Systems interoperability through use of semantic technologies

Semantic Days’ 2009
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Systems interoperability through use of semantic technologies

- The talk will give an overview of the major challenges related to system interoperability in general and the specific issues related to interoperability on the semantic level. Examples on solution approaches based on use of semantic technology from current European projects will be given.

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Summary

- Challenges related to system interoperability, Interoperability on the semantic level
- COIN – Collaboration and Interoperability – Using SAWSDL architecture for semantic annotations, experimenting with different technologies for realisation

Related projects presented at Semantic Days:

- **SWING/ENVISION**: Tue 1700-1730 Semantic annotation for web services and their relevance to environmental models (ENVISION, SWING)
- **SHAPE**: Wed 1030-1100 Supporting intelligent and automated integrated operations with agent technologies in a services architecture (using SoaML and Agents) (SHAPE)
- **EMPOWER/MEMPOWER**: Wed 1130-1200 IT architecture for supporting semantic interoperability through use of semantic annotations (and SAWSDL) (EMPOWER)
**The COIN Vision & Motto**

**COIN VISION:** “By 2020 enterprise collaboration and interoperability services will become an invisible, pervasive and self-adaptive knowledge and business utility at disposal of the European networked enterprises from any industrial sector and domain in order to rapidly set-up, efficiently manage and effectively operate different forms of business collaborations, from the most traditional supply chains to the most advanced and dynamic business ecosystems.”
The COIN Consortium & Funnel Model

Industrial Partners
- TXT e-solutions
- SOLUTA.NET
- IC FOCUS
- Atos Origin
- ESoNET
- SIEMENS

Academic & Research Partners
- VTT
- BIBA
- SINTEF
- DFKI
- Jožef Stefan Institute, Ljubljana, Slovenia

User Partners
- IND
- ISQIN
- PÖRY
- UNCONVENTIONAL BUSINESS
- Filas
- ACS

14 Meuro, 21 partners

FP7-1 IP project
Objective 1.3

4 years: 2008-2011
## COIN Market: starting point

<table>
<thead>
<tr>
<th>EC form / EI challenge</th>
<th>Knowledge i/op</th>
<th>Business i/op</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Chains</td>
<td>Aerospace DTA Lazio (ITA)</td>
<td>Automotive Slovenian Net (SLO)</td>
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<tr>
<td>Collaborative Networks</td>
<td>ICT Network (HUN)</td>
<td>Aeronautic Cluster of Andalusia (SPA)</td>
</tr>
<tr>
<td>Business Ecosystems</td>
<td>Pulp &amp; Paper Poyry (FIN)</td>
<td>Healthcare VEN (UK)</td>
</tr>
</tbody>
</table>
COIN Side A: main innovations

- The COIN Interoperability Space
  - To address Information, Knowledge and Business interoperability
  - To support the Federated interoperability approach
  - To integrate Model- and Semantic-driven interoperability methods
  - To enable Knowledge Profiles semantic mediation
  - To synchronize and optimize collaboration Business Processes
    - To go beyond state-of-the-art 1:1 transactions:
      - Supporting 1:1 negotiations (e.g. supplier-customer)
      - Enabling 1:n relations (e.g. tender-bidders)
      - Allowing n:m agreements (e.g. sellers-buyers)
COIN Side A: state-of-the-art

- **Enterprise Models**
  - Provided
  - Required

- **Processes**
  - Provided
  - Required

- **Services**
  - Provided
  - Required

- **Information / Data**
  - Provided
  - Required

- **Model-Driven Interoperability**
  - Cross-Organisational Business Processes
  - Flexible Execution and Composition of Services
  - Information Interoperability

- **Ontologies and Semantics**
  - Collaborative Enterprise Modelling

**COIN Side A: state-of-the-art**
EIF version 2.0 (2009)
European Interoperability Framework
EIF - Dimensions of Interoperability
Definition: Interoperability
(Revised in 2008 in EIF v2, to include common goals!)

"Interoperability is the ability of disparate and diverse organisations to interact towards mutually beneficial and agreed common goals, involving the sharing of information and knowledge between the organizations via the business processes they support, by means of the exchange of data between their respective information and communication technology (ICT) systems."

