



Data, Information and Process Integration
with Semantic Web Services

DIP

Data, Information and Process Integration with Semantic Web Services

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D7.5
Standardisation Strategy and Impact Analysis Update

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EXECUTIVE SUMMARY

This document is the first one in a series of planned update documents for the DIP deliverables D7.3-D7.4 (standardisation strategy and impact analysis) in the course of the workpackage WP7 “Standardisation and Technology Watch”. The deliverable directly contributes to the DIP main goal “Standard proposal”. As the consortium is committed to the main goals of DIP, it is of interest for every partner to get an overview and understanding of current standardisation activities and possible ways to actively support these.

This deliverable

- Explains new or ongoing activities based on the DIP “Standardisation Strategy” (D7.3)
- Details about new or ongoing activities in the context of the SDK standardisation coordination group” (D7.3)
- Describes interactions and relations to the WSMO activities.
- Gives an update and conclusions on the “Impact Analysis” (D7.4)

Summarizing the document

- Major achievements in terms of raising the visibility of the project DIP and working together with standardisation organizations, especially W3C.
- Leveraging the SDK cluster for promoting standardisation in the areas of Semantic Web Services and Ontologies.
- Further alignment of the WSMO activities with the goals and tasks of the project DIP.

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LIST OF KEY WORDS/ABBREVIATIONS

API – Application Programming Interface

ASM – Abstract State Machine

BPEL – Business Process Execution Language

BPM – Business Process Management

BPMI – Business Process Management Initiative

CWA – Closed World Assumption

EAI – Enterprise Application Integration

KR – Knowledge Representation

IT – Information Technology

MUWS – Management Using Web Services

MOWS – Management of Web Services

NAF – Negation-As-Failure

OASIS – Organization for the Advancement of Structured Information Standards

OMG – Object Management Group

ORDI – Ontology Representation and Data Integration

OWL – Ontology Language

OWL-S – Ontology of Services

PRR – Production Rule Representation

RDF – Resource Description Framework

SBVR – Semantic of Business Vocabulary and Business Rule meta-model

SOAP – Simple Object Access Protocol

SNAF – Scoped Negation As Failure

SWRL – Semantic Web Rule Language

WSDM – Web Services Distributed Management

WS-I – Web Services Interoperability

WSML – Web Services Modeling Language

WSMO – Web Services Modeling Ontology

WSMX – Web Services Execution Environment

W3C – World Wide Web Consortium

XML – Extensible Markup Language



TABLE OF CONTENTS

EXECUTIVE SUMMARY	I
LIST OF KEY WORDS/ABBREVIATIONS	VII
TABLE OF CONTENTS	IX
1 INTRODUCTION	1
2 REVIEW OF ACTIONS RECOMMENDED IN D7.4	1
3 ACTIVITIES IN THE REPORTING PERIOD	1
3.1 W3C Workshop on Rule Languages for Interoperability.....	1
3.2 W3C Workshop on Frameworks for Semantics in Web Services.....	3
3.3 WSMO W3C Member Submission	4
3.4 Standardisation update.....	6
3.5 WSMO new developments.....	7
3.5.1 WSMO – New developments	7
3.5.2 WSML – New developments	7
3.5.3 WSMX – New developments.....	8
3.6 Relation of WSMO with DIP and other Standards	9
3.6.1 Relation of WSMO with DIP	9
3.6.2 Relation of WSMO with other Standards.....	10
4 CONCLUSION	10
REFERENCES	13
APPENDIX A: REPORT FROM THE W3C WORKSHOP ON RULE LANGUAGES FOR INTEROPERABILITY	15
A.1 Introduction	15
A.2 The Program	15
A.2.1 Introductory Sessions	15
A.2.2 Candidate Technologies	16
A.2.3 Related Standards	16
A.2.4 Use Cases.....	17
A.3 Issues	18
A.3.1 Negation-As-Failure (NAF), Defaults, and the Closed World Assumption (CWA).....	18
A.3.2 Knowledge Representation (KR) vs. Applications Programming.....	18
A.3.3 Relationship to Description Logics (OWL).....	19
A.3.4 Uncertainty Reasoning and Fuzzy Logic.....	19
A.3.5 Tagged Co-Existing Rule Languages	19



A.3.6 Syntax Options	19
A.3.7 The 95% Solution	20
A.4 Conclusions	20

1 INTRODUCTION

This document is the first one in a series of planned update documents for the DIP deliverables D7.3-D7.4 (standardisation strategy and impact analysis) in the course of the workpackage WP7 “Standardisation and Technology Watch”.

In chapter 2 of this document a review of actions that were recommended in D7.4 is presented.

Chapter 3 describes new and ongoing activities that have been started based on the former recommendations. There are two major areas of activities, firstly the work towards standardisation or within standardisation bodies. Secondly, the new developments in WSMO (WSML, WSMX) and their relation to other standardisation activities as well as to the project DIP.

Finally, chapter 4 presents a conclusion as well as an outlook for future activities.

