TPC Benchmark™ H
Full Disclosure Report

DELL PowerEdge R610

6-core Intel® Xeon™ X-5690 3.46GHz 12MB L3 Cache
using
VectorWise™ 1.6
and
RedHat™ RHEL 6.0

Overview

This report documents the methodology and results of the TPC Benchmark™ H test conducted on a Dell PowerEdge R610 server, in conformance with the requirements of the TPC Benchmark™ H Standard Specification, Revision 2.14.0. The operating system used for the benchmark was Red Hat Enterprise Linux Server release 6.0; the DBMS was VectorWise release 1.6.

Standard and Executive Summary Statements

The pages following this preface contain the Executive Summary and Numerical Quantities Summary of the benchmark results.

Auditor

The benchmark configuration, environment and methodology used to produce and validate the test results and the pricing model used to calculate the cost per QphH was audited by Steve Barrish, Performance Metrics, to verify compliance with the relevant TPC specifications.

TPC Benchmark H Overview

The TPC Benchmark ™ H (TPC-H) is a decision support benchmark. It consists of a suite of business oriented ad-hoc queries and concurrent data modifications. The queries and the data populating the database have been chosen to have broad industry-wide relevance while maintaining a sufficient degree of ease of implementation. This benchmark illustrates decision support systems that

Examine large volumes of data;

Execute queries with a high degree of complexity;

Give answers to critical business questions.

TPC-H evaluates the performance of various decision support systems by the execution of sets of queries against a standard database under controlled conditions. The TPC-H queries:

Give answers to real-world business questions;

Simulate generated ad-hoc queries(e.g., via a point and click GUI interface);

Are far more complex than most OLTP transactions;

Include a rich breadth of operators and selectivity constraints;

Generate intensive activity on the part of the database server component of the system under test;

Are executed against a database complying to specific population and scaling requirements;

Are implemented with constraints derived from staying closely synchronized with an on-line production database.

The TPC-H operations are modeled as follows:

The database is continuously available 24 hours a day, 7 days a week, for ad-hoc queries from multiple end users and updates against all tables, except possibly during infrequent (e.g., once a month) maintenance sessions;

The TPC-H database tracks, possibly with some delay, the state of the OLTP database through on-going updates which batch together a number of modifications impacting some part of the decision support database;

Due to the world-wide nature of the business data stored in the TPC-H database, the queries and the updates may be executed against the database at any time, especially in relation to each other. In addition, this mix of queries and updates is subject to specific ACIDity requirements, since queries and updates may execute concurrently;

To achieve the optimal compromise between performance and operational requirements the database administrator can set, once and for all, the locking levels and the concurrent scheduling rules for queries and updates.

The minimum database required to run the benchmark holds business data from 10,000 suppliers. It contains almost ten million rows representing a raw storage capacity of about 1 GB. Compliant benchmark implementations may also use one of the larger permissible database populations (e.g. 1000 GB), as defined in Clause 4.1.3.

The performance metrics reported by TPC-H measure multiple aspects of the capability of the system to process queries. The TPC-H metric at the selected size (QphH@Size) is the performance metric. To be compliant with the TPC-H standard, all references to TPC-

H results for a given configuration must include all required reporting components (see Clause 5.4.7). The TPC believes that comparisons of TPC-H results measured against different database sizes are misleading and discourages such comparisons.

The TPC-H database must be implemented using a commercially available database management system (DBMS), and the queries executed via an interface using dynamic SQL. The specification provides for variants of SQL, as implementers are not required to have implemented a specific SQL standard in full. TPC-H uses terminology and metrics that are similar to other benchmarks, originated by the TPC and others. Such similarity in terminology does not in any way imply that TPC-H results are comparable to other benchmarks. The only benchmark results comparable to TPC-H are other TPC-H results compliant with the same revision.

Despite the fact that this benchmark offers a rich environment representative of many decision support systems, this benchmark does not reflect the entire range of decision support requirements. In addition, the extent to which a customer can achieve the results reported by a vendor is highly dependent on how closely TPC-H 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-H should not be used as a substitute for a specific customer application benchmarking when critical capacity planning and/or product evaluation decisions are contemplated.

Benchmark sponsors are permitted several possible system designs, provided that they adhere to the model described in Clause 6. A full disclosure report (FDR) of the implementation details, as specified in Clause 8, must be made available along with the reported results.

General Implementation Guidelines

The purpose of TPC benchmarks is to provide relevant, objective performance data to industry users. To achieve that purpose, TPC benchmark specifications require that benchmark tests be implemented with systems, products, technologies and pricing that:

Are generally available to users;

Are relevant to the market segment that the individual TPC benchmark models or represents (e.g. TPC-H models and represents complex, high data volume, decision support environments);

Would plausibly be implemented by a significant number of users in the market segment the benchmark models or represents.

Dell, Inc. does not warrant or represent that a user can or will achieve performance similar to the benchmark results contained in this report. No warranty of system performance or price/performance is expressed or implied by this report.
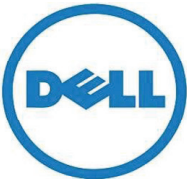
	Dell PowerEdge R610 using VectorWise 1.6	TPC-H Rev 2.14.0 TPC Pricing Rev 1.6.0
		Report Date: May 20, 2011

Total System Cost	Composite Query per Hour Metric	Price/Performance	TPC-Energy Metric
$48,328 USD	**303,289.8** QphH@100GB	**$0.16 USD** Price/QphH@100GB	**1.28** Watts/KQphH@100GB

Database Size	Database Manager	Operating System	Other Software	Availability Date
100 GB	**VectorWise 1.6**	**RedHat Enterprise Linux 6.0**	**None**	**6/30/2011**

Geometric Mean 1.1   Arithmetic Mean 13.9

☐ Power
■ Thruput
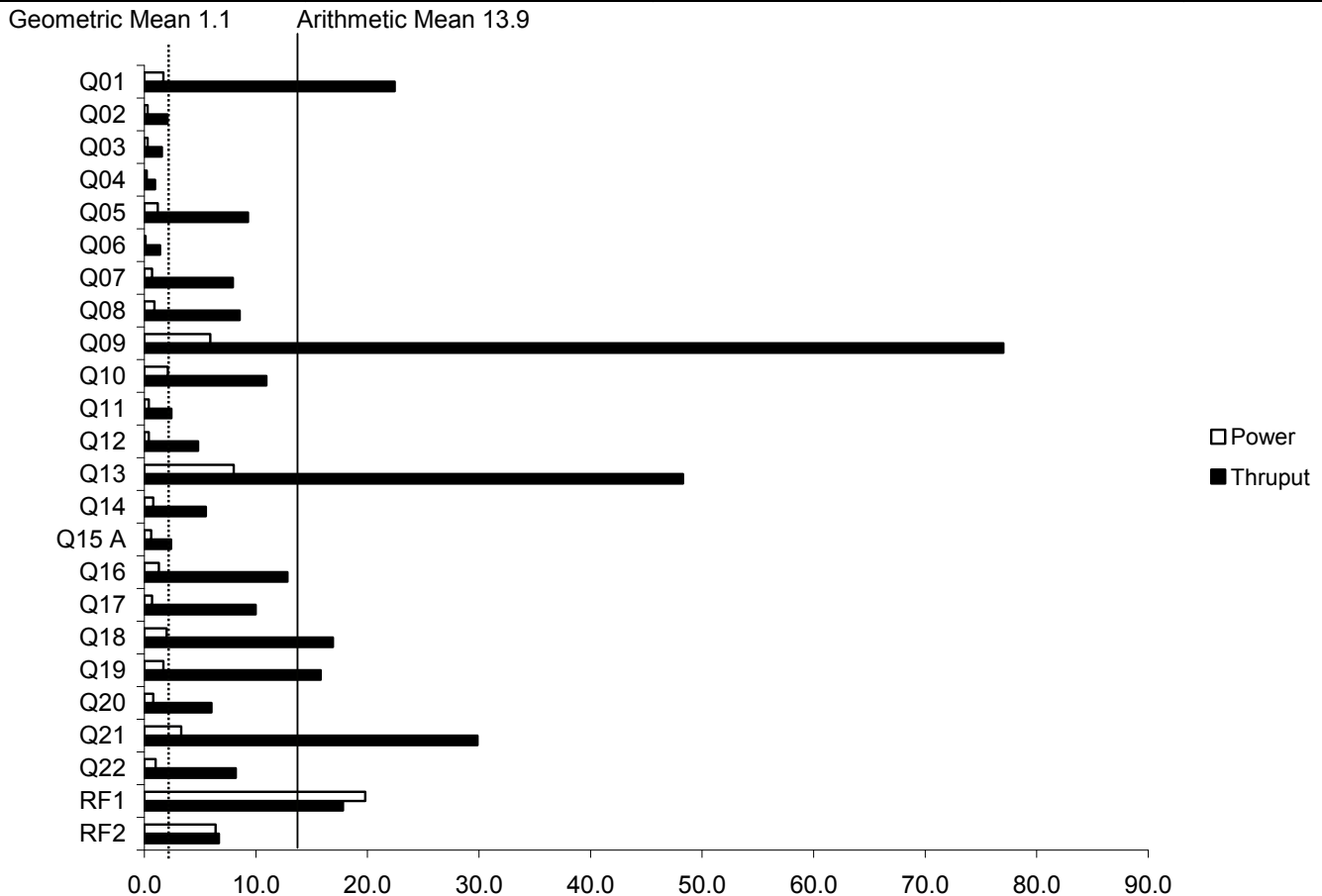
Database Load Time = 02:04:23	Load Includes Backup: N
Total Data Storage/Database Size = 8.76	Memory/Database Size Percentage = 192.%

