

An integrated distributed processing approach for e-commerce system design and development

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Abstract: - This paper proposes an integrated approach for e-commerce business modeling and system design, based on the Reference Model of the Open Distributed Processing (RM/ODP) standard. Initially, the main concerns of e-commerce with respect to business modeling are presented; next, the requirements induced by this modeling and the generic e-commerce system interfaces are discussed. Then, the adoption of UML for describing ODP viewpoints as a flexible and efficient mean for designing e-commerce system functions is proposed. Finally, an integrated design methodology taking into account the mapping requirements between the ODP viewpoints is presented. Finally, future work and open issues are discussed.

Key-Words: - E-commerce, business models, BMF, RM/ODP, ODP viewpoints, UML.

1 Introduction

As e-commerce becomes an integrated part of our everyday life, the respective systems must be reliable, efficient and well designed according to a customer-centric approach. During the past few years, many organizations have realized that e-commerce can improve profitability, productivity and market penetration while reducing costs. According to numerous studies by industry consultants, the e-commerce industry is steadily expanding to a trillion dollar scale [1]. This anticipated exponential growth has led many companies worldwide to enter this marketplace, either as sellers of goods and services, or as equipment and infrastructure providers. Small businesses have also begun employing the Internet as a business tool. For instance, the number of businesses with fewer than 100 employees that have websites doubles in less than two years. The trend is led by professional service businesses, such as law and real estate firms. Of course, the growth of the Internet worldwide facilitates the further proliferation of e-commerce. Another important finding regarding the perception of e-commerce in organizations as a strategic platform for their core business is that these organizations tend to consider intangible benefits as more important than tangible

benefits [2].

The continuous growth of e-commerce in business environments calls for an integrated designing approach in Business Modelling along with e-Commerce system design and implementation specifications. In this paper we focus mainly on the Reference Model of the Open Distributed Processing Standard (RM/ODP) of the International Standardization Organization (ISO).

The RM/ODP, being a successful ITU-T Recommendation and ISO/IEC International Standard, has proven to be increasingly important, mainly because it can be used to design and develop large, open and distributed systems [3]. Many major companies and organizations turn to RM/ODP as a promising alternative for specifying their IT systems and for structuring their large-scale distributed software designs. The fundamental virtues of RM/ODP are openness, flexibility, modularity, manageability, federation and portability. There are also provisions for quality of service, security and transparency [4]. In addition, ODP may establish technology- and tool- independent communication mechanisms between business and IT experts and therefore it provides an excellent basis for business modeling. In this respect, ODP seems to be an excellent framework and reference model for specifying e-commerce applications and services.

Our approach for e-commerce business modeling, system specification and design is based on the RM/ODP framework. But the Reference Model does not prescribe any specific notation for representing its concepts and viewpoint languages; several formal or semi-formal languages and notations may be used for writing and analyzing ODP system specifications, such as UML for ODP.

UML is a powerful notation with many advantages. It is an open standard and a common choice of many researchers and developers of distributed systems. UML unifies the perspectives among many different kinds of systems, development phases and internal concepts. UML provides a rich notation syntax using diagrams [5]. Within our approach UML is selected as the notation for writing the ODP based e-commerce system specifications.

This paper is organized as follows: in section 2 we initially discuss some important aspects of e-commerce such as the impact and the architectural requirements. In section 3 we examine e-commerce transaction types, as well as, the proposed e-commerce reference models. In section 4, the RM/ODP reference model is briefly presented, as well as the relationship of RM/ODP with UML. In section 5, we present an ODP/UML-based integrated approach for e-commerce business modeling and system design, which can be also enforced on other application sectors. In section 6, we conclude and discuss future work and open issues on the subject.

2 E-Commerce System Overview

Since e-commerce is pushing global competition while advancing technology, traditional commerce is deeply affected. The customer behaviour is consequently profoundly affected and in tandem affects both electronic and traditional commerce, having the characteristics of a closed loop system. E-commerce and globalization are placing exceptional demands on business enterprises today. E-commerce is also determining relations among market actors [6], [7]. Under these conditions companies have to revise their on-line business strategies, develop new, innovative strategies, invest on the penetration of the Internet and follow the changes in market demands in order to survive in the new era. In order to do so, they often need to adopt realistic, modern business models; established business models, techniques, structures and philosophies of the past are becoming less and less useful. According to Cloete, "there are no boundaries on innovation and degrees of functional integration experienced in e-Commerce" [8].

