



Data, Information and Process Integration  
with Semantic Web Services

**DIP**

*Data, Information and Process Integration with Semantic Web Services*

**FP6 - 507483**

Deliverable

**WP 7: Technology Watch and Standardisation**

**D7.7**

**Standardisation Strategy and Impact Analysis Update**

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June 21<sup>st</sup>, 2006



## **EXECUTIVE SUMMARY**

This document is the third deliverable in a series of planned update documents for the DIP deliverables D7.3-D7.4 (standardisation strategy and impact analysis [1], [2]) in the course of the workpackage WP7 “Standardisation and Technology Watch”, and a follow-up to deliverable D7.6 (second update of the standardisation impact analysis [3]).

The actions and advances of WSMO and WSML are reviewed in this deliverable as will the new and ongoing activities of the OASIS SEE Technical Committee (former SDK). Also presented is an update on other ongoing standardisation activities including the W3C Rule Interchange Format progress report, OMG Production Rules Representation progress report, the W3C Semantic Annotation for WSDL working group and some other related activities.

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## Document Information

<b>IST Project Number</b>	FP6 – 507483	<b>Acronym</b>	DIP
<b>Full title</b>	Data, Information, and Process Integration with Semantic Web Services		
<b>Project URL</b>	<a href="http://dip.semanticweb.org">http://dip.semanticweb.org</a>		
<b>Document URL</b>			
<b>EU Project officer</b>	Kai Tullius		

<b>Deliverable</b>	<b>Number</b>	7.7	<b>Title</b>	Standardisation Strategy and Impact Analysis Update
<b>Work package</b>	<b>Number</b>	7	<b>Title</b>	Technology Watch and Standardisation

<b>Date of delivery</b>	<b>Contractual</b>	M 30	<b>Actual</b>	21-June-06
<b>Status</b>	version. 0.1		final	<input checked="" type="checkbox"/>
<b>Nature</b>	Prototype	<input type="checkbox"/>	Report	<input checked="" type="checkbox"/>
	Dissemination	<input type="checkbox"/>	Ontology	<input type="checkbox"/>
<b>Dissemination Level</b>	Public	<input type="checkbox"/>	Consortium	<input checked="" type="checkbox"/>

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<b>Abstract (for dissemination)</b>	This document is the third deliverable in a series of planned update documents for the DIP deliverables D7.3-D7.4 (standardisation strategy and impact analysis [1], [2]) in the course of the workpackage WP7 “Standardisation and Technology Watch”, and a follow-up to deliverable D7.6 (second update of the standardisation impact analysis [3]).
<b>Keywords</b>	WSMO, WSML, OASIS SEE, SWS, SOA, W3C, OMG




Version Log			
Issue Date	Rev No.	Author	Change
29-May-06	001	Edward Kilgarriff	Initial structure and NUIG content.
18-June-06	002	Christian de Sainte Marie	Add ILOG content plus review of D7.6 recommendations.
21-June-06	003	Edward Kilgarriff	Review updates

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**LIST OF KEY WORDS/ABBREVIATIONS**

BPEL – Business Process Execution Language

BPMN – Business Process Modelling Notation

OASIS – Organization for the Advancement of Structured Information Standards

OMG – Object Management Group

OWL – Web Ontology Language

RDF – Resource Description Framework

RIF – Rule Interchange Format

SDK – Sekt, DIP, KnowledgeWeb

SEE – Semantic Execution Environment

SOA – Service Oriented Architecture

WSML – Web Services Modeling Language

WSMO – Web Services Modeling Ontology

WSMX – Web Services Execution Environment

W3C –World Wide Web Consortium

XML– Extensible Markup Language

XPDL – XML Process Definition Language

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## 1 INTRODUCTION

This document is the third deliverable in a series of planned update documents for the DIP deliverables D7.3-D7.4 (standardisation strategy and impact analysis [1], [2]) in the course of the workpackage WP7 “Standardisation and Technology Watch”, and a follow-up to deliverable D7.6 (second update of the standardisation impact analysis [3]). In this deliverable there will be no update regarding the "SDK Standardization Coordination Group" as it was decided that there were no major advances recently.