Storage Redundancy Level 1 for Base Tables, Auxiliary Data Structures, DBMS temporary space, and OS and DBMS Software

System Configuration

Number of Nodes:	1
Processors/Cores/Threads/Type:	2/12/12/Intel Xeon X5690 3.46 Ghz, 12MB L3 cache
Memory:	192 GB
Disk Controller:	Dell PERC H700 RAID Controller with 1GB NVRAM Cache on-board
Disk Drives:	6 x 146GB 2.5in SAS 6Gb/s 15k rpm
Total Disk Storage	876 GB
LAN Controllers	2 x 1Gb Ethernet on-board
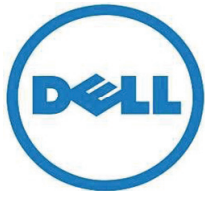
	Dell PowerEdge R610 using VectorWise 1.6	TPC-H Rev 2.14.0 TPC Pricing Rev 1.6.0
		Report Date: May 20, 2011

Description	Part Number	Source	Reference Price	Qty	Extended Price	3 yr Maint Price
Server Hardware						
PER610 CHASSIS, UP TO 6 2.5IN HDD	224-8479	1	$891.00	1	$891.00	included
192GB,12x16GB,800,4R,RDIMMs,2P,OP	317-2196	1	$9,865.00	1	$9,865.00	
HIGH OUTPUT PWRSPLY,NRDNT,717W	330-3519	1	$30.00	1	$30.00	
DVD+/-RW, SATA	313-9090	1	$99.00	1	$99.00	
PSMC 4H7X24 OS,PER610,UNY,2YR EXT	992-9972	1	$231.00	1	$231.00	
PSMC TECH SPT,PER610,3 YR	993-0162	1	$599.00	1	$599.00	
PSMC 4H7X24 OS,PER610,UNY,INIT	993-3670	1	$269.00	1	$269.00	
PSMC MISSION CRIT SVC,PER610,3YR	993-9408	1	$500.00	1	$500.00	
HW WRTY + SVC,PER610,UNY,INIT	993-9457	1	$183.00	1	$183.00	
HW WRTY + SVC,PER610,UNY,EXT	993-9458	1	$175.00	1	$175.00	
X5690,3.46GHz,12M,XN,6.4GT/s,6C	317-6160	1	$2,159.00	1	$2,159.00	
X5690,3.46GHz,12M,XN,6.4GT/s,6C	317-6167	1	$2,159.00	1	$2,159.00	
PERC H700 CTL 1GB NV Cache	342-1619	1	$799.00	1	$799.00	
146GB 15K SAS,6G,2.5,HP	342-0427	1	$359.00	6	$2,154.00	
RHEL6.0,FIx64,No Lic or Media	421-5717	1	$0.00	1	$0.00	
RHEL,1-2 SKT,3yr Sub and Lic,1VT Guest	421-5721	1	$2,349.00	1	$2,349.00	
RHEL6 Media Only X86_64, No Sub,FI	421-5737	1	$0.00	1	$0.00	
Slide Ready Rail,No Cb Mng Arm	330-3521	1	$149.00	1	$149.00	
Dell Discount (30%)				1	-$6,783.30	
				Subtotal	**$15,827.70**	**$0.00**
No External Storage						
Software						
VectorWise 1.6 3-year license Dell server**	ING-VW-3Y-GB-DELL	2	$250.00	100	$25,000.00	
VectorWise 1-year maintenance bug fixes**	ING-VW-3Y-GB-DELL-MNT	2	$25.00	300		$7,500.00
				Subtotal	**$25,000.00**	**$7,500.00**
				Total	**$40,827.70**	**$7,500.00**

Price Key: 1-Dell: Pricing may be verified by calling 1-800-BUY-DELL contact: Gregory Olsen, Greg_Olsen@dell.com and referencing quote # 583854113. 2-Ingres Pricing may be verified by calling 1-650-587-5538 contact: Mark Van de Wiel, mark.vandewiel@ingres.com	**3-yr Cost of Ownership in USD:** **$48,327.70** **QphH@100GB:** **303,289.8** **$/QphH@100Gb in USD:** **$0.16**

All discounts are based on list prices and for similar quantities and configurations.

Audited by:Steve Barrish for Performance Metrics, Inc.

Prices used in TPC benchmarks reflect 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 refelect standard pricing policies for the listed components. For complete details, see the pricing sections of the TPC benchmark specifications. If you find the stated prices are not available according to these terms, please inform the TPC at pricing@tpc.org. Thank you.

		TPC-H Rev 2.14.0 TPC Pricing Rev 1.6.0
	Dell PowerEdge R610 using VectorWise 1.6	
		Report Date: May 20, 2011

Measurement Results

Database Scaling (SF/size)	100
Total Data Storage/Database Size	8.76
Memory/Database Size Percentage	192.00%
Start of Database Load Time	04/30/11 18:13:49
End of Database Load Time	04/30/11 20:18:12
Database Load Time	2:04:23
Query Streams for Throughput Test (S)	11
TPC-H Power	333,328.3
TPC-H Throughput	275,958.2
TPC-H Composite Query-per-Hour Metric (QphH@100GB)	303,289.8
Total System Price Over 3 Years	$48,327.70 USD
TPC-H Price/Performance Metric ($/QphH@100GB)	$0.16 USD

Measurement Intervals

Measurement Interval in Throughput Test (Ts)	316

Duration of Stream Execution:

Power Run	Seed	Query Start Time Query End Time	Duration (sec)	RF1 Start Time RF1 End Time	RF2 Start Time RF2 End Time
	430201812	04/30/11 20:43:09 04/30/11 20:43:44	34	04/30/11 20:42:57 04/30/11 20:43:09	04/30/11 20:43:44 04/30/11 20:43:47

