



Data, Information and Process Integration
with Semantic Web Services

<http://dip.semanticweb.org>

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More and more business today is being conducted over the Internet. Consumers can purchase an ever expanding set of goods and services online. Predictions of the world value of business-to-business operations conducted via the Internet are in terms of trillions of Euros. A major bottleneck in conducting Internet based business, however, is the integration of the underlying ICT systems.

Each enterprise will hold its data according to a specific structure defined by the organisation and when two or more business systems need to communicate the data structures need to be harmonised. For example, one organisation may represent an address as a house number and a post code, whilst another may store all the constituent parts. This integration problem is exacerbated by the fact that large enterprises will typically contain tens of thousands of databases each with its own internal structure.

A single unified "standardised" organisational structure is not feasible because, companies are considering individual solutions as a tool to be more competitive, governmental authorities have to follow legal constraints and in addition, costs of re-structuring legacy data are prohibitive. One indication of the size of this problem can be found in studies at IBM which show that for every 1\$ spent on programming \$5-9 is spent on integration.

DIP is an Integrated Project funded within the IST programme which has involved 20 partners and aims to develop solutions for these problems by tackling the integration of business services through a combination of Semantic Web and Web Service technologies. The Semantic Web is an extension of the current Web which is readable by machines facilitating the delegation of certain classes of task to intelligent computer agents. Web Services are computer programs which can be invoked over the Internet using standard protocols. More importantly Web Services can act as proxies for business services. For example, online flight booking systems are typically implemented using Web Service technologies.

Although Web Services have led to a dramatic increase in the amount of business that is conducted online considerable human effort is still required to find and configure a set suitable of Web Services into a single coherent business software system. By semantically describing Web Services DIP provides a platform where many of the steps involved in application development are automated. Additionally, the DIP architecture enables the construction of brokers able to mediate between the goals of a client or consumer and the capabilities provided by online services.

Impact

In order to achieve the above goals, the efforts in the DIP project have been focussed in the following areas, specified as '4 golden bullets':

- **Design and Development of an Open Source Architecture** for Semantic Web Services - DIP architecture, DIP API, WSMO4J
- **Real Use Case Implementations proof of feasibility** SWS in different industrial sectors
 - **B2B in Telecoms** - Telecommunications sector
 - **Intelligent Information Management and EAI** - e-Government sector
 - **Dynamic & Smart e-business** - e-Banking sector
- **Development and implementation of exploitable tools and methods** – WSMX, IRSIII, WSMO Studio, Hybrid Reasoning tool, Ontology Management Suite.
- **Impact on International Standards** through member submissions to W3C, OASIS Semantic Execution Environment (SEE) Technical Committee and OMG

Open source Semantic Web Services Architecture.

One of the key public deliverables of DIP is the Open source Semantic Web Services Architecture WSMX.

WSMX (Web Service Modelling eXecution environment) <http://www.wsmx.org> is the reference implementation of [WSMO](#) (Web Service Modelling Ontology). It is an execution environment for business application integration where enhanced web services are integrated for various business applications. The aim is to increase business processes automation in a very flexible manner while providing scalable integration solutions.

WSMX internal language is [WSML](#) (Web Service Modelling Language). WSMO and WSML specifications together with WSMX environment are developed by DERI International under SDK cluster.

The subject deployment in all these areas was encouraging. The DIP framework now underpins a raft of new EU projects, e.g. SUPER, X-Media, NeOn, Tripcom, Luisa, SWING, KnowledgeWeb, SEKT, Nepomuk, Musing, Salero, FIT, Living Human Digital Library amongst other national and international research projects with a combined funding of over 70M Euros.

Real World Case-Studies:

During the course of the project DIP technologies were tested within three specific domains:

- *Telecommunications* – facilitating B2B integration across ISP partners, and supporting the management of product catalogues. In the Telecoms area the main issue is that of technology consolidation in high churn-rate business environments, along with converged services leading to narrowing margins. The DIP response includes service bundling and service reselling through dynamic supply chains. The challenges in these areas include data mediation, product catalogue compilation, billing and self-service service configuration and QoS management. DIP has demonstrated possible solutions to these problems in the telecoms usecase demonstrator.
- *eBanking* – supporting online mortgage application and stockbrokering. In the eBanking area, the marketplace has at the centre of its focus the issue of customer retention and, like the telecoms sector, is exploring the techniques of service bundling and dynamic supply chains to deliver novelty to attract new customers. However, like the eGovernment area there are compliance, identity management and security issues that must be robustly solved. Many of the capabilities of the DIP framework have been integrated into

the demonstrator for the eBanking usecase in order to offer the individual private share trader a level of service previously unknown in the personal banking sector.