An e-Commerce system usually includes the following generic points of contact: *Point-of-Information*, *Point-of-Offer* and *Point-of-Sale*. The relationship between product vendor and e-site takes place through the **Point-of-Offer** (PoO) interface to the system. Through this interface vendors can create presentation material for their products and/or services, distribute the material and pay for the service. The relationship between product retail agent/customer and service is expressed through the definition of the **Point-of-Sales** interface (PoS) to the site. Through this interface the users/customers can view presentation material, collect product/service information and order or buy products or services. As long as the functions are restricted to viewing, the interface is called **Point-of-Information** (PoI). The design of the point-of-sale interface must support three different types of targets of the marketing information: the agent, the customer and the agent interacting with the customer.

3 E-commerce Business Models

Organisations conducting businesses through electronic means have often proposed their own set of unique and innovative concepts and strategies for generating value. Models of doing businesses electronically include *business-to-business transactions*, where buyers and sellers are organizations, *business-to-consumers transactions* where the sellers are organizations and the buyers individuals, *consumer-to-organizations transactions* where consumers make known their particular needs for a product or service, and organizations compete to provide the product or service, *consumer-to-consumer transactions* where individuals sell products or services each other, *intra-business commerce transactions*, where an organization uses e-commerce internally to improve its operations, e.g. a business to its employees, *government-to-citizens transactions* where the government provides electronic services to its citizens, *government-to-government transactions*, where governments or government departments conduct businesses with other governments, and *collaborative commerce transactions* where business partners collaborate electronically, e.g. business partners along a supply chain.

In fact, the above e-commerce business models adapt or extend traditional commercial methods, eliminate intermediation of specific markets or create new types of intermediaries, restructure traditional value-chains, re-package products and services into new products, and facilitate community-based markets for peer-to-peer

exchanges [9],[10]. But the term “Business Model” is quite often misleading to describe exactly these business propositions because it is interpreted as a framework for strategies and plans [11]. Timmers defines a Business Model as an architecture for the product, service and information flows, including a description of the various business actors and their roles, as well as of the potential benefits for the various business actors [12]. On the other hand, Mahadevan proposes that a business model is a unique blend of the value stream, identifying the value proposition for actors, of the revenue generation for the business and of the logistical stream, addressing the design of the supply chain [10]. Actors perceive value arising from the reduction in transaction costs, the decrease of information asymmetry, the participation in virtual communities, the enhanced information, the reduced search costs, the security and trust.

A further elaboration on the definitions provided by Timmers and Mahadevan can be found in ref. [7]. Specifically, for this approach, which follows quite enough the distributed object-based model, a Business Model is an abstract description of the architecture of a business system, providing a definition of the latter in terms of its components, structure and dynamics. According to this work, a Business Model defines:

- the involved business actors;
- their roles and the inherent and underlying logical interdependencies among them;
- the interactions among the involved business actors, in terms of product flows, services and information;
- the potential benefits for the various business actors and the sources of revenues.

Business models classification is usually based on their common structural characteristics from various perspectives, such as market structure vs. building blocks [10], functional integration vs. innovation [13], economic layers [14] etc. For example, from the functional integration vs. innovation comparison viewpoint, the models can be broadly classified into two main classes: the “*Traditional*”, such as e-shop, e-mall, e-auction, e-procurement, as well as subscription and branding of products and services, and the “*Innovative*”, such as value-chain provider, value-chain integrator, collaborative platform, information broker and customer support. The central tenet of these models is the building and maintaining of supplier/customer relationships, the supply chain management, as well as the development of intra-, as well as inter-

organizational communication based on collaboration between partners on the value chain. In [12], the classification takes place in two dimensions, namely “Innovation” and “Functional Integration”.

4 Overview of RM/ODP

4.1 Impact of RM/ODP

An Open Distributed Processing (ODP) system is specified in terms of a set of related but distinctly separate *viewpoints*. A viewpoint provides a specification of the complete system (or a part of it) related to a particular set of concerns. For each viewpoint there is an associated viewpoint language, which defines a set of concepts for that viewpoint. The RM/ODP defines the following five viewpoints: *enterprise, information, computational, engineering and technology*. The system specification in RM/ODP is based on object modeling.

