Semantic Translation of Sensor Data

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Outline

- Objectives of the meanInGs Project
- Motivation
- Approach
  - Workflow
  - Semantic Search
  - Semantic Translation
- Conclusion

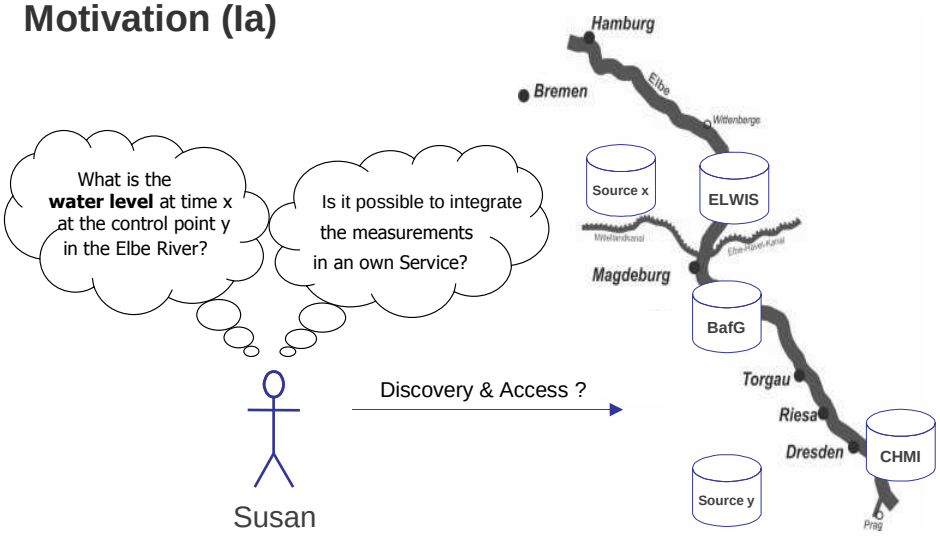
The meanInGs Project

GEOTECHNOLOGIEN

Semantic Interoperability by Means of Geoservices

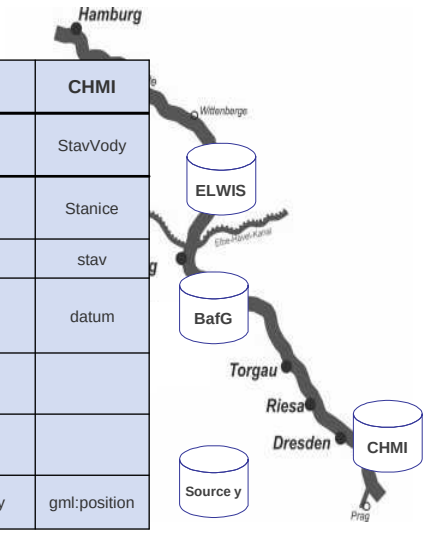
- Partner:
  - Delphi InformationsMusterManagement (DIMM), Potsdam
  - Institut für Geoinformatik (Ifgi), Münster
  - Center for Computing Technologies (TZI), Bremen
- Part of the GEOTECHNOLOGIEN program by BMBF and DFG
- Duration: 10/02 - 09/05

Motivation (Ia)



Motivation (Ib)

	ELWIS	BafG	CHMI
FeatureType	WasserstandMessung	PegelMessung	StavVody
Name of the control point	pegel	name	Stanice
Water level	hoehe	wasserstand_m	stav
Date & time of the measurement		zeitpunkt	datum
Date of the measurement	datum		
Time of the measurement	uhrzeit		
Point geometry	standort	gml:pointGeometry	gml:position



Motivation (II)

- Open and distributed environments of Spatial Data Infrastructures (SDIs)
- Dynamic sensor data
- Syntactic and semantic heterogeneity of data

- **Problems (due to semantic heterogeneity):**
  1. Finding and accessing suitable information sources
  2. Integration of appropriate information sources

