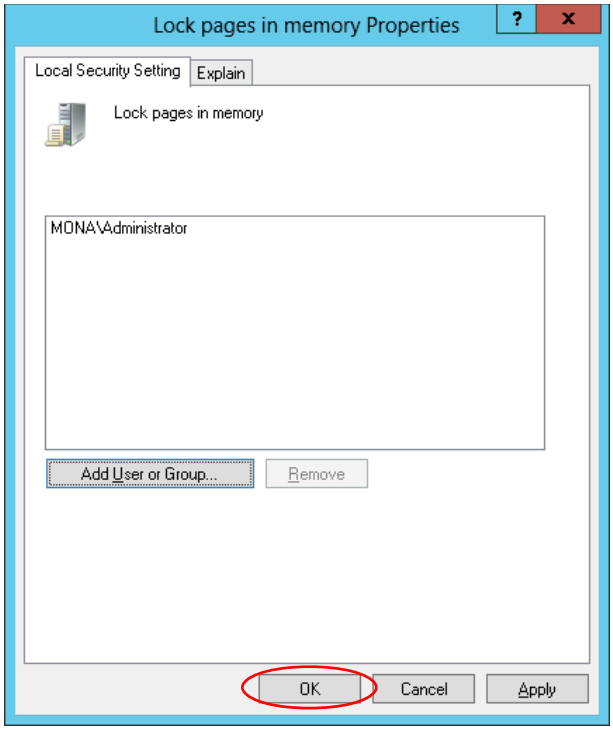
3. Click “Add User or Group”.



4. Enter “Administrator” and click “OK”.



5. Click “OK”.



6. Logoff to reflect new configuration.

Configure “Registry”

1. Run “Largepages.reg” to enable “code in large page” configuration controlled by the OS (the reg file “Largepages.reg” is included in the Supporting Files).
2. Reboot OS to reflect new configuration.

RAID Configuration for the Database Array

Step by Step instruction is shown in M300StorageSetup.docx and 4120StorageSetup.docx (included in the Supporting Files).

Configure Partitions for Database Server

Step.1: **Create Partitions**

Use “Disk Management” to create partitions as shown sydskmap_[1..3].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

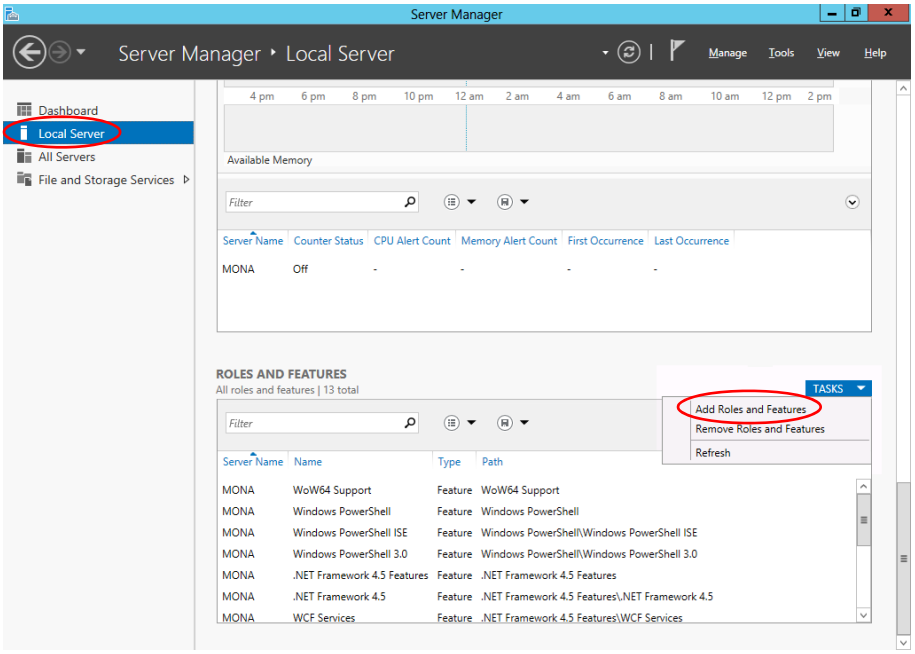
Assign mount points using diskpart command. Execute “diskpart /s mount.txt” from the command line. (the script file “mount.txt” is included in the Supporting Files).

SQL Server® Installation

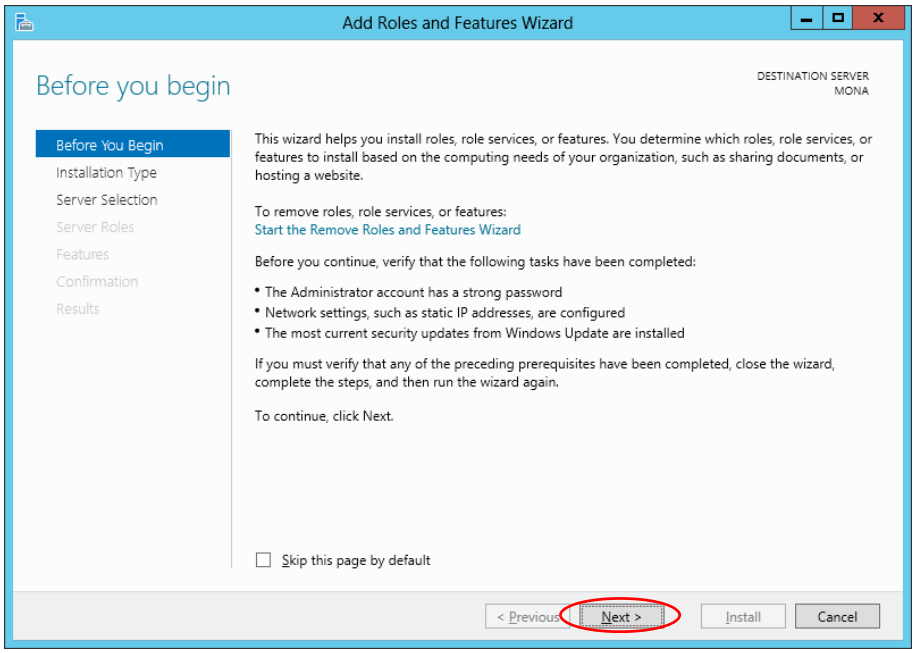
Install Microsoft® SQL Server® 2014. Here are the notes for the installation.

Step.1: Install .NET Framework 3.5

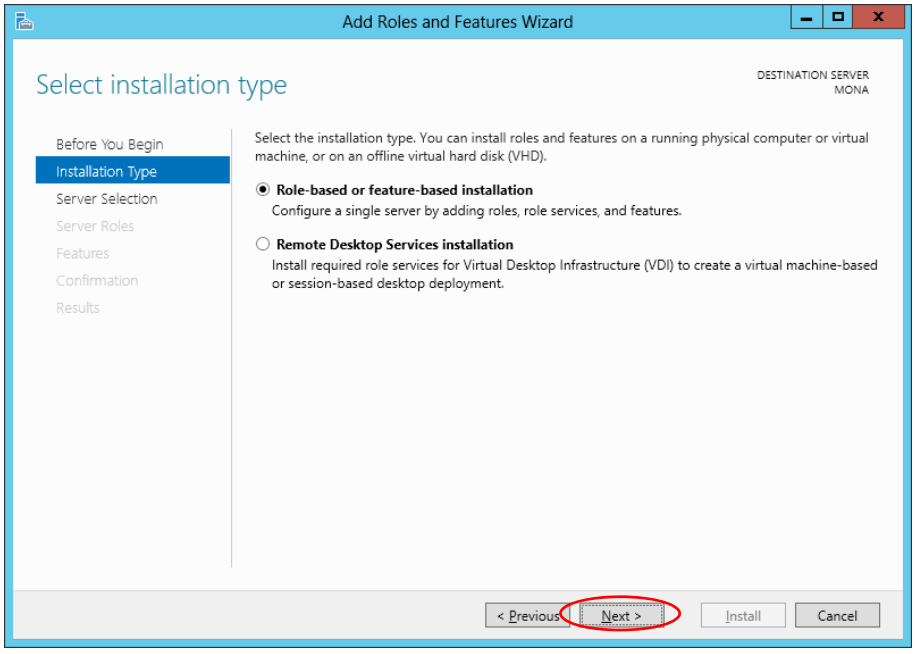
1. Run the configuration tool, “ServerManager.exe”.
2. Select “Local Server” in the left window. Then click “Add Roles and Features” in the right window.



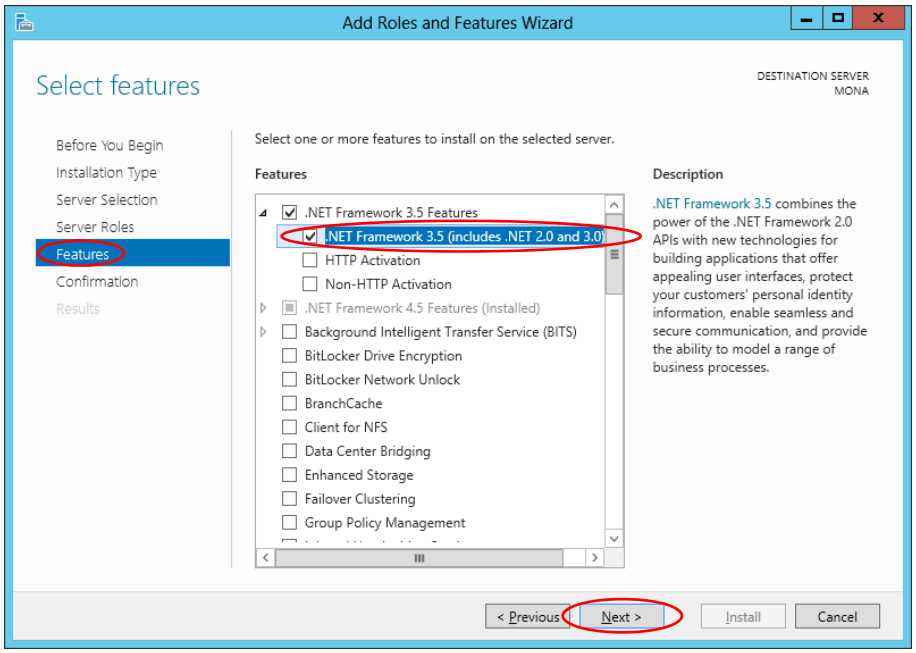
3. Click “Next”.



