Concept Exchange: Constructing Interoperable Electronic Product Catalogues in an Emergent Environment

Jingzhi Guo and Chengzheng Sun
School of Computing and Information Technology
Griffith University, Nathan, QLD 4111, Australia
{J.Guo, C.Sun}@cit.gu.edu.au

Abstract

Research in interoperability of electronic product catalogues has primarily focused on resolving semantic conflicts arisen from the heterogeneously designed electronic product catalogues. We argue that while existing integration strategies providing static connections between various heterogeneous catalogues over mediating ontologies, ontologies themselves exhibit heterogeneity and lack of evolvability. What's more, reclassifying terms to link public ontologies is very difficult to avoid inaccuracy problem that is critical to electronic commerce. This paper highlights the problems of flexibility, exactness and evolvability that have received little attention in the literature and provides an overview of the concept exchange approach to interoperability. It illustrates why this is able to better solve the identified problems, presents the different features compared with other approaches and suggests how the concept exchange framework is working.

1. Introduction

Internet technology has made it possible to physically connect various fragmented markets and to integrate them as a global market, which is critically dependent on mediation ability of matching demand and supply between buyers and sellers [1]. Nevertheless, the Internet does not necessarily lead to the exchange of meaningful product information. This problem can be referred to as *product interoperability* among the systems of *heterogeneous* electronic product catalogues (EPCs). The quest for product interoperability has been a major challenge for the electronic commerce community. In the past decade, there has been a proliferation of proposals for how such interoperability can be achieved. The body of research describing these endeavors has appeared under various headings in different places: for instance, multivendor catalogues [11], mediating EPCs [14], business data management [19] and product data integration [8]. In this paper, we use the generic phrase "*interoperable electronic product catalogue* (IEPC)" to encompass all of these usages in referring to a collection of electronic product catalogues called *local electronic product catalogues* (LEPCs) that are cooperating to achieve various degrees of global integration while preserving the evolution of IEPCs and the collaboration between each LEPC.

Despite the large body of research literature on IEPCs, most of the works have focused on how semantic conflicts of products can be reduced. A key tenet of this paper is that a viable product integration strategy must consider additional issues brought about by emergent IEPCs. For example, we need to consider the increasing number of electronic product representations consisted of various ad hoc product formats, de facto industrial and international product standards [3], [16], [21]. Take into account of the local practices of different semantic communities [20] that pertain to different local languages, cultures, preferences, and personalized requirements to represent their products [27]. These have three major implications. First, rigid integration scheme is impractical and flexible product integration strategy should be considered. Second, it is necessary to meet emergent requirements of providing dynamic real-time product data contents and accepting new semantic product terms to enable the evolution of IEPCs. Third, capturing exact meanings of product representation is critical to exchange transactional information between various standards and ad hoc formats.

The rest of this paper is organized as following. Section 2 will examine current issues and various strategies of integrating heterogeneous electronic product catalogues. In Section 3, issues concerning emergent IEPC will be discussed. Section 4 describes the concept exchange framework including the rationale underlying its design and the comparison with other competing EPC systems. In Section 5, some key technical points relating to the framework are discussed. Section 6 concludes our contribution and describes the work in progress.

2. Current Issues and Strategies of IEPCs

Proceedings of the IEEE International Conference on E-Commerce (CEC'03)
0-7695-1969-5/03 $17.00 © 2003 IEEE

2.1. Interoperable Electronic Product Catalogues

An IEPC is a set of interoperable products merged from a set of LEPCs, in which one product can be semantically interoperated with another to achieve a certain business goal. For example, after a buyer's purchasing system observes some products from a seller's catalogue, it generates a purchase order by the interpretation against its own product catalogue. A key concern to the interoperability is that one product in one LEPC should be able to aware and interpret another product in another LEPC in a semantically correct way.

2.2. Schematic and semantic heterogeneities

Schematic heterogeneity emphasizes on the object heterogeneities during the construction of different systems and the impacts on the semantic interoperations between these different systems. This kind of heterogeneities generally does not care the confusion of human's thinking and the disorder of human's logical views to the real world. Schematic heterogeneity has been extensively documented in [12], [9].

Semantic heterogeneity causes another kind of conflicts during the interactions between different systems. It arises from the differences of human's conceptual and logical views about the information caused by the heterogeneous representations of human concepts in systems. Semantic conflicts are classified in [5] as six categories: naming, measurement, representation, computational, confounding and granularity for databases, and later they are discussed by Kashyap and Sheth [10]. Related to electronic product catalogue integration, semantic conflicts are less well understood except some preliminary discussion found in [16]. In the following, we list some semantic problems in product catalogue integration.