Approach

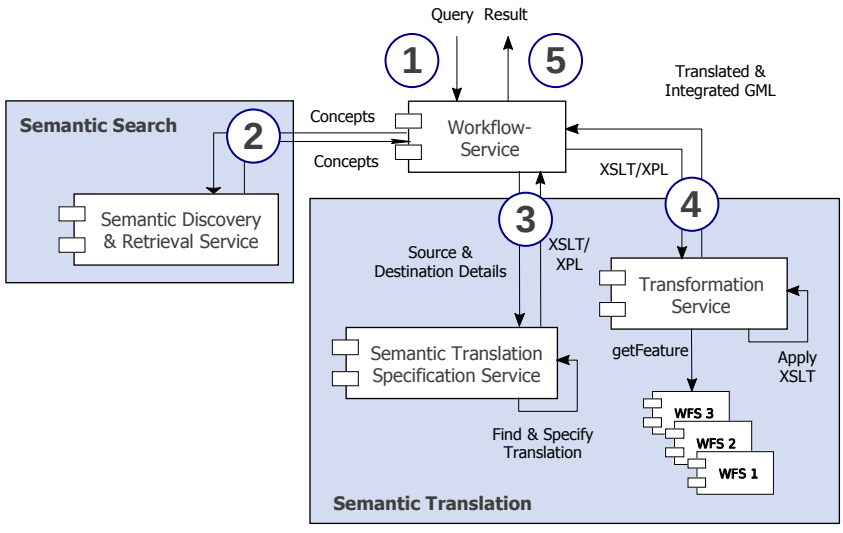
Semantic Search (Discovery & Retrieval)

- Define a semantic query based on ontologies in order to find appropriate information sources

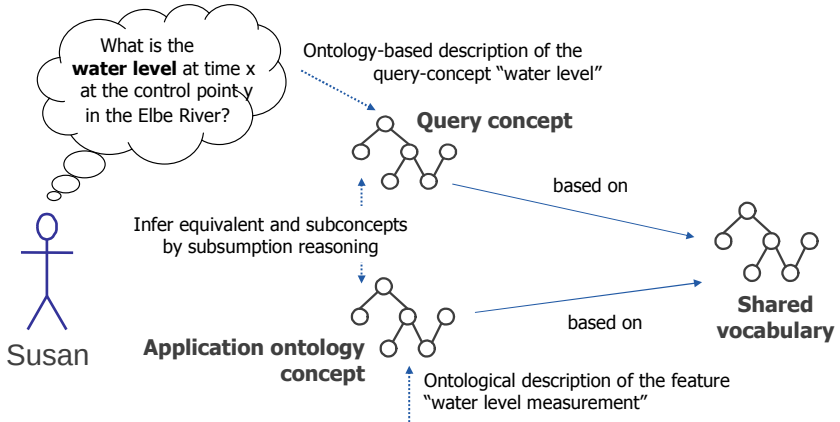
Semantic Translation

1. Identify semantic correlations within relevant information sources
2. Identify and define suitable transformations to enable data integration
3. Identify a plan to integrate the different information sources
4. Execute the transformation to receive a requested result

Workflow



Semantic Search (Discovery & Retrieval)



id	control point	source	height	date	time
1	Deggendorf	http://www.elwis.de/...	201	22.06.2005	05:00
2	Oberndorf	http://www.elwis.de/...	158	22.06.2005	05:00

Semantic Translation (I)

The problem is **not** to process the translation,
because for example from a technical point of view in this domain
the translation is a transformation of GML via XSLT

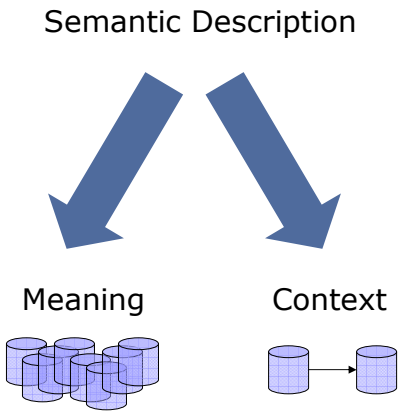
Challenge:

…to ***discover*** and ***specify*** the translation!