RM/ODP has several advantages that have made it popular and broadly used since its introduction in 1995 [16].

4.2 RM/ODP and UML

The ODP Reference Model does not prescribe any specific notation for representing its concepts and viewpoint languages. By the term *notation* we denote a textual or a diagrammatic way for representing the information and for describing the structure and functionality of a system and its components. Formal descriptions are employed in the ODP framework to enable clear and unambiguous definitions and interpretations of ODP standards. Several formal or semi-formal languages and notations may be used for specifying and analyzing ODP system specifications: UML, UML for ODP, EDOC and BPDM have been considered for this purpose [15], [17], [18], [19].

The *main concerns* when choosing notations for the ODP viewpoints are:

1. Since ODP is based on the object concept, the notation for each viewpoint should support that concept as well;
2. The notation should be broadly accepted and understood;
3. The notation should be able to express the concepts defined in that particular viewpoint;
4. Since an entity may be present in more than one viewpoints, it should be possible to check the consistency of the different viewpoint specifications of a system;
5. The notation adopted should be able to map the various e-commerce functions.

The use of different languages for different viewpoints makes it difficult to check the consistency between different viewpoint specifications and to trace system components across viewpoints. The use of a single language /notation in all viewpoints will solve these problems, but it requires that the language/notation have a rich set of core concepts to cover all the viewpoints. It was shown in practice [4], [18] that UML fulfils the above requirements. The ODP - UML combination helps also to map and to implement some ODP functions in different technologies such as the Common Object Request Broker Architecture (CORBA). For the above reasons, we have adopted UML for use in our proposed model.

The use of RM/ODP (in combination with UML) for business modelling and system design provides an excellent basis for establishing technology- and tool-independent communication mechanisms between business and IT experts.

4.3 ODP Terminology

ODP uses its own terminology that traces from it are the following:

- A *domain* is a set of objectives with a characterizing relationship and a control object that may be part of the domain or outside it.
- A *community* is a configuration of interacting objects aiming to fulfil an objective according to a contract defining how the objective can be met. Examples include market makers, procurers, clients, etc.
- An *actor* is an enterprise object (human or computational) that plays a *role* in the enterprise view.
- The term *artifact* may be used when the actor is a piece of data or information. Examples are: vendor interface server, sales server administrator, transaction security agent etc.
- A *role* is a unique identifier that characterises some behaviour. A role defines the behavior of objects within the community.
- A *scope* is a set of roles that define a business.
- A *contract* is a specified agreement to some behavior common to a configuration of objects, which tells the environment what to

expect. Contract is a set of obligation, prohibition or permission rules which either constrain or enable actions, as related to the purpose. A contract may contain *policies*.

- A *policy* is a set of actions that are triggered on events under specific constraints.

5 The Integrated Design Approach

This section is concerned with the methodology and the notation chosen for the development of an e-commerce business model and system using ODP. By the term *methodology*, we mean a set of rules for developing a system, by defining steps to be followed during system refinement. The proposed methodology and the uses of the UML notation are based on previous related efforts such as those described in [17], [18].

For mapping the different ODP viewpoints to UML diagrams of various types, we have adopted and further developed the approach proposed in [23]. This approach is illustrated in Figure 1. The major benefit of such a mapping consists of supporting both an object-oriented modelling and design process, and the design of reusable components and distributed services [27] in the sense of distributed systems as described in RM/ODP [3].

Figure 1 shows the links between ODP viewpoints and the relationships between them and the UML diagrams, as well as between UML diagrams of the same viewpoint, specifying different aspects of the same objects. The design of an e-commerce application starts with the definition of its functions with an *architectural diagram* and system requirements imposed by the various actors and communities, in terms of *Use Case Diagrams*. The results obtained from a use case model may be used to present high level *Class Diagrams* for the *Enterprise viewpoint*. These diagrams can be specified in more detail in the *Information viewpoint*. *Statechart Diagrams* allow the specification of the dynamic behaviour of significant information objects.

