Semantic Web Services

SWS are good for what: SUPER and SWING use cases

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### Where are we?

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Outline

• SUPER
  – Introduction and overview
  – Methodology and examples from the telco domain
  – Integrated demo/video

• SWING
  – Introduction and overview
  – Geospatial decision making use cases
  – Integrated demo/video

• Summary and Conclusions
SUPER
• Semantics Utilized for Process management within and between Enterprises (SUPER)

• The major objective of SUPER was to raise Business Process Management (BPM) to the business level, where it belongs, from the IT level where it mostly resides now
  – This objective requires that BPM is accessible at the level of semantics of business experts

http://www.ip-super.org/
SUPER – Introductory Demo/Video

(also available at http://www.ip-super.org/content/view/194/144/)
~ 5 min
SUPER – Key Objectives

• **Scientific objectives**
  – Construction and assessment of technological framework for SBPM
  – Acquiring new generic languages suited for representation of processes, different process models and goal description having in mind all aspects of system behaviour (e.g. costs, dependencies, constraints, other data flows, time limitations)
  – Creation of automated annotation techniques of already existing BPs, their fragments, IT components, etc
  – Development of process query tools
  – Adjustment existing reasoners to the specific needs of SUPER
  – Elaboration of industrial-strength mediation procedures for automated coupling between business and IT perspectives
  – Augmentation of SWS foundations on the basis of new experiences obtained from their deployment to large-scale test environments

• **Technical objectives**
  – Building horizontal ontologies in aim to annotate both complete BPs and their fragments
  – Assembling vertical ontologies for the chosen implementation domain
  – Complete inventory of tools supporting every stage of SBPM
SUPER – How Semantics Help

- Semantic technology improves the utility of BPM by creating a semantic „glue“ between different layers, artefacts and models.

- Links between business artefacts help to keep the „big picture“ and to improve the overall understanding of complex relationships and interdependencies.

- By unifying the vocabulary and explicating differences in a structured way, semantics support the understanding of business people and technicians.
## Value add of SUPER

| Making sense of a domain/problem | Solution maps |
| Communication tool | Mind maps |
| What is it all about? | Ad-hoc modelling techniques |

| Visualising/specifying business process | Business Scenario Maps |
| Focus: Business Problem | Event-driven process chains |
| Who does what, when, how and why? | Flowchart techniques |
| Usually multiple layers | BPMN |
| | ... |

| Process execution specification | BPEL |
| Formally specified grammar | ... |
| Focus: Implementation | |
| Which component is called when, how, by whom, with which data? | |

| Web service encapsulation | WS* |
| Focus: Implementation | ... |
| Which components can and should be exposed as services? | |

| Implementation of components | Programming languages |
| | ... |

Use of semantics allows us to cross business process representational boundaries
SUPER Ontology Stack

SUPER ontologies
Domain ontologies
Pre-existing ontologies
Imports
Maps to
Translates to

Upper-Level Process Ontology (UPO)
Business Process Modelling Ontology (BPMO)

Behavioural Reasoning Ontology (BRO)
sEPC Ontology
sBPMN Ontology

WSMO Ontology
sBPEL Ontology
Events Ontology (EVO)
Process Mining Ontology (PMO)
SUPER Ontology Stack – Benefits

• **Explicate Semantic Meaning of Data & Models**

• **Semantic Coherency of Information** among several levels of BPM

• **Higher Flexibility** for Web Service usage

• **Automated Handling** of Potential Heterogeneities

• **Make process definitions better understandable**
SUPER Architecture

SUPER Execution
- Semantic BPEL Execution Engine
- Semantic Execution Environment

SUPER Tooling
- Modelling Tool
- Monitoring & Management Tool
- Analysis Tool

Semantic Service Bus

SUPER Platform Services
- SBP Composition
- SBP Process Mediation
- SBP Discovery
- Data Mediation
- SBP Reasoner
- Transformation

SUPER Repositories
- Business Process Library
- Semantic Web Services Repository
- Execution History

Deployment
Event Sink
Protocol Binder
The **SUPER methodology** is a set of phases, methods and techniques to perform activities using SUPER technologies. Like a traditional BPM methodology, the SUPER methodology owns a proper business process “life cycle”, that is enriched with the semantic connotation of the overall SUPER framework.
Semantic Business Process Modelling

- First step of the SUPER Life Cycle

- Development of the Business Processes Model based on the Business Process Modelling Ontology (BPMO)