Product classification conflicts arise from the same product classified in different classified levels or different branches of a classification, which results in different concept denotation and connotation. For example, one classifies "refrigerator" in (home electronics ((refrigerator), (Oven))) while another classifies it in (refrigeration systems ((refrigerator), (quick freezing devices))), or one makes a classification as (electronic products (household products (refrigerator))) while another classifies (electronic products (refrigerator)).

Product definition conflicts arise from the unmatched product identification and its definition or annotation. For instance, an identification "1112" has been assigned "cooling systems" in one place and "drilling systems" in another places, or a "refrigerator" is assigned "2222" in one place and a "fridge" is assigned "3345" in another place though both actually mean the same.

Product structure conflicts arise from a same product structure defined in different representations such as a television either defined as television(color, size, ScreenType) or TV(colour, measurement, screen) according to the underlying systems.

Attribute description conflicts are similar to product definition conflicts. For example, definition of "capacity" for refrigerator may be differently defined as "volume" or "cubage.

Measurement conflicts arise from the different scales or units of the same attribute value. For example, gloves are sold either in piece or in pair. Sometimes an attribute value can have several implicit measurement standards, for example, "43" and "9" roughly means the same "size" of shoes in different measurement systems.

Attribute value structure conflicts arise from the different definitions of an attribute value. For instance, an attribute value of "Price Term" of gloves generally is defined in a sales contract as "CIF Rotterdam USD0.12/piece". It is obvious that semantic conflicts may arise if different LEPCs use different strategies of defining a value structure. In U.S.A., USD may implicitly be defined as "$", a company used to deal in "dozen" may change "dozen" from "piece", and even the expression structure of "USD0.12/piece" may be differently denoted as "us$0.12 per piece".

Semantic conflicts exhibited above severely prevent computers from exchanging meaningful product data and make interoperation between electronic product catalogues impossible.

2.3. Current strategies for electronic product catalogue integration

Interoperation of heterogeneous electronic product catalogues has received considerable attention in electronic commerce community in the recent years. We provide a brief tour of this literature by highlighting approaches for achieving meaning exchanges.

2.3.1. Single-layered mediation approach. Conflicts between multiple LEPCs are reconciled in the level of product ontology (or vocabularies) of existing electronic product catalogues. In this approach, one or several mediating ontologies are developed to enable the definition of federated product catalogues to mediate various heterogeneous LEPCs. The expected result is to form a homogeneous IEPC. The first type of this approach allows sellers or buyers to interact on a set of product ontologies underlying different LEPCs. An early famous example is smart catalogues [11] that dynamically map the terms of product vocabulary through facilitators (*multiple-ontology approach*). The second type adopts a *single-ontology approach* that provides a global shared vocabulary for constructing LEPCs. The examples are mediating EPCs [14] and Internet EPCs [23], which statically map product terms through one or more mediators governed by a mediating vocabulary.

2.3.2. Multiple-layered mediation approach. This approach generally resolves semantic conflicts between multiple LEPCs ([3] [21]) in the layers of syntaxes, objects and semantics. It regards an LEPC as a serialized document (actually a product classification or a vocabulary/ontology) consisted of a set of hierarchically arranged objects assigned semantics. This approach assumes that each enterprise has an LEPC and thus the integration complexity is $n \times m$ between buyers and sellers [8]. The focus of this approach is to decrease the complexity by layering of each LEPC and merge all LEPCs on the level of semantics. Solution to the semantic conflicts to achieve interoperability between LEPCs is to adopt existing marketplace ontologies, and to connect to these ontologies by reclassifying the terms of each existing LEPCs (such as cXML and xCBL), exploiting technologies such as transformation and mapping [17]. Examples of this approach can be referred to [18], [19].

A recent model-based mediation approach in scientific data integration advocates for a common semantic coordinate system that provides a reference mechanism to link a source's data objects with concepts at the mediator [15]. Its domain map provides terminological glue knowledge to link source data and domain experts together. One advantage is that domain experts can coordinate the data source linking.

3. Issues Related to Emergent IEPCs

In this Section, we examine the issues of *flexibility*, *exactness* and *evolvability* that have received comparatively little attention in the literature. We posit that these are important considerations in formulating a viable integration strategy for emergent IEPCs.

