Workflow support for simulation of service oriented B-to-C transaction

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Abstract: Computation technologies and computer tools offer varied resources for the implementation of applications of electronic commerce (e-commerce). The current organizational models are based on nets of associations that are integrated to achieve business objectives. Therefore, the effectiveness of the commercial operation doesn't only depend on an appropriate configuration of technologies but also on efficiency in the business services. Service-Oriented Architecture (SOA) is an architectural style for distributed computation that considers the creation and administration of business services. With Web Services the services can be published in the Web and accessed by applications independently from language and technology. In this work a workflow support for the modeling and simulation of applications of e-commerce based on services and technologies Web Services is proposed. Tools are applied of processes modeling, with their integration in TIBCO that result in the modeling of a process business to consumer (b-to-c), their simulation and the evaluation of metrics of performance.

Keywords: Electronic commerce. B-to-C. SOA. Web Services. Modeling. Simulation. Workflow.

1 Introduction

Computation technologies, storage and communications provide resources for the design of technological platforms of high consumption. In the last decade the organizations have experienced a growth in their computer technological platforms that is shown in the migration from a group of server to centers of data with thousands of processors. The reason was the need to implement applications that process transactions of electronic business, negotiate clients' data and support analytic tools to take decisions. As a result productivity in the business and increment of the corporate structure can be assured [1].

Another characteristic is the linking level presented by models of organizations with the purpose of achieving the objectives of business that are present in partners' nets, infrastructure of distributed Information Technology (IT), employees' interconnection, communication online with the client, among other [2].

Platforms Browser/Server and middleware are implementation technologies commonly used to support applications web-based. However, in electronic business a low use of resources is observed, between 5% and 20% of the total capacity. This encourages a change in the paradigm of processes design. The applications and equipment are no longer seen as technological entities but as business services [3]. The traditional applications are also subject to a tool of specific programming, centered in servers that hinder distributed invocation [4].

It is necessary to unify solutions in a net of global IT and to orchestrate the execution of operations in a transparent environment [5], with a dynamic and efficient architecture that integrates heterogeneous platforms with independence of operating system and programming language. For this reason, a methodology based on services that allows to link Web-based applications should be found [4].

SOA is an style architectural to build applications that use available services in a net like Internet [6][7]. With technologies Web Services, standards that offer capacities for interoperability and integration of applicable applications in SOA are available [1].

In this context, four fundamental aspects are identified: models and strategies characteristic of the process of business with a services-oriented paradigm, technological infrastructure (hardware, software and communications) to provide services; times for analysis, design and redraw of processes and important payments of capital. Therefore, an evaluation in design stage, guides the decisions, bases the investments and shows potentials benefits [8].

The simulation in the process of business constitutes a strategy to understand its essence, to identify opportunities for the change and to evaluate its impact on metrics of performance. Besides, it facilitates the experimentation of decisions of markets with alternative configurations of business without interrupting the operations of the current system [9].

Systems of Workflow are used to automatize business processes with possibility of simulating their behavior. Web Services is a technology that allows to design SOA and offers a composition infrastructure to orchestrate distributed workflows [4][10].

The objective of this work is to develop a workflow support for the modeling and simulation of applications of e-commerce type b-to-c based on services and Web Services technologies, with its integration to the TIBCO tool [11].

2 Related work and our contributions

2.1 Services, SOA and Web Services in business process

Papazoglou defines services like computational components (applications) autonomous and independent of a software technology with the purpose of carrying out functions that consist from simple operations until composition of applications distributed in complex processes.

SOA is an architectural style and its methodological foundation is the interaction between suppliers and consumers of services with poor connection and standard interfaces with the purpose of achieving processes of agile business. Highlighting, (i) architectural style used as a means of planning, design, implementation and administration of systems of IT; (ii) poor connection: independent services of their operating system or programming language that implement them, transparency regarding the location, interaction through asynchronous messages and standardized description of interfaces and their semantics; (iii) processes of agile business through orchestration of internal or external applications to the organization [11][12].

The benefit of the structure of IT of a SOA is the conception of applications like services, its reusability and independence of a specific technology and the capacity of executing business functions [6].

