HP 9000 V2500 Enterprise Server
using
HP-UX 11.00 64-bit
and
Sybase Adaptive Server Enterprise 12.0

TPC Benchmark® C
Full Disclosure Report

First Edition

Submitted for Review
August 24, 1999

First Edition - August 24, 1999

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All performance data contained in this report was obtained in a rigorously controlled environment. Results obtained in other operating environments may vary significantly. Hewlett-Packard Company does not warrant or represent that a user can or will achieve similar performance expressed in transactions per minute (tpmC®) or normalized price/performance ($/tpmC®). No warranty of system performance or price/performance is expressed or implied in this report.

Printed in U.S.A., August 24, 1999.

Abstract

Overview

This report documents the methodology and results of the TPC Benchmark® C test conducted on the HP 9000 V2500 Enterprise Server in a client/server configuration, using Sybase Adaptive Server Enterprise 12.0 and the TUXEDO 6.4 transaction monitor. The operating system used for the benchmark was Hewlett-Packard's HP-UX 11.00 64-bit. The application was written in C and compiled using HP C/ANSI C/HP-UX.

TPC Benchmark C Metrics

The standard TPC Benchmark® C metrics, tpmC® (transactions per minute), price per tpmC® (five year capital cost per measured tpmC®), and the availability date are reported as required by the benchmark specification.

Standard and Executive Summary Statements

Page *iii* contains the standard system summary and pages ***iv-vi*** contain the executive summary of the benchmark results for the HP 9000 V2500 Enterprise Server.

Auditor

The benchmark configuration, environment and methodology used to produce and validate the test results, and the pricing model used to calculate the price/performance, were audited by Lorna Livingtree for Performance Metrics, Inc. to verify compliance with the relevant TPC specifications.

Standard System Summary

Company Name	**System Name**	**Database Software**	**Operating System Software**
Hewlett-Packard Company	HP 9000 V2500 Enterprise Server	Sybase Adaptive Server Enterprise 12.0	HP-UX 11.00 64-bit Extension Pack 9911
HP H/W Availability Date - Available S/W Availability Date - November 30, 1999			
Total System Cost	**TPC-C® Throughput**	**Price/Performance**	
Hardware Software 5-year maintenance	Sustained maximum throughput of System running TPC-C® expressed in transactions per minute	Total system cost/tpmC ($6,448,894/102023.5)	
$6,448,894	**102,023.50 tpmC**	**$63.21 per tpmC**	

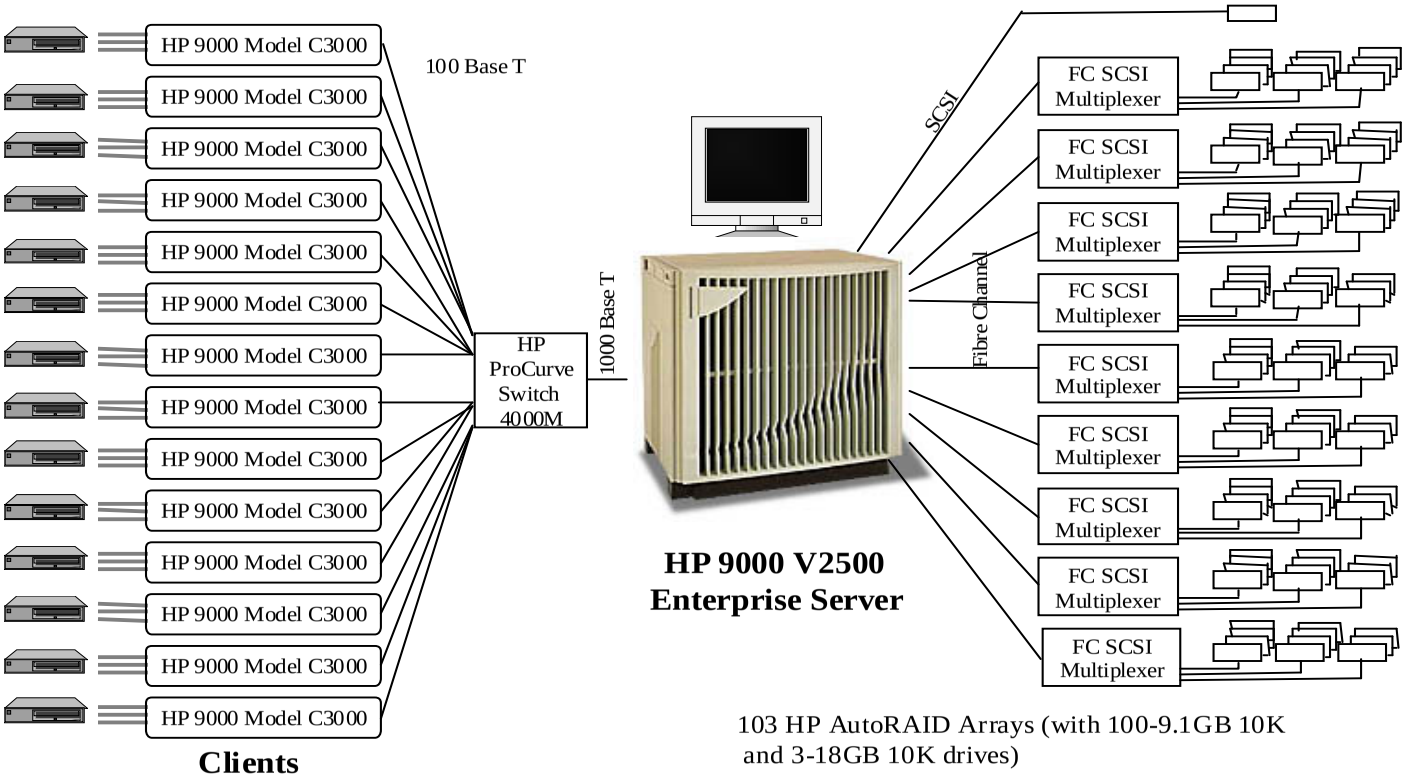
HP 9000 V2500 Enterprise Server
Client/Server with 14 C3000 front-ends

TPC-C Revision 3.4

Report Date: August 24, 1999

Total System Cost	TPC Throughput	Price/Performance	Availability Date
$6,448,894	**102,023.50 tpmC**	**$63.21/tpmC**	**November 30, 1999**

Processors	Database Manager	Operating System	Other Software	Number of Users
32 PA-RISC 8500 440MHz	**Sybase Adaptive Server Enterprise 12.0**	**HP-UX 11.00 64-bit Extension Pack 9911**	**TUXEDO 6.4**	**84,890**



System Components	*Server (HP 9000 V2500 Enterprise Server)*		*Each Client (14 C3000)*	
	Qty	*Type*	*Qty*	*Type*
Processors	32	440MHz PA-RISC 8500	1	400MHz PA-RISC 8500
Cache Memory	each	0.5 MB I-cache, 1 MB D-cache	each	0.5 MB I-cache/1 MB D-cache
Memory	32	GB	1	3 GB
Disk Controllers	9	HP-PCI Fibre Channel	1	Ultra2 SCSI LVD
	9	FC SCSI Multiplexer		
Disk Drives	103	HP AutoRaid Arrays with 100 9.1 GB 10K & 3 18 GB 10K drives	1	9 GB LVD 10K RPM disk
Total Storage	8,922	GB		
Tape Drives	1	DDS Storage System		
Terminals	1	Console Terminal		

HP 9000 V2500 Enterprise Server

TPC-C Rev 3.4

Report Date: August 24, 1999

Description	Part Number	Brand	Price Key	Unit Price	Qty	5 Year Price	Maint. Price
Server Hardware							
HP 9000 V2500 Enterprise Server	A5074A		1	139,825	1	139,825	119,532
Add'l Dual 440 MHz PARISC 8500 CPU's	A5492A Opt. 0D1		1	46,165	16	738,640	118,272
System Mgmt. Station	A4802B		1	8,197	1	8,197	2,116
Memory Controller Board	A5078A, Opt 0D1		1	7,140	4	28,560	
256 MB DIMM for a total of 2 GB	A5082A, Opt. 0D1		1	20,997	16	335,944	
PCI Fibre Channel Adapter	A3740A, Opt. 0D1		1	1,929	9	17,357	
PCI FWD SCSI-2 Adapter	A4800A, Opt. 0D1		1	858	1	858	
PCI 1000BT LAN Adapter	A4926A Opt 0D1		1	1,495	1	1,495	
4GB DDS-2 DAT Drive	A3183A, Opt 0DZ		1	1,180	1	1,180	
PCI 64-port Mux card	J3593A Opt. 0D1		1	1,068	1	1,068	
16 port RS232 DB25 port module	J2485A		1	627	1	627	
25 ft cable	J3595A		1	109	1	109	
5.5 kVA UPS	A3589A Opt. 002		1	7,000	1	7,000	336
1.8kVA HP UPS Rackmount	A2997A Opt. 002		1	2,310	52	120,120	16,027
2.0m Field Integrated Cabinet	C2787A		1	1,330	31	41,230	
FC SCSI Multiplexor	A3511A		1	7,280	9	65,520	71,019
16 Bit FW SCSI Adapter	A3511A Opt. 003		1	907	36	32,634	
Auto Raid Array Model 12H	A3700AZ		1	3,110	103	320,330	560,210
Two 96 MB controllers with Auto Raid	Opt. 203		1	9,385	103	966,655	
Twelve 9.1 GB disk modules, 10K rpm	Opt. 172		1	14,070	100	1,407,000	
Twelve 18 GB disk modules, 10K rpm	Option 192		1	18,900	3	56,700	
16M Fibre Channel Cable	A3661B, Opt AFY		1	112	9	1,008	
0.9m 68-pin high density male connec.	Option 801		1	84	66	5,544	
2.5m HDTS68 to HDTS68 Cable	C2924A		1	98	37	3,626	
				Subtotal		**4,301,224**	**887,512**
Server Software							
Sybase Adaptive Server		Sybase	2	295,000	1	295,000	244,316
Sybase Development			2	9,600	1	9,600	
Sybase open client			2	795	1	795	
Sybase discount			2	-30,540	1	-30,540	
HP-UX 11.0 Sys Media, CD-ROM	B3920EA, Opt AAF		1	137	1	137	
				Subtotal		**274,992**	**244,316**
Client Hardware							
HP Model C3000 Workstation	A4986A		1	7,700	14	107,800	55,641
256 MB memory module SDRAM	A4994A		1	806	56	45,158	
512 MB memory module SDRAM	A4995A		1	2,688	56	150,528	
Console	C1064GX		1	385	1	385	168
9 GB LVD 10K RPM Disk	A4997A		1	788	14	11,025	
100 Base T PCI LAN Adapter	B5509BA		1	191	14	2,675	
				Subtotal		**317,572**	**55,809**
Client Software							
HP C/ANSI C Compiler	B3899BA		1	774	1	774	993
BEA Tuxedo 6.4		Bea Sys.	3	3,000	14	42,000	33,600
				Subtotal		**42,774**	**34,593**
User Connectivity							
(8+1) port 10Mbps Ethernet Hub, 10% spares	DEH2924	SW House	4	24	11,734	281,616	
HP ProCurve Switch 4000M	J4121A		1	2,519	1	2,519	588
HP ProCurve Switch Gigabit-SX Module	J4113A		1	1,049	1	1,049	
HP ProCurve Switch 408	J4097		1	279	14	3,910	420
				Subtotal		**289,095**	**1,008**
				Other discounts*		**0**	**0**
				Total		**5,225,656**	**1,223,238**

Notes:1=Solarcom, 2=Sybase
3=BEA Systems, 4=Software House International

Audited by Lorna Livingtree, Performance Metrics, Inc.

Five Year Cost of Ownership:	**$6,448,894**
tpmC Rating:	**102,023.50**
$/tpmC:	**$63.21**

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

Numerical Quantities Summary for HP 9000 V2500 Enterprise Server

MQTH, Computed Maximum Qualified Throughput **102,023.50 tpmC**

Response Times (in seconds)

	90th %-ile	Maximum	Average
New-Order	2.54s	10.94s	1.36s
Payment	2.48s	11.55s	1.30s
Order-Status	2.64s	9.40s	1.44s
Delivery (interactive portion)	0.08s	0.83s	0.07s
Delivery (deferred portion)	2.87s	9.74s	1.68s
Stock-Level	3.42s	13.47s	1.91s
Menu	0.10s	1.24s	0.003s

Transaction Mix, in percent of total transactions

New-Order	44.82%
Payment	43.03%
Order-Status	4.04%
Delivery	4.05%
Stock-Level	4.07%

Keying/Think Times

	Keying Time			Think Time		
	Min	Avg	Max	Min	Avg	Max
New-Order	18.02s	18.03s	18.04s	0.01s	12.13s	179.25s
Payment	3.01s	3.02s	3.03s	0.01s	12.07s	190.62s
Order-Status	2.01s	2.02s	2.03s	0.01s	10.1s	143.35s
Delivery (interactive)	2.01s	2.02s	2.03s	0.02s	5.08s	64.36s
Stock-Level	2.01s	2.02s	2.03s	0.01s	5.06s	59.5s

Test Duration

Ramp up time	28.5 minutes
Measurement interval	30 minutes
Transactions during measurement interval	6,828,815
Ramp down time	0.005 minutes

Checkpointing

Number of checkpoints in measurement interval	1
Checkpoint Interval	30 minutes

Reproducibility Run

Throughput	101,806.20 tpmC
Relative to MQTH	-0.21%

Preface

TPC Benchmark C Overview

This is the full disclosure report for a benchmark test of the HP 9000 V2500 Enterprise Server using Sybase Adaptive Server Enterprise 12.0. It meets the requirements of the TPC Benchmark® C Standard Specification, Revision 3.4 dated August 25, 1998.

TPC Benchmark® C was developed by the **T**ransaction Processing **P**erformance **C**ouncil (TPC). It is the intent of this group to develop a suite of benchmarks to measure the performance of computer systems executing a wide range of applications. Hewlett-Packard Company Sybase Inc. are active participants in the TPC.

*TPC Benchmark® C is an **O**n **L**ine **T**ransaction **P**rocessing (OLTP) workload. It is a mixture of read-only and update intensive transactions that simulate the activities found in complex OLTP application environments. It does so by exercising a breadth of system components associated with such environments, which are characterized by:*

- The simultaneous execution of multiple transaction types that span a breadth of complexity
- On-line and deferred transaction execution modes
- Multiple on-line terminal sessions
- Moderate system and application execution time
- Significant disk input/output
- Transaction integrity (ACID properties)
- Non-uniform distribution of data access through primary and secondary keys
- Databases consisting of many tables with a wide variety of sizes, attributes, and relationships
- Contention 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.

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.

Hewlett-Packard Company 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.

1 General Items

1.1 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 HP C/ANSI C/HP-UX application code used in this TPC-C® test.

1.2 Test Sponsor

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

The High Performance Systems Division of Hewlett-Packard Company and Sybase Inc. are the test sponsors of this TPC Benchmark® C.

1.3 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 but not limited to:

- Database options
- Recover/commit options
- Consistency/locking options
- Operating system and application configuration parameters
- Compilation and linkage options and run-time optimizations used to create/install applications, OS, and/or databases

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

The intent of the above clause is that anyone attempting to recreate the benchmark environment has sufficient information to compile, link, optimize, and execute all software used to produce the disclosed benchmark result.

Appendix A contains the application "make" files. Appendix C contains the HP-UX operating system parameters used to generate the kernel for the configuration used in this benchmark. Also included are all of the Sybase Adaptive Server Enterprise 12.0 database parameters and the TUXEDO 6.4 transaction monitor parameters used.

1.4 Configuration Diagrams

Diagrams of both measured and priced configurations must be provided, accompanied by a description of the differences. This includes, but is not limited to:

- *Number and type of processors*
- *Size of allocated memory, and any specific mapping/partitioning of memory unique to the test*
- *Number and type of disk units (and controllers, if applicable)*
- *Number of channels or bus connections to disk units, including the protocol type*
- *Number of LAN (e.g. Ethernet) connections, including routers, work stations, terminals, etc, that were physically used in the test or are incorporated into the pricing structure (See Clause 8.1.8)*
- *Type and run-time execution location of software components (e.g. DBMS, client processes, transaction monitors, software drivers, etc)*

The server System Under Test, an HP 9000 V2500 Enterprise Server depicted in Figure 1.1, consisted of:

- 32 440MHz PA-RISC 8500 System Processors

- 32 GB of memory
- 9 HP-PCI Fibre Channel Adapters, 9 FC SCSI Multiplexers
- 103 HP AutoRaid Arrays (with 79-9.1GB 10K, 4-4.3GB, 17-4GB, and 3-18GB disks
- One LAN interfaces

As indicated in Figure 1.1, this benchmark configuration used Remote Terminal Emulator (RTE) programs that executed on 7 K460 Enterprise Server drivers to emulate TPC-C user sessions. The emulated users on the driver systems were connected through the same switch that connected the client systems to the system under test. Connections to the driver systems used 100 Base-T local area network (LAN) and communicated using TCP/IP. The clients were connected to the SUT via one HP ProCurve Switch 4000M switch.

The priced configuration for the HP 9000 V2500 Enterprise Server is shown in Figure 1.2. In the priced configuration, the RTE shown in the benchmark configuration is replaced by the appropriate number of workstations (emulating ANSI terminals) connected to hubs.

Figure 1.1: HP 9000 V2500 Enterprise Server Benchmark Configuration

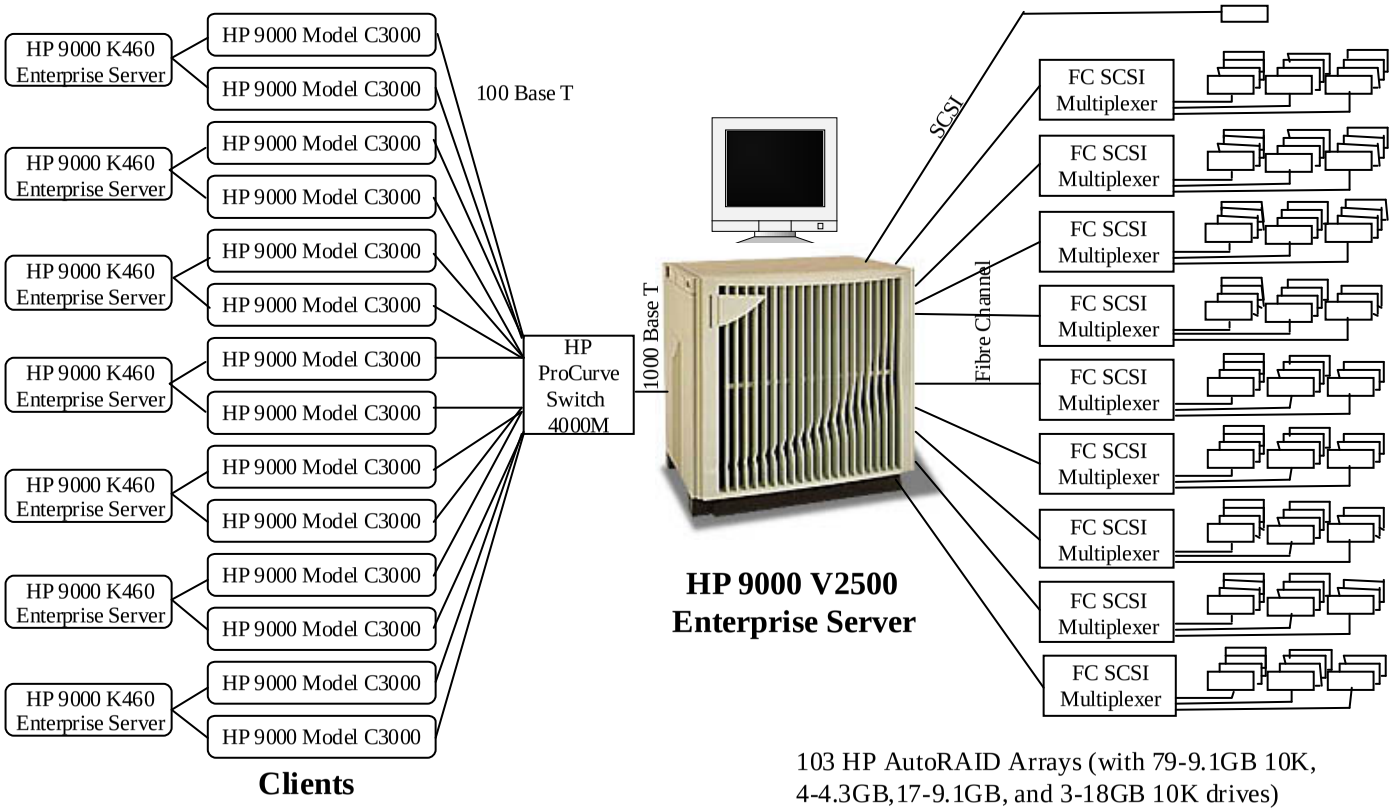
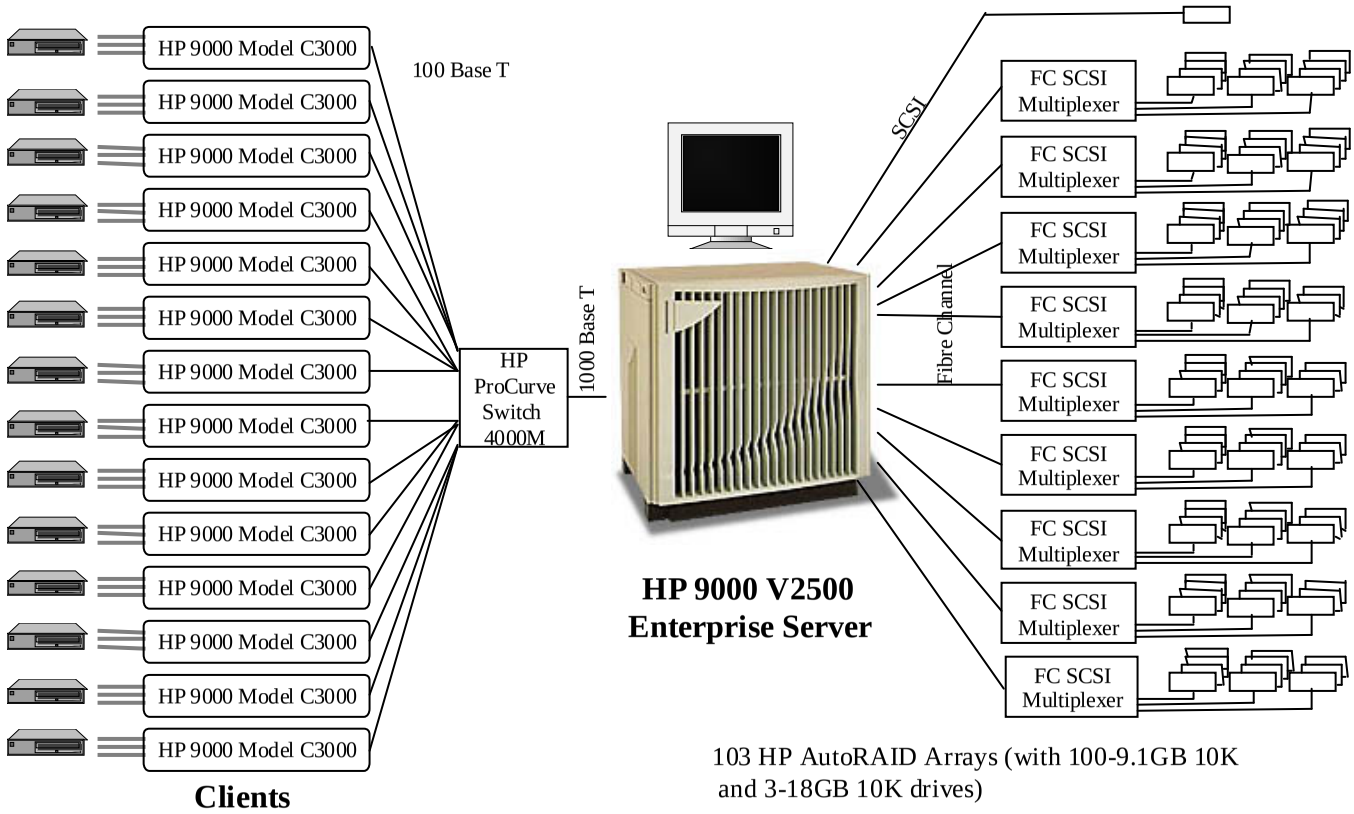


Figure 1.2: HP 9000 V2500 Enterprise Server Priced Configuration



2 Clause 1 Related Items

2.1 Table Definitions

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

Appendix B describes the programs that define, create, and populate the Sybase Adaptive Server Enterprise 12.0 database for TPC-C® testing.

2.2 Physical Organization of Database

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

Space was allocated to Sybase Adaptive Server Enterprise 12.0 according to the data in section 5.2. The size of the database table space on each disk drive was calculated to provide even distribution of load across the disk drives.

2.3 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 maximum key value for these new rows.

There were no restrictions on insert and delete operations to any tables.

2.4 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. 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.

Partitioning, replication, and additional or duplicated attributes were not used in this implementation.

3 Clause 2 Related Items

3.1 Random Number Generation

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

The library routine SRAND48 (3C) was used to seed the library routine DRAND48 (3C) which generated pseudo-random numbers using the well-known linear congruential algorithm and 48-bit integer arithmetic. Further information on SRAND48 (3C) and DRAND48 (3C) can be found in the HP-UX Reference Manual Vol. 3.

3.2 Input/Output Screen Layout

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

The screen layouts corresponded exactly to those in Clauses 2.4.3, 2.5.3, 2.6.3, 2.7.3, and 2.8.3 of the TPC-C® Standard Specification.

3.3 Priced Terminal Feature Verification

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

The terminal features were verified by manually exercising each specification on an HP 712/80 workstation running an ANSI terminal emulator.

3.4 Presentation Manager or Intelligent Terminal

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

Application code running on the client implemented the TPC-C user interface. A listing of this code is included in Appendix A. Used capabilities of the terminal beyond basic ASCII entry and display were restricted to cursor positioning.

A presentation manager was not used.

Table 3.1: Transaction Statistics

Type	Item	Value
New Order	Home warehouse items	99.00%
	Remote warehouse items	1.00%
	Rolled back transactions	1.00%
	Average items per order	10.00
Payment	Home warehouse	84.97%
	Remote warehouse	15.03%
	Non primary key access	60.02%
Order Status	Non primary key access	60.12%
Delivery	Skipped transactions	0
Transaction Mix	New Order	44.82%
	Payment	43.03%
	Order Status	4.04%
	Delivery	4.05%
	Stock Level	4.07%

3.5 Transaction Statistics

Table 3.1 lists the numerical quantities that Clauses 8.1.3.5 to 8.1.3.11 require.

3.6 Queuing Mechanism

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

Delivery transactions were submitted to servers using the same TUXEDO mechanism that other transactions used. The only difference was that the call was asynchronous, i.e., control would return to the client process immediately and the deferred delivery part would complete asynchronously.

4 Clause 3 Related Items

4.1 Transaction System Properties (ACID)

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

The TPC Benchmark® C Standard Specification defines a set of transaction processing system properties that a system under test (SUT) must support during the execution of the benchmark. Those properties are Atomicity, Consistency, Isolation, and Durability (ACID). This section quotes the specification definition of each of these properties and describes the tests done as specified and monitored by the auditor to demonstrate compliance.

4.2 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.

4.2.1 Completed Transaction

Perform the Payment transaction for a randomly selected warehouse, district, and customer (by customer number as specified in Clause 2.5.1.2) and verify that the records in the CUSTOMER, WAREHOUSE, and DISTRICT tables have been changed appropriately.

The values of w_ytd, d_ytd, c_balance, c_ytd_payment, and c_payment_cnt of a randomly selected warehouse, district, and customer were retrieved. The Payment transaction was executed on the same warehouse, district, and customer. The transaction was committed. The values w_ytd, d_ytd, c_balance, c_ytd_payment, and c_payment_cnt were retrieved again. It was verified that all values had been changed appropriately.

4.2.2 Aborted Transaction

Perform the Payment transaction for a randomly selected warehouse, district, and customer (by customer number as specified in Clause 2.5.1.2) and substitute a ROLLBACK of the transaction for the COMMIT of the transaction. Verify that the records in the CUSTOMER, WAREHOUSE, and DISTRICT tables have NOT been changed

The values of w_ytd, d_ytd, c_balance, c_ytd_payment and c_payment_cnt of a randomly selected warehouse, district, and customer were retrieved. The Payment transaction was executed on the same warehouse, district, and customer. The transaction was rolled back. The values of w_ytd, d_ytd, c_balance, c_ytd_payment, c_payment_cnt were retrieved again. It was verified that none of the values had changed.

4.3 Consistency

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

The TPC Benchmark C standard requires the System Under Test to meet the following 12 consistency conditions (c.f. *TPC Standard Specification, Clauses 3.3.2.1 to 3.3.2.12*):

1. the sum of the district balances in a warehouse is equal to the warehouse balance;
2. for each district, the next order-id minus one is equal to maximum order-id in the ORDER table and equal to the maximum new-order-id in the NEW-ORDER table;
3. for each district, the maximum order-id minus minimum order-id in the ORDER table plus one equals the number of rows in the NEW-ORDER table for that district;

4. for each district, the sum of the order-line counts equals the number of rows in the ORDER-LINE table for that district;
5. for each row in the ORDER table, the carrier-id is set to a null value only if there is a corresponding row in the NEW-ORDER table;
6. for each row in the ORDER table, the order-line count must equal the number of rows in the ORDER-LINE table for that order;
7. for any row in the ORDER-LINE table, the delivery date/time is set to a null value only if the corresponding row in the ORDER table has the carrier-id set to a null value;
8. for each warehouse, the year-to-date amount must equal the sum of the amounts in the HISTORY table for that warehouse;
9. for each district, the year-to-date amount must equal the sum of the amounts in the HISTORY table for that district;
10. for each customer, the balance must equal the sum of the order-line amount minus the sum of the history amount for that customer;
11. for each district, the total orders minus the total new-orders must equal the sum of the customer delivery count;
12. for any randomly selected customer, the balance plus the year-to-date payment must equal the sum of the order-line amount.

The TPC Benchmark C Standard Specification requires explicit demonstration that the conditions are satisfied for the first four conditions only.

To demonstrate that consistency is maintained, conditions 1-4 were verified for a sample of warehouses before and after the durability tests.

4.4 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.

*This property is commonly called **serializability**. Sufficient conditions must be enabled at either the system or application level to ensure serializability of transactions under any arbitrary mix of TPC-C transactions, unless otherwise specified by the transaction profile. The system or application must have full serializability enabled (i.e., repeated reads of the same rows within any committed transaction must return identical data when run concurrently with any arbitrary mix of TPC-C transactions), except in the case of Stock-Level transaction. For the Stock-Level transaction, the isolation requirement is relaxed to simply require that the transaction see only committed data.*

The TPC Benchmark C Standard (Revision 3) defines nine required tests to be performed to demonstrate that the required levels of transaction isolation are met.

For conventional locking schemes, isolation should be tested as described below. Systems that implement other isolation schemes may require different validation techniques. It is the responsibility of the test sponsor to disclose those techniques and the tests for them. If isolation schemes other than conventional locking are used, it is permissible to implement these tests differently provided full details are disclosed. (Examples of different validation techniques are shown in Isolation Test 7, Clause 3.4.2.7).

4.4.1 Isolation Test 1

This test demonstrates isolation for read-write conflicts of Order-Status and New-Order transactions.

The execution of the above test proceeded as follows:

1. An Order-Status transaction T0 was executed for a randomly selected customer, and the order returned was noted. T0 was committed
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.

This outcome demonstrates serialization of T2 before T1. It has equivalent validity to the outcome specified in the Standard which supposes T1 to be serialized before T2.

4.4.2 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 execution of the above test proceeded as follows:

1. An Order-Status transaction T0 was executed for a randomly selected customer and the order returned was noted. T0 was committed.
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.

4.4.3 Isolation Test 3

This test demonstrates isolation for write-write conflicts of two New-Order transactions.

The execution of the above test proceeded 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).

4.4.4 Isolation Test 4

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

The execution of the above test proceeded 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).

4.4.5 Isolation Test 5

This test demonstrates isolation for write-write conflicts of Payment and Delivery transactions.

The execution of the above test proceeded as follows:

1. A query was executed to find out the customer who would 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 business transaction T1 was started for the same warehouse used in step 1. T1 was stopped immediately prior to the COMMIT of the database transaction corresponding to the district used in step 1.
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.

4.4.6 Isolation Test 6

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

The execution of the above test proceeded as follows:

1. A query was executed to find out the customer who would 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 business transaction T1 was started for the same warehouse used in step 1. T1 was stopped immediately prior to the ROLLBACK of the database transaction corresponding to the district used in step 1.
4. A Payment transaction T2 was started for the same customer found in step 1. T2 waited.
5. T1 was allowed to 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.

4.4.7 Isolation Test 7

This test demonstrates repeatable reads for the New-Order transaction while an interactive transaction updates the price of an item.

The execution of the above test proceeded as follows:

1. The I_PRICE of two randomly selected items X and Y were retrieved.
2. A New-Order transaction T2 with a group of items including items X and Y was started. T2 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 T3 was started to increase the price of items X and Y by 10%.
4. T3 did not stall and no transaction was rolled back. T3 was committed.
5. T2 was resumed, and the prices of all items were retrieved again within T2. The prices of items X and Y matched those retrieved in step 1.
6. T2 was committed.
7. The prices of items X and Y were retrieved again. The values matched the values set by T3.

- Execution followed *Case D* of *Clause 3.4.2.7*.

4.4.8 Isolation Test 8

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

The execution of the above test proceeded 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. The most recent order for that customer was found.
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.

4.4.9 Isolation Test 9

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

The execution of the above test proceeded 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.

4.5 Durability

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

List of single failures:

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

Specified durability tests were executed to demonstrate satisfaction of the durability requirements for this implementation of TPC Benchmark C. One durability test, described below, covering the following failure situations was performed:

- *Permanent irrecoverable failure of any single durable medium containing TPC-C database tables or recovery log data (Clause 3.5.3.1).*

This test was performed under a load of 42,445 users on the full-scale database built for 50,000 users. Another durability test, described below, combining the following failure situations was performed:

- *instantaneous interruption which requires system reboot [of processors] to recover. (Clause 3.5.3.2*)
- *failure of all or part of memory. (Clause 3.5.3.3).*

This test was performed under the full performance-measurement load of 84,890 users.

4.5.1 Loss of Data Disk or Log Disk

Because the log and data-storage devices are Redundant Disk Arrays which each function independently of the rest of the system in ensuring data integrity under loss and/or replacement of any individual disk drive (and other failures as well), integrity under such failure and replacement does not entail any interruption in processing. The test below validates the durability by demonstrating persistence of the results of transactions processed both before and during these failures, validating the durability upon database recovery (in this instance, forced) of transactions which completed before the failure and the non-effect of transactions which did not complete.

1. The D_NEXT_O_ID fields for all rows in the DISTRICT table were summed up to determine the initial count of the total number of orders (count1).
2. A test was initiated with 42,445 terminals. On the driver system, completed/rolled-back transactions (including New-Orders) were recorded in a "success" file.
3. After 6 minutes, one of the individual disks containing Sybase system tablespace was unplugged from its array and after another 6 minutes, an individual disk containing recovery log was unplugged from its array. On the system console messages appeared indicating that the data from the missing disk was being rebuilt on other disks, using the redundancy features of the array. However, system processing continued normally.
4. The test finished normally.
5. Step 1 was repeated to determine the total number of orders (count2). Count2-count1 was the same as the number of records for successful New Orders in the RTE "success" file.
6. Consistency checks 1-4 were run before and after the benchmark run and the results were verified.

4.5.2 Instantaneous Interruption and Loss of Memory

Instantaneous interruption and loss of memory tests were combined because the loss of power erases the contents of memory. This failure was induced while the benchmark was running by turning off the power supplies to the server.

1. The D_NEXT_O_ID fields for all rows in district table were summed up to determine the initial count of the total number of orders (count1).
2. Transactions were started at full load. On the driver system, completed/rolled-back transactions (including New-Orders) were recorded in a "success" file.
3. After ten minutes the server systems were de-powered.
4. The test was aborted on the driver.
5. The server system was restarted.
6. The database was restarted and a recovery performed using the transaction log.
7. The contents of the "success" file on the driver and the ORDERs table were spot-compared to verify that records in the "success" file for completed New-Order transactions had corresponding records in the ORDERs table.
8. Step 1 was repeated to determine the current total number of orders (count2). Count2-count1 (= 671,709) was 24 more than the number of records for successful New Orders in the RTE "success" file (= 678,438 – 6,753 rolled-back =671,685). *This difference would be due only to transactions which were committed on the system under test but for which the output data was not displayed on the [emulated] input/output screen before the failure*.
9. Consistency checks 1-4 were run before and after the benchmark run and the results were verified.

5 Clause 4 Related Items

5.1 Initial Cardinality of Tables

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

The TPC-C database for this test was configured with 8,489 warehouses.

Table	Occurrences
Warehouse	8,489
District	84,890
Customer	254,670,000
History	254,670,000
Orders	254,670,000
New Orders	76,401,000
Order Line	2,546,703,360
Item	100,000
Stock	8,489,000,000

5.2 Database and Growth Layout

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

Table 5.2 indicates the distribution of the database tables over the disks of the tested and priced systems.

System drives

USE	NAME	SIZE OF EACH LUN (MB)
OS+SWAP	c14t6d0	2048
swap	c14t6d2	35000
/project	c14t6d1	2048
/traces	c14t14d2	10240

Drives used by the database

log[1-2]	vglogs	20004
master	vglogs	5004
master2	vglogs	2004
misc[1-19]	vgmisc	16044
stock[1-79]	c*t*d1	5000
customer[1-79]	c*t*d2	4000

Backup drives - attached to the test system and priced as 180 storage

backup/customer[1-79]	c*t*d4	4000
backup/stock[1-79]	c*t*d3	5000
backup/misc[1-38]	c*t*d7	8000
backup/master[1-2]	c*t*d7	8000

c*t*d*

A group of 79 disc arrays where the LUN number is designated by the final <nr>. These arrays are listed in order, so cust1 is on C23t2d2 and and stock 2.3 on c15t0d1. Each array in this group has 12 9GB mechanisms spinning at 10,000 RPM. Each LUN appears to the operating system as an independent raw disc.

c23t2 c15t0 c15t1 c15t2 c15t3 c23t0 c23t1 c14t15 c23t3 c25t0 c25t1 c25t2
c25t3 c27t0 c27t1 c27t2 c27t3 c31t0 c31t1 c31t2 c31t3 c32t0 c32t1 c32t2
c32t3 c38t0 c38t1 c38t2 c38t3 c39t0 c39t3 c41t0 c41t1 c41t2 c41t3 c42t0
c42t1 c42t2 c42t3 c43t0 c43t1 c43t2 c43t3 c45t0 c45t1 c45t2 c45t3 c46t0
c46t1 c46t2 c46t3 c47t0 c47t1 c47t2 c47t3 c49t0 c49t1 c49t2 c49t3 c50t0
c50t1 c50t2 c50t3 c51t0 c51t1 c51t2 c51t3 c52t0 c52t1 c52t2 c52t3 c6t0
c6t1 c6t2 c6t3 c7t0 c7t1 c7t2 c7t3

vglogs

A volume group consisting of 3 arrays, each containing 18 Gb mechanisms. All the logical volumes on this group are fully striped.

c37t2d4, c37t1d4, c37t0d4

vgmisc

A volume group of 21 arrays, consisting of a mixture of 4GB and 9GB mechanisms. All the logical volumes in this group are striped across all the arrays.

c12t14d3 c12t15d3 c12t2d3 c1t0d3 c1t14d3 c1t2d3 c1d3d3 c2t0d3 c2t1d3 c2t2d3
c2t3d3 c34t0d3 c34t1d3 c34t2d3 c34t3d3 c4t0d3 c4t1d3 c4t2d3 c4t3d3 c35t0d3
c35t1d3

The distribution of the database tables over the 103 disk arrays of the priced system is an extension of the distribution described in Table 5.2; some ancillary details are mentioned in Appendix E. 180-day storage growth requirements are met with the unused space of this configuration. Figure 1.2 shows the configuration of the priced-system disks.

