Standardisation Report

Ontology Language Standardisation Efforts

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WonderWeb Project

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Executive Summary

This document describes standardisation efforts relating to the definition of Ontology Languages for the Web. The Web Ontology Language OWL allows the definition of vocabularies and builds on existing standards for metadata such as RDF and RDF-Schema. OWL extends the expressivity of these languages with richer operators and backs these with a well-defined underlying formal semantics. We also discuss the contributions made by the WonderWeb consortium to the standardisation process.

1 OWL: A Web Ontology Language

The key standardisation activity in this area has been the work of the W3C's Webont Working Group[1], who in February 2004 produced a Recommendation for the Web Ontology Language OWL[2].

1.1 History

WebOnt was chartered[3] to produce a recommendation for a Web Ontology Language, with the starting point for the working group being the DAML+OIL[4] proposal. DAML+OIL was an ontology language which itself came about through the synthesis of earlier work, OIL [3] and DAML-ONT [5].

OIL (the Ontology Inference Layer) was the product of a group of largely European researchers, many involved in the OntoKnowledge[6] EU project. OIL provided a language for describing classes and properties and in its earliest incarnation used a textual concrete syntax along with an RDF Schema presentation. Using an underlying semantics based on Description Logics, reasoners for OIL could be provided, and early tools (such as OilEd [5]) were able to demonstrate the utility of reasoning when constructing and maintaining ontologies.

While OIL was under development, a group of largely US-based researchers were also working on an ontology language – DAML-ONT[7], provided as an extension of RDF Schema.

The two efforts came together in DAML+OIL, with the responsibility for the specification being held by the Joint US/EU ad hoc Agent Markup Language Committee[8]. The DAML+OIL specification of March 2001 included an RDF-Schema concrete syntax, an XML Schema, and a formal semantics for the language. This formed the starting point for the work of WebOnt.

1.2 Timeline

The WebOnt working group started in Nov 2001, with the first face to face meeting in January 2002. The Working Group officially concluded business on 31st May, 2004.

A W3C Technical Recommendation moves through a number of "maturity levels" during the recommendation process. These are:

Working Draft (WD) A Working Draft is a document that W3C has published for review by the community, including W3C Members, the public, and other technical organizations.

[1] http://www.w3.org/2001/sw/WebOnt/
[2] http://www.w3.org/News/2004#item14
[3] http://www.w3.org/2002/11/swv2/charters/WebOntologyCharter
[4] http://www.daml.org/2001/03/daml+oil-index.html
[5] http://www.daml.org/2000/10/daml-ont.html
[6] http://www.ontoknowledge.org
[7] http://www.daml.org/2000/10/daml-ont.html
[8] http://www.daml.org/committee/

Candidate Recommendation (CR) A Candidate Recommendation is a document that W3C believes has been widely reviewed and satisfies the Working Group's technical requirements. W3C publishes a Candidate Recommendation to gather implementation experience.

Proposed Recommendation (PR) A Proposed Recommendation is a mature technical report that, after wide review for technical soundness and implementability, W3C has sent to the W3C Advisory Committee for final endorsement.

W3C Recommendation (REC) A W3C Recommendation is a specification or set of guidelines that, after extensive consensus-building, has received the endorsement of W3C Members and the Director. W3C recommends the wide deployment of its Recommendations. W3C Recommendations are similar to the standards published by other organizations.

W3C process requires that a number of conditions (or Exit Criteria) are met before a recommendation can move to the next level of maturity. For example, in the case of OWL, sufficient implementation experience had to be demonstrated before the specification was able to progress from CR to PR. This will be discussed in more detail below.

For OWL, the key milestones were as follows:

CR The OWL Document set achieved Candidate Recommendation status in August 2003.

PR Proposed Recommendation status was achieved in December 2003.

REC OWL was endorsed as a Recommendation on February 10, 2004.

It is worth noting that the standardisation of OWL was a relatively speedy process. Specifications for the RDF Semantics were also published as a Recommendation on 10th February 2004. The RDF standardisation process had been running for a much longer period. RDF Schema had, in fact, been in Proposed Recommendation status since 1999.

1.3 OWL Recommendation

The OWL Document set comprises six recommendations, along with two Working Group Notes. WG Notes are not part of the official document set of a specification, but provide supporting documentation of particular aspects. The documents are:

OWL Web Ontology Language Overview [12] Gives a simple introduction to OWL by providing a language feature listing with very brief feature descriptions;

OWL Web Ontology Language Guide [17] Demonstrates the use of the OWL language by providing an extended example. It also provides a glossary of the terminology used in these documents;

OWL Web Ontology Language Reference [8] Gives a systematic and compact (but still informally stated) description of all the modelling primitives of OWL;

OWL Web Ontology Language Semantics and Abstract Syntax [14] The final and formally stated normative definition of the language;

OWL Web Ontology Language Test Cases [7] Contains a large set of test cases for the language;

OWL Web Ontology Language Use Cases and Requirements [9] Contains a set of use cases for a web ontology language and compiles a set of requirements for OWL;

OWL Web Ontology Language XML Presentation Syntax [10] A WG Note describing an alternative concrete syntax for OWL presented as an XML Schema;

OWL Web Ontology Language Parsing OWL in RDF/XML [2] A WG Note discussing the issues around parsing OWL in RDF/XML.

1.4 The OWL Language

We will not discuss the details of the OWL specification here – the interested reader can refer to the OWL Recommendations [8, 12, 17, 7, 9, 14], with the Overview [12] providing a good starting point. We will, however, briefly discuss the key aspects of the specification.

An ontology defines the terms used to describe and represent an area of knowledge. Ontologies are used by people, databases, and applications that need to share domain information. A key requirement for ontologies in the Semantic Web context is that they are "machine-understandable". This is not to say that we expect computers to be able to understand the world we live in, but the knowledge should be encoded in a way that amenable to processing by computers. In particular, this means that the semantics of the language should be well understood and well-defined.

