TPC Benchmark™ C

Full Disclosure Report

First Edition

15–Feb–2024

Using

Goldilocks v3.1 Standard Edition

on

KTNF KE780S1

First Edition: 25-Jan-2024

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

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Abstract

This report documents the methodology and results of the TPC Benchmark™ C (TPC-C) test conducted by TTA on the Goldilocks v3.1 Standard Edition on KTNF KE780S1

Goldilocks v3.1 Standard Edition on KTNF KE780S1

Company Name	System Name	Database Software	Operating System
Telecommunications Technology Association	KTNF KE780S1	Goldilocks v3.1 Standard Edition	RedHat Enterprise Linux 9.0

TPC Benchmark™ C Metrics

Total System Cost	TPC-C Throughput	Price/Performance	Availability Date
₩ 163,820,700 (KRW)	50,768 tpmC	3,227 KRW/tpmC	Available Now

Preface

The Transaction Processing Performance Council (TPC™) is a non-profit corporation founded to define transaction processing and database benchmarks and to disseminate objective, verifiable TPC performance data to the industry. The TPC Benchmark© C is an on-line transaction processing benchmark (OLTP) developed by the TPC.

TPC Benchmark™ C Overview

TPC Benchmark™ C (TPC-C) simulates a complete computing environment where a population of users executes transactions against a database. The benchmark is centered around the principal activities (transactions) of an order-entry environment. These transactions include entering and delivering orders, recording payments, checking the status of orders, and monitoring the level of stock at the warehouses. While the benchmark portrays the activity of a wholesale supplier, TPC-C is not limited to the activity of any particular business segment, but, rather represents any industry that must manage, sell, or distribute a product or service.

TPC-C consists of 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 of 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.

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.

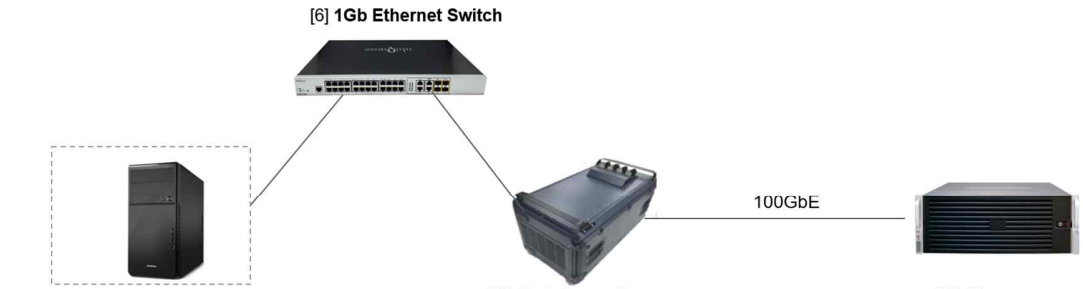
Despite the fact that this benchmark offers a rich environment that emulates many OLTP applications, this benchmark does not reflect the entire range of OLTP requirements. In addition, the extent to which a customer can achieve the results reported by a vendor is highly dependent on how closely TPC-C approximates the customer application. The relative performance of systems derived from this benchmark does not necessarily hold for other workloads or environments. Extrapolations to other environments 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 benchmark when critical capacity planning and/or product evaluation decisions are contemplated.

Further information is available at www.tpc.org

TTA	**Goldilocks v3.1 Standard Edition on KTNF KE780S1**			**TPC-C Version 5.11.0** **TPC Pricing 2.9.0** Report Date **25-Jan-2024**
Total System Cost	TPC-C Throughput	Price/Performance		Availability Date
₩ 163,820,700 (KRW)	**50,768 tpmC**	**3,227 KRW/tpmC**		**Available Now**
Server Processors/Cores/Threads	Database Manager	Operating System	Other Software	Number of Users
1/12/24	**Goldilocks v3.1 Standard Edition**	**RHEL 9.0**	**JBoss Web Server**	**40,000**

Priced Configuration (KTNF)



[2] **Web Application Server**

1 x HANSUNG DT-S170G1IV0
- 1 x Intel(R) Core(TM) i7-10700K CPU @ 3.80GHz
- 1 x 32GB Memory
- 1 x 2TB SATA HDD
- 1 x 512GB NVMe SSD
- 1 x 2-port 10G Ethernet
- 1 x 1G Ethernet

[1] **Database Server**

1 x KTNF KE780S1
- 1 x Intel(R) Xeon(R) Silver 4410Y CPU @ 2.00GHz
- 8 x 64GB (512GB) Memory
- 1 x 512GB NVMe SSD
- 1 x Dual port 100GbE Intel® Ethernet Network Adapter E810
- 1 x single port 1G Ethernet

[3] **Storage**

1 x GLUESYS AnyStor 700E-12
- 2 x Intel(R) Xeon(R) Gold 6326 CPU @ 2.90GHz
- 8 x 32GB Memory
- 4 x 7.68TB NVMe Drive (Write Through)
- 1 x Dual port 100GbE Intel® Ethernet Network Adapter E810
- 1 x NVIDIA RTX A2000 for GRAID

System Components	DB Server		WAS Server	
	Quantity	**Description**	**Quantity**	**Description**
Processors/Cores/Threads	1/12/24	Intel(R) Xeon(R) Silver 4410Y @ 2.00GHz	1/8/16	Intel(R) Core(TM) i7-10700K CPU @ 3.80GHz
Memory	8	64GB	1	32GB
Storage Controller	-	None	-	None
Storage Device	1 4	512GB NVMe SSD(Write Through) 7.68TB NVMe SSD(External, Write Through)	1 1	1TB SATA HDD 512GB SATA SSD
Total Storage Capacity		31.232 TB		

	Goldilocks v3.1 Standard Edition on KTNF KE780S1	TPC-C Version 5.11.0 TPC Pricing 2.9.0 Report Date 25-Jan-2024 *Available Now*

Description	Part Number	Source	Unit Price	Qty	*Price*	*3-Yr. Maint. Price*
Server Hardware						
DB Server - KTNF(KE780S1)	KE780S1	1	**43,000,000**	1	**43,000,000**	
4th Gen intel Xeon Scalable Processor Silver 4410Y	CPU	1	(included)	1		
64GB DDR5 4800RDIMM	RAM	1	(included)	8		
Dual port 100GbE Intel® Ethernet Network Adapter E810	NIC	1	(included)	1		
512GB M.2 NMVe SSD	SSD	1	(included)	1		
3year, 24x7x4hr Onsite Support Service	Maintenance	1	(included)	1		
WAS Servers - DT-S170G1IV0	DT-S170G1IV0	1	8,000,000	1	**8,000,000**	
Intel® Core Processor i7-10700K, 3.8GHz	CPU	1	(included)	1		
DDR4 32GB, Samsung, UDIMM PC4-25600U	RAM	1	(included)	1		
2TB SATA HDD	HDD	1	(included)	1		
512 M.2 NVMe SSD	SSD	1	(included)	1		
2port 10G RJ-45 Adapter	NIC	1	(included)	1		
1port 1G RJ-45 Adapter	NIC	1	(included)	1		
3year, 24x7x4hr Onsite Support Service	Maintenance	1	(included)	1		
Server Hardware Sub Total					***51,000,000***	
Storage Hardware						
Anystor 700E-12	ASE700E-12	2	97,000,000	1	**97,000,000**	
Intel® Xeon Gold 6326 Processor (16Core, 2.9GHz, 24MB Cache)	-	2		2		
32GB ECC Registered Memory	-	2		8		
2-port 10G RJ45 & 2-port 10G SFP+, Intel X710-TM4	-	2		1		
Hot-Swappable 12 SAS or SATA Disk Bay	-	2		1		
PCIe Gen4 x 16 GRAID SupremeRAID Core Software Module License with Full features, supports 32 native NVMe drives and NVMe-oF	-	2		1		
AnyStor-E NAS 전용 O/S (480GB SSD X2EA, RAID1)	OS	2		1		
SAMSUNG PM9A3, 7.68TB U.2 PCIe 4.0 NVMe (SAMSUNG MZQL27T6HBLA-00A07)	Disk Drive	2	1,250,000	4	5,000,000	
Dual-Port QSFP28 100GbE Network Card	NIC Card	2	2,500,000	1	2,500,000	
100G QSFP28 Cable 3M (MCP1600-C003E26N)	NIC Cable	2	300,000	2	600,000	
Premium Package 3-Year Support & Maintenance	Support & Maintenance	2	12,000,000	1		12,000,000
Storage Hardware Sub Total					**105,100,000**	**12,000,000**
Client/Server Software						
Red Hat Enterprise Linux Server Standard 3yrs	RH00004F3	3	4,089,000	2	8,178,000	
RHEL Server Standard Maintenance - 3yrs 24x7x4hrs	RP-CPS(OS)	3	8,000,000	2		16,000,000
Red Hat JBoss Web Server 4-Core Standard 3Year	MW00123F3	3	1,944,000	2	3,888,000	
JBoss Web Server per 4Core 3Year Maintenance	RP-CPS(WAS)	3	12,000,000	2		24,000,000

Goldilocks v3.1 Standard Edition	-	4	64,000,000	1	64,000,000	
Goldilocks v3.1 Standard Edition Technical Supports	-	4	20,000,000	3		60,000,000
Software Sub Total					**76,066,000**	**100,000,000**
Other Hardware						
DASAN Networks access switch - D2224GP, 24port POE	22917889	5	1,900,000	3	5,700,000	
Hansung Computer - HKM1000K Keyboard mouse set	-	6	19,900	3	59,700	
Hansung Computer - ULTRON 2235V Freesink real75 Monitor	-	6	97,000	3	291,000	
Other Hardware Sub Total					**6,050,700**	
Discounts*						
Storage Hardware Discount					-59,230,000	-7,500,000
Red Hat OS Discount					-2,978,000	-10,000,000
Red Hat JBoss Discount					-1,288,000	-6,000,000
SW Discount - Goldilocks					-46,600,000	-52,800,000
Discounts Sub Total					**-110,096,000**	**-76,300,000**
Total					**128,120,700**	**35,700,000**

Pricing Notes

1) KTNF Inc.
2) Gluesys Co.,Ltd.
3) Rockplace Inc.
4) Sunjesoft Inc.
5) DASAN Networks
6) Hansung Corp.

All of the prices are based on South Korea's currency, KRW (₩, Korean Won) and excluded VAT.

* All discounts are based on Korea list prices and for similar quantities and configurations. Discounts for similarly sized configurations will be similar to those quoted here, but may vary based on the components in the configuration.

Three year cost of ownership KRW(₩): 163,820,700

TPC-C throughput: 50,768 tpmC

Price/Performance: 3,227 ₩ / tpmC

Benchmark implementation and results independantly audited by Doug Johnson of InfoSizing (www.sizing.com)

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.

