Integrating e-commerce standards and initiatives in a multi-layered ontology

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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 the coding systems, on the level of detail of their descriptions, on their granularity, etc. This paper shows how these standards and initiatives, which are built to cover different needs and functionalities, can be integrated in an ontology using a common multi-layered knowledge architecture. This multi-layered ontology will provide a shared understanding of the domain for applications of e-commerce, allowing the information sharing between heterogeneous systems. We will present a method for designing ontologies from these information sources by automatically transforming, integrating and enriching the existing vocabularies with the *WebODE* platform. As an illustration, we show an example on the computer domain, presenting the relationships 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 that contribute to this effective non-human communication are: (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 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 [Karp et al, 99], SHOE [Luke et al, 00], OML [Kent, 98], RDF [Lassila et al, 99], RDF Schema [Brickley et al, 99], OIL [Horrocks et al, 00] and DAML+OIL [Van Harmelen et al, 01]). 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 most of 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[2], RosettaNet[3], e-cl@ss[4], NAICS[5], SCTG[6], etc) 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 the coding systems, on the level of detail, granularity, etc. All these issues are obstacles for the interoperability of applications that follow different standards. For instance, an application that uses the UNSPSC code cannot interoperate with an application that

[1] Formal must be understood as machine-readable.
[2] http://www.unspsc.org/
[3] http://www.rosettanet.org/
[4] http://www.eclass.de/
[5] http://www.census.gov/epcd/www/naics.html
[6] http://www.bts.gov/programs/cfs/sctg/welcome.htm

follows the e-class coding system. Consequently, we claim that with the current state of affairs is more suitable to establish relationships between existing standards and initiatives and create a common knowledge model than to pretend to build *the* unified knowledge model from scratch.

Several architectures for the Semantic Web, in general, have arisen during the last year. Examples can be found in [Ambroszkiewicz, 00], for solving semantic interoperability to assure a meaningful interaction between heterogeneous agents, and [Melnik et al, 00], where a layered architecture is proposed to solve the interoperability of different Web information models. Other layered architectures have been also proposed by different authors in other areas, such as in [Benslimane et al, 00], where a multi-layered ontologies definition framework is presented in a urban management application, consisting of ontology layers for describing functional and domain knowledge in that area.

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. We import standards and joint initiatives into the *WebODE* platform [Arpírez et al, 01], we integrate them, and we enrich the unified knowledge model using that platform. The result is a multi-layered knowledge architecture, which can be exported partially or completely by *WebODE* into different representation languages (XML, RDF(S) and OIL).

The proposed knowledge model is a layered ontology, which 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).

As sketched out before, the multi-layered knowledge model just covers UNSPSC, RosettaNet, and e-cl@ss, but can be extended easily with other sources of information. We will also use an existing e-commerce catalogue for representing the "catalogue layer" of the whole architecture, which will be presented in section 5. The logical organization of the contents of the paper is presented below:

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 an e-commerce catalogue where the products that are sold can be linked to the classifications selected for this study. In section 4 we describe briefly the process of automatic extraction of knowledge from the different sources of information. Section 5 deals with the resulting knowledge architecture that integrates the different proposals, paying special attention to the links between different layers of ontologies. In section 6, we will present the main guidelines we have followed for ontology integration and enrichment. Section 7 deals with the automatic implementation in different languages from partial or global views of the ontologies. Finally, sections 8 and 9 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 will 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 consists of automating the process of knowledge acquisition from the sources of information previously selected, adapting them to the knowledge model of *WebODE*, which can be represented in XML, and using its import functionality to upload them into the platform.
3. **Design of a multi-layered knowledge architecture**. Taking into account the main 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**. All the knowledge models that have been automatically imported into the *WebODE* platform, are integrated in the layered architecture, using the relationships 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. They just represent taxonomies of concepts. Hence, they can be enriched with this 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 in depth the method we propose in this paper, applying it to a case study in the computers domain.

3 E-commerce standards as knowledge models

Standards, joint initiatives, laws, etc., are a good starting point for the creation of ontologies, since they are pieces of information that have been agreed by consensus or are followed by a community.

