

SoKNOS - Using Semantic Technologies in Emergency Management Software

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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



EMERGENCIES & DISASTERS

Challenges in Crisis Situations - SoKNOS Motivation and Goal

Police



- 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.

Rescue



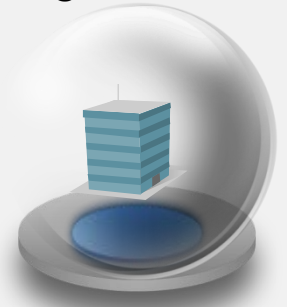
Fire Brigade



Technical Relieve
Agency



Agencies



SoKNOS Partner



GEFÖRDERT VOM



Bundesministerium
für Bildung
und Forschung



Berliner Feuerwehr



Berufsfeuerwehr Köln



Deutsche
Hochschule der Polizei



Deutsches
Forschungszentrum
für Künstliche
Intelligenz GmbH



Fraunhofer
Gesellschaft



ifgi
Institut für Geoinformatik
Universität Münster



TECHNISCHE
UNIVERSITÄT
DARMSTADT



TECHNISCHE
UNIVERSITÄT
DRESDEN



RUTGERS
THE STATE UNIVERSITY
OF NEW JERSEY

SoKNOS – User-centric Approach



Highly Flexible, Service-based System. Adjustable to the Needs of the Current Situation

