Geospatial Decision Making in the Semantic Web

Patrick Maué (IFGI)
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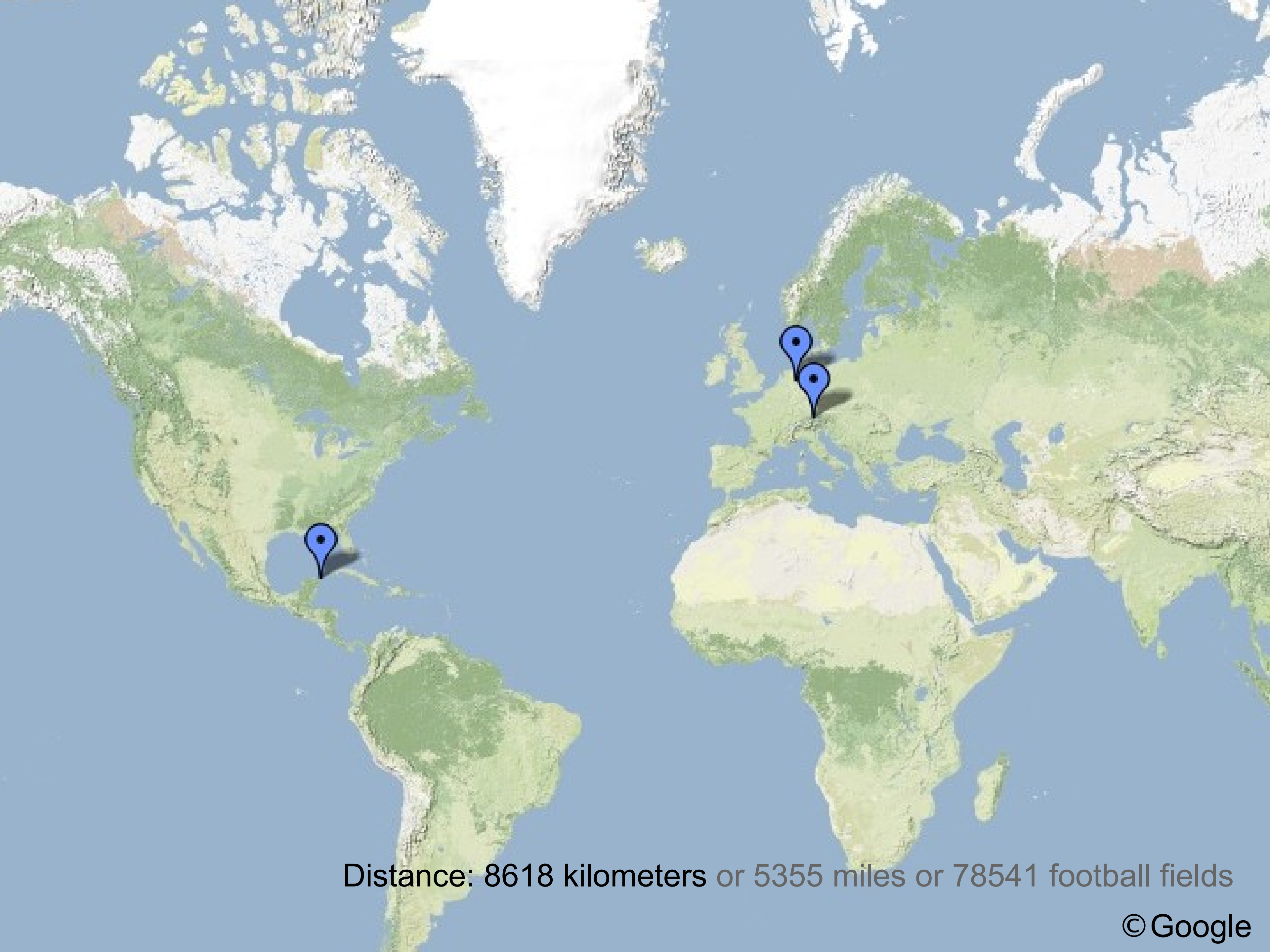
GEOWS 2009
February 1st, 2009 - Cancun, Mexico


Distance: 8618 kilometers or 5355 miles or 78541 football fields
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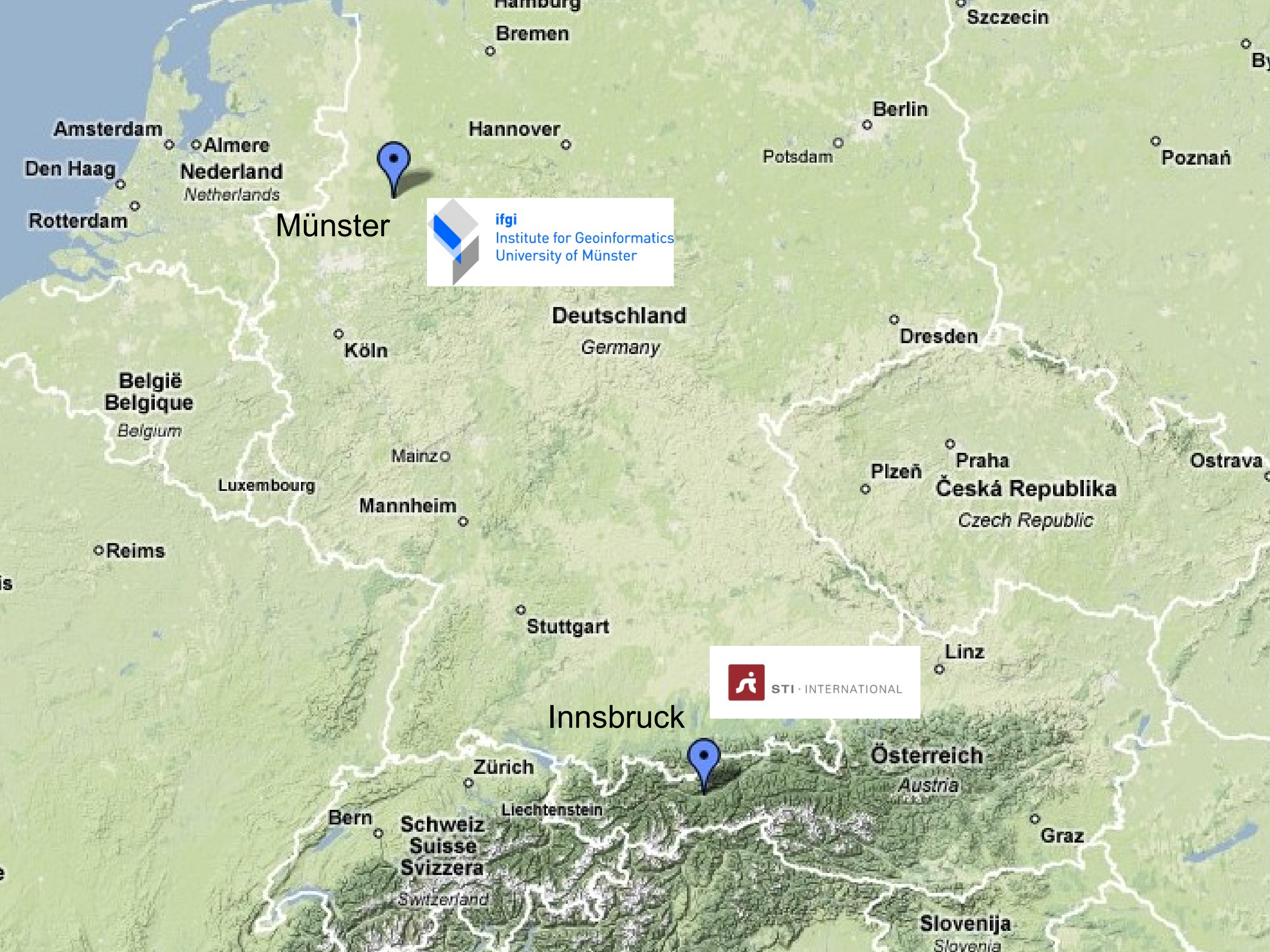
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We are: STI International

- Semantic Technologies Institute International
- Research in:
  - Knowledge representation
  - Semantic Web
  - Service-Oriented Computing

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We are: IFGI

- Institute for Geoinformatics at University of Münster, Germany
- Research in
  - Semantic Interoperability
  - Spatial Assistance Systems
  - Sensor Web and Geoprocessing
  - Environmental Measurement and Spatio-temporal Modeling

ifgi
Institute for Geoinformatics
University of Münster

Background: the SWING project

Semantic Web Services Interoperability for Geospatial Decision Making

Background: the SWING project

- Presented results mostly outcome of this project
- 3 Years until 02.2009
- Seven Partners, including users (BRGM), companies (ERDAS) and research (DERI, JSI, SINTEF)
- BRGM Use Cases further discussed later
- http://www.swing-project.org (with all deliverables and publications)

And who are you?

Tutorial Objective

- Demonstrating the SWING framework
- Geospatial Semantic Web
  - Discussing Potential Applications
  - Showing potential benefits
- Raise your interest

Overview

- **Spatial Data Infrastructures**
- Semantic Web Services
- Bridging the gap: Semantic Annotations
- SWING: use cases

- SWING: Developed Tools
- Demonstration (Videos)
- Hands-On Session


Spatial Data Infrastructures

Patrick Maué (IFGI)

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Overview

- Introducing Spatial Data Infrastructures
- The European INSPIRE Directive
- SDI Standards
- Examples of standard Web Services
- SDI Applications: Geospatial Decision-Making
- Web Service Compositions for Complex Tasks
- Contemporary Problems of SDIs

What is SDI?

- Transition from desktop GIS to distributed services
- Why we need SDI?
  - Keeping data up-to-date
  - Discovery and Evaluation (cross-country)
  - Resource-intensive
  - Billing and Security

What is SDI?

- Transition from desktop GIS to distributed services
- Why we need SDI?
  - Keeping data up-to-date
  - Discovery and Evaluation (cross-country)
  - Resource-intensive
  - Billing and Security
- SDI rebuild all functionality of GIS
- SDI framework provides basis for
  - Finding and Accessing spatial data
  - Describing and Evaluating spatial data
- Applications built on top of SDIs

INSPIRE in Europe

- Different data formats and quality standards across national borders
- Some Principles (Excerpt)
  - It must be possible to combine spatial data from different sources across the EU seamlessly and share them between several users and applications.
  - It should be easy to discover available spatial data, evaluate their fitness for purpose and know the conditions applicable to their use.
- Harmonisation (Standards!) required

Standards in SDIs

- Open Geospatial Consortium (OGC)
- Currently 372 Members (Companies, Universities, ...)
- Provides open standards
- Implementation guidelines for all SDI components
  - Geospatial Web Services
  - Geospatial Data
- OGC conformal Web Services can interoperate, regardless the intended applications and the served data.

OGC Standards: OWS Common

- OGC Conformal Web Service specifies
  - Access over HTTP (with KVP-encoding)
  - Minimum set of metadata
  - The getCapabilities operation
  - Exceptions handling
  - ...
- Normative reference for all OGC standards

OGC Standards: WFS

- Web Feature Service Interface
  - Specifies interface to retrieve Geographic Features
  - Data coming, for example, as Points, Lines, and Polygons
  - Features have Geometries and additional attributes
  - Data model specified in Feature Type Schema

