Technical workshop 1 – Ontologies and Data models

FUNITEC

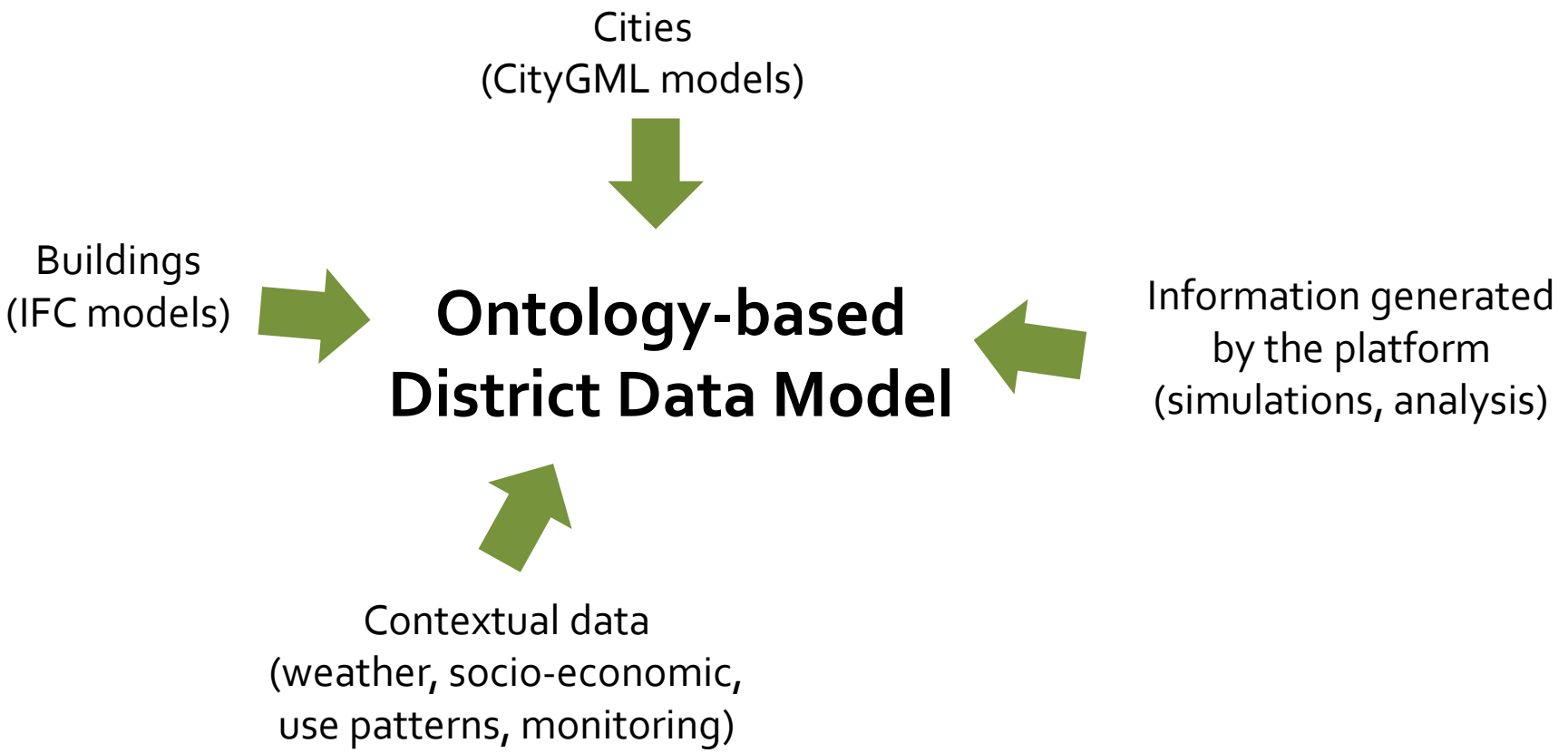
Optimised Energy Efficient Design Platform for Refurbishment at District Level

Optimised Energy Efficient Design Platform for Refurbishment at District Level

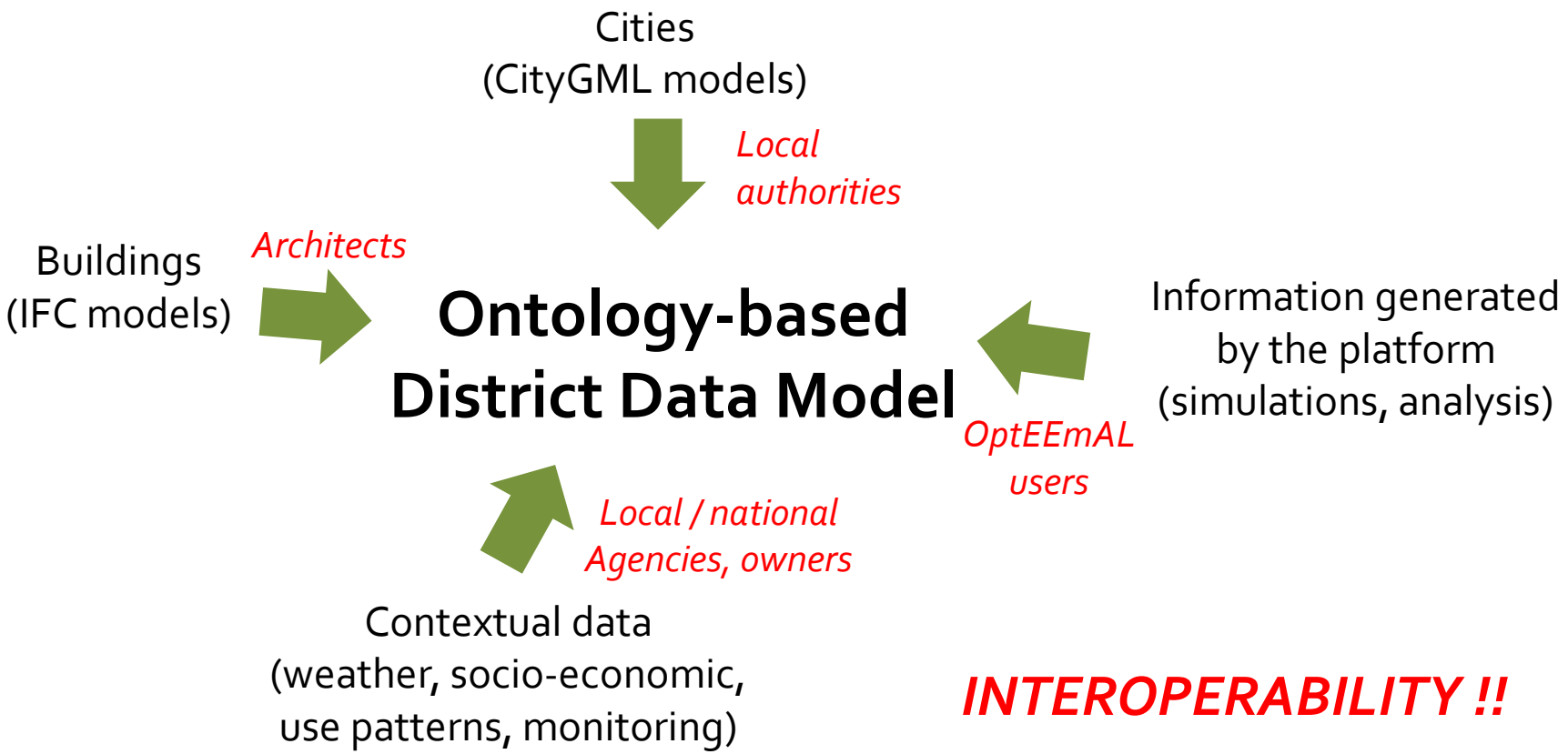
Agenda

- Introduction
- Topic 1: Centralized vs Decentralized approaches
- Topic 2: Ontology-based ECM catalogue
- Topic 3: Versioning
- …

Introduction



Introduction



INTEROPERABILITY !!