3.1. Flexibility

Previous research IEPCs is largely motivated by how to integrate distributed EPCs as one so that geographically dispersed sellers and buyers can interoperate on a common ground (cf. single-ontology approach). This leads to constructing ontologies as metadata to guide various local product catalogue building. Though an ontology is a set of formalized machine-understandable terms, a side-effect of this effort is that a term is rigid to expand to allow different views of a term if beyond the listed attributes. In fact, a term is merely a partial abstraction of a set of similar products and different buyers and sellers may have their own abstractions. More precisely, under the same umbrella of a concept, an annotated term or concept demands variable product structure, flexible in LEPC design time not in vocabulary design time. In theory, product differentiation is a general competition strategy in business [4], which requires different abstractions of a product term. In addition, flexible attribute-based product visibility strategy is generally preferred to achieve the control of attribute value release. An example is after a scientific document is defined as *document X* {publications, abstracts, definitions, research area, language, audience, databases}, it becomes fixed for release as a term of vocabulary. The fixed terminology feature enforces the users rigidly to follow.

3.2. Exactness

Exactness is critical in many e-business processes. For example, in the searching stage, if the buyer's needed product feature is matched. The search will go into the subsequent stages of inquiry, quotation and ordering that require real exactness. Another example is the different LEPCs that have encoded stock trading catalogue. The "opening price" in Hongkong is surely different in Tokyo. Exactness is a severe matter. Though multiple-ontology approach provides the dynamic mapping of product terms, the exact match appears a problem [25]. In multi-layered mediation approach, the exactness largely depends on the success of reclassification tool for the accurate mapping between terms. Nevertheless, exactness is still an open issue when exploiting this tool [8].

3.3. Evolvability

In addition to the flexibility and exactness, evolvability is highly required in that current electronic marketplace is emergent as the continuous requirements of customers [7], [24]. Reflecting in IEPC design, each LEPC is constantly generating new terms represented in local semantic formats [20] and evolves its LEPC in its own personalized way [27]. Second, there are an increasing number of electronic product representations consisted of various ad hoc customer product formats, de facto industrial standards and international product standards [3], [16], [21]. These emergent requirements call for integrating product semantic representations dynamically opposed to the intermittent new version release. However, though ontology evolution has mentioned in many references [25], current ontology-based approaches still have not touched the evolvability problem yet.

4. The concept exchange framework

The key to the *concept exchange* approach to achieving interoperability is the notion of *concept*. We use the word "concept" to refer to the implicit assumptions underlying the way in which a concept mediator routinely translates or interprets local product information and a concept collaborator emergently creates, inserts or deletes common product information. *Concepts* are classified identifiers and are semantic atoms of what are logically dealt in a business system and are independent of object constructs that convey the meanings of concepts. For example, the concept of "refrigerator" is a fact for human disregarding whether it is called as "refrigerator", "fridge" or "réfrigérateur". Given this *independence axiom* that a concept of a thing exists independently if a thing exists, we are possible to design a concept system that is compatible with current concept representation systems but flexible to partial interpretation of this concept. This axiom is desirable because computer systems and various semantic communities [20] of buyers and sellers can communicate each other based on a set of common concepts. The desirable result that human and computer share the same understanding enables us to design complex human-computer product systems. However, to be fruitful, the precondition is that the common concept system is possible and evolvable to contain arbitrary concepts. In addition, a distinction should be made between concept and *context*. By "concept", we emphasize its common semantic abstractions of various concrete products, unique and unambiguous to represent a category of concrete products though may be expressed structurally or physically differently. By "context", we mean local and dynamic representation of a real-world product situation with partial interpretation of a concept, which is directly related to a producer's or a consumer's personal cognitions, preferences and purposes. For example, a certain product context of the neutral concept "251020" for "refrigerator" can be different in the context of each LEPC such as the one as "white in color, 850 liters in capacity and one compartment in feature" while the other as "red in color, 750 liters in capacity, two compartments and a preserving time detector in feature". The context enables us to design the controls on the desired release and receipt of a specific product.

