Association for Information Systems
AIS Electronic Library (AISeL)

BLED 2003 Proceedings | BLED Proceedings

December 2003

# Collaborative Product Representation for Emergent Electronic Marketplace

Jingzhi Guo
*School of Computing and Information Technology, Griffith University*

Chengzheng Sun
*School of Computing and Information Technology, Griffith University*

16th Bled eCommerce Conference

eTransformation

Bled, Slovenia, June 9 - 11, 2003

# Collaborative Product Representation for Emergent Electronic Marketplace

**Jingzhi Guo, Chengzheng Sun**

School of Computing and Information Technology, Griffith University, Australia
J.Guo@cit.gu.edu.au, J.Sun@cit.gu.edu.au

## Abstract

*A B2B e-marketplace is emergent with product representation requirements in continuous changes. To capture the emergence, this paper proposes a novel collaborative product representation approach that collaboratively generates new product representations in real-time both at the sides of sellers/buyers and e-marketplace providers. The approach employs a well-defined product representation construct that decomposes each representation into a set of hierarchically arranged vector concept-based annotations and sub-structures. The use of vector-based concepts achieves flexibility, exactness and evolvability of the whole product representation system.*

## 1. Introduction

A *business-to-business electronic marketplace* (e-marketplace) is an emergent organization that has customer requirements in continuous change (Guo and Sun 2003b), such as artificial stock market (Chen et al, 2002). This results in difficulties to capture and design requirements for e-marketplace systems (Maidantchik et al, 2002). This argument is strongly supported by the researchers of emergence theory, which points out that there is no point to assume that stable structures underpin organizations. Social organizations are works-in-process, emergent as their actors respond to adapting to shifting environments, and constantly interacting with each other to re-negotiate the "rules of the game" for stability while never achieving it (Damsgaad et al, 2000; Ngwenyama, 1998). Applying this theory to analysis, many available system development means are inadequate, because they are not connected through a coherent framework that focuses on the emergent character of organizations (Truex et al, 1999 & 2000). To illustrate the difficulties, consider a basic e-marketplace that has two causal related basic target functions: to electronically represent various real-world products as machines-readable and multi-firm sharable data (we call it *e-representation*), and to match buyers and sellers (we call it *e-matching*) (Bakos, 1998). Three categories of continuous changes are immediately observed.

- Electronic product representations consisted of various ad-hoc customer product formats, de facto industrial standards and international product standards are continuously changing and required to be contingently mapped for interoperations between buyers and sellers (Dogac et al, 2001; Omelayenko et al, 2001; Shim et al, 2000).
- Geographically dispersed sellers and buyers have their local languages, cultures and preferences, and have variable personalized requirements to represent their products (Kim et al, 2000; Liu et al, 2001; Yen et al, 2002).
- E-marketplace organizational structure, the relationships between sellers, buyers and e-marketplace providers, is dynamic and not stable. When the e-marketplace becomes a profitable or cost-saving place, potential sellers and buyers will actively join in and vice versa.

These changes characterize an emergent e-marketplace that has its emergent customer requirements. These changes pose a severe problem to design a viable competitive e-marketplace that requires to electronically represent products in real-time because any statically designed services can lead to dysfunctional behavior to the emergent requirements (Maidantchik et at, 2002). For example, a released e-marketplace software version not including new electronic product representations will exclude customers using new representations. This results in losing customers' satisfaction and loyalty, and harming the competitiveness of an e-marketplace.

To deal with the above problem, an emergent e-marketplace must be continuously analyzed and dynamically negotiated with customers for emergent requirements (Guo and Sun 2003b). Systems structure must be flexible and evolvable to adapt to the incomplete and ambiguous specifications for continuous redevelopment of emergent e-marketplace (Truex et al, 1999). However, despite the widespread adoption and active roles e-marketplaces have played, less attention in the literature is received about how to electronically represent products in an emergent marketplace. It is still not clear what mechanism we should adopt to adaptively and electronically represent products to achieve exact match of buyers and sellers.

The purpose of this paper, therefore, is to investigate how to electronically represent products in an emergent e-marketplace to achieve *flexibility*, *exactness* and *evolvability* (Guo and Sun 2003a). We have proposed a novel COllaborative Product rEpresentation approach (COPE) in this paper and hope our initial research can attract more attention from the research community.

The rest of this paper is arranged as following. In Section 2, current approaches to electronic product representations are briefly discussed and some constraints are highlighted. Section 3 introduces the COPE design approach and implementation method to achieve the goal of this paper. Section 4 concludes the paper, discusses the further issues and current application scope of COPE approach, and suggests the future works and the COPE applicable areas.

