Design and Implementation of RMP - A Virtual Electronic Market Place

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1 Introduction

Electronic commerce is one of the currently most exciting and fast moving fields with a high demand for innovative new technologies. Looking at electronic commerce of today, one can distinguish between *business-to-business* and *private consumer-to-business* electronic commerce on the one hand, and *EDI-based* and *Internet-based* e-commerce on the other hand. In addition to these viewpoints one can further distinguish between a *1-supplier : m-customers* scenario and an *n-suppliers : m-customers* scenario.

Table 1 gives a classification of the different approaches. Today, business-to-business commerce is based on Electronic Data Interchange (EDI), a standard for conducting business over electronic networks. It enables companies to order products, bill customers, trace product shipments, and transfer funds electronically. If two companies want to transact business they must have some kind of business relationship first. EDI transactions are generally made over secure value-added networks built specifically for EDI, such as the network operated for example by GE Information Services and IBM's Global Network. Usually, EDI customers are large companies, because the networks and the IT infrastructure needed are quite expensive. Smaller companies have to use EDI in the case of business relationships with big companies. Although EDI has traditionally been available only on value-added networks, it is becoming available on the Internet [EDI]. For example, GE Information Services recently introduced a secure link between its network and the Internet, so businesses using the GE Information Services network can exchange private documents such as purchase orders and invoices with companies over the Internet. However, although the link to the Internet is secure, anything sent over the Internet is not secure unless it is encrypted. Current work in the context of EDI tries to overcome these limitations in linking EDI networks together with the Internet. Although EDI is the most successful form of business-to-business electronic commerce available today, it is still quite costly and causes too much overhead and difficulties for being used by small and medium companies.

Technology	Type of E-Commerce	Characteristics
EDI-based	business-to-business	driven by big companies; dedicated, closed networks; 1 : 1 scenario; well-established;
EDI-based with Internet access	business-to-business	driven by big companies; dedicated closed networks with optional access via Internet; 1 : 1 scenario;
Internet-based	private consumer-to-business	1 : n scenario; typical individual Internet shop; suffers from limitations on the private consumer side;
Internet-based	business-to-business	small and medium companies; 1 : n and n : m scenarios; not yet well-established;

Table 1: Classification of electronic commerce approaches.

Today's Internet commerce systems are quite strong in serving the needs for individual electronic shops, however, they still do not really cover the various aspects of trading *within* the system and lack support for business-to-business commerce. Although, there are going on many interesting development and research projects (e.g., SEMPER [Eur], OSM[Eur98], NetBill [Inf98], ICE-TEL [ERPpfbtECitTAP98], OTP [Ope98] which address particular issues like payment schemes, security, and open trading protocols, these projects do not aim directly at the development of an *integrated* electronic market place on the Internet.

In this paper, we report about RMP, a project on Internet commerce for small and medium enterprises (SME) funded by the European Commission[1].

RMP aims at the development and operation of adequate e-commerce solutions in rural areas. This includes the provision of basic Internet communication facilities such as e-mail and WWW applications as well as dedicated solutions for trading goods over the Internet. RMP addresses the *business-to-business* scenario for SMEs. One of the goals of the project, relevant in the context of this paper, is to develop technology and solutions which allow to create a virtual rural market place on the Internet, which consists of many customers (companies) looking for products and many suppliers offering their products according to an *n-suppliers* : *m-customers* scenario. The business processes which have to be supported in the RMP scenario are significantly different from those in an e-commerce scenario for private consumers. Following the requirements analysis of the project partners and the overall organizational framework and legal settings RMP users (customer and supplier companies) are registered users of RMP by means of having a contract with the RMP operator. This is a prerequisite for creating a trustworthy, serious trading environment for the given user group in the current situation of legal conditions and the Internet. This actually just reflects the traditional trading environment of SMEs in which business partners do not stay anonymous but are well known. It also does not mean that the user group is closed. Any company identifying itself can participate in RMP. RMP is currently released to users in particular regions in Europe and will become accessible world-wide later on.

