A proposal of infra-structural needs on the framework of the Semantic Web for ontology construction and use[1]

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Three extremely important factors contribute to the construction of the Semantic Web: (1) a common language in which the resources implied can be formally specified, (2) ontologies, which provide a shared knowledge model and description of the domain resources, (3) a workbench for (semi)automatic construction, evaluation, evolution and maintenance of ontologies, and for supporting the selection and use of ontologies for the Semantic Web. We call them the *syntactic*, *semantic* and *technological* dimensions. This position paper only covers the semantic and technological dimensions.

Semantic Dimension

The semantic dimension is related with ontologies. The construction of large and consensuated ontologies for the Semantic Web is difficult, time consuming and expensive to build. Currently, a few domain ontology servers (Ontolingua [1], Ontosaurus [2], Protégé2000 [3], WebODE [4], WebOnto [5], etc.) provide libraries with a few number of knowledge representation ontologies, common-sense ontologies, upper-level ontologies, generic ontologies that could be reusable across domains, domain ontologies, etc. However, the maturity level of such ontologies is insufficient for the construction of the Semantic Web. Efforts exist such as the IEEE Standard Upper Ontology (SUO) Working Group[2], which is working for the construction of a unified SUO ontology.

Therefore, a "hot" issue for the Semantic Web is the construction of a kind of **multilingual and multi-domain reference ontology** that could be used as a shared resource not only for the Semantic Web, but also for Natural Language applications, Intelligent Information Extraction, Intelligent Information Integration, e-commerce, Knowledge Management, etc.

The proposed multilingual and multi-domain reference ontology should provide formal and detailed knowledge models that will allow the vertical intra-operability of systems in specialized domains and also the horizontal inter-operability of application in different domains.

The approach consists of structuring the ontologies in several layers. Figure 1 shows a *multilayered content networks* that can be established between the ontologies that are present in the architecture. The following types of ontologies are needed:

- Several *Knowledge Representation Ontologies*, which formally define the primitives used to represent knowledge under a given knowledge representation paradigm (frames, description logic, etc.).
- *Upper Level Ontologies*, which define the common terms used in the communication between systems, providing a unified upper-level vocabulary for all the systems accessing the ontology.
- *Generic domain ontologies* provide broad, coarse-grained vocabulary in a given domain.
- More specialised ontologies in a given domain (*regional domain ontologies*) can be created. These ontologies can be organised in as many layers as the ontology developers consider necessary.

To speed up the construction of ontologies, existing upper-level ontologies and also standards and initiatives could be automatically processed and enriched. With the current state of affairs, it is more suitable to establish ontological mappings between well-formed existing ontologies and between standards and initiatives than to pretend to build *the* unified knowledge model from scratch.

From the methodological point of view, we also need:

- Methodologies for integrating and merging ontologies.
- Methodologies for evaluating ontologies.
- Methodologies for collaborative construction of ontologies.

Technological Dimension

In the last years, there has been a great number of tools developed for building ontologies (OILed[3], OntoEdit[4], Ontolingua [1], Ontosaurus [2], Protégé2000 [3], WebODE [4], WebOnto [5], etc.). There also exist some tools for merging ontologies (Chimaera [6], Ontomorph [7], PROMPT [8]) and for translating ontologies between different languages. The main problems that arise are:

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[1] This paper is an extension of the position paper presented to the Program Consultation Meeting on Knowledge Technologies, held in Brussels on 27/04/01.

[2] http://suo.ieee.org/

[3] http://img.cs.man.ac.uk/oil/

[4] http://ontoserver.aifb.uni-karlsruhe.de/ontoedit/

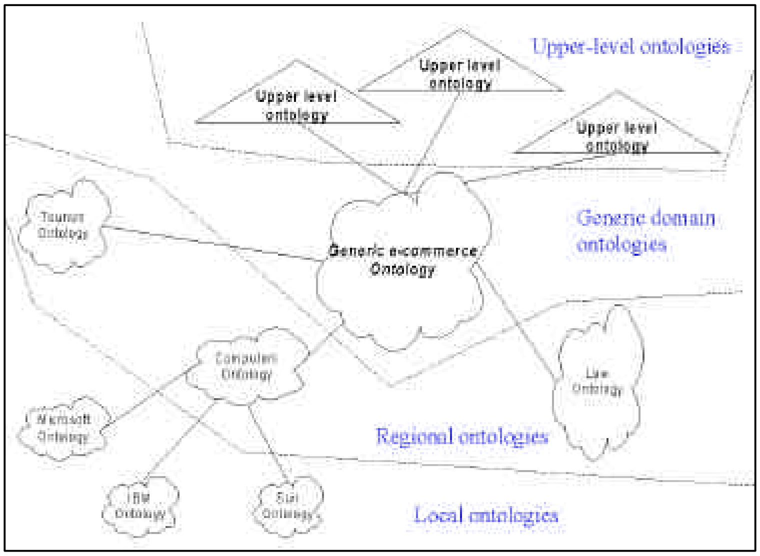

Figure 1. Multilingual and multi-domain reference ontology.