## 2. Current Approaches and Constraints

In general, e-marketplace can be divided into four types: one seller with many buyers, one buyer with many sellers, many buyers and many sellers, and sellers and buyers bridged via a third-party e-marketplace provider (cf. Ginsburg et al, 1999; Guo and Sun 2003b). In order to build these marketplaces, a common issue is how to represent real-world products as electronic forms for customers to use and interact. The challenge here is that given all sellers and buyers are geographically dispersed and connected via Internet, how their heterogeneous electronic product representations can machinably understand each other (regarding representation heterogeneity, please refer to a classic analysis (Robinson et al, 1991)). To meet this challenge, several approaches are proposed in the community of electronic commerce. Roughly, they can be classified into two categories: standardization approach and mediating approach. In the remaining part of this Section, we briefly have a tour of these two approaches. These two types of approaches all aim to facilitate the integration of users' electronic representations in an integrated system

### 2.1. Standardization Approach

Traditionally, an assumption is widely implied that machines of both sellers and buyers are able to communicate and understand each other if all comply with a standard product representation. This assumption is generally effective and applicable. Based on this assumption, many commercial systems and applications are done and in operation. Product standards are one category of the examples and truly play an important role in forming e-marketplaces that have provided the e-matching efficiency. Examples can be found in both research references such as eCo Framework [1] (Arpinar et al, 2000) and commercial standard specifications [2, 3, 4]. The benefit of adopting standardization approach can be measured by the size of matched e-representations of products (Guo and Sun 2003b). If more sellers and buyers adopt a same standard, the more effective the product standards will be, the more requirements of sellers and buyers will be met.

However, a standardizing process is often a complex socio-economic process (Fomin et al, 2000). Standards tend to be rigid and are not adaptive when facing emergent requirements. Counter-arguments of using standards to build an e-marketplace are:

- A standards is emergent by itself and thus needs to dynamically adapt (Damsgaad et al, 2000).
- The standardization process always lags behind the emergent requirements such as customers' personalization requirements (Kim et al, 2000; Liu et al, 2001; Yen et al, 2002), and makes customers difficult to adopt.
- There exist many highly standardized e-marketplaces with de factor industrial product standards. Interoperations between sellers and buyers in these e-marketplaces are difficult (Dogac et al, 2001; Shim et al, 2000).
- International organizations are launching many product standards [3, 4]. Sellers and buyers who adopt these international standards are often difficult to interact with those de facto standard e-marketplaces.
- There are more and more small and medium sized enterprises (SMEs) directly enter into competitive e-marketplace, each owns a small subset of direct related customers (Sommer et al, 2002). Their ad-hoc product representations, though representing a large portion of the total e-marketplaces, are unable or unaffordable to interact with and join in mainstream standardized e-marketplaces (Omelayenko et al, submitted).

1 http://eco.commerce.net
2 http://www.rosettanet.org
3 http://www.ucc.org
4 http://www.unspsc.org

The emergent nature of standards and their requirements mean that we cannot simply rely on standards but should find a more adaptive way to build emergent e-marketplaces.

### 2.2 Mediating Approach

The drawbacks of standardization approach encourage researchers to explore mediating approach to build e-marketplaces. This approach achieves interoperability between heterogeneous product standards, de facto industrial standards and ad-hoc electronic product representations by providing a set of mediating domain ontologies. It assumes that it is possible for heterogeneous product representations to be integrated into a large set of mutual understandable representations and thus different sellers and buyers are able to interoperate on a common ground. Abundant related works of this approach vary in solving specific representation tasks. The following are some examples.

- Fensel et al (2001) propose to integrate product data in AI approach by decomposing integration tasks into subtasks and reclassifying heterogeneous product representations into a core set of marketplace product domain ontologies to automate the mediation between sellers and buyers.
- MEMO (Quix et al, 2002) propose the federated database systems to store metadata to link the instances of product representations by a generic ontology schema.
- Omelayenko (2002a, 2002b) and his colleagues (2001, 2002) propose a more comprehensive mapping approach. They have developed the layered approach of Melnik and Decker (2000) and divide product documents into layers of processes, document models and vocabularies. They apply a RDFT transformation language to transform the source documents into the target documents through bridges and maps at each layer. They follow the standard models of WSDL, PSL and ebXML to construct mediating ontologies. The open issues currently in this framework are (1) how to increase the accuracy of reclassification including issues behind overlapping words, (2) how to control the number of object conceptual models in that there are numerous kind documents, (3) should the framework create all product terms itself in the mediating ontology?