	Goldilocks v3.1 Standard Edition on KTNF KE780S1	TPC-C Version 5.11.0 TPC Pricing 2.9.0 Report Date 25-Jan-2024 *Available Now*

MQTh, computed Maximum Qualified Throughput	50,768 tpmC	

Response Times (seconds)	Min	Average	90th	Max
New-Order	0.102	0.11	0.103	12.348
Payment	0.102	0.108	0.103	8.922
Order-Status	0.102	0.107	0.102	3.882
Delivery (interactive portion)	0.101	0.104	0.101	3.284
Delivery (deferred portion)	0.001	0.019	0.005	8.919
Stock-Level	0.102	0.108	0.103	3.882
Menu	0.101	0.105	0.102	3.308

Emulated Display Delay: 0.1 sec.

Transaction Mix	Percent	Number
New-Order	44.980%	21,322,770
Payment	43.011%	20,389,345
Order-Status	4.003%	1,897,459
Delivery	4.003%	1,897,757
Stock-Level	4.003%	1,897,541

Keying Times (seconds)	Min	Average	Max
New-Order	18.001	18.001	18.002
Payment	3.001	3.001	3.002
Order-Status	2.001	2.001	2.002
Delivery	2.001	2.001	2.002
Stock-Level	2.001	2.001	2.001

Think Times (seconds)	Min	Average	Max
New-Order	0.001	12.041	120.501
Payment	0.001	12.040	120.501
Order-Status	0.001	10.037	100.501
Delivery	0.001	5.032	50.301
Stock-Level	0.001	5.028	50.301

Test Duration	
Ramp-up time	65 min
Measurement Interval (MI)	420 min
Checkpoints in MI	14
Checkpoint Interval (Average / Max)	29:21 min / 29:22 min
Number of Transactions in MI (all types)	47,404,872

General Items

0.1 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 the application source code for the transactions.

0.2 Benchmark Sponsor

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

This benchmark was sponsored by TTA, Telecommunications Technology Association. The implementation was developed and engineered in partnership with SUNJESOFT Inc. and KTNF Inc.

0.3 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.

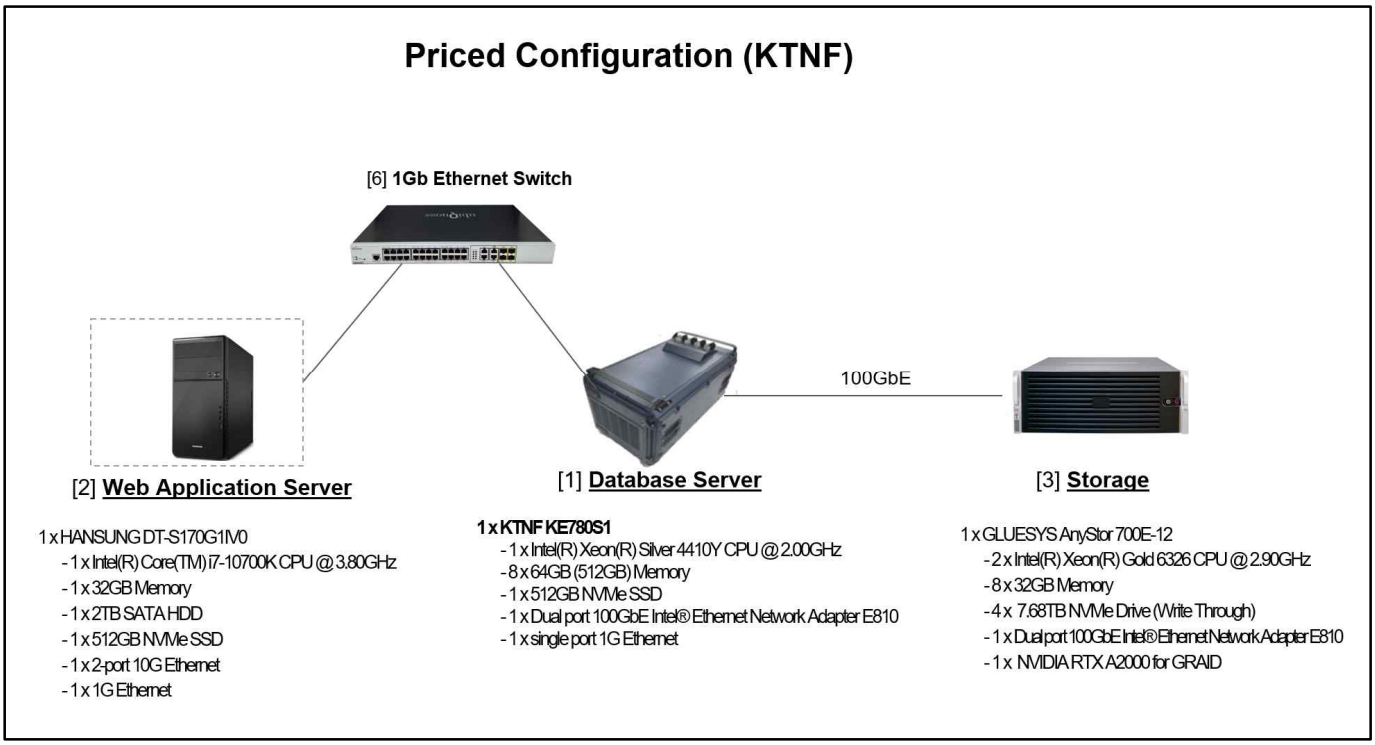
Appendix B contains the tunable parameters for the database, the operating system, and the transaction monitor.

0.4 Configuration Diagrams

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 system is depicted in Figure 0.1. There was no difference between the priced and tested configurations.

Figure 0.1: Benchmarked and Priced Configuration



Clause 1: Logical Database Design

1.1 Table Definitions

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

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

1.2 Physical Organization of Database

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

The physical organization of the database is shown in Table 1.2.

Table 1.2: Physical Organization of the Database

Controller	Array	RAID Array	Drives	Content
NVMe	Internal	None	1 x 512GB NVMe SSD	OS
GRAID SupremeRAID	AnySotr 700E-12 (External)	RAID 1	2 x 7.68TB NVMe SSD	Database files
GRAID SupremeRAID		RAID 1	2 x 7.68TB NVMe SSD	Redo Logs

1.3 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 verified to be fully operational during the entire benchmark.

1.4 Horizontal or Vertical 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 horizontal or vertical partitioning was used in this benchmark.

1.5 Replication or Duplication

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: Transaction and Terminal Profiles

2.1 Random Number Generation

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

Random numbers were generated using ‘SysVr4 rand_r()’ call. The seed value for ‘rand_r()’ was collected and reviewed by the auditor.

2.2 Input/Output Screens

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

All screen layouts were verified by the auditor to validate that they followed the requirements of the specifications.

2.3 Priced Terminal Feature

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 manually verified by the auditor by verifying that each required feature was implemented.

2.4 Presentation Managers

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

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

2.5 Transaction Statistics

Table 2.1 lists the transaction statistics defined in Clauses 8.1.3.5 to 8.1.3.11 and observed during the Measurement Interval.

Table 2.1: Transaction Statistics

Statistic		Value
New Order	Home warehouse order lines Remote warehouse order lines Rolled back transactions Average items per order	99.000% 1.000% 1.004% 10.001
Payment	Home warehouse Remote warehouse Accessed by last name	84.993% 15.007% 59.975%
Order Status	Accessed by last name	60.071%
Delivery	Skipped transactions	0
Transaction Mix	New Order Payment Order status Delivery Stock level	44.980% 43.011% 4.003% 4.003% 4.003%

2.6 Queuing Mechanism

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

The queuing mechanism was implemented using ‘BlockingQueue’ provided by Java.

Clause 3: Transaction and System Properties

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 conducted according to the specification.

3.1 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.

3.1.1 Atomicity of Completed Transactions

Perform the Payment transaction for a randomly selected warehouse, district, and customer (by customer number) and verify that the records in the CUSTOMER, DISTRICT, and WAREHOUSE tables have been changed appropriately.

A row was randomly selected from the CUSTOMER, DISTRICT, and WAREHOUSE tables, and the balances noted. A payment transaction was started with the same Customer, District, and Warehouse identifiers and a known amount. The payment transaction was committed and the rows were verified to contain correctly updated balances.

3.1.2 Atomicity of Aborted Transactions

Perform the Payment transaction for a randomly selected warehouse, district, and customer (by customer number) and substitute a ROLLBACK of the transaction for the COMMIT of the transaction. Verify that the records in the CUSTOMER, DISTRICT, and WAREHOUSE tables have NOT been changed.

A row was randomly selected from the CUSTOMER, DISTRICT, and WAREHOUSE tables, and the balances noted. A payment transaction was started with the same Customer, District, and Warehouse identifiers and a known amount. The payment transaction was rolled back and the rows were verified to contain the original balances.

3.2 Consistency

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

Verify that the data base is initially consistent by verifying that it meets the consistency conditions defined in Clauses 3.3.2.1 to 3.3.2.4. Describe the steps used to do this in sufficient detail so that the steps are independently repeatable.

The specification defines 12 consistency conditions, of which Consistency conditions 1 through 4 were demonstrated as follows:

1. The sum of balances (d_ytd) for all Districts within a specific Warehouse is equal to the balance (w_ytd) of that Warehouse.
2. For each District within a Warehouse, the next available Order ID (d_next_o_id) minus one is equal to the most recent Order ID [max(o_id)] for the ORDER table associated with the preceding District and Warehouse. Additionally, that same relationship exists for the most recent Order ID [max(o_id)] for the NEW-ORDER table associated with the same District and Warehouse. Those relationships can be illustrated as:
   d_next_o_id – 1 = max(o_id) = max(no_o_id)
   where (d_w_id = o_w_id = no_w_id) and (d_id = o_d_id = no_d_id)

3. For each District within a Warehouse, the value of the most recent Order ID [max(no_o_id)] minus the first Order ID [min(no_o_id)] plus one, for the NEW-ORDER table associated with the District and Warehouse, equals the number of rows in that NEW-ORDER table.
   That relationship can be illustrated as:
   max(no_o_id) – min(no_o_id) + 1 = rows in NEW-ORDER
   where (o_w_id = no_w_id) and (o_d_id = no_d_id)
4. For each District within a Warehouse, the sum of Order-Line counts [sum(o_ol_cnt)] for the Orders associated with the District equals the number of rows in the ORDER-LINE table associated with the same District.
   That relationship can be illustrated as:
   sum(o_ol_cnt) = rows in the ORDER-LINE table for the Warehouse and District

To test consistency, the following steps were executed:

1. The consistency conditions 1 through 4 were tested by running queries against the database. All queries showed that the database was in a consistent state.
2. An RTE run was executed at full load for a duration sufficient to include at least one completed checkpoint.
3. The consistency conditions 1 through 4 were tested again. All queries showed that the database was still in a consistent state.

3.3 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.

The benchmark specification defines nine tests to demonstrate the property of transaction isolation. The tests, described in Clauses 3.4.2.1 – 3.4.2.9, were all successfully executed using a series of scripts. Each included timestamps to demonstrate the concurrency of operations. The results of the queries were logged. The captured logs were verified to demonstrate the required isolation had been met.

Isolation Test 1

This test demonstrates isolation for read-write conflicts of Order-Status and New-Order transactions when the New-Order transaction is committed.

