LDAC Workshop

Linked Data in Architecture and Construction

Session 1: Open Product Modelling

Ghent, 28th-29th March 2012

Gonçal Costa

ARQUITECTURA
REPRESENTACIÓN
COMPUTACIÓN
ARC

Outlines

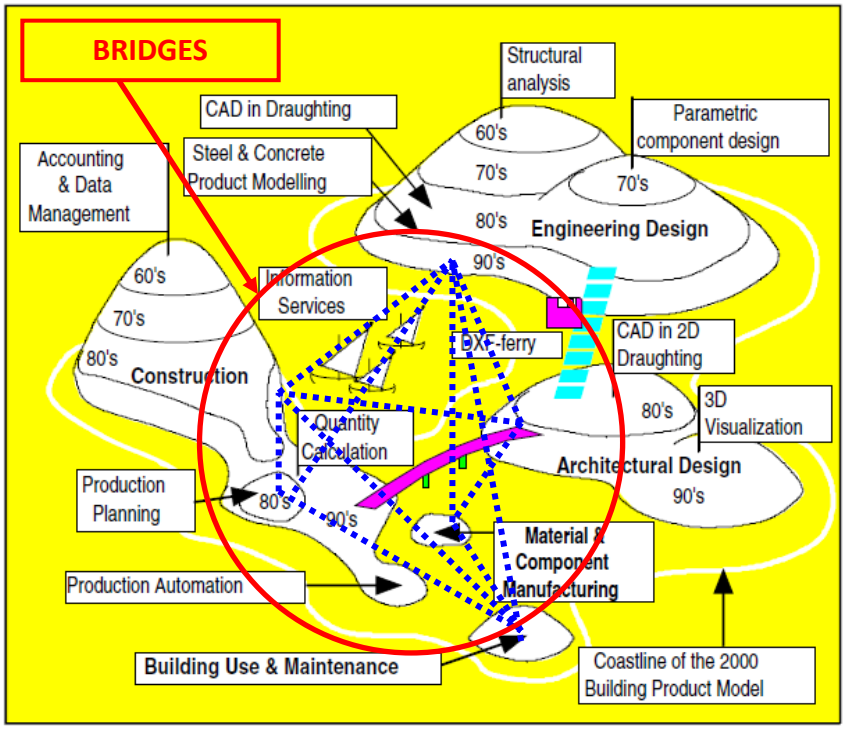
1. **Issues related to Interoperability in the AEC sector**
2. **Open Product Modelling**
3. **Open Building Components Platform**

1. Issues related to Interoperability in the AEC sector

Different Interoperability scenarios:

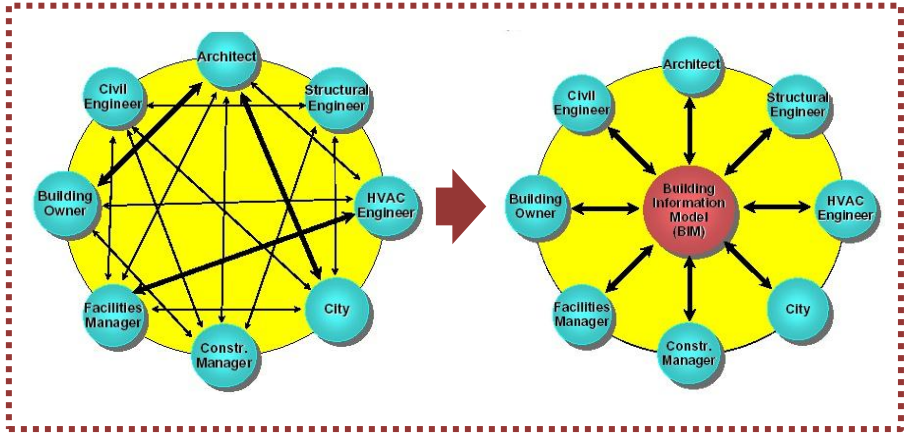
1. Sharing BIM model between programs and professionals involved in a building project.

2. Improving the methodology of BIM modelling process.



Björk, B.C. - "*Requirements and information structures for building project data models*" (1995).

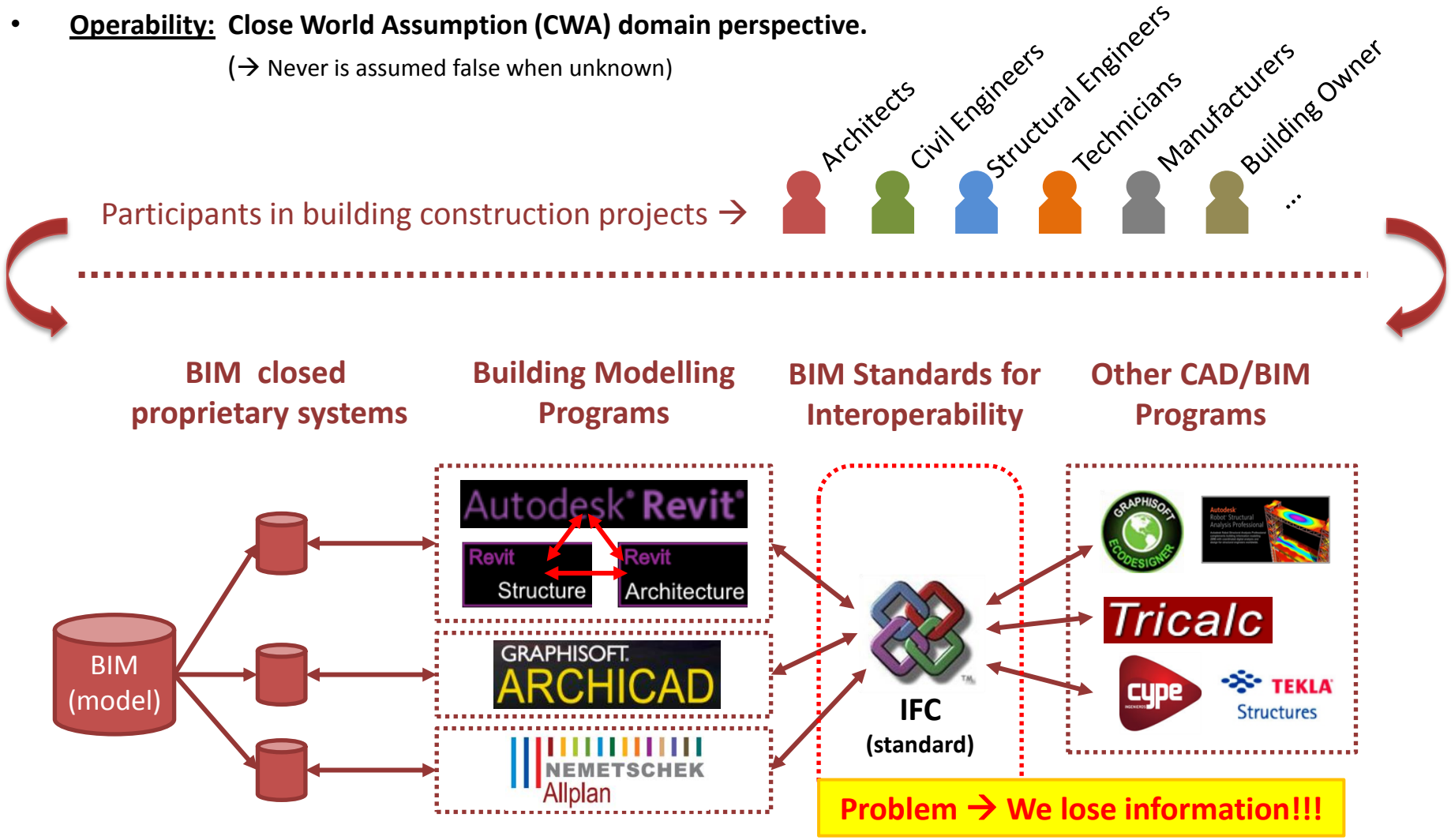
BIM contribution to the AEC Sector



1. Issues related to Interoperability in the AEC sector

BIM closed proprietary systems

- **<u>Operability:</u> Close World Assumption (CWA) domain perspective.**
  (→ Never is assumed false when unknown)



1. Issues related to Interoperability in the AEC sector

Why do we lose information? → We have to deal with several problems:

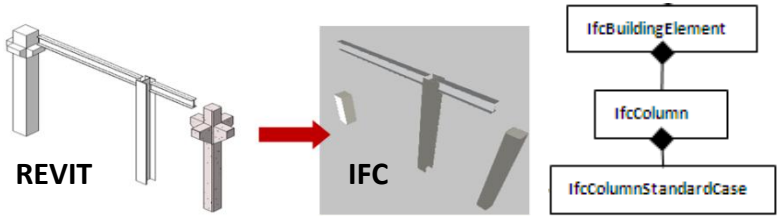
1. Lack of matching between different data models (schemas)

- Example: Revit BIM vs IFC
  (there is no possible data interchange between BIM proprietary systems in a direct way)

Issue: What does it happen if we create a new component?