Section 2 presents a review of actions recommended in DIP deliverable d7.6 and each is discussed or remarked on.

In Section 3 of this document, the recent actions and advances of both WSMO and WSML are reviewed. Section 4 describes new and ongoing activities of the OASIS SEE Technical Committee. A number of new developments are discussed. Section 5 contains an update on other ongoing standardisation activities including the W3C Rule Interchange Format progress report, OMG Production Rules Representation progress report, the W3C Semantic Annotation for WSDL working group and some other related activities. Finally, Section 6 presents a conclusion as well as an outlook for future activities.

## 2 REVIEW OF ACTIONS RECOMMENDED IN D7.6

Based on the analysis of activities undertaken during the previous semester to address the recommendations made in deliverable D7.5, as described in deliverable D7.6, D7.6 contained the follow-up recommendations that:

1. Continue activity in W3C, OASIS and OMG, closely monitoring alignment with WSMO/WSML and utility for DIP;
2. Monitor and even participate to potential developments at W3C of new activities related to semantic annotations in WSDL and the semantics of Web Services characterization;
3. Continue effort to integrate WSMO/WSML better within the existing Web service standard stack, in particular within W3C;
4. Closely follow the development in the BPEL areas;
5. Closely monitor future take-up of BPMN by software vendors and take into account BPMN and BPDM in the development of choreography functionality within DIP and WSMO.
6. Closely monitor future development of XPDL and its take-up by software vendors. Monitor efforts towards harmonisation with BPEL and BPMN. Moreover, XPDL should be taken into account in the development of orchestration functionality within DIP and WSMO.

The recommendations mentioned above are long term recommendations and a short term update for each was not included in this deliverable. There were no updates in relation to XPDL, BPEL and BPMN for this document, however an overview of the OASIS SEE Technical Committee can be found in section four. As mentioned in section one, there is a discussion on the work of various standardisation groups in section five.

### 3 WSMO/WSML UPDATE

This section will discuss the actions and advances of WSMO and WSML by the respective working groups. All new developments within WSMO since M24 were considered for this document; however some were omitted due to them being relatively incomplete.

#### 3.1 WSMO – New Developments

Since M24 of the DIP project, the new developments that have emerged in WSMO are Ontology-based Choreography WSMO Services [4], and WSMO Mediators have been defined in more detail in [5]. WSMO Grounding [7], Aligning WSMO and WSDL-S [8], Semantic Web Services Resource Framework (WSRF-S) [9] have also been detailed. The following listing briefly discusses these developments. For further detail of the work described here, please refer to the WSMO deliverables associated with them.

##### 3.1.1 Ontology-based Choreography of WSMO Services

It was decided that the focus of this work should be specifically of Choreography and not combined with Orchestration work as had previously been the case within WSMO. The aim is to provide a core conceptual model for describing choreography interfaces in WSMO, as well as providing a concrete syntax and semantics for this conceptual model. The state-based mechanism for describing WSMO choreography interfaces is inspired by the Abstract State Machine [10] methodology. An ASM is used to abstractly describe the behaviour of the service with respect to an invocation instance of a service. We have chosen an abstract machine model for the description of this interface since such a service invocation (e.g. the purchase of a book at amazon) may consist of a number of interaction steps. These interactions can be described by a stateful abstract machine. ASMs have been chosen as the underlying model for the following three reasons:

**Minimality:** ASMs provide a minimal set of modeling primitives, i.e., enforce minimal ontological commitments. Therefore, they do not introduce any ad-hoc elements that would be questionable to be included into a standard proposal.

**Maximality:** ASMs are expressive enough to model any aspect around computation.

**Formality:** ASMs provide a rigid framework to express dynamics.

##### 3.1.2 WSMO Mediators

This work is concerned with tackling the heterogeneity problem that naturally arises in open and distributed environments. The aim is to provide a detailed specification of the concept of Mediators as a top level element of the Web Service Modeling Ontology (WSMO), which identifies Mediators as a core element of Semantic Web Services. The end goal is an elaboration on the definition of the specification, usage and mediation techniques of WSMO Mediators as an extension of the definition provided in the WSMO specification [11].

