Digesting an Open-Source Fair-Use TPC-E Implementation: DBT-5

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Introductions

- Mark Wong
  - Database Performance specialist
  - Previously worked at OSDL (presently, Linux Foundation)
- Rilson Nascimento
  - MSc Candidate in the Federal University of Pernambuco, Brazil
  - Previously worked at Itautec Performance Lab

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- TPC-E Overview
- Workload Architecture
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Question Policy

- Interrupt us if something is unclear
- Keep long generic questions to the end
- Approach us during the conference
- Write us
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Why TPC-E?

- http://www.tpc.org/tpce/spec/TPCEpresentation.ppt
- TPC-C is over 14 years old
- Not practical to modify existing workload
- Transaction are too lightweight by today's standards
- CPU performance grew according to Moore's Law
- Disk latency did not
- Reduce cost/complexity of running benchmark
- Encourage DB uses which is more representative of what customer do

TPC-E vs. DBT-5

- TPC-E is a benchmarking specification for generating marketing collateral
- DBT-5 a test kit to help improve PostgreSQL

TPC-E Overview

- TPC-E Goals
  - OLTP Database-centric workload
  - Comparability of results
  - Familiar business model – easy to understand
  - Reduce cost of running benchmark
  - Enhance schema complexity
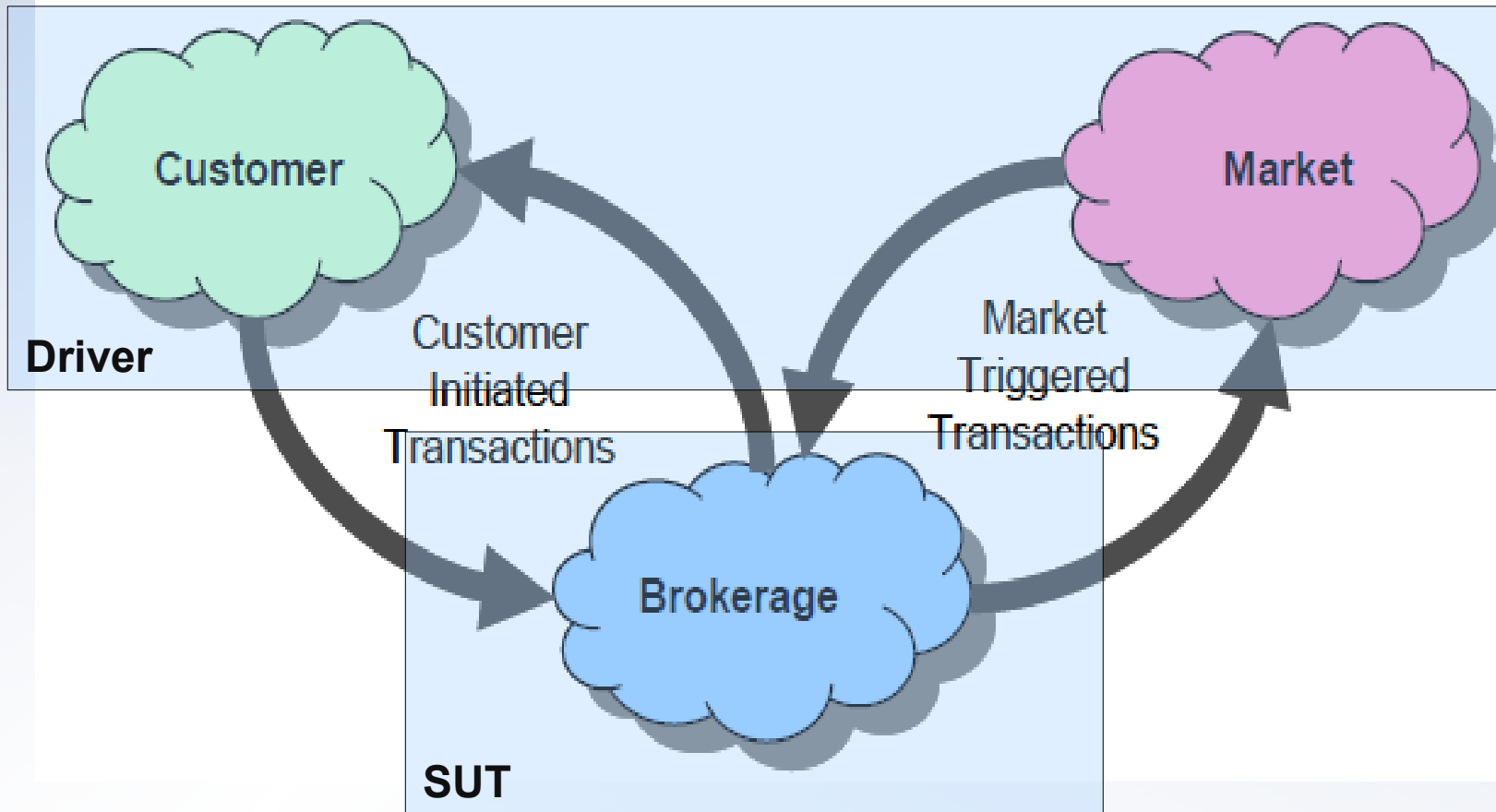 - Be more representative to what customers do

TPC-E Overview (2)