Mediating approach has many merits to mediate many existing heterogeneous product representations. However, this approach adopts mapping methods over static ontologies such as (Omelayenko, 2002a; Quix et al, 2002; Liu et al, 2001; Stanoevska-Slabeva, 2000; Keller et al, 1996), and lacks the ability to cope with the emergent e-marketplace requirements. The problem is that after the set of mediating product representations are designed, the e-marketplace is close until the next version releases. So the *openness* for evolving is intermittently static between two versions and not adaptive to the continuous changes.

Some researchers have advanced the mediating approach by focusing conducting business “on the fly”. For examples the research of Dogac et al (2002) emphasizes on collaborative building business process based on ebXML to capture customers’ dynamic requirements. Jung et al (2000) regard e-marketplace as the online spaces with people interacting for transaction, and thus need to collaborate and aware each other. These works imply an idea that an e-marketplace should meet as many instant requirements as possible. However, these researches still do not touch the core issue that emergent heterogeneous electronic representations need to map in real-time.

The non-supports of both standardization and mediating approaches to meet emergent e-marketplaces encourage us to develop a new methodology to increase *mediating ability* of heterogeneous product electronic representations (For the detailed discussion about mediating ability, please refer to Guo and Sun (2003b)). In the following Section, we propose a novel *CO*llaborative *P*roduct r*E*presentation (COPE) approach to cope with the problem.

## 3. Collaborative Product Representation

To meet emergent e-marketplace requirements, we devise COPE approach to model and design a basic e-marketplace involving functions of collaborative product representations for e-representation services. Different with the standard and mediating approach, we assume that the terms of products required by sellers and buyers are emergent in continuous changing, and put focus on the dynamic facet of the integration of product representations. To enable geographically dispersed sellers and buyers to work together (Hoffner, 2000), COPE adopts a partial replicated architecture shown in Figure 1 to model an e-marketplace: various personalized product representations of sellers and buyers (mapped onto a set of *local electronic product catalogues* (LEPC)) are globally distributed in sellers' and buyers' own local storages, and a set of shared product representations (mapped onto a set of *interoperable electronic product catalogues* (IEPC)) are replicated at remote public storages of their e-marketplace providers (EMP). The correctness and efficiency of the replicated architecture have already been discussed in many existing works such as real-time collaborative editing systems (Sun et al, 1998) and real-time collaborative graphic systems (Sun et al, 2002), and are not the focus of this paper.

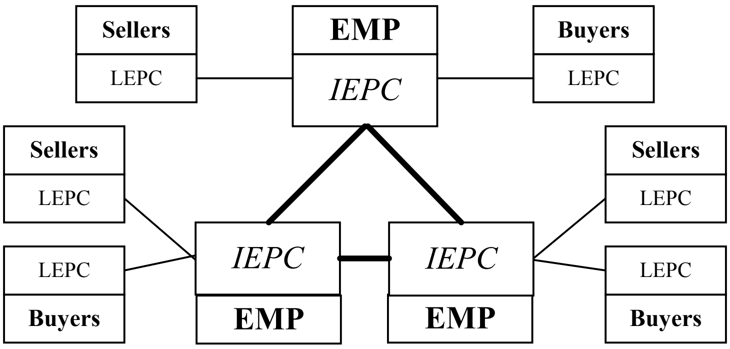


***Figure 1:*** *Partial Replicated Architecture of E-Marketplace*

### 3.1 COPE Model

COPE bases on three assumptions that (1) each local distributed company is a semantic community talking in its own "jargon" (Robinson et al, 1991), (2) the demand on new product representations is continuously increasing and changing, and (3) a concept is independent of its representation (e.g. a TV is independent of whether we call it "TV" or "television"). The design thought is when a company participates in the e-marketplace, it first electronically represents its products in local formats as needed (in many cases, it is important because the local business systems may base on these local semantics) and then maps its local formats onto e-marketplace commonly shared formats. If the e-marketplace providers cannot provide common representations to map local formats, they should real-time create the mappings or provides a means of mapping for local companies.