Throuput Stream	Seed	Query Start Time Query End Time	Duration (sec)	RF1 Start Time RF1 End Time	RF2 Start Time RF2 End Time
1	430201813	04/30/11 20:43:49 04/30/11 20:48:59	310	04/30/11 20:43:49 04/30/11 20:44:08	04/30/11 20:44:08 04/30/11 20:44:15
2	430201814	04/30/11 20:43:49 04/30/11 20:48:52	303	04/30/11 20:44:15 04/30/11 20:44:31	04/30/11 20:44:31 04/30/11 20:44:37
3	430201815	04/30/11 20:43:49 04/30/11 20:48:51	303	04/30/11 20:44:37 04/30/11 20:44:54	04/30/11 20:44:54 04/30/11 20:45:01
4	430201816	04/30/11 20:43:49 04/30/11 20:48:57	308	04/30/11 20:45:01 04/30/11 20:45:19	04/30/11 20:45:19 04/30/11 20:45:26
5	430201817	04/30/11 20:43:49 04/30/11 20:48:50	301	04/30/11 20:45:26 04/30/11 20:45:44	04/30/11 20:45:44 04/30/11 20:45:51
6	430201818	04/30/11 20:43:49 04/30/11 20:49:04	316	04/30/11 20:45:51 04/30/11 20:46:11	04/30/11 20:46:11 04/30/11 20:46:17
7	430201819	04/30/11 20:43:49 04/30/11 20:48:45	297	04/30/11 20:46:17 04/30/11 20:46:35	04/30/11 20:46:35 04/30/11 20:46:41
8	430201820	04/30/11 20:43:49 04/30/11 20:48:50	301	04/30/11 20:46:41 04/30/11 20:46:59	04/30/11 20:46:59 04/30/11 20:47:05
9	430201821	04/30/11 20:43:49 04/30/11 20:48:54	305	04/30/11 20:47:05 04/30/11 20:47:23	04/30/11 20:47:23 04/30/11 20:47:30
10	430201822	04/30/11 20:43:49 04/30/11 20:48:56	308	04/30/11 20:47:30 04/30/11 20:47:48	04/30/11 20:47:48 04/30/11 20:47:55
11	430201823	04/30/11 20:43:49 04/30/11 20:48:54	306	04/30/11 20:47:55 04/30/11 20:48:13	04/30/11 20:48:13 04/30/11 20:48:20

			TPC-H Rev 2.14.0
	Dell PowerEdge R610 using VectorWise 1.6		TPC Pricing Rev 1.6.0
			Report Date: May 20, 2011

TPC-H Timing Intervals (in seconds)

Duration of stream execution:

Stream ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Stream 00	1.7	0.3	0.3	0.2	1.2	0.1	0.7	0.9	5.9	2.1	0.4	0.4
Stream 01	19.2	2.3	2.2	0.2	9.3	1.1	8.4	7.9	72.1	12.0	2.4	5.2
Stream 02	24.1	2.1	1.5	1.0	9.8	0.4	7.7	8.0	71.2	9.9	2.0	6.2
Stream 03	22.0	1.5	1.1	1.1	10.1	1.8	8.5	10.5	83.5	12.0	3.5	4.0
Stream 04	24.8	2.8	0.4	1.2	11.3	1.3	6.1	7.7	82.9	10.3	2.1	4.3
Stream 05	22.7	2.0	1.6	1.2	8.3	1.8	7.2	12.1	77.9	9.9	2.1	4.2
Stream 06	23.7	2.0	2.0	1.0	12.6	3.0	11.6	8.6	81.6	11.3	2.7	4.2
Stream 07	23.4	2.8	1.6	1.1	11.0	1.3	11.5	7.8	73.5	10.4	2.6	4.0
Stream 08	22.7	2.1	2.4	1.3	9.6	1.9	8.0	8.0	81.7	11.2	1.5	4.5
Stream 09	21.6	1.9	1.4	0.4	6.3	1.4	8.7	9.7	73.8	10.8	3.5	7.3
Stream 10	21.4	1.8	1.5	0.9	1.5	0.3	7.4	5.6	78.4	12.8	1.6	4.7
Stream 11	21.3	1.5	1.7	1.2	12.3	1.3	2.1	8.0	70.5	9.7	2.5	4.3
Minimum	1.7	0.3	0.3	0.2	1.2	0.1	0.7	0.9	5.9	2.1	0.4	0.4
Maximum	24.8	2.8	2.4	1.3	12.6	3.0	11.6	12.1	83.5	12.8	3.5	7.3
Average	20.7	1.9	1.5	0.9	8.6	1.3	7.3	7.9	71.1	10.2	2.2	4.4

Stream ID	Q13	Q14	Q15a	Q16	Q17	Q18	Q19	Q20	Q21	Q22	RF1	RF2
Stream 00	8.0	0.8	0.6	1.3	0.7	2.0	1.7	0.8	3.3	1.0	12.6	3.5
Stream 01	50.8	3.9	1.9	16.5	8.7	18.3	20.0	8.0	34.1	5.8	19.8	6.4
Stream 02	47.9	6.5	2.8	11.8	11.9	18.0	16.8	8.4	26.7	8.3	15.9	6.3
Stream 03	47.2	4.8	2.5	10.4	9.8	7.5	16.3	5.3	32.2	7.1	16.5	7.8
Stream 04	46.8	4.5	2.0	16.1	9.9	18.4	17.5	1.5	30.5	5.5	17.8	6.4
Stream 05	50.9	4.5	1.7	12.2	12.8	17.4	16.3	7.0	18.7	8.5	18.2	7.4
Stream 06	45.6	9.2	2.0	13.7	8.0	19.6	16.9	5.6	21.6	9.3	19.4	6.6
Stream 07	44.8	4.2	2.1	11.1	9.1	11.1	16.6	7.1	30.2	9.1	18.0	5.9
Stream 08	48.2	3.7	2.0	15.2	9.2	16.1	7.8	5.3	30.9	7.4	17.6	5.8
Stream 09	46.1	4.3	5.6	7.4	9.9	18.6	17.3	6.2	33.4	9.7	18.3	7.1
Stream 10	54.8	6.7	2.6	13.5	9.0	20.6	14.1	5.4	34.5	8.7	18.2	6.7
Stream 11	48.0	8.2	1.2	13.1	11.4	20.4	14.2	6.4	35.6	10.8	18.3	6.7
Minimum	8.0	0.8	0.6	1.3	0.7	2.0	1.7	0.8	3.3	1.0	12.6	3.5
Maximum	54.8	9.2	5.6	16.5	12.8	20.6	20.0	8.4	35.6	10.8	19.8	7.8
Average	44.9	5.1	2.3	11.9	9.2	15.7	14.6	5.6	27.6	7.6	17.6	6.4
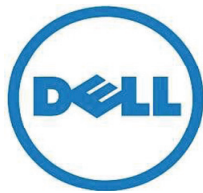
	Energy Summary		TPC-H Rev 2.14.0 TPC Pricing Rev 1.6.0 TPC Energy Rev 1.2.0
			Report Date May 20, 2011
Total System Cost	Composite Query per Hour Metric		Price/Performance	TPC-Energy Metric
$48,328 USD	**303,289.80** QphH@100GB		**$0.16 USD** $/QphH@100GB	**1.28** Watts/KQphH@100GB
Database Size	Database Manager	Operating System	Other Software	Availability Date
100 GB	**VectorWise 1.6**	**RedHat Enterprise Linux 6.0**	**None**	**June 30, 2011**

Numerical Quantities for Reported Energy Configuration:

REC Idle Power	**178.9**
Average Power of REC	**386.8**

Subsytem Reporting:

      Secondary (subsytem) Metrics are not reported.

      Comparisons to other TPC-Energy Results must not reference subsystem energy information.

Lowest ambient temperature at air inlet: 25.88 Degrees Celsius

Items in Priced Configuration not in the Reported Energy Configuration: None.

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

      Dell E170S Monitor

0   General Items

0.1   Benchmark Sponsor

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

Dell, Inc. is the test sponsor of this TPC Benchmark H benchmark.

0.2   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 but not limited to:

Database Tuning Options

Optimizer/Query execution options

Query processing tool/language configuration parameters

Recovery/commit options

Consistency/locking options

Operating system and configuration parameters

Configuration parameters and options for any other software component incorporated into the pricing structure;

Compiler optimization options.

The Supporting Files Archive contains the Operating System and DBMS parameters used in this benchmark.

0.3   Configuration Diagrams

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

Both the priced and measured configrations are the same (Dell PowerEdge R610):

2 x Intel Xeon X-5690 CPU's @3.46 GHz

192 GB Memory

6 x 146 GB 15K RPM SAS Drives

2 x 1GB Ethernet Connections

1   Clause 1 Logical Database Design Related Items

1.1   Database Definition Statements

Listings must be provided for all table definition statements and all other statements used to set up the test and qualification databases.

The Supporting Files Archive contains the scripts that define, create, and analyze the tables and indices for the TPC-H database.