2 REVIEW OF ACTIONS RECOMMENDED IN D7.4

Deliverable D7.4 (Standardisation Impact Analysis Update) contained four major recommendations:

1. DIP should take an active or even leading role in the emergence of a Semantic Web Services activity in the W3C
2. DIP should participate in the development of a (set of) standard(s) enabling the publication and exploitation of policies, rules and regulations
3. Activities outside DIP regarding standardisation of management issues should be monitored and DIP use case requirements in this area should be scrutinized.
4. Translators between OWL and WSML should be developed

Activities taken up to address recommendations 1 and 2 will be described in detail in Sections 3.1, 3.2 and 3.3. Section 3.4 contains information on the WSDM (Web Services Distributed Management) standard approved by OASIS. Finally, a Formal Mapping and Tool for mapping between WSMO and OWL-S is developed (see Section 3.5.2) and a tool for transformation between WSMO and OWL is developed as part of ORDİ in DIP WP6 (see Section 3.6.2).

All recommendations have thus been taken into account by the DIP consortium and corresponding activities will be continued during the remainder of the project.

3 ACTIVITIES IN THE REPORTING PERIOD

This section of the document describes activities and interactions based on the recommended actions. Most of the activities have started in the reporting period but have to be seen as “continuing” or “on going” work in progress.

3.1 W3C Workshop on Rule Languages for Interoperability

In the conclusion of deliverable D7.4, there was a strong recommendation that DIP supports and participates in the development of a standard or a set of standards enabling the publication and exploitation of rules on the Web. The recommendation was for DIP to take an active or even leading role to make that development happen.

In keeping with that recommendation, ILOG involved itself actively in the organisation of a W3C workshop on rule languages for interoperability. As part of the informal process of preparing an activity, W3C organizes workshops to bring people together to discuss topics that interest the W3C community. When there is enough interest in a topic, after a successful workshop, the W3C Director announces the development of a proposal for a new Activity or Working Group charter, depending on the breadth of the topic of interest. This is the formal part of preparing a new activity.

End of December 2005, W3C made the final decision to hold the workshop, with Sandro Hawke (W3C), Christian de Sainte Marie (ILOG) and Saïd Tabet (RuleML) being the co-chairs of the workshop.

The Call for Participation for the workshop was released on 15 February 2005 [2]. It set the focus of the workshop clearly on how best to exchange rules between different applications, for all kinds of rules and for all kinds of use cases, with the objective of coming to a common understanding on what are the use cases, the requirements and the priorities for a standard, and how best to handle the different use cases, incompatible requirements and conflicting priorities. The role of Semantic Web Services as a central use case was stressed.

The CFP began with this summary:

“Rule languages and rule systems are widely used in applications ranging from database integration, service provisioning, and business process management to loan underwriting, privacy policies and Web services composition. General purpose rule languages remain relatively unstandardized, however, and rule systems from different suppliers are rarely interoperable.

Meanwhile, the Web has achieved remarkable success in allowing documents to be shared and linked throughout the world. More recently, Semantic Web languages like RDF and OWL are beginning to support data/knowledge sharing on the same scale and with considerable flexibility. Having a language for sharing rules is often seen as the next step in promoting data exchange on the Web.” [2]

The workshop was hosted by ILOG in Washington, DC (USA), on 27 and 28 April, 2005. 82 people attended, each associated with one of the 71 accepted position papers. Several members of DIP submitted position papers and attended the workshop.

The workshop was organised in 9 sessions. The first two sessions were devoted to introducing the various communities and their general requirements to each other. The next two sessions were concerned with the presentation and discussion of existing or developing technologies, either candidates technologies for a standard rule language for the Web, or rule standards developed for different purposes in other organisations. This ended the first day. Most of the second day was devoted to use cases, with the exception of an additional session on candidate technologies. The workshop ended with a panel discussion on what would be the next steps.

In all the sessions, except the panel discussion, a small number of short presentations selected from the position papers were used to focus the general discussion that followed. WSMO and WSML were thus presented in the session devoted to candidate technologies.

The official report for the workshop has been released on June 7, 2005. It is reproduced *in extenso* as an appendix to this document. It is also publicly available on the W3C Web site, along with the list of attendees, the position papers, the programme and the presentations [3].

The most obvious conclusion from the workshop is that there is significant interest in establishing a standard language for expressing rules. There was much discussion and little consensus on what the scope of the standard should be, however. The report concludes that the W3C team should work with members and prospective members to find a Working Group scope which is broad enough to address a significant set of use cases yet narrow enough keep the Working Group oriented on timely delivery of a practical Recommendation. We strongly recommend that the relevant members of DIP (most relevant are ILOG, DERI and FZI) should continue to monitor closely and participate actively in the follow-up activity: starting a W3C working group is under consideration.

3.2 W3C Workshop on Frameworks for Semantics in Web Services

As said in section 2, there is the strong recommendation that DIP supports and participates in the development of standards. This is of major importance especially for the area of Semantic Web Services as the mission statement of DIP expressly states: “... *to make Semantic Web Services a reality...*”.

In February 2005 the W3C decided to hold a “Workshop on Frameworks for Semantics in Web Services” under the lead of the Program and Workshop Chairs Steve Battle (HP UK) and David Martin (SRI International). Several members of DIP were actively involved in the planning and the realization of this event, as well as participating at the workshop.

The Call for Participation summarizes the goals for the workshop [4]:

Web Services standards, under development in the W3C Web Services Activity and other organizations, make up an integrated technology stack that Web applications developers can rely on to ensure interoperability. ...

In parallel, starting from the need for metadata in resources, the W3C Semantic Web Activity has developed the initial building blocks of the Semantic Web technologies: the Resource Description Framework (RDF) and the Web Ontology Language (OWL). The W3C Semantic Web Services Interest Group has shown a strong interest in having more integrated semantics inside the Web Services stack, and also provides evidence of a rich variety of research proceeding in this area. This work aims towards the general objective of a more comprehensive, more expressive framework for describing all aspects of services, which can enable more powerful tools and fuller automation of a broad range of Web services activities.