In fact, interoperability is often confused with other, related concepts. It can be therefore a useful exercise to observe explicitly what interoperability is NOT:

- Interoperability is not **Integration**, which is a means of changing loosely coupled systems to make them into more tightly coupled systems.
- Interoperability is not **Compatibility**, which is more about the interchangeability of tools in a particular context.
- Interoperability is not **Adaptability**, which is a means of changing a tool, adding additional capabilities as needed even on an ad-hoc basis, whereas interoperability refers to inherent capabilities.
OMG BMM
Business Motivation Model
Goal alignment with BMM and service collaboration with SoaML

Figure on the left shows an example of a business motivation model that captures the following business requirements concerning the processing of purchase orders:

- Establish a common means of processing purchase orders.
- Ensure orders are processed in a timely manner, and deliver the required goods.
- Help minimize stock on hand.
- Minimize production and shipping costs

This example of a BMM model shows the business vision, the goals that amplify that vision, and the objectives that quantify the goals. It also shows the business mission, the strategies that are part of the mission plan, and the tactics that implement the strategies. Finally, the strategies are tied to the goals they support.

The example also shows a Process Purchase Order contract that formalizes the requirements into specific roles, responsibilities, and interactions. The Contract indicates what motivation elements it realizes through MeansRealizations.
SAWSDL - Semantic Annotations for WSDL and XML Schema

W3C Recommendation, August 2007

This specification defines a set of extension attributes for the Web Services Description Language and XML Schema definition language that allows description of additional semantics of WSDL components. The specification defines how such semantic annotation is accomplished using references to semantic models, e.g. ontologies

3 constructs: modelReference, liftingSchemaMapping, loweringSchemaMapping
Architecture for semantic annotation and reconciliation

Reference Ontology

Local Software & Data

SwApp#1

Sem Annot Set #1

Sem Rec Rules #1

Design-time

Run-time

Internet

SwApp#2

Local Software & Data

Sem Annot Set #2

Sem Rec Rules #2

SwApp#1

SwApp#2
Preparation phase
• **Mapping** = Semantic Annotation + Transf rules
• Mapping expressed in terms of a **RO**
• **Two rulesets** for each SA

Run time phase
• **Reconciliation** through pipelining application of rules

Transformation Rules
- Forward (App\textsubscript{X}2RO)
- Backward (RO2App\textsubscript{X})
Semantic Reconciliation Suite: from Athena to COIN

- **COIN Athos**: Ontology Management System
- **COIN A**: Web-service enabled
- **COIN A***: Reference Ontology
- **COIN Argos**: Annotation Repository
- **COIN Ares**: Transformation Rules Repository

**Doc Schema**
- **Doc SchemaA**: re-implemented as simpler
- **Doc SchemaB**: re-implemented

**RDFS Models Repository**
- **Preparation phase**
- **Run-time phase**

**AppA**
- **AppB**
- **Doc**
- **Doc InstanceA**
- **Doc InstanceB**

**Themis** repository
- **Transformation Rules Building Tool**

**Web-service enabled**
- **Bux Fixing**
- **Fully re-implemented**

**Semantic Reconciliation Suite: from Athena to COIN**
Example of Mismatch

EnterprA (Buyer)

Purchase Order

- Order_Number
- Order_Date
- Buyer_Info
  - Name
  - Address
    - Street_Name
    - Street_Num
    - City_Post_Code
    - Country
  - Telephone
- Products_Info
  - Product_Code
  - Description
  - Quantity
  - Price (unitary)
- Currency (Dollar, Euro, Pound)
- Charge
- RequestedDeliveryDate

EnterprB (Supplier)

Sale Order

- Date
- Organization_Name
- Contact_Person
- Location
  - Street_Address
  - City
  - LoCode
  - Country
- Phone_Number
  - Area_Code
  - Number
  - Ext
- Client_Order_Number
- Order_Lines
  - Product_Code
  - Description
  - Quantity
  - Price (total per line)
- Currency (USD, Euro, Yen)
- Total