WFS output example

- Feature Type Zico_region

```
<element name="Zico_region"
         type="con:Zico_regionType"
         substitutionGroup="gml:_Feature" />
<complexType name="Zico_regionType">
  <complexContent>
    <extension base="gml:AbstractFeatureType">
      <sequence>
        <element name="msGeometry" type="gml:GeometryPropertyType"/>
        <element name="REGIONAL" type="string"/>
        <element name="NATIONAL" type="string"/>
        <element name="LIBELLE" type="string"/>
        <element name="TYPE" type="string"/>
        <element name="LA_MESURE" type="string"/>
      </sequence>
    </extension>
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```

OGC Standards: WFS

- Web Feature Service Interface
  - Specifies interface to retrieve Geographic Features
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  - Features have Geometries and additional attributes
  - Data model specified in Feature Type Schema
  - Geographic Features with Geometry and arbitrary attributes
- WFS data encoded in OGC GML
  - XML-dialect used to encode feature-based geospatial data
  - Adapted ISO standard
- + WCS, WCTS, …
  - The storage layer of traditional GIS

OGC Standards: WPS and WMS

- Web Processing Service (WPS) Interface
  - Provides executable processes
  - No restrictions on input and output data
  - Takes role of GIS processing component

OGC Standards: WPS and WMS

- Web Processing Service (WPS) Interface
  - Provides executable processes
  - No restrictions on input and output data
  - Takes role of GIS processing component
- Web Mapping Service (WMS)
  - Visualisation of geospatial data
  - Render images in common formats
  - Can be directly integrated into websites

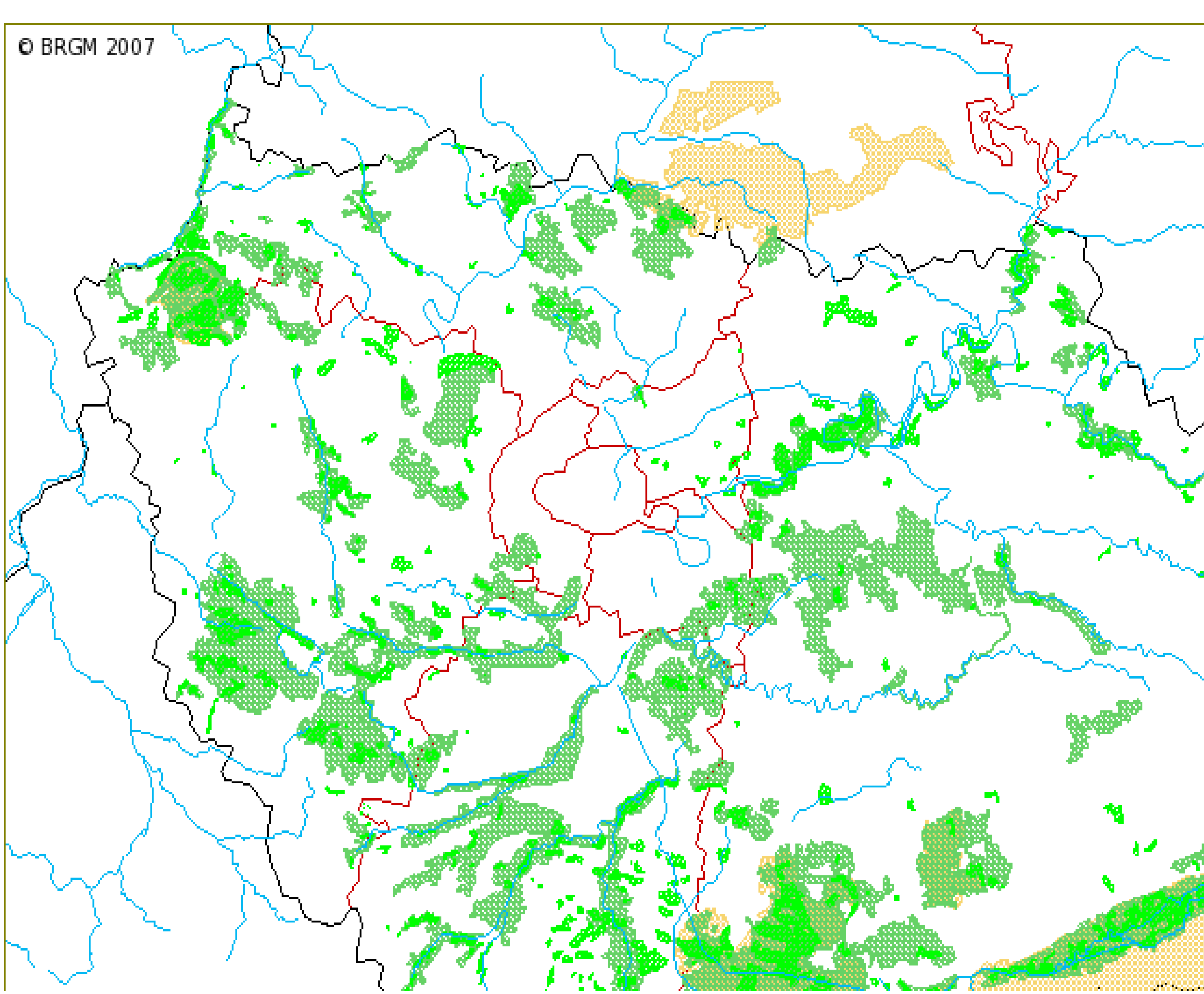
Examples

- Requesting a WFS from the Browser
- Requesting a WFS from generic GIS client

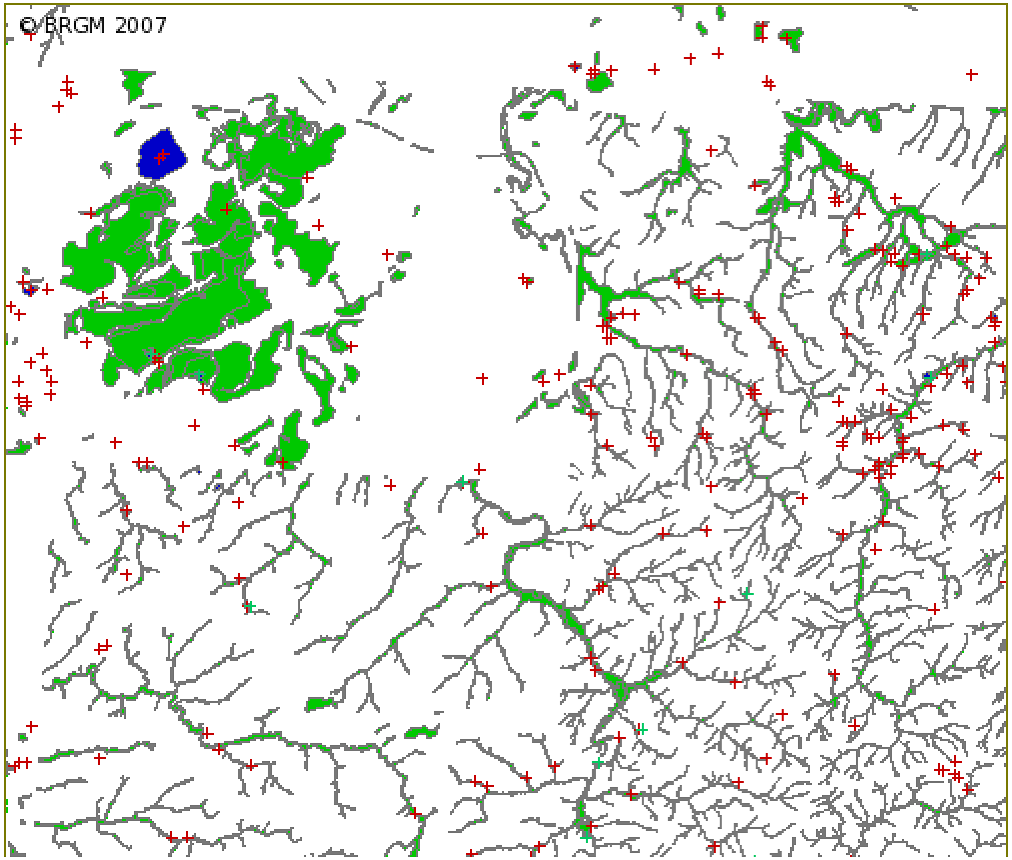
Geospatial Decision-Making

- Space as factor for decision making
- Examples: landfills, power plants, route planning
- Is a multi-criteria analysis looking at
  - Constraints (e.g. Important Bird Areas)
  - Requirements (e.g. water access)
- Requires
  - Acquisition of needed data
  - Preparation of data
  - Running the analysis
  - Rendering results for domain experts

Constraints



Requirements



Quarries With production

+ Exploitation with production

Quarries Without production

+ Exploitation

Quarries boundaries

Exploitation boundaries

Beds

Beds

Basins

Basins

Sites

Sites

Workflows

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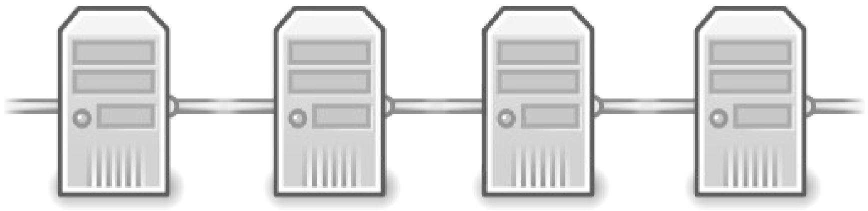
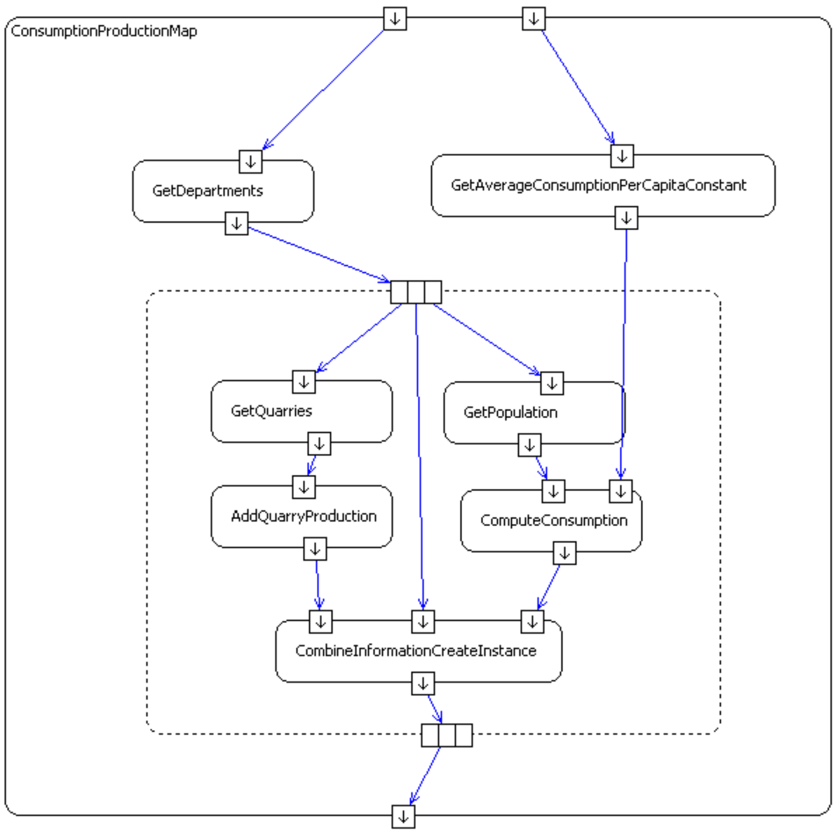
- Composing atomic Web Services
- Result itself a complex Web Service
- Workflow Engines
- Workflow Modeling Approaches
  - XML-based (BPEL, Wf-XML)
  - UML-based (Activity Diagrams)
  - ASM or Petri-Nets



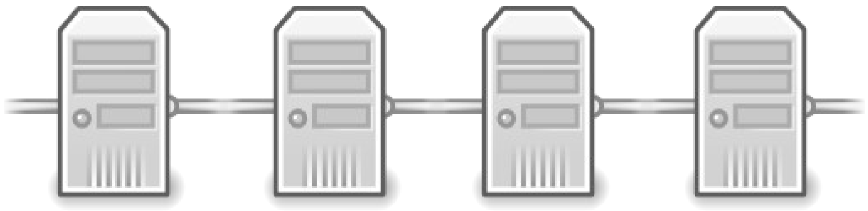
Workflow example




```
    in soa#AggregateRequest withGrounding _"http://set.sintef.no:8080/
(Aggregation/aggregate/aggregateRequest)"

      in wfs#Query
      in ogc#Intersects
      in swi#depproductionconsumption
      in gml#GeometryPropertyType

      out wfs#FeatureCollection
      //out sso#MultiplyResponse withGrounding _"http://localhost:8081
(Support/multiply/multiplyResponse)"
      out sso#MultiplyResponse withGrounding _"http://set.sintef.no:80
(Support/multiply/multiplyResponse)"
      out brgm#SocioEconomicConstantsResponse withGrounding _"http://s
wsdl#wsdl.interfaceMessageReference(SocioEconomicConstants/getValueByK
    out ins#INSEEgetPopulationByDepartmentResponse withGrounding _"htt
(INSEE/getPopulationFromRegion/getPopulationFromRegionResponse)"
    out soa#AggregateResponse

    controlled oasm#ControlState

    transitionRules _"http://www.example.org/TestCreateBoth_UoM#transi

    forall (?controlstate) with (
           ?controlstate[oasm#value hasValue oasm#InitialState] member

            forall (?constRequest,?coord) with (
                  ?constRequest memberOf brgm#SocioEconomicConstantsRe
                  ?coord memberOf gml#CoordinatesType)
            do
                  add(_#1[gml#coordinates hasValue ?coord, gml#srsName
                  add(_#2[ogc#propertyName hasValue "qua:msGeometry"] 
                  add(_#3[ogc#arguments hasValue _#1, ogc#refersTo has
                  add(_#4[ogc#encodes hasValue _#3] memberOf ogc#Filte
                  add(_#5[wfs#filter hasValue _#4,wfs#typeName hasValu
                  add(_#6[wfs#query hasValue _#5,wfs#service hasValue
virtual#GetDepartmentFeature)
            endForall

        delete(?controlstate[oasm#value hasValue oasm#InitialState])
            add(?controlstate[oasm#value hasValue oasm#DummyState])
      endForall
```

Workflows

- Composing atomic Web Services
- Result itself a complex Web Service
- Workflow Engines
- Workflow Standards
  - XML based (BPEL, Wf-XML)
  - ASM or Petri-Nets



Open Issues of SDIs

- Harmonization in between Standards
- Security and licensing
- Complexity & Performance
- **Semantic Interoperability**

Semantic Interoperability


```xml
<element name="Zico_region"
         type="con:Zico_regionType"
         substitutionGroup="gml:_Feature" />
<complexType name="Zico_regionType">
  <complexContent>
    <extension base="gml:AbstractFeatureType">
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- **Semantic Web Services**
- Bridging the gap: Semantic Annotations
- SWING: use cases

- SWING: Developed Tools
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- Hands-On Session

Semantic Web Services (SWS)

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Outline

- Tasks to be automated in SWS
- Ontologies and Web services: the WSMO approach
- WSML – the language for formalizing WSMO
- Web Service Discovery

Semantic Web and Web Services - SWS

Dynamic

Web Services
UDDI, WSDL, SOAP

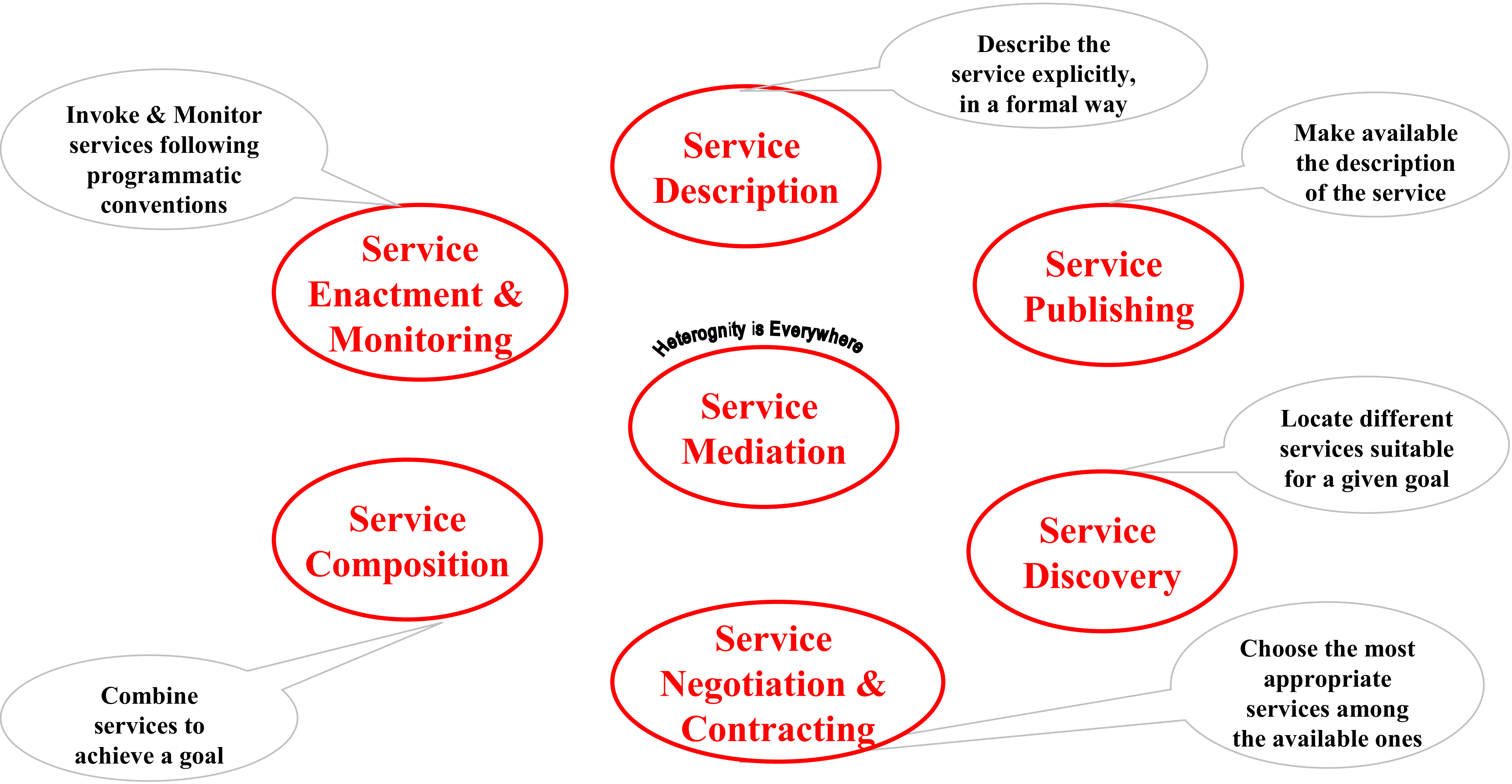
Semantic Web Services

Static

WWW
URI, HTML, HTTP

Semantic Web
RDF, RDF(S), OWL, etc.

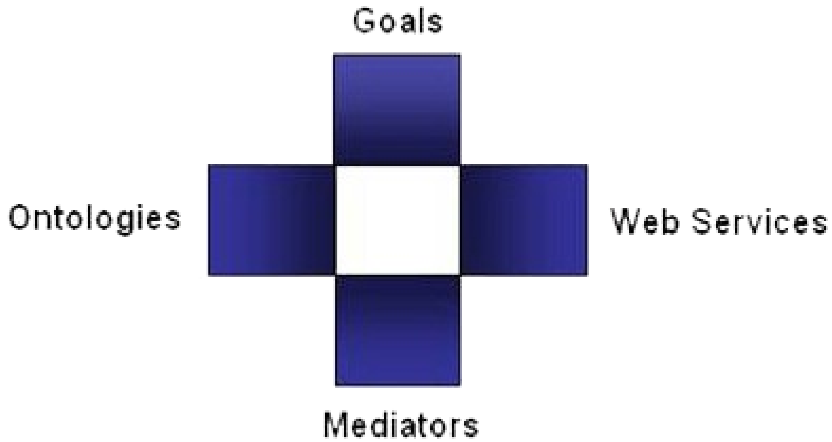
SWS – Tasks to be Automated



The WSMO Approach to SWS

Objectives that a client may
have when consulting a Web Service

Provide the formally specified terminology of the information used by all other components



Semantic description of Web Services:
- **Capability** (*functional*)
- **Interfaces** (*usage*)

Connectors between components with mediation facilities for handling heterogeneities

What is an ontology?