- Use of a Semantic Process Modelling Environment
  - WSMO Studio
  - Integrated BPMO Editor
• Business Process Model based on:
  – Company specific Business Function and Domain Ontologies
  – Semantic Web Services and Goals
• Business Process Model sources:
  – Business Analyst implicit knowledge and studies (business questions, Key Performance Indicators (KPIs), business outcomes, etc.)
  – Analysis reports created in an eventual previous Semantic Business Process (SBP) Analysis phase
• Several modelling methodologies are possible
  – Start business process modelling from scratch
  – Modify existing semantic business processes
  – Annotating non-semantic business processes
  – Re-use process patterns previously modeled
Example: TID Prototype
TID Modelling – Demo/Video

(also available at http://www.ipuper.org/demonstrators/TID/D8.6_Modelling_TID.htm)
~ 5 min
Benefits of SUPER Modelling

- **Business Process Modelling Notation (BPMN) independence** (BPMO representation)
- **Discovery** of existing Business Processes exploiting the semantic information
  - Search on specified Business Function, Domain and Patterns
  - Search on specified Business Goals, KPIs and Business Rules
- **Automatic validation and simulation** of the BPM
- Better **readibility** of models through a clear semantic
BPMO Editor Demo/Video

(also available at http://www.wsmostudio.org/demo/BPMO-editor.htm)

~ 10 min
Semantic Business Process Configuration

• Modelled Business Processes are configured
• Functions supported
  – Mapping of semantic BPEL processes (BPEL4SWS)
  – Integration of BPEL with SWS
• SUPER functionalities used
  – Task and process composition (SBP Composition)
  – SWS and process fragment discovery (SBP Discovery)
  – Semantic Business Process Repository
Example: SBP Configuration Scenarios

CRM & Fulfilment

- Create account
- Send postal confirmation to customer

Create customer account

- Decompose product bundle
- Notify for manual repopulation

Notify for manual repopulation

- Create email box
- Assign SIP URL
- Activate account
- Assign directory number

Assign directory number

- aDSL router procurement
- Send CPE request to 3rd party supplier

Send CPE request to 3rd party supplier

DSL Fulfilment

- Mail porting request to current provider

Mail porting request to current provider

- Info entered manually via order entry

Info entered manually via order entry

Customer data for verification

Order configuration in Internet system

- eTel Product Ordering (CRM 6-9 Fulfilment)

Customer Order Request

Customer Order Request
Configuration Requirements and Benefits

• Requirements
  – Each subsystem (its functionalities) represented by Semantic WS’s (SWS)
  – Each SWS described by the ontology
  – BPMO process composition
    • Task Composition implements each BPMO task with a combination of WS
    • Consistency Checking finds and removes bugs in the overall process
  – Use of SUPER Ontologies
    • Mapping BPMO into executable BPMO – all tasks bound to existing WS
    • Domain ontologies specify how WS affect the world – basis for combining WS and for checking/fixing the process

• Benefits
  – Binding process to company IT infrastructure
  – Coming from general process model to its concrete realisation
Semantic Business Process Execution

- Modeled and configured Semantic Business Processes are executed
- Execution history for SBP Analysis is produced
- Automates business activities
- Minimizes time-to-offer
- Supports
  - Execution of semantic BPEL processes (BPEL4SWS)
  - Discovery and execution of Semantic Web Services (SWS)
After the process execution has been finished, the result is returned to the user.
Example: Nexcom Customer Order Management Process

Customer uses a client application to start the Nexcom process.

Nexcom process is deployed as a semantic BPEL process.

Supplier exposes its process as SWS.
Benefits from SUPER SBP Execution

• Nexcom Use case requirements addressed by the SUPER SBP Execution phase
  – Supplier matching supported by Semantic Web Service discovery and invocation from within semantic business processes
  – Allows for more flexible traffic routing
  – Automates supplier matching and traffic routing process taking into account all existing suppliers
  – Minimizes time-to-offer
SBP Execution Demo/Video

(also available at http://www.ip-super.org/demonstrators/Nexcom/D8.6_execution_Nexcom.htm)
~ 11 min
Semantic Business Process Analysis

• Analysis of executed processes
  • Support of various analysis goals
    – Overview over process usage
    – Detect business exceptions
    – Detect technical exceptions
    – Compare As-Is with To-Be
  • Analysis methods
    – Semantic Process Mining
    – Semantic Reverse Business Engineering
Semantic Process Mining

• Semantic **auditing**
  – Use semantic information to check for properties in logs

• Semantic **control-flow mining**
  – Use semantic information to support different levels of abstraction in the mined models

• Semantic **organizational mining**
  – Automatically derive the teams and groups in the organization based on task similarity

• Semantic **performance analysis**
  – Use semantic information to check for Service Level Agreements (SLAs), throughput times, bottlenecks etc.
Semantic Reverse Business Engineering (RBE)

- Scenario based analysis with predefined content to ensure continuous business improvement
  - As-Is-Analysis
    Provide details and statistics about executed processes
  - Exception analysis
    Focus on business exceptions (deviation from the standard processes)
  - Standardisation & Harmonisation
    Check compliance of processes between organisational units or with predefined guidelines
  - User & Role analysis
    Check user and role behaviour and authorizations

How do I get the relevant information to redesign and improve my business processes?
Scenario Based Analysis

I am interested in all exceptions of the sales process.