- Business Model – Financial Market
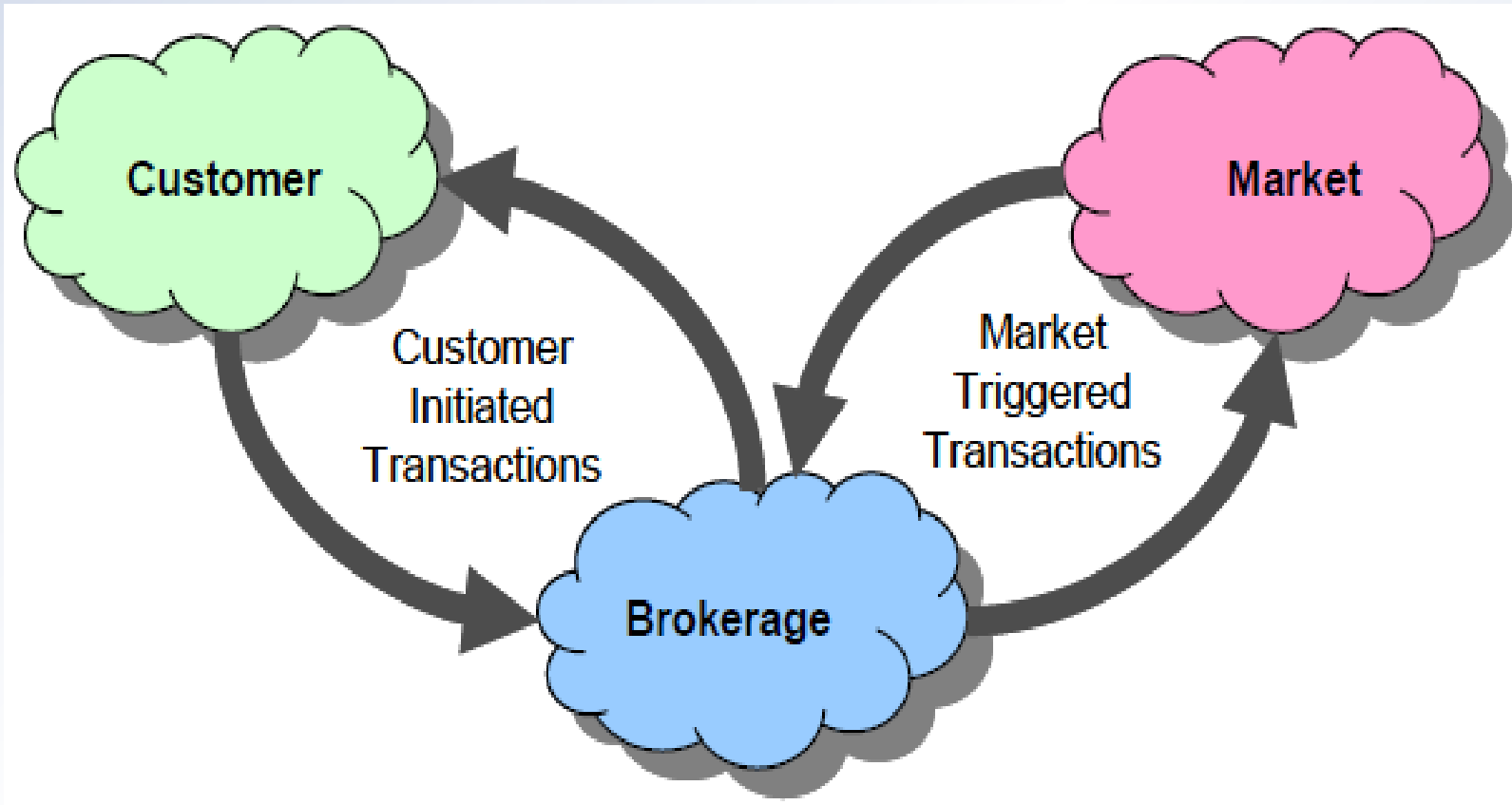
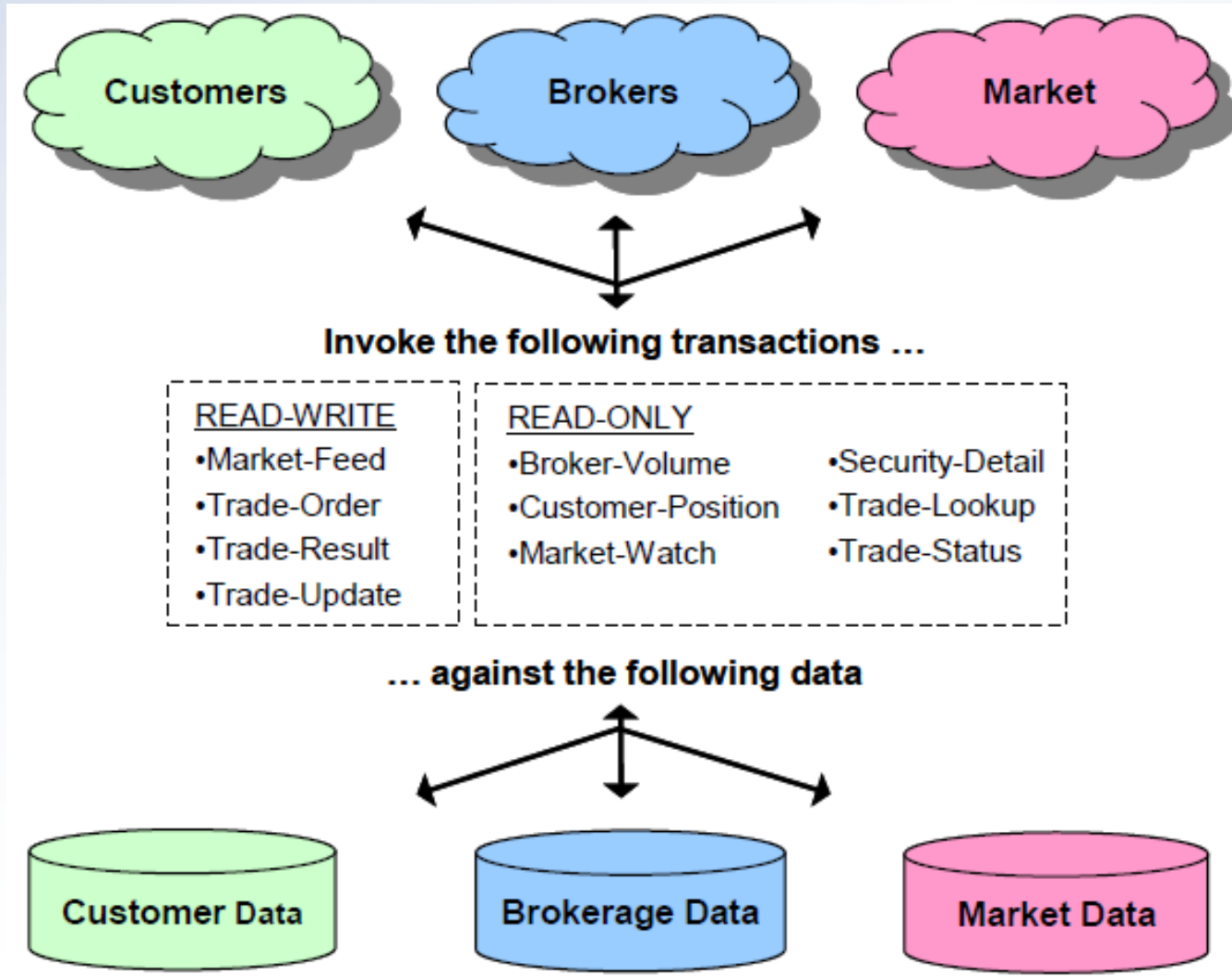# TPC-E Overview (3)

- Business Model – Financial Market

TPC-E Overview (4)

- Business Model – Financial Market

TPC-E Overview (5)

- Business Model – Comparison with TPC-C

TPC-C
- Wholesale supplier
- Organized by
  - Warehouses
    - Districts
      - Customers

TPC-E
- Brokerage House
- Organized by
  - Customers
    - Accounts
    - Securities
    - Companies

TPC-E Overview (6)

- Database Schema – Comparison with TPC-C

Characteristic	TPC-E	TPC-C
Tables	33	9
Columns	188	92
Min Cols / Table	2	3
Max Cols / Table	24	21
Data Type Count	Many	4
Data Types	UID, CHAR, NUM, DATE, BOOL, LOB	UID, CHAR, NUM, DATE
Primary Keys	33	8
Foreign Keys	50	9
Tables w/ Foreign Keys	27	7
Check Constraints	22	0
Referential Integrity	Yes	No

TPC-E Overview (7)