- Formal,
- explicit specification of
- a shared conceptualization of a domain.

- Meaning of ontology is unambiguous
- Avoids misunderstanding
- Specification using formal language
- Enables reasoning: making implicit information explicit
- Hampers consensus

- Make domain assumptions explicit
  - For reasoning
  - For clarifying understanding of domain
- Minimal ontological commitment
  - Too much explicit => no consensus
  - Too little explicit => ontology unusable
  - Minimal ontological commitment = "make as little as explicit as possible, while keeping ontology useful"

- Domain: specific part of the world
- Conceptualization
  - Forming idea of domain in the minds of people
- Shared among its users
  - Facilitates accepting the ontology

Elements of Ontologies

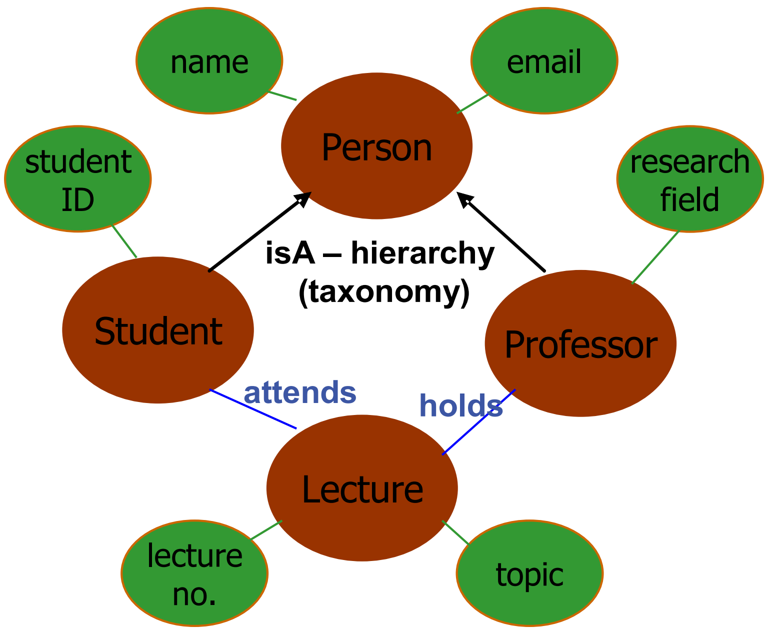
Concept
conceptual entity of the domain

Property
attribute describing a concept

Relation
relationship between concepts or properties

Axiom
coherency description between Concepts / Properties / Relations via logical expressions

Instance
individual in the domain

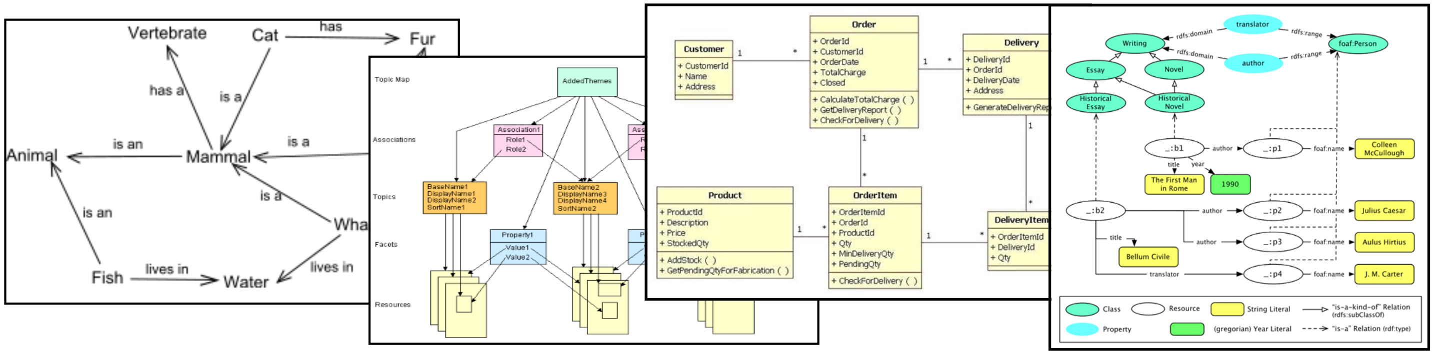


holds(Professor, Lecture) =>
Lecture.topic = Professor.researchField

Ann memberOf student
name = Ann Lee
studentID = 12345

Wide Variety of Languages for Specifying Ontologies

- **Graphical**: Semantic Networks, Topic Maps, UML, RDF



- **Logical**: Description Logics, First Order Logic, Rules, Conceptual Graphs

DL Syntax	Example
$C_1 \sqcap \ldots \sqcap C_n$	Human ⊓ Male
$C_1 \sqcup \ldots \sqcup C_n$	Doctor ⊔ Lawyer
$\neg C$	¬Male
$\{x_1\} \sqcup \ldots \sqcup \{x_n\}$	{john} ⊔ {mary}
$\forall P.C$	∀hasChild.Doctor
$\exists P.C$	∃hasChild.Lawyer
$\leqslant nP$	⩽1hasChild
$\geqslant nP$	⩾2hasChild

Brothers are siblings

$\forall x, y \;\; Brother(x,y) \;\Rightarrow\; Sibling(x,y).$

"Sibling" is symmetric

$\forall x, y \;\; Sibling(x,y) \;\Leftrightarrow\; Sibling(y,x).$

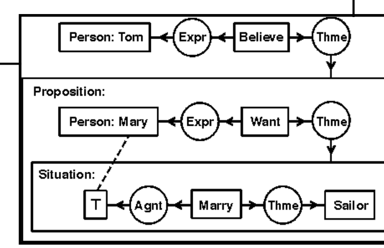
One's mother is one's female parent

$\forall x, y \;\; Mother(x,y) \;\Leftrightarrow\; (Female(x) \land Parent(x,y)).$

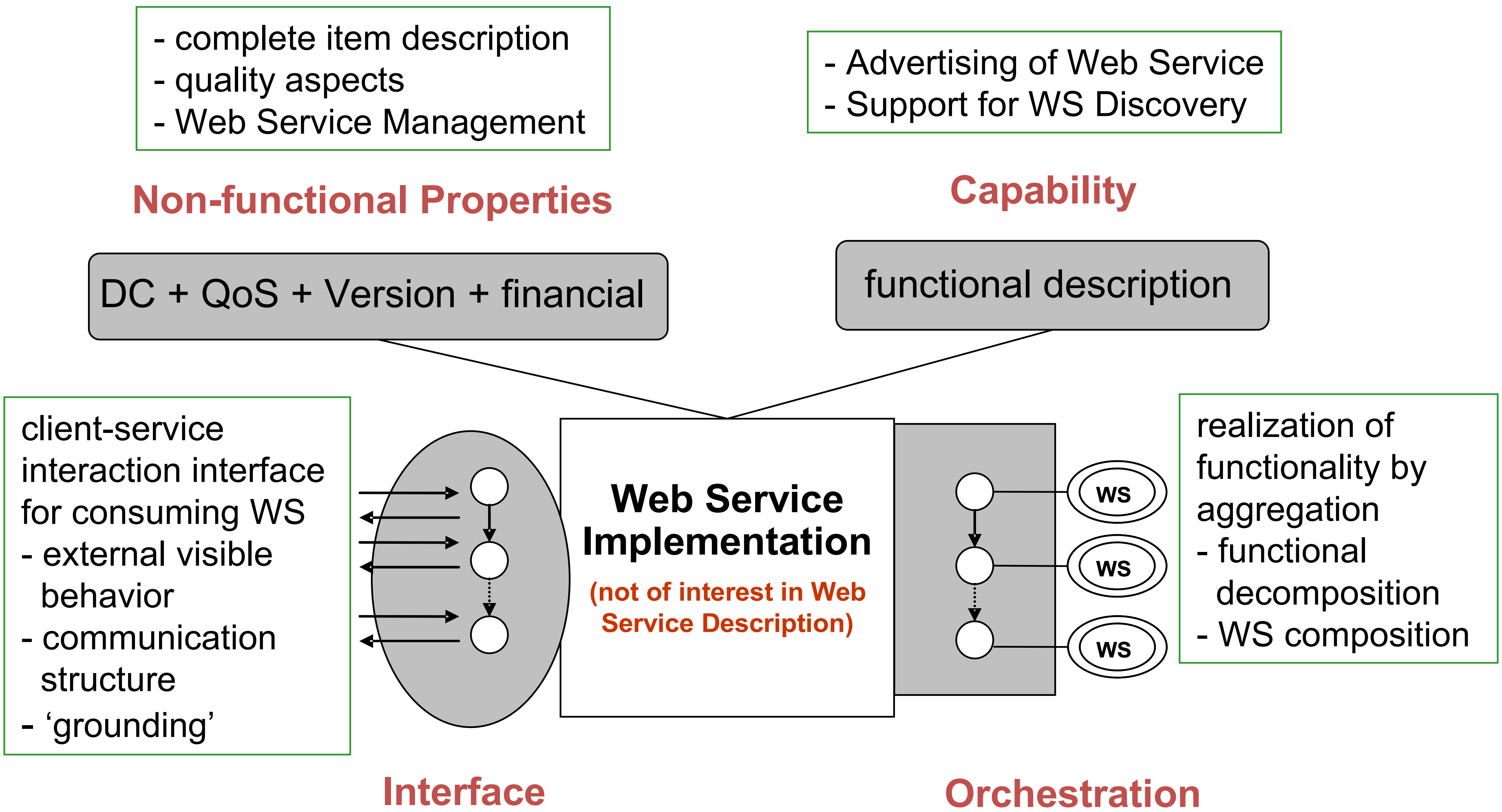
A first cousin is a child of a parent's sibling

$\forall x, y \;\; FirstCousin(x,y) \;\Leftrightarrow\; \exists p, ps \;\; Parent(p,x) \land Sibling(ps,p) \land Parent(ps,y)$

```
sibling(X, Y)      :- parent_child(Z, X), parent_child(Z, Y).
parent_child(X, Y) :- father_child(X, Y).
parent_child(X, Y) :- mother_child(X, Y).
mother_child(trude, sally).
father_child(tom, sally).
father_child(tom, erica).
father_child(mike, tom).
```



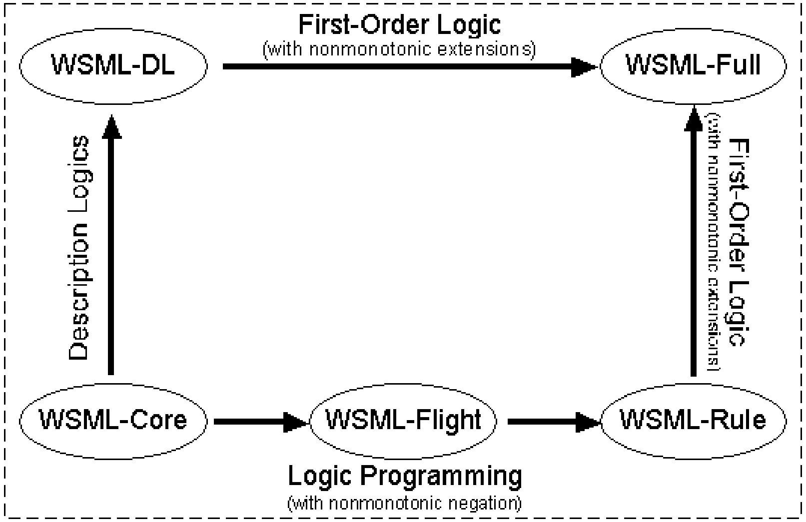
A Conceptual Model for Web Services



Web Service Modeling Language (WSML)

- Aim – to provide a language (or a set of interoperable languages) for representing the elements of WSMO: Ontologies, Web services, Goals, Mediators

- For ontologies, WSML provides a formal language based on:
  - *Description Logics*
  - *Logic Programming*
  - *First-Order Logic*
  - *F-Logic*



- WSML is a family of languages layered on top of XML and RDF

WSML in SWING

- Ontologies
  - GeographicDatatypes, GeospatialOperations, QuarriesOntology, MeasurementOntology, WFS, Annotation, etc.
- Web Services
  - Define functionalities of WFS and WPS Web Services
- Goals
  - Define WFS and WPS Goals
- Annotations
  - Encode annotations coming from the annotation tool

WSML in SWING - Example

GeographicDatatypes.wsml

```
wsmlVariant _"http://www.wsmo.org/wsml/wsml-syntax/wsml-flight"
namespace { _"http://swing-project.org#GeographicDatatypes"
 }

ontology GeographicDatatypes

concept GM_Object
hasSRS impliesType SRS

concept Polygon subConceptOf GM_Object

concept SRS

concept projSRS subConceptOf SRS

instance gk memberOf projSRS

axiom gm_objectDefinition definedBy
?x[hasSRS hasValue ?srs] implies ?x memberOf GM_Object.
```

UnionWPS.wsml

```
wsmlVariant _"http://www.wsmo.org/wsml/wsml-syntax/wsml-flight"
namespace { _"http://swing-project.org#UnionWPS",

        GeoTypes _"http://swing-project.org#GeographicDatatypes",
        GeoOp    _"http://swing-project.org#GeospatialOperations"
 }

webService UnionWPS

importsOntology {GeoOp#GeospatialOperations, GeoTypes#GeographicDatatypes}

capability UnionWPSCapability

sharedVariables { ?a, ?b, ?refsys }

precondition UnionWPSPrecondition definedBy
    ?a[GeoTypes#hasSRS hasValue ?refsys] memberOf GeoTypes#GM_Object and
    ?b[GeoTypes#hasSRS hasValue ?refsys] memberOf GeoTypes#GM_Object and
    ?refsys memberOf GeoTypes#projSRS.

postcondition UnionWPSPostcondition definedBy
    ?c memberOf GeoTypes#Polygon and
    ?c[GeoTypes#hasSRS hasValue ?refsys] and
    GeoOp#union(?a, ?b, ?c).
```

Goal2.wsml

```
wsmlVariant _"http://www.wsmo.org/wsml/wsml-syntax/wsml-flight"
namespace { _"http://swing-project.org#Goal2"
,
     GeoTypes _"http://swing-project.org#GeographicDatatypes",
     GeoOp _"http://swing-project.org#GeospatialOperations" }

goal Goal2

importsOntology {GeoOp#GeospatialOperations, GeoTypes#GeographicDatatypes}

capability Goal2Capability

sharedVariables { ?x, ?y }

precondition Goal2Precondition definedBy
    ?x[GeoTypes#hasSRS hasValue ?srs] memberOf GeoTypes#Polygon and
    ?y[GeoTypes#hasSRS hasValue ?srs] memberOf GeoTypes#Polygon and
    ?srs memberOf GeoTypes#projSRS.

postcondition Goal2Postcondition definedBy
    ?z memberOf ?outputType and
    GeoOp#overlay(?x, ?y, ?z).
```

WSML in SWING - Example

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webService UnionWPS

importsOntology {GeoOp#GeospatialOperations, GeoTypes#GeographicDatatypes}

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sharedVariables { ?a, ?b, ?refsys }

precondition UnionWPSPrecondition definedBy
    ?a[GeoTypes#hasSRS hasValue ?refsys] memberOf GeoTypes#GM_Object and
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    ?refsys memberOf GeoTypes#projSRS.

postcondition UnionWPSPostcondition definedBy
    ?c memberOf GeoTypes#Polygon and
    ?c[GeoTypes#hasSRS hasValue ?refsys] and
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WSML in SWING - Example