Introduction

"The ability of two or more systems or components to exchange information and to use the information that has been exchanged" IEEE 610.12-1990

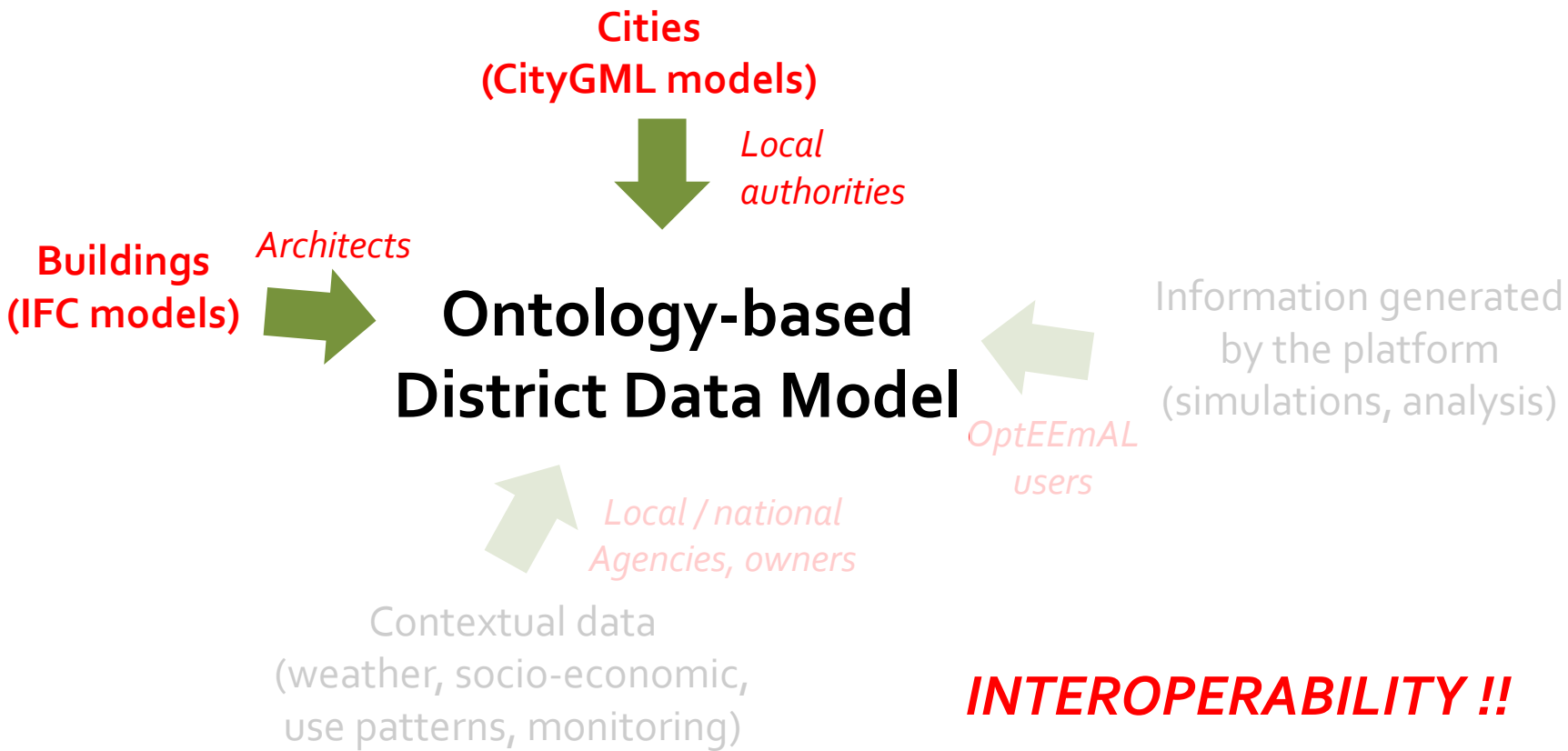
"The capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units" ISO/IEC 2382-01

"Syntactic" interoperability relies in the "ability" and "capacity" of the systems to communicate with each other. The semantics are implicit in the data, format, communication channel, systems…

"Semantic" interoperability is based on a shared understanding of the meanings associated to the data handled by the intercommunicating systems by means of ontologies which make explicit the semantics in a formal language.

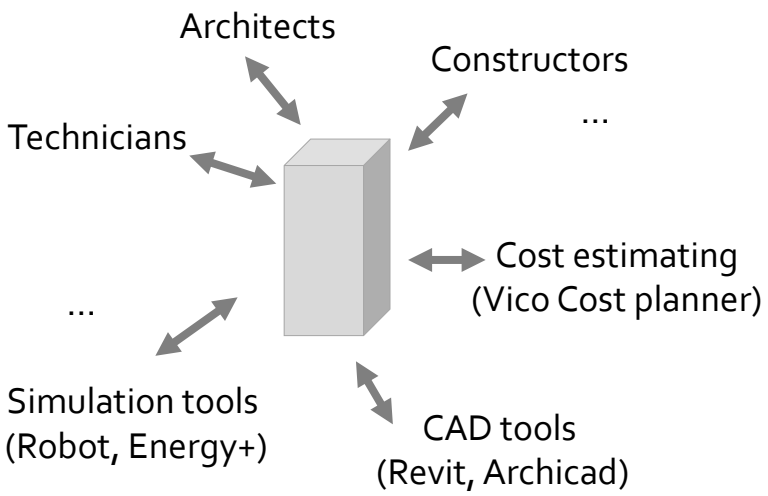
Semantic interoperability models, with explicit semantics, can ensure that the meaning of data can be unambiguously understood by both humans and systems (Manafov et al. 2013)

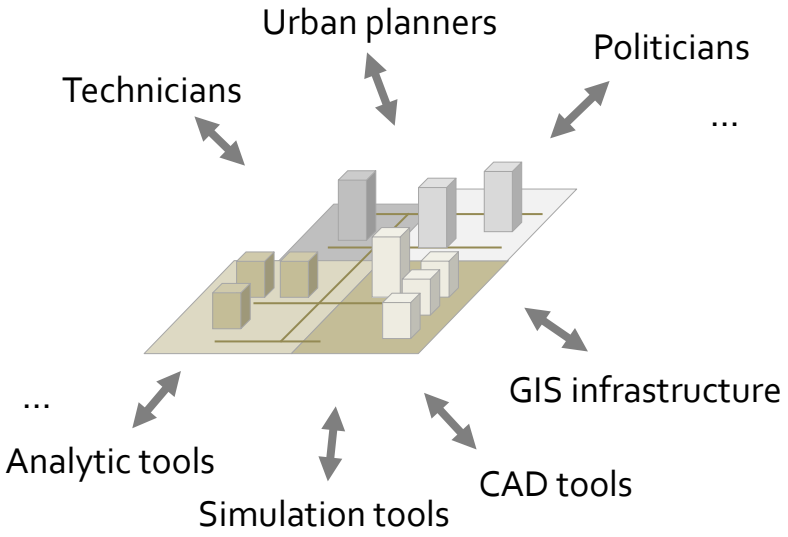
Introduction



Introduction

Standard data models –**IFC** (buildings) and **CityGML** (cities)– aim at ensuring interoperability by anticipating, or even preventing, communication problems between data and applications.





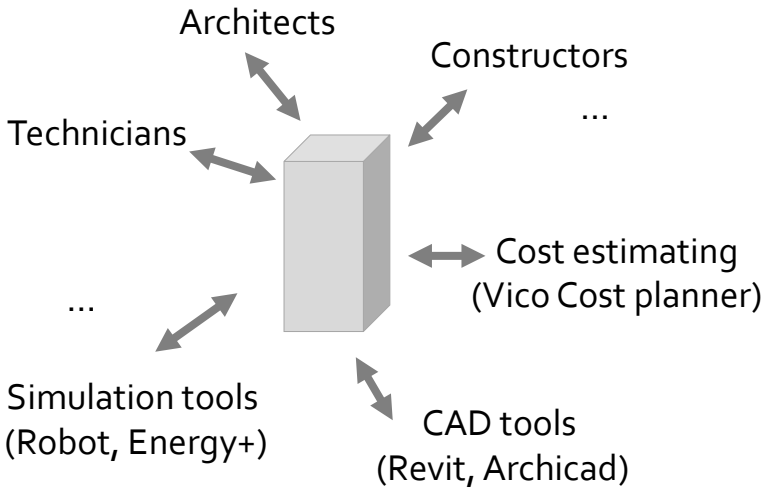
IFC files, BIM servers

CityGML files, 3DCityDB

Introduction

Industry Foundation Classes (IFC) is a data model developed by the International Alliance for Interoperability (IAI) to support data exchange in the Architecture, Engineering, and Construction (AEC) sector.

IFC provides a set of concepts (classes, attributes, relationships, property sets and quantity definitions) to represent a building and its components. It has been designed to exchange building information over the whole building life-cycle.