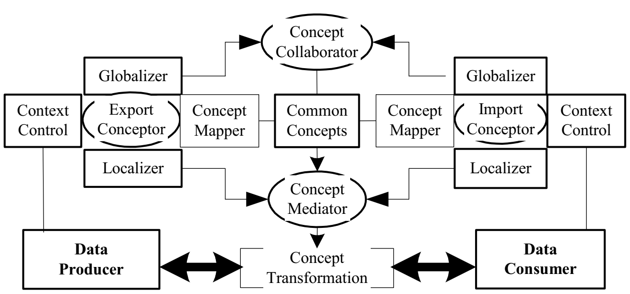

Figure 1: Concept exchange in producer-consumer systems

4.1. Concept exchange in producer-consumer systems

In this Section, we will discuss the key notions underlying the concept exchange strategy as depicted in Figure 1 with a simple scenario where there is a product data producer and a product data consumer (i.e. one LEPC applying for the functions of insert and delete and one LEPC applying for the functions of query and retrieval). To allow the meaningful exchange of product data between product data producer and product data consumer, product local concepts specific to both are captured in an *export conceptor* and an *import conceptor* respectively after a value release check by *context control* (context control is used for selective attribute value release control). It means that export conceptor and import conceptor, respectively, apply the assumptions of their local semantic communities [20] to produce and consume product data. The export and import conceptors define a product *local concept* in two alternatives: (1) by localizing a subset of product *common concepts* through *localizer*, if all needed common concepts are available, and mapping the local concept annotations and product structures through *concept mapper* back onto the common concepts. (2) By globalizing through *globalizer*, a local concept is propagated to *concept collaborator*, if a common concept is not available. The concept collaborator will real-time generate a common concept for export conceptor to apply and publish it in the set of common concepts for later uses from product data consumer. Here to maintain a set of product common concepts are necessary because the only way disparity can be identified is when we have consensus for consistently mapping different semantic annotations and product structures of a concept. In this framework, product data transmitted from the product data producer to the product data consumer is via a *concept transformation* process governed by a *concept mediator*. Concept mediator is similar to a relay: open the package sent from producer, compare the local concepts against the common concepts, then repack them into a package as per the consumer's community language and send it to the consumer. Another function of concept mediator is to detect the semantic conflicts if any. If there are conflicts, the package will be sent to the concept collaborator that will real-time resolve and publish them, and advise the producer to revise the LEPC (or automatically revise the LEPC online if mutually agreed). The mediated product concepts are exact without ambiguity. The exactness is fundamental to electronic transactions for e-business.

To make the discussion more concrete, we give an example that a data producer is editing a LEPC for inserting a product named "fridge". The producer queries the IEPC and cannot find an annotation about the concept related to "fridge" or commonly known "refrigerator". S/he then send "fridge" to concept collaborator for immediate resolution. In soon, s/he receives the notice and finds the annotation about "fridge" or "refrigerator" in IEPC. S/he sets several attributes for the "fridge" including a context control rule for "quantity" that a quote is made if the "quantity" is no less than 50. A buyer later builds its purchasing catalogue including refrigerator. Since s/he locates in

France, the buyer prefers French as the catalogue language. S/he has searched "fridge" and found the annotation about "refrigerator" and localizes it as "réfrigérateur" while the machine automatically uploads "réfrigérateur" as a synonym of "refrigerator" in the set of common concept annotations. S/he further sends the inquiry about purchasing 40 "réfrigérateur" to IEPC, concept mediator mediates it and sends the producer "fridge" as inquiry. The producer receives it but does not reply as per the context control rule "quantity is no less than 50".

4.2. Concept exchange in a generic electronic marketplace

The strategy for achieving interoperability in producer-consumer systems can be generalized to the scenario of an electronic intermediary marketplace (EIM) where there are product producers, consumers and third-party marketplace providers [7]. Figure 2 illustrates what the architecture of such a system might look like.

