Service Web 3.0

Deliverable

WP3: Standardisation, Networking, and Community Building

D3.1

Standardisation Activity Report

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Executive Summary

Throughout the project duration, a key task of Service Web 3.0 has been participation in the standardisation activites in the field of semantic technologies, particularly semantic web services. This document reports on the impact of these standardisation activities, namely:

1. The project's identification of and participation in appropriate standardisation bodies, including The World Wide Web Consortium (W3C), Organization for the Advancement of Structured Information Standards (OASIS), and The Conceptual Models of Services Working Group (CMS-WG) of STI International
2. The project's identification of emerging standards and suggestions for how these standards can be improved and exploited. Example standards include: MicroWSMO, WSMO-Lite, Semantic Execution Environment (SEE), and Business Process Modelling Ontology (BPMO).
3. The project's identification of and participation in evaluation programmes, which are important both to research and to eventual mainstream adoption of semantic technologies. Example evaluation programmes include: The Semantic Web Services (SWS) Challenge and the Semantic Evaluation At Large Scale (SEALS) project.

This document marks the final evolution of deliverable D3.1, a version of which was first submitted at the end of Month 12.

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List of Keywords/Abbreviations

API	Application programming interface
OU	Open University
OWL	Web Ontology Language
RDF	Resource Description Framework
REST	REpresentational State Transfer
RDF	Resource Description Framework
WSMO	Web Services Modelling Language
XML	Extensible Markup Language

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1 Introduction

Service Web 3.0's objective is to lay foundations for an Internet of Services, and to do so by integrating service-oriented architecture (SOA), Web (and Web2.0), and semantics, as well as the research communities behind them. A key route to achieving this is to create consensus through standardisation of the technical methods that derive from the research community. Without standards, neither community nor technology can progress to stability or relevance—the tools for creating services, and the services themselves, will not be interoperable, and the vision of a network based on ubiquitous service-based functionality cannot be realised.

Service Web 3.0 has identified venues for such standardisation, candidate technologies for standardisation within them, and participated in their development through its partners.

In section 2 we review the appropriate standardisation bodies active in the fields of web and business process management. Section 3 introduces the particular standards whose development the project has chosen to participate. Section 4 covers two prominent programmes which attempt to provide mechanisms for evaluating semantic web service frameworks. We conclude in section 5.

2 Standardisation Bodies

Most standards for the Web—the textual Web, semantic Web, and web services—have emerged from just two standards bodies: the World Wide Web Consortium (W3C) and the Organization for the Advancement of Structured Information Standards (OASIS). Those standards, in turn, often appear at those bodies after incubating elsewhere, and we also examine the work of one such feeder, the Conceptual Models of Services Working Group (CMS-WG) of the Semantic Technologies Institute International (STI2).

2.1 World Wide Web Consortium (W3C)

The W3C[1] is the key standards body for the Web. Founded in 1994, and led by Tim Berners-Lee, the W3C creates "Recommendations" which set de facto standards for most of the parts of the web. Some such standards include:

- Human web standards including HTML, XHTML, and Cascading Style Sheets (CSS).
- Machine processable web standards like XML, XSLT, and XPath.
- Semantic web standards like RDF, RDFa, OWL, SPARQL, and GRDDL.
- Services standards like SOAP, and the WS-* stack.

Covering the intersection of Web, services and semantics, the W3C runs a "Semantic Web Activity" with a number of groups whose published work includes:

- OWL-S member submission
- WSMO member submission
- SAWSDL recommendation

Although preceeding Service Web 3.0, both WSMO and SAWSDL were co-authored by current Service Web 3.0 partners (OU and UIBK).

