THE DURAARK APPROACH

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DURABLE
ARCHITECTURAL
KNOWLEDGE

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- **Introduction**
- **Challenges**
- **Approach**

Agenda

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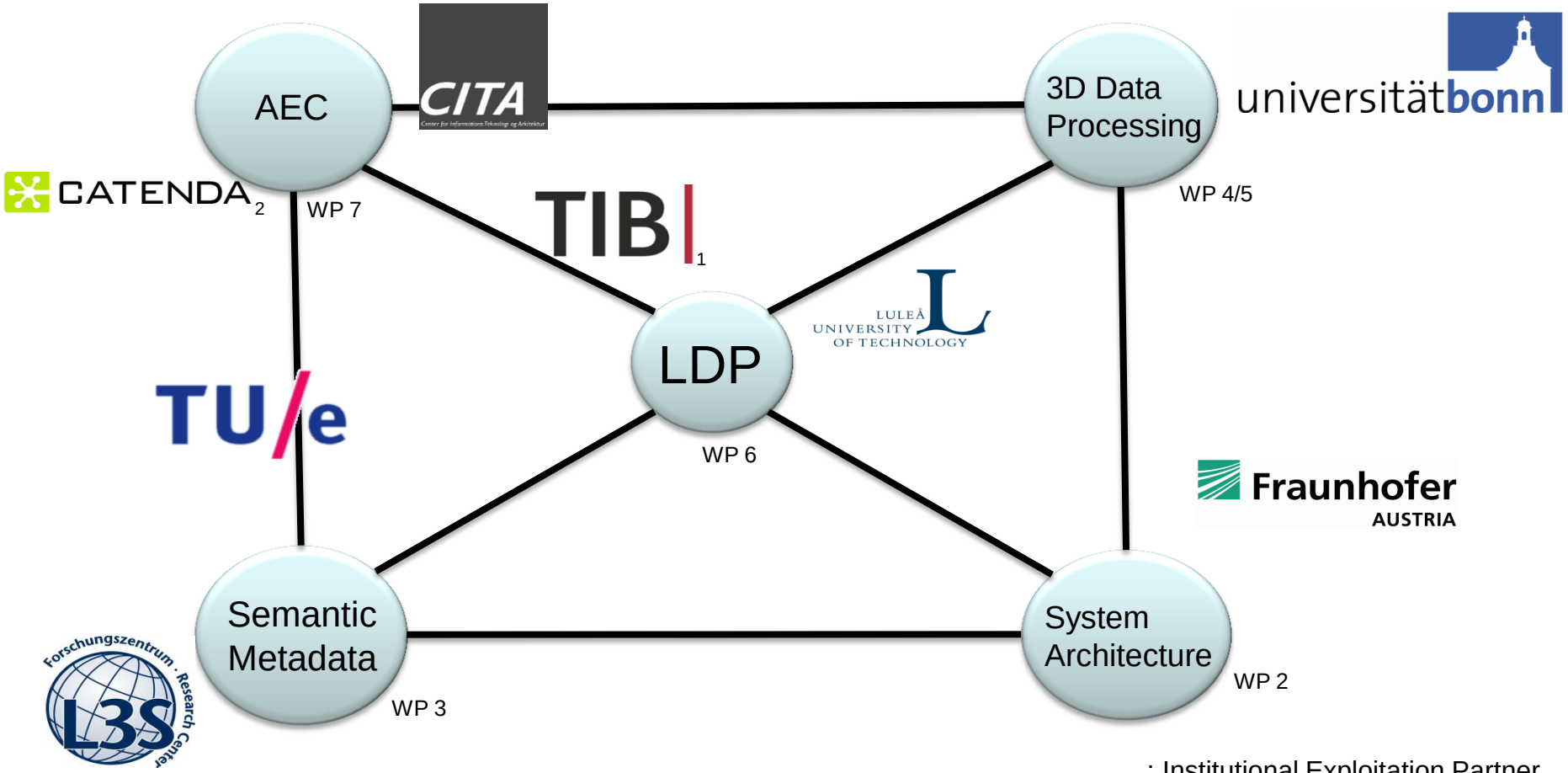
- Three year research project, EU-funded
- Developmnet of a secure and efficient long-term archival process for 3D architectural data
- Focus on combination of unsturctured data from point clouds from laser scans and highly structured data from Building-Information-Modelling (BIM) files
- Develops strategies to search and detect architectually meaningful information regarding semantic

DURAARK Consortium



1: Institutional Exploitation Partner

2: SME Exploitation Partner

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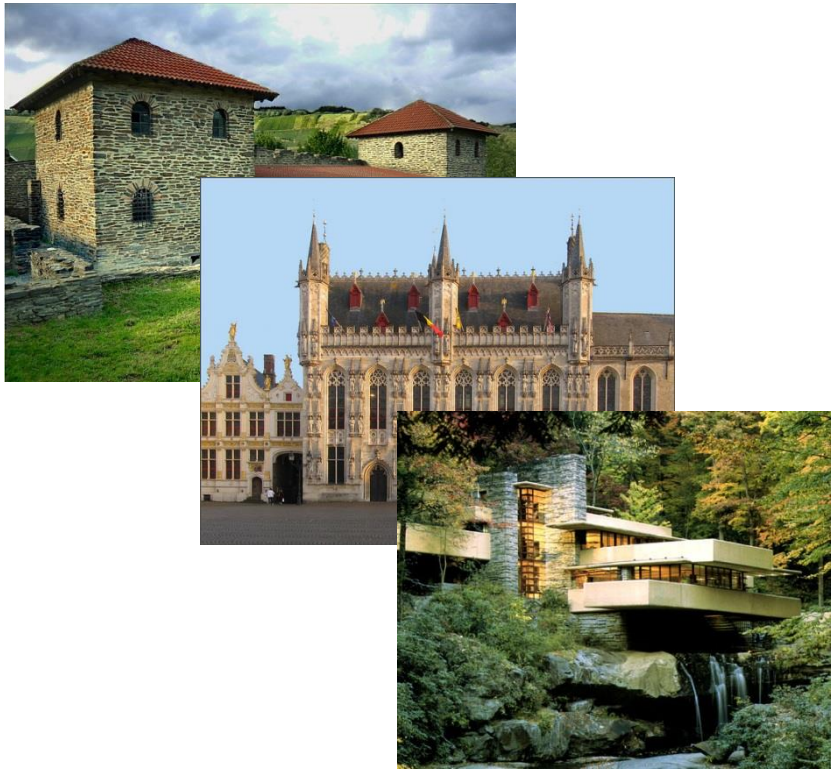
Long History of Architecture, Construction and Engineering



- Starting with **Neolithic Revolution** at latest

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Problem ever since

- Passing knowledge about constructions from one generation to the next

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Early Times of Architecture

- Mainly oral tradition

  Storage device for construction manuals: Human brain

  + Easy rendering - requires only language-compatible speaker and listener, imagination / abstraction
  + Easy integration of changes
  - Construction complexity strongly limited
  - Prone to error / „bit rot“
  - Limited life-span of storage device (< 100 years)