The test proceeds as follows:

1. An Order-Status transaction T0 was executed and committed for a randomly selected Customer, and the Order returned was noted.
2. A New-Order transaction T1 was started for the same Customer used in T0. T1 was stopped prior to COMMIT.
3. An Order-Status transaction T2 was started for the same Customer used in T1. T2 completed and was committed without being blocked by T1. T2 returned the same Order that T0 had returned.
4. T1 was allowed to complete and was committed.
5. An Order-Status transaction T3 was started for the same Customer used in T1. T3 returned the Order inserted by T1.

Isolation Test 2

This test demonstrates isolation for read-write conflicts of Order-Status and New-Order transactions when the New-Order transaction is rolled back.

The test proceeds as follows:

1. An Order-Status transaction T0 was executed and committed for a randomly selected Customer and the Order returned was noted.
2. A New-Order transaction T1 with an invalid item number was started for the same Customer used in T0. T1 was stopped immediately prior to ROLLBACK.
3. An Order-Status transaction T2 was started for the same Customer used in T1. T2 completed and was committed without being blocked by T1. T2 returned the same Order that T0 had returned.
4. T1 was allowed to ROLLBACK.
5. An Order-Status transaction T3 was started for the same Customer used in T1. T3 returned the same Order that T0 had returned.

Isolation Test 3

This test demonstrates isolation for write-write conflicts of two New-Order transactions when both transactions are committed.

The test proceeds as follows:

1. The D_NEXT_O_ID of a randomly selected district was retrieved.
2. A New-Order transaction T1 was started for a randomly selected customer within the District used in step 1. T1 was stopped immediately prior to COMMIT.
3. Another New-Order transaction T2 was started for the same customer used in T1. T2 waited.
4. T1 was allowed to complete. T2 completed and was committed.
5. The order number returned by T1 was the same as the D_NEXT_O_ID retrieved in step 1. The order number returned by T2 was one greater than the order number returned by T1.
6. The D_NEXT_O_ID of the same District was retrieved again. It had been incremented by two (i.e. it was one greater than the order number returned by T2).

Isolation Test 4

This test demonstrates isolation for write-write conflicts of two New-Order transactions when one transaction is rolled back.

The test proceeds as follows:

1. The D_NEXT_O_ID of a randomly selected District was retrieved.
2. A New-Order transaction T1, with an invalid item number, was started for a randomly selected customer within the district used in step 1. T1 was stopped immediately prior to ROLLBACK.
3. Another New-Order transaction T2 was started for the same customer used in T1. T2 waited.
4. T1 was allowed to roll back, and T2 completed and was committed.
5. The order number returned by T2 was the same as the D_NEXT_O_ID retrieved in step 1.
6. The D_NEXT_O_ID of the same District was retrieved again. It had been incremented by one (i.e. one greater than the order number returned by T2).

Isolation Test 5

This test demonstrates isolation for write-write conflicts of Payment and Delivery transactions when Delivery transaction is committed.

The test proceeds as follows:

1. A query was executed to find out the Customer who is to be updated by the next Delivery transaction for a randomly selected Warehouse and District.
2. The C_BALANCE of the Customer found in step 1 was retrieved.
3. A Delivery transaction T1 was started for the same Warehouse used in step 1. T1 was stopped immediately prior to COMMIT.
4. A Payment transaction T2 was started for the same Customer found in step 1. T2 waited.
5. T1 was allowed to complete. T2 completed and was committed.
6. The C_BALANCE of the Customer found in step 1 was retrieved again. The C_BALANCE reflected the results of both T1 and T2.

Isolation Test 6

This test demonstrates isolation for write-write conflicts of Payment and Delivery transactions when the Delivery transaction is rolled back.

The test proceeds as follows:

1. A query was executed to find out the Customer who is to be updated by the next delivery transaction for a randomly selected Warehouse and District.
2. The C_BALANCE of the Customer found in step 1 was retrieved.
3. A Delivery transaction T1 was started for the same Warehouse used in step 1. T1 was stopped immediately prior to COMMIT.
4. A Payment transaction T2 was started for the same customer found in step 1. T2 waited.
5. T1 was forced to execute a ROLLBACK. T2 completed and was committed. The C_BALANCE of the Customer found in step 1 was retrieved again. The C_BALANCE reflected the results of only T2.

Isolation Test 7

This test demonstrates repeatable reads for the New-Order transaction while an interactive transaction updates the prices of some items.

The test proceeds as follows:

1. The I_PRICE of two randomly selected items X and Y were retrieved.
2. A New-Order transaction T1 with a group of Items including Items X and Y was started. T1 was stopped immediately after retrieving the prices of all items. The prices of Items X and Y retrieved matched those retrieved in step 1.
3. A transaction T2 was started to increase the price of Items X and Y by 10%.
4. T2 did not stall and was committed.

5. T1 was resumed, and the prices of all Items were retrieved again within T1. The prices of Items X and Y matched those retrieved in step 1.
6. T1 was committed.
7. The prices of Items X and Y were retrieved again. The values matched the values set by T2.

The Execution followed Case D, where T3 does not stall and no transaction is rolled back. Query T4 verifies the price change made by T3.

Isolation Test 8

This test demonstrates isolation for phantom protection between New-Order and Delivery transactions.

The test proceeds as follows:

1. The NO_D_ID of all NEW_ORDER rows for a randomly selected Warehouse and District was changed to 11. The changes were committed.
2. A Delivery transaction T1 was started for the selected Warehouse.
3. T1 was stopped immediately after reading the NEW_ORDER table for the selected Warehouse and District. No qualifying row was found.
4. A New-Order transaction T2 was started for the same Warehouse and District. T2 completed and was committed without being blocked by T1.
5. T1 was resumed and the NEW_ORDER table was read again. No qualifying row was found.
6. T1 completed and was committed.
7. The NO_D_ID of all NEW_ORDER rows for the selected Warehouse and District was restored to the original value. The changes were committed.

Isolation Test 9

This test demonstrates isolation for phantom protection between New-Order and Order-Status transactions.

The test proceeds as follows:

1. An Order-Status transaction T1 was started for a randomly selected Customer.
2. T1 was stopped immediately after reading the ORDER table for the selected Customer to find the most recent Order for that Customer.
3. A New-Order transaction T2 was started for the same Customer. T2 completed and was committed without being blocked by T1.
4. T1 was resumed and the ORDER table was read again to determine the most recent Order for the same Customer. The Order found was the same as the one found in step 2.
5. T1 completed and was committed.

3.4 Durability

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

- *Permanent irrecoverable failure of any single durable medium containing TPC-C database tables or recovery log data (this test includes failure of all or part of memory)*
- *Instantaneous interruption (system crash/system hang) in processing that requires system reboot to recover*
- *Failure of all or part of memory (loss of contents)*

3.4.1 Durable Media Failure

3.4.1.1 Loss of Log Media and Data Media

This test was conducted on a fully scaled database. To demonstrate recovery from a permanent failure of durable medium containing TPC-C Log Media and Data Media, the following steps were executed:

1. The total number of Orders is determined by the sum of D_NEXT_O_ID of all rows in the DISTRICT table; giving count-1.
2. The consistency is verified.
3. The RTE is started with full user load.
4. The test is allowed to run for a minimum of 5 minutes after ramp-up.
5. A first checkpoint is initiated and completed.
6. The test is allowed to run for a minimum of 2 more minutes.
7. A second checkpoint is initiated.
8. Before the second checkpoint completes, one data disk is disabled by removing it physically. Since the data disks are configured with redundancy, the transactions continued to run without interruption.
9. The test is allowed to run until the completion of the second checkpoint and for at least 5 minutes
10. A third checkpoint is initiated.
11. Before the third checkpoint completes, one log device is disabled by removing it physically. Since the log devices are configured with redundancy, the transactions continued to run without interruption.
12. The test is allowed to run until the fourth checkpoint has completed, but no less than 5 more minutes.
13. The RTE run is completed.
14. The consistency is verified.
15. Step 1 is repeated, giving count-2.
16. The RTE result file is used to determine the number of New-Order transactions successfully completed during the full run.
17. The difference between the count-1 and count-2 is compared with the number of New-Order transactions successfully completed during the full run. The difference indicated that no committed transactions had been lost.
18. Data from the success file is used to query the database to demonstrate that the last 500 successful New-Orders have corresponding rows in the ORDER table.

3.4.2 Instantaneous Interruption, Loss of Memory

As the 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. The following steps were executed:

1. The total number of Orders is determined by the sum of D_NEXT_O_ID of all rows in the DISTRICT table; giving count-1.
2. The consistency is verified.
3. The RTE is started with full user load.
4. The test is allowed to run for a minimum of 5 minutes at full load (after ramp-up).
5. A first checkpoint is initiated and completed.
6. The test is allowed to run for a minimum of 2 more minutes.
7. A second checkpoint is initiated.
8. Before the second checkpoint completes, the primary power to the back-end server is shut off (removing both power cords).
9. The RTE is shutdown.
10. Power is restored to the database server and the system performs an automatic recovery.
11. GOLDILOCKS is restarted and performs an automatic recovery.
12. Step 1 is repeated, giving count-2.
13. The consistency is verified.
14. The RTE result file is used to determine the number of New-Order transactions successfully completed during the full run.
15. The difference between the count-1 and count-2 is compared with the number of New-Order transactions successfully completed during the full run. The difference indicated that all committed transactions had been successfully recovered.
16. Data from the success file is used to query the database to demonstrate that the last 500 successful New-Orders have corresponding rows in the ORDER table.

Clause 4: Scaling and Database Population

4.1 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

Table 4.1 shows that number of rows for each table as they were initially populated.

Table 4.1: Number of Rows for Server

Table	Cardinality
Warehouse	4,000
District	40,000
Customer	120,000,000
History	120,000,000
Order	120,000,000
New Order	36,000,000
Order Line	1,199,731,538
Stock	400,000,000
Item	100,000
Unused Warehouses	0

4.2 Database Implementation

A statement must be provided that describes: The data model implemented by DBMS used (e.g. relational, network, hierarchical). The database interfaces (e.g. embedded, call level) and access language (e.g. SQL, DL/1, 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.

Goldilocks v3.1 is an in-memory DBMS, implementing the relational model.

The transactions are implemented in SQL via JDBC calls to the database engine.

All application code and procedures are listed in Appendix A.

4.3 Distribution of Database Files

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

The database files are stored on a set of two 7.68TB disks configured as RAID1. The database log files are stored on two 7.68TB disks configured as RAID1.

Table 4.3: Database file locations

Name	Location	Description
system_XXX.dbf	/data/db/db1	System tables and dictionary
tpcc_data_XX.dbf	/data/db/db1 /data/db/db2 /data/db/db3 /data/db/db4 /data/db/db5	Database data files
redo_X_X.log	/wal	Database log files

The distribution of tables and logs across storage media is shown in Table 1.2.

4.4 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.

A test run of over 8 hours was executed to demonstrate that the configuration is capable of sustaining 8 hours of growth at the reported throughput. The computation of the 60-day storage requirements is shown in Table 4.4.