Mission Account

Tool Box

Situational Map

Web Service Repository

Mission Diary

Planning Tool

New Generation of Emergency Management Systems: SoKNOS Prototype



Kanzlerin Dr. A. Merkel und Gouverneur A. Schwarzenegger

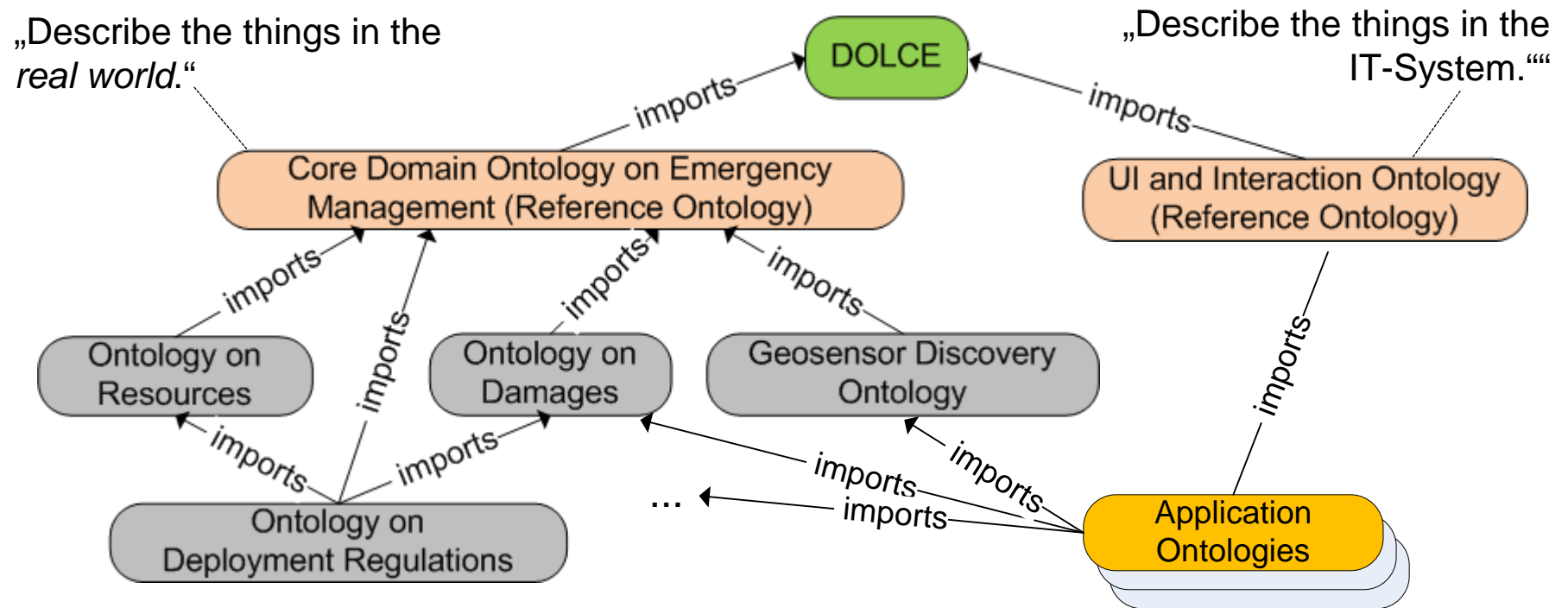


David Skellern, CEO NICTA



Ontologies

Ontology Stack



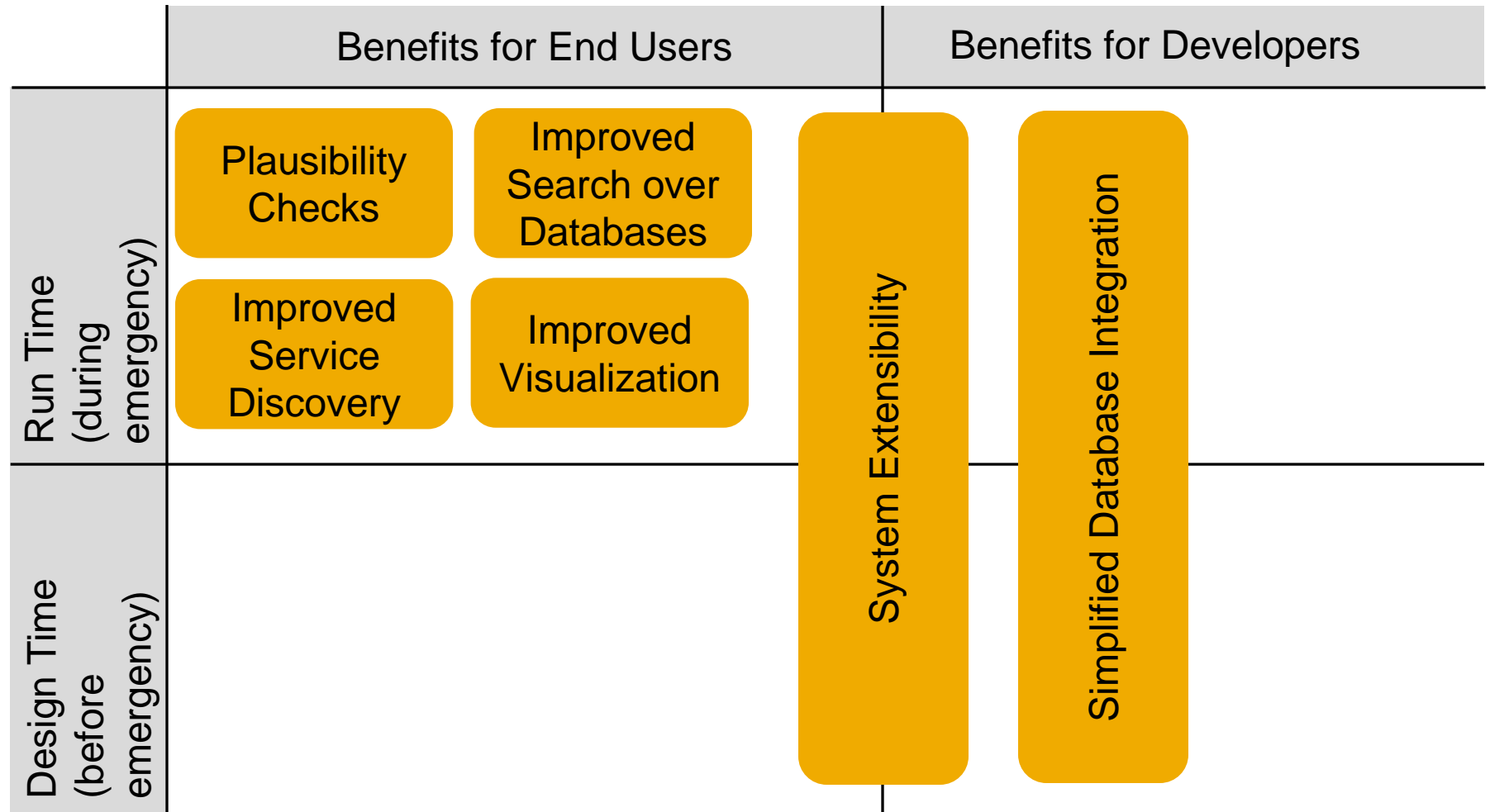