- Database Tables and Scaling

Customer	Broker	Market	
ACCOUNT_PERMISSION	BROKER	COMPANY	SECTOR
CUSTOMER	CASH_TRANSACTION	COMPANY_COMPETITOR	SECURITY
CUSTOMER_ACCOUNT	CHARGE	DAILY_MARKET	
CUSTOMER_TAXRATE	COMMISSION_RATE	EXCHANGE	
HOLDING	SETTLEMENT	FINANCIAL	Dimension
HOLDING_HISTORY	TRADE	INDUSTRY	ADDRESS
HOLDING_SUMMARY	TRADE_HISTORY	LAST_TRADE	STATUS_TYPE
WATCH_ITEM	TRADE_REQUEST	NEWS_ITEM	TAXRATE
WATCH_LIST	TRADE_TYPE	NEWS_XREF	ZIP_CODE
Legend:	Fixed Tables	Growing Tables	Scaling Tables

TPC-E Overview (8)

- Transactions

Transaction	Weight	Access	Mix%	90% Response Time Constraint
Trade-Order	Heavy	R/W	10.1	2 sec.
Trade-Result	Heavy	R/W	10	2 sec.
Trade-Lookup	Medium	R/O	8	3 sec.
Trade-Update	Medium	R/W	2	3 sec.
Trade-Status	Light	R/O	19	1 sec.
Customer Position	Mid-Heavy	R/O	13	3 sec.
Broker Volume	Mid-Heavy	R/O	4.9	3 sec.
Security Detail	Medium	R/O	14	3 sec.
Market Feed	Medium	R/W	1	2 sec.
Market Watch	Medium	R/O	18	3 sec.
Data Maintenance	Light	R/W	-	-
Trade-Cleanup	Medium	R/W	-	-

TPC-E Overview (9)

- Metrics
  - Performance (throughput), expressed in tpsE
  - Price/Performance, expressed in price/tpsE
  - Availability Date, when all products necessary to achieve the stated performance will be available
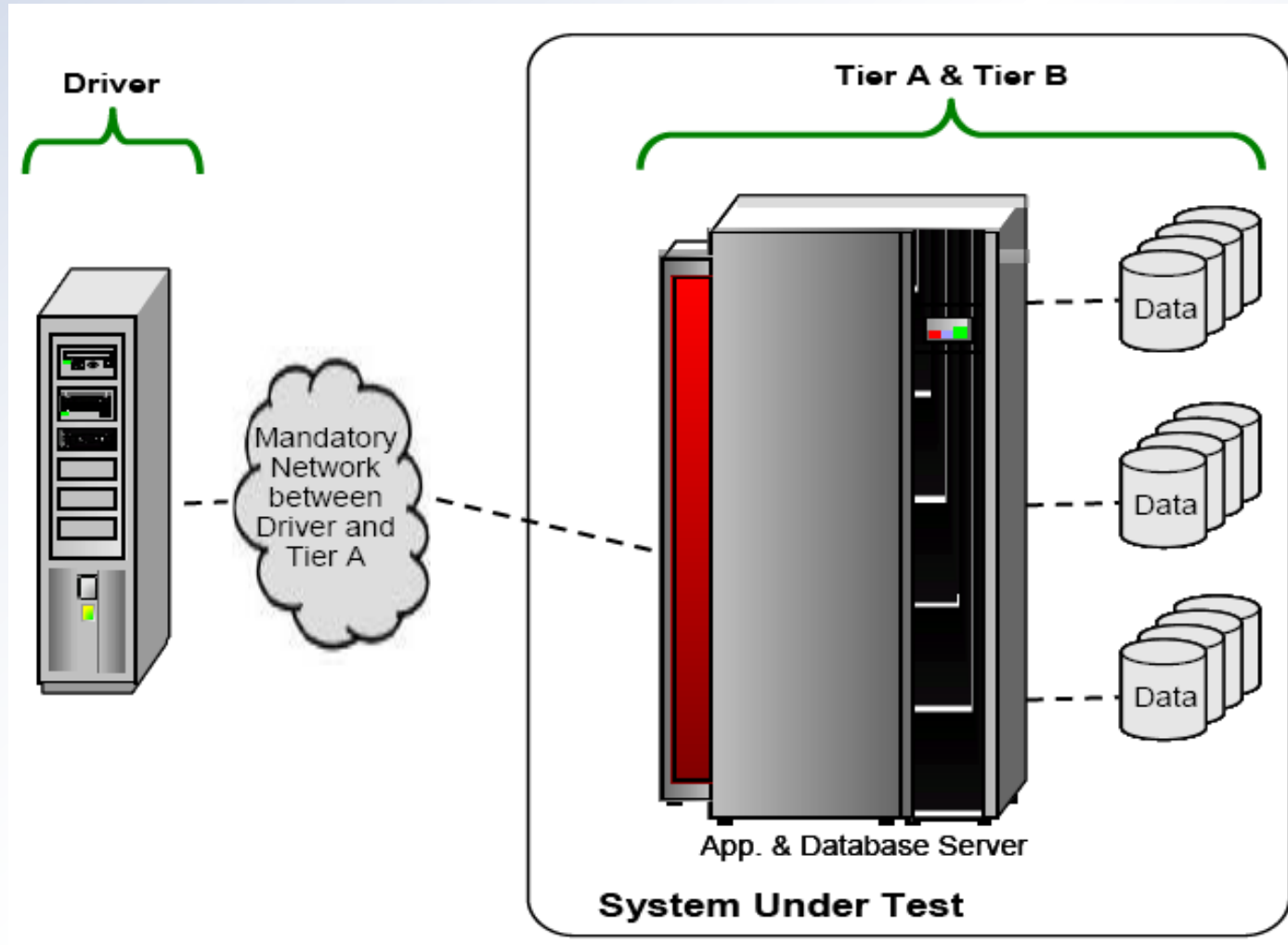
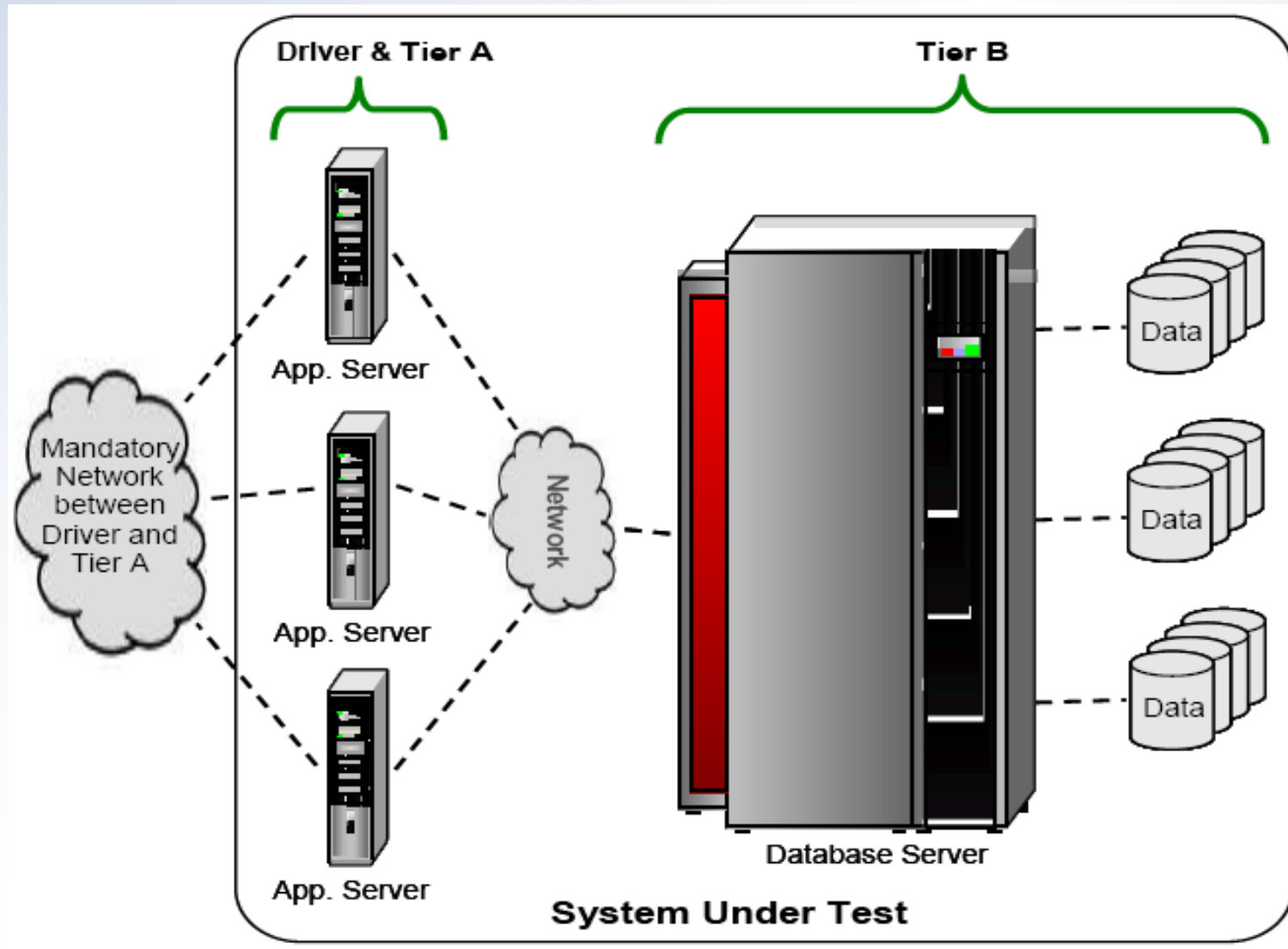# TPC-E Overview (10)