Table 4.4: 60-Day Space Calculations

Base Unit (KBytes)	1
tpmC	50,768.500

Table	Rows	Data	Index	Initial Population	5% Growth	8-Hour Growth	Required Runtime Space
WAREHOUSE	4,000	32,248	112	32,360	1,618	0	33,978
DISTRICT	40,000	5,128	1,208	6,336	317	0	6,653
CUSTOMER	120,000,000	77,141,608	9,820,784	86,962,392	4,348,120	0	91,310,512
NEW_ORDER	36,000,000	2,272,744	1,269,016	3,541,760	177,088	0	3,718,848
ITEM	100,000	10,808	2,784	13,592	680	0	14,272
STOCK	400,000,000	147,136,256	13,027,736	160,163,992	8,008,200	0	168,172,192
HISTORY	120,000,000	9,832,488	0	9,832,488	0	1,996,723	11,829,211
ORDERS	120,000,000	7,612,624	9,045,464	16,658,088	0	1,545,926	18,204,014
ORDER_LINE	1,199,731,538	112,456,952	46,777,864	159,234,816	0	22,837,083	182,071,899
Total		356,500,856	79,944,968	436,445,824	12,536,022	26,379,732	475,361,577

60-Day Requirements	
Dynamic-Space	129,902,064
Free-Space	482,288
Static-Space	306,543,760
Daily-Growth	26,379,732
Daily-Spread	0
60-Day Space	**1,889,327,665**

Memory Requirements	
Final Allocation	483,467,376
Non-Growing 5%	12,536,022
1-Day Memory	**496,003,398**

Storage Requirements	
Total Disk Space	15,002,570,752
Log space used	73,400,320
60-Day Space	1,889,327,665
Remaining Space	**13,039,842,767**

Clause 5: Performance Metrics

5.1 TPC Benchmark C Metrics

The TPC-C Metrics are reported in the front of this report as part of the executive summary.

5.2 Response Times

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

During the performance run transactions are submitted by the RTE in accordance with the required mix, Keying Times and Think Times of the benchmark Specification. Transactions are submitted by emulated users via HTTP. All timings are recorded by the RTE. The response time is measured from the submission of the transaction until the last byte of response is received by the RTE.

The details of the response times are reported in the front of this report as part of the Executive Summary.

5.3 Keying and Think Times

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

The details of the keying and think times are reported in the front of this report as part of the Executive Summary.

5.4 Distribution and Performance Curves

5.4.1 Response Time frequency distribution curves

Response Time frequency distribution curves must be reported for each transaction type.

Figure 5.4.1.1 shows the Response Time frequency distribution curves for the New-Order transaction.

Figure 5.4.1.2 shows the Response Time frequency distribution curves for the Payment transaction.

Figure 5.4.1.3 shows the Response Time frequency distribution curves for the Order-Status transaction.

Figure 5.4.1.4 shows the Response Time frequency distribution curves for the interactive portion of the Delivery transaction.

Figure 5.4.1.5 shows the Response Time frequency distribution curves for the Stock-Level transaction.