The query results are formatted and aggregated for the business user.

Business Question Repository

RBE Ontology

Business Function Ontology

Analysis Results

Execution History Repository

Process Mining

- How many sales orders were cancelled?
- Which sales orders are locked for further processing?
- How many sales orders are delayed?
- Where are the bottlenecks in the sales process?

Only business questions semantically assigned to Exception Analysis and to the Sales Process are to be selected. Business questions are executed on the Execution History Repository (log file) either directly or through Process Mining.
Analysis Results

How many sales orders were cancelled?

Which sales orders are locked for further processing?

- Get overview about system usage
- Find out exceptions within process flow
- Check conformance to defined Process model
- Find bottlenecks
- Get basis information to apply 6-sigma methodology
SBP Analysis Demo/Video

(also available at http://www.ip-super.org/demonstrators/eTel/super-d8-6-analysis-working.htm)
~ 11 min
SUPER Integrated Demo/Video

Also available at http://www.ip-super.org/demonstrators/Integrated/D8.6_demonstrator.htm
~ 20 min
SWING

- Semantic Web services Interoperability for Geospatial decision making (SWING)
- The main objectives of SWING were:
  - To develop an open, easy-to-use Semantic Web Service framework of suitable ontologies and inference tools for annotation, discovery, composition, and invocation of geospatial web services
  - To evaluate the appropriateness of this framework by developing a geospatial decision-making application that can dynamically find and provide interoperable semantic web services

http://www.swing-project.org/
SWING Components

- **MiMS**: Environment for domain expert. Convenient semantic annotation & discovery; use composed services like standard OGC services
- **WSMX**: Semantic web services platform. Geospatial semantic discovery; execution of composed services
- **Concept Repository**: Ontologies for semantic annotation. Used throughout components
- **Visual OntoBridge**: Annotation tool. Semi-automatic annotation of services and queries; provides user with most plausible annotations
- **Catalogue**: OGC Catalogue. Semantic discovery in interaction with WSMX; also provides adapter OGC ↔ WSMX execution
- **Composition Studio**: Environment for IT expert. Convenient semantic annotation & discovery; graphically compose services; automatic export into WSMX compositions
SWING – High-level Architecture and Interactions

Visual OntoBridge

Concept Repository

Composition Studio

MiMS

Catalogue

WFS Adapter

WSMX
SWING Use Cases – Application Theme

• Mineral Resources Management
• Aggregates production and consumption
  – Aggregates = crushed hard rock (limestone, volcanic rock, sandstone, recycled concrete, ….), or on- & off-shore sediments (sand & gravel)
  – EU aggregate production & consumption is the largest macro-regional market in the world
  – Aggregates - mineral resources with average low value
    • Sand, gravel, crushed stone, ….
    • Produced on-shore (quarries), off-shore, and some recycling (concrete)
  – EU production 3 billion tons
  – EU employment 250,000 jobs
  – EU value 35 billion €
  – consumption 5-15 tonnes per capita per year
  – about 25,000 production sites in Europe
• National Aggregate production in France
  – Source of exploitation limited in space
    • Geology determines location of aggregate resource
    • Transport cost (prices may double with every 30-50km)
    • Transport network (and carrier capacity)
  – Land-use conflicts (urban development, agriculture, water)
    • NIMBY issues ("Not In My Back-Yard")

• Aggregates in France
  – 5800 sites of extraction in France (source: DIREM)
  – Quarrying, transport and consumption administered on department-scale
  – Consumption steadily rising
    • from 347 Mt (1996) to 425 Mt (2000)
    • e.g. the Paris region imports about 50% of its aggregate consumption (31Mt/year)
  – Less natural sources, more crushed rock
    • against market demand
SWING Use Cases – Application Theme (cont’)

• Aggregates in France
• Department-scale administration
  – quarrying, transport and consumption administered on department-scale
    → requests national overview and fusion of information
  • To produce regionally harmonised maps
    – extraction, consumption, resource, nature reserves, fluxes

→ Problems
• Heterogeneous data
• Multiple data sources
• Heterogeneous responsibilities
• Few metadata
• No flexibility
• Not interactive
• No “national memory”
SWING Use Cases Overall Objective

