

Digital preservation of information models for the built environment -
an overview of the DURAARK project & preservation of semantically enriched BIMs



Jakob Beetz (Eindhoven University of Technology, NL) & DuraArK consortium

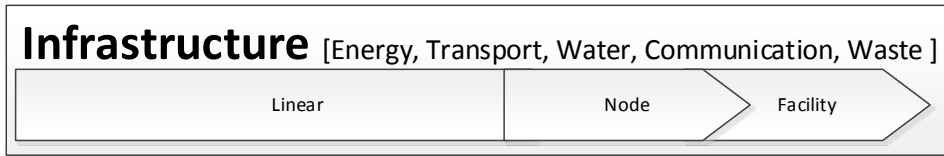
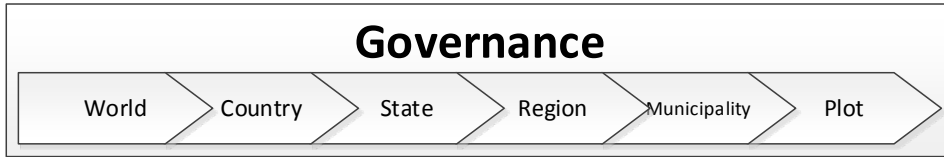


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ARCHITECTURAL
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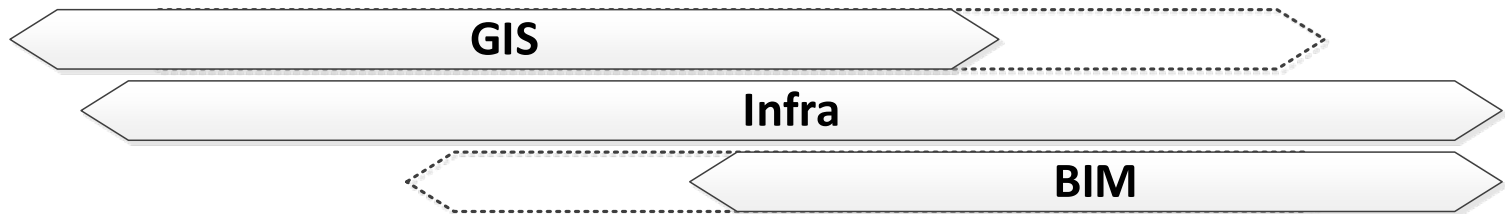
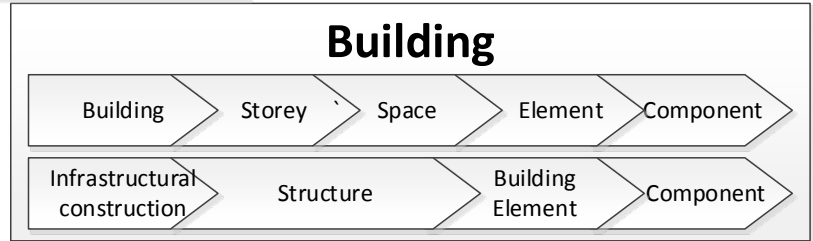
Nature
[Air, ground, water]

Society
[Individuals, Groups, Users, Creators]



small
fine
[mm]

big
coarse
[km]

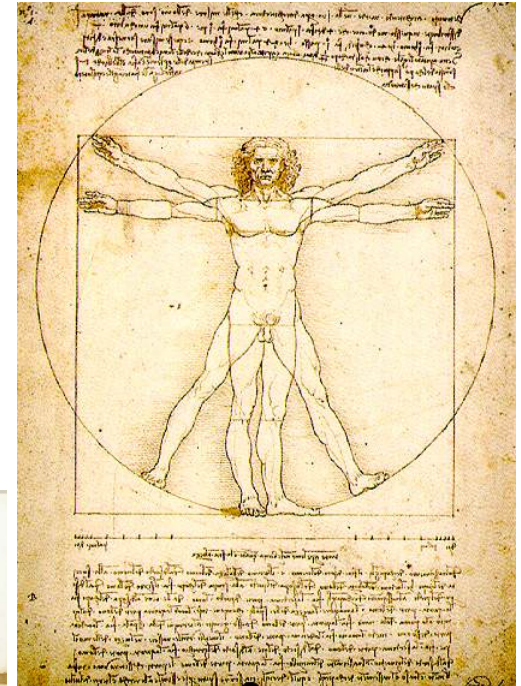
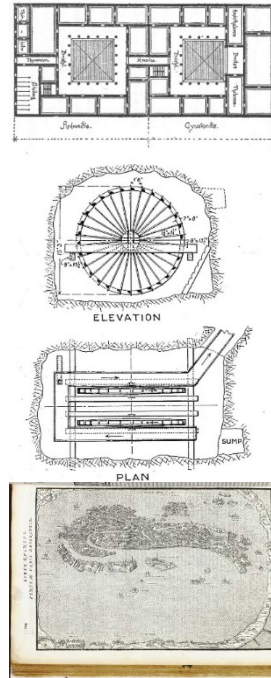
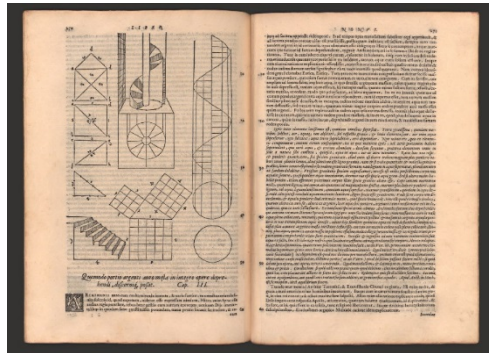
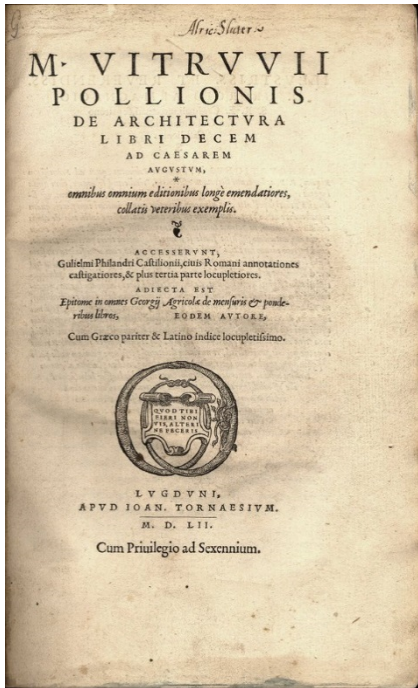


Building Information - the spectrum



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Building Information - then



Master Builder

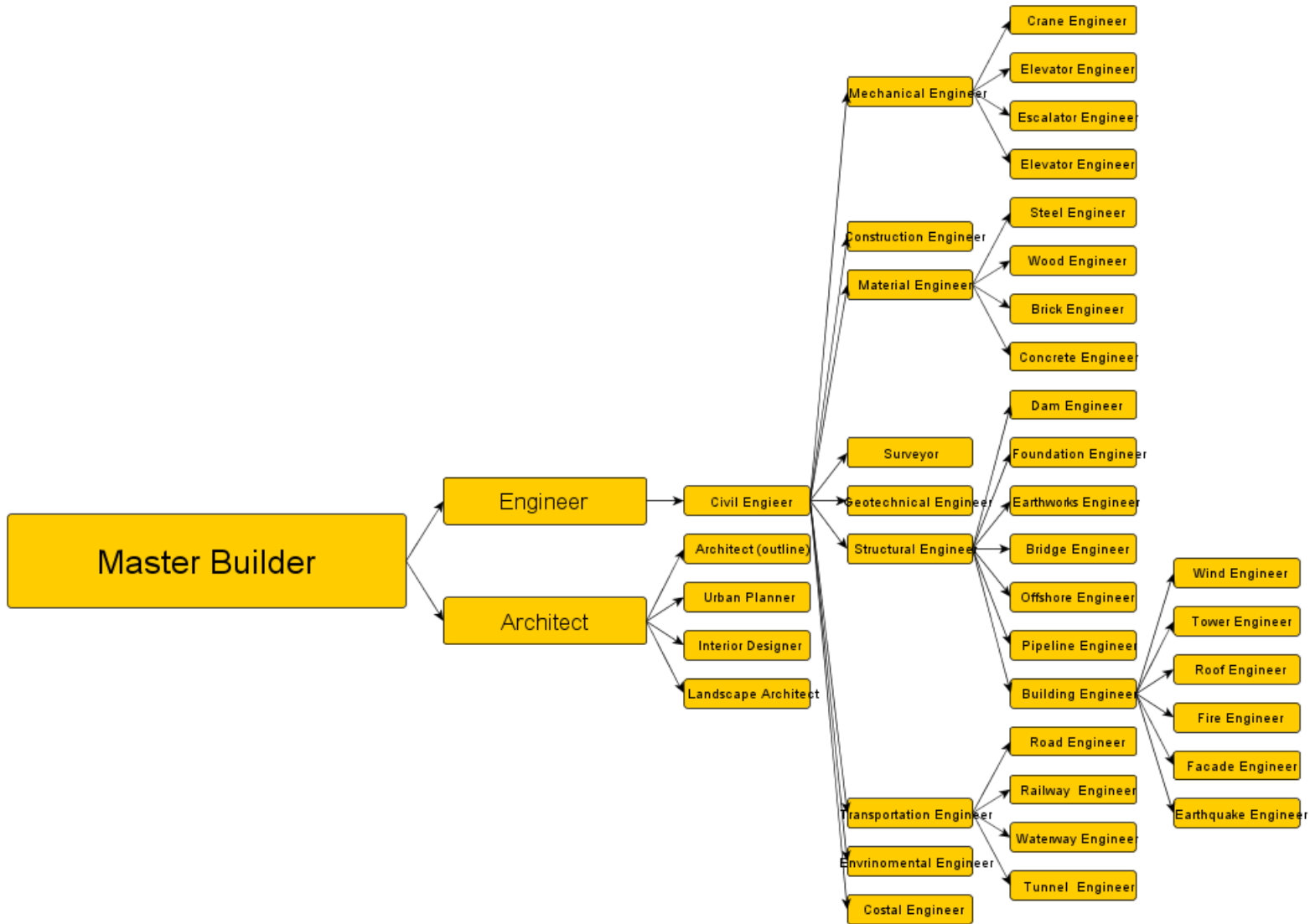
Building Information - in the meantime





Building Information - in the meantime





Relevance

- Approx 30% of energy use goes into building

[AIE, 2009]

Diversity

- Building stock in EU: ca. 40 % pre-1960, 42 % 1960-1990, 18% post 1990

[BPIE, 2011]

Fragmentation and heterogeneity

- 11 million jobs, 2 million companies
- 93% of companies less than 10 employees
- Only 100 companies with more that 2000 employees

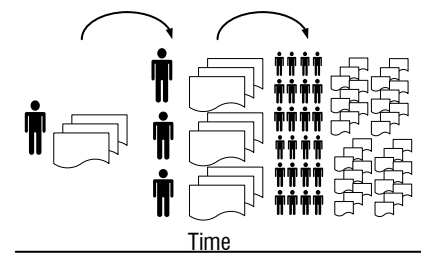
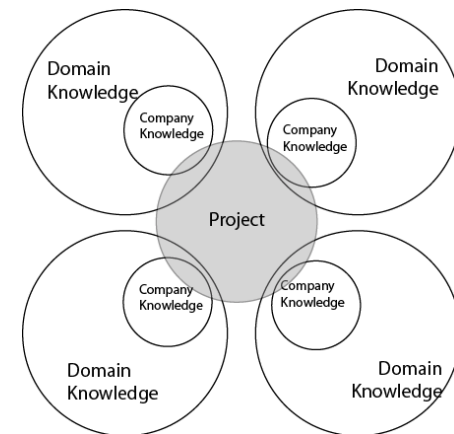
[EU in 2000, Kiviniemi]

- Often more than 200 actors and domains involved

Inefficiency

- \$ 15,4 Billion loss *per year* for *capital facilities alone* in the US due to interoperability and communication issues

[NIST: Gallaher et al, 2004]

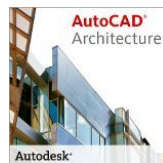
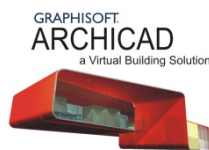


Characteristics of the building sector



Building Information Modeling (BIM): Covering the complete lifecycle of a building

- design drafts
- design development
- construction documentation
- production
- documentation of the current condition
- building operation



3D CAD

- Geometry along X-Y-Z axes



4D CAD

- Schedule time



5D CAD

- Cost-related information



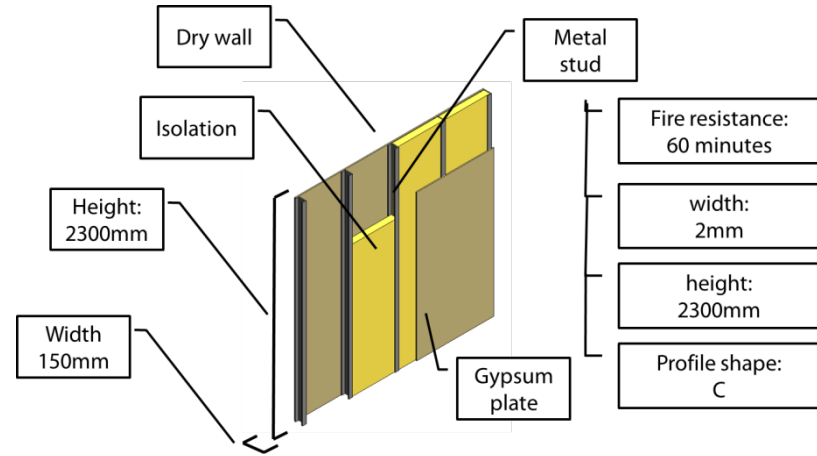
6D CAD

- Energy and sustainability



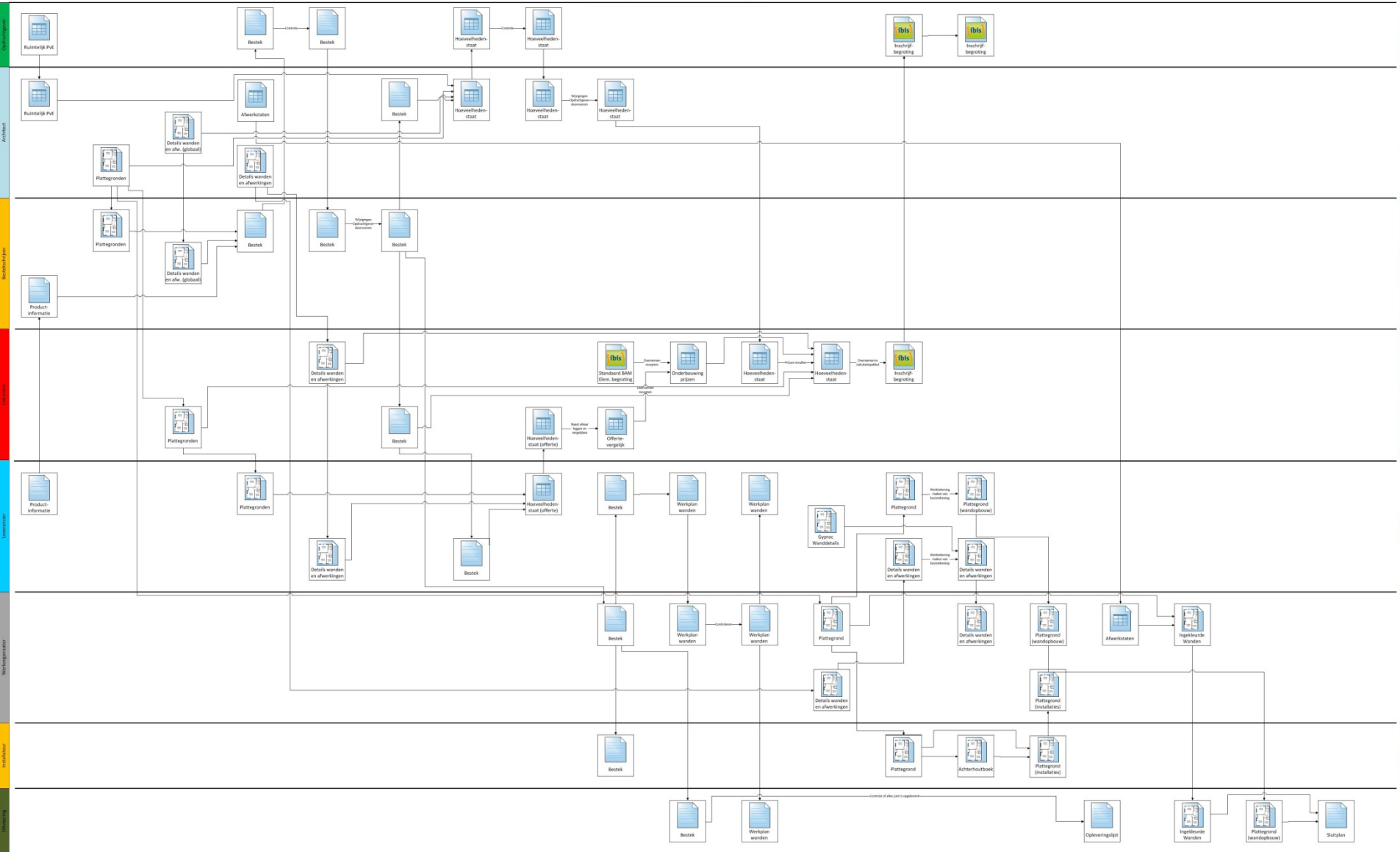
7D CAD

- Facility management



Provenance of Information: a simple example





Source: Royal BAM group, Daan Kuijsten

Flow of information during detail design



3D Object Acquisition

BIM

- *prescriptive* CAD
- shaping the future

3D Object acquisition:

- *descriptive* CAD
- documenting the current state
- preparing retro-fit / renovation



Tremendous progress in the last 10-15 years:

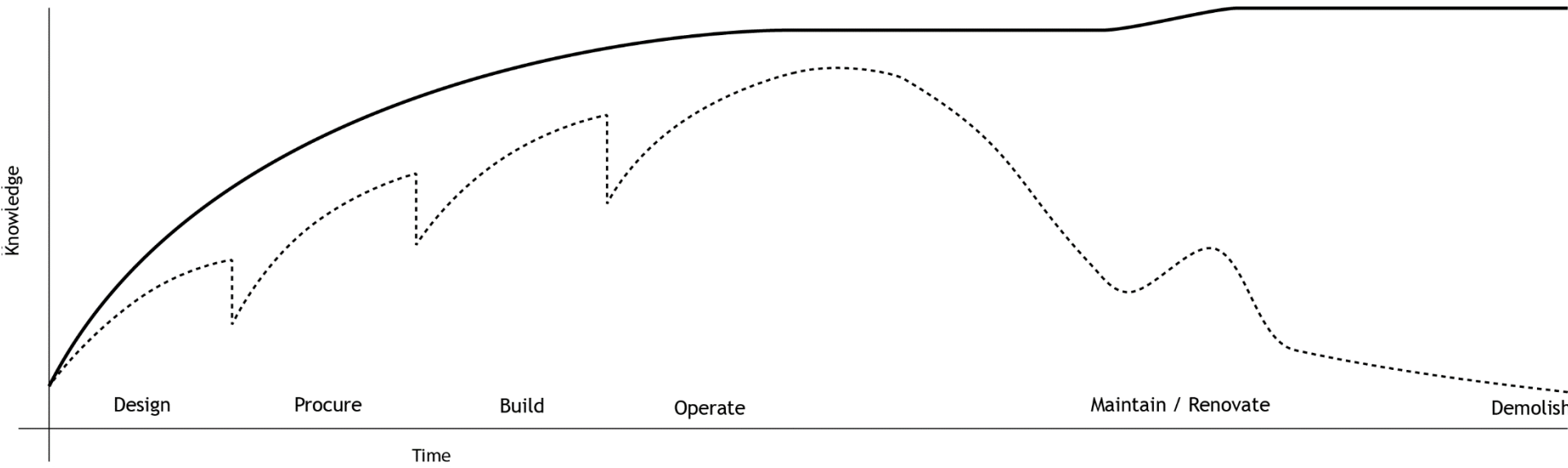
- Various methods: Laserscanning, photometric stereo, multiview reconstruction, structured light
- Fast
- Accurate
- Cheap... well, kind of like...





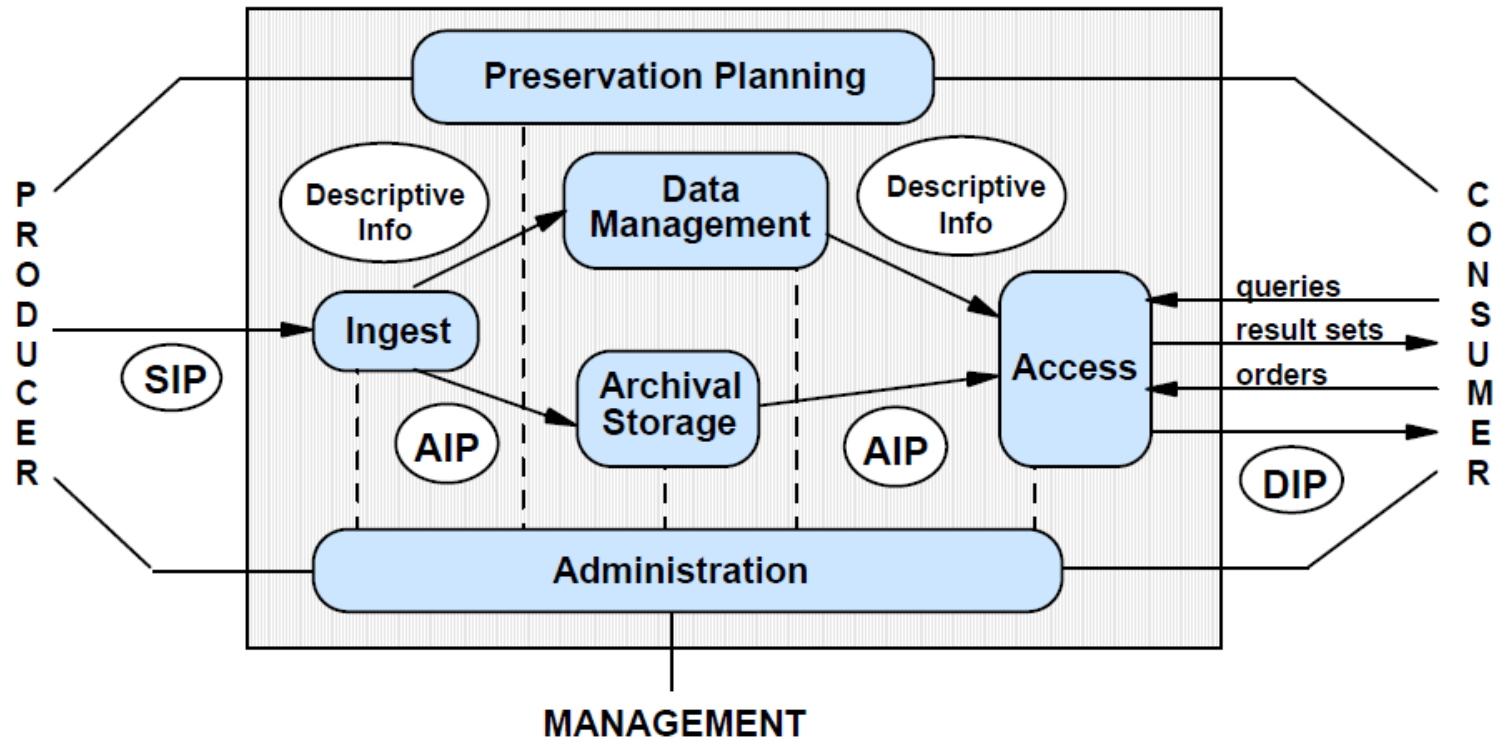
'Archival system' for project hand over





Information and knowledge loss and decay

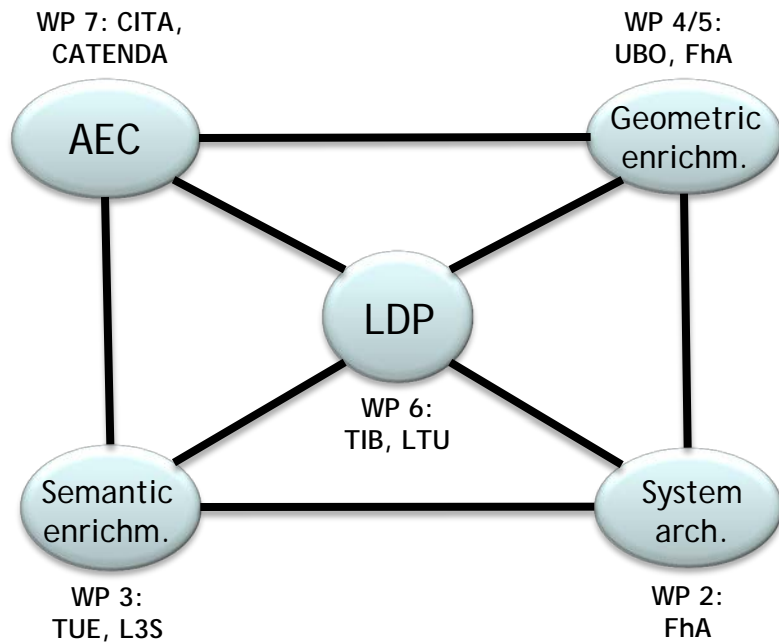




Open Archival Information System (OAIS) Framework



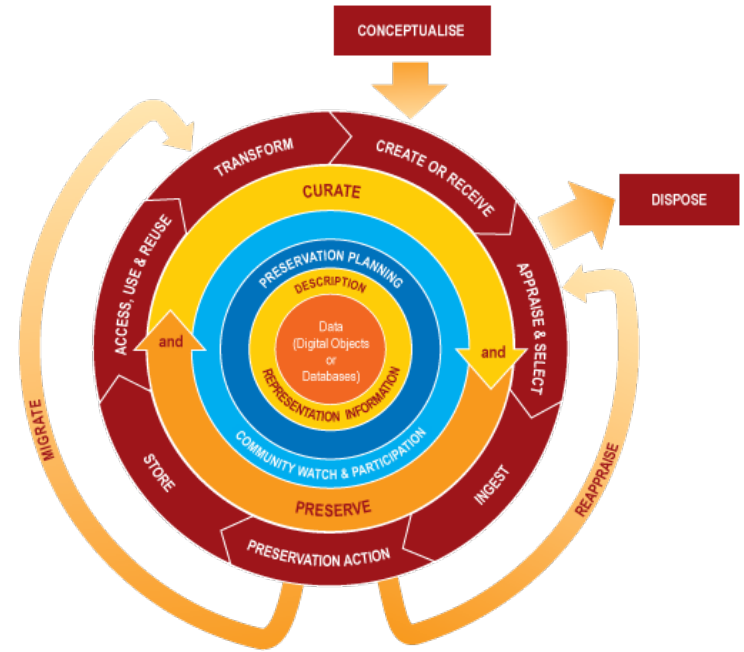
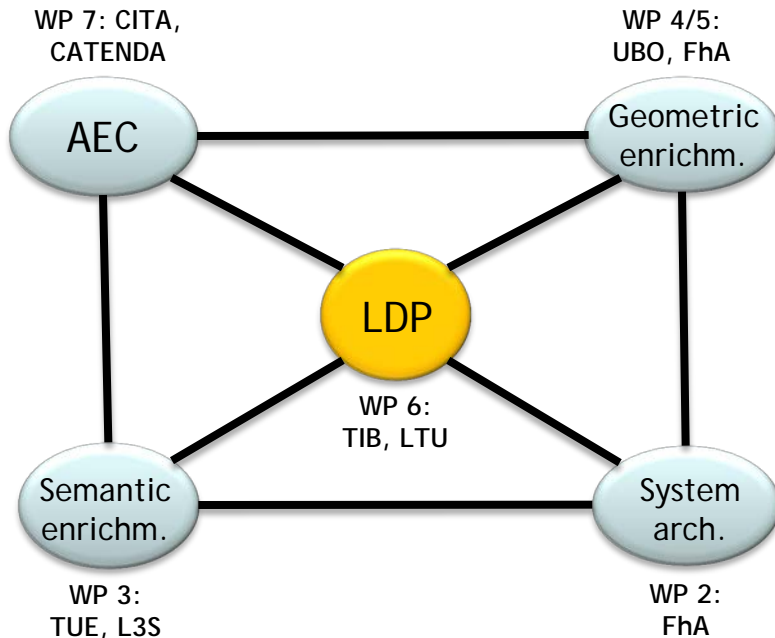
DURAARK Structure and Overview



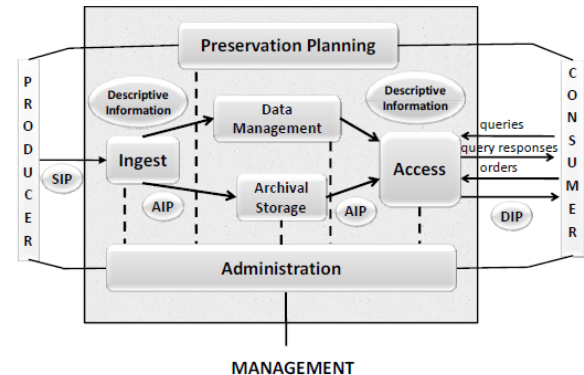
DURAARK Structure and Overview

WP 6 (TIB, LTU):

- Enable LDP for BIM and point cloud datasets
- Evaluation of LDP requirements (data formats, risk analysis, ingest, storage, etc.)



DCC Curational Lifecycle Model

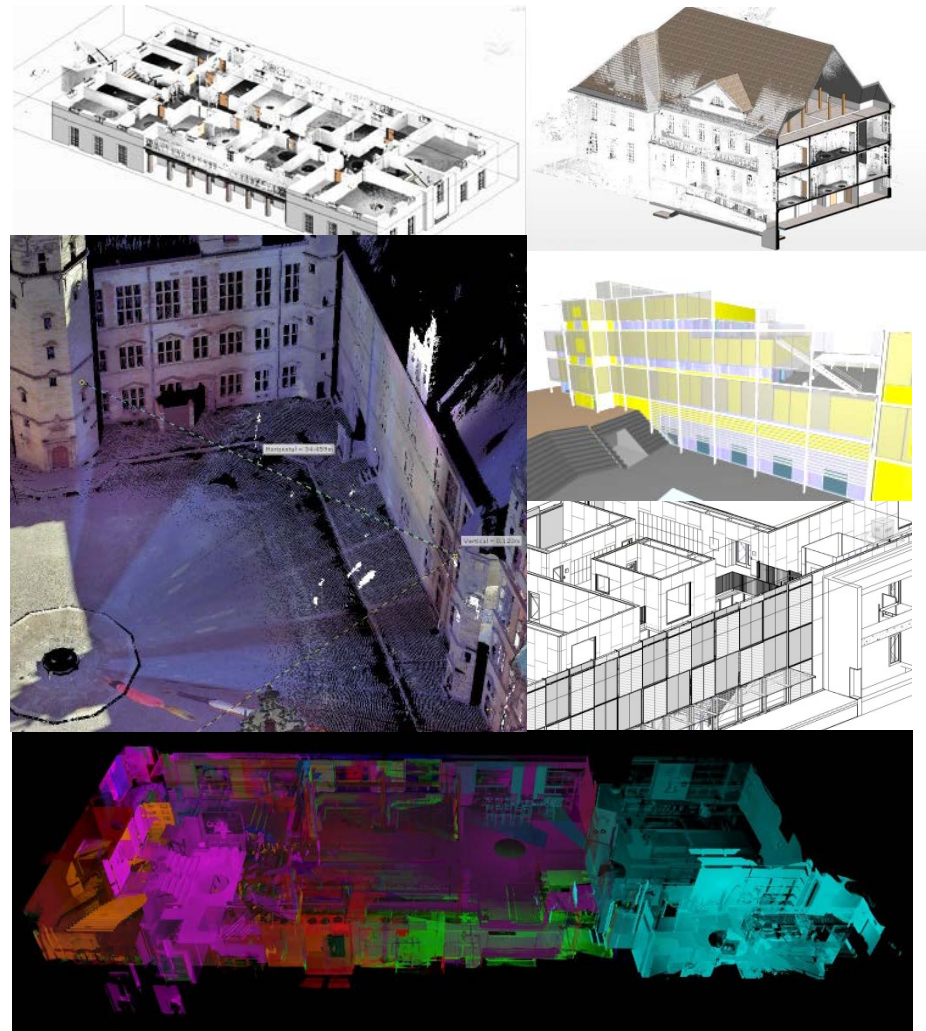
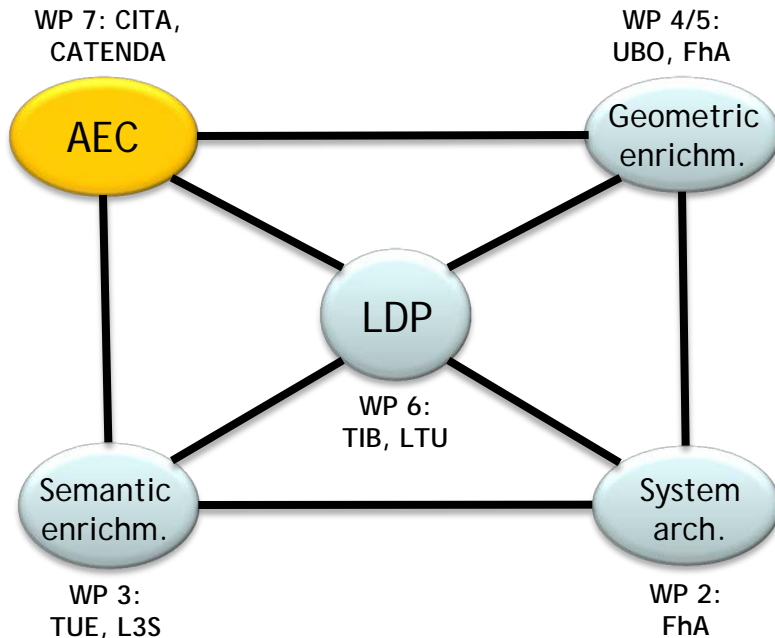


OAIS model overview

DURAARK Structure and Overview

WP 7 (CITA, CATENDA):

- Acquired many IFC and point cloud datasets
- In touch with stakeholders, practitioners and experts
- Evaluation of needs and outcomes



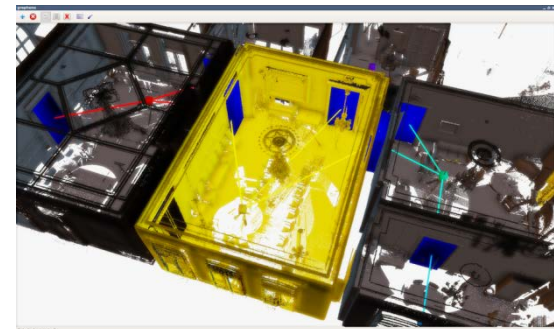
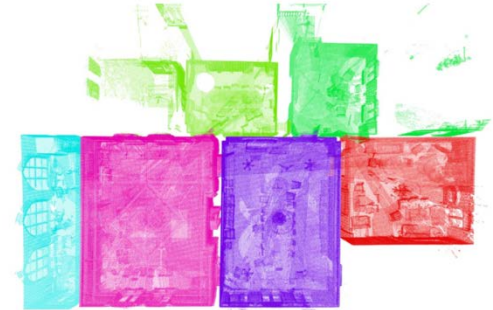
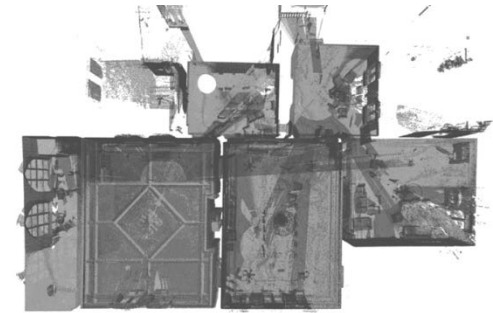
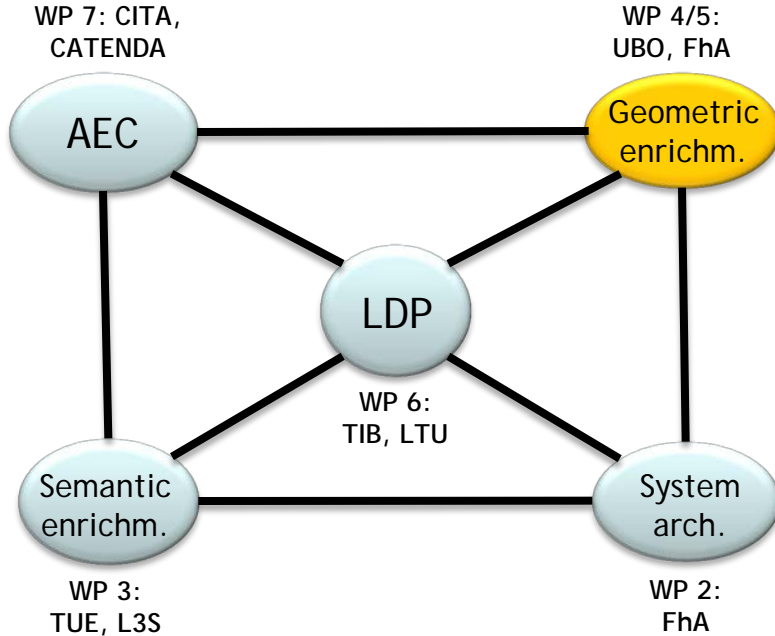
DURAARK Structure and Overview

WP 4 (UBO):

- Synchronization and comparison of BIM and point cloud datasets

WP 5 (UBO, FhA):

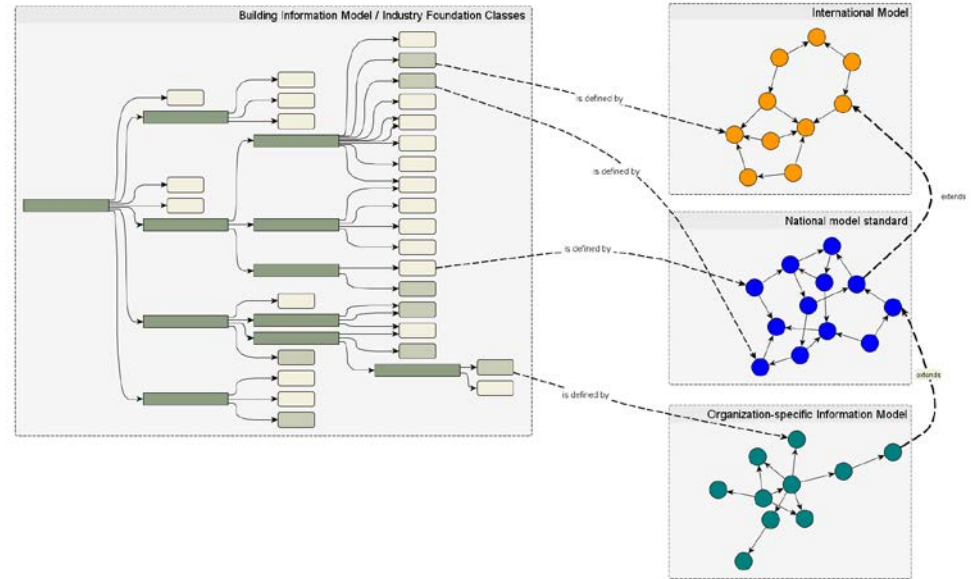
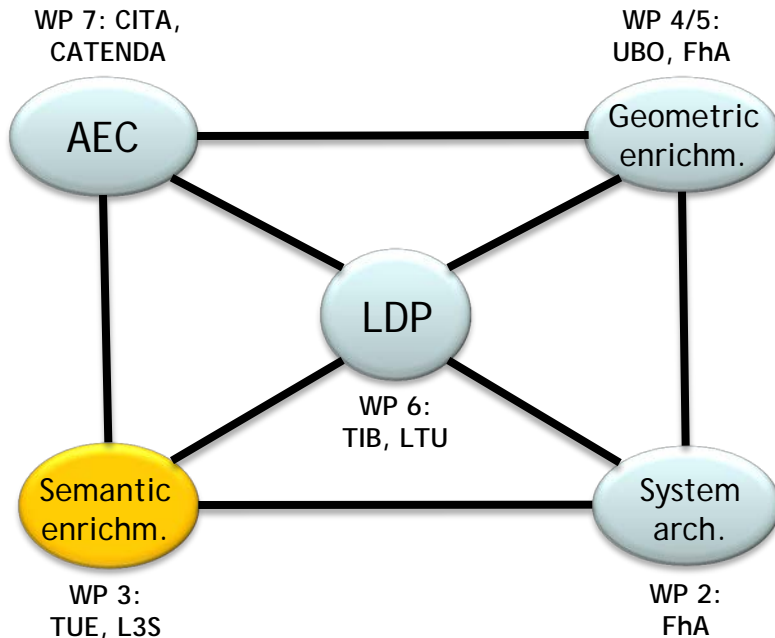
- Geometric enrichment of "low-level" datasets (i.e. point clouds)



DURAARK Structure and Overview

WP 3 (TUE, L3S):

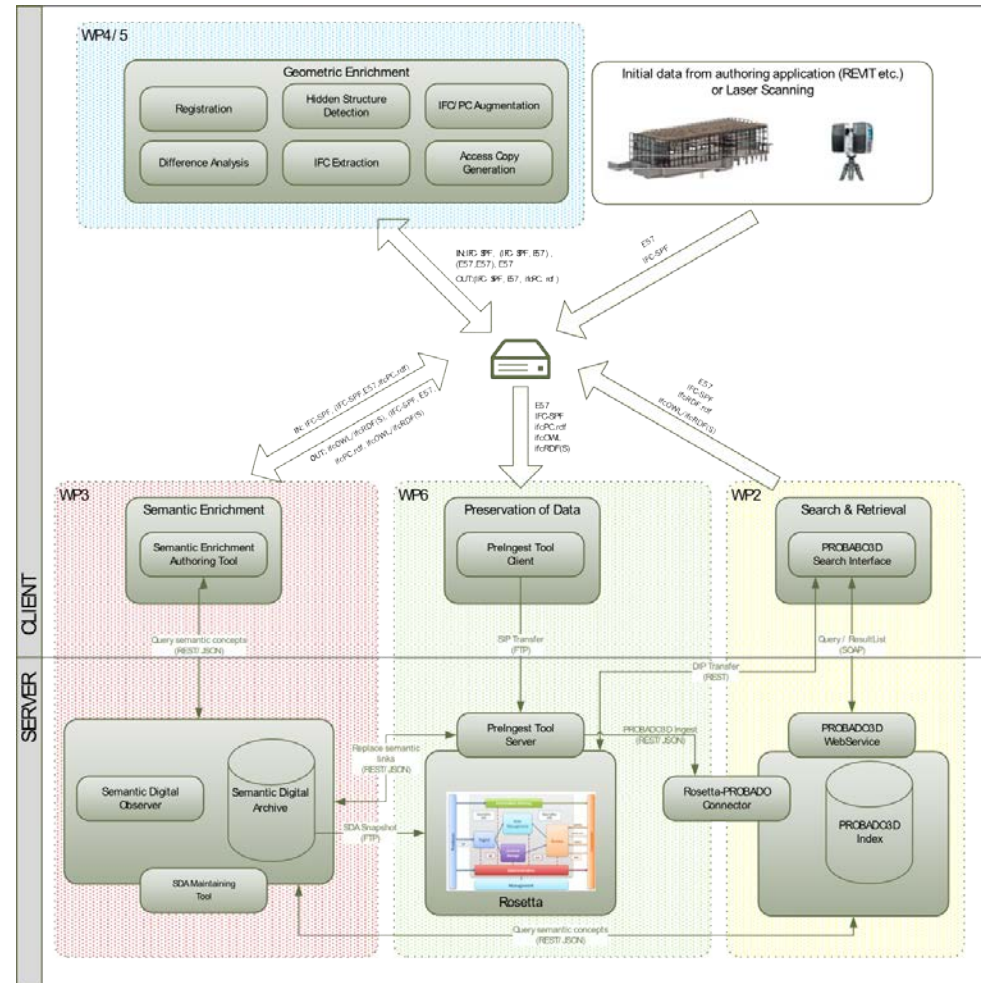
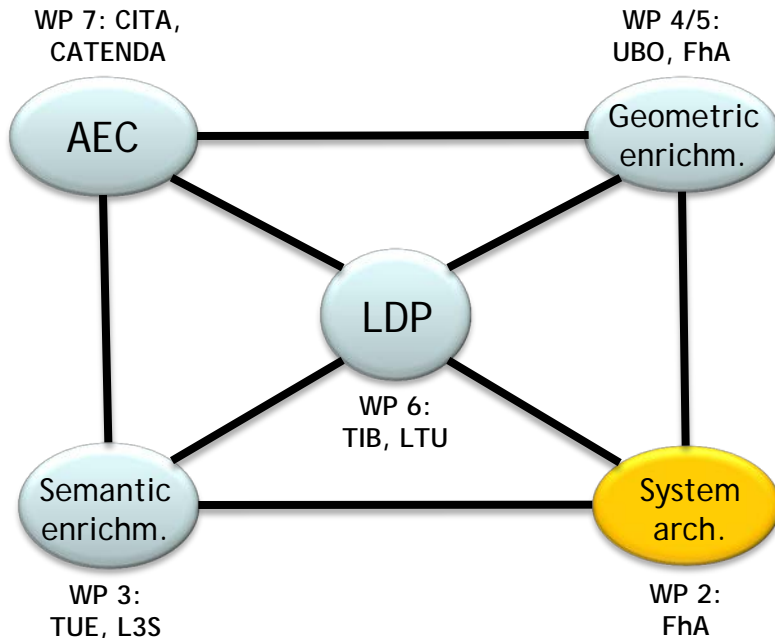
- Complementing datasets with semantic attributes
- Development of self-sustained knowledge database (semantic digital archive, SDA)

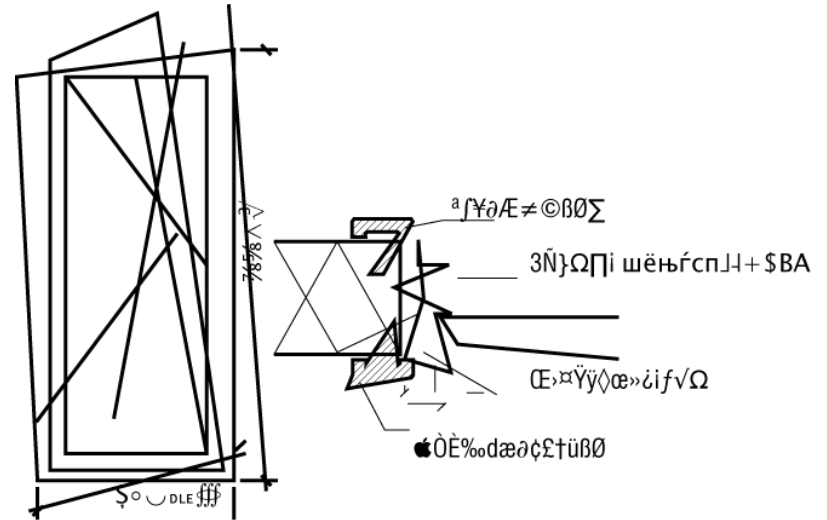
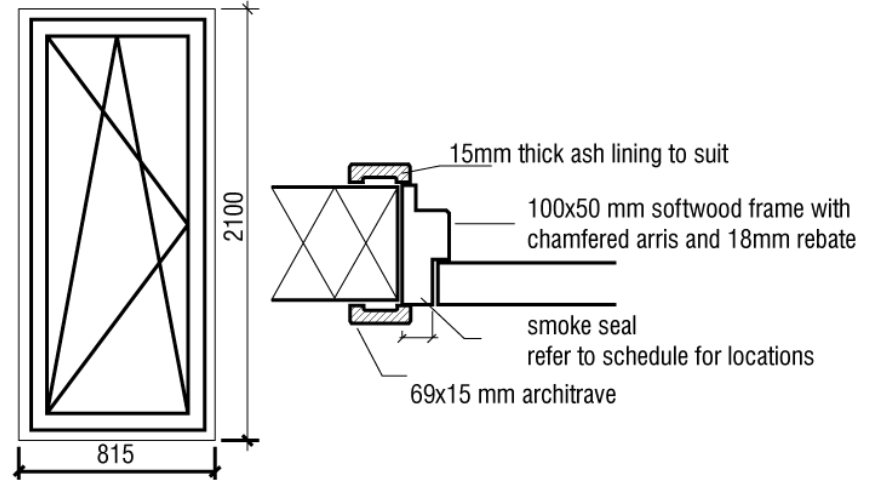


DURAARK Structure and Overview

WP 2 (FhA):

- Performed requirement analysis
- Specified system architecture ->
- LDP system prototype
- Tools for browsing the archive





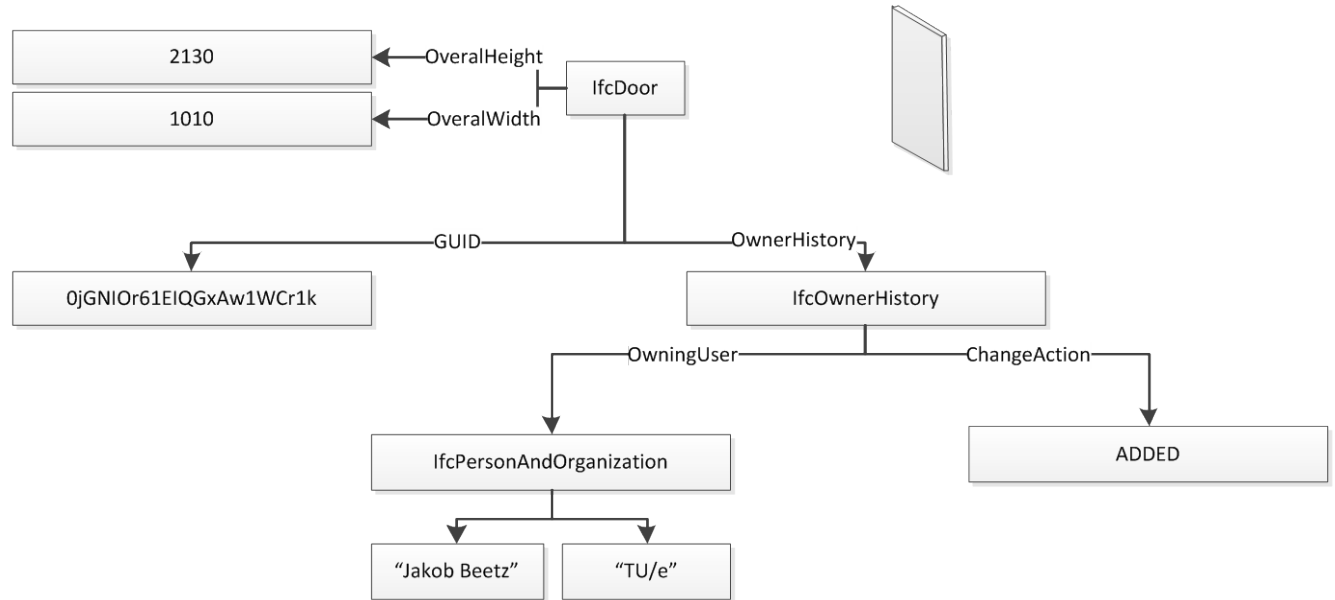
Lack of semantic information in CAD



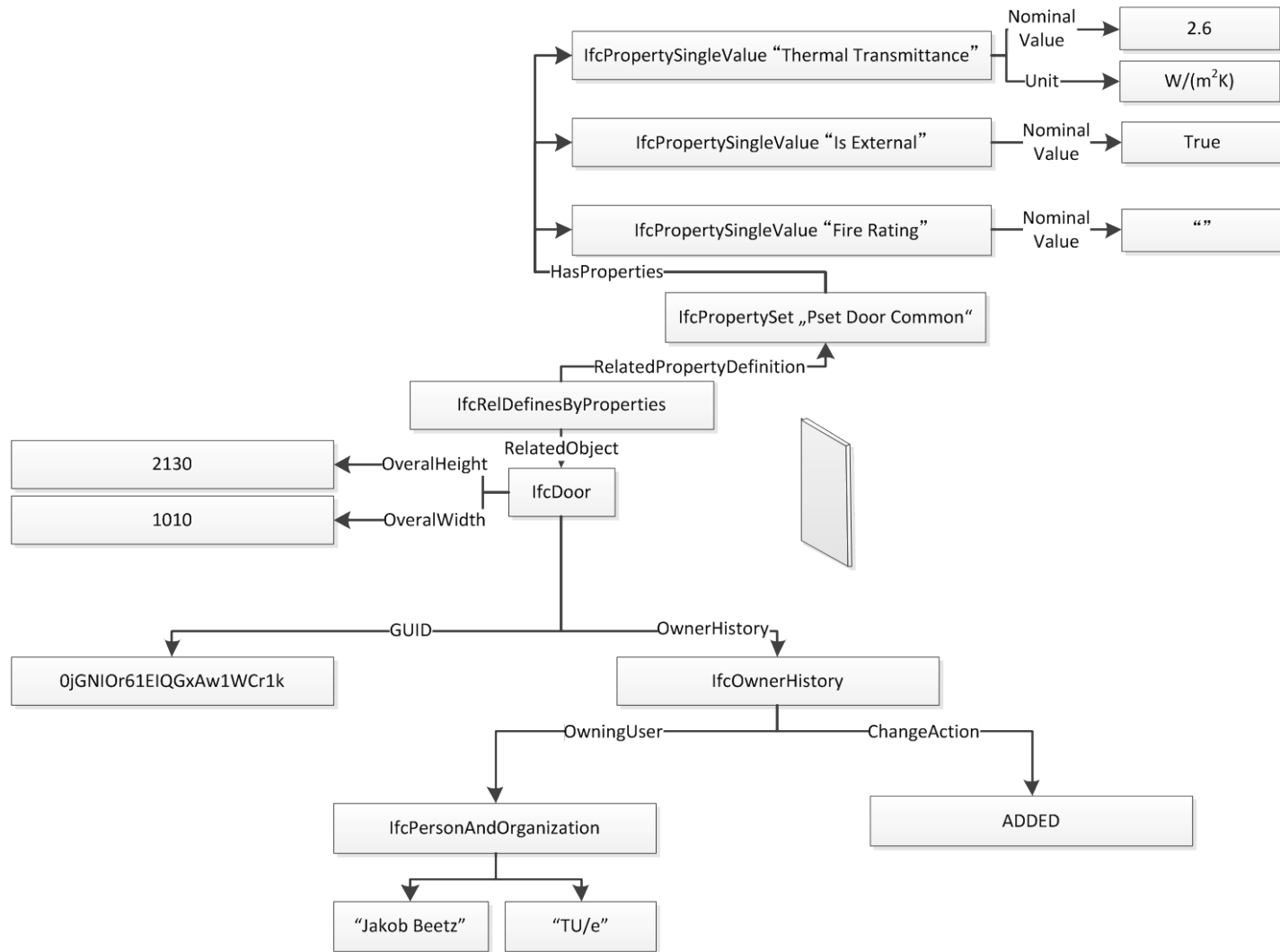
Semantic Definition in IFC



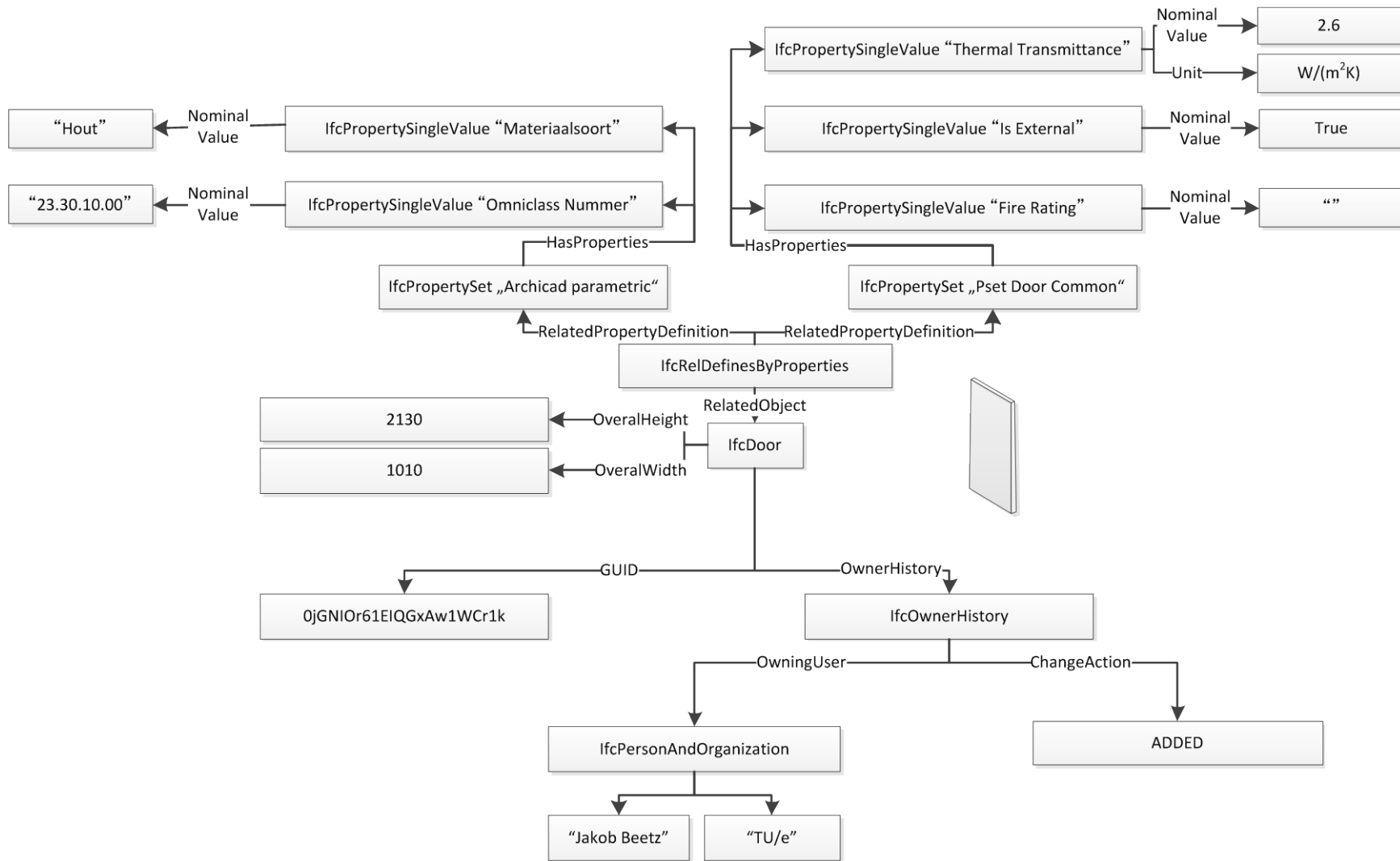
Definition by attributes



Definition by standardized properties



Definition by ad hoc properties





Now... *that* should clear up a few things around here

© Horrocks, Oxford University

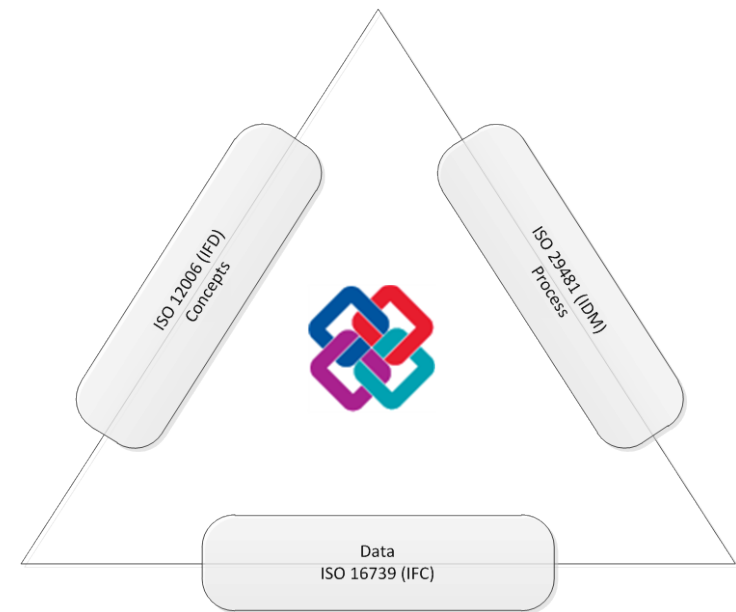
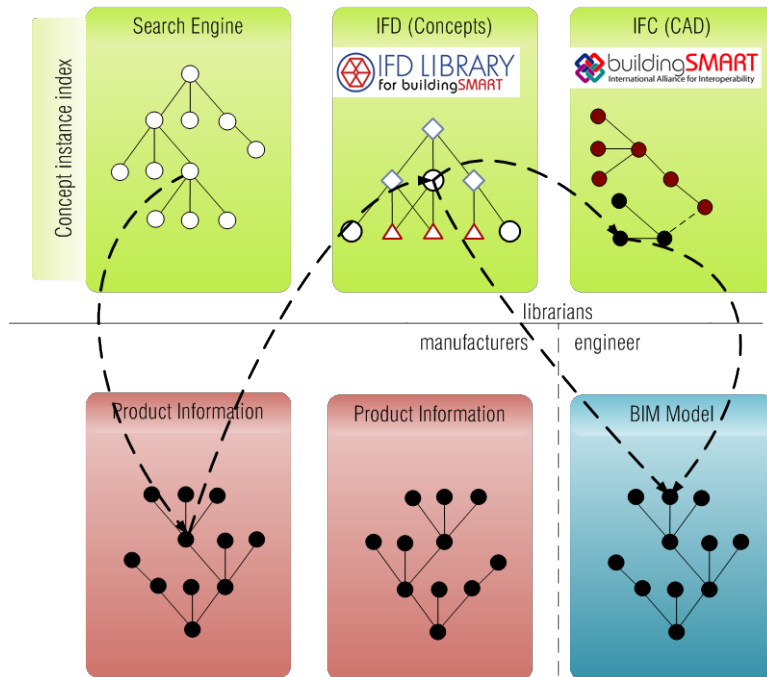


Legacy part 21 enrichment with RDF

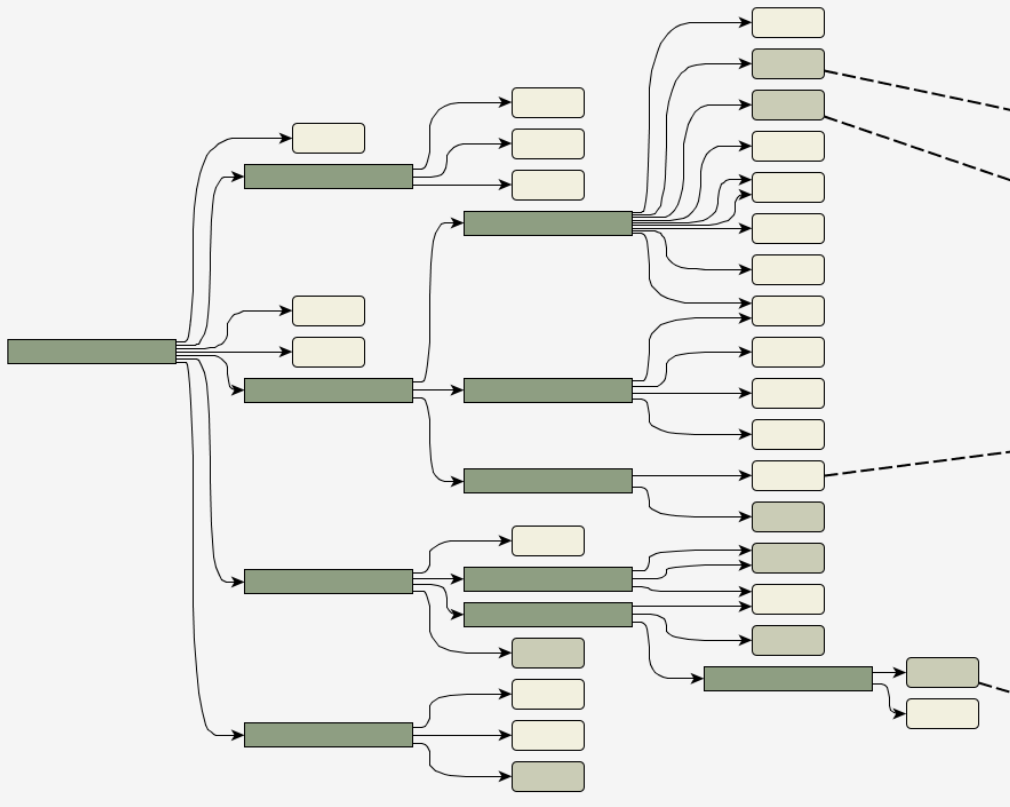


Increase semantic scope:

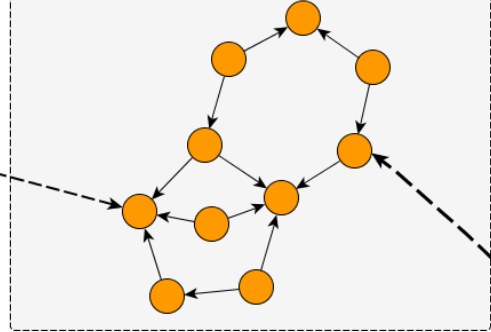
- International Framework for Dictionaries (IFD, ISO 12006):
 - Data structure to capture concepts, properties and relations
- buildingSMART Data Dictionary (bSDD)
 - Reference instance of IFD, currently filled with ca. 50,000 concepts



Building Information Model / Industry Foundation Classes



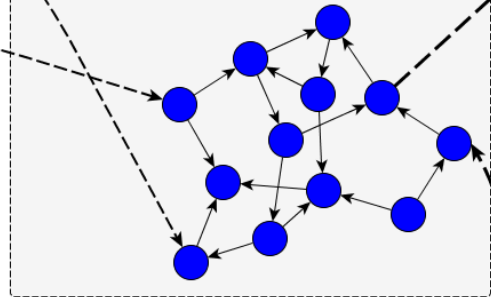
International Model



is defined by

is defined by

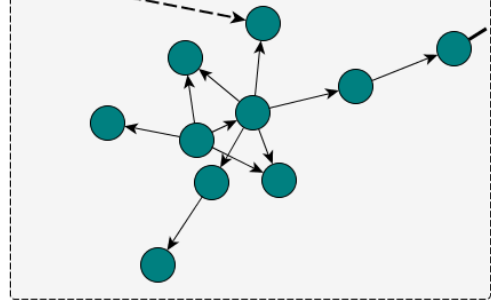
National model standard



is defined by

is defined by

Organization-specific Information Model



extends

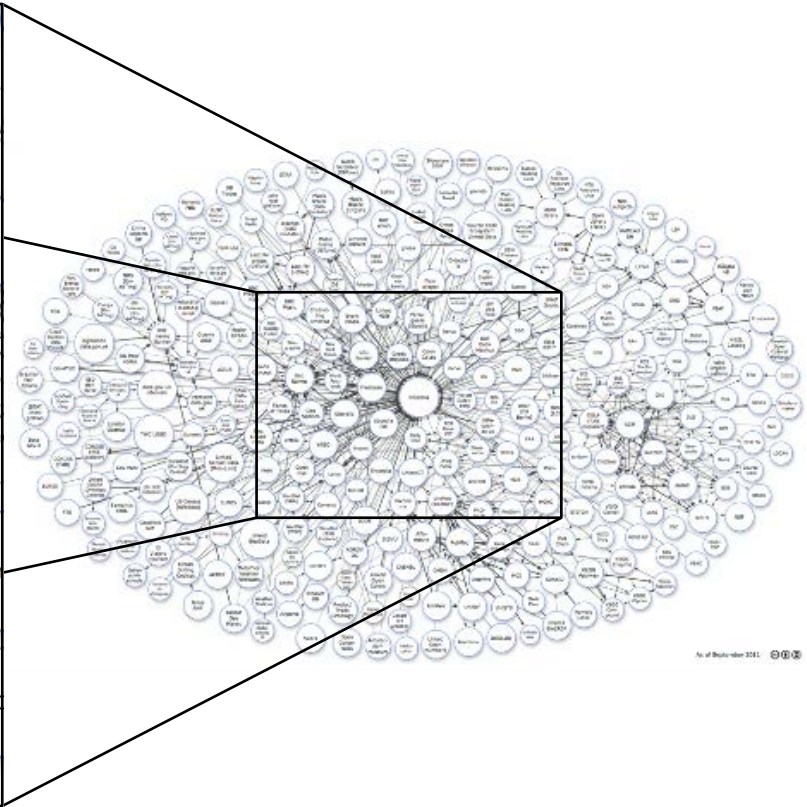
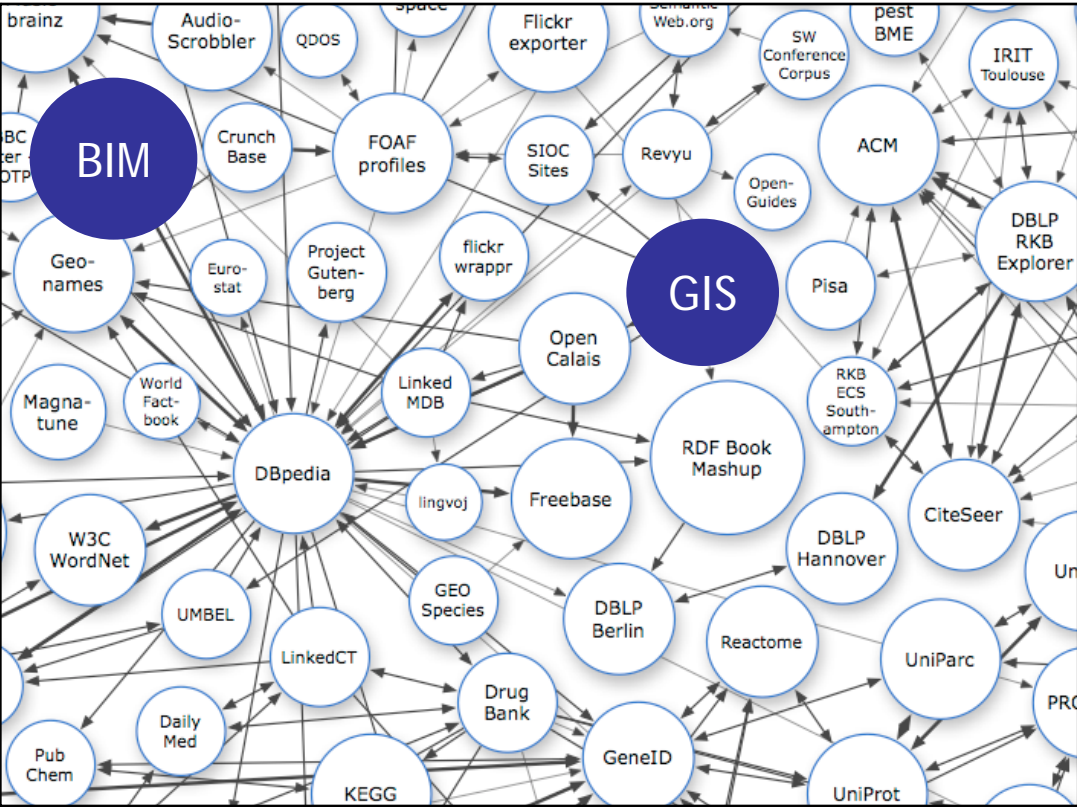
extends

Semantic Enrichment with distributed Vocabularies



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Linked data for engineering purposes

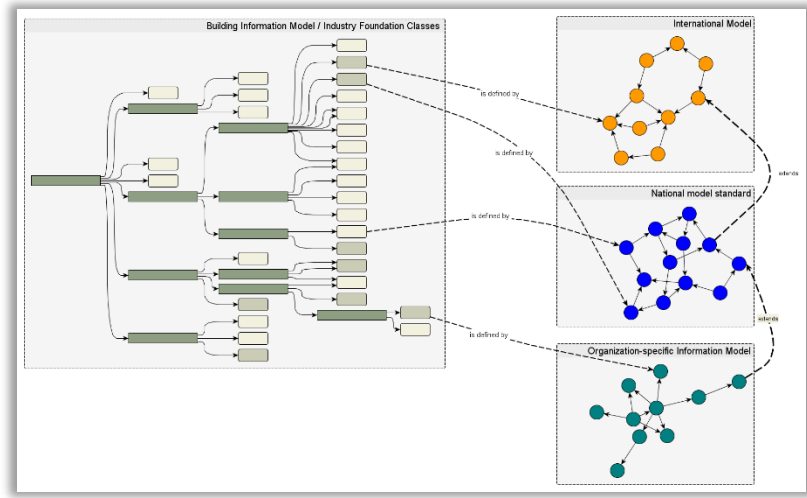
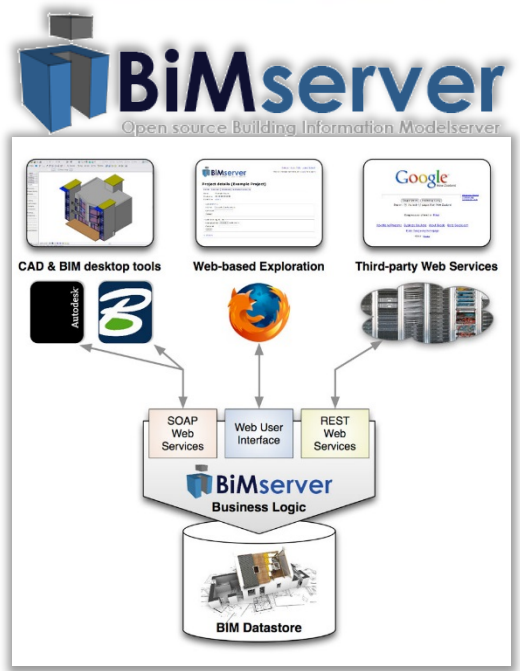


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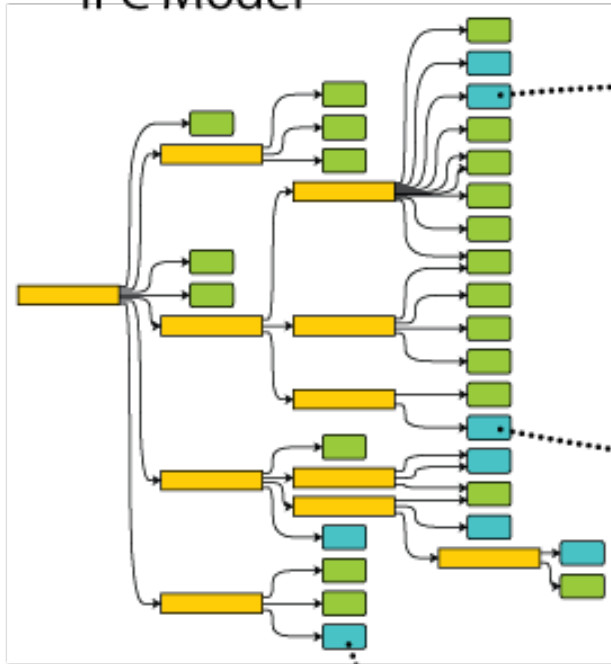
Objects

Type	Name	GUID
Beam	BEAM Verankering-staal-trompet in betonprop(128)	BMBVvbk5NY600000000
Beam	BEAM Verankering-staal-trompet in betonprop(2)	BMBVvbk5NY600000000
BuildingElementProxy	BUILDINGELEMENTPROXY Betonwerk prop in buispaal(30)	BMBVvbk5NY600000000
Column	COLUMN Buispaal-staal-1524x18(3)	BMBVvbk5NY600000000
Column	COLUMN Slot-staal-C6(114)	BMBVvbk5NY600000000
Beam	BEAM Verankering-staal-trompet in betonprop(83)	BMBVvbk5NY600000000
BuildingElementProxy	BUILDINGELEMENTPROXY Trekput kabels-put-beton(3)	BMBVvbk5NY600L00K00
Column	COLUMN Buispaal-staal-1524x18(38)	BMBVvbk5NY600000000
BuildingElementProxy	BUILDINGELEMENTPROXY Trekput kabels-put-beton(3)	BMBVvbk5NY600000000
Beam	BEAM Verankering-Jetmix-101.6x17.5-Groutlichaam 8m(11)	BMBVvbk5NY600000000



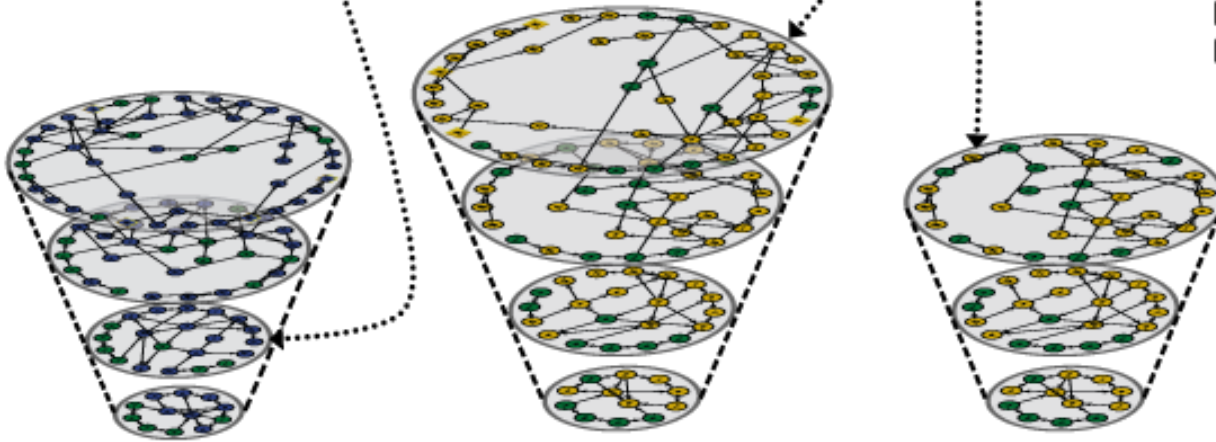
Semantic Enrichment prototype demo

IFC Model



Time ↑

- IFC Entity instance
- IFC built-in property / attribute
- link to external property / attribute



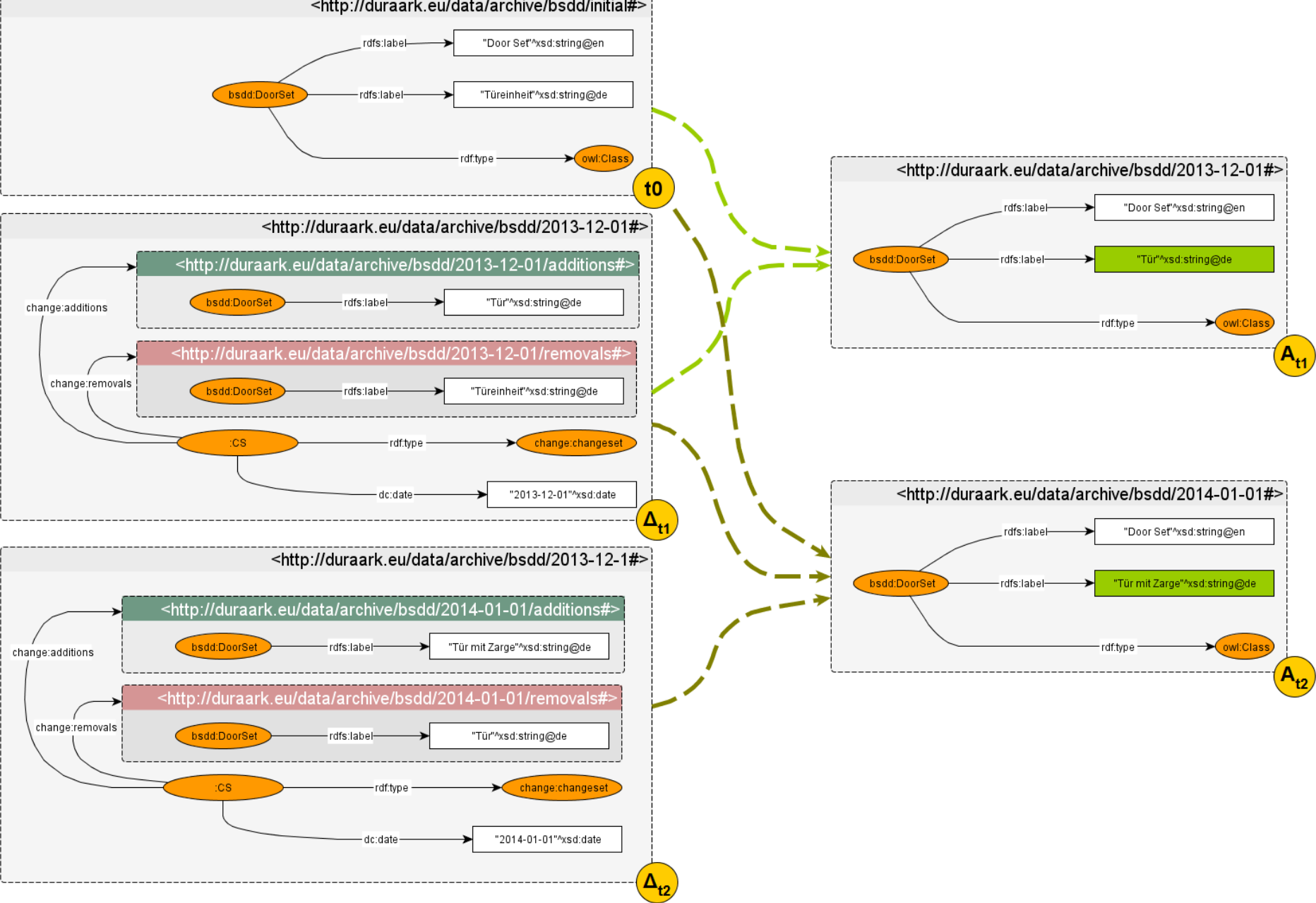
External Data Set

Semantic Concept Archive

External Data Set

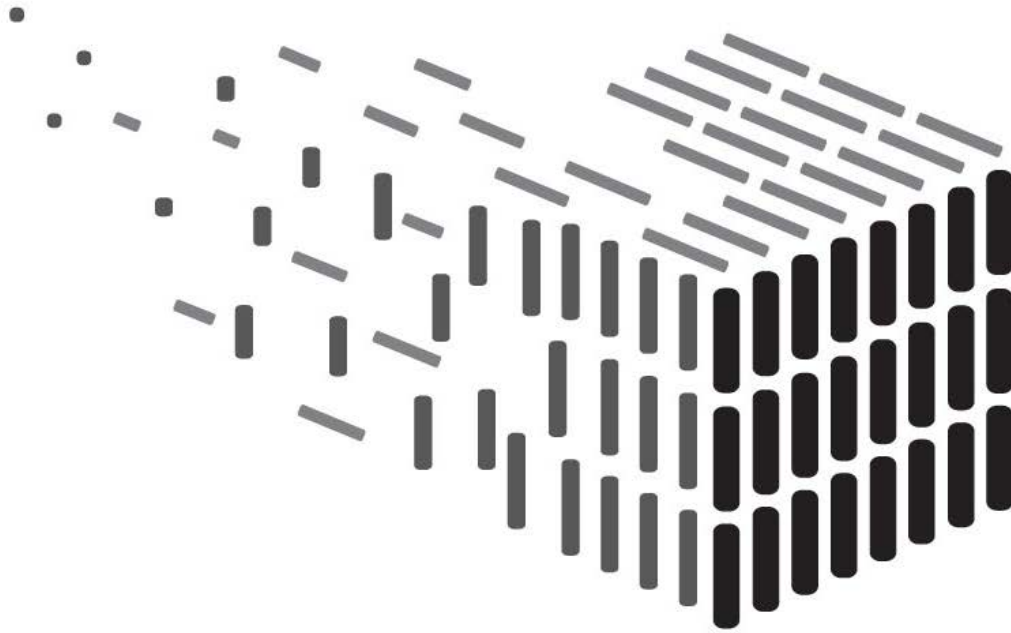
Use of evolving vocabularies





Versioning evolving vocabularies





DURAARK DURABLE ARCHITECTURAL KNOWLEDGE

<http://www.duraark.eu>