In this section, we will present three different proposals that have arisen, in the context of the e-commerce domain,

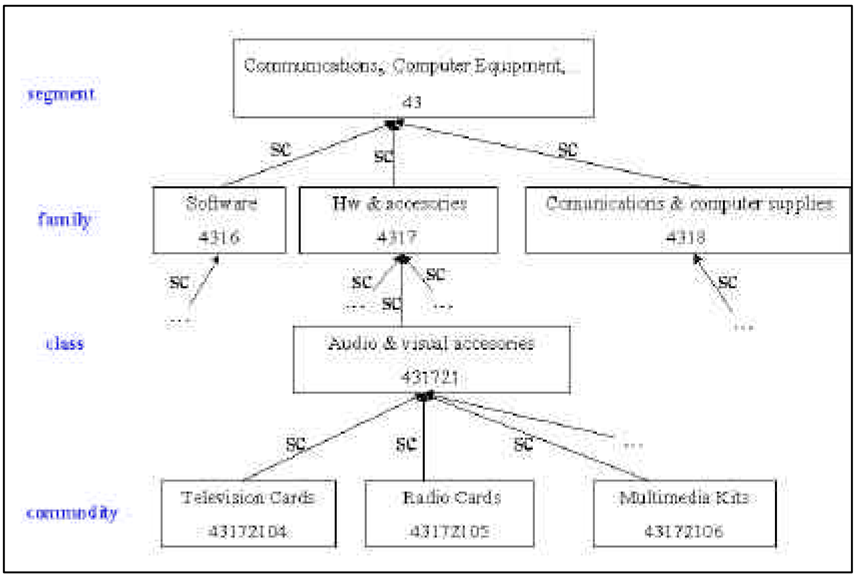

Figure 1. A snapshot of the classification of UNSPSC for computer equipment.

for the classification of products: UNSPSC, RosettaNet and e-cl@ss. Other similar approaches exist and are available (NAICS, for US, Canada and Mexico, SCTG for transporting goods, etc), but we have just selected the ones enumerated before to show the adequacy of our work in this context.

These initiatives are being developed to ease the information exchange between customers and suppliers, and between different suppliers, by providing consistent, standardised frameworks to identify products and services in a global market.

Finally, we will present an electronic catalogue from an e-commerce platform that can be fitted in the overall 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; (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

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.

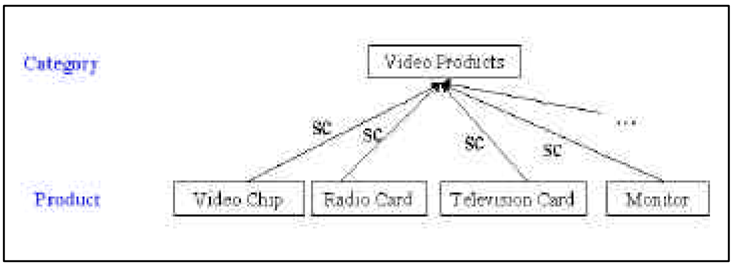

Figure 2. A snapshot of the classification of video products of the RosettaNet taxonomy.

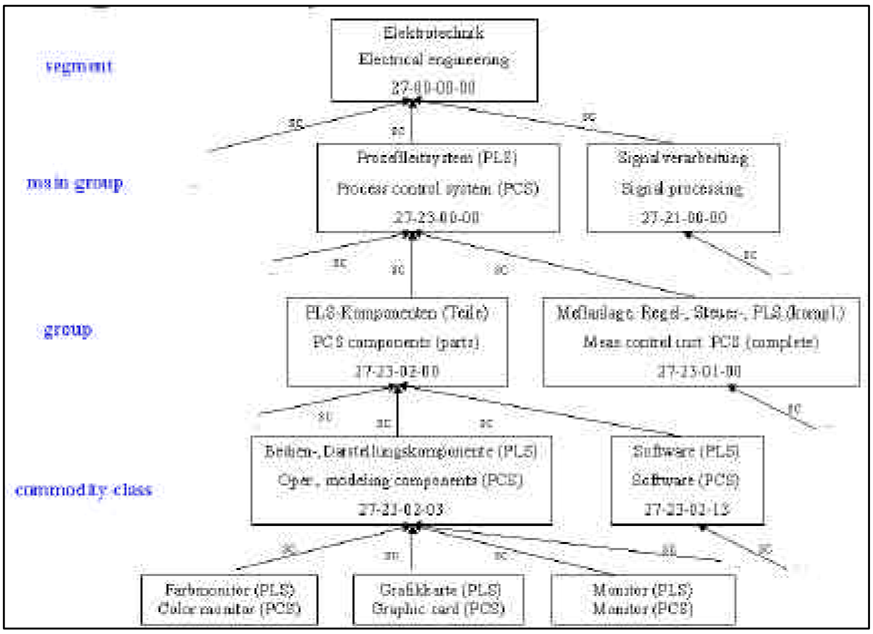

Figure 3. A snapshot of the classification of e-cl@ss for electrical engineering products (in German and English languages).