- A correspondence between existing methodologies for building ontologies and environments for building ontologies, except for METHONTOLOGY [9] and WebODE [4], does not exist.
- There exist a lot of "similar" ontology development tools that allow building ontologies, but neither they do interoperate nor they do cover all the activities of the ontology life cycle.
- Most of the tools only give support for designing and implementing the ontologies, but they do not support all the activities of the ontology life cycle.
- The lack of interoperability between all these tools provokes important problems when a given ontology is going to be integrated into the Ontology Library System of a different tool, or if two ontologies built using different ontology tools are integrated using the merging tools.
- None of these tools provide specialized modules that facilitate the (semi)automatic construction, evaluation and configuration management of ontologies.

Consequently, we need **a workbench for ontology developers**, as shown in figure 2, that facilitates:

- Ontology development construction during the whole ontology life cycle, including: knowledge acquisition, edition, browsing, integration, merging, ontological mappings, reengineering, evaluation, translation to different languages and formats, interchange of content with other tools, etc.
- Ontology management: configuration management and evolution of isolated ontologies as well as of ontology libraries.
- Ontology support: scheduling, documentation, etc.
- Workbench Administration.

A methodology for building ontologies using the workbench is also needed.

However, the ontology developers workbench should be accompanied by **a workbench for supporting the use of ontologies (ontology middleware services).** It should include:

- Software that helps to locate the most appropriate ontology for a given application.
- Formal metrics that compare the semantic similarity and semantic distance between terms of the same or different ontologies.
- Software that allows incremental, consistent and selective upgrades of the ontology which is being used by a given application.
- Query modules to consult the ontology.
- Remote access to the ontology library system.
- Software that facilities the integration of the ontology with legacy systems and databases.
- Administration services.

Finally, a wide transfer of this technology into companies, with the subsequent development of a large number of ontology-based applications in the Semantic Web context, will be achieved by the creation of **ontology application development suites**, which will allow the rapid development and integration of existing and future applications in a component based basis.

WebODE

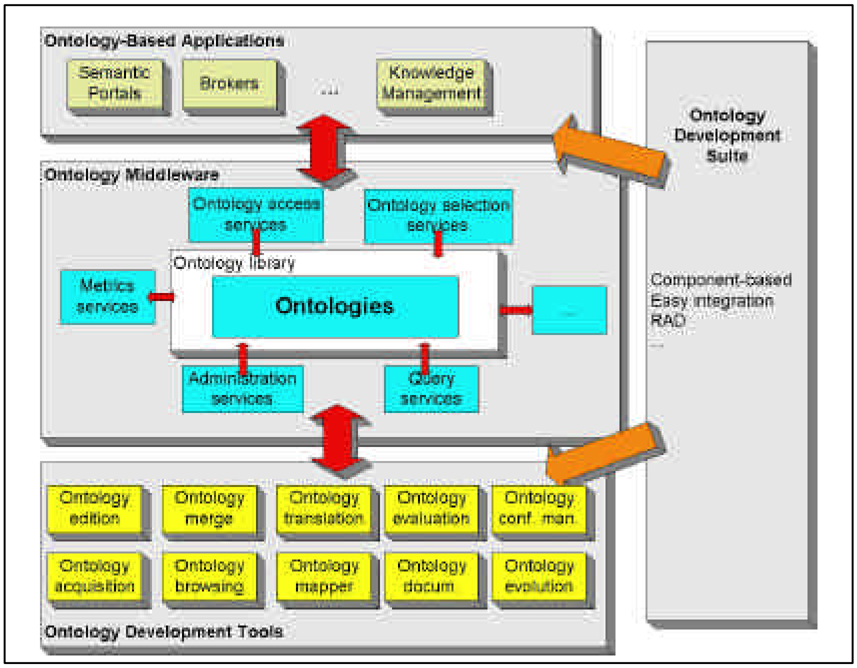

Figure 2. An ontological engineering workbench.

WebODE [4] is not an isolated tool for the development of ontologies, but an advanced ontological engineering workbench that provides varied ontology related services and covers and gives support to most of the activities involved in the ontology development process. In more detail, WebODE covers the following aspects of the workbench previously presented:

- Ontology development.- It offers an ontology editor, ontology translation into several languages, ontology evaluation, ontology documentation and ontology browsing capabilities.
- Ontology middleware.- It offers a well-defined ontology access API and an inference engine implemented in Prolog.
- Ontology-based applications.- Currently, several applications are being developed using the WebODE infrastructure, in the domains of Knowledge Management and e-commerce.

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