Web Services is a platform that supports SOA. The World Wide Web Consortium (W3C) defines them as: "software applications that can interact, with interfaces based on XML (eXensible Markup Lenguaje) and linked URIs (Uniform Resource Identifiers). The communication is based on messages XML and protocols of Internet". [7][12].

To sum up, the business applications of electronic transactions can be modeled with SOA and implemented with technologies Web Services, that facilitate integration of business operations in Internet through interfaces and structures of standard data [13][14][15].

2.2 Electronic Commerce and Worflow in SOA

A business process is a group of ordered and interrelated activities, with the purpose of reaching an business organizational goal [5]. The interrelation of the activities is carried out through elements of control of flow that determine the execution order (sequential, parallel, alternative or cyclic)[16].

E-commerce is a business process that consists of the purchase or sale of goods or services, either among public or private organizations, individuals or the government, driven on nets mediated by computers [17]. According to the parts that execute the transactions, the model of e-commerce can be categorized in: B-to-C (Business to Consumer): retail transactions, B-to-B (Business to Business): wholesale transactions, C-to-C (Consumer to Consumer): auction and operations with government organisms as G-to-B (Government to Business) and G-to-C (Government to Citizens) [18].

A proposed conceptual model of e-commerce for SOA is organized in five layers divided in two groups. A group of low level business-oriented that composes services through Web Services' orchestration. Another one of high level customer-oriented that introduces the offer logic and attention to the client. The layers of the business group are: application (infrastructure and resources of IT), service (Web Services that communicate operations) and business process (logic of processes); and the clients are: business output (logical solutions that satisfy the requirements of clients) and customer (the client's participation) [19].

For the representation of business processes there is a group of techniques of conceptual modeling described in three facets: operational (information systems), organizational (business processes, actors, roles, etc.) teleological considerations (purpose). The workflow models are in this category [5].

It is considered as workflow the automatization of a business process, total or partial, in which documents, information or tasks are move from a participant to another by an action, according to a group of procedure rules "[20].

A meta-model of workflow can be organized in six entities: workflow type definition, activity, transition conditions, data, role and invoked application that consists of an activities set with a defined list and associate data. Its information flow can be sequential or be subject to transitions according to conditions. Each activity invokes an application that implements a service [10]. The systems of workflow information apply information technology to business problems, so that they automatize processes combining human activities with applications of IT. Workflow model's framework [21] is shown in the figure 1.

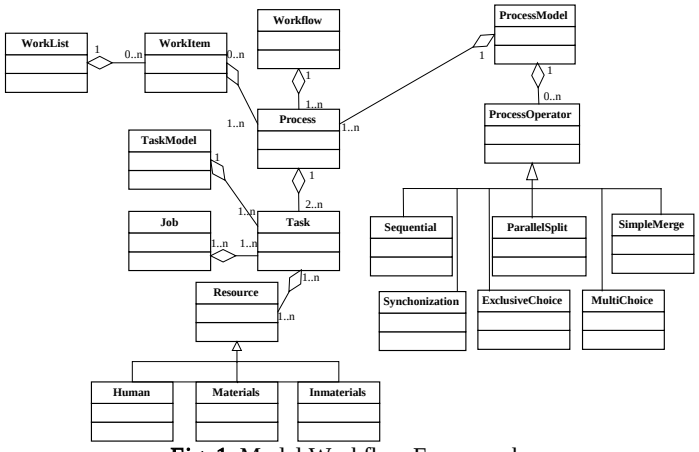


Fig. 1. Model Workflow Framework.

Its main components are: workflows, processes and tasks. The workflow model is formed recursively by processes and tasks. The process model indicates the structure of execution of tasks, organized by operators that determine the flow of data. Each task is executed by resources: human, materials (hardware, network, machines) and immaterial

(software, aplications). These resources fulfill one or more works. It is important to highlight that an activity is a logical step that can be executed in different cases (instances). A case in an activity is called work item.

2.3 Simulation

The simulation of computer systems consists of the description of the state of its components for a given load, therefore it is based on discrete states and, in order to work with them, the technique of discreet event is suitable [6].

