Solving integration problems of e-commerce standards and initiatives through ontological mappings

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Abstract

The proliferation of different standards and joint initiatives for the classification of products and services (UNSPSC, e-cl@ss, RosettaNet, NAICS, SCTG, etc.) reveals that B2B markets have not reached a consensus on coding systems, level of detail of their descriptions, granularity, etc. This paper shows how these standards and initiatives, which are built to cover different needs and functionalities, can be integrated using a common multi-layered knowledge architecture through ontological mappings. This multi-layered ontology will provide a shared understanding of the domain for applications of e-commerce, allowing information sharing and interoperation between heterogeneous systems. We will present a tool called *WebPicker* and a method for integrating these standards and initiatives, enriching them and obtaining the results in different formats using the *WebODE* platform. As an illustration, we show a case study on the computer domain, presenting the ontological mappings between UNSPSC, e-cl@ss, RosettaNet and an electronic catalogue from an e-commerce platform.

1 Introduction

The popularity of Internet and the huge growth of new Internet technologies have led in the last years to the creation of a great amount of e-commerce applications ([McGuinness, 99] [Fensel, 00] [Berners-Lee, 99]). However, technology is not the unique key factor for the development of current e-applications. The context of e-commerce, and especially the context of B2B (Business to Business) applications, requires that an effective communication between machines is possible. In other words, semantic interoperability between the information systems involved in the communication is crucial.

Two extremely important factors contribute to this effective non-human communication: (1) a common language in which the resources implied in the communication can be specified, and (2) a shared knowledge model and vocabulary between the different systems that are present in the whole process. We will call them the *syntactic* and *semantic* dimensions.

The first dimension has led to the creation of varied representation languages for the specification of web resources (XOL, SHOE, OML, RDF, RDF Schema, OIL and DAML+OIL). A comparative study of the expressiveness and reasoning mechanisms of these languages can be found in [Corcho et al, 00].

The semantic dimension is related with the knowledge model and vocabulary used by the systems involved in the communication. In that sense, the use of a shared and common knowledge model and vocabulary increases the interoperability among existing and future information systems. This problem can be solved by ontologies. In fact, ontologies can be defined as "formal[1] and explicit specifications of a shared conceptualization" [Studer et al, 98]. If we compare this definition with the one given for the Semantic Web in [Berners-Lee, 99] ("the conceptual structuring of the Web in an explicit machine-readable way"), we can foresee that ontologies will play a key role in its development, and hence they will be applied to the key areas of the Semantic Web: e-commerce among others.

Large and consensuated knowledge models for e-commerce applications are difficult and expensive to build. Several standards and initiatives (UNSPSC, RosettaNet, e-cl@ss, NAICS, SCTG, etc[2]) came up in the previous years to ease the information exchange between customers and suppliers, and between different suppliers, by providing frameworks to identify products and services in global markets. However, the proliferation of standards and initiatives reveals that B2B markets have not reached a consensus on coding systems, level of detail, granularity, etc., which is an obstacle for the interoperability of applications following different standards. For instance, an application that uses the UNSPSC code cannot interoperate with an application that follows the e-cl@ss coding system. Consequently, we claim that with the current state of affairs it is more suitable to establish ontological mappings between existing standards and initiatives than to pretend to build *the* unified knowledge model from scratch.

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[1] Formal must be understood as machine-readable.

[2] UNSPSC(http://www.unspsc.org), e-cl@ss(http://www.eclass.de) RosettaNet (http://www.rosettanet.org/), NAICS (http://www.census.gov/epcd/www/naics.html), SCTG (http://www.bts.gov/programs/cfs/sctg/welcome.htm).

Several architectures for the Semantic Web have arisen recently. Examples can be found in [Ambroszkiewicz, 00], for solving semantic interoperability to assure a meaningful interaction between heterogeneous agents, [Melnik et al, 00], where a layered architecture is proposed to solve the interoperability of different Web information models and [Benslimane et al, 00], where a multi-layered ontology definition framework is presented in a urban management application.

1.1 Aim of this paper

In this paper, we will focus on the semi-automatic integration of existing standards and initiatives in a multi-layered knowledge model for e-commerce applications through ontological mappings. We import semi-automatically standards and joint initiatives into the *WebODE* platform [Arpírez et al, 01] using the tool *WebPicker*, we integrate[3] them by means of ontological mappings, and enrich the unified knowledge model using *WebODE*. The resulting multi-layered knowledge architecture can be exported partially or completely into different representation languages (XML, RDF(S) and OIL).

The final multi-layered knowledge model will allow the intra-operability of vertical markets in specialized domains and also the inter-operability between different vertical markets (also known as horizontal markets).