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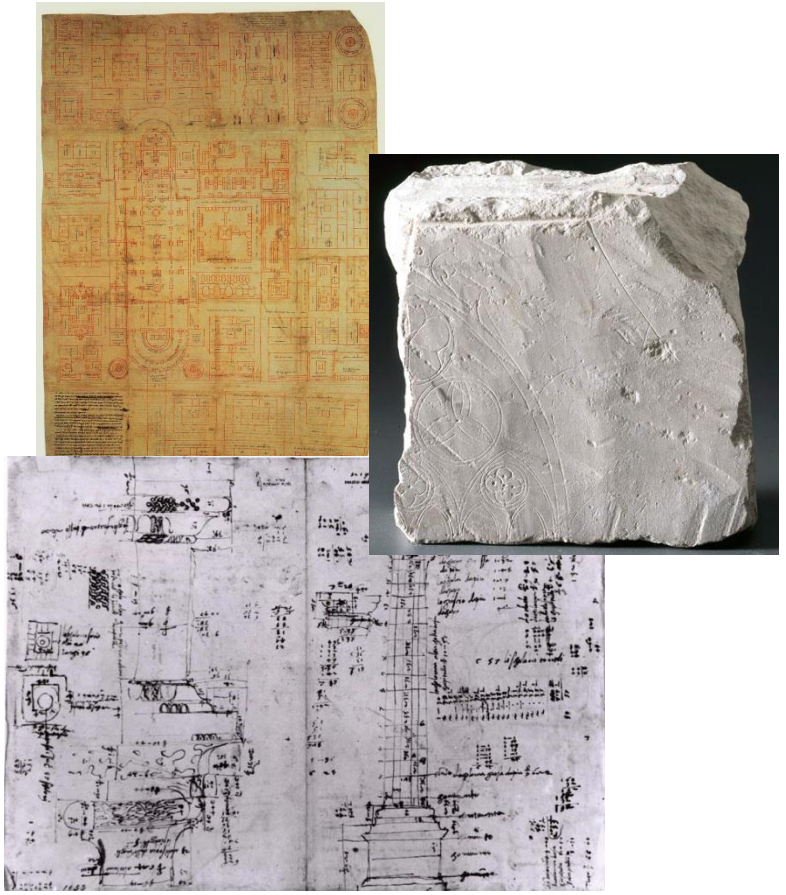
Increasing Complexity of Constructions

- Manual 2D drawing

  Storage devices: Stone, clay, leather, papyrus, paper etc.

  + Allows increased construction complexity, arbitrary details
  + Medium to long life-span
  - Still relative easy rendering: Eyes, loupe, imagination / abstraction, reading / mathematical skills
  – Integration of changes is hard



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Alternative: Haptic Models

- 3D scale models

  Storage devices: Stone, wood, clay

  + Depending on material, medium to long life-span
  + Most easy rendering
  – Depending on material, integration of changes is hard
  – Limited complexity / details due to size and occlusion

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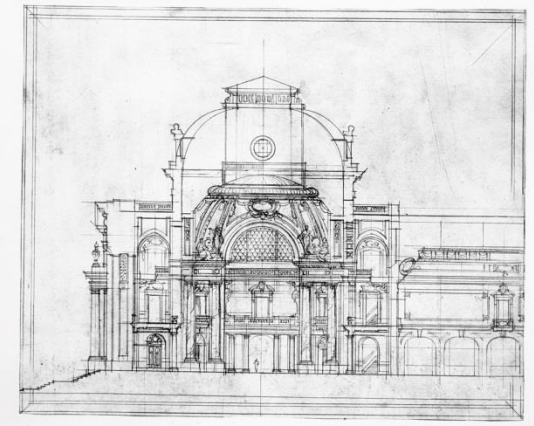
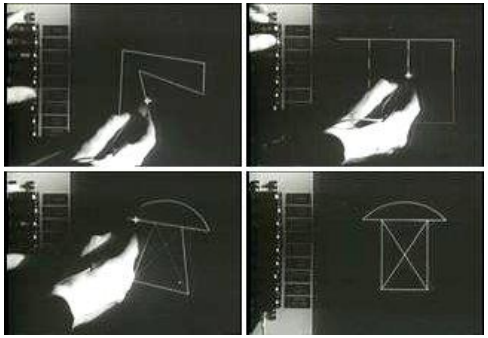
Game Changer No. 1: CAD

Analog 2D drafting



Digital 2D drafting

Early 1960



Sketchpad, 1962

Digital 3D drafting

Academic: mid 1960ies
Commercial: early 1980ies

Design Augmented by Computer (DAC-1) running on an IBM 2250 graphics console, 1964

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Game Changer No. 2: 3D Object Acquisition

BIM

- *prescriptive* CAD
- shaping the future

3D Object aquisition:

- *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…

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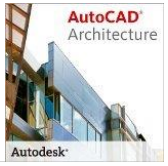
Today: 7D CAD and BIM

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

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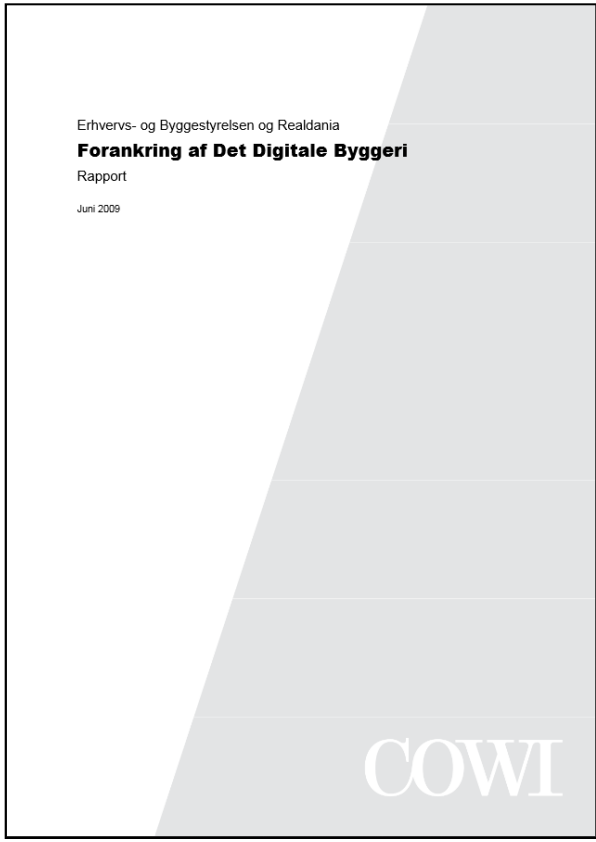
DENMARK
SINCE 2007: BIM DEMANDED FOR PUBLIC BUILDINGS

- State >2,5 mio Euro => BIM
- Municipalities >0,7 mio Euro => BIM

- Competition phase demands 3D model (IFC)
- Digital exchange of information via project web
- Quantity take-off from IFC model
- Digital handover of facility management information



ERHVERVSSTYRELSEN
(Tidl. Erhvervs- og Byggestyrelsen)

BIM development - Government driven

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UNITED KINGDOM FROM 2016:

"…The UK Government has mandated that all public projects in the UK will be delivered using BIM by 2016. This is driving the private sector to adopt Building Information Modelling processes, which is now becoming a common requirement for all major projects…."

