Welcome to OIL

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Abstract

The major objective for the development of OIL was to develop an international standard for web-bases representation of ontological information. This deliverable reports some lessons learnt in this process.

Contents

1	How it began ...	5
2	Initial Results: OIL	5
3	Intermediate Results: DAML+OIL	7
4	Ongoing Final Results: OWL	7
5	Why not eating your own dogs‘ food	8
6	... and how it will end?	9
7	References	12

1 How it began ...

The major objective for the development of OIL was not to create yet another knowledge representation language that will be used internally in a small project. We rather decided to aim for an international standard. Clearly this would help to disseminate our project results and it would improve the overall visibility of Ontoknowledge. When talking with colleagues on this aim, 95% thought I am mad and in 99% of the cases they would have been right. But in times of changes, unlikely things happen. This deliverable is about how this idea worked out.

2 Initial Results: OIL

We produced a long report of around 200 pages that summarized the state of the art on Ontology languages, that summarized the state of the art on related web standards, and that came up with a proposal for an Ontology Web Language based on four principles (cf. [Fensel et al., 2000(b)]):[1]

1 **OIL, a modeling language based on frames:** The central modeling primitives of predicate logic are predicates. Frame-based and object-oriented approaches take a different point of view. Their central modeling primitives are classes (i.e., frames) with certain properties called attributes. These attributes do not have a global scope but are only applicable to the classes they are defined for (they are typed) and the ”same” attribute (i.e., the same attribute name) may be associated with different range and value restrictions when defined for different classes. A frame provide a certain context for modeling one aspect of a domain. Many other additional refinements of these modeling constructs have been developed and have led to the incredible success of this modeling paradigm. Many frame-based systems and languages have been developed and, renamed as object-orientation they have conquered the software engineering community. Therefore, OIL incorporates the essential modeling primitives of frame-based systems into its language.

2 **OIL, a language where everybody can ask for its formal semantics based on experience in Description Logics (DL):** DLs describe knowledge in terms of concepts and role restrictions that are used to automatically derive classification taxonomies. The main effort of research in knowledge representation is in

1. A 5th principle was to come up with a good name. Thanks to Hans Akkermans we found it.

providing theories and systems for expressing structured knowledge and for accessing and reasoning with it in a principled way. In spite of the discouraging theoretical complexity of their results, there are now efficient implementations for DL languages, see for example DLP and the FaCT system. OIL inherits from Description Logic its formal semantics and the efficient reasoning support developed for these languages. In OIL, subsumption is decidable and with FaCT we can provide an efficient reasoner for this.

3 **OIL, a language with a web compartible syntax based on XML and RDF:** Modeling primitives and their semantics are one aspect of an Ontology language. Second, we have to decide about its syntax. Given the current dominance and importance of the WWW, a syntax of an ontology exchange language must be formulated using existing web standards for information representation. First, OIL has a well-defined syntax in XML based on a DTD and a XML schema definition. Second, OIL is defined as an extension of the Resource Description Framework RDF and RDFS.

4 **OIL, a solution for people who need a bike and people who like a Mercedes:** It is unlikely that a single ontology language can fulfill all the needs of the large range of users and applications of the Semantic Web. We have therefore organized OIL as a series of ever increasing layers of sub languages. Each additional layer adds functionality and complexity to the previous layer. This is done such that agents (humans or machines) who can only process a lower layer can still partially understand ontologies that are expressed in any of the higher layers. The layered architecture of OIL has three main advantages: First, an application is not forced to work with a language that offers significant more expressiveness and complexity that it actually needs. Second, application that can only process a lower level of complexity are still able to catch same of the aspects of an ontology. Third, an application that is aware of a higher level of complexity can still also understand ontologies expressed in a simpler ontology language.