- *eGovernment* – providing a single citizen portal which dynamically integrates services across three tiers of government, and supporting emergency planning through online context aware maps. In the eGovernment area, issues of concern include a demand for services to be made available on line, with improved workflow and reduced manual intervention; but all of this should be delivered at no-to-low risk and at no extra cost to the existing (small) IT budget. Within this sector, there are many cultural barriers to change as well as organisational inertia. Beyond these normal soft issues lay some really difficult additional soft problems related to client privacy, data protection and legal/regulatory aspects of service delivery. The demonstrator developed in this usecase is seeking to show that the DIP approach is not only affordable but that it also can support a level of service delivery previously unattainable.

DIP deployment in these three areas was very successful, leading to a new £1M internal project, the incorporation of DIP technologies within a corporate strategy plan and a new governmental funded project.

Through Semantic Web Services DIP offers the unique possibility to provide interoperable and seamless information exchange between heterogeneous business systems. Moreover, with DIP technology we see a future where client requirements are automatically on-the-fly transformed into corresponding new business applications created by combining and configuring online services.

Standard proposals through W3C, OASIS, OMG

W3C: A major standards proposal in the area of Semantic Web Services has been submitted to W3C. In addition Web Services Modeling Ontology (WSMO) has been submitted to the World Wide Web Consortium (W3C) as a comprehensive framework for addressing Semantic Web services challenges. It is designed to help overcome the current problems of Enterprise Application Integration (EAI) and Service Oriented Architectures (SOA).

DIP has contributed significantly to W3C standards:

- WSMO, WSML, W3C Submissions <http://www.w3.org/Submission/WSMO/>, <http://www.w3.org/Submission/WSML/>
- WSML Rule W3C RIF Submission: <http://www.w3.org/2005/rules/wg/wiki/>
- WSML reasoning contributes to W3C “Semantics in Software Engineering” task force
- SAWSDL: Semantic annotations to WSDL, Grounding for WSMO <http://www.w3.org/2002/ws/sawSDL/>

OASIS: DIP partners (NUIG, UIBK and OU) have been instrumental in setting up the OASIS Semantic Execution Environment (SEE) Technical Committee. The OASIS SEE TC aims to continue work initiated by the WSMX project and several other projects in Europe such as DIP, ASG and other projects in the area of Semantic Web Services that have started this year. It will develop guidelines, justifications, and implementation directions for an execution environment for Semantic Web services. These services would be built upon the Semantic Web stack as standardized at the WWW Consortium (W3C), with the goal of being introduced into the W3C's Semantic Web Infrastructure.

- WSMX OASIS SEE TC: DIP API will now be referred to as SEE API http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=semantic-ex

OMG: DIP partners also actively contribute to the “Object Management Group PSIG on Ontologies”, the aim of which is to enable the OMG to rapidly develop ontology-related

technology. <http://ontology.omg.org/>

Exploitable tools

DIP has created a wide range of support tools available for download from Tools specific page on the DIP Web-site.-: <http://dip.semanticweb.org/ToolsPrototypes.html> and also particulars in publicly available workpackage deliverables <http://dip.semanticweb.org/deliverables.html>.

The following is a summary list of these tools, sorted by the various “Work packages” (WPs) which accomplished the subject contributions.

- WSML-Flight Reasoner, WSML-DL Reasoner, Reasoning infrastructure (WP1)
- WSML, ORDI, Ontology Management Suite OMS, Ontology versioning tool, Ontology Mapping and Alignment tool (WP2)
- WSMO, WSTO (WP3)
- QoS Discovery engine, Composition tool (ILOG), 3-Layer Orchestration tool, WSMO Studio, Trust Based Invocation Tool, Orchestration Engine, Monitoring Tool (WP4)
- Data and Ontology Mediation tool, Business Process Mediation tool, Mediation and discovery tool, Mediation and composition tool (WP5)
- DIP Architecture, WSMX, IRS-III, WSMO4J (WP6)
- Assurance Integration Prototype, Contract Catalogue Prototype, Telecoms ontologies (WP8)
- Change of circumstances prototype, Emergency Planning GIS prototype, eGovernment ontologies (WP9)
- Stock broker prototype, Financial ontologies, Mortgage application prototype (WP10)

Exploitation Prospects

Results of the project range from mathematical proofs and conceptual frameworks through to software artefacts and fully functional trial implementations deployed in a range of Industrial sectors. The knowledge generated in the project is being exploited commercially and academically.