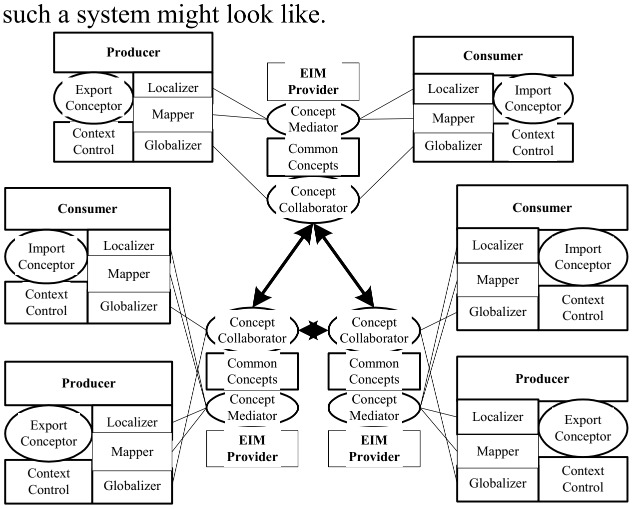

Figure 2: Concept exchange in an electronic intermediary marketplace

This architecture differs from the producer-consumer framework presented in Figure 1 in three significant ways. First, many LEPCs have involved to form a generic global electronic marketplace. It is conceivable that different electronic marketplace intermediaries (we call it *EIM provider*) may attract a certain number of their customers. Each EIM provider may act as a mediating entity of various LEPCs and present a set of common concepts for each LEPC to localize their LEPCs. This is actually not an assumption any more but has already become a practice in e-commerce such as the concept-alike standards cXML, xCBL or ebXML. Our focus to this point is that the fine-grained common concepts have presented the great opportunity to localize LEPCs in their own preferences. Common concepts collaboratively generated by producers, consumers and EIM providers guarantee that local LEPCs made by local concepts according to local business "jargons" [20] and applied for the common concepts are correctly interpreted by remote LEPCs.

Second, confronting with the vibrant and uncertain global electronic marketplace, security and permits of access to product data can be controlled. Context controls are embodied the new tasks of managing complex Internet-based security and accessibility. Sensitive product data and marketing rules are barred within the boundary of an enterprise in the level of product attributes. In addition, these rules have filtered information overloaded from Internet.

Third, the evolvability consideration of both LEPCs and IEPC is promoted. As noted earlier, both single-layered and multiple layered approaches are constrained to the rigidity of ontology evolution. In each case, when emergent requirements of customers to create new terms out of mediating ontology, it cannot well cope with the problem. In this framework, a novel concept globalizer has been extended the functions to cooperatively manage the creation of new terms for LEPCs by both coordinating internally within a IEPC and externally between IEPCs.

4.3. Advantages over existing integration strategies

We centralize that a distinguishing feature of the concept exchange approach is its focus on the *dynamic representation* of disparate product semantics as opposed to the periodical batch upgrading by new version release (the general practice of adopting marketplace mediating ontologies). This allows product semantic conflicts to be: (1) eliminated by a concept mediator if under the control of common concepts, and (2) resolved by a concept collaborator in real-time if out of control of common concepts. We claim that this brings about a number of features that are novel and advantageous over existing electronic product catalogue integration strategies compared in Table 1.

Feature 1: *Dynamically localizing product common concepts as representation of local product semantics*

As we have illustrated via the example in Section 3.1, the single-ontology approach achieve integration by providing a shared vocabulary for the specified semantics. One disadvantage of this approach is that the specification of the meaning is confined to a fixed set of attributes. For example, if in a LEPC the *document X* {publications, abstracts, definitions, research area, language, audience, databases }is again defined as *file 5*{pub, lost date, price} in another LEPC, then the interoperation is totally impossible though we still stick to the concept of a scientific document. The rigid semantic specification implies several problems. First, a canonical representation must exactly be committed to follow "one-size-fits-all" practice [2] disregarding the local semantic "jargons" to the concept representations. Second, semantic conflicts can only be resolved until they are detected and statically performed. Third, the re-use of the term is not possible if out of the specification. Fourth, constant modifications or inheritances from existing terms are implicitly implied to maintain an LEPC.

Feature 2: *Real-time globalizing representation of local product semantics as common concepts*

The second important distinction of concept exchange approach is its real-time collaborative creation of common concepts. We recognize that precise concept annotation and classification cannot fully be automated and must be aided by the collaboration of human experts at least as a supervisor and arbitrator. Thus, emergent terminology requirements from LEPCs must be submitted to a concept collaborator for globalizing them as common concepts. For instance, a five-in-one new product including TV, computer, video recorder, radio and hi-fi must be classified by a domain expert, otherwise it will become a severe issue because different producers or consumers may classify it in different locations of a classifications and cause heterogeneities. If using classification tool, it may not be able to recognize it if the second same five-in-one product appears in "televisions, laptop, home video maker, radio and digital sound instrument".

Feature 3: *Real-time inter-IEPC collaborative creation of common concepts*

We recognize that it is possible to build business alliance between providers of electronic intermediaries in that this strategy is a win-win strategy to resolve semantic conflicts of product standards owned by different providers and it is an effective way to integrate a global marketplace, though competition may exist. In this case, it is desirable to present a real-time inter-IEPC collaboration mechanism for providers to resolve semantic conflicts by exchanging information and expertise on a collaborative base.