5.3 Data Model & Interfaces

A statement must be provided that describes:

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

2. *The database interface used (e.g. embedded, call-level) and access language (e.g. SQL. DL/1, COBOL, read/write) used to implement the TPC-C transactions. 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.*

Sybase Adaptive Server Enterprise 12.0 is a relational DBMS. SQL stored procedures were used, invoked through the Sybase Open Client DB-Library; the application code appears in Appendix A.

5.4 Partitions/Replications

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

No partitioning or replication was used.

5.5 Growth Requirements

Details of the 180 day space computations along with proof that the database is configured to sustain 8 hours for the dynamic tables (Order, Order-Line, and History) must be disclosed.

See Appendix E.

6 Clause 5 Related Items

6.1 Throughput

Measured tpmC must be reported.

Table 6.1: Measured tpmC

tpmC®	102,023.50

6.2 Response Time

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

Table 6.2: Response Times

Response Times	Average	90th %-ile	Maximum
New-Order	1.36s	2.54s	10.94s
Payment	1.30s	2.48s	11.55s
Order-Status	1.44s	2.64s	9.40s
Delivery (interactive portion)	0.07s	0.08s	0.83s
Delivery (deferred portion)	1.68s	2.87s	9.74s
Stock-Level	1.91s	3.42s	13.47s
Menu	0.003s	0.10s	1.24s

6.3 Keying and Think Times

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

Table 6.3: Keying Times

Keying Times	Minimum	Average	Maximum
New Order	18.02s	18.03s	18.04s
Payment	3.01s	3.02s	3.03s
Order Status	2.01s	2.02s	2.03s
Interactive Delivery	2.01s	2.02s	2.03s
Stock Level	2.01s	2.02s	2.03s

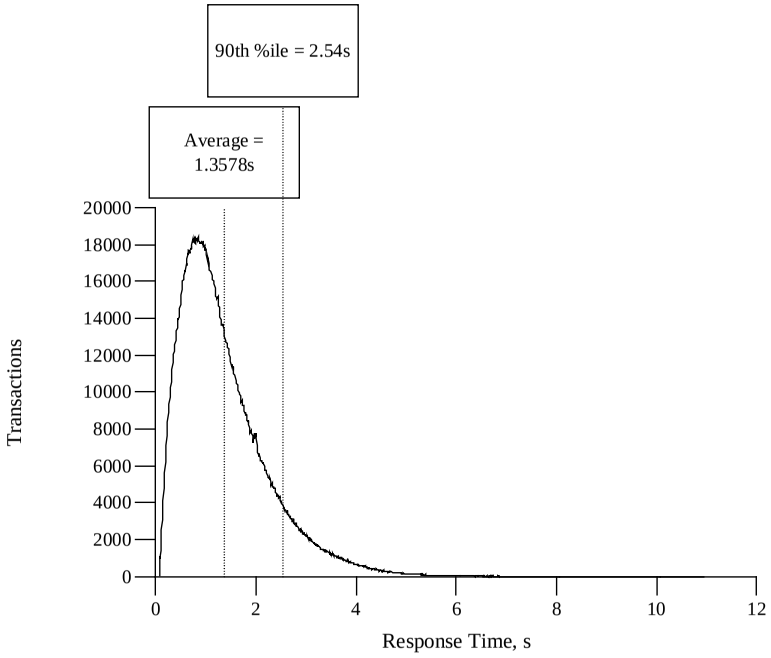
Table 6.4: Think Times

Think Times	Minimum	Average	Maximum
New Order	0.01s	12.13s	179.25s
Payment	0.01s	12.07s	190.62s
Order Status	0.01s	10.1s	143.35s
Interactive Delivery	0.02s	5.08s	64.36s
Stock Level	0.01s	5.06s	59.5s

6.4 Response Time Frequency Distribution Curves and Other Graphs

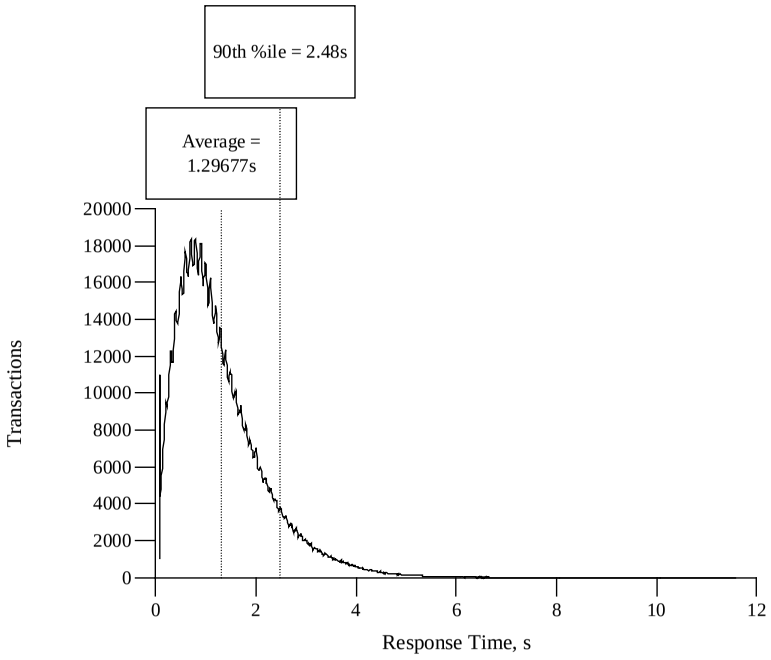
Response Time frequency distribution curves (see Clause 5.6.1) must be reported for each transaction type. The performance curve for response times versus throughput (see Clause 5.6.2) must be reported for the New-Order transaction. The Think Time frequency distribution curve (see Clause 5.6.3) must be reported for the New-Order transaction. A graph of throughput versus elapsed time (see Clause 5.6.5) must be reported for the New-Order transaction, and the measurement interval indicated.

Figure 6.1: New Order Response Time Distribution



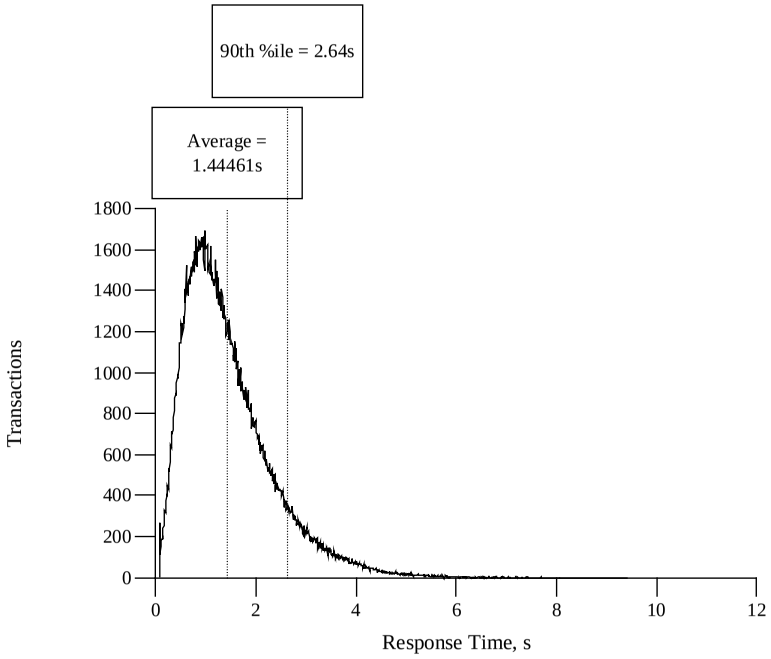
Response time frequency distribution for New Order transaction

Figure 6.2: Payment Response Time Distribution



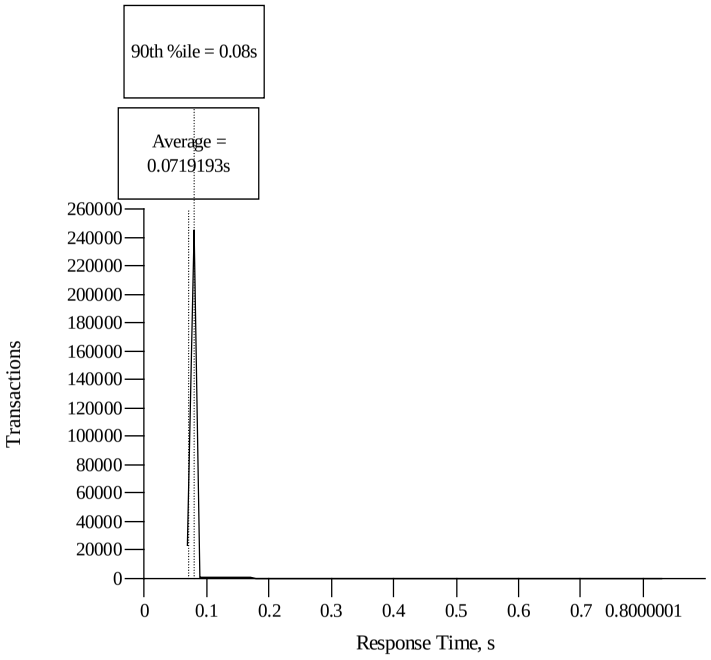
Response time frequency distribution for Payment transaction

Figure 6.3: Order Status Response Time Distribution



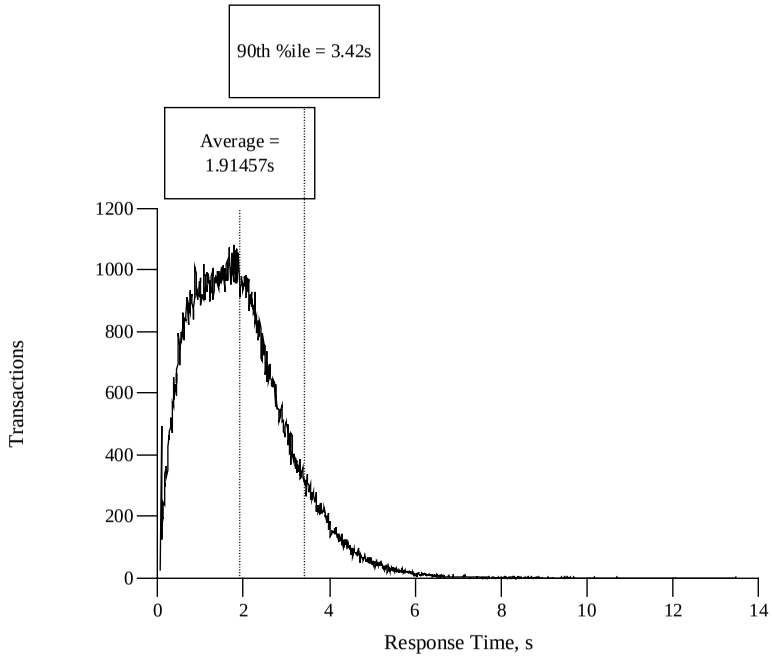
Response time frequency distribution for Order Status transaction

Figure 6.4: (Interactive) Delivery Response Time Distribution



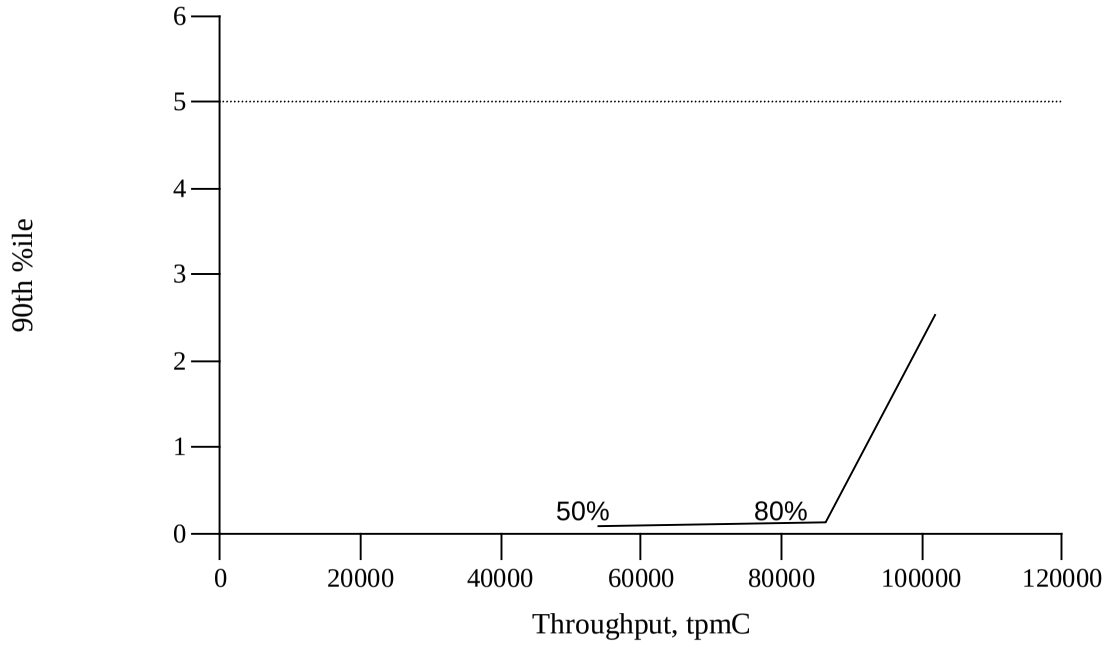
Response time frequency distribution for Delivery transaction

Figure 6.5: Stock Level Response Time Distribution



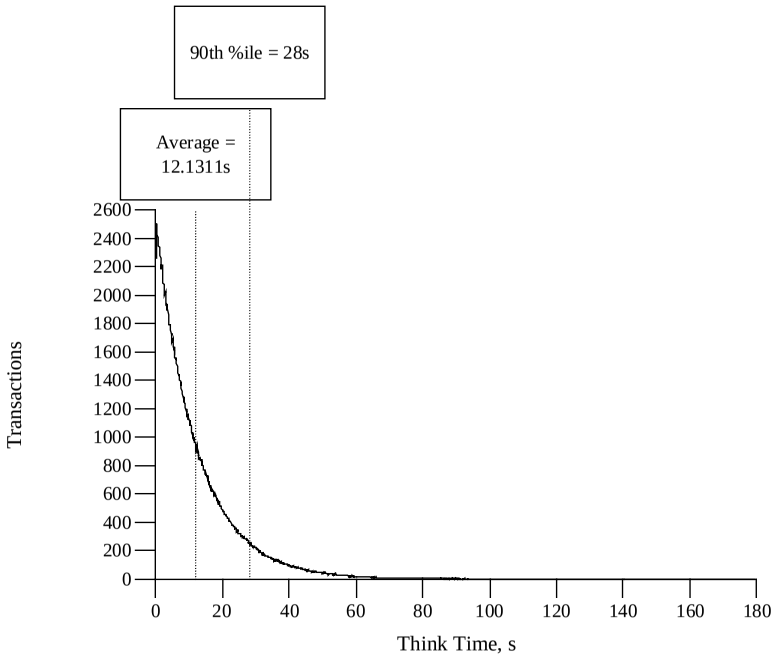
Response time frequency distribution for Stock Level transaction

Figure 6.6: Response Time Versus Throughput



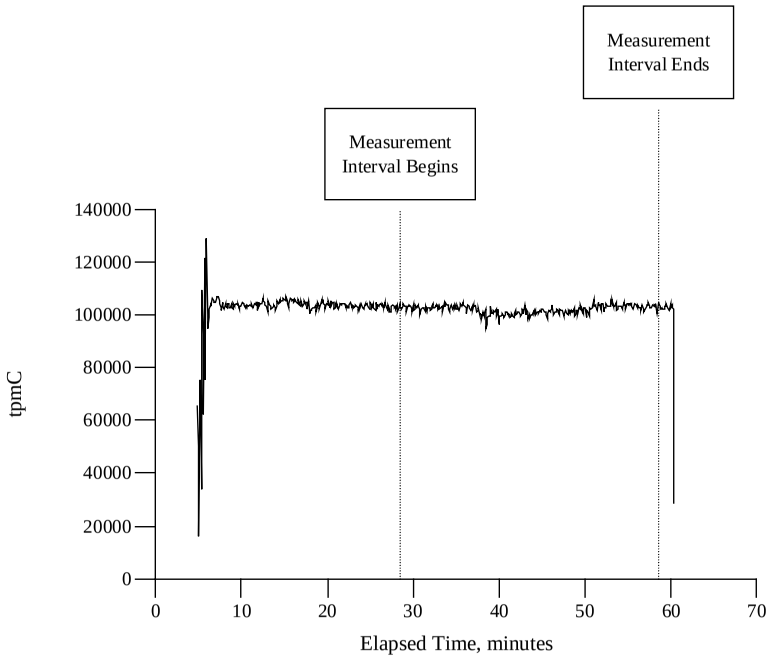
New Order response time versus Throughput

Figure 6.7: New Order Think Time Distribution



Think time frequency distribution for New Order transaction

Figure 6.8: Throughput Versus Time



Throughput of the New-Order transaction versus elapsed time

6.5 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.

The transaction throughput rate (tpmC) and response time were relatively constant after the initial 'ramp up' period. The throughput and response time behavior were determined by examining data reported for each interval over the duration of the benchmark.

6.6 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.

6.6.1 Checkpoint

A Sybase Adaptive Server Enterprise checkpoint forces all "dirty" pages (pages that have been updated since they were last written) to be written to the durable database devices. Checkpoints are marked by a special record written into the logs at the completion of the foregoing process.

6.6.2 Checkpoint Conditions

Sybase Adaptive Server Enterprise 12.0 performs a checkpoint for the following conditions:

1. Automatically, at an interval calculated by Sybase Adaptive Server Enterprise on the basis of system activity and the recovery interval value in the system table *syscurconfigs*. The recovery interval determines checkpoint frequency by specifying the amount of time it should take the system to recover.
2. Upon an explicit **checkpoint** request in Transact-SQL.

6.6.3 Checkpoint Implementation

For each benchmark measurement after all users are active, the script checkpoints issues a checkpoint and starts a background process, which sleeps and performs another checkpoint every 30 minutes. The recovery interval is configured large enough that no other checkpoints occur during the measurement.

6.7 Reproducibility

A description of the method used to determine the reproducibility of the measurement results.

A second measurement achieved a qualified throughput of 101806.2 tpmC over a 30-minute, steady-state interval.

6.8 Measurement Period Duration

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

The measurement interval was 30 minutes.

6.9 Regulation of Transaction Mix

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

The weighted selection method of *Clause 5.2.4.1* was used. The weights were not adjusted during the run.

6.10 Transaction Mix

The percentage of the total mix for each transaction type must be disclosed.

Table 6.5: Transaction Mix

Type	Percentage
New Order	44.82%
Payment	43.03%
Order Status	4.04%
Delivery	4.05%
Stock Level	4.07%

6.11 Transaction Statistics

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 trasaction must be disclosed. The percentage of remote order-lines entered per New-Order transaction must be disclosed. The percentage of remote Payment transactions must be disclosed. The percentage of customer selections by customer last name in the Payment and Order-Status transactions must be disclosed. The percentage of Delivery transactions skipped due to there being fewer than necessary orders in the New-Order table must be disclosed.

See Table 3.1

6.12 Checkpoint Count and Location

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

.

Table 6.6: Checkpoints

Event	From (s)	To (s)	Duration (s)
Checkpoint	413	832	419
Measured Interval	1710	3510	1800
Checkpoint	2213	3020	807

7 Clause 6 Related Items

7.1 RTE Description

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 input parameters, code fragments, functions, et cetera used to generate each transaction input field must be disclosed. Comment: The intent is to demonstrate the RTE was configured to generate transaction input data as specified in Clause 2.

The RTE (Remote Terminal Emulator) on the driver system was developed at Hewlett-Packard and is not commercially available. Appendix D lists RTE input parameters and code fragments used to generate each transaction input field.

For this instance of the TPC-C benchmark, 7 drivers and 14 clients were used. The drivers emulated 84,890 users logged in to the clients. An overview of the benchmark software on the drivers, clients and server is shown in Figure 7.1.

The benchmark is started with the **run** command on the driver system. **Run** controls the overall execution of the benchmark. After reading a configuration file, **run** starts TUXEDO on the client, collects pre-benchmark audit information and inserts a timestamp into a database audit table. When all the initial steps are completed, **run** invokes another program, **driver,** to start the benchmark. As the benchmark completes, **run** shuts down TUXEDO and collects the benchmark results into a single location.

Driver is the heart of the benchmark software. It simulates users as they log in, execute transactions and view results. **Driver** collects response times for each transaction and saves them in a file for future analysis.

Qualify is the post-processing analysis program. It produces the numerical summaries and histograms needed for the disclosure report.

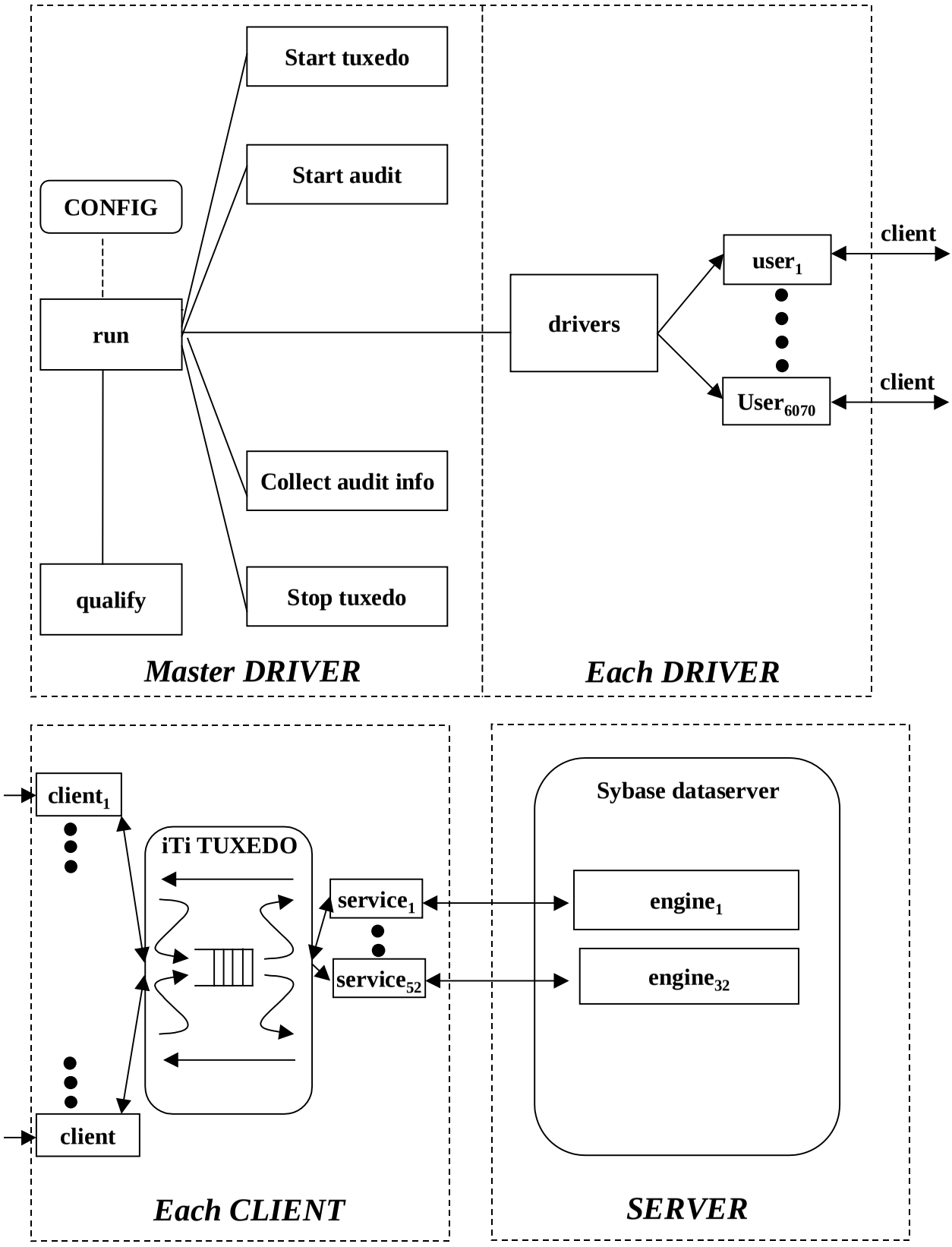


Figure 7.1: Benchmark Software

7.2 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.

In the priced configuration, workstations are connected to the clients via LANs. On the tested system, 7 LAN segments carried all the traffic between the 84,890 simulated users in the RTE system and the 14 client systems. In the priced configuration, this traffic has been divided among 7 separate LAN segments for each of the 14 clients, for a total of 84 LAN segments.

We used 100BaseT links between the driver systems and the clients but had priced 10BaseT hubs. This was done purely as a matter of simplifying the very large tested configuration, not to gain a performance advantage.

In the priced configuration, the 6,070 users assigned to each client were attached via 6 10BaseT lan segments (the priced --and tested-- network cards on the clients are self-sensing 10BaseT/100BaseT cards). However, in the measured configuration, the load for two clients (12,140 users) was generated by one driver connected to the switch via a single 100BaseT lan. This simplification was made to reduce the physical amount of cabling and the number of network cards on the driver systems, it was not intended to enhance performance.

To prove that this substitution was performance-neutral, we referenced section 6.2 of the N4000/Sybase TPC-C FDR. This section describes an experiment that showed no performance advantage from the substitution mentioned above.

7.3 Functional Diagrams

A complete functional diagram of both the benchmark 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.

Figures 1.1 and 1.2 (in Chapter 1) show functional diagrams of the benchmark and configured systems. A description of the RTE and benchmark software is provided above.

7.4 Networks

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

Figures 1.1 and 1.2 (in Chapter 1) diagram the network configurations of the benchmark and configured systems, and represent the Driver connected via LAN replacing the workstations and HUBs connected via LANs. The clients are connected via 100 Base-T to a ProCurve Switch 4000M which in turn is connected via 1000 Base-T Ethernet to the SUT.

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

Ethernet and 100 Base-T local area networks (LAN) with a bandwidth of 100 megabits per second are used in the tested/priced configurations. The 1000BT used has a bandwidth of 1000 megabits per second.

8 Clause 7 Related Items

8.1 System Pricing

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 data. 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.

The total 5-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.

Each priced configuration consists of an integrated system package, additional options, and components. Prices for all Hewlett-Packard products are US list prices. A one (1) year warranty is standard with all Hewlett-Packard products.

8.2 Support Pricing

The five year support pricing for Hewlett-Packard products is based on forty-eight (48) months of monthly support costs; sixty (60) months minus the twelve month warranty period. The Sybase Inc. support pricing is based on sixty (60) months of monthly support costs. The following support products were priced in the benchmark:

- HP four-hour on-site repair hardware support,
- HP telephone support for software and updates
- Sybase Inc. Standard Technical Support and,
- BEA TUXEDO Standard Technical Support

8.2.1 HP Hardware Support

HP four-hour maximum response, on-site support for hardware provides service from 8:00 A.M. to 5:00 P.M. Monday through Friday. Service requests made as late as 5:00 P.M. will receive a response the same day.

8.2.2 HP Software Support

HP Software Support provides the following:

- Access to the HP Response Centers for fault isolation and problem solving assistance,
- Guaranteed two (2) hour call return, immediate response for critical calls,
- Electronic access to product and support information,
- Electronic access to software patches,
- Right-to-use and copy software updates.

8.2.3 Hubs

An additional 10% of the needed hubs were included in the priced configuration to provide the required four hour repair for hardware components. The return-for-replacement support would be used to restock spares.

8.3 Sybase Inc. Standard Technical Support

Sybase Inc. Standard Technical Support includes:

Product updates,

- A regular technical publication,
- Three annual training credits,
- Unlimited, toll-free telephone service to assist in product installation, syntax, and usage that is available from 7:00 A.M. to 5:30 P.M. PST Monday through Friday.

8.4 Discounts

The following generally available discounts were applied to the priced configurations:

- A Sybase 5% dollar volume discount.

8.5 Availability

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

see below

8.6 Priced System Configuration

The hardware, software, and support/maintenance products priced in this benchmark are detailed on page *v*.

8.7 Throughput, Price/Performance, and Availability Date

A statement of the measured tpmC® *as well as the respective calculations for the 5-year pricing, price/performance (price/tpmC®).*

For Throughput and Price/Performance, please see page iv and v. The Price/Performance calculation spreadsheet appears on page v.

All hardware components in this test of the HP 9000 V2500 Enterprise Server system is available. HP-UX 11.00 64-bit incorporating Extension Pack 9911 will be available on November 1, 1999. Sybase Adaptive Server Enterprise 12.0 will be available on November 30, 1999.

9 Clause 9 Related Items

9.1 Auditor's Report

If the benchmark has been independently audited, then the auditor's name, address, phone number, and a brief audit summary report indicating compliance must be included in the Full Disclosure Report. A statement should be included, specifying when the complete audit report will become available and who to contact in order to obtain a copy.

If audited, the auditor's attestation letter must be made readily available to the public as part of the Full Disclosure Report, but a detailed report from the auditor is not required.

This implementation of the TPC Benchmark® C on the HP 9000 V2500 Enterprise Server was audited by Lorna Livingtree for Performance Metrics, Inc..

Lorna Livingtree
Performance Metrics, Inc.
137 Yankton St. Suite 101
Folsom, CA 95630
U.S.A.
Phone: 916-985-1131
Fax: 916-985-1185

The attestation letter is shown on the following pages.

August 24, 1999

Mr. Mark Kroot
Business Critical Computing Unit
Hewlett-Packard Company
19111 Pruneridge Avenue
Cupertino, CA 95014

I have verified the TPC Benchmark™ C client/server for the following configuration:

Platform: **Hewlett-Packard V2500**

Database Manager: **Sybase Adaptive Server Enterprise 12.0**

Operating System: **HP-UX 11.00**

Transaction Manager: **Tuxedo version 6.4**

Server: Hewlett-Packard V2500				
CPU's	**Memory**	**Disks**	**90% Response**	**TpmC**
32 PA-8500 @ 440 MHz	**Main: 32 GB iCache: 512KB each dCache: 1MB each**	**48 @ 4.1 GB 1152 @ 9.1 GB 36 @ 18 GB**	**2.57 sec.**	**102,023.50**

14 Clients: Hewlett-Packard Models C3000		
CPU	**Memory**	**Disks**
PA-8500@ 400 MHz	**Main: 3 GB iCache: 512KB dCache: 1MB**	**2 @ 9.1 GB**

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

- **The transactions were correctly implemented.**
- **The database files were properly sized.**
- **The database was properly scaled with 10,000 warehouses. The measurement used 8,498 warehouses. I verified that the warehouse rows for the unused warehouses were deleted.**
- **The ACID properties were met.**
- **The ACID tests were performed on the measured database.**

- **Input data was generated according to the specified percentages.**
- **Eight hours of durable log space was present on the tested system.**
- **Disks present on the system but not priced were verified to have no activity during the measured runs.**
- **Space for eight hours of growth in dynamic tables was present on the tested system.**
- **The data for the 180-day space calculation was verified.**
- **There were several differences in the emulation of users between the RTEs and the switch. The output of an experiment designed to comply with clause 6.6.4.3 was verified and I believe the substitutions did not enhance results.**
- **The steady state portion of the test was 30 minutes.**
- **One checkpoint was taken before the measured interval.**
- **One checkpoint was taken during the measured interval.**
- **The checkpoints were verified to be clear of the guard zone.**
- **The system pricing was checked for major components and maintenance.**

Auditor Notes:

The measured configuration included both 4.1GB and 9.1GB disks. Of the 9.1 GB disks, there were both 7,200rpm and 10,000 rpm disks. All disks priced were 9.1GB disks at 10,000rpm. This substitution was done in compliance with the requirements of the specification. The 4.1GB disks are no longer orderable. The technical specifications for the 91.GB disks show them to be better in performance than the measured disks. Performance data collected supported the conclusion that this substitution would not negatively impact performance.

The database columns normally populated with random alpha strings were found to contain exclusively lower case alpha characters. The DBMS vendor, Sybase, has stated in writing that Sybase ASE Server 12.0 does not use any data compression techniques or special algorithms to gain performance advantage of this limited population. Additional performance data was gathered to demonstrate that properly populated alpha strings show no performance impact.

Sincerely,

Lorna Livingtree

Lorna Livingtree, Auditor

10 Report Availability

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

TPC (Shanley Public Relations)
650 N. Winchester Blvd
Suite 1
San Jose, CA 95128

or your local Hewlett-Packard sales office.

Appendix A Client/Server Source

This appendix contains the source and makefiles for all client and server programs. All of the programs ran on the client machine.

