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Architecture and Business Potential of Mediating Electronic Product Catalogs

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Abstract

The Internet has the inherent potential of enabling a global marketplace. However, so far electronic shopping systems have had relatively limited success in supplanting or augmenting traditional physical and catalog shopping. The biggest impediment at the stage of product identification is the necessity to manually evaluate and integrate product information. This issue can be alleviated by modeling product information on a semantic level, which enables vocabularies of heterogeneous electronic product catalogs to be integrated. Adopting a mediator architecture for the construction of distributed federated product catalogs preserves each participating vendor's autonomy. Besides creating added value for customers this enables a variety of new business models for emerging intermediaries.

Introduction

The "information superhighway" and its current incarnation as the Internet has the inherent potential of enabling a global marketplace. Electronic product catalogs (EPC) form the web-based front-end to this rapidly evolving global marketplace. They also provide a virtual gateway to a company through which customers obtain product information, order goods and services, make payment, access customer support, provide feedback, and participate in other corporate activities, regardless of the time of day or the place in which the customer is physically located [Segev et al. 95]. Such a global marketplace offers so far unattained opportunities to potential customers. A buyer can search for a product or group of products all over the world in order to find the most suitable offer.

Unfortunately, so far electronic shopping systems have had relatively limited success in supplanting or even augmenting traditional physical and catalog shopping. Most systems offered today are proprietary structures that lack interoperability and cross navigation. Despite the growing number of companies that present their products on the Internet a global search for products is impeded by semantic differences between the offered EPCs. Thus, even though buyers enjoy broad access to different vendors' product specifications and can easily retrieve product information from all over the world, integration and evaluation of product information has to be performed manually. The impediments to an

effective and efficient use of the Internet as a global marketplace at the stage of product identification can be summarized as follows:

Buyers have to acquire and maintain the relevant addresses of suppliers of a product or a group of products manually.

Typically, products are presented by each company in a different semantic context. Buyers have to translate the semantics manually. Especially in a global environment as diverse as the Internet where people from many different cultural backgrounds meet and a wide variety of languages is in use the issue of translation between and integration of different vocabularies is exacerbated even further. The search engines available on the Internet today are of little to no help as they are all based on classic models of information retrieval that work on a purely syntactic basis [Belkin et al. 92].

Vendors tend to employ the user interface design of their EPCs as a means of differentiation. Thus, customers are continuously forced to get accustomed to new ways of interaction.

In order to overcome these problems a common language for the specification of product information is needed. In this paper a concept for a mediating electronic product catalog (MEPC) is proposed. Under the term MEPC we understand a product catalog that semantically integrates several individual EPCs or other MEPCs into a federated system. Such a MEPC will provide the following functionality:

maintenance of addresses and access rights and procedures of catalogs of product suppliers semantic integration of different EPCs transparent search over several EPCs in a distributed environment support for multilingual query resolution and national differences (conversion of sizes, currencies etc.) inference mechanisms for the evaluation of integrated information interfaces to additional market services, e.g. payment, logistics etc. An Architecture of Mediating Electronic Product Catalogs

A federated architecture of mediating electronic product catalogs (MEPC) is composed of an arbitrary number of catalog modules in a recursive manner [Fig. 1]. The basic building blocks are intelligent electronic product catalogs, which are product catalogs that are augmented by a semantic interface layer.
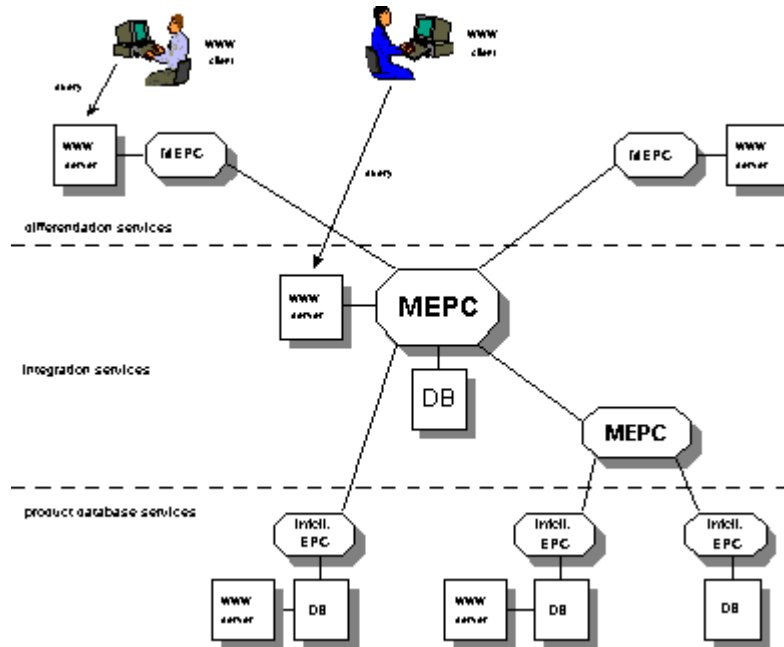
Fig. 1: A federation of intelligent and mediating electronic product catalogs

Catalog intermediaries integrate vocabularies of individual intelligent EPCs thus offering their customers a greatly expanded, terminologically consistent search space of product information as well as standardized access procedures and interfaces.