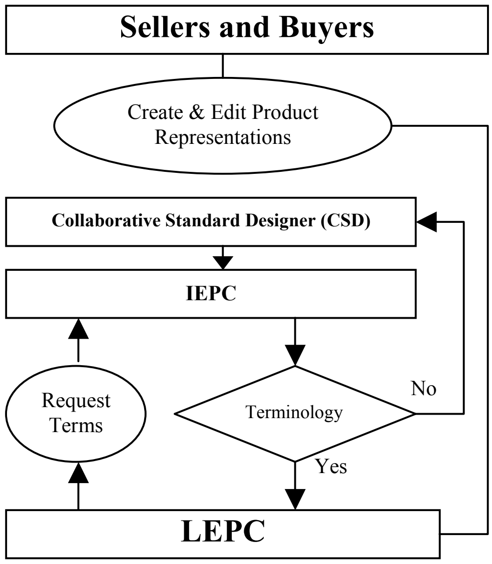


***Figure 2:*** *COPE Model*

COPE models the electronic product representation processes as per this simple thought (see the model shown in Figure 2). Sellers or buyers begin the execution process locally to create or edit local product representations against a LEPC (classified local semantic product representations). If a new term is involved, the seller or buyer requests the e-marketplace shared term from an IEPC (a global common product representation repository maintained by e-marketplace providers). If the shared term is not available from IEPC, the request is forwarded to a *collaborative standard designer* (CSD) where a group of product domain experts aware it and assign a new common term mapped into the local term request.

### 3.2 Interoperation between LEPCs and IEPCs

To understand how COPE model works, we first discuss the **interoperation mechanism**. That is, how various local product representations could be represented on a common ground for interoperation. Different with generic ontology theory, COPE introduces a novel concept-based method to express product semantics and regards all product catalogues as sets of tree-alike neutral concept-based product representations. The expectation is to avoid the rigid formality to semantically define each product representation but to provide flexibility and exactness for local semantic representation requirements for evolving in real-time (Guo and Sun 2003a). To start with the discussion, we first briefly describe how to generically represent a product. For the details about the product representations, please directly contact with the authors.

**Product representation** is defined as a nested triple (product concept, product annotation, product structure (attribute concept, attribute annotation, attribute structure (value concept, value annotation, value structure))), simplified as P = (PC, PA, PS(AC, AA, AS(VC, VA, VS))). A functional relationship P: PA × PS → PC represents a product representation that explicitly specifies the outer layer of a product representation. In this layer, PC is the concepts of product representations, PA defines the denotations and PS defines connotations of product representations. Specifically, the components of a product representation can be decomposed in the following and illustrated in Figure 3 (b).

- **Product concepts** (PC) are described as a set of vectors and are grouped in a *vector tree* in the form of $PC_i^k = \{1, 2i, \ldots, ki\}$ where $k$ is the cardinality denoting the tree *level*, $ki$ is the sibling node *position* of $k$-level under the parent node $PC_i^{k-1} = \{1, 2i, \ldots, (k-1)i\}$, and $PC_1^1 = \{1\}$ is the root. Please see Figure 3 (a).
- **Product annotations** (PA) are natural language descriptions that describe product concepts to specify the denotation or definition scopes of product concepts.
- A **product structure** (PS) is defined by a collection of *attribute representations A* that specifies the connotation of a product concept.
- **Attribute representations**, located in the middle layer of a product representation, are defined as a triple A = (AC, AA, AS) where A: AA × AS → AC. Similar to a product structure, an attribute structure (AS) contains zero to many *value representations V* and specifies the connotation of an attribute concept.
- **Value representations**, the inner layer of a product representation, are defined as a triple V = (VC, VA, VS) where V: VA × VS → VC. A value structure (VS), if it cannot be decomposed, is a leaf node of a product tree and is ready to be instantiated as a *value instance* (VI).