The top-level ontology DOLCE constraints the domain and application ontologies.

→ Result: High conceptual flexibility on lower levels while maintaining comparability of concepts.



Overview Use Cases

Central Use Cases for IT-Systems in Emergency Management





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**

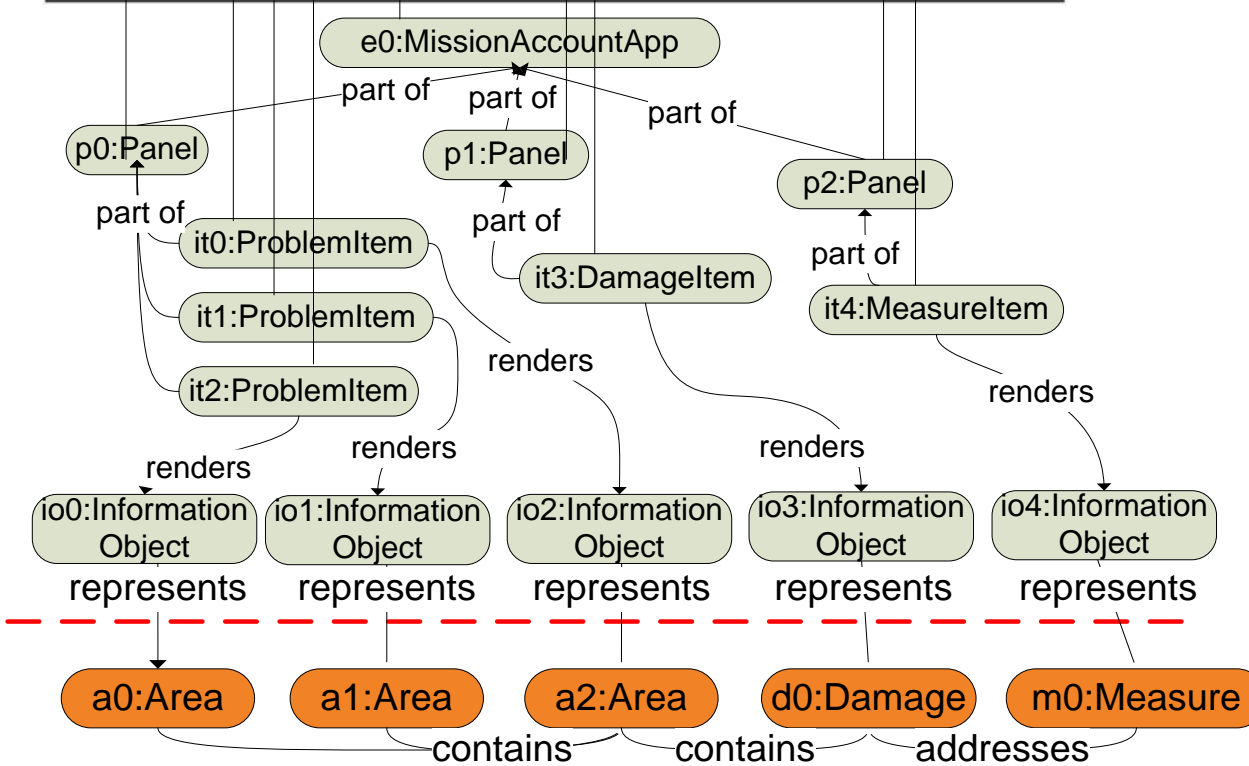
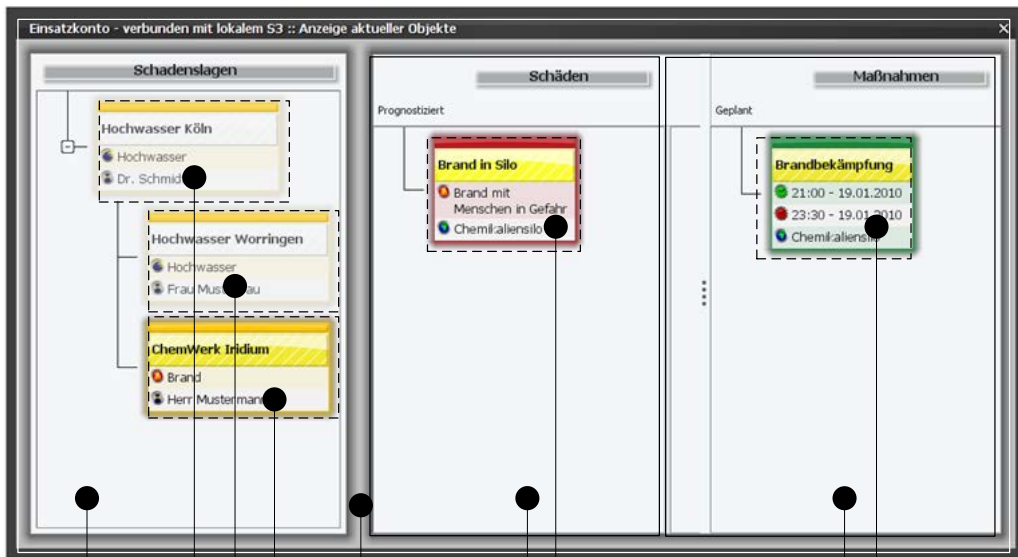
Use Case 5: Plausibility Checks