Accompanied with the right spirit and coming up in the right moment we could quickly acquire a large group of people that joined our vision and helped us in building up a widely visible proposal for an Ontology Web Language. Most of these results, cooperation partners, and events are mentioned in [Fensel et al., 2001(b)], an extra Deliverable we had to produce for the European Commission because we had been too successful. A highly visible web site that collects OIL resource was installed at http://www.ontoknowledge.org/oil. A large number of publications on OIL have been produced from which we just mention some of them: [Broekstra et al., to appear], [Decker et al., 2000], [Fensel et al., 2000(a)], [Fensel et al., 2001(a)], [Klein et al., 2002], and [Klein et al., to appear].

3 Intermediate Results: DAML+OIL

When a small European project touches the orbit of a large US project cluster like DAML[2] it is time for co-operation. DAML is a significantly funded project that puts 80 Million Dollar to develop semantic web technology. Many of the core members of OIL joined the DAML-ONT working group and in weekly telephone conferences a new language called DAML+OIL was born. A new body the *Joint EU/US ad hoc Agent Markup Language Committee*[3] was installed and has now been running for more than a year. In this process, we had to throw our OIL principles number 1, 4, and 5 over board, however, we came up with a truly international standard backed up by the strongest defence department of the world. Most of the results on DAML+OIL can be found at http://www.daml.org/2000/12/daml+oil-index.htm and http://www.daml.org/2001/03/reference.html.

4 Ongoing Final Results: OWL

Meanwhile the W3C[4], the recommendation committee of the World Wide Web, has set up a *Semantic Web Activity*[5] and as part of it a *Web-Ontology (WebOnt) Working Group*[6]. Working since late 2001 this working group deals with issues such as:

- What is the right name for the Ontology Web Language (OWL)?
- What are the significant use cases that justify the definition of certain language primitives?
- What is the right layering approach for the Semantic Web. Should OWL be based on RDF and does it matter that their model theories entail different conclusions?

Working in this group requires weekly phone conferences, regular face-to-face meetings and dealing with high email traffic[7]. Final results are expected for September 2002 and it is just too early to predict them.

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2. http://www.daml.org/
3. http://lists.w3.org/Archives/Public/www-rdf-logic/2000Nov/0093.html.
4. http://www.w3c.org/
5. http://www.w3.org/2001/sw/Activity
6. http://www.w3.org/2001/sw/WebOnt/
7. http://lists.w3.org/Archives/Public/www-webont-wg/

5 Why not eating your own dogs‘ food

Compared with the external use and adaptation of OIL, the internal use of OIL within Ontoknowledge[8] is rather disappointing. None of the case studies nor tools really employ OIL (cf. [Fensel et al., 2000(c)], [Fensel et al., submitted]). They all refer to RDF Schema or a subset of it which we called OIL_{Core} to mask our “failure”. What are the reasons for this:

1. Some case studies already started before even the first version of OIL was available.

2. OIL or OWL are ongoing standardization efforts including high change rates. No user nor tool developer can trust the current language version as being final and not just an intermediate step. Using OIL is of high risk, both for uses in case studies as well as for tool developers.

3. OIL lacks any tutorial support, any customized tool support, and any real practical experience. From a user point of view this makes it nearly unusable for the moment.

The lack of actual use of OIL may also be an indication for three different problems related to OIL:

1. **OIL is too less expressive.** Many things cannot be expressed in it but could be easily expressed in a rule-based language like F-logic (cf. [Kifer et al., 1995]) oriented on reasoning over instances. The initial approaches to the semantic web were oriented around this paradigm (cf. [Luke et al., 1996], [Fensel et al., 1998]).

2. **OIL is too expressive.** OIL is logic based and OIL is description logic based. Many people find it difficult or not worth while to express themselves within logic. For example, non of the standard ontologies in electronic commerce or widely used ontologies such as Wordnet[9] make use of any axiomatic statements. Mostly they are simple taxonomies enriched by attributes in the best case. Description logic adds a specific feature: Concept hierarchies do not need to be defined explicitly by can be defined implicitly by complex definitions of classes and properties. Many people may find it easier to directly define is-a relationships instead of enforcing them by complex and well-thought axiomatic definition of classes and properties.

