Service Provision and Composition in Virtual Business Communities

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e-business, service provision, service composition, virtual business communities

Service provisioning is at the base of business economy, and a major driver for business-to-business interaction. The strong competition induced by the globalisation of the markets is forcing businesses to concentrate on their core competencies, and to rely on specialised third parties for the provisioning of corollary service infrastructure. New expectations and opportunities are emerging for business uses of the Internet, and value chain optimisation is a priority. The role that the Internet is playing in the business-service market, at the moment revolves around a one-to-one model. Once two businesses have established a relationship, the Internet mainly acts as a communication channel. Efficiency is an important benefit offered by the electronic format of transactions, but very little value is added to the transaction itself. The decision on the best provider for a service and the trust in its capability to deliver the quality expected are instead high-value components for business transactions. Aim of our research is to explore electronic service provision in business-to-business scenarios, focusing on multi-party service composition. A composition-oriented service model has been designed, and it is presented together with the prototype of its support infrastructure.

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Abstract

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Keywords: e-business, service provision, service composition, virtual business communities.

1. Introduction

The interaction models currently used in business applications of the Internet are mainly based on a one-to-one and one-to-many paradigm [1,7]. Company web sites act as a distribution point for general information to potential and present stakeholders (namely customers, investors and employees), and specific requests are handled on a one-to-one basis [3,6]. The value added by the Internet to such a traditional approach to business communication is in terms of fast accessibility to updated information, and the electronic format of the information. Effective business-to-consumer

channels can be built on such a model, but business-to-business interaction has a different range of requirements [9,10,11].

Business communities have very stringent rules in terms of membership and transaction management [2,8]. Mutual knowledge and trust are the very basis of business-to-business interaction, and community members' can leverage on these values in order to improve their execution capability. The communication power provided by the Internet widen the potentials for business communities, but a specific infrastructure must be put in place in order to address the peculiarities of what are commonly known as *virtual* business communities [2]. The idea of virtual business communities is based on the same concepts of standard business communities, but the emphasis is in the electronic-service infrastructure that facilitates the interaction among the businesses involved. Competitive pressure is forcing businesses to adapt their processes to increasingly demanding standards, and automated management of business-to-business interaction becomes essential throughout the entire supply chain.

Our research focuses on the investigation of general requirements for virtual business communities, and the specification of a service model for business-to-business service provision. The basic service model is presented, and its service composition capabilities are discussed. A prototype for the support infrastructure has been designed, and implemented using a new-generation process management system (HP Changengine [4]) plus some software components specifically built.

2. Basic service model

In order for a service provider to enter a business transaction with a customer, the most important aspects of the interaction among the two parties are mutual understanding and trust. The service provider can publicise the specifications for the format of the service request, but the customer may already be using an internal format for order submission [8]. The range of possible formats for the content of a request goes from EDI-like (Electronic Data Interchange) protocols coded into XML (eXtensible Markup Language) structures, to simple documents generated with a text editor. Different companies in a virtual business community can have different internal IT (Information Technology) infrastructure, ranging from complex IT systems to simple workstations connected dial-up to the Internet. Translations between different formats and delivery management for the service request are basic aspects to consider for the service execution model in a virtual business community.

The same concepts apply to the information sent from to the customer when the service provider has processed the request.

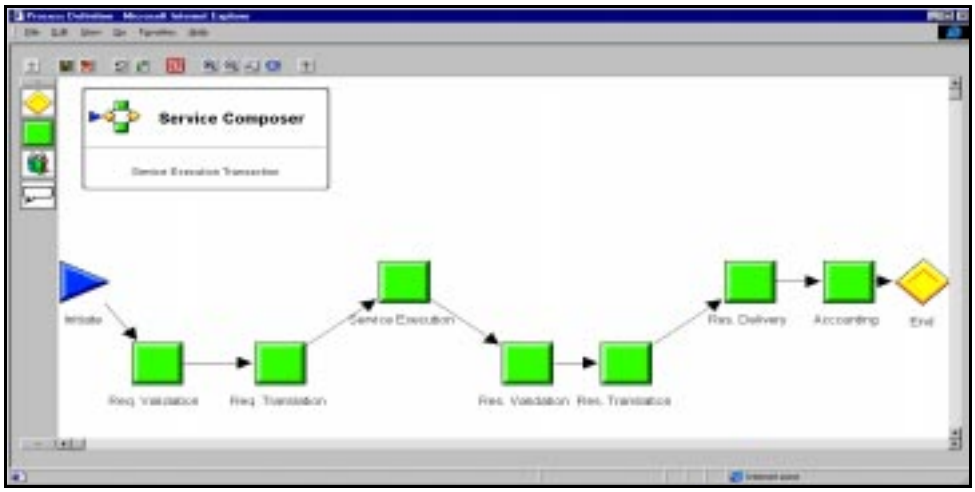

Figure 1: Service execution transaction

Trust comes into the service model in different forms, but authentication and non-repudiation are particularly relevant. When the service provider receives a request, it has to be guaranteed about the identity of the customer and the fact that the customer cannot change the terms of the request. When the customer receives information (e.g. confirmation letters) back from the service provider, it has to be guaranteed about the identity of the service provider and the fact that the information cannot be modified. In both cases, it has to be possible for the information to be unequivocally associated with the company from which it originates. The basic need is to recreate for electronic transactions the same level of trust that businesses have in traditional transactional procedures.