A.1 Client Front-End

client/client.c

```
/************************************************************************
 @(#) Version: A.10.10 $Date: 97/12/15 10:53:26 $

 (c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
************************************************************************/
/*********************************************************************
History
990501 JVM Added handling for blank item lines in neworder
941101 JVM Fixed login screen to detect broken connection (used to loop)
941013 JVM Added audit strings to the login form
941013 VM modified the getfield procedure to add digit and char check
       according to the field type.
941014 VM added the status_msg routine to display transaction results.
941015 VM added zip routine to format zip codes and phone routine
       to format phone numbers.
*********************************************************************/


#include "iobuf.h"
#include "tpcc.h"
#include <signal.h>

#define until(c)  while(!(c))


/* a generic transaction variable. */
generic_trans generic_transaction;
generic_trans *trans=&generic_transaction;

/* global variables set up during initialization */
int user;
ID warehouse;
ID district;

main(argc, argv)
    int argc;
    char **argv;
    {
    int key;

    /* setup the transactions */
    key = setup(argc, argv);

    /* repeat until done */
    while (key != '9' && key != EOF)
       {

        /* get the menu choice */
        key = menu_read();

        /* process according to the choice */
        switch(key)
            {
            case '1': key = neworder(&trans->neworder); break;
            case '2': key = payment(&trans->payment); break;
            case '3': key = ordstat(&trans->ordstat); break;
            case '4': key = delivery(&trans->delivery); break;
            case '5': key = stocklev(&trans->stocklev); break;
            case EOF: break;
            case '9': break;
            default:    msgline("Please enter a valid menu choice");
            }
        }

    /* done */
    cleanup();
    }


/*********************************************************************
**********************************************************************

Neworder form processing

**********************************************************************
**********************************************************************/

define_iobuf(neworder_form, 900);

int neworder(trans)
    neworder_trans *trans;
    {
    int key;
    display(neworder_form);
    key = neworder_read(trans);
    if (key != ENTER) return key;
    neworder_transaction(trans);
    neworder_write(trans);
    return key;
    }


int neworder_read(trans)
    neworder_trans *trans;
    {
    int i;
    int field;
    int key;
    int ol;

    /* Our warehouse number is fixed */
    trans->W_ID = warehouse;
    trans->D_ID = EMPTY_NUM;

    /* assume nothing set yet */
    trans->C_ID = EMPTY_NUM;
    for (i=0; i<15; i++)
        {
        trans->item[i].OL_I_ID = EMPTY_NUM;
        trans->item[i].OL_QUANTITY = EMPTY_NUM;
        trans->item[i].OL_SUPPLY_W_ID = EMPTY_NUM;
        }

    /* Process fields until done */
    for (field = 1; field > 0; field = next_field(field, key, 47))
        retry: switch (field)
            {

            case 1: key = read_number(4, 29, &trans->D_ID, 2);
                    break;

            case 2: key = read_number(5, 12, &trans->C_ID, 4);
                    break;

            case 3: case 6: case 9: case 12: case 15:
            case 18: case 21: case 24: case 27: case 30:
            case 33: case 36: case 39: case 42: case 45:
                ol = (field - 3) / 3;
                key = read_number(9+ol, 3, &trans->item[ol].OL_SUPPLY_W_ID,4);
                break;

            case 4: case 7: case 10: case 13: case 16:
            case 19: case 22: case 25: case 28: case 31:
            case 34: case 37: case 40: case 43: case 46:
```

```
            ol = (field - 3) / 3;
            key = read_number(9+ol,10, &trans->item[ol].OL_I_ID, 6);
            break;

        case 5: case 8: case 11: case 14: case 17:
        case 20: case 23: case 26: case 29: case 32:
        case 35: case 38: case 41: case 44: case 47:
            ol = (field - 3) / 3;
            key = read_number(9+ol, 45, &trans->item[ol].OL_QUANTITY, 2);
            break;
        }

/* abort the screen if requested */
if (key != ENTER)
    return key;

/* Do for each non-blank order line */
ol = 0;
for (i=0; i<15; i++)
   {
   if (trans->item[i].OL_I_ID == EMPTY_NUM &&
       trans->item[i].OL_SUPPLY_W_ID == EMPTY_NUM &&
       trans->item[i].OL_QUANTITY == EMPTY_NUM) continue;

   /* if necessary, move the order line forward to fill gaps ...  */
   if (ol != i)
       {
       trans->item[ol] = trans->item[i];
       number(9+ol, 3,  trans->item[ol].OL_SUPPLY_W_ID, 4);
       number(9+ol, 10, trans->item[ol].OL_I_ID, 6);
       number(9+ol, 45, trans->item[ol].OL_QUANTITY, 2);

       /* ... and then blank fill the old line */
       trans->item[i].OL_SUPPLY_W_ID = EMPTY_NUM;
       trans->item[i].OL_I_ID = EMPTY_NUM;
       trans->item[i].OL_QUANTITY = EMPTY_NUM;
       empty(9+i, 3,  4);
       empty(9+i, 10, 6);
       empty(9+i, 45, 2);
       }

/* end "Do for each non-blank order line" */
   ol++;
   }

/* Record the number of order lines */
trans->O_OL_CNT = ol;

/* make sure all necessary fields are filled in */
if (trans->D_ID == EMPTY_NUM)
    {field=1; msgline("Please specify district"); goto retry;}
if (trans->C_ID == EMPTY_NUM)
    {field=2; msgline("Please specify customer id"); goto retry;}
if (trans->O_OL_CNT == 0)
    {field=3; msgline("Please enter at least one orderline"); goto retry;}
for (i=0; i<trans->O_OL_CNT; i++)
    {
    if (trans->item[i].OL_SUPPLY_W_ID == EMPTY_NUM)
        {field=i*3+3; msgline("Please enter supply warehouse"); goto retry;}
    if (trans->item[i].OL_I_ID == EMPTY_NUM)
        {field=i*3+4; msgline("Please enter Item id"); goto retry;}
    if (trans->item[i].OL_QUANTITY == EMPTY_NUM
     || trans->item[i].OL_QUANTITY <= 0)
        {field=i*3+5; msgline("Please enter quantity > 0"); goto retry;}
    }

/* decide if they were all local */
for (i=0; i<trans->O_OL_CNT; i++)
    if (trans->item[i].OL_SUPPLY_W_ID != trans->W_ID) break;
trans->all_local = (i == trans->O_OL_CNT);

/* display number of order lines */
number(6, 42, trans->O_OL_CNT, 2);

msgline("");
flush();
return key;
}
```

```
neworder_write(t)
    neworder_trans *t;
    {
    int i;
    MONEY amount, total_amount, cost;

    /* Rev. 3.3 error checking: both of the following branches are
     * skipped.  We'll go to status and print an error message.
     */

    /* CASE: invalid item, display only these values */
    if (t->status == E_INVALID_ITEM)
        {
        text(5, 25, t->C_LAST);
        text(5,52,  t->C_CREDIT);
        number(6, 15, t->O_ID, 8);
        }

    /* CASE: everything OK, display everything */
    else if (t->status == OK)
        {
        text(5, 25, t->C_LAST);
        text(5,52,  t->C_CREDIT);
        number(6, 15, t->O_ID, 8);
        date(4, 61, t->O_ENTRY_D);
        real(5, 64, t->C_DISCOUNT * 100, 5, 2);
        real(6, 59, t->W_TAX*100, 5, 2);
        real(6, 74, t->D_TAX*100, 5, 2);

        total_amount = 0;
        for (i=0; i < t->O_OL_CNT; i++)
            {

            /* keep track of amount of each line and total */
            amount = t->item[i].I_PRICE * t->item[i].OL_QUANTITY;
            total_amount += amount;

            /* display the item line */
            text(9+i, 19, t->item[i].I_NAME);
            number(9+i, 51, t->item[i].S_QUANTITY, 3);
            position(9+i, 58);   pushc(t->item[i].brand_generic);
            money(9+i, 62, t->item[i].I_PRICE, 7);
            money(9+i, 71, amount, 8);
            }

        /* Clear the screen of any empty input fields */
        clear_screen();

        /* display the total cost */
        text(24, 63, "Total:");
        cost = total_amount * (1 - t->C_DISCOUNT) * (1 + t->W_TAX + t->D_TAX);
        money(24, 71, cost, 9);
        }

    /* display the status message */
    status(24, 1, t->status);
    }


neworder_setup()
    {
    int item;
    iobuf *old;

    /* start with an empty form */
    reset(neworder_form);

    /* redirect the data to a special menu buffer */
    old = out_buf;  out_buf = neworder_form;

    /* clear the iobuf below the menu */
    position(3,1);
    clear_screen();

    /* set up all the field labels */
    text(3, 36, "New Order");
    text(4, 1, "Warehouse:");
```

```
    number(4, 12, warehouse, 4);
    text(4, 19, "District:");
    empty(4, 29, 2);
    text(4, 55, "Date:");
    text(5, 1, "Customer:");
    empty(5, 12, 4);
    text(5, 19, "Name:");
    text(5, 44, "Credit:");
    text(5, 57, "Disc.:");
    text(6, 1, "Order Number:");
    text(6, 25, "Number of Lines:");
    text(6, 52, "W_Tax:");
    text(6, 67, "D_Tax:");
    text(8, 2, "Supp_W Item_Num   Item_Name");
    text(8, 45, "Qty Stock   B/G     Price  Amount");

    /* display blank fields for each item */
    for (item = 1; item <= 15; item++)
        {
        empty(8+item, 3, 4);
        empty(8+item, 10, 6);
        empty(8+item, 45, 2);
        }

    trigger();

    /* restore to the previous I/O buffer */
    out_buf = old;
    }



/*****************************************************************************
******************************************************************************

Payment form processing

******************************************************************************
*****************************************************************************/

define_iobuf(payment_form, 400);


int payment(trans)
    payment_trans *trans;
    {
    int key;
    display(payment_form);
    key = payment_read(trans);
    if (key != ENTER)  return key;
    payment_transaction(trans);
    payment_write(trans);
    return key;
    }


payment_setup()
    {
    int item;
    iobuf *old;

    /* start with an empty form */
    reset(payment_form);

    /* redirect the data to a special menu buffer */
    old = out_buf;  out_buf = payment_form;

    /* clear the iobuf below the menu */
    position(3,1);
    clear_screen();

    /* set up all the field labels */
    text(3, 38, "Payment");
    text(4, 1, "Date:");
    text(6, 1, "Warehouse:");
    number(6, 12, warehouse, 4);
    text(6, 42, "District:");
    empty(6, 52, 2);
    text(11, 1, "Customer:");
    empty(11, 11, 4);
    text(11, 17, "Cust-Warehouse:");
    empty(11, 33, 4);
    text(11, 39, "Cust-District:");
    empty(11, 54, 2);
    text(12, 1, "Name:");
    empty(12, 29, 16);
    text(12, 50, "Since:");
    text(13, 50, "Credit:");
    text(14, 50, "%Disc:");
    text(15, 50, "Phone:");
    text(17, 1, "Amount Paid:");
    empty(17, 23, 8);
    text(17, 37, "New Cust-Balance:");
    text(18, 1, "Credit Limit:");
    text(20, 1, "Cust-Data:");
    trigger();

    out_buf = old;
    }


int payment_read(t)
    payment_trans *t;
    {
    int i;
    int field;
    int key;

    /* Our warehouse number is fixed */
    t->W_ID = warehouse;
    t->C_ID = EMPTY_NUM;
    t->D_ID = EMPTY_NUM;
    t->C_W_ID = EMPTY_NUM;
    t->C_D_ID = EMPTY_NUM;
    t->H_AMOUNT = EMPTY_FLT;
    t->C_LAST[0] = '\0';

    /* Process fields until done */
    for (field = 1; field > 0; field = next_field(field, key, 6))
        retry: switch (field)
            {

            case 1: key = read_number(6, 52, &t->D_ID, 2);
                    break;

            case 2:
                /* if last name specified, skip this field */
                if (t->C_LAST[0] != '\0')
                    break;

                /* read in the customer id */
                key = read_number(11, 11, &t->C_ID, 4);

                /* if specified, don't allow last name to be entered */
                if (t->C_ID != EMPTY_NUM)
                    {
                    blanks(12, 29, 16);
                    t->C_LAST[0] = '\0';
                    }

                /* refresh the C_LAST underlines, if possibly needed */
                else if (t->C_LAST[0] == '\0')
                    empty(12, 29, 16);
                break;

            case 3: key = read_number(11, 33,  &t->C_W_ID, 4);
                    break;

            case 4: key = read_number(11, 54, &t->C_D_ID, 2);
                    break;

            case 5:
                /* skip this field if C_ID was already specified */
                if (t->C_ID != EMPTY_NUM)
                    break;
```

```
                /* read in the customer last name */
                key = read_text(12, 29, t->C_LAST, 16);

                /* if specified, don't allow c_id to be entered */
                if (t->C_LAST[0] != '\0')
                    {
                    blanks(11, 11, 4);
                    t->C_ID = EMPTY_NUM;
                    }

                /* refresh the C_ID underlines, if possibly needed */
                else if (t->C_ID == EMPTY_NUM)
                    empty(11, 11, 4);
                break;

            case 6: key = read_money(17, 23, &t->H_AMOUNT, 8);
                    break;
            }

    /* if Aborted, then done */
    if (key != ENTER)
        return key;


    /* Make sure all the fields were entered */
    if (t->D_ID == EMPTY_NUM)
        {field=1; msgline("Please enter district id"); goto retry;}
    if (t->C_ID == EMPTY_NUM && t->C_LAST[0] == '\0')
        {field=2; msgline("C_ID or C_LAST must be entered"); goto retry;}
    if (t->C_W_ID == EMPTY_NUM)
        {field=3; msgline("Please enter customer's warehouse"); goto retry;}
    if (t->C_D_ID == EMPTY_NUM)
        {field=4; msgline("please enter customer's district"); goto retry;}
    if (t->H_AMOUNT == EMPTY_FLT)
        {field=6; msgline("Please enter payment amount"); goto retry;}
    if (t->H_AMOUNT <= 0)
       {field=6; msgline("Please enter a positive payment"); goto retry;}


    t->byname = (t->C_ID == EMPTY_NUM);
    msgline("");
    flush();
    return key;
    }


payment_write(t)
    payment_trans *t;
    {

    /* if errors, display a message and quit */
    if (t->status != OK)
        {
        status(24, 1, t->status);
        return;
        }

    /* display the screen */
    date(4, 7, t->H_DATE);
    text(7, 1, t->W_STREET_1);
    text(7, 42, t->D_STREET_1);
    text(8, 1, t->W_STREET_2);
    text(8, 42, t->D_STREET_2);
    text(9, 1, t->W_CITY);
    text(9, 22, t->W_STATE);
    zip(9, 25, t->W_ZIP);
    text(9, 42, t->D_CITY);
    text(9, 63, t->D_STATE);
    zip(9, 66, t->D_ZIP);
    number(11, 11, t->C_ID, 4);
    text(12, 9, t->C_FIRST);
    text(12, 26, t->C_MIDDLE);
    text(12, 29, t->C_LAST);
    date_only(12, 58, t->C_SINCE);
    text(13, 9, t->C_STREET_1);
    text(13, 58, t->C_CREDIT);
    text(14, 9, t->C_STREET_2);
    real(14, 58, t->C_DISCOUNT*100, 5, 2);  /* percentage or fraction? */
    text(15, 9, t->C_CITY);
    text(15, 30, t->C_STATE);
    zip(15, 33, t->C_ZIP);
    phone(15, 58, t->C_PHONE);
    money(17, 17, t->H_AMOUNT,14);
    money(17, 55, t->C_BALANCE, 15);
    money(18, 17, t->C_CREDIT_LIM, 14);

    /* Display cust data if bad credit. */
    if (t->C_CREDIT[0] == 'B' && t->C_CREDIT[1] == 'C')
        long_text(20, 12, t->C_DATA, 50);
    }



/*************************************************************
*************************************************************

ORDSTAT form processing

*************************************************************
*************************************************************/

define_iobuf(ordstat_form, 300);



int ordstat(t)
    ordstat_trans *t;
    {
    int key;
    display(ordstat_form);
    key = ordstat_read(trans);
    if (key != ENTER)  return key;
    ordstat_transaction(trans);
    ordstat_write(trans);
    return key;
    }


ordstat_setup()
    {
    int item;
    iobuf *old;

    /* start with an empty form */
    reset(ordstat_form);

    /* redirect the data to a special menu buffer */
    old = out_buf;  out_buf = ordstat_form;

    /* clear the iobuf below the menu */
    position(3,1);
    clear_screen();

    /* set up all the field labels */
    text(3, 35, "Order-Status");
    text(4, 1, "Warehouse:");
    number(4, 12, warehouse, 4);
    text(4, 19, "District:");
    empty(4, 29, 2);
    text(5, 1, "Customer:");
    empty(5, 11, 4);
    text(5, 18, "Name:");
    empty(5, 44, 16);
    text(6, 1, "Cust-Balance:");
    text(8, 1, "Order-Number");
    text(8, 26, "Entry-Date:");
    text(8, 60, "Carrier-Number:");
    text(9, 1, "Supply-W");
    text(9, 14, "Item-Num");
    text(9, 25, "Qty");
    text(9, 33,"Amount");
    text(9, 45, "Delivery-Date");

    trigger();
```

```
    /* done */
    out_buf = old;
    }



int ordstat_read(t)
    ordstat_trans *t;
    {
    int i;
    int field;
    int key;

    /* Our warehouse number is fixed */
    t->W_ID = warehouse;
    t->C_ID = EMPTY_NUM;
    t->D_ID = EMPTY_NUM;
    t->C_LAST[0] = '\0';

    /* Process fields until done */
    for (field = 1; field > 0; field = next_field(field, key, 3))
        retry: switch (field)
            {

            case 1: key = read_number(4, 29, &t->D_ID, 2);
                    break;

            case 2:
                /* if last name specified, skip this field */
                if (t->C_LAST[0] != '\0')
                    break;

                /* read in the customer id */
                key = read_number(5, 11, &t->C_ID, 4);

                /* if specified, don't allow last name to be entered */
                if (t->C_ID != EMPTY_NUM)
                    {
                    blanks(5, 44, 16);
                    t->C_LAST[0] = '\0';
                    }

                /* refresh the C_LAST underlines, if possibly needed */
                else if (t->C_LAST[0] == '\0')
                    empty(5, 44, 16);
                break;

            case 3:
                /* skip this field if C_ID was already specified */
                if (t->C_ID != EMPTY_NUM)
                    break;

                /* read in the customer last name */
                key = read_text(5, 44, t->C_LAST, 16);

                /* if specified, don't allow c_id to be entered */
                if (t->C_LAST[0] != '\0')
                    {
                    blanks(5, 11, 4);
                    t->C_ID = EMPTY_NUM;
                    }

                /* refresh the C_ID underlines, if possibly needed */
                else if (t->C_ID == EMPTY_NUM)
                    empty(5, 11, 4);
                break;
            }

    /* if Aborted, then done */
    if (key != ENTER)
        return key;


    /* ensure all the necessary fields were entered */
    if (t->D_ID == EMPTY_NUM)
        {field=1; msgline("Please enter district id"); goto retry;}
    if (t->C_ID == EMPTY_NUM && t->C_LAST[0] == '\0')
        {field=2;  msgline("C_ID or C_LAST must be entered"); goto retry;}

    t->byname = (t->C_ID == EMPTY_NUM);
    msgline("");
    flush();
    return key;
    }


ordstat_write(t)
    ordstat_trans *t;
    {
    int i;

    /* if errors, display a status message and quit */
    if (t->status != OK)
        {
        status(24, 1, t->status);
        return;
        }

    /* display the results */
    number(5, 11, t->C_ID, 4);
    text(5, 24, t->C_FIRST);
    text(5, 41, t->C_MIDDLE);
    text(5, 44, t->C_LAST);
    money(6, 15, t->C_BALANCE, 10);
    number(8, 15, t->O_ID, 8);
    date(8, 38, t->O_ENTRY_DATE);
    if (t->O_CARRIER_ID > 0)
        number(8, 76, t->O_CARRIER_ID, 2);

    for (i=0; i< t->ol_cnt; i++)
        {
        number(i+10, 3, t->item[i].OL_SUPPLY_W_ID, 4);
        number(i+10, 14, t->item[i].OL_I_ID, 6);
        number(i+10, 25, t->item[i].OL_QUANTITY, 2);
        money(i+10, 32, t->item[i].OL_AMOUNT, 9);
        date_only(i+10, 47, t->item[i].OL_DELIVERY_DATE);
        }
    }




/*************************************************************
*************************************************************

delivery form processing

*************************************************************
*************************************************************/

define_iobuf(delivery_form, 300);



int delivery(t)
    delivery_trans *t;
    {
    int key;
    display(delivery_form);
    key = delivery_read(trans);
    if (key != ENTER)  return key;
    delivery_enque(trans);
    delivery_write(trans);
    return key;
    }


delivery_setup()
    {
    int item;
    iobuf *old;

    /* start with an empty form */
    reset(delivery_form);
```

```
    /* redirect the data to a special menu buffer */
    old = out_buf;  out_buf = delivery_form;

    /* clear the iobuf below the menu */
    position(3,1);
    clear_screen();

    /* set up all the field labels */
    text(3, 38, "Delivery");
    text(4, 1, "Warehouse:");
    number(4, 12, warehouse, 4);
    text(6, 1, "Carrier Number:");
    empty(6, 17, 2);

    trigger();

    /* done */
    out_buf = old;
    }



int delivery_read(t)
    delivery_trans *t;
    {
    int i;
    int field;
    int key;

    /* Our warehouse number is fixed */
    t->W_ID = warehouse;
    t->O_CARRIER_ID = EMPTY_NUM;

    /* Process fields until done */
    for (field = 1; field > 0; field = next_field(field, key, 1))
        retry: switch (field)
            {
            case 1: key = read_number(6, 17, &t->O_CARRIER_ID, 2);
                    break;
            }

    /* if Aborted, then done */
    if (key != ENTER)
        return key;

    /* Must enter the carrier id */
    if ((t->O_CARRIER_ID == EMPTY_NUM) ||
          (t->O_CARRIER_ID < 1) ||
          (t->O_CARRIER_ID > 10))
        {field=1; msgline("Please enter a Carrier Number within 1 and 10"); goto
retry; }

    /* clear the message line */
    msgline("");
    flush();
    return key;
    }


delivery_write(t)
    delivery_trans *t;
    {
    if (t->status == OK)
        text(8, 1, "Execution Status: Delivery has been queued");
    else
        status(8, 1, t->status);
    }



/*****************************************************************
*****************************************************************

stocklev form processing

*****************************************************************
*****************************************************************/

define_iobuf(stocklev_form, 300);



int stocklev(t)
    stocklev_trans *t;
    {
    int key;
    display(stocklev_form);
    key = stocklev_read(trans);
    if (key != ENTER)  return key;
    stocklev_transaction(trans);
    stocklev_write(trans);
    return key;
    }


stocklev_setup()
    {
    int item;
    iobuf *old;

    /* start with an empty form */
    reset(stocklev_form);

    /* redirect the data to a special menu buffer */
    old = out_buf;  out_buf = stocklev_form;

    /* clear the iobuf below the menu */
    position(3,1);
    clear_screen();

    /* set up all the field labels */
    text(3, 35, "Stock-Level");
    text(4, 1, "Warehouse:");
    number(4, 12, warehouse, 4);
    text(4, 19, "District:");
    number(4, 29, district, 2);
    text(6, 1, "Stock Level Threshold:");
    empty(6, 24, 2);
    text(8, 1, "low stock");

    trigger();

    /* done */
    out_buf = old;
    }



int stocklev_read(t)
    stocklev_trans *t;
    {
    int field;
    int key;

    t->W_ID = warehouse;
    t->D_ID = district;
    t->threshold = EMPTY_NUM;

    /* Process fields until done */
    for (field = 1; field > 0; field = next_field(field, key, 1))
        retry: switch (field)
            {
            case 1: key = read_number(6, 24, &t->threshold, 2);
                    break;
            }

    /* if Aborted, then done */
    if (key != ENTER)
        return key;


    /* make sure the necessary fields were entered */
    if ((t->threshold == EMPTY_NUM) ||
        (t->threshold < 10) ||
```

```
          (t->threshold > 20))

        {field=1; msgline("Please enter a threshold within 10 and 20"); goto retry;
}

    /* clear the message line */
    msgline("");
    flush();
    return key;
    }


stocklev_write(t)
    stocklev_trans *t;
    {
    if (t->status == OK)
        number(8, 12, t->low_stock, 3);
    else
       status(10, 1, t->status);
    }



/*********************************************************************
*********************************************************************

login form processing

*********************************************************************
*********************************************************************/

int login()
    {
    int field;
    int key;
    char auditstr[21];
    int w_id, d_id;

    /* assume the default values */
    w_id = warehouse;
    d_id = district;
    auditstr[0] = '\0';

    /* display the login menu */
    position(1,1);  clear_screen();
    text(3, 30, "Please login.");
    text(5,5,"Warehouse:");
    number(5, 16, w_id, 4);
    text(5, 24, "District:");
    number(5, 34, d_id, 2);
    text(15, 5, "Audit String:");
    text(15, 19, CLIENT_AUDIT_STRING);
    empty(16, 19, 20);
    trigger();

    /* Get values until done */
    for (field = 1; field > 0;  field = next_field(field, key, 3))
        retry: switch (field)
            {
            case 1:
                key = read_number(5, 16, &w_id, 4, Num);
                break;

            case 2:
                key = read_number(5, 34, &d_id, 2, Num);
                break;

            case 3:
                key = read_text(16, 19, auditstr, 20);
                break;
            }

    if (key != ENTER)
        return EOF;

    if (w_id == EMPTY_NUM && warehouse == EMPTY_NUM)
        {
        msgline("You must enter a warehouse id");
        field =1;
        goto retry;
        }

    if (d_id == EMPTY_NUM && district == EMPTY_NUM)
        {
        msgline("You must enter a district id");
        field = 2;
        goto retry;
        }

    if (w_id != EMPTY_NUM)
        warehouse = w_id;
    if (d_id != EMPTY_NUM)
        district = d_id;

    /* done */
    flush();
    return key;
    }



/*********************************************************************
*********************************************************************

menu form processing

*********************************************************************
*********************************************************************/

menu_setup()
    {

    /* display the menu on the iobuf -- never erased */
    position(1, 1);
    clear_screen();
    string("(1)New-Order (2)Payment (3)Order-Status ");
    string("(4)Delivery (5)StockLevel (9)Exit");
    }

int menu_read()
    {
    position(1, 1);
    trigger();
    return getkey();
    }



int next_field(current, key, max)
    int current;
    int key;
    int max;
    {

    if (key == BACKTAB)
        if (current == 1)    return max;
        else                 return current-1;
    else if (key == TAB)
        if (current == max)  return 1;
        else                 return current+1;
    else
        return 0;
    }



msgline(str)
    char *str;
    {
    position(24, 1);
    clear_screen();
    string(str);
```

```
    flush();  /* Needed? */
    }



int setup(argc, argv)
    int argc;
    char **argv;
    {
    int key;

    /* Ignore SIGPIPE, since they occur normally */
    signal(SIGPIPE, SIG_IGN);

    /* get the user, warehouse and district numbers */
    warehouse = EMPTY_NUM;
    district = EMPTY_NUM;
    key = login();
    user = warehouse*DIST_PER_WARE + district + 1;

    /* set up the forms */
    menu_setup();
    neworder_setup();
    payment_setup();
    ordstat_setup();
    delivery_setup();
    stocklev_setup();

    /* connect to the delivery queue */
    delivery_init(user);

    /* connect to the transaction processor */
    transaction_begin(user);

    return key;
    }


cleanup()
    {

    /* detach from transaction engine */
    transaction_done();

    /* detach from the delivery queue */
    delivery_done();

    /* clear the screen */
    position(1, 1);
    clear_screen();
    flush();
    }


/*************************************************************************
**************************************************************************

Screen Output Routines

**************************************************************************
**************************************************************************/


number(row, col, n, width)
    int row;
    int col;
    int n;
    int width;
    {
    char str[81];
    fmt_num(str, n, width);
    text(row, col, str);
    }



real(row, col, x, width, dec)
    int row;
    int col;
    double x;
    int width;
    int dec;
    {
    char str[81];
    fmt_flt(str, x, width, dec);
    text(row, col, str);
    }

date(row, col, date_str)
    int row;
    int col;
    char *date_str;
    {
    text(row, col, date_str);
    }


date_only(row, col, date_str)
    int row;
    int col;
    char *date_str;
    {
    date_str[10] = '\0';
    text(row, col, date_str);
    }

money(row, col, x, width)
    int row;
    int col;
    double x;
    int width;
    {
    char str[81];
    fmt_money(str, x, width);
    text(row, col, str);
    }


long_text(row, col, str, width)
    int row, col, width;
    char *str;
    {
    int pos;

    /* repeat until the entire string is written out */
    for (pos = width; *str != '\0';  str++, pos++)
        {

        /* if at end of line, position the cursor to next line */
        if (pos >= width)
            {
            position(row, col);
            pos = 0;
            row++;
            }

        /* output the next character */
        pushc(*str);
        }
    }


text(row, col, str)
    int row;
    int col;
    char str[];
    {
    position(row, col);
    string(str);
    }


phone(row, col,str)
      int row;
      int col;
```

```
      char *str;
      {

       char temp[30];

       fmt_phone(temp,str);
       text(row,col,temp);

       }


zip(row, col, str)
    int row;
    int col;
    char *str;
    {
    char temp[30];

    fmt_zip(temp,str);
    text(row,col,temp);
    }

empty(row, col, len)
    int row;
    int col;
    int len;
    {
    position(row, col);
    while (len-- > 0)
        pushc('_');
    }


blanks(row, col, len)
    int row, col, len;
    {
    position(row, col);
    while (len-- > 0)
        pushc(' ');
    }


status(row, col, status)
/*********************************************************************
status displays the transaction status
  Note: must correspond to 'get_status' in driver/keystroke.c
*********************************************************************/
   int row, col;
   int status;
   {
   text(row, col, "Execution Status: ");

   if (status == OK)
       string("Transaction Committed");
   else if (status == E_INVALID_ITEM)
       string("Item number is not valid");
   /* Do the rev. 3.3 error checking here.        */
   else if (status == E_INVALID_INPUT)
       string("Invalid input, transaction not executed");
   else
       {
       string("Rollback -- ");
       number(row, col+30, status, 5);
       }
   }

/*********************************************************************
*********************************************************************

ASCII terminal control

*********************************************************************
*********************************************************************/


trigger()
/*********************************************************************
trigger sends a turnaround sequence to let the driver know to send input
*********************************************************************/
    {
    pushc(TRIGGER);
    }


position(row, col)
/*********************************************************************
position positions the cursor at the given row and column
*********************************************************************/
    int row;
    int col;
    {
    pushc(ESCAPE);
    pushc('[');
    if (row >= 10)
        pushc('0' + row/10);
    pushc('0'+ row%10);
    pushc(';');
    if (col >= 10)
        pushc('0' + col/10);
    pushc('0' + col%10);
    pushc('H');
    }

clear_screen()
/*********************************************************************
clear_screen clears the iobuf from cursor position to end of iobuf
*********************************************************************/
    {
    pushc(ESCAPE);
    pushc('[');
    pushc('J');
    }




/*********************************************************************
*********************************************************************

Screen Input Routines

*********************************************************************
*********************************************************************/
#define funny(key)  (key != ENTER && key !=TAB && key != BACKTAB)


read_number(row, col, n, width)
/*********************************************************************
read_number reads an integer field
*********************************************************************/
    int row;
    int col;
    int *n;
    int width;
    {
    char temp[81];
    int key;
    int err;
    debug("read_number: row=%d  col=%d  width=%d n=%d \n",row, col,width,*n);

    /* generate the current characters */
    fmt_num(temp, *n, width);
    err = NO;

    /* repeat until a valid number or a funny key is pressed */
    for (;;)
        {
        /* Let the user edit the field */
        key = getfield(row, col, temp, width, Num);
          if (funny(key)) return key;

        /* convert the field to a number */
        *n = cvt_num(temp);
        if (*n != INVALID_NUM) break;

        msgline("Invalid digit entered");
          pushc(BELL);
```

```
        err = YES;
        }

    /* display the new number */
    number(row, col, *n, width);
    if (err) msgline("");
    debug("read_number: n=%d  key=%d\n", *n, key);
    return key;
    }


int read_money(row, col, m, width)
    int row;
    int col;
    double *m;
    int width;
    {
    char temp[81];
    int key;
    int err;

    err = NO;
    fmt_money(temp, *m, width);

    /* repeat until a valid number or a funny key is pressed */
    for (;;)
        {
        key = getfield(row, col, temp, width, Money);
          if (funny(key)) return key;

        *m = cvt_money(temp);
        if (*m != INVALID_FLT)  break;

        msgline("Please enter amount $99999.99");
        pushc(BELL);
        err = YES;
          }

    money(row, col, *m, width);
    if (err) msgline("");
    return key;
    }



int read_real(row, col, x, width, dec)
    int row, col, width;
    double *x;
    {
    char temp[81];
    int key;
    int err;

    /* generate the current characters */
    fmt_flt(temp, *x, width, dec);
    err = NO;

    /* repeat until a valid number or a funny key is pressed */
    for (;;)
          {
        key = getfield(row, col, temp, width);
          if (funny(key)) return key;

        /* convert the field to a number */
        *x = cvt_flt(temp);
          if (*x != INVALID_FLT) break;

        msgline("Please enter a valid floating pt number");
        pushc(BELL);
        err = YES;
        }

    /* display the new number */
    real(row, col, *x, width, dec);
    if (err) msgline("");

    return key;
    }
```

```
int read_text(row, col, s, width)
    int row, col, width;
    char *s;
    {
    char temp[81];
    int key;
    int i;

    /* generate the current characters */
    fmt_text(temp, s, width);

    /* let the user edit the field */
    key = getfield(row, col, temp, width, Text);
    if (funny(key)) return key;

    /* Strip off leading and trailing space characters */
    cvt_text(temp, s);

    /* redisplay the current text */
    fmt_text(temp, s, width);
    text(row, col, temp);

    return key;
    }



int getfield(row, col, buf, width,ftype)
    int row, col, width;
    char buf[];
    FIELD_TYPE ftype;

    {
    int pos, key;

    debug("getfield: width=%d  buf=%*s\n", width, width, buf);

    /* go to the beginning of the field */
    position(row, col);
    pos = 0;

    /* repeat until a special control character is pressed */
    for (;;)
        {

        /* get the next character */
        key = getkey();

        /* CASE: Add to buf if it fits and Is it a valid character ? */
        if (pos < width  && valid_char(key, ftype))
            {
            buf[pos] = key;
            pos++;
            pushc(key);
            }

        /* CASE: char is BACKSPACE.  Erase last character. */
        else if (key == BACKSPACE && pos > 0)
            {
            pos--;
            buf[pos] = '_';
            pushc(BACKSPACE);
            pushc('_');
            pushc(BACKSPACE);
            }

       /* CASE: enter, tab, backtab, ^c.  Exit loop */
       else if (key==ENTER || key==TAB || key==BACKTAB || key==CNTRLC
                || key == EOF)
           break;

       else if (key=='\031')   /* for debugging, let ^X == ENTER */
            {key=ENTER; break;}

       /* Otherwise, ignore the character and beep */
       else
           pushc(BELL);
```

```
       }

    debug("getfield: final key: %d  buf=%*s\n", key, width, buf);
    return key;
    }



int valid_char(key, ftype)
/*********************************************************************
valid_char is true if the key is valid for this type of field
*********************************************************************/
    int key;
    FIELD_TYPE ftype;
    {
    int valid;
    switch(ftype)
           {
           case Num : valid = (isdigit(key) || key == '-' || key == ' ');
                      break;

         case Text : valid = (isprint(key) || key == ' ');
                        break;

         case Money : valid = (isdigit(key) || key == '-' || key == '.'
                              || key == '$' || key == ' ');
                       break;

         default     : valid = NO;
                        break;
         }

     return valid;
     }
```

A.2 Tpc_lib Source

lib/tpcc.h

```
/*****************************************************************************
 @(#) Version: A.10.10 $Date: 97/12/15 14:01:49 $

 (c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
*****************************************************************************/
#ifndef TPCC_INCLUDED
#define TPCC_INCLUDED
#include <values.h>


/* The auditor can define these 20 char strings to be anything */
#define DRIVER_AUDIT_STRING  "driver audit string"
#define CLIENT_AUDIT_STRING  "client audit string"

#ifdef DEBUG
#define debug printf
#else
#define debug (void)
#endif

#include <stdio.h>

typedef int ID;           /* All id's */
typedef double MONEY;     /* Large integer number of cents */
typedef char TEXT;        /* Add an extra byte for null terminator */
typedef double TIME;      /* Elapsed seconds from start of run (float?) */
typedef int COUNT;        /* integer numbers of things */
typedef double REAL;      /* real numbers */
typedef int LOGICAL;      /* YES or NO */
typedef struct {          /* days and seconds since Jan 1, 1900 */
    int day;              /* NULL represented by negative day */
    int sec;
    } DATE;

/* Macro to convert time of day to TIME */
#include <time.h>
extern struct timeval start_time;
#define elapsed_time(t) ( ((t)->tv_sec - start_time.tv_sec) +  \
                          ((t)->tv_usec - start_time.tv_usec) / 1000000.0 )

typedef enum {Num,Money,Text,Time,Real,Date} FIELD_TYPE;   /* screen field types */


/* Various TPCC constants */
#define W_ID_LEN        4
#define D_ID_LEN        2
#define C_ID_LEN        4
#define I_ID_LEN        6
#define OL_QTY_LEN      2
#define PMT_LEN         7
#define C_ID_LEN        4
#define C_LAST_LEN      16
#define CARRIER_LEN     2
#define THRESHOLD_LEN   2
#define DIST_PER_WARE   10
#define CUST_PER_DIST   3000
#define ORD_PER_DIST    3000
#define MAXITEMS        100000
#define MAX_DIGITS      3       /* # of digits of the NURand number selected
                                   to generate the customer last name */
#define MAXWAREHOUSE   2000     /* maximum # of warehouses - scaling factor */
#define LOADSEED       42 /* # of digits of the NURand number selected

/*************************************************************/
/* database identifiers and populations                      */
/*************************************************************/

  int no_warehouse;                          /*  scaling factor    */
  int no_item;                               /*  100000            */
  int no_dist_pw;                            /*      10            */
  int no_cust_pd;                            /*    3000            */
  int no_ord_pd;                             /*    3000            */
  int no_new_pd;                             /*     900            */
  int tpcc_load_seed;                        /*     900            */

/* fields to add to each transaction for acid testing */
#define ACID_STUFF     \
    char acid_txn[2];  \
    int  acid_timing;  \
    int  acid_action;  \
    FILE *acid_res

typedef struct {
    ID OL_SUPPLY_W_ID;
    ID OL_I_ID;
    TEXT I_NAME[24+1];
    COUNT OL_QUANTITY;
    COUNT S_QUANTITY;
    MONEY I_PRICE;
    char brand_generic;
    } neworder_item;

typedef struct {
    int status;
    LOGICAL all_local;
    ID W_ID;
    ID D_ID;
    ID C_ID;
    TEXT C_LAST[C_LAST_LEN+1];
    TEXT C_CREDIT[2+1];
    REAL C_DISCOUNT;
    COUNT O_OL_CNT;
    ID O_ID;
    TEXT O_ENTRY_D[20];  /* dates as text fields */
    REAL W_TAX;
    REAL D_TAX;
    neworder_item item[15];
    ACID_STUFF;
    } neworder_trans;
```

```
typedef struct {
    int status;
    LOGICAL byname;
    ID W_ID;
    ID D_ID;
    ID C_ID;
    ID C_D_ID;
    ID C_W_ID;
    MONEY H_AMOUNT;
    TEXT H_DATE[20];  /* date as text field */
    TEXT W_STREET_1[20+1];
    TEXT W_STREET_2[20+1];
    TEXT W_CITY[20+1];
    TEXT W_STATE[2+1];
    TEXT W_ZIP[9+1];
    TEXT D_STREET_1[20+1];
    TEXT D_STREET_2[20+1];
    TEXT D_CITY[20+1];
    TEXT D_STATE[2+1];
    TEXT D_ZIP[9+1];
    TEXT C_FIRST[16+1];
    TEXT C_MIDDLE[2+1];
    TEXT C_LAST[16+1];
    TEXT C_STREET_1[20+1];
    TEXT C_STREET_2[20+1];
    TEXT C_CITY[20+1];
    TEXT C_STATE[2+1];
    TEXT C_ZIP[9+1];
    TEXT C_PHONE[16+1];
    TEXT C_SINCE[20]; /* date as text field */
    TEXT C_CREDIT[2+1];
    MONEY C_CREDIT_LIM;
    REAL C_DISCOUNT;
    REAL C_BALANCE;
    TEXT  C_DATA[200+1];
    ACID_STUFF;
    } payment_trans;


typedef struct {
    int status;
    LOGICAL byname;
    ID W_ID;
    ID D_ID;
    ID C_ID;
    TEXT C_FIRST[16+1];
    TEXT C_MIDDLE[2+1];
    TEXT C_LAST[16+1];
    MONEY C_BALANCE;
    ID O_ID;
    TEXT O_ENTRY_DATE[20];   /* date as text field */
    ID O_CARRIER_ID;
    COUNT ol_cnt;
    struct {
        ID OL_SUPPLY_W_ID;
        ID OL_I_ID;
        COUNT OL_QUANTITY;
        MONEY OL_AMOUNT;
        TEXT OL_DELIVERY_DATE[20]; /* date as text field */
        } item[15];
    ACID_STUFF;
    } ordstat_trans;


typedef struct {
    int status;
    ID W_ID;
    ID D_ID;
    COUNT threshold;
    COUNT low_stock;
    ACID_STUFF;
    } stocklev_trans;

typedef struct {
    int status;
    ID W_ID;
    ID O_CARRIER_ID;
    struct {
        ID O_ID;
          int status;
        } order[10];
    struct timeval enque[1];
    struct timeval deque[1];
    struct timeval complete[1];
    ACID_STUFF;
    } delivery_trans;


typedef union {
    neworder_trans neworder;
    payment_trans payment;
    ordstat_trans ordstat;
    delivery_trans delivery;
    stocklev_trans stocklev;
    int status;
    } generic_trans;


/*******************************************************
Record formats for results
*******************************************************/

#ifdef NOTYET
typedef struct
    {
    float t1, t2, t3, t4, t5;
    int status           :8;
    unsigned int type    :3;
    unsigned int ol_cnt  :4;
    unsigned int remote_ol_cnt :4;
    unsigned int byname :1;
    unsigned int remote  :1;
    unsigned int skipped  :4;
    } success_t;
#endif

typedef struct
    {
    TIME t1, t2, t3, t4, t5;
    int status;
    unsigned int type    :3;
    unsigned int ol_cnt  :4;
    unsigned int remote_ol_cnt :4;
    unsigned int byname :1;
    unsigned int remote  :1;
    unsigned int skipped  :4;
    } success_t;

typedef struct
    {
    struct timeval start_time;
    } success_header_t;


/*********************************************************************
Record formats for loading routines.  (DB's have own internal formats
*********************************************************************/
typedef struct
    {
    ID W_ID;
    TEXT W_NAME[10+1];
    TEXT W_STREET_1[20+1];
    TEXT W_STREET_2[20+1];
    TEXT W_CITY[20+1];
    TEXT W_STATE[2+1];
    TEXT W_ZIP[9+1];
    REAL W_TAX;
    MONEY W_YTD;
    } warehouse_row;

typedef struct
    {
    ID D_ID;
    ID D_W_ID;
    TEXT D_NAME[10+1];
```

```
    TEXT D_STREET_1[20+1];
    TEXT D_STREET_2[20+1];
    TEXT D_CITY[20+1];
    TEXT D_STATE[2+1];
    TEXT D_ZIP[9+1];
    REAL D_TAX;
    MONEY D_YTD;
    ID D_NEXT_O_ID;
    } district_row;

typedef struct
    {
    ID C_ID;
    ID C_D_ID;
    ID C_W_ID;
    TEXT C_FIRST[16+1];
    TEXT C_MIDDLE[2+1];
    TEXT C_LAST[16+1];
    TEXT C_STREET_1[20+1];
    TEXT C_STREET_2[20+1];
    TEXT C_CITY[20+1];
    TEXT C_STATE[2+1];
    TEXT C_ZIP[9+1];
    TEXT C_PHONE[16+1];
    DATE C_SINCE;
    TEXT C_CREDIT[2+1];
    MONEY C_CREDIT_LIM;
    REAL C_DISCOUNT;
    MONEY C_BALANCE;
    MONEY C_YTD_PAYMENT;
    COUNT C_PAYMENT_CNT;
    COUNT C_DELIVERY_CNT;
    TEXT  C_DATA[500+1];
    } customer_row;

typedef struct
    {
    ID H_C_ID;
    ID H_C_D_ID;
    ID H_C_W_ID;
    ID H_D_ID;
    ID H_W_ID;
    DATE H_DATE;
    MONEY H_AMOUNT;
    TEXT H_DATA[24+1];
    } history_row;

typedef struct
    {
    ID NO_O_ID;
    ID NO_D_ID;
    ID NO_W_ID;
    } neworder_row;

typedef struct
    {
    ID O_ID;
    ID O_D_ID;
    ID O_W_ID;
    ID O_C_ID;
    DATE O_ENTRY_D;
    ID O_CARRIER_ID;
    COUNT O_OL_CNT;
    LOGICAL O_ALL_LOCAL;
    } order_row;

typedef struct
    {
    ID OL_O_ID;
    ID OL_D_ID;
    ID OL_W_ID;
    ID OL_NUMBER;
    ID OL_I_ID;
    ID OL_SUPPLY_W_ID;
    DATE OL_DELIVERY_D;
    COUNT OL_QUANTITY;
    MONEY OL_AMOUNT;
    TEXT OL_DIST_INFO[24+1];
    } orderline_row;

typedef struct
    {
    ID I_ID;
    ID I_IM_ID;
    TEXT I_NAME[24+1];
    MONEY I_PRICE;
    TEXT I_DATA[50+1];
    } item_row;

typedef struct
    {
    ID S_I_ID;
    ID S_W_ID;
    COUNT S_QUANTITY;
    TEXT S_DIST_01[24+1];
    TEXT S_DIST_02[24+1];
    TEXT S_DIST_03[24+1];
    TEXT S_DIST_04[24+1];
    TEXT S_DIST_05[24+1];
    TEXT S_DIST_06[24+1];
    TEXT S_DIST_07[24+1];
    TEXT S_DIST_08[24+1];
    TEXT S_DIST_09[24+1];
    TEXT S_DIST_10[24+1];
    COUNT S_YTD;
    COUNT S_ORDER_CNT;
    COUNT S_REMOTE_CNT;
    TEXT S_DATA[50+1];
    } stock_row;


/* Empty field values */
#define EMPTY_NUM (MAXINT-1)
#define INVALID_NUM (MAXINT)
#define EMPTY_FLT   (MAXDOUBLE)
#define INVALID_FLT (MINDOUBLE)

/* Status conditions */
#define OK 0
#define E 1
#define E_INVALID_ITEM 2
#define E_NOT_ENOUGH_ORDERS 3
#define E_DB_ERROR 4
#define E_INVALID_INPUT 5

/* Error message strings */
static char *e_mesg[]={"Transaction complete.","Error","Invalid item number.",
                       "Not enough orders.", "Database ERROR !!!!"};



#define YES 1
#define NO 0



double cvt_flt();
double cvt_money();
TIME getclock();
TIME getlocalclock();

#define TPC_MSG_QUE  150


/*************************************
Transaction specific stuff
*************************************/

/* types of transactions */
#define NEWORDER 1
#define PAYMENT  2
#define ORDSTAT  3
#define DELIVERY 4
#define STOCKLEV 5
#define DEFERRED 6   /* deferred portion of delivery */

/* the name of each transaction */
```

```
static char *transaction_name[] =
    {"", "New_Order", "Payment", "Order-Status",
         "Delivery", "Stock-Level", "Deferred-Delivery"};

/* size of each transaction record */
static int transaction_size[] = {0,
     sizeof(neworder_trans),
     sizeof(payment_trans),
     sizeof(ordstat_trans),
     sizeof(delivery_trans),
     sizeof(stocklev_trans),
     sizeof(delivery_trans),
     0};

/* valid response time for each transaction */
static TIME valid_response[] = {0, 5, 5, 5, 5, 20};


#endif /* TPCC_INCLUDED */
```

