Business Semantics as an Interface between Enterprise Information Management and the Web of Data:

A Case Study in the Flemish Public Administration

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eBISS, July 2012

Vrije Universiteit Brussel

VU University Amsterdam

Collibra

Goals of this presentation

- Give an understanding of Enterprise Information Management for Semantic Interoperability (by means of a case)
- Understand the role of conceptual modeling and the tension field between
  - Reusability and usefulness of models
  - Types of semantic interoperability
- Identify requirements for methods for EIM
- Present a method (and tool) for EIM: Business Semantics Management

Introduction

- Christophe Debruyne
  - Vrije Universiteit Brussel, STARLab
    - Method, Tools and Application of Ontologies
  - MSc in Computer Science @ VUB in 2009

- Dr. Pieter De Leenheer
  - Vrije Universiteit Amsterdam, Business, Web & Media
    - Service science
  - Collibra NV/SA (http://www.collibra.com/)
  - MSc and PhD in Computer Science @ VUB in 2004 and 2009 resp.

Outline

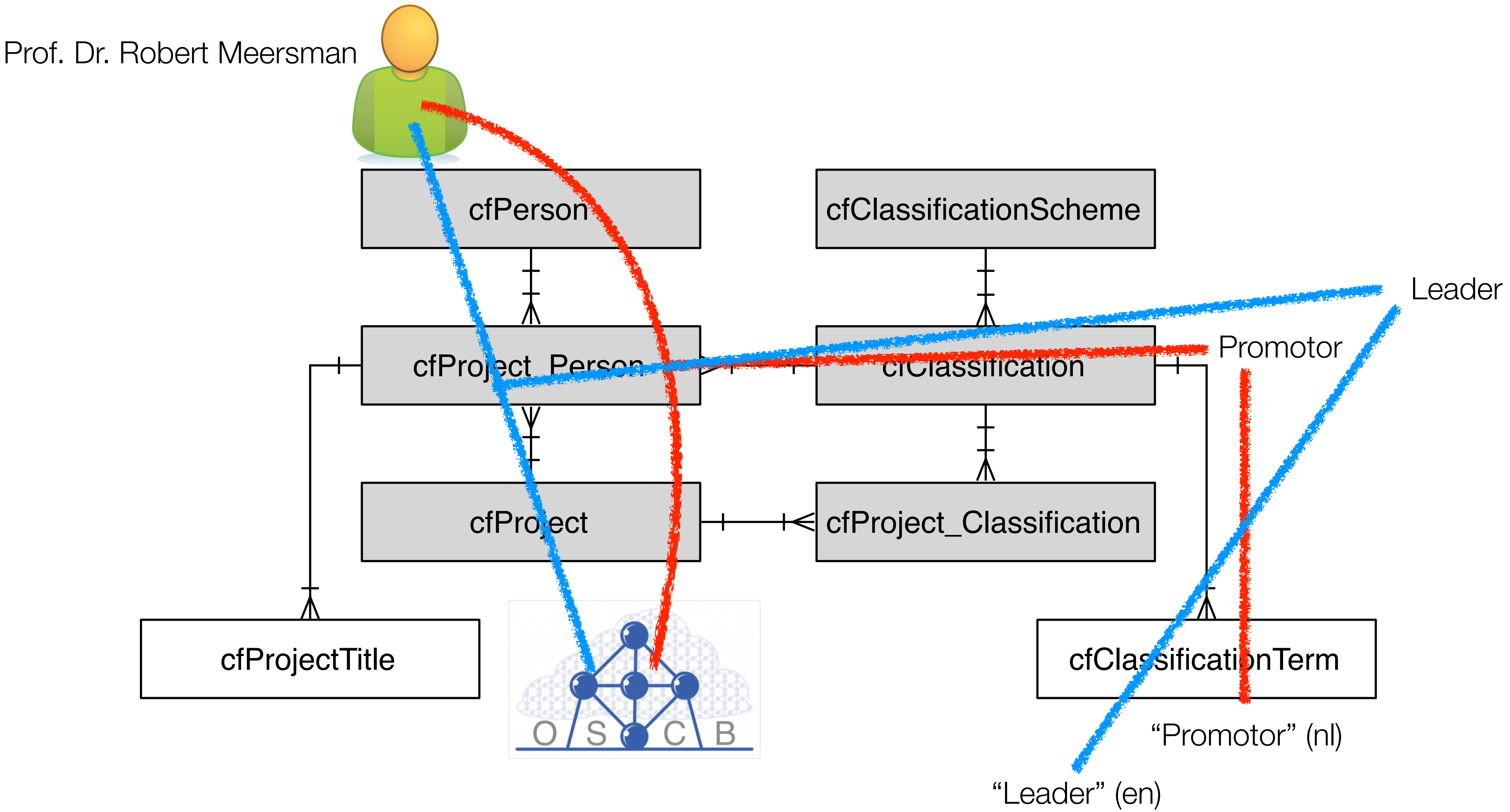
- Context - FRIS and CERIF
  - The need for enterprise information management and/for semantic interoperability
- Terminology and pinpointing the challenges
  - Requirements for tackling those challenges
- Business Semantics Management
  - Framework and Collaborative Method
- Hands-on BSM

Part I: Context

CERIF

- Common European Research Information Format (CERIF)
- Recommendation to EU-members for the storage and exchange of current research information.
- Aim: greatly facilitate the **reporting** process
- Created by euroCRIS by means of Entity-Relationship diagrams
  - To cope with multiple languages
  - For flexibility
- Core concept: Researcher, Research Project, Research Group, Equipment, Publication, etc.

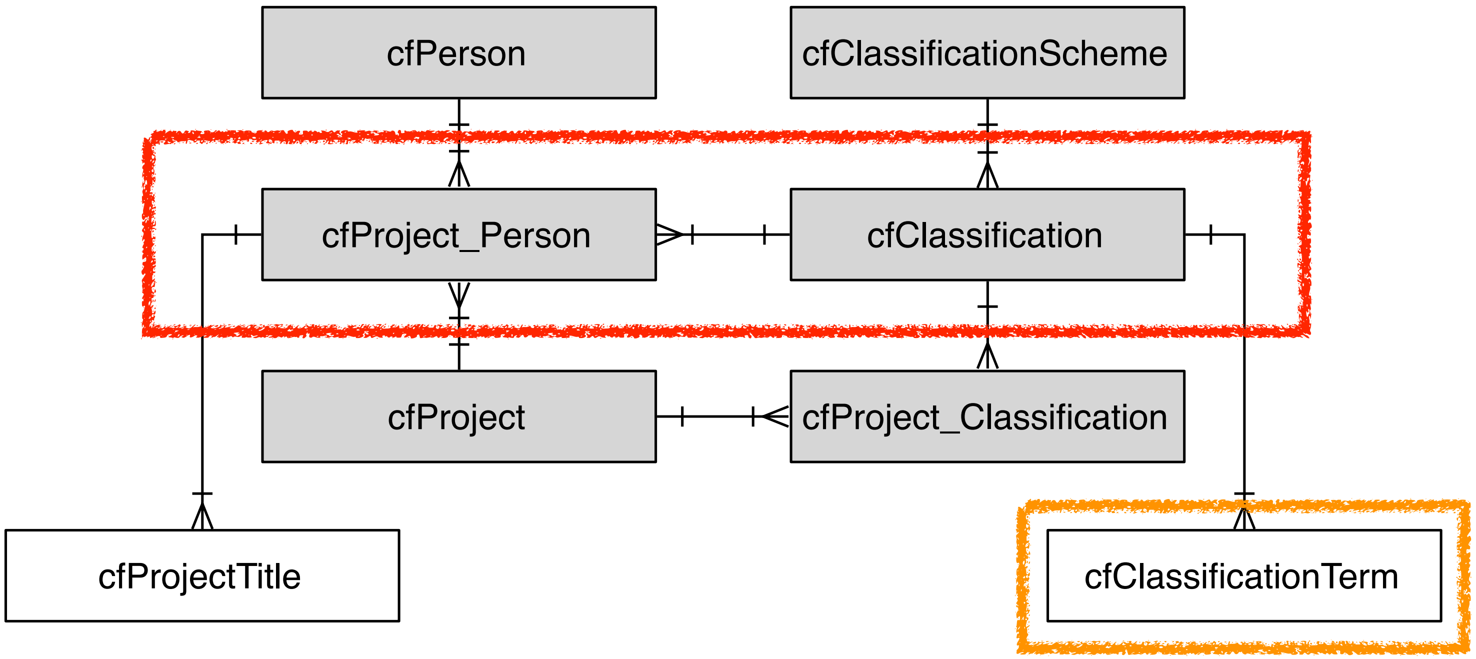
CERIF



Prof. Dr. Robert Meersman
cfPerson
cfClassificationScheme
Leader
cfProject_Person
cfClassification
Promotor
cfProject
cfProject_Classification
cfProjectTitle
OSCB
cfClassificationTerm
“Promotor” (nl)
“Leader” (en)

CERIF

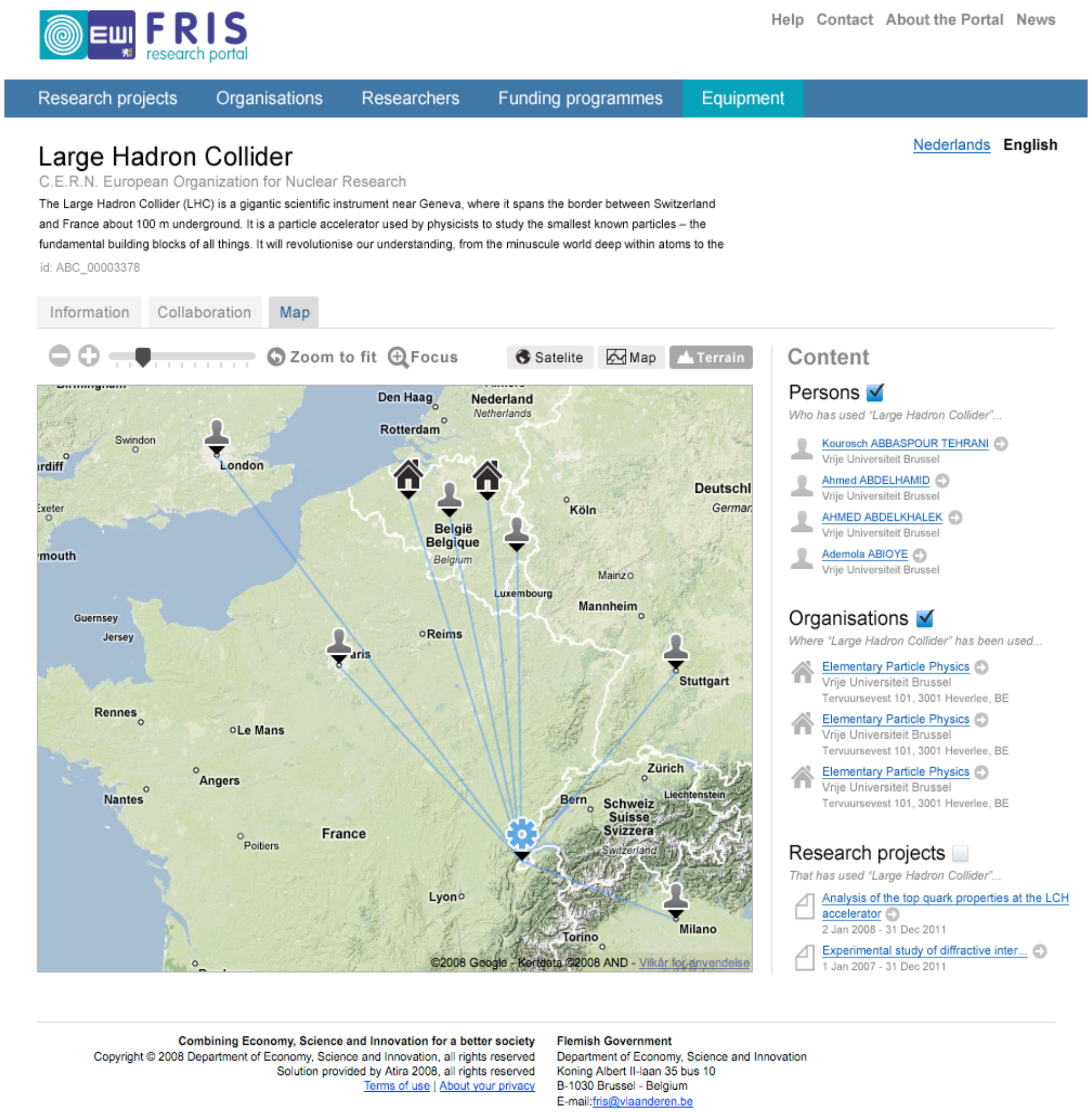
- Mismatches at different levels:
  - Terms
  - Relations
  - (Business rules)