2.2 Organization for the Advancement of Structured Information Standards (OASIS)

The Organization for the Advancement of Structured Information Standards [2], better known as OASIS, is an international open standards organization whose technical agenda is set by its members with the aim of meeting the needs of the marketplace. It has a more business-oriented outlook than W3C and draws a balanced membership base that spans a large number of different industries across many different countries, with a

[1] http://www.w3c.org/
[2] http://www.oasis-open.org/

mixture of users, suppliers, government agencies, academic institutions, individuals and multi-national organizations. Not all OASIS committees develop standards: some promote adoption, interoperability and conformance by articulating requirements, identifying gaps, recommending best practices, publishing test suites, and providing inputs to other groups.

While OASIS is not restricted to services it has been a driving force in establishing a large number of standards in the services domain, including:

- Electronic Business using eXtensible Markup Language (EBXML)
- Universal Description Discovery and Integration (UDDI)
- Web Services for Remote Portlets (WSRP)
- Web Services Distributed Management (WSDM)
- Business Process Execution Language (BPEL)
- WS-Security
- Reference Model for Service Oriented Architectures (SOA-RM)

Ongoing efforts from the Semantic Web Service community are trying to bring semantics into the OASIS Standardization body. As a first effort the Semantic Execution Environment Technical Committee (SEE-TC) was established in 2005 with the aim of standardizing the different broker services that exist within a Semantic Execution Environment for Semantic Web Services. Service Web 3.0, through its partners, is participating in two OASIS efforts — namely the Semantic Execution Environment (SEE and Semantic SOA Reference Ontology) which are detailed in Section 3.

2.3 Conceptual Models of Services Working Group (CMS-WG)

The Conceptual Models of Services (CMS) working group[3] operates under the aegis of the Semantic Technologies Institute (STI). STI itself is an international consortium of academic and industrial members who share an ambition to apply semantics to overcome technical and social problems. The remit of the CMS-EG is to continue the efforts of the WSMO working group. It maintains WSMO by adding appropriate updates fulfilling requests of Semantic Web service researchers and practitioners. Moreover, building on WSMO, the CMS working group will create new generic ontologies suitable for an Internet of billions of services including:

- WSMO-Lite—a lightweight ontology which uses RDFS as the description language and defines mechanisms to annotate WSDL descriptions using SAWSDL.
- MicroWSMO—an annotation mechanism for RESTful services.

[3] http://cms-wg.sti2.org

- Semantic Annotations of Processes—an ontology for describing processes which are implemented as Web services. Processes at varying levels of granularity will be considered (e.g. from high level business views to Web service aggregations).

The work of the CMS WG is based on the work of two recently concluded European projects: SUPER[4] and SEEMP[5] for the semantic annotations of processes, and the ongoing SOA4ALL[6] for WSMO-Lite and MicroWSMO. The group will take advantage of the standardisation efforts within W3C and OASIS especially: SAWSDL[7] and the SWS Testbed Incubator Group[8] within W3C; and the OASIS Semantic Execution Environments Technical Committee[9].

The CMS WG holds regular distributed meetings (e.g. teleconferences)and also organizes annual face-to-face meetings co-located with major events such as STI International meetings, European Semantic Web Conference (now Extended Semantic Web Conference) or International Semantic Web Conference.

[4] http://www.ip-super.org/
[5] http://www.seemp.org/
[6] http://www.soa4all.org/
[7] http://www.w3.org/2002/ws/sawsdl/
[8] http://www.w3.org/2005/Incubator/swsc/
[9] http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=semantic-ex

3 Emerging Standards

Within the bodies mentioned above are many ongoing standardisation activities. In this section, we describe standards-track proposals in which Service Web 3.0 partners have been participating.

A common thread links several of these standards: incrementality. There are several semantic web services standards already (OWL-S and WSMO), and other frameworks which have been proposed. However, industry takeup has been low, and there is now a view that greater efforts should be placed in adding small amounts of semantics to existing web services standards, allowing users to add semantics in an incremental fashion, with a shorter learning curve and less intrusiveness. These standards are aimed at being lightweight and compatible extensions of current standards in web services. Furthermore, for the purposes of realising and Internet of billions of services, these lightweight standards are seen as more appropriate than their heavyweight counterparts.