The basic format for a service execution transaction is represented in (Figure 1). The customer initiates the transaction by providing information about the kind of service it needs, and supplementary data required for the execution of the service. Data are validated, translated (if required), and the service request is submitted to a service provider. When the service has been performed, the result is validated, translated (if required), and delivered to the customer. The accounting at the end of the transaction deals with the charges for the transaction itself, but it can also manage the actual accounts of customer and service provider for the payment of the service.

Fundamental aspect of the model is the fact that the service provider can be selected automatically by the infrastructure of the virtual business community, depending on the information provided by the customer in the Initiate phase (Figure 1) of the transaction. The dynamics of the virtual business communities can cause new service providers to join the community, and existing members to withdraw services from their portfolio. Basic concept for the business community is that all the members can deliver comparable level of quality for comparable service requirements. The customer can still select a supplier on the basis of its brand, but focusing on the service more than on the provider it can be *automatically* put in contact with the best provider for the service required.

The definition of the rules for the selection of the supplier that best matches a service request represent a core aspect of the model. The rules depend on the information available from service specifications (technical and financial) and availability signalling provided by the suppliers, as well as information gathered by the service infrastructure on customer, suppliers and their history. The more information is available to the service infrastructure, the more precise the rules governing a virtual business community can be.

3. Service composition

The underlying principle in service composition is for a service provider to implement a new service reusing existing services as building blocks, and to add value to the sum of the parts. The value of a service is measured on its ability to satisfy specific needs, and the success of a new service depends more on the understanding of the problem it aims at solving than on the components it is built upon [10]. Nevertheless, when a clear service definition has been designed, the easy access to an existing service infrastructure is paramount to the implementation of the new service. The commercial success of new services tightly depends on the time-to-market factor, and the application of a component-based approach is no longer an option for service providers.

A service provider can act both as a customer and as a supplier in the virtual business community. The automatic selection of the service providers guarantees that the new service is available as long as there is at least one provider for each of its service components. Moreover, the overall quality of the new service is at any point in time the best possible, given the resources available. The automatic management of customer-supplier relationship considerably reduces the administrative overhead for the provider of the new service, hence increasing its operational efficiency. Service components are

accessed using a standard service execution transactions (Figure 1), and the overall structure of the set of service requests can be captured into a process defining timing, sequencing and conditional alternatives. When a customer requests the composed service, a service execution transaction is started. An instance of the service request process is enacted as part of the Service Execution activities (Figure 1).

The information on the dependency relation between different services can be used for dynamic service management, as well as service portfolio management. If some of the service components become temporary unavailable, all composed services depending on them are reported unavailable. Service providers are notified about the problem, no further requests are accepted from customers, and ongoing transactions are frozen (with a notification being sent to the customers). Similar procedures are put in place when the last service provider offering a service component withdraws the service from its portfolio. Specific rules can be enforced in terms of how service providers are required to manage changes in their service portfolio. The details of such rules depend on the peculiarities of each virtual business community.

4. Service infrastructure

The infrastructure required in order to support the proposed service model revolves around transaction management and information management. It is important to realise that the time scale for a service execution transaction (Figure 1) is totally different from more traditional transactional systems (e.g. banks or airline reservation systems). The emphasis is on reliability, availability and the possibility to track all the steps in a transaction. Using an open network like the Internet for communication, issues like data protection, authentication and non-repudiation become apparent.

The architecture (Figure 2) for the service infrastructure was designed using a three-tier approach. The base layer includes the repository for information concerning members and services of the virtual business communities. User profiles include information about the businesses composing the community, in terms of their role (customer/supplier), service requirements, financial capabilities and historic behaviour (e.g. number of times a customer had problems paying its suppliers, or the number of transaction not successfully completed by a supplier). Accounting data depend on the pricing model (e.g. fixed amount per transaction, or percentage of the total value of the transaction) for the usage of the community infrastructure, as well as the extent to which the actual payment for the

services exchanged is mediated by the community. In the simplest case, the clearing process for the payment related to the services exchanged is transparent to the community infrastructure. In some cases, the payment clearing is a service as well, provided by some members of the virtual business community. As an option, the community could add accounting and clearing facilities as part of the service infrastructure. The last case is particularly relevant to virtual business communities in which members are at the same time suppliers and customers. Such a situation should be the norm, when community members leverage on the principle as well as the infrastructure of the virtual business community.