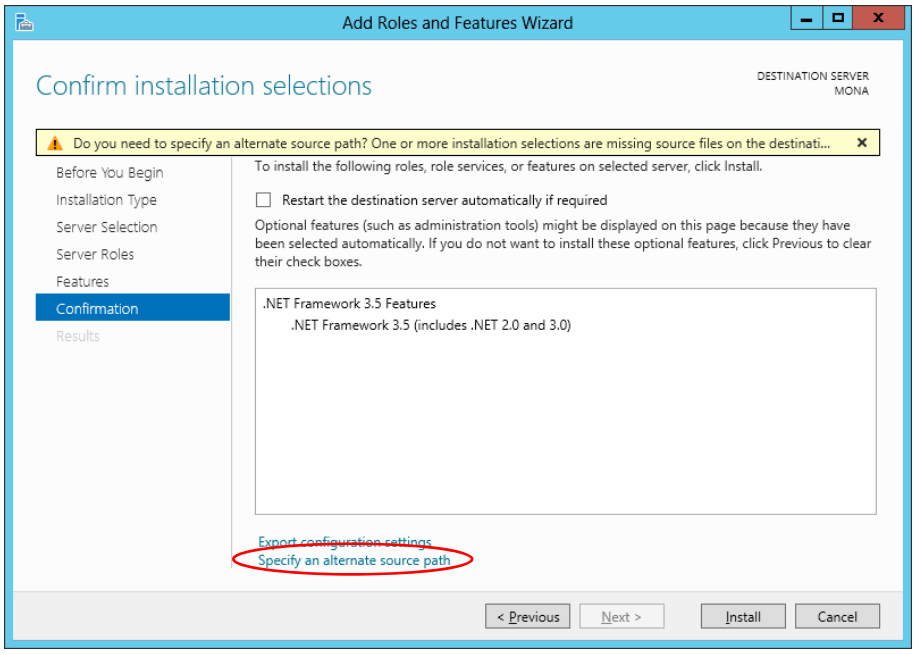
4. Click “Next”.



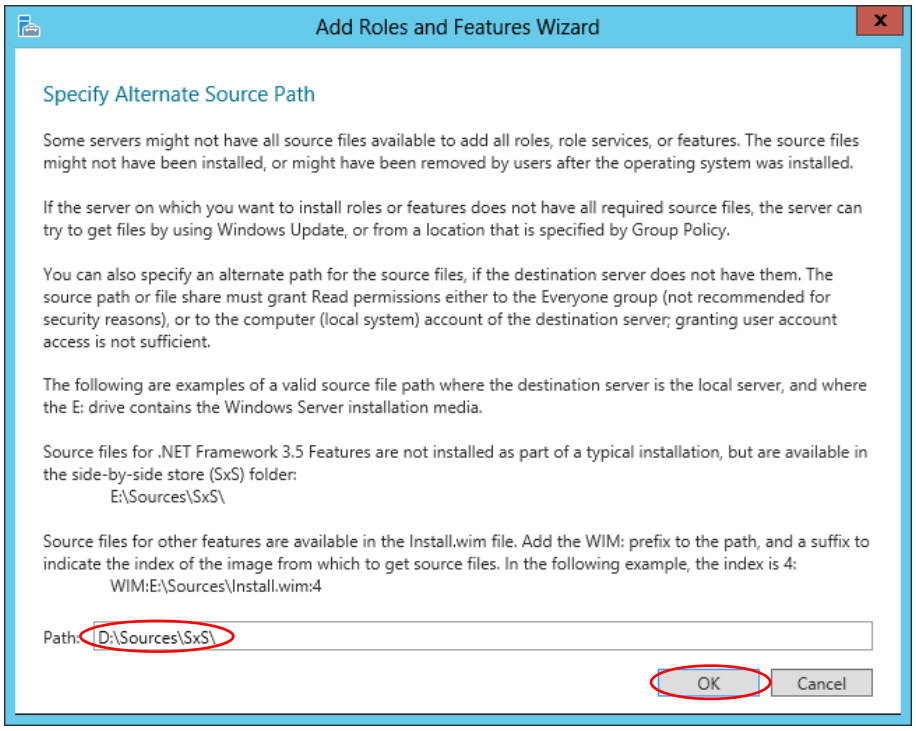
5. Select “Features” in the left window. Then select “.NET Framework 3.5” and click “Next”.



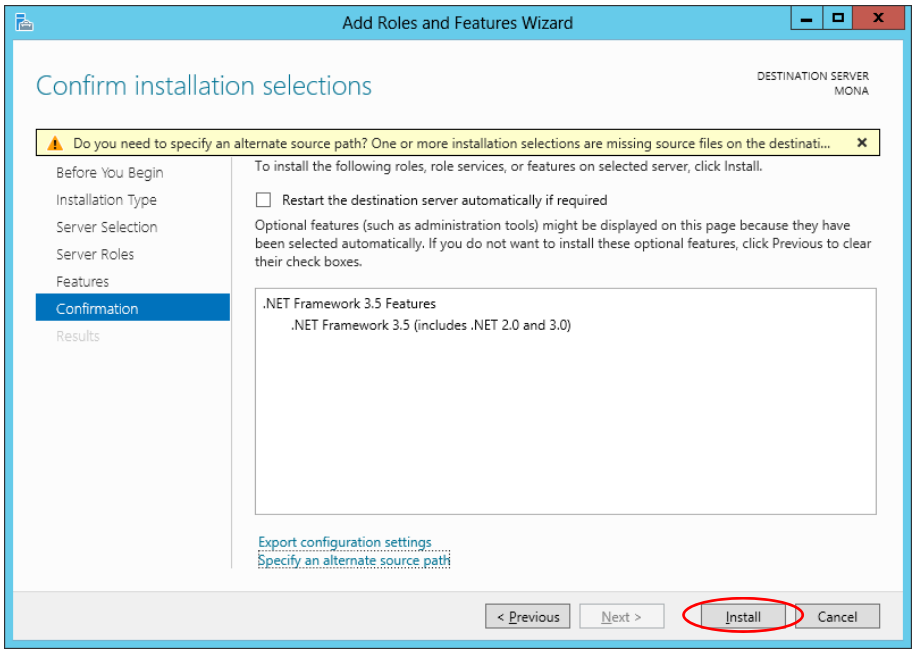
6. Click “Specify an alternate source path”.



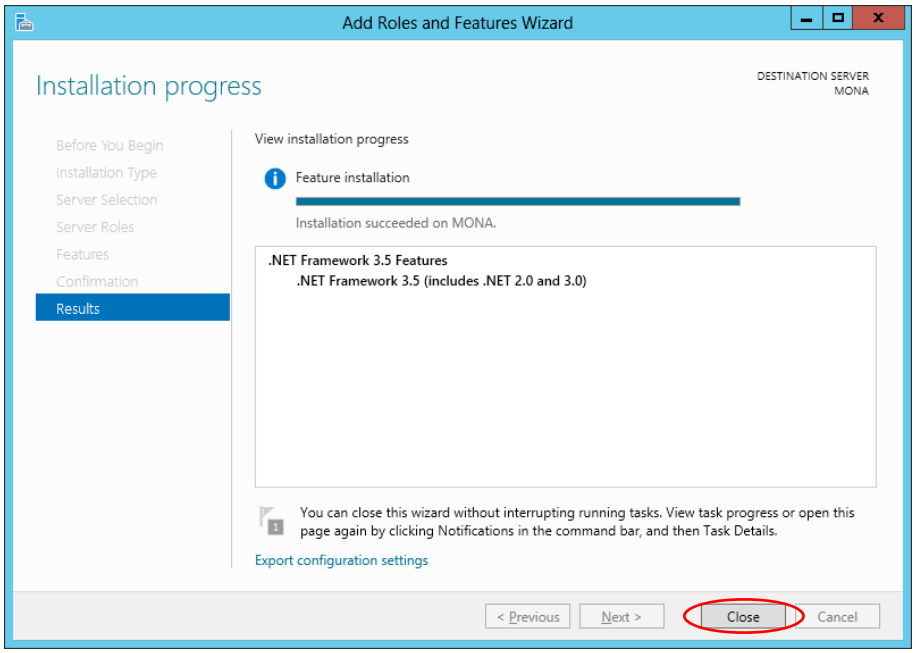
7. Enter Source Path and click “OK”.