Recently, during the Constraints and Capabilities Workshop, proposals including Semantic Web technologies have already been discussed, in the light of requirements for expressing policies for Web Services. We now aim at looking into a generic extensible framework based on Semantic Web technologies, to support longer-term objectives, while continuing to develop immediate solutions for the most pressing Web Services requirements. ...

The intent of the workshop on Frameworks for Semantics in Web Services is to provide advice to W3C on possible future work in the area, in particular the creation of a Working Group.

On June 9th-10th 2005 the W3C “Workshop on Frameworks for Semantics in Web Services” was hosted by DERI Innsbruck, Austria. The event was held in adjacency to the “WSMO Implementation Workshop” and in the context of the “Semantic Web Services Week”, also organized by DERI. There were several members of DIP actively involved in the Workshop Program Committee (Chris Bussler, DERI; Elmar Dorner SAP) and in the preparation of the workshop (DERI, UIBK).

As with all W3C workshops, potential participants or participating organizations were asked to submit a position paper either stating their interest in the topic area or providing case studies, industry relevance, or candidate technologies. 67 position statements were accepted, leading to a total of more than 70 participants. Several DIP members submitted position papers and attended the workshop (BT, DERI, EPFL, FZI, OU, SAP, UIBK). In addition, there was a broad range of participants from university (EPFL, CMU, HPI, INRIA, MIT, ...) and industry (Alcatel, BEA, Boing, DoCoMo, IBM, HP, Lucent, Oracle, NEC, Siemens, ...), either in the role of technology providers or users. The final workshop program as well as the position statements and presentations can be found on the W3C page [5].

The workshop itself was structured in four sessions, each half a day long. The first session set the ground by giving an introduction into the topic area and the working domains, presenting definitions and current challenges. The “Use Cases” session presented several working areas, already deploying one or another aspect of Semantic Web Services. With the third session “framework technologies” the goal of the workshop was picked up again and possible framework candidates were presented and discussed. The last session “Debate” closed the textual loop by taking a closer look at the current challenges in Semantic Web Services as presented in session one. Each of the four sessions closed with a panel discussion after the presentations, providing room for open discussions and also summarizing the sessions for the later W3C report.

The official report for the workshop is not yet available by the W3C, but will be included in the next version of this DIP deliverable series (provided the availability by the W3C). The expected outcome of this workshop, especially the establishment of a topic specific new working group, is currently not yet commented by the W3C.

3.3 WSMO W3C Member Submission

Based on the strategy described in the DIP deliverable D7.3 “Standardisation strategy and forums to be targeted” the WSMO activities were presented at several occasions within the SDK cluster. There were two types of presentations, each with a different aim in mind:

- Firstly, general WSMO presentations, which were held mainly during the course of project plenary meetings of SEKT, DIP, and KnowledgeWeb. These serve the purpose to educate the participants in terms of the current stage of the WSMO development. Additionally this was the place where the alignment of the respective project activities and the WSMO activities have been discussed.

- Secondly, the discussion of the WSMO activities in the course of respective project workpackages dealing with standardisation efforts in each of the projects.

Another task closely related to the preparation of standardisation activities is the early “buy in” of either contributing or supporting partners and organizations. This is especially important for standardisation efforts in the W3C. There is a well-defined process in the W3C how new technologies could be presented to the community for further discussion [6]:

The Member Submission process allows Members to propose technology or other ideas for consideration by the Team. After review, the Team MAY publish the material at the W3C Web site. The formal process affords Members a record of their contribution and gives them a mechanism for disclosing the details of the transaction with the Team (including IPR claims). The Team also publishes review comments on the Submitted materials for W3C Members, the public, and the media.

After extensively discussing the WSMO activities in the SDK cluster and the availability of an OWL-S submission to W3C from November 2004, it was decided by DERI to prepare a WSMO W3C member submission.

In January 2005 the first draft of WSMO documents to be considered for a W3C member submission was available. With these documents and the promotion activities described above, the work of actively approaching W3C members within the SDK started. Additionally other companies from related areas, e.g. Semantic Web were approached. This was of major importance, as the W3C member submission process only allows W3C members to be listed as Submitters.

In April the WSMO member submission was submitted to the W3C. The submission comprises, beside a WSMO overview (primer), documents related to each part of the respective WSMO parts (WSMO, WSMX, and WSML) and a document describing the relationship between WSMO and other relevant technologies.

Supporting members are

- DERI Innsbruck at the Leopold-Franzens-Universität Innsbruck
- DERI Galway at the National University of Ireland
- BT
- The Open University
- SAP AG

On June 3rd the W3C published the member submission on their web side, accompanied with the “W3C Team Comment on WSMO Submission” [8], [9].

During the W3C Workshop on Frameworks for Semantic in Web Services (see 3.2) a document was handed over to the W3C representatives. It comments and answers the questions that the response document of the W3C team raised.

Currently there is ongoing work in progress on updating the WSMO submission documents. These will be used for further discussions with the W3C team with the aim to establish a Working Group that targets this specific topic area. Secondly, they can be

used as reference documents for other projects and activities that like to build on or apply the new technologies.