The logical organization of the contents of the paper is as follows: Section 2 outlines the main steps of the proposed method, providing a global view of the whole process. Section 3 describes the standards and initiatives that we have selected as sources of information, as well as a product catalogue from an e-commerce platform. Section 4 describes the *WebODE* platform, which gives support for our method. In section 5, we describe briefly the tool *WebPicker* and the process of semi-automatic extraction of knowledge from the different sources of information. Section 6 deals with the final knowledge architecture that integrates the different proposals, paying special attention to the mappings between different layers of ontologies. Section 7 presents the main guidelines we have followed for ontology integration and enrichment. Section 8 deals with the automatic implementation in different languages from partial or global views of the ontologies. Finally, sections 9 and 10 will present the main conclusions that can be extracted from the work performed and future lines of work.

2 A method for reusing standards and initiatives to create e-commerce ontologies

In this section, we will explain the main steps of the method we propose for building e-commerce ontologies from standards and initiatives:

1. **Selection of standards, joint initiatives, laws, etc., of classification of products and services**. In this step, we select the sources of information that we consider relevant for our domain, from existing global or more specific agreements on classifications of products and services. They usually provide a commonly agreed taxonomy of products and/or services, which usually offers from 2 to 5 levels of depth.
2. **Knowledge models extraction**. This step semi-automates the process of knowledge acquisition from the sources of information previously selected and adapts them to the *WebODE's* knowledge model, which can be expressed in XML. This activity is performed using the tool *WebPicker*. Finally, the import service of *WebODE* is used to upload them into the platform.
3. **Design of a multi-layered knowledge architecture**. Taking into account features of the selected sources of information (covering, globality, specificity, etc), the aim of this step is the identification of relationships between components in the different taxonomies.
4. **Integration of knowledge models**. Knowledge models that have been automatically imported into the *WebODE* platform are integrated in the layered architecture, using the ontological mappings identified at the design phase.
5. **Enrichment of the integrated ontology**. Current standards do not include attributes for products, relations between products, disjoints nor exhaustive knowledge, functions, axioms, etc. Most of them just represent taxonomies of concepts, and other ones just include some attributes for them. Hence, they can be enriched with extra information when possible.
6. **Ontology exportation**. The whole ontology or specific parts of the ontology can be exported into different kinds of languages, so that they can be tractable by the systems that are using it for any application.

The following sections will describe this method and will apply it to a case study in the computers domain.

3 E-commerce standards as knowledge models

Standards, joint initiatives, laws, etc., are good sources for ontology building, since they are pieces of information that have been agreed by consensus or are followed by a community.

In this section, we present three proposals for the classifications of products that have arisen in the context of e-commerce: UNSPSC, RosettaNet and e-cl@ss. These initiatives are being developed to ease the information exchange between customers and suppliers, and between suppliers, by providing consistent, standardised frameworks to identify products and services in a global market.

Other similar approaches exist and are available (NAICS, for US, Canada and Mexico, SCTG for transporting goods, etc). We have just selected the ones enumerated before to show the adequacy of our work in this context.

[3] We talk about integration of ontologies instead of merge because we do not pretend to build a single knowledge model out from the existing ones, but preserve them in a common architecture.

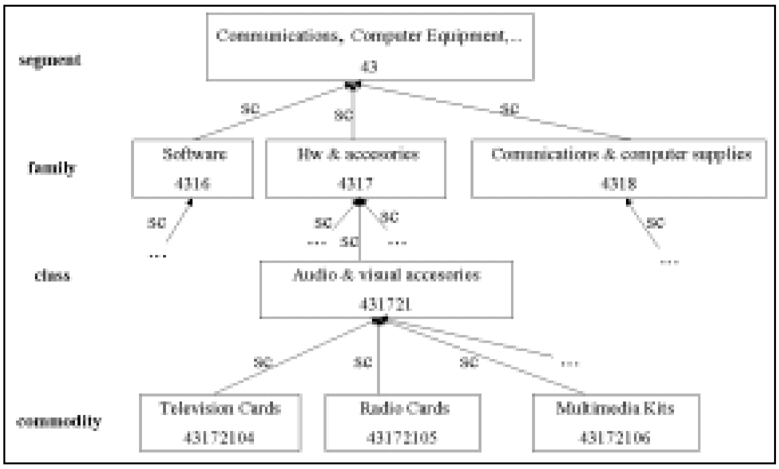

Figure 1. A snapshot of the classification of UNSPSC for computer equipment.

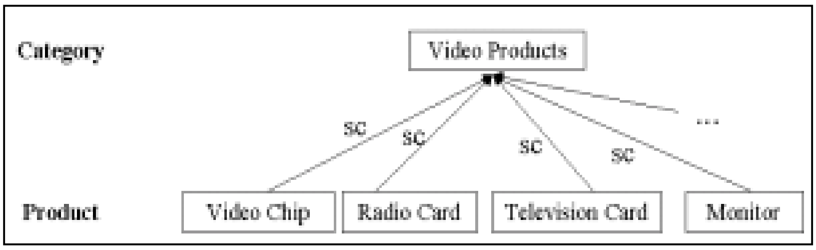

Figure 2. A snapshot of the classification of video products of the RosettaNet taxonomy.

Finally, we present an electronic catalogue from an e-commerce platform, which fits in the ontology architecture.