3.1 WSMO-Lite

WSMO-Lite is an ontology for semantic description of Web services that is built on the W3C standards Web Service Description Language[10] (WSDL) and Semantic Annotations for WSDL and XML Schema[11] (SAWSDL). It is mainly being developed in the scope of the projects SOA4ALL[12] under coordination through the Conceptual Models for Services Working Group[13] (CMS WG), with the intention of submitting it to the W3C as an input towards SWS standardization. At the time of writing, WSMO-Lite is close to being finalized. For describing Web services, WSMO-Lite distinguishes four kinds of semantics:

- Information model defines the semantics of input, output and fault messages.
- Functional semantics defines service functionality, that is, what a service can offer to its clients when it is invoked.
- Nonfunctional semantics defines any incidental details specific to the implementation or running environment of a service, such as its price or quality of service.
- Behavioral semantics specifies the protocol (ordering of operations) that a client needs to follow when consuming a service's functionality.

Concrete semantic descriptions are attached to WSDL service descriptions using the SAWSDL attributes modelReference, liftingSchemaMapping and loweringSchemaMapping. Mostly, the modelReference attribute serves to point from WSDL components to their respective semantics.

[10] `http://w3.org/TR/wsdl20/`
[11] `http://w3.org/TR/sawsdl/`
[12] `http://soa4all.eu/`
[13] `http://cms-wg.sti2.org/`

To describe the concrete semantics, WSMO-Lite defines the following ontology, which is then used to capture actual formal semantic descriptions:

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix wsl: <http://www.wsmo.org/ns/wsmo-lite#> .