3.4 Standardisation update

Regarding standardisation activities outside of DIP, four important developments have taken place in the first half of 2005:

- Support of BPEL by software vendors has continued to increase
- OASIS has approved WSDM v1.0 as an OASIS standard
- HP donated Web Services Management specifications to Apache
- WS-I established a Basic Security Profile Working Group

BPEL has clearly become the de-facto-standard for the technical specification of business processes. Although most vendors use proprietary formats for the execution of processes or workflows inside their solutions, almost all support the import and export of BPEL. Initially, BPEL was primarily supported by software vendors actively involved in the development of Web Services standards in general and BPEL in particular, e.g. BEA, IBM, Microsoft, SAP. Later they were followed by vendors with a strong technical focus, e.g. BPM/EAI vendors such as inubit, Seebeyond, Tibco or WebMethods. Now, vendors with a focus on the business aspects of Business Process Management, such as IDS Scheer or pikos, are also using BPEL as the standard representation language for process specifications on the technical level.

In March 2005, OASIS has approved Web Services Distributed Management (WSDM) v1.0 as an OASIS standard. WSDM consists of two sets of specifications: Management Using Web Services (MUWS) and Management Of Web Services (MOWS). The latter defined the manageability model for managing Web Services as a resource and how to describe and access that manageability using MUWS.

Also in March 2005 HP donated implementations of three related OASIS Web services management specifications to the Apache Software Foundation: Management Using Web Services, the Web Services Resource Framework and Web Services Notification. These specifications belong to the WSDM standard.

The Basic Security Profile Working Group at the WS-I (Web Services Interoperability Organization) is developing an interoperability profile dealing with transport security, SOAP messaging security and other Basic-Profile-oriented Web services security considerations. A first draft has been published in May 2005.

It is recommended that DIP continues to monitor activities in this area and that BPEL is taken into account in the choreography solution developed in DIP. In particular, the specification and prototypes of "Goal-oriented SWS composition", i.e. D4.9, D4.12, and D4.15, should consider providing BPEL output format for composite Semantic Web Services.

3.5 WSMO new developments

This section gives a brief outline of the new developments in WSMO since M12 of the DIP project. Included are also some developments specific to WSMX and WSML. The new developments include but are not limited to the following listings: WSMO, WSML and WSMX. The new developments specific to WSMO, WSML and WSMX are presented in the subsequent sub-sections. Some developments were not mentioned due to them being relatively incomplete.

3.5.1 WSMO – New developments

Since M12 of the DIP project, the new developments that have emerged in WSMO are Ontology-based Choreography and Orchestration of WSMO Services [10], WSMO Use Case Modeling and Testing [11], and WSMO Grounding [12]. The following listing briefly outlines these developments.

Ontology-based Choreography and Orchestration of WSMO Services

The aim is to provide a core conceptual model for describing choreographies and orchestrations in WSMO. The state-based mechanism for describing WSMO choreographies and orchestrations is based on the Abstract State Machines (ASMs) methodology for the following three reasons:

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

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

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

WSMO Use Case Modeling and Testing

WSMO Use Case Modeling exemplifies the usage of the Web Service Modeling Ontology WSMO for modeling Semantic Web Services along with specific technological solutions. The aim is to define the general organization of WSMO use cases, and presents specific examples of WSMO use cases.

WSMO Grounding

WSMO Grounding describes how WSMO service descriptions can be grounded to WSDL on the basis that WSDL provides the current industry standard for defining how messages can be exchanged between services over the Internet.

3.5.2 WSML – New developments

Since M12 of the DIP project, new developments that have been emerged in WSML are The Web Service Modeling Language WSML, version 2 [13], Formal Mapping and Tool to OWL-S [14], and WSML Reasoning Implementation [15]. The following listing briefly outlines these developments.

The Web Service Modeling Language WSML

This is an introduction to the Web Service Modeling Language WSML which provides a formal syntax and semantics for the Web Service Modeling Ontology WSMO. WSML is based on different logical formalisms, namely, Description Logics, First-Order Logic and Logic Programming, which are useful for the modeling of Semantic Web services.

Formal Mapping and Tool to OWL-S

A mapping between OWL-S and WSMO descriptions is provided in order to get a better understanding of what is the relation between them and to enable the interoperation between OWL-S and WSMO services.

WSML Reasoning Implementation

Reasoner implementations are provided for the variants of the WSML family of languages. Requirements posed by the different WSML variants on the reasoner implementation were considered. The reasoner implementations of different logical formalisms were surveyed and a description of a preliminary implementation of WSML-Rule on top of OntoBroker given.

3.5.3 WSMX – New developments

As with WSMO and WSML, there are some new developments in WSMX which are: Web Service Modeling Toolkit [16], WSML editor [17], Integration of WSMX with other SWS systems [18], WSMX Discovery [19], and Web Services Execution Environment – Conceptual Model (WSMX-O) [20]. The following listing briefly outlines these developments.

Web Service Modeling Toolkit (WSMT)

WSMT is a framework for the rapid deployment of graphical administrative tools, which can be used with WSMO, WSML and WSMX. The WSMT includes a WSML Editor, a WSMX invoker and a WSMX Monitor. The latest version (v0.2) of the WSMT software package is available at <http://www.sourceforge.net/projects/wsmx/>.

