Mediated E-Commerce Sites based on Adaptive Multiagent Systems

Ana B. Gil, Francisco J. García

Departamento de Informática y Automática – Facultad de Ciencias
University of Salamanca – Spain
{abg, fgarcia}@usal.es

Abstract. *E-Commerce is a business form that has grown in popularity in our society. E-Commerce applications are so consolidated in a certain kind of areas, and also have a very promising road in many others. In this way, new technologies have been applied to give an adequate response to this kind of software. One of these technologies is the agent technology that has found in the e-commerce one of the major application area. Our work is devoted to develop an e-commerce system that is especially thought for small and medium enterprises (SMEs), where several enterprises share a common mediated e-commerce site. Concretely, in this paper we present an e-commerce architecture definition proposal that is based on an agent-oriented technology, but also compliant with our past work in this area. This architecture establishes the basis for our future work on e-commerce solutions development, making near the e-business world to the small enterprises.*

Keywords. *Agent based technology; E-commerce; Adaptivity in E-commerce.*

1   Introduction

E-Commerce is a business form that has grown in popularity in our society. E-Commerce applications are so consolidated in a certain kind of areas, and also have a very promising road in many others. E-commerce is set to be a major research area inside the agent technology. Agent-mediated architectures are a concrete example of the successful application of this technology in e-business field. Agents are software entities that have been given enough autonomy and intelligence to enable them to carry out specified tasks with little or no human supervision [9].

The e-commerce sites diverge far enough from classic on-line information systems. While a hyperspace of information items still constitutes a major part of these systems, browsing the hyperspace is not a major activity, but is a by-product of the major activity (such as shopping goods). In fact, the better these systems work, the less browsing should be required. Adaptive characteristics are particularly interesting here [3]. For this reason, one of the forces that need to be resolved in the design of agent-based architectures for e-commerce systems is the *adaptability* characteristic. The end-users of an e-commerce site

differ in their status, level of expertise, needs, and preferences. The issue of adaptability is that of tailoring information to the features of the user [14].

Adaptive agents can support the adaptability issues. These agents could perform several functions in the e-commerce site: they should have the capability to respond to unexpected situations; they should help the end-users explore the site; they should learn from the visitor to the e-commerce site; they should adapt the interface to show always actualised information; they should make recommendation to the users…

Related to e-commerce systems, our group is interested in e-commerce models definition that allows the entry of the small and medium enterprises on the virtual commerce bandwagon. In this way, an e-commerce system has been implemented. It is based on product catalogue-based e-commerce architecture, so called e-CoUSAL [6].

These products catalogues are also known as electronic catalogues or simply e-catalogues. An e-catalogue can be defined as electronic representations of information about the products and/or services of an organisation [13]. E-catalogues are widely accepted in web-based business.

e-CoUSAL architecture is mainly supported by two components: a visual catalogue-designer tool and an e-commerce web server. The first one represents the authoring tool that is used by the enterprise to generate and manage the e-catalogues. E-catalogues represent enterprise's own business in the e-commerce site and were published in the e-commerce web server automatically. Then, the e-commerce site needs to adapt itself to show the correct interfaces and the actual information to its end-users through its e-commerce services.

In this work the overall e-CoUSAL architecture is redefined from an agent-based perspective. Thus, the remainder of the paper is organised as follows: Section 2 briefly explains the antecedents of the e-CoUSAL system. Section 3 defines the new agent perspective of the e-commerce architecture. Finally, Section 4 concludes the paper.

2 Antecedents in e-CoUSAL system

To understand the new definition of the system architecture under the auspices of the agent technology is important to know the work done [6], because the new approach should be compliant with the achieved goals.

In a schematic way, in the Figure 1 the major components of the proposed architecture are shown. As we stated above, the main commercial policy is based on e-catalogue shopping supported by two main components, the e-commerce web server and the visual catalogue-designer tool.

There is a central element, the e-commerce server, which interconnects the different parts involved in a typical commerce environment, but with more dynamism compared with the traditional business methods.