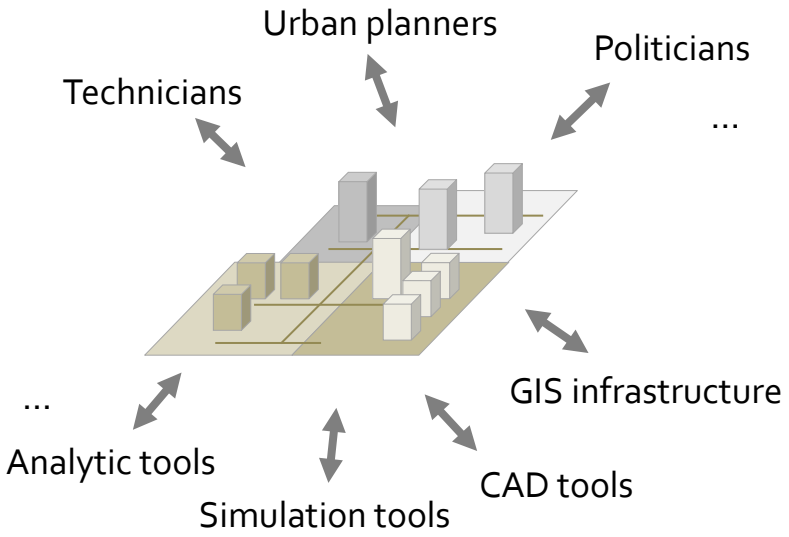


IFC's modeling approach is tailored to support the **planning**, **design**, **construction**, and operation of buildings

Introduction

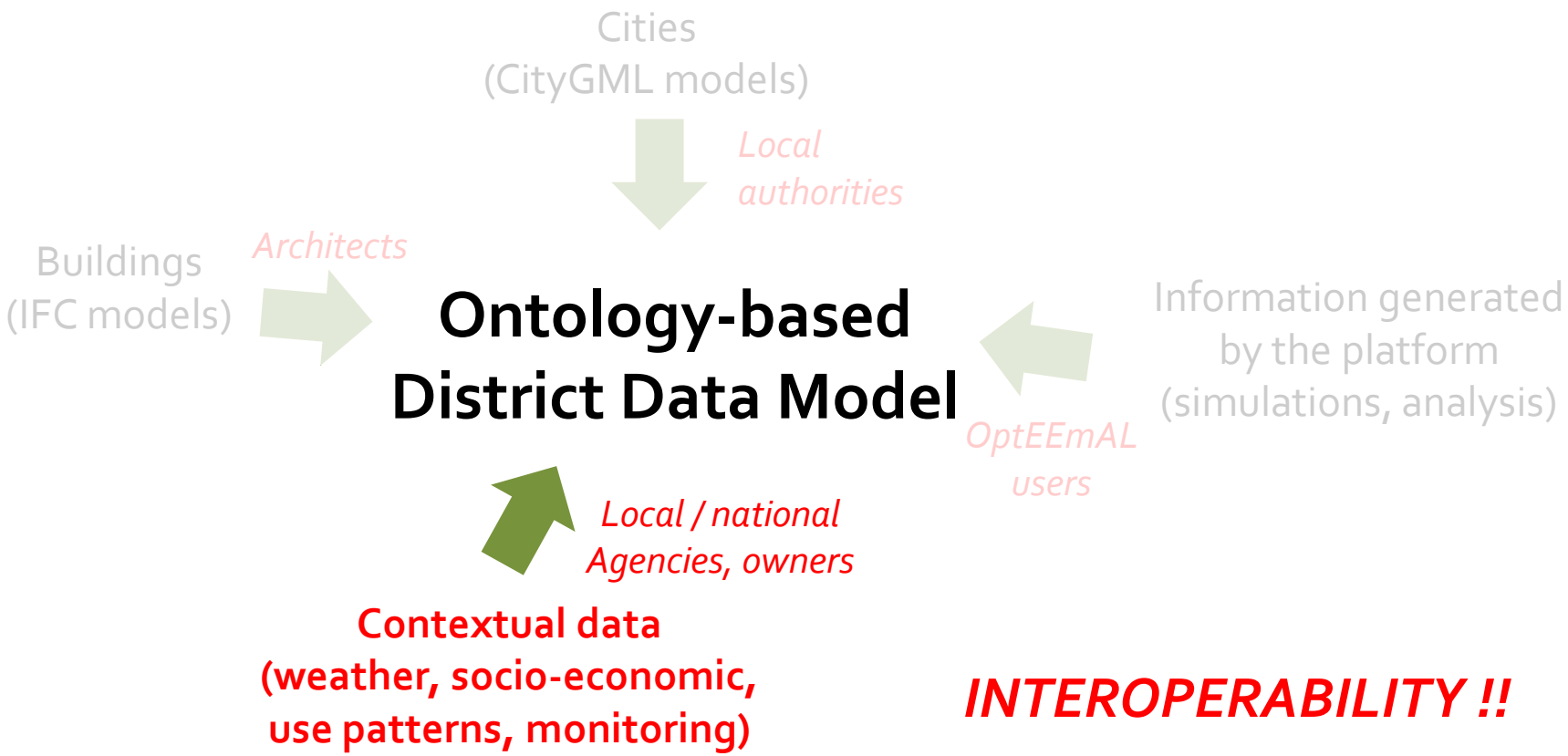
The City Geography Markup Language (CityGML) –an official standard of the Open Geospatial Consortium (OGC) since 2008– has become a de facto modelling language widely accepted by the geospatial industry.

- a multi-resolution representation of virtual 3D city models. Levels of detail.
- a rich semantic model with well-defined meanings of the geometric information



CityGML's modeling approach is tailored to describe the **real world** from **observations / measurements**

Introduction



Introduction

Contextual data

Different domains

- Energy
- Social
- Environment
- Economic

Different formats

- BEMS
- Databases
- Web Services
- XML/CSV/XLS files

Semantic Web technologies

Introduction

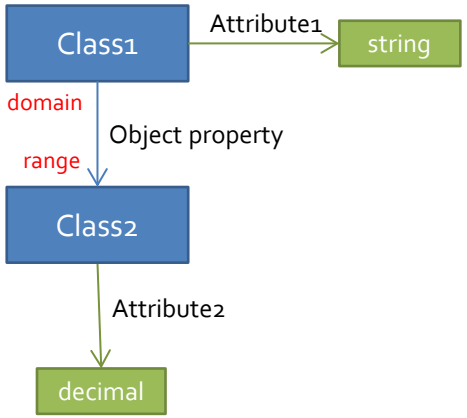
Ontology: *"a formal and explicit specification of a shared conceptualization"* [Gruber 1993]

The **formal specification** is done through concepts, attributes, values, relationships, roles and rules that describe a domain

shared conceptualization, indicates that reaching a **consensus** among users of how it has to represent the ontology

Ontology components

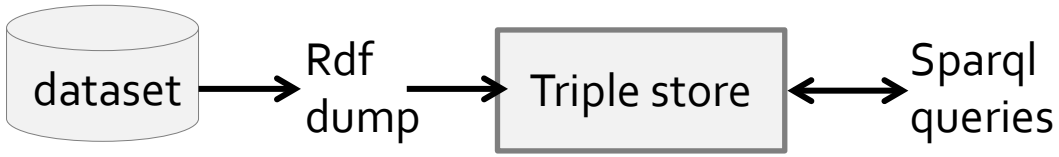
- **Individuals**: instances or objects.
- **Classes**: types of objects, or kinds of things.
- **Attributes**: aspects, properties, features,...
- **Relations**: ways in which classes and individuals can be related to one another.
- **Axioms**: assertions, rules...



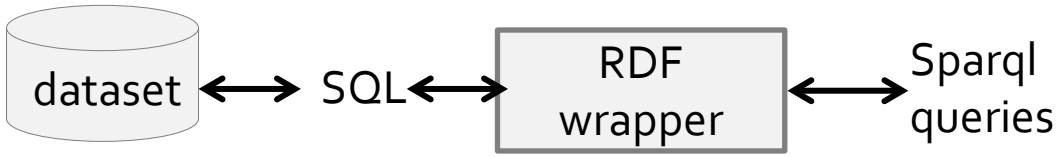
Introduction

1. Define an ontology to model the data sources based on existing ontologies and standards

2. Implement **integration methods**



- Fast
- Not up to date
- Materialized



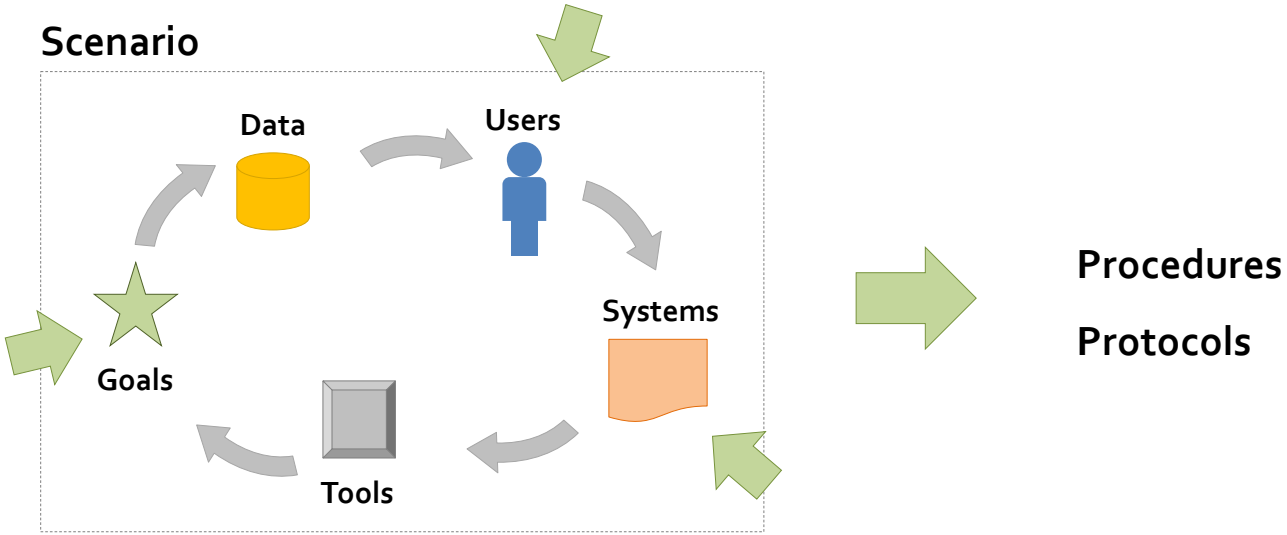
R2RML mappings

- Not fast
- Updated
- Relational databases

Interoperability is not only a technological challenge.