Flanders Research Information Space

http://www.researchportal.be/

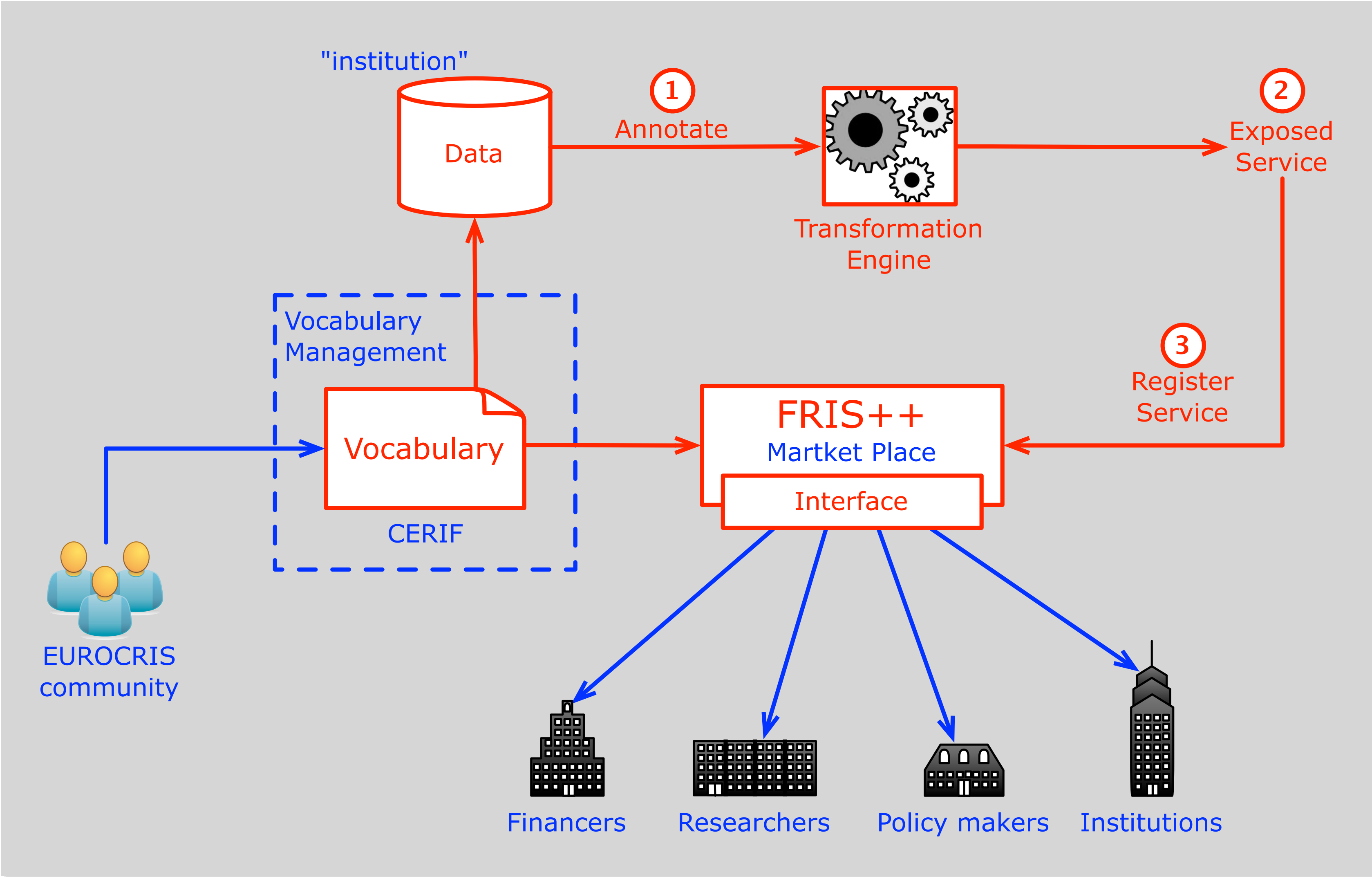
- Boost innovation through
  - aggregating data and make it publicly available
    - 19683 projects
    - 1976 organizations
    - 13982 researchers
    - ...
  - multiple parties deliver
- Enterprise Information Management
- Linked Data Approaches



FRIS Business Drivers

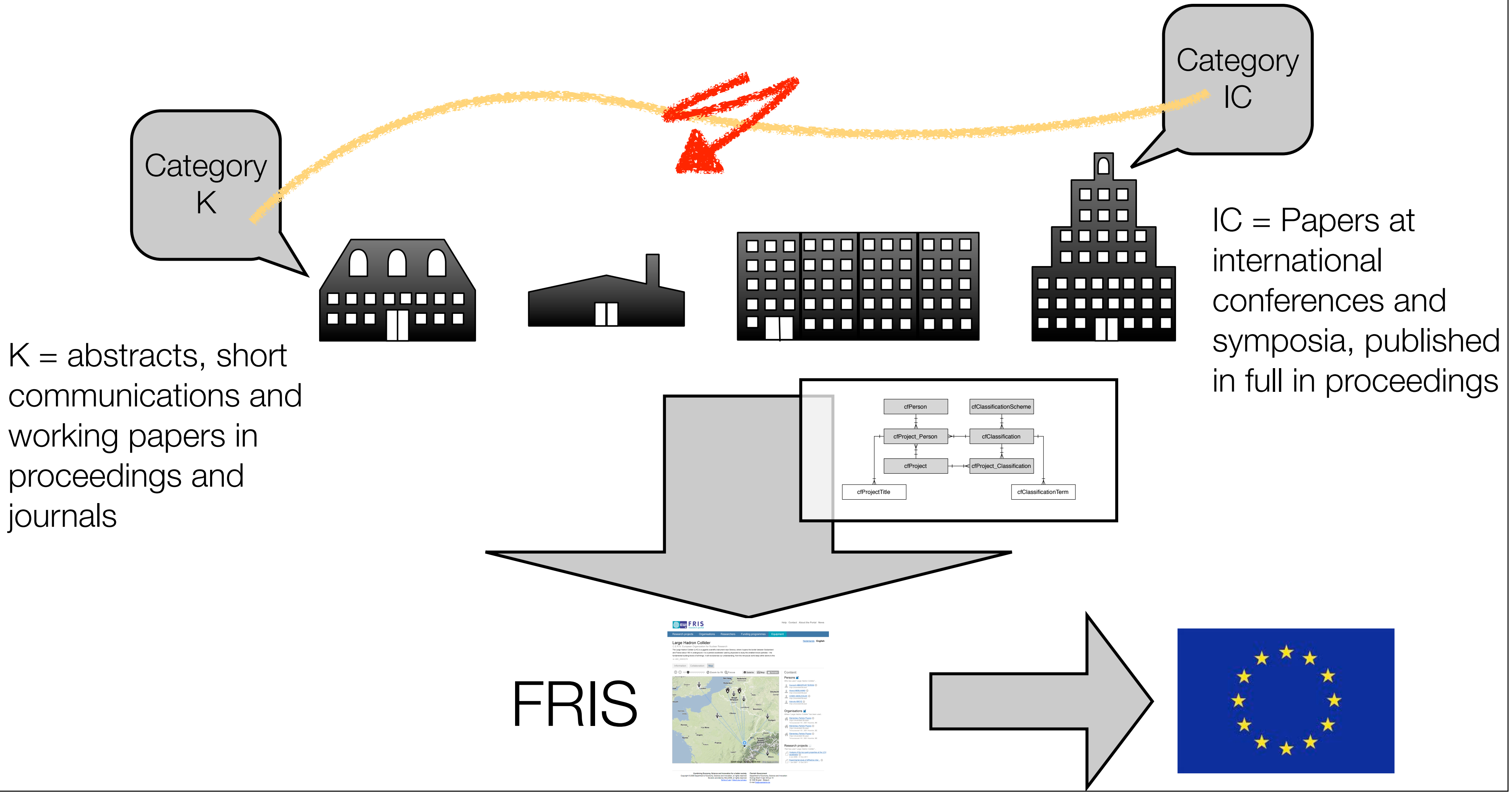
- **Research institutions**: a standard semantic framework for reporting on research activities and results.
- **Policy makers**: accurate and timely overview of research activities and results to improve innovation.
- **Funding agencies**: identify challenges in research or opportunities for exploitation.
- **Researchers**: avoid wasting valuable time collecting the same data over and over.

FRIS

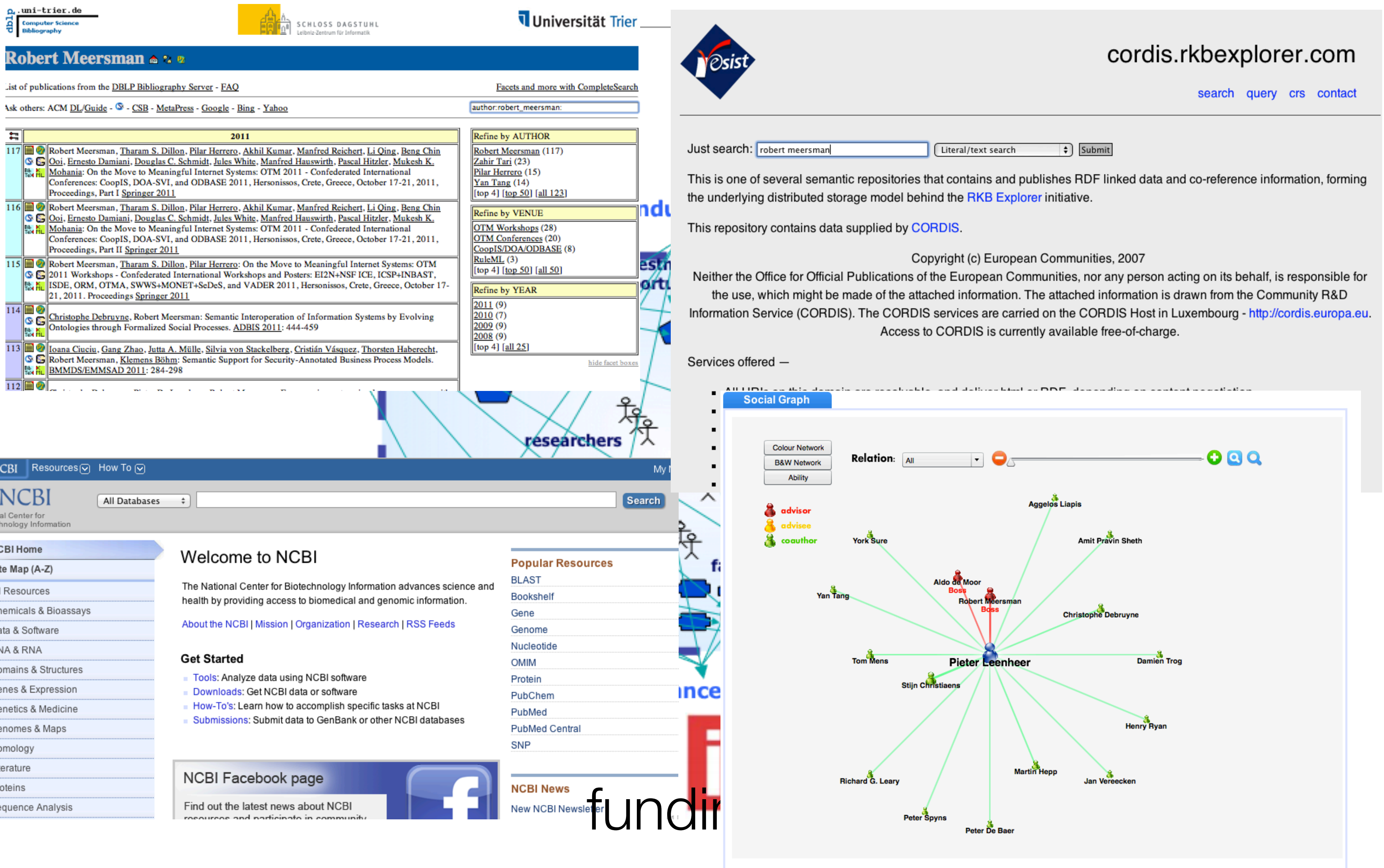


"institution"
Data
1
Annotate
Transformation
Engine
2
Exposed
Service
Vocabulary
Management
Vocabulary
CERIF
3
Register
Service
FRIS++
Martket Place
Interface
EUROCRIS
community
Financers
Researchers
Policy makers
Institutions

- How can we achieve consensus on terminology used?
  - Example: classifying workshop papers.



Linked Data and FRIS



Linked Data Web is another Story

- Many communities - heterogenous goals
- Open Innovation paradigm: boost change through sharing
- First unlock data, then think about possible applications
  - Lightweight loosely coupled vocabularies
  - Generative technologies such as RDF, HTTP, SPARQL

Resource Description Framework

- RDF is <u>not a language,</u> but a model
- RDF is a W3C recommendation
- RDF is designed to be <u>read by computers</u>
- RDF is for describing resources on the Web
- RDF uses URIs to identify and reference resources on the Web

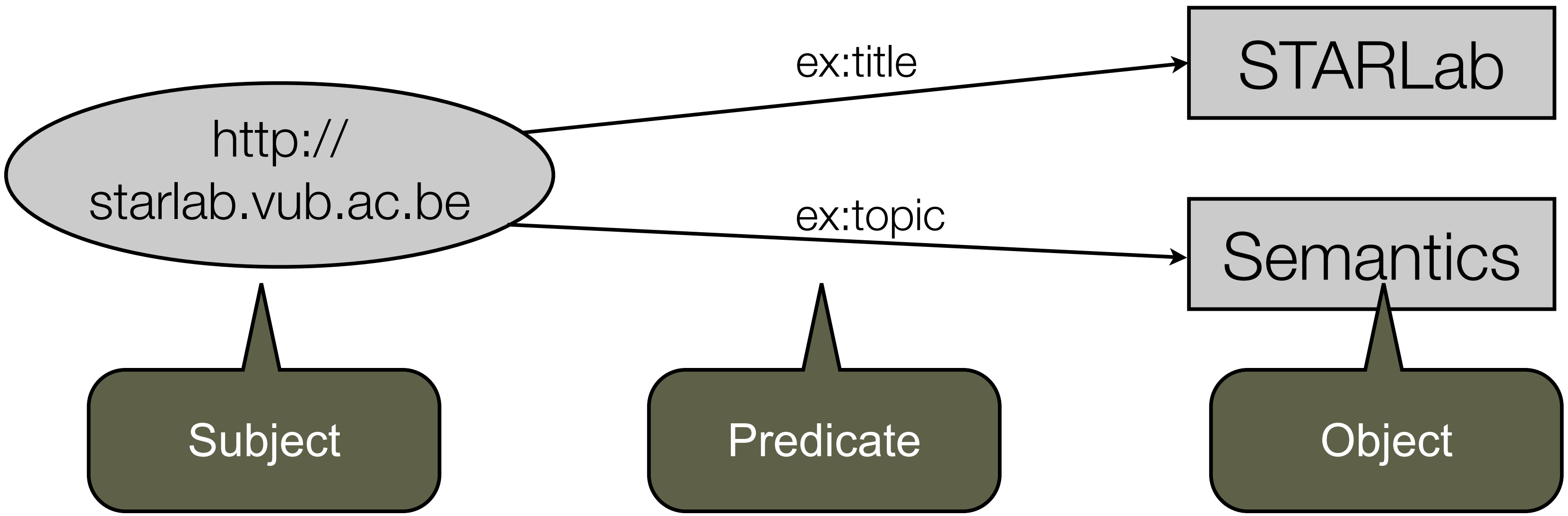
Example of RDF

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
         xmlns:ex="http://starlab.vub.ac.be/example#">

  <rdf:Description rdf:about="http://starlab.vub.ac.be">
    <ex:title>STARLab</ex:title>
    <ex:topic>Semantics</ex:topic>
  </rdf:Description>