### 3.1.3 WSMO Grounding

The aim of this work is to describe how WSMO service descriptions can be grounded to WSDL. WSDL provides the current industry standard for defining how messages can be exchanged between services over the Internet. There are two aspects to the problem. The first is that the data model of the input and output messages for WSDL services is defined using one or more XML Schemas while the data model for a WSMO service is defined using the conceptual model provided by one or more WSMO ontologies. This leads to the requirement of how to map between the ontological data in the state machine and its representation as XML messages. The second aspect of grounding is to specify how and when messages to and from the service are generated and sent. WSMO choreography only says that the client can read the data but in fact it is the responsibility of the service to send the data to the client in the form of a message. The grounding must also provide the necessary serialization and networking details, i.e. what underlying protocol (e.g. SOAP, HTTP) should be used for passing the messages, how the XML data is encapsulated in the underlying protocol, and where exactly the data should be sent.

### 3.1.4 Aligning WSMO and WSDL-S

Web Service Semantics (WSDL-S) [12] are a set of elements extending WSDL to allow semantic annotation of WSDL descriptions. WSDL-S is independent of any particular semantic annotation language, such as WSMO and OWL-S [13]. It is proposed that WSDL-S could be extended so that it usefully covers the features of WSMO, without compromising the main goals of WSDL-S: simplicity and independence.

### 3.1.5 Semantic Web Services Resource Framework (WSRF-S)

The Web Services Resource Framework [9] is a generic and open framework for modeling and accessing stateful resources using Web services. WSRF defines conventions for managing state so that applications discover, inspect, and interact with stateful resources in standard and interoperable ways. WSRF specifies machine-readable syntax like other Web services technologies such as WSDL and SOAP. However, its semantics are only described in plain text in the specifications, and WSRF does not use any semantic technologies. This work aims at discovering whether it would be possible to combine WSRF with semantic technologies to enable further automation of Web service resource interactions. The aim of this work is to extend WSRF with semantics.

These are the recent developments in WSMO since M24 in the DIP project. Work on a number of these topics discussed is still on going, and further information on each topic is available as the associated deliverable resource.

## 3.2 WSML

Since M24 of the DIP project, the new developments that have emerged in WSML include WSML/RDF [14], an interesting WSMO Use Case: Amazon E-commerce Service in [6], which demonstrates the use of WSDL files as well as a textual description of a service, to create a semantic description of a service. Finally, a number of survey efforts which aim to gauge to possibility for expanding the scope and use of

WSML. The following listing briefly discusses these developments. For further detail of the work described here, please refer to the WSMO deliverables associated with them.

### **3.2.1 WSML/RDF**

The RDF representation for WSML is the preferred way of representing WSML goals, web services, mediators and ontologies in RDF. Because of the nature of RDF, where every triple can be interpreted separately, it is hard to accurately capture WSML, because many parts of WSML descriptions are context-dependent, for example, non-functional properties. In WSML, URIs are interpreted depending on their context, because their context is always clear. In RDF, there is no such distinction of context and therefore it is very hard to capture WSML completely in RDF. It should be pointed out that the RDF representation of WSML is not completely accurate with respect to standard WSML. However, this work includes an RDF syntax that is a faithful representation of WSML using RDF triples. This representation, however, does not completely adhere to the RDF semantics, but can be used for exchanging WSML specification over the Semantic Web and using RDF tools for storing and retrieving WSML specifications.

### **3.2.2 WSMO Use Case: Amazon E-commerce Service**

This work looks at a pre-existing web service provided by amazon.com and it discusses a WSMO Ontology for the Amazon service data-types, the WSMO capability of the service and the WSMO Web service definition for the Amazon service. The work also includes a WSMO choreography for the service, including a State signature and Transition rules. Importantly, this work shows how a WSMO description can be created from a WSDL and textual description of a Web service. This use case is mainly intended to showcase the WSMO Choreography Language specified in WSMO D14 [27]; nevertheless it provides a complete annotation of the Amazon ECS Web service.