The RMP system is realized as a network of database-driven servers providing various e-commerce trading services to clients via the Internet. The architecture and implementation of the RMP trading components follow the EMP prototype [BGHK99] developed at the University of Ulm, Germany. The system exploits WWW infrastructure, is implemented in Java, and is based on a relational database system. RMP offers various other services like company and product catalogue Web pages, but these are not of further interest in the context of this paper.

In this paper, we give an introduction to the approach taken to realize the RMP trading services. Section 2 briefly presents the trading services offered by RMP. Section 3 outlines the overall system architecture. Section 4 gives an overview of the role and realization of the RMP database. Section 5 gives some implementation details, identifies some open research issues, and concludes the paper.

2 RMP Trading Services

RMP functionality is structured and offered to users by means of services. These services have been designed according to the needs of the participating user groups and the legal requirements as a result of an analysis of the users' business processes. From the viewpoint of a user the RMP system provides the adequate workflow needed to trade products over the Internet. It includes the possibility to interconnect the trading services with existing IT infrastructure of a user and provides a solution for the payment of products purchased via RMP.

In the following, we give some examples of services, illustrated by means of an application scenario. Figures 1, 2, and 3 show screen shots of the RMP clients providing the necessary functionality for such scenarios:

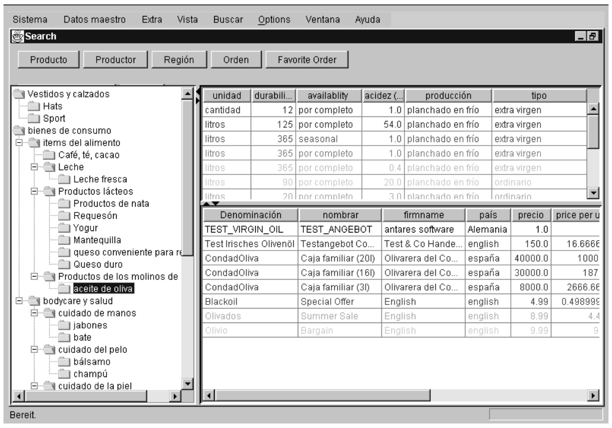

Figure 1: RMP client — Search and order service (customer view; Spanish interfcae).

[1]RMP is partially funded by the European Union under article 10 of the EFRE development programme RISI2. The project consortium includes among the authorities of the participating rural regions of Austria, France, Spain, and Greece the software companies Cap Gemini, France, Knowledge SA, Greece, CTA, Spain, telesis, Austria, a bank, and more than 60 SMEs participating in the project pilot.

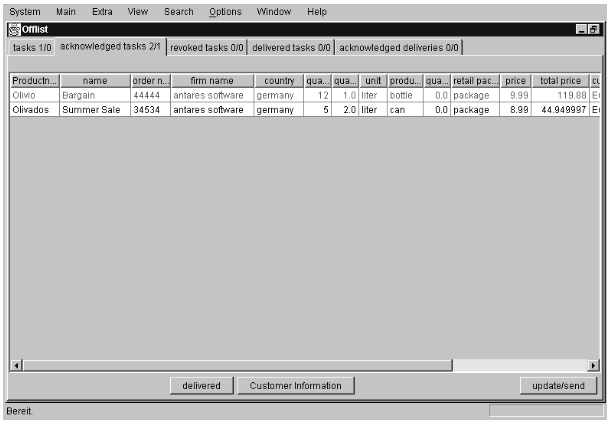

Figure 2: RMP client — Sample trading services (supplier view on confirmed orders; English interface).