</rdf:RDF>
```

RDF Namespace



SPARQL

- SPARQL Protocol and RDF Query Language
  - is an RDF query language

```
PREFIX ex: < http://starlab.vub.ac.be/example# >
SELECT ?title
WHERE {
  ?thingy ex:title ?title.
}
```

?title
STARLab

FRIS

- To populate the FRIS portal with all information provided by the delivered CERIF files and other heterogeneous sources, needed are:
  - Consensus amongst the involved parties on a common conceptual model for CERIF and the different classifications (inside that semantic layer);
  - An easy, repeatable process for validating and integrating the data form those sources;
  - Make available the information in a generic way on the Web on which third parties can develop services as demonstrated by other Linked Data initiatives.

Part II: Some terminology & identification of challenges

Enterprise Information Management and the Web of Data

- Knowledge management and conceptual modeling are important activities for both Enterprise Information Management (EIM) and the Web of Data.

- EIM (Top-down)
  - Satisfying IT needs emerging from organization's requirements
- The Web of Data (Bottom-up)
  - Provide structured data for (third party) services

Remember, FRIS aims at both!

Semantic Interoperability

- Semantic interoperability is defined as "the ability of two or more *autonomously* developed and maintained information systems (IS) to communicate data and to interpret the information in the data that has been communicated in a meaningful manner"
- When a need for semantic interoperability rises, the *community* of stakeholders formulates these in *semantic interoperability requirements*.

Closed vs. Open Systems

- Closed = developed within, and for, 1 organization

Semantic Interoperability NOT required

- Open = developed for deployment on internet

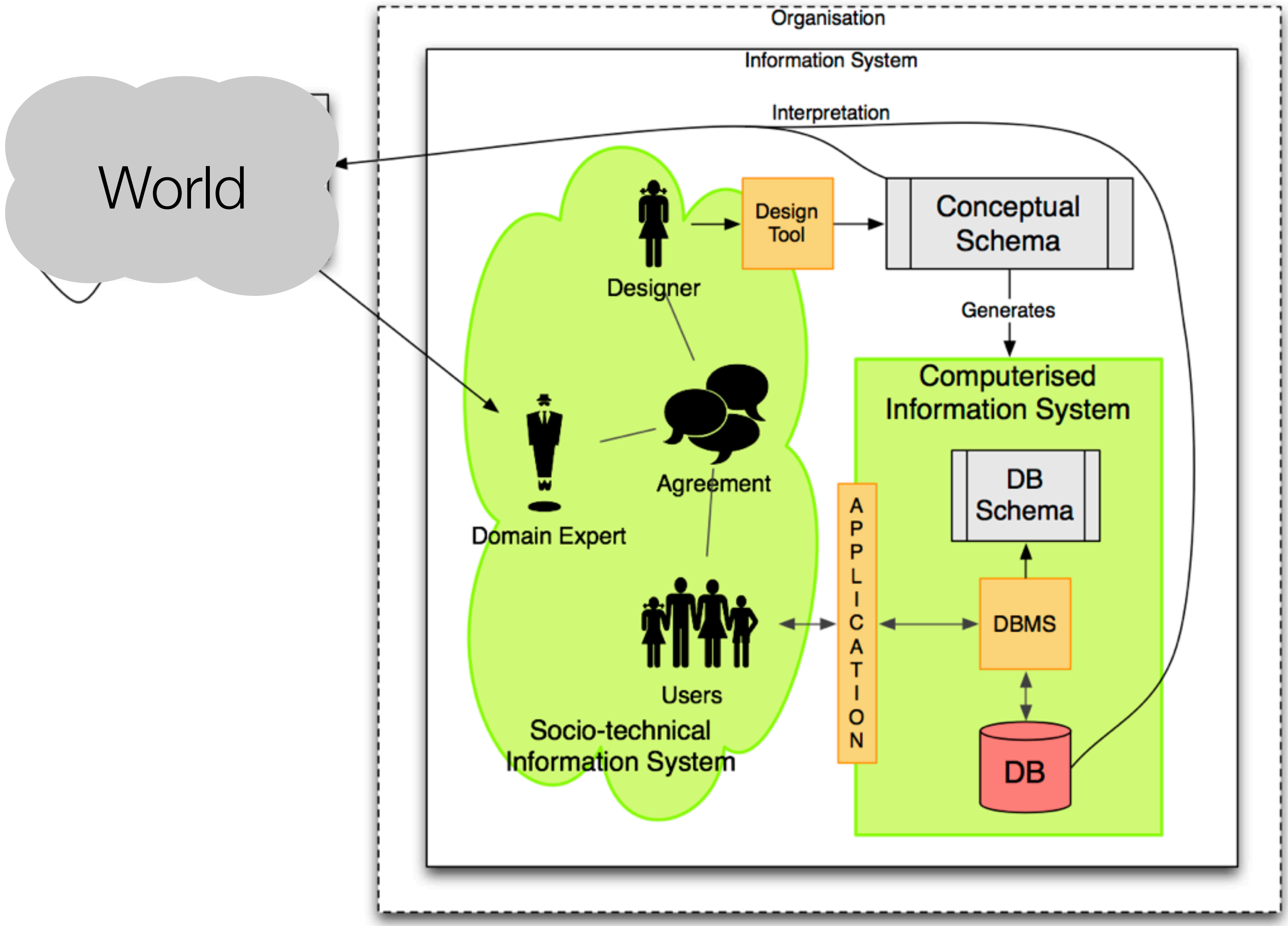
Semantic Interoperability ENABLED by a shared ontology:

Collaborative Ontology Engineering >
COMMUNITY!

Ontologies

- The formal semantics of a (computer-based) system is the correspondence between this system and some real world as perceived by humans and usually given by a formal mapping of the system's symbols.
- As the real world is not accessible inside a computer, the world needs to be replaced by an agreed conceptualization if we want to store and reason about semantics. Semantics are often stored in the shape of a formal (mathematical) construct. The resulting artifact is what we call an ontology.

Other definition of ontology: a computer-based, shared, agreed formal conceptualization is known as an ontology.


World
Organisation
Information System
Interpretation
Design Tool
Conceptual Schema
Designer
Generates
Computerised Information System
Agreement
Domain Expert
DB Schema
APPLICATION
DBMS
Users
Socio-technical Information System
DB

The study of the categories of *things* that exist or may exist in some domain.

What concepts do exist ?

How are concepts related to each other ?

How are concepts subdivided according to differences and similarities ?

Ontologies in Computer Science

- In summary: Semantics = Agreed Meaning
  - Links symbols in autonomously developed systems to shared reality
  - Agreed among humans as cognitive agents
  - Stored in ontologies
    - key technology for interoperability (SemWeb)
    - ontologies ≠ data models, but provide annotations for them
    - support both human- and system-based reasoning

Ontologies in Computer Science

- The problem is not so much what ontologies in computer science are, but how ontologies come to be.
- An ontology is the result of a series of interaction leading to agreements to a better approximation of a communities perceived reality, often for a specific goal.
- This goal is defined by the community’s semantic interoperability requirements

Challenges — Reusability vs. usability

- Ontologies contain references to the instances used in the application or application domain, and domain rules.
  - Domain rules typically contain constraints of identity, cardinality, mandatoriness, etc. and thus restrict the semantics (i.e. interpretation) in a specific conceptualization of a particular application domain.
  - Depending on the semantic interoperability requirements, domain rules can be crucial. E.g., conceptual reference structures.