BIM development - Government driven

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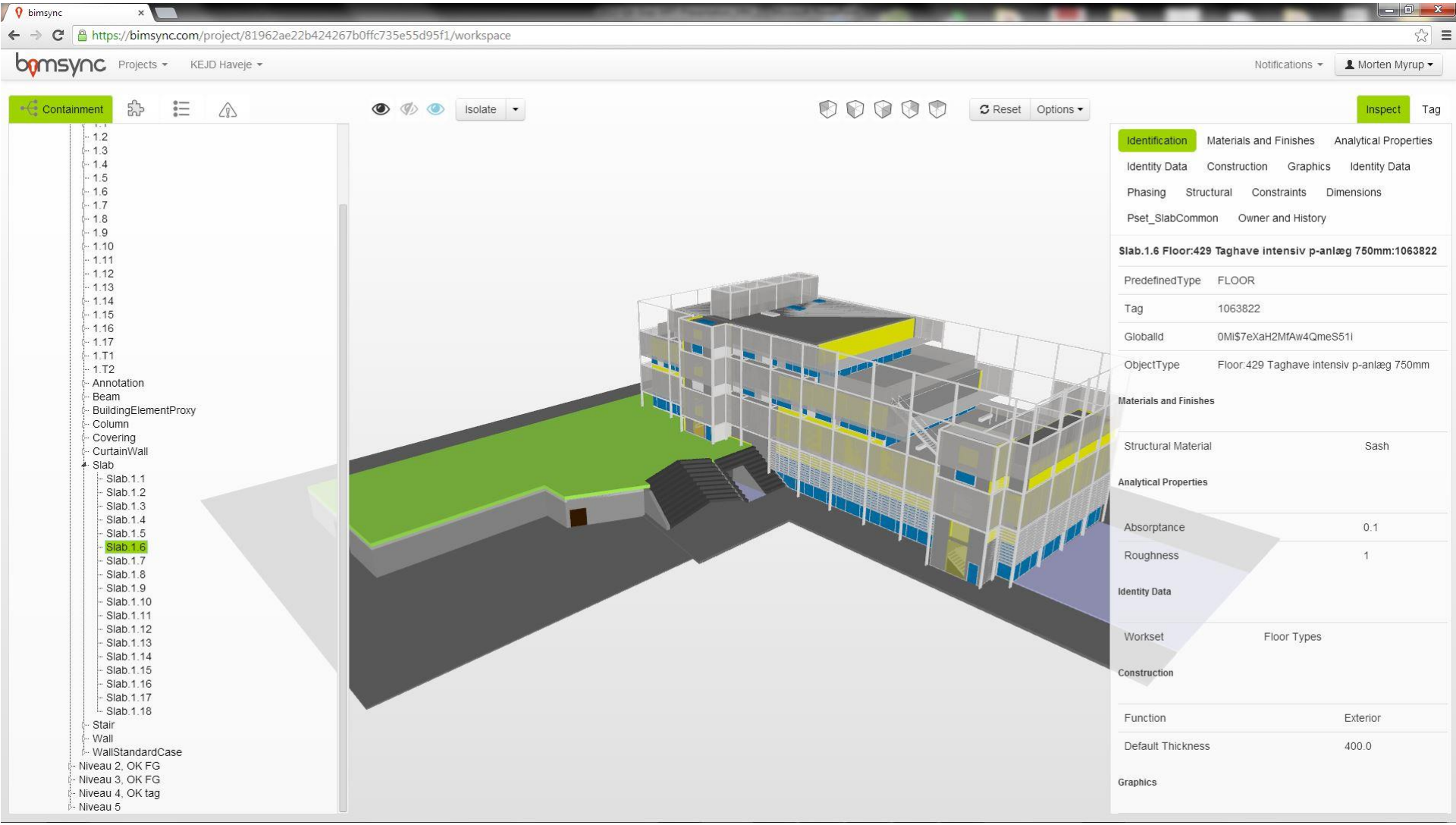
Internal Infrastructure: bimsync at catenda for web access of IFC



Approach

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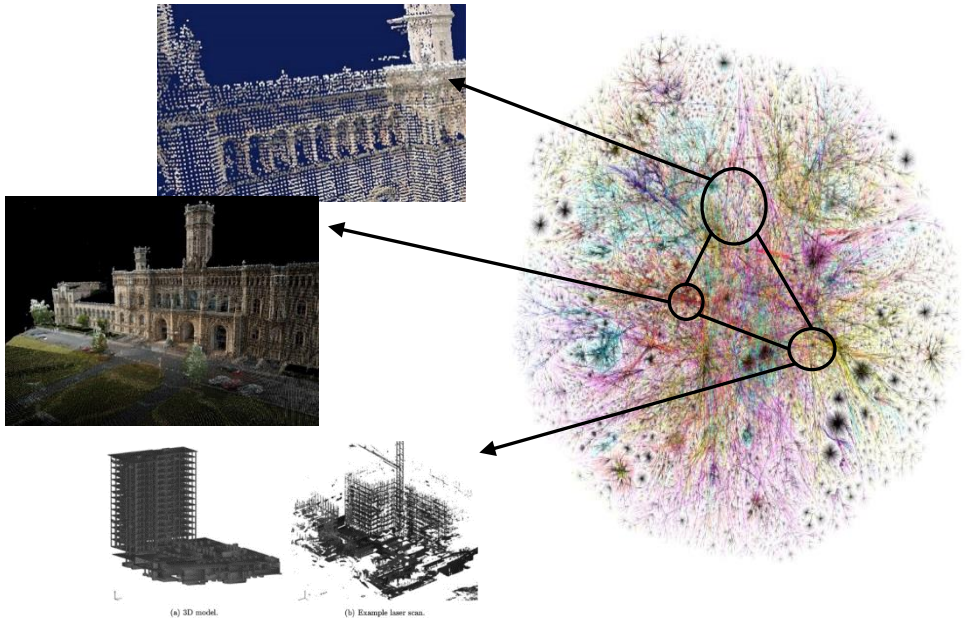
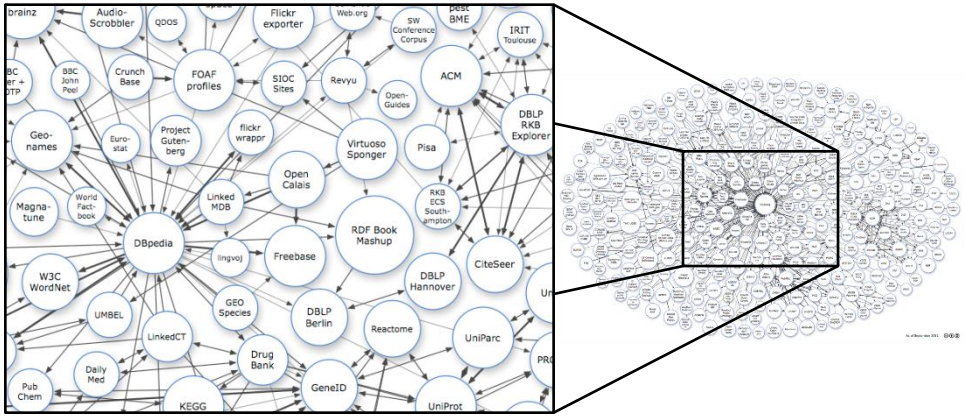
Challenges