1.2   Physical Organization

The physical organization of tables and indices, within the test and qualification databases, must be disclosed. If the column ordering of any table is different from that specified in Clause 1.4, it must be noted.

No record clustering or index clustering was used. Columns were not reordered in the tables.

1.3   Horizontal Partitioning

Horizontal partitioning of tables and rows in the test and qualification databases (see Clause 1.5.4) must be disclosed.

No horizontal partitioning was used

1.4   Replication

Any replication of physical objects must be disclosed and must conform to the requirements of Clause 1.5.6.

No replication was used.

2 Clause 2 Queries and Refresh Functions

2.1 Query Language

The query language used to implement the queries must be identified.

SQL was the query language used to implement all queries.

2.2 Verifying Method for Random Number Generation

The method of verification for the random number generation must be described unless the supplied DBGEN and QGEN were used.

TPC supplied versions 2.14.0 of DBGEN and QGEN were used for this TPC-H benchmark.

2.3 Generating Values for Substitution Parameters

The method used to generate values for substitution parameters must be disclosed. If QGEN is not used for this purpose, then the source code of any non-commercial tool used must be disclosed. If QGEN is used, the version number, release number, modification number, and patch level of QGEN must be disclosed.

QGEN version 2.14.0 was used to generate the substitution parameters.

2.4 Query Text and Output Data from Qualification Database

The executable query text used for query validation must be disclosed along with the corresponding output data generated during the execution of the query text against the qualification database. If minor modifications (see Clause 2.2.3) have been applied to any functional query definition or approved variants in order to obtain executable query text, these modifications must be disclosed and justified. The justification for a particular minor query modification can apply collectively to all queries for which it has been used. The output data for the power and throughput tests must be made available electronically upon request.

The Supporting Files Archive contains the actual query text and query output.

2.5 Query Substitution Parameters and Seeds Used

The query substitution parameters used for all performance tests must be disclosed in tabular format, along with the seeds used to generate these parameters.

The Supporting Files Archive contains the seed and query substitution parameters.

2.6 Query Isolation Level

The isolation level used to run the queries must be disclosed. If the isolation level does not map closely to the levels defined in Clause 3.4, additional descriptive detail must be provided.

The queries and transactions were run with "Snapshot Isolation".

2.7 Source Code of Refresh Functions

The details of how the refresh functions were implemented must be disclosed (including source code of any non-commercial program used).

The source code for the refresh functions is included in the Supporting Files Archive.

3 Clause 3 Database System Properties

3.1 ACID Properties

The ACID (Atomicity, Consistency, Isolation, and Durability) properties of transaction processing systems must be supported by the system under test during the timed portion of this benchmark. Since TPC-H is not a transaction processing benchmark, the ACID properties must be evaluated outside the timed portion of the test.

Source code for ACID test is included in the Supporting Files Archive.

3.2 Atomicity

The system under test must guarantee that 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 Transaction

Perform the ACID Transaction for a randomly selected set of input data and verify that the appropriate rows have been changed in the ORDERS, LINEITEM, and HISTORY tables.

1. The total price from the ORDERS table and the extended price from the LINEITEM table were retrieved for a randomly selected order key.

2. The ACID Transaction was performed using the order key from step 1.

3. The ACID Transaction committed.

4. The total price from the ORDERS table and the extended price from the LINEITEM table were retrieved for the same order key. It was verified that the appropriate rows had been changed.

Aborted Transaction

Perform the ACID Transaction for a randomly selected set of input data, substituting a ROLLBACK of the transaction for the COMMIT of the transaction. Verify that the appropriate rows have not been changed in the ORDERS, LINEITEM, and HISTORY tables.

1. The total price from the ORDERS table and the extended price from the LINEITEM table were retrieved for a randomly selected order key.

2. The ACID Transaction was performed using the order key from step 1. The transaction was stopped prior to the commit.

3. The ACID Transaction was ROLLED BACK.

4. The total price from the ORDERS table and the extended price from the LINEITEM table were retrieved for the same order key. It was verified that the appropriate rows had not been changed.

3.3 Consistency

Consistency is the property of the application that requires any execution of transactions to take the database from one consistent state to another.

Consistency Test

1. Verify that ORDERS and LINEITEM tables are initially consistent, submit the prescribed number of ACID Transactions with randomly selected input parameters, and re-verify the consistency of the ORDERS and LINEITEM.

2. The consistency of the ORDERS and LINEITEM tables was verified based on a sample of order keys.

3. 100 ACID Transactions were submitted from each of 12 execution streams.

4. The consistency of the ORDERS and LINEITEM tables was re-verified.

3.4 Isolation

Operations of concurrent transactions must yield results, which are indistinguishable from the results, which would be obtained by forcing each transaction to be serially executed to completion in some order.

Read-Write Conflict with Commit

Demonstrate isolation for the read-write conflict of a read-write transaction and a read-only transaction when the read-write transaction is committed.

1. An ACID query was run with randomly selected values for O_KEY, L_KEY and DELTA to get the initial value for O_TOTALPRICE

2. An ACID Transaction was started using the randomly dselected values from step 1. The ACID Transaction was suspended prior to COMMIT.

3. An ACID Query was started for the same O_KEY used in step 1. The ACID Query ran to completion but did not see any uncommitted changes made by the ACID Transaction.

4. The ACID Transaction was resumed, and COMMITTED.

5. The ACID Query was run again to verify that the transaction updated O_TOTALPRICE.

Read-Write Conflict with Rollback

Demonstrate isolation for the read-write conflict of a read-write transaction and a read-only transaction when the read-write transaction is rolled back.

1. An ACID Query was run for a randomly selected O_KEY, L_KEY and DELTA to get the initial value for O_TOTALPRICE.

2. An ACID Transaction was started using the values selected in step 1.. The ACID Transaction was suspended prior to ROLLBACK.

3. An ACID Query was started for the same O_KEY used in step 1. The ACID Query ran to completion but did not see the uncommitted changes made by the ACID Transaction.

4. The ACID Transaction was ROLLED BACK.

5. The ACID Query completed was run again to verify that O_TOTALPRICE was unchanged from step 1..

Write-Write Conflict with Commit

Demonstrate isolation for the write-write conflict of two update transactions when the first transaction is committed.

Two tests were run, the first with a transaction that COMMITS and the second with a transaction that ROLLS BACK

Results from the first test were as follows:

1. An ACID Query was run for a randomly selected O_KEY, L_KEY and DELTA to get the initial value for O_TOTALPRICE.

2. An ACID Transaction, T1, was started with the values used in stp 1. The ACID transaction T1 was suspended prior to COMMIT.

3. Another ACID Transaction, T2, was started using the same O_KEY and L_KEY used in step 1 and a randomly selected DELTA.

4. T2 COMMITTED and completed normally.

5. T1 was allowed to commitand revecived an error, this was expected due to the "Snapshot Isolation" in use by the DBMS. This is also known as "First Committer Wins" .

6. The ACID Query was run to verify that O_TOTALPRICE was the value from T2.

Results from the second test were as follows:

1. An ACID Query was run for a randomly selected O_KEY, L_KEY and DELTA to get the initial value for O_TOTALPRICE.

2. An ACID Transaction, T1, was started with the values used in stp 1. The ACID transaction T1 was suspended prior to COMMIT.

3. A Second ACID transaction, T2, was started with the same O_KEY and L_KEY as step 1 and a different value for DELTA.

4. T2 ROLLED BACK and completed.

5. T1 resumed and completed normally.

6. The ACID Query was run to verify the database was updated with the values from T1 and not T2.

Write-Write Conflict with Rollback

Demonstrate isolation for the write-write conflict of two update transactions when the first transaction is rolled back.

Two tests were run, the first with a transaction that COMMITS and the second with a transaction that ROLLS BACK

The results from the first test were as follows:

1. An ACID Query was run for a randomly selected O_KEY, L_KEY and DELTA to get the initial value for O_TOTALPRICE

2. An ACID Transaction, T1, was started for a randomly using the values from step 1. The ACID transaction T1 was suspended prior to ROLLBACK.