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wsmlVariant _"http://www.wsmo.org/wsml/wsml-syntax/wsml-flight"
namespace { _"http://swing-project.org#Goal2"
,
      GeoTypes _"http://swing-project.org#GeographicDatatypes",
      GeoOp _"http://swing-project.org#GeospatialOperations" }


goal Goal2

importsOntology {GeoOp#GeospatialOperations, GeoTypes#GeographicDatatypes}

capability Goal2Capability

sharedVariables { ?x, ?y }

precondition Goal2Precondition definedBy
     ?x[GeoTypes#hasSRS hasValue ?srs] memberOf GeoTypes#Polygon and
     ?y[GeoTypes#hasSRS hasValue ?srs] memberOf GeoTypes#Polygon and
     ?srs memberOf GeoTypes#projSRS.

postcondition Goal2Postcondition definedBy
     ?z memberOf ?outputType and
     GeoOp#overlay(?x, ?y, ?z).
```

Web Service Discovery

- Functionality
  - Identify possible web services W which are able to provide the requested service S for its clients
- An important issue …
  - „being able to provide a service“ has to be determined based on given descriptions only (WS, Goal, Ontos)
  - Discovery can *only be as good* as these descriptions
    - *Very detailed WS descriptions*: are precise, enable highly accurate results, are more difficult to provide; in general, requires interaction with the provider (outside the pure logics framework)
    - *Less detailed WS descriptions*: are easy to provide for humans, but usually less precise and provide less accurate results

Ease of provision

Possible Accuracy

WSML Discovery

Level of Abstraction

- Support a wide-variety of applications wrt. needed accuracy
- Basic possibilities for the description of web services:
  - Syntactic approaches
    - Keyword-based search, natural language processing techniques, Controlled vocabularies

→ WS as a set of keywords

  - Lightweight semantic approaches
    - Ontologies, What does W provide (not how)?, Coarse-grained semantic description of a service

→ WS as a set of objects

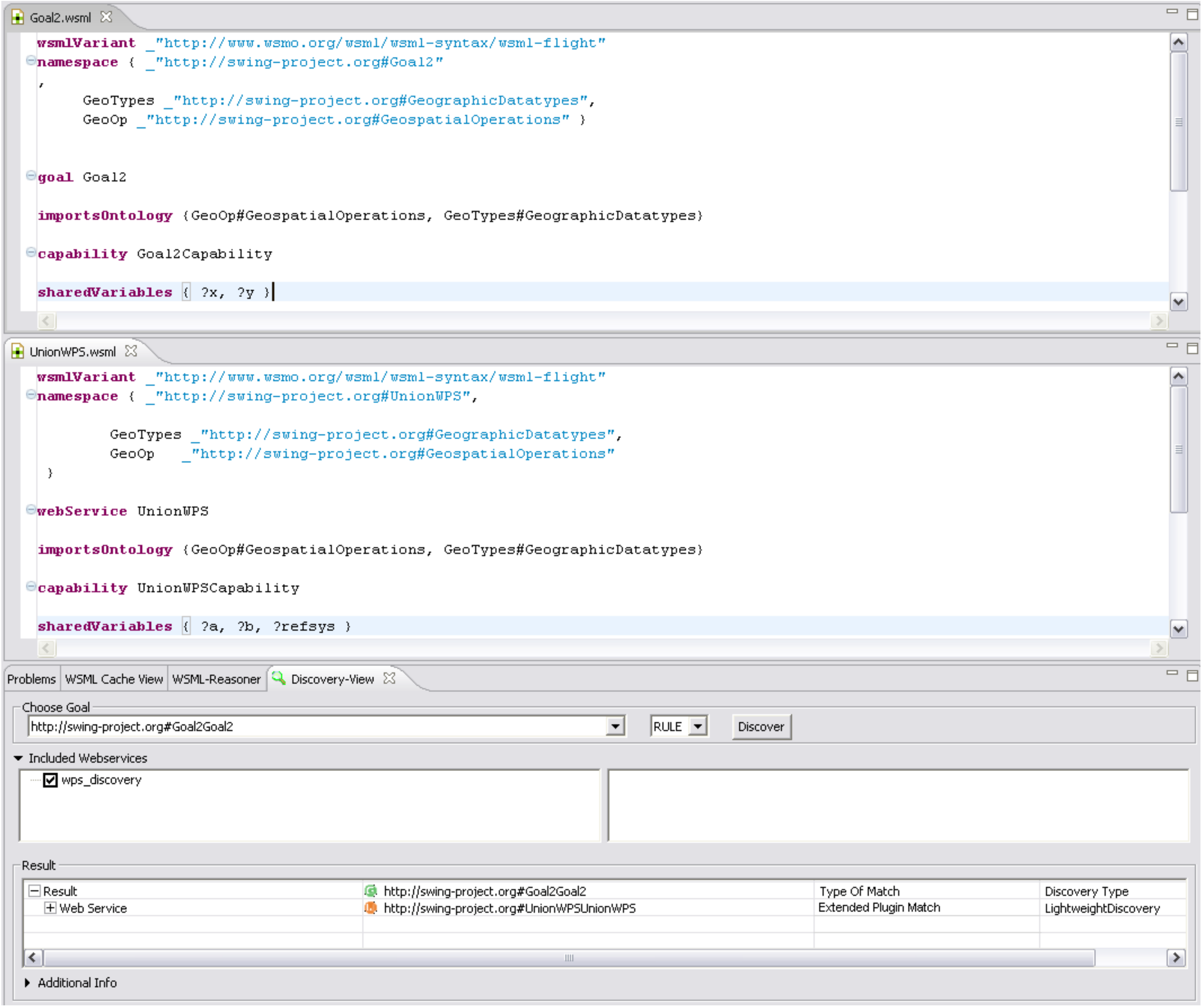
  - Heavyweight semantic approaches
    - Describes the service capability in detail, Pre/Post-Cond, takes „in-out" relationship into account, Fine-grained web service description

→ WS as a set of state-changes

WSML Discovery

- Responsible to find appropriate Web Services to achieve a goal
- Current discovery component is organized as a framework performing discovery in two steps:
  1. (optional) keyword-based matching
  2. discovery based on either simple or rich descriptions of services
     - Simple Descriptions → “lightweight” discovery
       - take into account postconditions and effects
       - WSML-DL: use concept subsumption; possible matches: exact, plugin, subsume, intersection
       - WSML-Flight / WSML-Rule: use query containment; possible matches: exact, plugin, subsume
     - Rich Descriptions → “heavyweight” discovery
       - take into account preconditions and assumptions, postconditions and effects, and the relation inbetween
       - WSML-Flight / WSML-Rule: use query containment; possible match: extended plug-in match

Discovery in SWING - Example



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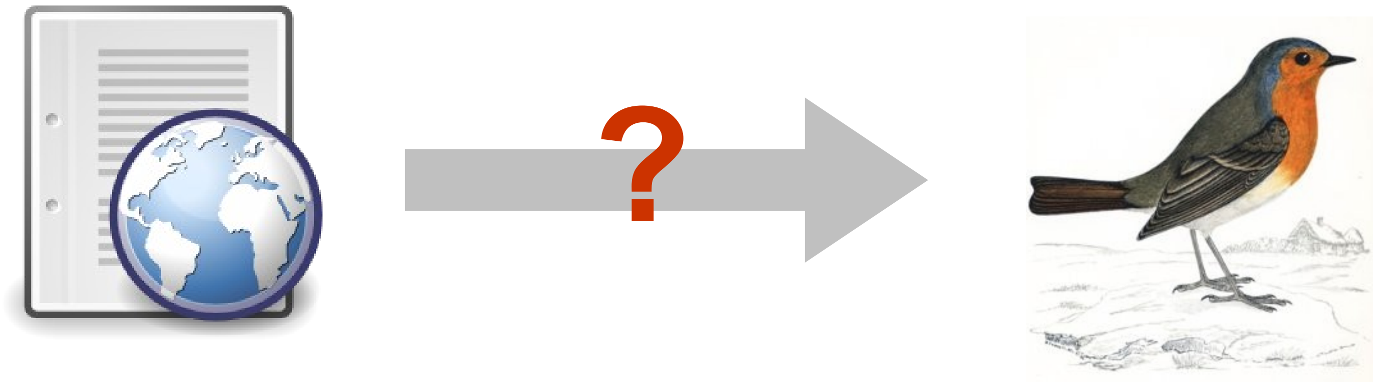

Semantic Annotations

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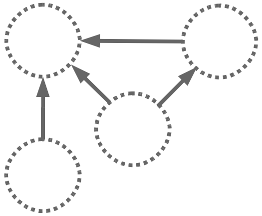
February 1st, 2009 - Cancun, Mexico

Looking Back

- Web Services in Spatial Data Infrastructures
  - Lack sophisticated thematic descriptions

- Semantic Web & Ontologies
  - Provide means to capture data semantics



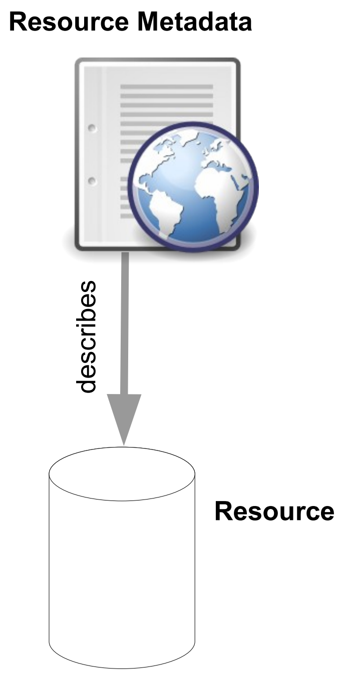
- Semantic annotations as approach to link the two worlds

Overview

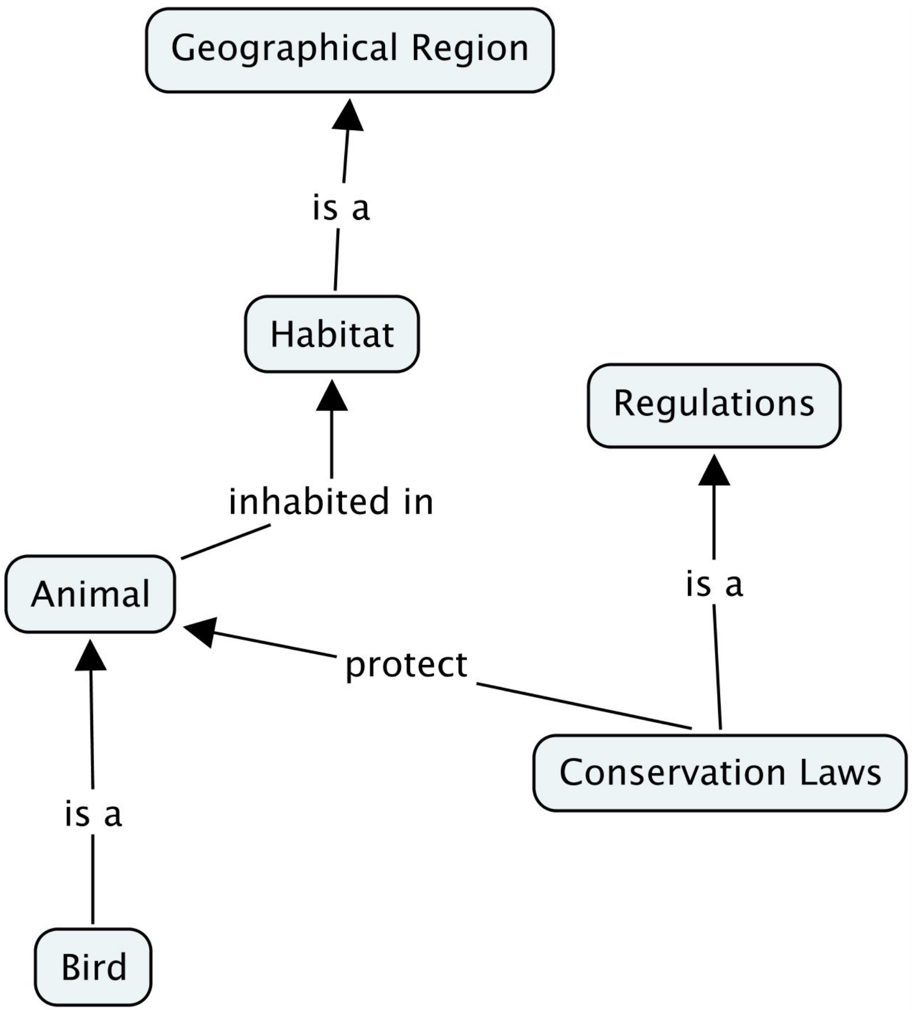
- Explaining semantic annotations
- Ways to establish the connection
- Making use of the link
  - Creating the semantic annotations
  - Querying based on semantic annotations
- Semantic Annotations in OGC Standards

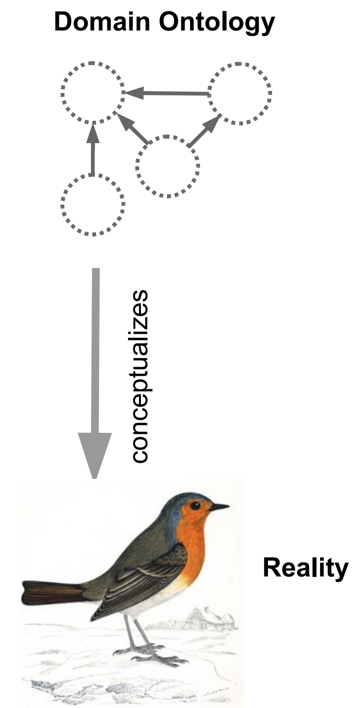
ZICO


