



Hewlett-Packard Company

TPC Benchmark™ C
Full Disclosure Report
for
HP ProLiant DL585 G7
using
Microsoft SQL Server 2005 Enterprise x64 Edition SP3
and
Windows Server 2008 R2 Enterprise Edition

Third Edition
Submitted for Review
June 21, 2010

Third Edition –June 2010

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Preface

The TPC Benchmark C was developed by the Transaction Processing Performance Council (TPC). The TPC was founded to define transaction processing benchmarks and to disseminate objective, verifiable performance data to the industry. This full disclosure report is based on the TPC Benchmark C Standard Specifications Version 5.11

TPC Benchmark C Overview

The TPC describes this benchmark in Clause 0.1 of the specifications as follows:

TPC Benchmark™ C (TPC-C) is an OLTP workload. It is a mixture of read-only and update intensive transactions that simulate the activities found in complex OLTP application environments. It does so by exercising 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
- On-line and deferred transaction execution modes
- Multiple on-line terminal sessions
- Moderate system and application execution time
- Significant disk input/output
- Transaction integrity (ACID properties)
- Non-uniform distribution of data access through primary and secondary keys
- Databases consisting of many tables with a wide variety of sizes, attributes, and relationships
- Contention on data access and update

The performance metric reported by TPC-C is a "business throughput" measuring the number of orders processed per minute. Multiple transactions are used to simulate the business activity of processing an order, and each transaction is subject to a response time constraint. The performance metric for this benchmark is expressed in transactions-per-minute-C (tpmC). To be compliant with the TPC-C standard, all references to tpmC results must include the tpmC rate, the associated price-per-tpmC, and the availability date of the priced configuration.

Although these specifications express implementation in terms of a relational data model with conventional locking scheme, 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-C uses terminology and metrics that are similar to other benchmarks, originated by the TPC or others. Such similarity in terminology does not in any way imply that TPC-C results are comparable to other benchmarks. The only benchmark results comparable to TPC-C are other TPC-C results conformant with the same revision.

Despite the fact that this benchmark offers a rich environment that emulates 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-C 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 as a result of these and other factors. Therefore, TPC-C should not be used as a substitute for a specific customer application benchmarking when critical capacity planning and/or product evaluation decisions are contemplated.

Abstract

Overview

This report documents the methodology and results of the TPC Benchmark C test conducted on the HP ProLiant DL585 G7. The operating system used for the benchmark was Windows Server 2008R2 Enterprise Edition. The DBMS used was Microsoft SQL Server 2005 Enterprise x64 Edition SP3.

TPC Benchmark C Metrics

The standard TPC Benchmark C metrics, tpmC (transactions per minute), price per tpmC (three year capital cost per measured tpmC), and the availability date are reported as:

1,193,472 tpmC
USD \$0.68 per tpmC

The availability date is September 1, 2010.

Standard and Executive Summary Statements

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

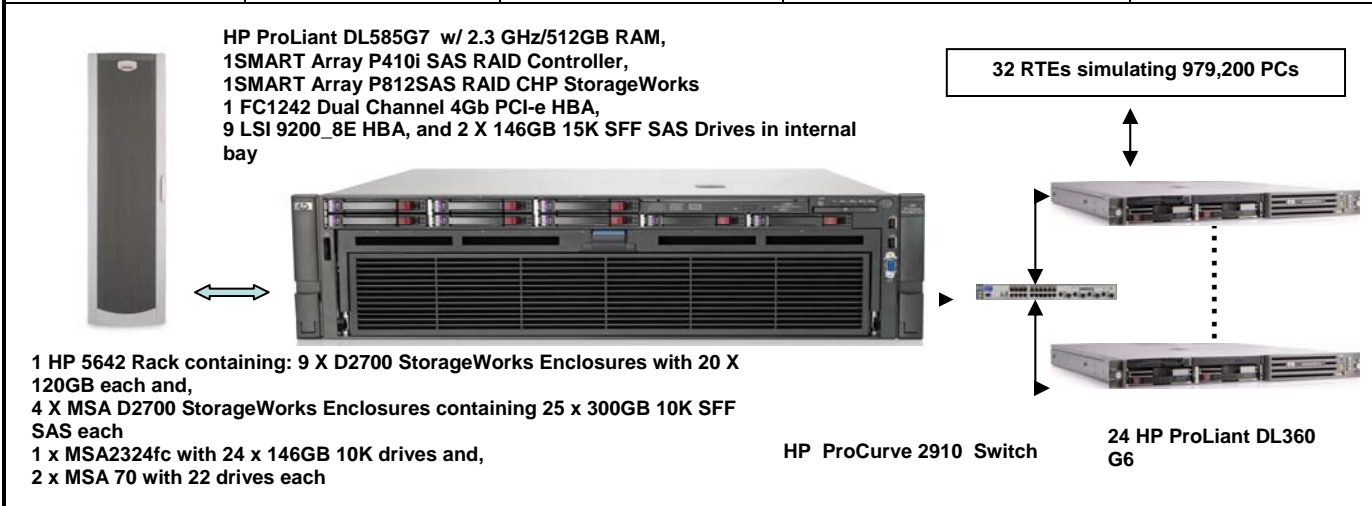
Auditor

The benchmark configuration, environment and methodology were audited by Lorna Livingtree of Performance Metrics, Inc. to verify compliance with the relevant TPC specifications.

Hewlett-Packard Company	HP ProLiant DL585G7 2.3 GHz 12MB L3		TPC-C Rev. 5.11 TPC-Pricing 1.5.0 TPC-Energy 1.1.1	
	C/S with 24 HP ProLiant DL360 G6		Report Date: June 21, 2010	

Total System Cost	TPC-C Throughput	Price/Performance	Availability Date	TPC-Energy Metric
USD \$804,660	1,193,472 tpmC	USD \$0.68	Sept 1, 2010	5.93 watts/KtpmC

Database Server Processors /Cores/Threads	Database Manager	Operating System	Other Software	Number of Users
4/48/48 AMD 2.3 GHz 12MB L3 cache	Microsoft SQL Server 2005 Enterprise x64 Edition SP3	Windows Server 2008 R2 Enterprise Edition	Microsoft Visual C++ Microsoft COM+	979,200



	Server		Each Client	
System Components	Quantity	Description	Quantity	Description
Processors/Cores/Threads	4/48/48	AMD 2.3GHz 12MB L3 cache	1/4/4	2.40 GHz Intel Xeon w/ 8MB L3 cache
Memory	512GB	(16x 16GB and 32x 8GB) DDR3	2GB	2048 MB
Disk Controllers	1 1 9 1	Smart P410i Controller Smart P812 Controller LSI 9200_8E HBA FC1242 Dual Channel 4Gb PCI-e HBA	1	Integrated Smart Array P410i Controller
Disk Drives	100 180 2 66	300GB 15K SFF SAS 6G 120 GB SSD 146 GB 15K SFF SAS 146 GB 15K SFF SAS	2	72 GB 15K SFF SAS
Total Storage		66,769.36 GB		72 GB

Hewlett-Packard		HP ProLiant DL585G7 2.3 GHz 12GB L3		TPC-C Rev. 5.11 TPC-Pricing 1.5.0 TPC-Energy 1.1.1	
Company		C/S with 24 HP ProLiant DL360 G6		Report Date: June 21, 2010	
Total System Cost	TPC-C Throughput	Price/Performance	Availability Date	TPC-Energy Metric	
USD \$804,660	1,193,472 KtpmC	USD \$0.68	September 1, 2010	5.93 watts/ KtpmC	

Numerical Quantities For Reported Energy Configuration:

REC Idle Power: 6694 watts

Average Power of REC: 7077 watts

	Secondary Metrics	Additional Numerical Quantities				Idle % of REC
	Watts / KtpmC	Full Load Avg Watts	Full Load % of REC	Full Load Watt Mins.	Idle Avg. Watts	
Database Server	0.80	950.80	13.4%	114,095	692.46	10.3%
Storage	1.75	2,084.47	29.5%	250,137	2,026.01	30.3%
Application Server	2.74	3,269.44	46.2%	392,333	3,203.36	47.9%
Miscellaneous	0.65	772.41	10.9%	92,689	772.59	11.5%
Total REC	5.93	7077	100%	849255	6694	100%

Lowest ambient temperature at air inlet: 20.56C

Items in Priced Configuration not in the Reported Energy Configuration:

None

Items in Reported Energy Configuration not in the Measured Energy Configuration:

25 HP LE1851w 18.5-Inch wide Monitor Part Number NK033AA#ABA

22 HP ProLiant DL360 G6 Rack Part Number 484184-B21

Hewlett-Packard		HP ProLiant DL585G7			TPC-C Rev. 5.11		
Company					Report Date	21-Jun-10	
Description	Part Number	Brand	Unit Price	Qty	Extended Price	3 yr. Maint. Price	
Server Hardware							
HP DL585R07 CTO Chassis Svr,HP NC382i nic,Smart Array P410i Controller	590480-B21	1	4,036	1	4,036		
HP DL585G7 6176SE FIO 2P Kit	601351-L21	1	3,600	1	3,600		
HP DL585G7 6176SE 2P Kit	601351-B21	1	3,599	1	3,599		
HP 16GB 4Rx4 PC3-8500R-7 Kit	593915-B21	1	1,549	16	24,784		
HP 8GB 2Rx4 PC3-10600R-9 Kit	593913-B21	1	509	32	16,288		
HP Smart Array P812/1G Flash Backed Cache Controller	462832-B21	1	649	1	649		
HP LE1851w 18.5-Inch wide Monitor	NK033AA#ABA	1	159	1	159		
HP PS/2 Keyboard And Mouse Bundle	RC464AA#ABA	1	39	1	39		
HP 5642 Pallet Unassembled Rack	358254-B21	1	865	1	865		
HP StorageWorks FC1242 Dual Channel 4Gb PCI-e HBA	AE312A	1	1,780	1	1,780		
2 m LC-LC Multi-Mode Fibre Channel Cable	221692-B21	1	75	2	150		
2 m LC-LC Multi-Mode Fibre Channel Cable (spares)	221692-B21	1	75	2		150	
HP StorageWorks 2324fc G2 Dual Controller Modular Smart Array (SFF)	AJ797A	1	8,900	1	8,900		
HP 3y 4h 24x7 MSA2000 Array HWSupp ,MSA2000 Dual Controller	UJ675E	1	1,513	1		1,513	
HP 300GB 6G SAS 10K SFF (2.5-inch) Dual Port Enterprise 3yr Warranty	507127-B21	1	519	100	51,900		
HP 120GB 3G SATA 2.5in MDL	572073-B21	1	2,659	180	478,620		
HP 146GB 6G SAS 15K SFF (2.5-inch)	512547-B21	1	499	66	32,934		
HP 146GB 6G SAS 15K SFF (2.5-inch)	512547-B21	1	499	2	998		
HP StorageWorks D2700 Disk Enclosure	AJ941A	1*	3,399	13	44,187		
HP 3y SupportPlus24 D2000 Enclosures,4h 24x7 onsite response	UQ105E	1	2,147	13		27,911	
HP StorageWorks MSA 70 Disk Enclosure	418800-B21	1	3,199	2	6,398		
HP 3y 4h 24x7 MSA60/70 HW Support	UF303E	1	1,906	2		3,812	
4-Hour On-site Service, 7-Day x 24-Hour Coverage, 3 Years , DL585	U4497E	1	698	1		698	
LSI 9200_8e	LSI00188	4	328	9	2,952		
LSI 9200_8e (10% spares)	LSI00188	4	328	2		656	
Subtotal					682,838	34,740	
Server Software							
Microsoft SQL Server 2005 Enterprise X64 Edition(per processor)	810-03134	2	23,432	4	93,728	Incl Below	
Microsoft Visual C++ Standard Edition	254-00170	2	109	1	109	Incl Below	
Microsoft Windows Server 2008 R2 Enterprise Edition	P72-04217	2	2,280	1	2,280	Incl Below	
Microsoft Problem Resolution Services		2	259	1		259	
Subtotal					96,117	259	
Client Hardware							
HP ProLiant DL360 G6 Rack CTO Chassis,NC382i Dual Port nic	484184-B21	1S	1,301	24	31,224		
HP E5530 DL360 G6 FIO Kit	505882-L21	1S	799	24	19,176		
HP 460W CS HE Power Supply Kit	503296-B21	1S	249	24	5,976		
HP 2GB 2Rx8 PC3-10600R-9 Kit	500656-B21	1S	120	24	2,880		
HP 72GB 15k 2.5 dual Port HP SAS Drive	418371-B21	1	379	48	18,192		
HP LE1851w 18.5-Inch wide Monitor	NK033AA#ABA	1	159	24	3,816		
HP PS/2 Keyboard And Mouse Bundle	RC464AA#ABA	1	39	24	936		
HP CP 3Y 4H 24x7 HW Entry300 4-Hour 24 Hour x 7 Day Coverage 3 Years	U4497E	1	698	24		16,752	
Subtotal					82,200	16,752	
Client Software							
Windows Server 2008 R2 Standard Edition	P73-04165	2	711	24	17,064	Incl. Above	
Subtotal					17,064	0	
User Connectivity							
HP ProCurve 2910al-48G Switch	J9147A#ABA	1	4,569	1	4,569		
HP ProCurve3 Yr 4 hr/24x7 Onsite	H2893E	1	1,307	1		1,307	
CAT 6 7 Foot Pink Patch Cable	CB242-7PK	3	2	50	80		
CAT 6 7 Foot Pink Patch Cable (spares)	CB242-7PK	3	2	5		8	
Subtotal					4,649	1,307	
Subtotal					(\$122,665)	(\$8,343)	
Total					\$760,203	\$44,456	
Prices used in TPC benchmarks reflect the actual prices a customer would pay for a one-time purchase of the stated components. Individually negotiated discounts are not permitted. Special prices based on assumptions about past or future purchases are not permitted. All discounts reflect standard pricing policies for the listed components. For complete details, see the pricing sections of the TPC benchmark pricing 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.					Three-Year Cost of Ownership: USD		\$804,660
					tpmC Rating:		1,193,472
					\$ / tpmC: USD		\$0.68
Pricing: 1=HP Direct 800-203-6748 2= Microsoft 3= deepsurplus.com 4= Microland Electronics							
Note 1 = Discount based on HP Direct guidance applies to all lines where pricing = 1 * SSD drive support in this enclosure will be available Sept 1 2010 see appendix F							
Note 2 = (S) One or more component of the measured configuration have been substituted in the priced configuration. See FDR for details.							
Note 3 = The benchmark results were audited by Lorna Livingtree of Performance Metrics							
One or more components of the measured configuration have been substituted in the Priced Configuration. See the FDR for details.							

Numerical Quantities Summary

MQTH, Computed Maximum Qualified Throughput

1,193,472 tpmC

Response Times (in seconds)	Average	90%	Maximum
New-Order	0.70	1.69	37.83
Payment	0.73	1.82	38.28
Order-Status	0.69	1.66	36.75
Delivery (interactive portion)	0.33	0.64	25.31
Delivery (deferred portion)	0.12	0.22	5.07
Stock-Level	0.76	1.73	26.59
Menu	0.35	0.69	40.40

Transaction Mix, in percent of total transaction

New-Order	44.94%
Payment	43.03%
Order-Status	4.01%
Delivery	4.01%
Stock-Level	4.01%

Emulation Delay (in seconds)

	Resp.Time	Menu
New-Order	0.10	0.10
Payment	0.10	0.10
Order-Status	0.10	0.10
Delivery (interactive)	0.10	0.10
Stock-Level	0.10	0.10

Keying/Think Times (in seconds)

	Min.	Average	Max.
New-Order	18.02/0.00	18.03/12.06	18.20/120.53
Payment	3.02/0.00	3.03/12.06	3.20/120.53
Order-Status	2.02/0.00	2.03/10.06	2.20/100.53
Delivery (interactive)	2.02/0.00	2.03/5.07	2.14/50.53
Stock-Level	2.02/0.00	2.03/5.06	2.18/50.53

Test Duration

Ramp-up time	33 minutes
Measurement interval	120 minutes
Transactions (all types) completed during measurement interval	318,657,481
Ramp down time	3.49 minutes

Checkpointing

Number of checkpoints	4
Checkpoint interval	30 minutes

General Items

Test Sponsor

A statement identifying the benchmark sponsor(s) and other participating companies must be provided.

This benchmark was sponsored by Hewlett-Packard Company. The benchmark was developed and engineered by Hewlett-Packard Company. Testing took place at HP benchmarking laboratories in Houston, Texas.

Application Code and Definition Statements

The application program (as defined in clause 2.1.7) must be disclosed. This includes, but is not limited to, the code implementing the five transactions and the terminal input output functions.

Appendix A contains all source code implemented in this benchmark.

Parameter Settings

Settings must be provided for all customer-tunable parameters and options which have been changed from the defaults found in actual products, including by not limited to:

- *Database options*
- *Recover/commit options*
- *Consistency locking options*
- *Operating system and application configuration parameters*

This requirement can be satisfied by providing a full list of all parameters.

Appendix C contains the tunable parameters to for the database, the operating system, and the transaction monitor.

Configuration Items

Diagrams of both measured and priced configurations must be provided, accompanied by a description of the differences.

The configuration diagram for both the tested and priced systems are included on the following page.

