

# SPACE, TIME, KNOWLEDGE

## FROM SEMANTIC HETEROGENEITY TO SEMANTIC INTEROPERABILITY

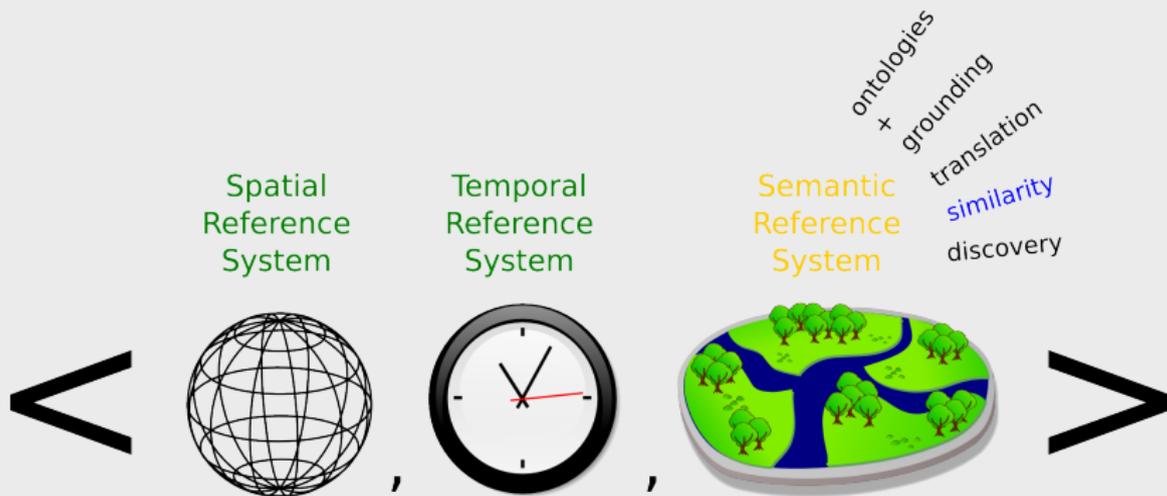
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USGS, Reston VA, USA

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# GEOINFORMATION – NOT JUST THREE COMPONENTS



# ONTOLOGY – RESTRICTING INTERPRETATIONS



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SOCIAL STRUCTURE MATTERS

# AN ONTOLOGY OF POTHOLES

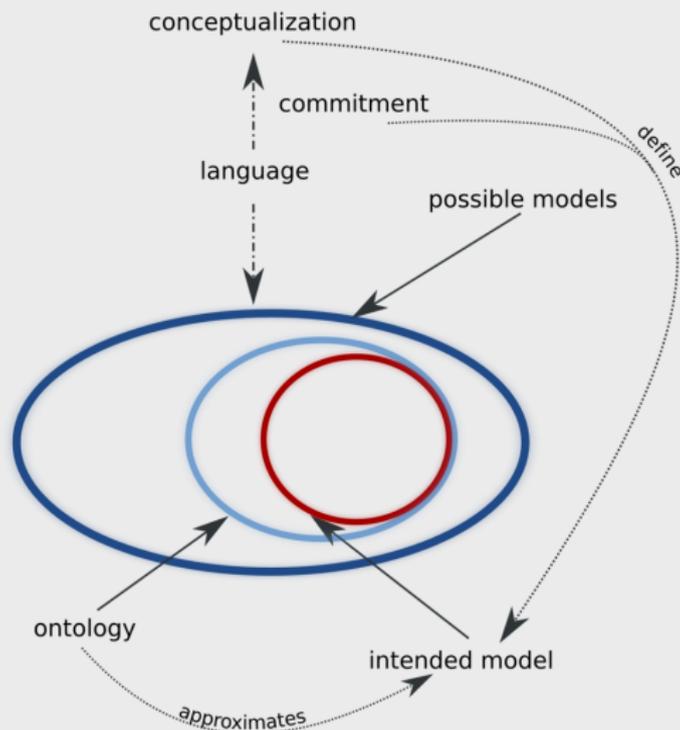
**Potholes** are defined as **cracks**

- of more than **30mm depth** [*North East Somerset, UK*]
- with a width of a **'large dinner plate'** (300mm) and the depth of a **'golf ball'** (40mm) [*Gloucestershire, UK*]
- with a width of a **'dinner plate'** (200mm) and a minimum depth of a **'fist'** (40mm) [*Worcestershire, UK*]
- if their depth is **'a pound coin and a 1p coin side by side'** [*Coventry*]