8. Click “Install”.

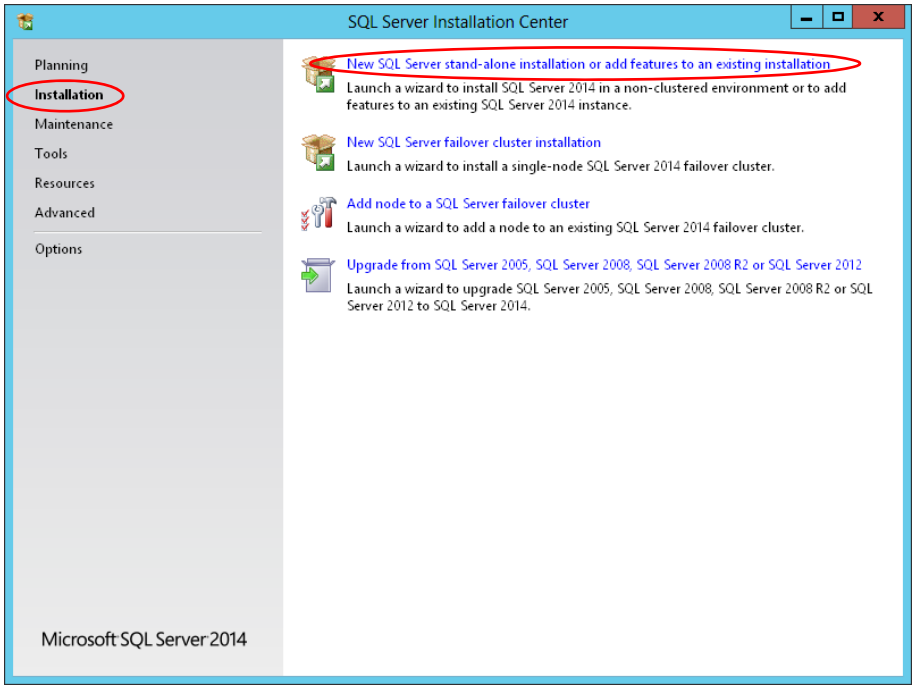


9. Click “Close”.

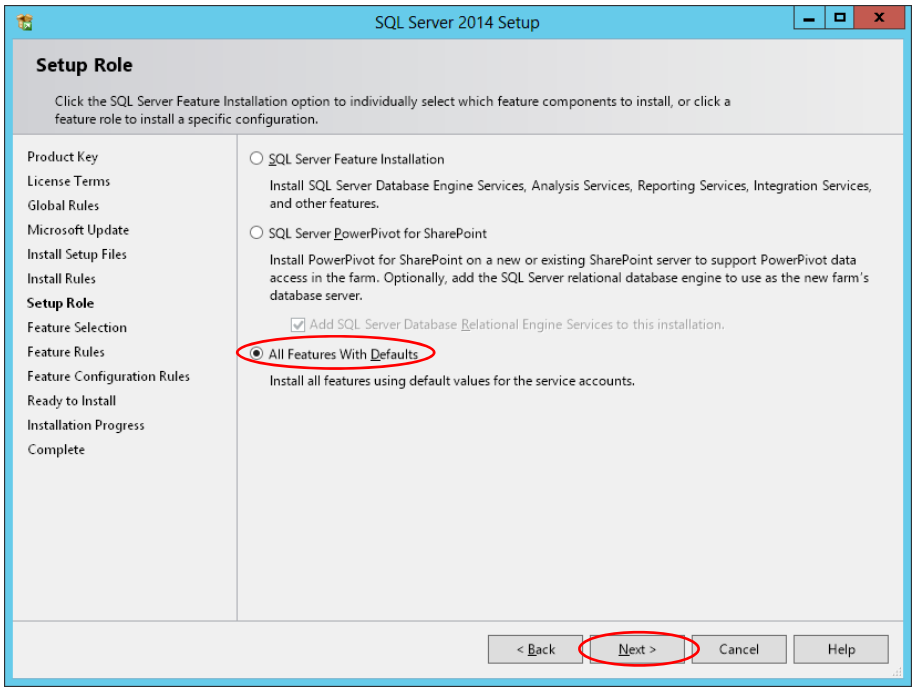


Step.2: **Install SQL Server® 2014**

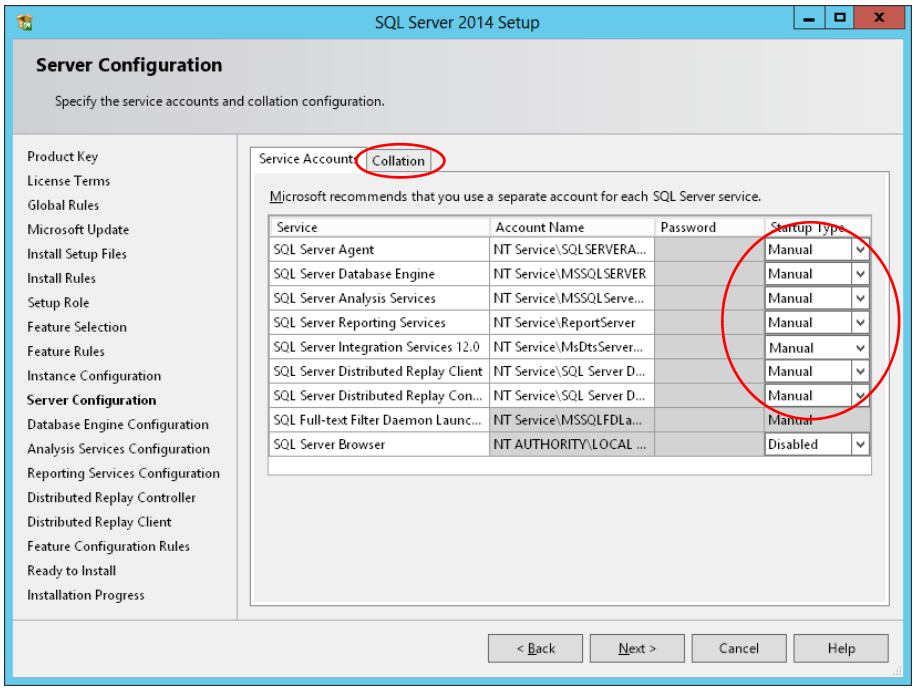
1. Put the “Microsoft SQL Server® 2014 Enterprise Edition” DVD medium into the DVD drive of the NEC Express5800/A2040b.
2. Run the setup program, “\setup.exe”.
3. Select “Installation” in the left window. Then click “New SQL Server stand-alone installation or add features to an existing installation” in the right window.



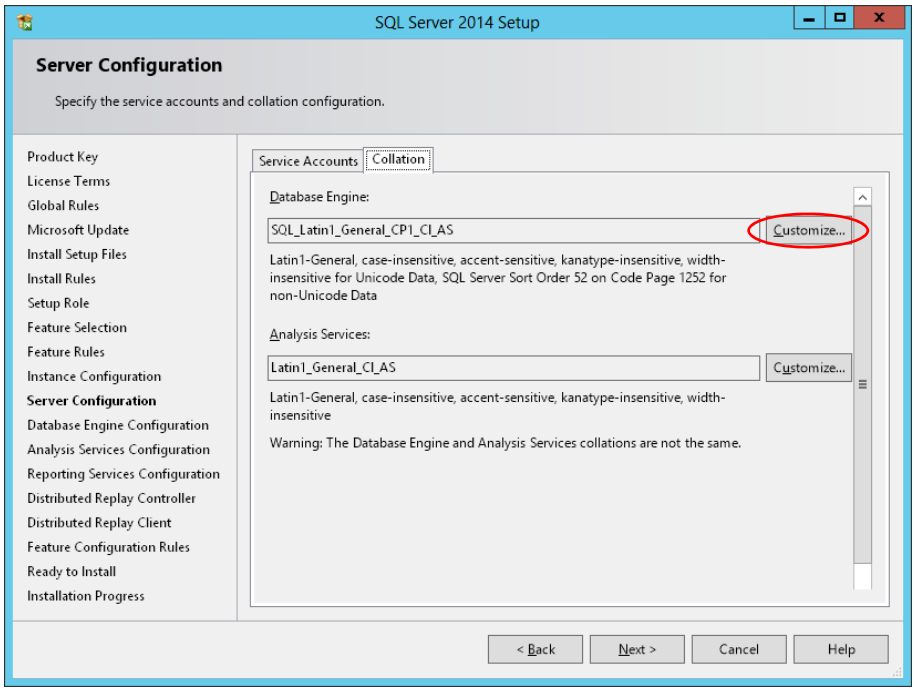
4. Select “All Features With Defaults” and click “Next”.



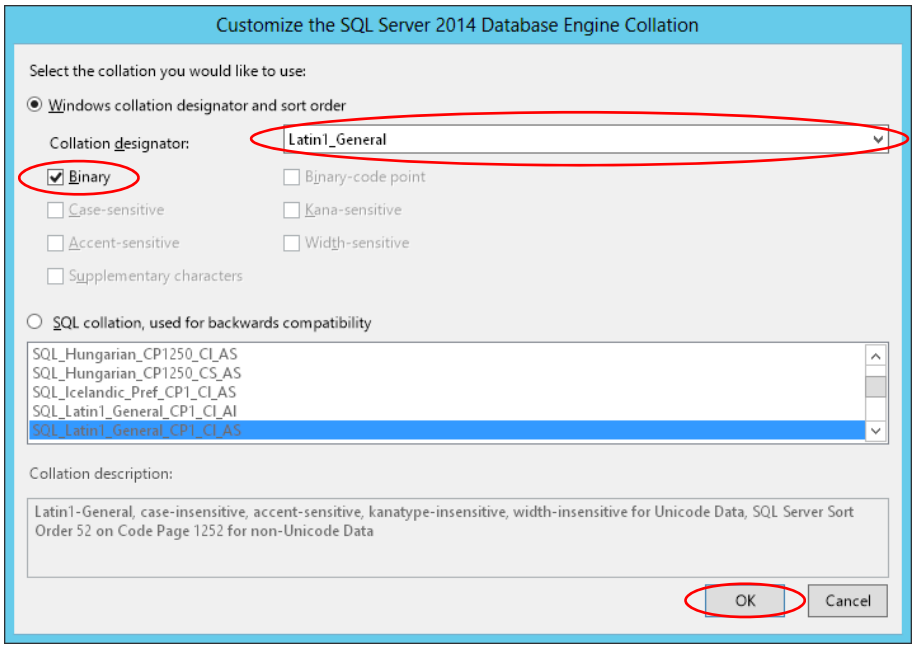
5. Change the “Startup Type” from Automatic to Manual and click “Collation”.



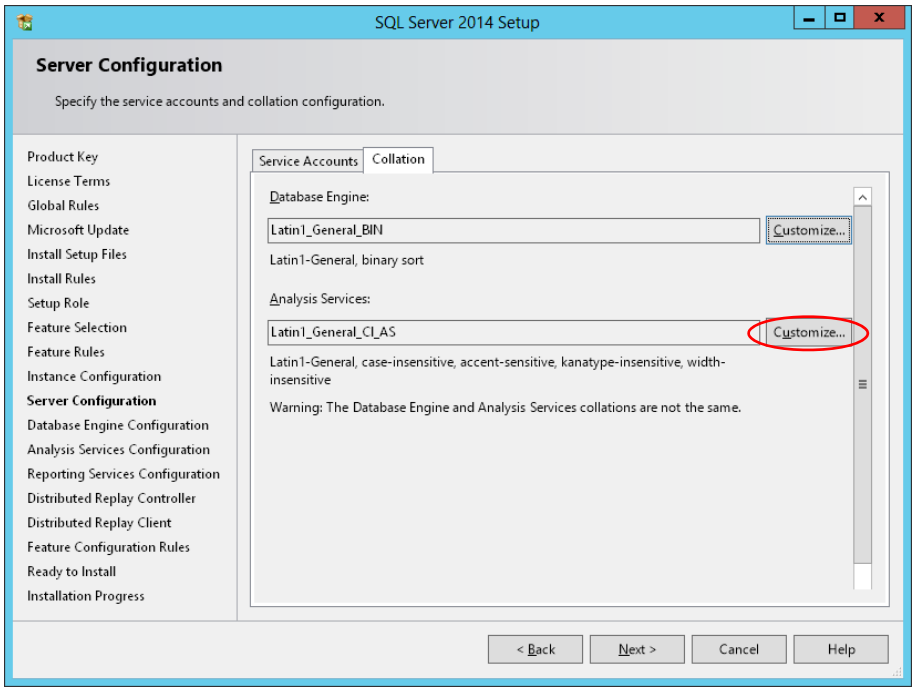
6. Click “Customize”.