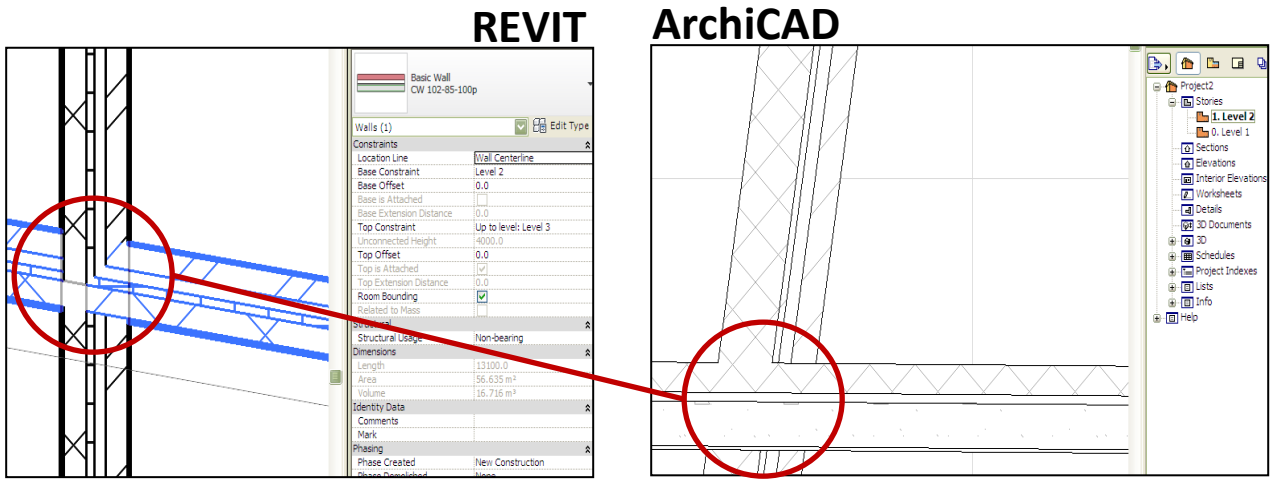
- Example: We create a new model of a corbel in Revit

  Then → which is its representation in the IFC?



2. Each BIM Program has different assembly rules for modelling

- Example: situation → two walls cross each other.

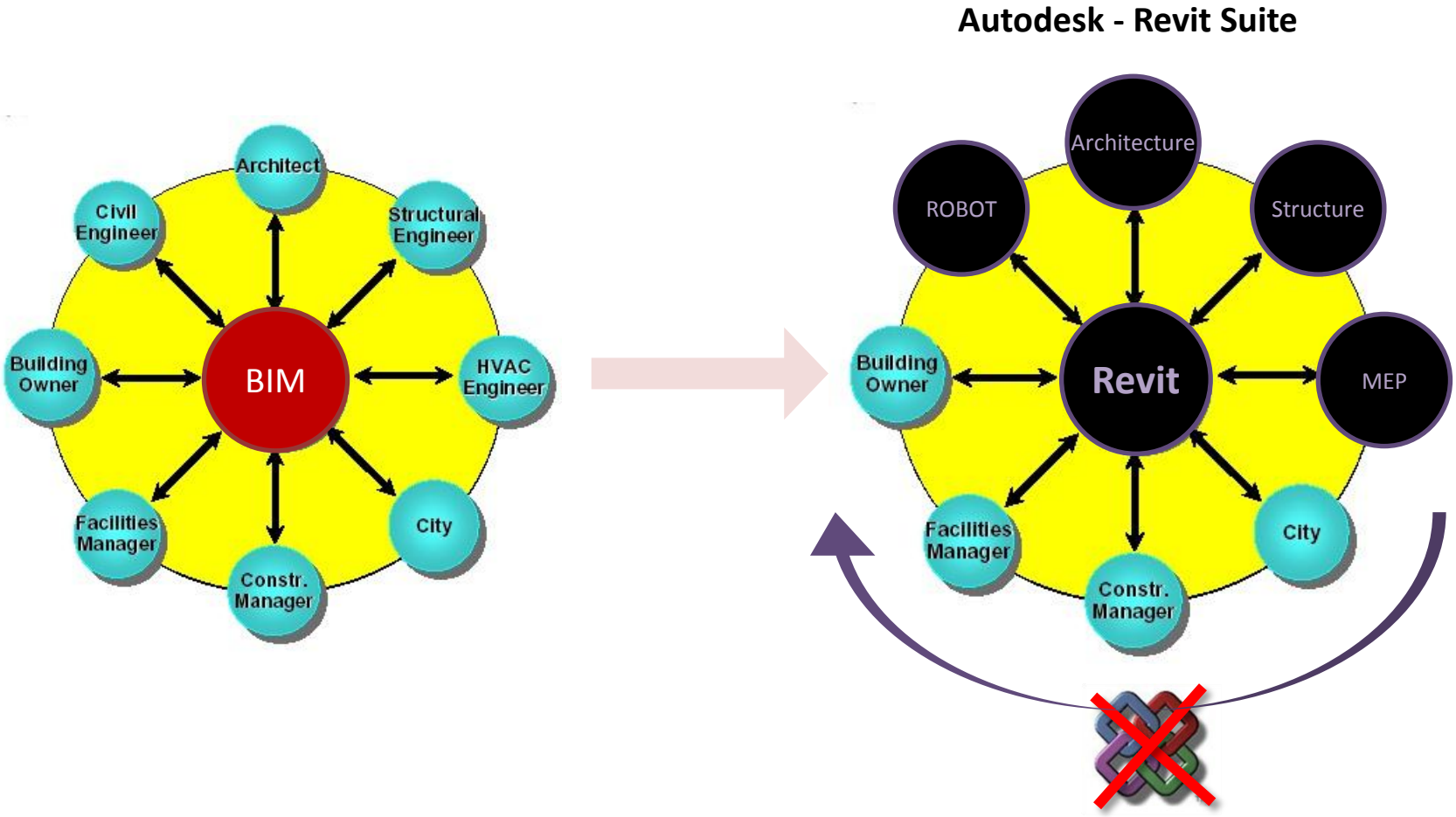


Different composition, layers, and detail level in the representation of the same wall element.

Each one has its own (internal) rules to solve each particular situation

1. Issues related to Interoperability in the AEC sector

Strategy of BIM software vendors:



1. Issues related to Interoperability in the AEC sector

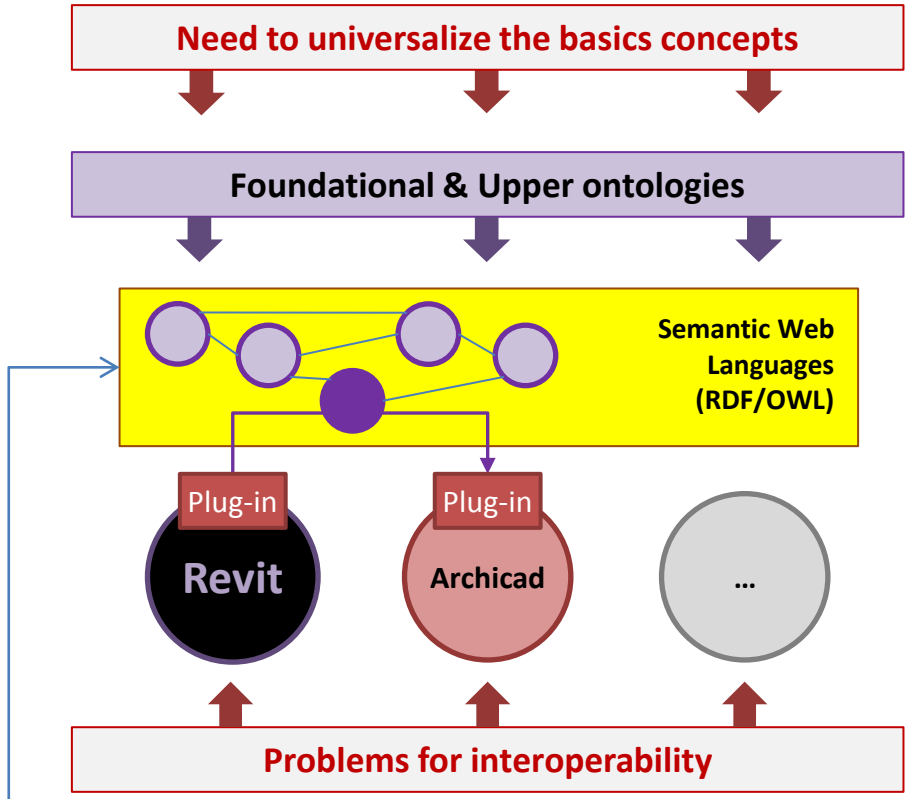
Different perspectives for BIM Interoperability

Scenario 1

Example:

Huge Data model
(Standard = unique)
We have lose of data

Scenario 2



*** IDEA**

Extract building component models as an ontology defined in RDF/OWL languages (for each one)
The plug-ins programming provides an alternative via.