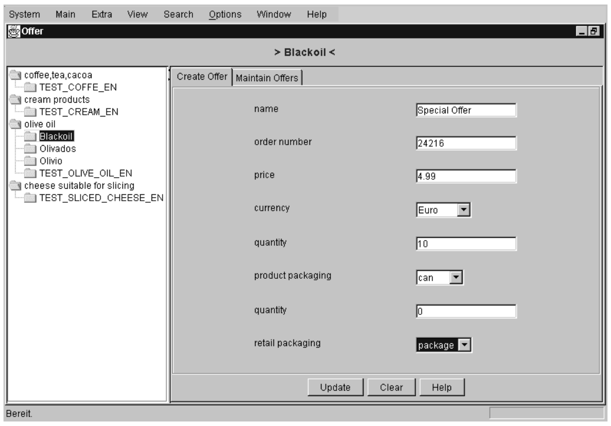

Figure 3: RMP clients — Offer maintenance service (English interface).

Let us first look at the services activated in the RMP system when a customer orders a product.

First, a customer uses a *search service* to look for products and corresponding product offers (Figure 1). This search service is based on product classification stored in the RMP system, visualized on the left. Then, after having chosen a product offer, the customer uses an *order placement service* to submit an order of a product to a supplier. Optionally, a customer may activate a service to start *negotiation* on some order details like the pricing or shipping conditions.

Upon notice of an incoming order the supplier of the product either accepts to negotiate order details, *confirms acceptance* of the order, or *rejects* the order. After products have been shipped, the supplier uses a service to *confirm shipment* of the ordered products.

The customer can make use of a service which allows him to *review details on the status of orders* (accepted, rejected, shipped).

Upon receipt of ordered goods, the customer may check the delivered products against the original order and then *confirms receipt* of the products, or issues a statement of complaint, or denies acceptance of delivery.

The supplier can make use of a service to review details on *open*, *accepted*, or *rejected orders*, on the *shipment*, and on the *receipt of products* by the customers (see Figure 2). Upon notice that the customer has received the shipment the supplier can *issue the invoice* and then the customer *triggers payment* via the bank.

Further services available to customers allow, e.g., to ask for bids.

Suppliers use specific services to place and to maintain product descriptions and offers (e.g., Figure 3) and to maintain customer lists for special offers.

The payment scheme of RMP follows the traditional payment scheme currently used by SME. Companies are customers of a bank (constituted by a contract) and can initiate a money transfer in order to pay for purchased products. When ordering products, the customer's bank may get triggered by RMP to issue a letter of credit for the supplier. This may serve as a basis for the decision whether to accept the order or not.

In addition, RMP offers many more services needed to manage product and offer data, handle user registration, etc. Specific services are offered for system administration to the operators of RMP, which are not available for regular RMP users.

3 Architecture of the RMP Trading System

The RMP trading system provides for a layered organization of the RMP trading services. The layer of *basic services* consists of services for the encryption of the communication between any system components, authentication and authorization verification, product data organization and access, database access, and the like. The layer of *business services* builds upon the basic services and includes for example user and service profiling, notification, search for suppliers, products, and offers, editing and visualization services. The layer of *market services* is based on the other two layers and realizes application domain-specific functionality for the registration and authentication of users, buying and offering goods, user guidance, general information and maintenance, and management of the system. The layered organization of the services is supported by a component-based implementation of the system according to the architecture of the EMP system [BGHK99].

The RMP system is based on a multi-client / multi-server architecture. Each RMP trading client is a computer system connected to the Internet and running a Java-applet within a Java-enabled WWW browser. In RMP a client connects to a dedicated RMP server, called the *RMP home server* which is part of a network of RMP servers. Although the RMP electronic market place is a distributed virtual market, it is presented to the user as a central market place with a single entry point via the user's RMP home server (see Figure 4).

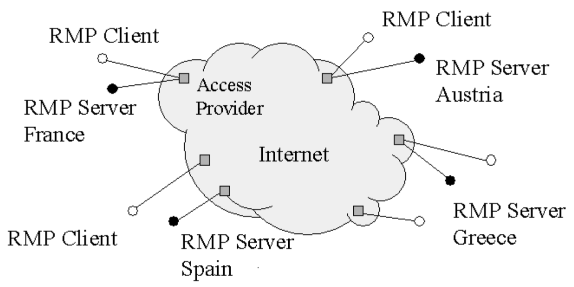

Figure 4: RMP — virtually central market place.