It also involves devising and applying procedures to avoid doing redundant work, to reduce design errors, and to be replicable in other contexts

the technological solutions need to be embedded in scenarios which encompass strategic goals, users and systems, along with the tools to analyse the data



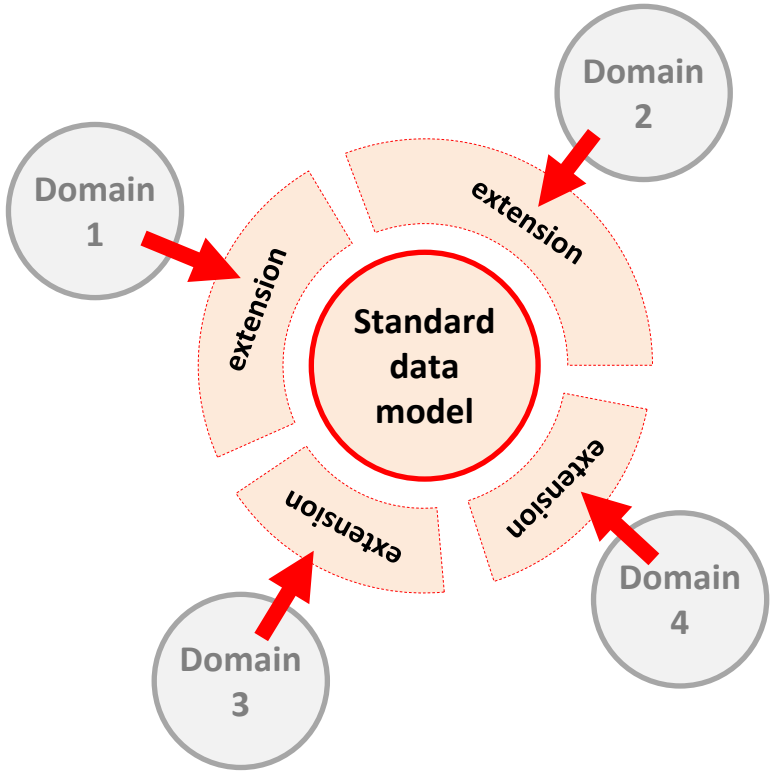
Optimised Energy Efficient Design Platform for Refurbishment at District Level

Agenda

- Introduction
- **Topic 1: Centralized vs Decentralized approaches**
- Topic 2: Ontology-based ECM catalogue
- Topic 3: Versioning
- …

Topic 1: Centralized vs Decentralized approaches

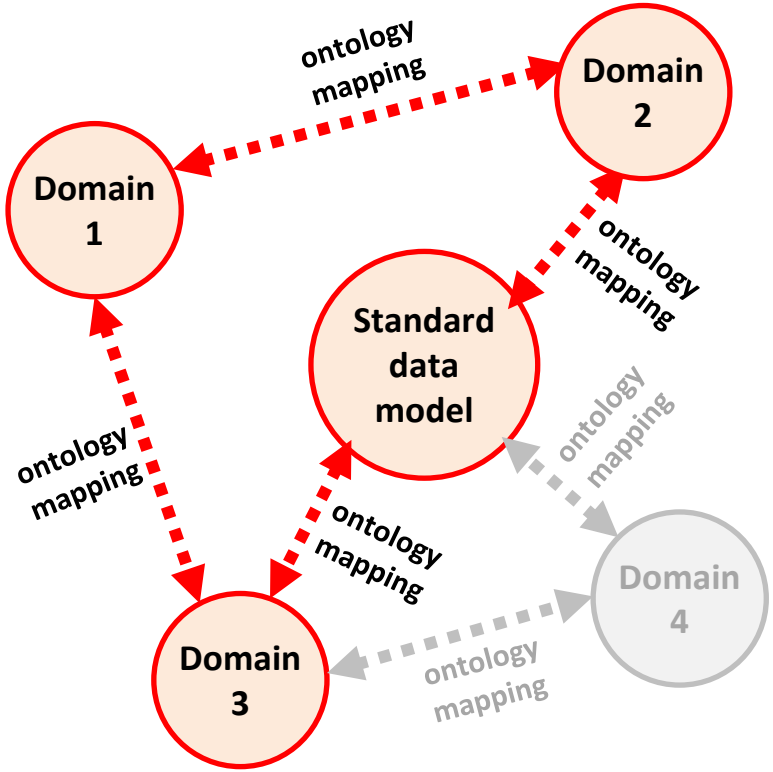
"Centralized" approach



Centralized standard data models (e.g. CityGML, IFC)

Including new domains by extensions mechanisms

"Decentralized" approach

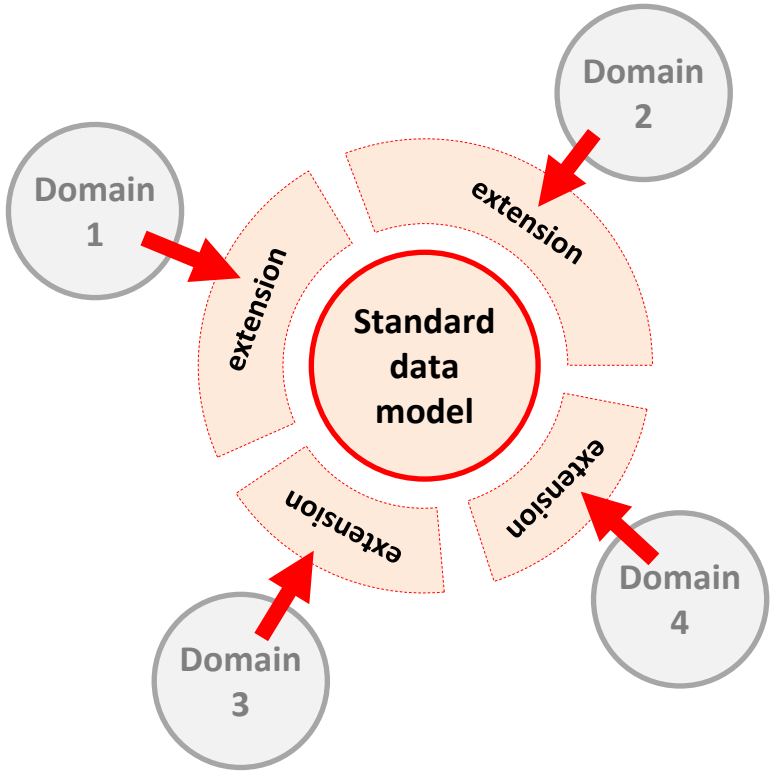


Decentralized and ad hoc solutions to interoperability

Including new domains by ontology mapping/linking

Topic 1: Centralized vs Decentralized approaches

"Centralized" approach



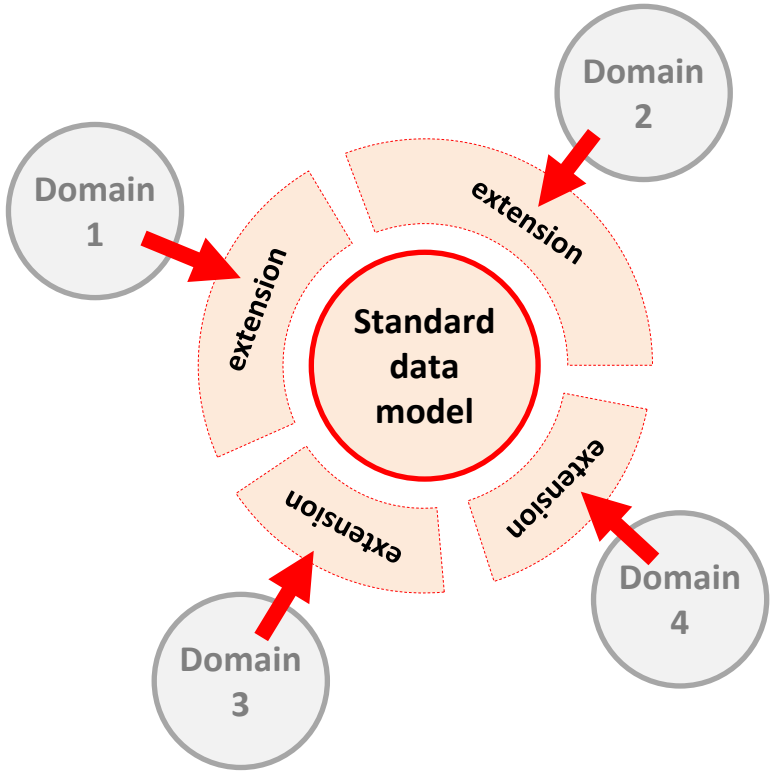
The standards data models are aimed at ensuring interoperability by anticipating, or even preventing, communication problems between data and applications.