Use Case 6: Improved Information Visualization

Semantics-based Integration of System Modules in SoKNOS

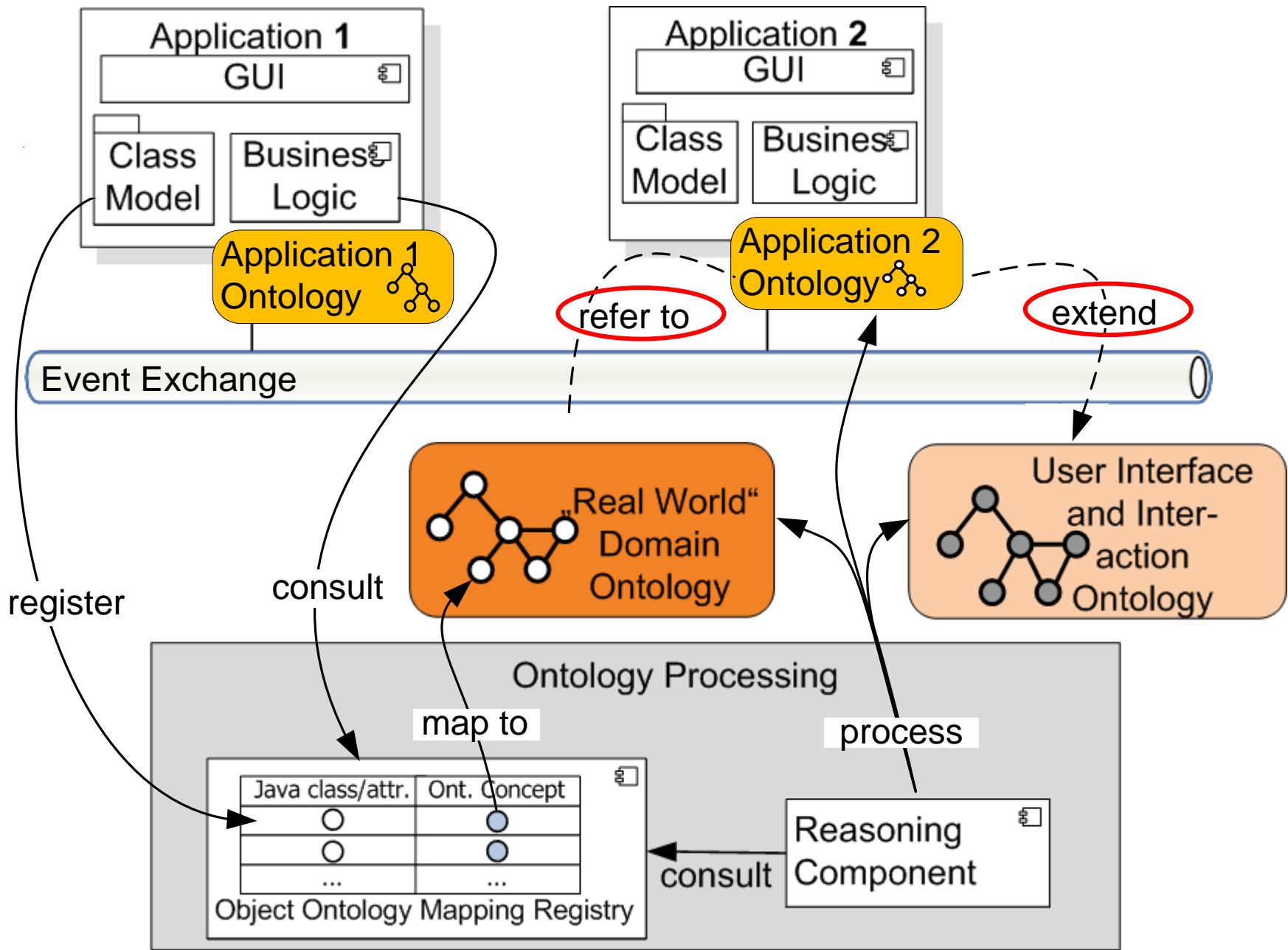
The screenshot displays the SoKNOS interface. At the top left, a window titled "S³-Portal" is visible. The main area features a map of a city region, including labels for "LEVENRUSEN", "SEIBERG", "KÖLN", and "LINDEN". A red circle highlights a specific area on the map, and a red arrow points from the text "select & highlight" to this circle. Another red arrow points from the text "drag & drop" to a red line that connects the highlighted area to a data panel below. This panel, titled "Müllmenge", contains a table with columns for "Tag", "Wochentag", "Müllmenge", and "Typ". To the right of the table is a form with fields for "Empfänger", "Verkehrsmittel", and "Vermerk". Below the map, there is another panel titled "Pegelmessung" showing a line graph of "Hohler Pegel (Meterech)" over time, with a y-axis ranging from 0 to 900 and an x-axis from 14:35 to 15:00.