wsl:Ontology rdf:type rdfs:Class ; rdfs:subClassOf owl:Ontology .
wsl:FunctionalClassificationRoot rdfs:subClassOf rdfs:Class .
wsl:NonfunctionalParameter rdf:type rdfs:Class .
wsl:Precondition rdf:type rdfs:Class .
wsl:Effect rdf:type rdfs:Class .
```

For describing information models, WSMO-Lite incorporates any ontologies built on top of RDF, including ontologies captured in languages such as OWL and WSML. These ontologies are identified through membership in the class wsl:Ontology. In WSDL, message schemas are annotated with SAWSDL modelReference pointers to the appropriate classes and properties from the information model ontology.

Functional semantics are expressed in WSMO-Lite in two ways: First, WSMO-Lite supports classifications of types of service functionalities, where the classifications are expressed as RDFS subclass hierarchies whose roots are marked as wsl:FunctionalClassificationRoot. Second, WSMO-Lite defines placeholders for preconditions and effects, which describe the functionality of a service using logical expressions. In WSDL, a service or its interface (portType in WSDL 1.1) can be annotated with a modelReference that points to appropriate functionality categories and/or the preconditions and effects that describe the service.

Non-functional semantics are also captured in WSMO-Lite using a placeholder class — a non-functional parameter can be described in any ontology language compatible with RDF, and then marked as an instance of the class wsl:NonfunctionalParameter, which is then attached to the service or its interface in WSDL with a modelReference. Finally, behavioral semantics are expressed through functional descriptions (functionality classifications or preconditions and effects) on the individual operations of a given service interface attached, as usual, with modelReferences.

Depending on what Web service usage tasks are to be automated, the client only needs subsets of all possible WSMO-Lite annotations. For instance, for functional service discovery, the services only need to have annotations of the functional semantics. For service invocation and mediation, the behavioural semantics and the information model must be described in the WSDL, but the functional semantics are not necessary. This makes WSMO-Lite very modular. A WSDL document annotated with SAWSDL pointers to WSMO-Lite semantics can be though of as a WSMO-Lite description of a concrete Web service. Since the semantics are expressed in RDF and layered on top of WSDL, WSMO-Lite is an incremental addition with a low barrier of entry, and it should be an acceptable basis for a new standard in this area.

3.2 MicroWSMO

While the most of standardization and research work around services on the Web has gone into messaging systems, such as Web services that use the SOAP protocol and are described in WSDL, the Web has been independently enriched with a different kind of services, built on the publication interface of HTTP. These services are made available by various Web applications and large Web sites under the names APIS and RESTful services, and examples include the APIS of flickr.com, del.icio.us, Yahoo! etc. MicroWSMO is a lightweight approach for technical and semantic description of these RESTful services. Like WSMO-Lite, it is mainly being developed in the scope of the project SOA4ALL under coordination through the Conceptual Models for Services Working Group (CMS WG).