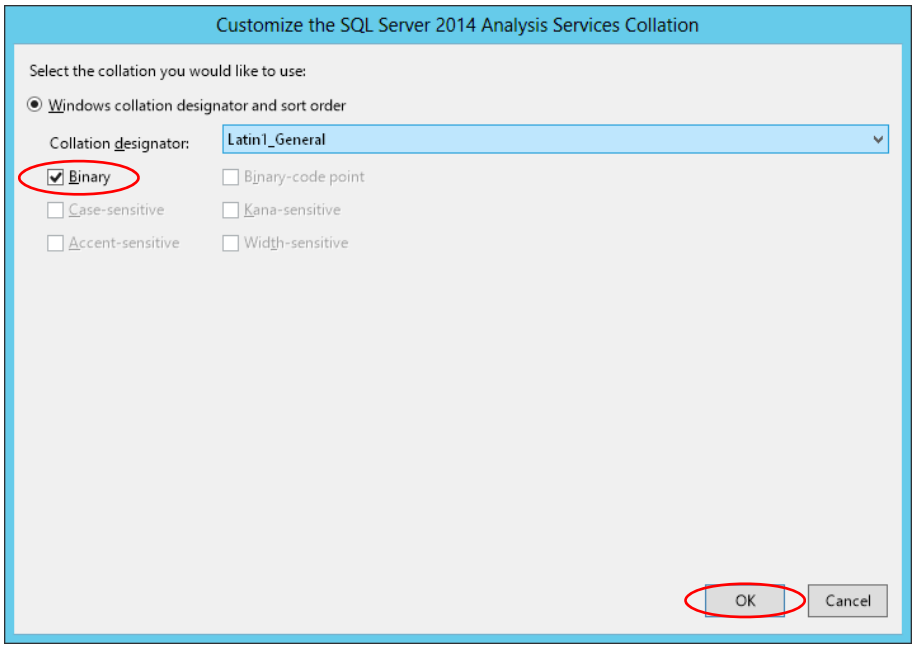
7. Select “Latin1_General” and “Binary”. Then click “OK”.



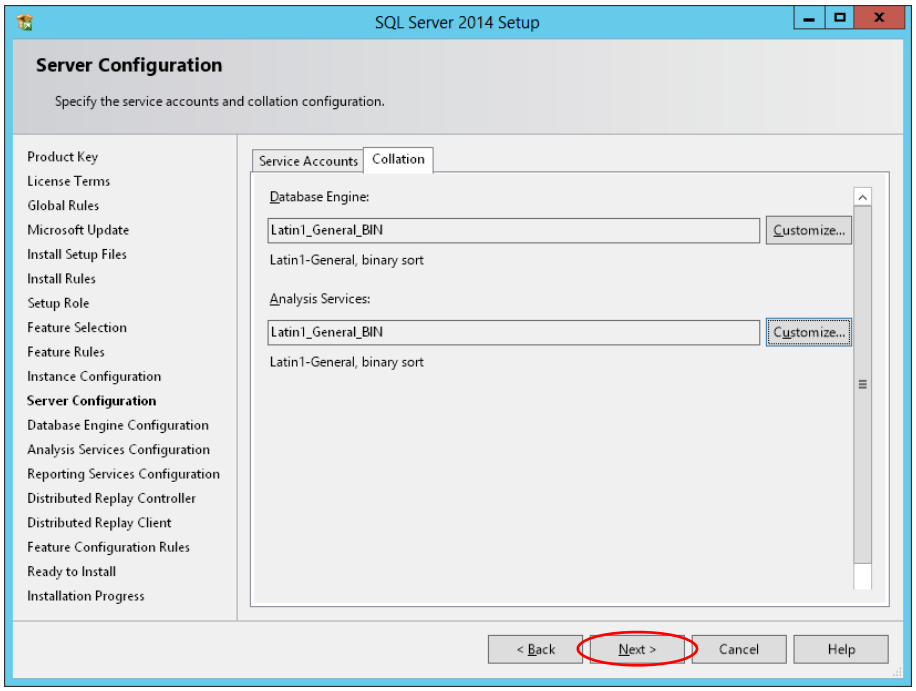
8. Click “Customize”.



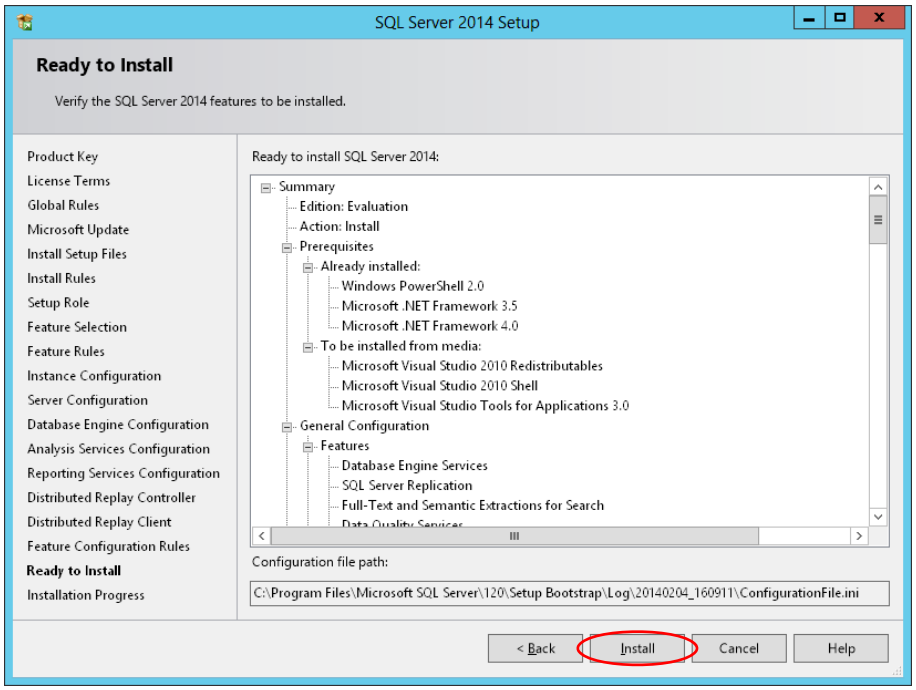
9. Select “Binary” and click “OK”.



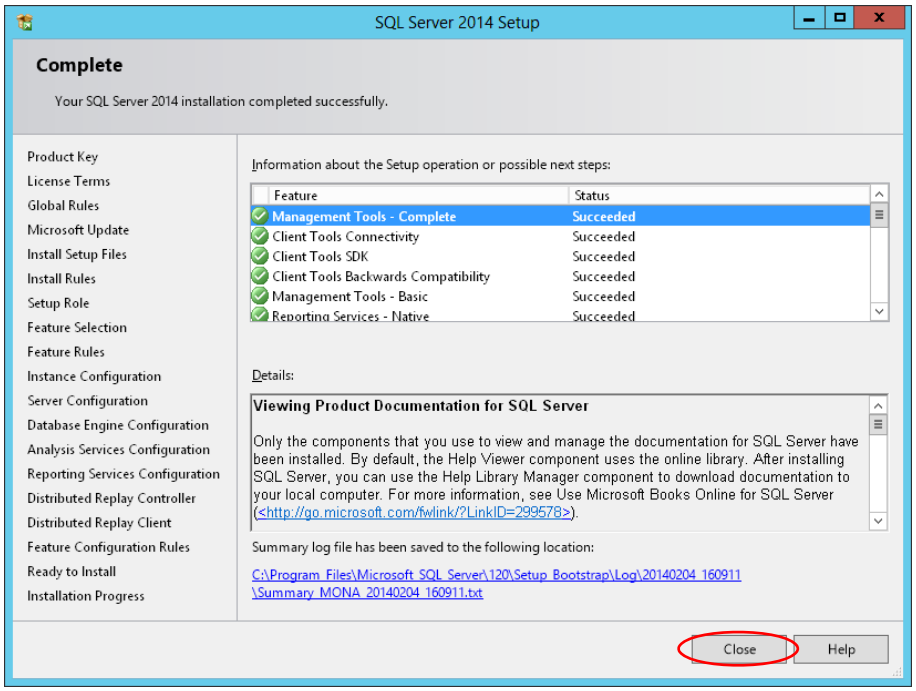
10. Click “Next”.



11. Click “Install”.



12. Click “Close”.



SQL Server® Configuration

Step.1: Startup Parameter

Start Microsoft® SQL Server® 2014 from the command line using startSQL.cmd (included in the Supporting Files).

Step.2: Configure 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	1073741823	1073741823
affinity64 I/O mask	-2147483648	2147483647	0	0
affinity64 mask	-2147483648	2147483647	0	0
Agent XPs	0	1	0	0
allow updates	0	1	0	0
backup checksum default	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
contained database authentication	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	32767	1	1
max full-text crawl range	0	256	4	4
max server memory (MB)	128	2147483647	1890000	1890000
max text repl size (B)	-1	2147483647	65536	65536
max worker threads	128	65535	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
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 tempdb**

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

Step.4: **Configure NUMA affinity**

Run NUMA-node-affinity.sql to configure the affinity of NUMA nodes (the sql file “NUMA-node-affinity.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).
3. Reboot OS to reflect new configuration.

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 2,750,000 customers. The SQL Server® scripts and setup command files are included in the Supporting Files\Clause2 folder. Two file groups are used for tables and indices. One filegroup called "fixed_fg" and the other filegroup called "growing_fg". "fixed_fg" uses all the V:\Device\Fixed_* disk partitions and "growing_fg" uses all the V:\Device\Growing_* disk partitions. 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® 2014 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 2,750,000 customers.

Table 2.1: Number of Rows for Server

Table Name	Rows Loaded
Scaling Tables	
ACCOUNT PERMISSION	19,525,677
ADDRESS	4,125,004
BROKER	27,500
COMPANY	1,375,000
COMPANY COMPETITOR	4,125,000
CUSTOMER	2,750,000
CUSTOMER ACCOUNT	13,750,000
CUSTOMER TAXRATE	5,500,000

DAILY MARKET	2,458,293,750
FINANCIAL	27,500,000
LAST TRADE	1,883,750
NEWS ITEM	2,750,000
NEWS XREF	2,750,000
SECURITY	1,883,750
WATCH ITEM	275,022,696
WATCH LIST	2,750,000
Growing Tables	
CASH TRANSACTION	43,718,468,517
HOLDING	2,432,976,985
HOLDING HISTORY	63,684,926,128
HOLDING SUMMARY	136,764,742
SETTLEMENT	47,520,000,000
TRADE	47,520,000,000
TRADE HISTORY	114,047,833,613
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	18x450GB, 10K, SAS M300 Base model RAID10	V: (NTFS) V:\Device\TPCE_Log\ (RAW) V:\Device\TPCE_TempLog (NTFS) V:\Device\TPCE_TempDB (NTFS)	10GB 2000GB 1616.87GB	Log TPCE_TempLog TPCE_TempDB
1	1	0-1	FC HBA	24x450GB, 10K, SAS M300 Base model RAID60	(NTFS)	7816.87GB	60-Day Space
2		Internal	SAS RAID	2x450GB, 10K, SAS Internal RAID1	Recovery Partition EFI System Partition C: (NTFS)	300MB 99MB 418.08GB	OS
3		1-0	SAS RAID	12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup_04 (NTFS)	1498.40GB	Backup_04
4				12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup_03 (NTFS)	1498.40GB	Backup_03
5		1-1		15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_01\ (RAW) V:\Device\Fixed_01\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_01 Fixed_01
6		2-0	SAS RAID	12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup_06 (NTFS)	1498.40GB	Backup_06
7				12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup_05 (NTFS)	1498.40GB	Backup_05
8		2-1		15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_02\ (RAW) V:\Device\Fixed_02\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_02 Fixed_02
9		3-0	SAS RAID	12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup_02 (NTFS)	1498.40GB	Backup_02
10				12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup_01 (NTFS)	1498.40GB	Backup_01
11		3-1		15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_03\ (RAW) V:\Device\Fixed_03\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_03 Fixed_03
12		4-0	SAS RAID	15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_04\ (RAW) V:\Device\Fixed_04\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_04 Fixed_04
13		5-0	SAS RAID	12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup_10 (NTFS)	1498.40GB	Backup_10
14				12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup_09 (NTFS)	1498.40GB	Backup_09
15		5-1		15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_05\ (RAW) V:\Device\Fixed_05\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_05 Fixed_05