In particular:

1. The OU are contributing to the development of a new UK Governmental programme worth £2M per year.
2. The WSMO conceptual model is being considered by a major Steel Production company to discover suitable simulation models out of a large set of candidate models before quoting for steel production.
3. BT will use DIP results to support increased automation in the delivery and support of BT (and its partners’) products and services – particularly in the ICT market. The lessons learned from BT’s use of SWS will allow revenue opportunities to be developed in the form of products and consultancy for external customers
4. Essex County Council continue to promote the use of SWS in the development of cost-effective eGovernment services to specific communities of interest (eg Emergency Planners)
5. Many different kinds of commercial exploitation plans have been derived by DIP partners
 - Acquisition of DIP partner by large IT company
 - Vertical exploitation of case studies in particular sectors
 - Horizontal exploitation of technologies developed
 - Joint exploitation plan for large organization and SME
5. All licensing for core technology is Open Source

6. DIP partners continue to have a strong influence on standards in leading standards bodies W3C, OASIS, OMG

7. Academic exploitation has resulted in take up in many recent R&D projects, EU funded projects, National and Internationally funded projects.

Follow on activities

The results and the experience gained in the DIP project will be sustained in large variety of activities both in academia and industry. A series of follow on projects will ensure the continuation of research, standardization and exploitation.

EU Funded Projects

FIT Fostering self-adaptive e-government service improvement using semantic technologies

FUSION Business process fusion based on Semantically-enabled Service-oriented Business Applications

KnowledgeWeb Ontology technology from Academia to Industry

LUISA Learning Content Management System Using Innovative Semantic Web Services Architect

MUSING MUlti-Industry, Semantic-based Next Generation Business INtelligence

NeOn Lifecycle Support for Networked Ontologies

NEPOMUK The Social Semantic Desktop

RIDE. A Roadmap for Interoperability of eHealth Systems, in Support of COM 356 with Special Emphasis on Semantic Interoperability

SALERO Semantic Audiovisual Entertainment Reusable Objects

SEKT Semantic Knowledge Technologies and Language Computation

SemanticGov Services for Public Administration

SEEMP Single European Employment Market Place

SUPER Semantics Utilised for Process management within and between Enterprises

X-Media Knowledge Sharing and Reuse across Media

National and International Research Projects:

Blue Brain Project Modeling the Mammalian Brain, EPFL (International)

ime Graduate School University of Karlsruhe project with FZI (German)

LHDL Living Human Digital Library (Consortium European Institutions)

MyOntology Open Ontology Environment for Semantic Web-based E-Commerce (Austrian-German)

Quaero European Internet search engine (French-German Consortium)

ReaSem Practical Reasoning Support for Semantic Technologies (German)

RW2 Reasoning With Semantic Web Services (Austrian)

SAOR Semantically Annotated Oncology and Radiology (Irish)

SemBiz Semantic descriptions of business processes with respective tool support (Austrian)

SEnSE Semantic Engineering Support Environment (Austrian)

SmartWeb Mobile Broadband Access to the Semantic Web (German Consortium)

Events in connection with DIP

DIP has participated in over 30 International Conferences and Workshops in the last year (<http://dip.semanticweb.org/publications.html>).

The project has had over 50 papers accepted and published at these events (<http://dip.semanticweb.org/publications.html>).

Of particular note:

- Semantics 2006: International Conference on Semantics, November 23-25, 2006, Vienna, Austria. <http://www.semantics2006.net/>