  - Providing more rules, however, also reduces the generality of these ontologies.

Challenges

Context of application

- Tension field Web of Data >< Enterprise Information Management (EIM)
- Describing existing (legacy) data can be done with lightweight ontologies.
- However, as more business rules are needed to ensure proper business within the community of stakeholders, EIM will be applied to capture the requirements on how and under what conditions data will be exchanged.

Challenges — Context of application

- The Web of Data and EIM are thus residing in two different business domains and have different business drivers.
- Bottom-up (Web Of Data) vs. Top-down (EIM)
- For EIM: vocabulary management is central

Requirements for a Method

- **Community** involvement
- Learn from database modeling methods and techniques:
  - **Technology matures**
  - **Analyzing natural language discourse**
  - **Employing legacy data, output reports, interviews, etc.**
  - **Lift data models into ontologies, remove application-specific context**

Part III: Business Semantics Management

Six principles of BSM

- **ICT Democracy**: ontology should be defined by its community
- **Emergence**: semantic interoperability requirements emerge autonomously from community evolution processes
- **Co-evolution**: ontology evolution processes are driven by the changing semantic interoperability requirements
- **Perspective Rendering**: ontology evolution processes must reflect the different stakeholder perspectives
- **Perspective Unification**: relevant parts of the various stakeholder perspectives serve as input for the unified perspective
- **Validation**: validating ontology against these perspectives

A Brief History ...

- 1995. VUB STARLab was founded
- 1999. DOGMA Ontology Engineering *Framework*
- 2006. DOGMA-MESS
  - Meaning Evolution Support System
  - A method built on top of DOGMA
- 2008. Business Semantics Management (BSM) (DOGMA-MESS revisited)
- 2008. Collibra was founded
- *2010. Research in social processes in OE*

Developing Ontology Guided Methods and Applications

- Fact-oriented. Communication of elementary fact-types by analyzing natural language discourse. Fact-types are “generalizations” of facts.
  - [Person] knows [Person] is a fact-type. [Christophe] knows [Pieter] a fact.
  - Elementary means fact-types can not be broken down (atomic)
- Lexon Base. A vast base of **plausible** binary fact-types called lexons.

Different from frame-oriented approaches!

Developing Ontology Guided Methods and Applications

- Lexons

Plausible in domain!

Person having Name

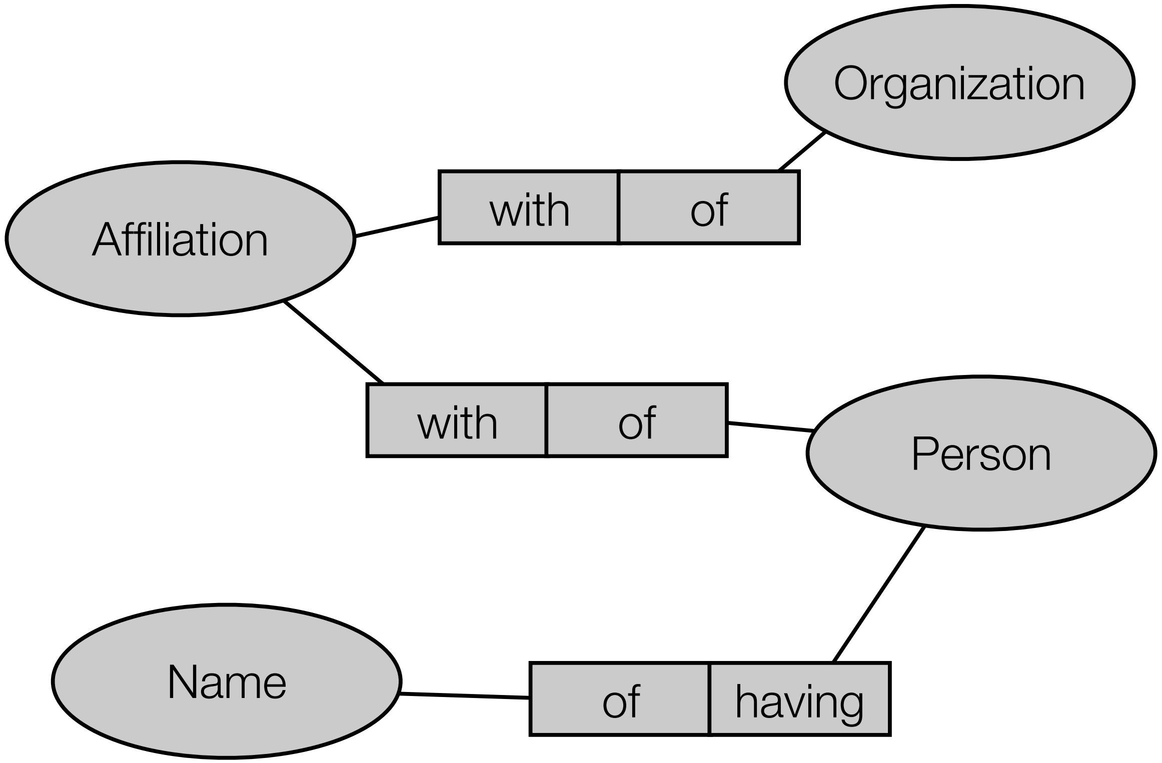
<CERIF Community, Person, having, of, Name>

Name of Person

Holding within a community!

Developing Ontology Guided Methods and Applications

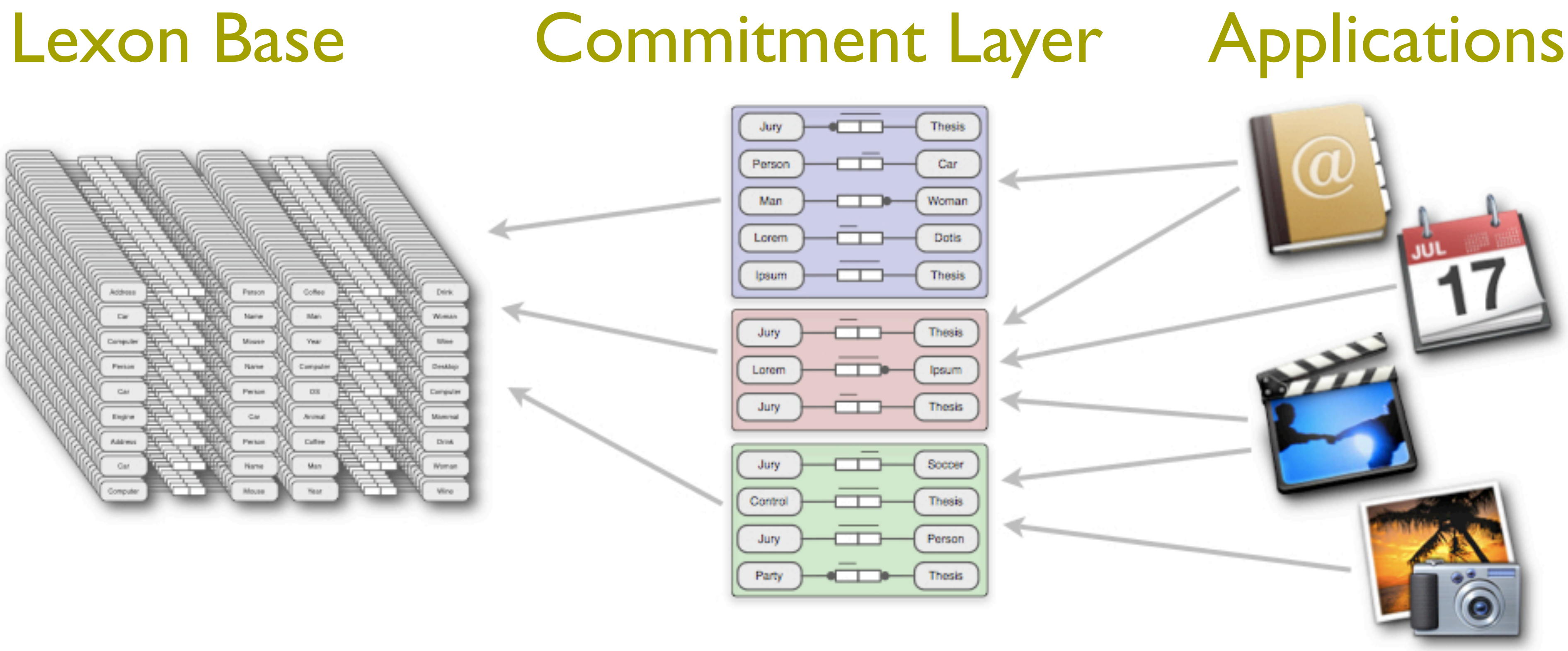
- Lexon paths



Developing Ontology Guided Methods and Applications

- Commitments are selections of the lexon base with constraints to represent the domain
  - *Community commitments* contain the selection of lexons and constraints the community is supposed to commit to. He or she engages in - at least - adhering to those agreed upon facts and constraints.
    - Represents the ontology!
  - *Application commitments* furthermore contain annotations of the application symbols

Developing Ontology Guided Methods and Applications



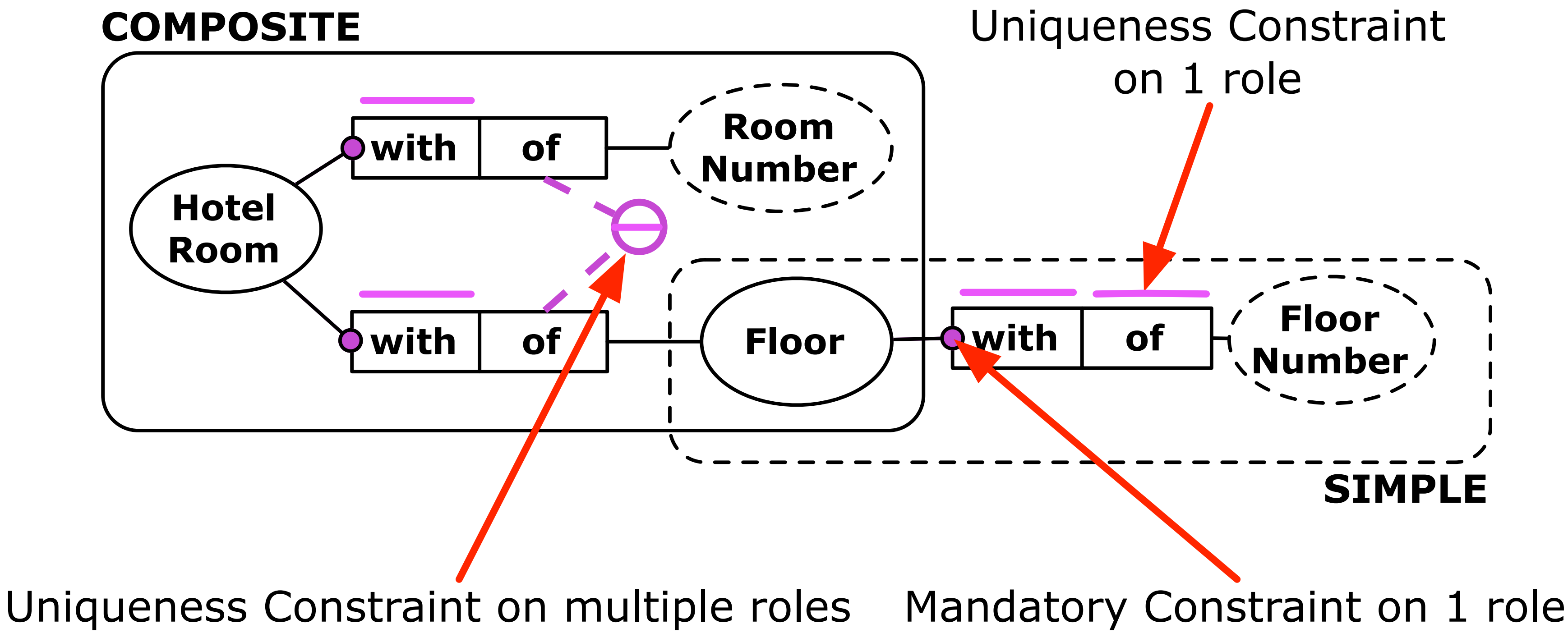
“Double articulation principle”

Developing Ontology Guided Methods and Applications

- Commitments are selections of the lexon base with constraints to represent the domain
  - Community commitments contain the selection of lexons and constraints the community is supposed to commit to. He or she engages in - at least - adhering to those agreed upon facts and constraints.
  - Application commitments furthermore contain annotations of the application symbols

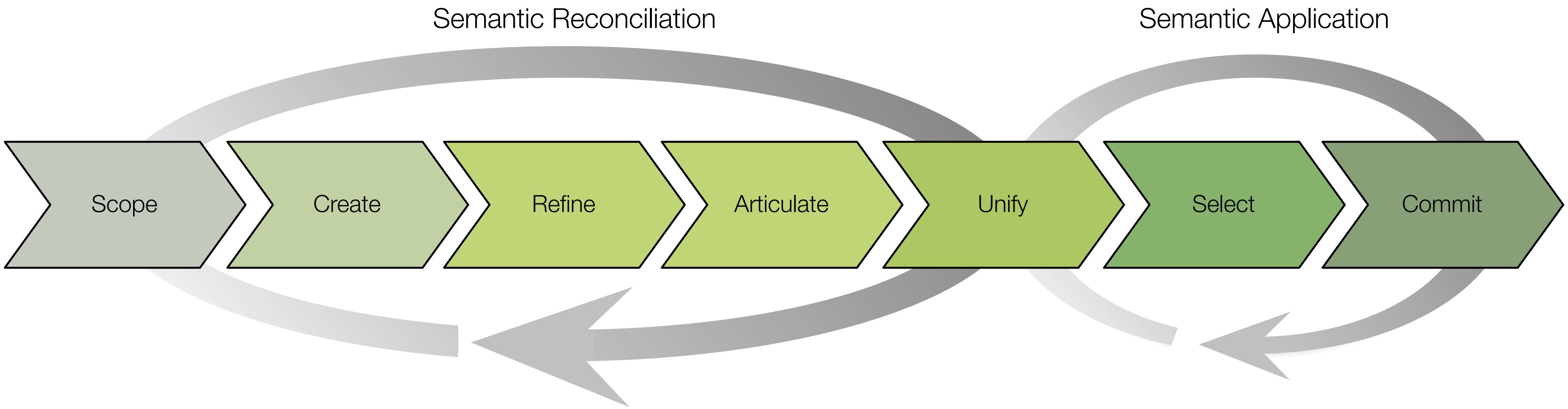
Developing Ontology Guided Methods and Applications

- Importance of domain rules.
- E.g., identification. Unique, total, and identifying set of attributes



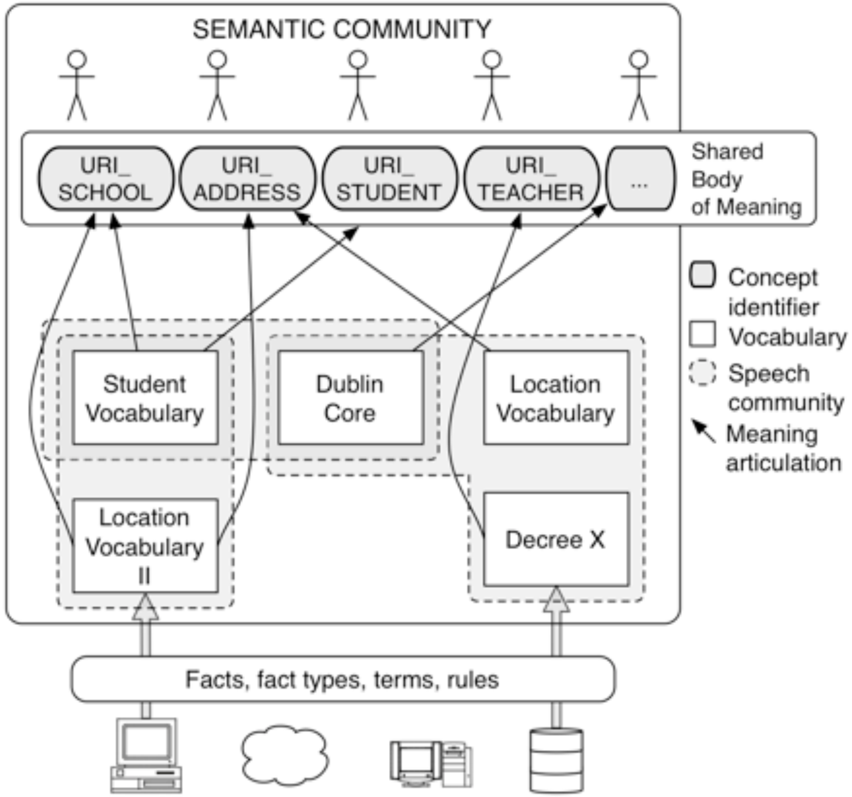
Business Semantics Management

- DOGMA provided the framework
- What is lacking is a method