3.1 UNSPSC (Universal Standard Products and Services Classification Code)

UNSPSC is a non-profit organisation composed of partners such as 3M, AOL, Arthur Andersen, BT, Castrol and others.

Its coding system is organised as a five-level taxonomy of products, each level containing a two-character numerical value and a textual description. These levels are defined as follows:

- **Segment.** The logical aggregation of families for analytical purposes.
- **Family.** A commonly recognised group of inter-related commodity categories.
- **Class.** A group of commodities sharing a common use or function.
- **Commodity.** A group of substitutable products or services.
- **Business Function.** The function performed by an organisation in support of the commodity. This level is seldom used.

The current version of the UNSPSC classification contains around 12000 products organized in 54 segments. Segment 43, which deals with computer equipment, peripherals and components, contains around 300 kinds of products.

Figure 1 shows a small part of the UNSPSC classification, related to computer equipment (segment 43 of the UNSPSC classification).

The main drawbacks of UNSPSC are: (a) the lack of vertical cover of the products and services which appear in the classification; (b) the lack of attributes attached to the concepts that appear in the taxonomy[4]; (c) the design of the classification without taking into account the inheritance between the products that are described; (d) the non-providing different views of the classification, taking into account cultural and social differences, where classifications could be made in different ways than the ones presented in this standard.

3.2 RosettaNet Technical Dictionary

RosettaNet is a self-funded, non-profit consortium composed of several information technology and electronic components companies. Therefore, this classification is just focused on electronic equipment.

RosettaNet classification does not use a numbering system, as UNSPSC does, but it is just based on the names of the products it defines. This classification is related to the UNSPSC classification by providing the UNSPSC code for each product defined in it.

[4] Initiatives such as UCEC (*Universal Content Extended Classification*) are trying to solve this problem by adding attributes to the concepts in the last level of the taxonomy. However, they are not freely available.

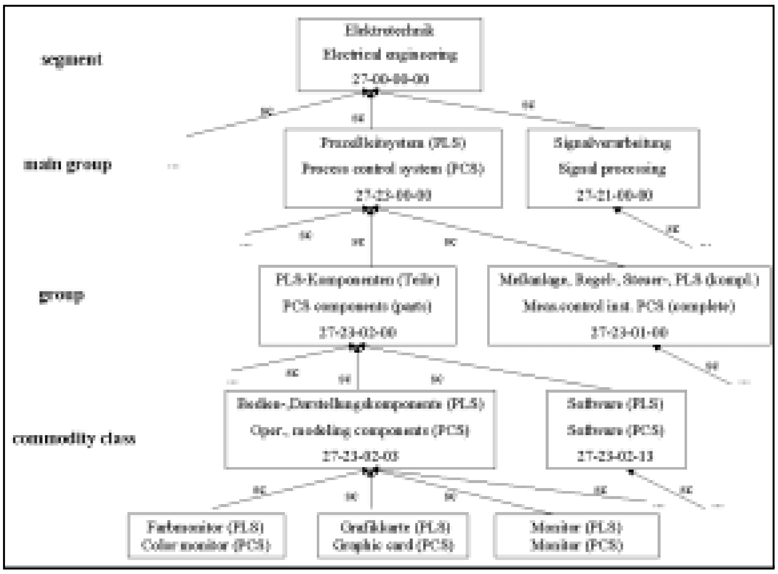

Figure 3. A snapshot of the classification of e-cl@ss for electrical engineering products (in German and English).

RosettaNet has just two levels in its taxonomy of concepts:

- **RN Category**. Group of products (i.e., *Video Products*)
- **RN Product**. Specific product (i.e., *Television Card*, *Radio Card*, etc.).

The RosettaNet Technical Dictionary classification consists of 14 categories and around 150 products. It must be taken into account (in relationship with UNSPSC) that RosettaNet just deals with the electronic equipment domain, which is more specific than the UNSPSC classification.

Figure 2 shows part of the RosettaNet classification, related to video products for computer equipment.

The main drawback of this taxonomy is that there are only two levels of classification, which implies that the structure of the taxonomy is very simple. This classification also shares some of the problems of UNSPSC, namely, lack of attributes and design without taking into account inheritance in the taxonomy of concepts.

The problem of using this classification in a vertical market is partially solved, as it is focused on the specific domain of electronic equipment, although it just offers a low level of detail in this domain.

3.3 E-cl@ss

E-cl@ss is a German initiative to create a standard classification of material and services for information exchange between suppliers and their customers. In fact, it is similar to the UNSPSC initiative, and will be used by companies like BASF, Bayer, Volkswagen-Audi, SAP, etc.

The e-cl@ss classification consists of four levels of concepts (called *material classes*), with a numbering code similar to the ones of UNSPSC (each level has two digits that distinguish it from the other concepts). These levels are: *Segment, Main group*, *Group* and *Commodity Class*.

e-cl@ss levels are equivalent to the first four ones provided in UNSPSC; hence, they are not described any further. Finally, inside the same commodity class we may find several products (in this sense, several products can share the same code, and this could lead to a fifth level with all of them, as it can be seen in figure 3).