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.

RosettaNet has just two levels in its taxonomy of concepts:

- **RN Category**. A group of products, such as *Video Products*.
- **RN Product**. A specific product, such as *Television Card*, *Radio Card*, etc.

The RosettaNet 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 a small 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. This issue will be shown in section 5.

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 one used in UNSPSC (each level has two digits that distinguish it from the other concepts). The four levels are: *Segment*, *Main group*, *Group* and *Commodity Class*.

These 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 can have 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 is intended to be used by German companies. Apart from that, a good feature of this classification is the possibility of having terms, and their descriptions, in both 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). The items of the catalogue correspond with actual products that are sold by the e-commerce platform. Attributes are defined on them with the main characteristics of each product to be sold. The 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 catalogue selected contains around 400 items, with 2/3 levels of depth in the hierarchy of categories. Figure 4 shows some elements in the catalogue.

In contrast with the classifications presented before, catalogues cannot be considered themselves as good sources of information for the development of 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, not from the knowledge point of view.

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

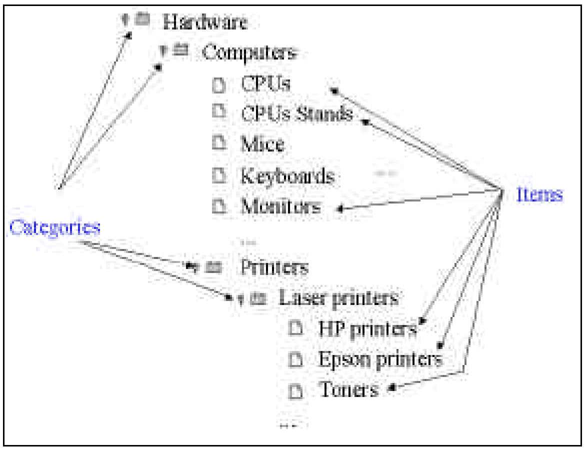

Figure 4. A snapshot of some elements in the catalogue.

4 Obtaining knowledge models from structured information

Each of the classifications described in the previous section is represented using a different representation format. UNSPSC is available in HTML format, where the taxonomies are presented visually; RosettaNet is in HTML, XML and Microsoft Excel format, and e-cl@ss is available in Microsoft Excel format; finally, the catalogue is available in XML format.

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 this sense, we will use the XML *WebODE* import functionality to import the conceptual models of all the selected sources of information. This will also allow us to use the *WebODE* platform for the integration and enrichment of all the information.

In [Corcho et al, 01], we present in detail the different processes we have followed to translate the contents of the different sources of information into *X-WebODE*, the XML format of *WebODE*, so that we have been finally able to import them into the platform.

As an illustration, we present figure 5, where we summarise graphically the process of including the information from the UNSPSC classification into *WebODE*.

The figure shows that pages containing the UNSPSC information are written in HTML, and distributed along different HTML pages, one per UNSPSC segment. The valuable information from these pages has been extracted by means of a Java program that identified the important parts

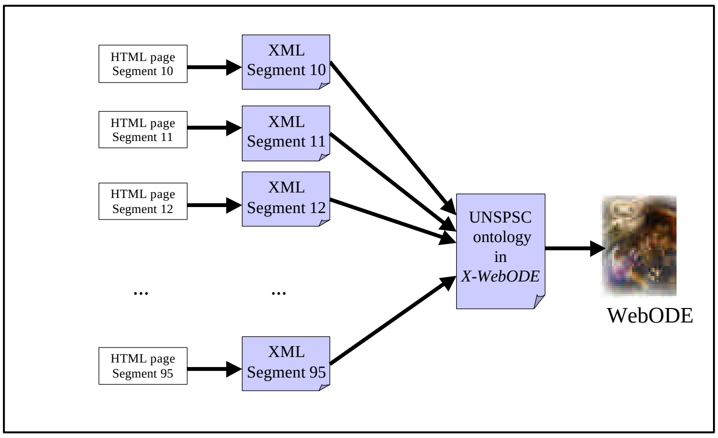

Figure 5. The process of importing UNSPSC into WebODE.