WSML Editor

The Web Service Modeling Language (WSML) is a formalization of the WSMO ontology and provides a language for describing Semantic Web Services. There are five language variants, WSML-Core, WSML-DL, WSML-Flight, WSML-Rule and WSML-Full. WSML-Core, which is the intersection of Description Logic and Horn Logic, provides the basis for all the variants, while WSML-Full unites the functionality of all variants. WSML Core is extended in the direction of more expressive Description Logic by WSML-DL and in towards Logic Programming by WSML-Flight and WSML-Rule. The WSML Editor is a graphical tool for editing Ontologies, Goals, Mediators and Web Services described in the WSML language.

Integration of WSMX with other SWS Systems

A description of the relationship between the Web Services Execution Environment (WSMX) and other implemented frameworks for working with Semantic Web Services. In particular, we look at how WSMX and these other systems can interoperate with each other. In the case of IRS III, both systems are compliant to the Web Services Modeling Ontology (WSMO). Development of a shared common API is currently being addressed by DERI NUI Galway.

WSMX Discovery

WSMO discovery provides a conceptual model for service discovery that exploits WSMO formal descriptions of goals and web services. Based on the theoretical foundations provided by WSMO and WSMO discovery, we investigate the implementation of a discovery engine that can provide dynamic Web service discovery.

We focus on the language requirements to formalize WSMO goals and Web service capabilities, on the integration of different approaches to Web service discovery defined by WSMO discovery, and on the definition of the interface and architecture of the discovery engine.

Web Service Modeling Execution Environment - Conceptual Model (WSMX)

The WSMX Conceptual Model identifies and describes the concepts within a Web Service Modeling Execution Environment (WSMX). By doing this, the aim is to provide not only a common vocabulary, meant to be used at different phases of this project, but also a central point of reference for the design and development team.

3.6 Relation of WSMO with DIP and other Standards

The following two subsections briefly describe the relation of WSMO with DIP and other standardisation activities.

3.6.1 Relation of WSMO with DIP

Providing a simple, complete and executable framework for solving an integration problem is one of the aims of WSMO. Realising this vision is one of the missions of DIP. Therefore, the WSMO vision and the DIP mission are somehow related to each other. In this section, we describe the practical relation that exists between WSMO and DIP.

The DIP *Reasoner* component prototype developed in WP1 is based on WSML. It provides the support for WSML through Ontology Representation and Data Integration (ORDI) APIs developed in WP2. The ORDI APIs are compliant with WSMO APIs. It is also aligned with the requirements of WSMX.

The Ontologies developed in WP3 are based on WSMO and are represented in WSML. That is, the ontology development in WP3 is based on the WSMO semantic description framework (WSMO-SDF) developed by the WSMO working group, which has been further refined in DIP. WSMO-SDF was built upon WSMO and WSMF.

The WSMO studio component developed in WP4 is based on the WSMO specification. It has been developed with the aim of facilitating easy integration of third party components. The Invocation Module Specification defined in WP4 has been used as a guideline for the WSMX invocation module implementation.

WP5 provides a concrete specification for data mediation which has been strengthening the WSMO and WSMX data-level mediation components. Data level and process level mediation in WSMX has a strong influence on WP5. The mediation modules created for WSMX have been influenced by those created for DIP. However, the influence of DIP on WSMX mediation could only be described as indirect due to those who contributed to the WP5 also working on WSMO mediation. The runtime component of WSMX Data Mediation was delivered in DIP.

The WSMX architecture was being developed in parallel to the DIP architecture, and it became clear that these efforts could be synergised. As a result, the WSMX architecture has been used in WP6 as a reference to define the first version of the DIP architecture.

DIP Prototypes

WSMX was used by the DIP use case VISIP prototype developed in WP8 as an execution environment platform. Though this prototype is now obsolete, it was the initial basis for the work that has come from this work package. B2B in Telecommunications is the new use case in WP8 and will also be built on WSMX.

Similarly WSMO has been the base technology for the use cases VISIP (WP8), eGovernment (WP9) and eBanking (WP10). Using WSMO based tools; both WP9 & WP10 attempt to validate DIP technology demonstrated in the prototypes.

3.6.2 Relation of WSMO with other Standards

Through [14] and [17], WSMO is moving forward to establish a relationship with other Semantic Web services (SWS) standards primarily with OWL-S. In this direction, [14] provides mappings between their conceptual models, foundational languages and APIs. [17] examines how different SWS execution environments can be integrated. The focus of [10] is to make SWS platforms interoperable with each other by using the mappings defined in [14]. D7.4 of DIP recommended that a transformation tool that transforms from WSMO to XML/RDF is necessary to make WSMO compliant systems interoperable with other Semantic Web services. As per this recommendation, a first step towards interoperability with other systems, in DIP WP6 as part of the ORDI framework a WSMO to OWL transformation tool has been developed. It is based on [14] and is similar to RDF Schema for OWL [21].

4 CONCLUSION

During the six months since the publication of D7.4, the landscape of Semantic Web Services and Semantic Web Services related standards and standardization activities evolved in directions that can be seen as positive from DIP's point of view:

- The W3C took the first steps towards launching formal standardization activities in two areas of great importance to DIP, namely: rule languages for interoperability and semantic Web services frameworks. In keeping with the recommendations issued in D7.4, DIP's partners played an important, even leading role in that evolution;
- WSMO was brought to the W3C and was published as a member submission on June 3, 2005 [8]. In addition to increasing WSMO's visibility outside of the SDK community, it puts the specification on a par with OWL-S (which was published as a W3C member submission in November 2004 [22]), in particular if and when the W3C starts a formal activity on Semantic Web Services frameworks or languages;
- Support for BPEL by software vendors continued to increase, which improves the appeal of application based or using complex and composite Web services. Ultimately, a Web services-based approach cannot scale without a semantic layer: everything that increases the appeal and deployment of Web services, and particularly of complex ones, ultimately benefits semantic Web services technology.

