SoKNOS - Using Semantic Technologies in Emergency Management Software
Grigori Babitski, Simon Bergweiler, Olaf Grebner, Daniel Oberle, Heiko Paulheim, and Florian Probst
ESWC 2011
Agenda

Using Semantic Technologies in Emergency Management (Motivation)
- Introduction to the research project SoKNOS
- Ontologies developed during the project

Use Cases and Ontology-based Improvements
- Use Case 1: Simplified Database Integration
- Use Case 2: System Extensibility
- Use Case 3: Improved Search
- Use Case 4: Improved Discovery of External Sensor Observation Services
- Use Case 5: Plausibility Checks
- Use Case 6: Improved Information Visualization

Lessons Learned
SoKNOS
The Next Generation of Emergency Management Systems
Current Situation in Managing Large Incidents

- Incomplete Emergency & Disaster Picture
- Ineffective resource/asset management
- Disjointed coordination and capabilities of stakeholders
- Recovery and reconstruction delays
Challenges in Crisis Situations - SoKNOS Motivation and Goal

- Shortening the chaos-phase.
- Getting continuously comprehensive information from all kinds of information sources.
- Support the seamless collaboration between all actors and organisations involved in fighting the incident.
SoKNOS Partner

Berliner Feuerwehr

Stadt Köln

Berufsfeuerwehr Köln

© 2011 SAP AG. All rights reserved.
SoKNOS – User-centric Approach

...reuse existing metaphors!
SoKNOS – User-centric Approach
Highly Flexible, Service-based System. Adjustable to the Needs of the Current Situation

- Endangered Area
- Forecast of water level
- Units onsite
- Available resources
- River Height Field Station
- Incoming message
Ontologies
Ontology Stack

The top-level ontology DOLCE constraints the domain and application ontologies.

→ Result: High conceptual flexibility on lower levels while maintaining comparability of concepts.
Reference Ontology for Emergency Management

... complex but still manageable...
Overview Use Cases
Central Use Cases for IT-Systems in Emergency Management

<table>
<thead>
<tr>
<th>Benefits for End Users</th>
<th>Benefits for Developers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plausibility Checks</td>
<td>System Extensibility</td>
</tr>
<tr>
<td>Improved Search over Databases</td>
<td>Simplified Database Integration</td>
</tr>
<tr>
<td>Improved Service Discovery</td>
<td></td>
</tr>
<tr>
<td>Improved Visualization</td>
<td></td>
</tr>
</tbody>
</table>

**Run Time (during emergency)**

**Design Time (before emergency)**
Use Case 1: Simplified Database Integration

Use Case 2: System Extensibility

Use Case 3: Improved Search

Use Case 4: Improved Discovery of External Sensor Observation Services

Use Case 5: Plausibility Checks

Use Case 6: Improved Information Visualization
Semantics-based Integration of System Modules in SoKNOS

Information exchange between (really!) independent modules → Quick configuration of the system.
User Interface & Interaction Domain Ontology

Real World Domain Ontology
Application 1
Ontology

Application 2
Ontology

Event Exchange

register
consult

map to

java class/attr. Ont. Concept

Object Ontology Mapping Registry

Reasoning Component

process

consult

User Interface and Interaction Ontology

extend

refer to

"Real World" Domain Ontology

Ontology Processing
Integrating Applications developed in Flex resp. Java

Flash Application for Ressource Management
Java Application „Mission Management Tool“
Use Case 1: Simplified Database Integration
Use Case 2: System Extensibility
Use Case 3: Improved Search
Use Case 4: Improved Discovery of External Sensor Observation Services
Use Case 5: Plausibility Checks
Use Case 6: Improved Information Visualization
Use Case 4: Improved Discovery of External Sensor Observation Services

Motivation:
- An accurate picture of the crisis situation is essential.
- Sensor Services can deliver this information, but finding them under time pressure is difficult.
- Enable the crisis management team to find sensor observation data fast and reliable.

Solution:
- Semantic annotation of Web Services designed according to the SOS specification (OGC).
The ontology is based on the OGC specification for sensor observation services.
Ontology-based Search for Sensor Observation Services

User specifies via the ontology:

- Feature (entity) of interest (e.g. wind, water body,)
- Observed quality of that entity (e.g. speed, direction, depth, concentration of x)

The approach extends existing OGC standards.

Goal: Semantic support for catalog services
Use Case 1: Simplified Database Integration

Use Case 2: System Extensibility

Use Case 3: Improved Search

Use Case 4: Improved Discovery of External Sensor Observation Services

Use Case 5: Plausibility Checks

Use Case 6: Improved Information Visualization
Use Case 6: Improved Information Visualization

Motivation

- Information contained in “silos” (aka IT systems)
  - hard to grasp interrelations (especially for end users across organization boundaries)
  - deriving information from data is a hard task
Use Case 6: Improved Information Visualization (cont.)

Idea

- Create a unified visualization …based on ontologies
- Reasoning for discovering implicit relations
Interaction

- Visualizing objects
  - by dragging and dropping them onto the canvas

- Navigating
  - by opening nodes (double clicking)

- Hybrid visualization
  - selected objects in the graph are highlighted in original application
  - and vice versa
Set up

- Select & explore

Understand the intended meaning of an information object.
Screenshot Semantic Data Explorer
Lessons Learned
Lessons Learned

Ontology Engineering Process

- Involving the end user (rather obvious)
- Establishing the role of an ontology engineer (in analogy to master courses in software engineering).
- Ontology editors need improvement in their browsing mechanisms, help systems and visualization metaphors." [Garca-Barriocanal], A statement from 2005 which unfortunately still holds true.

Software Engineering Process and Ontologies

- Developing new mechanisms for semantic annotations.
  - non-intrusive annotation of instances during run-time
- Addressing performance.
Lessons Learned

Ontology Usage and Suitability

- Finding the right modeling granularity.
- Domain experts were not used to concepts needed to create a formally correct ontology (DOLCE)
- End users were irritated by modeled domain terminology that was not part of their colloquial language.
- Finding the right visualization depth.
Lessons Learned: Data Models and Ontologies Serve Different Purposes → 1:1 Mappings are not Helpful

**Goal:** efficient programming

- Task-specific approach
- Prescriptive
- Simplicity over precise representation

**Goal:** „complete picture“, semantic account of terms in a domain

- Generic approach
- Descriptive
- Precise representation over simplicity

**Assumption:**

Shared conceptualization of a domain

- Class Model
- Software developer

- Ontology
- Ontology engineer

Good software requires both:

1. Efficient code (fast, reliable, easy to maintain)
2. Sound and formal semantics of the exchanged information items

→ Both requirements need to be fulfilled without halting the other.
Thank You!

Contact information:

Dr. Florian Probst
f.probst@sap.com