REQUIREMENTS FOR ELECTRONIC MARKETS ARCHITECTURE

BY BEAT F. SCHMID, UNIVERSITY OF ST.GALLEN, SWITZERLAND*

INTRODUCTION

Markets are media, that allow the exchange of goods and values between supplier and customer, and of related information. The transaction partners are autonomous: They decide with whom they want to interact and whether they want to sell or buy. So far, markets are passive media. But they provide the business partners with several kinds of (mostly aggregate) information on prices (exchange ratios), transaction volumes, etc., and time series of such quantities. It is this information layer which gives markets evolutionary power: As economic theory postulates, they lead (under certain conditions) to Pareto-optimal equilibrium. Moreover, in a Darwinean optic, they have a selective function, rewarding superior producers with faster growth.

Existing markets consist of a web of ecological niches, all inhabited by a historically grown population of suppliers and customers, controlled by man-made regulations or constraints given by nature (as topography), culture (as language) and other factors (Kauffmann, 1988). Market organisation itself has become subject to Darwinean evolution, from prehistoric trade to bazaars and stock exchanges, driven by the different increase of wealth they provided to their participants.

In the meantime, Electronic Markets (EM) are emerging, i.e. markets in the Cyberspace. In a first wave, global Electronic Markets on more or less closed, firm-owned networks, as e.g. in the financial or tourism industry, have been established. Now, the open Information Highway is providing a base for open Electronic Markets for all types of products, also for retail business. First forms of such markets are established now, as Compuserve, AOL (America Online), or the flood of poorly structured electronic product catalogues in the World Wide Web.

The evolution of EM has just started. It may bring us close to the ideal point-market of neo-classical theory (the rational principle, saying that each participant tends to maximize his benefit, a process that ensues automatically). But what kind of EM-architecture will attract enough participants (emigrating from today's market niches), and provide them with superior performance and faster growth? As in most evolutionary systems, we may expect the coexistence of several types of EM-architectures, each bearing a rich population of exchanging participants, adapted to their specific needs.

In the following, we first try to identify several requirements for EM-architectures, derived from the needs of its participants. Second, we give the sketch of an example architecture which more or less meets these requirements.

REQUIREMENTS FOR EM-ARCHITECTURES: THE CUSTOMER'S WISHES

Sometimes the potential customer is interested in browsing through (new) offers, either in a specific field, or even in a completely unspecified way, as we know it from advertising in existing media, from dawdling in shopping centres, touristic shopping areas, etc. So, EM should have one or several types of browsing functionalities.

*Beat F. Schmid (Beat.Schmid@iwi.unisg.ch) is Professor for Information Management. His main research interests are in the field of Business Media, with a special focus lies on Electronic Markets, and in the field of Knowledge Media. He is the designed Director of the new Institute of Media and Communication Management at the University St. Gallen, opening in 1998.

At other times the customer has a specific demand for a product of a certain type X. Thus, there should exist a specific EM for products of the type X. Economic reasons advocate for the presence of all offers, allowing an optimal selection (i.e. coming close to the aggregate supply of the neoclassical market mode). This goal may be softened thought, if the number of offers becomes too large, too high searching costs will result.

Services providing help for selection and evaluation of the offers are of high interest, reducing the search expenses and therefore the transaction costs. This selection should obey additional specifications of the customer (e.g. best price, highest quality, or other attributes of the offer), and the evaluation should be trustworthy and reliable.

Then, an EM should contain modules allowing for negotiation, e.g. auctions, based on order books. These need not result in increasing transaction cost – the contrary may be obtained.

In a global market, a reliable and generic way of contracting is crucial. Therefore, a successful EM-architecture grants mechanisms for the automated production of electronic contracts which are reliable for the customer and the supplier, giving security and guarantees, even in case of failure of one or the other sort.