Our recommendation is that DIP and DIP members should continue to interact closely with W3C, and take a strongly supportive, even leading role in getting formal activities relative to the standardization of Web rule languages and semantic Web services

framework started. DIP and DIP members should take an active role in such activities if and when they are started, to guarantee that DIP's positions and interests are duly taken into account.

We also recommend that DIP should monitor related organizations for the emergence or progress of relevant activities: OMG, in particular, seems to be moving closer to areas of close concern to DIP, as witnessed by its planned merger with the BPMI.

Good progress was on the WSMO front as well, in particular with respect to the recommendations in D7.4 that work was needed to integrate WSMO/WSML better within the existing Web services standards stack. We recommend that the effort be continued.

One area where little progress has been made, beside the above mentioned W3C member submission activity, is the coordination of the standardization strategy within the SDK cluster: we recommend that the role and activity of the SDK Standardisation Coordination Group should be re-examined and possibly re-aligned towards increased usefulness.

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Appendix A: Report from the W3C Workshop on Rule Languages for Interoperability

This report was prepared by

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A.1 Introduction

On 27 and 28 April, 2005, the W3C held a workshop in Washington, DC, to gather information about standards work related to rule languages. The Call for Participation was released on 15 February. It covered the background and goals of the workshop, and explained that attendance was limited and position papers were required. (Multiple people associated with a position paper were allowed to attend, space permitting.)

After review, the program committee accepted 71 papers and selected a subset of them for presentation, as listed in the program. 82 people attended, representing a wide range of interest. W3C is grateful to ILOG for hosting the workshop and DARPA for additional financial assistance.

A.2 The Program

The workshop was organized into nine sessions. The first two sessions were devoted to introducing the various communities to each other and to collecting general requirements. The next two sessions were concerned with the presentation and discussion of existing or developing technologies, either candidates technologies for a standard rule language for the Web, or rule standards developed for different purposes in other organizations. Most of the second day was devoted to use cases, with the exception of an additional session on candidate technologies and a panel on next steps which concluded the workshop.

Each session (except the closing panel) consisted of three to six presentations of 15 or 20 minutes, based on selected position papers, followed by about half an hour of discussion.

A.2.1 Introductory Sessions

The first session introduced everyone to some of the range of backgrounds and goals in the room. There were presentations from three people coming from three different backgrounds: business rules, logic programming, and the Semantic Web. It is tempting to divide the workshop participants into these three camps, or along some other lines, but it would be a mistake: behind the presentations and people's immediate concerns, there were often much deeper similarities than differences. It often seemed as if each participant had a deep interest in end users and domain applicability, in understanding and improving the mechanics of rule systems, and in making open distributed information environments. More than anything else, everybody seemed eager to learn about each others' use of rules and their requirements. The different areas of professional emphasis therefore suggest compatibility and synergy, rather than an underlying conflict.

The second session had two presentations proposing scopes for a standard, and one on the W3C approach to standardisation. Both scope/requirements presentations suggested that no single rule language would cover all the requirements but that there could be a common core to a family of languages. They came from different perspectives and the workshop reactions were mixed. Much of the discussion was focused on the 95% issue.

A.2.2 Candidate Technologies

Seven candidate technologies were presented in two sessions: WSML, RuleML, SWSL, N3, SWRL, Common Logic, TRIPLE. These are primarily academic efforts; all but RuleML are concerned explicitly with knowledge representation, mainly or only for the Semantic Web (except CL); none deals directly with production rules (if condition then action).

The discussion revolved largely around formal issues and semantic features, especially with respect to handling defaults, Negation-As-Failure (NAF), and the Closed World Assumption (see issues). What are the requirements, what constitutes a candidate technology for standardisation, what kind of specification is needed for a rule language? Perhaps a model theory; perhaps something less formal, with test cases. Recent W3C Recommendations in related fields (RDF and OWL) do both.

The RuleML presentation claimed a slightly different ground, focusing more on the exchange format and interoperability. It also contained a proposal for the scope for the initial 9 months of a Working Group (LP expressiveness including Datalog Horn + NAF + logical functions and some additional features). The other main line of discussion was thus about what is feasible in a short time and what should be the scope of the standard. Some of the participants argued for a simple set of features to start with instead of a very rich and complex language (80/20 argument, see issues). However, warned the audience, a simple language (e.g. Datalog + NAF) must come with extensibility in mind (learning from the MathML experience and others).

A point was raised and came up again several times about testing with business cases. In general, the candidate technologies have not been tested on commercial rule bases. The common use case in the business rules community (EU-Rent) was proposed, as well as a collection of production rules used as expressiveness tests in PRR.

A.2.3 Related Standards

Three standards (at different stages of development) were presented: the Production Rule Representation (PRR) meta-model under development at OMG, a standard Java API for rule engines (JSR 94) and the Semantic of Business Vocabulary and Business Rule meta-model (SBVR, aka the "semantic beaver"), which was developed as an answer to OMG's Business Semantics of Business Rules RFP. They are/were developed by groups consisting of mostly commercial organizations and they are more concerned with business applications than formal knowledge representation.