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

16		6-0	SAS RAID	12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup_08 (NTFS)	1498.40GB	Backup_08
17				12x147GB, 15K, SAS Disk Expansion Unit RAID5	V:\Device\Backup_07 (NTFS)	1498.40GB	Backup_07
18		6-1		15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_06\ (RAW) V:\Device\Fixed_06\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_06 Fixed_06
19		7-0	SAS RAID	15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_07\ (RAW) V:\Device\Fixed_07\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_07 Fixed_07
20		8-0	SAS RAID	15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_08\ (RAW) V:\Device\Fixed_08\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_08 Fixed_08
21		9-0	SAS RAID	15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_09\ (RAW) V:\Device\Fixed_09\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_09 Fixed_09
22		10-0	SAS RAID	15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_10\ (RAW) V:\Device\Fixed_10\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_10 Fixed_10
23		11-0	SAS RAID	15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_11\ (RAW) V:\Device\Fixed_11\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_11 Fixed_11

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	18x450GB, 10K, SAS M300 Base model RAID10	V: (NTFS) V:\Device\TPCE_Log\ (RAW) V:\Device\TPCE_TempLog (NTFS) V:\Device\TPCE_TempDB (NTFS)	10GB 2000GB 1616.87GB	Log TPCE_TempLog TPCE_TempDB
1	1	0-1	FC HBA	24x450GB, 10K, SAS M300 Base model RAID60	(NTFS)	7816.87GB	60-Day Space
2		Internal	SAS RAID	2x450GB, 10K, SAS Internal RAID1	Recovery Partition EFI System Partition C: (NTFS)	300MB 99MB 418.08GB	OS
5		1-1	SAS RAID	15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_01\ (RAW) V:\Device\Fixed_01\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_01 Fixed_01
8		2-1	SAS RAID	15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_02\ (RAW) V:\Device\Fixed_02\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_02 Fixed_02
11		3-1	SAS RAID	15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_03\ (RAW) V:\Device\Fixed_03\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_03 Fixed_03
12		4-0	SAS RAID	15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_04\ (RAW) V:\Device\Fixed_04\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_04 Fixed_04
15		5-1	SAS RAID	15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_05\ (RAW) V:\Device\Fixed_05\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_05 Fixed_05
18		6-1	SAS RAID	15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_06\ (RAW) V:\Device\Fixed_06\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_06 Fixed_06
19		7-0	SAS RAID	15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_07\ (RAW) V:\Device\Fixed_07\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_07 Fixed_07
20		8-0	SAS RAID	15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_08\ (RAW) V:\Device\Fixed_08\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_08 Fixed_08
21		9-0	SAS RAID	15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_09\ (RAW) V:\Device\Fixed_09\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_09 Fixed_09
22		10-0	SAS RAID	15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_10\ (RAW) V:\Device\Fixed_10\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_10 Fixed_10
23		11-0	SAS RAID	15x200GB, SSD, SAS 4120 JBOD RAID5	V:\Device\Growing_11\ (RAW) V:\Device\Fixed_11\ (RAW) (NTFS)	2402.00GB 54.00GB 144.81GB	Growing_11 Fixed_11

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® 2014, a relational database, was used in this benchmark. The SQL Server® 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 twenty. The number of EGenDriverCE instances is twenty.

Measured Throughput

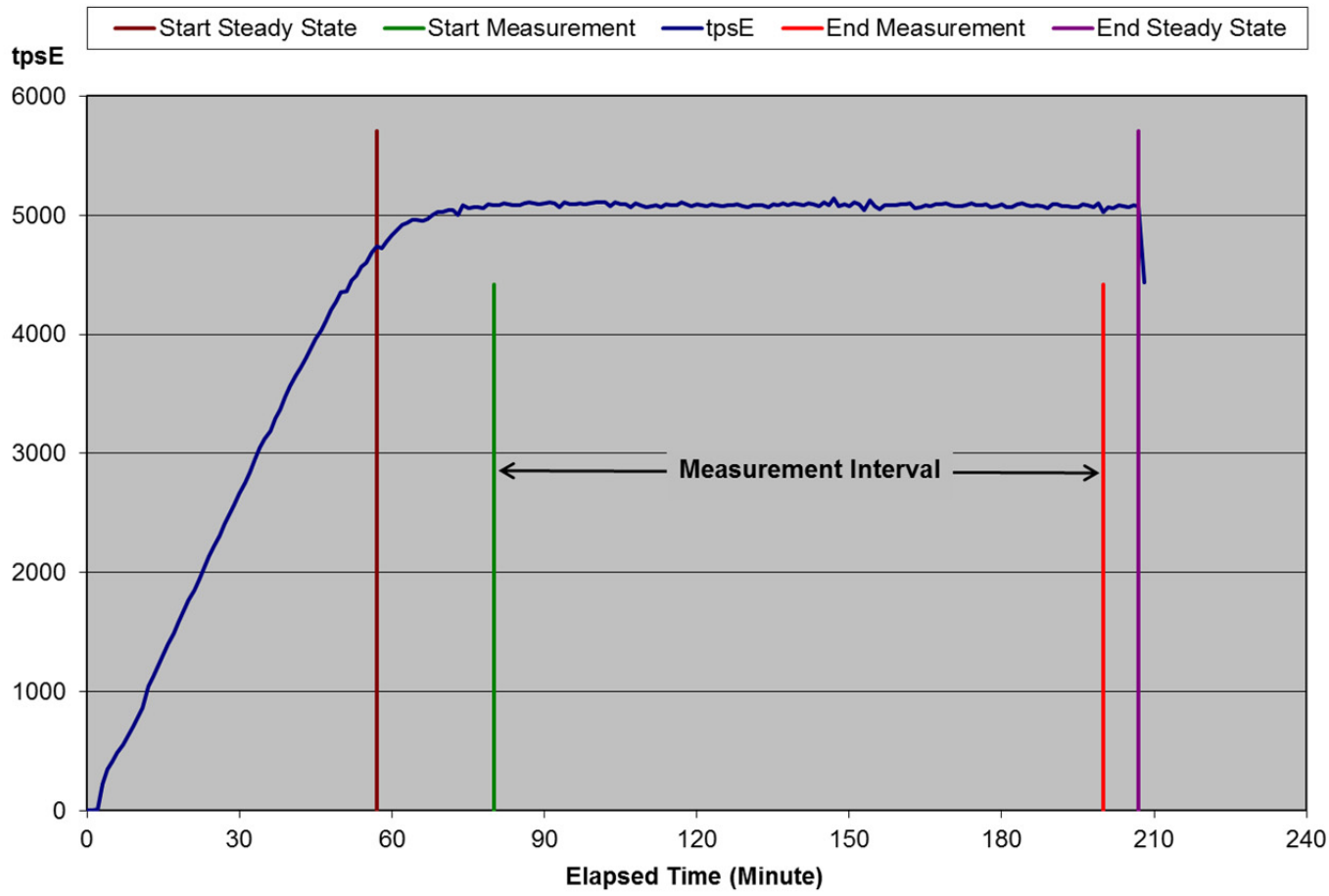
The Measured Throughput must be reported in the Report (see Clause 6.7.1.2).

Measured tpsE
5,087.17 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.

Steady state was determined by:

1. Verified that a full checkpoint had been completed.
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® 2014 wrote to disk all updated memory pages that had not been yet actually written to disk. The SQL Server® 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	50.00%	48% to 52%
get_history	1	50.00%	48% to 52%
Market-Watch			
Securities chosen by	Watch list	59.99%	57% to 63%
	Account ID	35.00%	33% to 37%
	Industry	5.00%	4.5% to 5.5%
Security-Detail			
access_lob	1	1.00%	0.9% to 1.1%
Trade-Lookup			
frame_to_execute	1	30.00%	28.5% to 31.5%
	2	30.01%	28.5% to 31.5%
	3	30.00%	28.5% to 31.5%
	4	10.00%	9.5% to 10.5%
Trade-Order			
Transactions requested by a third party		10.00%	9.5% to 10.5%
Security chosen by company name and issue		40.00%	38% to 42%
type_is_margin	1	8.00%	7.5% to 8.5%
roll_it_back	1	0.99%	0.94% to 1.04%
is_lifo	1	35.01%	33% to 37%
trade_qty	100	25.01%	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	29.99%	29.7% to 30.3%
	TLB	20.00%	19.8% to 20.2%
	TLS	10.00%	9.9% to 10.1%
	TSL	10.01%	9.9% to 10.1%
Trade-Update			
frame_to_execute	1	33.01%	31% to 35%
	2	33.01%	31% to 35%
	3	33.99%	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