• Given
  – Inputs for a new infrastructure project
  – Production/Consumption of actual quarries
  – Known Land-uses constraints
  – Goelogy

• Find places where to get aggregates
  – From existing quarries
  – By opening new ones (Land-use constraints + Geology)
Use Cases

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<tr>
<th>Substances</th>
<th>Quantity(*)</th>
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<td>Sand</td>
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<tr>
<td>Granite</td>
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</tr>
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<td>Concrete</td>
<td>200 tons</td>
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(*) All Quantity and Substances are given for example and are NOT real.
Use Case Steps

- Use Case 1: Production/Consumption Map
- Use Case 2: Land-Use constraints integration
- Use Case 3: Find the best place
Use Case 1 - Create a Simple Map

• Thematic objective:
  – Create a consumption-production map of aggregates

• Technical challenges:
  – Set up needed DATA and Web Services (OGC and WSDL)
  – Build a WSML Domain Ontology
  – Annotate available WS with the Domain Ontology
  – Register WS in CAT and Store WS annotations
  – Setup simple WS composition, annotate and store into CAT, execute it with WSMX
Use Case 1 - Create a Simple Map

Fake Consumption/Production Map (based on population of departments)
Use Case 2 - Create a Complex Map

• Thematic objective:
  – Create a map of land-use constraints and publish it as a decision making support document

• Technical challenges:
  – Implement WPS to combine multiple constraints
  – Extend the Domain Ontology to take land-use constraints into account; Improve the Ontology engineering process
  – Improve the annotation process (towards semi-automatic annotation)
  – Improve technical architecture of the end-user interface
Use Case 2 - Create a Complex Map

Land-Use Constraints
Negotiability level
Use Case 2 - Create a Complex Map
Use Case 3 - Use Created Complex Map to Make Sophisticated Queries

• Thematic Objective:
  – Create an interactive map of the ranking according to combined criteria

• Technical challenges:
  – Extended the domain ontology to catch domain experts knowledge
  – Use geoprocessing facilities to compute spatial data needed for answering more sophisticated queries
  – Improved the annotation process towards semi-automatic annotation
  – Use of mediation for interoperability (service request parameters mediation)
  – Improve technical architecture of the end-user interface
Use Case 3 - Make Sophisticated Queries

Get quarry best location

(*) All Quantity and Substances are given for example and are NOT real

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SWING Demo/Video

Also available at http://www.swing-project.org/showcase.html
~ 17 min
Summary and Conclusions – SUPER Benefits

• SUPER **bridges the gap** between Business experts and IT experts in setting up new products and processes
• SUPER provides a **new set of integrated BPM tools** for
  – Modelling
  – Automated Composition of Processes
• SUPER uses Semantics to gain a new level of **automation** for the modelling and configuration of business processes
• SUPER tools are based on open standards to guarantee independence from particular vendors
• Economic advantages
  – Lower development costs
  – Shorter time-to-market for new services and products
• Target Group Business Users
  – Global players
  – SMEs and government agencies
Summary and Conclusions – SUPER Business Impact

• Better process monitoring leading to more transparency
  – Faster reactions to emergency situations (technical problems, market requirements…)
  – Optimization of CRM, customer analysis, market analysis

• Flexible product design and management
  – Design: SUPER offers the opportunity to create new products out of a library of existing processes - in short time, without involving IT resources and without additional costs
  – Flexible product provisioning: technical realization of business processes can be changed without redesigning the process itself

• Enabling the user to rapidly implement and test business processes
Summary and Conclusions – SWING results and contributions

- A set of geospatial ontologies developed based on sound ontology engineering techniques
- Generic approach for semantic annotation of geospatial services
- The concept repository (CORE) – a novel and generic approach to ontology maintenance
- An efficient semi-automatic technique for annotation, combining text mining techniques, Page Rank-like algorithms, and Web search engines
  - Visual Onto Bridge – an easy comprehensive, graphic tool to semantically annotate OGC services
  - Cross-language support for creating annotations
- Identified ways to integrate semantic annotations in OGC catalogues
  - Design and implementation of OGC adaptors used to bridge the Catalogue and the WSMX platform and to expose WSML compositions as WFS services
- Visual model-based service composition, integrated with semantic discovery, annotation, and execution engine - with a possibility for platform independent realizations
  - Visual composition integrated with OGS services
References

• SUPER
  – http://www.ip-super.org/
  – Deliverables: http://www.ip-super.org/content/view/32/66/
  – Ontologies: http://www.ip-super.org/content/view/129/136/
  – Tools: http://www.ip-super.org/content/view/196/163/
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