The e-catalogue is the chosen element through the end-user views and interacts with the seller's information.

A small and medium enterprise (SME) becomes the main actor of its own virtual business approach. It is responsible for the inclusion and the management of its own contents in the e-commerce site, which allows the enterprise entrance into the e-commerce environment. The use of a specialised software tool to design the e-catalogue permits the organisation to be an active element within the commercial process.

Then, the overall architectural model defined above present a B2B/B2C hybrid e-commerce model [4].
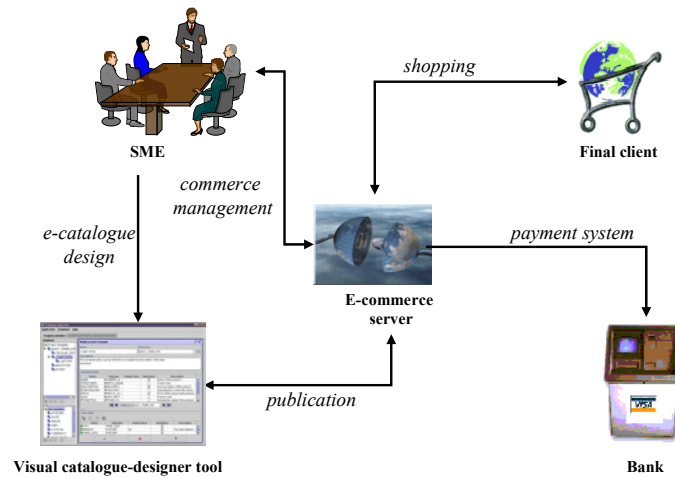

Fig. 1. Components of the e-CoUSAL e-commerce architecture

3 Agent-based architecture for e-CoUSAL system

The e-commerce architecture, introduced in the previous section, is now more concretely defined in terms of a multiagent system.

In a multiagent e-commerce environment it is necessary to organise agents into different categories depending on their functionality and competencies. Several different forms of agents for e-business systems are distinguished in [10], such as: Application agents, Personal agents, General business activity agents, Information brokering agents, Negotiation and contracting agents, System-level support agents, Interoperate agents, Business transaction agents or Security agents.

According to the agent classification presented above, we have identified the necessary agents and their relationships to support our e-commerce architecture proposal. These agents are shown in Figure 2. We present the agent-based architecture in coarse granularity and high abstraction levels, because we are defining the architectural layer of the system, relating the agents to the main components presented in Figure 1. In other works thinner grained agents are presented [1, 14]. These approaches are not incompatible with ours.

In the Figure 2 ovals represent agents and arrows represent communication between them or between external entities, as end-users. Also, the agents are related to the components presented in Figure 1, including the agents inside of them.
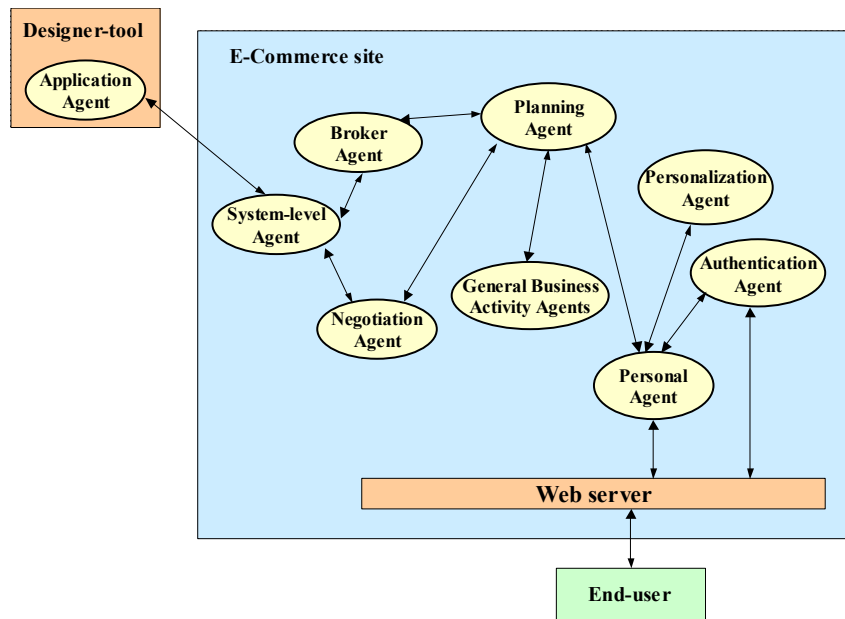