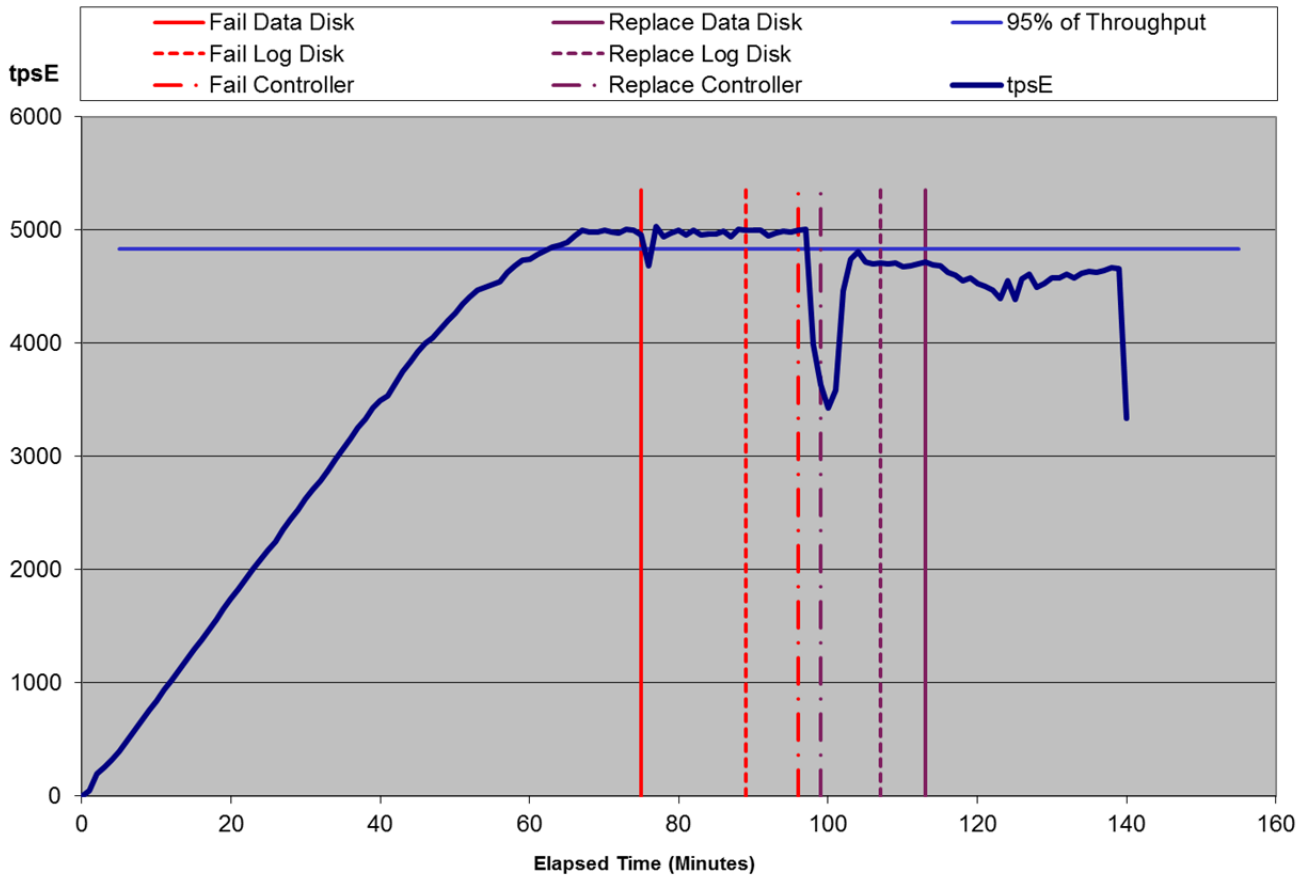
A Data Accessibility Graph for each run demonstrating a Redundancy Level must be reported in the Report (see Clause 7.6.4.2).

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: Two UPSs have been priced for NEC Storage M300 for the Database Log Array.

The following steps were successfully performed.

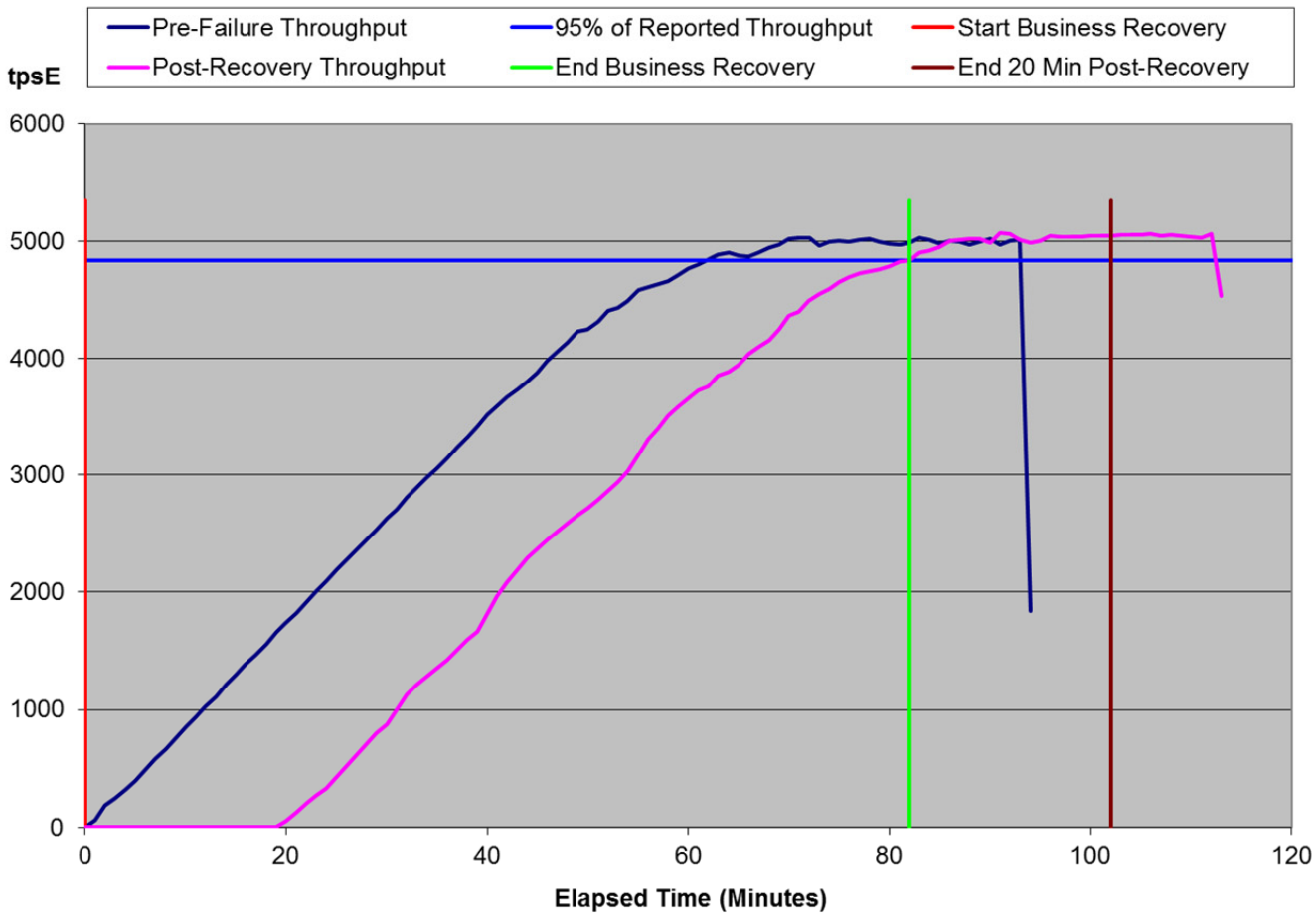
1. Determine the current number of completed trades in the database by running: *select count(*) as count1 from SETTLEMENT*
2. Start submitting Transactions and ramp up to the Durability Throughput Requirements (as defined in Clause 7.5.5.1) and satisfy those requirements for at least 20 minutes.
3. Tripping all circuit breakers for the NEC Express5800/A2040b and all the Dot Hill 4120 JBODs.
4. Stop the Driver.
5. Re-power and restart the NEC Express5800/A2040b and all the Dot Hill 4120 JBODs.

6. On the NEC Express5800/A2040b when Windows has started, start up Microsoft® SQL Server® 2014. Then database recovery starts automatically. The SQL Server® 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® 2014 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 0:18:09. The application recovery time was 1:03:00. The Business Recovery Time, which is the sum of the database recovery time and the application recovery time, was 1:21:09.

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.

Table 8.1: TPC-E Disk Space Requirements

Customers Used 2,750,000 **Performance** 5087.17 tpsE

Growing File Group	Initial Rows	Data (KB)	Index size (KB)	Extra 5% (KB)	Total + 5% (KB)	After run (KB)	Growth (KB)
CASH_TRANSACTION	43,718,468,517	4,544,057,672	9,583,480		4,553,641,152	4,563,398,112	9,756,960
HOLDING	2,432,976,985	162,692,480	111,227,384		273,919,864	277,207,328	3,287,464
HOLDING_HISTORY	63,684,926,128	2,315,816,160	1,547,058,152		3,862,874,312	3,873,803,664	10,929,352
HOLDING_SUMMARY	136,764,742	5,997,032	24,464		6,021,496	6,021,496	0
SETTLEMENT	47,520,000,000	2,265,938,504	4,778,728		2,270,717,232	2,276,159,496	5,442,264
TRADE	47,520,000,000	5,673,134,352	3,159,454,144		8,832,588,496	8,861,977,104	29,388,608
TRADE_HISTORY	114,047,833,613	3,430,010,712	8,943,152		3,438,953,864	3,448,908,696	9,954,832
TRADE_REQUEST	0	8	8		16	456,696	456,680
Scaling File Group							
ACCOUNT_PERMISSION	19,525,677	1,075,472	8,000	54,174	1,137,646	1,083,552	80
ADDRESS	4,125,004	238,192	2,664	12,043	252,899	240,912	56
BROKER	27,500	2,008	2,176	209	4,393	4,184	0
COMPANY	1,375,000	293,584	91,512	19,255	404,351	385,096	0
COMPANY_COMPETITOR	4,125,000	111,016	103,632	10,732	225,380	214,648	0
CUSTOMER	2,750,000	450,864	137,480	29,417	617,761	588,376	32
CUSTOMER_ACCOUNT	13,750,000	1,246,200	308,472	77,734	1,632,406	1,554,696	24
CUSTOMER_TAXRATE	5,500,000	114,928	2,664	5,880	123,472	117,744	152
DAILY_MARKET	2,458,293,750	115,287,536	338,168	5,781,285	121,406,989	115,627,064	1,360
FINANCIAL	27,500,000	3,099,192	11,000	155,510	3,265,702	3,110,520	328
LAST_TRADE	1,883,750	117,712	2,664	6,019	126,395	120,376	0
NEWS_ITEM	2,750,000	298,150,520	5,680	14,907,810	313,064,010	298,156,304	104
NEWS_XREF	2,750,000	68,648	2,664	3,566	74,878	71,312	0
SECURITY	1,883,750	261,360	75,736	16,855	353,951	337,120	24
WATCH_ITEM	275,022,696	7,721,336	30,656	387,600	8,139,592	7,752,288	296
WATCH_LIST	2,750,000	68,776	65,768	6,727	141,271	134,544	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	88	29	605	576	0
TOTALS (KB)		**18,825,954,840**	**4,842,259,672**	**21,474,904**	**23,689,689,416**		
Initial Database Size (MB)		**23,113,491**	**22,572 GB**	**22.04 TB**			