Information exchange between (really!) independent modules
→ Quick configuration of the system.



User Interface &
Interaction Domain
Ontology

Real World
Domain Ontology



Integrating Applications developed in Flex resp. Java

The screenshot displays two side-by-side application windows within the SAP S/4HANA Portal. The left window, titled 'Ressourcen-Verwaltungs-Flash-Plugin #4', is a Flash application showing a list of resources. The right window, titled 'Einsatzkonto - verbunden mit lokalem S3 :: Anzeige aktueller Objekte', is a Java application showing a mission management tool with various task cards.

Ressourcen-Verwaltungs-Flash-Plugin #4

Ressourcen

- LKW
 - DA-CW 1175
 - F-HF 54**
 - F-UZ 5724
 - F-MN 4872
- PKW
- FLUGGERAETE
- HUBSCHRAUBER
 - F-XB 8423

Details

Allgemein Beschreibung Koordinaten

NAME F-HF 54

ORGANISATION POLIZEI FRANKFURT

OPERATIONAL AREA STADT FRANKFURT

BESATZUNGSSTÄRKE 5

STATUS TRANSFERRING

Einsatzkonto - verbunden mit lokalem S3 :: Anzeige aktueller Objekte

Schadenslagen Schäden Maßnahmen

Prognostiziert Geplant

Deichbruch bei Merkenich

- Hochwasser
- unbekannt

Überschwemmung in Merkenich

- Hochwasser
- Dr. Schmidt

Überschwemmung Wohngebiet

- Gefährdung
- Bahnhofstraße

Hochwasser

- Hochwasser
- Innenstadt

Fahrzeug bereitstellen

- 12:11 - 18.02.2010
- 14:11 - 18.02.2010
- Sportplatz
- Medweich

Schutz Köln

- frei

Löschzug Köln

- frei

Pumpe vorbereiten

- 13:00 - 18.02.2010
- 17:00 -

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

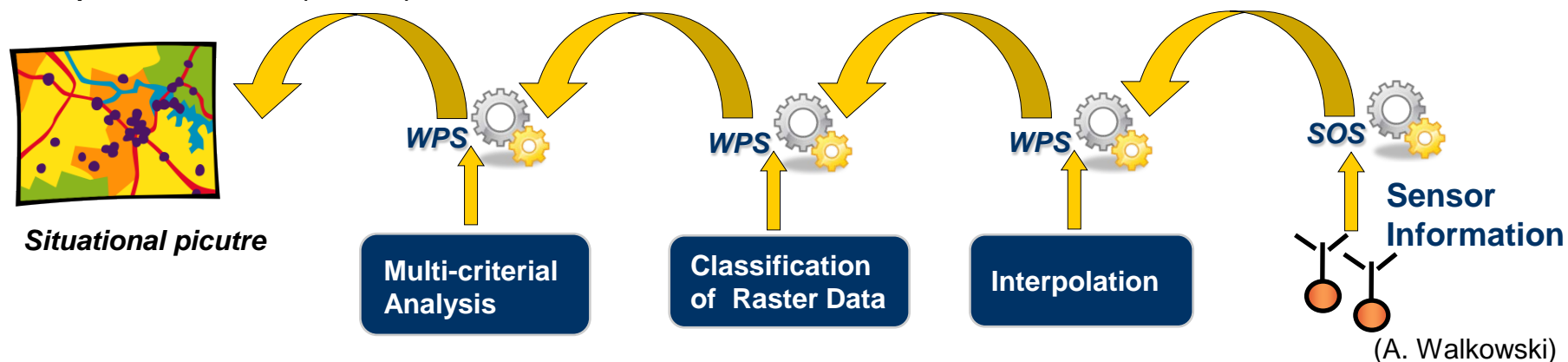
Use Case 4: Improved Discovery of External Sensor Observation Services

Motivation:

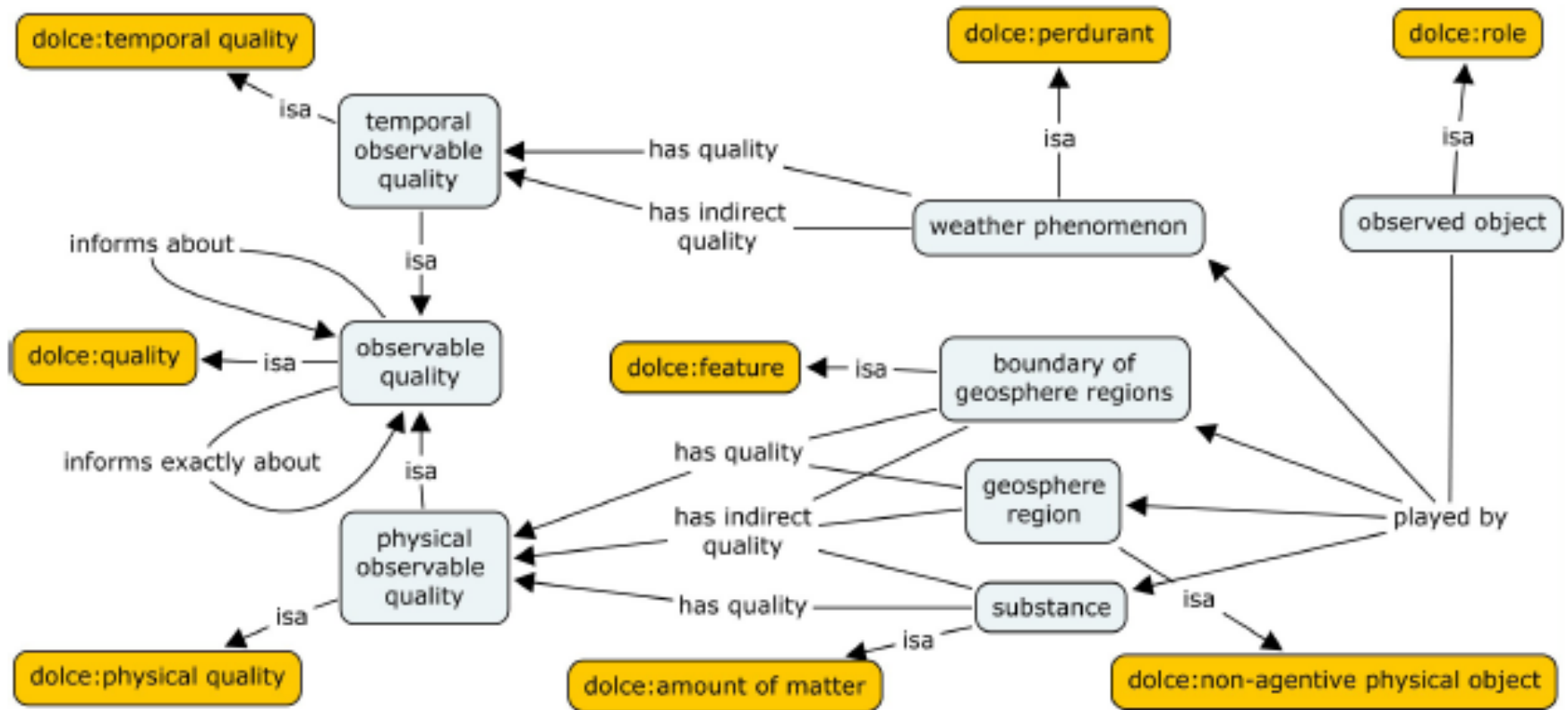
- An accurate picture of the crisis situation is essential.
- Sensor Services can deliver this information, but finding them under time pressure is difficult.
- Enable the crisis management team to find sensor observation data fast and reliable.

Solution:

- Semantic annotation of Web Services designed according to the SOS specification (OGC).



Ontology for Sensor Observation Services



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 entity (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

The screenshot shows a web interface for an ontology browser. At the top, there is a search bar containing the text 'flu'. Below the search bar is a button labeled 'Anzeigen'. The main area displays a hierarchical tree structure of ontology classes. The tree is expanded to show the following structure:

- Substanz
 - Reinstoff
 - Gemisch
- BeobachtbarePhysikalischeEigenschaft
 - UnaeareBeobachtbarePhysikalischeEigenschaft
 - BinaereBeobachtbarePhysikalischeEigenschaft
- BeobachtbareTemporaleEigenschaft
 - Wellenausbreitungseigenschaft
 - Intensitaet
 - Durchfluss
- Bewegungseigenschaft
- Geosphaeere-Bereich
 - Gewaesser
 - Meer
 - Binnengewaeasser
 - Salzgewaeasser
 - Flieessgewaeasser
 - UnterirdischeFlieessgewaeasser
 - OberirdischeFlieessgewaeasser
 - Bach
 - Fluss
- Bodenschicht
- Atmosphaere-Schicht

At the bottom of the interface, there is a timeline from -365Tage to 0Tage, with a date range from 24.05.2009 to 28.07.2009. There are 'Suchen' and 'Schließen' buttons at the bottom.

The screenshot shows the same ontology browser interface, but with a different search term. The search bar is empty. The tree structure is expanded to show the following structure:

- Wasserstand
 - HorizontaleAusdehnung
 - BeiebigGerichteteLineareAusdehnung
 - ElektromagnetischeFeldgrosse
 - Druck
 - Ausmass
 - BinaereBeobachtbarePhysikalischeEigenschaft
- BeobachtbareTemporaleEigenschaft
 - Wellenausbreitungseigenschaft
 - Intensitaet
 - Durchfluss
- Bewegungseigenschaft
 - Velozitaet
 - Geschwindigkeit
 - Bewegungsrichtung
 - Windrichtung
 - Stroemungsrichtung
- Geosphaeere-Bereich
 - Gewaesser
 - Meer
 - Binnengewaeasser
 - Salzgewaeasser
 - Flieessgewaeasser
 - UnterirdischeFlieessgewaeasser
 - OberirdischeFlieessgewaeasser
 - Bach
 - Fluss
- Bodenschicht

At the bottom of the interface, there is a timeline from -365Tage to 0Tage, with a date range from 24.05.2009 to 28.07.2009. There are 'Suchen' and 'Schließen' buttons at the bottom.