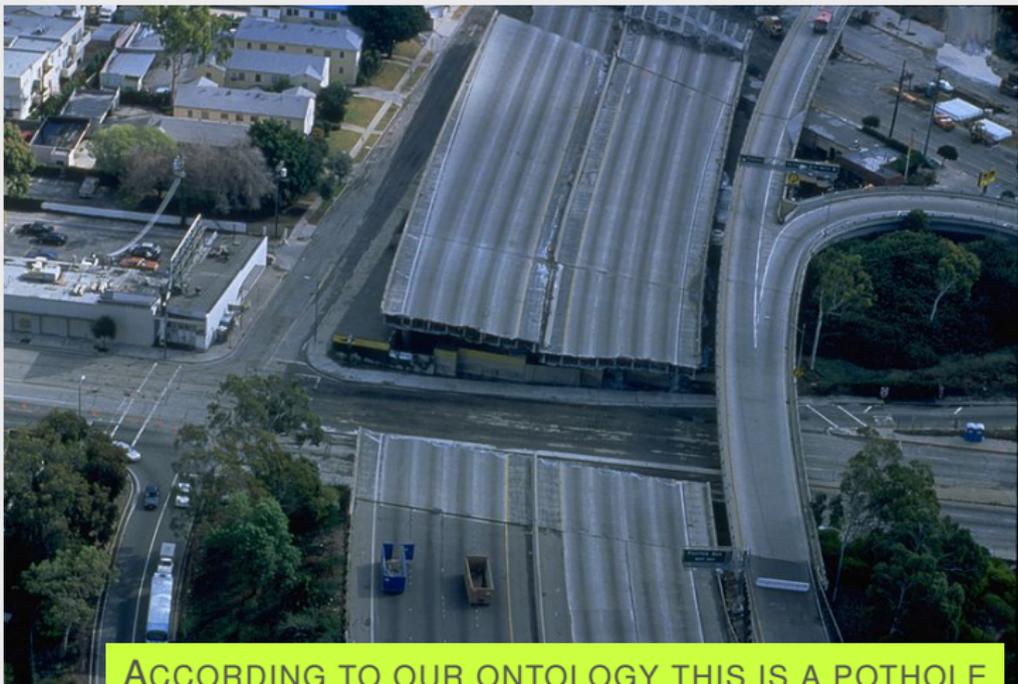


Due to a severe **winter** (T) millions of potholes need to be repaired by the **local councils** (S) that are **legally responsible** for the **roads maintenance** (A) within their administrative **boundaries** (S).