Wainer conceptualizes the paradigm of simulation of discrete event as changes of states of the system in discrete points of the simulated time, so that a state transition is executed in front of the occurrence of an event and it should be kept in mind: (i) a set of discrete variables; (ii) a set of events that happen in a certain time according to an arrival frequency; (iii) a global clock that controls the time of simulation [22].

This work is centered in simulation models for e-commerce as business processes organized by a composition of activities that implement the business goals. Of the types of operations of e-commerce, b-to-c is used. Each activity belongs together with a transaction that can be a client's operation in the Web site, internal actions of the organization and interrelation with external applications. Therefore, a process is formed by an orchestration of transactions and its functionalities obey a business service.

The architecture of the model requires solutions that allow a communication among applications, with independence of its platform and programming language. It should be thought then of a distributed architecture that implements services Webs on different platforms, programming languages and technologies. SOA involves the creation and administration of services and it follows a focus of discreet event. Web Services offers an implementation technology that facilitates interoperability of systems developed in heterogeneous environments.

Through workflow this proposal can be model and the performance of business processes for simulation of discreet event can be analyzed [6]. The workflow technologies are based on models of queue to store the work items until they are executed by a participant (application or human resource), according to the consumption of resources, metric of exit are calculated.

TIBCO Business Studio is a tool for the analysis, design, simulation, implementation, and deployment of business processes. The exit metric are measured as client's sessions that consist of different roads in the Web site or as individual services like costs, times, bottlenecks or underutilized resources [23][24].

3. Workflow support for model design

The proposal is based on the conceptual model of e-commerce for SOA presented in the section 2.2, so that the processes logic is designed starting from business goals and the

clients requirements. Each process contains the tasks corresponding to a service, which consist on transactions of business. The associates relation of operations is orchestrated with Web Services. For services like computer solution, the computational resources which execute that solution are assigned.

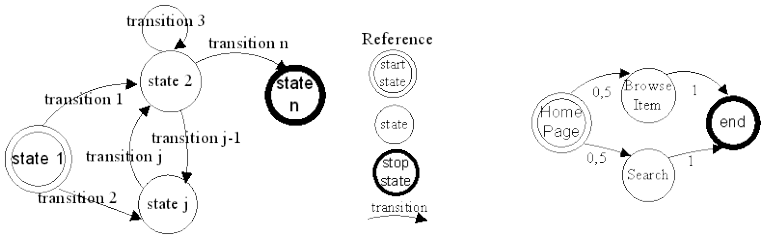
The goals are considered to have two levels: (i) the traditional business processes which consist of transactions automation to achieve the organizational goals; (ii) the comunicational goal i.e technologies for the communication services with clients.

The design method is:

Step 1: Characterization of (i). business through the identification of clients segment, (ii). commercialization strategies, and (iii). definition of goals.

Step 2: Outlining of services and execution rules. Each process will include the services corresponding to a sub-goal of business.

Step 3: Model design of electronic transactions. The corresponding tasks should be explained for each service. A transactions modeling tool is the Customer Behavior Model Graph [18]. In figure 2a a general model is presented which is organized in states and transitions among states. A state represents an task and a transition the probability of moving to the next task. Figure 2b exemplifies this. The possible path from an initial state to a final state is the clients sessions.



(a) (b)

Fig. 2a General diagram of states. **2b** Example of Diagram.

Step 4: Building the workflow model. Based on Model Workflow Framework in figure 1: (i) human resources and IT for each task are assigned, (ii) costs and time are assigned to each task, (iii) task logic with process operators are assigned to the process model.

Step 5: Implementation of model in step 4 in the TIBCO tool. In table 1 the graphic objects for the design of the model are observed. The processes are organized in pool and lanes. The model process is structured in a flow information among tasks that can be sequential, with alternative or in cycles. Each lane implements a sub-goal of business.

Table 1. Objects for the design of the pattern.