RESTful services do not use the SOAP protocol, instead they use the principles of the REST architectural style [1] that underlies the World-Wide Web and as such, they exchange data directly as payloads of the various methods of HTTP. Since the publication interface of HTTP differs from the common messaging approach supported by WSDL, the RESTful services and Web APIS are not commonly described using WSDL, and therefore we cannot apply WSMO-Lite directly to support automation.

RESTful services are generally provided with human-readable HTML documentation. MicroWSMO therefore provides hRESTS, a microformat for annotating such human-readable documentation so that it becomes machine-processible in a way similar to WSDL. On top of hRESTS, MicroWSMO adopts SAWSDL-like properties along with the WSMO-Lite ontology for service semantics.

A concrete human-oriented documentation of a RESTful service, which is structured using the hRESTS microformat and annotated using MicroWSMO can then be seen as an equivalent of a WSMO-Lite document, and it can support the same level of automation of Web service usage.

MicroWSMO is not as close to being finished at the time of this writing as WSMO-Lite, therefore it may still change. However, it is likely that the following pieces may be material for standardization:

- The hRESTS microformat that structures service documentation into a WSDL-like form, can be submitted for standardization to microformats.org, a community that develops microformats.
- The SAWSDL-like additional properties that are added to hRESTS to point to semantics can then be added as extension, and standardized in the W3C, thus tying together WSDL-based and RESTful Web services.

3.3 Business Process Modelling Ontology

A major result of the recently concluded EU IP project SUPER is the ontology stack shown in figure 3.1. Many of the ontologies in the stack are semantic counterparts of

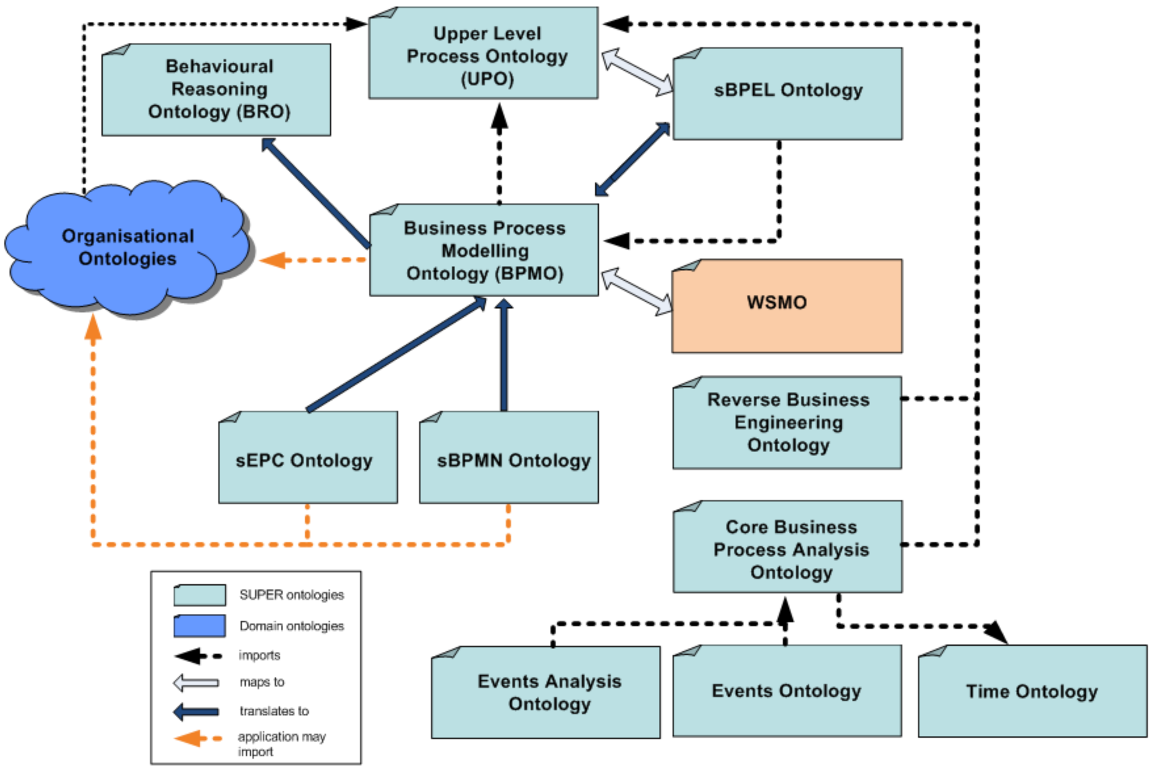

Figure 3.1: SUPER Process Ontology Stack.

established schemas from the area of web services and business process. The core part of the stack supports translation from Event-driven Process Chains (EPCS, via SEPC), Business Process Modelling Notation (BPMN, via SBPMN) and Business Process Execution Language (WS-BPEL via SBPEL) via BPMO, SUPER's own Business Process Modelling Ontology, to BPEL4SWS, SUPER's own extension to WS-BPEL with support for Semantic Web Services (again via SBPEL). Around these supporting tasks such as behavioural reasoning and analysis including monitoring and reverse business process engineering are provided for.

While the set of input languages is not canonical, merely convenient to the project participants, the ability to translate via a common business expert-oriented representation in BPMO to an IT-oriented view based on BPEL, which is a de facto standard in industry, has proven its flexibility. For this reason these two ontologies, BPMO and SBPEL, have been taken as the basis of a standardization activity in STI's Conceptual Models of Services Working Group. Although still in development, two deliverables are anticipated based around these respective ontologies.

3.4 SEMANTIC EXECUTION ENVIRONMENT

The main aim of OASIS Semantic Execution Environment Technical Committee is to standardize the description and required functionality from infrastructural support for a meaningful notion of Semantic SOA. This is documented in the form of a Reference Architecture that describes first the terminology for, and functional requirements upon, core infrastructural components in service style. The intended interactions between these components are then documented in process style, together with the user-oriented endpoints that trigger these processes.