- **Non-existent semantic relations** between architectural representations in BIM model, point clouds and geo-referenced data from web and images
- **Heterogeneous and insonsistent metadata** schemes and ontologies for the description of building elements and their properties in BIM models
- **No automated systems** to detect and search for architectural structures in point clouds
- **Fast changing development** of architectural software, files and referenced web-based data prohibits successful and easy long-term archival for companies and institutions





Challenges (1/2)

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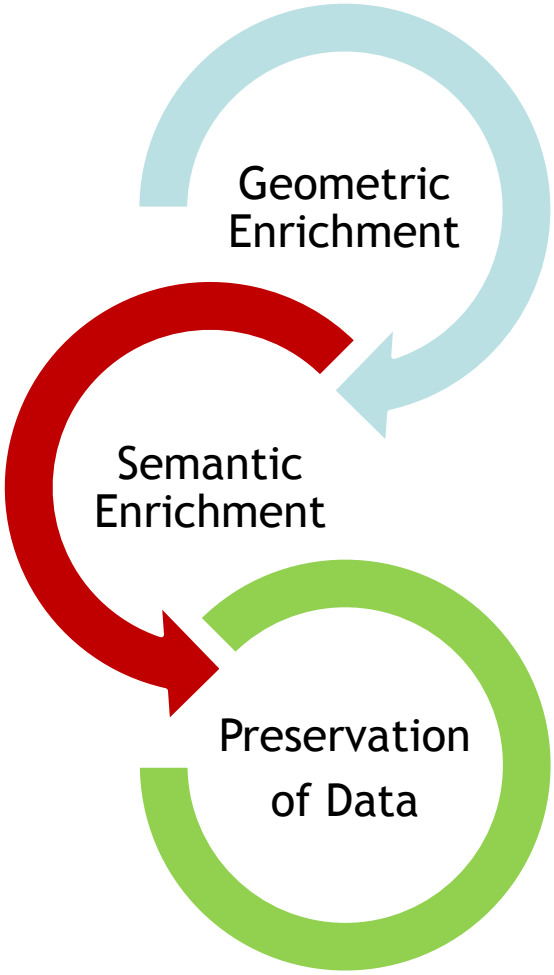
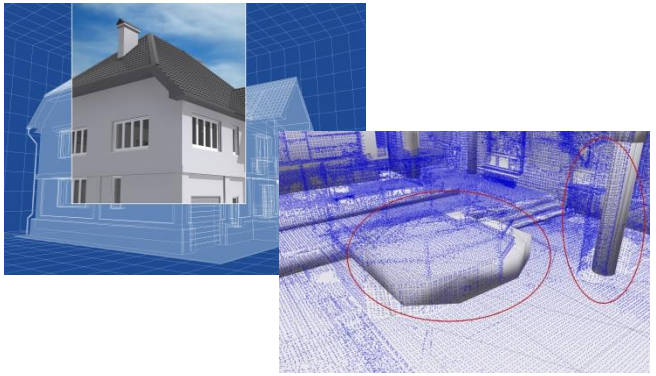
Challenges regarding preservation

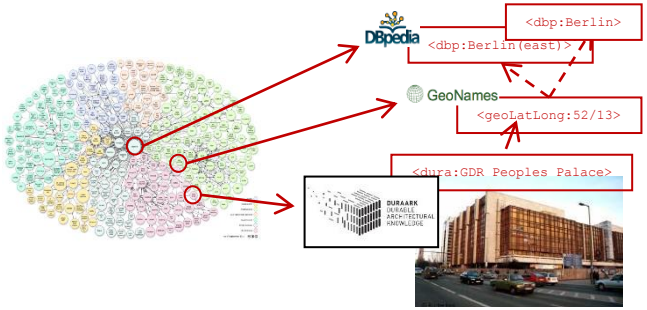
- BIM
  - Proprietary formats
  - Synchronization of representations
  - Inconsistent / incomplete data
  - Self-sustained storage
- Point Clouds
  - Lack of semantics
  - Lack of structure
  - Synchronization of representations
  - Amount of data

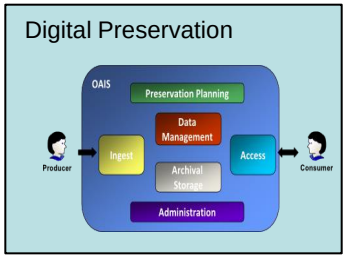
DURAARK Vision: LDP for BIM and point clouds

- Tools for geometric and semantic enrichment as part of the LDP framework
- Self-sustained information & knowledge databases (semantic digital archive, SDA)
- Usage of open standards and formats (e.g. OAIS, METS, PREMIS, RDF, E57, IFC)
- Implementation of a prototypical LDP platform