```
<element name="Zico_region"
         type="con:Zico_regionType"
         substitutionGroup="gml:_Feature" />
<complexType name="Zico_regionType">
  <complexContent>
    <extension base="gml:AbstractFeatureType">
      <sequence>
        <element name="msGeometry" type="gml:GeometryPropertyType"/>
        <element name="REGIONAL" type="string"/>
        <element name="NATIONAL" type="string"/>
        <element name="LIBELLE" type="string"/>
        <element name="TYPE" type="string"/>
        <element name="LA_MESURE" type="string"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>
```



Example of corresponding Ontology

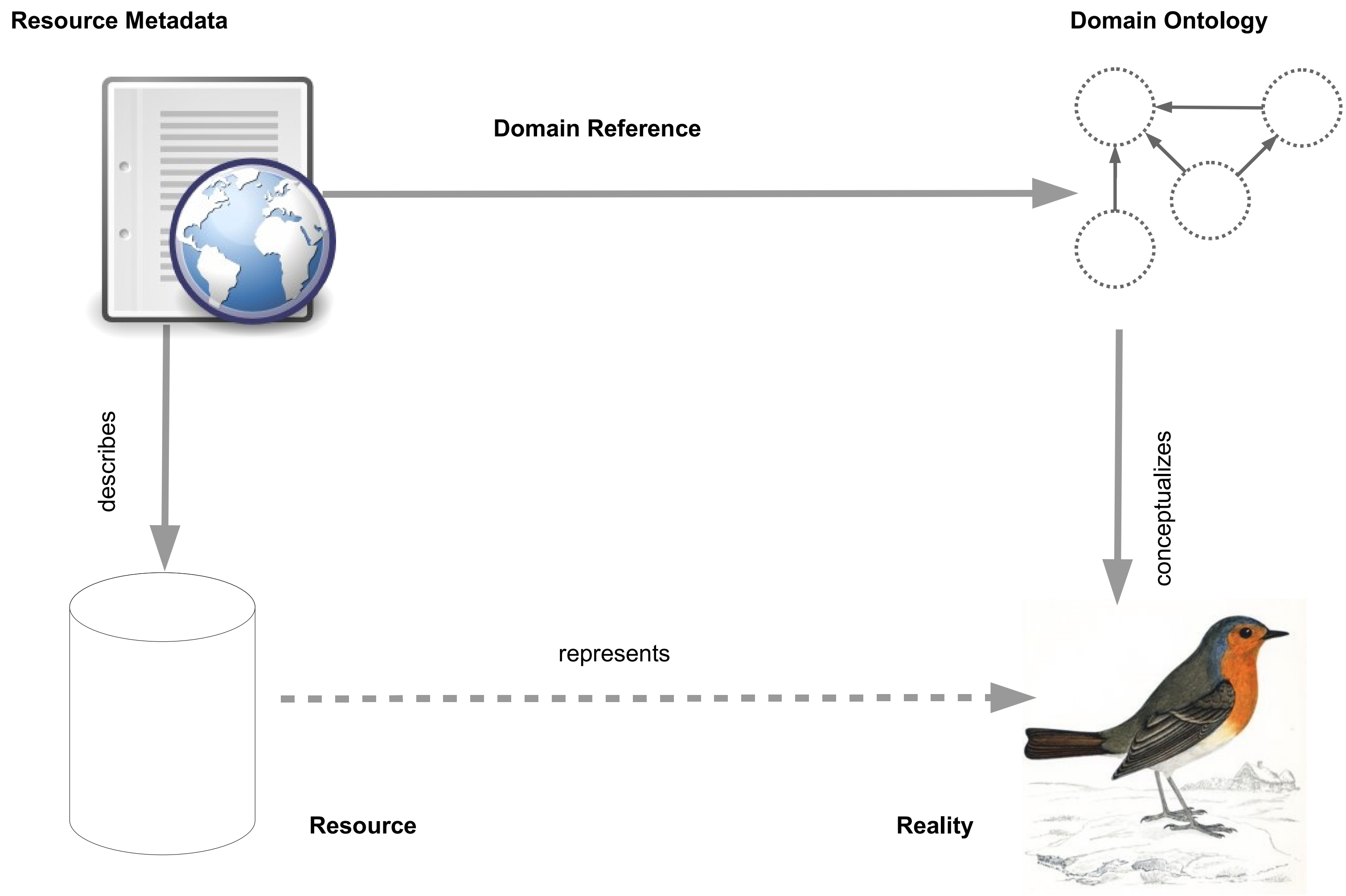




Why the difference?

- Local vs. Global
  - Describing the local and linking to global
  - Searching the global and finding the local
- Data Models vs. Real world
  - Domain Ontologies capture real world semantics
  - Data Models represent application specific knowledge
  - Semantic Annotations keep it separated

Simple solution: concept to concept



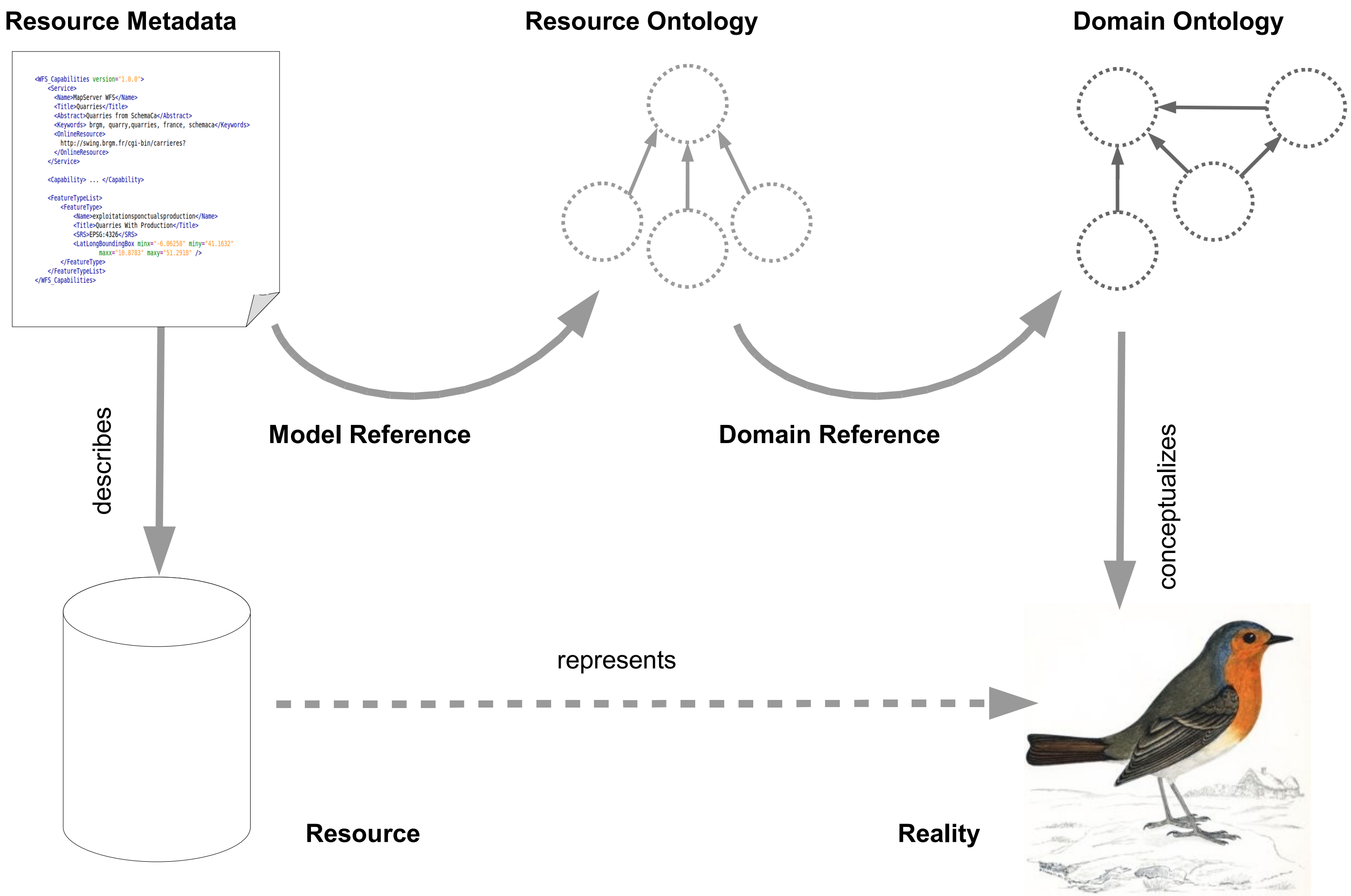
Doesn't work


```
<complexType name="Zico_regionType">
    <element name="REGIONAL" type="string" reference="dom:Identifier"/>
    <element name="LIBELLE" type="string" reference="dom:Identifier"/>
</complexType>
```

```
<complexType name="Zico_regionType">
    <element name="REGIONAL" type="string"
            reference="dom:GeographicalRegionName"/>
    <element name="LIBELLE" type="string"
            reference=="dom:ProtectedBirdRegionName"/>
</complexType>
```

- Too generic → loose benefits
- Too specific → cluttered domain vocabulary

Rule-based annotations



How to create rule based annotations