- ## Sample Test Configuration
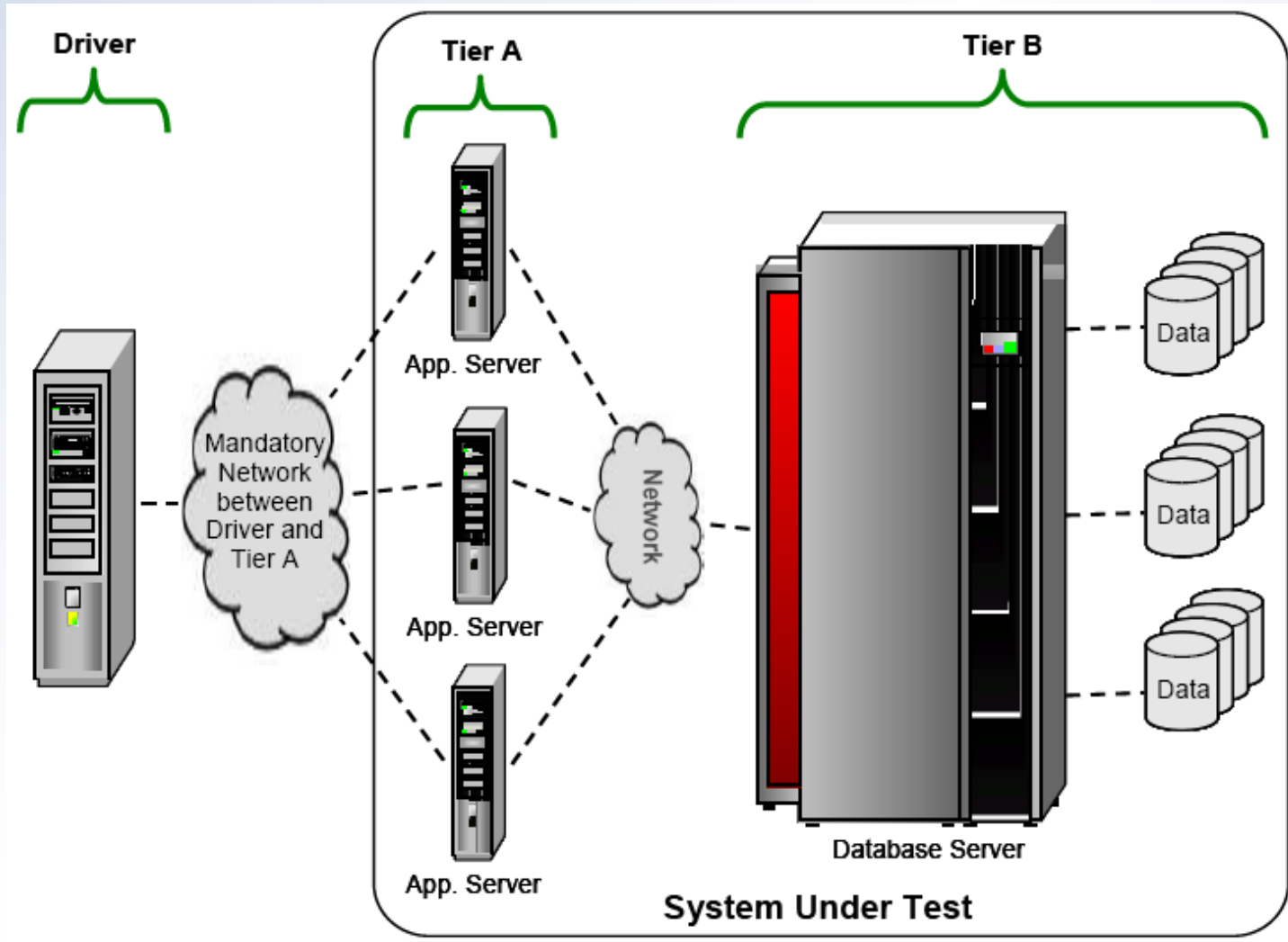
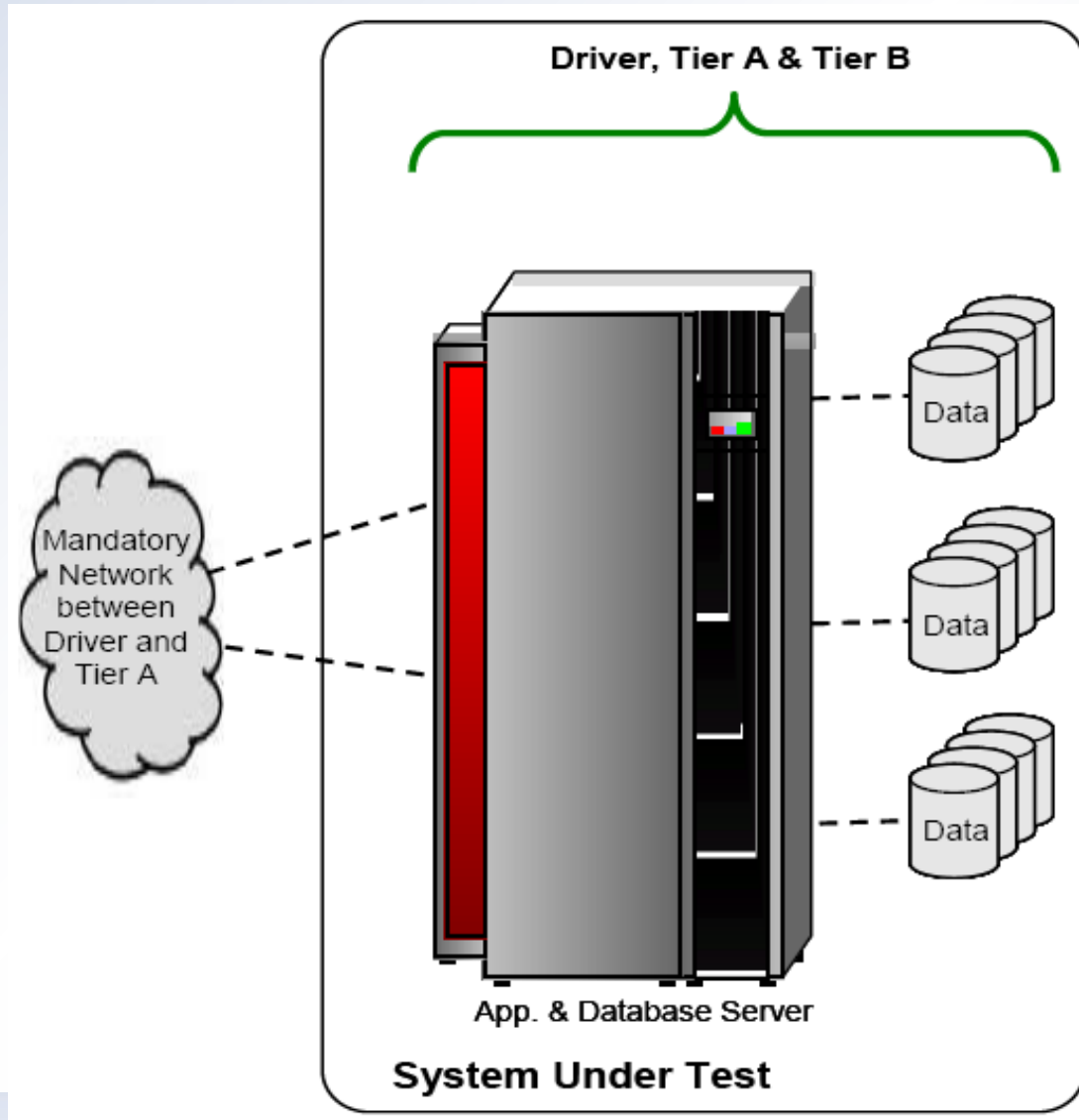# TPC-E Overview (11)