It also contains around 12000 products organized in 21 segments. Segment 27, which deals with *Electrical Engineering*, contains around 2000 products. Finally, the main group 27-23, which deals with *Process Control Systems*, together with the main groups 24-01 to 24-04, which deal with *Hardware*, *Software*, *Memory* and other computer devices, contain around 400 concepts.

This classification suffers from the same drawbacks as UNSPSC. In fact, it is a similar approach, although within a smaller social environment, as it will be used by German companies. Additionally, terms and their descriptions are written both in English and German.

3.4 E-commerce platform catalogue

We have selected a catalogue of products from an existing e-commerce platform that deals with computer equipment, so that we have found a common domain to show a whole case study in this paper.

This catalogue is structured in two kinds of elements, called categories and items (very similar to the RosettaNet structure). Catalogue items are actual products sold by the e-commerce platform. Attributes are defined on them with the main characteristics of each product. Categories are groups of products (items) or groups of other categories. They are created with the aim of grouping products taking into account factors such as marketing, common uses, etc. They do not have attributes defined on them.

The selected catalogue contains around 400 items, with 2/3 levels of depth in the hierarchy of categories. Figure 4 shows some elements in the catalogue.

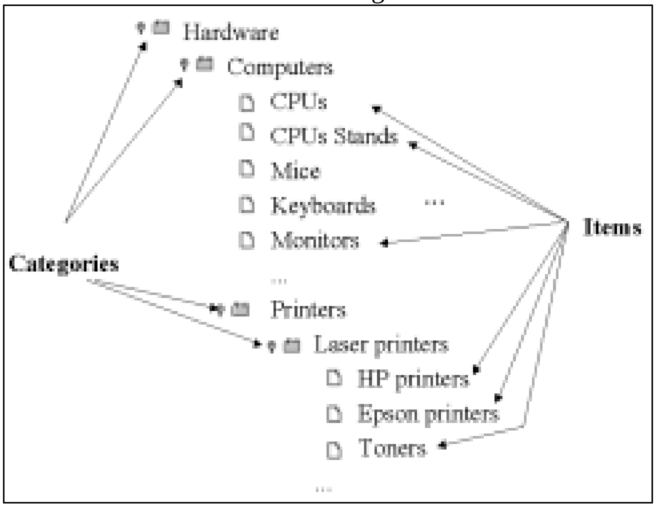

Figure 4. A snapshot of some elements in the catalogue.

In contrast with the classifications presented before, catalogues cannot be considered themselves as good sources of information for building ontologies, as they are not shared by a community nor represent any consensus. They are designed instead as classifications of products and services from the market point of view.

However, catalogues play an important role in the whole e-business process: they present the set of products offered by an e-commerce application and they are the front-end in the exchange of products in B2C and B2B environments.

4 WebODE

WebODE [Arpírez et al, 01] is an ontological engineering platform that allows the collaborative edition of ontologies at the conceptual level, providing means for their automatic exportation and importation in XML and their translation into and from varied ontology specification languages.

WebODE's conceptual model is based on the intermediate representations of METHONTOLOGY [Fernández et al, 99], allowing for the representation of concepts and their attributes (both class and instance attributes), taxonomies of concepts, disjoint and exhaustive knowledge, ad-hoc relations between concepts, constants, axioms and instances.

The conceptualization phase of ontologies is aided by both a HTML form-based and a graphical user interfaces, a user-defined-views manager, a consistency checker for the components defined in the ontology, an inference engine implemented in Prolog to perform inferences with the information provided, an axiom builder to assist the creation of these components and a the documentation service.

The platform is built upon an application server, which provides high extensibility by allowing the addition of new services and the common use of services provided by the platform. Examples of these services are the catalogue manager, the taxonomy merger and *WebPicker*, which is presented in the next section.

5 *WebPicker*: obtaining knowledge models from structured information

The classifications described in the previous section are represented using different representation formats. UNSPSC is available in HTML (taxonomies are presented visually); RosettaNet is in HTML, XML and Microsoft Excel, and e-cl@ss is available in Microsoft Excel; finally, the catalogue is available in XML.

If we want to work with all this information together, we should use a common representation format for it, so that the treatment of this information can be performed homogeneously, no matter what its origin is. We have decided to use the *WebODE* knowledge model [Arpírez et al, 01] as the reference model where all the information will be translated to.

In [Corcho et al, 01], we present in detail *WebPicker* and the different processes we have followed to translate the contents of the different sources of information into *X-WebODE*, the XML syntax of *WebODE*, so that we have been able to import them into the platform. As an illustration, we present figure 5, which shows a summary of the process of importing UNSPSC[5] into *WebODE*.

The figure shows that UNSPSC information is available in several HTML pages, one per UNSPSC segment. Once identified the valuable information in each page, it was extracted with *WebPicker*, which converted it into XML, and finally, all the XML documents were included in a single XML document that followed the grammar defined in the *WebODE* DTD [Arpírez et al, 01].