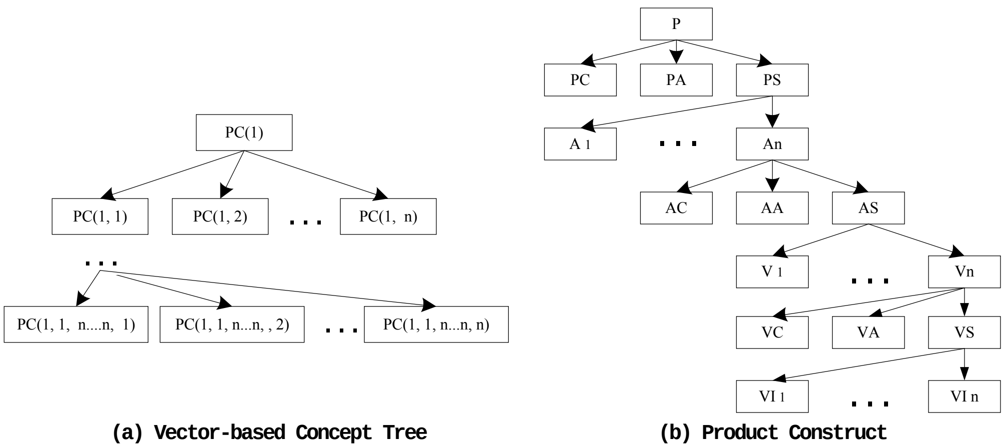


***Figure 3:*** *Vector-Based Concept Tree and Product Representation*

For example, a price attribute of refrigerator "FOB Amsterdam US$1000/piece" can be represented as a nested triple of (1.1.1.1.5, refrigerator, (1.1.1.1.5-3, price ((1.1.1.1.5-3-1, price term, FOB), (1.1.1.1.5-3-2, delivery port, Amsterdam), (1.1.1.1.5-3-3, currency, US$), (1.1.1.1.5-3-4, integer value, 1000), (1.1.1.1.5-3-5, unit scalar, piece)))). In which 1.1.1.1.5 is transformed from PC(1,1,1,1,5), "-3" represents the sibling position of the attribute "price" in the second level of the refrigerator tree, and "FOB, Amsterdam, US$, 1000, piece" are the instantiated leaf value structures of the third level of the refrigerator tree.

A generic product representation is the foundation of COPE model. Based on this construct, a set of **interoperable electronic product catalogues** (IEPCs) can be defined as a set of product catalogues where all possess a common set of product representations that are classified in the vector-based concept tree. In another word, each IEPC represents its product semantics based on the public product concepts by denotations and connotations. In contrast, **local electronic product catalogues** (LEPCs), though they construct similarly like IEPC, adopts their local product representations in semantics and interoperate with each other through a set of replicated IEPCs. An IEPC maintains a complete vector-based concept tree while each LEPC is a subset of IEPC.

In COPE model, *common product representations* are the precondition of interoperation between a set of LEPCs. A common product representation in IEPC can map multiple local product representations. It means that multiple sellers and buyers can apply different semantic product constructs (different annotations and product structures) to a same product concept. This mapping maintains the semantic consistency between various LEPCs if and only if they share the same set of product concepts.

For example, in two LEPCs a price attribute of a refrigerator can be respectively represented as “CIF Hongkong HK$5000 per piece” and “FOB Amsterdam US$1000/piece”. In IEPC, these two representation are abstracted as “ (1.1.1.1.5, refrigerator, (1.1.1.1.5-3, price, ((1.1.1.1.5-3-1, price term, {URL1, URL2}), (1.1.1.1.5-3-2, delivery port, {URL1, URL2}), (1.1.1.1.5-3-3, currency, {URL1, URL2}), (1.1.1.1.5-3-4, integer value, {URL1, URL2}), (1.1.1.1.5-3-5, unit scalar, {URL1, URL2})))). This abstraction denotes two equal product concepts. That is, the set of concepts from URL1 and URL2 are semantically the same in that both products have the same product representation concept structures. They are interoperable though the value instances of URL1 and URL2 may be different and need to be compared in transactional time.

*Vector-based product concept tree* is another important interoperation component of COPE model. It has two functions: to provide a classification mechanism of common product representations according to the semantics not the syntax, and to facilitate as a *mediation mechanism* to share common product representations as long as heterogeneously represented products converge their product semantics to the same product concepts.

For example, (1.1.1.1.5, refrigerator), (1.1.1.1.5, fridge) and (1.1.1.1.5, freezer) are all the same. “Refrigerator” can interoperate with “fridge” and “freezer” if they all share the product concept PC(1,1,1,1,5).

### 3.3 Collaborative Interaction between LEPCs and IEPCs

Besides the interoperation mechanism that COPE model suggests, another main theme of COPE is the collaborative interactions between IEPC and LEPCs. The purpose of providing **collaboration mechanism** is to cope with the emergent heterogeneous electronic product representations and to provide a real-time solution.

A collaboration mechanism is an interaction system for collaborating in the three layers of product representations: product (P), attribute (A) and value (V) shown in Figure 4. Each interaction cycle involves two operation modes: BROWSE and INSERT or BROWSE and REQUEST at the sides of LEPCs, and ACCEPT, CREATE and PUBLISH at the sides of IEPCs. The BROWSE starts from browsing the common annotations and terminating at insert and request. The INSERT is a process mapping local annotations onto common annotations. The REQUEST is a process submitting the requirements of creating the new product terms. The ACCEPT and CREATE operate at IEPCs where a group of new term developers check the emergent requirements and create new terms for PUBLISH. The order of collaborative interactions are specified in the way of product → attribute → value and cannot be reversed, because any lower level concepts are contained in the upper level of concepts.