3. Another ACID Transaction, T2, was started using the same O_KEY and L_KEY and a randomly selected DELTA.

4. T2 completed normally.

5. T1 was allowed to ROLLBACK.

6. It was verified that O_TOTALPRICE was from T2..

7. The results from the second test were as follows:

8. An ACID Query was run for a randomly selected O_KEY, L_KEY and DELTA to get the initial value for O_TOTALPRICE.

9. An ACID Transaction, T1, was started with the same values as from step 1. T1 suspended prior to COMMIT.

10. Another ACID Transaction, T2, was started.and it ROLLED BACK its updates and completed normally.

11. T1 resumed and COMMITED its updates.

12. An ACID Query was run to verify thaqt O_TOTALPRICE was the value from T1 and not T2.

Concurrent Progress of Read and Write on Different Tables

Demonstrate the ability of read and write transactions affecting different database tables to make progress concurrently.

1. An ACID Query was run for a randomly selected O_KEY, L_KEY and DELTA to get the initial value for O_TOTALPRICE.

2. An ACID Transaction, T1, was started with the values from step 1. T1 was suspended prior to COMMIT.

3. A query was started using random values for PS_PARTKEY and PS_SUPPKEY, all columns of the PARTSUPP table for which PS_PARTKEY and PS_SUPPKEy are equal are returned. The query completed normally.

4. T1 was allowed to COMMIT.

5. It was verified that O_TOTALPRICE had been changed by T1.

Read-Only Query Conflict with Update Transactions

Demonstrates that the continuous submission of arbitrary (read-only) queries against one or more tables of the database does not indefinitely delay update transactions affecting those tables from making progress.

1. A Stream was submitted that executed Q1 10 times in a row with a delta of 0 to ensure that each query ran as long a possible.

2. An ACID Transaction, T1, was started for a randomly selected O_KEY, L_KEY and DELTA.

3. T1 completed and it was verified that O_TOTALPRICE was updated correctly.

4. The stream submitting Q1 finished..

3.5   Durability

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

Failure of a Durable Medium

Guarantee the database and committed updates are preserved across a permanent irrecoverable failure of any single durable medium containing TPC-H database tables or recovery log tables.

1. The consistency of the ORDERS and LINEITEM tables was verified using 120 randomly chosen values for O_ORDERKEY.

2. At least 100 ACID transactions were submitted from 12 streams.

3. A randomly selected disk drive was removed from the SUT and the SUT comtimued to process work until each stream had submitted 300 transactions.

4. An analysis of the transaction start and end times from each stream showed that there was at least 1 transactioon in-flight at all times.

5. An analysis of the HISTORY table showed that all of the values used for O_ORDERKEY in step 1 were used by some transaction in step 2.

6. An analysis of the success file and the HISTORY table showed that all entries in the HISTORY table had a corresponding entry in the success file and that every entry in the success file had a corresponding entry in the HISTORY table.

System Crash

Guarantee the database and committed updates are preserved across an instantaneous interruption (system crash/system hang) in processing which requires the system to reboot to recover.

The system crash and memory failure tests were combined. First the consistency of the ORDER and LINEITEM tables was verified. Then transactions were submitted from 12 streams, once the driver script indicated that 100 transactions had been submitted from each stream power to the SUT was removed by turning off the switch to the power strip. When power was restored to the SUT, the system rebooted and the database was restarted. The HISTORY table and success files were compared to verify that every record in the HISTORY table had a corresponding record in the success file and that each record in the success file had a corresponding entry in the HISTORY table. The consistency of the ORDERS and LINEITEM tables was then verified again.

Memory Failure

Guarantee the database and committed updates are preserved across failure of all or part of memory (loss of contents).

See "System Crash"

Disk Durability

First the consistency of the ORDER and LINEITEM tables was verified. Then 12 streams were used to submit 300 transactions to the SUT. Once the driver script indicated that at least 100 transactions had been submitted from each stream a randomly selected disk drive was removed. The SUT continued to process work until all 300 transactions had completed from all 12 streams. The the start and end time stamps for every transaction in each stream were analyzed to verify that there was always at least 1 in-flight transaction. Then the HISTORY table and success files were compared to verify that every record in the HISTORY table had a corresponding record in the success file and that each record in the success file had a correcponding entry in the HISTORY table. The consistency of the ORDERS and LINEITEM tables was then verified again.

4   Clause 4 Scaling and Database Population

4.1   Ending Cardinality of Tables

The cardinality (e.g., the number of rows) of each table of the test database, as it existed at the completion of the database load (see clause 4.2.5) must be disclosed.

Table	Cardinality
Region	5
Nation	25
Supplier	1,000,000
Partsupp	80,000,000
Customer	15,000,000
Orders	150,000,000
LineItem	600,037,902
Part	20,000,000

4.2   Distribution of Tables and Logs Across Media

Distribution of tables and logs across media.

The SUT has 6 physical disk drives which appear to the OS as a single RAID-5 logical drive. This drive is partitioned into a 1GB and another partition occupying all remaining disk space which is used to store the OS, DBMS and user software and the DBMS data store. There is no swap partition.

Database (/ivw): executable files, database files, and database transaction logs.

Home (/home): all user files including benchmark scripts.

OS: Red Hat Enterprise Linux release 6.0 Installation

4.3   Database Partition/Replication Mapping

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

No database partitioning or replication was used

4.4   RAID Feature

Implementation may use some form of RAID to ensure high availability. If used for data, auxiliary storage (e.g. indexes) or temporary space, the level of RAID must be disclosed for each device.

RAID 5 storage was used, the RAID configuration is described in 4.2

4.5   DBGEN Modification

Any modifications to the DBGEN (see clause 4.2.1) source code must be disclosed. In the event that a program other than DBGEN was used to populate the database, it must be disclosed in its entirety.

The supplied DBGEN version 2.14.0 was modified (changes made to a header file) to generate the database population for this benchmark. This header file is included in the supporting files archive.

4.6 Database Load Time

The database load time for the test database (see clause 4.3) must be disclosed.

The database load time is disclosed in the Executive Summary at the beginning of this Full Disclosure Report.

4.7 Data Storage Ratio

The data storage ratio must be disclosed. It is computed as the ratio between the total amount of priced disk space, and the chosen test database size as defined in Clause 4.1.3.

The data storage ratio is computed from the following information:

Type	Number	Size
6Gb SAS 15k RPM	6	146G
TOTAL		876GB
Scale Factor		100
Size ratio		8.76

4.8 Database Load Mechanism Details and Illustration

The details of the database load must be described, including a block diagram illustrating the overall process.

The database was loaded using flat files stored on on an NFS server not included in the priced configuration
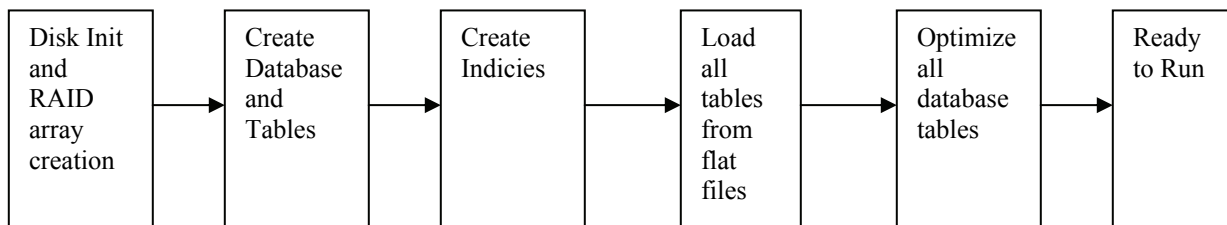
4.9 Qualification Database Configuration

Any differences between the configuration of the qualification database and the test database must be disclosed.

The qualification database used identical scripts to create and load the data with changes to adjust for the database scale factor.

4.10 Memory to Database Size Percentage

The memory to database size percentage, as defined in clause 8.3.5.10, must be disclosed.

The memory to database size percentage is disclosed in the Executive Summary at the beginning of this Full Disclosure Report.

5   Clause 5 Performance Metrics and Execution-Rules

5.1   System Activity Between Load and Performance Tests

Any system activity on the SUT that takes place between the conclusion of the load test and the beginning of the performance test must be fully disclosed.

Auditor requested script was run to display the indicies that had been created on the database.