Feature 4: *Exact mapping of heterogeneous local product representations between LEPCs*

Given a search of "fridge" in LEPC 1, if LEPC 2 has a term "réfrigérateur", then LEPC 2 will respond. Even an "ice box" will respond if it is localized as per the common concept of refrigerator. To achieve exactness, concept exchange approach does not guess a term mapping but provides a flexible yet accurate mapping. For example, when LEPC 1 sends a search {fridge | color, price, compartments}, LEPC 2 with {réfrigérateur | couleur, prix} will not reply but {refrigerator | colours, unit value, compartment, capacity} will reply. This flexible attribute-based query/answer mode can also reduce information overloading. In multi-layered approach, term mapping requires a reclassification process and cannot guarantee exactness.

Feature 5: *Support for existing product integration approaches*

The IEPCs from current approach are regarded as a set of LEPCs and their concepts are dynamically integrated in the set of common concepts. So integrating the concepts of other approached IEPCs is a gradual and evolutionary process. Multi-layered approach adopts an autonomous automatic approach by decomposing a catalogue document. It has achieved the speed but cannot avoid accurateness problem.

Table 1: Feature comparison of integration approaches

Feature	Single-ontology Approach	Multiple-Ontology Approach	Multi-Layer Approach
1.Dynamically localizing product common concepts as representation of local product semantics	Support if only following same ontology because formal ontology is not changeable except inheritance	Support but may have severe conflicts as each product ontology is independently developed	Not its task
2.Real-time globalizing representation of local product semantics as common concepts	Not support because no such concept.	Not support because no such concept.	Not support because no such concept.
3.Real-time inter-IEPC collaborative creation of common concepts	Not support because no such concept.	Not support because no such concept.	Not support because no such concept.
4.Exact mapping of heterogeneous local product representations between LEPCs	Support but miss all semantic conflicted terms because they have been thrown away.	Not support because dynamic matching results may contain errors.	Not support because mapping process involves reclassification tool that has accuracy problem
5.Support for existing product integration approaches	Not Support because all expected catalogues are based on the same mediating ontology	Limited support by manually design interfaces between languages	Support by decomposing different catalogue and linking in ontology level

5. Key technical points to the concept exchange strategy

Vector-based concept tree. An electronic catalogue is often organized as a tree [27]. The practices of international product standards also adopt this convention such as UNSPSC (www.unspsc.com) and el@ass (www.eclass.de). However, current tree structured product standards are rigid to evolve and fixed in levels. For example, UNSPSC "25173303" denotes "automotive computer systems" that may exist many subsystems at lower category levels. A query to this category may result in a large number of answers. To allow flexible classification evolution, we have proposed a *vector-based product concept* tree to classify meaningful products and define each of them as a vector node ($i1,\ldots,ik$) in a tree model of 1(1(1(1,…), 2(…), …), 2(…), …), where a node *level* is k and ik is the sibling position of k-level under the same parent node ($i1,\ldots,i(k-1)$). Please refer to [6] for the details. Vector-based product concept allows us to establish one-to-many product concept mapping on the assumption that a semantic concept exists objectively and is independent of concept representations whether a "refrigerator" is represented as "fridge" or "réfrigérateur". Computational ability of the vector concept tree allows us to dynamically create and delete product concepts required by the public and design the complex operations and algorithms to evolve a common concept tree. By this tree, all product concepts can be created and used through the careful designed user interfaces to satisfy real-time evolvability for emergent requirements.

Semantic representations of products. In concept exchange framework, a product is conceptually represented as a triple (product concept, product annotation, product structure) [6]. An annotation defines the product concept in natural languages, aiming to bind computer-readable concepts to human usable concepts. Annotation decides the *denotation* of product concept while product structure decides the *connotation* of product concept. Similar to ontology theory [26], a *product structure* is a set of product attributes. However, to achieve flexibility, our choice is that the size of attribute set is not fixed but a superset of attributes dynamically brought by all participants updating the product. Each attribute is defined as a triple (attribute concept, annotation, attribute structure). *Attribute structure* contains a set of value representations that is defined as a triple (value concept, value annotation, value structure). A *value structure* includes a set of value terms where each can be instantiated by a set of value instances. For example, a "price term" may be defined as PriceTerm → {URL1, URL2, URL3, URL4} that hyperlinks {FOB, Ex Works, C&F, FOB} of the value instances of the local value concepts in local catalogues' storages.

