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Dynamic Specialization of Data to Fit the Requirements of E-commerce Applications

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ABSTRACT

This works focuses on logical and physical database design to fit the requirements of electronic-commerce applications. In e-commerce context, the content is dynamically changing to strengthen partners' relationship. The paper proposes a process for dynamic specialization of data related to business objects such as customers and products. The specialization process is based on dynamic views. This specialization aims at taking into account dynamic changing in marketing partners' profiles and relationships affecting the content.

1. INTRODUCTION

Traditional databases have been designed and implemented to support day-to-day transactions. Nowadays, newer applications namely electronic commerce applications have become commonplace. These types of applications have new kinds of requirements. These requirements concern with matching products with customers (using techniques such as one-to-one relationships, segmentation and personalization of products, services and contents), and managing customer relationships (King et al., 2002).

These kinds of applications require additional concepts with respect to both logical and physical database design.

Various semantic concepts have been proposed to fit some newer applications' requirements. That is, concepts of specialization and generalization, enhance the E~R model (ElMasri, 2000) to represent more semantics. The object model uses the concepts of derivation (relationship IS-A) and composition (relationship HAS) to represent complex objects (Rumbaugh et al., 1991) and (Blaha 1998). The concept of tuning (Shasha, 1992) is used to update the physical design (e.g., indexes, queries optimization) depending on various parameters.

These powerful concepts have been used for solving multiples problems related to the semantics at logical design, and the performance at physical design. However, most of them express a static reality.

We propose to adapt these powerful concepts to take into account the dynamic and cyclic updates of running databases in the context of e-commerce. Indeed, in this context, the content, built upon products/services as well as customers databases, is continuously changing depending on the customers' profiles.

In this paper, we describe a solution where **dynamic specialization**, in a form of process, of the relevant business objects (customers, products) based on dynamic views will fulfill the requirements of e-commerce applications.

The next section specifies the requirements for e-commerce applications. Semantics data modeling concepts and database tuning mechanisms are described in the section 3. While section 4 proposes a dynamic specialization based on dynamic views to fit the requirements of e-commerce applications. Finally we discuss, in a conclusion section, some further issues.

2. E-C APPLICATIONS DATA REQUIREMENTS

E-commerce is the ability to perform business transactions via the services of Internet/Intranet/Extranet and Value-Added Networks (e.g., Word Wide Web, EDI). It is a method of conducting business. This method aims to offset barriers to the flows of information across and outside the enterprise. It is used to reach wider market, to develop and maintain relationships, to source products from a wider supplier-base, to empower consumers obtain product data they need to make informed purchase decisions, to respond consumer queries quickly, to cut costs in repetitive processes, and to save time.

These goals may be reached by one integrated solution or several case-by-case basis applications.

2.1 E-Commerce Applications

E-commerce applications require computational infrastructure supporting trading transaction. The infrastructure will include on one hand, heterogeneous software, which may be classified into e-commerce services, specific software (e.g., help desk, groupware), legacy systems and databases. On the other hand, these software have to communicate or be integrated using middleware and communication protocols. The set of specific software of all partners involved in an e-commerce transaction form an e-commerce application.

These kinds of applications use databases as backend. These databases keep track of the business objects. That is, the customers and their profiles, the products with their categories and subcategories, the services, the orders, the invoices and other content-specific elements. The e-commerce applications-specific databases should often be re-organized to fit the requirements of the e-commerce. That is, the content is changing (e.g., personalization of the types of customers, categorization of the products) according to some strategic partner's relationships.

2.2 E-Commerce Data Requirements

One of the greatest benefits of e-commerce is to match products and services with individuals consumers. This is done through different mechanisms.

2.2.1 One-to-one Marketing

One-to-one marketing is a type of relationship marketing. It consists of building a long-term cooperation, coordination and mutual dependence. To implement one-to-one marketing, a company must be able to change its behavior toward an individual customer based on what it knows about that customer. That is, a smart company must be able to change the presentation of its products and services based on the needs of each individual customer. This mechanism is periodically practiced as shown in Figure 1.

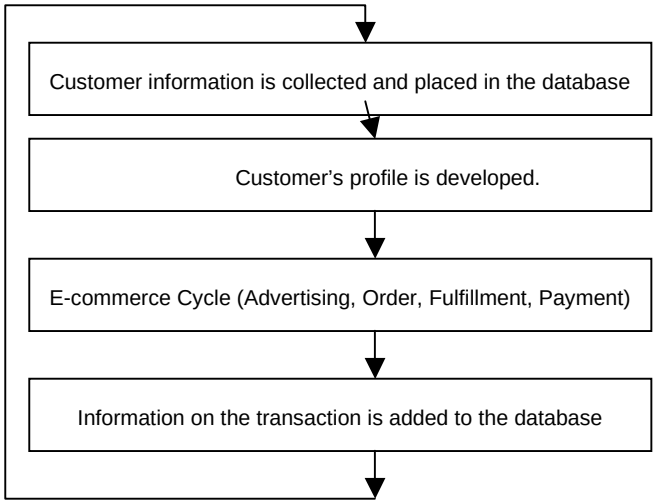

Fig 1. Building One-to-One Relationship Cyclic Process

2.2.2 Personalization

Personalization refers to the process of matching contents, services, or products to individuals. This matching process is based on the knowledge the company has about each individual customer. This information is usually referred to as a customer profile. The customer profile defines its preferences, behaviors, or demographics. There are several ways to build customers profiles, and the profiles are updated on a continuous basis. These ways include:

- Soliciting information directly from the customer by asking him to fill in a questionnaire or simply state what information he would like to receive.
- Perform data mining or Web mining.

Once a profile is constructed, a company matches the profile to a product, a service, or content.

2.2.3 Market Segmentation

Market segmentation is the process of dividing a customer market into logical group for conducting marketing research, advertising and sales. A consumer market can be segmented in several ways (e.g., for examples by regions, size of city, country, climate, age, occupation, Sex, Education, Family size, Religion, Race, Income, Nationality, Social class, Lifestyle, Usage rate).

2.3 Conclusion

E-commerce applications require periodically changing and personalized data. This requires new constructs and mechanisms at both logical and physical database design.

3. SEMANTIC DATA MODELING CONCEPTS

Newer applications are characterized by an increasing complexity of their objects. Modeling such kinds of objects require more concepts. The E~R model uses the concepts of specialization, generalization, union and categorization. The object model represents more semantics.

3.1 Specialization and Generalization

Specialization is the process of defining subclasses of an entity type. This entity type is called the superclass of the specialization. The set of subclasses that form a specialization is defined on the basis of some distinguishing features (attributes, participation to relationship, functions) of the entities in the superclass. For example the set of subclasses {regular, non-regular customers} is a specialization of the superclass customer that distinguishes customers based on their period of_purchasing.

3.2 Conceptual Object Modeling

The object model adds more semantics by integrating data and functions in the same computational entity (object). Relationships such as IS-A and HAS model respectively derivation and composition. Derivation allows subclasses to inherit features of their superclass. Composition allows objects to enter in the composition of other objects. These two concepts allow the modeling of more complexity.

3.3 Database Tuning

Tuning consists of reviewing the logical and physical database design regularly. The logical design consists of adjusting the logical schema or de-normalizes it. However, most of the performance and optimization problems are detected after a database is running. That is, actual use of database reveals performance problems. The goal of tuning operation is to cut response time and to save resources. Setting appropriate physical DBMS parameters and other similar activities can solve most of the physical tuning problems.

Physical tuning will be adapted to the e-commerce applications. Indeed, e-commerce applications are built on a top of running databases. However, e-commerce strategies are continuously changing. Running databases should not only reflect these changes but also triggers them.

We propose in the next section how to dynamically specialize data to reflect some e-commerce strategies described in section 2, and trigger e-commerce strategies.

DYNAMIC SPECIALIZATION OF DATA

4.1 Design Options

Concepts such as specialization, generalization, union, categorization, derivation and composition are used at design time i.e. they represent a static aspect of the reality. While, e-commerce applications require dynamic specialization of the pieces of data representing entity types such as customer and product.

To consider this dynamics, we have two process options:

1) Review the logical design using more specialization and categorization, or even de-normalize the schema.
2) Review the physical design to create views from running databases.

The second option was decided based on the short period of e-commerce content. However choosing one option does not necessary exclude the other one.

4.2 Dynamic Specialization Based on Views

The concept of dynamic specialization, to fit e-commerce applications, is based on the concept of views used in database systems. That is, instead of working on the customers' related base tables, we propose to work on views, which are cyclic and dynamic. This solution avoids using base tables commonly shared by numerous other applications.

4.2.1 Concept of Views

A view is a single table that is derived from other tables. These are the base tables or previously defined views. A view does not necessarily exist in physical form. It is considered as a virtual table, in contrast to base tables whose rows are actually stored in the database.

We will use view as a way of specifying a specialized and de-normalized table that we need to reference frequently, even though it may not exist physically.

```
CREATE VIEW     BAD_CUSTOMER
AS              SELECT * FROM CUSTOMER
                WHERE BALANCE < 1000;
```