All scripts and queries used are included in the Supporting Files Archive.

5.2   Steps in the Power Test

The details of the steps followed to implement the power test (e.g., system boot, database restart, etc.) must be disclosed.

The following steps were used to implement the power test:
1. RF1 Refresh Transaction
2. Stream 0 Execution
3. RF2 Refresh Transaction

5.3   Timing Intervals for Each Query and Refresh Functions

The timing intervals for each query for both refresh functions must be reported for the power test.

The timing intervals for each query and both update functions are given in the Executive Summary earlier in this document.

5.4   Number of Streams for the Throughput Test

The number of execution streams used for the throughput test must be disclosed.

11 streams were used for the throughput test.

5.5   Start and End Date/Time of Each Query Stream

The start time and finish time for each query stream must be reported for the throughput test.

The throughput test start time and finish time for each stream are given in the Executive Summary earlier in this document.

5.6   Total Elapsed Time of the Measurement Interval

The total elapsed time of the measurement interval must be reported for the throughput test.

The total elapsed time of the throughput test is given in the Executive Summary earlier in this document.

5.7   Refresh Function Start Date/Time and Finish Date/Time

Start and finish time for each update function in the update stream must be reported for the throughput test.

Start and finish time for each update function in the update stream are given in the Executive Summary earlier in this document.

5.8   Timing Intervals for Each Query and Each Refresh Function for Each Stream

The timing intervals for each query of each stream and for each refresh function must be reported for the throughput test.

The timing intervals for each query and each update function are given in the Executive Summary earlier in this document.

5.9   Performance Metrics

The computed performance metric, related numerical quantities and price performance metric must be reported.

The performance metrics, and the numbers, on which they are based, is given in the Executive Summary earlier in this document.

5.10 The Performance Metric and Numerical Quantities from Both Runs

The performance metric and numerical quantities from both runs must be disclosed.

Performance results from the first two executions of the TPC-H benchmark indicated the following percent difference for the metric points:

	Qpph@100GB	QthH@100GB	QphH@100GB
Reported Run	333328.3	275958.2	303289.8
Reproducibility Run	322123.0	287240.4	304182.1
% Difference	3.36%	4.09%	0.29%

5.11 System Activity Between Performance Tests

Any activity on the SUT that takes place between the conclusion of the Reported Run and the beginning of Reproducibility Run must be disclosed.

There was no activity on the SUT between the reported run and reproducibility run.

5.12 Dataset Verification

Verify that the rows in the loaded database after the performance test are correct by comparing some small number of rows extracted at random from any two files of the corresponding Base, Insert and Delete reference data set files for each table and the corresponding rows of the database.

Verified according to the specification.

5.13 Referential Integrity

Verify referential integrity in the database after the initial load.

An auditor supplied script was to verify referential integrity.

6 Clause 6 SUT and Driver Implementation Related Items

6.1 Driver

A detailed description of how the driver performs its functions must be supplied, including any related source code or scripts. This description should allow an independent reconstruction of the driver.

The supporting files archive contains the scripts that were used to implement the driver.

The power test is invoked through the script power_test.sh. It start the stream 0 SQL script along with the refresh functns such that:
• The SQL for RF1 is submitted and executed by the database
• Then the queries as generated by QGEN are submitted in the order defined by Clause 5.3.5.4
• The SQL for RF2 is then submitted from the same connection used for RF1 and executed by database

The Throughput test is invoked through the script throughput_test.sh. This script then ititiates all of the SQL streams and the refresh stream.

6.2 Implementation-Specific Layer (ISL)

If an implementation specific layer is used, then a detailed description of how it performs its functions must be provided. All related source code, scripts and configuration files must be disclosed. The information provided should be sufficient for an independent reconstruction of the implementation specific layer.

There was no Implementation Specific Layer.

6.3 Profile-Directed Optimization

If profile-directed optimization as described in Clause 5.2. is used, such use must be disclosed.

Profile-directed optimization was not used.

7 Clause 7 Pricing

7.1   Hardware and Software Used in the Priced System

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

A detailed list of hardware and software used in the priced system is included in the pricing sheet in the executive summary. All prices are currently effective.

7.2   Total Three Year Price

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.

A detailed pricing sheet of all the hardware and software used in this configuration and the 3-year maintenance costs, demonstrating the computation of the total 3-year price of the configuration, is included in the executive summary at the beginning of this document.

7.3   Availability Date

The committed delivery date for general availability of products used in the priced calculations must be reported. When the priced system includes 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.

Server Hardware	Currently Available
Server Software	Currently Available
Storage	Currently Available
Ingres VectorWise 1.6	Available June 30, 2011

8   Clause 8 Full Disclosure

8.1   Supporting Files Index Table

An index for all files included in the supporting files archive as required by Clauses 8.3.2 must be provided in the report.

Clause	Description	Archive File	Pathname
Clause 1	Device setup	benchmark_scripts.zip	scripts/ingres_vectorwise/sysinfo/disk
	Installation and configuration	benchmark_scripts.zip	scripts/ingres_vectorwise/sysinfo/install_*.txt
	OS Tunable Parameters	benchmark_scripts.zip	scripts/ingres_vectorwise/sysinfo/sysctl.conf
	DB creation scripts	benchmark_scripts.zip	scripts/ingres_vectorwise/ddl/create_*.sql scripts/ingres_vectorwise/create_db.sh
Clause 2	QGen Modifications	benchmark_scripts.zip	tpch_tools/tpcd.h
Clause 3	ACID Test scripts	benchmark_scripts.zip	scripts/ingres_vectorwise/acid/*.sh scripts/ingres_vectorwise/acid/{atom cons iso dur}/*.sh
	ACID Test Results	benchmark_scripts.zip	scripts/ingres_vectorwise/acid/{atom cons iso dur}/*output
Clause 4	Qualification db load results	benchmark_scripts.zip	scripts/ingres_vectorwise/output/7
	Qualification db validation results	benchmark_scripts.zip	scripts/ingres_vectorwise/output/8
	DBGEN Modifications	benchmark_scripts.zip	tpch_tools/tpcd.h
	Database Load Scripts	benchmark_scripts.zip	scripts/ingres_vectorwise/load_test.sh
	Test db Load results	benchmark_scripts.zip	scripts/ingres_vectorwise/output/9
Clause 5	Run 1 (10 performance run, 11 power, 12 throughput)	run1results.zip	scripts/ingres_vectorwise/output/10 scripts/ingres_vectorwise/output/11 scripts/ingres_vectorwise/output/12
	Run 2 (10 performance run, 13 power, 14 throughput)	run1results.zip	scripts/ingres_vectorwise/output/10 scripts/ingres_vectorwise/output/13 scripts/ingres_vectorwise/output/14
Clause 6	implementation scripts	benchmark_scripts.zip	scripts/ingres_vectorwise/run_perf.sh scripts/ingres_vectorwise/performance_test.sh scripts/ingres_vectorwise/power_test.sh scripts/ingres_vectorwise/throughput_test.sh
Clause 7	n/a	n/a	n/a
Clause 8	Executable query test	benchmark_scripts.zip	scripts/ingres_vectorwise/output/*/queries/stream*/*.sql
	Query substitution parameters and seeds	benchmark_scripts.zip	scripts/ingres_vectorwise/output/*/queries/stream*/*_param scripts/ingres_vectorwise/output/*/*test_report.txt
	RF function source code	benchmark_scripts.zip	scripts/ingres_vectorwise/*rf*

9 Clause 9 Audit Related Items

9.1 Auditor's Report

The auditor's agency name, address, phone number, and Attestation letter with a brief audit summary report indicating compliance must be included in the full disclosure report. A statement should be included specifying who to contact in order to obtain further information regarding the audit process.

This implementation of the TPC Benchmark H was audited by Steve Barrish for Performance Metrics. Further information regarding the audit process may be obtained from:

Performance Metrics

Box 984

Klamath, CA 95548

707-482-0523

Mr. David J Morse
Director, Systems Performance Analysis
Dell Enterprise Product Group
200 Dell Way
Round Rock TX, 78682

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

Platform: PowerEdge R610
Database Manager: VectorWise R1.6
Operating System: Red Hat Enterprise Linux 6.0

CPU's	Memory	Total Disks	Qpph@100GB	QthH@100GB	QphH@100GB
2 Intel Xeon X5690 @ 3.46 Ghz	192 GB	6 @ 146 GB	333,328.3	275,958.2	303,289.8

In addition to the performance metric, the energy consumption was measured during the performance runs in compliance with the TPC-Energy specification.