Fig. 2. Agents in e-CoUSAL architecture

Now, we are going to explain these agent categories in a detailed way.

Firstly, the application agent is the visual designer tool that is used by an enterprise to create the e-catalogues. This e-catalogue creation tool [6] allows both the conceptual and the visual design of a product catalogue, with the goal of publishing and selling them in the Internet.

A symbiotic relationship arises between this tool and the e-commerce site where the e-catalogues are published. From this point of view, the server imposes a minimum set of criteria for product and catalogue definition (basic description elements, category classification of the products and so on). On the other hand, the tool offers the server all the necessary information for the publication of the organisation contents. This interchanged information is the logical definition of the products that will be published, their conceptual organisation in an e-catalogue, and the concrete visualization format for this e-catalogue.

For this information interchange the markup language XML is used [2]. The use of this language is justified by its flexibility for modelling, its document semantic validation capability, and the separation between the data and their visualization format.

The broker agent is in charge of receiving the e-catalogues, expressed in XML format, validating them, and storing the information in the proper internal database. The tool through the system-level agent sends these catalogues.

This agent should attend to every enterprise that belongs to the e-commerce site to publish and manage its e-catalogues.

This broker entity implements the communication protocol for data interchange between the enterprise and the e-commerce server, allowing the whole system to be built over a self-maintained platform, capable of configuring itself when changes are incorporated by the organisation, with minimum interaction of the web master [5].

The negotiation agent receives the business components of each enterprise in the same way that the broker agent receives the e-catalogues. This property will allow not only that the enterprises are presented in the e-commerce site, but also they could personalize their business policies (discount, payments and so on) through these components. To support this facility the designer would be improved to design this kind of business components.

The general business activity agents form a set of agents that manage the services of a typical e-commerce site: shopping-cart management, selling certificates and so on.

The authentication agent is a security agent type that is in charge of identifying the end-user allowing the adaptation of its interfaces and shopping goods. Another type of security agent is the authorization agent that controls the access to sensitive information once identity has been verified.

The personal agent is related to the customization and personalization issues on e-commerce web sites. Paterno and Mancini define adaptable systems as systems that allow one self to modify some parameters of the systems and then adapt their behaviour accordingly. If the systems adapts to the user automatically it is called adaptive [11].

According to this definition, we need adaptive agents in our e-commerce architecture that are in charge of the adaptive aspects of the system. One of these is the negotiation agent, because the e-business components should adapt the e-services to be compliant with each enterprise's business strategy view.

But perhaps, the most suitable example of adaptive agent is the personal agent, because it is the responsible of personalizing the interaction with the user and e-catalogues presentation and navigation.

This agent dialogs with the web server module to interact with the user and dynamically generates the hypertextual pages that represent the e-catalogues.

The e-commerce site offers its clients efficient access and shopping management for the different products that are published in the server. From an end-user perspective, the e-commerce presents the specialised supermarket metaphor, where a client can find several related products from different suppliers.

For an end-user the e-commerce site should be like another commercial site in Internet (it should present the same facilities and an easy and familiar inter-

face), and the variety of the sources of the products has to be transparent for the end-user. For this reason, the personalizing capabilities of the site are very important.