### **3.2.3 Other Work**

The current work on Languages for Behavioural Specifications of Semantic Web Services [15] aims to analyse the suitability of existing formal methodologies for describing behavioural aspects of Web services and to eventually suggest a methodology to be embraced as the basis of a behavioural language for WSMO. Ontology languages around FOL and LP [16], surveys different existing approaches for combining Logical programming and First Order Logic based languages. Different possible approaches for combining FOL and LP are investigated, focusing on modal languages. One approach will be chosen, and a unifying semantic framework which combines FOL and LP will be developed. Finally, work is on going in the WSMO deliverable D28.1 that specifies a formal model for describing Web services and the semantics of functional descriptions (capabilities). Usage scenarios for functional descriptions are identified and requirements on the expressivity of the specification are derived. [28]

## 4 OASIS SEE TC

The aim of the OASIS Semantic Execution Environment technical committee is to provide guidelines, justifications and implementation directions for an execution environment for Semantic Web services. The resulting infrastructure will incorporate the application of semantics to service-oriented systems and will provide intelligent mechanisms for consuming Semantic Web services. The following is a brief outline of the recent developments by the technical committee.

### OASIS SEE TC – New Developments

Since M30 of the DIP project, the technical committee has been furthering their work on incorporating semantics into service-oriented systems.

#### 4.1 OASIS SEE SOA-RM

The reference model for semantic service oriented architecture [17] has been developed to extend the work done in the OASIS SOA-RM technical committee. The aim of this reference model is to provide justifications for the need for semantics in service oriented architecture and to show where semantics can be applied in the SOA-RM and the benefits such an application gives. This work is still in progress and some of the documents discussed below are currently under development.

#### 4.2 SEE Case Studies

The SEE case studies [19] aim to provide a justification for the work of the technical committee and to explain what should be expected from the Semantically Execution Environment infrastructure. The case studies present real-world problems that could be simplified by the SEE infrastructure. A number of the case studies, provided by the OASIS SEE TC reference case study work within the DIP project including the VISP case study [20], and SWS for E-Government. The other case studies include SWS applications in B2B (RosettaNet), SWS Applications for Telecommunications, SWS in e-Banking, and SWS applications in Bioinformatics. These case studies can be found at [21].

#### 4.3 Semantic Web Services Architecture and Information Model

The purpose of SEE Semantic Web Services Architecture and Information Model [22] is to define a skeleton of an infrastructure aiming for automation of service discovery, negotiation, adaptation, composition, invocation, and monitoring as well as service interaction requiring data, protocol, and process mediation. While there are several specifications to capture functionality expected from the particular components/services of the SEE infrastructure, there is no prescribed definition of how to put all of these components to work together. The contribution of SEE specification is to describe the components/services of an infrastructure that must be provided to enable a dynamic inter-operation of the Semantic Web Services to facilitate the SOA revolution towards open environments.

#### 4.4 SEE-Execution Semantics

The Execution Semantics of a SOA [18] is the formal definition of system behaviour. It describes in a formal, unambiguous notation how the system operates. Once the platform services are specified, they can be combined in arbitrary ways owing to the flexibility of SOA. Role of Execution Semantics is to express complex scenarios of their composition. Execution Semantics can be perceived as a layer on the top of platform services where the overall execution of SOA system for the given scenario can be specified by providing business logic that combines control and data flow between the platform services. Services that are performing their tasks are completely unaware of this upper business layer and their role within it.

The SEE TC F2F meeting was held in San Francisco in May 2006. The main outcome is that the SEE TC will layer its work on top of the standards being produced by the SOA-RM working group. This section has briefly introduced some of the work topics currently on going within the OASIS SEE Technical Committee. The work is still on going and a number of documents are still under development.