Figure 1. Benchmarked Configuration

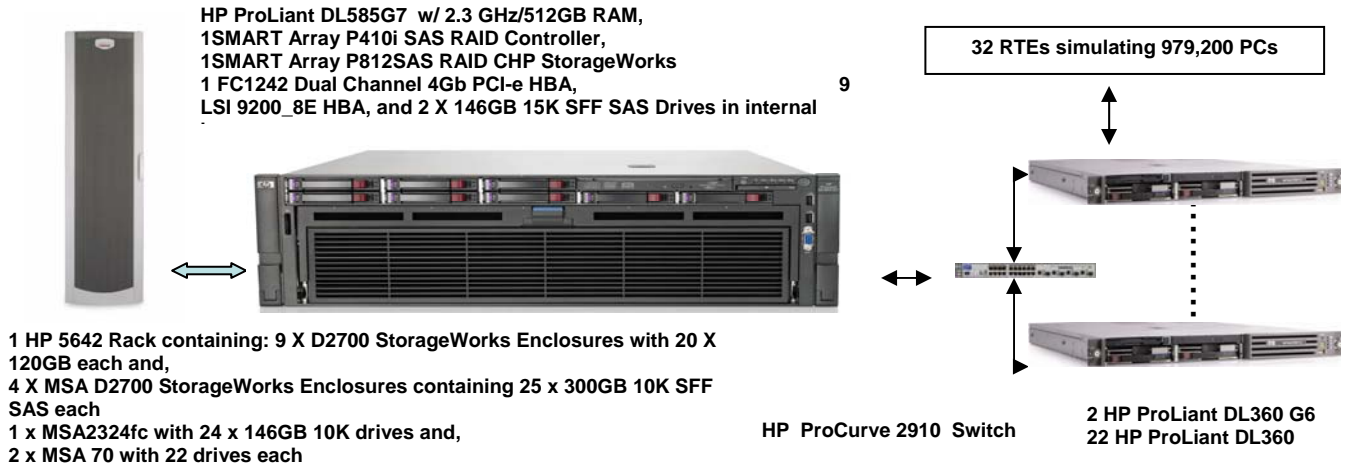
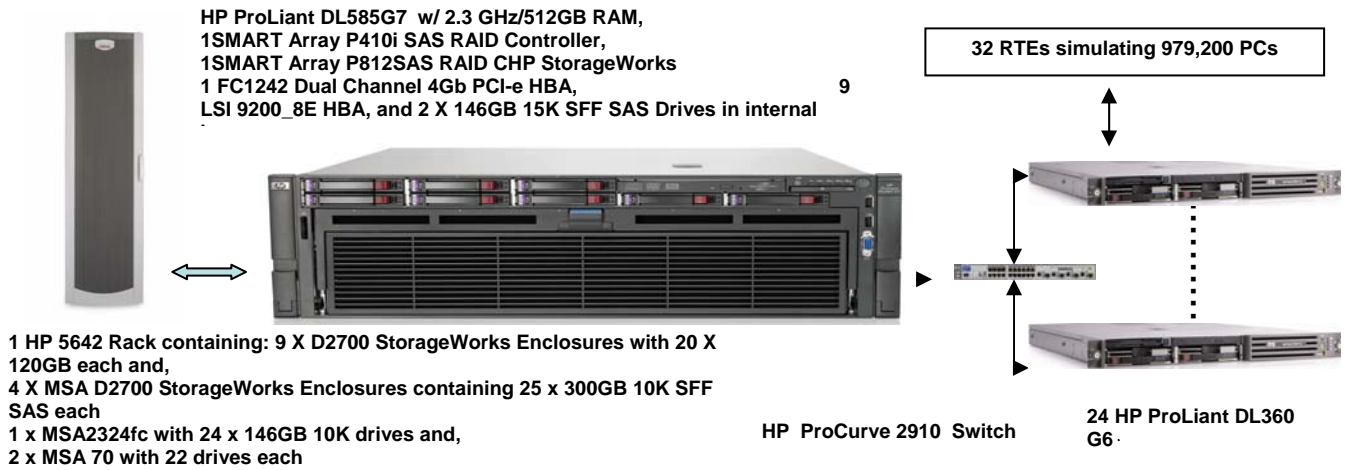


Figure 2. Priced Configuration



Clause 1 Related Items

Table Definitions

Listing must be provided for all table definition statements and all other statements used to set up the database.

Appendix B contains the code used to define and load the database tables.

Physical Organization of Database

The physical organization of tables and indices within the database must be disclosed.

The tested configuration consisted of 180 SSD drives at 120GB for database data, two 146GB drives for the operating system, 66 drives at 146GB for database log and 100 drives at 300 GB for backup and 60 day space. There were 180 SSD drives for database data on 9 LSI 9200-8e controllers connected to 9 D2700 storage boxes with 20 drives each, 100 x 300GB drives on one SMART P812 controller connected to 4 D2700 storage boxes for backup with 25 drives each, and 2 X 146GB drives on the SMART P410i controller for the operating system.

Benchmarked Configuration:

SMART-P400 Controller, Slot 0, Array A

LOGICAL DRIVE C: Total Capacity = 136.60 GB RAID 0+1
Microsoft Windows Server 2008 R2 Enterprise Edition

LSI 9200_8E, Slot 1, disk 1-20

LOGICAL DRIVE C:\stk\stk1-20: Total Capacity = 25.39 GB RAID 0

Stk_fg

LOGICAL DRIVE C:\cust\cust1-20: Total Capacity = 18.55 GB RAID 0

Cust_fg

LOGICAL DRIVE C:\ol\ol1-20: Total Capacity = 20.51 GB RAID 0

ol_fg

LOGICAL DRIVE C:\misc\misc1-20: Total Capacity = 5.86 GB RAID 0

Misc_fg

LSI 9200_8E, Slot 2, disk 21-40

LOGICAL DRIVE C:\stk\stk21-40: Total Capacity = 25.39 GB RAID 0

Stk_fg

LOGICAL DRIVE C:\cust\cust 21-40: Total Capacity = 18.55 GB RAID 0

Cust_fg

LOGICAL DRIVE C:\ol\ol 21-40: Total Capacity = 20.51 GB RAID 0

ol_fg

LOGICAL DRIVE C:\misc\misc 21-40: Total Capacity = 5.86 GB RAID 0

Misc_fg

LSI 9200_8E, Slot 3, disk 41-60

LOGICAL DRIVE C:\stk\stk 41-60: Total Capacity = 25.39 GB RAID 0

Stk_fg

LOGICAL DRIVE C:\cust\cust 41-60: Total Capacity = 18.55 GB RAID 0

Cust_fg

LOGICAL DRIVE C:\ol\ol 41-60: Total Capacity = 20.51 GB RAID 0

ol_fg

LOGICAL DRIVE C:\misc\misc 41-60: Total Capacity = 5.86 GB RAID 0

Misc_fg

LSI 9200_8E, Slot 4, disk 61-80

<u>LOGICAL DRIVE C:\stk\stk 61-80:</u> Stk_fg	<u>Total Capacity = 25.39 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\cust\cust 61-80:</u> Cust_fg	<u>Total Capacity = 18.55 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\ol\ol 61-80:</u> ol_fg	<u>Total Capacity = 20.51 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\misc\misc 61-80:</u> Misc_fg	<u>Total Capacity = 5.86 GB</u>	<u>RAID 0</u>

LSI 9200_8E, Slot 5, disk 81-100

<u>LOGICAL DRIVE C:\stk\stk 81-100:</u> Stk_fg	<u>Total Capacity = 25.39 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\cust\cust 81-100:</u> Cust_fg	<u>Total Capacity = 18.55 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\ol\ol 81-100:</u> ol_fg	<u>Total Capacity = 20.51 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\misc\misc 81-100:</u> Misc_fg	<u>Total Capacity = 5.86 GB</u>	<u>RAID 0</u>

LSI 9200_8E, Slot 6, disk 101-120

<u>LOGICAL DRIVE C:\stk\stk 101-120:</u> Stk_fg	<u>Total Capacity = 25.39 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\cust\cust 101-120:</u> Cust_fg	<u>Total Capacity = 18.55 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\ol\ol 101-120:</u> ol_fg	<u>Total Capacity = 20.51 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\misc\misc 101-120:</u> Misc_fg	<u>Total Capacity = 5.86 GB</u>	<u>RAID 0</u>

LSI 9200_8E, Slot 7, disk 121-140

<u>LOGICAL DRIVE C:\stk\stk 121-140:</u> Stk_fg	<u>Total Capacity = 25.39 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\cust\cust 121-140:</u> Cust_fg	<u>Total Capacity = 18.55 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\ol\ol 121-140:</u> ol_fg	<u>Total Capacity = 20.51 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\misc\misc 121-140:</u> Misc_fg	<u>Total Capacity = 5.86 GB</u>	<u>RAID 0</u>