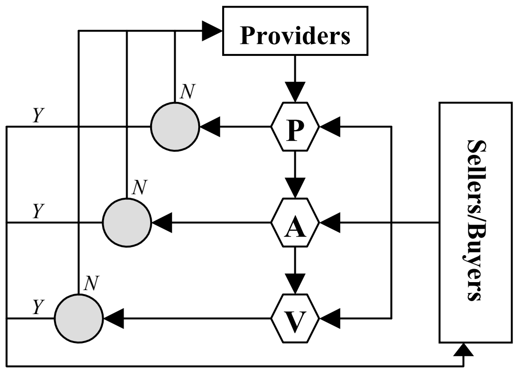


***Figure 4:*** *Interactions of IEPCs and LEPCs*

One outcome of collaborative interactions is there are a number of local annotations that sellers and buyers desire to maintain in IEPCs for whatever reasons. COPE preserves all these local annotations in an appositional list structure of IEPC. For instance, when a French seller wants to include its "réfrigérateur" in the Section 3.2' s example, the IEPC adds it as appositional annotations of concepts in IEPCs. Figure 5 illustrates the IEPC merging effects in the form of *node*(concept, annotations{1, …, n}, lower level structure) according to the vector-based product concepts. The merged result of the above example is "(1.1.1.1.5, {refrigerator, fridge, freezer, réfrigérateur}, (1.1.1.1.5-3, {price, prix}, (1.1.1.1.5-3-5, unit scalar, {$URL_1$, $URL_2$, $URL_3$})))".

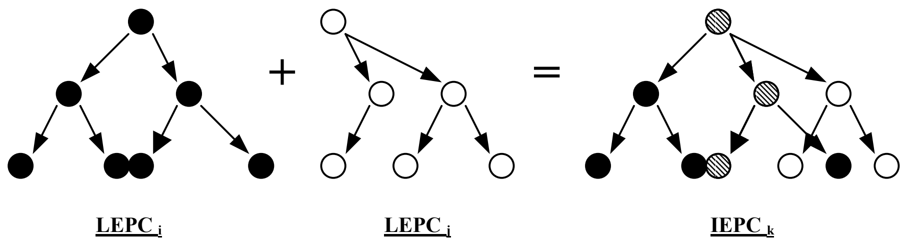


***Figure 5:*** *Merging of LEPCs into IEPC*

### *3.4 COPE Implementation*

Product representations may be blank in the initial time in a catalogue and are evolving in run-time. The suggested implementation of IEPC and LEPC include a *Product Constructor* (PCT), a *Representation Repository* (RRS) and a *Collaborative Representation Editor* (Reditor). The differences are:

- LEPC has a *Value Editor* (Veditor) to dynamically edit attribute values for real-time publishing.
- LEPC contains a *New Term Requester* (NTR) while IEPC has a correspondent *New Term Processor* (NTP) to contingently process the requests.
- In IEPC, a *Reditor* functions either to create terms directly or to collaboratively create new terms (function of CSD shown in Figure 2) while in LEPC a *Reditor* is to edit localized product representations.

- IEPC includes a *Vector Tree Constructor* (VCT).
- IEPC includes a *Replicator* (RPL) to replicate product data between multiple IEPCs.

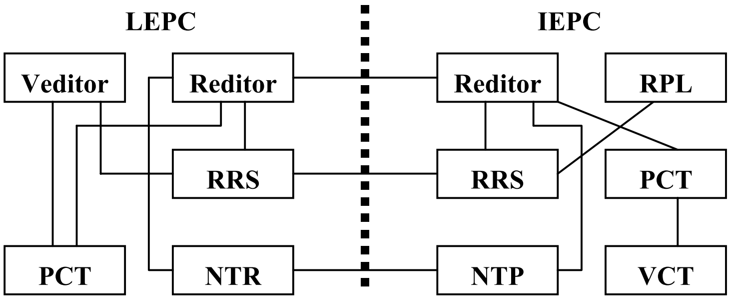


***Figure 6:*** *Electronic Product Catalogue Systems*

The overall electronic product catalogue systems are illustrated in Figure 6. The catalogue system evolves while sellers/buyers and domain experts separately or collaboratively create new product representations through Reditors.

## 4. Conclusion

This paper has contributed a new collaborative approach to represent the emergent product representations based on the calculable and evolvable product concepts. Different from current standard and mediating approaches, COPE has focused on the dynamic facets of flexibility, exactness and evolvability of product representations. These are achieved in our approach by constructing a novel evolvable and calculable vector concept tree, denoting products in a well-defined product representation construct, and binding representations with concepts on product catalogue systems. COPE approach signals a new path to the real-time product representations opposed to the traditional in-house ontology design.