They provide a priori solution to interoperability problems between tools, applications and services by means of a standard data model and the extension mechanism.

- CityGML → Application Domain Extensions (ADE)
- IFC → Information Delivery Manual, Model View Definitions

Topic 1: Centralized vs Decentralized approaches

"Centralized" approach



This approach has proved to have some limitations:

- difficulties to reach a consensus among a community of users
- lack of flexibility of the data models to adapt to changes
- the loss of information after exporting and importing data through applications

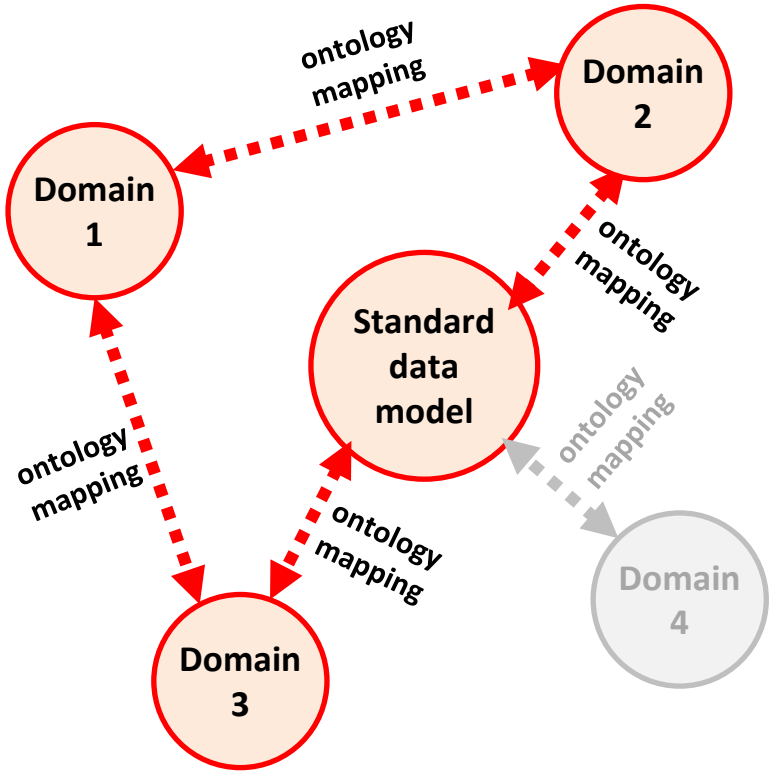
Topic 1: Centralized vs Decentralized approaches

Semantic-based interoperability facilitates the adoption of decentralized and ad hoc solutions to interoperability based on Semantic Web technologies (RDF, OWL, SPARQL…).

By means of ontologies it is possible to integrate multiple models, including models created with standards like CityGML and IFC.

The role of ontologies is to provide bridges between multiple models. Such ontologies do not need to be created from scratch but they can be based on standards like ISO or CEN.

"Decentralized" approach

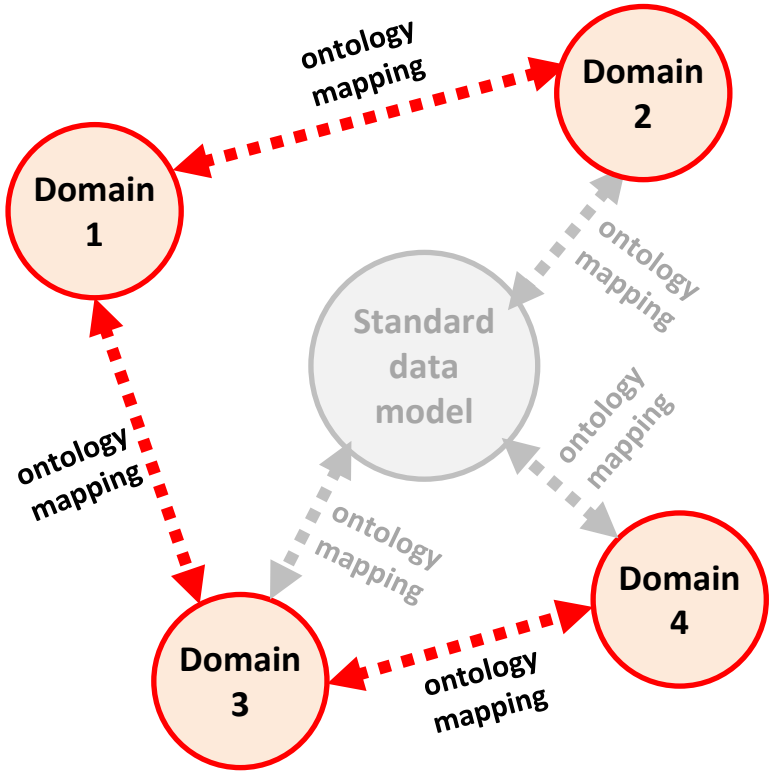


Topic 1: Centralized vs Decentralized approaches

Semantic-based interoperability brings together the best of the two worlds:

- a standardization based on the ontologies – rather than on the data models.
- a decentralization of the data models, applications and systems which are interlinked through the ontologies.

"Decentralized" approach



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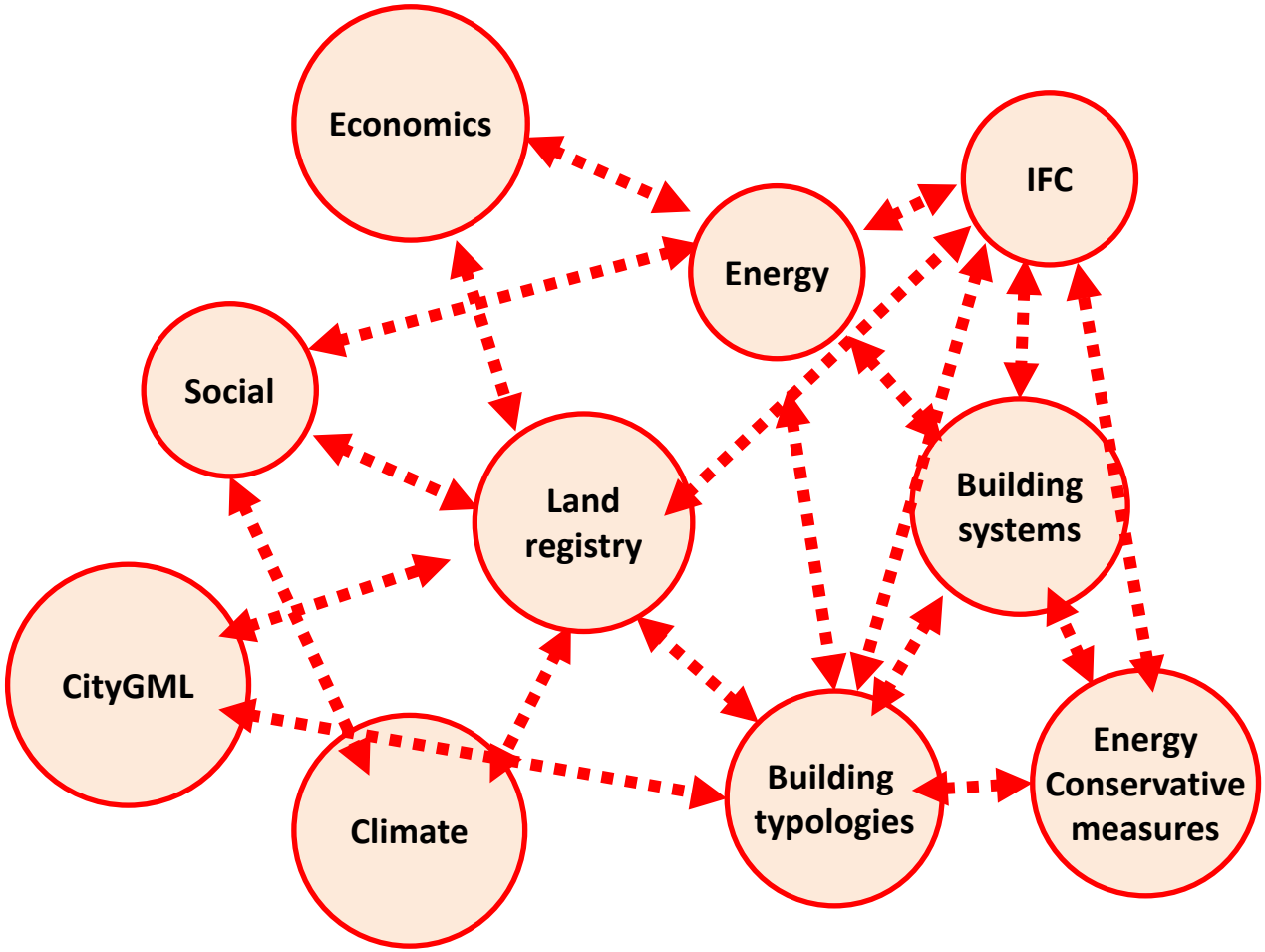