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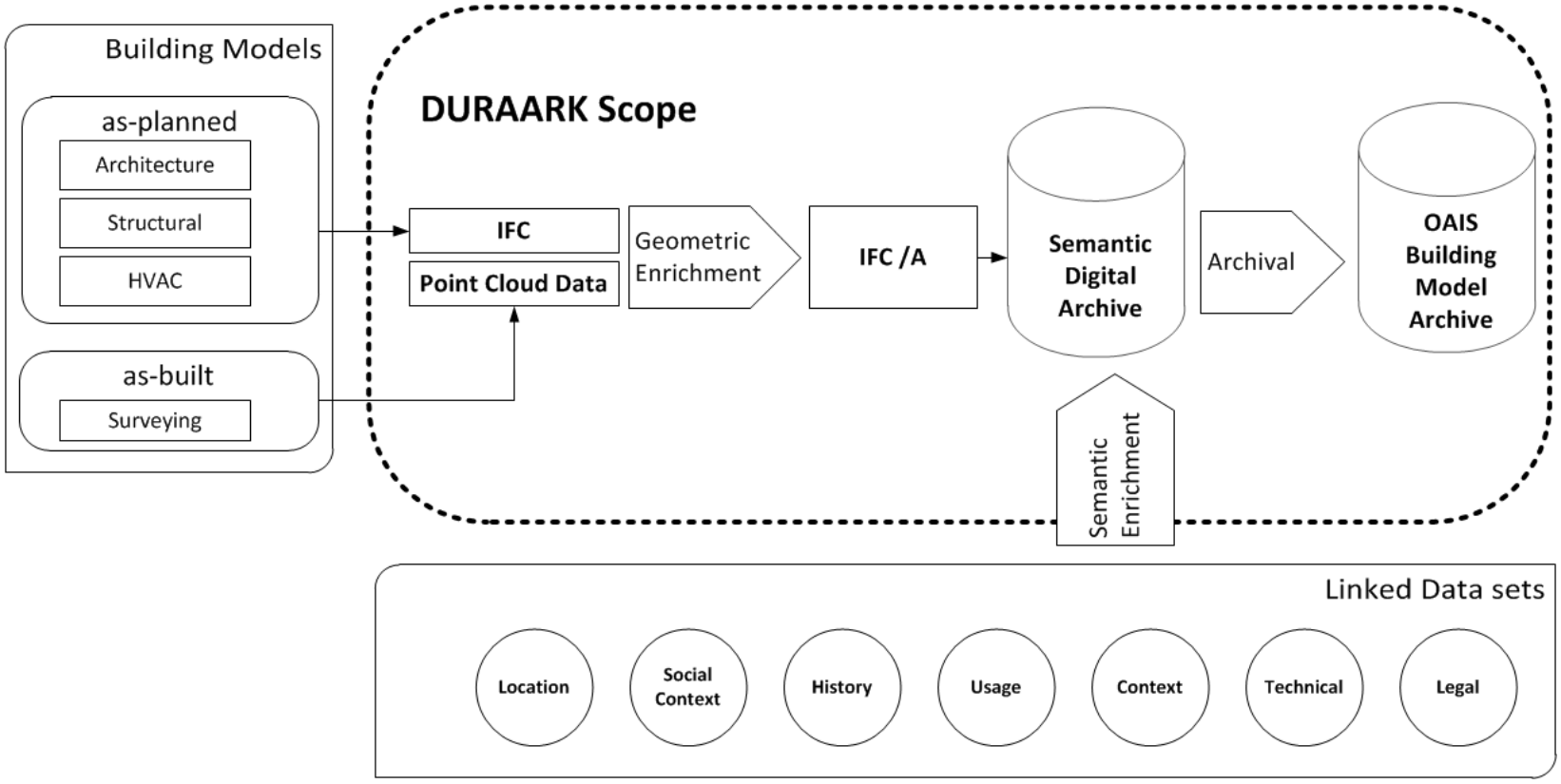

DURAARK Approach (detailed)

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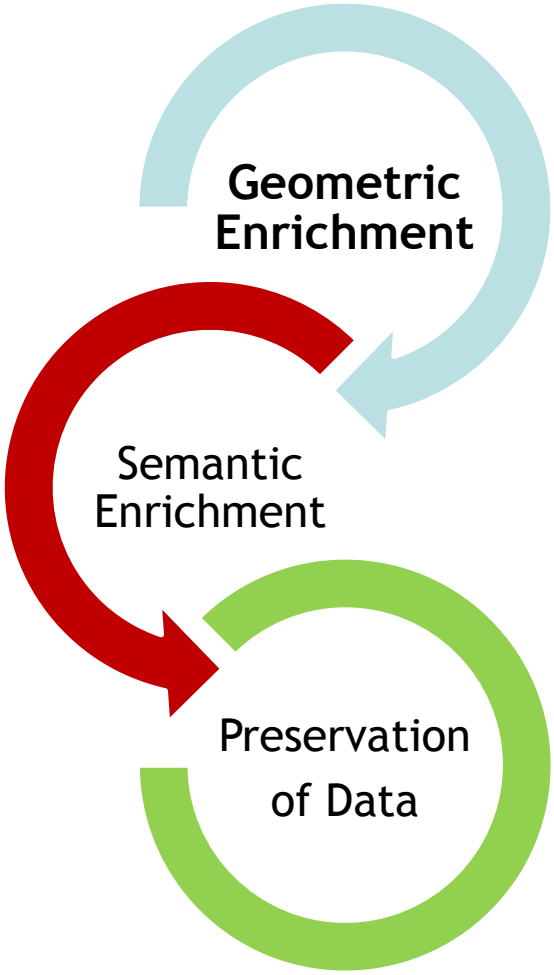