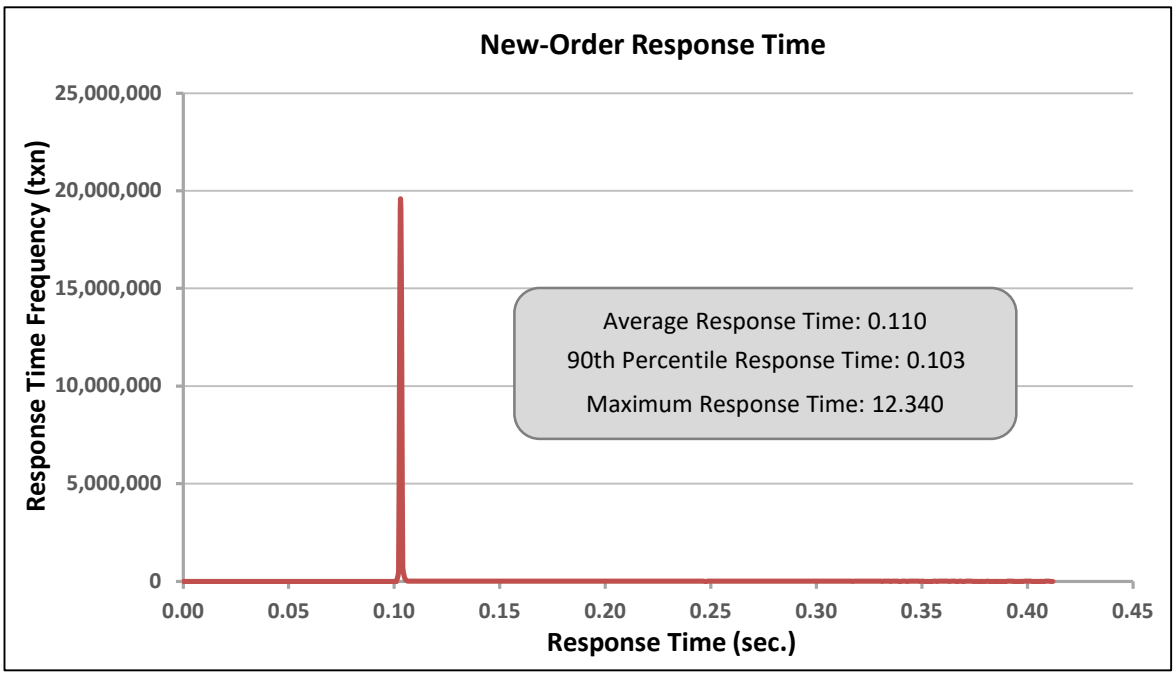


Figure 5.4.1.1: New-Order RT Frequency Distribution

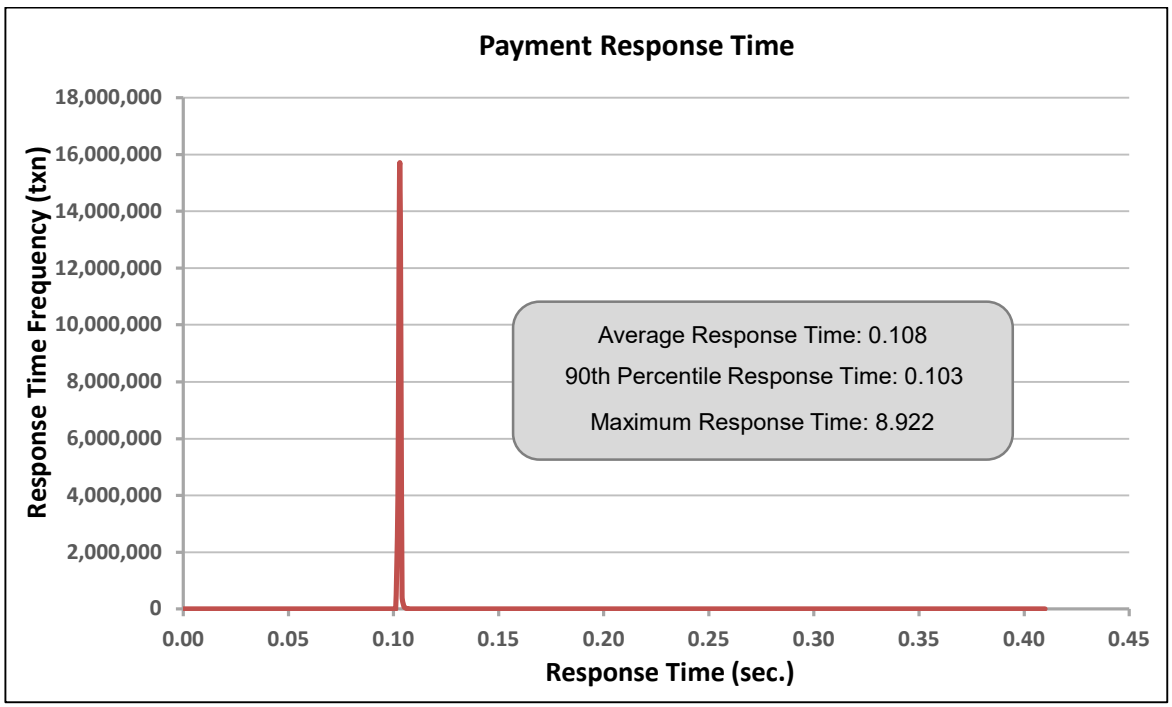


Figure 5.4.1.2: Payment RT Frequency Distribution

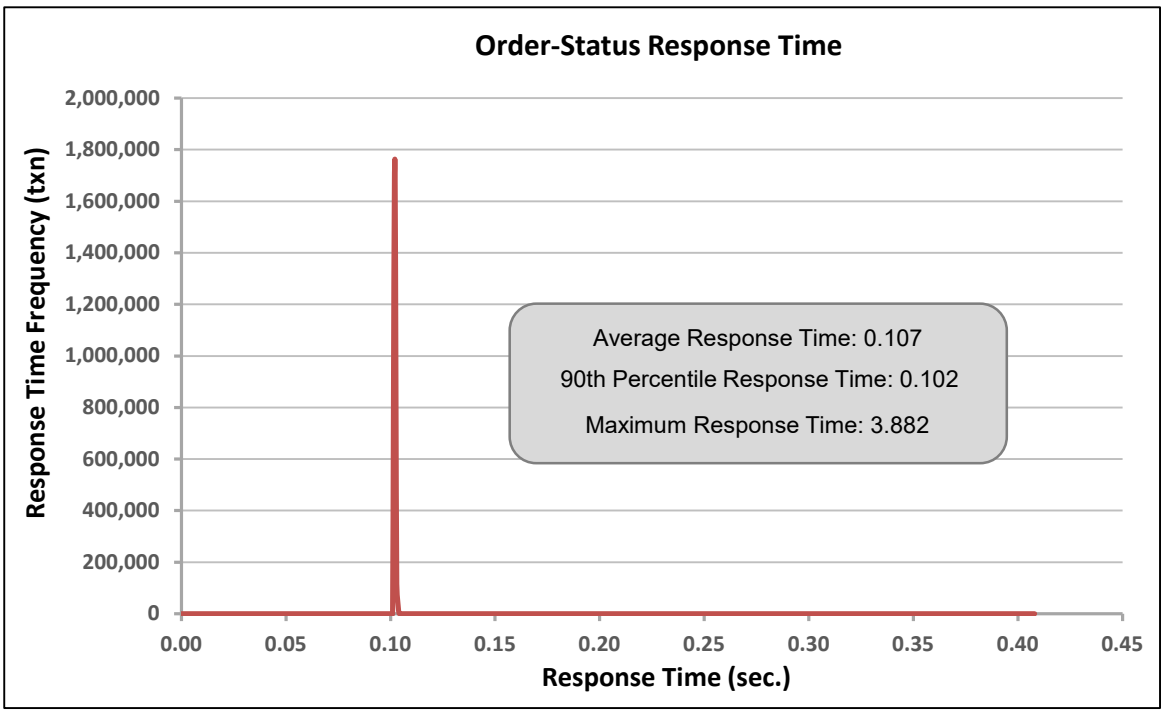


Figure 5.4.1.3: Order-Status RT Frequency Distribution

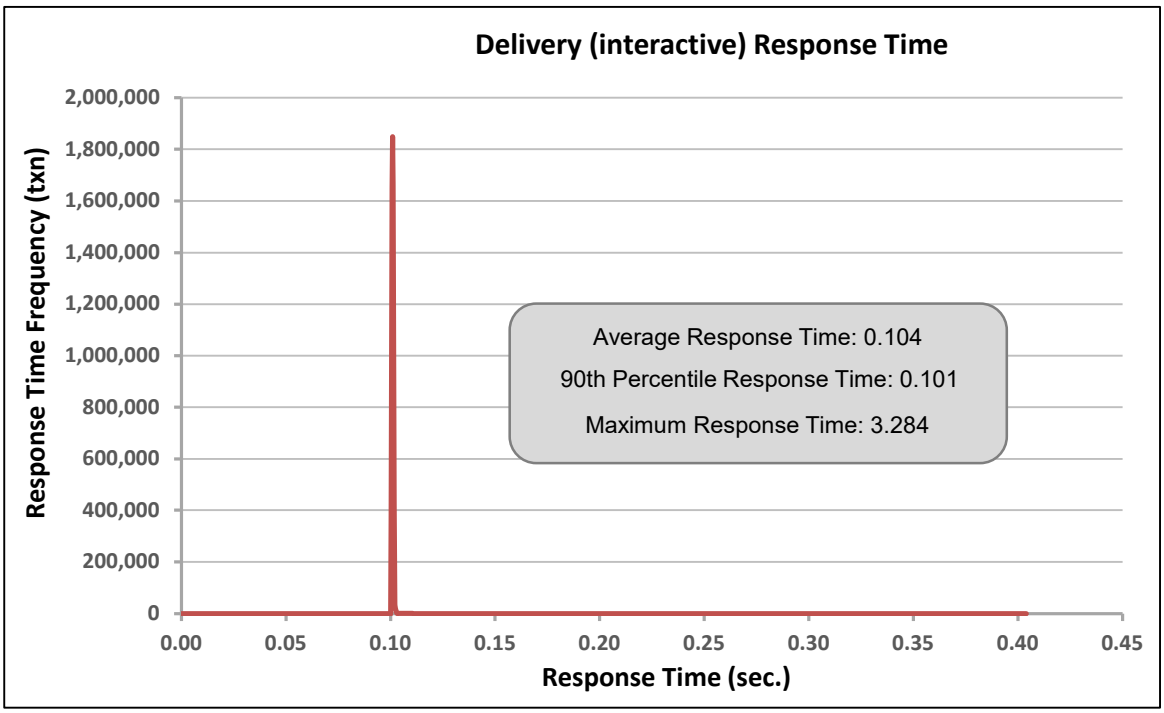


Figure 5.4.1.4: Delivery (Interactive) RT Frequency Distribution

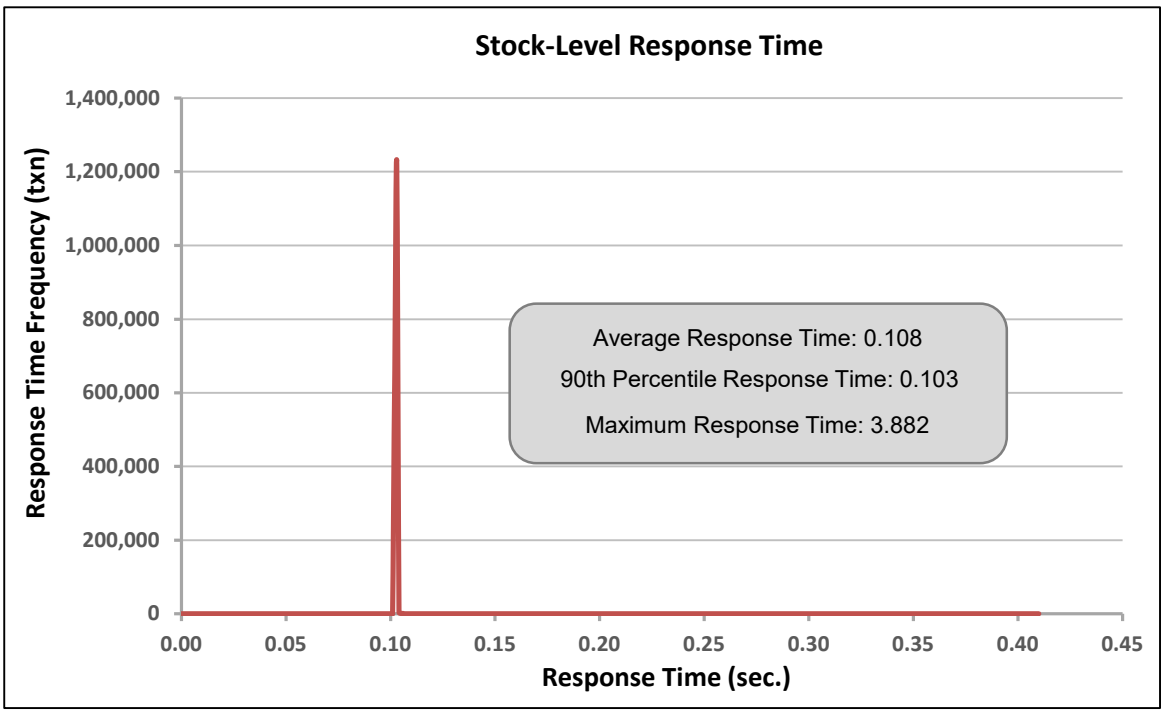


Figure 5.4.1.5: Stock-Level RT Frequency Distribution

5.4.2 Response Time versus throughput

The performance curve for response times versus throughput must be reported for the New-Order transaction.

Figure 5.4.2 shows the Response Time versus throughput curves for the New-Order transaction.

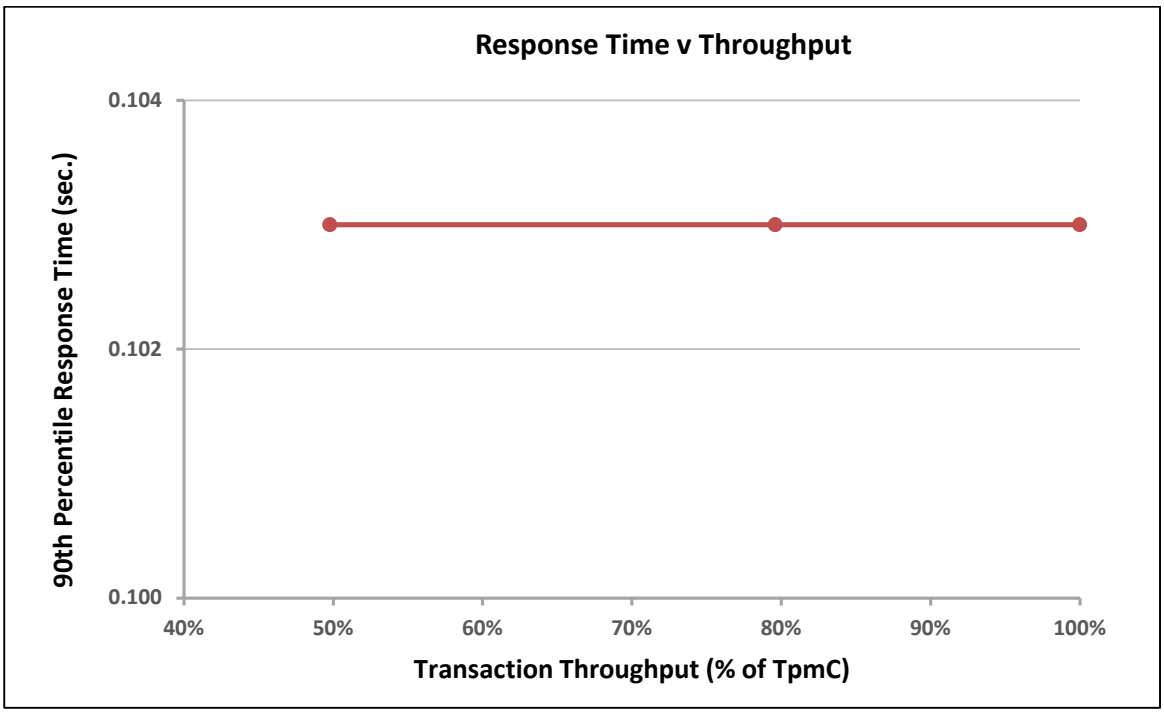


Figure 5.4.2: New-Order RT versus Throughput

5.4.3 Think Time frequency distribution

Think Time frequency distribution curves (see Clause 5.6.3) must be reported for the New-Order transaction.

Figure 5.4.3 shows the Think Time frequency distribution curves for the New-Order transaction.

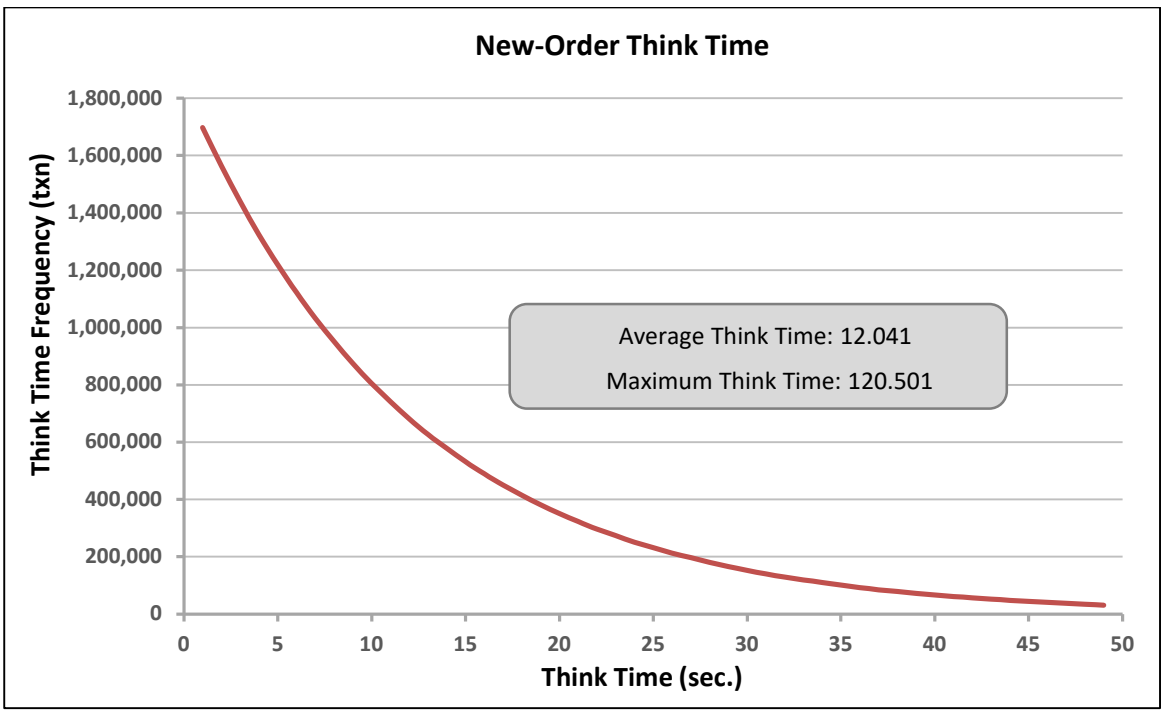


Figure 5.4.3: New-Order Think Time Frequency Distribution

5.4.4 Throughput versus elapsed time

A graph of throughput versus elapsed time must be reported for the New-Order transaction.