- Sample Test Configuration, Variation I

TPC-E Overview (12)

- Sample Test Configuration, Variation II

TPC-E Overview (13)

- Sample Test Configuration, Variation III

TPC-E Overview – Highlights and Benefits

- Financial business model
- Rich transaction set
- Diverse, realistic schema

- Server-centric workload with DB focus
- Realistic application model
- Rebalanced hardware configuration
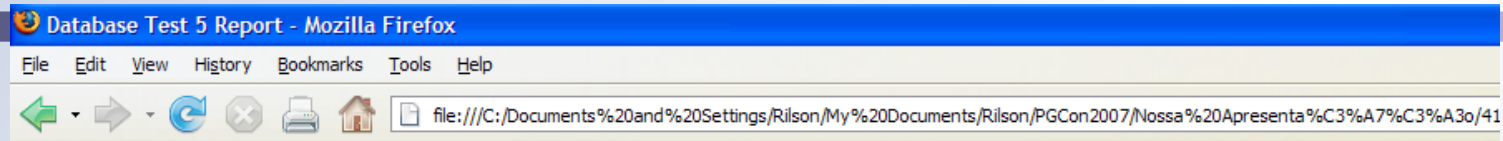- Specification provides code where sponsor creativity is not being tested

DBT-5 Architecture
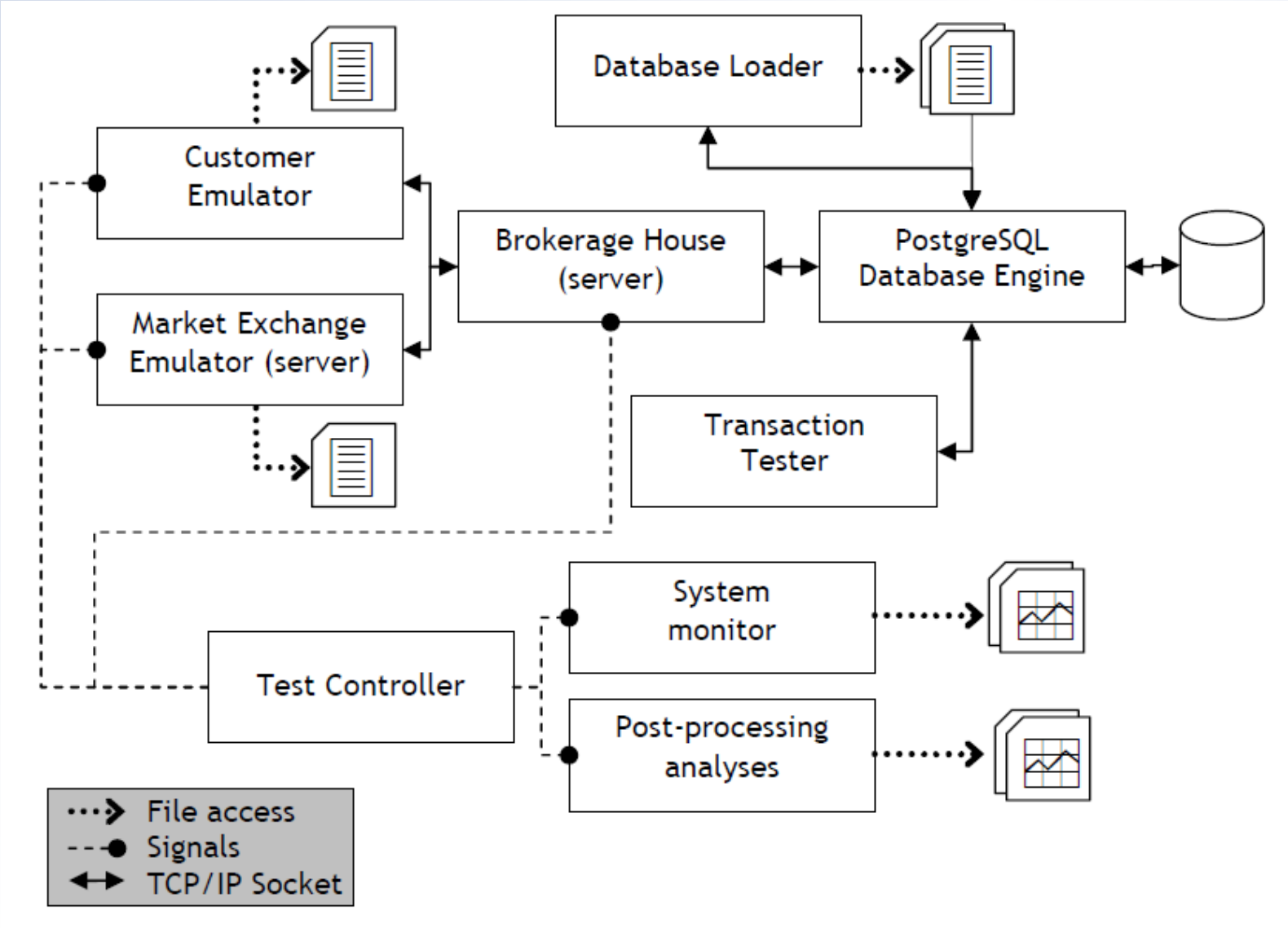
DBT-5 Architecture - Loader