# ONTOLOGIES CANNOT FIX MEANING



# ONTOLOGY VERSUS INTENDED MODELS



# ONTOLOGY VERSUS INTENDED MODELS



REASONING: CONSTRUCTING BRIDGES CREATES POTHOLES

## SPACE, TIME, CULTURE - HETEROGENEITY IS NOT A BURDEN

## Estuaries



Netherlands



Norway

## Forests



## Rivers

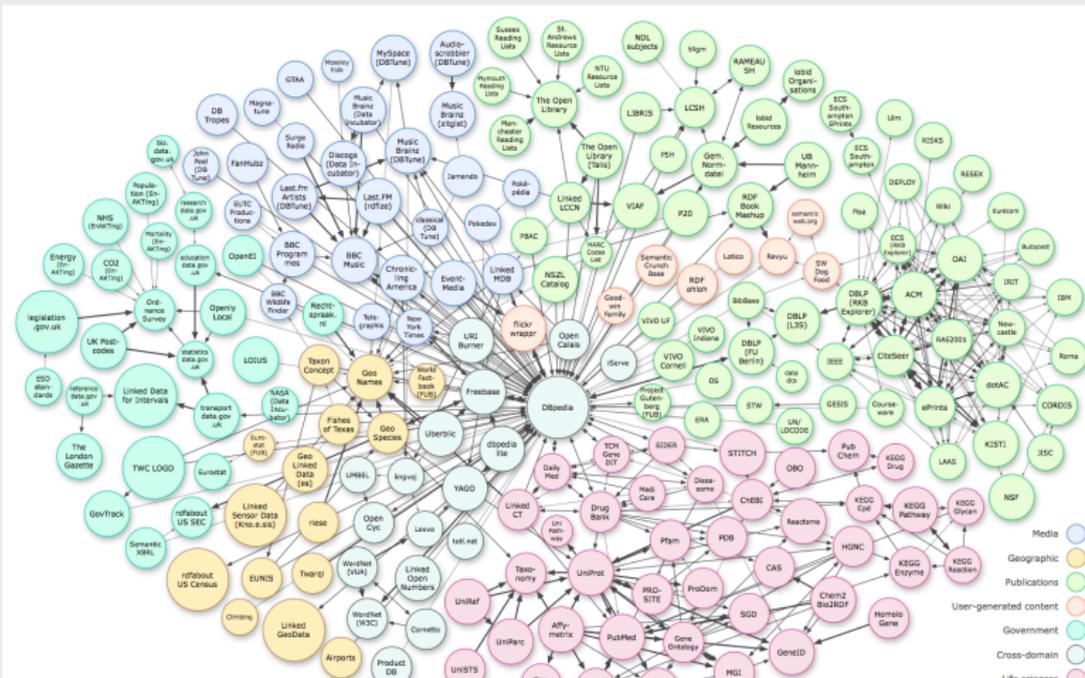


Germany



Spain

# LINKED DATA – REUSING DATA BY REMOVING THE CONTEXT?



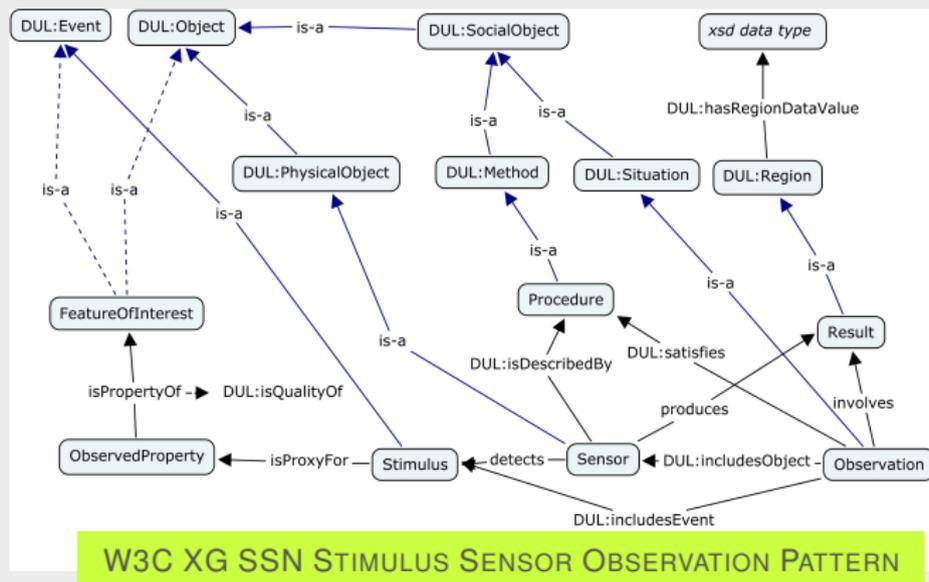
**LOCAL DEFINITIONS VS SAMEAs AND EQUIVALENTCLASS**

## FROM HETEROGENEITY TO INTEROPERABILITY

There are **no** features or **types** in a Platonic sense; conceptualization is an act of **cognition** and depends on space, time, cultural, etc.