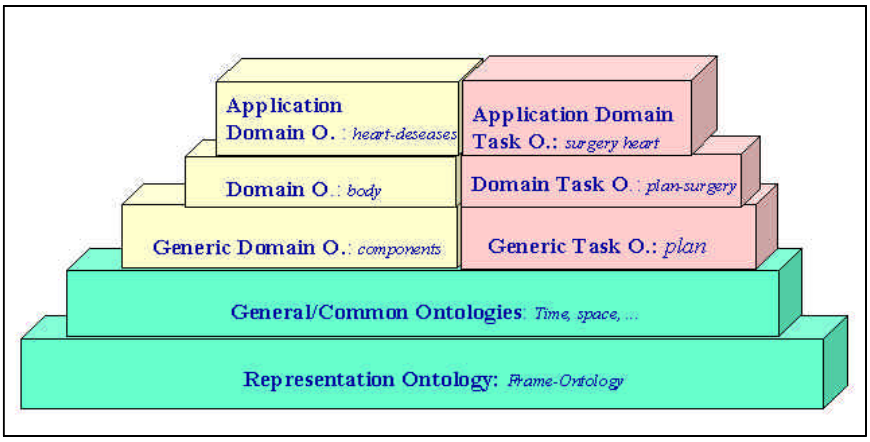

Figure 6. Libraries of ontologies.

embedded in the HTML pages and converted it into XML syntax[7].

After the resulting XML code was created for all the segments, another transformation was performed on it, using the Document Object Model[8], in order to include all of them in one single XML document, which followed the grammar defined in the *WebODE* DTD [Arpírez et al, 01].

Finally, the XML import facility of WebODE was used to upload the classification present in the document into the *WebODE* platform. This will allow us to perform changes/upgrades to the original classification using *WebODE*, rather than making changes directly in the HTML code provided by UNSPSC.

Related to RosettaNet, e-cl@ss and the catalogue, the process applied is very similar to the one described for UNSPSC.

[7] This transformation allowed us to detect some missing pieces of information in the HTML pages and errors on the numbering of several products, which were reported to the UNSPSC responsible.

[8] http://www.w3.org/DOM/

5 Designing a multi-layered ontology architecture

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.

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

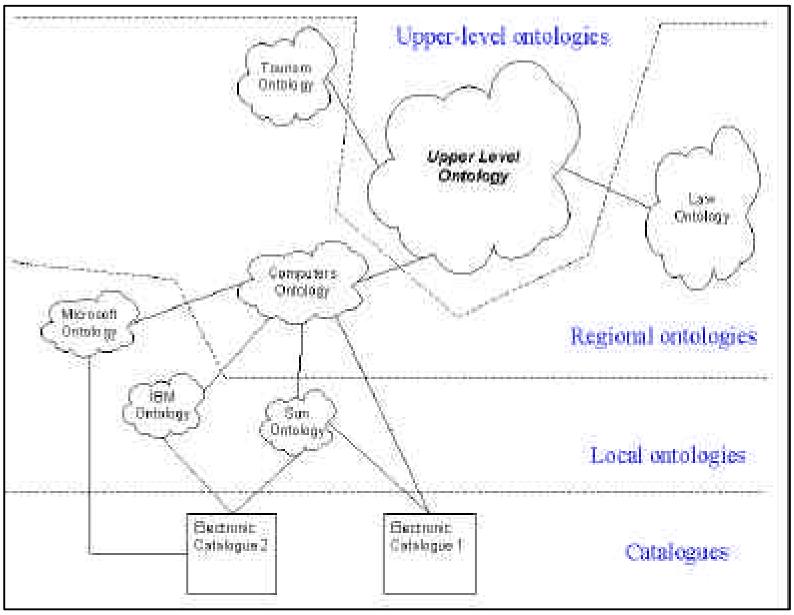

Figure 7. General relationships between ontologies, and between ontologies and catalogues.

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 terms which are not similar (common-sense terms vs. specialized domain ontologies).

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

Our approach consists of structuring the ontologies, which will be used as a shared vocabulary by the different applications, in several layers. We will follow the criteria presented in the ontology classifications explained above. This architecture will be illustrated with examples taken from the sources of information presented in section 3.

Figure 7 shows the relationships that can be established between the different ontologies that are present in the architecture.

In this sense, we propose a common upper level ontology, also called *global 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.

More specialized 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 global ontology, so that they share a common root for all the concepts. These ontologies will be called *regional domain ontologies*, and they can be organized in as many layers as the ontology developers consider necessary.

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

Finally, the lowest level (below the *local domain ontologies*) will contain the catalogue, with all 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 we set out in the introduction, this layered approach for the building of ontologies 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).