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8. http://www.ontoknowledge.org/
9. http://www.cogsci.princeton.edu/~wn/

3 **Ontologies should not be based on formal logic.** People with a background in databases (including one of our project reviewers) wonder in general whether axioms, i.e., complex logical statements should be part of an ontology. They tend to be application specific and very difficult to exchange and reuse in a different context. Spoken frankly, most of our experience conform with this statement. Still we may hope to make the world a better place in the future enabling more than just the exchange of concept taxonomies and some attributes.

In any case, it is too early to take a final conclusion from our exercise. We hope that we will get more insights from the use cases collected by the *Web-Ontology (WebOnt) Working Group*[10]. Also the *SIG on Ontology Language Standards*[11] of *Ontoweb*[12] is supposed to bring further insights here.

6 ... and how it will end?

It is much too early to give an answer to this question. Anyway, this mixture of model theory on the one side and sociology on the other side is quite interesting and unique (not really when reading [Latour, 1992]). Many new interesting issues are completely uncovered by the work described here:

- **The lack of rules:** We already mentioned the fact that early approaches for the semantic web were based on rule-based approaches. Also their is a clear consensus that the current Ontology Web Language needs an extension in this direction. The *Rule Markup Language Initiative*[13] may help to make a step into this direction.

- **The language tower of the semantic web:** Giving a real semantics to the semantic web language tower as sketched by Tim Berners-Lee in Figure 1 requires much more work. Currently many layering ideas oriented to syntactical and semantical extensions compete which each other[14]. Working out the proper relationship will be much more challenging than just developing one layer for it.

- **Web Services:** The easy information access based on the success of the web has made it increasingly difficult to find, present, and maintain the information required by a

10. http://www.w3.org/2001/sw/WebOnt/
11. http://www.cs.man.ac.uk/~horrocks/OntoWeb/SIG/
12. http://www.ontoweb.org/
13. http://www.dfki.uni-kl.de/ruleml/
14. see http://lists.w3.org/Archives/Public/www-webont-wg/