- Database creation is vendor specific, but...
- Database population can be vendor neutral
- TPC-E includes a data generator for database loading
  - C++ code to generate data
  - Flat file generation is provided
  - Sponsor is free to create to customize interface
- Libpqxx: C++ API for PostgreSQL

Experimental Results

- Test bed
  - Processor: Intel(R) Xeon(TM) CPU 2.80GHz w/HT
  - Memory: 3 GB
  - Disk: 14 disks in hw RAID 0 (data)
  - Operating System: Linux 2.6.20-gentoo-r4
  - Database Engine: PostgreSQL 8.2.3
  - Database Size: 2806 MB (1000 customers, 50 ITD)

Experimental Results – DBT-5 Report

Experimental Results


```
                          Response Time (s)
 Transaction         %    Average :   90th %       Total      Rollbacks       %
----------------- -----  ----------------- ----------- ----------- ------
Trade Order       10.21    0.021 :   0.043         3869          38    0.99
Trade Result       9.59    0.040 :   0.083         3635           0    0.00
Trade Lookup       8.08    0.346 :   0.945         3063           0    0.00
Trade Update       1.96    0.313 :   0.677          743           0    0.00
Trade Status      19.03    0.006 :   0.010         7212           0    0.00
Customer Position 12.89    0.005 :   0.009         4885           0    0.00
Broker Volume      4.84    0.003 :   0.004         1835           0    0.00
Security Detail   14.43    0.014 :   0.018         5467           0    0.00
Market Feed        0.96    0.055 :   0.090          363           0    0.00
Market Watch      17.99    0.009 :   0.017         6817           0    0.00
Data Maintenance  n/a      0.036 :   0.122            9           0    0.00
----------------- -----  ----------------- ----------- ----------- ------

2.02 trade-result transactions per second (TRTPS)
30.0 minute duration
20 total unknown errors
1 second(s) ramping up
```