Modeling communities in BSM

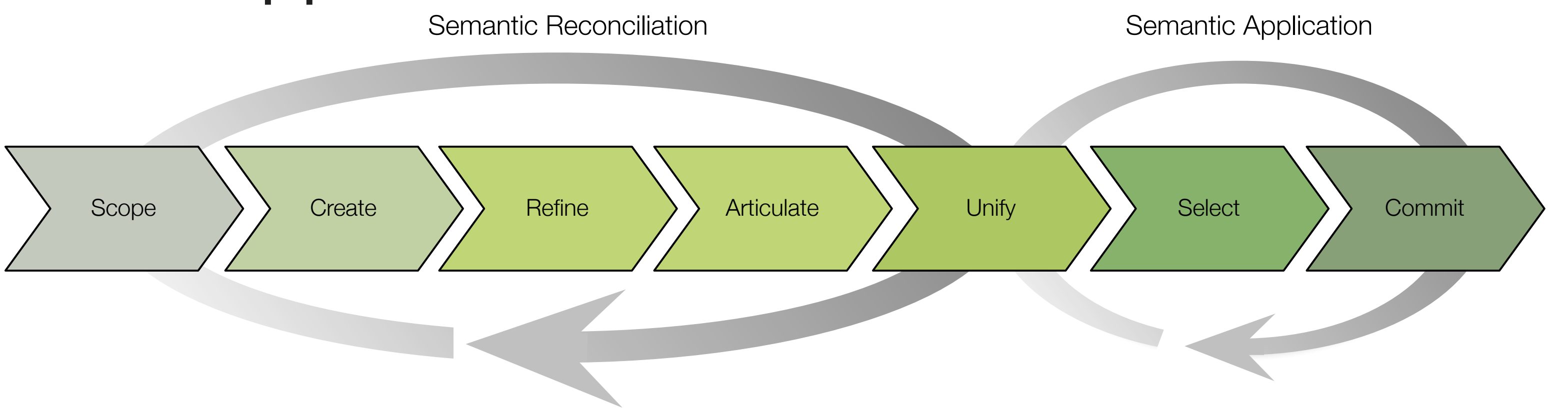
- Semantic communities
- Body of shared meaning
- Speech communities
- Vocabularies

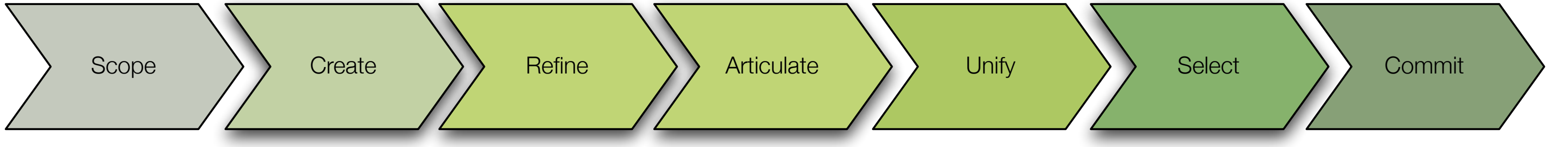


- Vocabularies are part of Speech Communities. Speech communities are part of Semantic communities.
- All information (formal and informal) stored in this system is called a *glossary*.

Semantic Reconciliation

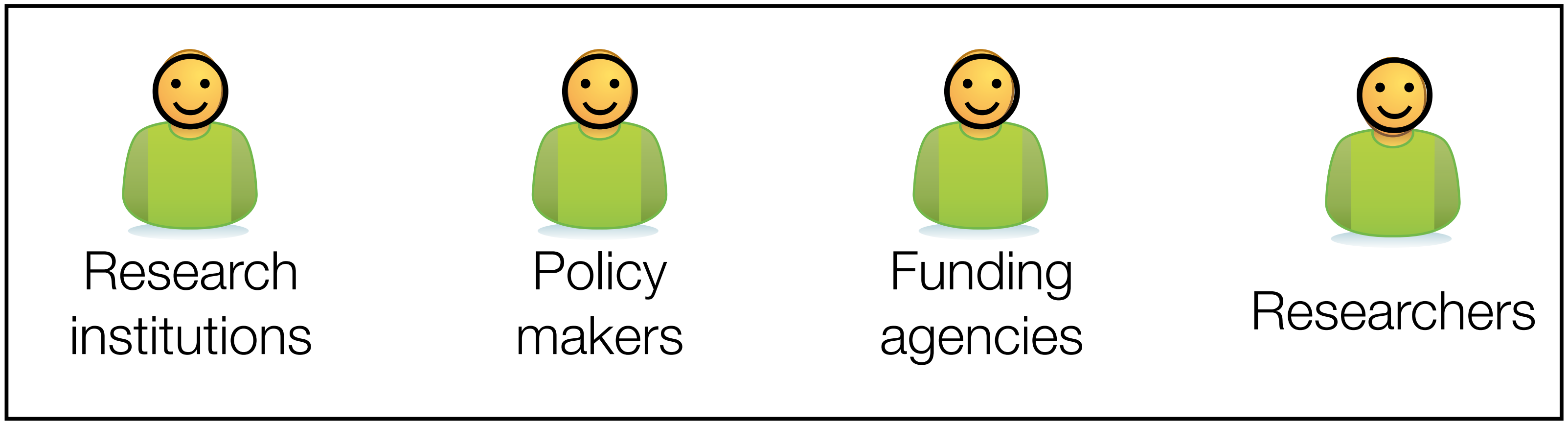
- Semantic Reconciliation. Business semantics are modeled by extracting, refining, articulating and consolidating fact-types from existing sources.
  - Results in a number of consolidated language-neutral semantic patterns (community commitments) that are articulated with informal meaning descriptions
  - These patterns are reusable for constructing various semantic applications.

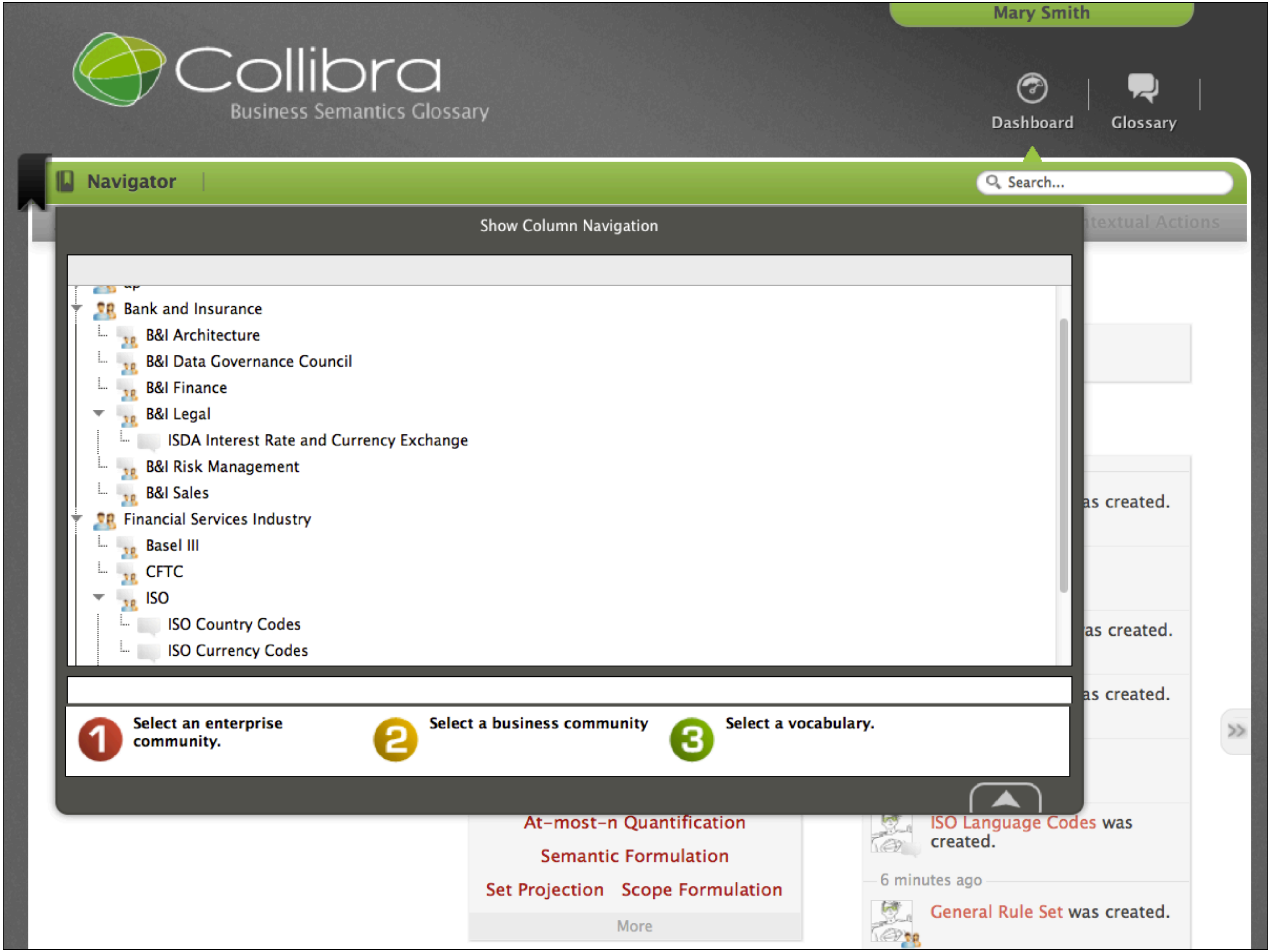


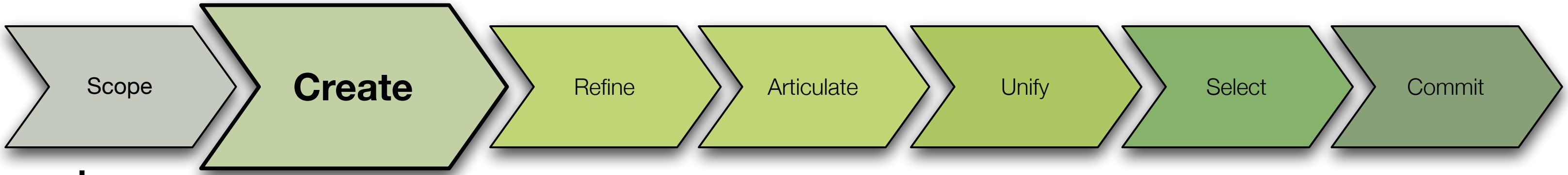


Scope

- Scope sets out the scoped terms that are actually needed to establish semantic interoperability
  - Distinction between an IT- or IS-context and a business context. They imply different kinds of threats
  - Involve the relevant stakeholders in this process and assign them with appropriate roles and responsibilities.




Mary Smith
Collibra
Business Semantics Glossary
Dashboard
Glossary
Navigator
Search...
Show Column Navigation
Bank and Insurance
B&I Architecture
B&I Data Governance Council
B&I Finance
B&I Legal
ISDA Interest Rate and Currency Exchange
B&I Risk Management
B&I Sales
Financial Services Industry
Basel III
CFTC
ISO
ISO Country Codes
ISO Currency Codes
Select an enterprise community.
Select a business community
Select a vocabulary.
At-most-n Quantification
Semantic Formulation
Set Projection
Scope Formulation
More
ISO Language Codes was created.
6 minutes ago
General Rule Set was created.

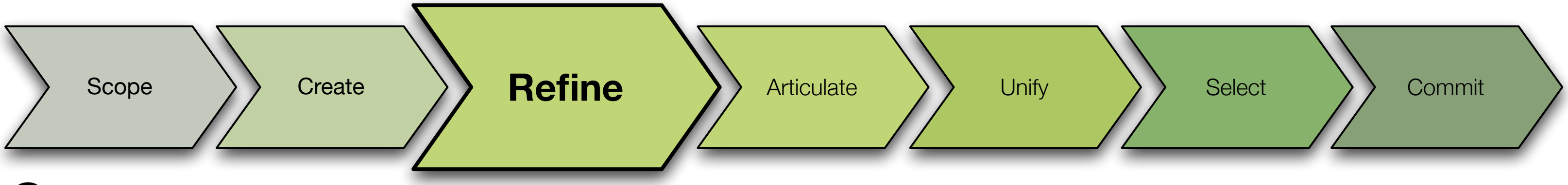


Create

- During this activity, every scoped term is syntactically defined.
  - In the CERIF Project Community
    - CFProject executed by / executes CFOrganiza
    - CFPerson having / of Person_Name
    - CFPerson having / of CFPersonAddress
    - CFPersonAddress of / used in CFAddress
    - EACH CFPerson having EXACTLY ONE Person_Name
    - ...

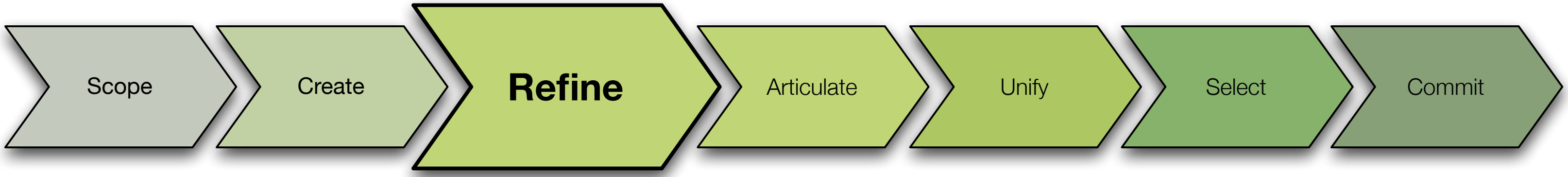
kijkt naar DOGMA METHODE DOCUMENT MET WIJN VOORBEELD

INTERACTIVITEIT VOORZIEN



Refine

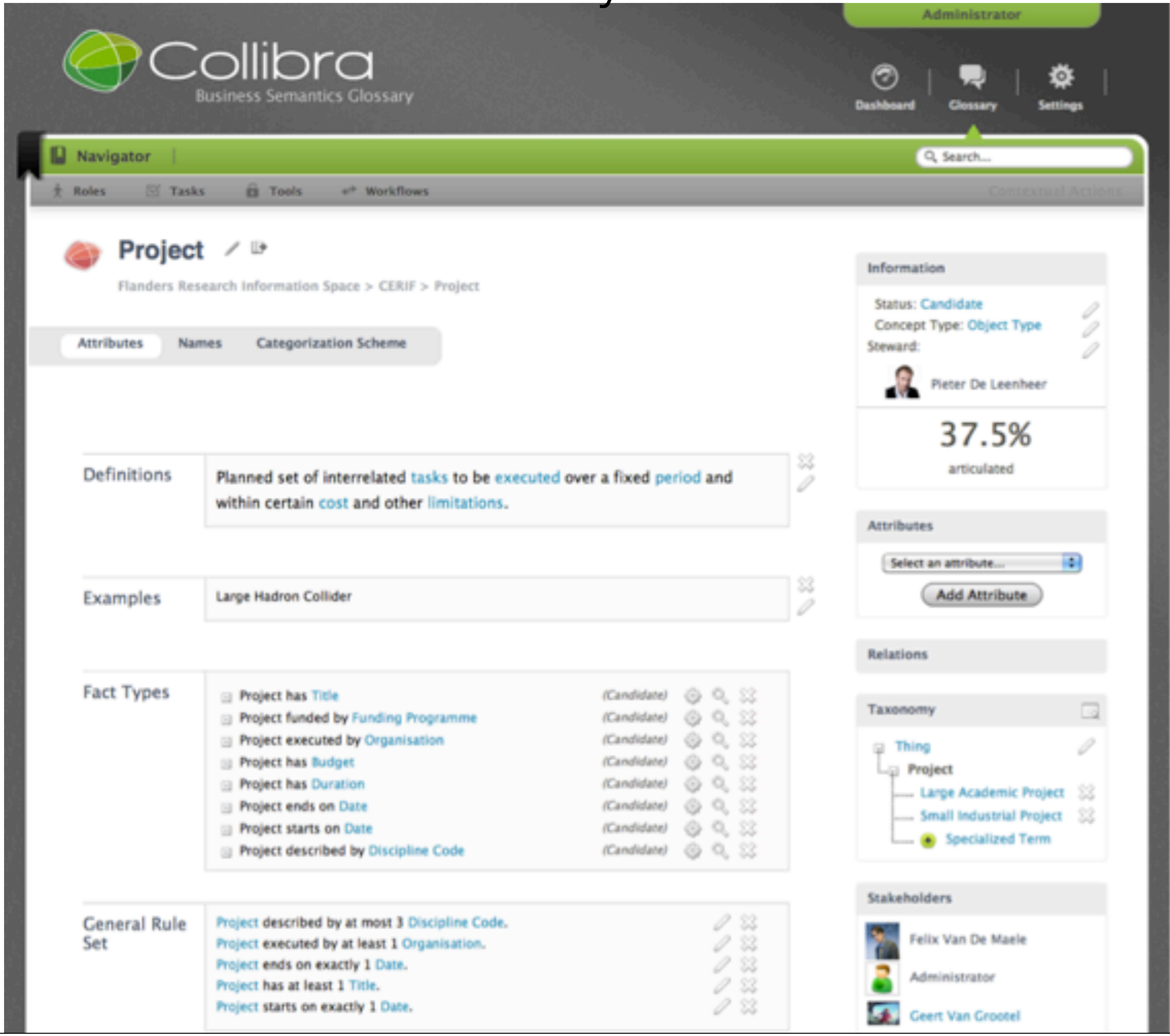
- During this activity, fact types that were created during the Create activity are refined so they are understandable to both business and technology
- CURE: Correct, Useful, Reusable, Elegant
- Objectification
- Capture missing link

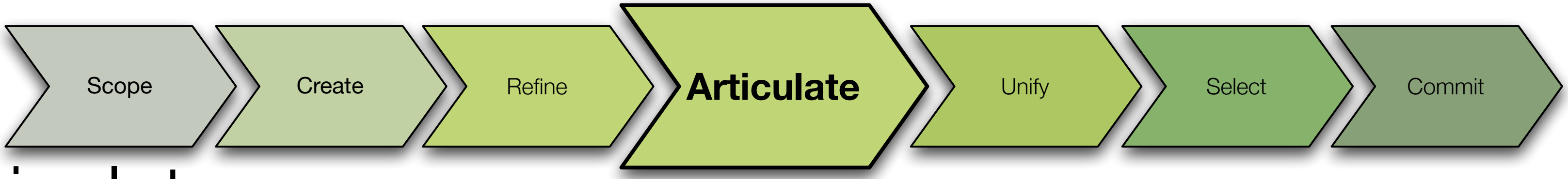


Refine

- In the CERIF Project Community
  - Project executed by / executes Organization
  - Person having / of Person_Name
  - Person located at / locates Address
  -
  - EACH Person having EXACTLY 1 Person_Name
  - ...

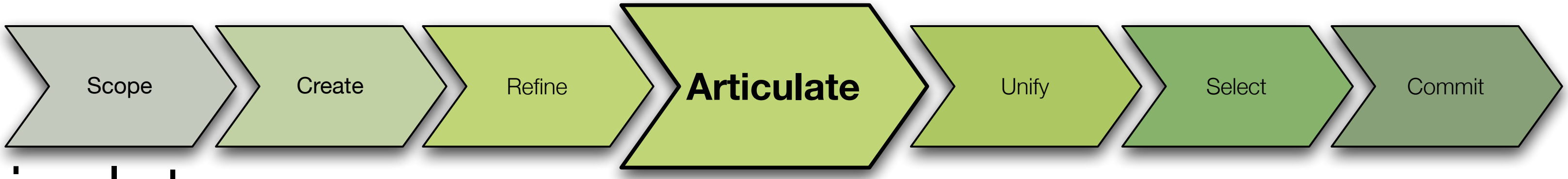
Business Semantics Glossary



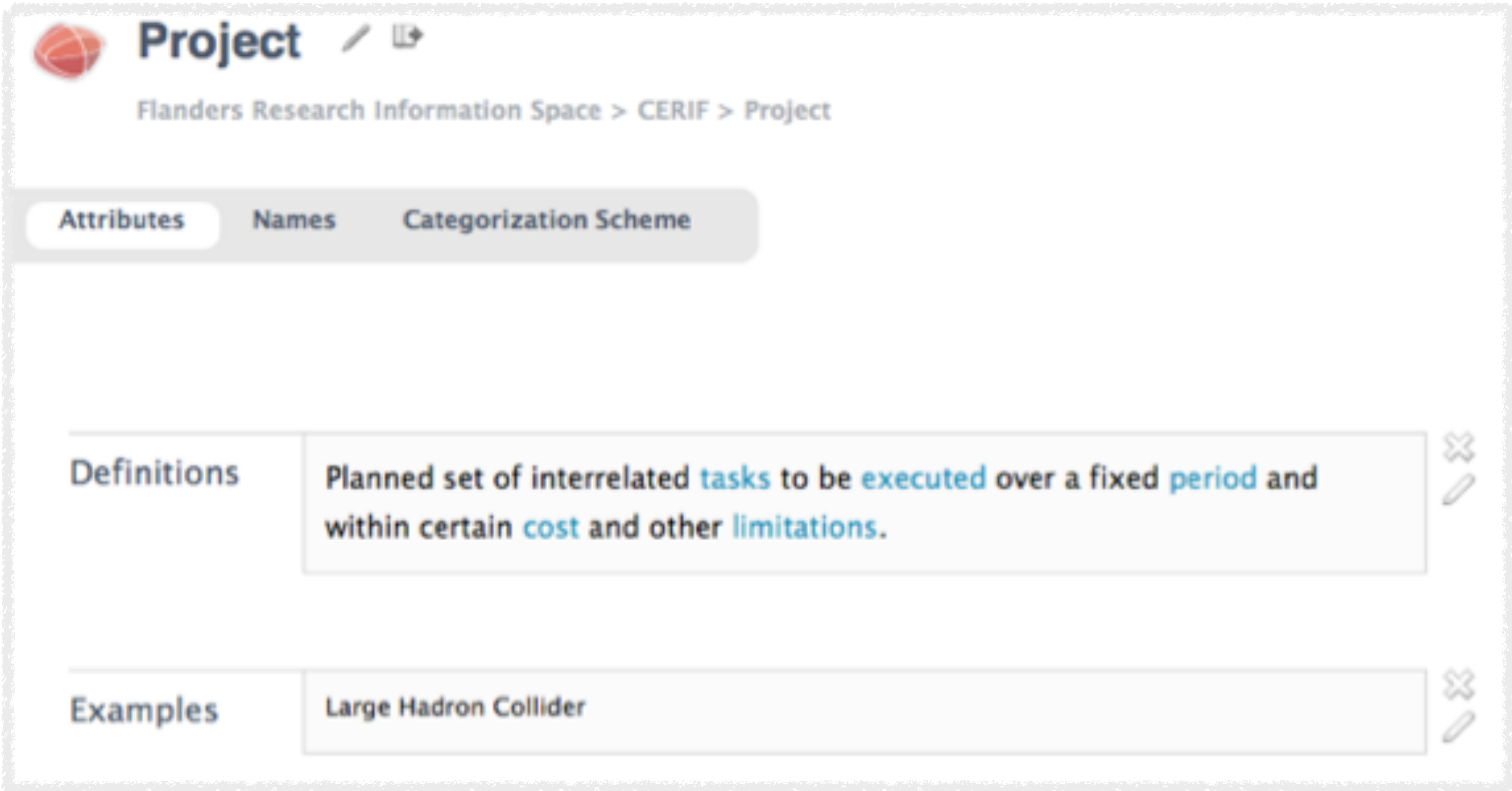


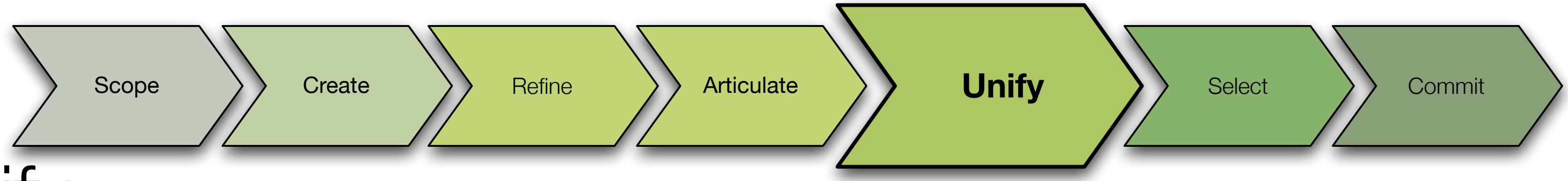
Articulate

- Create informal meaning descriptions as extra documentation.
- Include definitions and examples.
- serve as anchoring points when stakeholders have used different terms for the same concepts (i.e., detecting synonyms).
- Where available, descriptions already existing can be used (e.g., the euroCRIS website on CERIF) to speed up the process and facilitate reuse.


Scope
Create
Refine
Articulate
Unify
Select
Commit

Articulate


Project
Flanders Research Information Space > CERIF > Project
Attributes
Names
Categorization Scheme
Definitions
Planned set of interrelated tasks to be executed over a fixed period and within certain cost and other limitations.
Examples
Large Hadron Collider



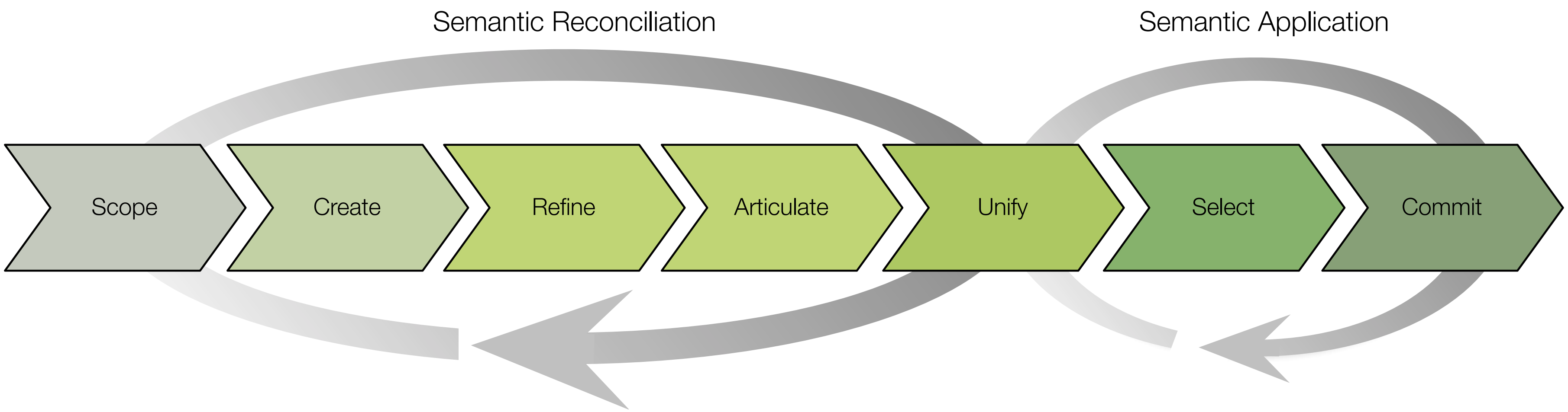
Unify

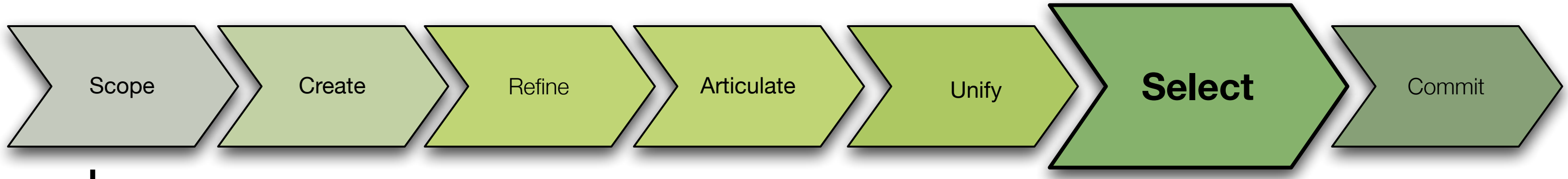
- A new version of the glossary is generated, which is a “flattened” version of the community commitment that is generated in a timely manner.
- The glossary is the product of semantic reconciliation and serves as a uniform technical specification to implement semantic applications.
- This glossary can be represented in many formats, such as UML, OWL, or XSD, serving a wide variety of applications.*