In order to provide a basis both for this terminology, and a formal model for the communications in the semantic service and process descriptions, the OASIS SOA Reference Model is extended with Semantic Web Services concepts, and this extended model is formalized as a Semantic SOA Reference Ontology, as shown in figure 3.2. This document has now been advanced as an OASIS Committee Draft. Work on the Semantic Execution Environment Reference Architecture now continues based on this draft.

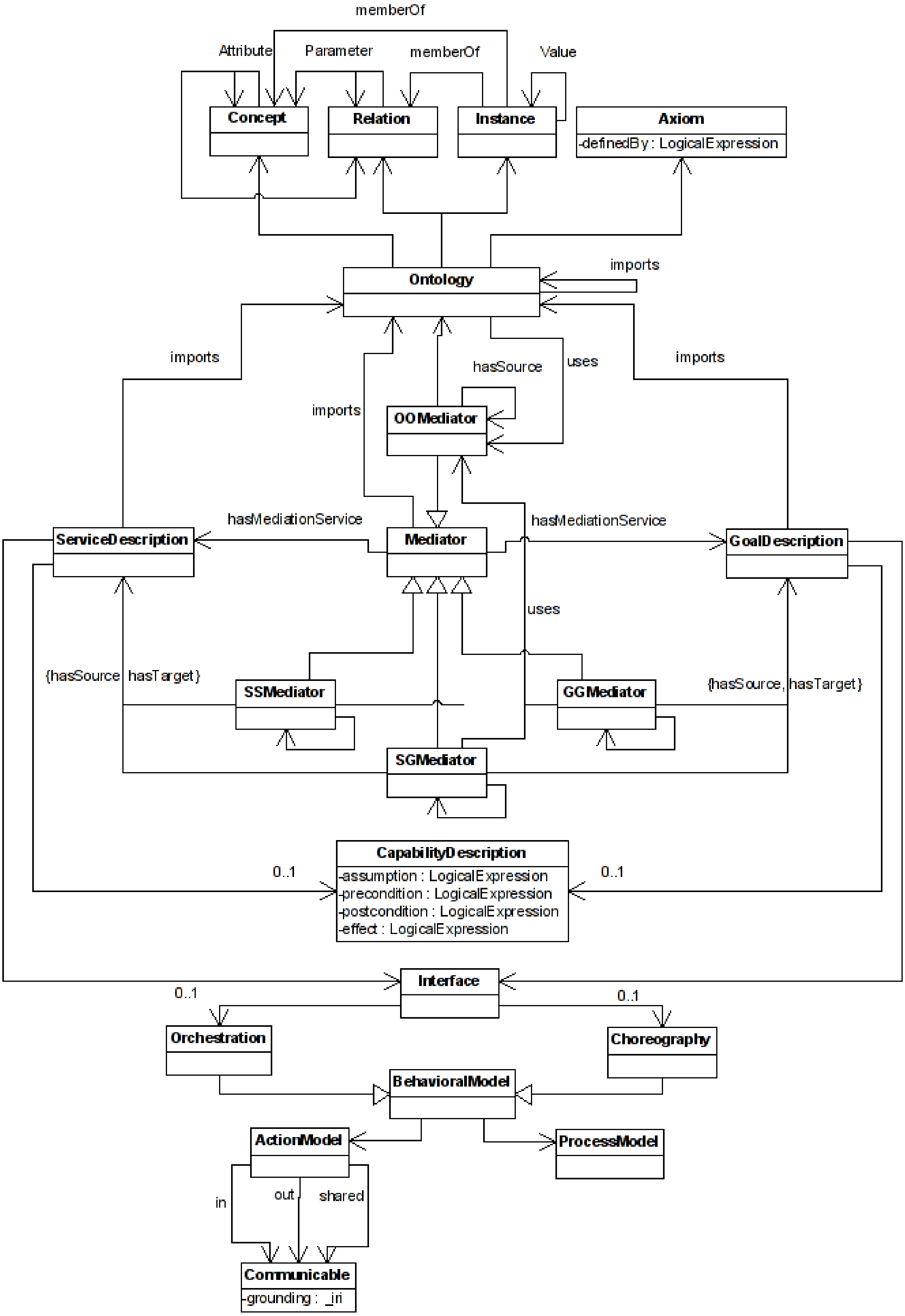

Figure 3.2: OASIS Semantic SOA Reference Ontology.

4 Evaluation Programmes

Another key component in standardisation is creating a means for comparing and evaluating semantic web services frameworks, platforms, and descriptions, and doing so against real-world tasks. While this can only truly be measured when standards enter large scale use, smaller scale challenge activities can provide a useful metric against which to measure progress. A key venue is again the W3C, which formed a semantic web services incubator group, which we discuss next.

One other initiative is the Online Portal for Semantic Services[14] (OPOSSUM). This is an attempt to provide a clearing house for service descriptions, and therefore serve to help compare them. It is an online database of semantic web service descriptions, contributed by the community.

4.1 The Semantic Web Services Challenge

The W3C runs a series of incubator groups, one of which is the Semantic Web Services incubator group[15]. This group closed as an incubator activity in December 2008, following publication of the W3C SWS Challenge Testbed Incubator Methodology Report[16]. Its primary legacy is the ongoing series of semantic web services challenge events.

The SWS Challenge invites participants to submit semantics-based solutions to set challenge problems. A series of changes are then made to the problems, and the participants must alter their submissions to cope. The objective is to discover how various frameworks for service discovery, mediation, choreography and orchestration can ease the application of services to business problems.

The challenge setting also provides a forum for discussion about the various merits and shortcomings of the entries. Participation is from both academia and industry, and entrants are encouraged to share their code and ideas.

This SWS Challenge is related to but distinct from the IEEE Web Services Challenge. The WSC is indeed beginning to consider semantics in relating XML descriptions of the input and output messages of the WSDL. The SWSC allows participants to provide additional semantic annotations of the WSDL in order to solve the problems and also evaluates the efficacy of the different approaches to doing so. The SWS Challenge does not anoint winners, but rather certifies entries for their ability to solve particular fragments of the challenge problem.

More information on this can be found at: `http://sws-challenge.org/wiki/index.php/Scenarios`

- Workshop Stanford (8.-10. Mar 2006)

[14] http://fusion.cs.uni-jena.de/opossum/index.php
[15] http://www.w3.org/2005/Incubator/swsc/
[16] http://www.w3.org/2005/Incubator/swsc/XGR-SWSC-20080331/

- Workshop Budva (15.-16. Jun 2006) results from the evaluation in Budva