5.2 Case study: fitting the sources of information in the architecture

Considering the main features of the standards and initiatives that we have selected for this study and imported into *WebODE*, we can try to fit them in the proposed architecture, with the following roles for each of them:

UNSPSC can act as a global, upper level 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).

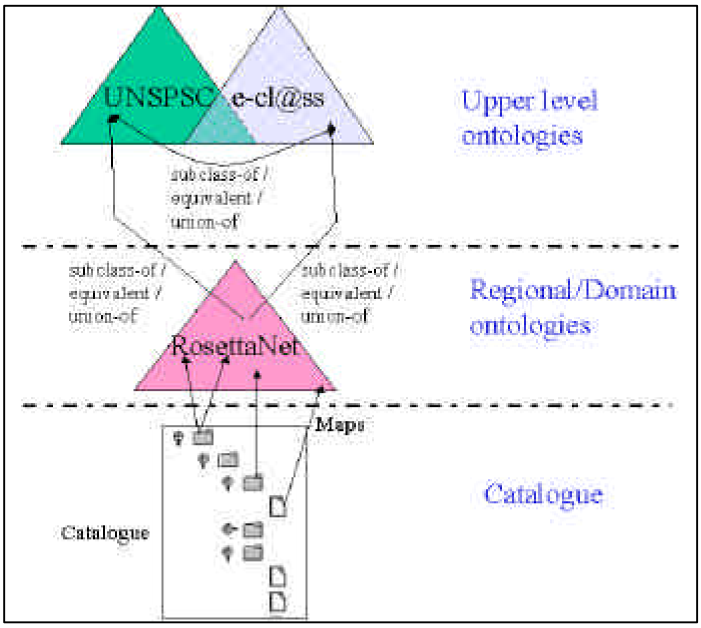

Figure 8. Relationships between UNSPSC, e-cl@ss and RosettaNet standards, and the catalogues.

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 linked to concepts in the ontology. Using these links, 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 relationships 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 upper-level 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 relationships between both of them will be established. The communication between the different systems using the ontologies in this architecture is still good, though providing much richer information on the products which are placed in its lowest levels.

6 Ontology integration and enrichment

6.1 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 relationship **between ontologies**, be them placed at the same level in the architecture or at different levels.

We have just focused on the most commonly used kinds of links that can be discovered between concepts in the different ontologies: *equivalence* relationships, *subclass-of* relationships and *union-of* relationships.

- **Equivalence relationships**. They occur when a concept in the ontology is equivalent (or the most similar) to other concept or concepts in another ontology.

  This relationship is specially interesting between ontologies at the same level, as it will allow systems using different standards or initiatives to interact between them. It also provides several means of classifying products in the ontology. For instance, concept *Diskette* in e-cl@ss (code 24-03-03-00) is equivalent to concept *Floppy diskettes* in UNSPSC (code 43180601).

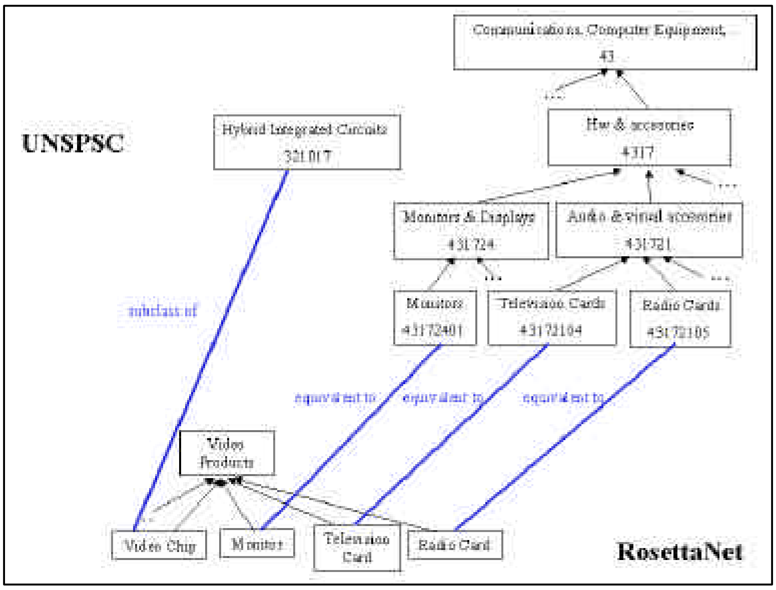

Figure 9. Some predefined mapping relationships between RosettaNet and UNSPSC.