The classification was uploaded into the WebODE platform using its XML import facility.

The processes applied for RosettaNet, e-cl@ss and the catalogue were very similar.

6 Multi-layered ontology architecture design

Before describing our contribution to ontology architectures, we will revise briefly some important pieces of the state of the art in the classification of ontologies.

Till now, many different types of ontologies have been identified and classified. [Mizoguchi et al, 95] distinguish between domain ontologies, common-sense ontologies, meta-ontologies and task ontologies. [Van Heijst et al, 97] classify ontologies using two dimensions: the amount and type of structure and the subject of the conceptualization. Terminological, information and knowledge modeling ontologies usually have a richer internal structure, and they belong to the first dimension. In the second dimension, they distinguish application, domain, generic and representation ontologies. A common framework for understanding both classifications in a unified manner is shown in figure 6.

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5 UNSPSC transformation allowed us to detect missing pieces of information in the HTML pages and errors on the numbering of some products that were reported to the UNSPSC responsible.

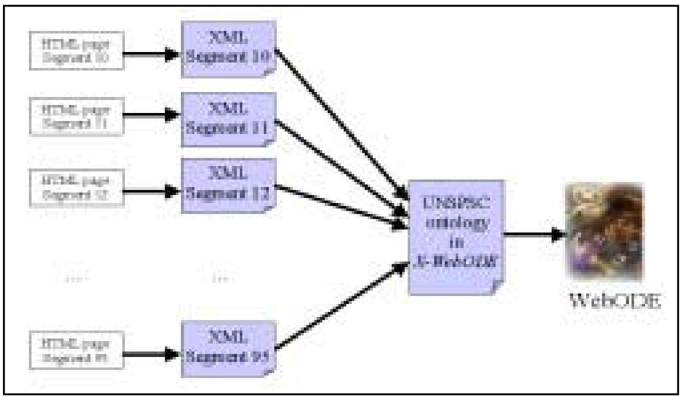

Figure 5. The process of importing UNSPSC into *WebODE*.

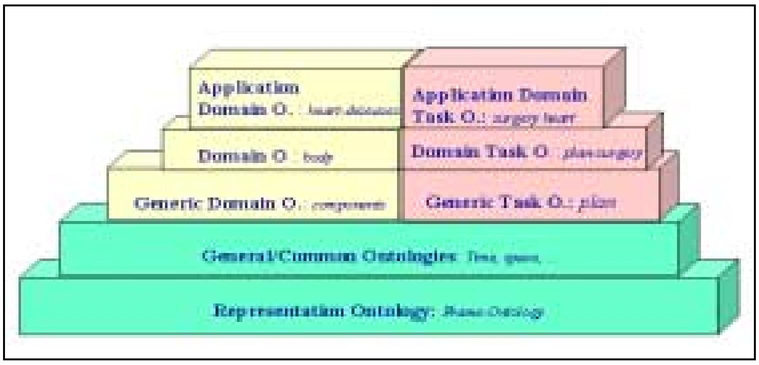

Figure 6. Libraries of ontologies.

Figure 6 also shows that ontologies are usually built on top of other ones (application domain ontologies on top of domain ontologies, domain ontologies on top of generic domain ontologies, and so on). This layered approach for the building of ontologies makes it easier their development, taking into account the following design criteria:

- Maximum monotonic extensibility [Swartout et al, 97] [Gruber, 93], as new general or specialized terms can be included in the ontology in such a way that it does not require the revision of existing definitions.
- Clarity [Gruber, 93], as the structure of terms implies the separation between non similar terms (common-sense terms vs. specialized domain ontologies).

6.1 A proposal for a multi-layered architecture of e-commerce ontologies

Our approach consists of structuring our ontologies in several layers, following the criteria presented above. This architecture will be illustrated with examples taken from the sources of information presented in section 3.

Figure 7 shows the ontological mappings that can be established between ontologies present in the architecture.

In this sense, we propose a common *upper level ontology*, which defines the common terms used in the communication between systems, providing a unified upper-level vocabulary for all the systems accessing the ontology.

Generic e-commerce ontologies provide broad, coarse-grained classifications of products and services in the e-commerce domain.

More specialized ontologies (*regional e-commerce ontologies*) can be created for the different domains that will be handled by the different systems (electronic equipment, tourism, vehicles, etc). The concepts of these ontologies will be mapped to the concepts in the generic e-commerce ontologies, so that they share a common root for all the concepts. These ontologies can be organized in as many layers as the ontology developers consider necessary.

Optionally, very specialized *local e-commerce ontologies* could be created for each one of the systems that access to the whole structure of the knowledge (electronic equipment companies, tourism companies, vehicle manufacturers, etc).

Finally, the lowest level (below *local e-commerce ontologies*) will contain the catalogues, with their products (*items*) and groups of products (*categories*) linked to one or more concepts at any level of the whole ontology (preferably the most specific ones).