lib/date.c

```
/*****************************************************************************
 @(#) Version: A.10.10 $Date: 97/12/15 10:56:52 $

 (c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
*****************************************************************************/
#include "tpcc.h"
#include <time.h>

/* macro to get starting day of a particular year (1901 thru 2100) */
#define YEAR(yr)  ( (yr-1900)*365 + (yr-1900-1)/4 )

CurrentDate(date)
/**********************************************************************
CurrentDate fetches the current date and time
**********************************************************************/
    DATE *date;
    {
    struct timeval time;
    struct timezone tz;

    /* get the current time of day */
    if (gettimeofday(&time, &tz) < 0)
          syserror("Can't get time of day\n");

    /* adjust the time of day by the timezone */
    time.tv_sec -= tz.tz_minuteswest * 60;

    /* convert seconds and days since EPOCH (Jan 1, 1970) */
    date->day = time.tv_sec / (24*60*60);
    date->sec = time.tv_sec - date->day * (24*60*60);

    /* convert to days since Jan 1, 1900 */
    date->day += YEAR(1970);
    }


EmptyDate(date)
/*************************************************
Get a NULL date and time
*************************************************/
    DATE *date;
    {
    date->day = 0;   /* Use EMPTYNUM instead */
    date->sec = 0;
    }

int IsEmptyDate(date)
    DATE *date;
    {
    return (date->day == 0 & date->sec == 0);
    }
```

```
#define Feb29 (31+29-1)

fmt_date(str, date)
/*********************************************************************
fmt_date formats the DATE into a string  MM-DD-YY HH-MM-SS
*********************************************************************/
    char str[20];
    DATE *date;
    {
    /* Note: should probably do date and time separately */

    int quad, year, month, day;
    int hour, minute, sec;

    static int dur[] = {31, 28, 31, 30, 31, 30, 31, 31, 30, 31, 30, 31};
    static int first = YES;

    day = date->day;
    sec = date->sec;

    /* if NULL date, then return empty string */
    if (day == EMPTY_NUM || sec == EMPTY_NUM)
          {str[0] = '\0';  return;}

    /* 2100, 1900 are NOT leap years.  If we are Feb 29 or later, add a day */
    if (day >= Feb29 + YEAR(2100))  day++;
    if (day >= Feb29)               day++;

    /* figure out which quad and day within quad we are in */
    quad = day / (4*365+1);
    day = day - quad * (4*365+1);

    /* get our year within quad and day within the year */
    if      (day < 1*365+1)    {year = 0;}
    else if (day < 2*365+1)    {year = 1; day -= 1*365+1;}
    else if (day < 3*365+1)    {year = 2; day -= 2*365+1;}
    else                       {year = 3; day -= 3*365+1;}

    /* if this is a leap year, february has 29 days */
    if (year == 0)          dur[1] = 29;
    else                    dur[1] = 28;

    /* decide which day and month we are */
    for (month = 0; day >= dur[month]; month++)
        day -= dur[month];

    /* decide what time of day it is */
    minute = sec / 60;
    sec = sec - minute * 60;
    hour = minute / 60;
    minute = minute - hour * 60;

    /* format the date and time */
    fmtint(str+0,  day+1, 2, ' ');
    str[2]='-';
    fmtint(str+3, month+1, 2, '0');
    str[5]='-';
    fmtint(str+6, 1900+quad*4+year, 4, '0');
    str[10] = ' ';
    fmtint(str+11, hour, 2, ' ');
    str[13] = ':';
    fmtint(str+14, minute, 2, '0');
    str[16] = ':';
    fmtint(str+17, sec, 2, '0');
    str[19] = '\0';
    }
```

lib/errlog.c

```
/*****************************************************************************
 @(#) Version: A.10.10 $Date: 97/12/15 10:56:52 $

 (c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
*****************************************************************************/
```

```
#include <stdio.h>
#include <varargs.h>
#include <unistd.h>
#include <errno.h>
#include <stdlib.h>
#include <fcntl.h>

int userid;

static msg_buf();

error(format, va_alist)
/************************************************************************
error formats a message and outputs it to a standard location (stderr for now)
************************************************************************/
    char *format;
          va_dcl
    {
    va_list argptr;

    msg_buf("error \n", strlen("error \n"));

    /* point to the list of arguments */
    va_start(argptr);

    /* format and print to stderr */
    vmessage(format, argptr);

    /* done */
    va_end(argptr);

    /* take an error exit */
    exit(1);
    }


syserror( format, va_alist )
/************************************************************************
syserror logs a message with the system error code
************************************************************************/
    char *format;
          va_dcl
    {
    va_list argptr;
    int save_errno = errno;

    msg_buf("syserror \n", strlen("syserror \n"));
    /* point to the list of arguments */
    va_start(argptr);

    /* format and print to stderr */
    vmessage(format, argptr);

    /* done */
    va_end(argptr);

    /* display the system error message */
    message("    System error message: %d %s\n", save_errno, strerror(save_errno));

    /* take an error exit */
    exit(1);
    }



message(format, va_alist)
/************************************************************************
message formats a message and outputs it to a standard location (stderr for now)
************************************************************************/
    char *format;
          va_dcl
{
    va_list argptr;

    msg_buf("message \n", strlen("message \n"));
    /* point to the list of arguments */
    va_start(argptr);

    /* format and print to stderr */
    vmessage(format, argptr);

    /* done */
    va_end(argptr);
    }



vmessage(format, argptr)
/************************************************

************************************************/
    char *format;
    va_list argptr;
{
  char buf[3*1024];

  /* format a message id */
  sprintf(buf, "Host %-8s User %-6d Pid %-6d ", getenv("HOST_NAME"), userid,
getpid());

  /* format the string and print it */
  vsprintf(buf+strlen(buf), format, argptr);
  if (getenv("NO_ERROR_LOG") == NULL)
      msg_buf(buf, strlen(buf));
  if (getenv("NO_STDERR") == NULL)
      write(2, buf, strlen(buf));
}



static msg_buf(buf, size)
  char *buf;
  int size;
  {
  int     fd;
  char  *fname;
  time_t tepoch = time(NULL);
  char timestamp[16];
  int ltimestamp;

  ltimestamp = strftime(timestamp, sizeof(timestamp), "%m/%d %T ",
localtime(&tepoch));

  /* get the file name to use */
  fname = getenv("ERROR_LOG");
  if (fname == NULL)
    fname = "/tmp/ERROR_LOG";

  /* get exclusive access to the error log file */
  fd= open(fname, O_WRONLY | O_CREAT, 0666);
  if (fd < 0)
    console_error("Can't open tpc error log file 'ERROR_LOG'\n");
  lockf(fd, F_LOCK, 0);

  /* write the new text at the end of the file */
  lseek(fd, 0, SEEK_END);
  write(fd, timestamp, ltimestamp);
  write(fd, buf, size);

  /* release the file */
  /* fsync(fd); */
  lockf(fd, F_ULOCK, 0);
  close(fd);
  }



console_error(str)
   char *str;
   {
   int fd = open("/dev/tty", O_WRONLY);
   write(fd, str, strlen(str));
   close(fd);
   exit(1);
```

```
   }
```

lib/fmt.c

```
/*****************************************************************************
 @(#) Version: A.10.10 $Date: 97/12/15 10:56:52 $

 (c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
*****************************************************************************/
#include "tpcc.h"
#include "iobuf.h"
#include <math.h>    /* needed for ceil (VM) */
#include <strings.h>

/* formatting routines.  */

/* Note: Currently use integer routines to format and convert.  Need to
   modify the code for cases when integers don't work.  */

fmt_money(str, m, width)
    char *str;
    MONEY m;
    int width;
    {

    if (m == EMPTY_FLT)
        {
        memset(str, '_', width);
        str[width] = '\0';
        return;
        }

    /* format it as a number with a leading blank */
    *str = ' ';
    fmt_flt(str+1, m/100, width-1, 2);

    /* fill in a leading dollar */
    while (*(str+1) == ' ')
        str++;
    *str = '$';
    }


double cvt_money(str)
    char *str;
    {
    char temp[81], *t, *s;
    double cvt_flt(), f;

    /* skip leading and trailing blanks */
    cvt_text(str, temp);

    /* remove leading $ */
    if (*temp == '$')   t = temp + 1;
    else                t = temp;

    /* start scan at current character */
    s = t;

    /* allow leading minus sign */
    if (*s == '-')
          s++;

    /* allow leading digits */
    while (isdigit(*s))
          s++;

    /* allow decimal pt and two decimal digits */
    if (*s == '.')    s++;
    if (isdigit(*s))  s++;
    if (isdigit(*s))  s++;

    /* There should be no more characters */
    if (*s != '\0') return INVALID_FLT;

    /* convert the floating pt number */
    f = cvt_flt(t);
    if (f == EMPTY_FLT)        return EMPTY_FLT;
    else if (f == INVALID_FLT) return INVALID_FLT;
    else                       return rint(f*100);
    }


fmt_num(str, n, width)
    char str[];
    int n;
    int width;
    {
    /* mark the end of the string */
    str[width] = '\0';

    /* if empty number, return the empty field */
    if (n == EMPTY_NUM)
        memset(str, '_', width);

    /* otherwise, convert the integer */
    else
        fmtint(str, n, width, ' ');

    debug("fmt_num:  n=%d  str=%s\n", n, str);
    }



cvt_num(str)
    char str[];
    {
    char text[81];
    cvt_text(str, text);
    if (*text == '\0')
        return EMPTY_NUM;
    else
        return cvtint(text);
    }



fmt_flt(str, x, width, dec)
/*****************************************************************************
fmt_flt converts a floating pt number to a string   "999999.9999"
*****************************************************************************/
    char *str;
    double x;
    int width;
    int dec;
    {
    int negative;
    int integer, fract;
    double absolute;

    static double pow10[] =
    {1., 10., 100., 1000., 10000., 100000., 1000000., 10000000., 100000000.};

    /* mark the end of string */
    str[width] = '\0';

    /* if empty value, make it be an empty field */
    if (x == EMPTY_FLT)
        {
        memset(str, '_', width);
        return;
        }

    absolute = (x < 0)? -x: x;

    /* separate into integer and fractional parts */
    integer = (int) absolute;
    fract   = (absolute - integer) * pow10[dec] + .5;

    /* let the integer portion contain the sign */
    if (x < 0) integer = -integer;

    /* Format integer and fraction separately */
    fmtint(str, integer, width-dec-1, ' ');
```

```
    str[width-dec-1] = '.';
    fmtint(str+width-dec, fract, dec, '0');
    }



double cvt_flt(str)
    char str[];
    {
    char text[81];
    char *t;
    double value;
    int div;
    int fract;
    int negative;
    int i;

    /* normalize the text */
    cvt_text(str, text);
    if (*text == '\0')
        return EMPTY_FLT;

    negative = NO;
    fract = NO;
    value = 0;
    div = 1.0;

    negative = (text[0] == '-');
    if (negative)    t = text+1;
    else             t = text;

    for (;  *t !=  '\0' ; t++)
        {

        if (*t == '.')
              if (fract)  return INVALID_FLT;
            else        fract = YES;

        else if (isdigit(*t))
            {
            value = value*10 + (int)*t - (int)'0';
            if (fract) div *= 10;
            }

        else
            return INVALID_FLT;
        }

    if (fract)
        value /= div;

    if (negative)
        value = -value;

    return value;
    }



fmt_text(s, text, width)
    char *s, *text;
    int width;
    {

    /* if an empty string, then all underscores */
    if (*text == '\0')
        for (; width > 0; width--)
            *s++  = '_';

    /* otherwise, blank fill it */
    else
        {

        /* copy the text into the new buffer */
        for ( ; *text != '\0';  width--)
            *s++ = *text++;

        /* fill in the rest with blanks */
        for (;  width > 0;  width--)
            *s++ = ' ';
        }

    /* and finally, terminate the string */
    *s = '\0';
    }



cvt_text(s, text)
    char *s;
    char *text;
    {
    char *lastnb;

    /* skip leading blanks and underscores */
    for (; *s == ' ' || *s == '_'; s++)
        ;

    /* copy the characters, keeping track of last blank or underscore */
    lastnb = text-1;
    for (; *s != '\0'; *text++ = *s++)
        if (*s != ' ' && *s != '_')
            lastnb = text;

    /* truncate the text string to last nonblank character */
    *(lastnb+1) = '\0';
    }



fmtint(field, value, size, fill)
/*********************************************************************
fmtint formats an integer value into a character field to make the integer
right-justified within the character field, padded with leading fill
characters (e.g. leading blanks if a blank is passed in for the fill argument
*********************************************************************/
    int value;
    char *field;
    int size;
    char fill;
    {
    int negative;
    int dividend;
    int remainder;
    char *p;

    /* create characters from right to left */
    p = field + size - 1;

    /* make note if this is a negative number */
    negative = value < 0;
    if (negative)
        value = -value;

    /* Case: Null field.  Can't do anything */
    if (p < field)
        ;

    /* Case: value is zero.  Print a leading '0' */
    else if (value == 0)
        *p-- = '0';

    /* Otherwise, convert each digit in turn */
    else do
        {

        dividend = value / 10;
        remainder = value - dividend * 10;
        value = dividend;

        *p-- = (char) (  (int)'0'  +  remainder  );

        } while (p >= field && value > 0);

    /* insert a minus sign if appropriate */
    if (negative && p >= field)
```

```
        *p-- = '-';

    /* fill in leading characters */
    while (p >= field)
        *p-- = fill;
    }


int cvtint(str)
/*************************************************************
getint extracts an integer value from the given character field
(ex: turns the string "123" into the integer 123)
*************************************************************/
    char *str;
    {
    int value;
    char c;
    int negative;
    debug("cvtint: str=%s\n", str);

    negative = (*str == '-');
    if (negative)  str++;

    /* convert the integer */
    for (value = 0; isdigit(*str); str++)
        value = value*10 + (int)(*str) - (int)'0';

    /* if any non-digit characters, error */
    if (*str != '\0')
          return INVALID_NUM;

    /* make negative if there was a minus sign */
    if (negative)
        value = -value;

    debug("cvtint: value=%d\n", value);
    return value;
    }



fmt_phone(str, phone)
    char str[20];
    char *phone;

    {
    /* copy phone number and insert dashes  999999-999-999-9999 */
    str[0] = phone[0];  str[1] = phone[1]; str[2] = phone[2];
    str[3] = phone[3];  str[4] = phone[4]; str[5] = phone[5];
    str[6] = '-';
    str[7] = phone[6];  str[8] = phone[7]; str[9] = phone[8];
    str[10] = '-';
    str[11] = phone[9]; str[12] = phone[10]; str[13] = phone[11];
    str[14] = '-';
    str[15] = phone[12]; str[16] = phone[13]; str[17] = phone[14];
    str[18] = phone[15];
    str[19] = '\0';
    }


fmt_zip(str,zip)
    char str[20];
    char *zip;
    {
    /* copy zip code and insert dashes 99999-9999 */
    str[0] = zip[0];  str[1] = zip[1];  str[2] = zip[2];
    str[3] = zip[3];  str[4] = zip[4];
    str[5] = '-';
    str[6] = zip[5]; str[7] = zip[6]; str[8] = zip[7];  str[9] = zip[8];
    str[10] = '\0';
    }
```

lib/iobuf.h

```
/*****************************************************************************
 @(#) Version: A.10.10 $Date: 97/12/15 10:56:52 $

 (c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
*****************************************************************************/

/*********************************************************************
History
941220 LAN Added definition and initialization of the line_col[] array.
       This was needed for modifications made of client program to do
       block I/O using a WYSE terminal.
*********************************************************************/

/* structure for screen emulation */
typedef struct
    {
    int row;
    int col;
    char buf[25][81];
    } screen_t;


typedef struct {
    char *beg;
    char *end;   /* for output buffers */
    char *max;
    char *cur;   /* for input buffers */
    } iobuf;

/* Macro do define an I/O buffer of x characters, initialized to empty */
#define define_iobuf(name, size)                          \
char name##_data[size];                                   \
iobuf name[1] = {{name##_data, name##_data,       \
                  name##_data+size, name##_data}}

#define reset(buf)  if (1) { \
    (buf)->cur = (buf)->end = (buf)->beg;                 \
    *(buf)->beg = '\0';                                    \
    } else (void)0

#define flush()  if(1) { \
        display(out_buf);    \
        reset(out_buf);     \
     } else (void)0


/* Standard I/O to and from in_buf and out_buf */
#ifdef DECLARE_IO_BUFFERS
define_iobuf(output_stuff, 4*1024);
define_iobuf(input_stuff, 1024);
iobuf *in_buf = input_stuff;
iobuf *out_buf = output_stuff;
#else
iobuf *in_buf;
iobuf *out_buf;
#endif

#define pushc(c) if (1) { \
    if (out_buf->end >= out_buf->max)   \
         error("out_buf overflow:  beg=0x%x end=%d  max=%d\n",  \
          out_buf->beg, out_buf->end-out_buf->beg,out_buf->max-out_buf->beg); \
    *(out_buf->end++) = (c);  \
    *(out_buf->end) = '\0';  /* debug */ \
    } else (void)0

#define popc()  \
    (*in_buf->cur++)


/* Standard characters used for screen control */
#define ENTER '\015'
#define TAB   '\t'
#define BACKTAB '\02'  /*  ^B  */
#define CNTRLC '\03'
#define BACKSPACE '\010'
#define BELL '\07'
#define BLANK ' '
#define UNDERLINE '_'
#define ESCAPE '\033'
/*#define EOF    ((char)-1) */
```

```
#define TRIGGER '\021'  /* dc1 */
```

lib/iobuf.c

```
/*****************************************************************************
 @(#) Version: A.10.10 $Date: 97/12/15 10:56:52 $

 (c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
*****************************************************************************/
#define DECLARE_IO_BUFFERS
#include "iobuf.h"
#undef DECLARE_IO_BUFFERS
#include "tpcc.h"
#include <errno.h>



string(str)
    char str[];
    {
    for (; *str != '\0'; str++)
        pushc(*str);
    }


push(str, len)
    char *str;
    int len;
    {
    for (; len > 0; len --)
        pushc(*str++);
    }


display(scr)
    iobuf *scr;
    {
/* Note: if problems doing output, let the input routine detect it */
    char *p;
    int len;
    for (p = scr->beg; p < scr->end; p+=len)
        {
        len = write(1, p, scr->end - p);
        if (len <= 0) break;
        }
    }


input(scr)
    iobuf *scr;
    {
    int len;

    /* read in as many characters as are available */
    len = read(0, scr->end, scr->max - scr->end);

    /* if end of input, then pretend we read an END character */
    if (len == 0 || (len == -1 && errno == ECONNRESET))
        {
        *scr->end = EOF;
        len = 1;
        }

    /* Check for errors */
    else if (len == -1)
        syserror("input(scr): unable to read stdin\n");

    /* update the pointers to reflect the new data */
    scr->end += len;
    *scr->end='\0';  /* for debugging */
    }
```

```
getkey()
    {
    if (in_buf->cur == in_buf->end)
        {
        flush();
        reset(in_buf);
        input(in_buf);
        }

    return popc();
    }
```

lib/random.c

```
/*****************************************************************************
 @(#) Version: A.10.10 $Date: 97/12/15 14:01:59 $

 (c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
*****************************************************************************/
#include "tpcc.h"
#include "string.h"
#include "random.h"

double drand48();

char lastNames[1000][16];
char customerData1[10][301];
char customerData2[10][201];
char stockData1[10][27];
char stockData2[10][25];
char historyData1[10][13];
char historyData2[10][13];
char citystreetData1[10][11];
char citystreetData2[10][11];
char firstNameData1[10][9];
char firstNameData2[10][9];
char StockDistrict[10][25];
char phoneData[10][17];

static long RandySeedIter = 7;

void GenerateLastNames()
{
    int      i;
    char *name;
    static char *n[] = {"BAR", "OUGHT", "ABLE", "PRI", "PRES",
                        "ESE", "ANTI", "CALLY", "ATION", "EING"};

    for(i = 0; i < 1000; i++) {
        name = lastNames[i];
        strcpy(name, n[(i/100)%10]);
        strcat(name, n[(i/10) %10]);
        strcat(name, n[(i/1)  %10]);
    }
}

int MakeNumberString(min, max, num)
    int min;
    int max;
    TEXT num[];
    {
    static char digit[]="0123456789";
    int length;
    int i;

    length = RandomNumber(min, max);

    for (i=0;  i<length;  i++)
        num[i] = digit[RandomNumber(0,9)];
    num[length] = '\0';

    return length;
    }
```

```
ID RandomWarehouse(local, scale, percent)
    ID local;
    ID scale;
    int percent;   /* percent of remote transactions */
    {
    ID w_id;

    /* For the given percent of the time, pick the local warehouse */
    if (RandomNumber(1, 100) > percent || scale == 1)
        w_id = local;

    /* Otherwise, pick a non-local warehouse */
    else
        {
        w_id = RandomNumber(2, scale);
        if (w_id == local)
            w_id = 1;
        }
    return w_id;
    }


/* Initialize a table of Random strings for the stock-district
   field in the stock table.  We can use a table of 10 elements
   and select randomly from this table via rule 4.3.2.2 in
   the TPC-C spec */
void InitRandomStrings()
{
    int i;

    for (i=0; i < 10; i++) {
              MakeAlphaString(24,24,&StockDistrict[i]);

              MakeAlphaString(300,300,&customerData1[i]);
              MakeAlphaString(0,200,&customerData2[i]);

              MakeAlphaString(26,26,&stockData1[i]);
              MakeAlphaString(0,24,&stockData2[i]);

              MakeAlphaString(12,12,&historyData1[i]);
              MakeAlphaString(0,12, &historyData2[i]);

              MakeAlphaString(10,10,&citystreetData1[i]);
              MakeAlphaString(0 ,10,&citystreetData2[i]);

              MakeAlphaString(8,8,&firstNameData1[i]);
              MakeAlphaString(0,8,&firstNameData2[i]);

              MakeNumberString(16,16,&phoneData[i]);
          }
          GenerateLastNames();
}

int MakeAlphaString(min, max, str)
/*****************************************************************
Note: actually an alphunumeric string of upper, lower, digits
*****************************************************************/
    int min;
    int max;
    TEXT str[];
    {
    static char character[] =
       "ABCDEFGHIGHLMNOPQRSTUVWXYZ0123456789abcdefghijklmnopqrstuvwxyz";
    int length;
    int i;

    length = RandomNumber(min, max);

    for (i=0;  i<length;  i++) {
        /* NOTE:  we use sizeof(character)-2 because of the following:
           subtract 1 because we are numbering from 0 instead of 1 and
           subtract 1 because the sizeof(character) is 1 greater than
           the data in character because of the inivisible C string
           terminator at the end. */
       str[i] = character[RandomNumber(0, sizeof(character)-2)];
    }
    str[length] = '\0';
    return length;
    }

void RandomPermutation(perm, n)
    int perm[];
    int n;
    {
    int i, r, t;

    /* generate the identity permutation to start with */
    for (i=1; i<=n; i++)
        perm[i] = i;

    /* randomly shuffle the permutation */
    for (i=1; i<=n; i++)
        {
        r = RandomNumber(i, n);
        t = perm[i]; perm[i] = perm[r]; perm[r] = t;
        }
    }


void RandomDelay(mean, adjust)
/*****************************************************************
random_sleep sleeps according to the TPC specification
*****************************************************************/
    double mean;
    double adjust;
    {
    double secs;
    double exponential();

    secs = exponential(mean);

    delay(secs+adjust);
    }

double exponential(mean)
/*****************************************************************
exponential generates a reverse exponential distribution
*****************************************************************/
    double mean;
    {
    double x;
    double log();

#ifdef USE_DRAND48
    x = -log(1.0-drand48()) * mean;
#else
    x = -log(1.0-randy()) * mean;
#endif

    return x;
    }

void SetRandomSeed(val)
long val;
    {
#ifdef USE_DRAND48
    srand48(val);
#else
    RandySeedIter = val;
#endif
    }

void Randomize()
    {
    SetRandomSeed(time(0)+getpid());
    }

/* Random number generator from Proceeding of the ACM */
#define RANDY_A_VAL 16807
/* 2^31 - 1 */
#define RANDY_M_VAL 2147483647
/* m / a */
#define RANDY_Q_VAL 127773
/* m % a */
#define RANDY_R_VAL 2836
```

```
double randy()
{
  long    hi, lo, test;

  hi = RandySeedIter / RANDY_Q_VAL;
  lo = RandySeedIter % RANDY_Q_VAL;

  test = (RANDY_A_VAL * lo) - (RANDY_R_VAL * hi);
  RandySeedIter = (test > 0) ? test : test + RANDY_M_VAL;

  return( (double)RandySeedIter / (double)RANDY_M_VAL );
}  /* end of fn randy  */
```

lib/random.h

```
/*****************************************************************************
 @(#) Version: A.10.10 $Date: 97/12/15 14:02:00 $

 (c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
*****************************************************************************/
#ifndef TPCC_RANDOM
#define TPCC_RANDOM

#ifdef USE_DRAND48
double drand48();
#else
double randy();
#endif

extern int    MakeNumberString();
extern ID     RandomWarehouse();
extern int    MakeAlphaString();
extern void   RandomPermutation();
extern void   RandomDelay();
extern double exponential();
extern void   Randomize();
extern void   SetRandomSeed();

extern char lastNames[1000][16];
extern char customerData1[10][301];
extern char customerData2[10][201];
extern char stockData1[10][27];
extern char stockData2[10][25];
extern char historyData1[10][13];
extern char historyData2[10][13];
extern char citystreetData1[10][11];
extern char citystreetData2[10][11];
extern char firstNameData1[10][9];
extern char firstNameData2[10][9];
extern char StockDistrict[10][25];
extern char phoneData[10][17];

/*********************************************************************
RandomNumber selects a uniform random number from min to max inclusive
*********************************************************************/
#ifdef USE_DRAND48
#define RandomNumber(min,max)  \
          ((int)(drand48() * ((int)(max) - (int)(min) + 1)) + (int)(min))
#else
#define RandomNumber(min,max)  \
          ((int)(randy() * ((int)(max) - (int)(min) + 1)) + (int)(min))
#endif

/*********************************************************************
NURandomNumber selects a non-uniform random number
*********************************************************************/
#define NURandomNumber(a, min, max, c) \
    ((RandomNumber(0, a) | RandomNumber(min, max)) + (c)) % \
                    ((max) - (min) + 1) + (min)


#define SelectCityStreetData(data) \
{ \
    strcpy(data,citystreetData1[RandomNumber(0,9)]); \
    strcat(data,citystreetData2[RandomNumber(0,9)]); \
}

#define SelectFirstName(data) \
{ \
    strcpy(data,firstNameData1[RandomNumber(0,9)]); \
    strcat(data,firstNameData2[RandomNumber(0,9)]); \
}

#define SelectHistoryData(data) \
{ \
    strcpy(data,historyData1[RandomNumber(0,9)]); \
    strcat(data,historyData2[RandomNumber(0,9)]); \
}

#define SelectStockData(data) \
{ \
    strcpy(data,stockData1[RandomNumber(0,9)]); \
    strcat(data,stockData2[RandomNumber(0,9)]); \
}

#define SelectClientData(data) \
{ \
    strcpy(data,customerData1[RandomNumber(0,9)]); \
    strcat(data,customerData2[RandomNumber(0,9)]); \
}

#define SelectPhoneData(data) strcpy(data,phoneData[RandomNumber(0,9)])
#define SelectStockDistrict(data) strcpy(data,StockDistrict[RandomNumber(0,9)])

#define MakeZip(zip) \
{ \
   MakeNumberString(4, 4, zip); \
   zip[4] = '1'; \
   zip[5] = '1'; \
   zip[6] = '1'; \
   zip[7] = '1'; \
   zip[8] = '1'; \
   zip[9] = '\0'; \
}

#define MakeAddress(str1, str2, city, state, zip) \
{ \
    SelectCityStreetData(str1); \
    SelectCityStreetData(str2); \
    SelectCityStreetData(city); \
    MakeAlphaString(2,2,state); \
    MakeZip(zip); \
}

#define LastName(num, name) strcpy(name, lastNames[(num)])

#define Original(str) \
{ \
    int len = strlen(str); \
    if (len >= 8) { \
        int pos = RandomNumber(0,(len-8)); \
        str[pos+0] = 'O'; \
        str[pos+1] = 'R'; \
        str[pos+2] = 'I'; \
        str[pos+3] = 'G'; \
        str[pos+4] = 'I'; \
        str[pos+5] = 'N'; \
        str[pos+6] = 'A'; \
        str[pos+7] = 'L'; \
    } \
}


#endif
```

lib/results_file.c

```
/*****************************************************************************
 @(#) Version: A.10.10 $Date: 97/12/15 14:02:01 $
```

```
 (c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
*************************************************************************/
#include <unistd.h>
#include <stdio.h>
#include <stdlib.h>
#include "tpcc.h"



static FILE *rfile;

results_open(id)
    int id;
    {
    char fullname[128];
    char *basename;

    /* get the base file name for the deferred results */
    /*
     * Make it a directory under /tmp so at least we can set it to a
     * symbolic link in case /tmp doesn't have enough room.
     */
    basename = getenv("TPCC_RESULTS_FILE");
    if (basename == NULL)
        basename = "/tmp/TPCC_RESULTS_FILE";

    /* create the full file name */
    sprintf(fullname, "%s.%d", basename, id);

    /* open the file */
    unlink(fullname);
    rfile = fopen(fullname, "wb");
    if (rfile == NULL)
        syserror("Delivery server %d can't open file %s\n", id, fullname);

    /* allocate a larger buffer */
    }



results(t)
    delivery_trans *t;
    {
    if (fwrite(t, sizeof(*t), 1, rfile) != 1)
        syserror("Delivery server: Can't post results\n");
    }


results_close()
    {
    if (fclose(rfile) < 0)
        syserror("Delivery server can't close file\n");
    }
```

lib/delay.c

```
/*************************************************************************
 @(#) Version: A.10.10 $Date: 97/12/15 10:56:52 $

 (c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
*************************************************************************/
#include <sys/time.h>
#include <errno.h>
#ifndef HPUX9
#include <time.h>
#endif
#include "tpcc.h"
#include "shm.h"

delay(sec)
/*********************************************************************
delay sleeps for the specified number of seconds.  (to closest 1/100'th second)
*********************************************************************/
    double sec;
    {
#ifdef HPUX9
    struct timeval delay;
#else
    struct timespec delay;
#endif

    /* if no delay,  done */
    if (sec <= 0.0) return;

    /* add a portion of a clock tick to keep averages correct */
    sec += 1.0 / CLK_TCK;

    /* convert the delay to seconds and nanoseconds */
    delay.tv_sec = sec;
#ifdef HPUX9
    delay.tv_usec = (sec - delay.tv_sec) * 1000000;
#else
    delay.tv_nsec = (sec - delay.tv_sec) * 1000000000;
#endif

    /* sleep on a select call */
#ifdef HPUX9
    if (select(0, NULL, NULL, NULL, &delay) < 0) {
        syserror("delay:  select() call failed\n");
    }
#else
    if (nanosleep(&delay,NULL) == -1) {
          if (errno != EINTR) {
            syserror("delay:  nanosleep() call failed, errno = %d\n",errno);
          }
    }
#endif
}



struct timeval start_time;

initclock()
    {
    gettimeofday(&start_time, NULL);
    }


TIME getclock()
/*********************************************************************
getclock returns the current time, expressed in seconds from start of run
*********************************************************************/
    {
    struct timeval current;
    gettimeofday(&current, NULL);

    return elapsed_time(&current);
    }
```