- Workshop Athens (10-11 November 2006) results from the evaluation in Athens
- Workshop Innsbruck (6-7 June 2007) results from the evaluation in Innsbruck
- Special Session at ICEIS2007 (12-16 June 2007)
- Workshop Stanford (2) (external page) (5-6 November 2007) results from the evaluation in Stanford
- Workshop Tenerife (2-3 June 2008)
- Workshop Karlsruhe (October 2008, at ISWC2008)

The latest list of workshops can be found at: `http://sws-challenge.org/wiki/index.php/Workshops`. An updated list of organizing and program committee of the SWS-Challenge workshop can be found at: `http://sws-challenge.org/wiki/index.php/Program_Committee`

4.2 Semantic Evaluation At Large Scale (SEALS)

Service Web 3.0 has begun collaborating with a new EU project SEALS, in which the Open University is a participant. The goal of the SEALS project is to provide an independent, open, scalable, extensible and sustainable infrastructure (the SEALS Platform) that allows the remote evaluation of semantic technologies thereby providing an objective comparison of the different existing semantic technologies. This will allow researchers and users to effectively compare the available technologies, helping them to select appropriate technologies and advancing the state of the art through continuous evaluation.

The SEALS Platform will provide an integrated set of semantic technology evaluation services and test suites. They will be used in two public and worldwide evaluation campaigns. The results of these evaluation campaigns will be used to create semantic technology roadmaps identifying sets of efficient and compatible tools for developing large-scale semantic applications.

The semantic technology evaluation services will initially be available for five different types of technologies (ontology engineering tools, storage and reasoning systems, matching tools, semantic search tools, and semantic web service tools) and for different evaluation criteria (interoperability, scalability, etc.). The platform will provide easy and free access to the evaluation services and to the results of the evaluations performed.

5 Conclusion

This deliverable presented the overview and action plan of the collaboration of the Service Web 3.0 project. This collaboration is to ensure coherence of projects and increase effectiveness of the EU collaboration. One of the main collaborations planned is chairing and fostering work of the Services and Architectures WG, one of the working groups created within the Future of the Internet Initiative. Its members work jointly on topics of services management and governance, trust at scale and high granularity, architectures and infrastructures and lifecycle engineering for Future Internet Applications.

Other initiatives discussed within the deliverable cover STI Conceptual Models for Services Working Group as well as recently established Semantic Technologies and Ontologies Working Group targeted at research at semantic foundation of the Web of Services. All groups hold (or will hold) at least monthly conference calls, and have a defined work plan that is to be achieved by the end of the year. The actions are intended to be genuinely cooperative in that they are envisioned not to change the project plans of involved projects or partners.

REFERENCES

[1] Roy Thomas Fielding. *Architectural Styles and the Design of Network-based Software Architectures*. PhD thesis, University of California, Irvine, 2000.