- ISWC 2006 Semantic Web Challenge, November 6-9, 2006, at the International Semantic Web Conference , Athens, GA, USA Athens, Georgia, USA. (2 papers in main conference, 3 papers in associated workshops, 1 Poster (SAWSDL). WP9 Emergency GIS use case a finalist in ISWC Semantic Web Challenge.
http://iswc2006.semanticweb.org/submissions/web_challenge.htm
- 1st Asian Semantic Web Conference, September 3(Sunday)- 7(Thursday), 2006 Beijing, China. <http://www.aswc2006.org/index.php>
- ESWC 2006 - 3d European Semantic Web Conference 2006, 11 -14 June 2006, Budva, Montenegro. <http://www.eswc2006.org/>
- Terra Future-The impact of future trends on information businesses, 19 September 2006 Ordnance Survey, Southampton, SO16 4GU. Keynote speaker: Workshop: Creating a knowledge-based economy: information integration. Sir Tim Berners-Lee, Leticia Gutierrez Villarias, Essex County Council, Dr. Cathy Dolbear and John Darlington
<http://www.ordnancesurvey.co.uk/oswebsite/partnerships/research/terrafuture/>
- Advances in Semantics for Web services 2006 Workshop (semantics4ws'06), in conjunction with the Fourth International Conference on Business Process Mangement (BPM 2006) September 4, 2006, Vienna, Austria. <http://events.deri.at/semantics4ws2006/>
- The Fourth Summer School on Ontological Engineering and the Semantic Web (SSSW'06), July 9, 2006 - July 15, 2006. Cercedilla (Spain).Tutorials: John Domingue.
<http://torresq.dia.fi.upm.es/sssw06/frames.jsp>
- Semantic Web Service Challenge - Phase I, March, 2006, Stanford University, California, USA. Semantic Web Service Challenge Workshop - Phase II, in conjunction with 3rd European Semantic Web Conference 2006-ESWC2006. Budva, Montenegro, 2006. 11-14 June 2006. <http://www.eswc2006.org/>
- WWW2006, Edinburgh, Scotland. 22-26 May 2006. Workshop Presentation The next wave of the Web,: Overview of several commercial applications that incorporate Semantic Web technology, Richard Benjamins. <http://www2006.org/>
- DIP and eBankinter are mentioned, within the annual Cotec Report on Technology and Innovation in Spain 2006 from COTEC Foundation , as an example of "good practice" regarding innovation in the Financial field in Spain. The Annual Report presents a compilation of indicators regarding the status of innovation and technology in Spain and the latter's ranking in respect of other countries. <http://www.cotec.es>

Dissemination activities of the project DIP

Dissemination was a substantial focus area of all project related activities. The following list summarizes the subject efforts and shows that as of November 2006 the DIP Consortium has published or contributed so far to:15 Journal Papers, 4 Book chapters, 8 Books (includes forthcoming DIP book), 3 Technical Reports, 63 Workshop papers, 123 Conference papers, 48 Invited Talks, 21 Tutorials, 56 Workshops, 79 Conferences, 12 Posters

DIP Links

DIP Website

<http://dip.semanticweb.org>

DIP Deliverables

<http://dip.semanticweb.org/deliverables.html>

DIP Publications

<http://dip.semanticweb.org/publications.html>

DIP Tutorials

<http://kmi.open.ac.uk/projects/dip/events.html>

DIP eGovernment Emergency Management Showcase

<http://istresults.cordis.lu/index.cfm/section/news/tpl/article/BrowsingType/Features/ID/82690>

European Semantic Systems Initiative (ESSI)

<http://www.essi-cluster.org/>

Administrative details

DIP is an Integrated Project (no. FP6 - 507483) supported by the European Union's IST programme. It started in January 2004 and with a duration of 36 months. The planned finish date is the 31st December, 2006. It has a total funding of €16.3 M.

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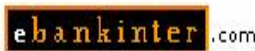


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List of participants

Partner	Acronym	Country
National University of Ireland Galway	NUIG  National University of Ireland, Galway <i>Ollscoil na hÉireann, Gaillimh</i>	Ireland
Fundacion De La Innovacion.Bankinter	Bankinter 	Spain
British Telecommunications Plc.	BT 	UK
Swiss Federal Institute of Technology, Lausanne	EPFL 	Switzerland
Essex County Council	Essex 	UK
Forschungszentrum Informatik	FZI 	Germany
Institut für Informatik, Leopold-Franzens Universität Innsbruck	UIBK 	Austria
inubit AG	Inubit  <i>the integration experts</i>	Germany
Intelligent Software Components, S.A.	ISOCO 	Spain

<p>MDR Partners</p>	<p>MDR</p> 	<p>UK</p>
<p>Hanival Internet Services GmbH</p>	<p>HANIVAL</p> 	<p>Austria</p>
<p>The Open University</p>	<p>OU</p> 	<p>UK</p>
<p>SAP AG</p>	<p>SAP</p> 	<p>Germany</p>
<p>Sirma AI Ltd.</p>	<p>Sirma</p> 	<p>Bulgaria</p>
<p>Vrije Universiteit Brussel</p>	<p>VUB</p>  <p>Vrije Universiteit Brussel</p>	