Tasks		Event		Process		Exclusive Gateway	Sequence Connections Flow		
Service Task	User Task	Start	End	Pool	Lane		Inconditional	Conditional	Default

In the figure 3a a model begins with Start Event, continues in a sequential way with an operation, and it then forks in an exclusive gateway with 50% of probability. The model concludes with the End Event. Figure 3b shows a model which represents a cycle, with a probability of 60% if it returns to Browse and 40% if it continues to Search.

(a) (b)

Fig. 3a Alternative structure. **3b** Cyclic structure.

Step 6: Parametrizing simulation. Each task is related to a demand which is the average service requirement of the task in the resource (IT or human) to execute a transaction. The inputs to the simulation are the number of cases and the frequency of arrival.

Step 7: Outlining performance metrics. The metrics are taken from the number of cases, the time of simulation and the consumed resources, by service and by clients' session. For example, average time of a system case, quantity of cases by service, quantity of cases by clients' session and services use (bottlenecks or underutilized resources), among others.

4 E-commerce b-to-c model

A -commerce b-to-c model based on Web Services is designed. In figure 4 its architecture is observed, according to a general process presented in the EcommerceWebServicesArchitecture pool. The pool is subdivided in the following lanes: WebSite (services for the internal administration of the business logic); WebServiceSearch (service of searches with Web Service); WebServiceCredit (service for the evaluation of the client's credit state with Web Service); FrontEnd (services for the business site connection with Internet); WAN (communication in Internet); Client process.

Each transaction is modeled as distributions of constant probability of the demand [25]. The flow of information follows a sequential structure, of decision or cycles. The cases are generated in the start event and they follow a distribution of constant probability of the time inter-arrivals.

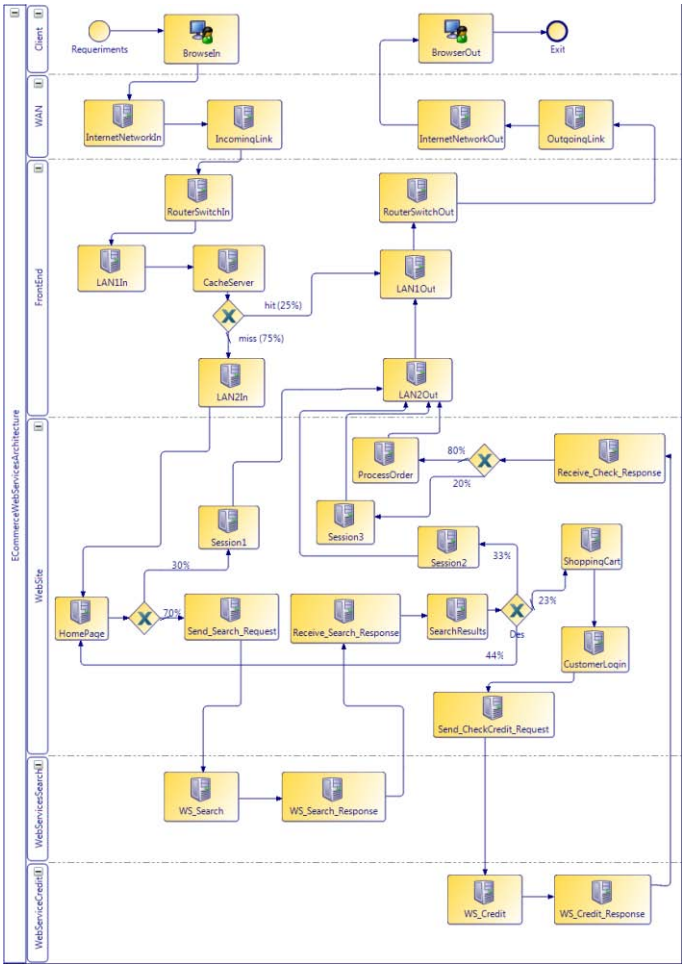


Fig. 4. E-commerce b-to-c model.

Each case begins with the client online, who navigates the Internet to arrive at the business site. The FrontEnd process contains a Cache service which responds to a hit; for the miss Cache the service directs the client to the HomePage. The tasks of searching and evaluation of the client's credit are carried out by Web Services. The modeling of Web Services consists of the requestor´s requirement sending, the supplier´s attention and the corresponding answer.