A.3 Transaction Source

client/sybase/transaction.c

```
/*************************************************************************
 @(#) Version: A.10.10 $Date: 98/02/03 08:14:29 $

 (c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
*************************************************************************/

#include <sybfront.h>
#include <sybdb.h>
#include "tpcc.h"

#define MaxTries 10
```

```
int deadlock = NO;

int user;
LOGINREC        *login;
DBPROCESS *dbproc;

#define from_sybase_date(sybdate, date) { \
    date.day = sybdate.dtdays; \
    date.sec = sybdate.dttime / 300; \
}

transaction_begin(u)
    int u;
    {
    char *packet;
    int message_handler(), error_handler();

    user = u;

    /* initialize dblib */
    if (dbinit() != SUCCEED)
        error("Can't initialize the DB library\n");

    /* install a message handler */
    (void)dbmsghandle(message_handler);
    (void)dberrhandle(error_handler);

    /* set up Sybase structures */
    login = dblogin();
    DBSETLUSER(login, "sa");
    DBSETLPACKET(login,4096);

    /* Open the connection to the server. */
    if ((dbproc = dbopen(login, (char *)NULL )) == NULL)
        error("Could not open connection\n");

    /* Use the TPCC database */
    dbuse(dbproc, "tpcc");
    }


transaction_done()
    {
    /* put detach from database here */
    dbexit();
    }



#define INT2(p) ((short *)(p)+1)
#define INT1(p) ((char *)(p)+3)


void neworder_transaction(t)
    neworder_trans *t;
    {
    int try;

    /* repeat until we give up trying */
    for (try=0; try<MaxTries; try++)
        {
          deadlock = NO;
        /* if the transactation succeeds, then done */
        if (neworder_body(t))
            break;

        /* clean up and try again */
        dbcancel(dbproc);
        sleep_before_retry();

        /* don't retry if caused by operator error */
        if (t->status == E_INVALID_INPUT) break;
        }

    /* if we finally gave up, then display a message */
    if (try >= MaxTries)
        t->status = E_DB_ERROR;
    }
```

```
int neworder_body (t)
    neworder_trans *t;
    {
    int i;
    DBDATETIME o_entry_d;
    DATE       o_entry_d_DATE;
    REAL tax_n_discount;
    deadlock = NO;

    debug("Neworder: w_id=%d d_id=%d c_id=%d\n", t->W_ID, t->D_ID, t->C_ID);

    /* assume everthing fine unless otherwise */
    t->status = OK;

    /* see if our items are all local */
    for (i=0;  i<t->O_OL_CNT; i++)
        if (t->item[i].OL_SUPPLY_W_ID != t->W_ID) break;
    t->all_local = (i >= t->O_OL_CNT);

    /* prepare the parameters for the "neworder" transaction. */
    if (t->all_local)    dbrpcinit(dbproc, "neworder_local", 0);
    else                 dbrpcinit(dbproc, "neworder_remote", 0);
    dbrpcparam(dbproc, NULL, 0, SYBINT2,  -1, -1, INT2(&t->W_ID));
    dbrpcparam(dbproc, NULL, 0, SYBINT1,  -1, -1, INT1(&t->D_ID));
    dbrpcparam(dbproc, NULL, 0, SYBINT4,  -1, -1, &t->C_ID);
    dbrpcparam(dbproc, NULL, 0, SYBINT4,  -1, -1, &t->O_OL_CNT);

    /* Send the orderlines (up to 15) */
    for(i = 0; i < t->O_OL_CNT; i++)
        {
        debug("    i=%d  i_id=%d  w_id=%d  qty=%d\n", i, t->item[i].OL_I_ID,
             t->item[i].OL_SUPPLY_W_ID, t->item[i].OL_QUANTITY);
        dbrpcparam(dbproc,NULL,0,SYBINT4, -1, -1, &t->item[i].OL_I_ID);
        if (!t->all_local)
            dbrpcparam(dbproc,NULL,0,SYBINT2, -1, -1,
                    INT2(&t->item[i].OL_SUPPLY_W_ID));
        dbrpcparam(dbproc,NULL,0,SYBINT1,-1,-1,INT1(&t->item[i].OL_QUANTITY));
        }

    /* execute the neworder transaction */
    if (dbrpcsend(dbproc) != SUCCEED) return NO;
    if (dbsqlok(dbproc)   != SUCCEED) return NO;

    /* get results from order lines */
    for (i = 0; i < t->O_OL_CNT; i++)
        if (!order_line_result(dbproc, &t->item[i], &t->status))
            break;

    /* get the results of the overall neworder transaction */
    if ((dbresults(dbproc) != SUCCEED) || deadlock) return NO;
    dbbind(dbproc, 1, FLT8BIND,         0, &t->W_TAX);
    dbbind(dbproc, 2, FLT8BIND,          0, &t->D_TAX);
    dbbind(dbproc, 3, INTBIND,           0, &t->O_ID);
    dbbind(dbproc, 4, NTBSTRINGBIND, sizeof(t->C_LAST), t->C_LAST);
    dbbind(dbproc, 5, FLT8BIND,          0,              &t->C_DISCOUNT);
    dbbind(dbproc, 6, NTBSTRINGBIND, sizeof(t->C_CREDIT), t->C_CREDIT);
    dbbind(dbproc, 7, DATETIMEBIND,  0,    &o_entry_d);
    if ((dbnextrow(dbproc) != REG_ROW) || deadlock) return NO;
    if ((dbcanquery(dbproc) != SUCCEED) || deadlock) return NO;

    /* convert the date */
    from_sybase_date(o_entry_d, o_entry_d_DATE);
    fmt_date(&t->O_ENTRY_D,&o_entry_d_DATE);

    /* Check for invalid input (what is -6 anyway?) */
    if (dbretstatus(dbproc) == -6)      {
          deadlock = YES;
        t->status = E_INVALID_INPUT;
        return NO;
    }
    /* done */
    return YES;
    }


int order_line_result(dbproc, item, status)
```

```
    DBPROCESS *dbproc;
    neworder_item *item;
    int *status;
    {

    /* Each order line is a separate query. Fetch the data */
    if ((dbresults(dbproc) != SUCCEED) || deadlock) return NO;
    dbbind(dbproc, 1, NTBSTRINGBIND, sizeof(item->I_NAME), item->I_NAME);
    dbbind(dbproc, 2, FLT8BIND, 0, &item->I_PRICE);
    dbbind(dbproc, 3, INTBIND,  0, &item->S_QUANTITY);
    dbbind(dbproc, 4, CHARBIND, 1, &item->brand_generic);
    if ((dbnextrow(dbproc) != REG_ROW) || deadlock)  return NO;
    if ((dbcanquery(dbproc) != SUCCEED) || deadlock) return NO;
    if (dbhasretstat(dbproc) && dbretstatus(dbproc) != 0)  return NO;

    /* Note: items that weren't found will have empty I_NAME */
    if (item->I_NAME[0] == '\0')
        *status = E_INVALID_ITEM;
    return YES;
    }



void payment_transaction(t)
    payment_trans *t;
    {
    int try;

    /* repeat until we give up trying */
    for (try=0; try<MaxTries; try++)
        {

        /* if the transactation succeeds, then done */
        if (payment_body(t))
            break;

        /* clean up and try again */
        dbcancel(dbproc);
        sleep_before_retry();

        /* don't retry if caused by operator error */
        if (t->status == E_INVALID_INPUT) break;
        }

    /* if we finally gave up, then display a message */
    if (try >= MaxTries)
        t->status = E_DB_ERROR;
    }


int payment_body(t)
    payment_trans *t;
    {
    DBDATETIME H_DATE;
    DATE  H_DATE_DATE;
    DBDATETIME C_SINCE;
    DATE C_SINCE_DATE;
    deadlock = NO;
    if (t->byname)
        {
        dbrpcinit(dbproc, "payment_byname", 0);
        dbrpcparam(dbproc, NULL, 0, SYBINT2, -1, -1, INT2(&t->W_ID));
        dbrpcparam(dbproc, NULL, 0, SYBINT2, -1, -1, INT2(&t->C_W_ID));
        dbrpcparam(dbproc, NULL, 0, SYBFLT8, -1, -1, &t->H_AMOUNT);
        dbrpcparam(dbproc, NULL, 0, SYBINT1, -1, -1, INT1(&t->D_ID));
        dbrpcparam(dbproc, NULL, 0, SYBINT1, -1, -1, INT1(&t->C_D_ID));
        dbrpcparam(dbproc, NULL, 0, SYBCHAR, -1, strlen(t->C_LAST), t->C_LAST);
        }
    else
        {
        dbrpcinit(dbproc, "payment_byid", 0);
        dbrpcparam(dbproc, NULL, 0, SYBINT2, -1, -1, INT2(&t->W_ID));
        dbrpcparam(dbproc, NULL, 0, SYBINT2, -1, -1, INT2(&t->C_W_ID));
        dbrpcparam(dbproc, NULL, 0, SYBFLT8, -1, -1, &t->H_AMOUNT);
        dbrpcparam(dbproc, NULL, 0, SYBINT1, -1, -1, INT1(&t->D_ID));
        dbrpcparam(dbproc, NULL, 0, SYBINT1, -1, -1, INT1(&t->C_D_ID));
        dbrpcparam(dbproc, NULL, 0, SYBINT4, -1, -1, &t->C_ID);
        }

    if (dbrpcsend(dbproc) != SUCCEED) return NO;
    if (dbsqlok(dbproc) != SUCCEED) return NO;
    if ((dbresults(dbproc) != SUCCEED) || deadlock) return NO;

    dbbind(dbproc,  1, INTBIND,     0, &t->C_ID);
    dbbind(dbproc,  2, NTBSTRINGBIND, sizeof(t->C_LAST), t->C_LAST);
    dbbind(dbproc,  3, DATETIMEBIND,  0, &H_DATE);
    dbbind(dbproc,  4, NTBSTRINGBIND, sizeof(t->W_STREET_1), t->W_STREET_1);
    dbbind(dbproc,  5, NTBSTRINGBIND, sizeof(t->W_STREET_2), t->W_STREET_2);
    dbbind(dbproc,  6, NTBSTRINGBIND, sizeof(t->W_CITY), t->W_CITY);
    dbbind(dbproc,  7, NTBSTRINGBIND, sizeof(t->W_STATE), t->W_STATE);
    dbbind(dbproc,  8, NTBSTRINGBIND, sizeof(t->W_ZIP), t->W_ZIP);

    dbbind(dbproc,  9, NTBSTRINGBIND, sizeof(t->D_STREET_1), t->D_STREET_1);
    dbbind(dbproc, 10, NTBSTRINGBIND, sizeof(t->D_STREET_2), t->D_STREET_2);
    dbbind(dbproc, 11, NTBSTRINGBIND, sizeof(t->D_CITY), t->D_CITY);
    dbbind(dbproc, 12, NTBSTRINGBIND, sizeof(t->D_STATE), t->D_STATE);
    dbbind(dbproc, 13, NTBSTRINGBIND, sizeof(t->D_ZIP), t->D_ZIP);

    dbbind(dbproc, 14, NTBSTRINGBIND, sizeof(t->C_FIRST), t->C_FIRST);
    dbbind(dbproc, 15, NTBSTRINGBIND, sizeof(t->C_MIDDLE), t->C_MIDDLE);
    dbbind(dbproc, 16, NTBSTRINGBIND, sizeof(t->C_STREET_1), t->C_STREET_1);
    dbbind(dbproc, 17, NTBSTRINGBIND, sizeof(t->C_STREET_2), t->C_STREET_2);
    dbbind(dbproc, 18, NTBSTRINGBIND, sizeof(t->C_CITY), t->C_CITY);
    dbbind(dbproc, 19, NTBSTRINGBIND, sizeof(t->C_STATE), t->C_STATE);
    dbbind(dbproc, 20, NTBSTRINGBIND, sizeof(t->C_ZIP), t->C_ZIP);
    dbbind(dbproc, 21, NTBSTRINGBIND, sizeof(t->C_PHONE), t->C_PHONE);
    dbbind(dbproc, 22, DATETIMEBIND,  0, &C_SINCE);
    dbbind(dbproc, 23, NTBSTRINGBIND, sizeof(t->C_CREDIT), t->C_CREDIT);
    dbbind(dbproc, 24, FLT8BIND,      0, &t->C_CREDIT_LIM);
    dbbind(dbproc, 25, FLT8BIND,      0, &t->C_DISCOUNT);
    dbbind(dbproc, 26, FLT8BIND,      0, &t->C_BALANCE);
    dbbind(dbproc, 27, NTBSTRINGBIND, sizeof(t->C_DATA), t->C_DATA);

    if ((dbnextrow(dbproc) != REG_ROW) || deadlock) return NO;
    if ((dbcanquery(dbproc) != SUCCEED) || deadlock) return NO;

    t->status = OK;
    /* need to be in string format */

    from_sybase_date(C_SINCE, C_SINCE_DATE);
    from_sybase_date(H_DATE, H_DATE_DATE);
    fmt_date(t->H_DATE, &H_DATE_DATE);
    fmt_date(t->C_SINCE, &C_SINCE_DATE);

    /* Check for invalid input */
    if (dbretstatus(dbproc) == -6)      {
        t->status = E_INVALID_INPUT;
        return NO;
    }

    return YES;
    }


void ordstat_transaction(t)
    ordstat_trans *t;
    {
    int try;

    /* repeat until we give up trying */
    for (try=0; try<MaxTries; try++)
        {

        /* if the transactation succeeds, then done */
        if (ordstat_body(t))
            break;

        /* clean up and try again */
        dbcancel(dbproc);
        sleep_before_retry();

        /* don't retry if caused by operator error */
        if (t->status == E_INVALID_INPUT) break;
        }

    /* if we finally gave up, then display a message */
```

```
    if (try >= MaxTries)
        t->status = E_DB_ERROR;
    }



int ordstat_body(t)
    ordstat_trans *t;
    {
    ID ol_supply_w_id;
    ID ol_i_id;
    COUNT ol_quantity;
    MONEY ol_amount;
    DBDATETIME ol_delivery_d;
    DBDATETIME o_entry_d;
    DATE       ol_delivery_d_DATE;
    DATE       o_entry_d_DATE;

    int i, code;
    deadlock = NO;

    /* if this is by name, then invoke the byname procedure */
    if (t->byname)
        {
        dbrpcinit(dbproc, "order_status_byname", 0);
        dbrpcparam(dbproc, NULL, 0, SYBINT2, -1, -1, INT2(&t->W_ID));
        dbrpcparam(dbproc, NULL, 0, SYBINT1, -1, -1, INT1(&t->D_ID));
        dbrpcparam(dbproc, NULL, 0, SYBCHAR, -1, strlen(t->C_LAST), t->C_LAST);
        }

    /* otherwise, invoke the by id procedure */
    else
        {
        dbrpcinit(dbproc, "order_status_byid", 0);
        dbrpcparam(dbproc, NULL, 0, SYBINT2, -1, -1, INT2(&t->W_ID));
        dbrpcparam(dbproc, NULL, 0, SYBINT1, -1, -1, INT1(&t->D_ID));
        dbrpcparam(dbproc, NULL, 0, SYBINT4, -1, -1, &t->C_ID);
        }

    /* make the rpc call and check for errors */
    if (dbrpcsend(dbproc) != SUCCEED) return NO;
    if (dbsqlok(dbproc) != SUCCEED) return NO;
    if ((dbresults(dbproc) != SUCCEED) || deadlock) return NO;

    /* Code for TPC-C rev. 3.3 error checking.  */
    if (dbrows(dbproc) != SUCCEED )     {
        t->status = E_INVALID_INPUT;
    }
    /* prepare to fetch the results */
    dbbind(dbproc, 1, INTBIND,       0,     &ol_supply_w_id);
    dbbind(dbproc, 2, INTBIND,       0,     &ol_i_id);
    dbbind(dbproc, 3, INTBIND,       0,     &ol_quantity);
    dbbind(dbproc, 4, FLT8BIND,      0,     &ol_amount);
    dbbind(dbproc, 5, DATETIMEBIND,  0,     &ol_delivery_d);


    /* do for each row */
    for (i=0; (code = dbnextrow(dbproc)) == REG_ROW &&  i<15; i++) {

        /* move the information into the structure  */
        t->item[i].OL_SUPPLY_W_ID = ol_supply_w_id;
        t->item[i].OL_I_ID = ol_i_id;
        t->item[i].OL_QUANTITY = ol_quantity;
        t->item[i].OL_AMOUNT = ol_amount;
        from_sybase_date(ol_delivery_d, ol_delivery_d_DATE);
        if (IsEmptyDate(&ol_delivery_d_DATE)) {
            t->item[i].OL_DELIVERY_DATE[0] = '\0';
        } else {
            fmt_date(t->item[i].OL_DELIVERY_DATE, &ol_delivery_d_DATE);
        }
    }

    if (code != NO_MORE_ROWS) return NO;

    /* remember how many rows we found */
    t->ol_cnt = i;

    if ((dbresults(dbproc) != SUCCEED) || deadlock) return NO;

    /* Code for TPC-C rev. 3.3 error checking.  */
    if (dbrows(dbproc) != SUCCEED )     {
        t->status = E_INVALID_INPUT;
    }

    /* fetch the remaining information */
    dbbind(dbproc, 1, INTBIND,     0,     &t->C_ID);
    dbbind(dbproc, 2, NTBSTRINGBIND, sizeof(t->C_LAST), t->C_LAST);
    dbbind(dbproc, 3, NTBSTRINGBIND, sizeof(t->C_FIRST), t->C_FIRST);
    dbbind(dbproc, 4, NTBSTRINGBIND, sizeof(t->C_MIDDLE), t->C_MIDDLE);
    dbbind(dbproc, 5, FLT8BIND,      0,     &t->C_BALANCE);
    dbbind(dbproc, 6, INTBIND,       0,     &t->O_ID);
    dbbind(dbproc, 7, DATETIMEBIND,  0, &o_entry_d);
    dbbind(dbproc, 8, INTBIND,     0,     &t->O_CARRIER_ID);
    if ((dbnextrow(dbproc) != REG_ROW) || deadlock) return NO;
    if ((dbcanquery(dbproc) != SUCCEED) || deadlock) return NO;

    /* convert the date */
    from_sybase_date(o_entry_d, o_entry_d_DATE);
    fmt_date(t->O_ENTRY_DATE, &o_entry_d_DATE);

    t->status = OK;
    return YES;
    }



delivery_transaction(t)
    delivery_trans *t;
    {
    ID d;

    int try;
    d = 1;

    /* repeat until we give up trying */
    for (try=0; try<MaxTries; try++)
        {

        /* if the transactation succeeds, then done */
        d = delivery_body(t, d);
        if (d > 10) break;

        /* clean up and try again */
        dbcancel(dbproc);
        sleep_before_retry();

        /* don't retry if caused by operator error */
        if (t->status == E_INVALID_INPUT) break;
        }

    /* any uncompleted districts have an error */
    for (  ; d <= 10;  d++)
        t->order[d-1].status = E_DB_ERROR;
    }


int delivery_body(t, d)
    delivery_trans *t;
    ID d;
    {
    deadlock=NO;

    dbrpcinit(dbproc, "delivery", 0);
    dbrpcparam(dbproc, NULL, 0, SYBINT2, -1, -1, INT2(&t->W_ID));
    dbrpcparam(dbproc, NULL, 0, SYBINT2, -1, -1, INT2(&t->O_CARRIER_ID));
    dbrpcparam(dbproc, NULL, 0, SYBINT1, -1, -1, INT1(&d));
    if (dbrpcsend(dbproc) != SUCCEED) return d;
    if (dbsqlok(dbproc) != SUCCEED) return d;

    for ( ; d <= 10; d++)
        {

        /* Each order line is a separate query. Fetch the data */
        if ((dbresults(dbproc) != SUCCEED) || deadlock) break;
        dbbind(dbproc, 1, INTBIND,  0, &t->order[d-1].O_ID);
        if (dbnextrow(dbproc) != REG_ROW)  break;
        if (dbcanquery(dbproc) != SUCCEED) break;
```

```
        if (dbhasretstat(dbproc) && dbretstatus(dbproc) != 0)  break;

        if (t->order[d-1].O_ID == 0) t->order[d-1].status=E_NOT_ENOUGH_ORDERS;
        else                         t->order[d-1].status = OK;
        }

    return d;
    }



stocklev_transaction(t)
    stocklev_trans *t;
    {
    int try;
    /* repeat until we give up trying */
    for (try=0; try<MaxTries; try++)
        {

        /* if the transactation succeeds, then done */
        if (stocklev_body(t))
            break;

        /* clean up and try again */
        dbcancel(dbproc);
        sleep_before_retry();

        /* don't retry if caused by operator error */
        if (t->status == E_INVALID_INPUT) break;
        }

    /* if we finally gave up, then display a message */
    if (try >= MaxTries)
        t->status = E_DB_ERROR;

    }


int stocklev_body (t)
    stocklev_trans *t;
    {
    int iid, uniq[500];
    int i, j, count;
    int duplicate_found;
    deadlock = NO;

    dbrpcinit(dbproc, "stock_level", 0);
    dbrpcparam(dbproc, NULL, 0, SYBINT2, -1, -1, INT2(&t->W_ID));
    dbrpcparam(dbproc, NULL, 0, SYBINT1, -1, -1, INT1(&t->D_ID));
    dbrpcparam(dbproc, NULL, 0, SYBINT2, -1, -1, INT2(&t->threshold));
    if (dbrpcsend(dbproc) != SUCCEED) return NO;
    if (dbsqlok(dbproc) != SUCCEED) return NO;

    if ((dbresults(dbproc) != SUCCEED) || deadlock) return NO;
    dbbind(dbproc, 1, INTBIND,  0, &iid);
    count = 0;
    while ((dbnextrow(dbproc) == REG_ROW) && !deadlock) {
        duplicate_found = 0;
        for (j = 0; j < count; j++) {
            if (iid == uniq[j]) {
               duplicate_found = 1;
               break;
            }
        }
        /* if this was a dupicate of something already found, then
           don't count it and continue */
        if (duplicate_found) continue;

        if (count < 500) {
            uniq[count++] = iid;
        } else {
            return NO;
        }
    }
    if ((dbcanquery(dbproc) != SUCCEED) || deadlock) return NO;

    t->status    = OK;

    t->low_stock = count;
    return YES;
    }


int sleep_before_retry()
    {
    delay(.1);
    }


to_sybase_date(date, sybdate)
    DATE *date;
    DBDATETIME *sybdate;
    {
    sybdate->dtdays = date->day;
    sybdate->dttime = date->sec*300;
    }


error_handler(dbproc, msgno, msgstate, severity, msgtext, srvname,
                procname, line)
/*****************************************************************************
error_handler deals with error messages
*****************************************************************************/
    DBPROCESS *dbproc;
    DBINT     msgno;
    int       msgstate;
    int       severity;
    char      *msgtext;
    char      *procname;
    DBUSMALLINT line;
    {
    if (deadlock)
        message("Error: Deadlock detected from %s line %d\n", procname, line);
    else
        message("Error #%d from %s line %d\n%s\n",
                    msgno,    procname, line, msgtext);

    deadlock = NO;
    return INT_CANCEL;
    }



message_handler(dbproc, msgno, msgstate, severity, msgtext, srvname,
                procname, line)
/*****************************************************************************
message_handler deals with informational messges
*****************************************************************************/
    DBPROCESS *dbproc;
    DBINT     msgno;
    int       msgstate;
    int       severity;
    char      *msgtext;
    char      *procname;
    DBUSMALLINT line;
    {

    /* Ignore messages that will be passed to error handler anyway */
    if (msgno == SYBESMSG)
        return(SUCCEED);

    /* Force an error for Deadlocks */
    else if (msgno == 1205)
        {
        deadlock = YES;
        message("Message: Deadlock detected from %s line %d\n", procname, line);
        return(FAIL);
        }

    else if (msgno != 5701 && msgno != 5703 && msgno != 5704)
        {
        message("Message #%d from %s line %d\n%s\n",
                    msgno,    procname, line, msgtext);
        return(FAIL);
        }
    }
```

client/sybase/tux_transaction.c

```
/*****************************************************************************
 @(#) Version: A.10.10 $Date: 97/12/15 10:53:27 $

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*****************************************************************************/

#include <varargs.h>
#include <errno.h>


#include "atmi.h"
#include "Uunix.h"
#include "tpcc.h"
int user;


neworder_trans *neworder_ptr;
payment_trans  *payment_ptr;
ordstat_trans *ordstat_ptr;
stocklev_trans *stocklev_ptr;
delivery_trans *delivery_ptr;

int result;



transaction_begin(u)
    int u;
    {

    /* keep track of which user we are (for error messages only) */
    user = u;

    /* attach to Tuxedo */
    if (tpinit( (TPINIT *)NULL) == -1)
        tux_error("Failed to attach to Tuxedo\n");

    /* allocate structures for each transaction */
    neworder_ptr = tpalloc("CARRAY", NULL, sizeof(neworder_trans));
    payment_ptr = tpalloc("CARRAY", NULL, sizeof(payment_trans));
    ordstat_ptr = tpalloc("CARRAY", NULL, sizeof(ordstat_trans));
    stocklev_ptr = tpalloc("CARRAY", NULL, sizeof(stocklev_trans));
    delivery_ptr = tpalloc("CARRAY", NULL, sizeof(delivery_trans));
    if (neworder_ptr == NULL || payment_ptr == NULL || ordstat_ptr == NULL
        || stocklev_ptr == NULL || delivery_ptr == NULL)
        tux_error("Unable to allocate Tuxedo memory\n");
    }



transaction_done()
    {
    if (tpterm() == -1)
        tux_error("Unable to detach from Tuxedo\n");
    }



void neworder_transaction(t)
    neworder_trans *t;
    {
    *neworder_ptr = *t;
    while (tpcall("NEWO_SVC", neworder_ptr, sizeof(neworder_trans),
              &neworder_ptr, &result, TPSIGRSTRT|TPNOTIME) == -1) {
        tux_error("Tuxedo failed for neworder transaction\n");
          *neworder_ptr = *t;
          }
    *t = *neworder_ptr;
    }



void payment_transaction(t)
    payment_trans *t;
    {
    *payment_ptr = *t;
    while (tpcall("PMT_SVC", payment_ptr, sizeof(payment_trans),
                          &payment_ptr, &result, TPSIGRSTRT|TPNOTIME) == -1) {
        tux_error("Tuxedo failed for payment transaction\n");
          *payment_ptr = *t;
          }
    *t = *payment_ptr;
    }


void ordstat_transaction(t)
    ordstat_trans *t;
    {
    *ordstat_ptr = *t;
    while (tpcall("ORDS_SVC", ordstat_ptr, sizeof(ordstat_trans),
                          &ordstat_ptr, &result, TPSIGRSTRT|TPNOTIME) == -1) {
          tux_error("Tuxedo failed for ordstat transaction\n");
          *ordstat_ptr = *t;
          }
    *t = *ordstat_ptr;
    }



stocklev_transaction(t)
    stocklev_trans *t;
    {
    *stocklev_ptr = *t;
    while (tpcall("STKL_SVC", stocklev_ptr, sizeof(stocklev_trans),
                          &stocklev_ptr, &result, TPSIGRSTRT|TPNOTIME) == -1) {
        tux_error("Tuxedo failed for stocklev transaction\n");
          *stocklev_ptr = *t;
          }
    *t = *stocklev_ptr;
    }


delivery_init(u)
    int u;
    {
    }


delivery_enque(t)
    delivery_trans *t;
    {
    gettimeofday(&t->enque, NULL);
    t->status = OK;

    *delivery_ptr = *t;
    while (tpacall("DVRY_SVC", delivery_ptr, sizeof(delivery_trans),
                TPNOREPLY) == -1) {
        tux_error("Tuxedo failed enqueing delivery transaction\n");
          *delivery_ptr = *t;
          }
    }


delivery_done()
    {
    }



static tux_error(format, va_alist)
    char *format;
    va_dcl
    {
    va_list argptr;

    va_start(argptr);
    vmessage(format, argptr);
```

```
    message("Tuxedo error %d\n", tperrno);

    errno = Uunixerr;
    if (tperrno == TPEOS)
        syserror("Tuxedo encountered O/S error\n");

    if (tperrno != TPESVCERR)
          error("EXITING !!!\n");
    else
          message("Retrying transation\n");

    }
```

client/service.c

```
/*********************************************************************************
 @(#) Version: A.10.10 $Date: 97/12/15 10:53:26 $

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*********************************************************************************/

#include <unistd.h>
#include <sys/types.h>
#include "tpcc.h"
#include "atmi.h"

extern int userid;
char *cmd           = NULL;

int tpsvrinit(argc, argv)
int    argc;
char **argv;
{
    char c;
    int ret;

    /*
     * search for the options
     *    "-n" server number
     *    "-S" server program
     * purpose: to get svr_id & progname for DVRY_LOG files
     *
     */
    while ((c = getopt(argc, argv, "n:S:h:")) != EOF) {
        switch(c) {
        case 'n':
            userid = atoi(optarg);
            break;
        case 'S':
            cmd  = optarg;
            break;
       }
    }

    ret = transaction_begin(userid);
    results_open(userid);

    return 0;
}


void NEWO_SVC(svcinfo)
TPSVCINFO *svcinfo;
{
    neworder_transaction((neworder_trans *)svcinfo->data);
    tpreturn(TPSUCCESS, 0, svcinfo->data, svcinfo->len, 0);
}


void PMT_SVC(svcinfo)
TPSVCINFO *svcinfo;
{

    payment_transaction((payment_trans *)svcinfo->data);
    tpreturn(TPSUCCESS, 0, svcinfo->data, svcinfo->len, 0);
}

void ORDS_SVC(svcinfo)
TPSVCINFO *svcinfo;
{
    ordstat_transaction((ordstat_trans *)svcinfo->data);
    tpreturn(TPSUCCESS, 0, svcinfo->data, svcinfo->len, 0);
}

void STKL_SVC(svcinfo)
TPSVCINFO *svcinfo;
{
    stocklev_transaction((stocklev_trans *)svcinfo->data);
    tpreturn(TPSUCCESS, 0, svcinfo->data, svcinfo->len, 0);
}

void DVRY_SVC(svcinfo)
TPSVCINFO *svcinfo;
{
    delivery_trans *t = (delivery_trans *)svcinfo->data;
    gettimeofday(t->deque, NULL);
    delivery_transaction(t);
    gettimeofday(t->complete, NULL);
    results(t);

    /* Why do we return things ? */
    tpreturn(TPSUCCESS, 0, svcinfo->data, svcinfo->len, 0);
}

/*************************************************************
tpsrvdone cleans up after the TPC transaction service
*************************************************************/
void tpsvrdone()
{
    transaction_done();
    results_close();

    /* Log a message saying we are done */
    message("TUXEDO service %s has shutdown\n", cmd);
}
```