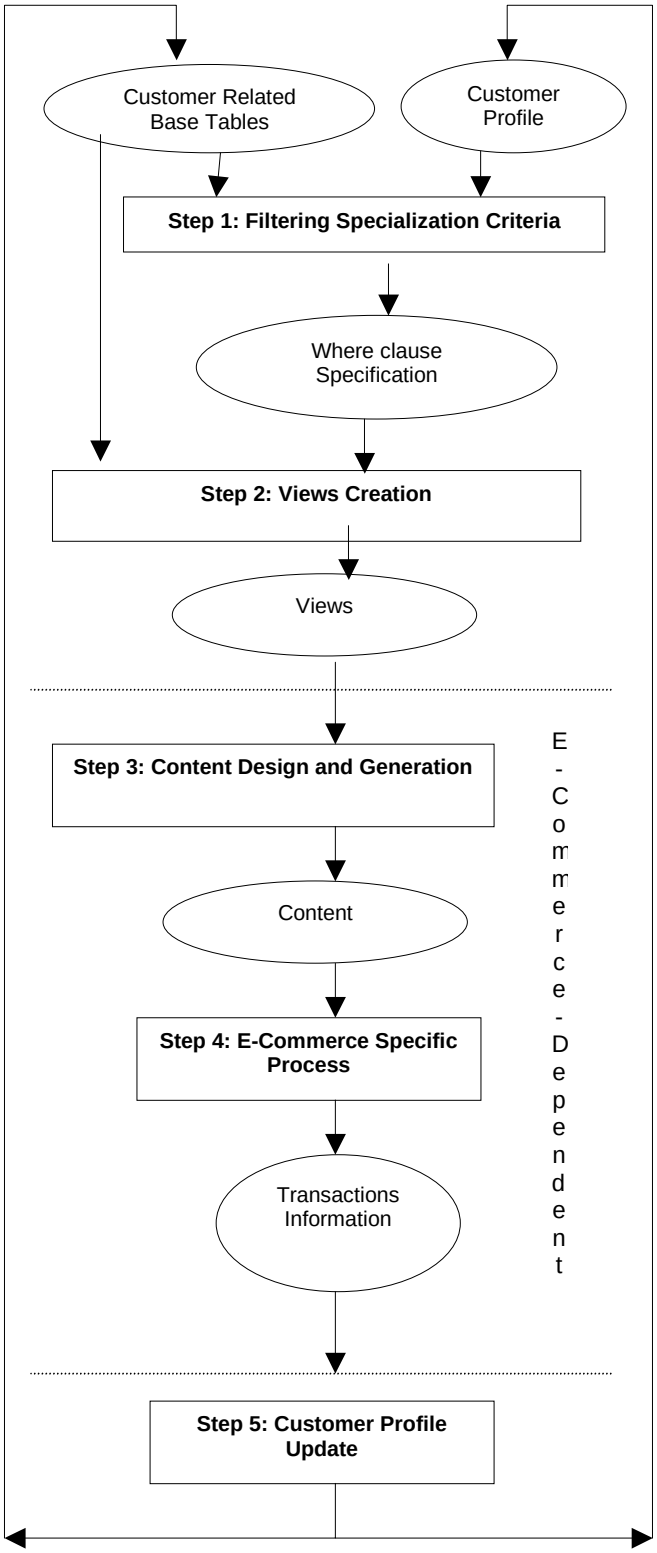

Fig 2. Dynamic Update of Customer to Fulfill E-Commerce Applications

4.2.2 Run-time Specilization Process

The dynamic and cyclic process is practiced as follows:

Step 1. Filtering Specialization Criteria

From running database and existing customers' profiles, criteria are gathered. These criteria will be used in the WHERE clause to create views.

Step 2. Views Creation

Views are kinds of run-time specializations of data related to customers including his/her profile in terms of products and services (e.g., products prices, promotion, delivery condition). These views are built based upon running databases and criteria representing customers' profiles. Views are then used (instead of base tables) to generate the content.

Step 3. Content Design and Generation

Content concerns with the position of offered products, customers' questions and answers, promotions. Managing content is of paramount importance for e-commerce applications. This content is dynamically changing to take into account new customers profiles and e-commerce strategies. It is based on a part on data kept in databases. To be able to present various contents to different customers, we need to specialize data related those customers. This is done through the dynamic views.

Step 4. E-commerce Specific Process

Once the content is displayed, e-commerce specific transaction can start. It concerns with transaction processing (orders, taxes, fulfillment, shipping, payment processing, returns and partial delivery), post sales (customers' services, answers to customers and order status questions), marketing (analysis of gathered information about sales, customers and advertising trends) and brand (communication with customer, reinforcing company image). Gathered information in the e-commerce specific process lead to update database and customers' profiles.

Step 5. Customer Profile Update

After some transactions are finished, information about these transactions is used to update the database and customers' profiles. This new changes will generate new specialization criteria and therefore new views (Figure 2). This process is cyclic.

CONCLUSION

This work focused on data required for designing and generating content for e-commerce applications. A solution, where specialized data are generated from running databases using the concept of views, is presented in a form of content design process. This solution avoids using base tables that are commonly shared by numerous other applications.

This is an issue today where almost all e-commerce applications and namely content management are based upon running databases. However, these running databases, as they are, do not fit the requirements of e-commerce applications.

We expect the contribution of this paper to open more challenging issues (e.g., automatic mapping customer profile into where clauses, concept of specialization at run-time).

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