Further, the customer is interested in a contract that fixes delivery at a specified place, at the required date, and for an end price containing all costs for this, including insurance costs for failures, fees for customs, taxes, etc. That means, the customer not only asks for end prices for products delivered at his place, but also for the possibility to buy futures and even options. Moreover, it should be possible to sell contracts (i.e. futures, options, etc.) on the same EM, if the actual owner does not need the products attached, as it is possible today e.g. in financial markets.

Requirements for EM-Architectures: The Suppliers' Requirements

Complementary to the customer's wish for browsing, the supplier wants to have media for advertising. In the emerging Electronic Markets these wishes are welcome as an important source of financing.

The electronic product catalogues (EPC) are a key element in EM. They are much more than the electronic version of printed product catalogues: They are an interface of the supplier to the EM, allowing for ordering and for an unlimited number of services adding value, as e.g. service information, test reports, users' platforms (as they are known in the World Wide Web). The supplier wants his EPC to reach a high number of customers: That quantity is the factor deciding on his success in the evolutionary competition, besides price and quality. So, the bridge function between the supplier's EPC and the customers, looking for a specific EM for the required product X, is another key issue in EM.

The supplier prefers to indicate the actual price of the product at its current location – while the customer wants to know the end price which is to pay for the product when it arrives at its destination. Thus, functions are required which help to calculate the total logistics costs, including costs as taxes, fees, risk costs, credit costs (if needed). These functions should be as cheap as possible, and as precise as necessary.

Corresponding to the customer, the supplier needs information about the customer, and access to mechanisms for negotiation, if prices or other parameters are not fixed. The requirements concerning electronic contracts are the same, but with date and price specified before the shipping takes place.

If we compare the wishes of supplier and customer concerning the main elements of the contract, the role of the settlement process becomes clear: It is to overcome the differences of location, of transportation time, of prices, etc. So, the settlement of electronic contracts in a generic and in the most advantageous way will be a key service in EM.

Requirements for EM-Services and EM-Structure

The Protocol

EM as media are systems themselves, providing customer and supplier with the required services. These services, produced by providers, ask for structure and order, i.e. for a protocol. This EM-protocol defines the different types of agents in the market, their rights and obligations, and the language each of them uses to communicate to the others.

The existing markets show very different organizational structures and a variety of protocols. Some are very rigid, reserving the production of market services only for a privileged group, and/or regulating the processes in details. Others are open for all players obeying the given protocol, e.g. transportation markets in many countries. As mentioned above, we already have and, even more, we will see a variety of competing EM. Therefore an EM-architecture should be designed in a way that allows for variations of the different processes and therefore for creativity and innovation, and which are open for all service providers to increase competition. This should improve evolutionary success of the EM-architecture. The protocol itself should be open for slow evolutionary changes.

A crucial role is played by the protocol for EPC adopted. If it allows for a recursive architecture as the HTML-protocol of the World Wide Web on the level of quite simple data types, a similar productivity in the creation of new EPCs, meeting closer the customers' requirements, might be expected.

Intermediaries

In a successful EM, the gap between the supplier's description of his offers and requirements on the one side and the wishes and requirements of the customer on the other side must be bridged. This is the field of intermediaries. They match the supplier's electronic product catalogue EPC with the customer's EPC (Fig. 1).

Bibliography

Alt, R. Cathomen, I. and Klein, S. (1995). "CIL – Computerintegrierte Logistik" Report from the Competence Center Electronic Markets, Institute for Information Management, University St. Gallen (HSG): Report No. IM2000/ CCEM/21, April 1995.

Bushev, Michael (1994). "Synergetics. Chaos, Order, Self-Organisation" World Scientific Publishing, Singapore.

Geyer G., Kuhn Ch. and Schmid, B. (1996). "An Electronic Product Catalog for distributed Environments" In: Information and Communication Technologies in Tourism. Proceedings of the International Conference ENTER 96, Innsbruck, Austria.

Haken, Hermann (1978). "Synergetics – An introduction" Springer Verlag Wien-Heidelberg.