The model sessions are measured to analyze the client's behavior: Session 1 represent the client who has only visited HomePage; Session 2 represent the client´s searches; Session 3 represent the client who could not purchase due to lack of credit authorization and Process Order represent the client who could buy.

5. Simulation and Analysis of Results

The first hypothesis simulation consist of the process behavior analysis for different quantities of clients in the site. The scenario consists of the variation of the number of cases (clients), with a time between constant arrivals of 0,5 seconds. The original quantity of cases is a hundred, concluding in a thousand, with increments of a hundred.

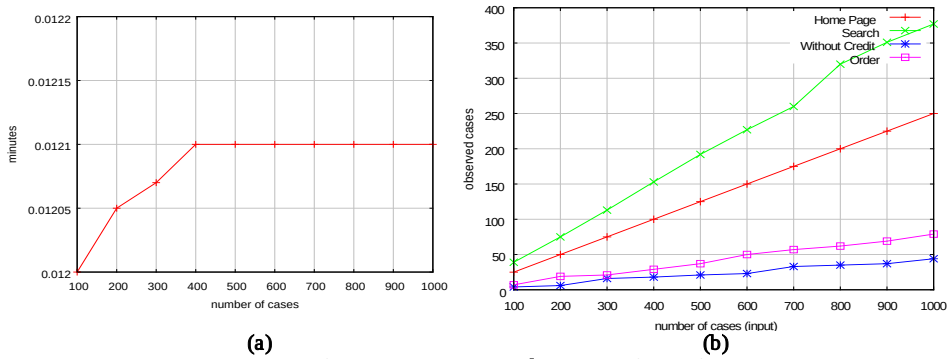


Fig. 5a Average time of a case in the process. **5b** Number of cases for session type.

In figure 5a the mean time is observed by case, beginning in 0,012 minutes and stabilizing in 0,0121 minutes after the 400 cases. All and all, the simulated process has an efficient architecture for a frequency of clients' of 0,5 seconds arrivals. In figure 5b the quantity of cases is shown by session type, this facilitates the client's evaluation in the different services and mainly it allows for the estimation of the average number of clients who buy.

A second scenario, the process behavior is simulated for a variation of the time between arrivals and a constant number 500 cases.

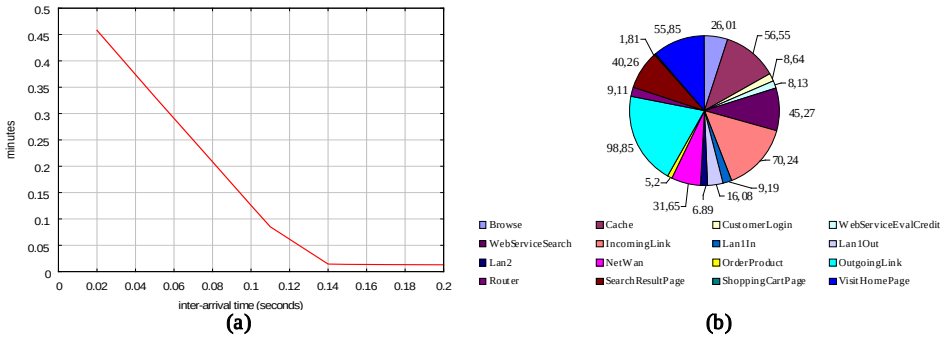


Fig. 6a Average time of a case for different frequencies of arrivals. **6b** Utilization percentages for service.

In figure 6a the average times of a case are shown and a saturation of the process is observed for frequencies inferior to 0,14 seconds. For a further analysis the utilization of the services are studied. Figure 6b shows 70% for the Incoming Link and 98,85% for the Outgoing Link as services which are closer to saturation.

6. Conclusion

A workflow support for the modeling of processes of e-commerce type b-to-c is proposed. This model integrates the business requirements with the services which implement them. The requirement performance which is simulated in the TIBCO tool is analyzed using the metrics base of the average time of the system case and the services uses.

The simulation of processes allows for the evaluation of the business logic without interrupting the execution of the processes in order to predict unexpected behaviors.

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