For a complete, auditable and reliable trace of all the steps in every transaction mediated by the service infrastructure, logging all the events occurring in the community is fundamental. The events are always marked with a timestamp, and depending on the sensitivity of the information they can be encrypted and/or digitally signed. Legal issues play a major role in the activities of the virtual business community, both in terms of the relationship between community members and between provider of the service infrastructure and community members.

The specifications for a service relate to both technical and financial characteristics, plus information on availability and references to the service providers. For each service, there are two types of data stored in the Service & Rules repository. A first type of data is targeted to the automatic selection rules, and they are in the form of property tables on which the decision process can be applied algorithmically. A second type of data is targeted to potential customers, and they are in the form of files of information in any kind of format the supplier can provide. Format translation is a basic component of the service infrastructure. The content of the selection rules depends on the community policies, while their format depends on the characteristics of the Business Transaction Manager.

The basic components of the service infrastructure are located in the middle tier of the architecture. The Authentication service deals with digital signature and encryption of data exchanged as part of a transaction. The Translation service deals with basic format conversion for data files. The User Management service is in control of the information on community members. The SLA (Service Level Agreement) Management service monitors the various steps in the transaction, focusing on duration. Finally, the Business Transaction Manager handles the execution of service execution transactions between the members of the community. Service composition processes are defined and managed within the business transaction manager.

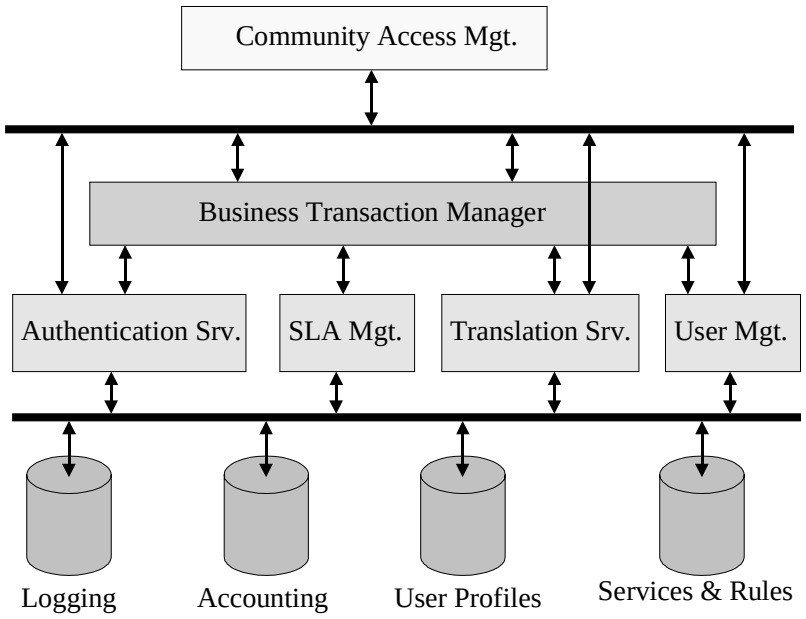

Figure 2: Service Infrastructure

The range of access possibilities to service infrastructure depends on the requirement of the members. A web based access interface (both interactive and programmatic) represents the minimum requirement, but the integration with MOM (message oriented middleware) should also be possible.

5. Infrastructure prototype

A prototype of the service infrastructure (Figure 2) has been developed, based on a new-generation process management system (HP Changengine [4,5]) and a set of standard software components. Main aspects taken into consideration for the selection of the support technology were reliability and features offered. Performance issues have been addressed looking at the scalability of the overall system, more than at the characteristic of single components.

For the choice of the transaction management system, a balance was needed between flexibility, functional completeness and performance. Changengine presented a number of characteristics that made it suitable for prototyping the architecture, and the key aspect was its capability to dynamically bound resources to process instances based on easily definable rules. Rules can be defined using a functional-style language that supports the integration of information coming from different sources

and in different formats. The rules can be associated to any step of a process, and the actual binding between process step and the resources involved is decided at run-time for each process instance.