COPE has solved three challenging problems. First, it has provided the exact mapping of product semantics between LEPCs through IEPCs. If different local semantics all commit to the same concepts, they are exactly same and interoperable. The public annotations in IEPCs are the concept commitment mechanism and transparently implemented. Second, it has provided the flexibility to define local product representations. Unlike traditional ontologies that are formally or rigidly defined, representations in COPE are not required to commit the formal representation definitions. COPE allows LEPC designers to partially design their product representations in their local semantic expressions as long as the semantics converge to the public concepts of IEPCs. This flexibility has solved the issues of localization and personalization. Third, it has provided the catalogue evolving ability through the internal vector-based concept tree and the collaboration to meet the emergent requirements. The created new terms are transparently mapped onto the machine-readable product concepts. The evolution can be traced by the concepts themselves. For example, if a "portable refrigerator" is evolved in the sequence of "52: domestic appliances and supplies and consumer electronic products → 14: domestic appliances → 15: domestic kitchen appliances → 1: domestic refrigerator → 3: portable refrigerator", the product concept is PC(1, 52, 14, 15, 1, 3). Any of its higher-level concepts can be immediately converted back to a sequence of natural language annotations. The benefit of this "gene-alike" evolvability is whenever a local product representation commits to a public concept by collaborative interactions with IEPCs, it is immediately usable and interoperable within the global systems domain.

There is still an unsolved problem in COPE. If the merging of LEPCs into IEPCs involves a large number of new term requests, the collaborative domain experts will be kept busy. In such circumstance, the collaboration group may be unable to handle the mass requests. Therefore, certain collaborative aid tools must be further investigated to help process the collaborative new term creation. At the current research status, we assume that, prior to any commercial release, a designed IEPC needs to be almost complete to contain the most of the public concepts for a certain product domain. This will mitigate the tension of the unexpected large volume of requests. Before the collaborative aid tools are developed, a better strategy is to apply this approach for small and medium sized enterprises that own their LEPCs with simpler structured product representations and more stable attribute and value structures.

To accommodate the further investigation of collaborative representation issues and to enhance the COPE model, we plan our future works in the following. (1) To develop a prototype of COPE containing a very small yet complete IEPC to observe the correctness of the merging process of LEPCs and to check the bearable frequency of the new term requests against a given number of domain experts. (2) To represent the semantic contexts of LEPCs, which are in the formats of relational table records, XML files or ad-hoc web pages. The semantic context representations will allow local semantics to be compared against global semantic contextual representations.

The concept-proof prototype of COPE is expected to apply to B2B e-marketplace for directly plugging into the existing applications of enterprise resource planning and supply chain management. It can also be independent front-end product catalogue systems for various small and medium enterprises to extend their business to the global e-marketplace.

## Acknowledgement

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

## References

Arpinar, S., and A. Dogac (2000) 'Provision of Market Services for eCo Compliant Electronic Marketplaces', *ACM SIGMOD Record* 29(3):24-30.

Bakos, Y. (1998) 'The Emerging Role of Electronic Marketplaces on the Internet', *Communications of the ACM* 41(8): 35-42.

Chen, S., and C. Yeh (2002) 'On the Emergent Properties of Artificial Stock Markets: the Efficient Market Hypothesis and the Rational Expectations Hypothesis', *Journal of Economic Behavior & Organization* 49:217-239.

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

Dogac, A. and I. Cingil (2001) 'A Survey and Comparison of Business-to-Business E-Commerce Frameworks', *ACM SIGecom Exchanges* 2(2):14-25.

Dogac, A., Tambag, Y., Pembecioglu, P., Pektas, S., Laleci, G. B., Kurt, G., Toprak, S., and Y. Kabak (2002) 'An ebXML Infrastructure Implementation through UDDI Registries and RosettaNet PIPs', Proceedings of the 2002 *ACM SIGMOD International Conference on Management of* Data: 512-523, Madison, Wisconsin, USA.

Fensel, D., Ding, Y., Omelayenko B., Shulten E., Botquin, G., Brown, M. and Flett, A. (2001) 'Product Data Integration in B2B E-Commerce', *IEEE Intelligent Systems* 16(4): 54-59.

Fomin, V., and T. Keil (2000) 'Standardization: Bridging the Gap between Economic and Social Theory', *AIS ICIS 2000*, Brisbane, Australia, 1-3 December.

Ginsburg, M., Gebauer, J. and A. Segev (1999) 'Multi-Vendor Electronic Catalogs to Support Procurement: Current Practice and Future Directions', *12th Int'l Bled Electronic Commerce Conference*, Bled, Slovenia, 7-9 June.

Guo, J. and C. Sun (2003a) 'Concept Exchange: Constructing Interoperable Electronic Product Catalogues in an Emergent Environment', *IEEE Conference on Electronic Commerce*, Newport Beach, CA, USA, 24-27 June.

Guo, J. and C. Sun (2003b) 'Measurement Models for Survivability and Competitiveness of Very Large E-Marketplace', *The 3rd Int'l Conf. of Computational Science (ICCS 2003)*, St. Petersburg, Russian Federation, 2-4 June.