A.4 TPC-C Stored Procedures

tpcc_proc.sh

```
################################################################################
#
# tpcc_proc_case.sh
#
################################################################################
#
# This is the version of procs which was used in the Compaq-Sybase 11.G
# TPC-C benchmark (with the last-minute fixes) - March 26 1997
#
# This case script has the following changes from tpcc_proc_spec.sh
#   In new_order (both local and remote), the stock-item cursor, c_no_is
#   has been removed and replaced with an update-set-local variable stmt.
# Also CASE statements replace the nested if's.
#
# Also modified delivery proc where the ol and order table cursors have
#   been replaced by update_set_local_variable statements.
#
# In Payment procs, the cursor on customer, c_pay_c has been removed. Instead.
# added two update statements (with set local variables).
#
# Reinstated c_find cursor to find cust_id given c_last;
# Stock_level is back o its "single query" state!
#
#
################################################################################
```

```
#
#!/bin/sh -f

# Stored procedure for TPC-C 3.2 on SQL Server 11.1 and later
# Copyright Sybase 1997
#
isql -Usa -P$PASSWORD <<EOF
use tpcc
go
if exists ( SELECT name FROM sysobjects WHERE name = 'neworder_local')
          DROP PROC neworder_local
go

CREATE PROC neworder_local (
          @w_id               smallint,
          @d_id               tinyint,
          @c_id               int,
          @o_ol_cnt int,

          @i_id     int = 0, @ol_qty    smallint = 0,
          @i_id2    int = 0, @ol_qty2   smallint = 0,
          @i_id3    int = 0, @ol_qty3   smallint = 0,
          @i_id4    int = 0, @ol_qty4   smallint = 0,
          @i_id5    int = 0, @ol_qty5   smallint = 0,
          @i_id6    int = 0, @ol_qty6   smallint = 0,
          @i_id7    int = 0, @ol_qty7   smallint = 0,
          @i_id8    int = 0, @ol_qty8   smallint = 0,
          @i_id9    int = 0, @ol_qty9   smallint = 0,
          @i_id10   int = 0, @ol_qty10  smallint = 0,
          @i_id11   int = 0, @ol_qty11  smallint = 0,
          @i_id12   int = 0, @ol_qty12  smallint = 0,
          @i_id13   int = 0, @ol_qty13  smallint = 0,
          @i_id14   int = 0, @ol_qty14  smallint = 0,
          @i_id15   int = 0, @ol_qty15  smallint = 0
)
as

declare
          @w_tax              real,              @d_tax              real,
          @c_last             char(16), @c_credit char(2),
          @c_discount         real,              @commit_flag        int,
          @c_ins_id           int,               @local_d_id         int,

          @i_price  float,
          @i_name             char(24), @i_data             char(50),

          @s_quantity         smallint, @ten_smallint       smallint,
          @s_ytd              int,               @s_order_cnt        int,
          @s_dist             char(24), @s_data             char(50),
          @one_smallint       smallint, @zero_smallint      smallint,
          @ninenine_smallint  smallint,

          @ol_number          int,               @o_id               int,
          @o_entry_d          datetime, @b_g                char(1),
          @ol_amount          float



begin

          begin transaction NO


          -- @#@# UPDATE district FROM district, warehouse, customer
          --

          UPDATE district
          SET         d_next_o_id       = d_next_o_id + 1
                    , @o_id             = d_next_o_id
                    , @d_tax  = d_tax
                    , @commit_flag      = 1
                    , @ol_number        = 0
                    , @local_d_id       = @d_id
                    , @ten_smallint     = 10
                    , @zero_smallint = 0
                    , @ninenine_smallint          = 99
                    , @one_smallint     = 1
                    , @o_entry_d        = getdate()
          WHERE               d_w_id    = @w_id
                    AND       d_id      = @d_id

           while (@ol_number < @o_ol_cnt) begin
                     SELECT @ol_number = @ol_number + 1
                     ,@i_id = case @ol_number
            when 1 then @i_id2
                     when 2 then @i_id3
                     when 3 then @i_id4
                     when 4 then @i_id5
                     when 5 then @i_id6
                     when 6 then @i_id7
                     when 7 then @i_id8
                     when 8 then @i_id9
                     when 9 then @i_id10
                     when 10 then @i_id11
                     when 11 then @i_id12
                     when 12 then @i_id13
                     when 13 then @i_id14
                     when 14 then @i_id15
                     else @i_id
                     end
                      , @ol_qty = case @ol_number
                     when 1 then @ol_qty2
                     when 2 then @ol_qty3
                     when 3 then @ol_qty4
                     when 4 then @ol_qty5
                     when 5 then @ol_qty6
                     when 6 then @ol_qty7
                     when 7 then @ol_qty8
                     when 8 then @ol_qty9
                     when 9 then @ol_qty10
                     when 10 then @ol_qty11
                     when 11 then @ol_qty12
                     when 12 then @ol_qty13
                     when 13 then @ol_qty14
                     when 14 then @ol_qty15
                     else @ol_qty
                     end

          /* set i_id, ol_qty for this lineitem */
          /* this is replaced by case statement */

          /* convert c_no_is cursor to a simple select */
          /* get item data (no one update item) */

                    select @i_price = i_price,
                           @i_name = i_name,
                           @i_data = i_data
                      from item HOLDLOCK
                        where i_id = @i_id

                    if (@@rowcount = 0)
                      begin
                        select @commit_flag = 0
                        select NULL, NULL, NULL, NULL
                        continue
                      end
             /*Otherwise if the item is found */
                      update stock
                         set s_ytd = s_ytd + @ol_qty,
                                @ol_amount = @ol_qty * @i_price,
                               @s_quantity = s_quantity - @ol_qty +
                                    case when (s_quantity - @ol_qty < @ten_smallint)
                                    then @ninenine_smallint else @zero_smallint end,
                              s_quantity = s_quantity - @ol_qty +
                                    case when (s_quantity - @ol_qty < @ten_smallint)
                                    then @ninenine_smallint  else @zero_smallint end,
                                s_order_cnt = s_order_cnt + @one_smallint,
                              @s_data = s_data,
                              @s_dist = case @local_d_id
                                    when 1 then s_dist_01
                                    when 2 then s_dist_02
                                    when 3 then s_dist_03
                                    when 4 then s_dist_04
                                    when 5 then s_dist_05
                                    when 6 then s_dist_06
                                    when 7 then s_dist_07
                                    when 8 then s_dist_08
                                    when 9 then s_dist_09
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                                when 10 then s_dist_10
                                end
                           where s_w_id = @w_id and
                                 s_i_id = @i_id
            if (@@rowcount = 0)
                begin
                  select @commit_flag = 0
                  select NULL, NULL, NULL, NULL
                  continue
                  end
             /*Otherwise if the Stock is found */

      INSERT INTO order_line (
           ol_o_id, ol_d_id, ol_w_id, ol_number, ol_i_id,
           ol_supply_w_id, ol_delivery_d, ol_quantity,
           ol_amount, ol_dist_info)
      VALUES (
           @o_id, @d_id, @w_id, @ol_number, @i_id,
           @w_id, "19000101", @ol_qty,
           @ol_amount, @s_dist)


   /* send line-item data to client */
   select
      @i_name,
      @i_price,
      @s_quantity,
      b_g= case when((patindex("%ORIGINAL%", @i_data) > 0) and
                     (patindex("%ORIGINAL%", @s_data) > 0))
                then "B" else "G" end

   end /* while */

   SELECT     @c_last  = c_last,
              @c_discount         = c_discount,
              @c_credit           = c_credit,
              @c_ins_id           = c_id
   FROM       customer (index c_clu prefetch 2 lru)  HOLDLOCK
   WHERE      c_w_id    = @w_id
     AND      c_d_id    = @d_id
     AND      c_id      = @c_id

   INSERT INTO orders (
             o_id, o_c_id, o_d_id, o_w_id,
             o_entry_d, o_carrier_id, o_ol_cnt, o_all_local)
   VALUES (
             @o_id, @c_ins_id, @d_id, @w_id,
             @o_entry_d, -1, @o_ol_cnt, 1)
   INSERT INTO new_order (no_o_id, no_d_id, no_w_id)
   VALUES (@o_id, @d_id, @w_id)


   SELECT  @w_tax      = w_tax
   FROM warehouse HOLDLOCK
   WHERE w_id = @w_id



   if (@commit_flag = 1)
             commit transaction NO
   else
             rollback transaction NO

   select               /* Return to client */
             @w_tax, @d_tax, @o_id, @c_last,
             @c_discount, @c_credit, @o_entry_d
end
go

if exists ( SELECT name FROM sysobjects WHERE name = 'neworder_remote')
   DROP PROC neworder_remote
go
CREATE PROC neworder_remote (
   @w_id                smallint,
   @d_id                tinyint,
   @c_id                int,
   @o_ol_cnt int,

   @i_id     int = 0, @s_w_id    smallint = 0, @ol_qty         smallint = 0,
   @i_id2    int = 0, @s_w_id2   smallint = 0, @ol_qty2        smallint = 0,
   @i_id3    int = 0, @s_w_id3   smallint = 0, @ol_qty3        smallint = 0,
   @i_id4    int = 0, @s_w_id4   smallint = 0, @ol_qty4        smallint = 0,
   @i_id5    int = 0, @s_w_id5   smallint = 0, @ol_qty5        smallint = 0,
   @i_id6    int = 0, @s_w_id6   smallint = 0, @ol_qty6        smallint = 0,
   @i_id7    int = 0, @s_w_id7   smallint = 0, @ol_qty7        smallint = 0,
   @i_id8    int = 0, @s_w_id8   smallint = 0, @ol_qty8        smallint = 0,
   @i_id9    int = 0, @s_w_id9   smallint = 0, @ol_qty9        smallint = 0,
   @i_id10   int = 0, @s_w_id10  smallint = 0, @ol_qty10       smallint = 0,
   @i_id11   int = 0, @s_w_id11  smallint = 0, @ol_qty11       smallint = 0,
   @i_id12   int = 0, @s_w_id12  smallint = 0, @ol_qty12       smallint = 0,
   @i_id13   int = 0, @s_w_id13  smallint = 0, @ol_qty13       smallint = 0,
   @i_id14   int = 0, @s_w_id14  smallint = 0, @ol_qty14       smallint = 0,
   @i_id15   int = 0, @s_w_id15  smallint = 0, @ol_qty15       smallint = 0
)
as

declare
   @w_tax              real,              @d_tax              real,
   @c_last             char(16), @c_credit char(2),
   @c_discount         real,              @commit_flag        tinyint,
   @c_ins_id           int,               @local_d_id         int,

   @i_price  float,
   @i_name             char(24), @i_data             char(50),

   @s_quantity         smallint, @ten_smallint       smallint,
   @s_ytd              int,               @s_order_cnt        int,
   @s_dist             char(24), @s_data             char(50),
   @one_smallint       smallint, @zero_smallint      smallint,
   @ninenine_smallint  smallint,

   @ol_number          int,               @o_id               int,
   @o_entry_d          datetime, @b_g                 char(1),
   @ol_amount          float


begin

   begin transaction NO

   -- @#@# UPDATE district FROM district, warehouse, customer
   --

   UPDATE district
   SET         d_next_o_id       = d_next_o_id + 1
             , @o_id             = d_next_o_id
             , @d_tax  = d_tax
             , @commit_flag      = 1
             , @ol_number        = 0
             , @local_d_id       = @d_id
             , @ten_smallint     = 10
             , @zero_smallint = 0
             , @ninenine_smallint          = 99
             , @one_smallint     = 1
             , @o_entry_d        = getdate()
   WHERE               d_w_id    = @w_id
             AND       d_id      = @d_id

   while (@ol_number < @o_ol_cnt) begin
             SELECT @ol_number = @ol_number + 1
             ,@i_id = case @ol_number
    when 1 then @i_id2
            when 2 then @i_id3
            when 3 then @i_id4
            when 4 then @i_id5
            when 5 then @i_id6
            when 6 then @i_id7
            when 7 then @i_id8
            when 8 then @i_id9
            when 9 then @i_id10
            when 10 then @i_id11
            when 11 then @i_id12
            when 12 then @i_id13
            when 13 then @i_id14
            when 14 then @i_id15
            else @i_id
            end
             , @ol_qty = case @ol_number
```

```
        when 1 then @ol_qty2
        when 2 then @ol_qty3
        when 3 then @ol_qty4
        when 4 then @ol_qty5
        when 5 then @ol_qty6
        when 6 then @ol_qty7
        when 7 then @ol_qty8
        when 8 then @ol_qty9
        when 9 then @ol_qty10
        when 10 then @ol_qty11
        when 11 then @ol_qty12
        when 12 then @ol_qty13
        when 13 then @ol_qty14
        when 14 then @ol_qty15
        else @ol_qty
        end
         ,@s_w_id = case @ol_number
when 1 then @s_w_id2
        when 2 then @s_w_id3
        when 3 then @s_w_id4
        when 4 then @s_w_id5
        when 5 then @s_w_id6
        when 6 then @s_w_id7
        when 7 then @s_w_id8
        when 8 then @s_w_id9
        when 9 then @s_w_id10
        when 10 then @s_w_id11
        when 11 then @s_w_id12
        when 12 then @s_w_id13
        when 13 then @s_w_id14
        when 14 then @s_w_id15
        else @s_w_id
        end

/* convert c_no_is cursor to a simple select */
/* get item data (no one update item) */
          select @i_price = i_price,
                 @i_name = i_name ,
                 @i_data = i_data
            from item HOLDLOCK
            where i_id = @i_id

        if (@@rowcount = 0)
           begin
                 select @commit_flag = 0
                 select NULL, NULL, NULL, NULL
                   continue
           end
 /* Otherwise if the item is found */
    update stock
      set s_ytd = s_ytd + @ol_qty,
            @ol_amount = @ol_qty * @i_price,
            @s_quantity = s_quantity - @ol_qty +
                  case when (s_quantity - @ol_qty < @ten_smallint)
               then @ninenine_smallint else @zero_smallint end,
          s_quantity = s_quantity - @ol_qty +
              case when (s_quantity - @ol_qty < @ten_smallint)
              then @ninenine_smallint  else @zero_smallint end,
            s_order_cnt = s_order_cnt + @one_smallint,
          @s_data = s_data,
          @s_dist = case @local_d_id
                 when 1 then s_dist_01
                 when 2 then s_dist_02
                 when 3 then s_dist_03
                 when 4 then s_dist_04
                 when 5 then s_dist_05
                 when 6 then s_dist_06
                 when 7 then s_dist_07
                 when 8 then s_dist_08
                 when 9 then s_dist_09
                 when 10 then s_dist_10
                 end,
            s_remote_cnt = s_remote_cnt +
            case when (@s_w_id = @w_id)
              then 0 else 1 end
   where s_w_id = @s_w_id and
         s_i_id = @i_id

   if (@@rowcount = 0)
        begin
          select @commit_flag = 0
          select NULL, NULL, NULL, NULL
          continue
        end

     INSERT INTO order_line (
          ol_o_id, ol_d_id, ol_w_id, ol_number, ol_i_id,
          ol_supply_w_id, ol_delivery_d, ol_quantity,
          ol_amount, ol_dist_info)
     VALUES (
          @o_id, @d_id, @w_id, @ol_number, @i_id,
          @s_w_id, "18000101", @ol_qty,
          @ol_amount, @s_dist)

          /* send line-item to client */
          select
               @i_name,
       @i_price,
       @s_quantity,
       b_g = case when ((patindex("%ORIGINAL%", @i_data) > 0) and
                        (patindex("%ORIGINAL%", @s_data) > 0))
                 then "B" else "G" end
end /* while */


SELECT     @c_last  = c_last,
           @c_discount        = c_discount,
           @c_credit          = c_credit,
           @c_ins_id          = c_id
FROM       customer (index c_clu prefetch 2 lru)  HOLDLOCK
WHERE     c_w_id    = @w_id
  AND     c_d_id    = @d_id
  AND     c_id      = @c_id

INSERT INTO orders (
          o_id, o_c_id, o_d_id, o_w_id,
          o_entry_d, o_carrier_id, o_ol_cnt, o_all_local)
VALUES (
          @o_id, @c_ins_id, @d_id, @w_id,
          @o_entry_d, -1, @o_ol_cnt, 0)
INSERT INTO new_order (no_o_id, no_d_id, no_w_id)
VALUES (@o_id, @d_id, @w_id)

SELECT  @w_tax      = w_tax
FROM warehouse HOLDLOCK
WHERE w_id = @w_id

if (@commit_flag = 1)
          commit transaction NO
else
          rollback transaction NO

select              /* Return to client */
          @w_tax, @d_tax, @o_id, @c_last,
          @c_discount, @c_credit, @o_entry_d
end
go
if exists (select * from sysobjects where name = 'payment_byid')
          DROP PROC payment_byid
go
CREATE PROC payment_byid
          @w_id               smallint, @c_w_id             smallint,
          @h_amount           float,
          @d_id               tinyint,  @c_d_id             tinyint,
          @c_id     int
as
declare   @c_last             char(16)

declare   @w_street_1         char(20), @w_street_2         char(20),
          @w_city             char(20), @w_state  char(2),
          @w_zip              char(9),  @w_name             char(10),
          @w_ytd              float,              @w_id_retrieved smallint

declare   @d_street_1         char(20), @d_street_2         char(20),
          @d_city             char(20), @d_state  char(2),
          @d_zip              char(9),  @d_name             char(10),
          @d_ytd              float,              @commit_flg         int
```

```
declare   @c_first  char(16), @c_middle char(2),
          @c_street_1         char(20), @c_street_2         char(20),
          @c_city             char(20), @c_state  char(2),
          @c_zip              char(9),  @c_phone  char(16),
          @c_since  datetime, @c_credit char(2),
          @c_credit_lim       numeric(12,0),      @c_balance          float,
          @c_discount         real,
          @data1              char(250),          @data2              char(250),
          @c_data_1 char(250),          @c_data_2 char(250)

declare @screen_data          char(200),          @today    datetime


BEGIN TRANSACTION PID

          UPDATE district
                    SET d_ytd = d_ytd + @h_amount
                       ,@d_ytd = d_ytd
                       ,@d_street_1 = d_street_1
                       ,@d_street_2 = d_street_2
                       ,@d_city = d_city
                       ,@d_state = d_state
                       ,@d_zip = d_zip
                       ,@d_name = d_name
                       ,@commit_flg = 1
                    WHERE d_w_id        = @w_id
                    AND       d_id      = @d_id

          UPDATE warehouse
                    SET w_ytd = w_ytd + @h_amount
                       ,@w_ytd = w_ytd
                       ,@w_id_retrieved = w_id
                       ,@w_street_1 = w_street_1
                       ,@w_street_2 = w_street_2
                       ,@w_city = w_city
                       ,@w_state = w_state
                       ,@w_zip = w_zip
                       ,@w_name = w_name
                    WHERE w_id = @w_id

          if (@@rowcount = 0)
             begin
                    select @commit_flg = 0
             end

          /* Customer data */
          UPDATE customer SET
                      @c_first = c_first
                    , @c_middle = c_middle
                    , @c_last = c_last
                    , @c_street_1 = c_street_1
                    , @c_street_2 = c_street_2
                    , @c_city = c_city
                    , @c_state = c_state
                    , @c_zip = c_zip
                    , @c_phone = c_phone
                    , @c_credit = c_credit
                    , @c_credit_lim = c_credit_lim
                    , @c_discount = c_discount
                    , c_balance = c_balance - @h_amount
                    , @c_balance = c_balance - @h_amount
                    , c_ytd_payment = c_ytd_payment + @h_amount
                    , c_payment_cnt = c_payment_cnt + 1
                    , @c_since = c_since
                    , @data1 = c_data1
                    , @data2 = c_data2
                    , @today = getdate()
          where
                    c_id = @c_id
                    and c_w_id = @c_w_id
                    and c_d_id = @c_d_id

          if (@@rowcount = 0)
             begin
                    select @commit_flg = 0
             end

          if (@c_credit = "BC")
          begin
                    SELECT  @c_data_2 =
                              substring(@data1, 209, 42) +
                              substring(@data2, 1, 208)
                              ,@c_data_1 =
                              convert(char(5), @c_id) +
                              convert(char(4), @c_d_id) +
                              convert(char(5), @c_w_id) +
                              convert(char(4), @d_id) +
                              convert(char(5), @w_id) +
                              convert(char(19), @h_amount/100) + substring(@data1,
1, 208)

                    UPDATE customer SET
                                c_data1 = @c_data_1
                              , c_data2 = @c_data_2
                              , @screen_data = substring(@c_data_1, 1, 200)
                    WHERE
                              c_id = @c_id
                              AND c_w_id = @c_w_id
                              AND c_d_id = @c_d_id
          end /* if */

          /* Create the history record */
          INSERT INTO history (
                    h_c_id, h_c_d_id, h_c_w_id, h_d_id, h_w_id,
                    h_date, h_amount, h_data)
          VALUES (
                    @c_id, @c_d_id, @c_w_id, @d_id, @w_id_retrieved,
                    @today, @h_amount, (@w_name + "    " + @d_name))

/* COMMIT TRANSACTION PID */

          if (@commit_flg = 1)
              COMMIT TRANSACTION PID
           else
                ROLLBACK TRANSACTION PID

          select              /* Return to client */
                    @c_id,
                    @c_last,
                    @today,
                    @w_street_1,
                    @w_street_2,
                    @w_city,
                    @w_state,
                    @w_zip,

                    @d_street_1,
                    @d_street_2,
                    @d_city,
                    @d_state,
                    @d_zip,

                    @c_first,
                    @c_middle,
                    @c_street_1,
                    @c_street_2,
                    @c_city,
                    @c_state,
                    @c_zip,
                    @c_phone,
                    @c_since,
                    @c_credit,
                    @c_credit_lim,
                    @c_discount,
                    @c_balance,
                    @screen_data
go
if exists (select * from sysobjects where name = 'payment_byname')
          DROP PROC payment_byname
go
CREATE PROC payment_byname
          @w_id               smallint, @c_w_id             smallint,
          @h_amount           float,
          @d_id               tinyint,  @c_d_id             tinyint,
          @c_last   char(16)
as
declare   @n        int,      @c_id     int
```

```
declare   @w_street_1         char(20), @w_street_2         char(20),
          @w_city             char(20), @w_state  char(2),
          @w_zip              char(9),  @w_name             char(10),
          @w_ytd              float,              @w_id_retrieved smallint

declare   @d_street_1         char(20), @d_street_2         char(20),
          @d_city             char(20), @d_state  char(2),
          @d_zip              char(9),  @d_name             char(10),
          @d_ytd              float,              @commit_flg         int

declare   @c_first  char(16), @c_middle char(2),
          @c_street_1         char(20), @c_street_2         char(20),
          @c_city             char(20), @c_state  char(2),
          @c_zip              char(9),  @c_phone  char(16),
          @c_since  datetime, @c_credit char(2),
          @c_credit_lim       numeric(12,0),      @c_balance          float,
          @c_discount         real,
          @data1              char(250),          @data2              char(250),
          @c_data_1 char(250),          @c_data_2 char(250)

declare @screen_data          char(200),          @today    datetime



BEGIN TRANSACTION PNM
          SELECT @n = (count(*)+1)/2
          FROM customer (index c_non1 prefetch 2 lru) HOLDLOCK
          WHERE     c_w_id = @c_w_id and
                    c_d_id = @c_d_id and
                    c_last = @c_last

          set rowcount @n

          -- @#@ SELECT FROM customer HOLDLOCK
          SELECT @c_id = c_id
          FROM customer (index c_non1 prefetch 2 lru) HOLDLOCK
          WHERE     c_w_id = @c_w_id and
                    c_d_id = @c_d_id and
                    c_last = @c_last

          -- Reset, so as to do full retrievals hereafter.
          set rowcount 0

          UPDATE district
                    SET d_ytd = d_ytd + @h_amount
                       ,@d_ytd = d_ytd
                       ,@d_street_1 = d_street_1
                       ,@d_street_2 = d_street_2
                       ,@d_city = d_city
                       ,@d_state = d_state
                       ,@d_zip = d_zip
                       ,@d_name = d_name
                       ,@commit_flg = 1
                    WHERE d_w_id        = @w_id
                    AND       d_id      = @d_id

          if (@@rowcount = 0)
             begin
                    select @commit_flg = 0
             end

          UPDATE warehouse
                    SET w_ytd = w_ytd + @h_amount
                       ,@w_ytd = w_ytd
                       ,@w_id_retrieved = w_id
                       ,@w_street_1 = w_street_1
                       ,@w_street_2 = w_street_2
                       ,@w_city = w_city
                       ,@w_state = w_state
                       ,@w_zip = w_zip
                       ,@w_name = w_name
                    WHERE w_id = @w_id

          /* Customer data */
          UPDATE customer SET
                      @c_first = c_first
                    , @c_middle = c_middle
                    , @c_last = c_last
                    , @c_street_1 = c_street_1
                    , @c_street_2 = c_street_2
                    , @c_city = c_city
                    , @c_state = c_state
                    , @c_zip = c_zip
                    , @c_phone = c_phone
                    , @c_credit = c_credit
                    , @c_credit_lim = c_credit_lim
                    , @c_discount = c_discount
                    , c_balance = c_balance - @h_amount
                    , @c_balance = c_balance - @h_amount
                    , c_ytd_payment = c_ytd_payment + @h_amount
                    , c_payment_cnt = c_payment_cnt + 1
                    , @c_since = c_since
                    , @data1 = c_data1
                    , @data2 = c_data2
                    , @today = getdate()
          where
                    c_id = @c_id
                    and c_w_id = @c_w_id
                    and c_d_id = @c_d_id

          if (@@rowcount = 0)
             begin
                    select @commit_flg = 0
             end

          SELECT    @screen_data = NULL
          if (@c_credit = "BC")
          begin
                    SELECT  @c_data_2 =
                              substring(@data1, 209, 42) +
                              substring(@data2, 1, 208)
                              ,@c_data_1 =
                              convert(char(5), @c_id) +
                              convert(char(4), @c_d_id) +
                              convert(char(5), @c_w_id) +
                              convert(char(4), @d_id) +
                              convert(char(5), @w_id) +
                              convert(char(19), @h_amount/100) + substring(@data1,
1, 208)
                    UPDATE customer SET
                                c_data1 = @c_data_1
                              , c_data2 = @c_data_2
                              , @screen_data = substring(@c_data_1, 1, 200)
                    WHERE
                              c_id = @c_id
                              AND c_w_id = @c_w_id
                              AND c_d_id = @c_d_id
          end /* if */

          /* Create the history record */
          INSERT INTO history (
                    h_c_id, h_c_d_id, h_c_w_id, h_d_id, h_w_id,
                    h_date, h_amount, h_data)
          VALUES (
                    @c_id, @c_d_id, @c_w_id, @d_id, @w_id_retrieved,
                    @today, @h_amount, (@w_name + "    " + @d_name))

/* COMMIT TRANSACTION PNM */

          if (@commit_flg = 1)
              COMMIT TRANSACTION PNM
           else
                ROLLBACK TRANSACTION PNM

          select              /* Return to client */
                    @c_id,
                    @c_last,
                    @today,
                    @w_street_1,
                    @w_street_2,
                    @w_city,
                    @w_state,
                    @w_zip,

                    @d_street_1,
                    @d_street_2,
                    @d_city,
```

```
                    @d_state,
                    @d_zip,

                    @c_first,
                    @c_middle,
                    @c_street_1,
                    @c_street_2,
                    @c_city,
                    @c_state,
                    @c_zip,
                    @c_phone,
                    @c_since,
                    @c_credit,
                    @c_credit_lim,
                    @c_discount,
                    @c_balance,
                    @screen_data
go
if exists (select * from sysobjects where name = 'order_status_byid')
          DROP PROC order_status_byid
go
CREATE PROC order_status_byid
          @w_id               smallint,
          @d_id               tinyint,
          @c_id               int
as

DECLARE   @o_id               int,
          @o_entry_d          datetime,
          @o_carrier_id       smallint

BEGIN TRANSACTION OSID

/* Get the latest order made by the customer */
          set rowcount 1
          SELECT    @o_id = o_id, @o_carrier_id = o_carrier_id,
                    @o_entry_d = o_entry_d
          FROM      orders (index o_clu prefetch 16 mru) HOLDLOCK
          WHERE     o_w_id    = @w_id
          AND       o_d_id    = @d_id
          AND       o_c_id    = @c_id
          ORDER BY o_w_id DESC, o_d_id DESC, o_id DESC
          set rowcount 0

/* Select order lines for the current order */
          select    /* Return multiple rows to client */
                    ol_supply_w_id,
                    ol_i_id,
                    ol_quantity,
                    ol_amount,
                    ol_delivery_d
          FROM      order_line HOLDLOCK
          WHERE     ol_o_id = @o_id
          AND       ol_d_id = @d_id
          AND       ol_w_id = @w_id

          select    /* Return single row to client */
                    @c_id, c_last, c_first, c_middle, c_balance,
                    @o_id,
                    @o_entry_d,
                    @o_carrier_id
          FROM      customer (index c_clu prefetch 2 lru) HOLDLOCK
          WHERE   c_id    = @c_id
          AND       c_d_id  = @d_id
          AND       c_w_id  = @w_id

COMMIT TRANSACTION OSID
go
if exists (select * from sysobjects where name = 'order_status_byname')
          DROP PROC order_status_byname
go
CREATE PROC order_status_byname
          @w_id               smallint,
          @d_id               tinyint,
          @c_last   char(16)
as

DECLARE   @o_id               int,
          @o_entry_d          datetime,
          @o_carrier_id       smallint

declare   @n        int,      @c_id     int

BEGIN TRANSACTION OSNM
          SELECT @n = (count(*)+1)/2
          FROM customer (index c_non1 prefetch 2 lru) HOLDLOCK
          WHERE     c_w_id = @w_id and
                    c_d_id = @d_id and
                    c_last = @c_last


          -- Retrieve upto mid-point number of rows.
          set rowcount @n

          -- @#@# SELECT FROM customer HOLDLOCK
          SELECT @c_id = c_id
          FROM customer (index c_non1 prefetch 2 lru) HOLDLOCK
          WHERE     c_w_id = @w_id and
                    c_d_id = @d_id and
                    c_last = @c_last


/* Get the latest order made by the customer */
          set rowcount 1
          SELECT    @o_id = o_id, @o_carrier_id = o_carrier_id,
                    @o_entry_d = o_entry_d
          FROM      orders (index o_clu prefetch 16 mru) HOLDLOCK
          WHERE     o_w_id    = @w_id
          AND       o_d_id    = @d_id
          AND       o_c_id    = @c_id
          ORDER BY o_w_id DESC, o_d_id DESC, o_id DESC
          set rowcount 0

/* Select order lines for the current order */
          select    /* Return multiple rows to client */
                    ol_supply_w_id,
                    ol_i_id,
                    ol_quantity,
                    ol_amount,
                    ol_delivery_d
          FROM      order_line HOLDLOCK
          WHERE     ol_o_id = @o_id
          AND       ol_d_id = @d_id
          AND       ol_w_id = @w_id

          select    /* Return single row to client */
                    @c_id, c_last, c_first, c_middle, c_balance,
                    @o_id,
                    @o_entry_d,
                    @o_carrier_id
          FROM      customer (index c_clu prefetch 2 lru) HOLDLOCK
          WHERE   c_id    = @c_id
          AND       c_d_id  = @d_id
          AND       c_w_id  = @w_id

COMMIT TRANSACTION OSNM
go

if exists (select * from sysobjects where name = 'delivery')
        drop proc delivery
go

CREATE PROC delivery
        @w_id           smallint,
        @o_carrier_id   smallint,
        @d_id           tinyint = 1
as

declare @no_o_id        int,            @o_c_id         smallint,
        @ol_total       float,          @ol_amount      float,
        @junk_id        smallint,       @ten_tinyint        tinyint,
          @one_tinyint        tinyint,  @one_smallint       smallint,
        @today          datetime

declare c_del_no CURSOR FOR
        SELECT  no_o_id
        FROM    new_order (index no_clu) HOLDLOCK
        WHERE   no_d_id = @d_id
```

```
        AND     no_w_id = @w_id
        FOR UPDATE

        /*
        ** The only purpose of the index hint in the above is to ensure
        ** that the clustered index is used.  As it turns out, our optimizer
        ** chooses the clustered index anyway -- with or without the hint.
        */
begin
    SELECT @one_tinyint = 1, @ten_tinyint = 10, @one_smallint = 1
    while (@d_id <= @ten_tinyint ) begin
    BEGIN TRANSACTION DEL

        OPEN c_del_no

        FETCH c_del_no INTO @no_o_id

        if (@@sqlstatus != 0)
        begin
                COMMIT TRANSACTION DEL
                select NULL
                CLOSE c_del_no
        end
        else
        begin
                DELETE  FROM new_order
                WHERE   CURRENT OF c_del_no
                CLOSE   c_del_no

                SELECT  @ol_total = 0.0, @today = getdate()

                    -- @#@# UPDATE order_line
                UPDATE order_line
                SET       ol_delivery_d = @today
                        , @ol_total = @ol_total + ol_amount
                WHERE   ol_o_id = @no_o_id
                AND     ol_d_id = @d_id
                    AND       ol_w_id = @w_id

                    -- @#@# UPDATE orders
                UPDATE  orders
                SET       o_carrier_id = @o_carrier_id
                        , @o_c_id = o_c_id
                WHERE   o_id    = @no_o_id
                AND     o_d_id  = @d_id
                AND     o_w_id  = @w_id

                UPDATE  customer
                SET     c_balance       = c_balance + @ol_total,
                        c_delivery_cnt  = c_delivery_cnt + @one_smallint
                WHERE   c_id    = @o_c_id
                AND     c_d_id  = @d_id
                AND     c_w_id  = @w_id

                COMMIT TRANSACTION DEL

                select      /* Return to client */
                        @no_o_id
        end
          SELECT @d_id = @d_id + @one_tinyint
    end
end
go


if exists ( SELECT name FROM sysobjects WHERE name = 'stock_level')
    DROP PROC stock_level
go

CREATE PROC stock_level
          @w_id     smallint,
          @d_id     tinyint,
          @threshold smallint
as
          select  s_i_id /* Return to client */
          FROM      district,
                    order_line (index ol_clu prefetch 2 lru),
                    stock (index s_clu prefetch 2 lru)
          WHERE     d_w_id    =         @w_id
          AND       d_id      =         @d_id
          AND       ol_w_id   =         @w_id
          AND       ol_d_id   =         @d_id
          AND       ol_o_id   between (d_next_o_id - 20) and (d_next_o_id - 1)
          AND       s_w_id    =         ol_w_id
          AND       s_i_id    =         ol_i_id
          AND     s_quantity < @threshold
go
EOF

if [ "$?" != "0" ]
then
          echo ""
          echo " **** WARNING: Could not connect to server to install procs! ****"
          echo " ****               SQL SErver must have failed!!! ****"
          echo " ****               TPC-C build & run will fail!!! ****"
          echo ""
fi
```

Appendix B Database Design

The source code for the process to define, create and populate the Sybase Adaptive Server Enterprise 12.0 TPC-C database is included in this appendix.

B.1 Main Shell Scripts

build

```
#!/usr/bin/ksh
#*******************************************************************************
#@(#) Version: A.10.10 $Date: 97/12/15 10:49:50 $
#
#(c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
#*******************************************************************************


# Note: Had problem with log space on tempdb. Either need larger log or
#  need to truncate log when it gets full. Shouldn't that happen automatically
#  for tempdb? Otherwise, database hangs until log gets truncated.

echo "Creating devices"
date
create_devices
echo "Finished creating devices"
date
echo "Loading database"
load_database
echo "Finished loading database"
date
```

create_devices

```
#!/usr/bin/sh -x
#*******************************************************************************
#@(#) Version: A.10.10 $Date: 97/12/15 13:17:08 $
#
#(c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
#*******************************************************************************

#
# Clean up some stuff first
#
rm -rf $DB/logs/dev_create.OUT
rm -rf $DB/logs/*.log

#
# Create the log file
#
exec > $DB/logs/dev_create.OUT 2>&1

shutdown_server.sh
rm -f $DB/dev/errorlog

echo `date` "Started bld_system"
bmbinary=$SYBASE/bin/buildmaster

# Build the device.
(cd $DB/dev; `devcreate.sh buildmaster $bmbinary < $DB/load/devices`)

# Boot server, run installmaster, shutdown server

run_server - -T1608

# extend the tempdb - otherwise hangs during creation
#isql -Usa -P <<- EOF
#alter database tempdb on master=500 log on master=500
#go
#EOF


isql -Usa -P < $SYBASE/scripts/installmaster > $DB/logs/$$_im.log

# Reboot, build devices, database, and segments
echo `date` "Creating devices, databases and segments"
devcreate.sh sql System10 < $DB/load/devices | isql -e -Usa -P
echo `date` " Finished building database"

# Create tables, some indexes, and administrative procs.
tpcc_tables.sh

# Truncate log, checkpoint
dumptran_server.sh master
dumptran_server.sh tpcc
```

load_database

```
#!/usr/bin/ksh -x
#*******************************************************************************
#@(#) Version: A.10.10 $Date: 97/12/15 13:11:36 $
#
#(c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
#*******************************************************************************

rm -rf $DB/logs/load.OUT
exec > $DB/logs/load.OUT 2>&1

# restart the server with logging disabled
stop_server
sleep 600
start_server - -T699

# Load the data; shutdown again.
echo `date` " Started loading data"

isql -Usa -P$PASSWORD << EOF
use master
go

sp_dboption tpcc,"select into/bulkcopy",true
go

sp_dboption tpcc,"trunc log on chkpt",true
go

use tpcc
go

checkpoint
go
EOF

# load small tables in serial
load_wdi
# load large tables in parallel
load_stock &
sleep 5
load_customer &
sleep 5
load_orderline &
sleep 5
load_orders &
sleep 5
load_history &
sleep 5
```

```
load_neworder &

wait

shutdown_server.sh

sleep 600

run_server

index_wdi
# load large tables in parallel
index_stock &
sleep 5
index_customer &

wait

tpcc_proc.sh

echo `date` -- Done building, get the table sizes
table_size.sh

shutdown_server.sh

echo `date` "Finished bld_system"
```

devcreate.sh

```
#!/usr/bin/sh
#*******************************************************************************
#@(#) Version: A.10.10 $Date: 97/12/15 13:16:43 $
#
#(c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
#*******************************************************************************

# @(#) devcreate.sh 1.1 6/7/95
#
#         scripts/devcreate.sh
#
#         Read a device file from stdin in the format given in format/devices
#         and ouput on stdout the SQL statements to create the devices,
#         databases and segments defined by the input device file.
#
#         The SQL is output in the following order
#
#         1) Disk inits and disk mirrors
#         2) Create databases
#         3) sp_addsegments and sp_extendsegments
#

if [ "$1" = "buildmaster" ]
then
          bm=y
          bmbinary=$2
elif [ "$1" = "sql" ]
then
          bm=n
          release=$2
else
          echo "Usage : $0 [builmaster buildmaster_binary |sql] < device_file" >&2
          echo "buildmaster - generate buildmaster command" >&2
          echo "sql [release] - generate SQL commands" >&2
          exit 1
fi

in_device=n
in_db=n

logical_name=
physical_name=
device_size=

vdevno=0

sql_file=/tmp/dvsql$$
db_file=/tmp/dvdb$$
db_s_file=/tmp/dvdb_s$$
seg_file=/tmp/dvseg$$
export sql_file db_file seg_file

grep -v '^#' | tr -s '\011 ' '\012\012' | while read token garbage
do
          case $token in
                    DEVICE)   # A new device
                              # clear the fields for the next device
                              logical_name=
                              physical_name=
                              device_size=
                              vstart_offset=
                              mirror=

                              in_device=y
                              in_db=n
                              ;;

                    db=*)  # database name
                              if [ "$in_db" = "y" ]
                              then
                                        # Store info about db
                                        echo
                              fi

                              # Start the new database
                              db_name=`echo $token | sed 's/db=//'`
                              db_log=
                              db_size=0

                              in_db=y
                              ;;


                    log)      # This disk is the log disk for the current db
                              if [ "$in_db" = "y" ]
                              then
                                        db_log="log on"
                              fi
                              ;;

                    vstart=*)
                              vstart_offset=`echo $token | sed 's/vstart=//'`
                              ;;

                    mirror=*)
                              # store info about log-mirror
                              mirror=`echo $token | sed 's/mirror=//'`
                              ;;

                    size=*) # the size of the current db on this disk
                              if [ "$in_db" = "y" ]
                              then
                                        # Store info about size
                                        db_size=`echo $token | sed 's/size=//'`
                              fi
                              ;;

                    segment=*)
                              if [ "$in_db" = "y" ]
                              then
                                        segment=`echo $token | sed 's/segment=//'`
                                        echo "$db_name $segment $logical_name" >>
$seg_file
                              fi
                              ;;

                    DEVICE_END)         # Complete the device

                              # Save any database fragment information
                              if [ "$in_db" = "y" ]
                              then
                                        echo "$db_name $logical_name $db_size
$db_log" >> $db_file
                              fi
```

```
                        if [ "$bm" = "y" -a "$in_device" = "y" -a
"$logical_name" = "master" ]
                        then
                                # Convert Mb to 2k pages.
                                page_size=`expr $device_size \* 512`

                                echo "$bmbinary -d$physical_name -
s$page_size"
                        fi

                        # The disk init SQL, but not for the master device
                        #
                        if [ "$bm" = "n" -a "$in_device" = "y" -a
"$logical_name" != "master" ]
                        then
                                # Convert Mb to 2k pages.
                                page_size=`expr $device_size \* 512`

                                # echo SQL to create the device
                                echo "disk init"
                                echo "  name = '$logical_name',"
                                echo "  physname = '$physical_name',"
                                echo "  vdevno = $vdevno,"
                                echo "  size = $page_size"
                                if [ "$vstart_offset" != "" ]
                                then
                                        echo "  , vstart = $vstart_offset"
                                fi
                                echo go
                        fi


                        # The disk mirror SQL (including master)
                        if [ "$mirror" = "" -o "$bm" = "y" ]
                        then
                                false;
                        else
                                # Echo SQL to create the disk mirror
                                echo "disk mirror"
                                echo "  name = '$logical_name',"
                                echo "  mirror = '$mirror',"
                                echo "  writes = noserial"
                                echo go
                        fi

                        ;;

                *)      # could be one of several
                        if [ "$in_device" = "y" ]
                        then
                                if [ "$logical_name" = "" ]
                                then
                                        logical_name=$token
                                        if [ $logical_name != "master" ]
                                        then
                                                vdevno=`expr $vdevno +
1`
                                        fi
                                elif [ "$physical_name" = "" ]
                                then
                                        physical_name=$token
                                elif [ "$device_size" = "" ]
                                then
                                        device_size=$token
                                else
                                        echo
                                fi
                        else
                                echo
                        fi
                        ;;
        esac
done

# If we are in buildmaster mode we can just stop here.
if [ "$bm" = "y" ]
then
        rm $db_file $seg_file
        exit 0
fi

#
# Now we have generated the disk init commands, create the
# create database commands.
#
$DB/load/make_create
echo go

#
# Now we have the create database commands, create the segment commands
#
# The file $seg_file will have been created with the following format
#
# dbname device segment
#

current_db=
current_seg=
seg_db=
export current_seg current_db seg_db

sort $seg_file | while read dbname segment device garbage
do
        if [ "$dbname" = "$current_db" ]
        then
                false
        else
                echo "use $dbname"
                echo go
                # In System 10 segment procs now takes db as 2nd arg
                if [ "$release" = "System10" ]
                then
                        seg_db="$dbname ,"
                fi
        fi

        if [ "$segment" = "system" -o "$segment" = "default" ]
        then
                false # do nothing
        elif [ "$segment" = "$current_seg" ]
        then
                echo "sp_extendsegment $segment , $seg_db  $device"
                echo go
        else
                echo "sp_addsegment $segment , $seg_db $device"
                echo go
        fi
        current_seg=$segment
        current_db=$dbname
done

# now sort the segment file in database, device order
# to enable us to drop the unwanted system and default segments

in_device=no
export in_device
sort +0 -1 +2 -3 $seg_file | while read dbname segment device garbage
do
        if [ "$device" = "$current_dev" ]
        then
                false
        else
                if [ "$in_device" = "yes" ]
                then
                        if [ "$drop_segs" = "yes" ]
                        then
                                echo "sp_dropsegment 'default', $seg_db
$current_dev"
                                echo go
                                echo "sp_dropsegment 'system', $seg_db
$current_dev"
                                echo go
                        fi
                fi

                in_device=yes
                drop_segs=yes
```

```
        fi

        if [ "$dbname" = "$current_db" ]
        then
                false
        else
                echo "use $dbname"
                echo go
                # In System 10 segment procs now takes db as 2nd arg
                if [ "$release" = "System10" ]
                then
                        seg_db="$dbname ,"
                fi
        fi

        if [ "$segment" = "system" -o "$segment" = "default" ]
        then
                drop_segs=no
        fi

        current_dev=$device
        current_db=$dbname
done

rm $seg_file

echo    "use master"
echo    go
echo    "checkpoint"
echo    go
```

tpcc_tables.sh

```
#!/usr/bin/sh -f
#*****************************************************************************
#@(#) Version: A.10.10 $Date: 97/12/15 13:16:06 $
#
#(c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
#*****************************************************************************

isql -Usa -P$PASSWORD -e << EOF
/* This script will create all the tables required for TPC-C benchmark */
/* It will also create some of the indexes. */
sp_dboption tpcc,"select into/bulkcopy",true
go
use tpcc
go
checkpoint
go


if exists ( select name from sysobjects where name = 'history' )
        alter table history unpartition
go
if exists ( select name from sysobjects where name = 'history' )
        drop table history
go

if exists ( select name from sysobjects where name = 'orders' )
        drop table orders
go
if exists ( select name from sysobjects where name = 'new_order' )
        drop table new_order
go
if exists ( select name from sysobjects where name = 'item' )
        drop table item
go
if exists ( select name from sysobjects where name = 'district' )
        drop table district
go
if exists ( select name from sysobjects where name = 'warehouse' )
        drop table warehouse
go

if exists ( select name from sysobjects where name = 'order_line' )
        drop table order_line
go


create table order_line (
        ol_o_id             int,
        ol_d_id             tinyint,
        ol_w_id             smallint,
        ol_number tinyint,
        ol_i_id             int,
        ol_supply_w_id      smallint,
        ol_delivery_d       datetime, /*- Updated by D */
        ol_quantity         smallint,
        ol_amount float,
        ol_dist_info        char(24)
) on Sorder_line
go

create unique clustered index ol_clu
        on order_line(ol_w_id, ol_d_id, ol_o_id, ol_number)
        on Sorder_line
go
dbcc tune(ascinserts, 1, order_line)
go
dbcc tune(oamtrips, 100, order_line)
go

create table warehouse (
        w_id                smallint,
        w_name              char(10),
        w_street_1          char(20),
        w_street_2          char(20),
        w_city              char(20),
        w_state             char(2),
        w_zip               char(9),
        w_tax               real,
        w_ytd               float               /*- Updated by PID, PNM */
) with max_rows_per_page = 1 on Swarehouse
go

create table district (
        d_id                tinyint,
        d_w_id              smallint,
        d_name              char(10),
        d_street_1          char(20),
        d_street_2          char(20),
        d_city              char(20),
        d_state             char(2),
        d_zip               char(9),
        d_tax               real,
        d_ytd               float,              /*- Updated by PID, PNM */
        d_next_o_id         int                 /*- Updated by NO */
) with max_rows_per_page = 10 on Sdistrict
go

create table item (
        i_id                int,
        i_im_id             int,
        i_name              char(24),
        i_price             float,
        i_data              char(50)
) on Sitem
go

go

if exists ( select name from sysobjects where name = 'customer' )
        drop table customer
go
create table customer (
        c_id                int,
        c_d_id              tinyint,
        c_w_id              smallint,
        c_first             char(16),
        c_middle  char(2),
        c_last              char(16),
        c_street_1          char(20),
        c_street_2          char(20),
```

```
          c_city              char(20),
          c_state             char(2),
          c_zip               char(9),
          c_phone             char(16),
          c_since             datetime,
          c_credit  char(2),
          c_credit_lim        numeric(12),
          c_discount          real,
          c_delivery_cnt      smallint,
          c_payment_cnt       smallint, /*- Updated by PNM, PID */
          c_balance float,              /*- Updated by PNM, PID */
          c_ytd_payment       float,              /*- Updated by PNM, PID */
          c_data1             char(250),          /*- Updated (?) by PNM, PID */
          c_data2             char(250) /*- Updated (?) by PNM, PID */
) on Scustomer
go

create unique clustered index c_clu
          on customer(c_w_id, c_id, c_d_id)
          on Scustomer
go

create table history (
          h_c_id              int,
          h_c_d_id  tinyint,
          h_c_w_id  smallint,
          h_d_id              tinyint,
          h_w_id              smallint,
          h_date              datetime,
          h_amount  float,
          h_data              char(24)
) on Shistory
go
/* alter table history partition 512 */
/* go                                        */

create table new_order (
          no_o_id             int,
          no_d_id             tinyint,
          no_w_id             smallint,
) on Snew_order
go

create unique clustered index no_clu
          on new_order(no_w_id, no_d_id, no_o_id)
          on Snew_order
go
dbcc tune(ascinserts, 1, new_order)
go
dbcc tune(oamtrips, 100, new_order)
go

create table orders (
          o_id                int,
          o_c_id              int,
          o_d_id              tinyint,
          o_w_id              smallint,
          o_entry_d datetime,
          o_carrier_id        smallint, /*- Updated by D */
          o_ol_cnt  tinyint,
          o_all_local         tinyint
) on Sorders
go

create unique clustered index o_clu
          on orders(o_w_id, o_d_id, o_id)
          on Sorders
go
dbcc tune(ascinserts, 1, orders)
go
dbcc tune(oamtrips, 100, orders)
go

if exists ( select name from sysobjects where name = 'stock' )
          drop table stock
go
create table stock (
          s_i_id              int,
          s_w_id              smallint,
          s_quantity          smallint, /*- Updated by NO */
          s_ytd               int,                /*- Updated by NO */
          s_order_cnt         smallint, /*- Updated by NO */
          s_remote_cnt        smallint, /*- Updated by NO */
          s_dist_01 char(24),
          s_dist_02 char(24),
          s_dist_03 char(24),
          s_dist_04 char(24),
          s_dist_05 char(24),
          s_dist_06 char(24),
          s_dist_07 char(24),
          s_dist_08 char(24),
          s_dist_09 char(24),
          s_dist_10 char(24),
          s_data              char(50)
) on Sstock
go
dbcc tune(ascinserts, 1, stock)
go

create unique clustered index s_clu
          on stock(s_i_id, s_w_id)
          on Sstock
go
dbcc tune(indextrips, 10, stock)
go

checkpoint
go
EOF
```

tpcc_indexes.sh

```
#!/usr/bin/sh -f
#*****************************************************************************
#@(#) Version: A.10.10 $Date: 97/12/15 10:49:58 $
#
#(c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
#*****************************************************************************

isql -Usa -P$PASSWORD << EOF
/* This script will create the TPC-C indexes that are best
   created after the load. */
use tpcc
go

create unique clustered index w_clu
          on warehouse(w_id)
          with fillfactor = 100
          on Swarehouse
go
dbcc tune(indextrips, 100, warehouse)
go

create unique clustered index d_clu
          on district(d_w_id, d_id)
          with fillfactor = 100
          on Sdistrict
go
dbcc tune(indextrips, 100, district)
go

create unique clustered index i_clu
        on item(i_id)
        with fillfactor = 100
        on Sitem
go
dbcc tune(indextrips, 10, item)
go

checkpoint
go

drop index customer.c_clu
go
```

```
checkpoint
go

create unique clustered index c_clu
          on customer(c_w_id, c_id, c_d_id)
          with sorted_data
          on Scustomer
go

checkpoint
go

create unique nonclustered index c_non1
          on customer(c_w_id, c_d_id, c_last, c_first, c_id)
        with fillfactor = 100, consumers=8
          on Sc_index
go

checkpoint
go

drop index stock.s_clu
go

checkpoint
go

create unique clustered index s_clu
          on stock(s_i_id, s_w_id)
          with sorted_data
          on Sstock
go

checkpoint
go

EOF
```