Outlines

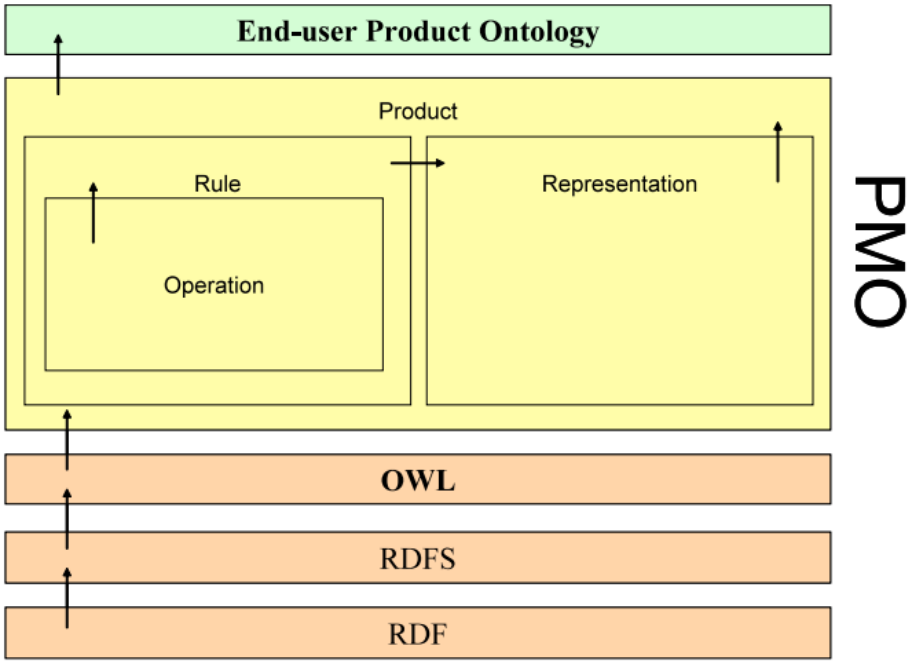
1. **Issues related to Interoperability in the AEC sector**
2. **Open Product Modelling**
3. **Open Building Components Platform**

2. Open Product Modelling

SWOP Project - European Semantic Web-based Open engineering Platform

Led by TNO - Delft, The Netherlands

Upper Ontology Definition

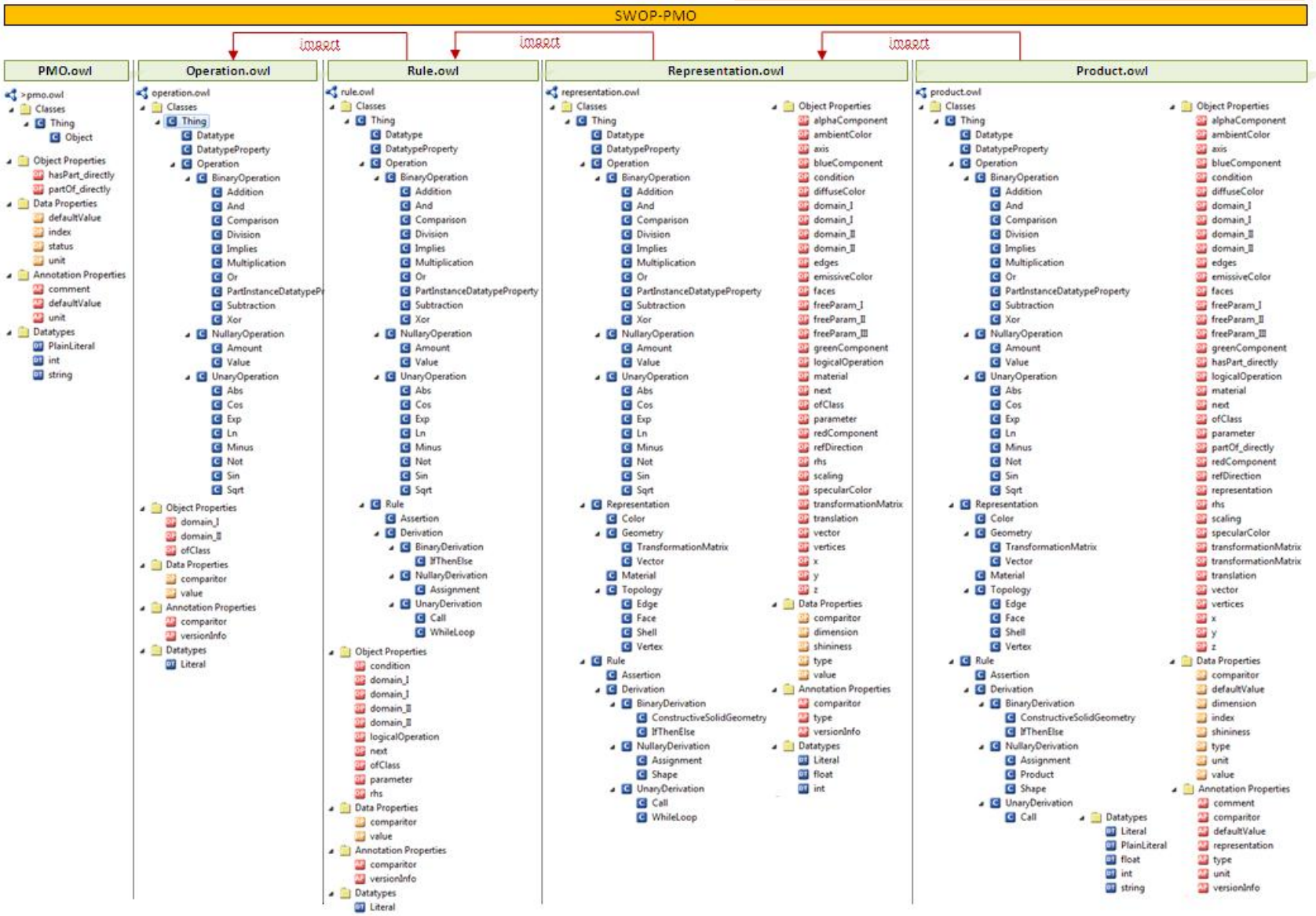


M. Böhms, P. Bonsma, M. Bourdeau, "Semantic Product Modeling And Configuration: Challenges and Opportunities", (2009)

2. Open Product Modelling

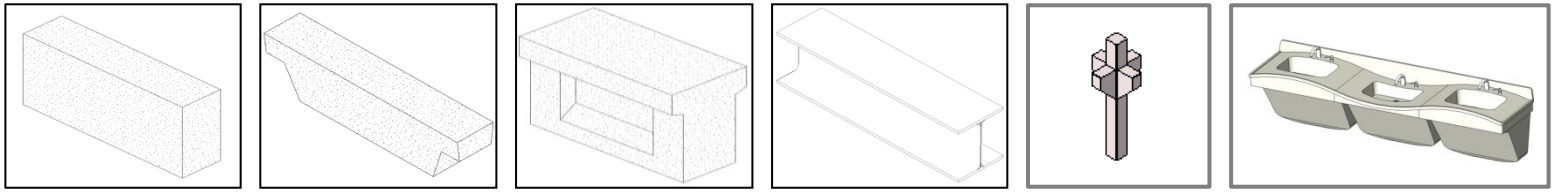
SWOP Project

Upper Ontology Layer



2. Open Product Modelling

Product modelling approach for the AEC Industry



Issues related to BIM programs:

1. **The challenges for data integration in product modelling (user to model)**

   We deal with different perceptions, representation rules, matching the user request in front of available services, final user needs, …

2. **Conflicts (model to model)**

   We deal with different representations for the same type of object, units, precision, naming, object identification, regulations of each country, … (BIM Programs have their own criteria)

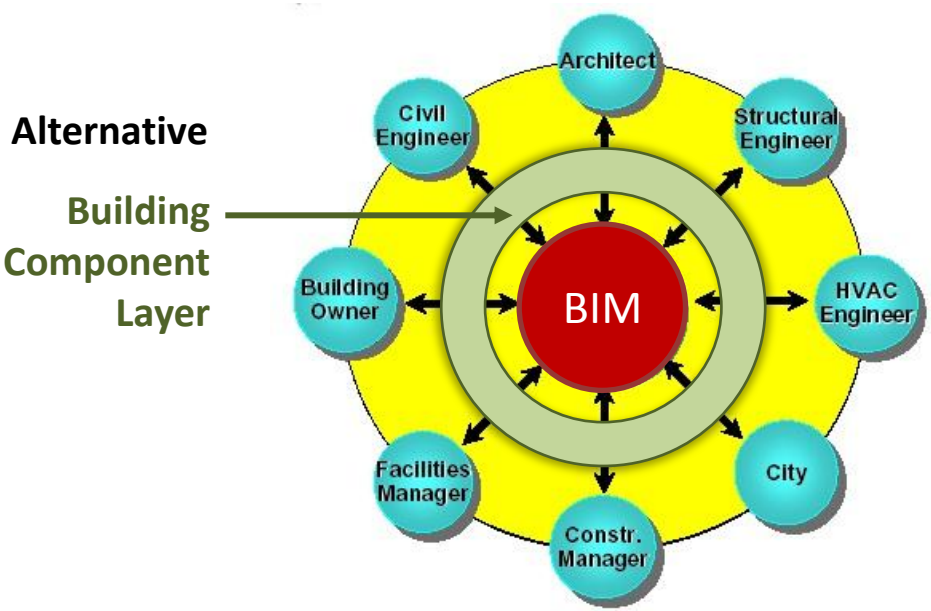
Alternatives:

We can define the building components outside of the BIM Programs (externally)

- For example, defining the components through an on-line catalog.