## 5 OTHER ACTIVITIES UPDATE

### 5.1 W3C Rule Interchange Format progress report

As of June 19, 2006, the working group had 76 participants from 31 organisations, plus 3 experts. The group meets weekly for a 90 min teleconference, and about quarterly for a 2 days face-to-face meeting.

After 6 months of activity, the attendance to the weekly conference call is stable around 35-40, which shows the sustained interest in and importance of the subject. After the kick-off meeting in Burlingame, CA, in December 2005 (collocated with OMG's technical meeting), the working group had face to face meetings in Cannes, 27-28 February 2006 (collocated with the W3C technical week), and in Budva, 8-9 June 2006 (collocated with the European Semantic Web Conference). The February meeting was hosted by W3C and the June meeting was hosted by DERI.

The working group released the first public working draft of the Use Cases and requirements document in March 2006 [25], and the second public working draft is expected to be published early July.

The first public working draft focused on the use cases for the RIF. Among the eight use cases presented, half are directly relevant to semantic Web services, and thus to DIP: “negotiating eBusiness contracts across rule platforms”, “negotiating eCommerce transactions through disclosure of buyer and seller policies and preferences”, “access to business rules of supply chain partners” and “vocabulary mapping for data integration”.

Since then, the working group has conducted a Critical Success Factors analysis, and the second public working draft will contain an initial set of requirements for the RIF. The goals, critical success factors and requirements that the group proposes to consider for RIF are summarised in a graphical form in the Figure 1, below.

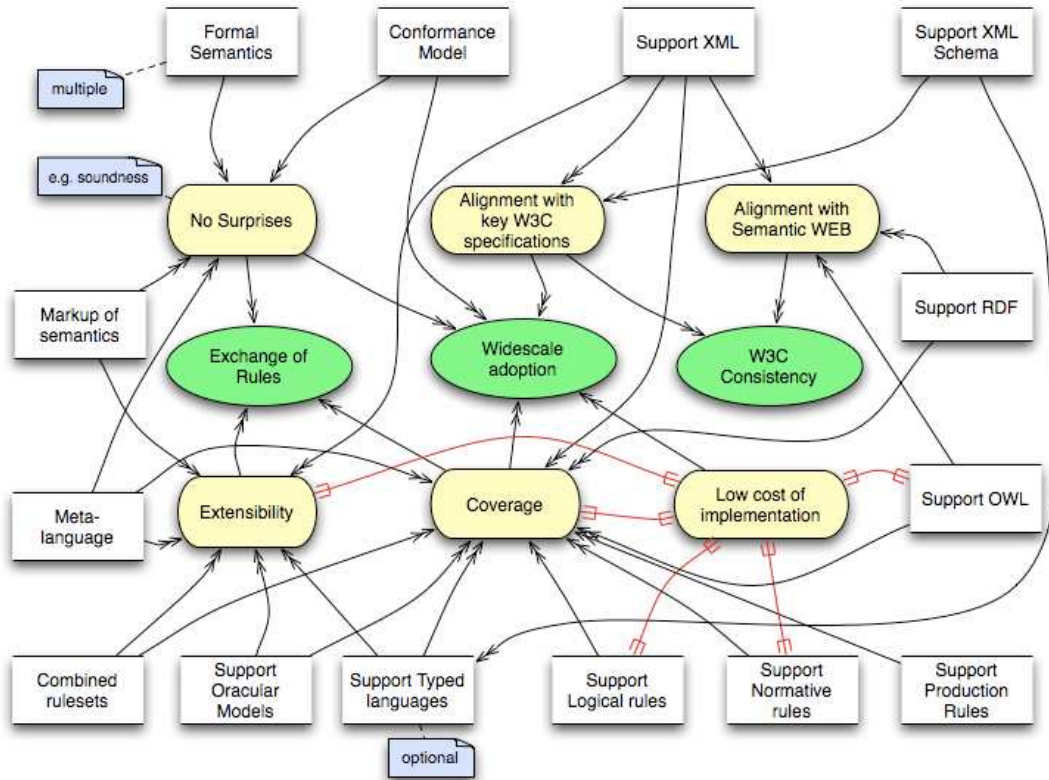
In parallel with the requirements, the working group started to work on the technical design. Due to the great variety of rule language with different features and semantics that the RIF has to cover, the group decided to first explore, in a staged way, the feasibility of a common format for rule conditions, starting with a very simple language with positional atoms only and no negation, as shown below (in BNF syntax):

```

Data      ::= value
Ind       ::= object
Var       ::= '?' name
TERM     ::= Data | Ind | Var | Expr
Expr     ::= Fun '(' TERM* ')'
Atom     ::= Rel '(' TERM* ')' | TERM '=' TERM
LITFORM  ::= Atom
QUANTIF  ::= 'Exists' Var+ '(' CONDIT ')'
CONJ     ::= 'And' '(' CONDIT* ')'
DISJ     ::= 'Or' '(' CONDIT* ')'
CONDIT   ::= LITFORM | QUANTIF | CONJ | DISJ
  