Common concept vs. local concept. A *common concept* is a superset of local concepts in the form of {local concepts} $\subseteq$ {common concepts}. This design choice is based on the assumption that each LEPC is a "semantic community" [20] and they have different semantic expressions to annotate the semantically same product concepts. Thus, in order not to lose the richness, these different semantic representations are merged as a superset in an IEPC. Another consideration is that the expressive power of the annotated common concepts is limited. For example, when we search "TV" in UNSPSC, the search result is none unless we search "television(s)". In this case, it is better to build appositional annotations for a common concept for the benefit of search and retrieval.

6. Conclusion

We have presented a new approach to interoperable electronic product catalogues based on the notion of concept exchange. Unlike the existing integration strategies that focus on resolving semantic conflicts by batch upgrading of mediating ontologies through intermittently releasing new versions, we have suggested that semantic conflicts should be eliminated by dynamic representation of concepts in disparate LEPCs. This is achieved in our framework by exactly localizing common concepts as per the "jargons" of local semantic communities in both export and import conceptors, explicitly submitting the semantic conflicts to concept collaborators for real-time resolution for continuing the LEPC's design work. By exploiting an evolvable vector-based concept tree and enabling superset of product attributes from LEPCs, we now have a more flexible framework for precise system implementations required by sensitive e-commerce applications and gaining the elegant solution especially critical for global emergent environment.

The richness of this integration model has opened up a wide range of research opportunities. First, we have recognized that the design of common concepts that are evolvable in run-time is a complex task and there is a need for a well-defined methodology for accomplishing this. The issue is core to how to separate an objective semantic concept from the disparate physical representations in a fixed object or in a structure. Common concept must be neutral, aloof and detached from the arbitrary local system dependent constructs. For example, if "123456" is a neutral concept of "refrigerator", "1234567" may be a neutral concept of "portable refrigerator". However, "123456" and "1234567" should not particularly rely on a peculiar construct to represent them. In fact, before we use these two digits, we should not embody them any meanings until we use them. Another epistemological issue is that we should equally treat computer and human being to enforce the concept creation. By so doing, we can move a small step toward semantic IEPC. Second, the real-time collaborative concept creation signals a new path to the concept creation opposed to traditional in-house ontology design approach. The challenge here is how to organize domain experts to work together and how to ensure the responsiveness in a concurrent work environment. A possible arguable issue is how to split the collaborative task between intelligent agents and domain experts and what exact roles the domain experts will play. Third, a choice must be made which kind of language should be designed to represent and query product concepts specific to the IEPC system. XML is a good vehicle with wide acceptance but the tag rigidity problem must be solved. A protocol interfacing to the current product databases should be devised to re-use and integrate existing product resources. Another more subtle challenge is to clarify the value structure of how to ensure the dynamic updating attribute values without the semantic conflicts of scales and quantum against local context control.

A prototype of concept exchange IEPC system is currently being implemented in pursuit of these issues. The ongoing implementation is designing an XML-based language called XPM (XML Product Map) for representing concepts for both IEPCs and LEPCs. It includes a set of primitive operations for browsing, inserting and deleting. This prototype is to simulate the integration of 3 IEPCs and 18 LEPCs for household products.

7. Acknowledgement

We thank the anonymous reviewers for their insight comments, which were invaluable for improving the presentation of this work.

8. Reference

[1] Bakos, Y., "The Emerging Role of Electronic Marketplaces on the Internet", *Communications of the ACM.* Vol. 41, no. 8, pp. 35-42, August 1998.

[2] Damsgaad, J. and D. Truex, "Binary Trading Relations and the Limits of EDI Standards: The Procrustean Bed of Standards", *European Journal of Information Systems*, 9(3), pp.173-188, 2000.

[3] Dogac, A. and I. Cingil, "A Survey and Comparison of Business-to-Business E-Commerce Framework", *ACM SIGecom Exchanges*, Vol 2. 2, pp.14-25, June 2001.

[4] Gazzale, R., and J. Mackie-Mason, "Endogenous Differentiation of Information Goods under Uncertainty", *ACM EC'01*, Tampa, Florida, USA, October 14-17, 2001.

[5] Goh, C., Madnick, S. and M. Siegel, "Context Interchange: Overcoming the Challenges of Large-Scale Interoperable Database Systems in a Dynamic Environment", *ACM CIKM'94*, 11/94 Caitheburg MD USA, 1994.

[6] Guo, J. and C. Sun, "Collaborative Product Representation for Emergent Electronic Marketplace", *16th Bled Electronic Commerce Conference: eTransformation*, Bled, Slovenia, June 9-11, 2003.