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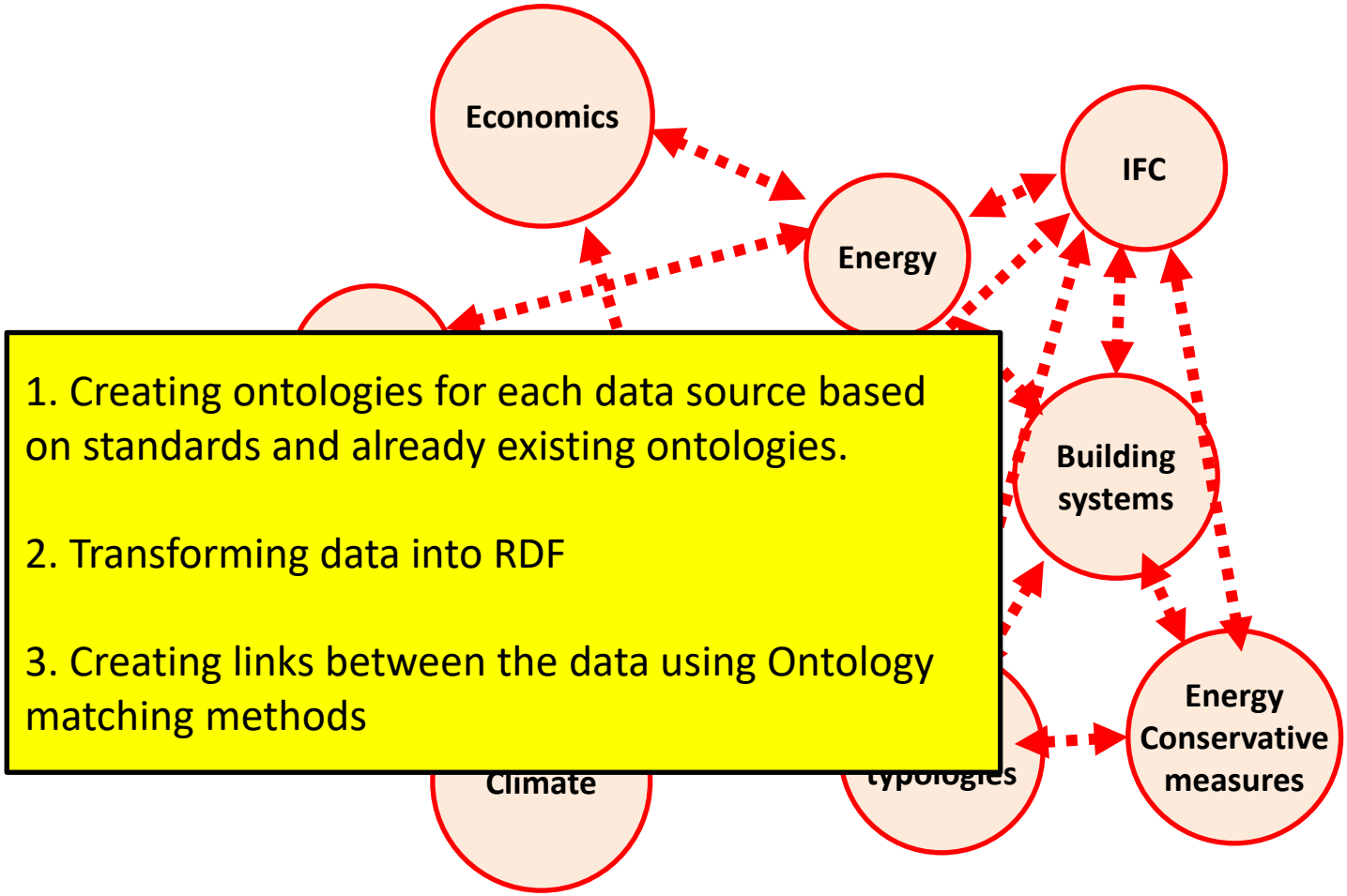


1. Creating ontologies for each data source based on standards and already existing ontologies.

2. Transforming data into RDF

3. Creating links between the data using Ontology matching methods

Topic 1: Centralized vs Decentralized approaches

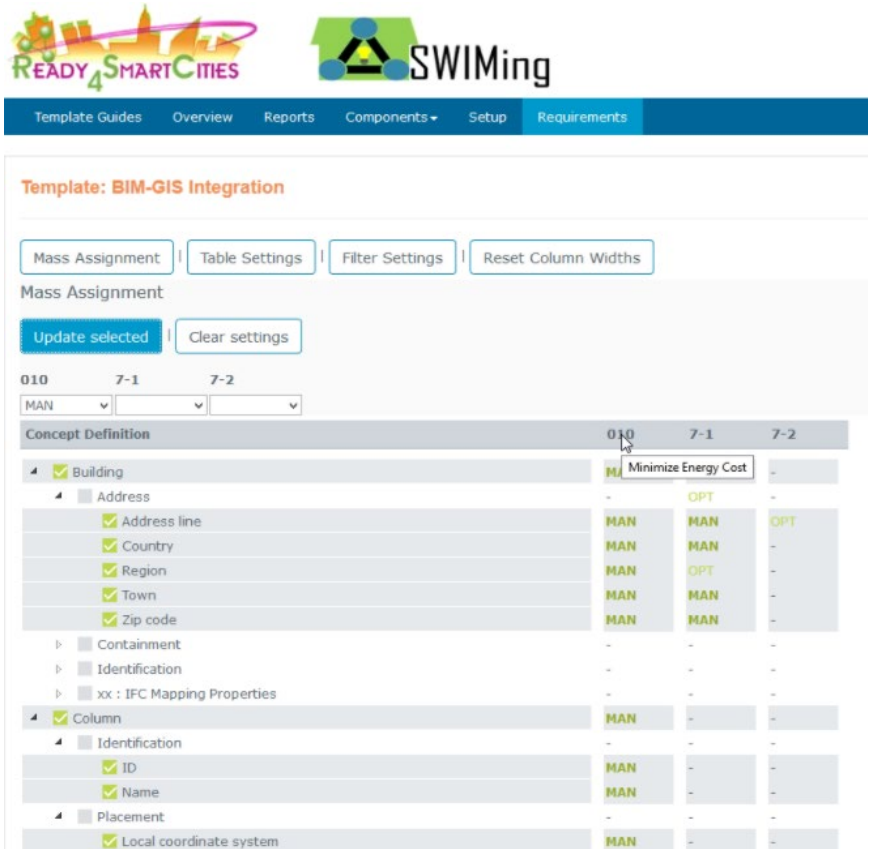
Examples of initiatives based on open standards for interoperability:

LINKED BUILDING DATA COMMUNITY GROUP
https://www.w3.org/community/lbd/

Linked Data Working Group in BuildingSMART International
http://www.buildingsmart.org/standards/standards-organization/groups/linked-data-working-group/

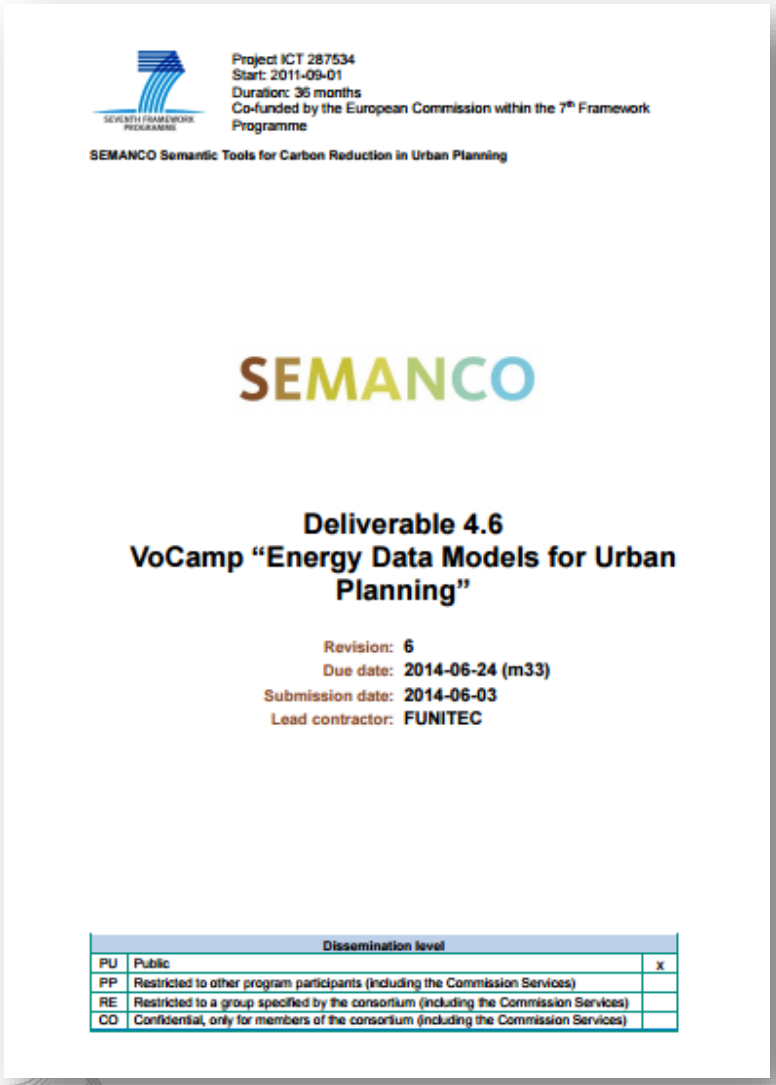
ifcOWL

Project intended to increase awareness and interoperability for the adoption of ICT and semantic technologies in energy system
http://www.ready4smartcities.eu/



Example: tool for capture the requirements of information for projects. Properties mandatory for an specific use case can be selected.