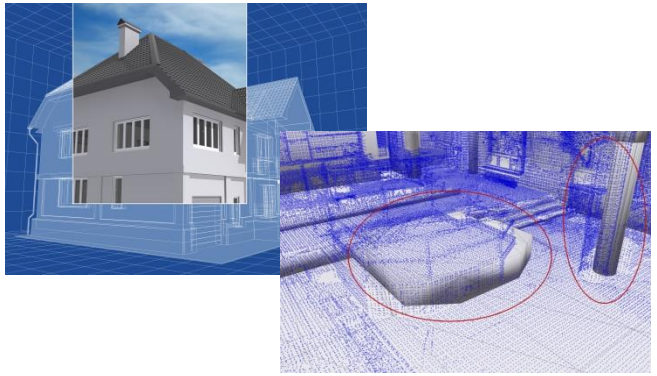

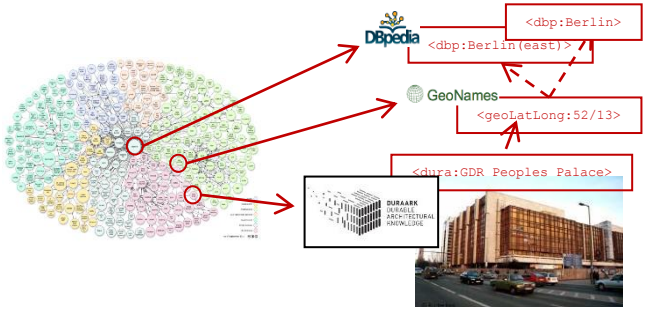

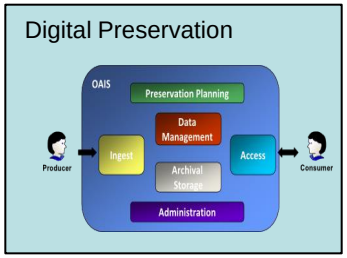

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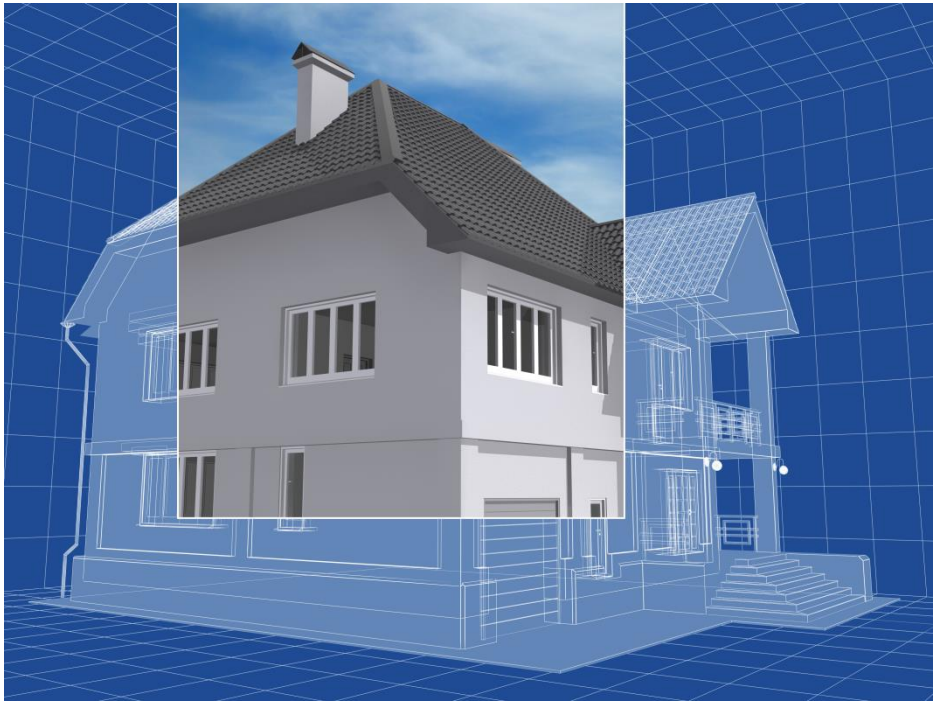
Use case: Detect differences between planning and as-built state



BIM

Scan

Geometric Enrichment

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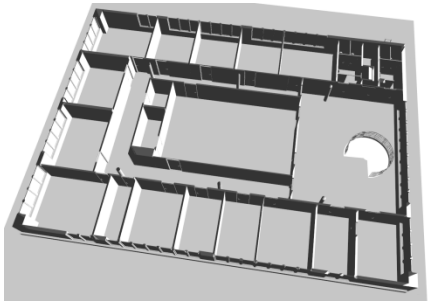
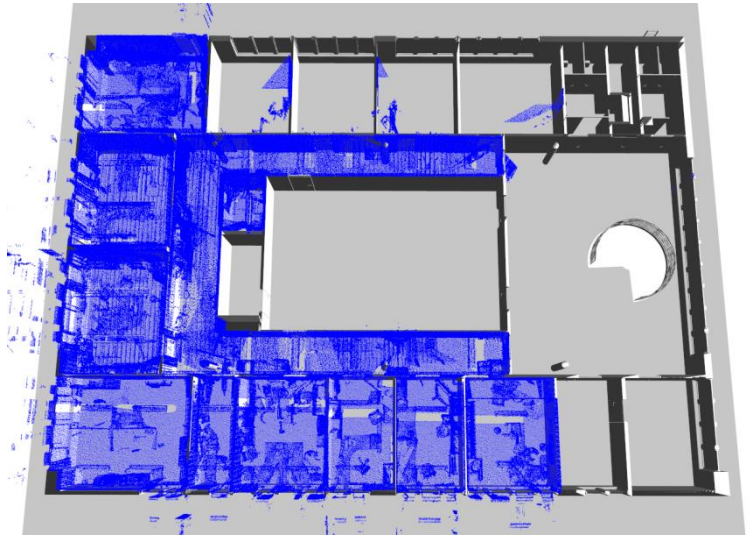
Use case: Monitor the evolution of a structure over long time periods

Leaning Tower of Pisa

Einsturz des Kölner Stadtarchives am 3. März 2009
(Quelle: http://www.spiegel.de/)