[7] Guo, J. and C. Sun, "Measurement Models for Survivability and Competitiveness of Very Large E-Marketplace", *The Third International Conference on Computer Science*, July 2-4, St. Petersburg, Russia.

[8] Fensel, D., Ding, Y., Omeleyenko, B., Schulten, E., Botquin, G., Brown, M. and A. Flett, "Product Data Integration in B2B E-Commerce", *IEEE Intelligent Systems*, pp. 54-59, July/August 2001.

[9] Kashyap, V. and A. Sheth, "Schematic and Semantic Similarities Between Database Objects: A Context-based Approach", *The VLDB Journal* 5, pp.276-304, 1996.

[10] Kashyap, V. and A. Sheth, "Semantic Heterogeneity in Global Information Systems: the Role of Metadata, Context and Ontologies", In M. Papazoglou and G. Schlageter (eds) *Cooperative Information Systems: Current Trends and Applications*, 1996.

[11] Keller, A. and M. Genesereth, "Multivendor Catalogs: Smart Catalogs and Virtual Catalogs", *EDI Forum: Journal of Electronic Commerce*, 9(3), pp.87-93, 1996.

[12] Kim, W., and Seo, J, "Classifying Schematic and Data Heterogeneity in Multidatabases Systems", *IEEE Computer* 24, 12 (1991), pp.12-18, 1991.

[13] Krishnamurthy, R., Litwin, W. and W. Kent, "Language Features for Interoperability of Databases with Schematic Discrepancies", In *Proceedings of ACM SIGMOD Conference*, pp. 40-49, 1991.

[14] Linche, D. and B. Schmid, "Mediating Electronic Product Catalogs", *Communications of the ACM*, vol. 41, no. 7, July 1998.

[15] Ludäscher, B., Gupta, A. and M. Martone, "Model-Based Mediation with Domain Maps", In *17th International Conference on Data Engineering (ICDE)*, Heidelberg, 2001.

[16] Omelayenko, B. and D. Fensel, "An Analysis of B2B Catalogue Integration problems", *ICEIS-2001*, Setubal, Portugal, July 7-10, 2001.

[17] Omelayenko, B., "Integrating Vocabularies: Discovering and Representing Vocabulary Maps", *ISWC-2002*, June 9-12, Sardinia, Italy, 2002.

[18] Omelayenko, B. and D. Fensel, "Scalable Document Integration for B2B Electronic Commerce", *Special Issue of Electronic Commerce Research Journal on B2B Research*, (submitted).

[19] Quix, C., Schoop, M. and M. Jeusfeld, "Business Data Management for Business-to-Business Electronic Commerce", *ACM SIGMOD Record*, Vol. 31, No. 1, pp. 49-54, March 2002.

[20] Robinson, M. and L. Bannon, "Questioning Representations", *ECSCW'91*, Amsterdam, Holland, 24-27 September 1991.

[21] Shim, S., Pendyala, V., Sundaram, M. and J. Gao, "Business-to-Business E-Commerce Framework", *IEEE Computer*, pp.40-47, October 2000.

[22] Stanoevska-Slaveva, K., Hombrecher, A., Handschuh, S. and B. Schmid, "Efficient Information Retrieval: Tools for Knowledge Management", In *Proc. Of the 2nd Int. Conf. on Practical Aspects of Knowledge Management (PAKM98)*, Basel, Switzerland, 29-30 October, 1998.

[23] Stanoevska-Slabeva, K and B. Schmid, "Internet Electronic Product Catalogs: an Approach beyond Simple Keywords and Multimedia", *Computer Networks*, 32(2000), pp. 701-705, 2000.

[24] Truex, D., Baskerville, R. and H. Klein, "Growing Systems in Emergent Organizations", *Communications of the ACM*, Vol. 42, No. 8, August 1999.

[25] Wache, H., Vögele, T., Visser, U., Stuchenschmidt, H., Schuster, G., Neumann, H. and S. Hübner, "Ontology-based Integration of Information – A Survey of Existing Approaches", In *Proceedings of IJCAI-01 Workshop : Ontologies and Information Sharing*, pp. 108-117, Seattle, WA, 2001.

[26] Wand, Y., Storey, V. and R. Weber, "An Ontological Analysis of the Relationship Construct in Conceptual Modeling", *ACM Transactions on Database Systems*, Vol. 24, No. 4, pp. 494-528, December 1999.

[27] Yen, B. and R. Kong, "Personalization of Information Access for Electronic Catalogs on the Web", *Electronic Commerce Research and Applications* 1, pp. 20-40, 200.