Each RMP server offers the functionality of the services outlined above. Each server consists of the following components (see Figure 5): a collection of Java modules realizing the individual services of the three layers, a binding service which organizes the network of active RMP servers currently on-line, a distributed JDBC driver [BGHK99] which allows for accessing local and remote RMP databases via commercial JDBC drivers, and a relational database management system which stores all the data on users registered at the server, on products and offers, on business transactions, on billing, and information related to the different security levels, i.e., user authorization, service authorization which ensures that only authorized services can call other services, and privileges granted to users and services for executing services and accessing the database.

The databases of the RMP servers are disjoint with respect to data on participating users, products, offers, etc., needed for trading goods via RMP. The only replicated data stored in the RMP databases are data needed to organize the network of RMP servers. This organization of the RMP databases allows to restrict updates on products and offers to the local RMP database maintained by the RMP home server a user is assigned to. Some more details on the organization of an RMP database are given in Section 4.

The RMP network of servers can be expanded at any point in time during operation of RMP. The set of RMP servers known to be on-line at a specific point in time by all individual servers forms the universe of RMP. The binding service of an RMP server makes use of this information in order to provide the interconnection between active RMP servers. At start-up time of an RMP server the binding service gets the information about at least one other RMP server in order to build up and to consistently maintain the information about the network of RMP servers by periodically querying other RMP servers. The binding service is used by the distributed JDBC driver to locate remote RMP databases and to transparently access product and offer data available at remote servers.

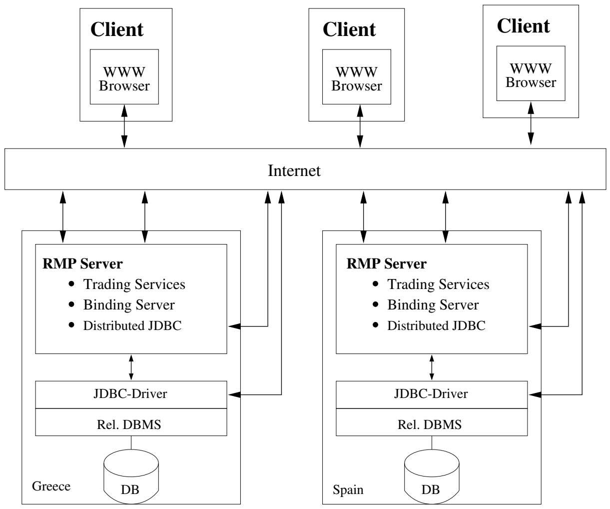

Figure 5: RMP Architecture

4 The RMP database

Data stored in an RMP database can be classified into data on the *organization* of product information, data describing *products*, data describing *offers* on products, data related to the *ordering* and *trading processes*, data on *security features*, and data of *user* and *service profiles*.

Product information is organized and viewed as a hierarchy of product types. Product types inherit attributes from their supertypes, e.g., the attributes *name* and *base-unit* of the root type *product* are inherited by any direct or (indirect) subtype, e.g., *liquid products*, *alcoholic products*, and *wine* which itself provides product specific attributes like *quality*, *grape type*, etc. This hierarchical organization is mapped to a relational schema such that each node in the hierarchy results in a corresponding relational table. This allows us to provide searching for non-leaf product types like *liquid products* in the hierarchy very easily. In addition, this mapping provides for schema evolution during the operation of the RMP databases, which is one of the most important features required. Whenever one wants to add a new product type to the product hierarchy the metadata about the product tree has to be updated and a new table with the new product type-specific attributes has to be created. Adding an attribute to or removing one from a product type can be simply done by adding or deleting a column from the corresponding table, enforcing the assumption that the attributes assigned to types along a path in the product tree are named differently. The product type hierarchy is maintained and distributed among the RMP servers by the operating authority of RMP. Each time the product hierarchy is changed, the system propagates an update package of the information describing the product hierarchy to all RMP servers in the network. This update includes, e.g., *create table*, *insert*, and *update* instructions to maintain each existing RMP database in the network.