Figure 5.4.4 shows the throughput versus elapsed time for the New-Order transaction. The start and end of the Measurement Interval is included on the figure.

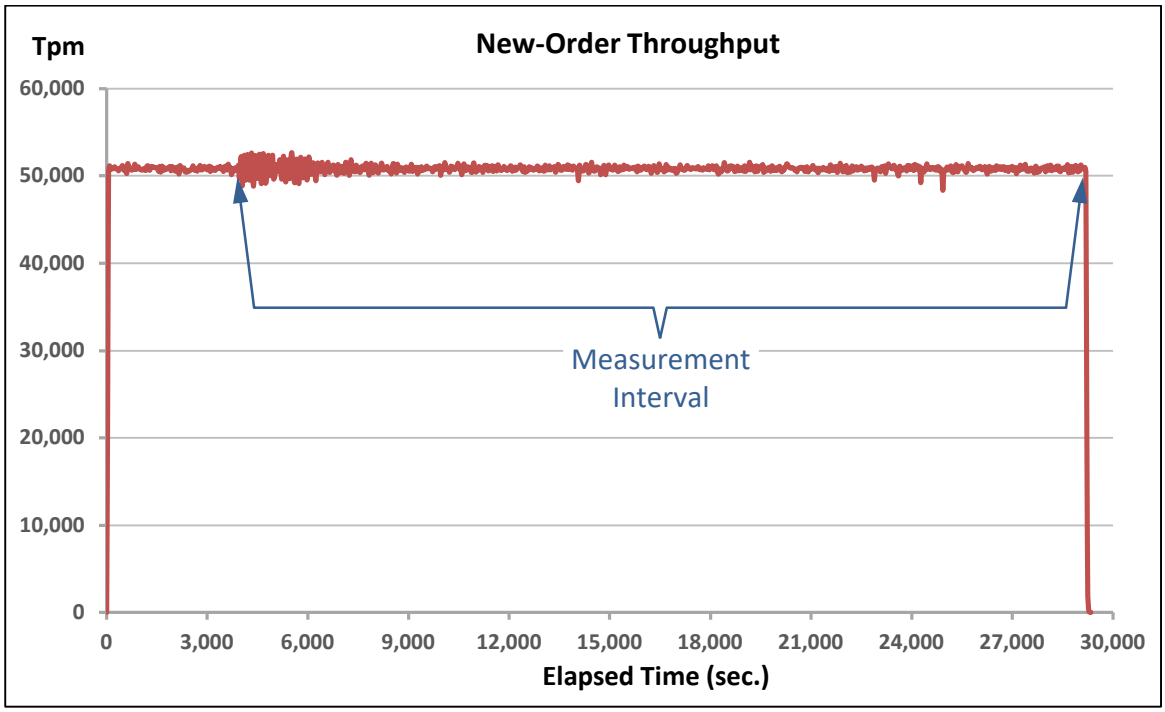


Figure 5.4.4: New-Order Throughput versus Elapsed Time

5.5 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 a visual analysis of the throughput graph.

5.6 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.

During the test, Goldilocks satisfied all of the ACID properties required by the benchmark specification. Committed transactions write a Redo record in the transaction log, to be used in case of system failure. The Redo records are used for roll-forward recovery during a re-start following a failure. This prevents the system from losing any committed transactions. Checkpoints periodically occurred about every 29.3 min. and are completed in about 3.3 min.

5.7 Measurement Period Duration

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

The duration of the reported measured interval was 7 hours (7hr = 420min = 25,200sec).

5.8 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 skipped Delivery transactions must be disclosed.

The details of the transaction statistics are reported in the front of this report as part of the Executive Summary.

5.9 Checkpoints

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.

Two full checkpoints occurred before the Measurement Interval. 14 full checkpoints occurred during the Measurement Interval. The checkpoints' start and end times and durations during the Measurement Interval are listed in table 5.6.

Table 5.6: Checkpoints

Event	Event time	Execution time	Interval
Measurement Interval Begin	2023-11-10 17:14:18	-	-
Checkpoint3 Begin	2023-11-10 17:31:01		00:29:21
Checkpoint3 End	2023-11-10 17:34:08	00:03:07	
Checkpoint4 Begin	2023-11-10 18:00:18		00:29:17
Checkpoint4 End	2023-11-10 18:03:31	00:03:13	
Checkpoint5 Begin	2023-11-10 18:29:39		00:29:21
Checkpoint5 End	2023-11-10 18:32:51	00:03:12	
Checkpoint6 Begin	2023-11-10 18:58:59		00:29:20
Checkpoint6 End	2023-11-10 19:02:11	00:03:12	
Checkpoint7 Begin	2023-11-10 19:28:18		00:29:19
Checkpoint7 End	2023-11-10 19:31:35	00:03:17	
Checkpoint8 Begin	2023-11-10 19:57:38		00:29:20
Checkpoint8 End	2023-11-10 20:00:47	00:03:09	
Checkpoint9 Begin	2023-11-10 20:26:59		00:29:21
Checkpoint9 End	2023-11-10 20:30:02	00:03:03	
Checkpoint10 Begin	2023-11-10 20:56:19		00:29:20
Checkpoint10 End	2023-11-10 20:59:27	00:03:08	
Checkpoint11 Begin	2023-11-10 21:25:38		00:29:19
Checkpoint11 End	2023-11-10 21:28:44	00:03:06	
Checkpoint12 Begin	2023-11-10 21:54:57		00:29:19
Checkpoint12 End	2023-11-10 21:58:06	00:03:09	
Checkpoint13 Begin	2023-11-10 22:24:18		00:29:21
Checkpoint13 End	2023-11-10 22:27:22	00:03:04	
Checkpoint14 Begin	2023-11-10 22:53:39		00:29:21
Checkpoint14 End	2023-11-10 22:56:43	00:03:04	
Checkpoint15 Begin	2023-11-10 23:23:00		00:29:21
Checkpoint15 End	2023-11-10 23:26:04	00:03:04	
Checkpoint16 Begin	2023-11-10 23:52:20		00:29:20
Checkpoint16 End	2023-11-10 23:55:29	00:03:09	
Measurement Interval End	2023-11-11 00:17:49	-	-

Clause 6: SUT, Driver and Communication

6.1 Remote Terminal Emulator (RTE)

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 software used was internally developed. The RTE simulated web users. It generated random input data based on the benchmark requirements and recorded response times and other statistics for each transaction cycle.

6.2 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.

No components were emulated by the driver system.

6.3 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 diagram in Figure 0.1 shows the tested and priced benchmark configurations.

6.4 Networks

The network configuration of both the tested services and proposed (target) services which 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.

The diagram in Figure 0.1 shows the network configuration between the components of the tested configuration. The RTE and the SUT are connected through a 1Gbit switch.

The network bandwidths are listed in Figure 0.1.

6.5 Operator Intervention

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

No operator intervention is required to sustain eight hours at the reported throughput.

Clause 7: Pricing

7.1 Hardware and Software 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 date. 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 details of the hardware and software are reported in the front of this report as part of the Executive Summary.

7.2 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.

The pricing details for this TPC-C result are reported in the front of this report as part of the Executive Summary.

7.3 Availability Dates

The committed delivery date for general availability (availability date) of products used in the price 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.

All components of the priced system are available as of the date of this publication.

Clause 8: Reporting

8.1 Full Disclosure Report

A Full Disclosure report is required in order for results to be considered compliant with the TPC-C benchmark specification

This document constitute the Full Disclosure Report for the TPC-C benchmark result describes within.

Clause 9: Auditor Attestation

9.1 Auditor Information

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 benchmark was audited by:

InfoSizing

Doug Johnson

63 Lourdes Drive

Leominster, MA, 01453 USA
Phone: +1 (978) 343-6562

www.sizing.com

9.2 Attestation Letter

The auditor's attestation letter is included in the following pages.

InfoSizing
The Right Metric For Sizing IT

TPC
Certified Auditor

Sejin Hwang
Senior Research Engineer
Telecommunications Technology Association (TTA)
Bundang-ro 47, Bundang-gu, Seongnam-city
Gyeonggi-do, 13591, Republic of Korea

February 23, 2022

I verified the TPC Benchmark™ C v5.11.0 performance of the following configuration:

Platform:	KTNF KE780S1
Operating System:	Red Hat Enterprise Linux 9.0
Database Manager:	Goldilocks v3.1 Standard Edition

The results were:

Performance Metric	**50,768 tpmC**
Number of Users	40,000

Server	**KTNF KE780S1**		
CPUs	1x Intel® Xeon® Silver 4410Y @ 2.00 GHz, 12-core, 30 MB L3		
Memory	512 GB		
Storage	***Qty***	***Size***	***Type***
	1	512 GB	NVMe
	4	7.68 TB	NVMe (External)

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

The following verification items were given special attention:

- The transactions were correctly implemented.
- The database records were the proper size.
- The database was properly scaled and populated.
- The ACID properties were met.
- Input data was generated according to the specified percentages.
- The transaction cycle times included the required keying and think times.
- The reported response times were correctly measured.
- At least 90% of all delivery transactions met the 80 Second completion time limit.
- All 90% response times were under the specified maximums.

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- The measurement interval was representative of steady state conditions.
- The reported measurement interval was over 120 minutes.
- Checkpoint intervals were under 30 minutes.
- The 60-day storage requirement was correctly computed.
- The system pricing was verified for major components and maintenance.

Additional Audit Notes:

None.