As set out before, this layered approach will allow the intra-operability of vertical markets in specialized domains and also the inter-operability between different vertical markets (also known as horizontal markets).

6.2 A case study in the computers domain

Considering the main features of the standards and initiatives that we have selected for this study and imported

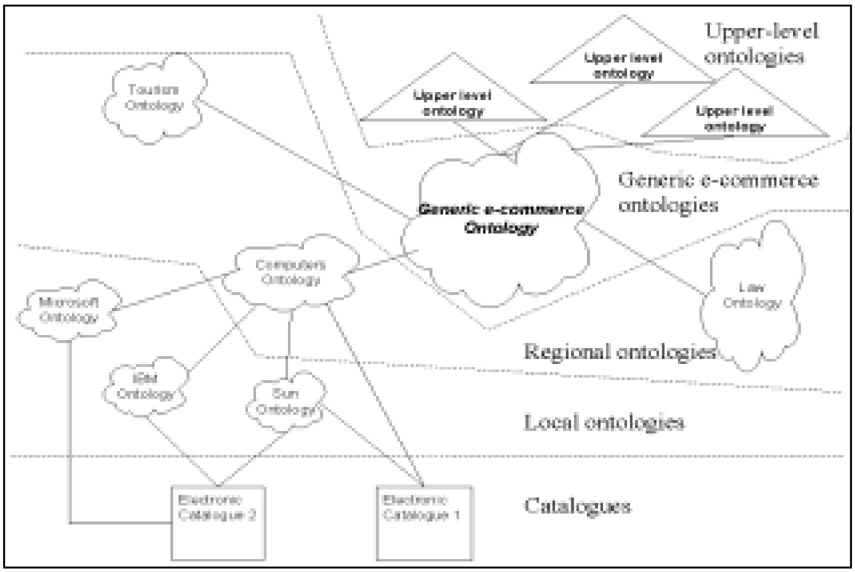

Figure 7. General ontological mappings between ontologies, and between ontologies and catalogues.

into *WebODE*, we can try to fit them in the proposed architecture, with the following roles for each of them[6]:

UNSPSC can act as a generic e-commerce ontology, where a coarse-grained classification of products and services is offered. Hence, it can provide the roots for all the products and services that will be inserted in the different regional and local ontologies that use it, and could be also interesting to use it for allowing the interoperability between different vertical markets (because of its wide covering of products and services).

The same applies to e-cl@ss, whose development is being performed following a similar set of criteria. In this sense, both classifications share most of the products and services, although they are classified in different ways.

Finally, RosettaNet will play the role of a *regional ontology* in the domain of electronic equipment, focusing on this particular business area, although not presenting too much detail on the components that can be sold/bought/exchanged.

More regional ontologies could be created below RosettaNet (for instance, regional ontologies for computer manufacturers, hi-fi equipment, electrical device manufacturers, etc.), and local ontologies could be also created: for instance, one local ontology for each specific company in each of the business sectors identified above (IBM, HP, Sun, etc.).

Finally, we have to take into consideration the role of the catalogue presented in section 3.4. Its items and categories are mapped to concepts in the ontology. Using these mappings, we will be able to access the attributes of any product through the taxonomy of concepts of the ontology, we will be able to perform reasoning with the information represented in the ontology, we will facilitate searches of products from many different points of view, etc.

Figure 8 summarizes the ontological mappings between the standards and between the standards and catalogues in the context of the architecture proposed in this paper.

Please note that we present two generic e-commerce ontologies in our example. This fact enforces the idea of facilitating searches of products using different points of view, as products will commonly be classified with respect to the different standards and initiatives, and ontological mappings between both of them will be also established. Communication between systems using the ontologies in this architecture is still good, though providing much richer information on products that are placed in its lowest levels.

An additional remark must be made on the flexibility of this architecture. In case we want to include another classification in it, we shall study its characteristics and decide the level it should be placed in. The structure we present in figure 8 is adapted for this case study, but new ontologies could appear above our current generic e-commerce ontologies and additional intermediate levels in the regional or local ontologies area could also appear.

7 Ontology integration and enrichment

7.1 Ontology integration

Once sketched the similarities and differences between the standards described and the role of each of them in the multi-layered architecture proposed, we will make a detailed analysis of the relationships that can be established between their terminology.

1. We will start with the ontological mappings **between ontologies**, be them placed at the same level in the architecture or at different levels:

Equivalence mappings. They occur when a concept in the ontology is equivalent (or the most similar) to other concept

[6] There are no strict rules for the decision of the role of each classification in the overall architecture. It usually depends on its degree of generality and granularity

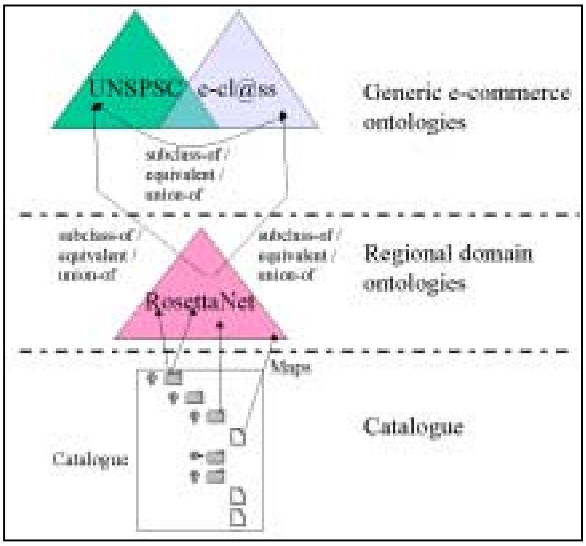

Figure 8. Ontological mappings between UNSPSC, e-cl@ss, RosettaNet and the catalogue.

or concepts in another ontology.

