TPC Benchmark

Márk Kaszó, Tihamér Levendovszky

Department of Automation and Applied Informatics, Budapest University of Technology and Economics
mkaszo@aut.bme.hu, tihamer@aut.bme.hu

Abstract: Scalability is one of the many challenges in designing an e-commerce or an e-business application. Transaction Processing Performance Council (TPC) [6] designed well-usable models to analyze applications. These models include detailed database structure and typical workloads. It gives a great opportunity to understand how these system works. In this paper TCP-W, and TCP-APP are presented in terms of workloads, databases, and key metrics. The complete database structure and the most typical workloads are also presented. These workloads provide an appropriate starting point to analyze E-Commerce and E-Business systems.

Keywords: Benchmark, TPC-W, TPC-APP, Business-to-business (B2B), Business-to-customer (B2C)

1 Introduction

Nowadays the E-Market is a most important part of our life. Every big company has a website. It is very fast and comfortable using the Internet to perform our everyday transactions. There are several types of E-Market such as Business-to-Business (B2B), Business-to-Customer(B2C), Customer-to-Customer(C2C), or Government-to-Business (G2B) or Government-to-Citizens(G2C). In this paper, Businness-to-Business, and Business-to-Customer are presented in terms of performance issues. There are several challenges in designing an e-commerce or an e-business application. (i) What are the typical workloads for the site? (ii)How does somebody determine the server performance and price/performance for an Internet commerce? (iii)What is the maximum number of transactions that can be served in a unit time? (v) How can we upgrade the site? (vi) Is there any architectural design problems? The answers for these questions are gained from benchmarking. In this paper, two benchmark technology are presented. Firstly, TPC-W for E-Commerce, secondly, TPC-APP for E-Business application are presented. Some important technologies such as customer behavior model graph (CBMG) are also presented.

2 TPC-W

TPC-W is a benchmark for E-Commerce. The benchmark's main features include the following:

- Multiple online browser sessions,
- Dynamic page generation with database access
- Consistent web objects
- On-line transaction execution modes
- Database consisting of many tables with a wide of sizes, attributes, and relationships
- Transaction integrity (ACID properties)

2.1 Architecture

There are three main components in this configuration: the Remote Browser Emulator that simulate the requests; the System Under Test (SUT) is the system to be evaluated; and finally, performance monitor that monitories several performance metrics Figure 1.

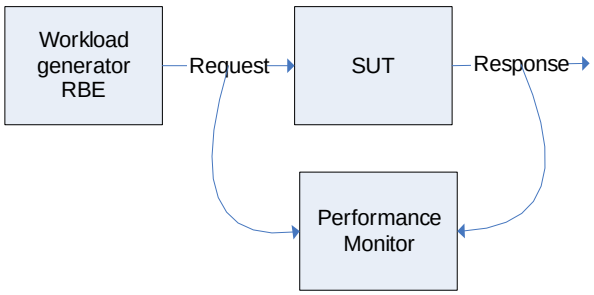

Figure 1
Benchmark components [3]

2.2 Workload

TPC-W specifies an E-Commerce workload that simulates transactions for a web-shop. Emulated users are simulated by a Remote Browser Emulator, RBE that simulates the same HTTP network traffic like a real user. An RBE must emulate users in separate connections to the SUT. Thus in the SUT there are separate sessions for the users. The workload generated by the RBE is specified by the navigation patterns in the custom behavior model graph (CBMG), and, of course,

the intensity of the simulated users. This intensity depends on the number of emulated users and the average think time. RBE simulates users using think time, which is the time between when an emulated user receives the last byte of the response and when it sends the first byte of the new request. The average think time is 7 seconds and the maximum think time is 70 seconds. In TPC-W there are 14 unique pages specified in the full CBMG. The 14 unique pages can be divided into two main parts: ordering and browsing. Figure 2 shows the 'Browse' part of the full CMBG. There are 6 pages (Home, New Products, Best Sellers, Search Result, Product Detail, Search Request).

The transaction probabilities in CBMG is described in three different 'Web Interaction Mix' WIPS for shopping, WIPSb for browsing and WIPSo for ordering (Table 1). In the WIPS mix, 80% percent of the web requests accessed the browsing pages and 20% of the web request accessed the ordering pages. In the WIPSb mix 95% percent of the web requests accessed the browsing pages and 5% of the web request accessed the ordering pages. In the WIPSo mix 50% percent of the web requests accessed the browsing pages and 50% of the web request accessed the ordering pages.