Based on catalog intermediaries providers of differentiation services can be established. These services focus on a niche market by extracting specialized areas of product information from catalog intermediaries combining them with additional sources of related information to create added value for their customers.

Intelligent Electronic Product Catalogs

Intelligent electronic product catalogs form the basic building block of the MEPC architecture. Their functionality is divided into three separate layers which provide interfaces among each other as well as to outside systems [Fig. 2]. Graphical presentation services and a foundation on a relational data model are properties of most product catalogs offered on the Internet today. By augmenting these with a semantic representation of their product information a basic precondition for their integration is met.
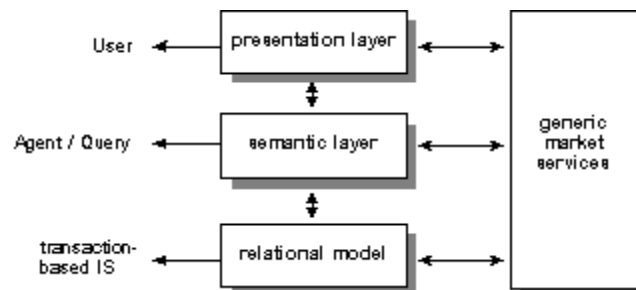
Fig. 2: Layers of an intelligent electronic product catalog

The topmost layer is the presentation layer which provides the interface to the end user. Typically, this is a web-based interface which offers universal access and allows for the inclusion of a wide variety of data types for the visualization of product data.

In order to allow a human or software agent to easily identify and classify the contents of a catalog when searching for products and to facilitate semantic integration of heterogeneous product databases a semantic layer is necessary. It offers a machine-readable, open protocol to the vocabulary used in the catalog. The method used for semantically representing product information is Q-Calculus [Schmid et al. 96]. Q-Calculus defines the language in which a vocabulary describing a domain of knowledge can be defined. Employing a basic set of concepts allowing for the representation of generalization and specialization relations and first order logic predicates a semantic network can be constructed using Vocabulary Definition Language (VDL) [Kuhn 97].

Unlike Q-Calculus other methods of knowledge manipulation and representation like Knowledge Query and Manipulation Language (KQML) [Finin et al. 94] do not specify a specific method for the integration of vocabularies. Whereas Q-Calculus constructs a semantic network through static mapping of vocabularies, KQML dynamically resolves vocabulary expressions through use of facilitators. KQML has also already been adopted for semantically integrating product information [Keller 95].

A relational representation of the product data ensures integration with a vendor's transaction-based information systems. All layers offer additional interfaces to generic market services such as payment, logistics, contracting etc.

Catalog Integration through Mediators

The open semantic representation of product data offered by intelligent EPCs enables the construction of large, terminologically consistent search spaces through integration of the vocabularies of multiple EPCs. The architectural approach taken employs a mediator architecture which allows for interoperability of heterogeneous systems while preserving each single system's autonomy [Wiederhold 94]. The autonomy of the participants enables the overall system to grow since new sources and new means of transport can be inserted. Incremental growth only requires that a few mediating hubs be acquired to link the new facilities into the federated system. As the new catalog facilities become more popular, further mediators will adapt to take advantage of them and the business they represent. Those users that need the new catalogs will use the adapted mediators; users that don't care remain unaffected.

Vendors are free in the way they choose to design their EPCs' database and presentation layers as all interaction in an MEPC federation is carried out over Q-Calculus protocol interfaces. A MEPC system is recursively structured in the form of an acyclic graph of arbitrary depth. Mechanisms to automatically propagate semantically relevant changes

throughout an MEPC hierarchy ensure consistency in the overall system [Lincke 97, 26ff.].

The MEPC furthermore offers individualized views on the integrated schema tailored to each user's preferences through a HTTP interface. A catalog repository serves for the maintenance of the addresses and access procedures of the connected individual EPCs.

Business Models for Mediating Electronic Product Catalogs

By offering a semantically integrated view and search facilities on distributed, heterogeneous sources of product information the maintainer of a MEPC is offering added value to its customers. In doing so there is three different business strategies he can adopt:

General integration: Several product catalogs covering various different kinds of product families are integrated under a common user interface, which offers multilingual support to users. This scenario corresponds to the model of a traditional shopping mall.

Specialized integration: By integrating catalogs covering homogeneous product categories the search scope of users' queries can be vastly expanded. In addition to an immensely increased supply and variety of products, that way painless global comparative shopping becomes reality. Applications of this kind of MEPC have already been proposed in the field of tourism [Geyer et al. 95].

Cross integration: The proposed MEPC's true potential, however, is only realized through integration of catalogs of complementary goods or services. E.g. by integrating hotel booking and flight reservation systems automatic creation of travel arrangements individually configured according to each customer's needs can be offered. Thus, maintainers of MEPCs are not limited to a role as pure information brokers, but can enter the global marketplace themselves as suppliers of combined product solutions. Their businesses are transformed into virtual enterprises that flexibly make use of other companies' services [Davidow et al. 92].

On the customer side the introduction of new intermediaries into the usage process of electronic product catalogs offers significant added value to users. On the sides of vendors and catalog intermediaries new business opportunities are arising and new business models become viable.

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