run_server

```
#!/usr/bin/ksh
#*******************************************************************************
#@(#) Version: A.10.10 $Date: 96/04/15 13:12:00 $
#
#(c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
#*******************************************************************************
set -x

# The default dataserver is the one from the release bin.
dataserver=$SYBASE/bin/dataserver
server_options="-c${CONFIG_FILE}"

# Do we override this ?
if [ $# != 0 ]
then
        if [ "$1" != "-" ]
        then
                dataserver=$1
        fi

        # Pick up the remaining arguments.
        shift
        server_options=$server_options" $*"
fi

# options;
#         3443 & 3444 Disable PFTS.
#         1130 prototype
#         1131 prototype - "Des" hint: For 12.0, should be disabled.
#         1132 prototype - "RANDOM Des" hint:  1131 should be enabled!
#         1133 prototype - sh_latch on firstoam. For 12.0, should be disabled.
#         7406 speed up recover
#         1231 reduce spinlock contention on tablelock
#         7822 Disable NETMNE( only in 12.0).

(cd $DB/dev; $dataserver -d$MASTER_DEVICE -T1131 -T1132 -T3443 -T3444 -T1231 -T7822
$server_options )&
touch $DB/dev/errorlog; tail -f -c1 $DB/dev/errorlog | grep -q 'Recovery complete'

# Configure the server for TPC-C
set_queue
tpcc_proc.sh
cache_bind.sh
init_server.fast.sh
set.processors $dataserver
```

stop_server.sh

```
#!/usr/bin/sh -f
#*******************************************************************************
#@(#) Version: A.10.10 $Date: 97/12/15 13:15:36 $
#
#(c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
#*******************************************************************************

isql -Usa -P$PASSWORD -e << EOF
use tpcc
go
dbcc tune(maxwritedes, 1000)
go
select getdate()
go
checkpoint
go
select getdate()
go
dump tran tpcc with truncate_only
go
dbcc tune(maxwritedes, 5)
go
shutdown
go
EOF
sleep 60
```

take_a_checkpoint

```
#!/usr/bin/sh
#*******************************************************************************
#@(#) Version: A.10.10 $Date: 97/12/15 10:49:57 $
#
#(c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
#*******************************************************************************

echo "    `hostname` starting at `date`"
isql -Usa -P -e << EOF >> /tmp/checkpoint_details
use tpcc
go
dbcc tune(maxwritedes, 50)
go
checkpoint
go
dbcc tune(maxwritedes, 10)
go
EOF
echo "    `hostname` finished at  `date`"
```

schedule_checkpoints

```
#!/usr/bin/ksh

schedule_checkpoints() #<start delay><interval in seconds><list of servers>
```

```
{
start=$1; interval=$2; shift;shift; servers=$*
echo "Scheduling checkpoints `date` $start $interval $servers"

# do the first checkpoint
sleep $start
checkpoint $servers &

# keep doing the remaining ones
while [ 1 -eq 1 ]; do
    sleep $interval
    checkpoint $servers &
done
}

checkpoint() # <list of servers>
{
echo
echo "Starting checkpoint at `date`"
for srv in $*
do
    remsh ${srv} -n "take_a_checkpoint > /tmp/checkpoint.details" &
done
wait
echo "Finished at `date`"
}



list_of_servers() # <name> <nr>
{
list=""

# for i = 1 to nr_servers
i=1; while [ $i -le $2 ]; do

    # add name to list
    list="$list ${1}$i"

# end "for i ..."
i=`expr $i + 1`; done

echo $list
}


schedule_checkpoints $*
```

tpcc_warm.sh

```
#!/usr/bin/sh -f
#*****************************************************************************
#@(#) Version: A.10.10 $Date: 97/12/15 10:49:59 $
#
#(c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
#*****************************************************************************

# This script will warm up the TPC-C database.
# Single session:
#         tpcc_warm.sh
# 6 parallel sessions:
#         tpcc_warm.sh 1 6 &
#         tpcc_warm.sh 2 6 &
#         tpcc_warm.sh 3 6 &
#         tpcc_warm.sh 4 6 &
#         tpcc_warm.sh 5 6 &
#         tpcc_warm.sh 6 6 &

x=${1:-1}
y=${2:-1}

isql -e  -Usa -P$PASSWORD << EOF
use tpcc
go

if ($x = 1)
         select count(*) from item (index item prefetch 2 lru)
         select count(*) from warehouse (index warehouse prefetch 2 lru)

go

set forceplan on

declare   @delta    smallint
select    @delta    = max(w_id)/$y
         from warehouse (index warehouse prefetch 2 lru)

select              d_w_id ware, d_id dist,
         (select min(no_o_id) from new_order
                   where     no_w_id = d.d_w_id
                   and       no_d_id = d.d_id) first,
         d_next_o_id next
         into #spread
         from district d (index district prefetch 2 lru)
         where     d_w_id between ($x-1)*@delta+1 and $x*@delta
go

set forceplan on
select    first, count(*)
         from      #spread,
                   orders o1 (index o_clu prefetch 2 lru),
                   orders o2 (index o_clu prefetch 2 lru),
              new_order (index no_clu prefetch 2 lru),
                   order_line (index ol_clu prefetch 2 lru)
         where     o1.o_w_id = ware and o1.o_d_id = dist and o1.o_id = first
         and       o2.o_w_id = ware and o2.o_d_id = dist and o2.o_id = next-1
         and       no_w_id = ware and no_d_id = dist and no_o_id = next-1
         and       ol_w_id = ware and ol_d_id = dist and ol_o_id = first
         and       ol_number = 1
         group by first
go

set forceplan on

declare   @delta    smallint
select    @delta    = max(w_id)/$y
         from warehouse (index warehouse prefetch 2 lru)

declare @ware int
declare @tail int

/* do for each warehouse */
select @ware = ($x-1)*@delta+1
while @ware <= $x*@delta
begin

    /* do for last N orders */
    select @tail = 3
    while @tail >= 1
    begin

        /* select orderlines and stock for the given warehouse */
        select      count(*)
              from  district,
                            order_line (index ol_clu prefetch 2 lru),
                            stock (index s_clu prefetch 2 lru)
              where d_w_id = @ware
              and   d_w_id    =         ol_w_id
              and   d_id      =         ol_d_id
              and   ol_o_id = d_next_o_id - @tail
              and   s_w_id    =         ol_w_id
              and   s_i_id    =         ol_i_id

    /* end "do for last N orders */
        select @tail = @tail -1
    end

/* end "do for each warehouse */
    select @ware = @ware + 1
end
go
EOF
```

cache_bind.sh

```
#!/usr/bin/sh -f

isql -Usa -P$PASSWORD -e << EOF

use master
go
sp_dboption tpcc, "single user", true
go

use tpcc
go
checkpoint
go

/*
** Cache c_log
*/

sp_bindcache "c_log", "tpcc", "syslogs"
go

sp_bindcache "c_wid", "tpcc", "sysindexes"
go
sp_bindcache "c_wid", "tpcc", "sysindexes", "sysindexes"
go

use master
go
sp_dboption tpcc, "single user", false
go

use tpcc
go
checkpoint
go

sp_bindcache "c_wid", "tpcc", "item"
go
sp_bindcache "c_wid", "tpcc", "item", "i_clu"
go
sp_bindcache "c_wid", "tpcc", "district"
go
sp_bindcache "c_wid", "tpcc", "district", "d_clu"
go
sp_bindcache "c_wid", "tpcc", "warehouse"
go
sp_bindcache "c_wid", "tpcc", "warehouse", "w_clu"
go

/*
** Cache New Order
*/

sp_bindcache "c_no", "tpcc", "new_order"
go
sp_bindcache "c_no_order_index", "tpcc", "new_order", "no_clu"
go


/*
** Cache Order Line
*/
sp_bindcache "c_ol", "tpcc", "order_line"
go
sp_bindcache "c_ol_index", "tpcc", "order_line", "ol_clu"
go

/*
** Cache orders
*/

sp_bindcache "c_orders", "tpcc", "orders"
go

sp_bindcache "c_no_order_index", "tpcc", "orders", "o_clu"
go

/*
** Cache c_stock_index
*/

sp_bindcache "c_stock_index", "tpcc", "stock", "s_clu"
go

/*
** Cache c_stock
*/

sp_bindcache "c_stock", "tpcc", "stock"
go

/*
** Cache c_customer
*/

sp_bindcache "c_customer", "tpcc", "customer"
go

/*
** Cache c_customer_index
*/

sp_bindcache "c_cust_index", "tpcc", "customer", "c_clu"
go

/*
** Cache c_customer_non_index
*/

sp_bindcache "c_cust_non_index", "tpcc", "customer", "c_non1"
go

/*
** Default cache
*/

sp_bindcache "default data cache", "tpcc", "history"
go
EOF
```

init_server.fast.sh

```
#!/usr/bin/sh -f

#dbcc tune("gc_times_to_yield", 16)
#dbcc tune(elcsize, 128)
#go
#sp_dboption tpcc, "no free space acctg", false
#go

isql -Usa -P <<- EOF
use master
go

sp_dboption tpcc,"trunc log on chkpt",false
go

use tpcc
go

checkpoint
go

dbcc tune(des_bind, 6, warehouse)
dbcc tune(des_bind, 6, district)
dbcc tune(des_bind, 6, item)
dbcc tune(des_bind, 6, stock)
dbcc tune(des_bind, 6, order_line)
dbcc tune(des_bind, 6, orders)
```

```
dbcc tune(des_bind, 6, new_order)
dbcc tune(des_bind, 6, customer)
dbcc tune(des_bind, 6, history)

dbcc tune(des_bind, 6, neworder_local)
dbcc tune(des_bind, 6, neworder_remote)
dbcc tune(des_bind, 6, payment_byid)
dbcc tune(des_bind, 6, payment_byname)
dbcc tune(des_bind, 6, order_status_byid)
dbcc tune(des_bind, 6, order_status_byname)
dbcc tune(des_bind, 6, delivery)
dbcc tune(des_bind, 6, stock_level)
go

EOF

isql -Usa -P <<- EOF
dbcc tune(maxwritedes, 18)
go
dbcc tune(deviochar, -1, "8")
go
dbcc tune("doneinproc", 0)
go
dbcc tune("cleanup", 0)
go
dbcc traceoff(-1)
go
dump tran tpcc with truncate_only
go
EOF

isql -Usa -P <<- EOF
use tpcc
go
sp_logiosize "8"
go
EOF
```

B.2 Code to Populate

load.c

```
/*****************************************************************************
 @(#) Version: A.10.10 $Date: 97/12/15 14:06:16 $

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*****************************************************************************/

/*****************************************************************
******************************************************************

To Do:
  o Need to add CLAST and CID constants and way to set them

*****************************************************************
*****************************************************************/

#include <unistd.h>
#include <time.h>
#include <stdio.h>
#include "tpcc.h"
#include "random.h"

/* configurable parameters */
#define NURAND_C 123

typedef unsigned long   BitVector;
#define WSZ             (sizeof(BitVector)*8)
#define nthbit(map,n)   map[(n)/WSZ] &  (((BitVector)0x1)<< ((n)%WSZ))
#define setbit(map,n)   map[(n)/WSZ] |= (((BitVector)0x1)<< ((n)%WSZ))

int load_item;
int load_warehouse;
int load_district;
int load_history;
int load_orders;
int load_orderline;
int load_neworder;
int load_customer;
int load_stock;

ID first;
ID last;

void LoadWarehouse();
void LoadDistrict();
void LoadItems();

int main(argn, argv)
    int argn;
    char **argv;
    {
    ID  w_id;

    configure(argn, argv);
    begin_load();

    /* NOTE:  Orders and Orderline must have the same seed to work
              properly */
    if (load_item)
          { SetRandomSeed(100); InitRandomStrings(); LoadItems();}
    if (load_warehouse)
          { SetRandomSeed(101); InitRandomStrings(); LoadWarehouse(first, last); }
    if (load_district)
          { SetRandomSeed(102); InitRandomStrings(); LoadDistrict(first, last); }
    if (load_stock)
          { SetRandomSeed(103); InitRandomStrings(); LoadStock(first, last); }
    if (load_customer)
          { SetRandomSeed(104); InitRandomStrings(); LoadCustomer(first, last); }
    if (load_history)
          { SetRandomSeed(105); InitRandomStrings(); LoadHist(first, last); }
    if (load_orders)
          { SetRandomSeed(106); InitRandomStrings(); LoadOrders(first, last); }
    if (load_orderline)
          { SetRandomSeed(106); InitRandomStrings(); LoadOrderLine(first, last); }
    if (load_neworder)
          { SetRandomSeed(107); InitRandomStrings(); LoadNeworder(first, last); }

    end_load();

    return 0;
    }


/*********************************************************************
**********************************************************************

Warehouse

**********************************************************************
**********************************************************************/

void
LoadWarehouse(first, last)
    ID first, last;
    {
    warehouse_row r[1];
    ID w_id;

    begin_warehouse_load();

    printf("loading warehouses %d to %d\n",first,last);
    r->W_YTD = 30000000;
    for (w_id = first;  w_id <= last; w_id++)
        {
        printf("loading warehouse %d\n",w_id);

        r->W_ID = w_id;
        MakeAlphaString(6, 10, r->W_NAME);
        MakeAddress(r->W_STREET_1, r->W_STREET_2, r->W_CITY, r->W_STATE,
```

```
                    r->W_ZIP);
        r->W_TAX = RandomNumber(0, 2000) / 10000.0;

        warehouse_load(r);
        }

    end_warehouse_load();
    }


/*************************************************************************
**************************************************************************

District

**************************************************************************
**************************************************************************/

void
LoadDistrict(first, last)
    ID first, last;
    {
    ID w_id, d_id;
    district_row r[1];

    begin_district_load();

    r->D_YTD = 3000000;
    r->D_NEXT_O_ID = 3001;

    for (w_id = first;  w_id <= last; w_id++)
        {
             printf("loading districts for warehouse %d\n",w_id);
        r->D_W_ID = w_id;

        for (d_id = 1;  d_id <= DIST_PER_WARE;  d_id++)
            {

            r->D_ID = d_id;
            MakeAlphaString(6, 10, r->D_NAME);
            MakeAddress(r->D_STREET_1, r->D_STREET_2, r->D_CITY, r->D_STATE,
                        r->D_ZIP);
            r->D_TAX = RandomNumber(0, 2000) / 10000.0;

            district_load(r);
            }
        }

    end_district_load();
    }



/*************************************************************************
**************************************************************************

Item

**************************************************************************
**************************************************************************/

void
LoadItems()
    {
    item_row r[1];
    int perm[MAXITEMS+1];
    ID i_id;

    begin_item_load();

    /* select exactly 10% of items to be labeled "original" */
    RandomPermutation(perm, MAXITEMS);

    /* do for each item */
          printf("loading item table\n");
    for (i_id = 1;  i_id <= MAXITEMS; i_id++)
        {

        /* Generate Item Data */
        r->I_ID = i_id;
        MakeAlphaString(14, 24, r->I_NAME);
        r->I_PRICE = RandomNumber(100,10000);
        MakeAlphaString(26, 50, r->I_DATA);
        if (perm[r->I_ID] <= (MAXITEMS+9)/10)
            Original(r->I_DATA);
        r->I_IM_ID  = RandomNumber(1, 10000);

        item_load(r);
        }

    end_item_load();
    }



/*************************************************************************
**************************************************************************

History

**************************************************************************
**************************************************************************/


LoadHist(first, last)
    ID first, last;
{
    ID w_id, d_id, c_id;
    static history_row r;

    begin_history_load();

    for (w_id = first;  w_id <= last; w_id++) {
        printf("Loading history for warehouse %d\n",w_id);
        for (d_id = 1;  d_id <= DIST_PER_WARE;  d_id++) {
            for (c_id = 1; c_id <= CUST_PER_DIST; c_id++) {
                  r.H_C_D_ID = r.H_D_ID = d_id;
                  r.H_C_W_ID = r.H_W_ID = w_id;
                  r.H_C_ID = c_id;
                  CurrentDate(&r.H_DATE);
                  r.H_AMOUNT = 1000;
                  SelectHistoryData(r.H_DATA);
                  history_load(&r);
            }
        }
    }
    end_history_load();
}


/*************************************************************************
**************************************************************************

Customer

**************************************************************************
**************************************************************************/

LoadCustomer(first, last)
    ID first, last;
{
    ID w_id;

    begin_customer_load();

    for (w_id = first;  w_id <= last; w_id++) {
          printf("Loading customer for warehouse %d\n",w_id);
        Customer(w_id);
    }

    end_customer_load();
}
```

```
Customer(w_id)
/*****************************************************************
Load customers for the given warehouse and district
*****************************************************************/
    ID w_id;
    {
    int i;
    ID   id[CUST_PER_DIST+1];
    ID c_id;
    ID d_id;
    customer_row r[1];
    static int bad_credit_perm[DIST_PER_WARE+1][CUST_PER_DIST+1];

    /* 10% of customers will have bad credit */
    for (d_id = 1;  d_id <= DIST_PER_WARE;  d_id++)
         RandomPermutation(bad_credit_perm[d_id], CUST_PER_DIST);


    /* Order by customer id, then district */
    r->C_W_ID          = w_id;
    r->C_CREDIT_LIM    = 5000000;
    r->C_BALANCE       = -1000;
    r->C_YTD_PAYMENT   = 1000;
    r->C_PAYMENT_CNT   = 1;
    r->C_DELIVERY_CNT = 0;
    for (c_id=1; c_id <= CUST_PER_DIST; c_id++)
        {
        r->C_ID    = c_id;
        for (d_id = 1;  d_id <= DIST_PER_WARE;  d_id++)
            {
            r->C_D_ID = d_id;

            if (c_id <= 1000)
                LastName(c_id - 1, r->C_LAST);
            else
                LastName(NURandomNumber(255, 0, 999, NURAND_C), r->C_LAST);

            strcpy(r->C_MIDDLE, "OE");
            SelectFirstName(r->C_FIRST);
            MakeAddress(r->C_STREET_1, r->C_STREET_2, r->C_CITY, r->C_STATE,
                        r->C_ZIP);
            SelectPhoneData(r->C_PHONE);
            CurrentDate(&r->C_SINCE);
            if (bad_credit_perm[d_id][r->C_ID] <= ((CUST_PER_DIST + 9)/10))
                strcpy(r->C_CREDIT, "BC");
            else
                strcpy(r->C_CREDIT, "GC");
            r->C_DISCOUNT      = RandomNumber(0, 5000) / 10000.0;
            SelectClientData(r->C_DATA);

            customer_load(r);
            }
        }
    }



/*****************************************************************
*****************************************************************

Order, Order line, New order

*****************************************************************
*****************************************************************/
LoadOrders(first, last)
    ID first, last;
    {
    ID w_id, d_id;

    begin_order_load();

    for (w_id = first;  w_id <= last; w_id++) {
        printf("Loading Orders for warehouse %d\n",w_id);
        for (d_id = 1;  d_id <= DIST_PER_WARE;  d_id++) {
            Orders(w_id, d_id);
          }
    }
    end_order_load();
    }

LoadOrderLine(first, last)
    ID first, last;
    {
    ID w_id, d_id;

    begin_orderline_load();

    for (w_id = first;  w_id <= last; w_id++) {
        printf("Loading Orderline for warehouse %d\n",w_id);
        for (d_id = 1;  d_id <= DIST_PER_WARE;  d_id++) {
            OrderLine(w_id, d_id);
          }
    }
    end_orderline_load();
    }

Orders(w_id, d_id)
    ID w_id, d_id;
    {
    int cust[ORD_PER_DIST+1];
    ID o_id, ol_number;
    ID ol;
    order_row       r[1];
    orderline_row olr[1];
    int sum;

    r->O_W_ID = w_id;
    r->O_D_ID = d_id;

    RandomPermutation(cust, ORD_PER_DIST);

    r->O_ALL_LOCAL    = 1;
    olr->OL_QUANTITY  = 5;
    for (o_id = 1;  o_id <= ORD_PER_DIST;  o_id++) {
        r->O_ID   = o_id;
        r->O_C_ID = cust[o_id];
        CurrentDate(&r->O_ENTRY_D);

        if (r->O_ID <= 2100) r->O_CARRIER_ID = RandomNumber(1,10);
        else                     r->O_CARRIER_ID = EMPTY_NUM;

        /* map the range 1..n onto 5..15 for orderline count */
        r->O_OL_CNT = RandomNumber(5,15);

        /* load the order */
        order_load(r);

        /* generate the order lines */
          olr->OL_O_ID        = o_id;
          olr->OL_D_ID        = d_id;
        olr->OL_W_ID        = w_id;
          olr->OL_SUPPLY_W_ID = w_id;
        for (ol_number = 1;  ol_number <= r->O_OL_CNT; ol_number++) {
              olr->OL_NUMBER      = ol_number;
              olr->OL_I_ID        = RandomNumber(1, MAXITEMS);

            /* Store null CurrentDate in the DB as "01/01/1800 12:00:00AM" */
            if (o_id <= 2100) {
                  olr->OL_DELIVERY_D = *(&r->O_ENTRY_D);
                olr->OL_AMOUNT     = 0;
            } else {
                  EmptyDate(&olr->OL_DELIVERY_D);
                olr->OL_AMOUNT = RandomNumber(1, 999999);
              }

            SelectStockDistrict(olr->OL_DIST_INFO);

          }
    }
}

OrderLine(w_id, d_id)
    ID w_id, d_id;
    {
    int cust[ORD_PER_DIST+1];
    ID o_id, ol_number;
    ID ol;
    order_row       r[1];
```

```
    orderline_row olr[1];
    int sum;

    r->O_W_ID = w_id;
    r->O_D_ID = d_id;

    RandomPermutation(cust, ORD_PER_DIST);

    r->O_ALL_LOCAL    = 1;
    olr->OL_QUANTITY  = 5;
    for (o_id = 1;  o_id <= ORD_PER_DIST;  o_id++) {
        r->O_ID   = o_id;
        r->O_C_ID = cust[o_id];
        CurrentDate(&r->O_ENTRY_D);

        if (r->O_ID <= 2100) r->O_CARRIER_ID = RandomNumber(1,10);
        else                 r->O_CARRIER_ID = EMPTY_NUM;

        /* map the range 1..n onto 5..15 for orderline count */
        r->O_OL_CNT = RandomNumber(5,15);

        /* generate the order lines */
          olr->OL_O_ID        = o_id;
          olr->OL_D_ID        = d_id;
        olr->OL_W_ID        = w_id;
          olr->OL_SUPPLY_W_ID = w_id;
        for (ol_number = 1;  ol_number <= r->O_OL_CNT; ol_number++) {
              olr->OL_NUMBER      = ol_number;
              olr->OL_I_ID        = RandomNumber(1, MAXITEMS);

            /* Store null CurrentDate in the DB as "01/01/1800 12:00:00AM" */
            if (o_id <= 2100) {
                olr->OL_DELIVERY_D = *(&r->O_ENTRY_D);
                olr->OL_AMOUNT     = 0;
            } else {
                 EmptyDate(&olr->OL_DELIVERY_D);
                olr->OL_AMOUNT = RandomNumber(1, 999999);
              }

            SelectStockDistrict(olr->OL_DIST_INFO);

            orderline_load(olr);
          }
    }
}


LoadNeworder(first, last)
    ID  first, last;
    {
    ID w_id, d_id;

    begin_neworder_load();

    for (w_id = first;  w_id <= last; w_id++) {
          printf("Loading NewOrder for warehouse %d\n",w_id);
        for (d_id = 1;  d_id <= DIST_PER_WARE;  d_id++) {
            neworder_row r[1];

            r->NO_D_ID = d_id;
            r->NO_W_ID = w_id;
            for (r->NO_O_ID=2101;  r->NO_O_ID <= ORD_PER_DIST; r->NO_O_ID++) {
                neworder_load(r);
              }
          }
    }

    end_neworder_load();
}

#define ITEM_BITVEC_SIZE ((MAXITEMS/(8*sizeof(BitVector)))+1)*sizeof(BitVector)

LoadStock(first, last)
    ID first, last;
{
    BitVector **perm;
    stock_row r[1];
    ID w_id;
    ID i_id;

    unsigned long count = 0;
    unsigned long checkPointTime, checkPointChunk, totalRowsToLoad;
    int i;
    long j;

    begin_stock_load();

    perm = (BitVector **) malloc((last-first)*sizeof(BitVector *));
    if (perm == NULL) {
          syserror("LoadStock: can't allocate memory for permutations\n");
    }
    /* select exactly 10% of items to be labeled "original" */
    for (w_id = first; w_id <= last; w_id++)
    {
          int index = w_id - first;
        perm[index] = (BitVector *)malloc(ITEM_BITVEC_SIZE);
        if (perm[index] == NULL) {
                  syserror("LoadStock: can't allocate memory\n");
          }
          (void) memset(perm[index],0,ITEM_BITVEC_SIZE);
          /* Mark exactly 10% of items as "original" */
          for (i = 0; i < (MAXITEMS+9)/10; i++) {
                  do {
                          j = RandomNumber(0,MAXITEMS-1);
                  } while (nthbit(perm[index],j));
                  setbit(perm[index],j);
          }
    }

    /* do for each item and warehouse */
    printf("Loading stock items for warehouses %d to %d....\n",first, last);
    r->S_YTD        = 0;
    r->S_ORDER_CNT  = 0;
    r->S_REMOTE_CNT = 0;
    totalRowsToLoad = MAXITEMS*(last - first + 1);
    /* Every 5% loaded, print message 8 */
    checkPointTime = checkPointChunk = (totalRowsToLoad)/20;
    for (i_id = 1;  i_id <= MAXITEMS;  i_id++) {
        r->S_I_ID = i_id;
          if (checkPointTime < count) {
                  printf("Loaded %4.1lf%% of stock
rows\n",100.0*((double)count/(double)totalRowsToLoad));
                  checkPointTime += checkPointChunk;
          }
        for (w_id = first; w_id <= last; w_id++) {
            /* Generate Stock Data */
            r->S_W_ID = w_id;
            r->S_QUANTITY = RandomNumber(10,100);
          SelectStockDistrict(r->S_DIST_01);
            SelectStockDistrict(r->S_DIST_02);
            SelectStockDistrict(r->S_DIST_03);
            SelectStockDistrict(r->S_DIST_04);
            SelectStockDistrict(r->S_DIST_05);
            SelectStockDistrict(r->S_DIST_06);
            SelectStockDistrict(r->S_DIST_07);
            SelectStockDistrict(r->S_DIST_08);
            SelectStockDistrict(r->S_DIST_09);
            SelectStockDistrict(r->S_DIST_10);
            SelectStockData(r->S_DATA);
              if (nthbit(perm[w_id - first], r->S_I_ID -1)) {
                  Original(r->S_DATA);
              }
            stock_load(r);
              count++;
        }
    }
    printf("finished loading stock items for warehouses %d to %d\n",
          first,last);

    for (w_id = first; w_id <= last; w_id++) {
        free(perm[w_id-first]);
    }

    free(perm);

    end_stock_load();
}
```

```
configure(argc, argv)
/*****************************************************************
configure configures the load stuff
   By default, loads all the tables for a the specified warehouse.
               When loading warehouse 1, also loads the item table.
*****************************************************************/
    int argc;
    char **argv;
    {
    char ch;
    int any_except_item,  any_at_all;

    /* use unbuffered I/O (for output to files) */
    setvbuf(stdout, 0, _IONBF, 0);
    setvbuf(stderr, 0, _IONBF, 0);

    /* define the defaults */
    load_item = load_warehouse = load_district = load_history =
        load_orders = load_orderline = load_neworder = load_customer = load_stock =
NO;

    /* do for each option */
    while ((ch = getopt (argc, argv, "t:")) != EOF)

        /* process according to options */
        switch ( ch )
            {

            /* check for TPC-A or TPC-B */
            case 't':
                if      (strcmp(optarg, "warehouse") == 0)load_warehouse = YES;
                else if (strcmp(optarg, "district") == 0)  load_district = YES;
                else if (strcmp(optarg, "stock") == 0)  load_stock = YES;
                else if (strcmp(optarg, "item") == 0)  load_item = YES;
                else if (strcmp(optarg, "history") == 0)  load_history = YES;
                else if (strcmp(optarg, "orders") == 0)  load_orders = YES;
                else if (strcmp(optarg, "orderline") == 0)  load_orderline = YES;
                else if (strcmp(optarg, "new_order") == 0)  load_neworder = YES;
                else if (strcmp(optarg, "customer") == 0)  load_customer = YES;
                else
                    error("%s is not a valid table name\n", optarg);
                continue;

            default:   error("Bad runstring argument.\n");
                       break;
            }


    /* some common flags depending on tables asked for */
    any_except_item = load_warehouse || load_district || load_stock ||
                      load_history  || load_orders || load_orderline ||
                           load_neworder || load_customer;
    any_at_all = any_except_item || load_item;


    /* if only asked for item, don't allow warehouse to be specified */
    if (!any_except_item && load_item)
        {
        if (optind != argc)
            error("Don't specify warehouse when loading items");
        }

    /* otherwise get the warehouse number */
    else
        {
        if (optind >= argc)
            error("Must specify warehouses to load\n");
        first = atoi(argv[optind++]);

        if (optind >= argc)
            last = first;
        else
            last = atoi(argv[optind++]);

        if (first > last)
            error("First warehouse is greater than last warehouse\n");
        if (first <= 0)
            error("Warehouse must be positive non-zero\n");
        }

    /* if no tables mentioned explicitly, then load them all */
    if (!any_at_all)
        {
        load_warehouse = load_district = load_history = load_orders =
             load_orderline = load_neworder = load_customer = load_stock = YES;
        load_item = (first == 1);
        }
    }
```

Appendix C Tunable Parameters

The HP-UX operating system tunable parameters employed to generate the kernel for the HP 9000 V2500 Enterprise Server and the 14 HP 9000 Model C3000 clients are listed below. Included as well are the Sybase Adaptive Server Enterprise 12.0 and TUXEDO 6.4 paramters.

C.1 HP-UX Configuration - Clients

Config/Client/ostune.ver

```
* Drivers and Subsystems

GSCtoPCI
SCentIf
asio0
asp
audio
btlan3
btlan5
c720
ccio2
cdfs
clone
core
diag1
diag2
dlpi
dmem
echo
ffs
foreign
framebuf
graph3
hcd
hid
hpstreams
hub
inet
inet_clts
inet_cots
ite
klog
lasi
lba
ldterm
lv
lvm
netdiag1
netman
nfs
ni
pa
pci
pckt
pipedev
pipemod
ptem
ptm
pts
sad
sc
sctl
sdisk
side
strlog
strpty_included
superio
timod
tirdwr
tpiso
uipc
usbd
vxbase
wsio


* Kernel Device info

dump lvol


* Tunable parameters

STRMSGSZ        65535
bufpages        1024
create_fastlinks 1
dbc_max_pct     10
dbc_min_pct     10
default_disk_ir 1
fs_async        1
maxdsiz         2063806464
*maxfiles        2048
*maxfiles_lim    2048
maxfiles        4096
maxfiles_lim    4096
maxssiz         (80*1024*1024)
maxswapchunks   16384
maxtsiz         (1024*1024*1024)
maxuprc         (NPROC-128)
*maxusers        4096
maxusers        (NPROC-512)
msgmax          32768
msgmnb          65535
msgmni          (NPROC-128)
msgseg          (MSGTQL*4)
msgssz          512
msgtql          (NPROC-512)
*nfile           20000
*nflocks         4096
nfile           25000
nflocks         25000
ninode          25000
nproc           8400
npty            512
nstrpty         200
semmni          (NPROC-128)
semmns          (SEMMNI)
semmnu          (SEMMNI)
semvmx          32768
shmmax          0X40000000
shmmni          1024
shmseg          16
swapmem_on      0
timezone        480
unlockable_mem  1
```

C.2 HP-UX Configuration – Server

Config/Server/ostune.ver

```
******************************************************************************
* Dfile for V-class TPC-C
******************************************************************************

* Bus dependent subsystem
epic
```

```
* Fiber channel
fc_arp
fcT1_fcp
fcT1_cntl
fcpmux
fcT1
fcp
fcms

* SCSI drivers
sdisk
stape
sctl
c720

* Other device drivers
btlan6
fddi4
consp1
sppcore

* Pseudo drivers
prf
asyncdsk
onyxe

* Nfs
nfs_core
nfs_client
nfs_server

* Subsystems
uipc
inet
nms
lvm
tun

* Streams, DLIP, and Streams-based PTY Drivers/Modules
* Note: To remove the Streams PTY driver from the dfile, you need to
* yank out the following items:
* ptm, pts. ldterm, ptem, pckt, and nstrpty 60
hpstreams
clone
echo
sad
strlog
timod
tirdwr
sc
pipemod
pipedev
ffs
dlpi
ptm
pts
ldterm
ptem
pckt


*************************************************************************
* Tunables
*************************************************************************
nfsm
autofsc
token_arp
btlan3
maclan
default_disk_ir    0
fs_async           0
nhtbl_scale        1
nstrpty               60
npty               50
STRMSGSZ           65536
maxfiles           2048
maxfiles_lim       2048
nflocks            2048
bufpages           1024
maxusers           64
maxuprc            192
nproc              256
maxswapchunks     10000
nfile              7500
ninode             7500
* Shared Memory
shmseg             8
shmmni             16
shmmax             34359738368
*Misc
maxssiz            0x10000000
maxdsiz            0x30000000
timezone           480
unlockable_mem     1
swapmem_on         0
max_fcp_reqs      1024
num_tachyon_adapters    3
```

C.3 Sybase Adaptive Server Enterprise 12.0 Parameters

Config/Server/sybase.cfg

```
################################################################################
#
#                   Configuration File for the Sybase SQL Server
#
#                   Please read the System Administration Guide (SAG)
#                   before changing any of the values in this file.
#
################################################################################


[Configuration Options]

[General Information]

[Backup/Recovery]
          recovery interval in minutes = 32767
          print recovery information = DEFAULT
          tape retention in days = DEFAULT

[Cache Manager]
          number of oam trips = DEFAULT
          number of index trips = DEFAULT
          procedure cache percent = 1
          memory alignment boundary = DEFAULT
          global async prefetch limit = 90
          global cache partition number  = 16

[Named Cache:c_cust_index]
          cache size = 640M
          cache status = mixed cache
          cache status = HK ignore cache
          cache replacement policy = relaxed LRU replacement
          local cache partition number = 8

[2K I/O Buffer Pool]
          pool size = 640M
          wash size = 64 K
          local async prefetch limit = 0

[Named Cache:c_cust_non_index]
          cache size = 710M
          cache status = mixed cache
          cache status = HK ignore cache
          cache replacement policy = DEFAULT
          local cache partition number = 8
```

```
[2K I/O Buffer Pool]
          pool size = 710M
          wash size = 64 K
          local async prefetch limit = 0

[Named Cache:c_customer]
          cache size = 16M
          cache status = mixed cache
          cache replacement policy = DEFAULT
          local cache partition number = 8

[2K I/O Buffer Pool]
          pool size = 16M
          wash size = 1024 K
          local async prefetch limit = 0

[Named Cache:c_log]
          cache size = 20M
          cache status = log only
          cache replacement policy = DEFAULT
          local cache partition number = 1

[2K I/O Buffer Pool]
          pool size = 3M
          wash size = 512 K
          local async prefetch limit = 0

[16K I/O Buffer Pool]
          pool size = 17M
          wash size = 7168 K
          local async prefetch limit = 0

[Named Cache:c_no]
          cache size = 340M
          cache status = mixed cache
          cache replacement policy = relaxed LRU replacement
          local cache partition number = 4

[2K I/O Buffer Pool]
          pool size = 340M
          wash size = 2048 K
          local async prefetch limit = 0

[Named Cache:c_no_order_index]
          cache size = 90M
          cache status = mixed cache
          cache status = HK ignore cache
          cache replacement policy = relaxed LRU replacement
          local cache partition number = 4

[2K I/O Buffer Pool]
          pool size = 90M
          wash size = 64 K
          local async prefetch limit = 0

[Named Cache:c_ol]
          cache size = 1280M
          cache status = mixed cache
          cache replacement policy = relaxed LRU replacement
          local cache partition number = 8

[2K I/O Buffer Pool]
          pool size = 1280M
          wash size = 2048 K
          local async prefetch limit = 0

[Named Cache:c_ol_index]
          cache size = 340M
          cache status = mixed cache
          cache status = HK ignore cache
          cache replacement policy = relaxed LRU replacement
          local cache partition number = 8

[2K I/O Buffer Pool]
          pool size = 340M
          wash size = 1024 K
          local async prefetch limit = 0

[Named Cache:c_orders]
          cache size = 1880M
          cache status = mixed cache
          cache replacement policy = DEFAULT
          local cache partition number = 8

[2K I/O Buffer Pool]
          pool size = 1660.0000M
          wash size = 8192 K
          local async prefetch limit = 0

[16K I/O Buffer Pool]
          pool size = 220.0000M
          wash size = 4096 K
          local async prefetch limit = 0

[Named Cache:c_stock]
          cache size = 19900M
          cache status = mixed cache
          cache replacement policy = DEFAULT
          local cache partition number = 32

[2K I/O Buffer Pool]
          pool size = 19900M
          wash size = 10240 K
          local async prefetch limit = 0

[Named Cache:c_stock_index]
          cache size = 1500M
          cache status = mixed cache
          cache status = HK ignore cache
          cache replacement policy = relaxed LRU replacement
          local cache partition number = 32

[2K I/O Buffer Pool]
          pool size = 1500M
          wash size = 1024 K
          local async prefetch limit = 0

[Named Cache:c_wid]
          cache size = 70M
          cache status = mixed cache
          cache status = HK ignore cache
          cache replacement policy = relaxed LRU replacement
          local cache partition number = 16

[2K I/O Buffer Pool]
          pool size = 70M
          wash size = 64 K
          local async prefetch limit = 0

[Named Cache:default data cache]
          cache size = 40M
          cache status = default data cache
          cache replacement policy = relaxed LRU replacement
          local cache partition number = 4

[2K I/O Buffer Pool]
          pool size = 40M
          wash size = 512 K
          local async prefetch limit = 0

[Meta-Data Caches]
          number of open databases = DEFAULT
          number of open objects = 100
          open object spinlock ratio = 2
          number of open indexes = 100
          open index hash spinlock ratio = 5
          open index spinlock ratio = 5

[Disk I/O]
          disk i/o structures = 6400
          page utilization percent = DEFAULT
          number of devices = 256
          disable disk mirroring = 1
          disable character set conversions = DEFAULT
          enable unicode conversions = DEFAULT
          size of unilib cache = DEFAULT
```

```
[Network Communication]
          default network packet size = DEFAULT
          max network packet size = 4096
          remote server pre-read packets = DEFAULT
          number of remote connections = DEFAULT
          number of remote logins = DEFAULT
          number of remote sites = DEFAULT
          max number network listeners = 1
          tcp no delay = DEFAULT
          allow sendmsg = DEFAULT
          syb_sendmsg port number = DEFAULT

[O/S Resources]
          max async i/os per engine = 2048
          max async i/os per server = 2048

[Parallel Query]
          number of worker processes = DEFAULT
          memory per worker process = DEFAULT
          max parallel degree = DEFAULT
          max scan parallel degree = DEFAULT

[Physical Resources]

[Physical Memory]
          total memory = 15450000
          additional network memory = 10027008
          shared memory starting address = DEFAULT
          max SQL text monitored = DEFAULT

[Processors]
          max online engines = 32
          min online engines = DEFAULT

[SQL Server Administration]
          default database size = DEFAULT
          identity burning set factor = DEFAULT
          allow nested triggers = DEFAULT
          allow updates to system tables = 1
          print deadlock information = DEFAULT
          default fill factor percent = DEFAULT
          default exp_row_size percent = DEFAULT
          number of mailboxes = DEFAULT
          number of messages = DEFAULT
          number of alarms = DEFAULT
          number of pre-allocated extents = DEFAULT
          event buffers per engine = DEFAULT
          cpu accounting flush interval = 2147483647
          i/o accounting flush interval = 2147483647
          sql server clock tick length = DEFAULT
          runnable process search count = DEFAULT
          i/o polling process count = DEFAULT
          time slice = DEFAULT
          deadlock retries = DEFAULT
          cpu grace time = DEFAULT
          number of sort buffers = DEFAULT
          number of large i/o buffers = DEFAULT
          size of auto identity column = DEFAULT
          identity grab size = DEFAULT
          page lock promotion HWM = DEFAULT
          page lock promotion LWM = DEFAULT
          page lock promotion PCT = DEFAULT
          housekeeper free write percent = 0
          enable housekeeper GC = 0
          partition groups = DEFAULT
          partition spinlock ratio = DEFAULT
          allow resource limits = DEFAULT
          number of aux scan descriptors = DEFAULT
          SQL Perfmon Integration = DEFAULT
          allow backward scans = DEFAULT
          row lock promotion HWM = DEFAULT
          row lock promotion LWM = DEFAULT
          row lock promotion PCT = DEFAULT
          license information = DEFAULT
          disable sort-merge join = 1
          text prefetch size = DEFAULT

[User Environment]
          number of user connections = 820
          stack size = DEFAULT
          stack guard size = DEFAULT
          permission cache entries = DEFAULT
          user log cache size = 4096
          user log cache spinlock ratio = DEFAULT
          enable HA = DEFAULT
          enable DTM = DEFAULT
          allow remote access = DEFAULT
          lock shared memory = 1
          allow sql server async i/o = DEFAULT

[Lock Manager]
          number of locks = 20000
          deadlock checking period = 900
          freelock transfer block size = DEFAULT
          max engine freelocks = 50
          lock spinlock ratio = 10
          lock address spinlock ratio = 5
          lock table spinlock ratio = 1
          lock hashtable size = DEFAULT
          lock scheme = DEFAULT
          lock wait period = DEFAULT
          read committed with lock = DEFAULT

[Security Related]
          systemwide password expiration = DEFAULT
          audit queue size = DEFAULT
          curread change w/ open cursors = DEFAULT
          allow procedure grouping = DEFAULT
          select on syscomments.text = DEFAULT
          auditing = DEFAULT
          current audit table = DEFAULT
          suspend audit when device full = DEFAULT
          max roles enabled per user = DEFAULT
          check password for digit = DEFAULT
          minimum password length = DEFAULT
          maximum failed logins = DEFAULT
          unified login required = DEFAULT
          use security services = DEFAULT
          msg confidentiality reqd = DEFAULT
          msg integrity reqd = DEFAULT
          secure default login = DEFAULT

[Extended Stored Procedure]
          esp unload dll = DEFAULT
          esp execution priority = DEFAULT
          esp execution stacksize = DEFAULT
          xp_cmdshell context = DEFAULT
          start mail session = DEFAULT

[Error Log]
          event logging = DEFAULT
          log audit logon success = DEFAULT
          log audit logon failure = DEFAULT
          event log computer name = DEFAULT

[Rep Agent Thread Administration]
          enable rep agent threads = DEFAULT

[Component Integration Services]
          enable cis = 0
          cis connect timeout = DEFAULT
          cis bulk insert batch size = DEFAULT
          max cis remote connections = DEFAULT
          max cis remote servers = DEFAULT
          cis packet size = DEFAULT
          cis cursor rows = DEFAULT
          cis rpc handling = DEFAULT

[Java Services]
          enable java = 0
          size of process object heap = DEFAULT
          size of shared class heap = DEFAULT
          size of global fixed heap = DEFAULT

[DTM Administration]
          enable xact coordination = 0
          xact coordination interval = DEFAULT
          number of dtx participants = DEFAULT
```

```
          strict dtm enforcement = DEFAULT
          txn to pss ratio = DEFAULT
          dtm lock timeout period = DEFAULT

[Diagnostics]
          dump on conditions = DEFAULT
          maximum dump conditions = DEFAULT
          number of ccbs = DEFAULT
          caps per ccb = DEFAULT
          average cap size = DEFAULT

[Monitoring]
          Q diagnostics active = DEFAULT
          autostart collector = DEFAULT
          collector repository server = DEFAULT
          collector application host = DEFAULT
          collector errorlog file = DEFAULT
          collector failover file = DEFAULT
          collection interval = DEFAULT
          sql text pipe active = DEFAULT
          sql text pipe max messages = DEFAULT
          plan text pipe active = DEFAULT
          plan text pipe max messages = DEFAULT
          statement pipe active = DEFAULT
          statement pipe max messages = DEFAULT
          errorlog pipe active = DEFAULT
          errorlog pipe max messages = DEFAULT
          deadlock pipe active = DEFAULT
          deadlock pipe max messages = DEFAULT
          wait event timing = DEFAULT
          process wait events = DEFAULT
          object lockwait timing = DEFAULT
          SQL batch capture = DEFAULT
          statement statistics active = DEFAULT
```