Respectfully Yours,

Doug Johnson, Certified TPC Auditor

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Appendix A: Source Code

The source code and scripts used to implement the benchmark is provided as a soft appendix. This soft appendix includes the following files:

```
\ACID
    \ACID\include
    \ACID\src
    \ACID\include\acid.h
    \ACID\src\atom.c
    \ACID\src\compare.c
    \ACID\src\consist.c
    \ACID\src\Delivery.c
    \ACID\src\isol1.c
    \ACID\src\isol2.c
    \ACID\src\isol3.c
    \ACID\src\isol4.c
    \ACID\src\isol5.c
    \ACID\src\isol6.c
    \ACID\src\isol7.c
    \ACID\src\isol8.c
    \ACID\src\isol9.c
    \ACID\src\Makefile
    \ACID\src\NewOrder.c
    \ACID\src\OrderStatus.c
    \ACID\src\Payment.c
    \ACID\src\support.c
\bin
    \bin\load.sh
\html
    \html\DeliveryInput.html
    \html\MainMenu.html
    \html\NewOrderInput.html
    \html\OrderStatusInput.html
    \html\PaymentInput.html
    \html\StockLevelInput.html
\include
    \include\spt_proc.h
    \include\support.h
\java
    \java\Common.java
    \java\Delivery.java
    \java\NewOrder.java
    \java\OrderStatus.java
    \java\Payment.java
    \java\StockLevel.java
\scripts
    \scripts\analyze_system.sql
    \scripts\analyze_table.sql
    \scripts\analyze_table_district.sql
    \scripts\analyze_table_item.sql
    \scripts\analyze_table_new_order.sql
    \scripts\analyze_table_orders.sql
    \scripts\analyze_table_order_line.sql
```

```
    \scripts\analyze_table_stock.sql
    \scripts\analyze_table_warehouse.sql
    \scripts\audit.sql
    \scripts\checkpoint.py
    \scripts\count.sql
    \scripts\create_audit_table.sql
    \scripts\create_index.sql
    \scripts\create_procedure.sql
    \scripts\create_table.sql
    \scripts\create_tablespace.sql
    \scripts\dbcheck.sql
    \scripts\dbtables.sql
    \scripts\runcheck.sql
    \scripts\sys
         \scripts\sys\be
             \scripts\sys\be\part_info.sh
             \scripts\sys\be\reboot_info.sh
             \scripts\sys\be\sw_info.sh
             \scripts\sys\be\sys_info.sh
\src
    \src\free_space.c
    \src\load.c
    \src\load_new.c
    \src\Makefile
    \src\support.c
```

Appendix B: Tunable Parameters

goldilocks.properties.conf

```
TRANSACTION_COMMIT_WRITE_MODE = 1
TRANSACTION_TABLE_SIZE = 1024
UNDO_RELATION_COUNT = 1024
LOG_BUFFER_SIZE = 3G
LOG_FILE_SIZE = 14G
LOG_GROUP_COUNT = 5
PENDING_LOG_BUFFER_COUNT = 8
SPIN_COUNT = 1
BUSY_WAIT_COUNT = 1000
SYSTEM_TABLESPACE_DIR = '/data/db/db1'
SYSTEM_MEMORY_UNDO_TABLESPACE_SIZE = 2G
SYSTEM_MEMORY_TEMP_TABLESPACE_SIZE = 1G
SHARED_MEMORY_STATIC_SIZE = 4G
PARALLEL_IO_FACTOR = 1
PARALLEL_IO_GROUP_1 = '/data/db/db1'
LOG_DIR = '/wal'
CLIENT_MAX_COUNT = 1024
PROCESS_MAX_COUNT = 1024
PARALLEL_LOAD_FACTOR = 16
SHARED_SESSION = NO
CONTROL_FILE_COUNT = 2
CONTROL_FILE_0 = '/wal/control_0.ctl'
CONTROL_FILE_1 = '/wal/control_1.ctl'
DATABASE_FILE_IO = 1
SYSTEM_FILE_IO = 1
LOG_FILE_IO = 1
```

limit.conf

```
# /etc/security/limits.conf
#
#This file sets the resource limits for the users logged in via PAM.
#It does not affect resource limits of the system services.
#
#Also note that configuration files in /etc/security/limits.d
directory,
#which are read in alphabetical order, override the settings in this
#file in case the domain is the same or more specific.
#That means for example that setting a limit for wildcard domain here
#can be overriden with a wildcard setting in a config file in the
#subdirectory, but a user specific setting here can be overriden only
#with a user specific setting in the subdirectory.
#
#Each line describes a limit for a user in the form:
#
#<domain>        <type>  <item>  <value>
#
tpcc    soft    nofile  1000000
tpcc    hard    nofile  1000000
tpcc    soft    nproc   unlimited
tpcc    hard    nproc   unlimited

# End of file
```

server.xml

```
<?xml version='1.0' encoding='utf-8'?>
<Context>

    <WatchedResource>WEB-INF/web.xml</WatchedResource>


<Resource
    name='jdbc/goldilocks'
    auth='Container'
    type='javax.sql.DataSource'
    driverClassName='sunje.goldilocks.jdbc.GoldilocksDriver'
    url='jdbc:goldilocks://10.100.250.139:22581/test'
    username='test'
    password='test'
    maxActive='10'
    maxIdle='10'
    maxWait='-1'
/>

</Context>
```

tm_server_fe1.conf

```
<?xml version='1.0' encoding='utf-8'?>
<Server port="8005" shutdown="SHUTDOWN">
  <Listener
className="org.apache.catalina.startup.VersionLoggerListener" />
  <!-- Security listener. Documentation at /docs/config/listeners.html
  <Listener className="org.apache.catalina.security.SecurityListener"
/>
  -->
  <!--APR library loader. Documentation at /docs/apr.html -->
  <!--Initialize Jasper prior to webapps are loaded. Documentation at
/docs/jasper-howto.html -->
  <Listener className="org.apache.catalina.core.JasperListener" />
  <!-- Prevent memory leaks due to use of particular java/javax APIs--
>
  <Listener
className="org.apache.catalina.core.JreMemoryLeakPreventionListener"
/>
  <Listener
className="org.apache.catalina.mbeans.GlobalResourcesLifecycleListener
" />
  <Listener
className="org.apache.catalina.core.ThreadLocalLeakPreventionListener"
/>

  <GlobalNamingResources>
    <Resource name="UserDatabase" auth="Container"
              type="org.apache.catalina.UserDatabase"
              description="User database that can be updated and
saved"

factory="org.apache.catalina.users.MemoryUserDatabaseFactory"
              pathname="conf/tomcat-users.xml" />
  </GlobalNamingResources>

  <Service name="Catalina">



        <Connector port="8080"
                   acceptCount="150000"
                   maxConnections="141000"
                   connectionTimeout="20000000"
                   maxThreads="1024"
                   maxKeepAliveRequests="-1" keepAliveTimeout="-
1"

protocol="org.apache.coyote.http11.Http11NioProtocol"
redirectPort="8443"
        />


    <Connector port="8009" protocol="AJP/1.3" redirectPort="8443" />


    <Engine name="Catalina" defaultHost="localhost">


      <Realm className="org.apache.catalina.realm.LockOutRealm">
        <Realm className="org.apache.catalina.realm.UserDatabaseRealm"
               resourceName="UserDatabase"/>
      </Realm>

      <Host name="localhost"  appBase="webapps"
            unpackWARs="true" autoDeploy="true">



      </Host>
    </Engine>
  </Service>
</Server>
```

Appendix C: Price Quotations

DB&WAS Server

견 적 서

수 신 : TTA
참 조 :
귀사의 성공적인 사업을 진심으로 기원하며 아래와 같이 견적드립니다.

견 적 번 호 : 20240118-001
건 명 :

최종견적가(VAT포함): 일금 오천육백일십만 원정 (₩56,100,000)

견 적 일 자 : 2024년 1월 18일
견적 유효 기간 : 견적일로부터 1개월
납품 예정 일자 : 협의
무상 보증 기간 : 3년
지 불 조 건 : 현금
견 적 담 당 : 김종법 이사 (Mobile : 010-8753-5644, jbkim@ktnf.co.kr)

KTNF
KOREA TECHNOLOGY AND FUTURE

주식회사 케이티엔에프
서울시 강서구 마곡중앙 8로 3길 21
(마곡동, KTNF빌딩)
TEL : 02-865-5200, FAX : 02-3661-3377

등록번호	106-86-07697
대표이사	이 중 연
업 태	제 조
종 목	컴퓨터제조

(단위: 원, VAT별도)

구분	파트번호 Part Number	규 격 Specification	수량 Q'ty	소비자가 단가	소비자가 합계	공급가 단가	공급가 합계
KE780S1 (12C 2.0GHz x1P / 512GB DDR4 / 512GB M.2 SSD x1)			1			43,000,000	43,000,000
KE780S1 엣지 서버 (DB 서버)		** 컴퓨팅 모듈 **					
	CPU	4th Gen intel Xeon Scalable Processor Silver 4410Y (12C/24T, 2.0Ghz, 30M, 150W)	1				
	RAM	64GB DDR5 4800 RDIMM	8				
	NIC	100GbE Network Card	1				
	SSD	512GB M.2 NVMe SSD	1				
	무상보증	납품 및 검수 완료일로부터 3년 (24시간 x7일)	1				
한성컴퓨터 Desktop			1			8,000,000	8,000,000
한성컴퓨터 Desktop (Web/Was)	CPU	Intel Core i7-10700K (3.8GHz)	1				
	RAM	32GB DDR5 Memory	1				
	HDD	2TB SATA HDD	1				
	SSD	512 M.2 NVMe SSD	1				
	NIC	2port 10G RJ-45 Adapter 1	1				
	NIC	port 1G RJ-45 Adpater	1				
	무상보증	납품 및 검수 완료일로부터 3년 (24시간 x7일)	1				

Remarks
1. 상기 제품은 대외무역법 제19조 제1항에 따라 전략물자에 해당되며, 해외수출시 대외무역법에 따라 전략물자 기술 수출입 통합고시에서 규정하는 허가기관의 장으로부터 수출허가를 득하시기 바랍니다.
2. 본 제품을 제3자에게 양도 또는 재판매할 경우 해당 제3자에게 상기에 언급한 의무사항들을 사전에 충분히 고지하시기 바랍니다.
3. OS 및 SW는 별도입니다.

공급가 합계	₩ 51,000,000
VAT	₩ 5,100,000
공급가 합계 (VAT포함)	₩ 56,100,000

Storage

견 적 서

수 신 : TTA
참 조 : 황세진 선임연구원 님

gluesys

1. 납품일자 : 협의 후 지정
2. 결제조건 : 협의
3. 견적일자 : 2024년 2월 14일
4. 견적유효일자 : 견적일로부터 90일

경기도 안양시 동안구 시민대로327번길 11-31
파낙스 R&D센터 5F ㈜글루시스
대 표 이 사 : 박 성 순

견적 금액 : **일금오천오백사십만칠천원정(VAT포함)**
건 명 :

담 당 자 : 김유상 부장
연 락 처 : 010-2353-2325
이 메 일 : yskim@gluesys.com

귀사의 무궁한 발전을 기원하오며, 아래와 같이 견적합니다.