- The power analyzer used was verified to be approved and calibrated within one year prior to this measurement.

- The energy measurements met all requirements of the specification unless an exception is noted below.

- The calculations for the TPC-Energy Primary Metric were verified as completed correctly.

- The EMS software was verified to be the correct version and without any changes.

- The executive summary page and the FDR were verified for accuracy.

Auditor's Notes: None

Sincerely,

S
Auditor

Appendix APrice Quotes

INGRES Order Confirmation

**Ingres Corporation
500 Arguello Street Suite 200
Redwood City, CA 94063
United States**

Phone: (650) 587-5500
Fax: (650) 649-2358

Order Number: 04-12803
Account Number: 123456
Agreement ID:
Payment Terms: Net 30
Partner:

Prepared by:
Mark Van de Wiel
(650) 587-5538
mark.vandewiel@ingres.com

Message:

PREPARED FOR (BILL TO)	SHIP TO
David J. Morse **Director, Systems Performance Analysis** **Dell | Enterprise Product Group** **office + 1 512 723 2758**	**Dell | Enterprise Product Group** **Attn. David J. Morse** **Mail Stop: RR5-18** **200 Dell Way** **Round Rock, TX, 78682**

Product item	Memo	Contract Start	Contract End	Unit	Qty	Price	Discount %	Extended Price
ING-VW-3Y-GB-DELL	3 year license, 1 GB source data, Dell server	30-June-2011	29-June-2014	GB	100	USD 250	0	USD 25,000
ING-VW-3Y-GB-DELL-MNT	1 year professional support, bug fixes only, 1 GB source data, Dell server	30-June-2011	29-June-2014	GB	300	USD 25	0	USD 7,500

Grand Total:	USD 32,500

Appendix B   TPC-Energy Report

B.1. TPC-Energy Clause 2-related items (Methodology)

B.1.1. Minimum ambient temperature
The minimum ambient temperature must be discolsed

The minimum ambient temperature during the measured run was 25.88 C.

B.1.2. External electric power source characteristics
The characteristics of the external electric power source must be disclosed. In particular, the voltage, frequency in Hertz, and phase information must be reported.

The external electric power source has the folowing characteristics: 120V, 60Hz, single phase.

B.1.3. Air-pressure alterations
A statement is required that assures that nothing was done to alter the air-pressure in the measurement environment.

The measurement environment was a machine room with forced air cooling. The air pressure at the SUT was the same as the rest of the room.

B.1.4. Temperature measurement
A description of where the temperature was measured and how it was determined that this was representative of the lowest ambient temperature is required.

Temperature was measured at the SUT air inlet and this is representative because it was a single system.

B.1.5. Cooling method
If a method of cooling other than circulation of ambient air is employed in the REC, a statement describing this method must be included.

No other method of cooling was used.

B.1.6. PTD license
To be compliant with licenses associated with EMS, the following statement must be included in every FDR which contains a TPC-Energy Metric:

The power and temperature characteristics of the MEC were measured using TPC's Energy Measurement Software (EMS). This includes the EMS-PTD, a modified version of the SPEC PTDaemon, which is provided under license from the Standard Performance Evaluation Corporation (SPEC).

B.2. TPC-Energy Clause 3-related items (Metrics)

B.2.1. Primary Metric
The normalized work derived from the Performance Metric (as described in Clause 3.2.1) must be disclosed

The computation for total energy used for each measurement segment that contributes to a Performance Metric must be disclosed. If the energy of the entire Priced Configuration is not derived from direct measurements, the methods for deriving the energy for components that were not measured must be disclosed (See Clause 7.3.3.4)

The duration of each measurement that produces a Performance Metric must be disclosed
The average power requirement for each measurement that produces one of these metrics,

The TPC-Energy Primary Metric must be disclosed, including the calculation that is used to derive it.

Power Full Load Energy

PMU	Full Load Average Watts Reading	% of Reading Uncertainty	Watts Reading Correction	Wattage Range Setting	% of Range Uncertainty	Wattage Range Correction	Total Wattage Correction	Accuarcy Correction Factor	Reported Watt / Seconds	Adjusted Watt / Seconds	Measurement Reported Seconds	Adjusted Average Watts
DB Server PMU-1	318.49	0.10%	+0.32	1600	0.10%	+1.60	+1.92	0.60%	16,880.0	16,981.7	53.0	320.4
DB Server PMU-2	0	0.10%	+0.00	1600	0.10%	+1.60	+1.60	0.00%	-	-		0.0
DB Server PMU-3	0	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	-	-		0.0
DB Server Total	318.49								16,880.0	16,981.7	55.0	308.8
Storage PMU-1	0	0.10%	+0.00	0	0.10%	+0.00	+0.00	0.00%	-	-		0.0
Storage PMU-2	0	0.10%	+0.00	0	0.10%	+0.00	+0.00	0.00%	-	-		0.0
Storage PMU-3	0	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	-	-		0.0
Storage PMU-4	0	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	-	-		0.0
Storage Total	0								-	-	55.0	0.0
Monitor Name Plate	19	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	1,007.0	1,007.0	53.0	19.0
Misc PMU-2	0	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	-	-		0.0
Misc PMU-3	0	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	-	-		0.0
Misc Total	19								1,007.0	1,007.0	55.0	19.0
REC Total	337.49								17,887.0	17,988.7	53.0	339.4

Throughput Full Load Energy

PMU	Full Load Average Watts Reading	% of Reading Uncertainty	Watts Reading Correction	Wattage Range Setting	% of Range Uncertainty	Wattage Range Correction	Total Wattage Correction	Accuarcy Correction Factor	Reported Watt / Seconds	Adjusted Watt / Seconds	Measurement Reported Seconds	Adjusted Average Watts
DB Server PMU-1	373.7	0.10%	+0.37	1600	0.10%	+1.60	+1.97	0.53%	118,833.5	119,461.1	318.0	375.7
DB Server PMU-2	0.0	0.10%	+0.00	1600	0.10%	+1.60	+1.60	0.00%	-	-	318.0	-
DB Server PMU-3	0.0	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	-	-	318.0	-
DB Server Total	373.7								118,833.5	119,461.1	318.0	375.7
Storage PMU-1	0.0	0.10%	+0.00	0	0.10%	+0.00	+0.00	0.00%	-	-	318.0	-
Storage PMU-2	0.0	0.10%	+0.00	0	0.10%	+0.00	+0.00	0.00%	-	-	318.0	-
Storage PMU-3	0.0	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	-	-	318.0	-
Storage PMU-4	0.0	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	-	-	318.0	-
Storage Total	0.0								-	-	318.0	-
Monitor Name Plate	19.0	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	6,042.0	6,042.0	318.0	19.0
Misc PMU-2	0.0	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	-	-	318.0	-
Misc PMU-3	0.0	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	-	-	318.0	-
Misc Total	19.0								6,042.0	6,042.0	318.0	19.0
REC Total	392.69								124,875.5	125,503.1	719.5	174.4

Power MI Seconds	Throughput MI Seconds	Reported QphH	SUT Total Work
53.0	318	303,289.8	31,256
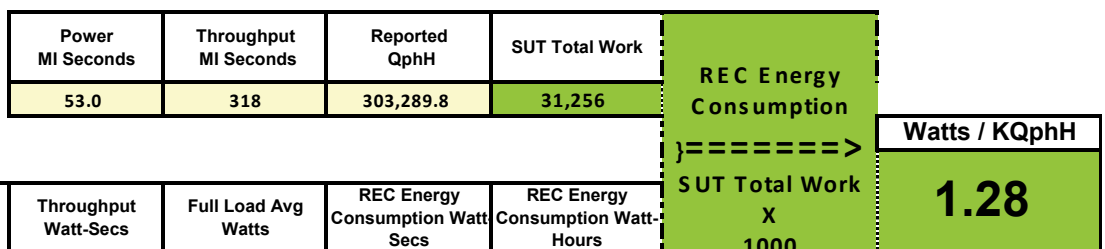
	Power Watt-Secs	Throughput Watt-Secs	Full Load Avg Watts	REC Energy Consumption Watt-Secs	REC Energy Consumption Watt-Hours
Total REC	17,989	125,503	386.8	143,492	39.9
DB Server	16,982	119,461	367.8	136,443	37.9
Storage	0	0	0.0	0	0.0
Misc.	1,007	6,042	19.0	7,049	2.0

REC Energy Consumption

}=======>

SUT Total Work X 1000

Watts / KQphH

1.28

B.2.2. Secondary Metrics At Reported Performance

If the TPC-Energy Secondary Metrics are reported, the components of the REC that are included in each subsystem must be identified. This can be achieved with separate lists to be included in the FDR or with a specific designation in the price spreadsheet. Every component in the REC that consumes energy must be included in exactly one subsystem.