25

Experimental Results – Response Time Plots
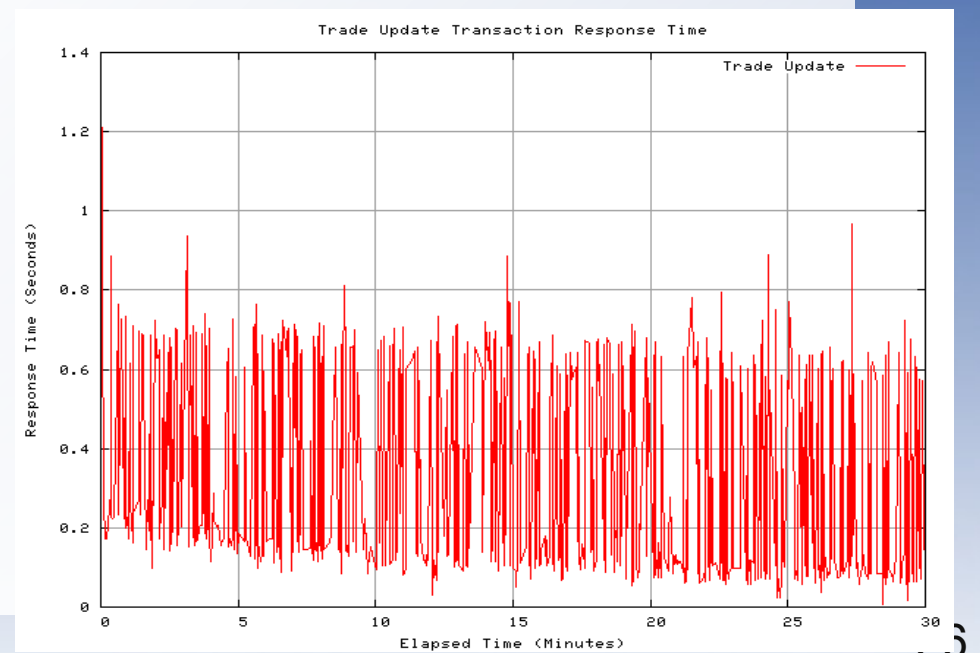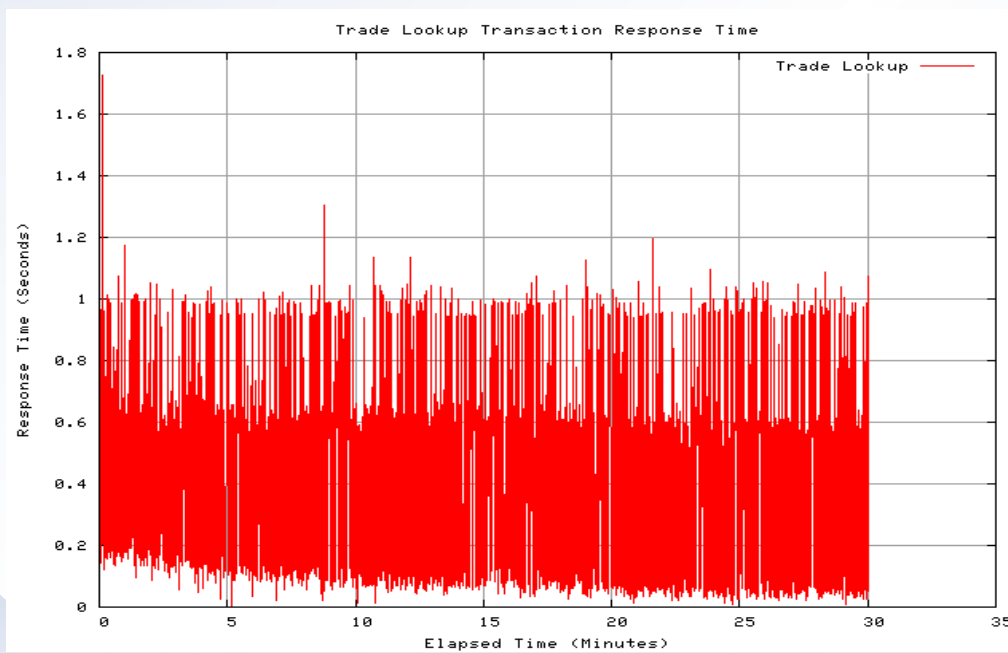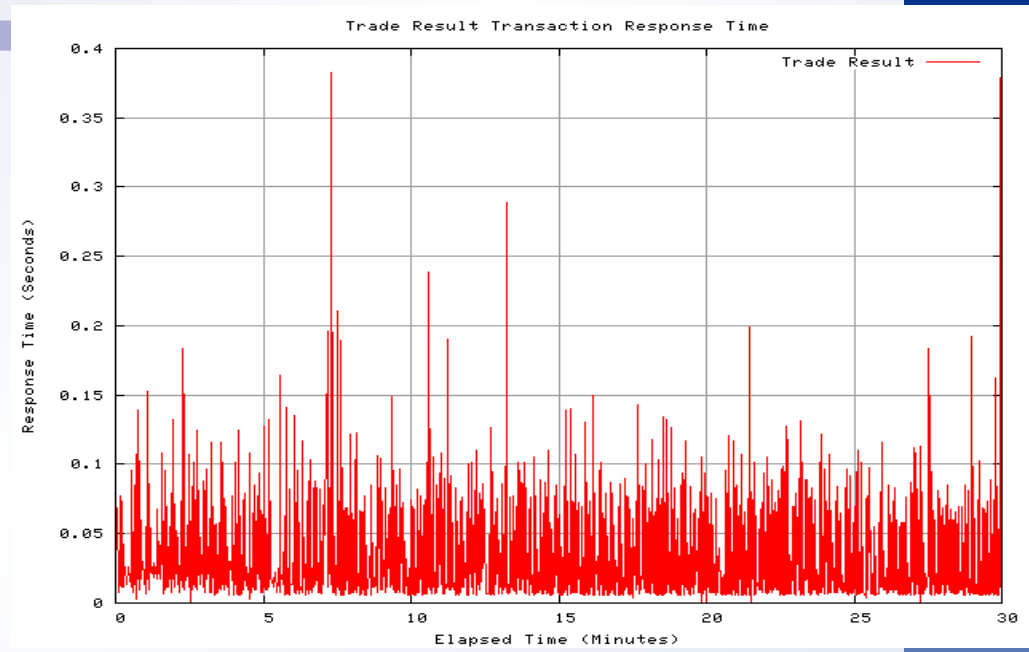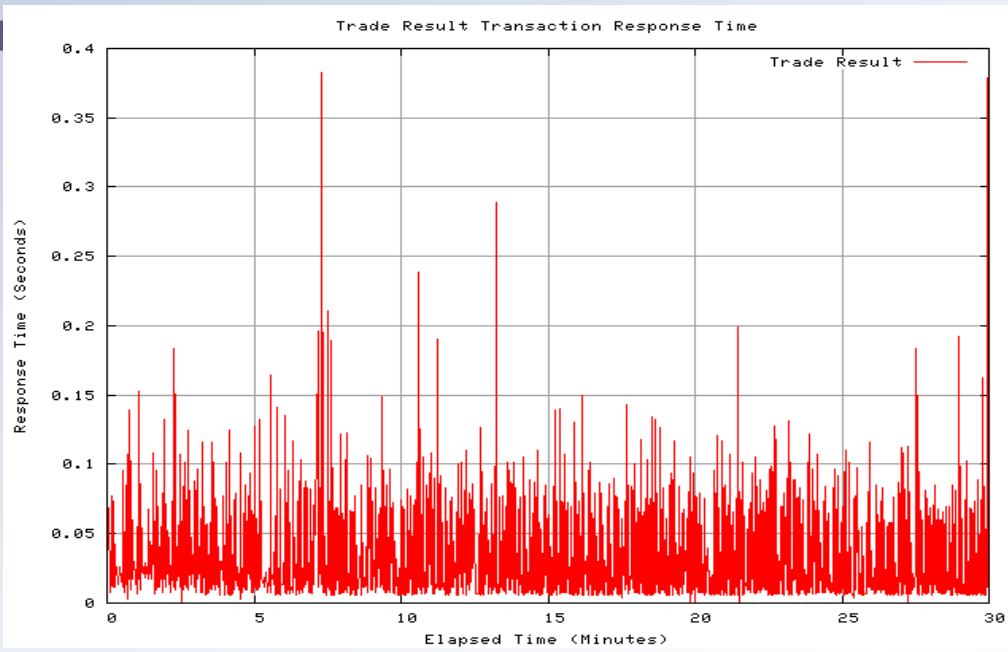
Experimental Results – System Statistics
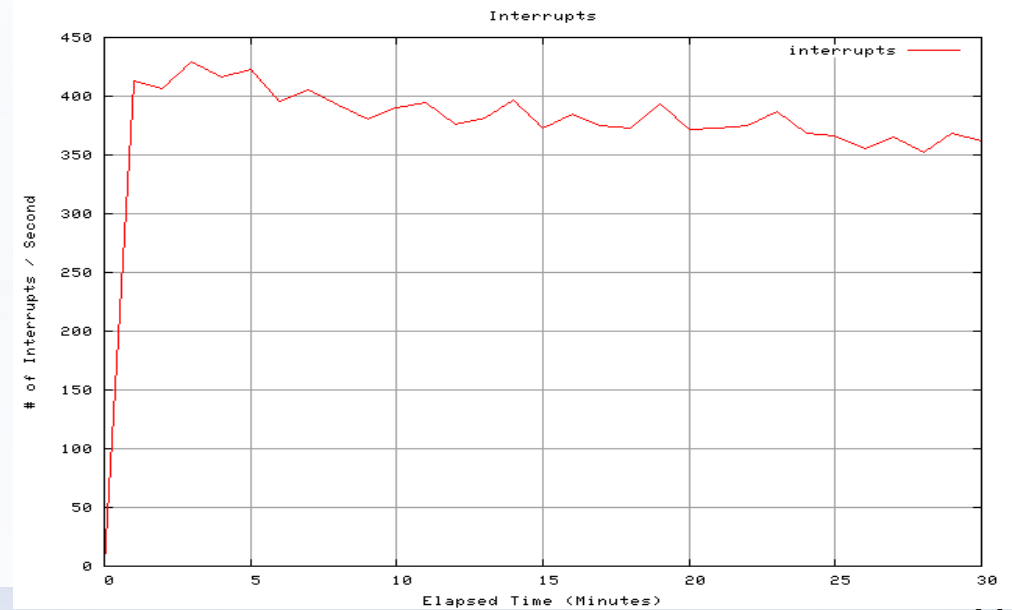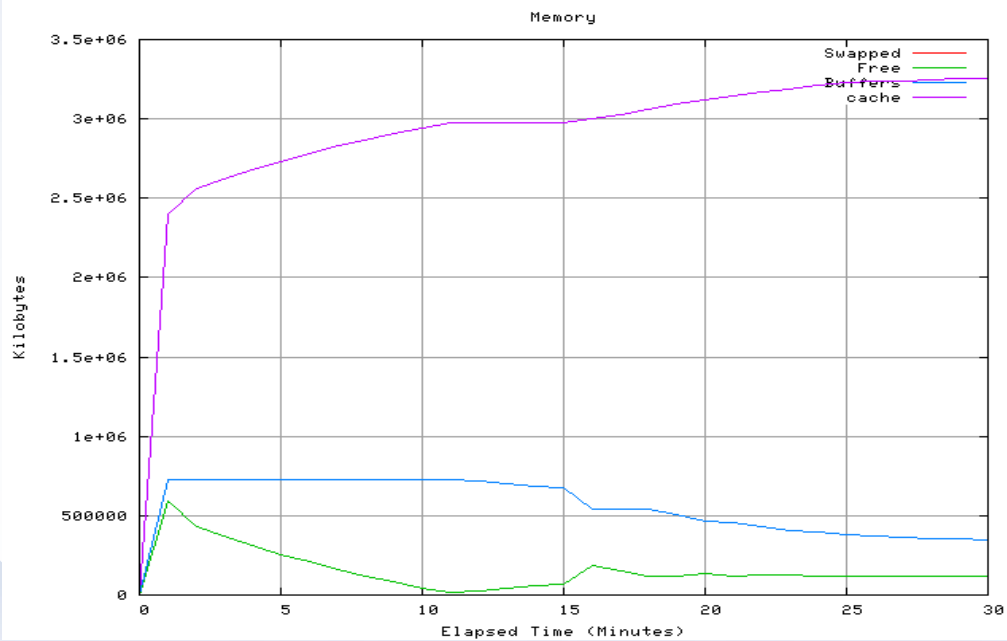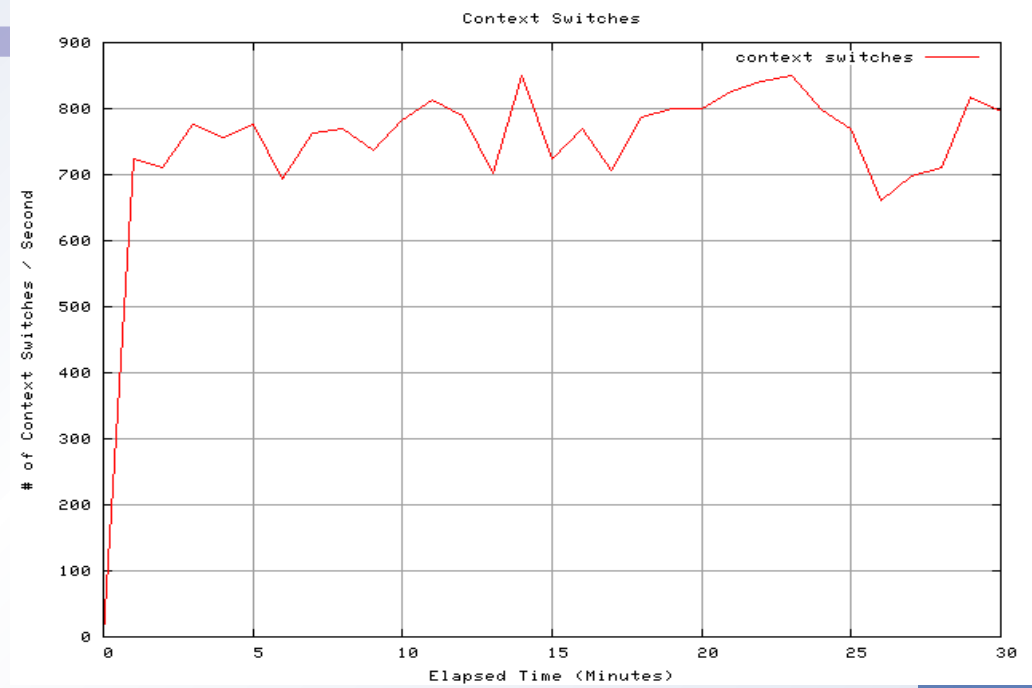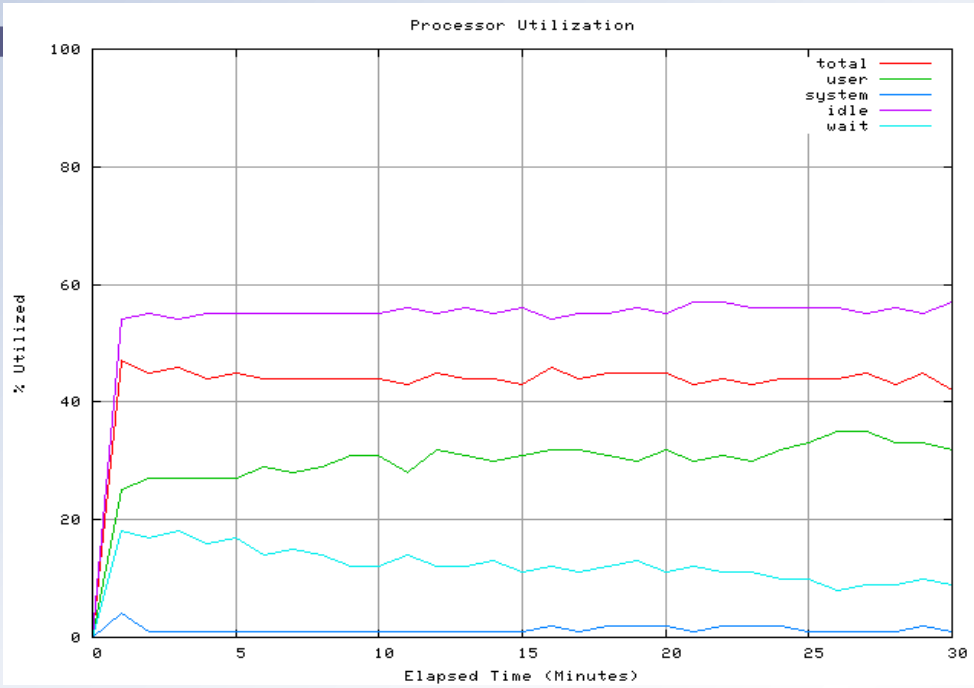
Research