```

The initial trials to map existing rule languages to and from the simple strawman were very fruitful in raising a number of interesting questions regarding e.g. the compliance model for RIF. Note that, of three test mappings, two were volunteered by ILOG and DERI, respectively.

The working group is slightly behind schedule: the first public working draft of the technical specification, which was initially scheduled for May 2006 is now expected in September.



**Figure 1: Summary of RIF goals, critical success factors and requirements**

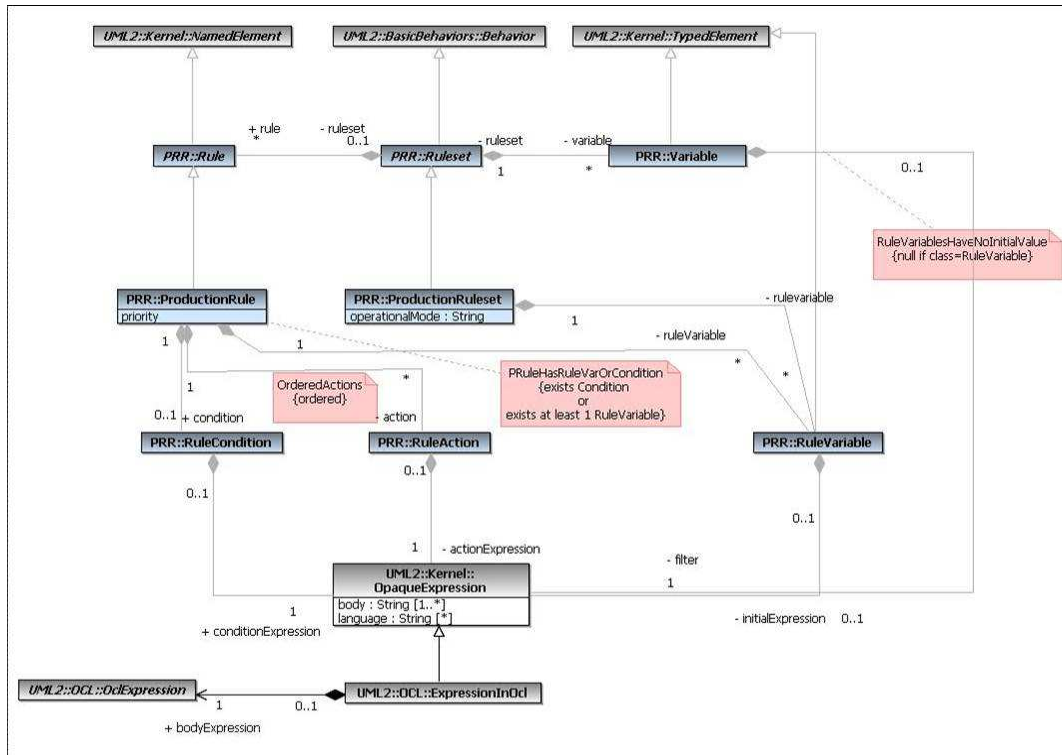
## 5.2 OMG Production Rules Representation progress report

One of the issues that the W3C RIF working group will have to solve is the compatibility of RIF and the OMG PRR meta-model, as the latter is nearing completion while the former is still in its infancy. However, PRR being focused on production rules only, with an abstract `Rule` class as a point of extensibility, and under the assumption that the format for `RuleCondition` and `RuleVariable` will be basically the same across all types of rules, we expect that the PRR meta-model can be considered as a special case of the general RIF meta-model.