Slot 8 FC1242 Dual Channel 4Gb PCI-e HBA MSA 2324fc Controller A, VD1

<u>LOGICAL DRIVE E:</u> MSSQL_tpcc_log_1	<u>Total Capacity = 1092.44 GB</u>	<u>RAID 10</u>
---	------------------------------------	----------------

Slot 8 FC1242 Dual Channel 4Gb PCI-e HBA MSA 2324fc Controller A, VD2

<u>LOGICAL DRIVE F:</u> MSSQL_tpcc_log_2	<u>Total Capacity = 1092.44 GB</u>	<u>RAID 10</u>
---	------------------------------------	----------------

Slot 8 FC1242 Dual Channel 4Gb PCI-e HBA MSA 2324fc Controller B, VD3

<u>LOGICAL DRIVE G:</u> MSSQL_tpcc_log_3	<u>Total Capacity = 1092.44 GB</u>	<u>RAID 10</u>
---	------------------------------------	----------------

Slot 8 FC1242 Dual Channel 4Gb PCI-e HBA MSA 2324fc Controller B, VD4

<u>LOGICAL DRIVE H:</u> MSSQL_tpcc_log_4	<u>Total Capacity = 1092.44 GB</u>	<u>RAID 10</u>
---	------------------------------------	----------------

LSI 9200_8E, Slot 9, disk 141-160

<u>LOGICAL DRIVE C:\stk\stk 141-160:</u> Stk_fg	<u>Total Capacity = 25.39 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\cust\cust 141-160:</u> Cust_fg	<u>Total Capacity = 18.55 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\ol\ol 141-160:</u> ol_fg	<u>Total Capacity = 20.51 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\misc\misc 141-160:</u> Misc_fg	<u>Total Capacity = 5.86 GB</u>	<u>RAID 0</u>

LSI 9200_8E, Slot 10, disk 121-180

<u>LOGICAL DRIVE C:\stk\stk 161-180:</u> Stk_fg	<u>Total Capacity = 25.39 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\cust\cust 161-180:</u> Cust_fg	<u>Total Capacity = 18.55 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\ol\ol 161-180:</u> ol_fg	<u>Total Capacity = 20.51 GB</u>	<u>RAID 0</u>
<u>LOGICAL DRIVE C:\misc\misc 161-180:</u> Misc_fg	<u>Total Capacity = 5.86 GB</u>	<u>RAID 0</u>

SMART-P812Controller, Slot 11, Array B

<u>LOGICAL DRIVE T:</u> Backup 1	<u>Total Capacity = 2048.00GB</u>	<u>RAID 1+0</u>
<u>LOGICAL DRIVE U:</u> Backup 2	<u>Total Capacity = 2048.00GB</u>	<u>RAID 1+0</u>
<u>LOGICAL DRIVE V:</u> Backup 3	<u>Total Capacity = 2048.00GB</u>	<u>RAID 1+0</u>
<u>LOGICAL DRIVE W:</u> Backup 4	<u>Total Capacity = 2048.00GB</u>	<u>RAID 1+0</u>
<u>LOGICAL DRIVE X:</u> Backup 5	<u>Total Capacity = 2048.00GB</u>	<u>RAID 1+0</u>
<u>LOGICAL DRIVE Y:</u> Backup 6	<u>Total Capacity = 2048.00GB</u>	<u>RAID 1+0</u>
<u>LOGICAL DRIVE Z:</u> Backup 7	<u>Total Capacity = 1680.00GB</u>	<u>RAID 1+0</u>

Priced Configuration vs. Measured Configuration:

The benchmarked configuration was run using 22 DL360G5/ 1.60GHz and 2 DL360G6 / 2.40GHz client systems. The priced configuration substituted 24 DL360G6 / 2.40GHz client systems. The substitution was verified in the HP ProLiant DL385G7 published TPC-C benchmark published 4/8/2010 available at tpc.org.

Insert and Delete Operations

It must be ascertained that insert and/or delete operations to any of the tables can occur concurrently with the TPC-C transaction mix. Furthermore, any restrictions in the SUT database implementation that precludes inserts beyond the limits

defined in Clause 1.4.11 must be disclosed. This includes the maximum number of rows that can be inserted and the minimum key value for these new rows.

All insert and delete functions were fully operational during the entire benchmark.

Partitioning

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

No partitioning was used in this benchmark.

Replication, Duplication or Additions

Replication of tables, if used, must be disclosed. Additional and/or duplicated attributes in any table must be disclosed along with a statement on the impact on performance.

No replications, duplications or additional attributes were used in this benchmark.

Clause 2 Related Items

Random Number Generation

The method of verification for the random number generation must be described.

In the Benchcraft RTE from Microsoft, each driver engine uses an independent random number sequence. All of the users within a given driver draw from the same sequence.

The Benchcraft RTE computes random integers as described in "Random Numbers Generators: Good Ones Are Hard to Find." Communications of the ACM - October 1988 Volume 31 Number 10.

The seeds for each user were captured and verified by the auditor to be unique. In addition, the contents of the database were systematically searched, and randomly sampled by the auditor for patterns that would indicate the random number generator had affected any kind of a discernible pattern; none was found.

Input/Output Screen Layout

The actual layout of the terminal input/output screens must be disclosed.

All screen layouts followed the specifications exactly.

Priced Terminal Feature Verification

The method used to verify that the emulated terminals provide all the features described in Clause 2.2.2.4 must be explained. Although not specifically priced, the type and model of the terminals used for the demonstration in 8.1.3.3 must be disclosed and commercially available (including supporting software and maintenance).

The terminal attributes were verified by the auditor. The auditor manually exercised each specification on a representative HP ProLiant web server.

Presentation Manager or Intelligent Terminal

Any usage of presentation managers or intelligent terminals must be explained.

Application code running on the client machines implemented the TPC-C user interface. No presentation manager software or intelligent terminal features were used. The source code for the forms applications is listed in Appendix A.

Transaction Statistics

Table 2.1 lists the numerical quantities that Clauses 8.1.3.5 to 8.1.3.11 require.

Table 2.1 Transaction Statistics

Statistic		Value
New Order	Home warehouse order lines	99.00%
	Remote warehouse order lines	1.00%
	Rolled back transactions	1.00%
	Average items per order	10.00
Payment	Home warehouse payments	85.00%
	Remote warehouse payments	14.999%
	Accessed by last name	60.01%
Order Status	Accessed by last name	60.05%
Transaction Mix	New Order	44.94%
	Payment	43.03%
	Order status	4.01%
	Delivery	4.01%
	Stock level	4.01%

Queuing Mechanism

The queuing mechanism used to defer the execution of the Delivery transaction must be disclosed.

Microsoft COM+ on each client machine served as the queuing mechanism to the database. Each delivery request was submitted to Microsoft COM+ asynchronously with control being returned to the client process immediately and the deferred delivery part completing asynchronously.

The source code is listed in Appendix A.

Clause 3 Related Items

Transaction System Properties (ACID)

The results of the ACID tests must be disclosed along with a description of how the ACID requirements were met. This includes disclosing which case was followed for the execution of Isolation Test 7.

All ACID property tests were successful. The executions are described below.

Atomicity

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

Completed Transactions

A row was selected in a script from the warehouse, district and customer tables, and the balances noted. A payment transaction was started with the same warehouse, district and customer identifiers and a known amount. The payment transaction was committed and the rows were verified to contain correctly updated balances.

Aborted Transactions

A row was selected in a script from the warehouse, district and customer tables, and the balances noted. A payment transaction was started with the same warehouse, district and customer identifiers and a known amount. The payment transaction was rolled back and the rows were verified to contain the original balances.

Consistency

Consistency is the property of the application that requires any execution of a database transaction to take the database from one consistent state to another, assuming that the database is initially in a consistent state.

Consistency conditions one through four were tested using a script to issue queries to the database. The results of the queries verified that the database was consistent for all four tests.

A run was executed under full load lasting over two hours and included a checkpoint.

The script was executed again. The result of the same queries verified that the database remained consistent after the run.

Isolation

Sufficient conditions must be enabled at either the system or application level to ensure the required isolation defined above (clause 3.4.1) is obtained.

Isolation tests one through nine were executed using shell scripts to issue queries to the database. Each script included timestamps to demonstrate the concurrency of operations. The results of the queries were captured to files. The captured files were verified by the auditor to demonstrate the required isolation had been met.

In addition, the phantom tests and the stock level tests were executed and verified.

For Isolation test seven, case A was followed.

Durability

The tested system must guarantee durability: the ability to preserve the effects of committed transaction and insure database consistency after recovery from any one of the failures listed in Clause 3.5.3.

Durable Media Failure

Loss of Data and Log

This was verified in the HP ProLiant DL385G7 published 4/8/2010, and available at TPC.org.