Topic 1: Centralized vs Decentralized approaches



Project ICT 287534
Start: 2011-09-01
Duration: 36 months
Co-funded by the European Commission within the 7th Framework Programme

SEMANCO Semantic Tools for Carbon Reduction in Urban Planning

SEMANCO

Deliverable 4.6
VoCamp "Energy Data Models for Urban Planning"

Revision: 6
Due date: 2014-06-24 (m33)
Submission date: 2014-06-03
Lead contractor: FUNITEC

Dissemination level		
PU	Public	x
PP	Restricted to other program participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

VoCamp "Energy Data Models for Urban Planning"

http://www.semanco-project.eu/index_htm_files/SEMANCO_D4.6_20140603.pdf

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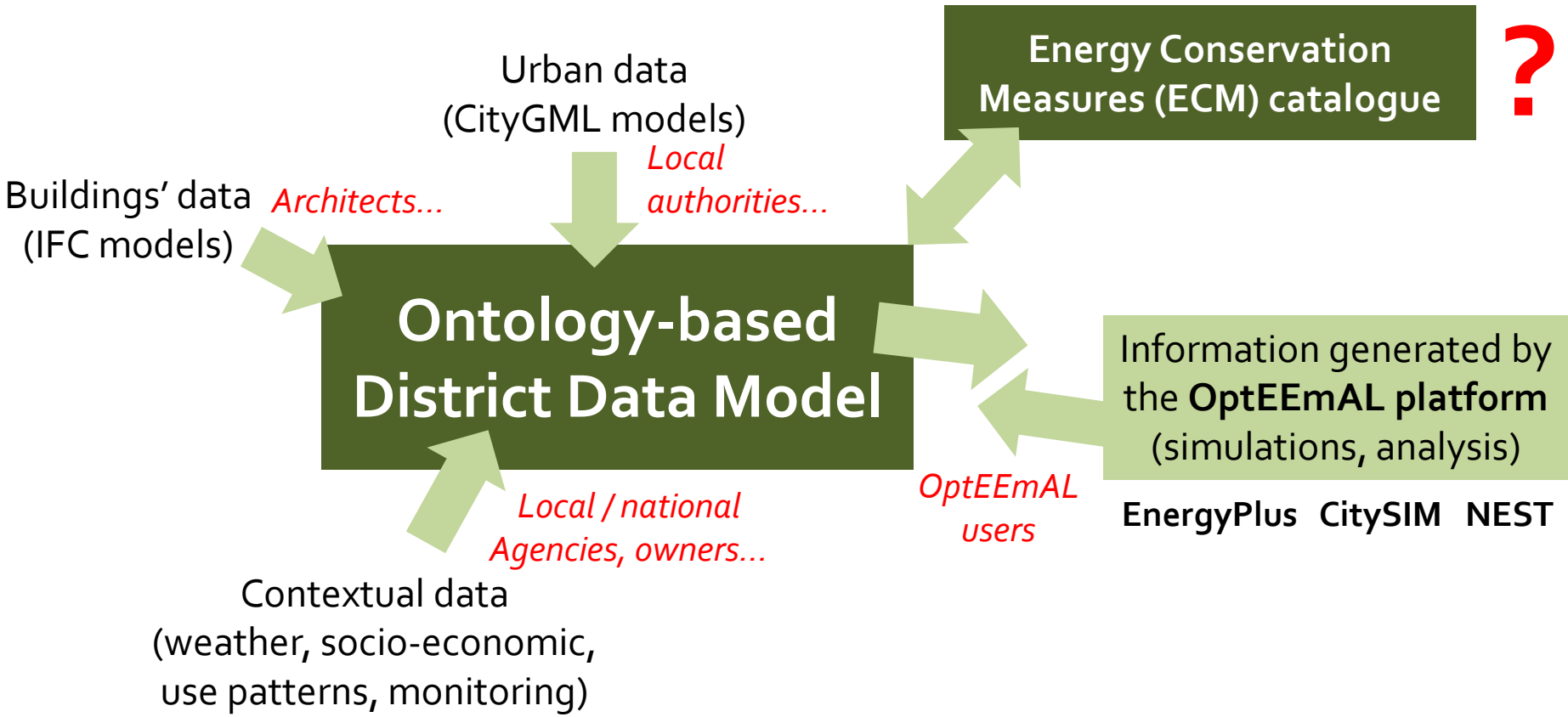
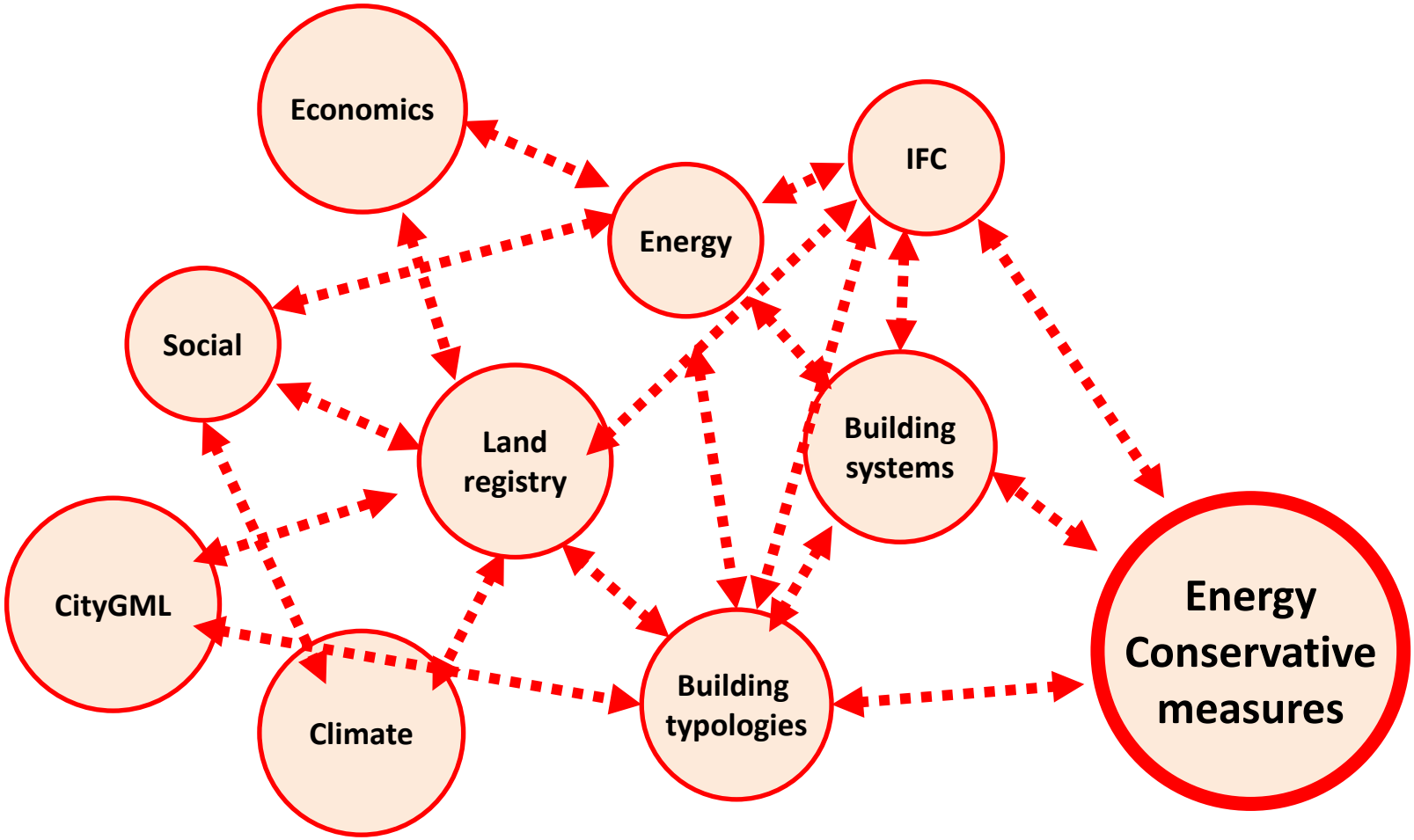
Topic 2: Ontology-based ECM catalogue



Topic 2: Ontology-based ECM catalogue



Topic 2: Ontology-based ECM catalogue

Hypothesis:

IF the information in the ECMs catalogue can be defined in a semantic format

THEN semantic rules can be created and automatically applied to infer (to help to decide) what measures can be more appropriate.