Web interaction	WIPSb	WIPS	WIPSo
Browse	**95%**	**80%**	**50%**
Home	29	16	9,12
New Products	11	5	0,46
Best sellers	11	5	0,46
Product detail	21	17	12,35
Search request	12	20	14,53
Search result	11	17	13,08
Order	**5%**	**20%**	**50%**
Shopping cart	2	11,6	13,53
Registration	0,82	3	12,86
Buy request	0,75	2,6	12,73
Buy confirm	0,69	1,2	10,18
Order inquiry	0,30	0,75	0,25
Order display	0,25	0,66	0,22
Admin request	0,10	0,1	0,12
Admin confirm	0,09	0,09	0,11

Table 1
Web Interaction Mix for TCP-W [3]

These probabilities are giving us a good start point to analyze E-Commerce systems, because they show real statistics.

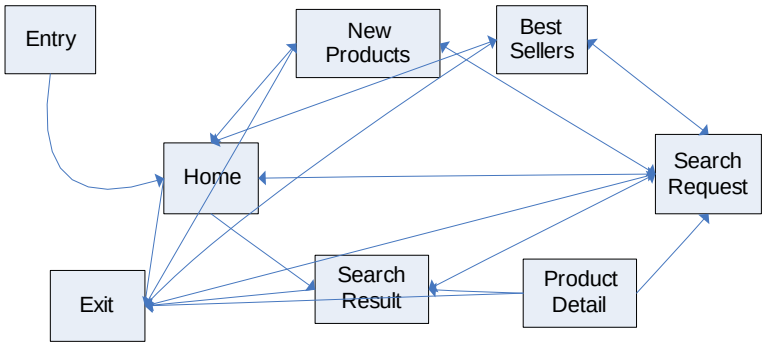

Figure 2
Example CBMG graph for TCP-W [3]

2.3 Database

Figure 3 shows the entity relationship diagram for the system. There are 8 tables presented (Customer-, Orders, Order_Line, Item, Author, Address, Country, CC_Xcats –for credit card transactions).

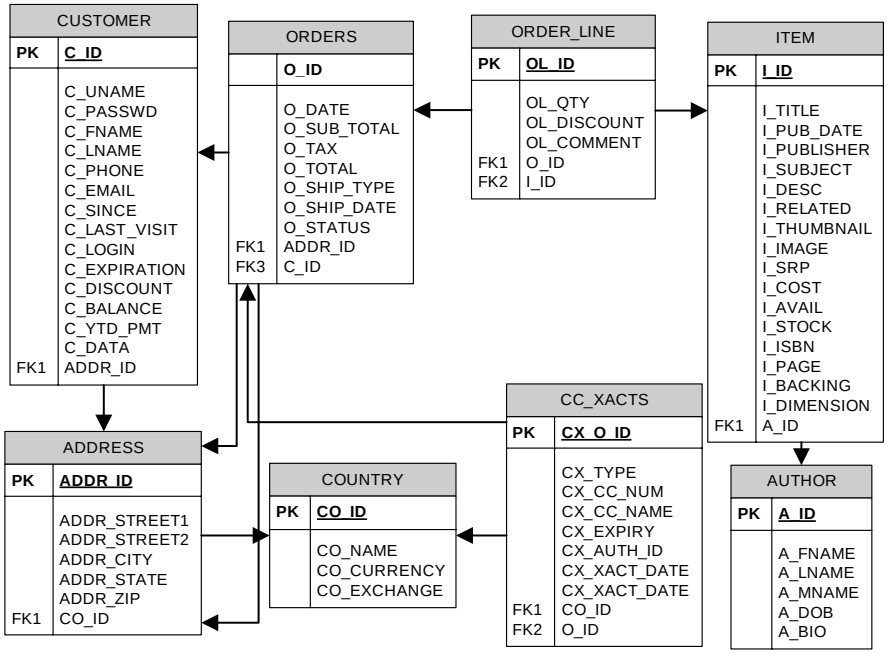

Figure 3
Database schema for TCP-W system [3]

These tables show a common E-Commerce data structure. This is a great example for designers to design E-Commerce databases. The cardinality of each tables are used for scaling the system. There can be many configurations accordingly the number of emulated users. Table 2 shows the relationships between the cardinality of the tables, and the number of the emulated users:

Table Name	Cardinality (rows)
CUSTOMER	2880*(number of EB)
COUNTRY	92
ADDRESS	2* CUSTOMER
ORDERS	0,9* CUSTOMER
ORDER_LINE	3* ORDERS
AUTHOR	0,25*ITEM
CC_XACTS	1* ORDERS
ITEM	1K,10K,100K,1000K,10000K

Table 2
Cardinality of each table in TCP-W [3]

2.4 Metrics

TPC-W measures two main metrics. Firstly, TPC-W measures web interactions per second (WIPS) during a shopping mix. Secondly, TPC-W measures the ratio between total price of the SUT and the WIPS value in the system under test (SUT). For managers it is a great opportunity to compare systems from different producers. It is an excellent help to choose the best system for their companies. Of course these values do not provide (for the architectures) enough information about the systems. Some other relevant parameters are needed for the architectures in case of every server. These are the following:

- Throughput (Request per second)
- Resource utilization (CPU, Memory, Network, Hard Disk utilization)
- Response time

TPC-W uses WIPS, WIPSb, WIPSo to measure systems performance in different terms. WIPS, WIPSb, WIPSo generates different workload for the servers. Thus, we are able to analyze our systems in different workload profile.

3 TPC-APP

TPC-APP is an application and web services benchmark. The workload is designed to generate activities in a typical business-to business application. The main features are the following:

- Multiple on-line business session
- Use of XML documents and SOAP for date exchange
- Business to business application logic
- Transaction integrity (ACID)
- Dynamic web service response generation with database access and update

3.1 Architecture

TPC-APP architecture is very similar to the TCP-W architecture. In this case there are three main components in the system as well. Primarily, there is a component called Remote Browser Emulator that simulate the requests; the System Under Test (SUT) is the system to be evaluated; and finally, performance monitor that monitories several performance metrics.

3.2 Workload

TCP-APP contains the following web services:

- New Customer- register a new customer and returns the new customer ID(CUSTOMER_ID) to the active EB.
- Change Payment Method – a customer is able to modify the method of payment
- Create Order- creates an order on the database and then notifies an order fulfillment system to ship the order
- Order Status - returns information about the last n orders placed by the customer
- New Product - returns a list of recently modified items (I_PUB_DATE)
- Product Detail - returns detailed information about the requested items
- Change Item – modifies the I_PUB_DATE for a set of items

In addition, there are two processes as follows:

- Shipping Process: this handles durable messages sent from the Create Order web services and the Stock management process via the shipping queue (for Orders)
- Stock Management Process: this handles durable messages sent from the Shipping Process via the Stock Management queue (if there is a Back Order)

The workload determines a web services mix.

Web service interaction type	Required Mix
New Customer	1%
Change Payment Method	5%
Create Order	50%
Order Status	5%
New Product	7%
Product Detail	30%
Change Item	2%

Table 3
Web Interaction Mix for TCP-APP [2]

In TCP-APP, similarly to TCP-W, uses Emulated Browsers as well. These EB-s are simulated by RBE using the web interaction mix.

3.3 Database

Figure 4 shows the entity-relationship diagram for the system. There are also 8 tables presented (Customer, Address, Country, Order, Order_Line, Item, Author, Stock).

These tables show a common E-Business data structure. This is a great example for designers to design E-Business databases**.** In this case the cardinality of the tables is also used for scaling the system. Thus, there are different configurations according the number of emulated users. The cardinality of each table and the main differences between TPC-W database cardinality and TCP-APP cardinality are presented in Table 4.