Instantaneous Interruption and Loss of Memory

Because loss of power erases the contents of memory, the instantaneous interruption and the loss of memory tests were combined into a single test. This test was executed on a fully scaled database of 108000 warehouses, of which 97920 warehouses were used, under a full load of 979200 users. The following steps were executed:

- The total number of New Orders was determined by the sum of D_NEXT_O_ID of all rows in the DISTRICT table giving the beginning count.
- The RTE was started with 979200 users.
- The test was allowed to run for a minimum of 6 minutes.
- Pulling the power cords from the SUT induced system crash and loss of memory. No battery backup or Uninterruptible Power Supply (UPS) were used to preserve the contents of memory.
- The RTE was paused then stopped.
- Power was restored and the system restarted.
- Microsoft SQL Server was restarted and performed an automatic recovery.
- Consistency condition #3 was executed and verified.
- Step 1 was repeated and the difference between the first and second counts was noted.
- An RTE report was generated for the entire run time giving the number of NEW-ORDERS successfully returned to the RTE.
- The counts in step 9 and 10 were compared and the results verified that all committed transactions had been successfully recovered.
- Samples were taken from the RTE files and used to query the database to demonstrate successful transactions had corresponding rows in the ORDER table.

Clause 4 Related Items

Initial Cardinality of Tables

The cardinality (e.g. number of rows) of each table, as it existed at the start of the benchmark run, must be disclosed. If the database was over-scaled and inactive rows of the WAREHOUSE table were deleted, the cardinality of the WAREHOUSE table as initially configured and the number of rows deleted must be disclosed.

Table 4.1 Number of Rows for Server

Table	Cardinality as built
Warehouse	108000
District	1080000
Customer	3240000000
History	3240000000
Orders	3240000000
New Order	972000000
Order Line	32399889468
Stock	10800000000
Item	100,000
Unused Warehouses	10080

Database Layout

The distribution of tables and logs across all media must be explicitly depicted for tested and priced systems.

The benchmarked configuration used 180 SSD drives at 120GB for database data, two 146 GB SAS drives for the operating system, and 66 SAS drives at 146GB for database log and (100) 300GB drives for backup and 60 day space. Nine LSI 92000_8E connected to nine D2700 drive boxes 2 controller ports per D2700. Each controller was configured into individual drives. The SMART P410i controller was connected to the internal drive cage which contained 2 X 146GB SAS drives configured as a RAID 0+1 logical drive. One P812 was configured as RAID1+0 and connected 4 D2700 drive boxes for backup. A FC1242 Dual Channel 4Gb PCI-e HBA was connected to an MSA2324fc using both HBA ports and both controllers of the MSA 2324fc. The MSa2324fc cache configuration was set to fault tolerant active-active. This MSA2324fc contained 22 drives at 300GB and connected to two MSA 70 drive boxes each with 22 drives each at 146 GB for the transaction log. These were configured as 4 virtual disks at RAID 10.

Section 1.2 of this report details the distribution of database tables across all disks. The code that creates the file groups and tables is included in Appendix B.

Type of Database

A statement must be provided that describes:

- The data model implemented by DBMS used (e.g. relational, network, hierarchical).

- *The database interface (e.g. embedded, call level) and access language (e.g. SQL, DL/I, COBOL read/write used to implement the TPC-C transaction. If more than one interface/access language is used to implement TPC-C, each interface/access language must be described and a list of which interface/access language is used with which transaction type must be disclosed.*

Microsoft SQL Server 2005 Enterprise x64 Edition is a relational DBMS.

The interface used was Microsoft SQL Server stored procedures accessed with Remote Procedure Calls embedded in C code.

Database Mapping

The mapping of database partitions/replications must be explicitly described.

The database was not replicated.

60 Day Space

Details of the 60-day space computations along with proof that the database is configured to sustain 8 hours of growth for the dynamic tables (Order, Order-Line, and History) must be disclosed.

To calculate the space required to sustain the database log for 8 hours of growth at steady state, the following steps were followed:

- The free space on the log file was queried using *dbcc sqlperf(logspace)*.
- Transactions were run against the database with a full load of users.
- The free space was again queried using *dbcc sqlperf(logspace)*.
- The space used was calculated as the difference between the first and second query.
- The number of NEW-ORDERS was verified from the difference in the sum(d_next_o_id) taken from before and after the run.
- The space used was divided by the number of NEW-ORDERS giving a space used per NEW-ORDER transaction.
- The space used per transaction was multiplied by the measured tpmC rate times 480 minutes.

The same methodology was used to compute growth requirements for dynamic tables Order, Order-Line and History.

Details of both the 8-hour transaction log space requirements and the 60-day space requirements are shown in Appendix D.

Clause 5 Related Items

Throughput

Measured tpmC must be reported

Measured tpmC 1,193,472 tpmC

Price per tpmC USD \$0.68

Response Times

Ninetieth percentile, maximum and average response times must be reported for all transaction types as well as for the menu response time.

Table 5.2: Response Times

Type	Average	90 th %	Maximum
New-Order	0.70	1.69	37.83
Payment	0.73	1.82	38.28
Order-Status	0.69	1.66	36.75
Interactive Delivery	0.33	0.64	25.31
Deferred Delivery	0.12	0.22	5.07
Stock-Level	0.76	1.73	26.59
Menu	0.35	0.69	40.40

Keying and Think Times

The minimum, the average, and the maximum keying and think times must be reported for each transaction type.

Table 5.3: Keying Times

Type	Minimum	Average	Maximum
New-Order	18.02	18.03	18.20
Payment	3.02	3.03	3.20
Order-Status	2.02	2.03	2.20
Interactive Delivery	2.02	2.03	2.14
Stock-Level	2.02	2.03	2.18

Table 5.4: Think Times

Type	Minimum	Average	Maximum
New-Order	0.00	12.06	120.53
Payment	0.00	12.06	120.53
Order-Status	0.00	10.06	100.53
Interactive Delivery	0.00	5.07	50.53
Stock-Level	0.00	5.06	50.53

Response Time Frequency Distribution Curves and Other Graphs

Response Time frequency distribution curves (see Clause 5.6.1) must be reported for each transaction type.

The performance curve for response times versus throughput (see Clause 5.6.2) must be reported for the New-Order transaction.

Think Time frequency distribution curves (see Clause 5.6.3) must be reported for each transaction type.

Keying Time frequency distribution curves (see Clause 5.6.4) must be reported for each transaction type.

A graph of throughput versus elapsed time (see Clause 5.6.5) must be reported for the New-Order transaction.