The current work on PRR is limited to forward-chaining and sequential rule processing, most typically found in business rules environments/engines (ECA rules can be considered a subclass). It is meant to define behaviours, not for generic knowledge representation. The motivation is to make production rules a first-class citizen in UML models, e.g. enabling rule modeling in tools such as Rational Rose. The focus is on modeling. A compatible standard rule language – possibly a concrete syntax for the meta-model – is required for run-time rule exchange.

The lightweight JSR-94 API does not specify the behaviour of the engine: it relies on the underlying rule language – explicitly out of scope of the standard – to determine the unambiguously the result of executing a rule set. The message is that JSR-94 really needs a standard rule language.

SBVR is for business modeling by business users, in their own terms, independent of implicit or explicit information technology (IT) consideration or design decision. It provides structured English for business rules from which the meaning can be extracted as formal logic.

Although not presented at the workshop, the SPARQL query language for RDF, a work in progress at W3C, is obviously related.

A.2.4 Use Cases

The three use case sessions drew a lot of interest, positive feedback, and many questions. Real world scenarios helped illustrate the need for rules and ontologies (including anatomical knowledge to label brain parts, situation awareness using OWL and Rules, and others such as RDF in the automotive industry, in access control, and rules for geospatial applications). The regulatory compliance and mortgage scenario talks went even further to demonstrate a clear need for rules interoperability.

Almost all the applications presented in the use case sessions were using existing standards (RDF and OWL) and/or proposed languages (SWRL). This was encouraging and will help validate the direction of this effort. However, most of them have additional requirements or comments about the usability of these standards/languages for their purpose and in the context of their applications. That raised some fundamental questions regarding the adequacy of the languages/standards for the purpose of developing certain kinds of rule-based applications. This was another sign of the demand for a rule language.

In the first use case session, we learned about applications using rules and ontologies, and discussed the level of expressiveness that is needed in such cases. The use case about content rating of large web sites was a very good illustration of rule-based applications affecting all of us. HP's presentation on Jena showed a promising set of features that seemed important to many participants.

The second session showed the need for functionality beyond what most vendors offers (fuzzy logic was cited a few times). In this session, we also learned to take into consideration the need for non-declarative or procedural functionality (see issue description). We also learned that rules are actively used in the automotive industry, and that they are a key component in compliance and regulatory systems where interoperability is a must have. IBM's use case showed the need to deal with the 80/20 rules (highly expressive languages are not always needed). The mortgage industry is one of the most important industry verticals using rule-based technology.

The final use case session provided both a Business Rules and a Semantic Web perspective. Oracle presented their work on rules technology, defining it as a strategic component to lower project risks and cut costs. Other use cases confirmed the need for expressive rules for privacy systems, and the integration of rules and ontologies (again) in government applications.

More abstract use cases, like the general Semantic Web use case where rules and data are made available on the internal or public web and then re-used without additional

overhead, were discussed briefly in various sessions, including a special unofficial evening session on the Semantic Web.

A.3 Issues

Throughout the workshop, a variety of recurrent topics appeared. Most of them hinge on the relative importance of feature and use cases; what one person views as a core requirement, another may see as no more than a desirable feature. Some of the hard decisions raised by these issues will need to be addressed in the chartering process, some can be addressed later, and some may give way to technical solutions or an evolving understanding of the use cases and technologies.

A.3.1 Negation-As-Failure (NAF), Defaults, and the Closed World Assumption (CWA)

This cluster of issues, mostly called "naf" at the workshop, appears to result from a broad uncertainty about how rules on the Web are different from what people are used to. Many features of the Web (including search engines) report failure for inscrutable and unpredictable reasons. Contrast this with most traditional database systems or rule-based business applications, where the results of a query are expected to be complete. In those systems, if a fact is not returned, then we can safely assume it is not true. If a book is not listed in the inventory database, then we conclude we don't have it. On the Web, however, if a book isn't found by a search engine, it might just mean the search engine failed to crawl the appropriate part of the Web.

Rule systems often provide for negation, defaults, or rule priorities, founded on this "closed world" assumption of complete information. In the developing future, a rule like "if book1 is not in stock then recommend book2" may have to be parameterised by exactly what mechanism and what document or knowledge base scope is used to find book1 in the stock listings. The term Scoped Negation As Failure (SNAF) was proposed to indicate NAF where the scope of the search failure is well defined.

A.3.2 Knowledge Representation (KR) vs. Applications Programming

Another set of issues is raised by the use of rules for specifying and controlling behaviour as opposed to representing knowledge.

The commercial rule vendors and some business rules users are primarily interested in forward-chaining if-condition-then-action rules (production rules). Formal logic is much happier with if-condition-then-condition. The notion was expressed that these may be duals, of a sort, with the help of assert/retract/modify actions, or procedural attachments in the condition. How will this play with users and with implementers?

One of the issues was the expressiveness of the action part (the programming capabilities). Most commercial rule vendors are very flexible with respect to what goes in the action part of the rules. No one suggested that a standard rule language should include the full power of a programming language, but that requirement must be addressed one way or another.