* The how is out of the scope of this lecture. However, feel free to contact us after the lecture for more information.

Semantic Application

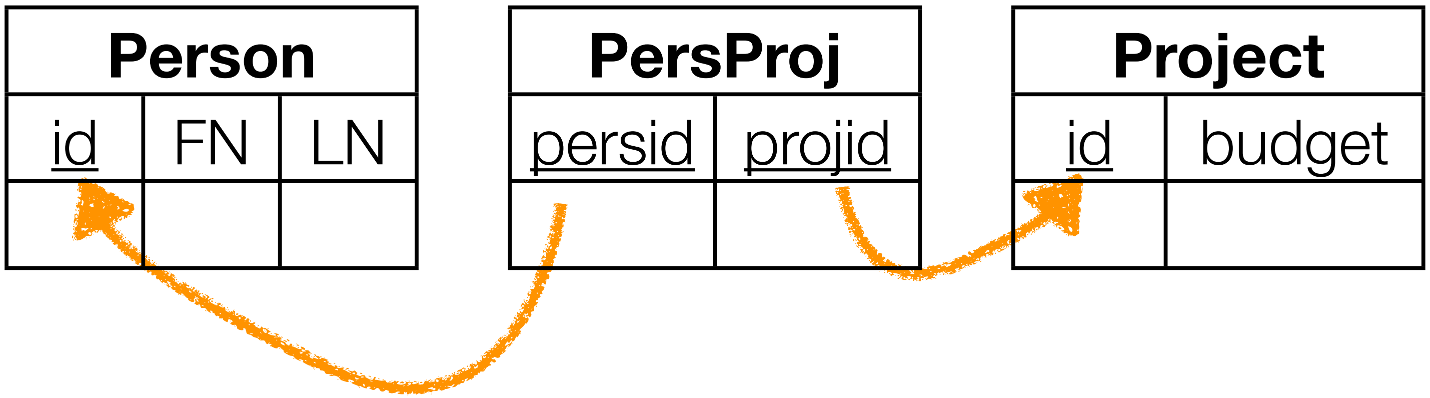
- Semantic Application. Existing information sources and services are committed to a selection of semantic patterns.
  - I.e., creating application commitments
  - The existing data itself is not moved nor touched!

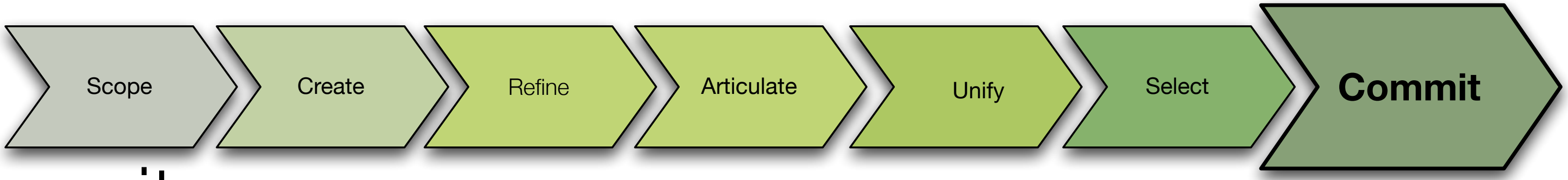




Select

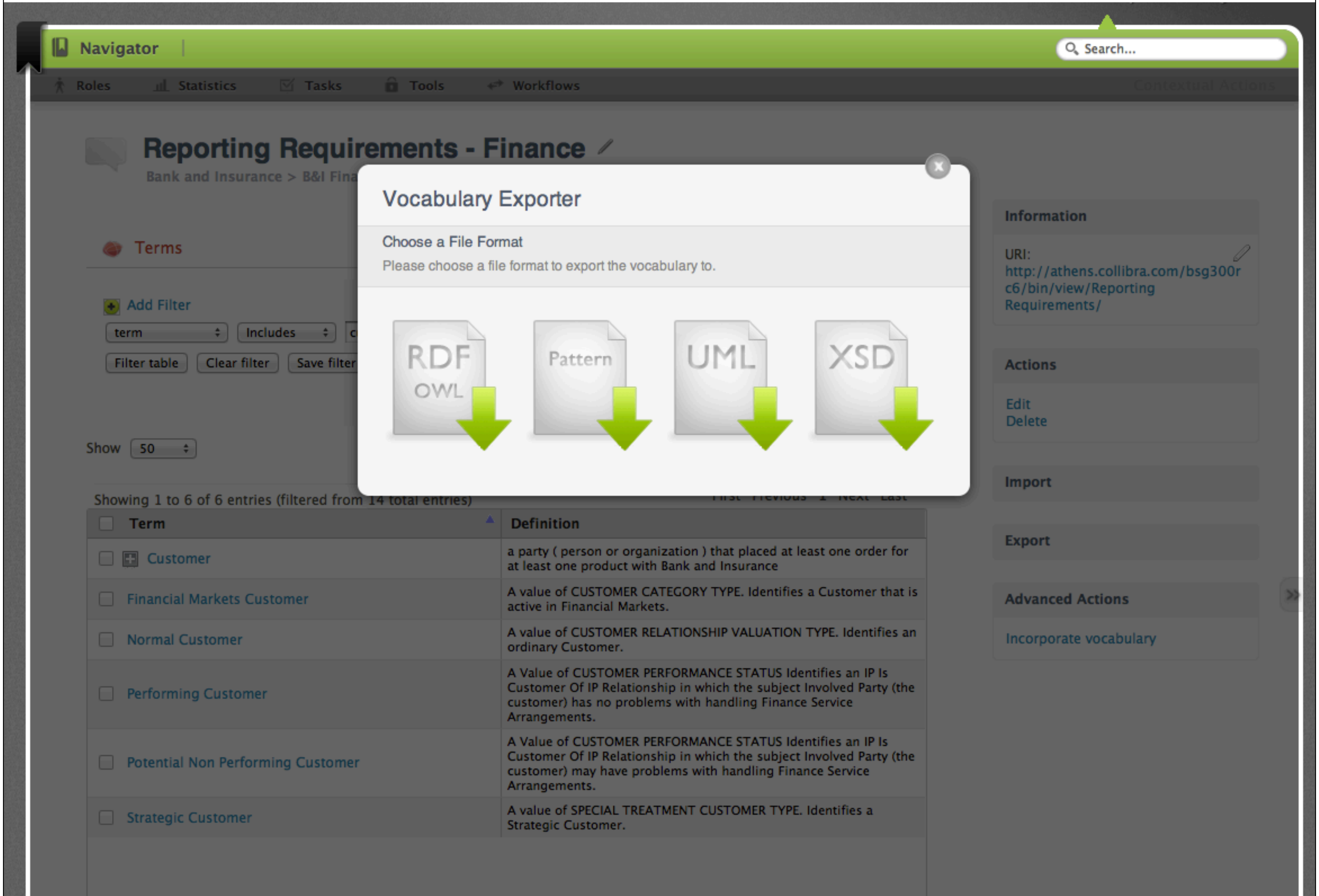
- Given an application context (such as a workflow or business artifact), relevant concepts are selected from the EIM for a particular application. It may be required to add additional application-specific concepts and constraints that could not be agreed upon on the community level.
- Anyone an idea of an example of application specific concepts and constraints?





Commit

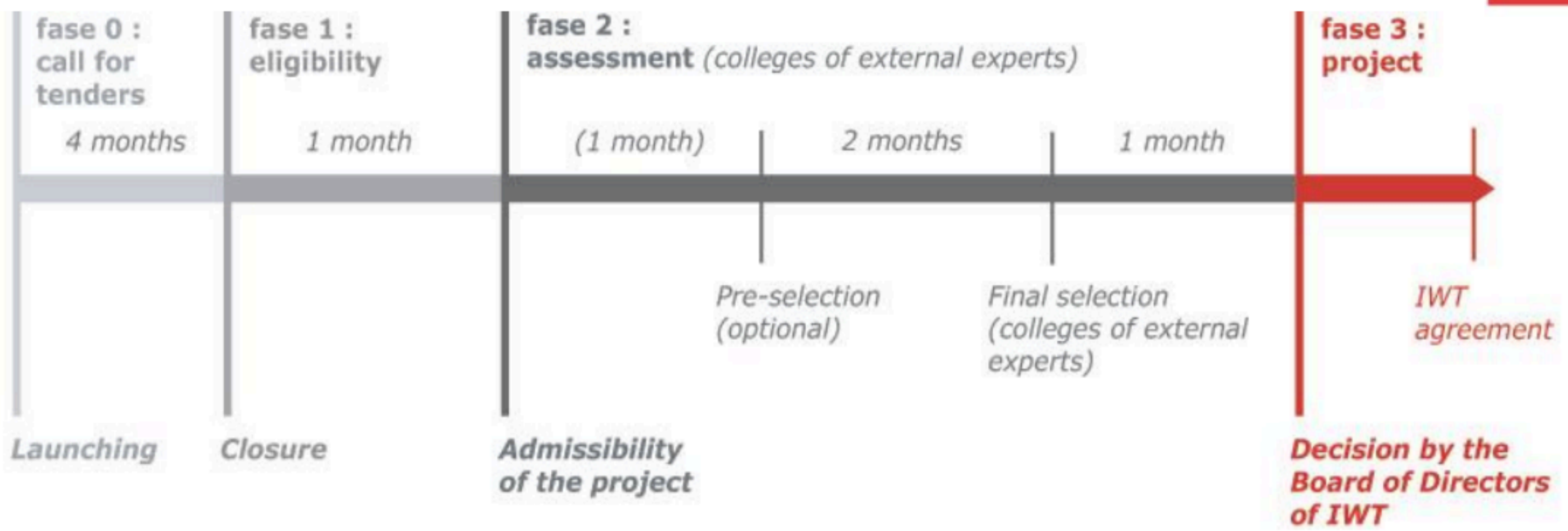
- Information systems are improved using the selected concepts. Depending on the application context, this can be implemented in different ways.
- Concretely, this boils down to data transformation, validation, and governance services. For example:
  - Integrating two or more XML structures by defining XSLT transformations to a shared XSD-formatted EIM.
  - The EIM may also be used to convert relational databases into RDF triple stores.



Navigator
Search...
Roles
Statistics
Tasks
Tools
Workflows
Reporting Requirements - Finance
Bank and Insurance > B&I Fina
Terms
Add Filter
term
Includes
Filter table
Clear filter
Save filter
Show 50
Showing 1 to 6 of 6 entries (filtered from 14 total entries)
Term
Definition
Customer
a party (person or organization) that placed at least one order for at least one product with Bank and Insurance
Financial Markets Customer
A value of CUSTOMER CATEGORY TYPE. Identifies a Customer that is active in Financial Markets.
Normal Customer
A value of CUSTOMER RELATIONSHIP VALUATION TYPE. Identifies an ordinary Customer.
Performing Customer
A Value of CUSTOMER PERFORMANCE STATUS Identifies an IP Is Customer Of IP Relationship in which the subject Involved Party (the customer) has no problems with handling Finance Service Arrangements.
Potential Non Performing Customer
A Value of CUSTOMER PERFORMANCE STATUS Identifies an IP Is Customer Of IP Relationship in which the subject Involved Party (the customer) may have problems with handling Finance Service Arrangements.
Strategic Customer
A value of SPECIAL TREATMENT CUSTOMER TYPE. Identifies a Strategic Customer.
Vocabulary Exporter
Choose a File Format
Please choose a file format to export the vocabulary to.
RDF OWL
Pattern
UML
XSD
Information
URI:
http://athens.collibra.com/bsg300rc6/bin/view/Reporting Requirements/
Actions
Edit
Delete
Import
Export
Advanced Actions
Incorporate vocabulary

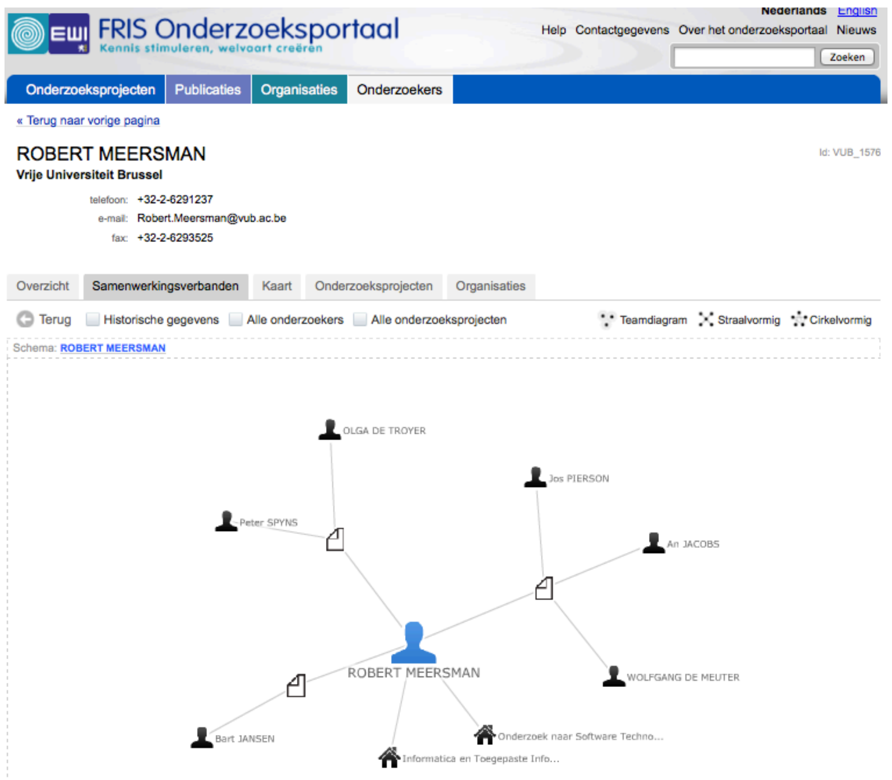
Semantic Interoperability Between Actors

- FRIS Ecosystem. Funding agencies wish to form appropriate review boards.
- IWT: “bottleneck lies in defining varying review boards with no conflict of interest”

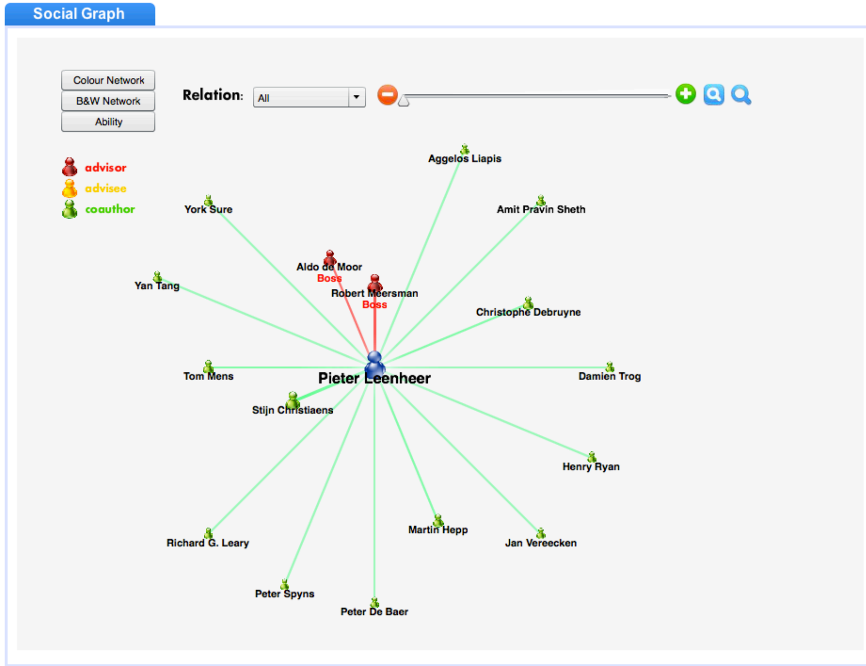


Optimize Review Cycle by Automating Error-prone Tasks

Experts who are a **party concerned** in one of the project proposals are excluded from participating in the colleges of experts. Next to this, experts who are not party concerned, but have an affiliation with a division/service/department identical to that of one of the applicants, **may not take part** in the assessment of the corresponding projects.



http://researchportal.be/person/robert-meersman-(VUB_1576)/collaboration.html#tabs



http://arnetminer.org/person/-680689.html

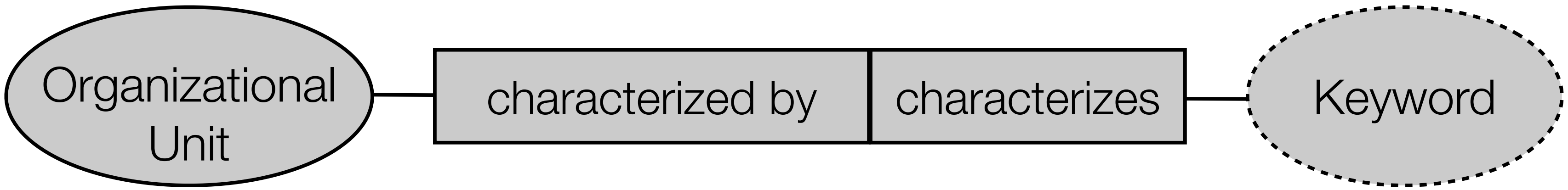
in collaboration with P. Malarme (Collibra)

Towards Linked Data for FRIS

- Modeling ontologies have several advantages
  - Fact-types and constraints are easily verbalized
  - No distinction between entities and relations (fact-oriented, rather than frame-oriented)
  - Grounded in natural language
- Disadvantages?
  - Based on FOL --> Decidability
  - No everything can be modeled (e.g., procedures).

Towards Linked Data for FRIS

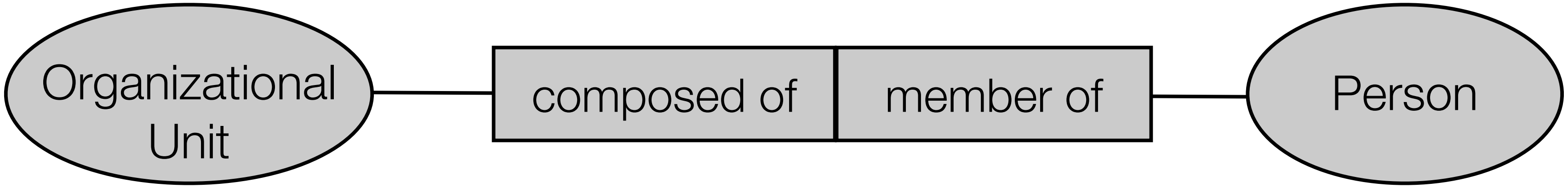
- Translating community commitments into OWL DL is fairly straightforward.