Figure 3. New Order Response Time Distribution

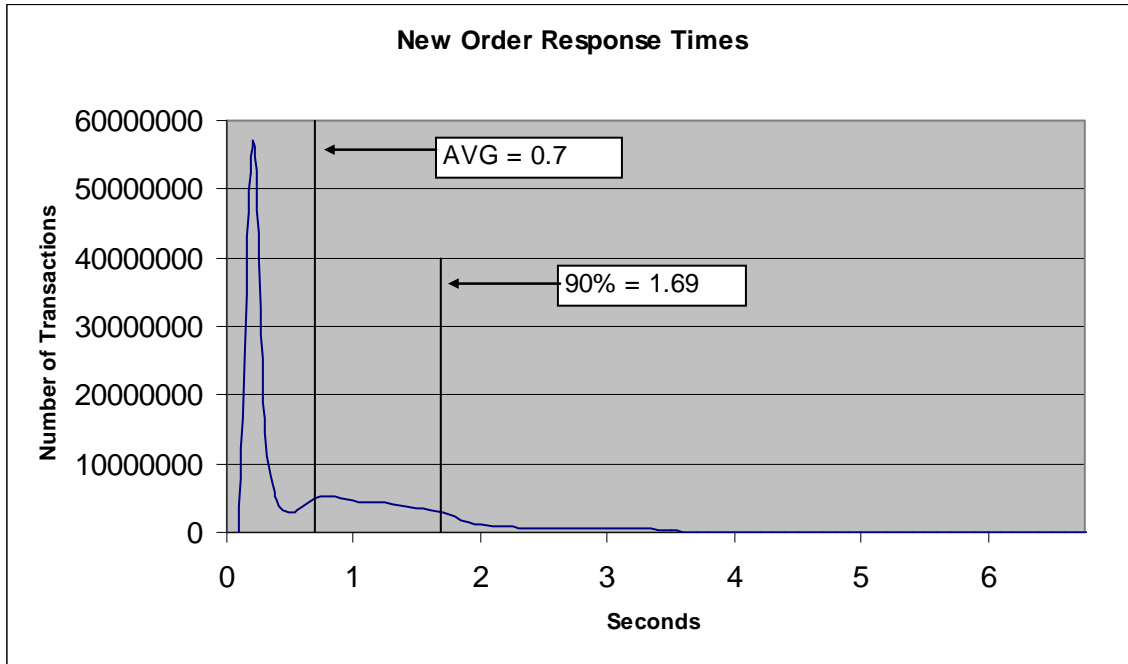


Figure 4. Payment Response Time Distribution

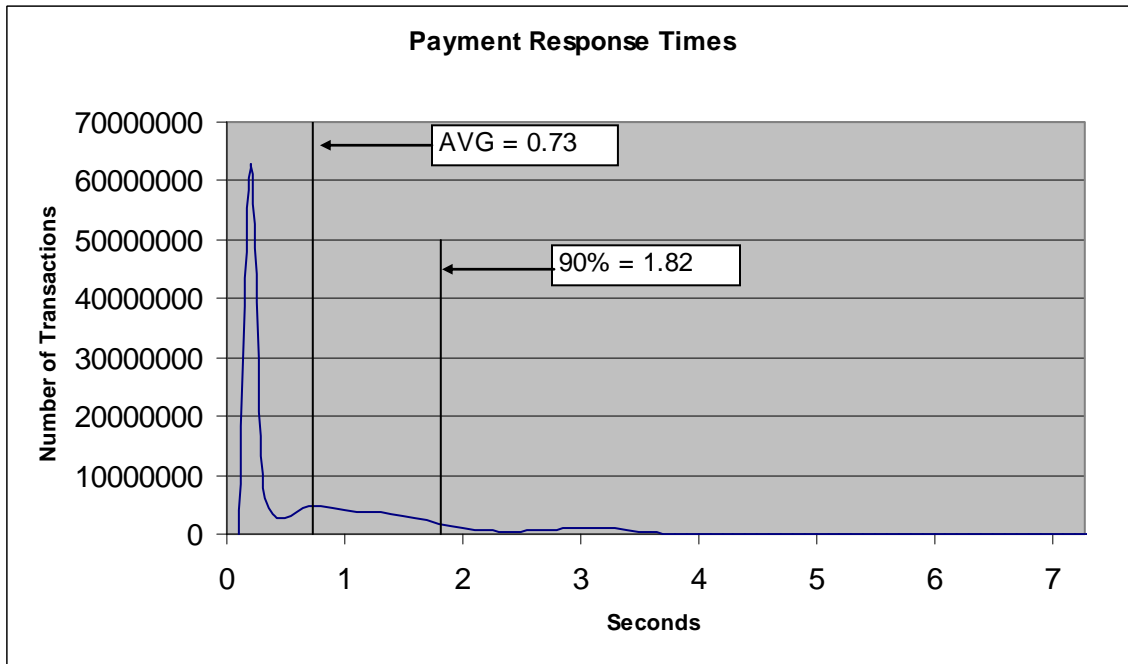


Figure 5. Order Status Response Time Distribution

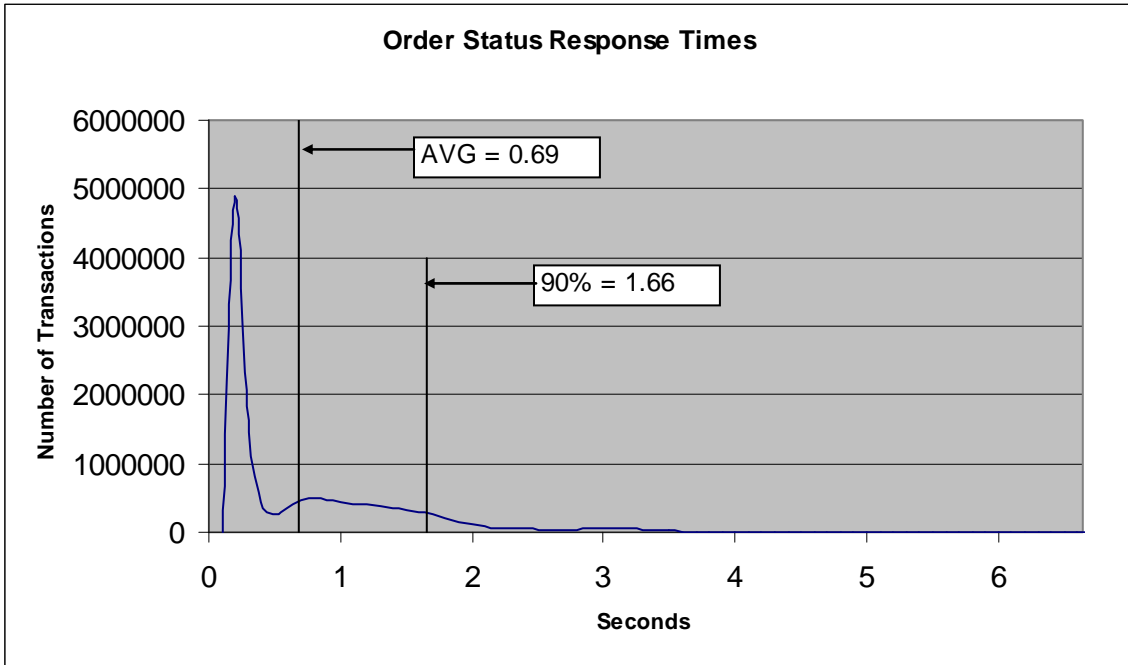


Figure 6. Delivery Response Time Distribution

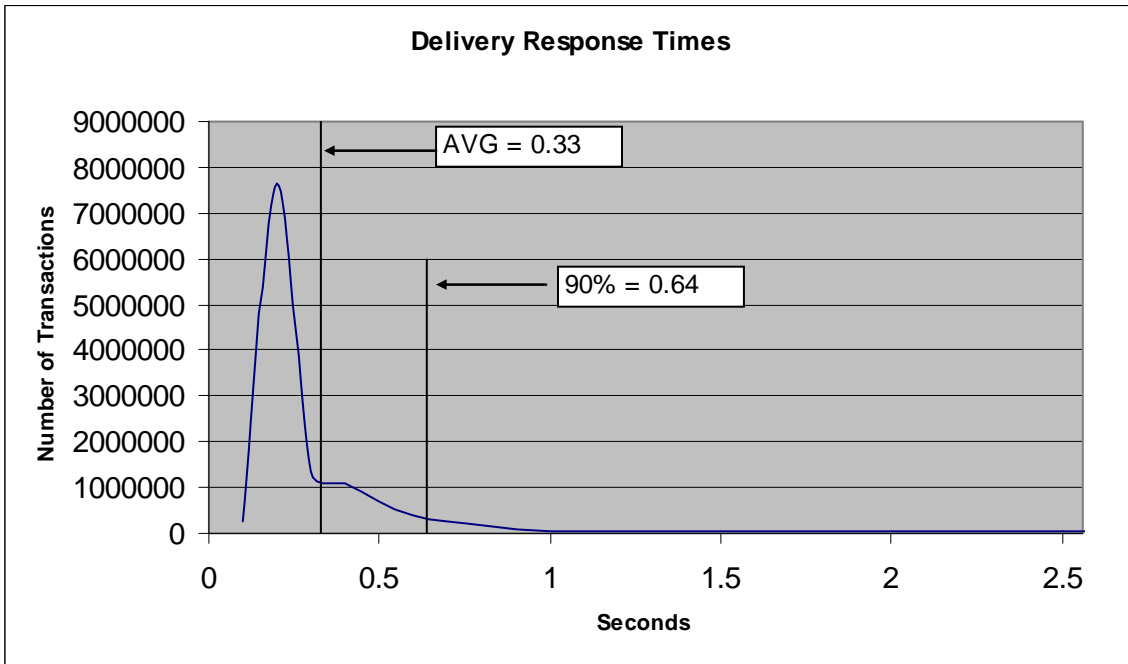


Figure 7. Stock Level Response Time Distribution

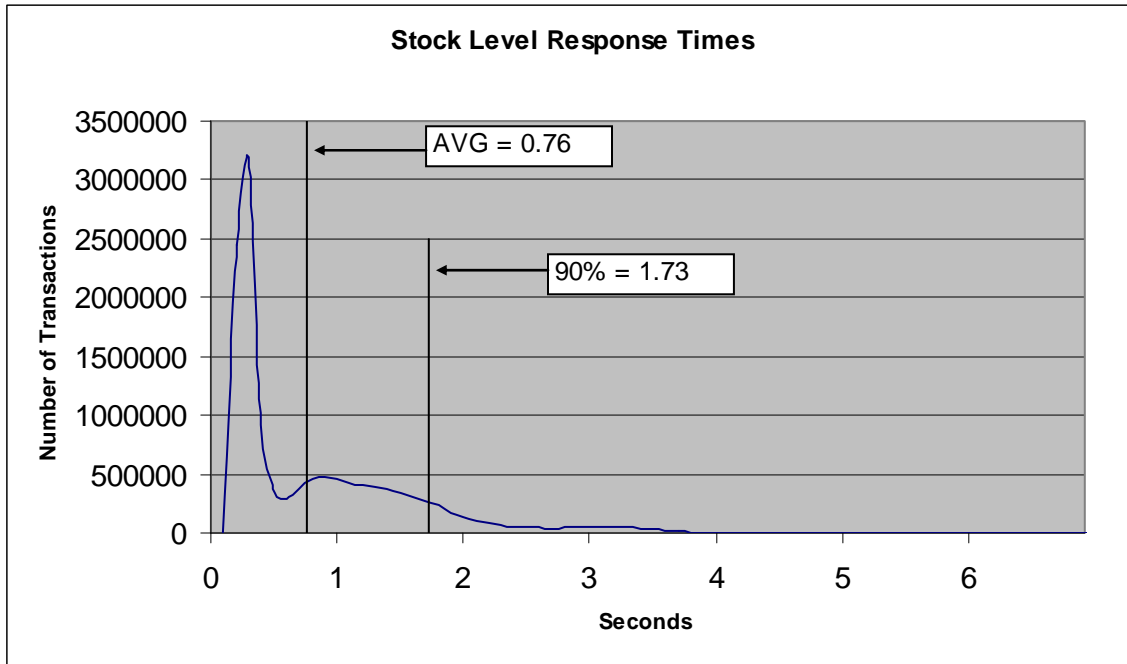


Figure 8. Response Time vs. Throughput

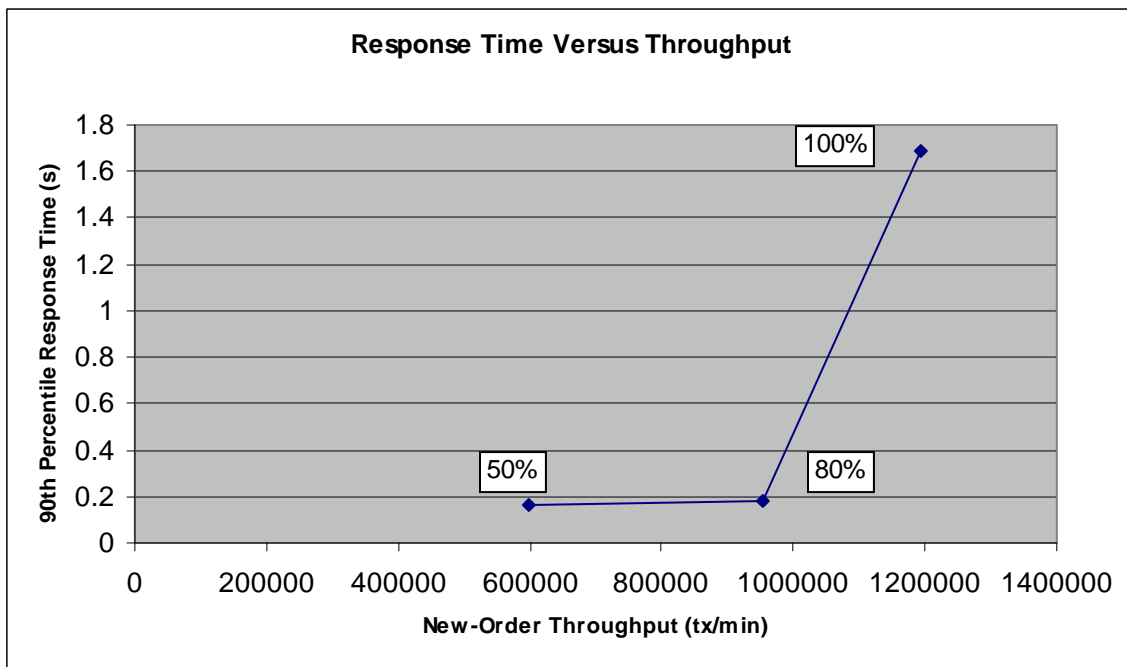
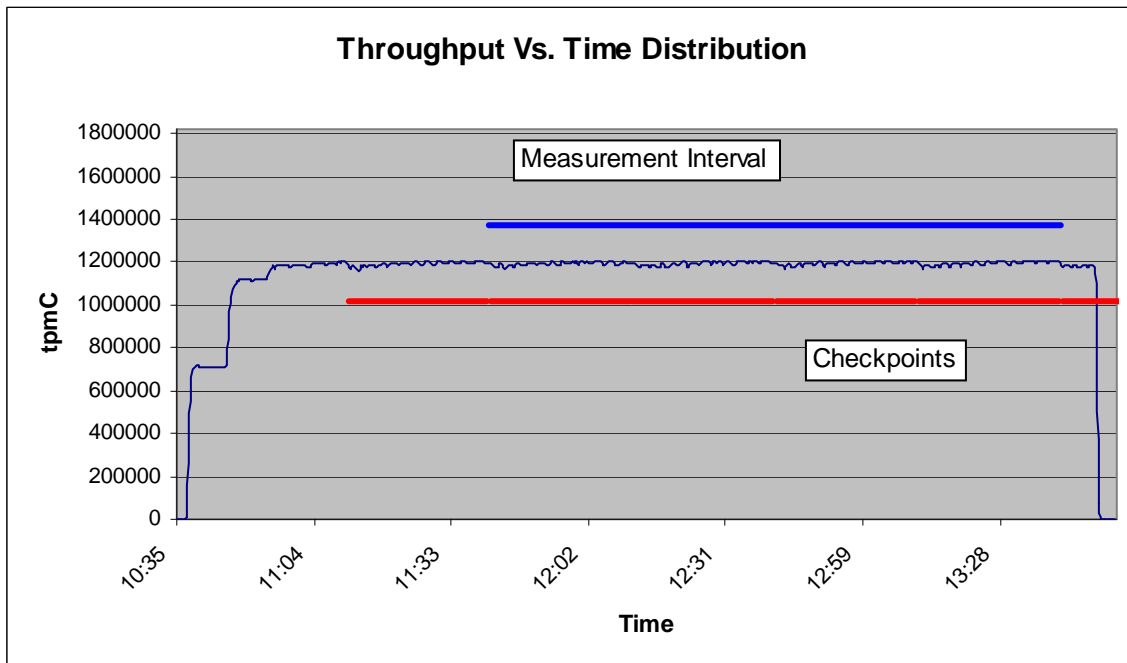


Figure 9. New Order Think Time Distribution



Figure 10. Throughput vs. Time Distribution



Steady State Determination

The method used to determine that the SUT had reached a steady state prior to commencing the measurement interval must be disclosed.

Steady state was determined using real time monitor utilities from the RTE. Steady state was further confirmed by the throughput data collected during the run and graphed in Figure 10.

Work Performed During Steady State

A description of how the work normally performed during a sustained test (for example checkpointing, writing redo/undo log records, etc.), actually occurred during the measurement interval must be reported.

The RTE generated the required input data to choose a transaction from the menu. This data was time stamped. The input screen for the requested transaction was returned and time stamped. The difference between these two timestamps was the menu response time. The RTE writes to the log file once per transaction on selective fields such as order id. There is one log file per driver engine.

The RTE generated the required input data for the chosen transaction. It waited to complete the minimum required key time before transmitting the input screen. The transmission was time stamped. The return of the screen with the required response data was time stamped. The difference between these two timestamps was the response time for that transaction.