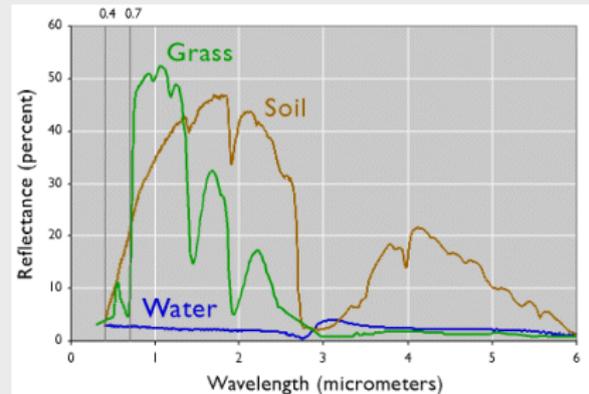
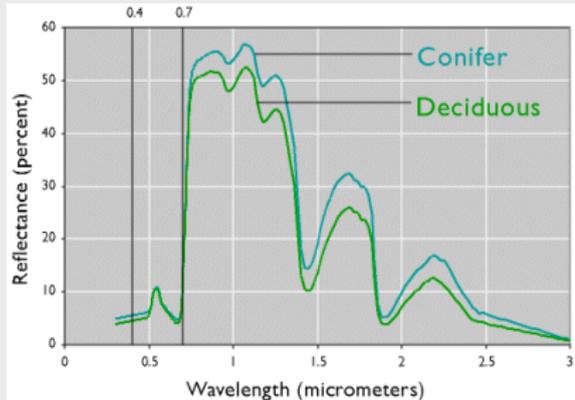
- 1 Assist communities and users in becoming active **knowledge engineers** (*my Web3.0 vision; compare to Amit's*)  
⇒ Ontology Design **Patterns** and Semantic **Signatures**
- 2 Structure **local ontologies** using space, time, and attributes  
⇒ **Microtheories/Contexts** and relations between them
- 3 Maintain **semantic interoperability**: Retrieve, reuse, combine  
⇒ Reasoning with/about **similarity, defaults, inconsistencies**

# 1. DESIGN PATTERNS - GROUNDING IN OBSERVATIONS



Common ground: Observable **depression** (O) in a **supporting surface** (IS) that impacts the motion of a **vessel** (A) along a **path** (IS) [*meaningful URI HowTo*].