No TPC-Energy secondary metrics are reported.

For each defined subsystem, the calculations defined for the TPC-Energy Secondary Metrics in Clause 3.3 must be reported, using the Performance Metric of the entire SUT and the energy consumption for each REC subsystem.

No TPC-Energy secondary metrics are reported.

B.2.3. Idle Power reporting

The Idle Power measurement/calculation for the REC must be reported as numerical quantities.

										Idle Milli Seconds:	656	
				Idle Load Energy								
PMU	**Full Load Average Watts Reading**	**% of Reading Uncertainty**	**Watts Reading Correction**	**Wattage Range Setting**	**% of Range Uncertainty**	**Wattage Range Correction**	**Total Wattage Correction**	**Accuarcy Correction Factor**	**Reported Watt / Seconds**	**Adjusted Watt / Seconds**	**Reported Seconds**	**Adjusted Average Watts**
DB Server PMU-1	158.1	0.10%	+0.16	1600	0.10%	+1.60	+1.76	1.11%	103,709.5	104,862.8	600.0	174.8
DB Server PMU-2		0.10%	+0.00	1600	0.10%	+1.60	+1.60	0.00%	-	-	656.0	-
DB Server PMU-3	0.0	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	-	-	656.0	-
DB Server Total	158.1								103,709.5	104,862.8	600.0	159.9
Storage PMU-1	0.0	0.10%	+0.00	0	0.10%	+0.00	+0.00	0.00%	-	-	656.0	-
Storage PMU-2	0.0	0.10%	+0.00	0	0.10%	+0.00	+0.00	0.00%	-	-	656.0	-
Storage PMU-3	0.0	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	-	-	656.0	-
Storage PMU-4	0.0	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	-	-	656.0	-
Storage Total	0.0								-	-	656.0	-
Monitor Name Plate	19.0	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	12,521.0	12,521.0	659.0	19.0
Misc PMU-2	0.0	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	-	-	656.0	-
Misc PMU-3	0.0	0.00%	+0.00	0	0.00%	+0.00	+0.00	0.00%	-	-	656.0	-
Misc Total	19.0								12,521.0	12,521.0	659.0	19.0
REC Total	177.09								116,230.5	117,383.8		178.9

If TPC-Energy Secondary Metrics are reported, then the Idle Power measurement/calculation for each subsystem must also be reported as numerical quantities.

No TPC-Energy secondary metrics are reported.

The length of time between the conclusion of the performance measurement and the start of the idle measurement must be reported.

Idle measurement was started immediately after the conclusion of the performance measurement.

The duration of the idle measurement must be reported

Idle measurement duration was 656 seconds.

A statement is required that assures that the system is in a state that is ready to run the Application(s) of the benchmark for the duration of the idle measurement.

There were no changes to the system after the performance run. During the idle measurement the system was ready to process any query and the acid query performed after the idle perior met the requirements of clause 3.3.3.

B.2.4. Disclosure requirements when only part of the REC is measured for power

If all PMU's of the REC are not measured for energy use, the FDR must include a description of which PMUs of REC were measured with a power analyzer. The FDR must disclose which PMUs of the REC were computed based on the energy measurements of similar PMUs. A diagram must be included that identifies the portions of the configuration which were measured for energy use and which were calculated. This diagram may be combined with other diagrams required by the TPC Benchmark Standard.
- *The method used to determine which PMUs were measured must be disclosed.*
- *The power values for the each partial-REC measurement for duration of the performance and idle measurements must be disclosed.*
- *The calculation for the power requirements of the entire REC and, if applicable, each subsystem must be disclosed.*

The values used for the monitor were based on the vendor's max wattage specifications (name plate value).

B.2.5. Disclosure requirements when component substitution is used

If the TPC Benchmark Standard allows the Priced Configuration to differ from the Measured Configuration, the methods used to assign energy or power characteristics to the substitute components must be disclosed

There were no substitutions. The Priced Configuration was identical to the Measured Configuration.

The method used to determine which PMUs were measured must be disclosed

The monitor was the only component not measured. All other components were internal to the SUT.

The power values for the each partial-REC measurement for duration of the performance and idle measurements must be disclosed.

See values presented in spreadsheet form in previous section of this repot.

B.3. TPC-Energy Clause 4-related items (Drivers /Controller)

A statement indicating the version of EMS used must be included in the FDR, including a statement that no alterations of this code were made for the benchmark, except as specified by Clause 7.3.4.3. This includes levels for the EMS-PTD Manager, EMS-PTD and EMS-controller

EMS version was 1.2.0 and no alterations were made.

Input parameters for the EMS software must be disclosed

The followig EMS script was used to configure the EMS software:
```
start log temp > temp
start log power1 >power1
start log power2 >power2
start data "..."
```

Any changes in the EMS components must be documented. Documentation must include a description of the issue, the reason the change was necessary for disclosure of the Result, and the changes made to resolve it. Any change to TPC-Provided Code must be included with the submission as a Supporting File.

No changes to EMS components were made.

B.4. TPC-Energy Clause 6-related items (Instrumentation)

B.4.1. Power Analyzer information

Power analyzer #1
Instek GPM-8212 Serial Number: CK160090
Certification date : 6/22/2010
Amperage Range setting: 10A Manual
Voltage Range setting: 160V Manual
Reading accuracy: 0.1% from manufacturer's documentation
Range accuracy: 0.1% from manufacturer's documentation

Power analyzer #1
Instek GPM-8212 Serial Number: CK210085
Certification date : 11/15/2010

Amperage Range setting: 10A Manual
Voltage Range setting: 160V Manual
Reading accuracy: 0.1% from manufacturer's documentation
Range accuracy: 0.1% from manufacturer's documentation

B.4.2. Temperature Sensor information

InsideOut Networks WatchPort/H USB Humidity/Temperature Sensor
Accuracy: +/0.5^{o} C at (-10° Cto 85° C) (from Vendor website)

B.5. TPC-Energy Clause 8-related items

B.5.1. Auditor's attestation letter.

Mr. David J Morse
Director, Systems Performance Analysis
Dell Enterprise Product Group
200 Dell Way
Round Rock TX, 78682

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

Platform: PowerEdge R610
Database Manager: VectorWise R1.6
Operating System: Red Hat Enterprise Linux 6.0

CPU's	Memory	Total Disks	Qpph@100GB	QthH@100GB	QphH@100GB
2 Intel Xeon X5690 @ 3.46 Ghz	192 GB	6 @ 146 GB	333,328.3	275,958.2	303,289.8

In addition to the performance metric, the energy consumption was measured during the performance runs in compliance with the TPC-Energy specification.

- The power analyzer used was verified to be approved and calibrated within one year prior to this measurement.

- The energy measurements met all requirements of the specification unless an exception is noted below.

- The calculations for the TPC-Energy Primary Metric were verified as completed correctly.

- The EMS software was verified to be the correct version and without any changes.

- The executive summary page and the FDR were verified for accuracy.

Auditor's Notes: None

Sincerely,

S
Auditor

B.6. TPC-Energy Supporting Files Index

Clause	Description	Pathname
Clause 7	Energy Measurement Log Files	SupportingFiles/Energy
	Energy Measurement Configuration Files	SupportingFiles/Energy/CollectData.ems