Structuring
Ontology-based Reconciliation Approach

Address

Street_Name
Street_Number
City-Post_Code

Location

Street_Address
City
Zip_Code
Country
LoCode

Reference Ontology
Semantic annotations

Local Schema (XML Schema)

```xml
...<xsd:element name="Address">
  <xsd:complexType>
    <xsd:sequence>
      <xsd:element name="Street_Name" type="xsd:string"/>
      <xsd:element name="Street_Number" type="xsd:positiveInteger"/>
      <xsd:element name="City-Post_Code" type="xsd:string"/>
      <xsd:element name="Country" type="xsd:string"/>
    </xsd:sequence>
  </xsd:complexType>
</xsd:element>
...```

Reference Ontology (OWL)

```xml
...<owl:Class rdf:ID="Address"/>
  <owl:DatatypeProperty rdf:ID="Street">
    <rdfs:domain rdf:resource="Address"/>
    <rdfs:range rdf:resource="&xsd;string"/>
    <owl:DatatypeProperty>
      <owl:DatatypeProperty rdf:ID="Snum">
        <rdfs:domain rdf:resource="Address"/>
        <rdfs:range rdf:resource="&xsd;positiveInteger"/>
      </owl:DatatypeProperty>
      <owl:DatatypeProperty rdf:ID="City">
        <rdfs:domain rdf:resource="Address"/>
        <rdfs:range rdf:resource="&xsd;string"/>
      </owl:DatatypeProperty>
      <owl:DatatypeProperty rdf:ID="Zip_Code">
        <rdfs:domain rdf:resource="Address"/>
        <rdfs:range rdf:resource="&xsd;string"/>
      </owl:DatatypeProperty>
      <owl:DatatypeProperty rdf:ID="Country">
        <rdfs:domain rdf:resource="Address"/>
        <rdfs:range rdf:resource="&xsd;string"/>
      </owl:DatatypeProperty>
    </owl:DatatypeProperty>
  </owl:DatatypeProperty>
</owl:Class>
...```
COIN Metal: Baseline – Semantic SOA

Problem Solving Layer
- Ontologies
- Applications
- Developer Tools

Broker Layer
- Discovery
- Adaptation
- Composition
- Choreography
- Mediation
- Grounding
- Fault Handling
- Monitoring

Base Layer
- Formal Languages
- Reasoning
- Storage and Communication

WSMO/WSML

Objectives that a client wants to achieve by using Web Services
- Provide the formally specified terminology of the information used by all other components
- Goals
- Ontologies
- Web Services
- Semantic description of Web Services
  - Capability (functional)
  - Interfaces (usage)
- Mediators
- Connectors between components with mediation facilities for handling heterogeneities

SINTEF ICT
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See also: www.soaml.org
Platform independent annotations
“Address” in the source and target transformation rules

Create mapping rules from source to ontology, and ontology to target using ATL

Source to Ontology

Ontology to Target
“Address” transformations from source.xml and target.xmi
COIN Side B: state-of-the-art

- Business Opportunity
- Market turbulence
- Fast configuration of a temporary consortium well suited to the needs
- Short window of opportunity
- Successful & Effective collaboration
- Preparedness
- Breeding Environments
- VBE
- PVC
- CNO creation
- Metamorphosis
- Management / Governance

© The ECOLEAD Integrated Project
COIN Side B: main innovations

- The COIN Collaboration Space

- To allow **Endogenous** generation of Business Opportunities (LivingLabs & Open Innovation)
- To support **Product Design, Production Planning, Project Mgmt**
- To enable **Co-operativity** of Enterprise Applications (groups as users)
  - To support **Web 2.0** and participative services (Enterprise 2.0)
  - To involve also the Customers in the whole life-cycle of **Virtual Organizations** (VOs):
    - **VO preparation** (get the enterprises prepared to form VOs)
    - **VO creation** (select partners and competencies)
    - **VO operations & mgmt** (performance indicators definition-governance)
    - **VO dissolution** (inheritance and knowledge transfer)
COIN Side B: future outlook

• The Innovation Knowledge Ecosystem
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