The RTE then waited the required think time interval before repeating the process starting at selecting a transaction from the menu.

The RTE transmissions were sent to application processes running on the client machines through Ethernet LANs. These client application processes handled all screen I/O as well as all requests to the database on the server. The applications communicated with the database server over gigabit Ethernet LANs using ODBC and RPC calls.

To perform checkpoints at specific intervals, the SQL Server *recovery interval* was set to 32767 and a script was written to schedule multiple checkpoints at specific intervals. The script included a wait time between each checkpoint equal to 30 minutes. The measurement interval was 120 minutes. The checkpoint script was started manually after the RTE had all users logged in and the database had achieved steady state.

At each checkpoint, Microsoft SQL Server wrote to disk all memory pages that had been updated but not yet physically written to disk. The positioning of the measurement interval is depicted on the graph in Figure 9.

Measurement Period Duration

A statement of the duration of the measurement interval for the reported Maximum Qualified Throughput (tpmC) must be included.

The reported measured interval was exactly 120 minutes long.

Regulation of Transaction Mix

The method of regulation of the transaction mix (e.g., card decks or weighted random distribution) must be described. If weighted distribution is used and the RTE adjusts the weights associated with each transaction type, the maximum adjustments to the weight from the initial value must be disclosed.

The RTE was given a weighted random distribution, which was not adjusted during the run.