Db/Filegroups	LUN Count	Partition Size(KB)	MB allocated	MB Loaded	MB Loaded+5%	Ending size	8 Hours
Growing_FG	11	2,493,492,224	26,785,561	22,694,059	22,694,059	22,761,653	22,875,903
Fixed_FG	11	56,492,032	606,848	419,432	440,403	419,434	419,438

Settlements	**54,459,904**						
		Number of disks	165				
		Disk Capacity (MB)	190,171				
		RAID5 Overhead	7%				
Initial Growing Space (MB)	22,694,059	**Subtotal Space (MB)**	29,286,334				
Final Growing Space (MB)	22,761,653	**Number of disks**	24	**Initial Log size (MB)**	65,014	**Log Disks**	18
Delta (MB)	67,594	**Disk Capacity (MB)**	412,658	**Final Log size (MB)**	433,320	**Disk Capacity (MB)**	412,658
Data Space per TR (MB)	0.001241168	**RAID6 Overhead**	20%	**Log Growth (MB)**	368,305	**RAID10 overhead**	50%
1 Day Data Growth (MB)	181,844	**Subtotal Space (MB)**	7,923,034	**Log Growth/TR (MB)**	0.0067628736	**Tempdb**	1,665,915
60 Day Space (MB)	**34,024,142**	**Total Space (MB)**	**37,209,368**	**1 Day log space (MB)**	**990,832**	**Log Space (MB)**	**2,048,007**

Product Availability

All hardware, software and support used in the calculations must be Orderable by Any Customer on the availability date. For each of the Components that are not Orderable on the report date of the FDR, the following information must be included in the FDR:

- *Name and Part Number of the item that is not Orderable*
- *The date when the Component can be ordered (on or before the Availability Date)*
- *The method to be used to order the Component (at or below the quoted price) when the order date arrives*
- *The method for verifying the price*

The total solution as prices will be generally available on April 15, 2014. The dates for ordering and availability are detailed in Table 8.2 below for those components that are not immediately orderable.

Table 8.2: Ordering and Pricing Information

Description	Part Number	Orderable Date	Availability Date	Order Method	Verify Method
Express5800/A2040b (with MGM×2, Fan (full), Rack Mount Kit, SUV Cable, Cover for PCI Hot-plug)	NE3400-040F	28-Feb-2014	28-Mar-2014	See note 1	See note 2
Xeon E7-4890 v2 Processor Kit	NE3301-H001F	28-Feb-2014	28-Mar-2014	See note 1	See note 2
Memory Riser Card (A2040b/A2020b/A2010b)	NE3402-H001	28-Feb-2014	28-Mar-2014	See note 1	See note 2
64GB Memory (2 x 32GB DIMM)	NE3302-H012F	28-Feb-2014	28-Mar-2014	See note 1	See note 2
RAID Controller (1GB, RAID 0/1/5/6)	NE3303-168	28-Feb-2014	28-Mar-2014	See note 1	See note 2
450GB HDD(10Krpm, SAS)	NE3350-322	28-Feb-2014	28-Mar-2014	See note 1	See note 2
Fibre Channel Controller (2 port)	NE3390-154	28-Feb-2014	28-Mar-2014	See note 1	See note 2
External RAID Controller (1GB, RAID 0/1/5/6)	NE3303-H001	28-Feb-2014	28-Mar-2014	See note 1	See note 2
10GBASE Adapter (SFP+/2ch)	NE3304-128	28-Feb-2014	28-Mar-2014	See note 1	See note 2
SFP+ Module (10G-SR)	NE3304-129	28-Feb-2014	28-Mar-2014	See note 1	See note 2
Internal DVD Super Multi Drive	NE3351-107	28-Feb-2014	28-Mar-2014	See note 1	See note 2
Power Supply Unit (1000W)	NE3381-88	28-Feb-2014	28-Mar-2014	See note 1	See note 2
Front Bezel (A2040b/A2020b/A2010b)	NE3446-H001	28-Feb-2014	28-Mar-2014	See note 1	See note 2
Cable Arm (70mm)	NE3343-H001	28-Feb-2014	28-Mar-2014	See note 1	See note 2
Platinum Warranty (Yr 1,2 & 3)	Q24-DN000000068496	28-Feb-2014	28-Mar-2014	See note 1	See note 2
SQL Server 2014 Enterprise Edition	TBD (See note 3)	15-Apr-2014	15-Apr-2014	See note 3	See note 3

Note 1: NEC Call +1 866 632 3226

Note 2: These components are not immediately orderable. For price verification before order date, call NEC at +1 866 632 3226.

Note 3: SQL Server 2014 Enterprise Edition will be orderable by April 15, 2014. The part number for SQL Server 2014 Enterprise Edition will be set and the product will be available by April 15, 2014. For price verification or any further assistance on this product, please contact a Microsoft Authorized Reseller or visit the Microsoft Online Store at www.MicrosoftStore.com.

Auditor's Attestation Letter

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

InfoSizing
The Right Metric For Sizing IT

TPC Transaction Processing Performance Council
Certified Auditor

Tomonori Hoshino
NEC Corp. IT Platform Division
1-10 Nisshin-cho, Fuchu-shi
Tokyo, 1838501
Japan

February 13, 2014

I verified the TPC Benchmark ™ E v1.12.0 performance of the following configuration:

Platform:	NEC Express5800/A2040b
Operating System:	Microsoft Windows Server 2012 Standard Edition
Database Manager:	Microsoft SQL Server 2014 Enterprise Edition

The results were:

Performance Metric	**5,087.17 tpsE**
Trade-Result 90th %-tile	0.13 Seconds

Tier B (Server)	**NEC Express5800/A2040b**		
CPUs	4 x Intel Xeon processor E7-4890 v2 (2.80GHz, 15-core, 37.5MB L3)		
Memory	2048 GB		
Storage	***Qty***	***Size***	***Type***
	44	450 GB	10Krpm SAS HDD
	165	200 GB	SAS SSD

Tier A (2 Clients)	**NEC Express5800/R120d-2M**
CPUs	2 x Intel Xeon processor E5-2690 (2.90GHz, 8-core, 20MB L3)
Memory	256 GB
Storage	2 x 147GB 15Krpm SAS HDD

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 transaction were correctly implemented
- The database was properly scaled and populated for 2,750,000 customers
- The mandatory network between the driver and the SUT was configured

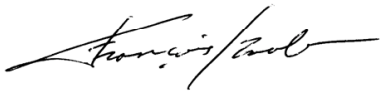
531 Crystal Hills Blvd • Manitou Springs, CO 80829 • 719-473-7555 • www.sizing.com

- 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 120 minutes
- The implementation used Redundancy Level 1
- The Business Recovery Time of 01:21:09 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,



François Raab, President

531 Crystal Hills Blvd • Manitou Springs, CO 80829 • 719-473-7555 • www.sizing.com

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/	4120StorageSetup.docx M300StorageSetup.docx mkmp.cmd mount.txt StorageDiagram.docx sydskmap_[1..3].png
	TierB(server) configuration	SupportingFiles/Introduction/Hardware/	TierB_A2040b_R120d-2M_setup.docx
	TierA(client) setup	SupportingFiles/Introduction/Hardware/	TierA_R120d-2M_setup.docx
	Database Tunable Parameters	SupportingFiles/Introduction/Software/	Largepages.reg NUMA-node-affinity.sql SoftNUMA-node-cpumask.reg SoftNUMA-ports.reg sp_configure.out startSQL.cmd TempDB.sql
	OS Tunable Parameters	SupportingFiles/Introduction/Software/	syhwTierA_[1..2].out syhwTierB.out syostune.docx
	Tier A Scripts	SupportingFiles/Introduction/Software/	ce[1..20].cmd me[1..20].cmd

Clause2	Table creation scripts	SupportingFiles/Clause2/DDL/	BulkInsert_[1..160].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 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_Table.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_Addon_Files.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	2750000Customers_Load_Timer.log BrokerVolume.log BuildSteps.log BulkInsert_[1..160].out Check_Constraints_Fixed.log Check_Constraints_Growing.log Check_Constraints_Scaling.log Convert_NI_ITEM_Data.log Create_DB_Audit_Tables.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 DB_Check.log DB_FK_Constraints.log DB_Primary_Key_Check.log DB_Tables.log Drop_DB_Audit_Tables.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 Insert_Duplicates_Tests.log Load_Timer.log Load_Timer_Proc.log Load_TPCE_Info.log MarketFeed.log MarketWatch.log Referential_Integrity_Tests.log RemoveDB.log SecurityDetail.log SQL_Server_Configuration.log Tables_Fixed.log Tables_Growing.log Tables_Scaling.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/	BenchCraftProfile.xml
	EGenLoader Parameters	SupportingFiles/Clause5/	BuildSteps.log EGenLoaderFrom1To17000.log EGenLoaderFrom17001To34000.log EGenLoaderFrom34001To52000.log EGenLoaderFrom52001To69000.log EGenLoaderFrom69001To86000.log EGenLoaderFrom86001To103000.log EGenLoaderFrom103001To120000.log EGenLoaderFrom120001To138000.log EGenLoaderFrom138001To155000.log EGenLoaderFrom155001To172000.log EGenLoaderFrom172001To189000.log EGenLoaderFrom189001To206000.log EGenLoaderFrom206001To223000.log EGenLoaderFrom223001To241000.log EGenLoaderFrom241001To258000.log EGenLoaderFrom258001To275000.log EGenLoaderFrom275001To292000.log EGenLoaderFrom292001To309000.log EGenLoaderFrom309001To327000.log EGenLoaderFrom327001To344000.log EGenLoaderFrom344001To361000.log EGenLoaderFrom361001To378000.log EGenLoaderFrom378001To395000.log EGenLoaderFrom395001To413000.log EGenLoaderFrom413001To430000.log EGenLoaderFrom430001To447000.log EGenLoaderFrom447001To464000.log EGenLoaderFrom464001To481000.log EGenLoaderFrom481001To498000.log EGenLoaderFrom498001To516000.log EGenLoaderFrom516001To533000.log EGenLoaderFrom533001To550000.log EGenLoaderFrom550001To567000.log EGenLoaderFrom567001To584000.log EGenLoaderFrom584001To602000.log EGenLoaderFrom602001To619000.log EGenLoaderFrom619001To636000.log EGenLoaderFrom636001To653000.log EGenLoaderFrom653001To670000.log