Another issue was declarativeness: how to guarantee that the rules will produce the same behaviour in different execution environments when the result depends on the engine's rule ordering and conflict resolution strategy? Can the users be expected to explicitly declare the complete execution context/expected behaviour of their rules, without relying on the underlying engine's idiosyncrasy? Or the implementers to

translate the engine's strategy into additional context in the rules? Or, at the other end of the spectrum, should the standard (or subsets of the standard, modules, etc) attempt to specify the behaviour of engines (same results by guaranteed same execution in different environments)? Provide tagging for different control strategies/classes of engines?"

A.3.3 Relationship to Description Logics (OWL)

A new Semantic Web stack was proposed with 'Rules' sitting next to OWL, on top of RDF. In some versions, the two boxes overlapped. Is this appropriate? How would a rule language relate to OWL? Mix-and-match RDF triples, or as in SWRL? Users want a language where they can represent both rules and ontologies. This topic came up in nearly every session.

See also issue description.

A.3.4 Uncertainty Reasoning and Fuzzy Logic

Several use case presentations (situation awareness, DoD applications, Telecom applications, geospatial scenarios) described an interest in uncertainty reasoning and fuzzy logic. It was asserted engines which support these can work with more traditional data and rules quite effectively, as well as with rules written to use these features. (This assertion was greeted with some scepticism, however.) One workshop paper directly addressed this topic.

No one suggested that these features were necessary, but rather that they could be quite useful and fairly easy to add.

A.3.5 Tagged Co-Existing Rule Languages

A few participants proposed that instead of recommending one language for expressing rules, W3C could recommend a way which rules could be packaged and tagged with identifiers for their syntax and intended semantics. It was unclear whether this approach, proposed mostly as an interim measure, would provide significant benefit, and how the packaging format would be different from XML.

A.3.6 Syntax Options

People want rules in many different styles of syntax, largely driven by who (or what) they expect will be reading and writing rules.

- **XML** is convenient for machine interchange, and appears to be widely deployed and understood by rule users and implementers. It also side-steps debates about usability and syntactic sugar because it's likely to be so difficult to author by hand.
- **English-like** syntaxes (or natural-language-like syntaxes in general) are often good for people who are not experts in the language, especially if they need to read and understand a rule set.
- **Programmer-oriented** syntaxes, on the other hand, are designed for people who know the language well.
- An **Abstract** syntax is defined to not be directly usable; rather, it is mapped to one or more *concrete* syntaxes, each of which will be in one of the above styles. It is possible to have an abstract syntax, several normative concrete syntaxes, and several non-normative concrete syntaxes.

- An **RDF** syntax (where the syntactic structures are described in RDF) has some of the appeal of an abstract syntax while being directly usable by machines. However, there is significant doubt whether a rule language can be defined with an RDF syntax and still have consistent semantics.

There were some indicators that consensus is possible around use of XML for the sole or primary normative interchange syntax, perhaps based on an abstract syntax.

A.3.7 The 95% Solution

The terms "95%" and "80/20" were used in somewhat different ways at the workshop, but generally refer to the overall scope of a possible standard language.

While no one suggested the language should be more complex than necessary, the term "95%" first came up in arguing that a larger, more complete language actually makes the application programs and rule sets much simpler. It was suggested that perhaps prolog failed in the marketplace because its standard built-ins and libraries were relatively meager. So while 95% of each application may be simple, the last 5% need sophisticated language features.

In contrast, the term "95%" came up again in the claim that most users need a very simple language. Not only do they not need complexity, but anything complex (such as prolog!) will drive them off.

So perhaps the issues here are:

1. How much functionality do most users need, once they are well underway with their work?
2. How much complexity can users handle when getting started?
3. Are there ways to provide functionality without start-up complexity, such as through modularity and extensibility?

In more concrete terms: to provide cross-vendor portability, a standard needs to cover at least the essential features present in the intersection of the vendor feature sets. Which features in that intersection are essential?

A.4 Conclusions

The most obvious conclusion from the workshop is that there was significant interest in establishing a standard language for expressing rules. Each use case presented clear and immediate requirements for this work, and the overall attendance was impressive. It was less obvious what the scope of a first Recommendation should be. People have been thinking about rules in many different forms for many years, with certain commonalities but also important differences. Unfortunately, there is not even consistent terminology about the differences, so the use cases could not directly apply themselves to the differences. Can we bridge the gaps and make a unifying core which can be cleanly extended to address nearly all needs? Or will we have to pick a manageable subset of use cases and set the others aside?

The concluding panel at the workshop made some observation about our situation and how to proceed from here:

- Customers are demanding standards to protect their rule assets. They want portability across vendors, platforms, and applications. They want to be able to repurpose, reuse, and redistribute rule sets.
- The standard should be simple. This field tends towards overwhelmingly complex work, and we will seriously endanger deployment if we go that route. It should be simple to use and relatively simple to implement. A clean extension and evolution mechanism is essential so that important features can be comfortably postponed
- Compatibility with deployed and emerging technologies and areas of expertise will significantly aid adoption. In particular, compatibility with RDF, OWL, OMG PRR, and ISO Common Logic, along with common programming and rule methodologies will allow people to understand and adopt the work much more quickly, without interfering with ongoing technology investments.
- A Working Group in this field should be given a narrow and well-defined scope. People should be able to see, early on, if the work is relevant to their uses for rules, instead of having the Working Group trying to prioritize from an overwhelming sea of features.

From here, the W3C team should work with members and prospective members to find a Working Group scope which is broad enough to address a significant set of use cases yet narrow enough keep the Working Group oriented on timely delivery of a practical Recommendation.