Transaction Statistics

The percentage of the total mix for each transaction type must be disclosed. The percentage of New-Order transactions rolled back as a result of invalid item number must be disclosed. The average number of order-lines entered per New-Order transaction must be disclosed. The percentage of remote order lines per New-Order transaction must be disclosed. The percentage of remote Payment transactions must be disclosed. The percentage of customer selections by customer last name in the Payment and Order-Status transactions must be disclosed. The percentage of Delivery transactions skipped due to there being fewer than necessary orders in the New-Order table must be disclosed.

Table 5.5: Transaction Statistics

Statistic		Value
New Order	Home warehouse order lines	99.00%
	Remote warehouse order lines	1.00%
	Rolled back transactions	1.00%
	Average items per order	10.00
Payment	Home warehouse payments	85.00%
	Remote warehouse payments	14.999%
	Accessed by last name	60.01%
Delivery	Skipped transactions (interactive)	0
	Skipped transactions (deferred)	0
Order Status	Accessed by last name	60.05%
Transaction Mix	New Order	44.94%
	Payment	43.03%
	Order status	4.01%
	Delivery	4.01%
	Stock level	4.01%

Checkpoint Count and Location

The number of checkpoints in the Measurement Interval, the time in seconds from the start of the Measurement Interval to the first checkpoint, and the Checkpoint Interval must be disclosed.

The initial checkpoint was started 34 minutes after the start of the ramp-up. Subsequent checkpoints occurred every 30 minutes. Each checkpoint in the measurement interval lasted 29 minutes and 10 seconds. The measurement interval contains four checkpoints.

Checkpoint Duration

The start time and duration in seconds of at least the four longest checkpoints during the Measurement Interval must be disclosed.

Checkpoint Start Time	Duration
11:41:51PM	29 minutes, 10 seconds
12:11:49PM	29 minutes, 10 seconds
12:41:46PM	29 minutes, 10 seconds
13:11:43PM	29 minutes, 10 seconds

Clause 6 Related Items

RTE Descriptions

If the RTE is commercially available, then its inputs must be specified. Otherwise, a description must be supplied of what inputs (e.g., scripts) to the RTE had been used.

The RTE used was Microsoft Benchcraft RTE. Benchcraft is a proprietary tool provided by Microsoft and is not commercially available. The RTE's input is listed in Appendix A.

Emulated Components

It must be demonstrated that the functionality and performance of the components being emulated in the Driver System are equivalent to the priced system. The results of the test described in Clause 6.6.3.4 must be disclosed.

The driver system consisted of 32 HP ProLiant servers. These driver machines emulated the users' web browsers.

Functional Diagrams

A complete functional diagram of both the benchmark configuration and the configuration of the proposed (target) system must be disclosed. A detailed list of all hardware and software functionality being performed on the Driver System and its interface to the SUT must be disclosed.

The driver system performed the data generation and input functions of the priced display device. It also captured the input and output data and timestamps for post-processing of the reported metrics. No other functionality was included on the driver system.

Section 1.4 of this report contains detailed diagrams of both the benchmark configuration and the priced configuration.

Networks

The network configuration of both the tested services and proposed (target) services that are being represented and a thorough explanation of exactly which parts of the proposed configuration are being replaced with the Driver System must be disclosed.

The bandwidth of the networks used in the tested/priced configuration must be disclosed.

In the tested configuration, 32 driver (RTE) machines were connected through a gigabit Ethernet switch to the client machines at 1Gbps, thus providing the path from the RTEs to the clients. The server (SUT) was connected to the clients through a gigabit Ethernet switch on a separate LAN.

The priced configuration was connected in the same manner as the tested configuration.

Operator Intervention

If the configuration requires operator intervention (see Clause 6.6.6), the mechanism and the frequency of this intervention must be disclosed.

This configuration does not require any operator intervention to sustain eight hours of the reported throughput.

Clause 7 Related Items

System Pricing

A detailed list of hardware and software used in the priced system must be reported. Each separately orderable item must have vendor part number, description, and release/revision level, and either general availability status or committed delivery data. If package-pricing is used, vendor part number of the package and a description uniquely identifying each of the components of the package must be disclosed. Pricing source and effective date(s) of price(s) must also be reported.

The total 3 year price of the entire configuration must be reported, including: hardware, software, and maintenance charges. Separate component pricing is recommended. The basis of all discounts used must be disclosed.

The details of the hardware and software are reported in the front of this report as part of the executive summary. All third party quotations are included at the end of this report as Appendix E.

Availability, Throughput, and Price Performance

The committed delivery date for general availability (availability date) of products used in the price calculation must be reported. When the priced system included products with different availability dates, the reported availability date for the priced system must be the date at which all components are committed to be available.

A statement of the measured tpmC as well as the respective calculations for the 5-year pricing, price/performance (price/tpmC), and the availability date must be included.

- **Maximum Qualified Throughput** **1,193,472tpmC**
- **Price per tpmC** **USD \$0.68 per tpmC**
- **Availability** **September 1, 2010**

Country Specific Pricing

Additional Clause 7 related items may be included in the Full Disclosure Report for each country specific priced configuration. Country specific pricing is subject to Clause 7.1.7

This system is being priced for the United States of America.

Usage Pricing

For any usage pricing, the sponsor must disclose:

- Usage level at which the component was priced.
- A statement of the company policy allowing such pricing.

The component pricing based on usage is shown below:

- 24 Microsoft Windows Server 2008 R2 Standard Edition
- 1 Microsoft Windows Server 2008 R2 Enterprise Edition
- 1 Microsoft SQL Server 2005 Enterprise x64 Edition (per processor) SP3
- 1 Microsoft Visual Studio Standard 2005
- HP Servers include 3 years of support.

Clause 9 Related Items

Auditor's Report

The auditor's name, address, phone number, and a copy of the auditor's attestation letter indicating compliance must be included in the Full Disclosure Report.

This implementation of the TPC Benchmark C was audited by Lorna Livingtree of Performance Metrics, Inc.

Performance Metrics, Inc.
PO Box 984
Klamath CA 95548
(phone) 707-482-0523
(fax) 707-482-0575
e-mail: lornaL@perfmetrics.com

Availability of the Full Disclosure Report

The Full Disclosure Report must be readily available to the public at a reasonable charge, similar to the charges for similar documents by the test sponsor. The report must be made available when results are made public. In order to use the phrase "TPC Benchmark™ C", the Full Disclosure Report must have been submitted to the TPC Administrator as well as written permission obtained to distribute same.

Requests for this TPC Benchmark C Full Disclosure Report should be sent to:

TPC
Presidio of San Francisco
Building 572B Ruger St. (surface)
P.O. Box 29920 (mail)
San Francisco, CA 94129-0920

or

Hewlett-Packard Company
Database Performance Engineering
P.O. Box 692000
Houston, TX 77269-2000



June 19, 2010

Mr. David Adams
 Database Performance Engineer
 Hewlett-Packard Company
 20555 SH 249
 Houston, TX 77070

I have verified by remote the TPC Benchmark™ C for the following configuration:

Platform: HP ProLiant DL585G7
 Database Manager: Microsoft SQL Server 2005 Enterprise X64 Edition SP3
 Operating System: Microsoft Windows Server 2008 R2 Enterprise Edition
 Transaction Monitor: Microsoft COM+

System Under Test:				
CPU's	Memory	Disks (total)	90% Response	TpmC
4 AMD 12 core @ 2.3 Ghz	Main: 512 GB	100 @ 300 GB 180 @ 120 GB 2 @ 146 GB	1.69	1,193,472
Clients: 22 DL360 G5				
1 Intel quad core @ 1.6 Ghz	1 GB	2 @ 72 GB	NA	NA
Clients: 2 DL360 G6				
1 Intel quad core @ 2.4 Ghz	2 GB	2 @ 72 GB	NA	NA

In my opinion, these performance results were produced in compliance with the TPC requirements for the benchmark. The following attributes of the benchmark were given special attention:

- The transactions were correctly implemented.
- The database files were properly sized.
- The database was properly scaled with 108,000 warehouses, of which 97,9200 were active during the measured interval.
- The ACID properties were successfully demonstrated on an identical configuration previously publish. The system loss test was repeated on this configuration and successfully recovered.
- Input data was generated according to the specified percentages.
- Eight hours of mirrored log space was present on the tested system.
- Eight hours of growth space for the dynamic tables was present on the tested system.
- The data for the 60 days space calculation was verified.
- The steady state portion of the test was 120 minutes.
- There was one complete checkpoint in steady state before the measured interval.

- There were 4 checkpoints started and completed inside the measured interval.
- The system pricing was checked for major components and maintenance.
- Third party quotes were verified for compliance.

Auditor Notes:

The DL360G5 client machines are no longer orderable. There were two DL360G6 clients present in the measured system. The throughput for each client machine was verified to comply with the pricing specification requirements for measured substitution. This substitution is compliant with the pricing and substitution rules.

Sincerely,

A handwritten signature in cursive script that reads "Lorna Livingtree".

Lorna Livingtree, Certified Auditor