```
axiom defineZICO
 definedBy
  ?feature[LIBELLE ofType ?attrLibelle] memberOf ZicoFT and
  ?domBirdArea memberOf dom#ImportantBirdArea and
  ?domIdentifier memberOf dom#Identifier and
  dom#domainReference(?feature, ?domBirdArea) and
  dom#domainReference(?attrlibelle, ?domIdentifier) and
  dom#names(?attrlibelle, ?feature).
```

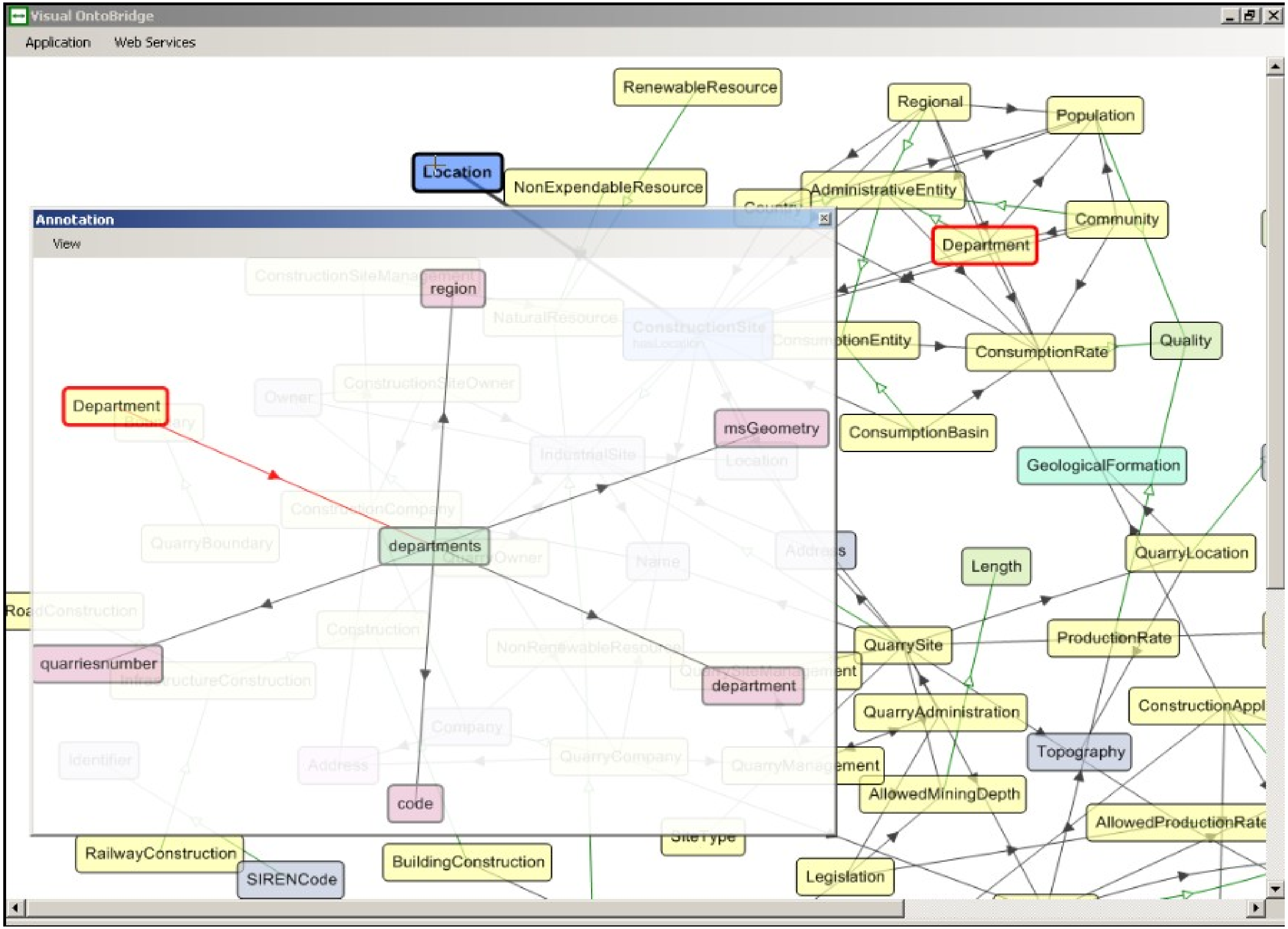
How to query rule based annotations

Goal

Post Condition

?domBirdArea memberOf dom#ImportantBirdArea and
?domIdentifier memberOf dom#Identifier and
dom#domainReference(?feature, ?domBirdArea) and
dom#domainReference(?attrlibelle, ?domIdentifier) and
dom#names(?attrlibelle, ?feature).

Visually-supported Annotations/Queries



Open Issues: Standardization

- Model References already standard (W3C SAWSDL)
- Support in OGC Standards required
  - Storing semantic annotation
  - Querying semantic annotations
  - End-user tools support
- Discussion Paper with different approaches prepared

Open Issues: Processes

- Model References already standard (W3C SAWSDL)
- Support in OGC Standards required
  - Storing semantic annotation
  - Querying semantic annotations
  - End-user tools support
- Discussion Paper with different approaches prepared
- How can we annotate Geoprocesses
  - Domain vocabulary of Geo-operations required? All?
  - Or just describing relation between input and output?

Overview

- Spatial Data Infrastructures
- Semantic Web Services
- Bridging the gap: Semantic Annotations
- **SWING: use cases**

- SWING: Developed Tools
- Demonstration (Videos)
- Hands-On Session

Semantic **W**eb Services **In**teroperability in **G**eospatial decision making

Use Cases

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SWING application theme

- BRGM : Mineral resources Management
- Aggregate production and consumption
  - **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

SWING application theme

- Quarries and Aggregates

Aggregates = crushed hard rock (limestone, volcanic rock, sandstone, recycled concrete, ….), or on- & off-shore sediments (sand & gravel)


Vosges


Puy-de-Dome


Loire-Atlantique


Sarthe


Loiret


la Manche


Amsterdam


Essonne

SWING

- Decision Making Support :
  - A new way of doing things in the Inspire Context
    - Reduce time to deliver
    - Brings interactivity

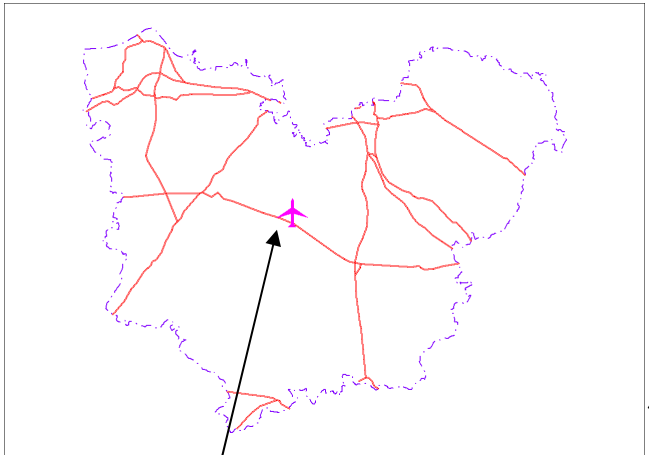
- Objectives in SWING