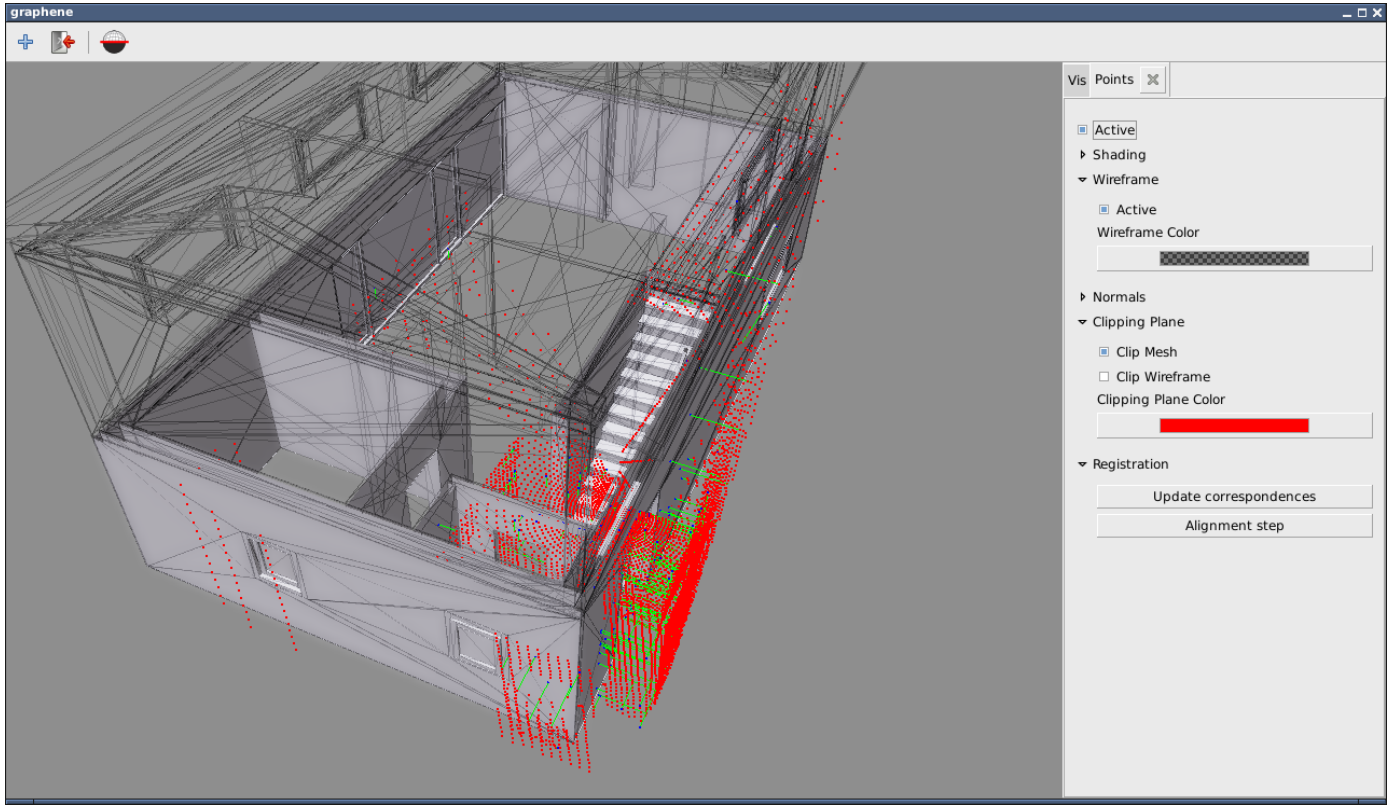
Find alignment

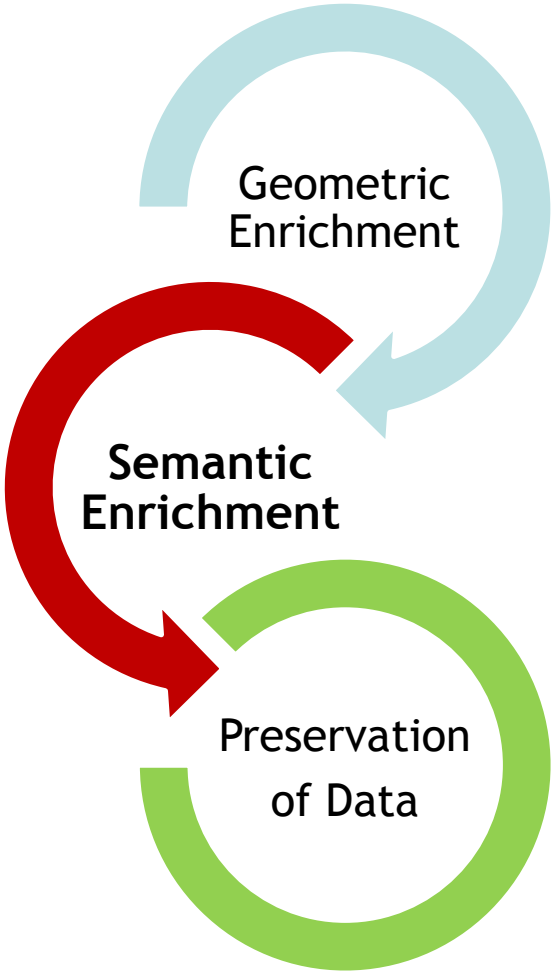


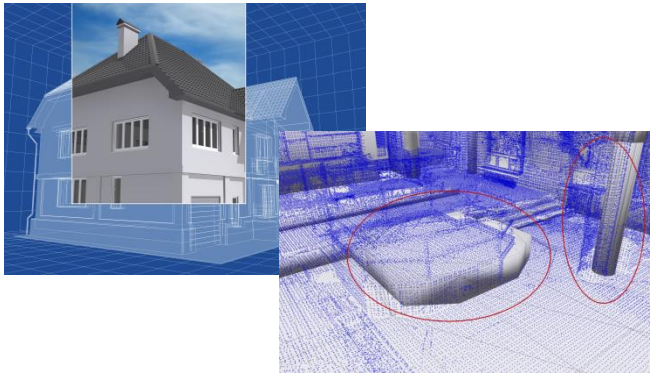
Registered (spatially aligned) representations

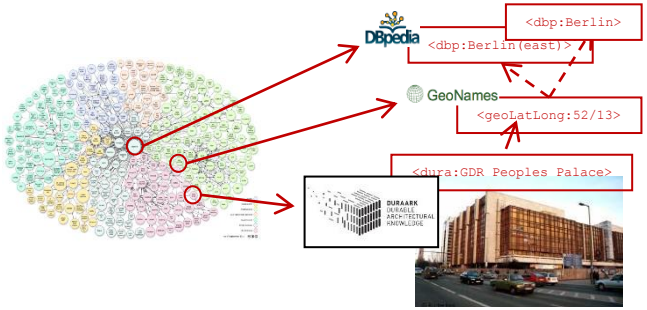
Point cloud scan ("as-built")

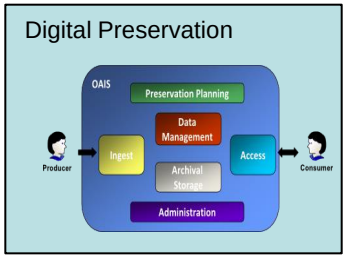
Difference Visualization











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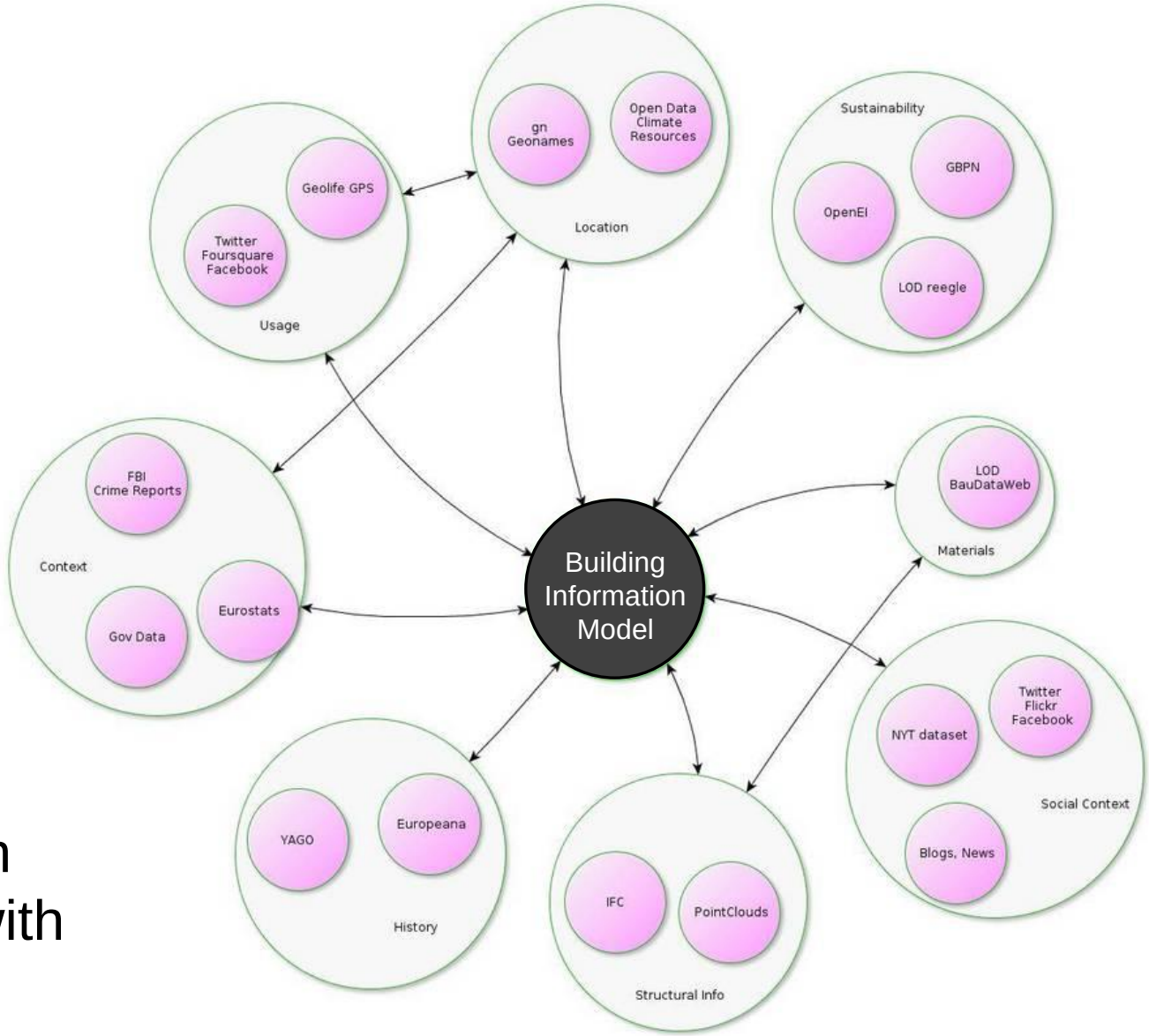
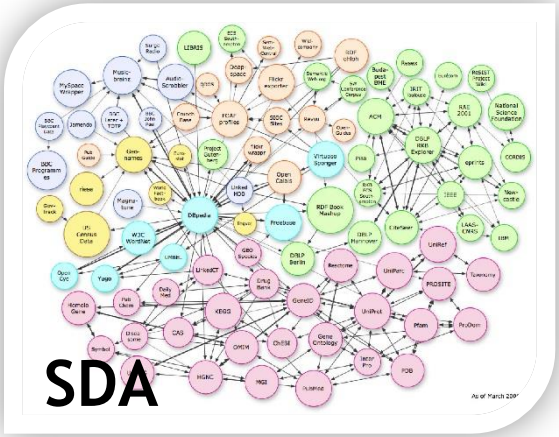