```
<owl:DatatypeProperty
rdf:about="#Organizational_Unit_characterised_by_Keyword">
 <rdfs:label>characterised by Keyword</rdfs:label>
 <rdfs:domain rdf:resource="#Organizational_Unit"/>
 <rdfs:range
  rdf:resource="http://www.w3.org/2000/01/rdf-schema#Literal"/>
```

Towards Linked Data for FRIS

- Translating community commitments into OWL DL is fairly straightforward.




```
<owl:ObjectProperty
 rdf:about="#Organizational_Unit_composed_of_Person">
 <rdfs:label>composed of Person</rdfs:label>
 <rdfs:domain rdf:resource="#Organizational_Unit"/>
 <rdfs:range rdf:resource="#Person"/>
 <owl:inverseOf
  rdf:resource="#Person_member_of_Organizational_Unit"/>
 </owl:ObjectProperty>
```

Towards Linked Data for FRIS

- Datasources are annotated with the ontology
- By means of of-the-shelve solutions for “triplifying” relational databases to RDF triples (cfr. RDB2RDF community)

SPARQL:

```
PREFIX db: <http://starpc14.vub.ac.be:2020/resource/>
PREFIX person: <http://starpc14.vub.ac.be/ontologies/person.owl#>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
PREFIX orgunit: <http://starpc14.vub.ac.be/ontologies/organization.owl#>
PREFIX v: <http://www.w3.org/2006/vcard/ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX project: <http://starpc14.vub.ac.be/ontologies/project.owl#>
PREFIX d2r: <http://sites.wiwiss.fu-berlin.de/suhl/bizer/d2r-server/config.rdf#>
PREFIX map: <file:/usr/local/d2r-server-0.7/vub.starlab.gospl.glosses.ewicase/ewi.n3#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX vocab: <http://starpc14.vub.ac.be:2020/vocab/resource/>
```