Information:

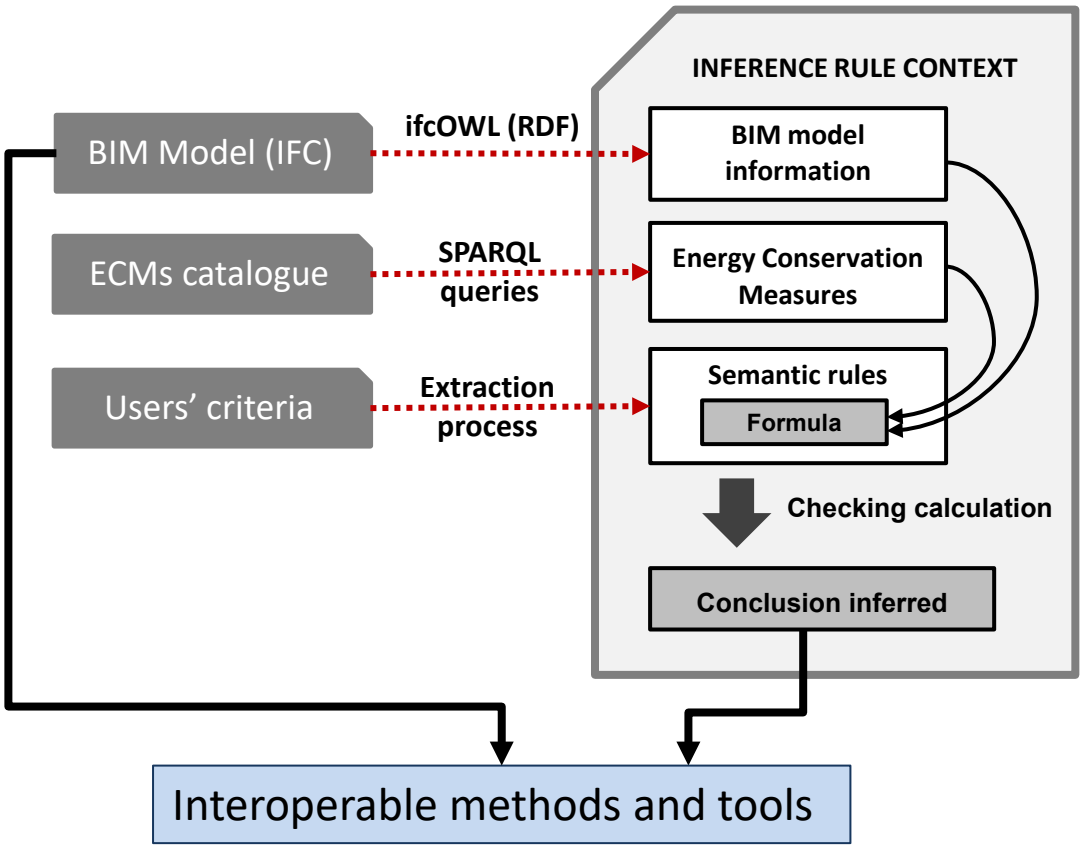
- **IFC model** → need to be transformed to **ifcOWL** (or in some kind of RDF graph)
- **ECMs catalogue definitions** → need to be provided semantically described in RDF
- **Linked data rules** → rules in RDF generated automatically based on users' criteria.

Semantic rule processors:

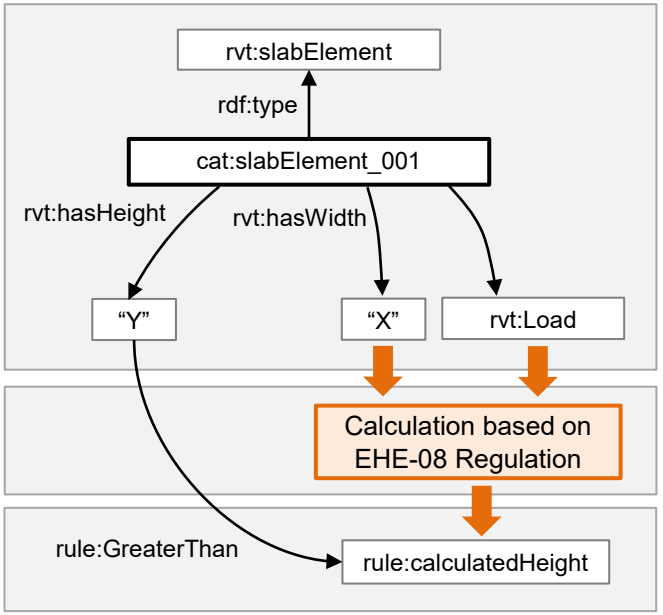
- Jena.
- EYE engine.

Topic 2: Ontology-based ECM catalogue

- **BIM Rule checking approach**



Example:



Topic 2: Ontology-based ECM catalogue

"Pros" and "Cons" of applying semantic web technologies to ECM Catalogue:

Pros

- Information is described **"explicitly"** (it describe the content itself) so information ca be **inferred** in an **automatic way.**
- Information can be **"Linked"** to other data sources, providing **specific answers** for new **domains.**
- **"Decoupling data"**: different services/applications can be created accessing to the same data.
- Most software developments supporting these technologies are **open source**.

Cons

- **Changes in the original data sources** need to be anticipated.
- Probably not all **technical staff** will be **familiar** with semantic technologies.
- Triple data stores technologies are **few**, **harder to connect** with other platform technologies, and less supported by major software vendors.
- Data **provenance**? (*original information is trusted?*)

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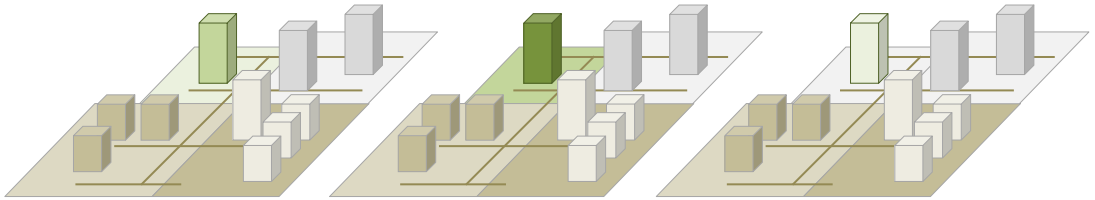
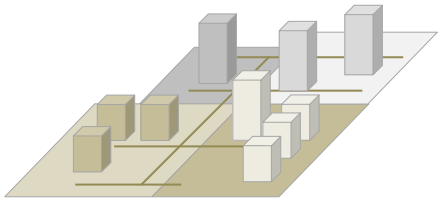
Topic 3: Versioning

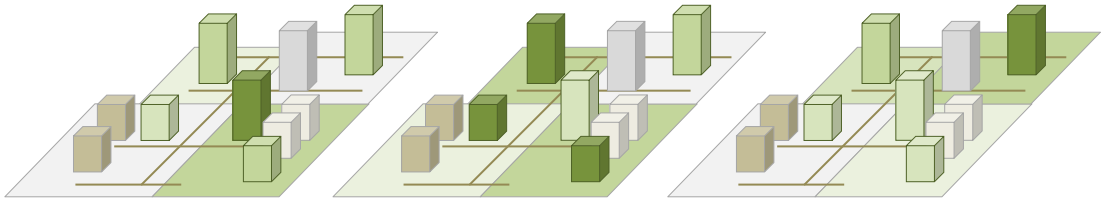
Scenarios type A: *A building is retrofitted*



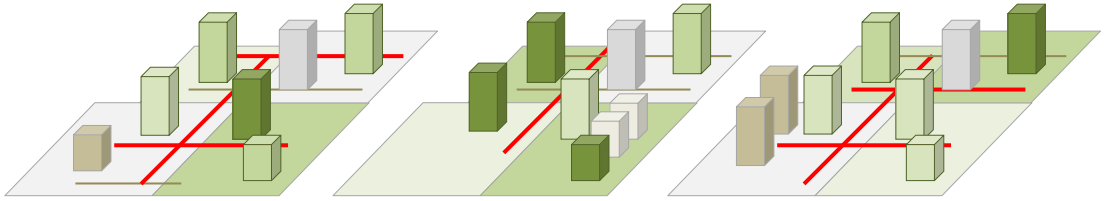
Baseline:
Starting point



Scenarios type B: *A set of buildings are retrofitted*



Scenarios type C: *District retrofitting (district heating, land use)*



...Time

Open discussion and Comittments

Include here the comittments after the discussion.

THANKS FOR YOUR ATTENTION!
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