This ontological mapping is especially interesting between ontologies at the same level, as it allows interaction between systems using different standards or initiatives. It also provides several means of classifying products. For instance, concept *Diskette* in e-cl@ss (24-03-03-00) and *Floppy diskettes* in UNSPSC (43180601) are equivalent.

There are also equivalence mappings between concepts from ontologies in different layers, as it is shown in figure 9. For instance, concept *Monitor* in RosettaNet is equivalent to concept *Monitors* in UNSPSC (43172401).

As RosettaNet has already predefined the equivalence mappings between its concepts and concepts in UNSPSC, this task has been performed automatically with *WebPicker*. However, some of these equivalence mappings have been transformed into subclass-of ones after a detailed analysis of both standards, as it is shown in figure 9 with concepts *Video chip* in RosettaNet and *Hybrid Integrated Circuits* in UNSPSC (321017).

Subclass-of mappings. They occur when a concept in an ontology is a subclass of other concept or concepts in another ontology.

For instance, concept *Dot Matrix Printers* in UNSPSC (43172503) is subclass of concepts *Printer (PCS)* and *Printer (proc. comp.)* in the e-cl@ss classification (27-23-02-12 and 27-23-02-34).

This mapping can be also established between concepts in ontologies from different layers. For instance, concept *Laser Printer* in RosettaNet is also a subclass of *Printer (PCS)* and *Printer (proc comp)* in e-cl@ss classification (27-23-02-12 and 27-23-02-34).

An important remark must be made at this point. Brother concepts in an ontology do not have to share the same parent concepts in another ontology: classification criteria may be different in both ontologies.

Union-of mappings. They occur when a concept in an ontology is equivalent to the union of two or more concepts in another ontology.

For instance, concept *Monitors* in UNSPSC (code 42172401) is equivalent to the union-of concepts *Monitor (PCS)* and *Monitor* (codes 27-23-02-03 and 24-01-06-00, respectively) in e-cl@ss.

2. The second kind of ontological mappings that we have studied deal with **catalogues and ontologies**.

We have just considered *maps* between items (and categories) in the catalogue and concepts in the ontology: an item/category in the catalogue can be mapped to one or more concepts in the ontology (be it the local ontology, any of the regional ontologies or the generic e-commerce ontologies), stating that the item/category is defined by the concept(s) in the ontology to which it is linked.

The previous remark about subclass-of mappings between concepts in ontologies can also be applied to this case. Taking into consideration design issues of catalogues, it will be common to find items under the same category linked to very distant concepts in the ontology. For instance, let's suppose items in the catalogue that are grouped together because of their use: *laser printers* and *toners*. They will be probably mapped to very distant concepts in the ontology.

Other works on ontology integration have proposed their sets of inter-ontology relationships. For instance, the OBSERVER [Mena et al, 2000] system proposes synonym, hyponym, hypernym, overlap, disjoint and covering relationships between concepts in the same and different ontologies. DWQ [Calvanese et al, 98] proposes intermodel assertions such as subsetting, definition, completeness, synonym and homonym relationships.

Although terminology used in different projects is different, the meaning of these relationships is very similar to each other. In our work, we propose the equivalence relationship (which is named synonym in both projects), the

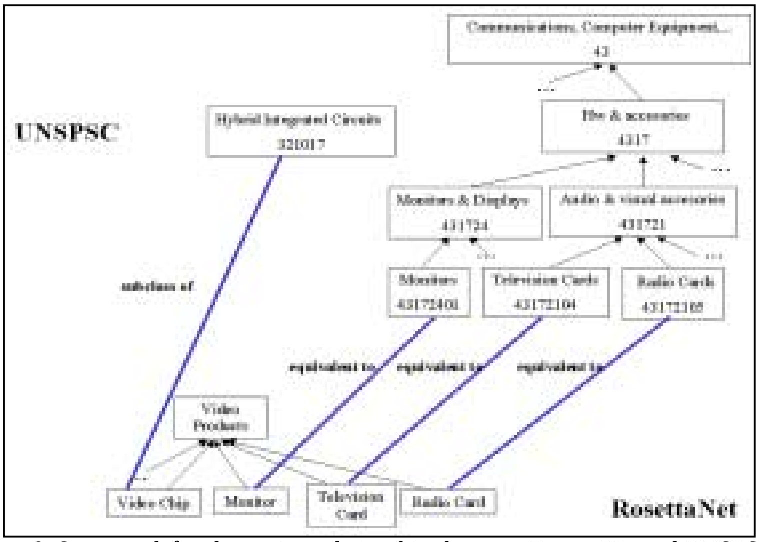

Figure 9. Some predefined mapping relationships between RosettaNet and UNSPSC.

subclass-of relationship (which is named hyponym and subsetting, respectively) and union-of (which is named covering and completeness). The rest of relationships are not important for our domain.