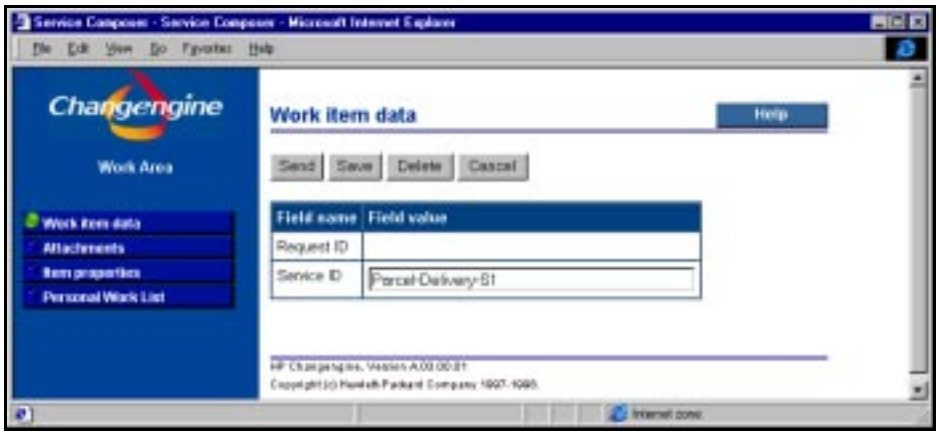

Figure 3a: Service Request

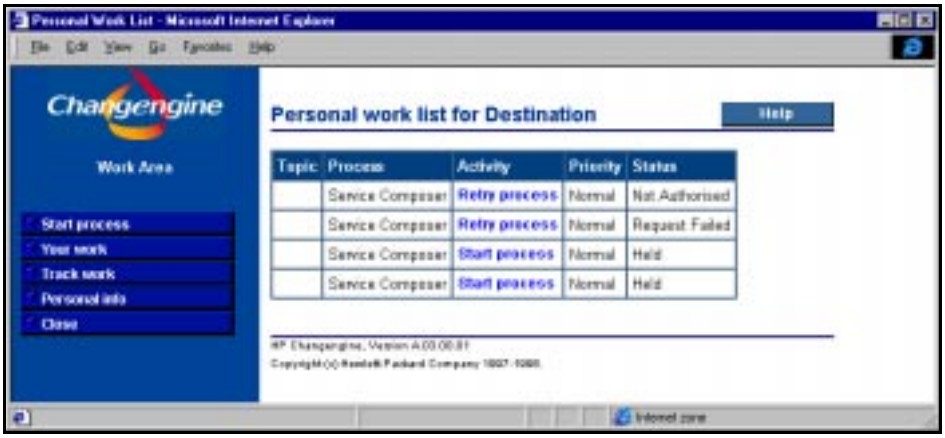

Figure 3.b: Customer report on requested services

The system offers open connectivity to almost any kind of database and application, web-based access (both interactive and programmatic) and an integrated process definition tool (e.g. Figure 1). Specific access control privileges can be defined per single users as well as user groups, and there are embedded facilities for tuning the level of detail when logging process-related events. The service model was deployed into the system in the form of a set of basic process definitions. The process-based option proved to be especially useful for service composition. A simple web interface is

automatically generated by the system for each process definition (Figures 3.a), which is integrated in the overall session management interface. When a community member logs into the system (password protected), it can do three main types of operations: request of a new service (Figure 3.a), execution of service requests issued by other members, and monitoring the state of the transactions it is currently involved in (Figure 3.b). The programmatic interface (API) to the community offers the same level of capabilities, and it can be easily integrated with user applications (an E-mail based interface is also available).

The service infrastructure manager is provided with a web-based management console that allows complete control on all the (possibly distributed/replicated) components of the system, as well as all the transaction ongoing and completed in the community. Access to logging data and statistics to external application is possible using systems defined views on specific data table in the central database.

6. Related work and future development

A number of research initiatives are currently focusing on business-to-business electronic commerce. International projects like COSMOS (Hamburg University, Germany), Multiplex (New Castle University, UK) [12], as well as industry-led initiatives (from companies like IBM, Hewlett-Packard, SAP) are only some examples. Technology not only acts as an enabler for current business practices, it is the basis on which entirely new business models are created.

Capturing the complexity of the interaction models regulating virtual business communities, and providing adequate support in terms of the service infrastructure will be the most challenging aspect of our future work.

7. Conclusions

The Internet is a powerful enabler for business-to-business interaction, and the formation of virtual business communities is a clear sign of the paradigm shift ongoing in trade models. Effective access to a wide service base opens new possibilities for businesses, both in terms of optimisation of existing processes and new business creation. The composition-oriented service model presented addresses

issues like security, reliability and manageability for Internet-based service provision. Crucial aspect of the model is the separation between service request and service provider, whereby the matching between customer and supplier depends on the dynamic evaluation of specific business rules. Existing services can be composed in process-like structure, in order to support the creation of a new service.

The experience with the service infrastructure suggests that flexibility is the most important aspect to look for when choosing the component technology. Economic, social and legal issues are paramount, and they impact both the service model and the service infrastructure.

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