Examples of this relationship between ontologies in different layers is shown in figure 9. For instance, concept *Monitor* in RosettaNet is equivalent to concept *Monitors* in UNSPSC (code 43172401). In section 3.2, we said that RosettaNet has already predefined the equivalence relationships between its concepts and concepts in the UNSPSC classification. Hence, the task of establishing the links between those concepts has been done automatically in the import phase of the acquisition process that we have presented in section 4, although some equivalence relationships have been transformed into subclass-of relationships after a detailed analysis of both standards, as shown in figure 9, between *Video chip* in RosettaNet and *Hybrid Integrated Circuits* in UNSPSC (code 321017).

- **Subclass-of relationships**. 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 (code 43172503) is subclass of concepts *Printer (PCS)* and *Printer (proc. comp.)* in the e-cl@ss classification (codes 27-23-02-12 and 27-23-02-34, respectively).

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

  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. This is because the classification criteria can be different in both ontologies.

- **Union-of relationships**. 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 relationships that we have studied are the relationships between **catalogues and ontologies**.

We have just found interesting for our application the mapping relationships between items (and categories) in the catalogue and concepts in the ontology. In this sense, 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 upper level ontology), 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 relationships between concepts in ontologies can also be applied to this case. Taking into consideration the design issues of catalogues, it will be very 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 linked to very distant concepts in the ontology (as the ontology design, in case it is specific enough, will commonly avoid grouping both concepts under the same parent concept).

6.2 Ontology enrichment

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

We are currently working on the enrichment of these classifications, specially on the properties for defining products that are provided by the RosettaNet IT and EC Technical Dictionaries, together with common-sense properties that we consider interesting from the knowledge representation point of view.

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.

We will also focus on the most important relations between concepts that can be useful for our purposes, such as "concept X uses concept Y", "concept X and concept Y are commonly used together", "concept X and concept Y have the same functionality", etc.

Finally, we will try to find other useful components in the ontologies, such as functions or axioms.

7 Ontology exportation

The last step of the method proposed in section 2 deals with the exportation of global or partial views of the ontology 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. 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 the whole ontology or exporting just partial, user-defined views of it.

Currently, translations into XML, RDF(S) and OIL can be performed automatically, and more translators will be integrated in the platform soon.

8 Conclusions

Ontologies play a crucial role on the construction of the Semantic Web, because they provide a shared conceptualization of the knowledge and services available on the web in a machine-readable way, allowing the information sharing between heterogeneous systems. In this paper, we have put our attention onto a specific area of the Semantic Web: the world of e-commerce applications (both B2C and B2B).

We have proposed a method that shows how standards and joint initiatives for the classification of products and services (built by different organisms) might be processed, transformed into knowledge models, integrated in a multi-layered architecture, enriched with new attributes, relations, etc., and transformed again into an implementation code suitable for its use by different systems.

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.
- There is a significant reduction in the time used for knowledge acquisition and reaching consensus, hence ameliorating the KA bottleneck.
- Multiple views are allowed for any component in the ontology, in the sense that different upper-level ontologies can be selected, which will offer different sets of criteria for the classification of products and services.
- A knowledge architecture is proposed that is 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.

Finally, from a technological point of view, we have presented the *WebODE* platform as an ontological engineering tool that allows:

- Processing HTML pages, Excel documents, etc., and transform them into the *WebODE* knowledge model.
- Creating the multi-layered ontology presented.
- Enriching the multi-layered ontology with new attributes, disjoints and exhaustive knowledge, relations, axioms, etc.
- Exporting the whole ontology or user-defined views into implementation code, suitable for their use by other systems.

9 Future work

In this paper, we have identified some of the relationships between the components in the different ontologies that are structured according to the architecture presented in section 5. However, deeper studies are needed in order to find out other kinds of useful relationships that can be established between them.

The identification of these relationships will be mainly based on the experience of using this knowledge architecture in different domains and different applications.

The use of this architecture will also lead to define the main services that ontology servers must provide for applications and to redesign the main software components of ontology servers in order to accomplish the new tasks that the new services of the Semantic Web will ask for.

Acknowledgements

This work is supported by a FPI grant (*Formación de Personal Investigador*) funded by UPM. We would also like to thank Alberto Cabezas for implementing the transformations from UNSPSC, RosettaNet and e-cl@ss into *X-WebODE*, and Julio César Arpírez, for the design and implementation of the *WebODE* platform.

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