7.2 Ontology enrichment

Once all the classifications have been integrated in *WebODE*, the next phase consists of enriching them with new attributes for concepts, disjoints and exhaustiveness knowledge, relations, functions and axioms. This will make the resulting ontologies richer and will allow performing reasoning with the knowledge contained in them.

We are currently working on the enrichment of these classifications. First, we have focused on properties, taking into account several sources of information for creating them: properties for defining products that are provided by the RosettaNet IT and EC Technical Dictionaries; properties that we have found in several actual e-commerce catalogues from different companies and other common-sense properties that we consider interesting from both KR and marketing points of view. Unfortunately, we have not been able to use attributes from the UCEC classification for UNSPSC, because this information is not publicly available.

Work on taxonomies is also being performed. We are trying to identify and specify disjoint and exhaustive partitions between concepts, with the aim of making more robust taxonomies of concepts, as well as providing better search mechanisms for applications using these ontologies.

We will also focus on the most useful relations between concepts for e-commerce purposes, such as "concept X uses concept Y", "concept X and concept Y are used together", "concept X and concept Y have the same functionality", etc., as well as functions or axioms.

8 Ontology exportation

The last step of the method proposed in section 2 deals with the exportation of global or partial views of the ontologies to implementation code. This step is important, as it will generate the ontology in a format/code that is tractable for the systems involved in the application that justifies its use.

This exportation step is automatically performed using the translators provided by the *WebODE* platform (currently, XML, RDF(S) and OIL). These translators transform the ontologies conceptualized using the knowledge model of *WebODE* into the knowledge model of the target implementation language.

We may also choose whether exporting all the components in the ontologies or exporting just restricted sets of components, which the user can specify explicitly.

9 Conclusions

E-business applications are adopting standards and initiatives for allowing interoperation and interchange of information between information systems. Ontologies aim to provide a shared machine-readable view of domain knowledge, allowing information sharing for heterogeneous systems. In this paper, we have put together both areas, proposing a method for reusing and improving existing standards and initiatives for classification of products and services in the e-business domain creating of a multi-layered ontology that integrates them into a single architecture.

This paper shows how these standards and joint initiatives can be processed, transformed into knowledge models, integrated in a multi-layered architecture, enriched with new information and transformed again into implementation code suitable for its use by different systems.

From the e-business point of view, this approach offers the following advantages:

- Existing standards and initiatives are enriched with additional information that can be used for offering better services in e-business applications: deducting new information about products and customers, allowing a better search for products and services, etc.

- Multiple criteria for classificating a product or service.
- E-commerce catalogues can be integrated in the whole knowledge architecture, allowing a clear distinction between KR and marketing decisions.
- E-commerce catalogues are not necessarily built from scratch, as they can be built from the existing ontology and adapted later because of marketing decisions.

From the ontological engineering point of view, this approach offers the following advantages:

- Ontologies are not built from scratch. Their skeleton is built extracting relevant information from distributed sources that contain consensus knowledge. Hence, there is a great time reduction for knowledge acquisition and reaching consensus, ameliorating the KA bottleneck.
- Multiple views are allowed for any component in the ontology, in the sense that different generic ontologies can be selected, which will offer different sets of criteria for the classification of products and services.
- A knowledge architecture suitable for representing ontologies shared by e-commerce applications. It is based on a layered approach, which distinguishes global/widely-shared concepts, more domain specific ones and a final place for e-commerce catalogues.

From a technological point of view, we present *WebODE* as an ontological engineering platform that allows:

- Processing HTML pages, Excel documents, etc., and transform them into the *WebODE* knowledge model, using its specialized service *WebPicker*.
- Creating a multi-layered ontology through ontological mappings.
- Enriching ontologies with attributes, disjoints and exhaustive knowledge, relations, axioms, etc.
- Exporting the whole ontology or user-defined views into implementation code, suitable for other systems.

10 Future work

UPM participates in the EU-project MKBEEM (IST-1999-10589), which is building a mediation system for enabling online access to products and services in the customer's native language [Leger et al, 00]. The multi-layered knowledge architecture presented in this paper is used in this project for the representation of products and services offered in the catalogues of a B2B company.

Experience obtained in this project helped us identify the ontological mappings presented in section 7, and will help us identify more useful mappings between components in the same and different layers of the architecture. The use of this architecture will also aid the definition of many services that ontology servers must provide for applications in the Semantic Web (especially in the e-commerce domain).

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