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**

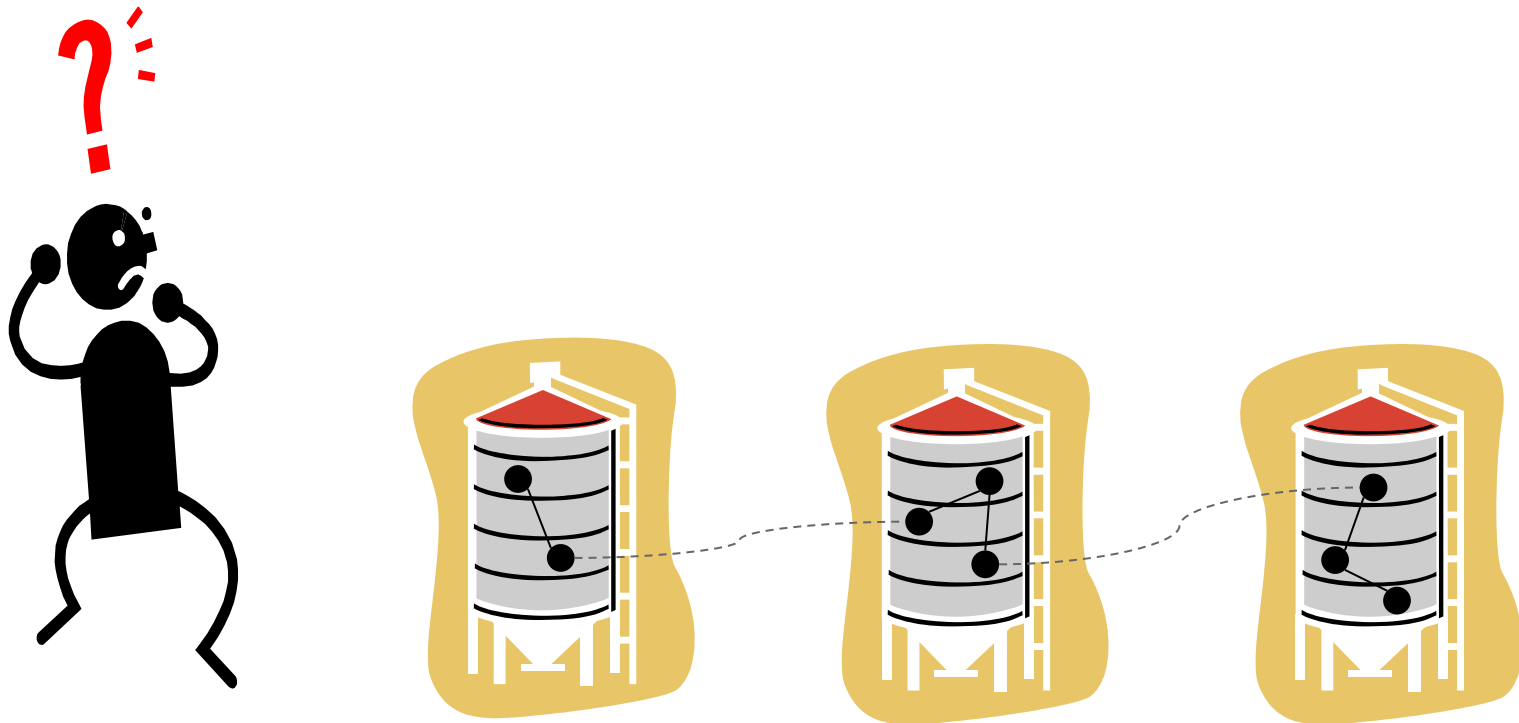
Use Case 5: Plausibility Checks

Use Case 6: Improved Information Visualization

Use Case 6: Improved Information Visualization

Motivation

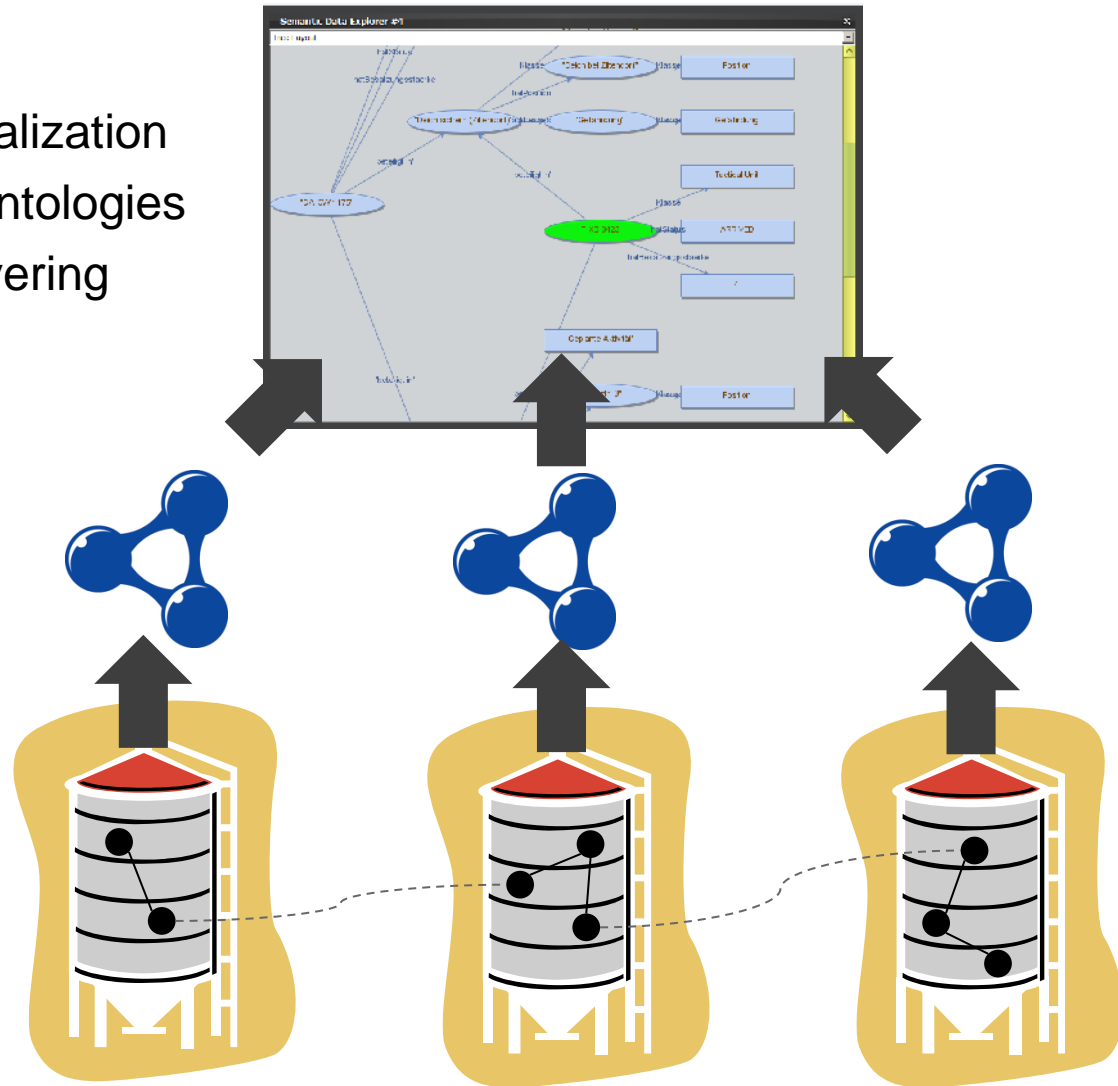
- Information contained in “silos” (aka IT systems)
 - hard to grasp interrelations (especially for end users across organization boundaries)
 - deriving information from data is a hard task



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

Setup

Mission account :: Showing laufende Objekte

Schadenslagen

- Feuer in Chempark
 - Brand
 - Dr. Schmidt
- Überschwemmung in Merkenich
 - Hochwasser
 - Dr. Schmidt
- Feuer in Industriepark
 - Brand
 - Dr. Meyer
- Überschwemmung in Frankfurt (Oder)
 - Hochwasser
 - Dr. Meyer

Schäden

Prognostiziert | Aktuell | Geplant | Laufend

- Deichbruch bei Merkenich
 - Hochwasser
 - unbekannt
- Deichbruch bei Wiesdorf
 - Hochwasser
 - unbekannt
- Deichbruch bei Kasselbera
 - Hochwasser
 - unbekannt
- Deichbruch bei Rheindorf
 - Hochwasser
 - unbekannt

Maßnahmen

- Kasselberg evakuieren
 - 13:55 - 16.09.2010
 - unbekannt
 - Kasselberg
- F-LK 5845
 - unbekannt
- Deich sichern (Rheindorf)
 - 13:55 - 16.09.2010
 - unbekannt
 - Deich bei Rheindorf
- F-VI 243
 - unbekannt