Kauffmann, Stuart A. (1988). "The evolution of Economic Webs" In: The Economy as an Evolving Complex Systems, ed. by Philip W. Anderson, Santa Fe Institute studies in the sciences of complexity, vol. 5, Addison-Wesley, 1988

Schmid, Beat (1997). "Zur Konstruktion Elektronischer Märkte: Der Elektronische Produktkatalog" In: Informatik/Informatique. Zeitschrift der Schweizerischen Informatikorganisationen, Nr. 1/1997.

Schmid, Beat (ed.) (1995). "Electronic Mall: Banking and Shopping in globalen Netzen" Teubner Verlag Stuttgart.

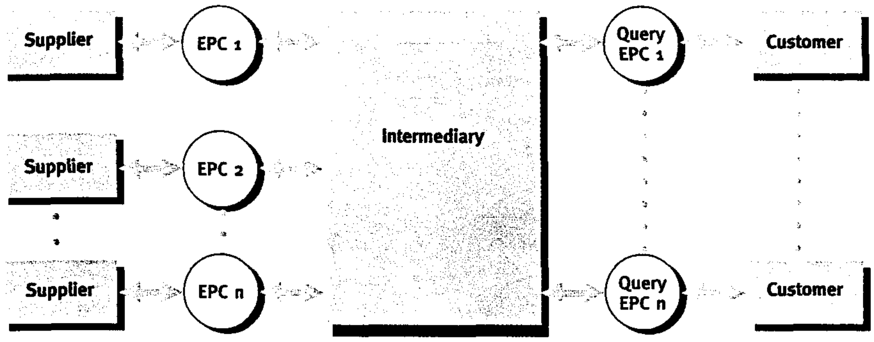


Figure 1
The field for intermediaries

A great number of organizational solutions for this problem are established in real markets or are proposed for EM, as e.g. the establishment of EM for specific product types, institutions of dealer or trader, or the concept of automated intelligent agents. All these solutions have their advantages and shortcomings. A symbiosis of several of them seems most efficient and probable.

SEARCH EXPENSE, ASSESSMENT, CONTRACTING

One of the central considerations in an EM will be the reduction in search costs. A full search in the ocean of millions of EPCs is too expensive. A database as it is common today in the Internet may be too slow to reflect the fast changing prices, products, etc. Therefore, order book based auctions may be more appropriate in such situations.

The assessment of offers and potential customers in a global market is another field which requires services. A simple and well established form is the institution of the dealer who stands with his reputation for reliability and quality. Rating information, tests and user platforms are also of high value.

Electronic contracts imply a bundle of (partly potential) services: legal ones, insurance related ones, and many others. The production of contracts is often quite expensive. Therefore, it is a key success factor of an EM-architecture to allow a cheap and generic way of producing electronic contracts. These contracts should be abstract enough to leave open a variety of ways for fulfillment or settlement. On the other hand, the contract should specify all requirements of the customer and supplier, e.g. when and where the product has to be delivered, how and when the payment has to be made, what penalty will be applied if things go wrong, etc. In short: The contract should specify completely the "What" (including exceptions), and leave open the "How".

Finally, services to settle contracts are needed: logistics, payments, tracing and tracking, etc. These services may be produced in a generic and integrated way, as Computer Integrated Logistic (CIL) service (Alt, 1995).

REQUIREMENTS OF THE EM-MEDIUM

As stated above, markets are media allowing for the exchange of goods, money and related information, with an additional information layer, containing information on an aggregate level as market prices, transaction volumes, etc. Stock exchanges give good evidence for this, with rather different profiles. So, the EM-architecture is decisive not only for structure and protocol of the medium, but also for the type and amount of market information it produces, as well as its dissemination.

When we consider a market as a synergetic system (Haken, 1978 or Bushev, 1994), the architectural elements (structure, protocol, market information) represent the order parameters of the system: They decide on its behavior and evolutionary success. Therefore, these parameters must be relatively stable, though still allowing for slow variations in order to find superior designs.

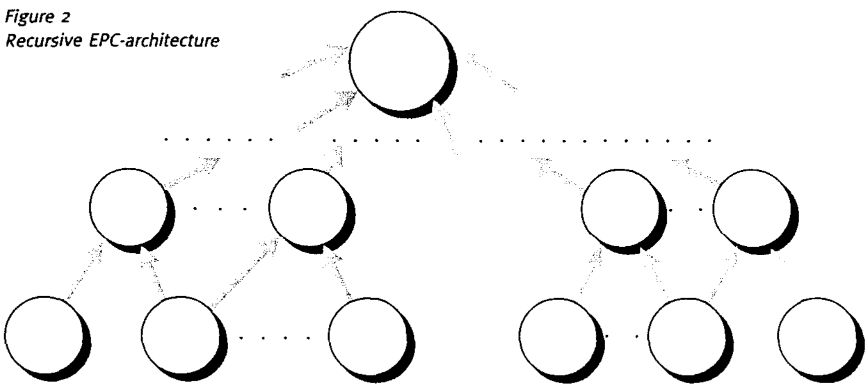
AN EXAMPLE OF AN EM-ARCHITECTURE

We now give the sketch of a simplified model of an EM-architecture:

Customers are represented in directories, e.g. based on X.500, which contain not only names and addresses, but also electronic signatures, encryption keys e.g. well as further, partly non-mandatory information about the customer. These directories are managed by authorities, e.g. governmental institutions or private companies, giving reasonable guarantees for the reliability of the information in the directory. Thus, they serve as a means for identification of the customer and contain all information needed for contracting.

The supplier represents his products (and himself) in an EPC allowing for a recursive architecture similar to the HTML-pro-

Figure 2
Recursive EPC-architecture



tocol, i.e. the production of new EPCs based on already existing catalogues, in a generic way (Fig. 2).

These catalogues are open for use not only to potential customers, but also to intermediaries. Like this, intermediaries are enabled to produce catalogues for their customers, or to build an EM for products of a given type. This requires an open EPC-protocol.

Adding the requirement that the customer is provided with a query language, allowing him to describe the type X of the product he or she is looking for, we find that such a query is basically corresponding to a virtual EPC (X), which comprises all offers of the type X that are contained in the suppliers' EPCs. For more information see (Schmid, 1996) and a forthcoming Newsletter on EM.

The EPC should also contain or provide links to data structures, which allow for meta-information such as ratings, consumer feedback, etc., but do not prescribe such data. This gives the supplier and the intermediary the possibility to add value to the catalogue. Such data structures may be blackboards, discussion platforms, or other.

The electronic contract should be produced automatically and signed on the base of the information contained in the EPC and the directory, respectively. This allows not only a cheap production of contracts, but offers, because of standardization and the existence of links to EPC and directory, also the possibility of the establishment of a market for contracts, both for their settlement and for the purchase of no longer needed contracts (e.g. futures or options), as in financial markets.

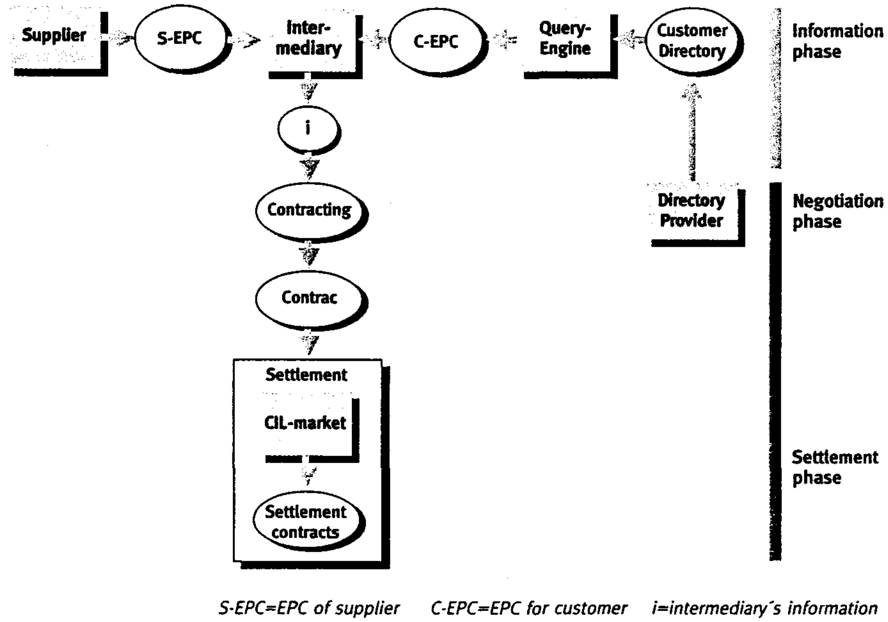


Figure 3: Information model for EM

The settlement of contracts will be offered and performed by CIL-service providers. CIL-services may be offered and bought on a separate CIL-EM, which integrates already existing transportation and other services. (This requires the possibility to project subcontracts out of the electronic contract.)

Figure 3 gives a coarsely gained model of the sketched EM-architecture in terms of data flows.

The data types in the circles have to adopt openly declared EM-standards, i.e. use a common and sufficiently stable protocol. The functions in the squares should be offered by different competing providers. Here a fast evolution is not only allowed but desirable.

ELECTRONIC SERVICE MARKETS

BY MICHAEL MERZ, UNIVERSITY OF HAMBURG, GERMANY*

INTRODUCTION

The term "Electronic Service Market" (ESM) can be decomposed into the parts "market", "service" and "electronic", i.e. the allocation mechanism of the market is used to co-ordinate service utilisation in a computer-supported way. This definition restricts that for electronic markets from (Schmid, 1993) to the provision and consumption of on-line available services. In an ESM, all transaction phases should be supported. This article motivates an ESM architecture and illustrates these design goals by taking pattern from the EU-funded Project OSM that Hamburg University participates in.

MARKETS

The definition of the market found in microeconomics textbooks is often restricted to the model of perfect competition where a sufficient number of suppliers and demanders, the lack of any preference of transaction partners, and full price transparency constitute the only required preconditions. However, in real life, aspects like transactions and set-up costs often hinder the free flow of market forces and innovative technologies, which lead to market evolution. As a result of the later factors, suppliers are constantly forced to adapt to changes in demand. In the case of sufficiently low transaction costs, this will be achieved through the combination, enrichment, or individualisation of existing goods – i.e. through the establishment of new levels of a value chain. The exchange between demanders and suppliers is carried out through business transactions, which in turn part into three phases: information, negotiation, and execution (Schmid, 1993).

ELECTRONIC MARKETS

Electronic markets map the abstract co-ordination mechanism of the micro-economic market model onto a distributed computing system – i.e., in real terms, to the Internet. Electronic markets support at least one of the three transaction phases and are open in the sense of interoperability, portability, user access, and in regard to the legal right to become a market participant. By reducing transaction costs, electronic markets usually raise the co-ordination efficiency of the market system. As an example, electronic stock market systems and also on-line-services – such as CompuServe or AOL – support their participant to find potential transaction partners, to agree on an accepted price, and finally to execute the contract. The stock exchange supports all of these phases, while the on-line service supports either the first one or the last. Also Internet services such as NetNews or WWW-based forums may be considered as on-line services in this sense.

However, what most electronic market systems lack is the support of market evolution, i.e. the possibility for suppliers to introduce a new product at low setup costs or to establish an additional stage of a value chain in combination with the support of all transaction phases. Most electronic market systems are either far too specialised so that they do not allow to co-ordinate markets for heterogeneous product specifications (the cost to convert a stock market system to a trading system for a different commercial sector is often prohibitive) or they are generic enough to allow the creation of an additional marketplace (e.g. a new NetNews group) – yet at the costs of supporting only the information phase. Today, electronic market systems pay off only when their expected turnover justifies the considerable investment to set them up.

*Michael Merz
(merz@informatik.uni-hamburg.de)
project director for electronic commerce projects at the Distributed Systems group of Hamburg University, Germany. He has studied Computer Science and Business Administration.

ELECTRONIC SERVICE MARKETS

The electronic service market (ESM) reduces the goods traded to on-line accessible services and extends the transaction support to all phases (Merz, 1997). The ESM should allow for market evolution by forming value chains at lowest possible costs and by providing innovative services without centralised registration or standardisation.

ESM infrastructures may differ regarding the functions that are standardised or left to competitive suppliers: an ESM may either only standardise the communication layer in order to allow third party providers to establish EMS software components or it may raise the borderline in order to include services such as directory, payment, accounting, non-repudiation as an integral part of the ESM. It is not important, how and by whom these supporting services are provided. However, if they are not available at all, full transaction support will not be feasible.

OSM – AN OPEN SERVICE MODEL FOR ELECTRONIC SERVICE MARKETS

As a project funded by the EU ACTS programme, the OSM (Open Service Model) strongly focuses on the support of ESMs (OSM, 1996). The OSM architecture is compliant with the OMG Electronic Commerce Reference Model that provides a framework for the integration of CORBA Common facilities for payment support, on-line catalogues, service brokerage, and the unified access to services that are offered commercially.

Components of the OSM (Open Service Model) development that have been developed at Hamburg University aim at integrating the following mechanisms that support business transactions in a flexible way:

- Generic user access to remote services is provided by a browsing tool, called the generic client (Merz et al., 1994) It supports customers to establish sessions with suppliers, to integrate them visually at the desktop-level, and to store, transfer, and resume sessions on different network sites.

- The ad-hoc configuration of support services such as payment, authentication, or notary services. Each time a business transaction is to be established this configuration takes place using a unified description technique and a matching mechanism to specify the transaction partners' needs. In order to achieve this, a generic constraint unification facility is being developed.

- Value chains emerge in the following two ways: first, through the establishment of mediators, i.e. services that provide service references to their clients. Mediators may either supply a query interface (such as in the case of the trading service (Merz et al., 1994)) or a browsing interface (on-line catalogues or directories). Secondly, value chains may emerge by enriching, combining, or co-ordinating existing services. A broker that hides the identities of the actual services involved is an example for such a value-added service.

- The service profile is established as a common vehicle for service offer description and as a persistent data store. Compared with the CORBA Interface Repository, the service profile allows applications to extend its data schema. Further, a profile may be transferred through the network as a light-weight object store. This allows all OSM components involved to dynamically provide or obtain specific information in a well-structured way: traders may process service type definitions, catalogues may extract icons and description texts, or the generic client may obtain information on the support service requirements of the transaction partner (Merz at al., 1996).

- Finally, the OSM architecture aims at supporting service negotiation between client and server by structuring conversations into a limited set of speech-acts (Finin et al., 1994). This helps to reduce the complexity that is principally given when two parties agree step-by-step on a set of service attributes and it allows for a higher level of automation.

TRANSACTION SUPPORT

The OSM ESM software supports all business transactions phases:

- Service Navigation. Navigation and service matching support is facilitated through catalogue and trader services. Both allow providers to register service profiles. The catalogue service maintains a hierarchy of service offers, which are classified by provider, product, or the registration date. The trader allows to match requested and offered services. Since both trader and catalogue use the service profile, the customer may select an exemplary profile and order to catalogue server to retrieve a list of matching offers from the trader (Figure 1). As a result of using these services, a collection of profiles is obtained.

- Service Negotiation. This transaction phase leads to the agreement on business terms with one of the possible suppliers. In order to achieve this agreement, a negotiation is required, which leads step-by-step to the identification of contract properties and their values. Therefore, the contract is sent forth and back between the transaction partners on the basis of a given conversation protocol. The contract template as a data object is standardised by the definition of a common superclass. However, for specific business contexts, this class may be arbitrarily extended through subclassing in order to cover individual contract conditions.

- Service Execution. This phase does not only involve both contract parties but also subordinated support service providers, which are required to carry through service utilisation securely and completely. Two examples for such support services are the notary and the bank. The first authenticates all parties and allows to archive the contract itself and the data exchanged in a non-repudiative way. The second supports payment between customer and supplier. The selection of the required set of support services takes place at run-time, i.e. when the generic clients binds to the supplier's server.

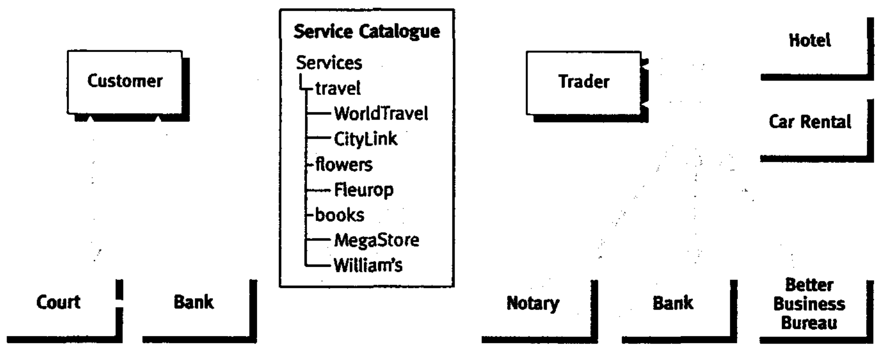


Figure 1
Player on the electronic service market

SUPPORT SERVICE SELECTION

Support services can be generally classified by the functions they supply. Some of these functions (payment and notary) have been involved in the scenario sketched by Figure 1. Others may be distinguished as complementary functions such as quality assertion services, which certify a distinct quality of service property to the client, or protocol validation services, which allow to restrict both client and server to a calling sequence (or lifecycle), originally specified by the server as a part of an augmented service description.

Many more support services may emerge that cannot be covered at design time by the EMS architecture. Therefore, a flexible naming schema is required that allows the registration of newly introduced support service classes at run-time.

Within support service classes, several support service protocols may be selected alternatively to perform the required function. The payment example of the scenario illustrated the options for client and server to involve payment service like Ecash, SET, or NetBill. These protocols are standardised, i.e. an agreed protocol identifier will lead to a well-known behaviour of the respective service. Also in the case of notary services several notary protocols may be available and have thus to be identified by agreed protocol names.

Finally, for a single support service protocol, a large set of individual support service providers may exist. 'German Fed' may be one provider of the Ecash payment service besides of several more banks that support the same protocol. This leads to a 3-level hierarchy of support service classes, protocols, and providers.

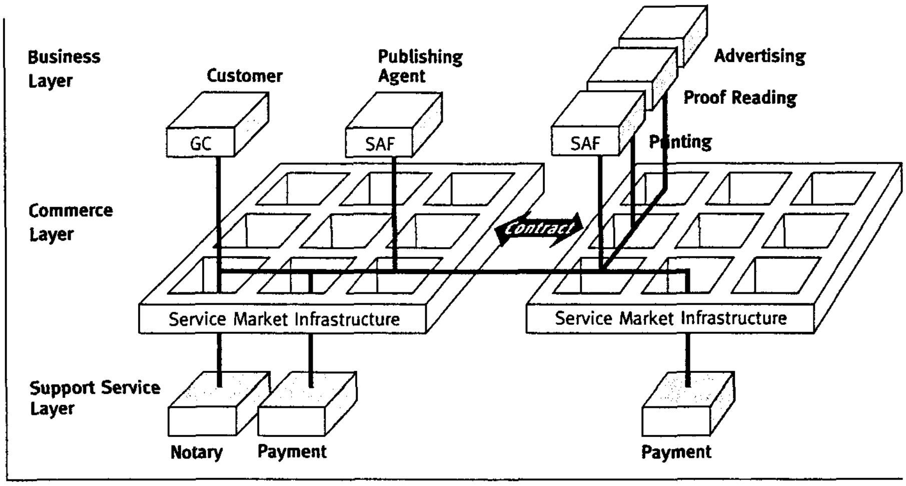


Figure 2: A contract that bindscustomer, supplier, andsupport services *Contractual Binding*

ARCHITECTURE

The overall architecture distinguishes three main layers:

- The business layer
  The business consists of components that facilitate the access of customers and suppliers to the ESM platform. Human users may use the generic client for market access. Each user provides an individual user profile that characterises the specific requirements concerning the selection of support services.

  On the other hand, suppliers need a service access facility (SAF) as a counterpart to the generic client. This manages the communication with support services, the generic client, and the actual commercial service offered. The supplier also provides a profile object to specify the service offer including initial contractual terms that may be negotiable.

- The electronic commerce layer
  The actual commerce layer has been designed as thin as possible in order to factor out every possible functionality that can be provided by third parties. Thus the commerce layer plays a co-ordinating role that aims to create sessions, which bind all participants that are described by a contract. In particular, the profile matching function is located at the commerce layer.

- The support service layer
  Support service are used to facilitate business transactions at low transaction costs. They are themselves deployed as commercial services and only play a supporting role. In a different context, a bank may be accessed not as a support service (to carry out funds transfer) but as business layer application. Since business transactions may be carried out anonymously, additional services are required to enforce non-repudiation and a secure payment.

IMPLEMENTATION

The current implementation of the ESM system is based on plain Java. Certain components of the user interface, the communication system, and in particular support services will be migrated to industrial components such as CORBA-IIOP (Internet Inter-ORB Protocol), Java Beans, and the Java Electronic Commerce Framework.

OUTLOOK

Further activities will focus on the automated support of negotiation protocols as well as automated support service integration. Here, a common standardisation for the representation of contracts is required. Another extension of the OSM research platform leads to the integration of mobile agents as mediators between mobile users and commercial servers in the Internet. The current development uses the profile object as the agent representation. Since Java classes and objects can be embedded as profile content, agents may migrate through the network as self-contained objects.

In order to evaluate the ESM infrastructure, an application trial is planned for late 1997 by another project partner (ACS Systemberatung, Hamburg), which connects a digital press archive as a commercial service to the publicly available trial platform.

REFERENCES

Finin T., Fritzson, R., McKay, D., McEntire, R. (1994). "KQML as an Agent Communication Language" In: Proc. 3rd Conference on Information and Knowledge Management (CIKM '94), ACM Press.

Merz, M., Müller-Jones, K., Lamersdorf, W. (1994). "Service Trading and Mediation in Distributed Computing Systems" In: Proc. 14th 'International Conference on Distributed Computing Systems', Poznan, Polen, IEEE Computer Society Press, pp. 450-457.

Merz, M. (1997). "Elektronische Dienstmärkte - Modelle und Mechanismen zur Unterstützung von Handelstransaktionen in offen verteilten Systemen" Diss., Universität Hamburg, November 1996.

Merz, M., Tu, T., Lamersdorf, W. (1996). "Dynamic Support Service Selection for Business Transactions in Electronic Service Markets" In: Spaniol, W., Linnhoff-Popien, C., Meyer, B. (eds.), Proc. TREDS - Intl. Workshop on Trends in Distributed Systems, October 1996.

OSM (1996). Home Page of the Open Service Model project at Hamburg University: http://osm-www.informatik.uni-hamburg.de.

Schmid, B. et al. (1995). "Electronic Mall: Banking und Shopping in globalen Netzen" Teubner, Stuttgart.