Concretely, the implementation of this personal agent is based on the adaptive agent model proposed in [7, 8], which is shown in Figure 3.
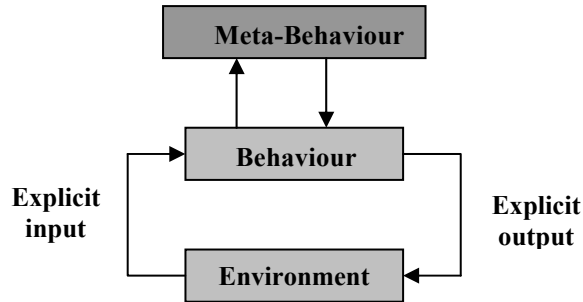

Fig. 3. Generic adaptive agent model

The model presented in Figure 3 proposes a meta-behaviour layer that gives each agent the ability to make appropriate decisions about control or to adapt its behaviours over time to new circumstances. It provides the agent with a self-control mechanism to dynamically schedule its behaviours in accordance with its internal state and its world state. The meta-behaviour allows to dynamically updating the set of rules describing the agent behaviours.

The meta-behaviour relies on data about the agent himself, its environment, and the decision system used by the behaviour while the way to modify it too.

We have adapted this general adaptive agent model to the characteristics of the e-CoUSAL e-commerce architecture, as we present in Figure 4. The user interacts with the e-commerce server that presents the personalized pages to offer relevant information to the client.
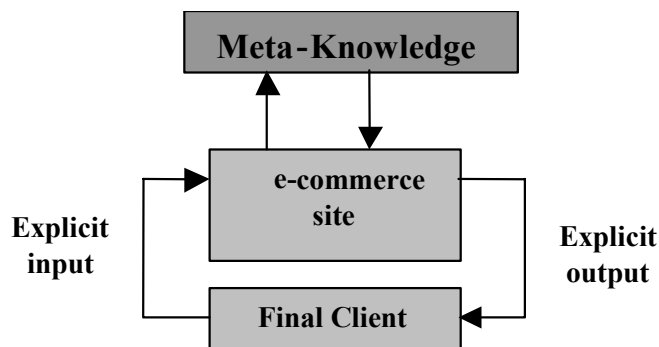

Fig. 4. E-commerce adaptive agent model

The hypermedia pages that represent the e-catalogues are dynamically generating on the fly, getting the contents from the e-catalogues that were sent by

the enterprises. However, to take out the information from the e-catalogues and introducing the data in the server database, there must be an ontology or meta-knowledge for e-catalogue definition that is shared between the server and the catalogue-designer tool.

Another kind of adaptive behaviour in the e-commerce system is directed to support the personalization of the end-users' needs. For these issues we have identified a personalization agent that is in charge of acquiring and maintaining the end-users profiles, which represent the system's hypotheses on the users' needs and can be used to tailor the layout of the hypermedia pages to each specific end-user. So this agent should learn from the visitors of the e-commerce site to infer the end-users' interests. From the visitor's viewpoint, the agent should help the user make sure that useful information is not overlooked. On the other hand, a personalized profile should be used to make right recommendations to the users [12] that could reduce the browsing actions of them.

Finally, we introduce a planning agent. The presence of heterogeneous problems to be faced and the fact that many tasks could be carried out at the same time invite to design the multiagent architecture outlined above. But in order to permit a good cooperation among the different agents, we introduce a planning agent that controls the main data flows in the system. In a few words it is the responsible of publishing the e-catalogues that are sent by the enterprises, managing the e-catalogues database, accepting the orders of the e-commerce service agents, and giving to the personal agent the proper data to generate the personalized information pages.

4   Conclusions

In this paper we have defined an agent-based architecture for the e-commerce system, where two main components are identified: a visual catalogue-designer tool to generate e-catalogues and an e-commerce server site that stores the generated catalogues. These components comprise several different kinds of agents that support the commercial policy of the system.

One of the most suitable capabilities of the proposed architecture is the adaptive ones, which are supported by an adaptive agent that performs the interaction with the user and e-catalogues presentation and navigation, dynamically generating the information pages.

This architecture is compliant with the work done by the research group before, where the main goal is bringing the small and medium enterprises over the e-commerce area.

The further work is devoted to implement the whole defined architecture taking special attention to the adaptive agents.

5   References

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