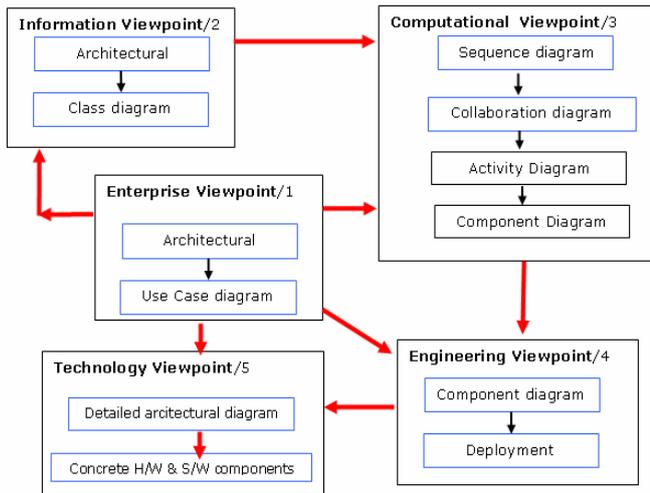


Figure 1 – General simplified proposed methodology

Thus, the proposed methodological ODP based design approach is as follows:

1. We start from the *Enterprise viewpoint*, where the system requirements are defined and modelled. *Actors, roles, communities, scopes, contracts, policies, business processes* and the entire *supply chain* are all defined and clarified here. Next, procedures for the accomplishment of the purposes of each community are defined.
2. Then we go to the *Information viewpoint* where we identify the information requirements of the Enterprise viewpoint and the resources required to support them. What actually has to be specified concerns: information elements and their attributes, relationships between them, information flows and allowed manipulations. At this phase we don't focus on coding (implementation), but on structure and quality.
3. Based on the results of the *Enterprise and Information viewpoints*, we go to the *Computational viewpoint* that deals with the functional decomposition of a system, i.e., the computational objects, the interfaces they offer, the functionality they support, and the interactions between them. We must define the processes and action *structures* used to build up the system. However, the description does not focus on their implementation or physical appearance, issues tackled in the following two viewpoints.
4. The results of the *Enterprise and*

Computational viewpoints feed the *Engineering viewpoint*. *Implementation issues* such as data processing components, communication issues and the deployment of functionality have to be defined here. The infrastructure needed to support distribution, i.e., the provisioning of transparencies, should also be described here. Quality and performance issues are also tackled in this viewpoint.

5. Finally, the results of the *Enterprise and Engineering viewpoints* feed the *Technology viewpoint*, which is concerned with the implementation details regarding the hardware and software components needed to build the system. Here, we have to describe the specific kind of technology used to transform the architectural components into working devices.

It is clear that the above-described approach provides not only a model but a business modelling and an implementation methodology, as well.

6 DISCUSSION AND CONCLUSION

6.1 Discussion

In this paper, we have proposed RM/ODP as an integrated approach for e-commerce business modeling, as well as for e-commerce system design and implementation. RM/ODP has an additional, very important advantage: it provides a methodology for developing not only models for e-commerce but also the means for achieving consistency and mapping between the various system viewpoints. RM/ODP was used in conjunction with UML, which was chosen as a notation to describe the models. Since there are a great variety of e-commerce business models available, we focused on a general methodology rather than producing a model for each case.

6.2 Future work and Open Issues

In a future work, we shall demonstrate the derivation of a model and system specification for a classic B2C e-commerce system as a case study. Initial work has been done on such a case study but due to space limitations cannot be presented in this paper. Our methodology needs to be further elaborated. Although UML provides rich notation syntax, some of the RM/ODP constructs do not have a direct correspondence in UML. Another problem with RM/ODP is that in various implemented architectures, different notations have been used for

the same RM/ODP constructs. Therefore, more effort in standardization is needed. As a consequence, the selection of certain RM/ODP constructs will affect the design consistency in engineering tools using UML. For complex systems it is absolutely critical to choose the representation that best exploits the consistency and validation checks available in the used tool. The solution of this problem will facilitate greatly the RM/ODP and UML combination and promote further their use.

Although viewpoint correspondences are defined in RM/ODP, they are not very useful and they have not been used extensively in practice [17]. In order for us to be able to ensure component traceability across the various viewpoints, viewpoint correspondence needs to be further elaborated. In a globalized world where there is a strong demand for strategies accelerating the worldwide adoption of e-commerce [1], adequate methods for scalable, reliable and high quality telematic systems must be developed. We believe that our research effort contributes on this direction.

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