- A scientific article portraying DBT-5 was accepted in the 27th Brazilian Computer Society Conference, that will be held in Rio de Janeiro in June 2007
  - http://www.sbc.de9.ime.eb.br/en/index.php?view=wperformance&from=eventos&lang=en

- Rilson's Master's dissertation is employing DBT-5: Synthesizing Representative I/O Workloads for TPC-E

Future Work

- Update the workload to the latest TPC-E specification
  - EGen
  - Functions
- Write the Functions in C (in progress)
- Tune indexes/functions
- Support other databases

Resources

- DBT-5
  svn co https://osdldbt.svn.sourceforge.net/svnroot/osdldbt/trunk/dbt5 dbt5

- libpqxx: C++ API for PostgreSQL
  http://pqxx.org/

- TPC-E Specification
  http://www.tpc.org/tpce/spec/TPCE-v0.32.2g.pdf (PDF)
  http://www.tpc.org/tpce/spec/TPCE-v0.32.2g.doc (DOC)

Bibliography

- TPC BENCHMARK™ E Standard Specification   Version 1.0.0

- TPC Site - www.tpc.org

- Do Nascimento, R. O., M. Wong and P. R. M. Maciel. *DBT-5: A Fair Usage Open Source TPC-E Implementation for Performance Evaluation of Computer Systems*. XXVII Brazilian Computer Society Conference, 2007. (to appear)

Thank you! :)

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