Resource Management (Flex) #3

Ressources

- F-XB 8423
- Flugzeuge
 - F-HH 4823
 - F-LK 5845
 - F-XZ 5845

Details

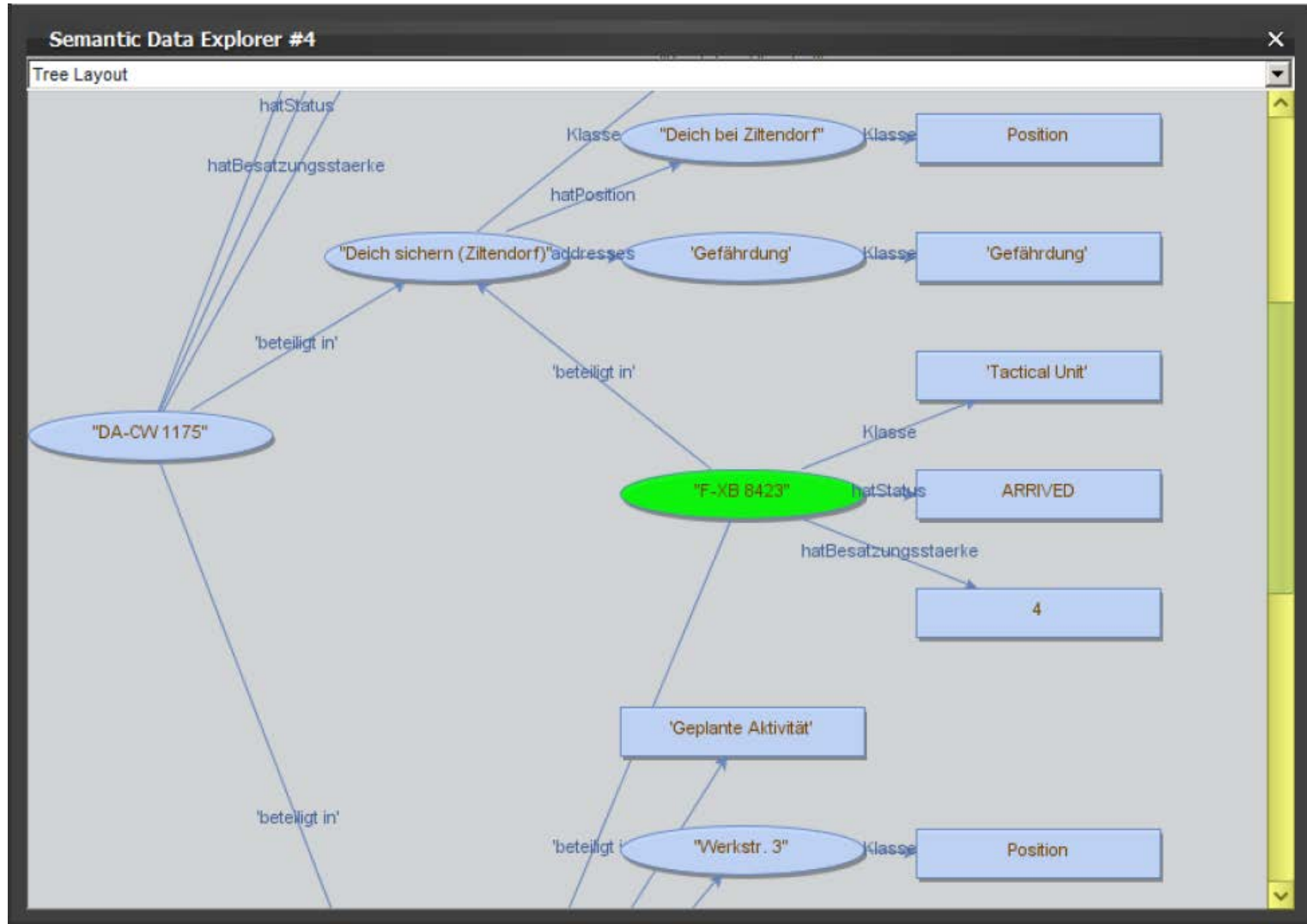
Allgemein | Beschreibung | Koordinaten

Name	F-LK 5845
Organisation	Flugbereitschaft Rhein-Main
Einsatzgebiet	Südhessen
Besatzungsstärke	7
Status	IDLE

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

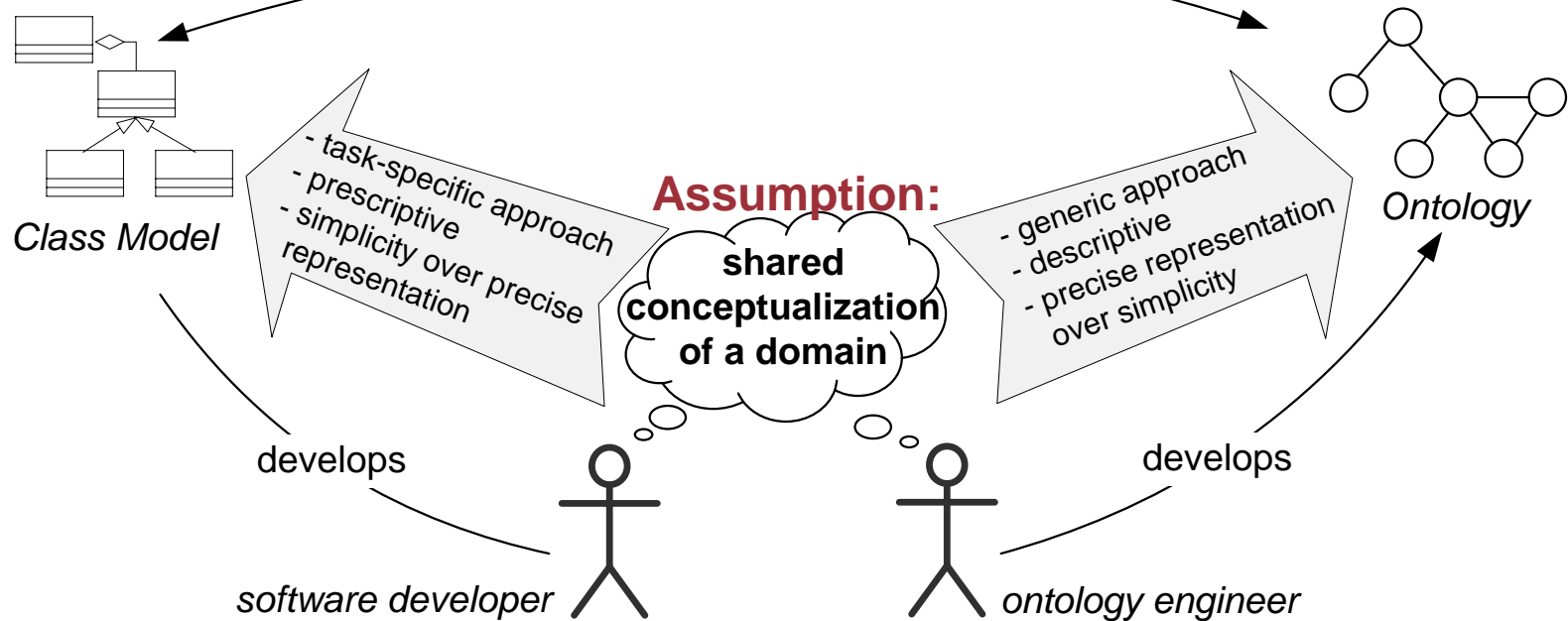
- Finding the right modeling granularity.
- Domain experts were not used to concepts needed to create a formally correct ontology (DOLCE)
- End users were irritated by modeled domain terminology that was not part of their colloquial language.
- Finding the right visualization depth.

Lessons Learned: Data Models and Ontologies Serve Different Purposes → 1:1 Mappings are not Helpful

Complete 1 : 1 Mappings are unlikely due to different goals

Goal: efficient programming

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



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 hampering the other.



Thank You!

Contact information:

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