  - **develop a geospatial decision-making application that can dynamically find and integrate interoperable semantic web services.** (…. *with the potential of being further developed and turned into a management and assessment system for natural resources)*
  - **evaluate the appropriateness of the technical framework**

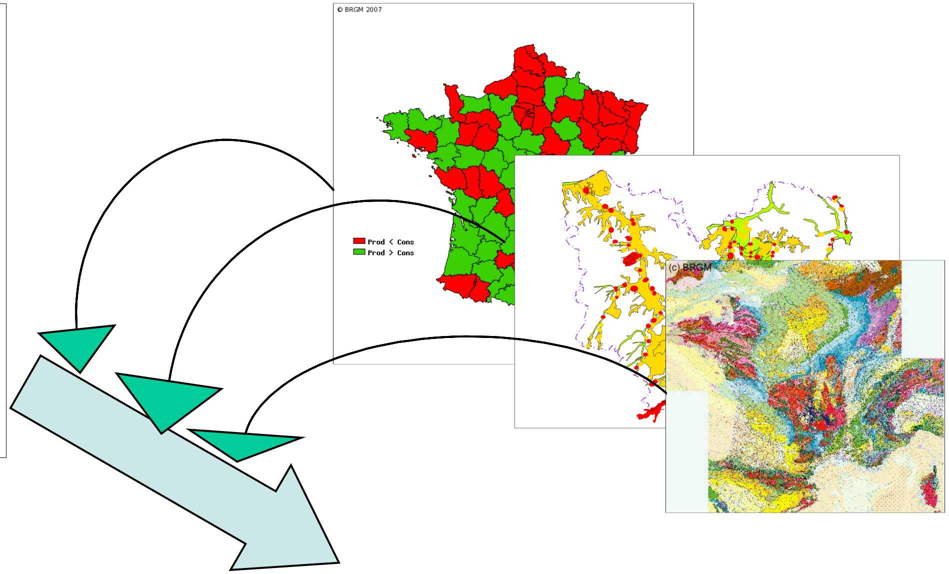
Use Cases overall objective

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

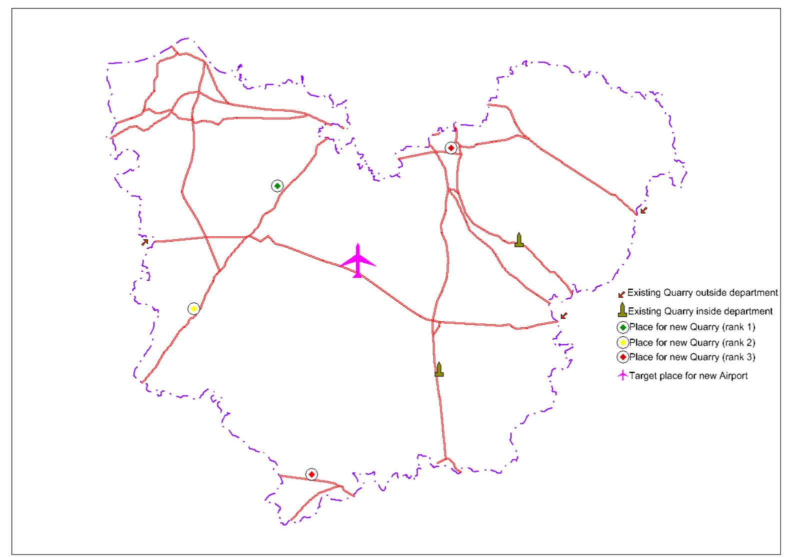
- Find places where to get aggregates
  - From existing quarries
  - By opening new ones (Land-use constraints + Geology)

Use Cases





Substances	Quantity(*)
Sand	**110 000 tons**
Granite	**50 000 tons**
Concrete	**200 000 tons**



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

The differents steps

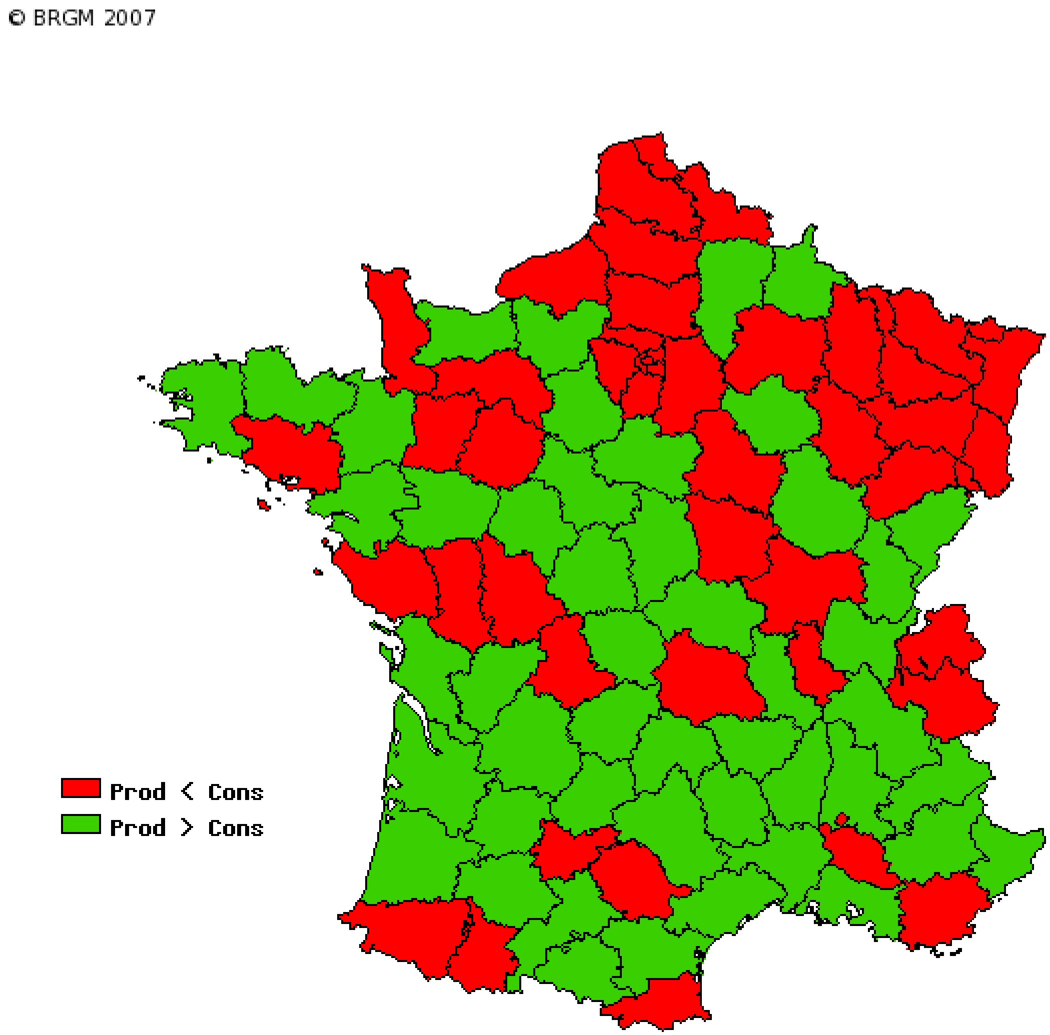
- Use Case 1 : Production/Consomption Map
- Use Case 2 : Land-Use constraints integration
- Use Case 3 : Find the best place

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.

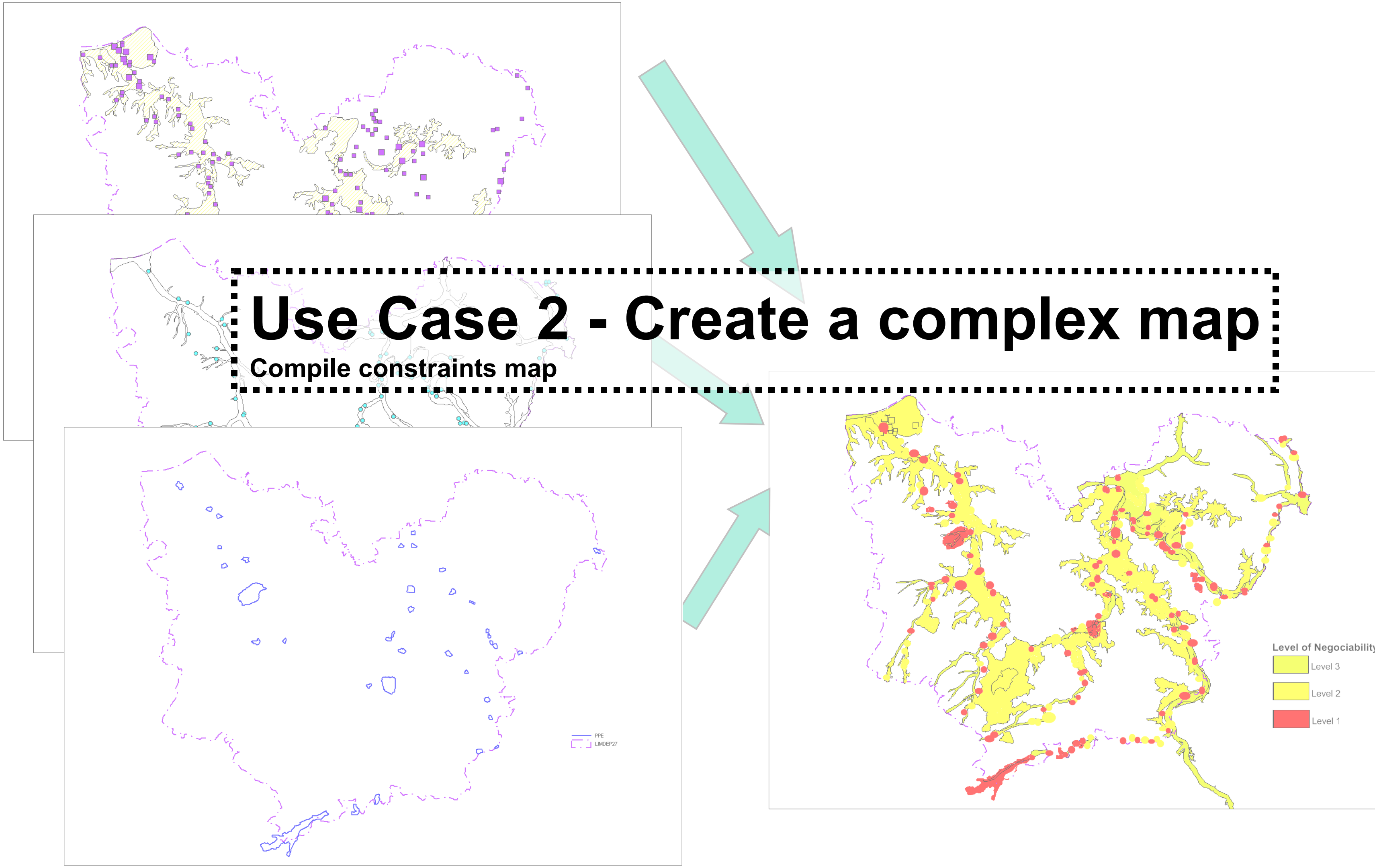
Use Case 1 - Create a simple map



Fake Consumption/Production Map (based on population of departments)

Use Case 2 - Create a complex map

Compile constraints map



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.
- Data Sources for Use Case 2
- 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

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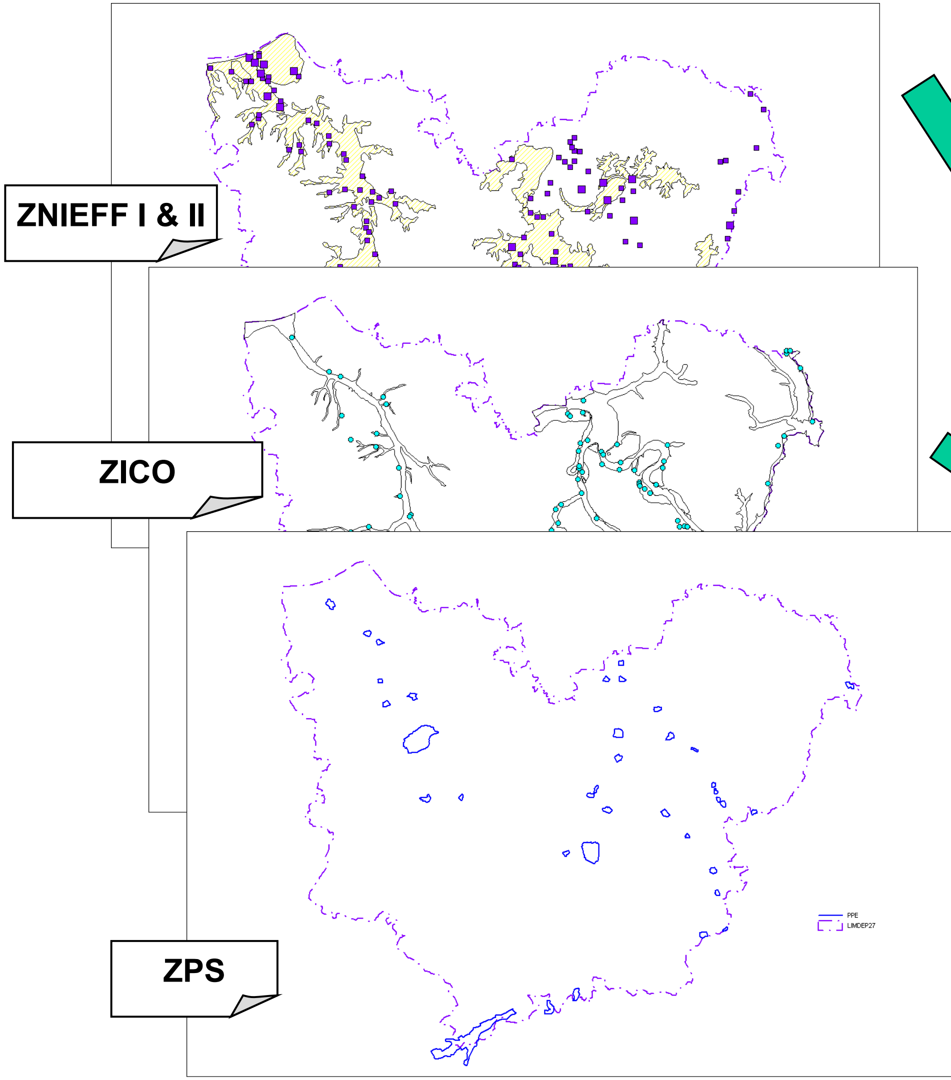
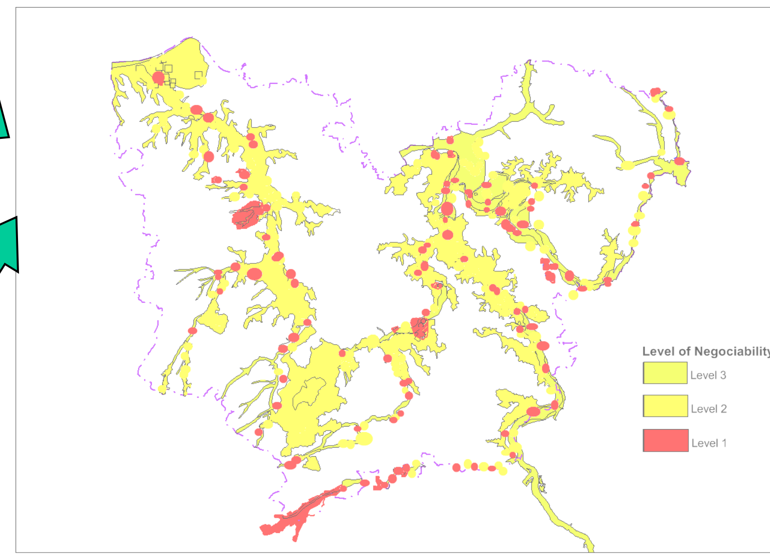
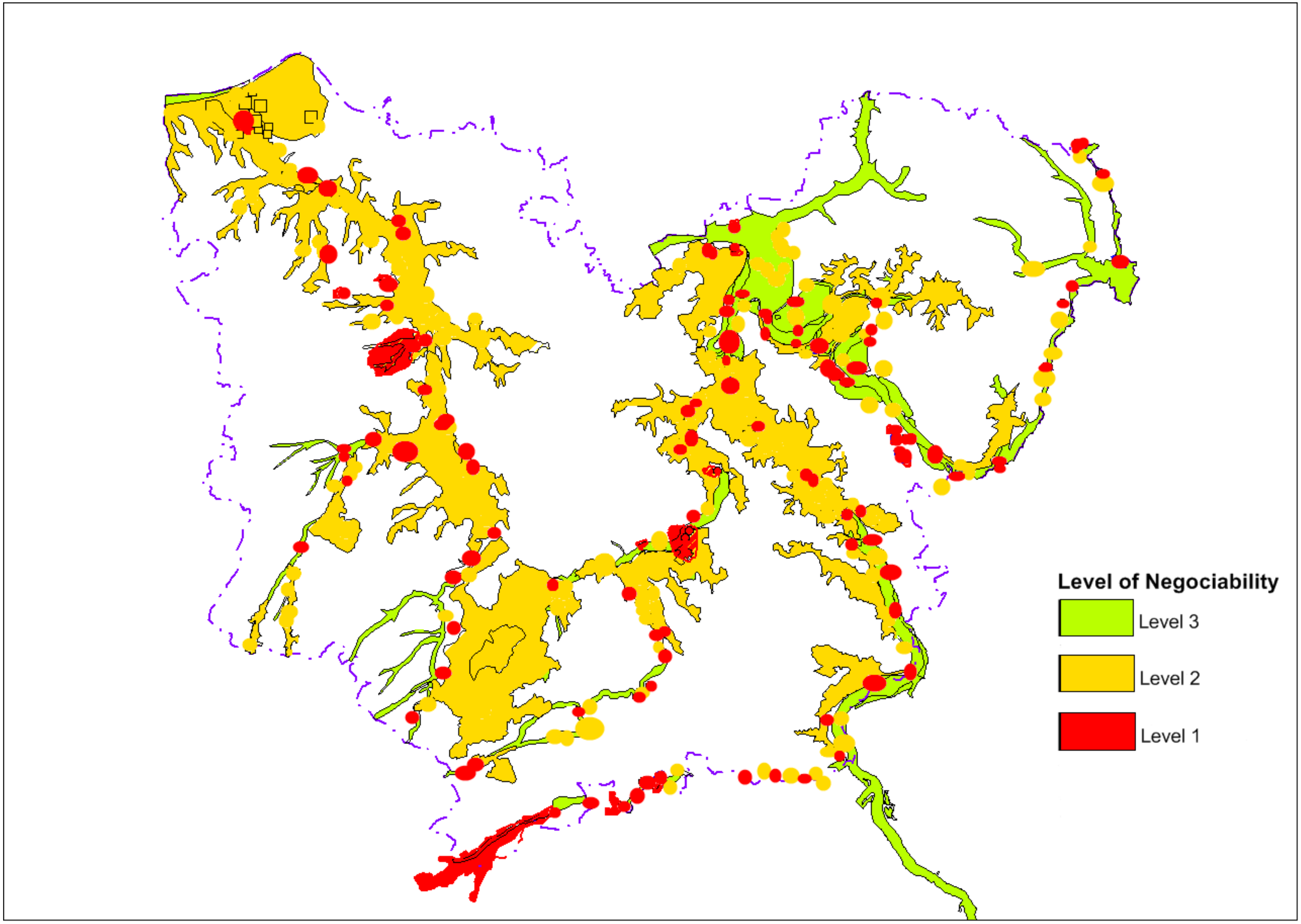


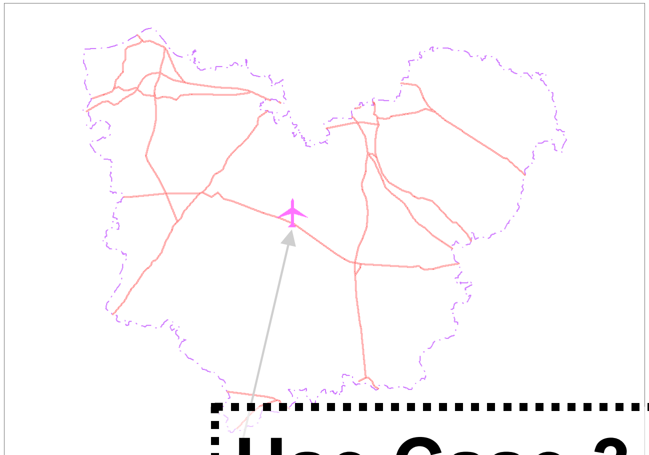
Land-Use Constraints

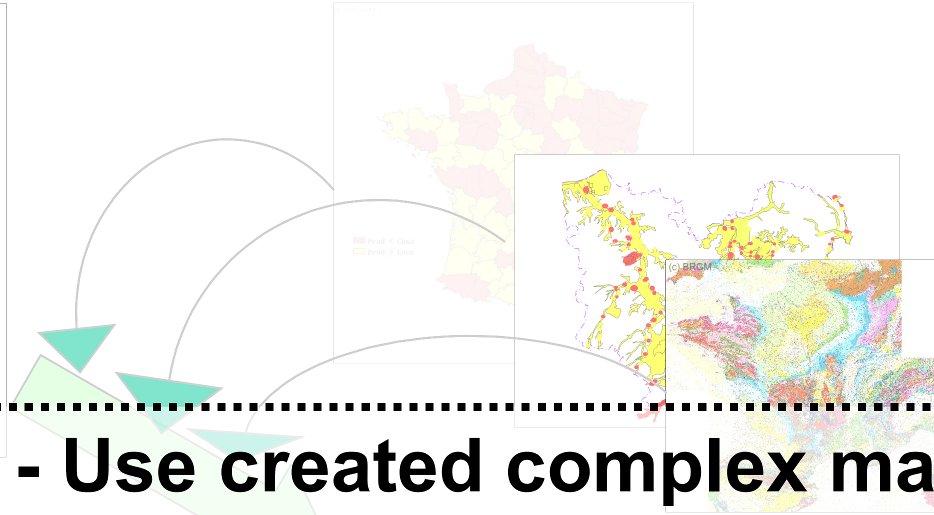
Negotiability level



Use Case 2 - Create a complex map







Use Case 3 - Use created complex map to make sophisticated queries

Get quarry best location

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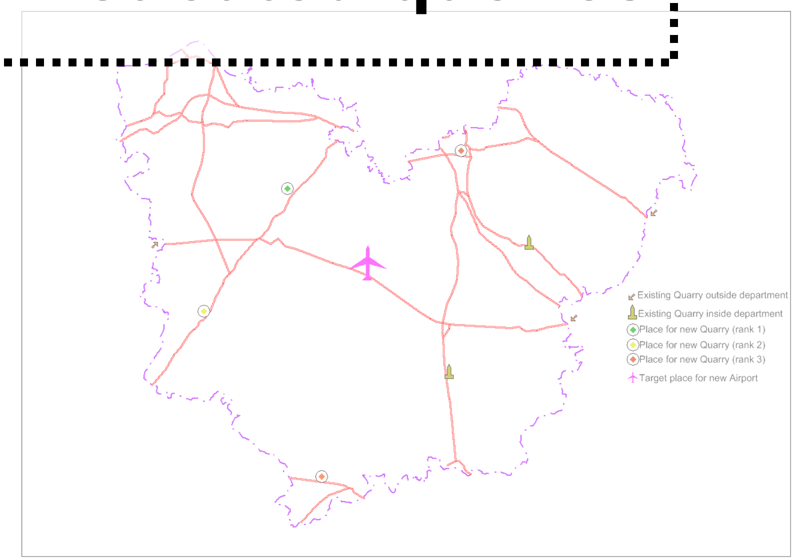

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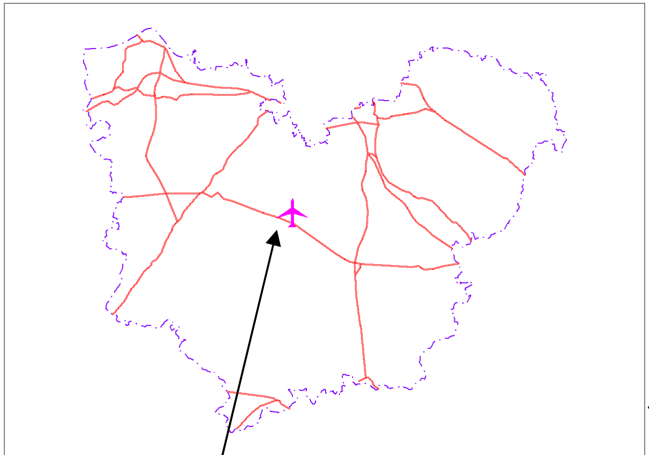
Use Case 3 – Integrate Multiple Criteria

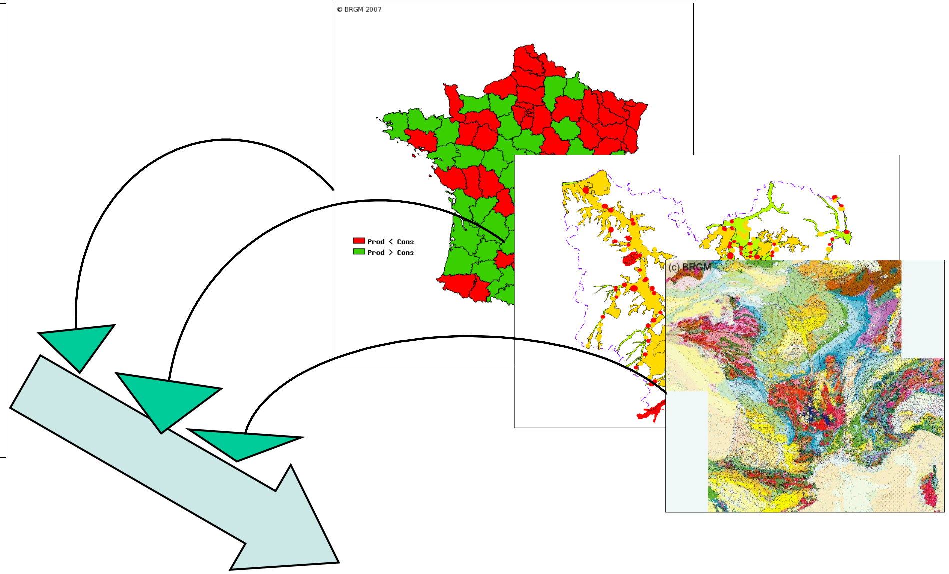
- Thematic Objective: Create an interactive map of the ranking according to combined criteria

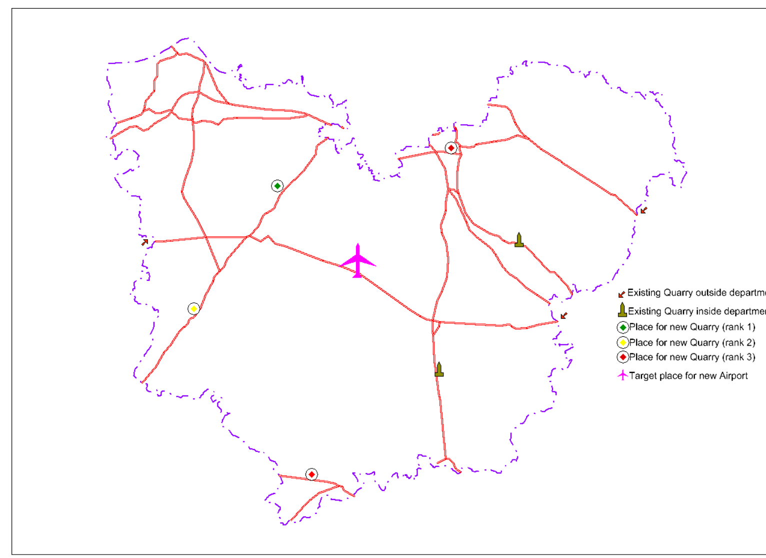
- Data Sources for UC3

- 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







Substances	Quantity(*)
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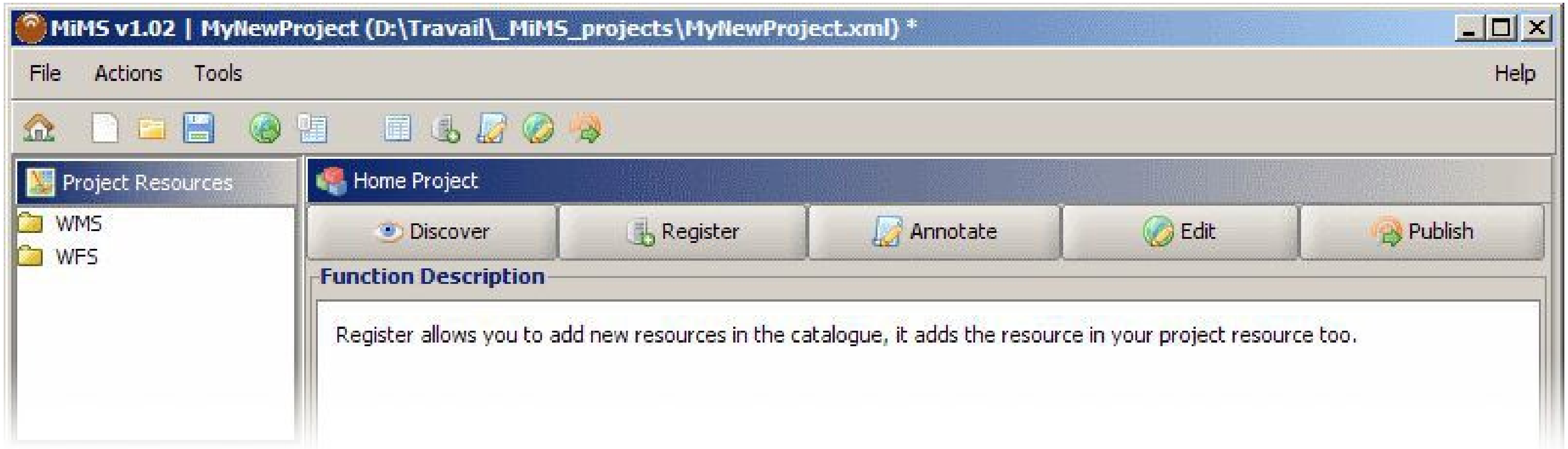