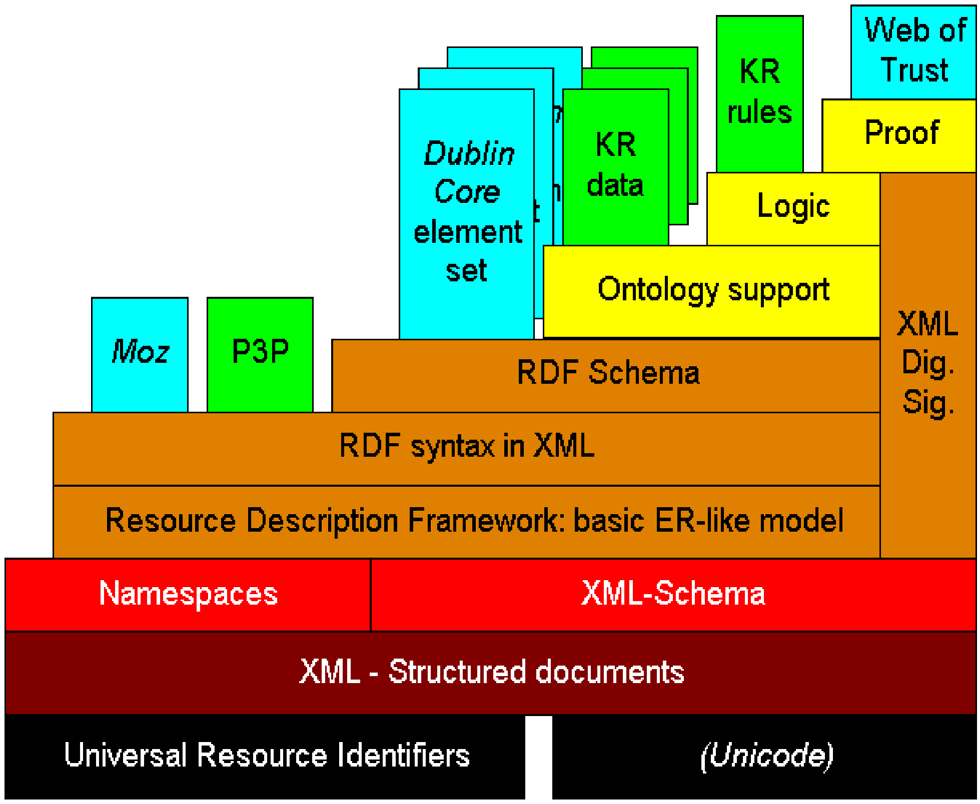

Fig. 1 The layer language model for the semantic web.

wide variety of users. In response to this problem, many new research initiatives and commercial enterprises have been set up to enrich available information with machine-understandable semantics. This **semantic web** will provide intelligent access to heterogeneous, distributed information, enabling software products to mediate between user needs and the information sources available. **Web Services** tackle with an orthogonal limitation of the current web. It is mainly a collection of information but does not yet provide support in processing this information, i.e., in using the computer as a computational device. Recent efforts around UDDI[15], WSDL[16], and SOAP[17] try to lift the web to a new level of service. Software programs can be accessed and executed via the web. However, all these service descriptions are based on semi-formal natural language descriptions. Therefore, the human programmer need be kept in the loop and

15. http://www.uddi.org/
16. http://www.wsdl.org/
17. http://www.soap.org/

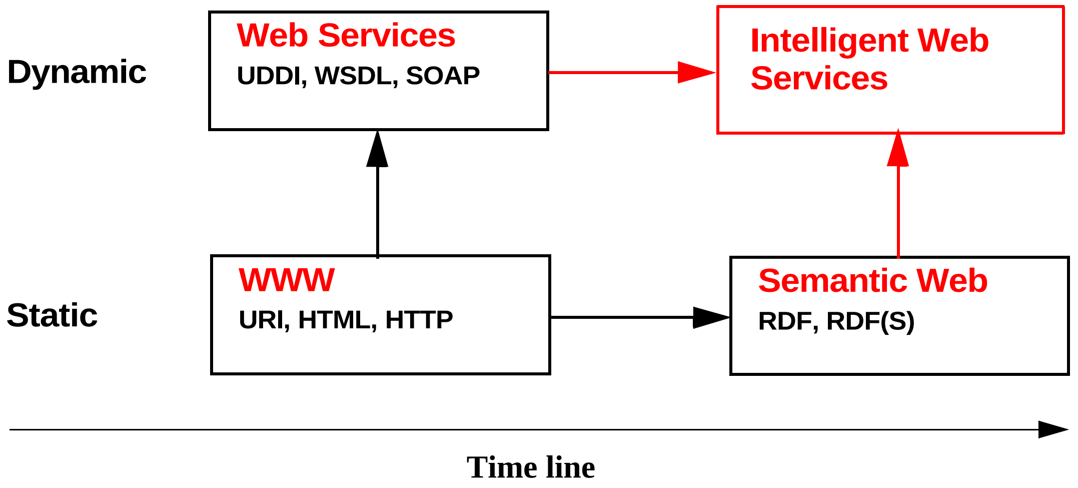

Fig. 2 The development process of the web.

scalability as well as economy of web services are limited. Bringing them to their full potential requires their combination with semantic web technology. It will provide mechanization in service identification, configuration, comparison, and combination. **Semantic Web enabled Web Services** have the potential to change our life in a much higher degree as the current web already did (Figure 2). We are currently in the process of extending UPML [Fensel et al., to appear] to a full-fledged **Web Service Modeling Language (WSML)**.

In any case, future projects such as *Wonderweb* and *Swap* will help to provide better insights in the mentioned problems.

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