Electronic Market Systems for the Tourism Industry: Reqirements and Architectures[1]

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Abstract. Recent advancements of global communications networks allow individuals to carry out transactions - for example on the tourism market - such as information gathering or reservations easily and efficiently. Additionally, permanent changes of the economic environment require on-line information service and their underlying infrastructure to provide a high degree of adaptability in order to reflect demands of such service providers and their clients adequately.

This contribution presents innovative software support for a *Common Open Service Market* (COSM) as a decentralized information service infrastructure. The corresponding COSM support system allows autonomous clients and service providers to adapt flexibly to an Electronic Market System and to let demand and supply depend on the price mechanism in a more flexible form as it is given in existing centralized information service systems.

1. Introduction

This contribution discusses the influence of customer-accessible information services on future development directions of the tourism market. In the tourism field there are service suppliers and consumers - both in a sufficiently high number - such that a high potential for perfect competition is given. However, perfect competition as a microeconomic model is usually considered as an unrealistic simplification for real markets due to transaction costs and - specifically in the tourism field - due to search costs for customers and travellers [1]. To reduce these costs, travel agencies play the role of contracting agents between customers and service suppliers. They mostly benefit from their advantage in information and from economies of scale concerning their role as immediate clients of electronic reservation system.

Goals of actors involved in the tourism market do conflict: Suppliers (e.g. hotels and airlines) attempt to raise capacity utilisation and charges, whilest consumers (travellers) prefer to minimize the price/performance ratio as well as an effortless service selection and reservation support. Value added resellers (e.g., travel agencies, package tour organizers, reservation systems) institutionalize search costs. They promote standardisation, substitutability of services, and gain from economies of scale.

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Taking pattern from the definition given by Schmid [2], an *electronic market* (EM) is a medium that realizes market coordination at any time and place and increases transparency for all subjects involved in such transactions. It should reduce transaction costs in all three transaction phases: information gathering, trading, and settlement. *Electronic market systems* (EMS) provide the computational infrastructure required by EMs. Within the scope of this contribution, the EMS concept is further restricted to systems that are not designed to electronically support one single segment, but the arbitrary market variety of on-line services across a multitude of business fields. Such a generalized EMS is not yet realized, since the existing ones do not support *all* transaction phases. Nevertheless, several research projects focus on distinct aspects and components such as, e.g., electronic currency representations [3], notary services[4], or specific support of information gathering [5].

This contribution introduces critical success factors for customer oriented information and reservation services in Section 2. It further analyses existing information service architectures with regard to their suitability as EMS platforms. In the third section our own architecture and prototype system, COSM (Common Open Service Market), is presented based on a scenario from the tourism field. Conclusions are drawn for a further development of EMSs in the final discussion.

2. Critical success factors for electronic market systems

Information service *infrastructures,* or *middleware platforms* support interaction and cooperation between both of their user types, clients and servers. They provide a multitude of *auxilary services* like connection support, billing, encryption, directory services, client authentication, etc. Auxilary services are not required for a connection if the server's address and functionality are well-known to the client and both customer and supplier trust in each others reliability. In order to separate the real market sphere from the electronic medium, the following terms are defined:

- *Client*: the software component allowing access to servers.
- *Customer*: the user of a client software component.
- *Server*: the software component accessible via a communication network.
- *Supplier, provider*: the person or company providing a service via the server.
- *Infrastructure service*: the communication medium, allowing not only server access based on a EMS-specific protocol. The infrastrcucture might the mere communication network that supports transparent server access or, additionally, a logically centralized provider organization.

Before examining existing information service infrastructures for their suitability to establish a general electronic market system, some critical success factors are to be considered. Afterwards, information systems are classified according to their fulfillment of the following requirements:

- The reduction of *search costs* for clients [6] - and therefore transaction costs - to a lowest possible scale. Search costs result from a lacking transparency of supply.
- Accordingly, *switching costs* [7] arise when customers plan to examine different services than the currently accessed one. The occuring switching costs restrict clients from evaluating these services or gathering new ones. Switching costs comprise either billable cost for accessing a new service provider as well as costs that arise from familarization with the new service functionality. To give an example, current on-line image databases are such heterogenous as far as user interface and database functionality is concerned, that clients are required to install and maintain individual client software for each service used.
- *Adaption costs* concern both, client and server. These set-up costs are charged by EMS infrastructure providers and comprise e.g. fixed subscription fees, service offer fees for providers, software purchase and installation costs for clients or servers, etc.
- An adequate *standardization*: communication standards are vital for open systems communications, but the more standardisation involves application-level aspects the more restrictions have to be imposed on service individuality is restricted. A distinction is therefore made between *representation standards,* which rather prescribe syntactical aspects of data exchanged, and *content standards* which concern service semantics. If, e.g., "car model" is a standardization subject for rental services, providers are obliged to adhere to the model palette specified. Specialized "one-of-a-kind" services might become incompatible because their offer is not classifiable by the standard.
- *Dynamic emergence of value chains*: In a scenario of 100000+ on-line services offered world-wide there is a rising demand for transparency, selection support, and service evaluation [Drexler/Miller]. The EMS architecture should allow or even encourage the existence of value-added services (VAS) to customize, enrich, or combine existing ones and to flexibly close occuring gaps between supply and demand. VASs act on behalf of their clients and in turn access other services in the role of a client.
- *Decentralization level* of EMS infrastructure: Despite of physical decentralization, EMSs may be logically centralized in the sense that they are involved in each single market transaction as a central control unit. Auxilary services are then provided exclusively by the central infrastructure provider.
- *Security, and trust* [3]: Both cooperating parties, client and server, establish a legal contract when, e.g., a reservation is made. Beyond fundamental security requirements, a *trusted* auxilary service is required to assure the identity and reliability of the respective contracting partners. This service may be provided by the EMS infrastructure itself or by third-party services which play the role of a notary.

System infrastructures, like the BTX service of German Telekom, provide a logically centralized accounting and billing service. Anonymous user activities are thus impossible. However, this does not reflect market transaction in real life where, e.g., theater tickets are anonymously purchased. However, additional clearing and accounting services such as banks may be involved in the trading process, if payment is to be effected in a traceable way.

Apart from transaction cost reductions, flexibility in mapping real world activities to an electronic market system appears as a fundamental factor for the success of EMSs. Current commercial infrastructures, like BTX or CompuServe, lack this ability: Every transaction involves distinct parties: the client, the actual service provider, and the infrastructure provider. Current developments, however, rather focus on a peer-to-peer oriented communications infrastructure [8,9] where auxilary services may be optionally involved and selected from both contracting partners. One of the most obvious aspects of these systems is that auxilary services (e.g. directory services) are not an infrastructure component but have to be realized at the application level (Fig. 1). In principle, these services can thus be provided by third parties and are allowed to evolve more rapidly in order to respond faster to changing market demands.

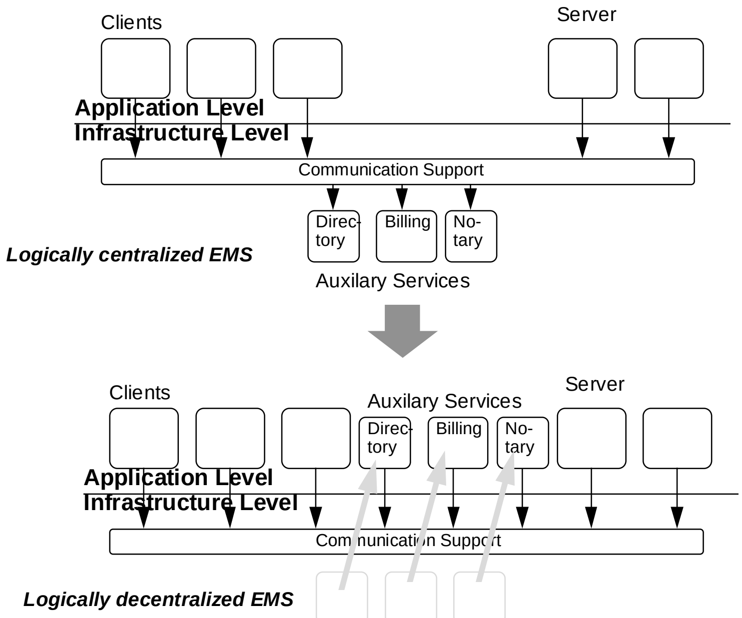

Fig. 1. Lifting infrastructure services to the application level

Finally, EMSs should not be restricted to specific market sectors. The tourism market field however can be considered as a highly relevant and representative testbench, since real services are easily mapped to their electronic counterparts and the tourism field shows sufficient heterogeneity to allow for a decentralized environment to emerge. The following section presents "COSM" as a recent research prototype system to support EMS application in open distributed systems.

3. The COSM project: Assumptions and Architecture

3.1. COSM Architecture

The COSM/TRADE (Common Open Service Market / TRADing Environment) infrastructure allows providers to offer a newly created service without previous content standardization [5]. After provided services have gained maturity and coherence among competing providers, an a-posteriori standardization based on a uniform service type may take place. The specific advantage of the COSM architecture lies in the autonomy of service providers and clients: providers are not obliged to adhere to existing service interface standards for their own operational interface.

To give a tourism-related example, an "innovative" car rental company may provide the end-users with an on-line reservation service, which allows to browse interactively through the offered car models and to inspect various rental conditions. This car rental service may provide a world-wide unique interface: From a technical point of view, the operational service interface of the respective server software can vary substancially from service to service as a consequence of the multitude of providers within this business field. Customers are confronted with severe problems od such a heterogeneity if they want to reserve a car at any arbitrary supplier. This motivates the need for mediating services (value adding services) which hide interface heterogeneity from accessing users.

The architectural model of COSM comprises the following main components:

- The *Generic Client* (GC) supports users in service discovery, service access, and in the inspection of service descriptions during run-time.
- A common *Service Representation* (SR) which contains several descriptional components (defining the operational service interface, the GC's user interface layout, the interrelation between user interface and remote procedure invocation, human-understandable descriptions of service functionality, billing information on the charge of procedure invocations, a description of the order of operation invocations, etc.).
- *Service providers* (servers) implement dedicated functionalities and are accessible on-line in the COSM network. They supply SRs to their potential users.
- *Mediating services*: A multitude of value-adding services allowing customers to gather suppliers more efficiently. SR Browsers and repositories support users to find out and inspect service descriptions. Traders automate the search for a best suitable service based on given service description criteria. Finally, mediation services may provide an application specific task, e.g., collecting news articles for their customers.

When binding to a server, a GC receives the SR and generates the corresponding user interface automatically (Fig. 2). The user is able to inspect the information provided by the SR now and to familiarize with the described service functionality. A binding to the server can be released if this information does not specify the kind of service the user is looking for. In COSM, the user interface representation of a remote services site is standardized at the GC whilest layout and content may vary from service to service. This interface enables the user to execute remote operation calls by filling out forms and pressing corresponding buttons.

A sample prototype as presented in [9] allows clients to first select a car model for a distinct time period. After the selection operation is executed, an offer is sent to the customer. Finally, the customer either accepts the offer by pressing a "selection button" or rejects it by releasing the connection.

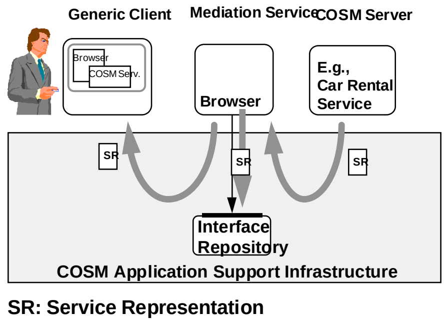

Fig. 2. Accessing remote services in COSM

Service references are data values which can be transferred across the network. On this basis, dedicated COSM services are enabled to act as directory services allowing servers to register their service representation and clients to obtain detailed information about the requested services. Such mediation services may act on behalf of their clients to evaluate the quality of services offered, or they may act on behalf of servers to "advertise" registered entries.

In a commercial environment, interaction with remote servers frequently implies a contract establishment as well as a payment flow for service utilization. Therefore, current research also focusses on the integration of an anonymous electronic payment as suggested by [3]. Accordingly, servers may charge their clients either on a connection basis, by operation invocation, or by the amount of data transferred. Mediating services may thus charge either service registration operations (advertising services) or service reference look-up (directory services). In the first case service look-up is free of charge for clients, in the latter server registration [10].

Despite of the fact that COSM servers are defined by their operational interface, they might constitute a hybrid system consisting of the on-line accessible software part and human users who take part in a server's response activity. Mediators which evaluate remote services carry out their task by letting users access remote servers for testing purposes and making this information available for clients afterwards.

3.2. Advantages of the COSM approach

This subsection presents the COSM approach and how requirements of section 2 are satisfied. Two basic assumptions are made when comparing information services:

- Any information service infrastructure that is widely accessible inflicts communication costs on customers. Since these costs are not specific for architectures and generally decreasing over time, they are considered negligible in this context.
- In addition, the ubiquitous availability of a common communication infrastructure, like the Internet, for private households is assumed. Only at this scale value-adding services become profitable.
- Furthermore, a sufficient communication bandwith (>=30 kBit/s) is required for accessing clients to support smooth data interchange.

A comparison of COSM with the information service platforms *World Wide Web (WWW)* [8] and *BTX* suggests to focus first on the few but substantial differences between COSM and the WWW:

1. COSM allows to interactively access *software applications* whilest WWW supports *document exchange*. Although interactive forms are supported by WWW, "operation calls" only result in delivery of a further document. Restrictions of WWW apply when results of previous operation calls are used as parameters for further ones (statefull servers).
2. The second difference concerns possibilities for *chaining* service providers to allow value chains to emerge. Since COSM servers present an operational interface, they allow to develop specific client software that *automatically* executes operation calls. This software does not provide a user interface but may act itself as a COSM server. In addition, in order to let client calls directly pass-through to the back-end server, this front-end server may carry out specific computation on parameter and result values.

Both, COSM and WWW differ from such centralized system as BTX in several points:

- *Autonomy*: In BTX, service providers are strictly required to register at the infrastructure provider which additionally charges such service offers, i.e. the mere accessibility imposes costs on providers. In WWW and COSM servers can emerge at any time and be accessible on the Internet without additional registration or administration effort. Instead, service providers are expected to care for the registration at existing directory or mediation services on their own. BTX thus poses higher adaption costs on service providers.
- *Accounting and billing* as auxilary services are provided by the infrastructure provider, BTX. Therefore, both BTX clients and servers have to adapt to the provided payment policy. Customers are thus not capable to anonymously access remote services.
- *Decentralization*: In WWW and COSM, connections are immediately established between communicating peers. Service access does not require registration at any central unit.

Architecture	**BTX**	**WWW**	**COSM**
Infrastructure provider	German PTT	No provider	No provider
Cost structure for clients	Connection costs, Subscribtion fee, costs based on connection-time and service charge	Connection costs, free service access	Connection costs, servers (mediators, etc.) may charge fees
Cost structure for servers	High	Low	Low
Standardization requirements	Access protocol, page layout, interaction schema	Syntactical and graphical representations of documents	Syntactical and graphical representations of interface descriptions
Emerg. of value chains	On a referencial basis	On a referencial basis	By reference & chaining
Centralization of administration	BTX host is a logically centralized control unit	No central administration	No central administration
Security, trust	Central server handles billing, information servers may not provide demanded service	Billing is completely excluded from information service (e.g., by credit card), no quality guaranty for provided services	Privacy and trusted third-party services can be optionally involved in client/server contracts

Table 1. Comparison of information service infrastructures.

Value chains in COSM

In reality, value chains supply abstraction, sophistication, and transparency to their respective consumers. Consumers are usually not involved in mining raw materials, manufacturing parts, assembly, or packaging of the goods they purchase. Accordingly package tourists are not willing to be involved in time consuming service selection, evaluation, and combination processes **-** they preferably rely on the specialization of dedicated firms like travel agencies, tour organizers, or organizations such as the "better business bureaus". Transformed into the context of the COSM approach, an important infrastructure design goal is to facilitate the emergence of value-adding services (VAS) which build on pre-exisiting ones. The only precondition for a reliable use of COSM VASs is a stable interface of underlying services over time: servers are allowed to introduce additional operations, to accept additional parameters, or reduce the number of result values but syntax and semantic of previous interface versions must preserve.

Applied to the tourism field, VASs may implement a search for the best offer for a given car model within a regional scope. Such services hide the confusing heterogeneity of implementations from different providers to the customer. Current research focusses on how to support dynamic transaction-based service access to a group of servers: the user is initially asked to select such a group of servers that the succeeding interaction with these is considered as a single transaction which can be either committed or aborted by the user if one of the operation calls does not return the expected result. As a usual example, the combination of hotel, flight and car reservation can be bracketed by a single transaction. Such a VAS then acts as a transaction monitor, that routes operation invocations to servers and provides roll-back mechanisms for the case of failure (Fig. 3).

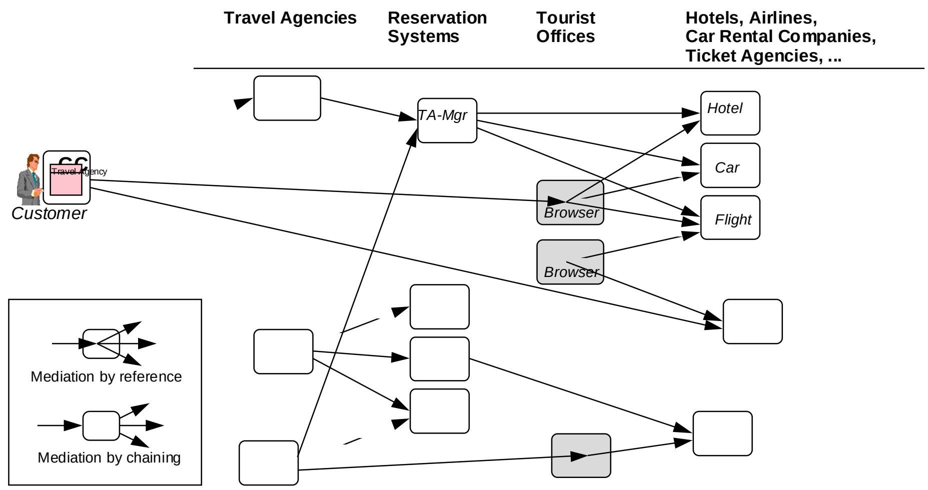

Fig. 3. Chaining COSM servers.

4. Discussion

Future developments in global communication networks allow individual access to remote services at any point in time and space. In such an environment, restricted proprietary or nationally provided on-line information services (that rely on gateway functions between one another to let customers access services accross borders) do not appear to be appropriate for a tourism industry that is itself distributed at a global scale. The current dramatic expansion of the World-Wide-Web information service illustrates the demand for a greatest common denominator at this global level. WWW supports information gathering and rudimentary form-based interactions such that information kiosks or visitor information services are feasible already today.

However, due to pure document exchange the WWW infrastructure still lacks support for arbitrary and individually callable network services. Assumed that there exists a WWW-like infrastructure allowing these services to emerge, a tremendous potential is given for a shift from large-scale tour organizers and travel agencies to small and innovative service providers with comparably low operating costs.

5. Conclusion

The COSM project proposes an architecture system for supporting arbitrary client/server interactions in open distributed environments. Practical experiences are derived from the corresponding prototype implementation of a strongly decentralized collection of services. It comprises such support tools as the Generic Client as well as browsers, repositories, and mediation services like an ODP-conform trader. As a consequence, the reduced effort to make existing program libraries or "legacy systems" available for external access decreases set-up costs for service providers. The resulting lack of a centralized cost-intensive infrastructure nexus is compensated by reduced transaction costs and the possibility to involve auxilary service like, e.g., notary services if both customer and supplier agree on it.

Generalized EMSs will not be established in the tourism field unless they satisfy the requirements described in section 2 and unless they do not cause too severe conflicts in the goals of participating roles. Otherwise either customers or suppliers will not be willing to take advantage of the EM medium.

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