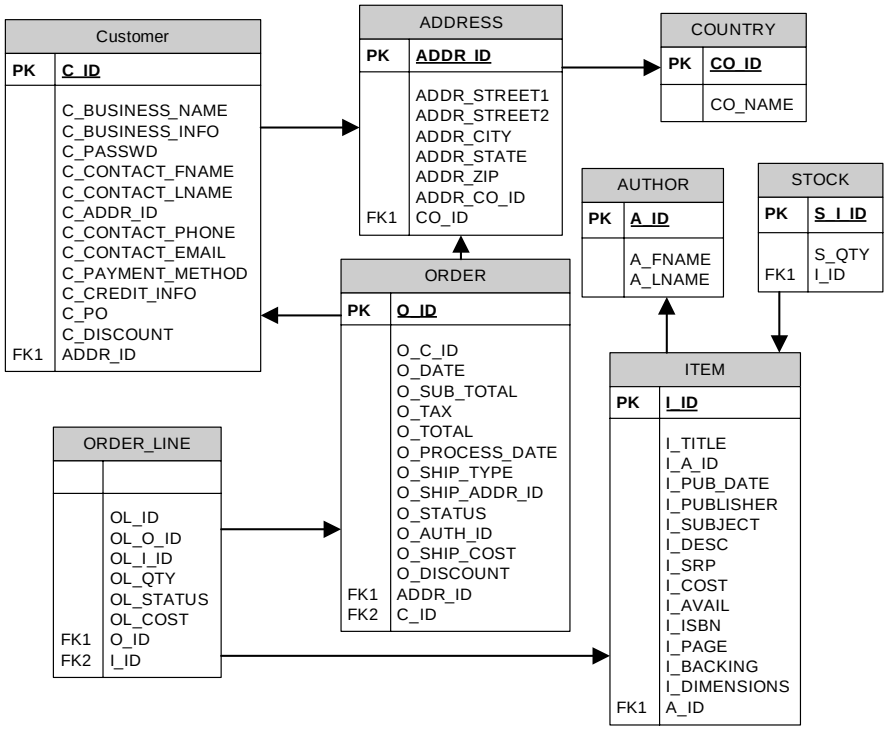

Figure 4
Database schema for TCP-APP system [2]

Table Name	Cardinality (rows)
CUSTOMER	***192*(number of EB)***
COUNTRY	92
ADDRESS	1,4* CUSTOMER
ORDERS	***10* CUSTOMER***
ORDER_LINE	***5,5* ORDERS***
AUTHOR	0,25*ITEM
STOCK	ITEM
ITEM	100K

Table 4
Cardinality for each table in TCP-APP database schema [2]

This configuration shows the different between a typical B2C and a typical B2B application (highlighted rows). In a B2B application there are much fewer customers but there are much more order in the system. In addition, there are more items in an order.

3.4 Metrics

In TPC-APP there are also important metrics: web service interaction per second (SIPS) per application server, total SIPS for the entire test configuration, and total price of the entire configuration per total SIPS. These metrics are also very useful for managers to compare systems.

TPC-APP measures web service interaction response time (SIRT) is the time taken to perform an interaction by an Emulated Browser. SIRT is measured in the RBE machine as follows:

- SIRT= T2-T1
    - T1 is the time measured before the first byte of the request SOAP message sent to the SUT
    - T2 is the time measured after the last byte of the response SOAP message received by the RBE

Throughput is computed as the total number of successful request in the measured interval divided by the length of the measured interval in seconds. Moreover, resource utilization for servers is also important information for the architectures.

Conclusion

TPC is defines several benchmarks for the industry. It is very profitable in many situations for managers and for architects as well. These benchmarks give us excellent opportunity to compare systems. Furthermore, it gives us very good and detailed models for different areas.

In this paper, TPC-W and TPC-APP were presented including system architecture, database schema, workload model and key metrics. TPC-W is mainly designed for E-Commerce application. It contains a typical E-Commerce data structure. A typical workload model is also included.

TPC-APP is designed for E-Business applications. This architecture is based on web services. The database structure is almost equal to TCP-W data structure, but the workload model is different.

TPC-APP and TPC-W have the same limitation. Of course, similarly to every model these models also have limitations. They do not accurately represent some specific situation. For example a workload characteristic of an E-Commerce or E-Business application can be much more different in a sale out like the usual activity.

To conclude, these benchmarks provide a suitable starting point to understand the how these E-Commerce and E-Business systems are used. In addition, they provide an environment that helps us to analyze the systems. Thus, we are able to make an excellent prediction for our systems performance.

References

[1] Daniel A. Menascé: Scaling for E-Business, April 27, 2000

[2] TPC: TPC-Benchmark APP, version 1.1.1, August 11, 2005

[3] TPC: TPC-Benchmark W, version 1.8, February 19, 2002

[4] Wayne D. Smith: TPC-W:Benchmark for E-Commerce Solution

[5] Daniel A. Menascé: TPC-W A Benchmark for E-Commerce, Scaling the Web

[6] www.tpc.org