Hoffner, Y., Facciorusso, C., Field, S., and A. Schade (2000) 'Distribution Issues in the Design and Implementation of a Virtual Market Place', *Computer Networks* 32:717-730.

Jung, Y., and Lee, A. (2000) 'Design of a Social Interaction Environment for Electronic Marketplaces', in *Proceedings of ACM DIS'00*: 129-136, Brooklyn, New York, USA.

Keller, A. M. and Genesereth, M. R. (1996) 'Multivendor Catalogues: Smart Catalogues and Virtual Catalogues', *EDI Forum: Journal of Electronic Commerce* 9(3): 87-93.

Kim, W., Kerschberg, L., and A. Scime (2002) 'Learning for Automatic Personalization in a Semantic Taxonomy-based Meta-Search Agent', *Electronic Commerce Research and Applications* 1 (2):150-173.

Liu, D., Lin, Y., Chen, C. and Y. Huang (2001) "Deployment of personalized e-catalogues: An agent-based framework integrated with XML metadata and user models', *Journal of network and Computer Applications* 24: 201-228.

Maidantchik, C., Montoni, M., and G. Santos (2002) 'Learning Organizational Knowledge: An Evolutionary Proposal for Requirements Engineering', in *Proceeding of ACM SEKE'02*: 151-157, Ischia, Italy.

Melnik, S. and S. Decker (2000) 'A Layered Approach to Information Modeling and Interoperability on the Web', *ECDL-2000*, Lisbon, Portugal, 21 September.

Ngwenyama, O. K. (1998) 'Groupware, social action and organizational emergence: on the process dynamics of computer mediated distributed work', *Accounting, Management and Information Technology* 8: 127-146.

Omelayenko, B. (2002a) 'Ontology-Mediated Business Integration', In: *Proceedings of the 13-th EKAW 2002 Conference*: 264-269, Siguenza, Spain.

Omelayenko, B. (2002b) 'Integrating Vocabualry: Discovering and Representating Vocabualry Maps', *ISWC-2002*, Sardinia, Italy, 9-12 June.

Omelayenko, B. and D. Fensel (2001) 'An Analysis of B2B Catalogue Integration Problems', in *Proc. of ICEIS-2001*, Setubal, Portugal, 7-10 July.

Omelayenko, B., Fensel, D. and C. Bussler (2002) 'Mapping Technology for Enterprise Integration', *Proceedings of the Fifteenth International FLAIRS Conference (FLAIRS-2002)*: 419-424, Pensacola, FL, USA.

Omelayenko, B. and D. Fensel (submitted) 'Scalable Document Integration for B2B Electronic Commerce'.

Quix, C., Schoop, M., and M. Jeusfeld (2002) 'Business Data Management for Business-to-Business Electronic Commerce', *Special Section on Data Management Issues in E-commerce, ACM Sigmod Record* 31(1): 49-54.

Robinson, M. and L. Bannon (1991) 'Questioning Representations', *Proceedings of ECSCW'91*: 219-233, Amsterdam, Holland.

Shim, S., Pendyala, V., Sundaram, M., and J. Gao (2000) 'Business-to-business E-Commerce Frameworks', *IEEE Computer* 33(10): 40-47.

Sommer, R., Gulledge, T. and D. Bailay (2002) 'The n-Tier Hub Technology', *ACM SIGMOD Record* 31(1): 18-23.

Stanoevska-Slabeva, K., and Schmid, B. (2000), 'Internet Electronic Product Catalogs: an Approach beyond Simple Keywords and Multimedia', *Computer Networks* 32: 701-715.

Sun, C.; Jia, X.; Zhang, Y., Yang, Y. and Chen, D. (1998) 'Achieving Convergence, Causality Preservation, and Intention Preservation in Real-Time Cooperative Editing Systems', *ACM Transactions on Computer-Human Interaction* 5(1): 63-103.

Sun, C. and Chen, D. (2002) 'Consistency Maintenance in Real-Time Collaborative Graphics Editing Systems', *ACM Transactions on Computer-Human Interaction* 9(1): 1-41.

Truex, D. P., Baskerville, R., and H. Klein (1999) 'Growing Systems in Emergent Organizations', *Communications of the ACM* 42(8): 117-123.

Truex, D., Baskerville, R., and Travis, J. (2000) 'Amethodical Systems Development: the Deferred Meaning of Systems Development Methods', *Accounting, Management and Information Technologies* 10: 53-79.

Yen, B., and Kong R. (2002) 'Personalization of information access for electronic catalogs on the web', *Electronic Commerce Research and Applications* 1: 20-40.