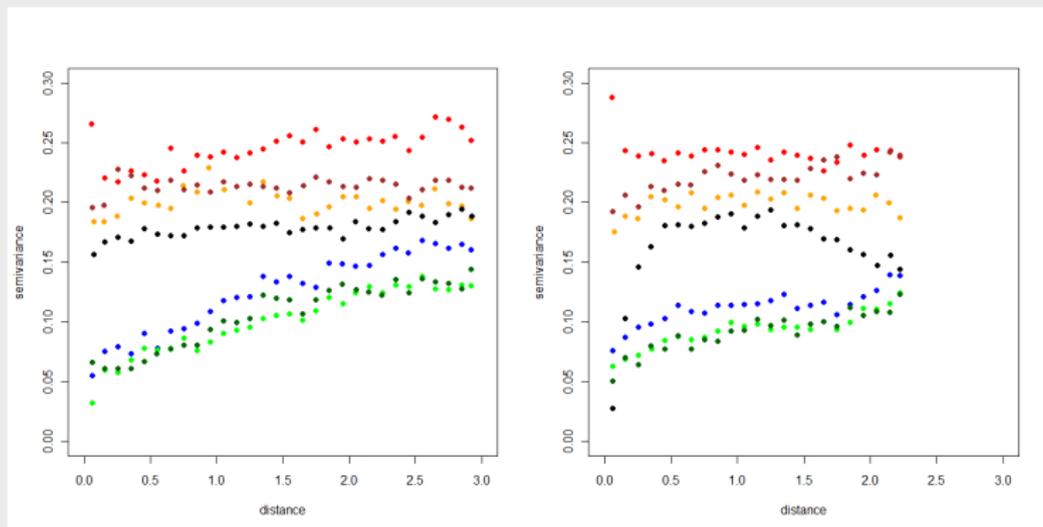
# (1) INTRODUCING SEMANTIC SIGNATURES



Figures by ASTER Spectral Library at <http://speclib.jpl.nasa.gov>

- Combine **numerical** (statistical) **models** and data with ontologies by **local** (personal) **reifications** → Think of **SWRL** built-ins
- **Analogy** to **Spectral Signatures** used in Remote Sensing
- Multiple **bands** → multiple **Semantic Signatures**

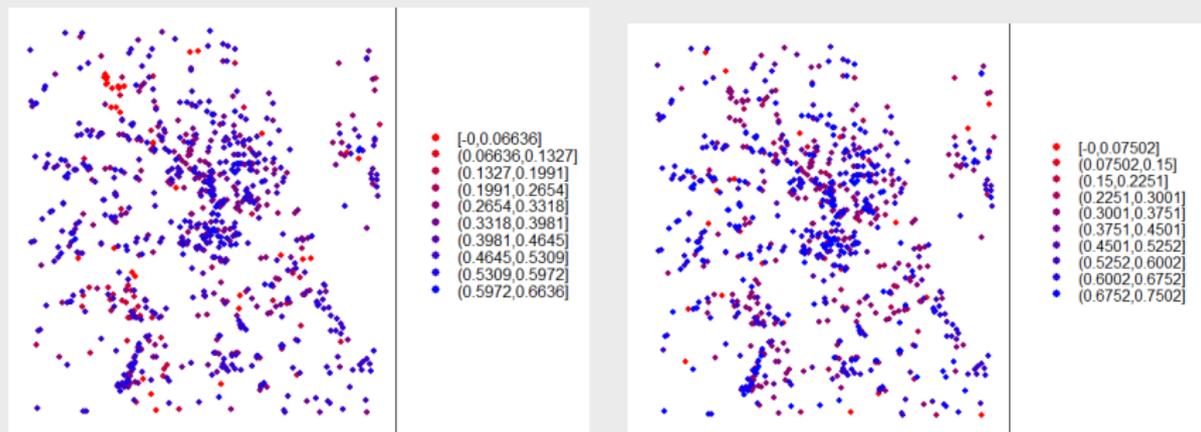
# (1) SEMANTIC SIGNATURES BY EXAMPLE



Figures by Christoph Mülligann

- **OSM** data from Münster(left) and Bonn, Germany
- **Call Booth**
- **School**

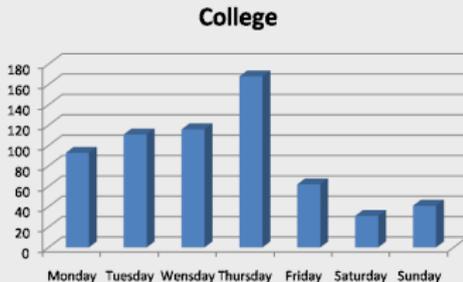
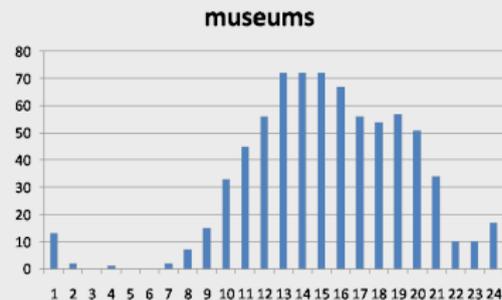
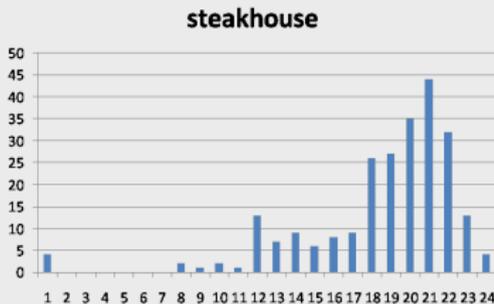
# (1) SEMANTIC SIGNATURES BY EXAMPLE



Figures by Christoph Mülligann

- POIs plotted by **similarity** to school **School(left)** versus **Call Booth** in Bonn, Germany
- **Reifications**: e.g., **Uniform** and **Clumped** (local signatures!)