			EGenLoaderFrom670001To688000.log EGenLoaderFrom688001To705000.log EGenLoaderFrom705001To722000.log EGenLoaderFrom722001To739000.log EGenLoaderFrom739001To756000.log EGenLoaderFrom756001To773000.log EGenLoaderFrom773001To791000.log EGenLoaderFrom791001To808000.log EGenLoaderFrom808001To825000.log EGenLoaderFrom825001To842000.log EGenLoaderFrom842001To859000.log EGenLoaderFrom859001To877000.log EGenLoaderFrom877001To894000.log EGenLoaderFrom894001To911000.log EGenLoaderFrom911001To928000.log EGenLoaderFrom928001To945000.log EGenLoaderFrom945001To963000.log EGenLoaderFrom963001To980000.log EGenLoaderFrom980001To997000.log EGenLoaderFrom997001To1014000.log EGenLoaderFrom1014001To1031000.log EGenLoaderFrom1031001To1048000.log EGenLoaderFrom1048001To1066000.log EGenLoaderFrom1066001To1083000.log EGenLoaderFrom1083001To1100000.log EGenLoaderFrom1100001To1117000.log EGenLoaderFrom1117001To1134000.log EGenLoaderFrom1134001To1152000.log EGenLoaderFrom1152001To1169000.log EGenLoaderFrom1169001To1186000.log EGenLoaderFrom1186001To1203000.log EGenLoaderFrom1203001To1220000.log EGenLoaderFrom1220001To1238000.log EGenLoaderFrom1238001To1255000.log EGenLoaderFrom1255001To1272000.log EGenLoaderFrom1272001To1289000.log EGenLoaderFrom1289001To1306000.log EGenLoaderFrom1306001To1323000.log EGenLoaderFrom1323001To1341000.log EGenLoaderFrom1341001To1358000.log EGenLoaderFrom1358001To1375000.log EGenLoaderFrom1375001To1392000.log EGenLoaderFrom1392001To1409000.log EGenLoaderFrom1409001To1427000.log EGenLoaderFrom1427001To1444000.log EGenLoaderFrom1444001To1461000.log EGenLoaderFrom1461001To1478000.log EGenLoaderFrom1478001To1495000.log EGenLoaderFrom1495001To1513000.log EGenLoaderFrom1513001To1530000.log EGenLoaderFrom1530001To1547000.log EGenLoaderFrom1547001To1564000.log EGenLoaderFrom1564001To1581000.log EGenLoaderFrom1581001To1598000.log EGenLoaderFrom1598001To1616000.log EGenLoaderFrom1616001To1633000.log EGenLoaderFrom1633001To1650000.log EGenLoaderFrom1650001To1667000.log EGenLoaderFrom1667001To1684000.log EGenLoaderFrom1684001To1702000.log EGenLoaderFrom1702001To1719000.log EGenLoaderFrom1719001To1736000.log EGenLoaderFrom1736001To1753000.log EGenLoaderFrom1753001To1770000.log EGenLoaderFrom1770001To1788000.log EGenLoaderFrom1788001To1805000.log EGenLoaderFrom1805001To1822000.log EGenLoaderFrom1822001To1839000.log EGenLoaderFrom1839001To1856000.log EGenLoaderFrom1856001To1873000.log EGenLoaderFrom1873001To1891000.log EGenLoaderFrom1891001To1908000.log EGenLoaderFrom1908001To1925000.log

			EGenLoaderFrom1925001To1942000.log EGenLoaderFrom1942001To1959000.log EGenLoaderFrom1959001To1977000.log EGenLoaderFrom1977001To1994000.log EGenLoaderFrom1994001To2011000.log EGenLoaderFrom2011001To2028000.log EGenLoaderFrom2028001To2045000.log EGenLoaderFrom2045001To2063000.log EGenLoaderFrom2063001To2080000.log EGenLoaderFrom2080001To2097000.log EGenLoaderFrom2097001To2114000.log EGenLoaderFrom2114001To2131000.log EGenLoaderFrom2131001To2148000.log EGenLoaderFrom2148001To2166000.log EGenLoaderFrom2166001To2183000.log EGenLoaderFrom2183001To2200000.log EGenLoaderFrom2200001To2217000.log EGenLoaderFrom2217001To2234000.log EGenLoaderFrom2234001To2252000.log EGenLoaderFrom2252001To2269000.log EGenLoaderFrom2269001To2286000.log EGenLoaderFrom2286001To2303000.log EGenLoaderFrom2303001To2320000.log EGenLoaderFrom2320001To2338000.log EGenLoaderFrom2338001To2355000.log EGenLoaderFrom2355001To2372000.log EGenLoaderFrom2372001To2389000.log EGenLoaderFrom2389001To2406000.log EGenLoaderFrom2406001To2423000.log EGenLoaderFrom2423001To2441000.log EGenLoaderFrom2441001To2458000.log EGenLoaderFrom2458001To2475000.log EGenLoaderFrom2475001To2492000.log EGenLoaderFrom2492001To2509000.log EGenLoaderFrom2509001To2527000.log EGenLoaderFrom2527001To2544000.log EGenLoaderFrom2544001To2561000.log EGenLoaderFrom2561001To2578000.log EGenLoaderFrom2578001To2595000.log EGenLoaderFrom2595001To2613000.log EGenLoaderFrom2613001To2630000.log EGenLoaderFrom2630001To2647000.log EGenLoaderFrom2647001To2664000.log EGenLoaderFrom2664001To2681000.log EGenLoaderFrom2681001To2698000.log EGenLoaderFrom2698001To2716000.log EGenLoaderFrom2716001To2733000.log EGenLoaderFrom2733001To2750000.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/	Iso1_S1.out Iso1_S2.out Iso1_S3.out Iso1_S4.out Iso2_S1.out Iso2_S2.out Iso2_S3.out Iso2_S4.out Iso3_S1.out Iso3_S2.out Iso3_S3.out Iso4_S1.out Iso4_S2.out Iso4_S3.out

	Durability Business Recovery	SupportingFiles/Clause7/Durability/BusinessRecovery/	BusinessRecoveryTimeGraph.xlsx 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_TxnReport.xlt DataAccessibilityGraph.xlsx dblgDataAccessibility.out loss_and_replace_data_disk.out loss_and_replace_log_disk_and_cont.out
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

February 4, 2014

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
Database Management System				
*	**SQL Server 2014 Enterprise Edition** *2 Core License* *Open Program - Level C*	$13,472.50	30	$404,175.00
Tier-A Operating System(s)				
P73-05761	**Windows Server 2012 Standard** *2 Processor License* *Open Program - Level C* *Unit Price reflects a 17% discount from the retail unit price of $882.*	$735.00	3	$2,205.00
Support				
N/A	**Microsoft Problem Resolution Services** *Professional Support* *(1 Incident).*	$259.00	1	$259.00

Windows Server 2012 Standard is 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**

SQL Server 2014 Enterprise Edition will be orderable by April 15, 2014. The part number for SQL Server 2014 Enterprise Edition will be set and the product will be available by April 15, 2014.

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_qhtplylGYLKTVUKf95957fiii_2014_ngngt.

800.800.4239

Shopping Cart

Item	Quantity	Availability	Unit Price	Item Total
NEC AccuSync AS171-BK 17" LCD MFG Part#: AS171-BK CDW Part#: 1994501 UNSPSC: 43211902 **Pricing Option Applied:** Advertised Price	3	In Stock	$136.99	$410.97
Tripp Lite 14ft Cat5e / Cat5 350MHz Snagless Patch Cable RJ45 M/M Blue 14' MFG Part#: N001-014-BL CDW Part#: 324495 UNSPSC: 26121604 **Pricing Option Applied:** Advertised Price	8	In Stock	$5.99	$47.92
C2G 10ft Cat5E 350 MHz Snagless Patch Cable - Red MFG Part#: 15203 CDW Part#: 442457 UNSPSC: 26121604 **Pricing Option Applied:** Advertised Price	4	In Stock	$4.99	$19.96
Tripp Lite 3M 10Gb MMF Fiber 50/125 OM3 LSZH Patch Cable LC/LC Aqua 10ft MFG Part#: N820-03M CDW Part#: 793221 UNSPSC: 26121604 **Pricing Option Applied:** Advertised Price	6	In Stock	$25.99	$155.94
Linksys SE2500 - switch - 5 ports - unmanaged - desktop MFG Part#: SE2500 CDW Part#: 2378360 UNSPSC: 43222612 **Pricing Option Applied:** Advertised Price	4	In Stock	$53.99	$215.96

Subtotal: $850.75

Tax and shipping will be calculated in checkout.

Lease Option ($26.54 /month)

Items Related to Products in Your Cart (12)

CDW 10' Hi-Speed USB 2.0 Cable $4.99 Advertised Price	EnGenius ENH200 - wireless access point $83.99 Advertised Price	Transcend JetFlash 300 - USB flash drive - 8 GB $7.99 Advertised Price	Apple 12W USB Power Adapter - power adapter $19.00 Advertised Price	Targus Wireless Numeric - keypad - After Instant Savings... (6) $34.99 Advertised Price	Cisco 891 - router - desktop $878.99 Advertised Price

Customers Who Viewed Similar Products Also Viewed (12)

Tripp Lite 10ft Cat5e/ Cat5 350MHz Snagless Patch Cable M/M... $2.99 Advertised Price	Tripp Lite 5M 10Gb MMF Fiber 50/125 OM3 LSZH Patch Cable LC/LC... $28.99 Advertised Price	Tripp Lite 2M 10Gb MMF Fiber 50/125 OM3 LSZH Patch Cable LC/LC... $24.99 Advertised Price	Samsung 840 Pro Series MZ-7PD256 - solid state drive - 256 GB... (34) $227.99 Advertised Price	Linksys SE1500 - switch - 5 ports - unmanaged - desktop (2) $20.99 Advertised Price	Tripp Lite patch cable - 7 ft - blue $4.99 Advertised Price

This page was printed on 1/26/2014 8:26:38 PM.

Promark
an Ingram Micro company

Mailing Address:
Promark Technology
10900 Pump House Road, Suite B
Annapolis Junction, MD 20701

Customer: NEC Corporation
Date: 2/ 10/ 14
Quote# PROQ021014
Sales Contact: Ron Crise
Phone: 240- 280- 8057
Email: ronc@promarktech.com

Manufacturer: Dot Hill Systems

Part #	Description	Qty	MSRP	Unit Cost	Extended Cost
D4120C000000BA	AssuredSAN 4000 JBODS ------ DUAL Controller JBOD w/2u24 chassis, SAS 6G connection, 2.5" Drive Size 4120, 2JM, No drives, AC, V2, DH	11	$7,075.00	$3,500.00	$38,500.00
PFRUKRXSXN145-01	12G SAS 200GB SSD eMLC	182	$3,600.00	$1,800.00	$327,600.00
PFRUKF31-01	AMS SFF DRIVE BLANK BB FRU PKG	99	$37.50	$18.00	$1,782.00
DS-7X24X-SJ-1Y-A-U	1YR UPG ONSITE 7X24X4 SFF JBOD 1YR AME	33	$3,659.00	$1,771.00	$58,443.00

Shipping	ADD
Grand Total	$426,325.00

Quote Valid for 90 days