With any representation language there is always a trade-off between expressivity and tractability of inference. If we allow rich expressiveness in a language, it may not be the case that we can provide a well-behaved inference process over that language. With OWL, this trade-off as been partly addressed through a layered approach. Three different "dialects" or sublanguages are provided with differing characteristics in terms of their expressiveness (and thus computational behaviour).

OWL Full is provided for users who want maximum expressiveness and the syntactic freedom of RDF, but with no guarantess of computational behaviour. Reasoning in OWL Full is *incomplete* – we cannot always guarantee that an answer will be found for a problem.

OWL DL is provided for users for whom computational completeness (a guarantee that an answer can be found) and decidability (a guarantee that all comutations will finish in finite time) are important. OWL DL has both syntactic and semantic restrictions which support this guaranteed behavior. OWL DL semantics are based on Description Logics (hence the DL name), a family of logics which have been the subject of much recent study and research [1].

OWL Lite is provided for those users requiring a classification hierarchy and simple constraints. It is likely that tool provision will be easier for OWL Lite, and it also provides a quick migration path for users currently using thesauri and other simple taxonomies.

The languages are layered in that all OWL Lite ontologies are OWL DL, and all OWL DL ontologies are OWL Full. Thus users can migrate to more expressive layers with ease (but should be aware that the computational characteristics of the supporting systems may change).

Within WonderWeb, implementation emphasis has been placed primarily on support for the OWL DL language, as the reasoning support provided by the WonderWeb tools is based on underlying description logic research.

1.5 WonderWeb and OWL

Five members of WonderWeb: **Frank van Harmelen** and **Guus Schreiber** of the Free University of Amsterdam; **Ian Horrocks** and **Sean Bechhofer** of the University of Manchester; and **Raphael Volz** of the University of Karlsruhe were all members of the Working Group. All five made key contributions to the standardisation process, taking part in weekly teleconference calls and attending occasional face-to-face meetings.

1.5.1 WG Chair

- **Guus Schreiber** was co-chair of the Working Group along with Jim Hendler of the University of Maryland.

1.5.2 Document Editors

- **Ian Horrocks** was co-editor of the OWL Semantics and Abstract Syntax document [14].
- **Frank van Harmelen** was co-editor of the OWL Overview [12].

1.5.3 Document Authors

- **Raphael Volz** made significant contributions to the OWL Use Cases and Requirements [9] and the OWL Guide [17] documents.
- **Sean Bechhofer**, **Ian Horrocks** and **Frank van Harmelen** made contributions to the OWL Reference document [8].
- **Ian Horrocks** and **Sean Bechhofer** contributed a large number of tests to the OWL Test Cases [7]. These included tests taken from existing collections of test data for Description Logic systems[9], which were then highly useful in exercising reasoner implementations.
- **Sean Bechhofer** authored a WG Note [2] on Parsing OWL in RDF/XML.

[9] http://dl.kr.org/dl98/comparison/data.html

1.5.4 Implementation Experience

In addition to document editing and authorship, implementations from WonderWeb were critical in the standardisation process. The Exit Criteria for Candidate Recommendation included a number of criteria based on implementation experience, for example demonstrations that reasoners implementing significant subsets of the OWL-DL fragment *are* indeed implementable. Results from FaCT++ [18] and Hoolet[10] (an OWL reasoner based on a translation to First Order Logic) contributed to this implementation experience.q

Implementation experience regarding the handling of OWL concrete syntax was also required, in particular a demonstration that *species recognition* was possible. This is the process whereby an application is able to determine whether an ontology represented in OWL using RDF/XML is in a particular OWL subfragment. Species recognition has proved to be a non-trivial task (see [4] for details). A validator based on the WonderWeb OWL API [6] was among the first implementations to demonstrate validation and pass all the tests in the OWL Test Suite [7].

2 Rules

Work on Standardisation of Rules Extensions to Ontology Languages is in a less mature state than that for core Ontology Languages. A proposal for a Semantic Web Rules Language SWRL [11] has been put forward, again (as with DAML+OIL) under the auspices of the Joint US/EU ad hoc Agent Markup Language Committee. SWRL attempts to marry efforts such as the Rule Markup Langauge (RuleML)[11] with OWL.

It is expected that this proposal will form the starting point for a W3C working group on Rule Language Extensions, and SWRL has been accepted as a W3C Member Submission[12]. Work on Rule Extensions is also being pursued in the Knowledge Web Network of Excellence, in particular within Work Package 2.5[13] of the Network.

3 Service Ontologies

Again, Web Service ontologies are at an early stage of development. Members of WonderWeb have been active in groups contributing towards the definition of languages for service description. **Marta Sabou** is an author of the OWL-S Web Service Ontology[14]. In addition, experiences of working with Service ontologies [15, 16] and work describing the alignment of Web service ontologies with the upper level DOLCE ontology have been published [13].

[10] http://owl.man.ac.uk/hoolet
[11] http://www.dfki.uni-kl.de/ruleml/
[12] http://www.w3.org/Submission/SWRL/
[13] http://www.kw.man.ac.uk/language/
[14] http://www.daml.org/services/owl-s/1.0/

4 Next Steps

Now that OWL has been endorsed as a Recommendation, work is underway on the next stage in the process. A Semantic Web Best Practice Working Group[15] has been chartered, and is in the process of starting up. **Guus Schreiber** will again chair the WG, and **Aldo Gangemi** of ISTC-CNR will also participate. The WG will help application developers by providing them with ”best practices” in various forms, ranging from engineering guidelines, ontology/vocabulary repositories to educational material and demo applications.

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