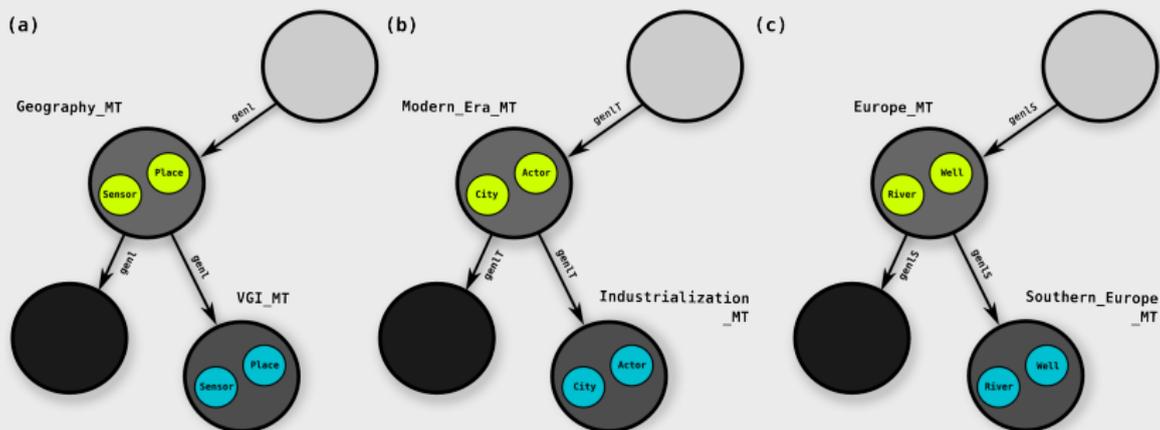
# (1) SEMANTIC SIGNATURES BY EXAMPLE



Figures by Mao Ye

- Locations types and **log-in** patterns from Whrrl, New York, USA
- **Reifications**: e.g., **Weekend** and **Evening** (local signatures!)

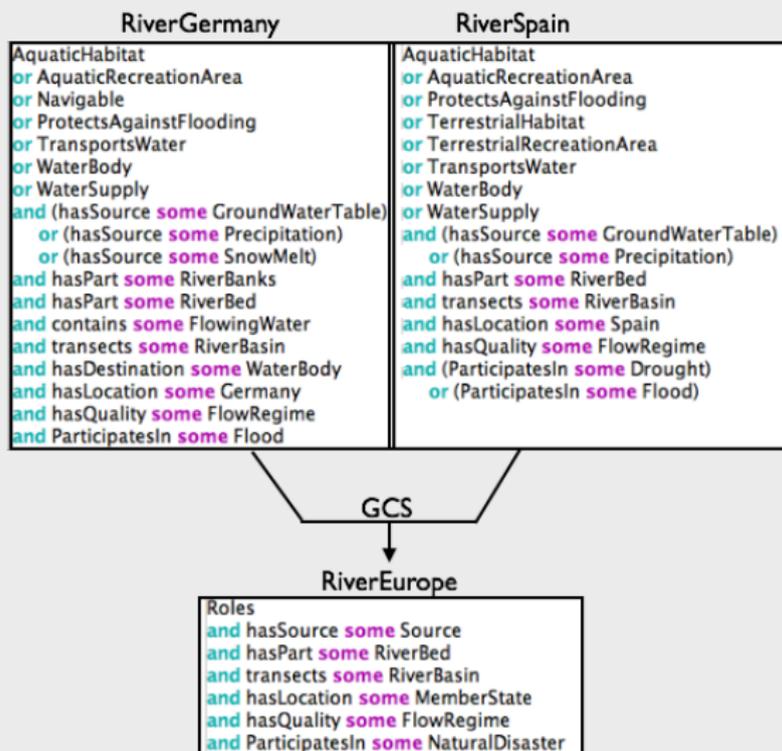
## (2) MICROTHEORIES - HANDLING SEMANTIC HETEROGENEITY



- **Structure** feature type **definitions** based on **space and time** (e.g., River by administrative containment)
- INSPIRE **Watercourse**: 'A natural or man-made **flowing water** course or stream.'