Data on offers are related to product data, but kept separately, since offers change more often than the information about products. Offer data is related to order data which are related to a detailed description of business transactions. This information is used by the RMP operating authority to bill customers. The concrete billing scheme depends on the RMP operating authority. The current instantiation of an RMP network has adopted a billing scheme which charges suppliers in case of a successful business transaction. Note that all activities on the RMP market are driven by the database system. It captures the data on users, products, offers, business transactions, RMP services, access rights and privileges, and billing data. More details on the realization of the RMP databases are given in [BGHK99].

5 Conclusion

In this paper, we report about the RMP project aiming at the establishment of a virtual electronic market place providing business-to-business trading functionality for small and medium companies on the Internet. RMP realizes an electronic market place on the basis of an *n-suppliers : m-customers* scenario. The implementation of RMP basically follows the EMP prototype [BGHK99] developed at the University of Ulm, Germany, but adapts the end user interface to the specific needs of RMP users and extends the set of services offered at the layer of market services. The system is implemented in Java and uses Oracle 8 as the RMP database management system. RMP realizes secure communication streams between clients and servers and provides multi-language support available via user profiles.

The RMP trading system is currently being piloted with users in Austria, France, Spain, and Greece, i.e., for example, hotels, producers of various types of products, and retailers. Since RMP integrates fax services for the ordering of products it also allows to trade products of suppliers not yet registered as RMP users. This allows to incrementally expand the network of RMP users in the domain of small and medium companies with the ultimate goal to acquire more and more registered on-line suppliers.

The development in the project currently focuses on the integration of the payment service which will follow the traditional payment scheme in place in the application domain. Later on, it is planned to integrate one or more of electronic payment solutions commercially available on the Internet. To provide for further wide-spread of RMP the project also implements a simple mapping of the RMP ordering functionality to HTML-based forms which allows to use RMP ordering without prior registration and which can be placed on any Web page. Further development will focus on the support of different billing models at different RMP home servers and on individualization of services. Theses aspects are important for the operating authorities of an RMP server since they can exploit the market information available within RMP to better serve individual customers and suppliers.

An important lesson learned in the context of this project is that SMEs to some extent have a somehow different view on e-commerce on the Internet than often found in the scientific community. Improvement of development and maintenance of adequate product differentiation is needed in order to avoid a barrier to RMP acceptance for some user groups. Today's payment schemes on the Internet are not yet settled enough for employment in application domains like RMP. SMEs as well as their banks in some regions are very reluctant to accept this new form of electronic payment and it will be very important to ensure that these payment schemes can be mapped onto traditional payment schemes and related business processes in place today. Another issue becoming equally important in this context is the application of digital signatures and its legal framework. The European Union is working on a proper legal framework and Germany starts operating a trust center infrastructure for issuing and handling digital signatures in late 1998. These are very important steps toward a broader acceptance of e-commerce on the Internet.

The overall experience with RMP so far is very good, which is also due to its user-driven approach. Many regions in European countries, currently from Austria, Germany, and Italy, plan to set up their local RMP servers and would like to join the existing RMP network or create their own Internet trading network. However, there are many important research issues left in this domain concerning the *generic* database system support, optimization and further exploitation of a component-based e-commerce architecture including the design of a flexible set of services which can be composed in a highly modular way forming an appropriate model for the business processes behind. The individual business steps forming the RMP services can be seen as a workflow executed by a set of RMP servers. We would like to investigate the integration of workflows existing in the user's environment and the coupling and integration of workflow systems at the client side. The overall goal is to try to come up with a toolkit that allows to choose and combine the services and their interactions according to appropriate business processes in order to build up virtual electronic market places for other branches of business.

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