```
SELECT DISTINCT ?first_name ?last_name WHERE {
?person person:Person_having_First_Name ?first_name.
?person person:Person_having_Last_Name ?last_name.
?affiliation orgunit:Affiliation_of_Person ?person.
?affiliation orgunit:Affiliation_of_Organizational_Unit ?org.
?org orgunit:Organizational_Unit_has_Name "Informatica en Toegepaste Informatica"@nl.}
LIMIT 10
```

Results: Browse Go! Reset

SPARQL results:

first_name	last_name
"JEROEN"	"HOPPENBROUWERS"
"Sara"	"JANSSENS"
"Nina"	"LANDAU"
"FENG"	"LIU"
"Leen"	"RYMENANS"
"Eric"	"TANTER"
"Damien"	"TROG"
"ANTONIO"	"VALLEJOS VARGAS JORGE"
"Tom"	"VAN CUTSEM"
"SVEN"	"VAN SEGBROECK"

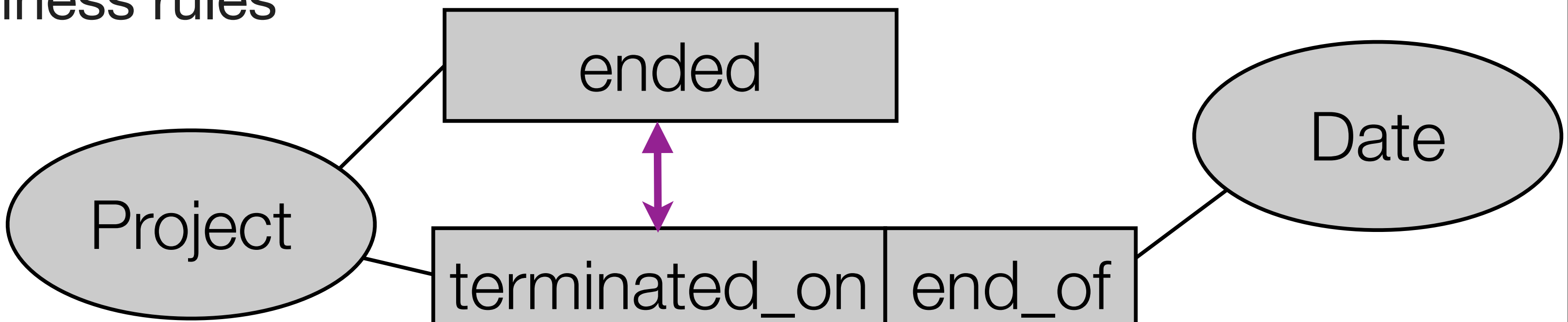
But that’s not all ...

Business Semantics Management

- From a high-level perspective, three different kinds of data exchange exist within large organizations:
  - Exchange of knowledge between people;
  - Exchange of understanding between people and information systems;
  - Exchange of data between disparate information systems.
- We presented the application of BSM for Semantic Interoperability

Business Semantics Management

- In the context of this lecture, we limited ourselves to binary fact-types in the example
- BSM, however, adopted SBVR. SBVR is an OMG standard providing - amongst others - means for:
  - Including “named” instances
  - Modeling n-ary fact-types
    - Unary fact-types: [Proposal] is accepted, [Project] is running
    - Unary fact-types are useful for describing “dynamic” business rules



Conclusions

- Presented an application of BSM the EIM method within the Flemish Government for Semantic Interoperability and Linked Data
- The role of conceptual modeling and some tension fields
- A notion of fact-orientation

Future work?

- Grounding Ontologies with Social Processes and Natur
  - Hy
- Analy
  - exp of i
- Explo grour

Community	null	chdebru@vub.ac.	jvchaute@vub.ac.	steven.adriaensen	ktanaka@vub.ac.b	gvershu@vub.ac	bceulem@vub.ac	hedarisheid@	akafazis@vub.ac.b	jeanen@vub.ac.	pstroba@vub.ac.	dhong@vub.ac.be	iaambat@vub.ac.	svlaere@vub.ac.b	cvameyl@vub.ac.	necibe.anat@vub.	fmarin@vub.ac.b	ncostvo@vub.ac	jepen.heymans@	svdevat@vub.ac	kroppe@vub.ac.b	nicolaslarea@gma	jsvalkens@vub.ac.	acalij@vub.ac.be	zahmadi@vub.ac.	maxime@vub.ac.	srivash@vub.ac.b	cedric.ovenee	andrei-manuel.	mali.lo@hotmail.	dtlinc@vub.ac.b	pikalai@gmail.com	wnerses@vub.ac	wrossen@vub.ac	olivier@olympia	nikvanmechelen@	mattij@vub.ac.b	kcevic@vub.ac.	gginde@vub.ac.	eenish@vub.ac.	droogh@vub.ac	mattgoos@vub.ac	sielenc@vub.ac.	sam.leland@ve	renoux@vub.ac.b	Total
Album Community	0	0	1	0	0	1	21	18	0	2	0	0	12	0	5	0	2	0	40	15	0	9	5	0	0	3	0	0	1	2	0	1	1	0	0	0	0	55	0	19	0	0	0	0	0	213
Artist Community	0	0	2	5	0	4	86	7	0	5	0	0	7	0	0	0	0	17	11	7	1	11	8	0	0	1	0	0	1	0	0	0	1	1	0	0	0	20	14	1	0	1	3	0	0	214
Category	0	0	0	16	0	0	0	0	0	0	0	0	0	1	7	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	29
Cinema Community	0	0	0	0	0	0	0	0	39	0	0	0	19	0	8	0	53	0	0	0	0	0	0	0	0	0	5	0	1	15	0	1	1	0	13	0	0	0	0	0	0	0	0	0	0	155
Color Community	0	0	0	36	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	1	0	0	0	0	0	0	46
Comment Community	0	0	31	2	0	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	23	13	1	0	0	0	0	0	143
Concert Community	0	0	0	1	0	0	36	41	0	19	0	0	4	0	15	4	0	34	0	104	3	1	25	0	0	0	0	0	1	0	0	1	0	0	0	0	0	4	2	3	0	0	0	0	0	298
Contact	0	0	0	0	0	0	0	0	34	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	67
Coordinate Community	0	0	0	3	6	0	9	0	0	3	40	0	0	20	0	0	0	0	43	0	0	0	7	0	0	0	0	0	1	0	0	0	0	4	0	1	0	13	0	0	0	0	0	0	0	150
Date and Time Community	0	4	8	40	10	3	0	1	6	20	7	1	1	100	85	0	15	10	18	0	7	0	0	7	0	0	1	3	1	0	15	1	1	20	4	4	0	9	7	0	0	1	0	0	0	410
Date and Time Intervals Com…	0	0	10	6	0	15	0	1	0	0	1	0	0	4	0	0	0	0	2	0	0	0	3	0	0	0	0	8	1	0	21	0	0	0	0	15	5	6	55	1	0	0	0	0	0	154
Dimensions Community	0	0	0	75	0	0	1	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	114
Division Community	0	0	0	0	8	0	11	0	0	0	22	0	0	22	2	0	0	13	19	0	2	0	8	0	0	0	0	0	1	0	18	0	1	7	1	0	0	0	0	0	0	0	0	0	0	135
Event Community	2	0	1	106	1	4	3	0	0	0	3	0	0	5	1	1	0	2	0	1	5	0	5	0	0	2	0	2	4	0	11	0	2	3	1	11	4	6	0	1	0	0	0	0	0	187
Exposition Community	0	0	0	137	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	7	36	0	9	0	2	0	8	0	0	0	0	0	0	0	0	0	1	0	0	0	0	205
Exposition Items Community	0	0	0	158	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	14	0	0	0	0	0	0	0	0	0	1	0	0	0	0	177
Facility community	0	0	141	0	0	78	2	1	0	0	0	1	0	1	5	0	0	72	1	10	29	0	7	0	0	140	1	0	1	0	1	0	1	1	2	0	0	92	7	1	0	0	9	2	0	606
Festival Community	0	0	123	1	0	26	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	33	9	0	0	1	0	0	0	196
Genre	0	0	0	2	0	0	3	15	0	3	0	0	0	0	0	0	2	1	0	2	0	4	0	0	0	0	0	0	3	0	0	0	1	0	14	0	0	0	0	6	0	0	0	0	0	56
Instrument Community	0	0	13	0	0	6	17	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	23	56	10	0	0	0	0	0	148
Item Community	0	0	0	444	1	0	4	0	0	0	0	0	0	0	0	1	0	2	0	0	0	1	0	0	1	0	0	1	31	0	25	0	0	0	0	0	0	3	0	1	0	0	0	0	1	516
Lan-party	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	345	244	0	0	0	0	0	0	0	0	591
Language	0	0	0	0	21	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	3	0	0	0	0	0	0	0	0	36
Location Community	0	0	8	15	1	0	12	1	0	6	42	1	2	14	0	0	0	0	14	2	0	2	10	0	0	0	0	2	1	0	4	0	0	2	0	3	0	4	0	1	0	0	0	0	0	147
Media Community	0	0	3	1	16	2	0	0	0	0	1	0	4	2	3	59	0	2	1	0	1	0	0	0	0	0	0	0	1	0	2	0	0	1	3	3	1	22	0	1	0	0	0	0	0	129
Monetary Community	0	0	0	15	0	0	0	1	1	3	3	1	0	4	6	0	0	4	13	0	2	0	4	0	0	1	0	0	4	0	2	0	0	36	0	1	10	13	0	0	0	1	2	0	0	127
Movie community	0	0	0	2	0	0	1	0	22	0	0	0	46	0	0	0	77	0	1	0	0	0	0	0	0	0	11	0	1	25	0	0	83	0	132	0	0	1	0	1	0	0	0	0	0	403
News Community	0	0	31	1	0	31	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	143	29	0	0	0	0	0	0	243
Organization Community	0	0	0	11	5	0	0	6	0	0	13	0	0	28	11	1	0	13	14	11	13	7	0	6	0	0	0	0	1	0	0	0	0	7	0	0	0	0	0	14	0	0	0	0	0	161
Part	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	8
Person Community	0	0	9	25	19	4	8	0	7	4	0	1	11	0	0	1	9	0	25	0	12	9	0	0	0	0	7	0	1	3	1	0	0	7	0	3	0	27	0	4	1	1	4	0	0	203
Photography Community	0	0	0	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52
Place Community	0	0	0	1	2	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	11
Press-work	0	0	0	1	1	0	0	0	0	0	0	0	0	0	33	0	0	6	0	0	54	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	97
Price	0	0	1	0	0	0	0	3	0	0	2	0	0	3	0	0	0	9	5	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	6	2	0	2	0	0	5	0	0	41
Publication Community	0	0	0	79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	111
Social Media Community	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	78	0	0	0	0	0	5	0	0	0	0	1	0	11	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	103
Song	0	1	1	2	0	0	28	14	0	0	0	0	2	0	4	4	0	1	0	0	0	56	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	48	0	3	0	0	0	0	0	166
Sponsor community	0	0	10	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	4	3	1	0	0	0	0	0	29
Theatre Community	0	0	0	2	19	0	0	0	0	0	7	0	0	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	53	0	0	0	0	0	0	0	0	0	0	0	140
Ticket Community	0	1	1	5	0	0	6	21	4	3	6	2	5	21	7	0	2	21	5	13	1	1	1	21	12	0	7	0	1	0	3	0	1	7	0	39	20	3	3	3	1	1	0	0	4	252
Track Community	0	0	0	3	0	0	20	94	0	1	1	0	1	0	0	0	7	17	1	0	0	28	1	0	0	0	0	0	1	0	1	0	2	0	0	0	0	65	0	9	0	0	0	0	0	252
Transport Community	0	0	78	0	0	9	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	36	0	0	0	0	0	0	9	5	0	0	0	0	0	0	140
Unit Community	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	112
User Community	0	0	8	1	0	3	0	31	0	0	0	0	0	4	0	7	0	0	20	0	1	20	0	0	1	0	0	0	24	0	0	0	0	11	0	4	1	71	1	1	2	0	0	0	0	211
Venue community	0	0	0	2	4	0	19	0	0	10	0	0	0	0	1	0	0	7	12	2	3	3	74	0	0	4	0	0	1	0	1	0	1	4	4	1	0	7	2	1	0	0	0	0	0	163
booth	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Total	4	6	502	1322	127	275	355	271	120	247	174	17	133	341	217	156	177	301	321	184	154	164	201	48	52	153	48	16	122	83	324	7	105	175	182	448	298	733	207	92	8	9	23	2	6	8910