단위. 원(V.A.T 별도)

번호	구분	설명	수량	소비자가	소비자가 합계	공급단가	공급금액
A		**Anystor 700E-12** **(7.68TB NVMe SSD *2)**	1		117,100,000	**50,370,000**	**50,370,000**
1	ASE700E-12	Intel® Xeon Gold 6326 Processor (16Core, 2.9GHz, 24MB Cache) X2ea 32GB ECC Registered Memory X8EA 2-port 10G RJ45 & 2-port 10G SFP+, Intel X710-TM4 Hot-Swappable 12 SAS or SATA Disk Bay PCIe Gen4 x 16 GRAID SupremeRAID Core Software Module License with Full features, supports 32 native NVMe drives and NVMe-oF RAID 0, 1, 5, 6, 10	1	97,000,000	97,000,000	**40,000,000**	**40,000,000**
	OS	AnyStor-E NAS 전용 O/S (480GB SSD X2EA, RAID1) 지원프로토콜 - NFS, CIFS, SNMP, FTP, NVMeoF AnyManager - 웹 기반의 NAS 관리도구 - Cluster Management - Volume Managent & Monitoring - Auto / Manual recovery - Parallel & distributed recovery - Data Replication Management - Online Scale-Out Support - POSIX FS API Support - Monitoring Tool on WEB (WMS) - Data Distributed I/O - Data Replication & NetworkRAID					
2	Suuport & Maintenance	Premium Package 3-Year Support & Maintenance	1	12,000,000	12,000,000	**4,500,000**	**4,500,000**
3	Disk Drive	SAMSUNG PM9A3, 7.68TB U.2 PCIe 4.0 NVMe (SAMSUNG MZQL27T6HBLA-00A07)	4	1,250,000	5,000,000	**1,000,000**	**4,000,000**
4	NIC Card	Dual-Port QSFP28 100GbE Network Card	1	2,500,000	2,500,000	**1,500,000**	**1,500,000**
5	NIC Cable	100G QSFP28 Cable 3M (MCP1600-C003E26N)	2	300,000	600,000	**185,000**	**370,000**
					공 급 가		**50,370,000**
					부 가 가 치 세		**5,037,000**
					총 합 계		**55,407,000**

비고
1. 무상 유지보수 기간 : 납품 및 설치 후 3년

RHEL/JWS

rockPLACE
(주)락플레이스 www.rockplace.co.kr

㈜락플레이스
03129 서울시 종로구 종로 33길 15 (연지동 연강빌딩 5층) Tel : 02-6251-7788 Fax : 02-6499-1478

rockPLACE, Inc.
15, Jong-ro 33-gil, Jongno-gu, Seoul, Korea 03129 Tel : 82-2-6251-7788 Fax : 82-2-6499-1478

Metanet

견 적 서

REF No.	: 2024RPI01-1613			TERMS AND CONDITION	
DATE	: 2024. 1. 16.				
COMPANY	: TTA(한국정보통신기술협회)			납 기	: 발주후 4주이내
ATTN	: 황 세 진 선임연구원 귀하	TEL	: 010-5110-4883	유지보수	:
Email	: hsejin314@tta.or.kr			결제조건	: 납품 검수 후 30일
FROM	: ㈜락플레이스 허 운 범 차장	TEL	: 010-6605-2146	유효기간	: 견적일로부터 4개월

下記와 같이 見積합니다.

㈜ 락플레이스
대표이사 김 재 준, 김 연 수

ITEM DESCRIPTION (VAT 별도, 단위 : 원)

Part No.	Description	수량	소비자가	공급단가	공급합계
Subscription	*Red Hat Enterprise Linux Server*				
RH00004F3	**Red Hat Enterprise Linux Server, Standard (Physical or Virtual Nodes) 3Year** support : Easy ISOs: OS, Source, Documentation ISO Images 가상화 Guest OS : 2guests Red Hat Network 서비스 : 3년 Phone,email Support : 09:00 ~ 17:00 Scope of Coverage : Standard Maximum Memory Support: Unlimited	2	4,089,000	2,600,000	5,200,000
RP-CPS(OS)	**rockPLACE Support Carepack - Linux Standard (3년) per Server** 3 Year, 24x7, 4hr response 이메일, 전화, 원격지원, 현장지원 서비스 On Site Support - Total 연간 10회 Support (아래 지원내역에 준함) - Installation & Startup Service Included - Problem tracking/Emergency assistance - Update, Patch 작업 지원 - 서비스, 시스템 환경, 네트워크 환경 설정 변경 지원 - 인수 시험, 성능 시험, 비상 복구 훈련 지원	2	8,000,000	3,000,000	6,000,000
소 계 금 액					11,200,000

Part No.	Description	수량	소비자가	공급단가	공급합계
Subscription	**Red Hat JBoss Web Server**				
MW00123F3	**Red Hat JBoss Web Server, 4-Core Standard 3Year** - 전화/웹 지원 : 월-금, 9 a.m. - 5 p.m. 4시간내 응답 - unlimited incidents,	2	1,944,000	1,300,000	2,600,000
RP-CPS(WAS)	**rockPLACE Support Carepack - JBoss Standard (3년) per 4Core** 3 Year, 24x7, 4hr response 이메일, 전화, 원격지원, 현장지원 서비스 On Site Support - Total 10회 Support (아래 지원내역에 준함) - Installation & Startup Service Included - Problem tracking/Emergency assistance - Update, Patch 작업 지원 - 서비스, 시스템 환경, 네트워크 환경 설정 변경 지원 - 인수 시험, 성능 시험, 비상 복구 훈련 지원	2	12,000,000	9,000,000	18,000,000
소 계 금 액					20,600,000

합 계	31,800,000
부가세	3,180,000
합 계(부가세포함)	34,980,000

Remarks

1. Red Hat 제품은 년간 Subscription 제품이며, 기간이 만료되실 경우 Renewal을 하셔야합니다.
2. 발주 시에는 반드시 고객정보(엔드유저명, 담당자, 연락처, Email)가 있어야 합니다.
3. OnSite 방문지원이 필요하실 경우에는 케어팩을 구매하셔야 합니다.

락플레이스에서 제안하는 고성능 premium 솔루션

구분	Description	가격정책
1. OS 백업	**OS 백업복구 통합관리 솔루션 cider v2.0 (CiderV2)** 유닉스,리눅스,윈도우 OS백업복구 통합관리 툴 Web기반의 간편한 UI를 통한 OS백업, 복구, 복제, 조회 기능 제공 베어메탈(Bare Metal) 자동복구 AIX,HP-UX,Solaris ,Linux,Windows 5개 플랫폼을OS백업 통합관리 지원하는 유일한 솔루션	perpetual subscription
2. OSS 개발 관리툴	**Toad Data Point Base edition** **Toad Data Point Professional edition** 전세계 시장 점유율 1위 Multi DB (MySQL, Oracle, MSSQL, DB2, MonggoDB, 등) 개발툴 간편한 데이터베이스 오브젝트 관리 데이터 프로파일링을 통해서 데이터 품질 향상 (Professional Edition 이상에서 지원)	perpetual
	Toad Edge MySQL, PostgreSQL, MariaDB, EDB 구매한 라이선스에 맞게 전용 제품으로 활성화 (각각 별도 라이선스) 효율적인 SQL 작성(SQL Worksheet) 스키마 비교와 동기화 스크립트 생성 JSON 데이터 탐색 및 편집 / 데이터베이스 Snapshot 기능	subscription

Network Switch

23. 12. 22. 오후 2:10 상품상세정보

상품상세정보

확대보기 수량 : 대

네트워크스위치

업체명 : 주식회사에스비정보기술[중소기업]
계약자/공급자 정보조회

계약방법 : 다수공급자계약

규격명 : 네트워크스위치, 다산네트웍스, (CN)D2224GP, 24port POE (공급)

가격 : 1,900,000 원 다량납품할인을 확인

Price

단위 : 대

원산지 : 중국

주요부품1[원산지] : soc[중국]

주요부품2[원산지] : 메모리[중국]

제조사 : (주)다산네트웍스

납품장소 : 수요기관 지정장소

인도조건 : 현장설치도

공급지역 : 전지역

부가세여부 : 부가가치세포함

계약기간 : 2023/11/15 ~ 2024/11/14

납품기한 : 60일 (납품요구일로부터)

조달수수료여부 : 조달수수료 별도 조달수수료 안내·계산

첨부파일 : 2023/11/01_0023C053500-(계약에규)물품구매(제조)계약일반조건(기획재정부계약예규제583호20211201).hwp
2023/11/02_0023C053500-물품다수공급자계약특수조건.hwp
2023/11/03_0023C053500-물품구매계약품질관리특수조건(231101).hwp
2023/11/04_0023C053500-규격서.zip

대분류 : 09 - 전자/정보/통신/영상

중분류 : 07 - 음향장비 및 신호장치

물품분류번호 : 43222612

세부품명번호 : 4322261201

물품식별번호 : 24567061

계약번호 : 0023C053500-6

징수구분 : 후징수

감추기

구매의사결정을 위한 구매정보

우선(의무)구매대상	해당 없음
평균배송일/납품기한	관련정보없음 / 60일 (납품요구일로부터)
품질보증조달물품여부	해당없음
본사소재지	경기도 의왕시 성고개로53, 10층 A동 1016호(포일동, 에이스청계타워)

Keyboard/Mouse/Monitor

좋은컴퓨터를만드는사람들

한성컴퓨터

견 적 일: 2024년 02월 15일 22시 00분

이 름: 고객님성함입력! 고객님

상품금액: 350,700 원

배 송 비: 0 원

합계금액: 350,700 원

공 급 자			
사업자번호	106-86-17410		
상호명	(주)한성	대표	한 동 열
주소	서울 강서구 마곡중앙8로 7길 35, 1층 (마곡동 [illegible])		
업태	제조,도소매	종목	컴퓨터,컴퓨터및주변기기
대표전화	02-715-5714	FAX	02-714-5714

No	분류	상품명	판매가	수량	합계
1	키보드/키캡	[9926] [한성컴퓨터] HKM1000K 키보드마우스 세트	19,900원	3	59,700원
		[키보드/키캡] HKM1000K 키보드마우스 세트	0원	3	0원
2	22형	[24623] [한성컴퓨터] ULTRON 2235V 프리싱크 리얼75	97,000원	3	291,000원
		[22형] ULTRON 2235V 프리싱크 리얼75(일반-무결점보증없음)	0원	3	0원
3	배송비	배송비(무료배송)			0원

합계금액: 350,700 원
(부가세포함)

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입금계좌 안내
예금주: (주)한성
우리은행 : 1005-301-076521

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DBMS

견 적 서

TTA 貴中

Title : TPC-C Performance&Quality Authentication

SUNJESOFT
(주)선재소프트

대표이사 : 김 기 완

▣ 수 신 : 황세진 선임연구원님 (010-5110-4883, hsejin314@tta.or.kr)
▣ 견적일자 : 2024년 1월 16일
▣ 유효기간 : 견적일로부터 4개월

주 소 : 서울시 영등포구 당산로171
금강펜테리움IT타워 604호
영업대표 : 사업본부 김수호 부장
전화번호 : 010-4734-4646
e-mail :shkim@sunjesoft.com

※ Goldilocks Standard Edition for LINUX 1식

(단위 : 원)

No.	Description	Unit Price	Q'ty	Total Price	Offer Price	비 고
[24Core]						
1	Goldilocks Ver 3.1 DBMS Standard Edition	64,000,000	1 Set(s)	64,000,000	17,400,000	
	- Query Processes Module					
	- Storage Management Module					
소 계 (부가세 별도)				64,000,000	**17,400,000**	
2	DBMS Implementaion & Supports	20,000,000	3 Set(s)	60,000,000	7,200,000	
소 계 (부가세 별도)				60,000,000	**7,200,000**	
합 계 (부가세 별도)				124,000,000	**24,600,000**	

총 합 계 (부가세 별도)	**24,600,000**	

* Remarks
- For Technical supports, it indicates 24 x 7 x 4 hours of support