C.4 Tuxedo UBBconfig

Config/Client4/ubbconfig

```
# This is a UBBconfig for a client1-server configuration.
#
# This UBBconfig requires settings for:
# SERVER_NAME CLIENT_NAME MASTER_NAME SERVER_ADDR CLIENT_ADDR NODE_NAMES
# TLISTEN_PORT TBRIDGE_PORT
# In addition, it requires setting the things all UBBconfig.gens need:
#         IPCKEY              some decent IPCKEY, should be different for each
config
#         ROOTDIR
#         TUXCONFIG
#         APPDIR
#         ULOGDIR
#

#------------------------------------------------------------------------
*RESOURCES
#------------------------------------------------------------------------
          IPCKEY    40001
          PERM      0666
          MASTER    client1

   MAXACCESSERS     6450      # 1024 or more
   MAXGTT           1024
   MAXSERVERS       57
   MAXSERVICES      270   # MAXSERVERS * #-of-services-each-server + 10( for BBL)
   MODEL  SHM
   LDBAL  Y

# During benchmark, don't want to scan too often.  In particular, while
# the client1s are stabilizing in virtual memory, we don't want to sanity
# scan; and if we do sanity scan, we want large timeouts, since the BRIDGE
# the BBL, the DBBL, and the client1s aren't getting much CPU time during that
# period.  Current settings:
#         *  scan servers every 5 minutes (maximum allowed by TUXEDO);
#         *  wait 1 minute for sanity  responses (maximum allowed by TUXEDO);
#         *  scan all the BBLs from DBBL every 30 minutes (want one scan in the
#            audited results);
#         *  timeout a blocking call after 5 minutes (the maximum).
          SCANUNIT  60
          SANITYSCAN          5
          DBBLWAIT  1
          BBLQUERY  30
          BLOCKTIME 5
#
#------------------------------------------------------------------------
*MACHINES
#------------------------------------------------------------------------
DEFAULT:
                TUXCONFIG="/project/iti/confs/TUXconfig.client1"
                    ROOTDIR="/project/iti"
                    APPDIR="/project/tpcc/bin"
                    ULOGPFX="/tmp/TUXEDO_LOG"

# for debugging, put both into the same log on the same machine
#                   ULOGPFX="/home/iti/confs/tpcc/ULOG"
# but for a big run, need some space, and want them local to the
# machine rather than across the net.

# Leave TUXCONFIG alone on the MASTER machine; over-ride for each
# other machine?
client1   LMID=client1
        TUXCONFIG="/project/iti/confs/TUXconfig.client1"
#------------------------------------------------------------------
*GROUPS
#------------------------------------------------------------------
group1            LMID=client1
                   GRPNO=1
group2            LMID=client1
                   GRPNO=2
group3            LMID=client1
                   GRPNO=3
group4            LMID=client1
                   GRPNO=4
group5            LMID=client1
                   GRPNO=5
group6            LMID=client1
                   GRPNO=6
group7            LMID=client1
                   GRPNO=7
group8            LMID=client1
                   GRPNO=8
group9            LMID=client1
                   GRPNO=9
group10            LMID=client1
                   GRPNO=10
group11            LMID=client1
                   GRPNO=11

#------------------------------------------------------------------
#------------------------------------------------------------------

#------------------------------------------------------------------
*SERVERS
#------------------------------------------------------------------
#
# "--" is application-specific arguments to be passed to server
# "-n" is designed to specify server-id

service SRVGRP=group1
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -n1"
        RQADDR=tpcc_1 SRVID=1

service SRVGRP=group1
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -n2"
        RQADDR=tpcc_2 SRVID=2

service SRVGRP=group1
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -n3"
        RQADDR=tpcc_3 SRVID=3

service SRVGRP=group1
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -n4"
```

```
        RQADDR=tpcc_4 SRVID=4

service SRVGRP=group1
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -n5"
        RQADDR=tpcc_5 SRVID=5

service SRVGRP=group2
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -n6"
        RQADDR=tpcc_6 SRVID=6

service SRVGRP=group2
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -n7"
        RQADDR=tpcc_7 SRVID=7

service SRVGRP=group2
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -n8"
        RQADDR=tpcc_8 SRVID=8

service SRVGRP=group2
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -n9"
        RQADDR=tpcc_9 SRVID=9

service SRVGRP=group2
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n10"
        RQADDR=tpcc_10 SRVID=10

service SRVGRP=group3
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n11"
        RQADDR=tpcc_11 SRVID=11

service SRVGRP=group3
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n12"
        RQADDR=tpcc_12 SRVID=12

service SRVGRP=group3
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n13"
        RQADDR=tpcc_13 SRVID=13

service SRVGRP=group3
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n14"
        RQADDR=tpcc_14 SRVID=14

service SRVGRP=group3
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n15"
        RQADDR=tpcc_15 SRVID=15

service SRVGRP=group4
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n16"
        RQADDR=tpcc_16 SRVID=16

service SRVGRP=group4
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n17"
        RQADDR=tpcc_17 SRVID=17

service SRVGRP=group4
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n18"
        RQADDR=tpcc_18 SRVID=18

service SRVGRP=group4
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n19"
        RQADDR=tpcc_19 SRVID=19

service SRVGRP=group4
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n20"
        RQADDR=tpcc_20 SRVID=20

service SRVGRP=group5
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n21"
        RQADDR=tpcc_21 SRVID=21

service SRVGRP=group5
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n22"
        RQADDR=tpcc_22 SRVID=22

service SRVGRP=group5
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n23"
        RQADDR=tpcc_23 SRVID=23

service SRVGRP=group5
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n24"
        RQADDR=tpcc_24 SRVID=24

service SRVGRP=group5
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n25"
        RQADDR=tpcc_25 SRVID=25

service SRVGRP=group6
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n26"
        RQADDR=tpcc_26 SRVID=26

service SRVGRP=group6
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n27"
        RQADDR=tpcc_27 SRVID=27

service SRVGRP=group6
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n28"
        RQADDR=tpcc_28 SRVID=28

service SRVGRP=group6
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n29"
        RQADDR=tpcc_29 SRVID=29

service SRVGRP=group6
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n30"
        RQADDR=tpcc_30 SRVID=30

service SRVGRP=group7
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n31"
        RQADDR=tpcc_31 SRVID=31

service SRVGRP=group7
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n32"
        RQADDR=tpcc_32 SRVID=32

service SRVGRP=group7
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n33"
        RQADDR=tpcc_33 SRVID=33

service SRVGRP=group7
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n34"
        RQADDR=tpcc_34 SRVID=34

service SRVGRP=group7
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n35"
        RQADDR=tpcc_35 SRVID=35

service SRVGRP=group8
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n36"
        RQADDR=tpcc_36 SRVID=36
```

```
service SRVGRP=group8
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n37"
        RQADDR=tpcc_37 SRVID=37

service SRVGRP=group8
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n38"
        RQADDR=tpcc_38 SRVID=38

service SRVGRP=group8
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n39"
        RQADDR=tpcc_39 SRVID=39

service SRVGRP=group8
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n40"
        RQADDR=tpcc_40 SRVID=40

service SRVGRP=group9
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n41"
        RQADDR=tpcc_41 SRVID=41

service SRVGRP=group9
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n42"
        RQADDR=tpcc_42 SRVID=42

service SRVGRP=group9
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n43"
        RQADDR=tpcc_43 SRVID=43

service SRVGRP=group9
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n44"
        RQADDR=tpcc_44 SRVID=44

service SRVGRP=group9
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n45"
        RQADDR=tpcc_45 SRVID=45

service SRVGRP=group10
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n46"
        RQADDR=tpcc_46 SRVID=46

service SRVGRP=group10
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n47"
        RQADDR=tpcc_47 SRVID=47

service SRVGRP=group10
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n48"
        RQADDR=tpcc_48 SRVID=48

service SRVGRP=group10
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n49"
        RQADDR=tpcc_49 SRVID=49

service SRVGRP=group10
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n50"
        RQADDR=tpcc_50 SRVID=50

service SRVGRP=group11
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n51"
        RQADDR=tpcc_51 SRVID=51

service SRVGRP=group11
           CLOPT="-s NEWO_SVC -s PMT_SVC -s ORDS_SVC -s STKL_SVC -s DVRY_SVC -- -
n52"
        RQADDR=tpcc_52 SRVID=52
```

```
#------------------------------------------------------------------------
*SERVICES
#------------------------------------------------------------------------
*ROUTING
#------------------------------------------------------------------------
```

Appendix D RTE Configuration

This appendix lists RTE input parameters and code fragments used to generate each transaction input file, to demonstrate the RTE was configured to generate transaction input data as specified in *Clause 2* of the specification.

D.1 RTE Parameters

TESTENV

```
#############################################################################
# Environment variables for running TPC-C
#############################################################################
setenv COMMENT   "10000 Warehouse TPCC"

# Database Information
setenv DB_SIZE    8498
setenv DATABASE   "sybase"
setenv DSQUERY    "dbtpcc"

# Note: Configuration must have integral numbers of clients per driver
#       and each system must have numbered names system1, system1_1
#       defined in the hosts file, even if there is only one of them.
#
# Hardware configuration
setenv SERVER       "sut"
# setenv NR_SERVER  "1"
setenv CLIENT       "client"
setenv NR_CLIENT    "14"
setenv DRIVER       "driver"
setenv NR_DRIVER    "7"

setenv OPS                0      # Set to 1 if using OPS
setenv NT                 0      # Set to 1 if using NT

setenv BATCH_TPCC         0      # Set to 1 for "batch_tpcc" with the
setenv TESTROOT     results
setenv RESULTS_NAME  3tier     # Directory name of RESULTS (put in root of
                                 # Directory name of RESULTS (put in root of
                                 # ~tpcc).  So actual directory is
                                 # ~tpcc/${TESTROOT}


setenv TRANS_TIME         60   # Total time to run the test for (in minutes)
setenv CHKPNT_INTERVAL   420   # Seconds to wait before forcing first checkpoint
setenv CHKPNT_INTERVAL2  1800  # Seconds between subsequent checkpoints

setenv WINDOW_BEGIN     27       # measurement interval, assuming 10 minute
checkpoint
setenv WINDOW_END       57


# setenv NR_HOSES        "1"      # For multiple lans between client and server
setenv NR_LAN           "1"      # For multiple lans between driver and client

setenv TPCC_SUCCESS_FILE "/tmp/SUCCESS"

setenv LOCAL_PORT    11000    # Required when creating lots of outbound socket
                                  # connections. Otherwise, you run out of ports
                                  # at around 4000 users.
setenv TPCC_SERVICE  11000    # Just a coincidence - should be different
                                  # from LOCAL_PORT to avoid confusion
#
# statistics, should probably all be off during your audit runs (performance
# runs).
#
setenv SERVER_STATS      0      # turn on statistics on the server(1)
setenv CLIENT_STATS      0      # turn on statistics on the client(1)
setenv SAR_STATS         0      # turn on SAR (1)
setenv ONYXE_STATS       0      # turn on onyxe (PCX-U)
setenv FULL_ONYXE        0      # go for the full, 25-minute onyxe counts
setenv KERNEL_STATS      0      # turn on kernel gprof (20)
setenv KERNEL_TIME       0      # collection time
setenv SPIN_STATS        0      # turn on spinwatcher (18)
setenv SPIN_TIME         0      # collection time
setenv CPI_STATS         0      # turn on cpi measurement (cyclemeter) (14)
setenv NET_STATS         0      # turn on netstat (1)
setenv SAMPLER_STATS     0      # turn on KI sampler (12)
setenv SAMPLER_TIME      0      # collection time
setenv DATABASE_STATS    0      # collect Sybase statistics (16)
setenv DATABASE_TIME     0      # collection time in _SECONDS_
setenv PMON_STATS        0      # collect pmon statistics (22)
setenv PMON_SECONDS      0      # collection time >>in seconds<<.  Note that


setenv PEPSI_STATS       0      # turn on pepsi (T5xx)
setenv JOLT_STATS        0      # turn on JOLT counters (Jade) (12)
setenv JOLT_TIME         0      # collection time in seconds for _EACH_ sample
setenv TORNADO_STATS     0      # turn on tornade (PCX-T')
setenv LOGIC_ANALYZER    0      # turn on the logic analyzer
setenv LOG_ANAL_WAIT     0      # wait time in _MINUTES_
setenv LOG_ANAL_TIME     0      # collection time in _MINUTES_
                                       # pmon makes 13 passes, each this long

#
# Audit related stuff + misc
#
setenv CONSISTENCY       0       # run consistancy checks before/after run
                                 # this should be 1 when doing your final
                                 # performance runs. (Adds hours to run)

setenv RUNCHECK          0       # perform the runcheck script after the run
                                        # which is needed during final performance
                                        # runs

setenv POST_TRANSACTIONS 0       # set to 1 to log all transaction data
#setenv POST_NEWORDERS    1023    # Specifies the fraction of users that should
                                 # log neworder transactions.  Useful for
                                        # durability tests (1/n users post
neworders)

setenv REMOVE_OUTPUT     0       # set to 1 to compress "success" and
                                 # "deliv_results" files after each run
setenv COMPRESS_OUTPUT   0       # set to 1 to compress "success" and
                                 # "deliv_results" files after each run

setenv CLEAR_LOGS        1       # set to 1 to do a dumptrans after the run

setenv CONFIG_FILE  /DB/10000/config/sybase.cfg  # database configuration file

#############################################################################
# The lines below should really not be modified much (if at all)
#############################################################################
# For ODBC
# setenv SHLIB_PATH /opt/odbc/drivers:/opt/odbc/lib
setenv TRANS_NUM   1300000000      # Total number of transactions to run

setenv DELIVERY_LOGS  logs       # Directory name for logfiles

setenv RPT_WINDOW_SIZE   30      # Reporting window size in number of
                                       # RPT_GRANULARITY; for example,
                                       # window size is 10 minutes if
                                       # RPT_GRANULARITY=30 and RPT_WINDOW_SIZE=20

setenv TRANS_TYPE        0       # 0=all, 1=new-order, 2=payment,
                               # 3=order_status, 4=delivery, 5=stock_level


#
# For TPC-C rev 3.1 and later the difference between the LOAD value of
# CLAST_CONST_C and the run value needs to be within 65-119 inclusive
```

```
# but can't be 96 or 112
#
setenv CLAST_CONST_C     208    # a run-time constant chosen within [0..255]
setenv CID_CONST_C       498    # a run-time constant chosen within [0..1023]
setenv IID_CONST_C      3415    # a run-time constant chosen within [0..8191]

setenv COPY_ENV              1          # 1 = Copy TESTENV to other Drivers.
                                # 0 = DO NOT copy. It is the tester's
                                #     responsibility to make TESTENVs on all
                                #     the other drivers.

#
# The following emulex communication values are measured, do not change these
#
#setenv COMM_ADJUST_NEWO  0.83  # new-order comm delay
#setenv COMM_ADJUST_PMT         0.35  # payment comm delay
#setenv COMM_ADJUST_ORDS  0.47  # order-status comm delay
#setenv COMM_ADJUST_DVRY  0.29          # delivery comm delay
#setenv COMM_ADJUST_STKL  0.27          # stock-level comm delay

#
# The following COMM delays should be used when using the HUB solution
#
setenv COMM_ADJUST_NEWO        0.00   # new-order comm delay, Convert TELNET to DTCs
setenv COMM_ADJUST_PMT         0.00   # payment comm delay
setenv COMM_ADJUST_ORDS        0.00   # order-status comm delay
setenv COMM_ADJUST_DVRY        0.00     # delivery comm delay
setenv COMM_ADJUST_STKL        0.00     # stock-level comm delay

#
# The following menu value are measured for Emulex, do not change these
#
#setenv NEWO_MENU         0.56   # new order menu RTE delay
#setenv PMT_MENU          0.41   # payment menu RTE delay
#setenv OS_MENU           0.32   # order status menu RTE delay
#setenv DVRY_MENU         0.45   # delivery menu RTE delay
#setenv STKL_MENU         0.46   # stock menu RTE delay

#
# Use the following menu times if using HUBs instead of Emulex
#
setenv NEWO_MENU         0.00   # new order menu RTE delay
setenv PMT_MENU          0.00   # payment menu RTE delay
setenv OS_MENU           0.00   # order status menu RTE delay
setenv DVRY_MENU         0.00   # delivery menu RTE delay
setenv STKL_MENU         0.00   # stock menu RTE delay

#
# Keying times  Don't change these unless doing special tests.  They need
# to be float values.
#
setenv NEWO_KEY          18.01   # new order keying time (18.0)
setenv PMT_KEY            3.01   # payment keying time (3.0)
setenv OS_KEY             2.01   # order status key time (2.0)
setenv DVRY_KEY           2.01   # delivery key time (2.0)
setenv STKL_KEY           2.01   # stock level key time (2.0)

#
# Think times.  Twiddle these as needed.  They need to be float values.
#
setenv NEWO_THINK        12.12   # new order keying time (12.20)
setenv PMT_THINK         12.05   # payment keying time (12.20)
setenv OS_THINK          10.10   # os keying time (10.25)
setenv DVRY_THINK         5.05   # delivery keying time (5.20)
setenv STKL_THINK         5.05   # stock level keying time (5.20)
```

D.2 Field Value Generation

generate.c

```
/*************************************************************************
 @(#) Version: A.10.10 $Date: 97/12/15 13:53:51 $

 (c) Copyright 1996, Hewlett-Packard Company, all rights reserved.
*************************************************************************/

#include <stdio.h>
#include <values.h>
#include <unistd.h>
#include <time.h>
#include <sys/types.h>
#include <sys/ipc.h>
#include <fcntl.h>
#include <signal.h>
#include <math.h>

#include "shm_lookup.h"
#include "random.h"

#include <time.h>

int CLAST_CONST_C = 208;
int CID_CONST_C =  37;
int IID_CONST_C = 75;

int trans_type = 0;   /* type of transaction 0 == all */

extern ID warehouse;
extern ID district;

extern int no_warehouse;
extern int no_item;
extern int no_dist_pw;
extern int no_cust_pd;
extern int no_ord_pd;
extern int no_new_pd;
extern int tpcc_load_seed;

neworder_gen(t)
    neworder_trans *t;
    {
    int i;

    t->W_ID = warehouse;

    t->D_ID = RandomNumber(1, no_dist_pw);
    t->C_ID = NURandomNumber( 1023, 1, no_cust_pd, CID_CONST_C);

    t->O_OL_CNT = RandomNumber(5, 15);

    for (i=0; i<t->O_OL_CNT; i++)
        {
        t->item[i].OL_I_ID = NURandomNumber(8191, 1, no_item, IID_CONST_C);
        t->item[i].OL_SUPPLY_W_ID = RandomWarehouse(warehouse, scale, 1);
        t->item[i].OL_QUANTITY = RandomNumber(1, 10);
        }

    /* 1% of transactions roll back. Give the last order line a bad item */
    if (RandomNumber(1, 100) == 1)
        t->item[t->O_OL_CNT - 1].OL_I_ID = -1;
    }

payment_gen(t)
    payment_trans *t;
    {

    /* home warehouse is fixed */
    t->W_ID = warehouse;

    /* Random district */
    t->D_ID = RandomNumber(1, no_dist_pw);

    /* Customer is from remote warehouse and district 15% of the time */
    t->C_W_ID = RandomWarehouse(warehouse, scale, 15);
    if (t->C_W_ID == t->W_ID)
        t->C_D_ID = t->D_ID;
```

```
    else
        t->C_D_ID = RandomNumber(1, no_dist_pw);

    /* by name 60% of the time */
    t->byname = RandomNumber(1, 100) <= 60;
    if (t->byname)
        LastName(NURandomNumber(255, 0, no_cust_pd/3 - 1, CLAST_CONST_C),
                    t->C_LAST);
    else
        t->C_ID = NURandomNumber(1023, 1, no_cust_pd, CID_CONST_C);

    /* amount is random from [1.00..5,000.00] */
    t->H_AMOUNT = RandomNumber(100, 500000);

    }

ordstat_gen(t)
    ordstat_trans *t;
    {

    /* home warehouse is fixed */
    t->W_ID = warehouse;

    /* district is randomly selected from warehouse */
    t->D_ID = RandomNumber(1, no_dist_pw);

    /* by name 60% of the time */
    t->byname = RandomNumber(1, 100) <= 60;
    if (t->byname)
        LastName(NURandomNumber(255, 0, no_cust_pd/3 - 1, CLAST_CONST_C),
                    t->C_LAST);
    else
        t->C_ID = NURandomNumber(1023, 1, no_cust_pd, CID_CONST_C);
    }

delivery_gen(t)
    delivery_trans *t;
    {
    t->W_ID = warehouse;
    t->O_CARRIER_ID = RandomNumber(1,10);
    }

stocklev_gen(t)
    stocklev_trans *t;
    {
    t->W_ID = warehouse;
    t->D_ID = district;
    t->threshold = RandomNumber(10, 20);
    }

int get_trans_type()
/*********************************************************************
 * get_trans_type selects a transaction according to the weighted average
 * For TPC-C rev 3.0 and less and TPC-C rev 3.2 this is:
 *       new-order :  ???
 *       payment   : 43.0%
 *       order stat:  4.0%
 *       delivery  :  4.0%
 *       stock     :  4.0%
 *********************************************************************/
    {
    static double weight[] = { 0.0,  0.0, .4305, .0405, .0405, .0405};
    double drand48();
    int type;
    double r;

    /* choose a random number between 0.0 and 1.0 */
    if (trans_type == 0) {
#ifdef USE_DRAND48
        r = drand48();
#else
        r = randy();
#endif

        /*
         * select one of STOCKLEV, DELIVERY, ORDSTAT and PAYMENT
         * based on weight
         */
        for (type = STOCKLEV;  type > NEWORDER;  type--) {
            r -= weight[type];
            if (r < 0) break;
        }
    } else {
        /* user wants only a certain type (say all stocklevel) so do that
         instead */
        type = trans_type;
    }
    /* return the value of the selected card, or NEWORDER if none selected */
    return type;
    }
```

Appendix E Disk Storage

The calculations used to determine the storage requirements for the 8 hours logical log and the 180-day space calculations are contained in this appendix.

TPC-C 180 Day Space Requirements

Warehouses:	10000					
tpmC:	102,023.50					
Table	**Rows**	**Data 1K pages**	**Index 1K pages**	**Overhead**	**Extra 5%**	**Total with 5%**
Warehouse	10,000	20,002	72	0	1,004	21,078
District	100,000	20,120	84	0	1,010	21,214
Item	100,000	9,572	46	0	481	10,099
Customer	300,000,000	200,000,000	15,516,102	0	10,775,805	226,291,907
New_order	90,000,000	983,608	11,848	0	49,773	1,045,229
Stock	1,000,000,000	333,466,666	1,842,362	0	16,765,451	352,074,479
History (D)	300,000,000	16,406,254		0	0	16,406,254
Orders (D)	300,000,000	8,108,110	97,686	0	0	8,205,796
Order_line (D)	3,000,253,284	181,833,534	2,392,546	0	0	184,226,080
System	0	768,000		0	0	768,000
Totals (in 1K pages)		**741,615,866**	**19,860,746**		**27,593,524**	**789,070,136**
As ideally configured	**761,476,612**					
As needed for 5%	**789,070,136**					
Total as built	**0** (see below)					
Below in MB						
Dynamic space	201,511.62	Sum of Data + Overhead for Order, Order_Line and History				
Static space	569,065	Sum of all data,index,bitmap (including the rootdbs) + 5% - above dynamic space				
Free space	0	Total space allocated to DBMS - dynamic and static				
Daily growth	32,894	(Dynamic space/(W * 62.5))* tpmC				
Daily spread	0	Free space - 1.5 * Daily growth (zero if negative)				
180 day space (MB)	6,490,034	Static space + 180 (daily growth + daily spread)				
180 day in GB	**6,337.92**					
8 hr log space (GB)	**176.74**					

	Space needed
180 day space	6337.923672
Logical logs (w/ mirrors)	0
SWAP (GB)	34.1796875
OS+File System (GB)	4
Total Space Needed	**6376.10336**

Priced System Configuration	**Size (MB) [see note 1]**	**Quantity**	**Total**
AutoRAID 12H with 12 9.1 GB disk drives	86186	100	**8417**
AutoRAID 12H with 12 18 GB disk drives	172372	3	**505**
Total Storage in Priced System (GB) [Note 1: The sizes given are after RAID5 redundency]			**8922**

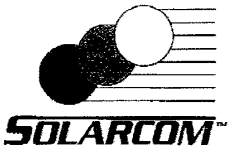
Log space calculation

before		
device	size	free_pages
log1	20000.0MB	10,182,448
log2	20000.0MB	10,200,000
Total free		20,382,448
after		
device	size	free_pages
log1	20000.0MB	1,969,088
log2	20000.0MB	7,670,992
Total free		9,640,080
Difference		10,742,368
Page size in bytes		2,048
GB used		20
begin d_next_o_id		332,902,814
after d_next_o_id		338,523,490
Committed NewOrders		5,620,676
GB per NewOrder		3.64537E-06
tpmC		102,024
% of N-O in tpmC		99.0066%
GB @ tpmC for 8hrs		176.74

Appendix E Price Quotes

The following pages contain the price quotes for the hardware included in this FDR.

From: Pratibha de Silva
Hewlett-Packard Company
19111 Pruneridge Avenue
Cupertino, CA 95014



To: Steve Brooks
Sun Data Corporation
1 Sun Court
Norcross, GA 30092

Date: 8/18/99

Item Description	Part Number	Unit Price	Qty	Extended Price	5 yr. Maint. Price
Server Hardware					
HP 9000 V2500 Enterprise Server	A5074A	$ 139,825	1	$ 139,825	$ 119,532
Add'l Dual 440 MHz PARISC 8500 CPU's	A5492A Opt. 0D1	$ 46,165	16	$ 738,640	$ 118,272
System Mgmt. Station	A4802B	$ 8,197	1	$ 8,197	$ 2,116
Memory Controller Board	A5078A Opt 0D1	$ 7,140	4	$ 28,560	
256 MB DIMM for a total of 2 GB	A5082A Opt. 0D1	$ 20,997	16	$ 335,944	
PCI FWD SCSI-2 Card	A4800A Opt 0D1	$ 858	1	$ 858	
PCI Fibre Channel 1062 Mb/s	A3740A Opt. 0D1	$ 1,929	9	$ 17,357	
PCI 1000 BaseSX Lan	A4926A Opt 0D1	$ 1,495	1	$ 1,495	
4GB DDS DAT Drive with data compression	A3183A Opt 0DZ	$ 1,180	1	$ 1,180	
PCI 64-port MUX	J3593A Opt. 0D1	$ 1,068	1	$ 1,068	
16 port RS-232 DB25 port module	J2485A	$ 627	1	$ 627	
25 ft cable	J3595A	$ 109	1	$ 109	
5.5 kVA UPS	A3589A Opt. 002	$ 7,000	1	$ 7,000	$ 336
1.8 kVA UPS rackmount	A2997A Opt. 002	$ 2,310	52	$ 120,120	$ 16,027
2.0m Field Integrated Cabinet	J1500A	$ 1,330	31	$ 41,230	
FC SCSI Multiplexer	A3511A	$ 7,280	9	$ 65,520	$ 71,019
16 bit FW SCSI Adapter	A3511A Opt. 003	$ 907	36	$ 32,634	
Auto Raid Array Model 12H	A3700AZ	$ 3,110	103	$ 320,330	$ 560,210
Two 96 MB controllers with Auto Raid	A3700AZ Opt. 203	$ 9,385	103	$ 966,655	
Twelve 9.1 GB disk modules, 10K rpm	A3700AZ Opt. 172	$ 14,070	100	$ 1,407,000	
Twelve 18 GB disk modules, 10k rpm	A3700AZ Opt 192	$ 18,900	3	$ 56,700	
0.9m 68-pin high density male connec.	A3700AZ Opt. 801	$ 84	66	$ 5,544	
2.5m HDTS68 to HDTS68 Cable	C2924A	$ 98	37	$ 3,626	
16 Meter fibre channel cable	A3661B Opt. AFY	$ 112	9	$ 1,008	
			Subtotal	**$ 4,301,224**	**$ 887,512**
Server Software					
HP-UX 11 Instant Ignition	B3920EA, Opt AAF	$ 137	1	$ 137	
HP-UX 11 Unlimited License for V-Class	B3919EA, Opt B9V	$ -	1	$ -	
			Subtotal	**$ 137**	$ -
Client Hardware					
Hewlett Packard Model C3000 Workstation	A4986A	$ 7,700	14	$ 107,800	$ 55,641
256MB SDRAM Module	A4994A	$ 806	56	$ 45,158	
512 MB SDRAM Module	A4995A	$ 2,688	56	$ 150,528	
Console	C1064GX	$ 385	1	$ 385	$ 168
9 GB LVD 10k RPM Disk	A4997A	$ 788	14	$ 11,025	
100 Base T PCI LAN Adapter	B5509BA	$ 191	14	$ 2,675	
			Subtotal	**$ 317,572**	**$ 55,809**
Client Software					
HP C/ANSI C Compiler	B3899BA	$ 774	1	$ 774	$ 993
			Subtotal	**$ 774**	**$ 993**
User Connectivity					
HP ProCurve Switch 4000M	J4121A	$ 2,519	1	$ 2,519	$ 588
HP ProCurve Switch Gigabit-SX Module	J4113A	1049.3	1	$ 1,049	
HP ProCurve Switch 408	J4097A	279.3	14	$ 3,910	$ 420
			Subtotal	**$ 7,479**	**$ 1,008**
			Total	**$ 4,627,184**	**$ 945,322**

Note: Above configuration are generally available and prices are guaranteed for 60 days. The service prices are based on a service agreement for the entire system. The above prices may vary if items are purchased separately. Pricing is subject to approved credit terms.

August 10, 1999

Mark Kroot
Hewlett Packard
19111 Pruneridge Avenue
Cupertino, CA 95014

Dear Mark

Below is the Sybase pricing for Sybase Adaptive Server Enterprise. Please use this for the pricing of the benchmark on the V2500. This quote is good for 90 days from today's date.

High-End Pricing (machine has physical capacity of greater than eight processors)

ASE Deployment Pricing	**$295,000**	**(this pricing has no development attached to it)**
Development Pricing	**$9,600**	**(8 user license)**
Open Client	**$795**	
Total	**$305,395**	
Pdt Pricing Less 10% Discount	**($30,540)**	
Total	**$274,855**	
Net Pricing Support Pricing 16% x 305,295 x 5 yrs	**$244,316**	
Total Price	**$519,171**	

Regards,

Russ Puryear
Global Alliance Mgr.

August 13, 1999

Mark Kroot
TPC-C Performance Project Manager
Hewlett Packard
408 447 0763
408 447 5958 FAX

Dear Mr. Kroot:

Per your request I am enclosing the pricing information regarding TUXEDO 6.4 that you requested. This pricing applies to Tuxedo 6.1, 6.2, 6.3, 6.4 and 6.5. Please note that Tuxedo 6.5 is our most recent version of Tuxedo but that all 6.x releases are generally available.
Core functionality services pricing is appropriate for your activities. As per the table below HP PA-RISC server systems are classified as either a Tier 2, 3, 4 or 5 server depending on the performance and CPU capacity of the system. The C-3000 is a tier 2 system, and the V-2500 is a Tier 5 system. This quote is valid for 90 days from the date of this letter.

10.1.1 Tuxedo Core Functionality Services (CFS) Program Product Pricing and Description

TUX-CFS provides a basic level of middleware support for distributed computing, and is best used by organizations with substantial resources and knowledge for advanced distributed computing implementations.

TUX-CFS prices are server only and are based on the overall performance characteristics of the server and uses the same five tier computer classification as TUXEDO 6.x. Prices range from $3,000 for Tier 1 to $250,000 for Tier 5. Under this pricing option EVERY system running TUX-CFS at the user site must have a TUXEDO license installed and pay the appropriate per server license fees.

Very Truly Yours,

Lewis D. Brentano,
Director, Market Planning

10.1.1.1 BEA Tux/CFS Unlimited User License Fees Per Server

Unlimited User License fees per server	Number of Users	Dollar Amount	Maintenance (5 x 8) per year	Maintenance (7 x 24) per year
Tier 1 -- PC Servers with 1 or 2 CPUs, entry level RISC Uni-processor workstations and servers	**Unlimited**	**$3,000.00**	**$480.00**	**$690.00**

Tier 2 - PC Servers with 3 or 4 CPUs, Midrange RISC Uni-processor servers and workstations	**Unlimited**	**$12,000.00**	**$1,920.00**	**$2,760.00**
Tier 3 - Midrange Multiprocessors, up to 8 CPUs per system capacity	**Unlimited**	**$30,000.00**	**$4,800.00**	**$6,900.00**
Tier 4 - Large (more than 8, less than 32 CPUs)	**Unlimited**	**$100,000.00**	**$16,000.00**	**$23,000.00**
Tier 5 - Massively Parallel Systems, > 32 processors	**Unlimited**	**$250,000.00**	**$40,000.00**	**$57,500.00**

HP 9000 server tier classifications

Platform	Tier 1	Tier 1	Tier 2	Tier 3	Tier 3	Tier 4	Tier 5
Hewlett-Packard	**Uni-processor Workstations**	**9000/E25 9000/E35 9000/E45 9000/E55 9000/G30 9000/G40**	**9000/G50 9000/G60 Multi-Processor Workstations 9000/D200, 210 220,230 C-3000**	**9000/H20 9000/H30 9000/H40 9000/H50 9000/I30 9000/I40 9000/K1XX 9000/D310, 320,330 9000/D250/60**	**9000/I50,60 9000/H60 9000/G70 9000/H70 9000/I70 9000/K2XX 9000/K3XX 9000/K4XX 9000/K5XX 9000/D350/60/70**	**9000/T500, T600 1-16 CPUs**	**9000/V 2xxx, 2500 series all models**

Software House International **Pricing Proposal**	**Quotation #MO-990810-62161** **08/10/99**

Hewlett Packard
Mark Kroot
Quote Good for Ninety Days
,
Phone: **Fax: 447-5958**

SHI Account Exec: Matthew O. Martin
Telephone : (408) 922-1106
Fax : (408) 526-1222

Reference:

Product	Part #	Qty	List	Your Price	Total
8 Port 10BT Hub 1 Uplink 5 Year return to man warr.		10000		$24.00	$240,000.00
Total					**$240,000.00**

Additional Comments: