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***Abstract*-Tourist services are one of the most popular products offered online. This has given rise to all service suppliers to offer their products over the Internet. Currently elementary services as hotels, flights or rental cars and travel packages can be booked online. Despite the high interdependence of tourist products there is no possibility for easy and user friendly online bundling of tourist products. In this paper a solution for online bundling of products will be presented based on multi-vendor Electronic Product Catalogs developed with the Q-Technology.**

I. Introduction

The convergence of information and communication technology and the emergency of information highways enable revolutional changes in the travel industry. For the first time suppliers and buyers can communicate directly over an information and data-rich channel and services can be offered through electronic markets with a global reach [5], [19]. Suppliers of tourist services such as providers of elementary services, as well as intermediaries such as tour operators and travel agencies, try to take advantage of the new direct sales channel and have established platforms for online sales. Currently all types of tourist services as hotels, flights, rental cars and travel packages can be booked online either through the supplier or through travel intermediaries.

Internet offers new opportunities for the end customer, too. Tourist products can easily be described by few keywords and understandably presented online. The end customer can now choose and book travel services conveniently and directly during out of office hours and from his home. As a consequence online booking of tourist services has become the most popular and revenue generating transaction in the digital economy. According to Jupiter Communications (www.nua.net/surveys/) online travel booking will be worth 16,6 Billion by 2003.

But, surveys also show that online customers like to visit several online travel sites and to compare services and prices before they make their booking [11]. Thus, online travel providers have to offer additional functionality in order to enhance and stimulate customer loyalty [11]. One possibility to achieve this is to provide more vacation-planning content. This could be achieved by providing user friendly possibilities for online bundling, i.e. combination with complementary services from other suppliers.

Bundling of products is a well known concept from the offline economy and can provide significant advantages for online markets as well [1]. In the context of tourism, bundling is a logical consequence of the nature of tourist products and has a long tradition on the traditional tourist market [4].

Tourist services are complementary and depend on each other. For example to book a hotel in a foreign city requires a simultaneous booking of transportation to the hotel, food and entertainment. Only one elementary service in form of lodging, food or adventure is seldom sufficient. Bundling could be an interesting alternative for travel packages as well. They could be more attractive if the customer can choose between different alternatives for the services comprising the package or can enhance them with booking of local services and events.

Even though bundling is an attractive enhancement for all online suppliers of tourist services and is favored by the great number of suppliers offering their services online, currently there are no appropriate solutions. Travel cybermediaries as travel portals (see for example travel.yahoo.com or www.travelocity.com) have done a first step in this direction, but do not go beyond simple aggregation of links for a destination or type of journey, or by offering independent booking for different services without offering an automatic connection between them.

In order to enable online bundling of tourist services more sophisticated solutions, which enable semantic reconciliation of terminological differences as well as interoperability of existing markets are required. In this paper a possible approach for supporting online bundling of tourist products based on multi-vendor electronic product catalogs developed with the Q-Technology will be presented.

In section 2 first multi-vendor EPC will be defined and described. Section 3 continues with a description of the Q-Technology. Section 4 presents a concept for bundling of tourist products based on the Q-Technology. Section 5 concludes the paper with a short summary and directions for further research.

II. Definition of Multi-Vendor EPC

A. *Definition and Functionality of Multi-Vendor EPC*

Intuitively under the term catalog we understand a sorted list of keywords enabling an easy search for available content (see also [27]). Product catalogs are sorted lists of keywords, which represent products and their features. The keywords usually provide a quick access to product information as pictures and product descriptions.

Internet EPC (IEPC) represent a new type of product catalogues, which are based on a powerful ubiquitous carrier of information. They are online and can seamlessly integrate with other functions of the company and it's business partners. They are furthermore up-to date, allow for dynamic adoption of content presentation according to the needs of the customer and direct communication between seller and buyer. With other words we can define IEPC as interactive and multimedia interfaces between buyers and sellers on the Internet, which support product representation, classification and search and have interfaces to other market services as negotiation, ordering, and payment.

Existing IEPC can be classified in single and multi-vendor EPC [10]. Single EPC provide an online representation of the products within the context of one supplier. Thus, they are based on a consistent terminology and are valid within the context of the given market. The most common form of single EPC are attribute-based EPC, which describe available products based on their features.

Multi-vendor EPC (MV EPC) have in general the same features as single IEPC: interactivity, multimedia presentation and interfaces to other modules, but provide additionally an integrated and transparent search space over individual IEPC of different suppliers. They integrate the product representation and data of several suppliers into a single interface and perform thereby semantic reconciliation. MV EPC enable cross-vendor business strategies as comparative shopping, one-stop shopping, and online bundling of complementary products provided by different suppliers.

The main functions of a MV-EPC are:

- the development and maintenance of a common language for product description, which integrates the offers of the different suppliers and
- the coordination of the query process and the integration of search results from different suppliers into a single answer.

Integration of independent product-descriptions is not easy to achieve. Prevailing solutions are based on product-descriptions and IEPC, that have been established without mutual consideration. Thus, they are usually based on differing representation concepts, languages, structure and search engines. The main challenge is to provide concepts, which will cope with this heterogeneity [17]. As diversity is considered an important differentiation possibility [17], [14] integration has to be achieved through preserving the autonomy of the existing markets and IEPC. Currently, two approaches to achieve this can be distinguished:

- Integration by definition of a common product representation;
- Integration through real-time discovery of similarity and integration.

In the first case a common languages for product description is used as mediator in order to map the different product descriptions. Examples for this approach are the smart and virtual catalogs developed at the Stanford university [17], [18], [12], [13] or the concept of Mediating Electronic Product Catalog developed at the Institute for Media and Communications Management [20], [14], [8].

Integration through real-time discovery of similarities is performed without a predefined common language, but by parsing of existing online content and natural language translation. Artificial agents called shopping boots are the basic technology applied here [10]

Besides providing a common product description language, the MV EPC is furthermore responsible for coordination of the search process. This involves in particular creation of specific queries for each individual IEPC out of the common language, coordination of the query process and integration of the individual replies into a coherent answer to the customer.

MV EPC can be applied by suppliers in order to provide interoperability to business partners or by cybermediaries, who integrate the offers of several suppliers and enable comparative and complementary shopping [10].

In the next section a concept for modeling and online bundling of tourist products based on a common language developed with the Q-Technology will be presented.

III. Multi-Vendor Epc Based on the Q-Technology

B. The Q-Technology

The Q-Calculus is a formal language for the description and classification of sets of objects, which was developed by [21], [23], [9]. The formal language can be used for definition of classification structures and vocabularies for product description.

The basic language constructs offered by the Q-Calculus are: BasicSorts, BasicScales, and Attributes.

- *Basic sorts*, delimit sets of objects or abstract concepts by naming them.

For example in the context of tourism possible sorts could be:

Hotel, Room, CulturalEvent

Thereby the sort Hotel denotes hotels offered by one supplier (for example travel agency or tour operator) and the sort Room denotes hotel rooms offered by the hotels.

- *Basic scales*, refer to features of objects and consist of possible values for classification criteria for sets of similar objects.

For example:

Class ={*, **, ***, ****, *****}.

Location = {Downtown, Near Airport, Near Railway, ...}.

PriceRange = {50 –100, 101-150, 151-200, 201-250, ...}

Price = {50 –100, 101-150, 151-200, 201-250, ...}

- *Attributes*, which combine sorts with scales. The scale of an attribute defines partitions on sets of objects represented by the sort. In other words, it defines a classification structure for the set of objects denoted by the sort. For example: If the scale *"Class"* is applied to the sort *"Hotel"* by a defined Attribute *"Hotel.Class"*, then the set of hotel objects is divided in subsets of hotels which fall in the different quality categories. Examples of Attributes are:

Hotel.Class = Sort: Hotel ->Scale: Class

HotelRoom = Sort: HotelRoom ->Scale: Price

One sort can be the definitorial domain of several attributes. The Cartesian product of the attributes of one sort defines the maximal search space delimited by the sort.

Based on the above described basic language constructs more complex, i.e. derived terms can be defined. The Q-Calculus distinguishes two types of derived terms: sub-sorts and multiplication sorts.

Sub-sorts define sub-sets of objects by using logical operators on scale elements of attributes. Sub-sorts denote an is-a relationship to the basic sorts.

For example:

LuxuryHotel = Sort: Hotel, Attribute: Class = **** or Class = *****

The sub-sort LuxuryHotel delimits the sub-set of hotels which belong to the category with 5 or 4 stars.

Multiplication sorts are defined by multiplication of several sorts and/or sub-sorts. They are used to describe complex object sets. The components of the derived term denote a part-of relationship

towards the derived term. Multiplication sorts inherit the features of the sorts, i.e. objects described by the definitorial sorts. For example a hotel room, which is a multiplication of the sort "Hotel" and the sort "Room"

HotelRoom = Hotel X HotelRoom

inherits the general features of a hotel as category, amenities, location, but has also specific features for rooms as for example number of beds, type of room etc. The maximal search space of a multiplication sort is given by the Cartesian product of the scales of all involved sorts.

Basic and derived terms are the foundation for further definition of new derived terms. The set of logically related terms referring to a special domain of discourse, i.e. world, form together one Q-Vocabulary. The terms of one Q-Vocabulary form a semantic net of Q-terms. The well-defined relations between the terms can be evaluated by the Q-Inference, thus allowing for complex and intelligent search. In addition each term is accompanied with a definition in natural language providing for an unambiguous semantic.

C. Implementation of MV-EPC based on the Q-Technology

As mentioned above integration of individual IEPC has to be achieved by preserving the autonomy of the individual suppliers. In order to achieve this the Q-Technology applies the paradigm of federated information systems.

Based on the definition for federated databases by Sheth and Larson [6], federated information systems are considered as a group of autonomous and possibly heterogeneous information systems, which cooperate and interoperate through mediators in order to perform a common task or to achieve a common goal [24]. Thereby a mediator is considered as a "*... software module that exploits encoded knowledge about some sets or subsets of data to create information for a higher layer of application*" [25]. "*The main difference among mediator, wrapper and container, lies in the way communication and coordination are done; a container can understand components directly, a wrapper hides the heterogeneity between components and a mediator passes messages and helps with negotiation between two components.*" [2]. Applied in the context of IEPC, this means that integration of single IEPC should be achieved through a mediating terminology which arbitrates, between the different concepts.

Against this background the Q-Technology applies the following procedure for definition of MV EPC:

1. Reconstruction of the individual information sources into a Q-wrapper. A Q-wrapper provides product representation based on the formal Q-Language.
2. Definition of the common terminology out of the individual terminologies by following the approach described in [23]. The aim of this step is the construction of common language terms through semantic reconciliation of differences in the existing terminologies. The common terminology is a combination of the terminology of the participating suppliers.
3. Definition of a Q-Mediator which contain the translation relations between the individual terminology and the common one.

The result of the above procedure is a mediating EPC with the following architecture (c.f. 1):

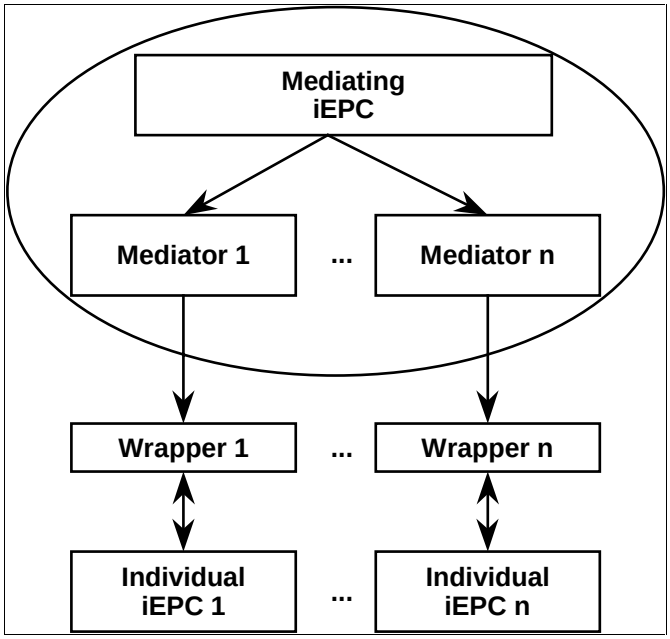

Figure 1: Architecture of a Mediating EPC

The common terminology and the Q-mediators are defined by the cybermediary or the supplier who wants to provide interfaces to cooperating suppliers. The Q-wrappers can be maintained by the individual supplier or by the provider of the Q-mediator.

Based on the above architecture a network of interoperable electronic markets can be created [24], [20].

IV. Application of the Q-Technology for Cross-Supplier Bundling of Tourist Products

D. The initial situation

The above described approach was used in an experiment for online bundling of hotels and cultural events to cultural travel packages consisting of both services. The aim of the experiment was to provide a solution for ad-hoc online bundling of the two services based on a mediating EPC.

The experiment was based on data provided by two cybermediaries offering information about Swiss hotels and events. The hotels are offered online by Hotel Gastro Forum (www.forum.ch) a new cybermediary located in Switzerland. The information about hotels are stored in a relational database. The end customer can search for hotels either through an alphabetical list, by city or by clicking on an interactive map of Switzerland. The search results comprise links to the hotel home pages. Online booking is not explicitly supported. Only a fax interface to the hotel's reservation desk is available. Thus their site does not distinguish between hotels and hotel rooms.

The events calendar is maintained by Swiss Destination Management (www.sdm.ch). Information about events are not available online, but in text documents. For that reason, first the data were made available in a relational database, so that a search over the Web became possible.

The aim of the experiment was to develop a concept for online bundling of hotels and events from the different providers through a

mediating catalog and to implement and validate it on the example of packages for cultural journeys. The result of the search should be combinations of hotels and events which together comply to common requirements of a cultural journey.

In order to achieve the goal of the project, the procedure for developing a mediating EPC based on the Q-Technology described above was applied. The results of each step are described below.

E. Reconstruction of the individual product databases

In a first step the given hotel and event database were reconstructed into Q-wrappers. A simplified model of the Hotels and the hotel rooms are given below (c.f. 2):

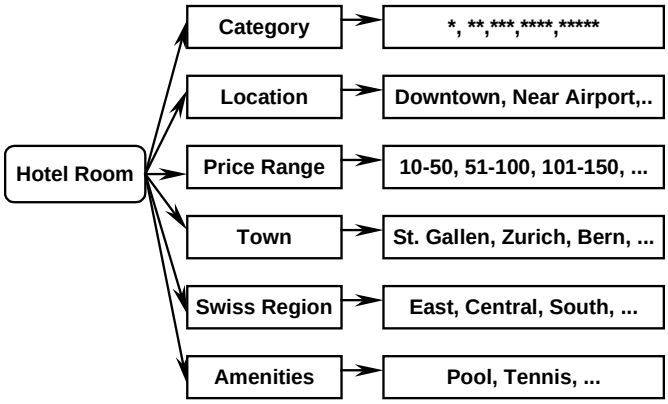

Figure 2: The Q-Model of Hotels

In the same manner a reconstruction of the event database was performed. The reconstruction of the event database resulted in the following model (c.f. 3):

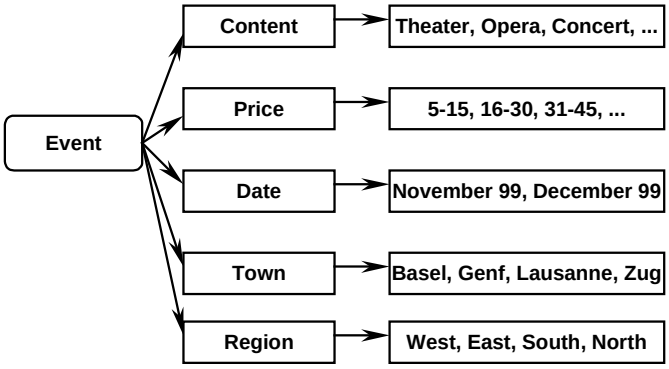

Figure 3: The Q-model of the event calendar

As a result of this step both databases received a multidimensional search interface.

F. Development of the Mediating Terminology

In a next step the mediating terminology was developed. A new multiplication sort – "CulturalJourney" -was constructed, which had hotels and events as components. The analysis of the models of hotels and events showed that the most of the applied scales are complementary with several overlapping scales. The complementary scales were taken over in the mediating terminology (c.f. 4).

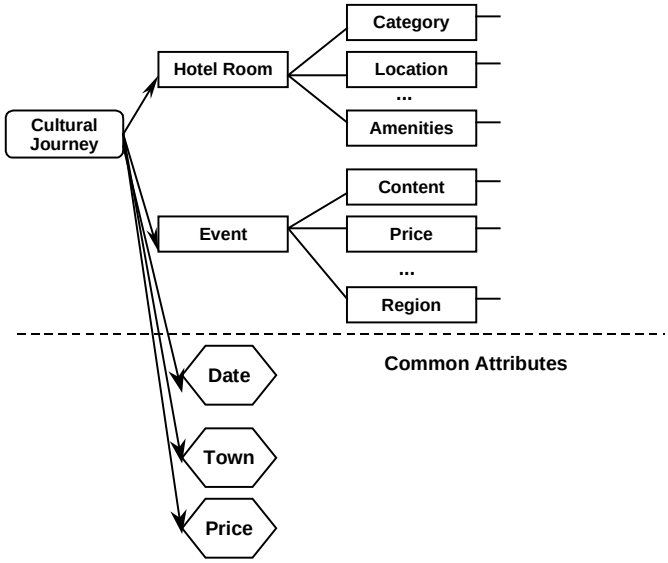

Figure 4: The Mediating Terminology

Date, region, i.e. location, and price were identified as overlapping scales. Soon it became clear that they impose common constraint on both databases. For example it does not make much sense to reserve a hotel in St. Gallen and tickets for an opera in Geneva for a given date (Geneva is about 300 km away from St. Gallen). Or it does not make sense to book a hotel if the booking interval does not include the date of the required event.

The examples show that for the overlapping scales, common scale are necessary, which grant integrity of the selected components of a cultural journey. The solutions developed for the three common scales will be described below.

The easiest problem was the scale date. After the reconstruction it was available only in the model for events. But, because of the reasons described above the decision was made to model it as a common scale for hotels as well. The date chosen for the event could be passed as a parameter to the fax interface in case of booking. An other problem here was to provide additional functions to match different date formats. For example the event takes place in one day, but the hotel is booked for several days. Here it is not only important to match a single date description, but to check if a given date is included in a time interval.

The construction of a common scale for location, i.e. region where the hotel is located and the event takes place was a little bit more complicated. First a common name had to be provided for the scales "SwissRegion", which was part of the hotel model and "Region", which was part of the event model had to be found. In the common model the word "Region" was applied. The next problem arose from the different meanings associated with the scale elements of the applied regional classification of hotels and events. The two suppliers associated different meanings even with identical regional names. For example the term "East Switzerland" used in both models, denoted slightly different parts of Switzerland. In addition some scale elements were on different level of aggregation. The event model was based on regions and larger cities. The hotel model mixes up cities, cantons and regions. So it was not possible

to take one of the scales as a base for mapping, but a new solution had to be developed, which could be used as a common denominator. The solution was found by using the classification on the lowest level of abstraction – town – as a common mapping scale. Out of the towns it is possible to reconstruct the regional classification criteria of both models

The last common scale, which had to be defined was price. In both individual models price was available as classification criteria for the service. The common price can be calculated out of the individual ones. But again no one of the scales could be taken as a base for mapping as the price of the combined cultural journey is actually a sum of the prices of the two services.

CulturalJourneyPrice = HotelRoom.Price + EventPrice

A better solution would be, where the customer can choose a common price, which is then broken down into possible combinations of individual prices. This means a new restriction on possible hotels and events as the total cost of both of them should not exceed the total amount chosen for the cultural journey.

G. Definition of the Q-Mediators

After the common terminology was designed, it was used as a base for the definition of the specific mediators for the two suppliers. The mediators include basically mappings of the individual overlapping scales into the common scales. Examples of the mappings are given below:

Hotel(SwissRegion) = Common(Region);

Hotel(SwissRegion ->East) = (Common(Region->(St. Gallen, Zuerich, ...).

The mappings are used for translation in both directions. First from the common terminology in a query with the individual language and then for translation of the individual answer into the common terminology.

V. Conclusion and Further Work

Based on the models described above a prototype was implemented. In the first version of the prototype a trial was conducted to develop a common language automatically based on the Q-wrappers. It soon became clear, that this was possible only to a certain extend because of the semantic differences between the two individual models.

In a next step the prototype was enhanced with a pr edefined language construct for bundling of hotels and events. The end customer can choose if he wants to look only for events or hotels or for an arrangement of both of them. Even though this solution is very similar to travel packages, it is still more flexible and offers several advantages:

- It only offers on empty stricture of the package, which can be filled with different combinations of the two elements.
- The common scales provide common constraints, which enable automatic plausibility check
- The customer can play and choose different combinations by changing the common constraints.

The above experiment showed that bundling of tourist services can be enabled my MV EPC. But, it also showed that in many cases solutions for bundling will only be possible with certain changes and adoptions of the individual IEPC.

In a next step we plan to provide additional functionality, which will enable ad-hoc bundling of tourist services. In addition it is planned to enlarge the model with transportation services. An other direction for further research is the integration of the MV EPC with other online functionality as booking and payment.

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