See Figure 2 for a graphical representation of the PRR Core meta-model.

Notice that what the meta-model refers to as `RuleVariable` in the specific context of production rules, correspond more generally to logical variables.

The OMG PRR working group submitted a revised draft of the PRR meta-model early June 2006. The revised draft includes PRR OCL, a side-set of the OMG object constraint language (OCL) for expressing constraints on the instantiations of a rule. Notice, indeed that, for PRR, a rule is a class that is instantiated as rule objects when evaluated against a given data source; for RIF, on the other hand, rules are data items to be fed to a rule based application.



**Figure 2: OMG PRR Core meta-model**

### 5.3 W3C Semantic Annotation for WSDL working group

On March 21, 2006, the W3C announced the creation of a working group on Semantic Annotations for the Web service description language (SA-WSDL) [24].

The Web Services Description Language (WSDL) specifies a way to describe the abstract functionalities of a service and concretely how and where to invoke it. The WSDL 2.0 specification does not include semantics in the description, thus two services can have similar descriptions while totally different meanings.

The objective of the Semantic Annotations for WSDL Working Group is to develop a mechanism to enable annotation of Web services descriptions. This mechanism will take advantage of the WSDL 2.0 extension mechanisms to build a simple and generic support for semantics in Web services.

The scope of the working group as it is described in the charter [24] falls short of what would be required for DIP implementations (e.g. of the use cases) and of WSMO/WSML recommendations. For instance, adding semantics for components that WSDL 2.0 does not define in its component model is explicitly ruled out of scope, as is discussing the expression of Web services constraints and capabilities, or, generally, supporting Web services discovery, composition, relocation, etc.

Nevertheless, the working group is a first step and it was important that DIP be involved and a driving force. As a consequence, Jacek Kopecki of DERI is the chair of the working group, in which DERI, ILOG and the Open University are active as well (along

with IBM, Semagix, Telecom Italia, the University of Maryland, the University of Southampton and the Chinese Academy of Science).

The schedule of the working group really allows DIP to influence the result, as the specification is expected to reach the “candidate recommendation” status in December 2006 (that is, before the end of the project).

Notice that, at the same date the SA-WSDL working group was announced, the Semantic Web Services Interest Group was re-chartered through February 2008.

#### 5.4 Related activities

On June 1<sup>st</sup>, W3C announced the creation of the Web service policy working group. Although that working group does not impact DIP directly, it is certainly relevant to the field of semantic Web services. As such DIP will monitor its progress closely.

## 6 CONCLUSION

In this deliverable we have shown how DIP will bring the Semantic Web to its full potential. During the six months since the publication of D7.6, Semantic Web services related standards and standardization activities have evolved in directions that can be seen as positive from DIP's point of view.

- The continuation of the OASIS formal standardization activity regarding the deployment and execution of Semantic Web Services in a service-oriented architecture has been positive with a large amount of work produced by the technical committee as presented in section 4.
- The WSMO and WSML working groups continue to seek that standardisation efforts are aligned with them.
- The W3C has reported on its formal standardization activity regarding the interchange rules;
- OMG has submitted a revised draft on its Production Rules Representation.

As we saw from section 5, there are currently a number of on going standardisation efforts, with the W3C standing out in this regard and it is recommended that DIP should closely monitor the progress of the numerous W3C efforts. One of the aims of this deliverable was closely monitor the activity in the W3C, OASIS and OMG in order to observe the alignment with WSMO/WSML. This monitoring activity should be continued.

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