2. Open Product Modelling

Building components on-line catalog



Building Components Specifications

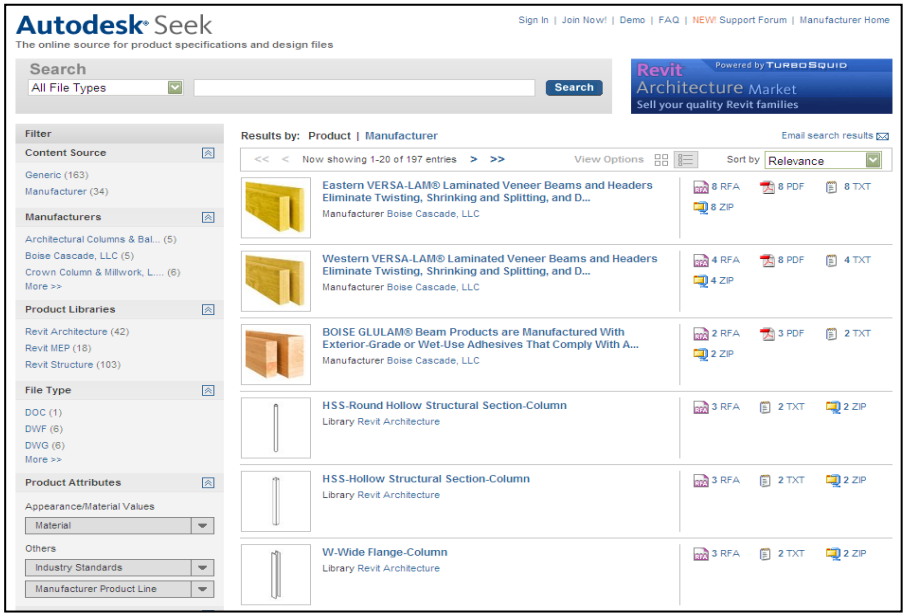
(parametric models, prices, transportation, quality requirements, regulations, …)

Manufacturers | Architects, BIM Designers | Other participants

2. Open Product Modelling

Building products on-line catalogs

Examples

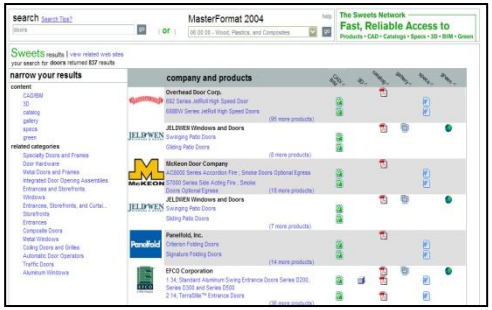


These catalogs have a set of files with the component models information in one or more BIM formats, which sometimes include the IFC version.

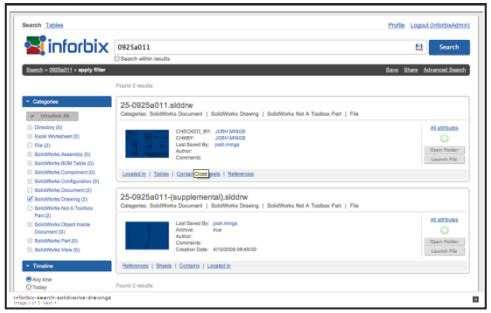
But, these catalogs do not represent an improvement for interoperability.

Idea → Create different component models (or a mixed model) for cover each data type, purpose, or need:

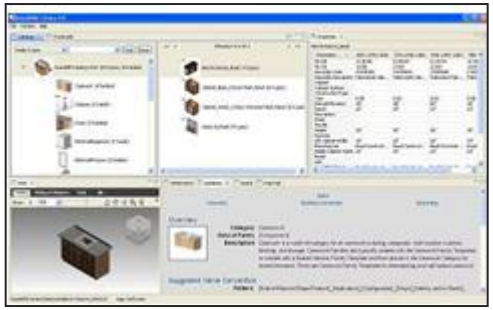
1. A metadata model.
2. Different heterogeneous database.
3. Proprietary component models (IFC, Rvt, …)



Sweet Networks
(McGraw-Hill)



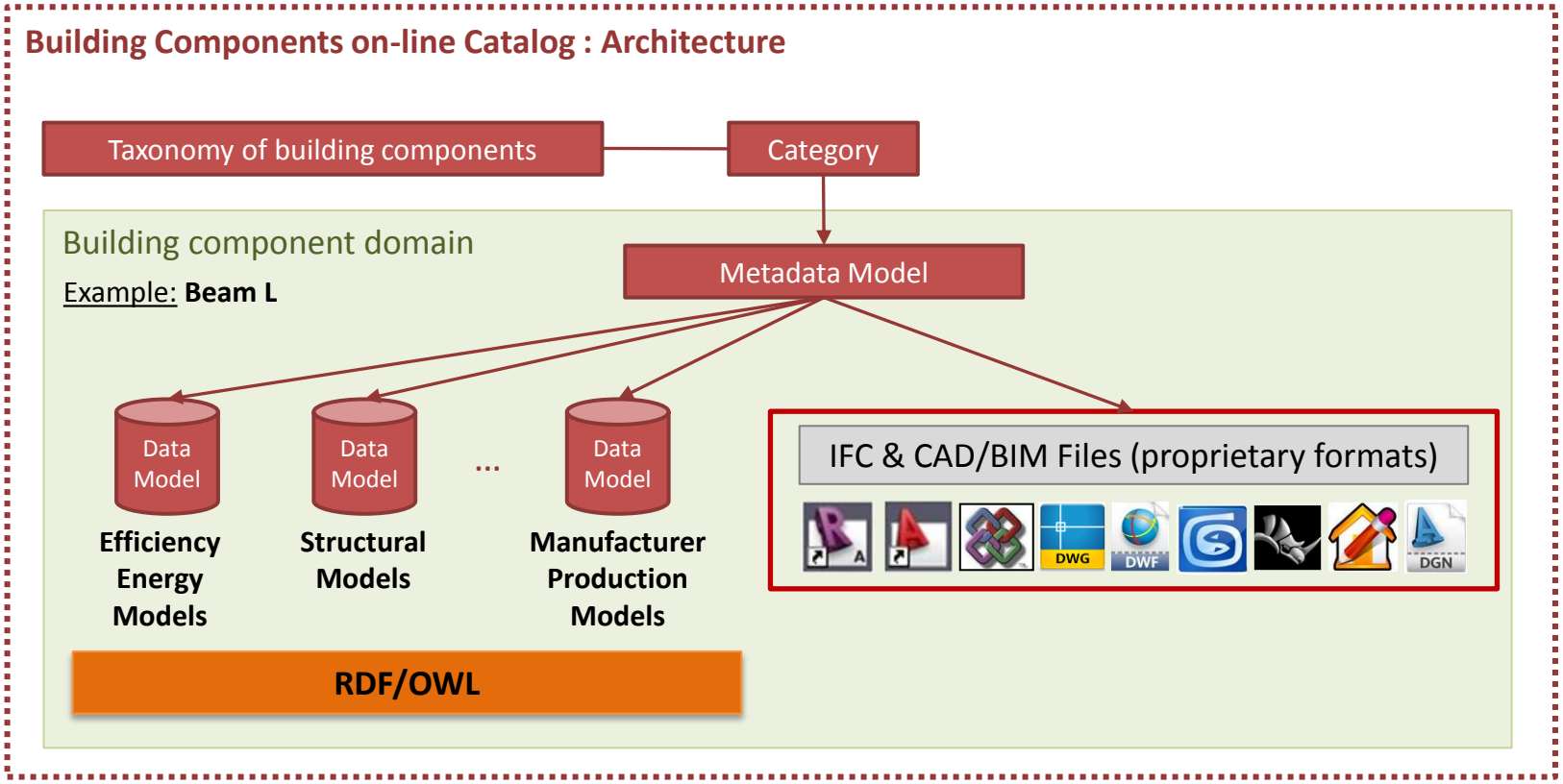
Inforbix
Product data application for engineering and manufacturing



SmartBIM Library
(Reed Construction Data's BIM Products & Services)

2. Open Product Modelling

- The model integrates heterogeneous sources of structured data and BIM Files (IFC & proprietary formats)



Conclusions

Ontologies and semantic web technologies to improve the model

In order to overcome the inherent limitations of a static model, such as the IFC standard, we can use the semantic web technologies as a mechanism to **obtain a flexible data modeling**.

- The main difference is that we no longer use a standard model (IFC), but we use standard modelling languages (RDF/OWL) with high expressivity to create different data models.
- Using RDF/OWL languages, a data model of a building component can be formalized as an ontology, which can be handled by the expert on its domain. Then, an expert can freely define a building component model without having to rely on overly strict rules.
- Besides, ontologies can improve the capacity for interoperability using mediation processes and ontology matching techniques.
- Building component models formalized as ontologies and data sets can be published in the web and also linked with other published data models - Linked Open Data (LOD).

Issues

- One difficulty for modelling building components is the lack of methods to enable an expert user in the domain, but inexperienced in modeling data, to formalize the model definition.
  → Manufacturers do not know what is an ontology.
  → The process requires a good guidance.

Outlines

1. **Issues about Interoperability in the AEC sector**
2. **Open Product Modelling**
3. **Open Building Components Platform**

3. Open Building Components Platform

Goal To design and implement a web platform for building components and services linked to them, based on semantic web technologies.

Professionals Manufacturers, architects, consultants, contractors, …,
involved in the processes of design and construction of building.

Capabilities

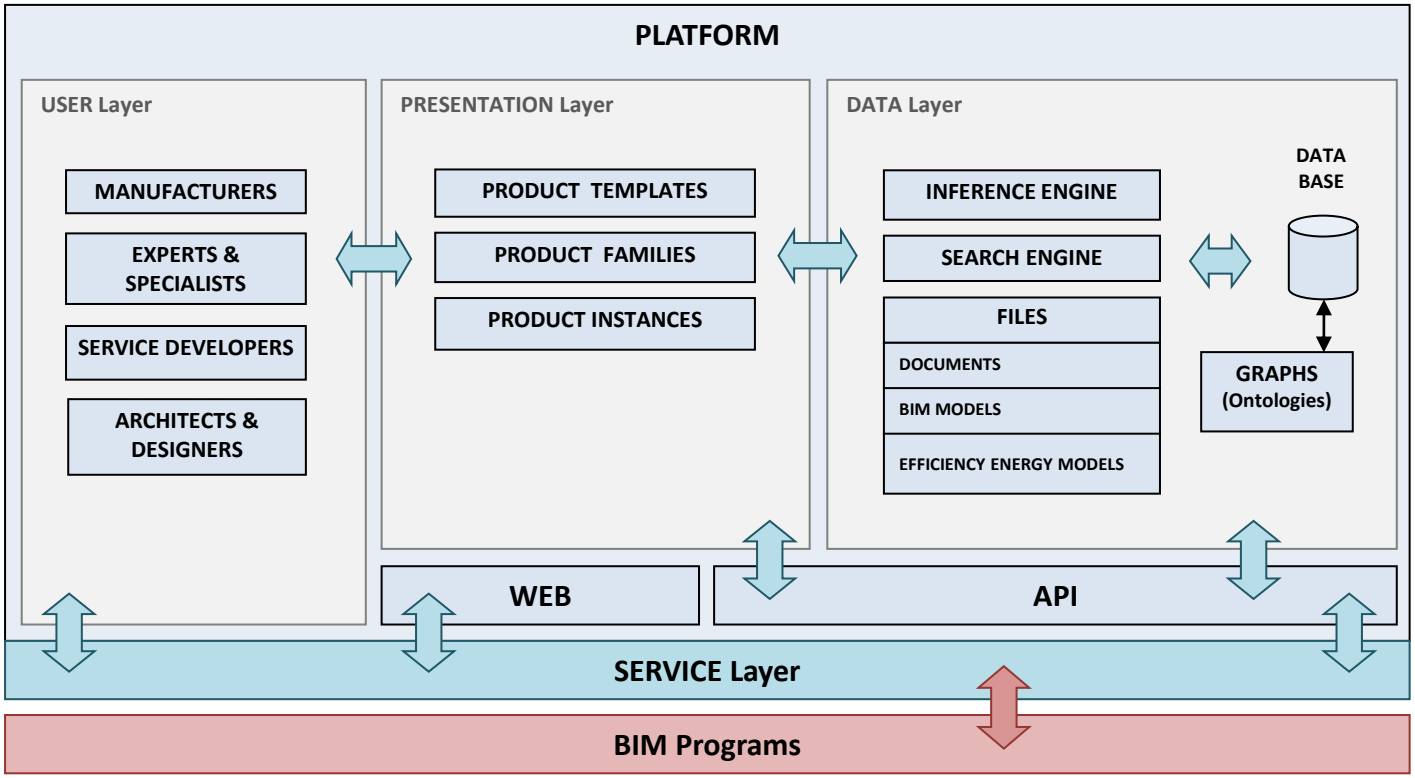
- Define products (and services associated with them).
- Download product information in formats that allow insertion into BIM models.
- Request specific services (cost, predimensioning, energy consumption, ...) the provider of a product.

Process

1. Experts in the domain of a product manufacturing define its schema and the rules.
2. Manufacturers configure the component parameters and characteristics of their products.
3. Specialists in each area (energy efficiency, structural design,…) can define data models, link them with other types of data, or work with them.
4. The technicians and architects can select the components for final assembly of the building model.
   The platform can assist them in the choice of the most suitable components.
   - For example, in order to select the correct building element for a specific type of building project.

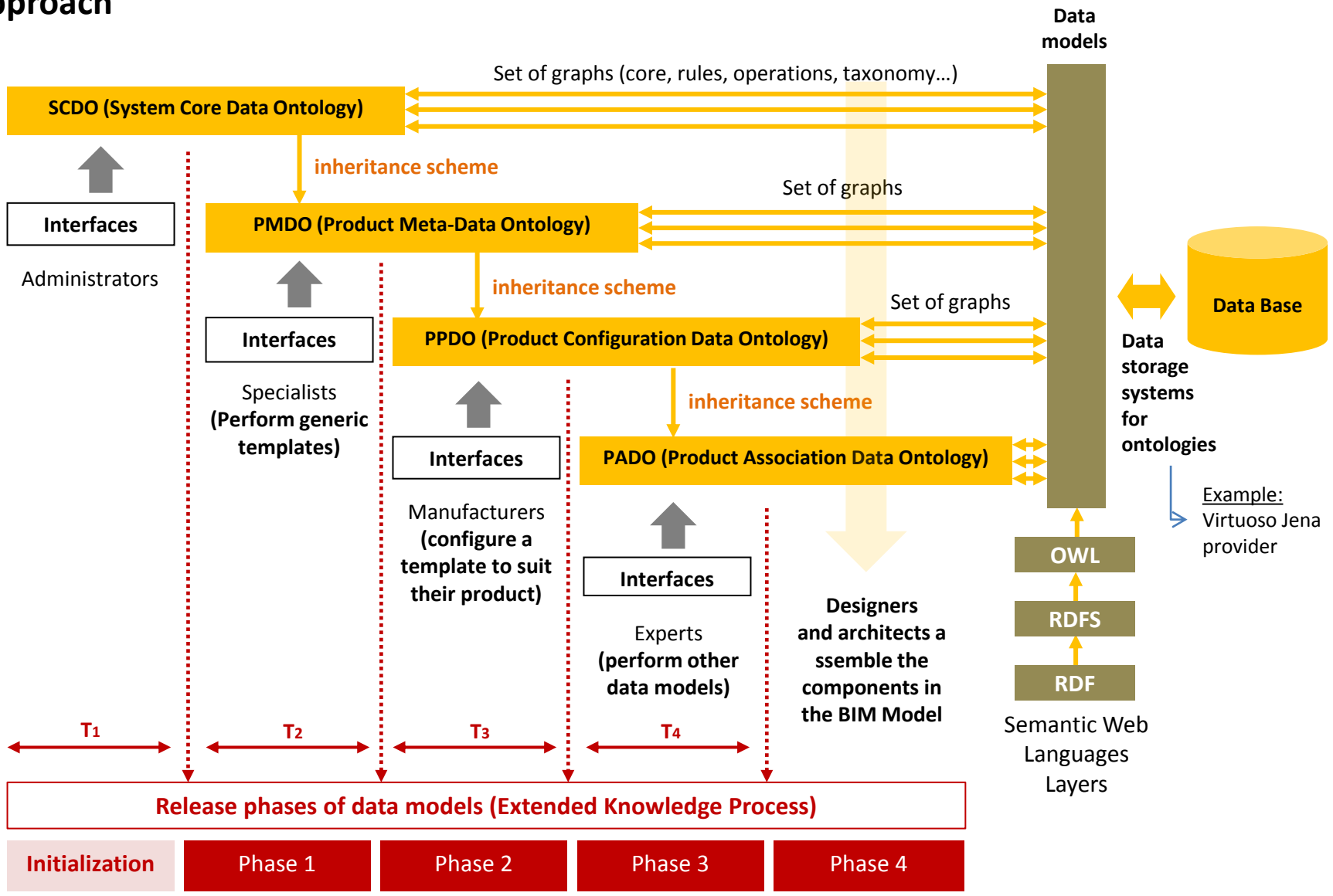
3. Open Building Components Platform

Architecture of the Platform



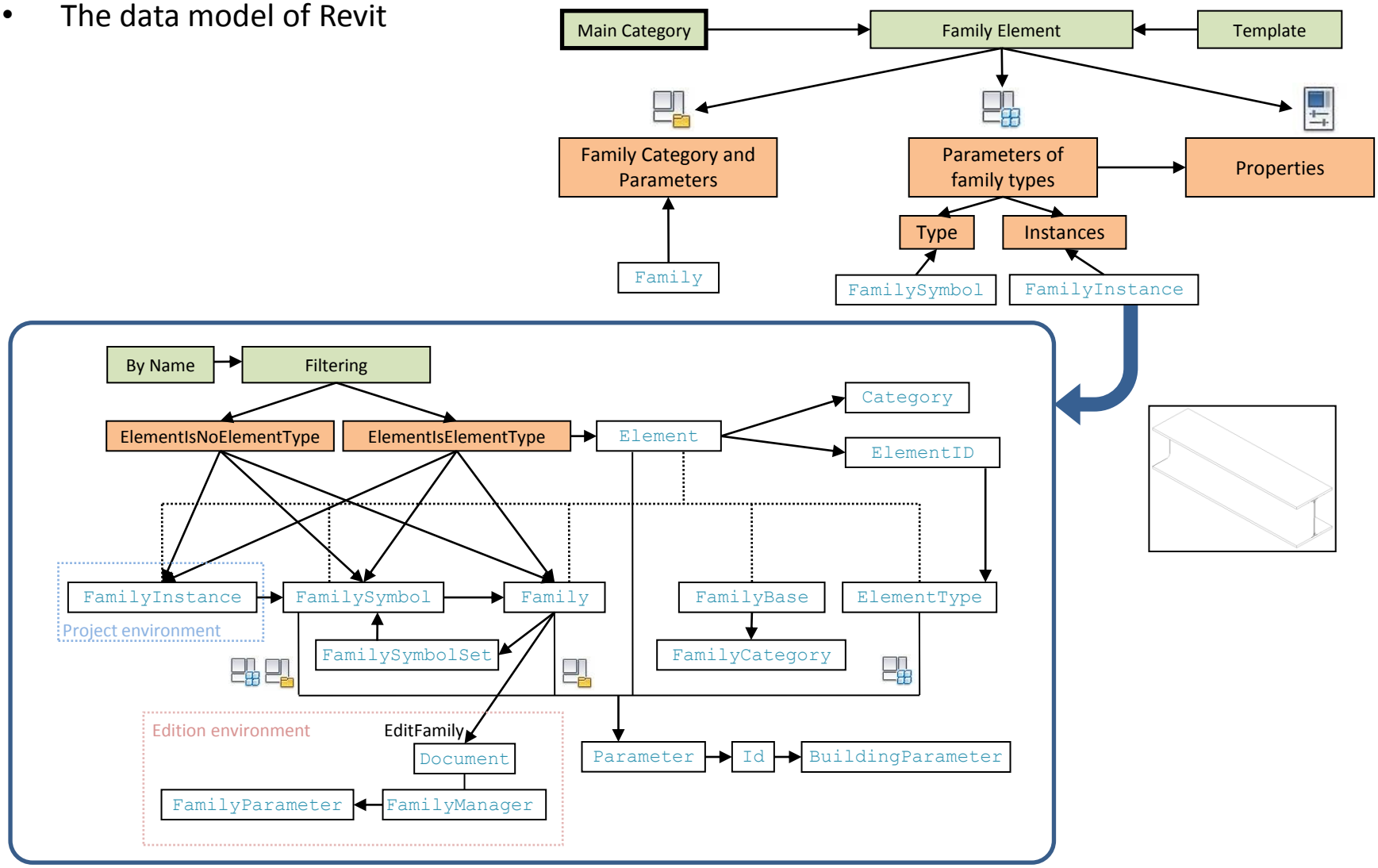
3. Open Building Components Platform

Approach



A data model organization reference

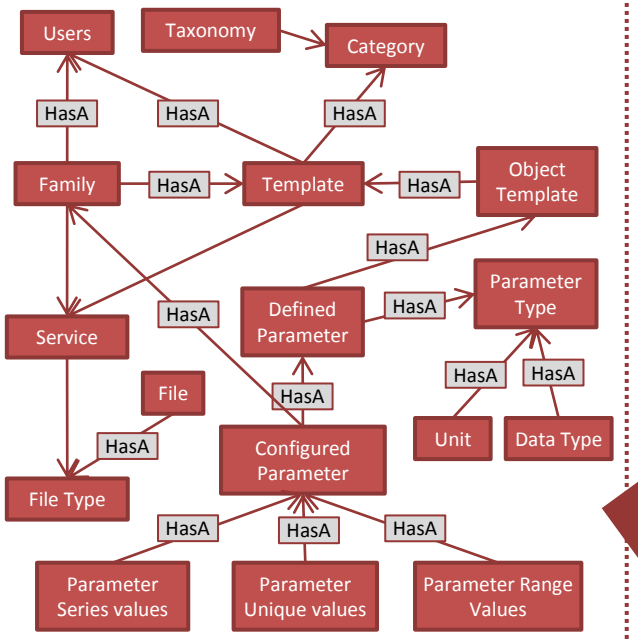
- The data model of Revit



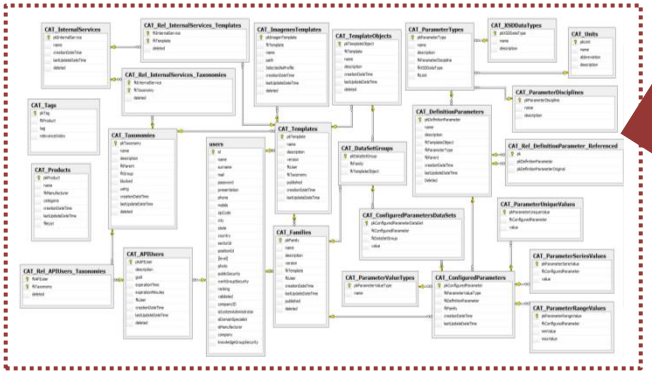
3. Open Building Components Platform

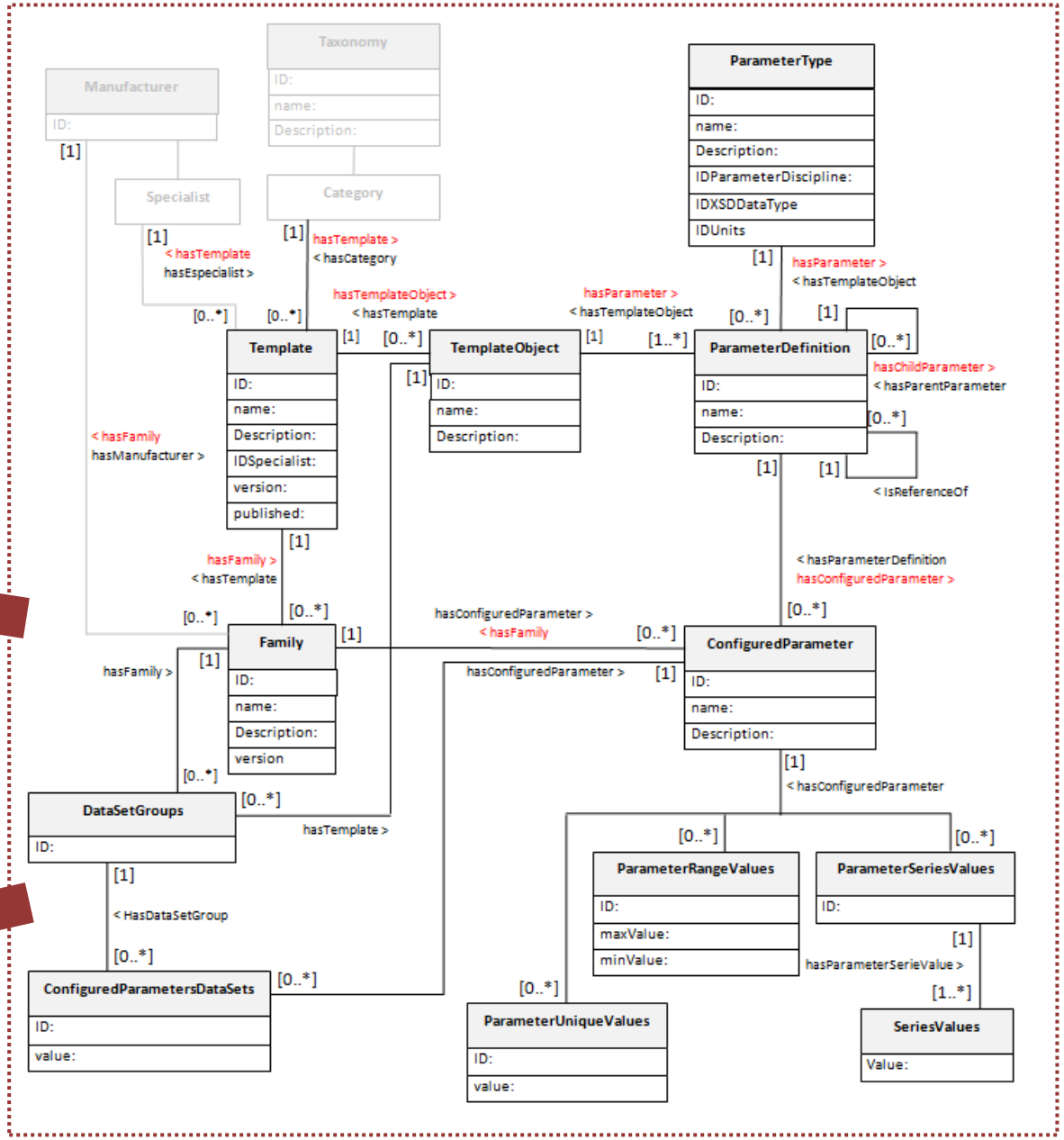
Conceptual metadata model

Flexible data model implementation



Relational database model implementation

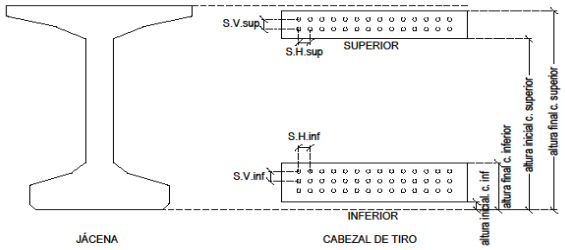


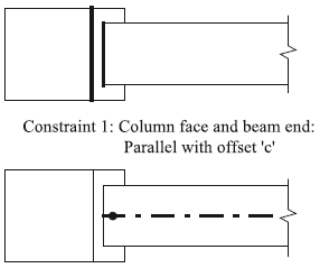


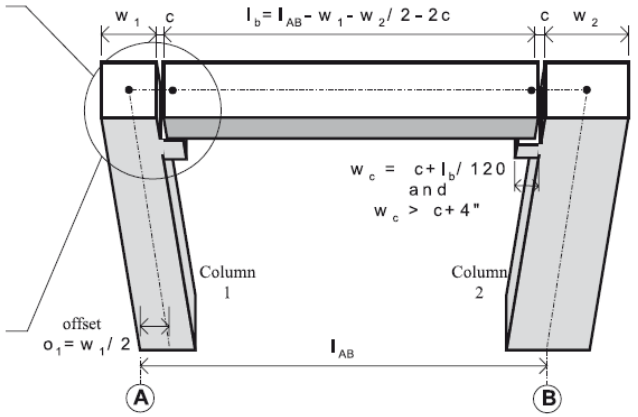
3. Open Building Components Platform

Case study: Precast concrete beam

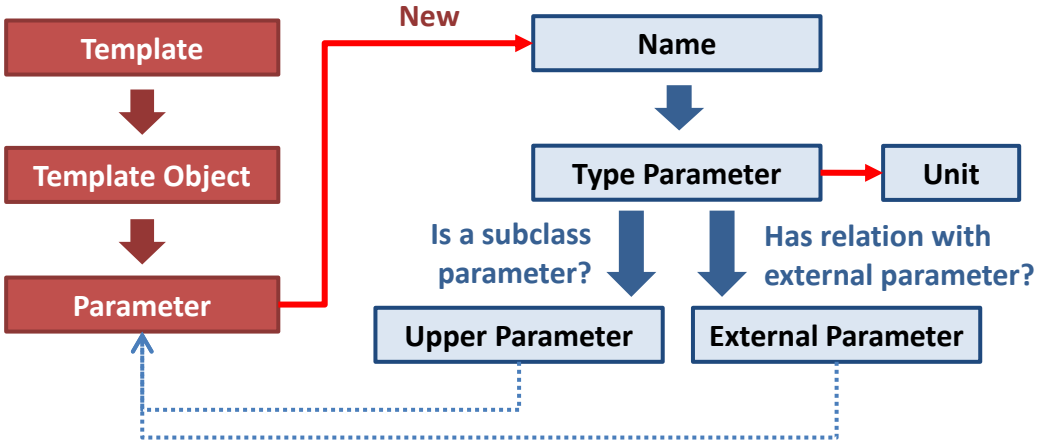
Define some of the production features of components (by the manufacturer)







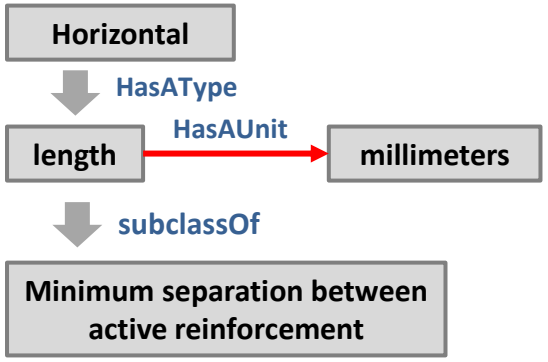
- **Component definition interface process**



Example - Template: **Beam I XXX**

Template object: **Extrusion machine**

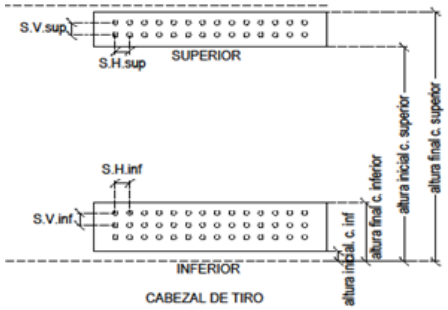
→ New Parameter



* In the process of creating a family, the manufacturer will set the value of each parameter.

3. Open Building Components Platform

- **Parametric definition of "extrusion machine" (Template object)**



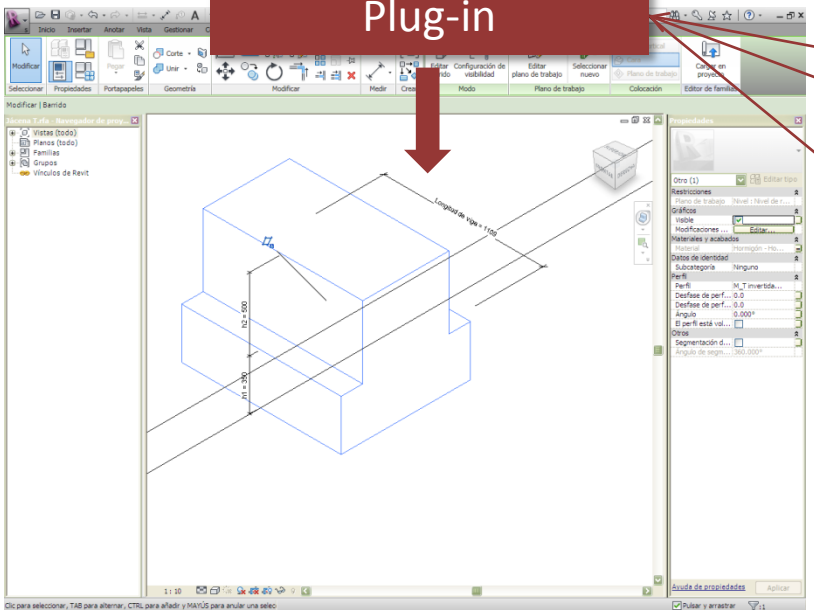
Head	Side	Minimum separation betw een active reinforcement		Start height	End height	Maximum number of anchors for alignment		Maximum tensioning
		Horizontal	Vertical			Horizontal	Vertical	
A	Top	5	5	70	120	20	10	200
	Down	5	5	0	600	40	12	750
B	Top	-	-	-	-	-	-	-
	Down	5	5	0	600	40	10	750

Template information

Family information

- **Parametric definition of building component (by Manufacturer)**

Plug-in



Autodesk REVIT Structure

On-line Catalog

1

Metadata Model

2

3

Data Model

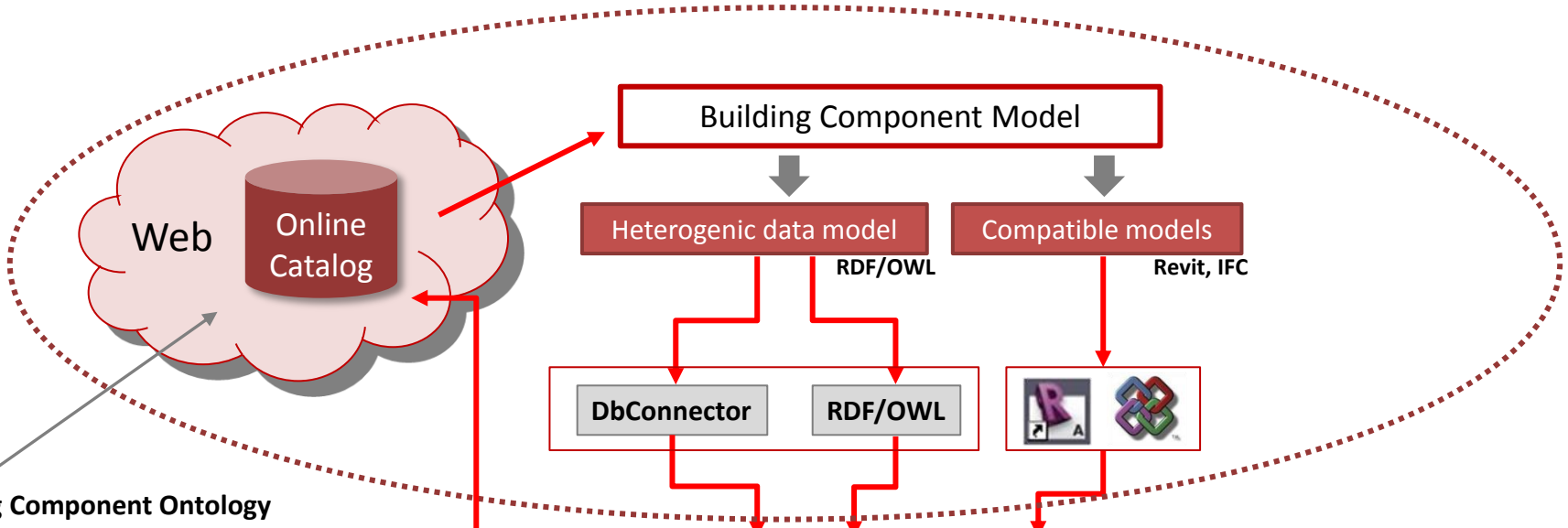
4

Manufacturer Production Models

Close model

3. Open Building Components Platform

- **Next step: Selection of building components from the catalog (by Designers)**

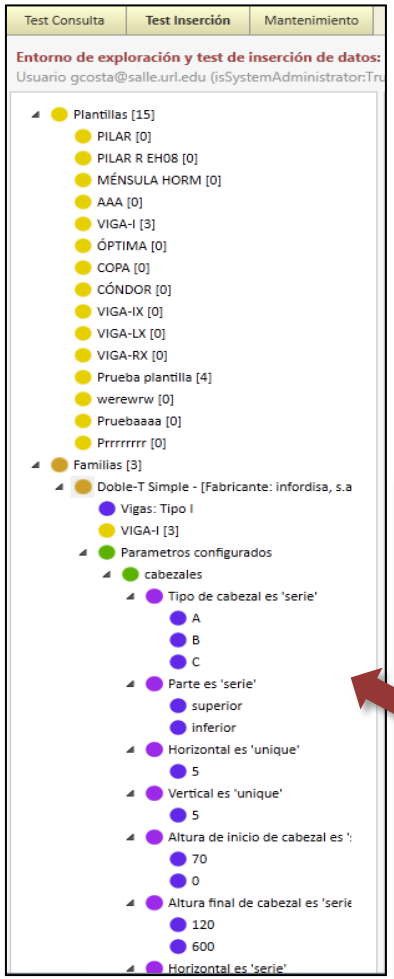


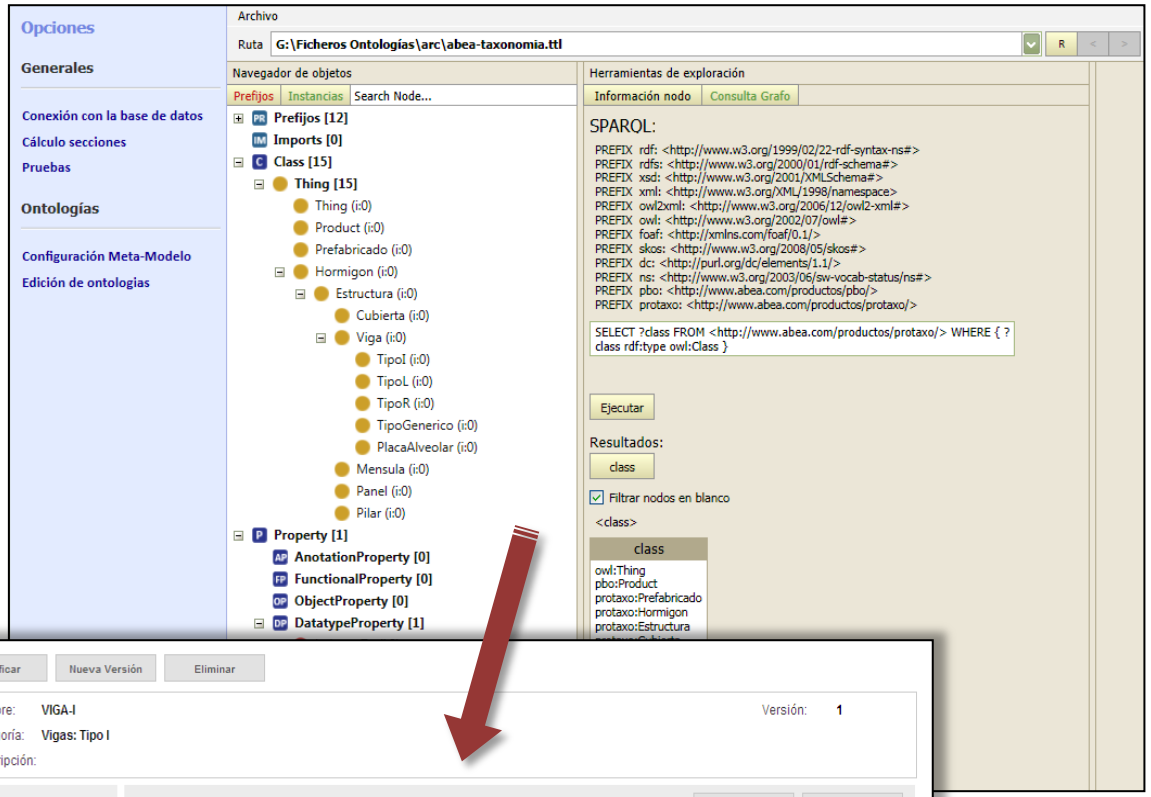
Building Component Ontology Endpoint:
http://openBC.net:8080/structure/sparql

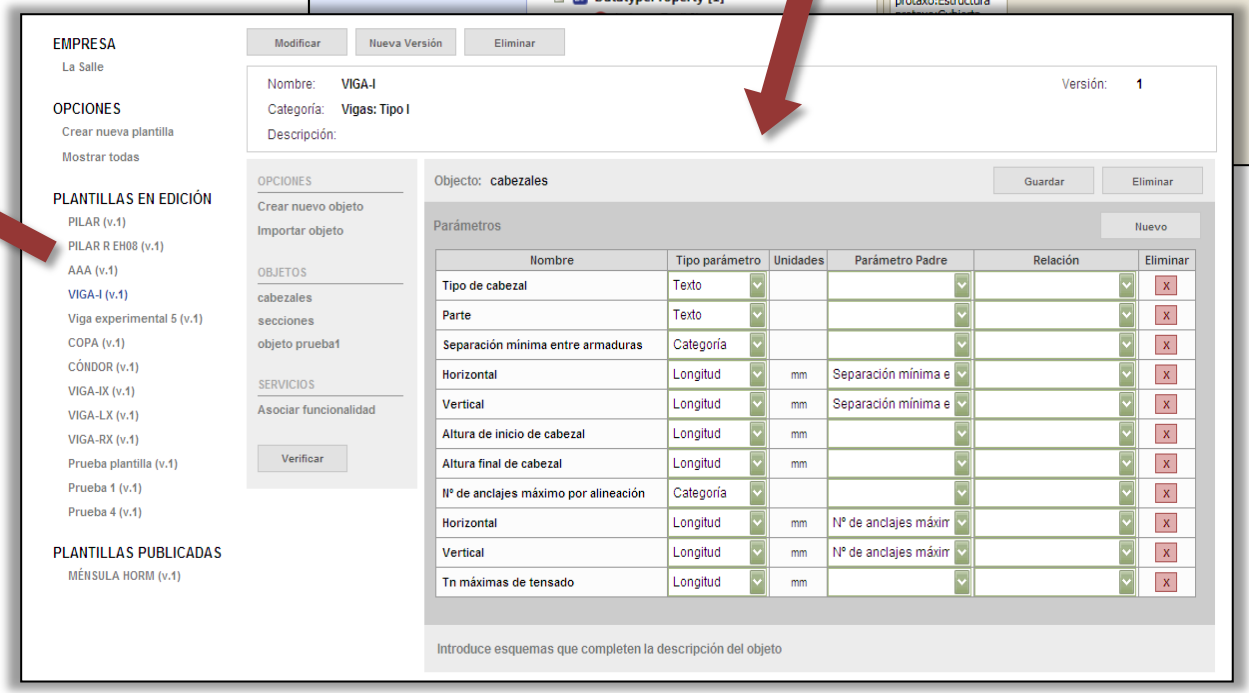
For example, **we can retrieve a list** containing **all the components of a building project** (each one with **all associated information** from other data models of the same component) and **make decisions** for improving the BIM model.

3. Open Building Components Platform

Current work and results







Conclusions

General conclusions

- The **capabilities** of BIM programs to perform the data extraction are **limited**.
- The study of interoperability sometimes involves the study of the **nature of the systems** and the analysis of the **conditions** in which data are generated.
- Interoperability depends on **what you do and you want to allow** with the information of the model.
- The use of standards for the BIM models interchange may **not be a good solution** for a constantly changing world. Instead, the **semantic web languages** and technologies enable a **high degree of flexibility** in the design and management of the data models.
- **Open Linked Data** is a good alternative for improving the capability of interchanging and sharing building data models.