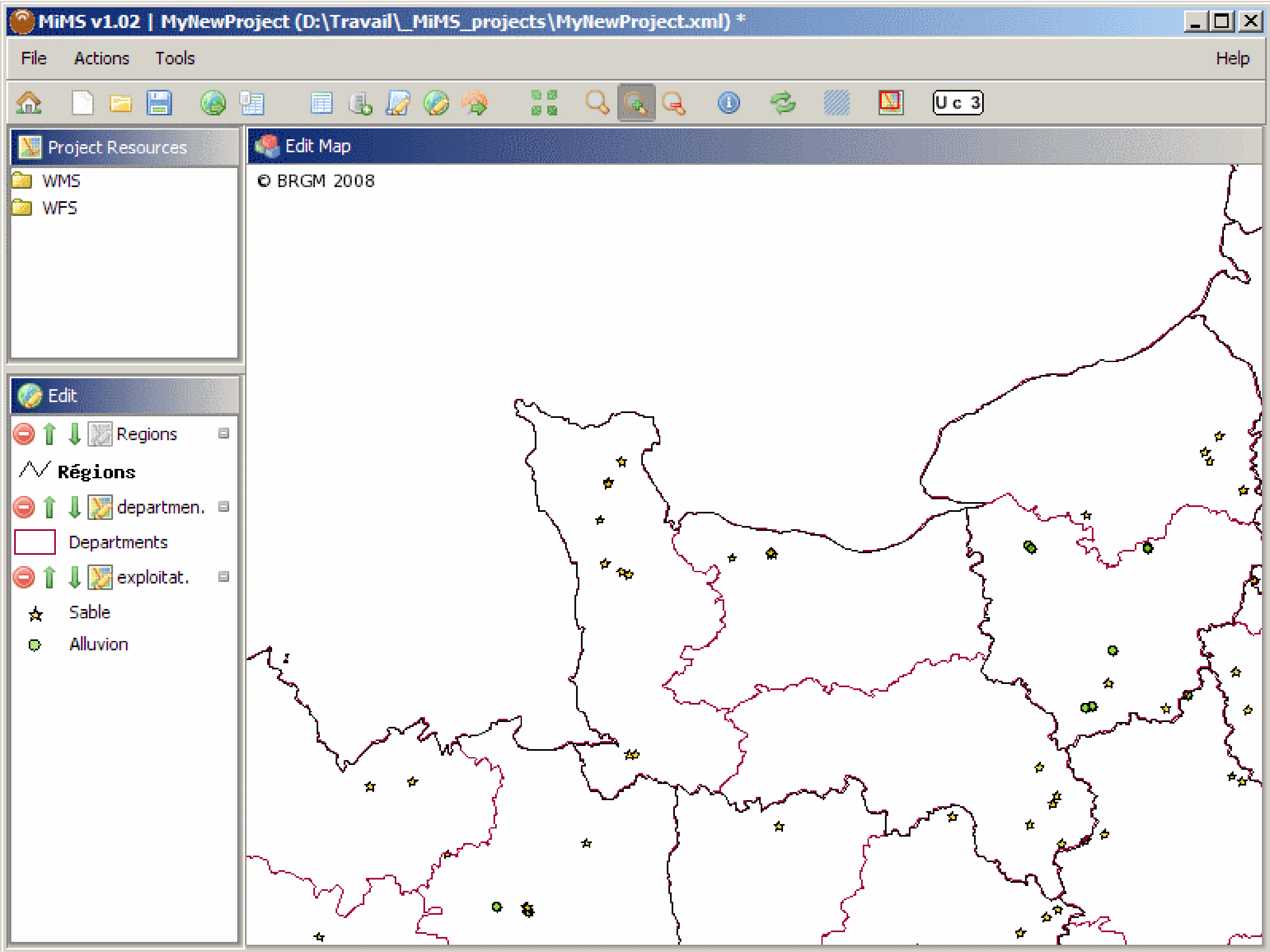
Generating and Publishing the Website using MiMS



Generating and Publishing the Website using MiMS (cont')



Break

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- **SWING: Developed Tools**
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SWING Architecture Overview

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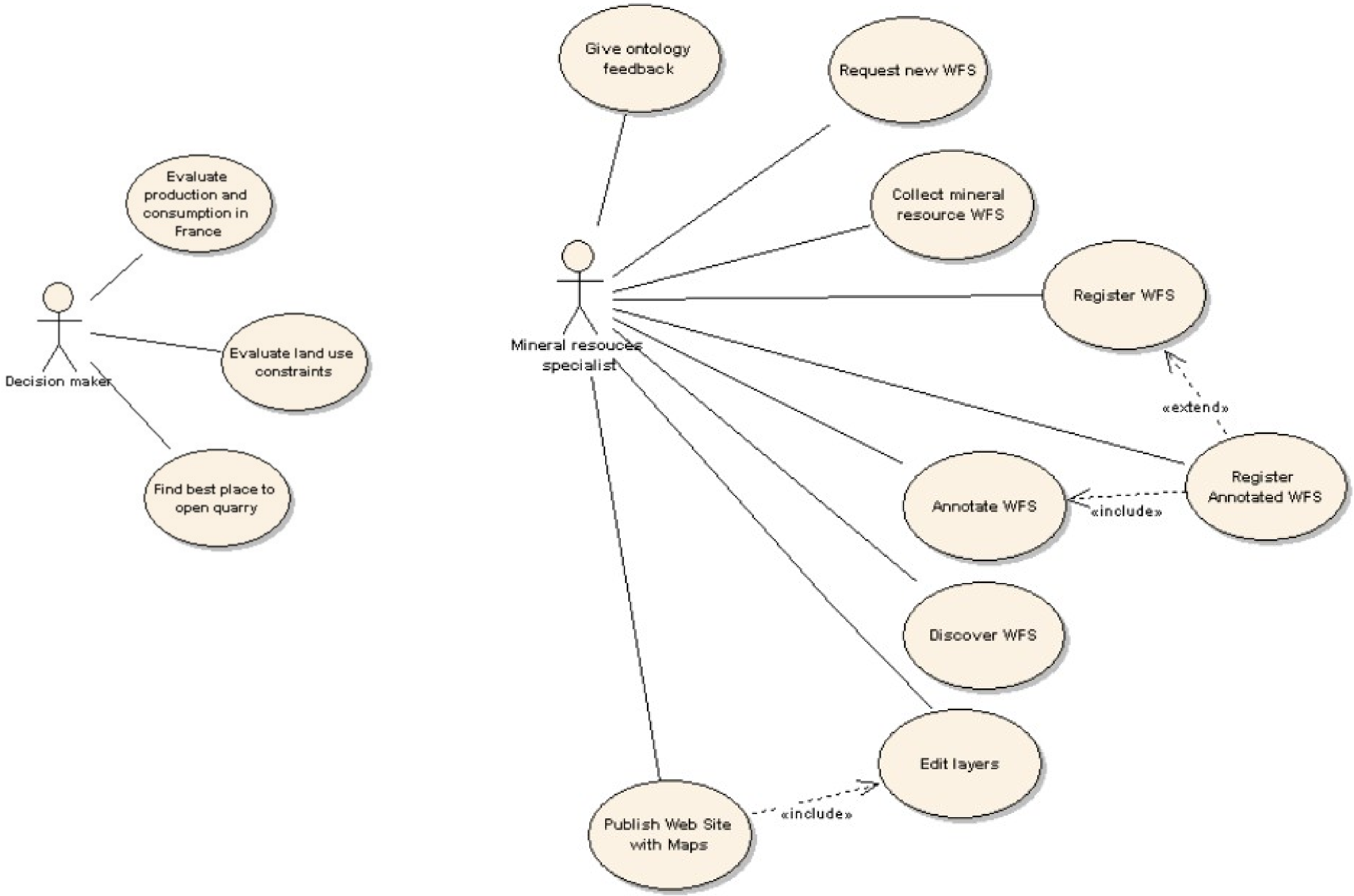
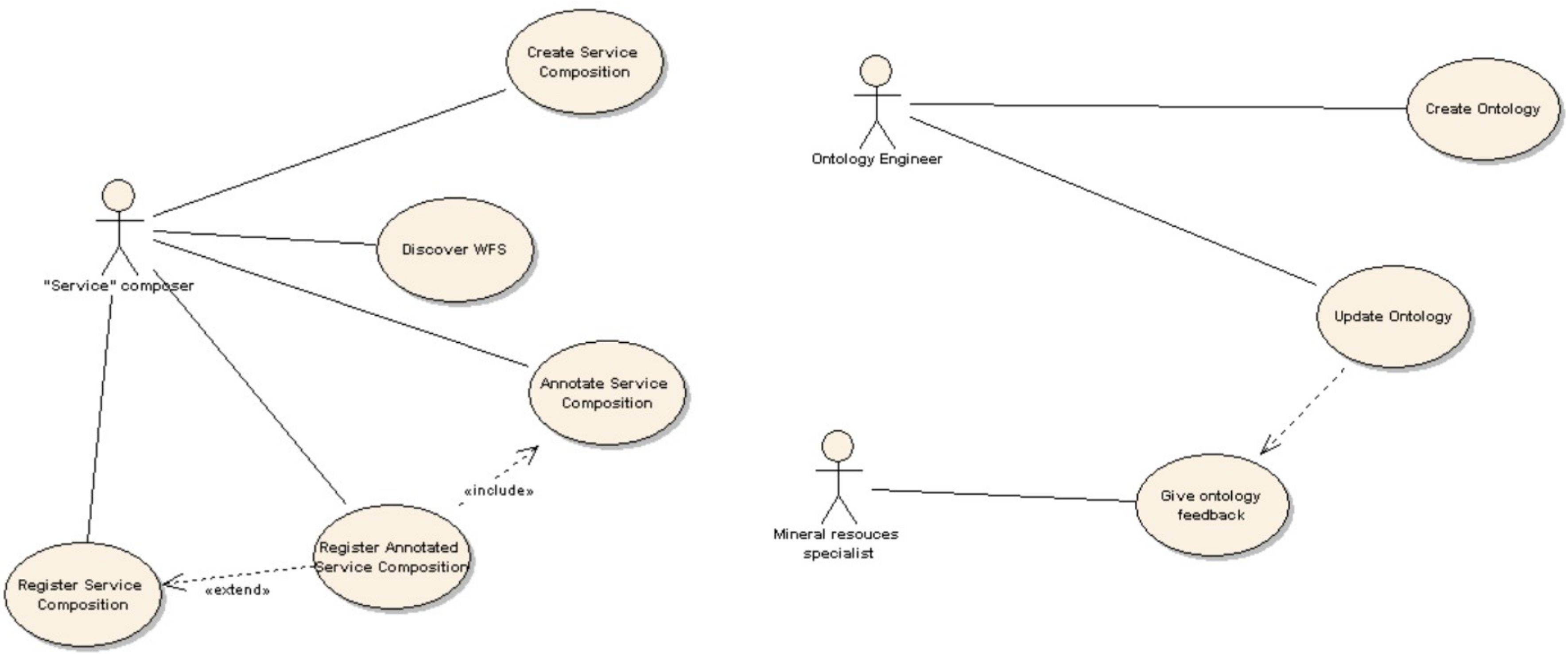
Outline

- Roles
- Components and Interactions

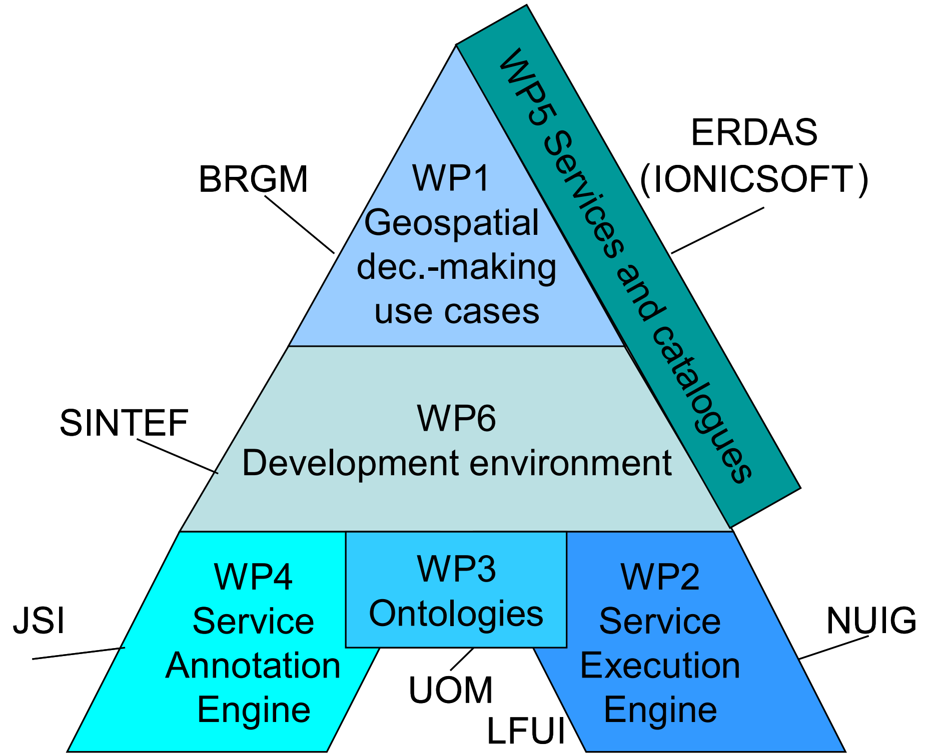
Roles – Decision Maker and Mineral Resource Specialist



Roles – Service Composer and Ontology Engineer



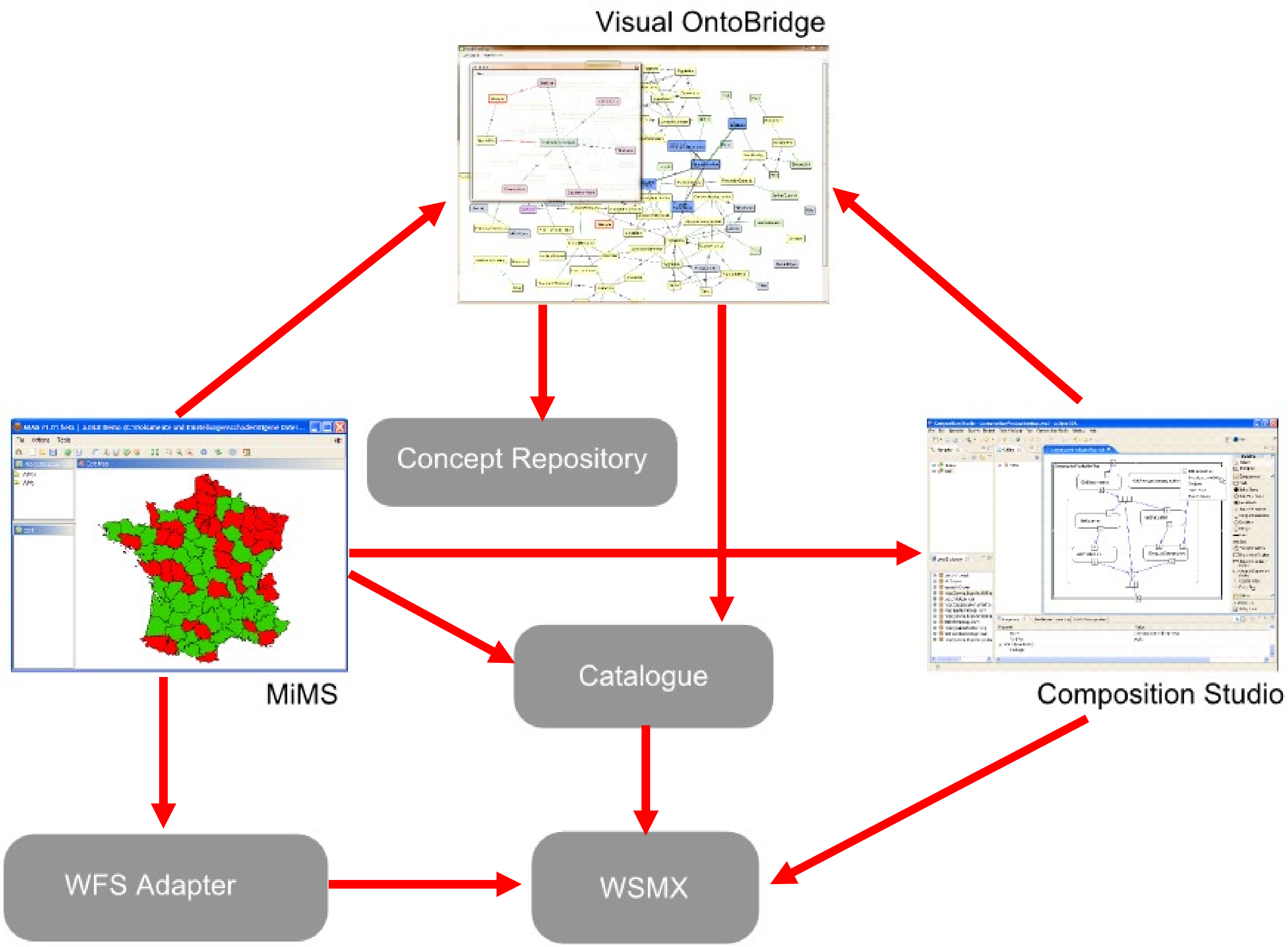
SWING Work Packages and Main Responsibilities



SWING Components

- **MiMS** (WP1): Environment for domain expert. Convenient semantic annotation & discovery; use composed services like standard OGC services
- **WSMX** (WP2): Semantic web services platform. Geospatial semantic discovery; execution of composed services (as ASMs)
- **Concept Repository** (WP3): Ontologies for semantic annotation. Used throughout components
- **Visual OntoBridge** (WP4): Annotation tool. Semi-automatic annotation of services and queries; provides user with most plausible annotations
- **Catalogue** (WP5): OGC Catalogue. Semantic discovery in interaction with WSMX; also provides adapter OGC $\leftrightarrow$ WSMX ASM execution
- **Composition Studio** (WP6): Environment for IT expert. Convenient semantic annotation & discovery; graphically compose services; automatic export into WSMX ASMs

High-level Architecture and Interactions



Overview

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- SWING: use cases

- SWING: Developed Tools
- **Demonstration (Videos)**
- **Hands-On Session**

Hands-On Session

- **Exercise**: Building a workflow with Composition Studio
- **Task**: *Create a composition as described in the File CreatingWorkflowsSlides.pdf*

- **Exercise**: Creating a decision-support map with MiMS: Extract MiMS.zip in folder c:\MiMS and start launcher.bat
- **Tasks**:
  - *Try to follow the Steps in the mentioned Video*
  - *Create a „background" map (e.g. search for departments)*
  - *Find data about protected bird areas, quarries, mineral resources, ...*
  - *Create a legend and publish it as a website*
  - *Annotate an existing Web Feature Service about Birds*