\*INSPIRE: Infrastructure for Spatial Information in the European Community

## (2) MICROTHEORIES - HANDLING SEMANTIC HETEROGENEITY



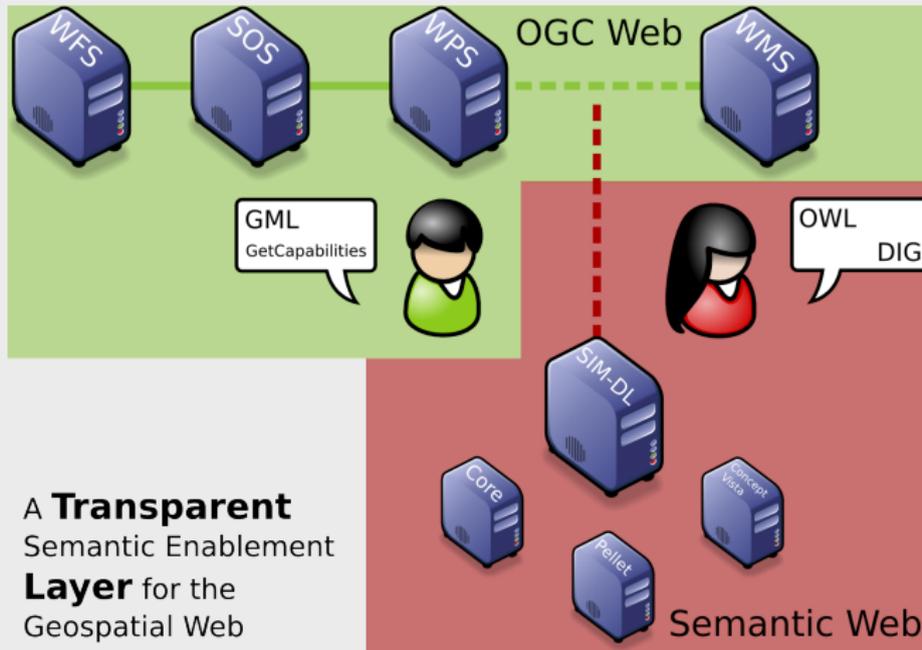
## (2) MICROTHEORIES - HANDLING SEMANTIC HETEROGENEITY

The screenshot displays the 'RiversReasoning.owl' ontology in a web browser. The left pane shows the 'Inferred class hierarchy' for 'GermanRiver', which includes subclasses like 'EuropeanRiver' and 'INSPIREWatercourse'. The right pane shows the 'Description' for 'GermanRiver', listing its properties and restrictions, such as 'hasSource some GroundWaterTable' and 'hasLocation some Germany'.

- INSPIRE definition is **too restrictive**
- **LCS** & Similarity works for a limited amount of different types
- Add reasoning with **Defaults** and inconsistencies in the future



# INTEGRATION WITH SPATIAL DATA INFRASTRUCTURES



- **WRS**: Encapsulate Semantic Web reasoners by OGC Web Processing Services (WPS); *first release available at 52N.*

# CONCLUSIONS?



The paper to the talk:

Janowicz, K. (2010): The Role of Space and Time For Knowledge Organization on the Semantic Web. Semantic Web - Interoperability, Usability, Applicability, IOS Press, 1/1-2, pp 25-32.

*[I am very thankful to the contributors of Wikimedia Commons where the pothole pictures were taken from. The LOD diagram is designed by Richard Cyganiak. The collage of rivers, forests, and estuaries has been composed by my former student Stephanie Duce.]*