Semantic Translation (II) – Integration Formalism

- Using a high modularity ***rule-based integration formalism*** with two kinds of transformation rules
  1. *Query decomposition rules*
  2. *Context transformation rules*
- Basis for identifying sequences of integration steps using logical inference
- The inference result is encoded in XSLT/XPL in order to be able to integrate the GML sources

Semantic Translation (III) – Concept of Semantics



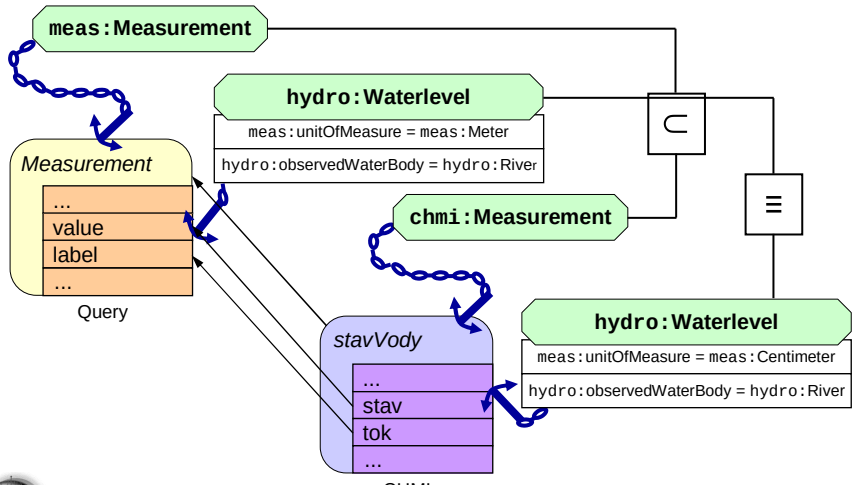
- **Semantic Description** = *Meaning + Context*
- **Meaning**
  - Defined across all information sources
  - Used to identify semantic correlations
- **Context**
  - Contains knowledge to represent the specific characteristics of an information

Semantic Translation (IV) – Query Decomposition

Query decomposition rules:

- Contain the information how queries can be transformed into equivalent queries against related feature types
- Define rules between semantically similar schemes
- Resolve structural conflicts

Semantic Translation (V) – Query Decomposition *Example*

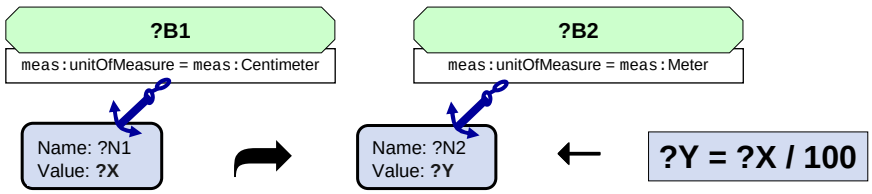


Semantic Translation (VI) – Context Transformation

Context transformation rules:

- Contain the operation to overcome conflicts between different contexts of semantically similar information and
- Resolve sematical conflicts

Example: Transformation of a unit of a measurement



Conclusion

- ***Semantic Search Service*** identifies appropriate information sources
- ***Semantic Translation Specification Service (STSS)*** discovers and specifies the translation
  - Divide the semantics of a feature type into *meaning* and *context*
  - Generation of transformation rules
  - Specify a plan to integrate the information sources based on logical inference
  - Encoding the specification into XSLT Style Sheets and XPL
- ***Transformation Service (TS)*** to execute the transformation
- Approach of semantic data integration could be adapted to different domains

A Sample CHMI-Measurement

```
...
<chiMember>
      <StavVody>
         <stav>180</stav>
         <teplotaVody>1.9</teplotaVody>
         <datum>2004-11-24T12:00:00</datum>
         <tok>LABE</tok>
         <url>http://www.chmi.cz/hydro/SRCZ04.html</url>
         <stanice>USTI N.L.</stanice>
         <prutok>149.</prutok>
         <gml:position xmlns:gml="http://www.opengis.net/gml">
            <gml:Point srsName="http://www.opengis.net/gml/srs/epsg.xml#32632">
               <gml:coordinates>859015.7375721685,5624676.8195826</gml:coordinates>
            </gml:Point>
         </gml:position>
      </StavVody>
   </chiMember>
...
```