Use Case: Enrich BIM/IFC model with metadata

Maintain Semantic Digital Archive.



- inclusion of new linked data sets
- mapping into the ontological metadata framework of the concept repository
- version control of linked data set mappings
- creation of local snapshots of linked data sets
- exposure of mappings for semantic enrichment of building models

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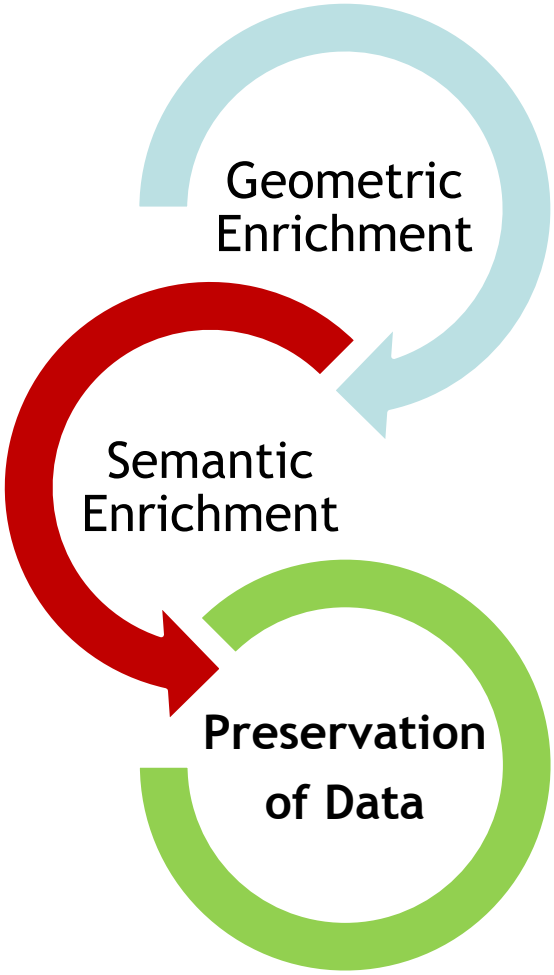

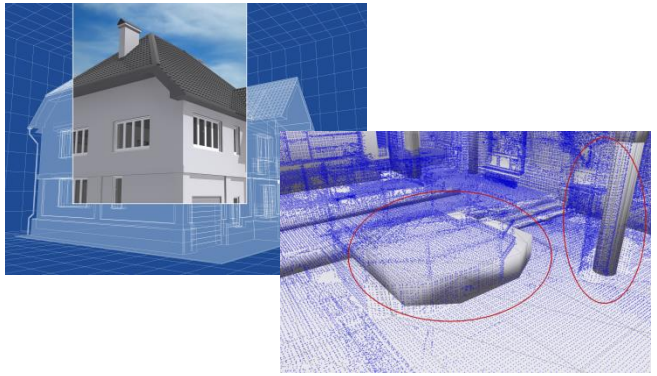

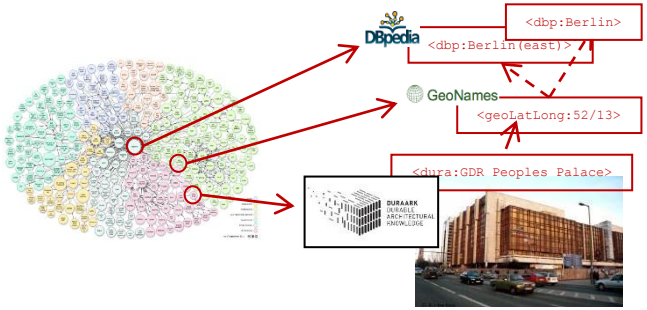

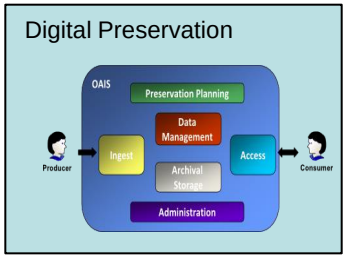

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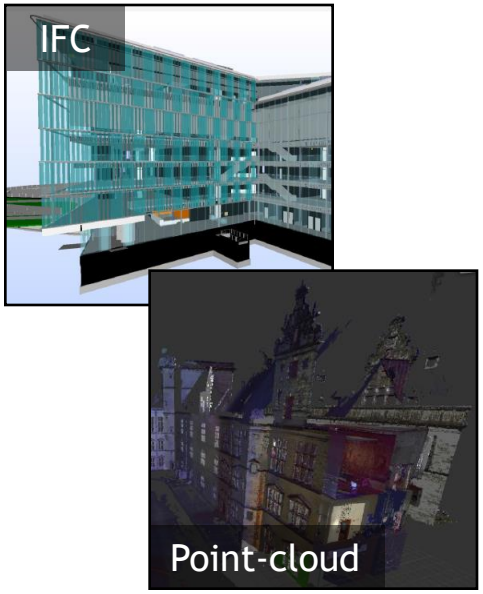
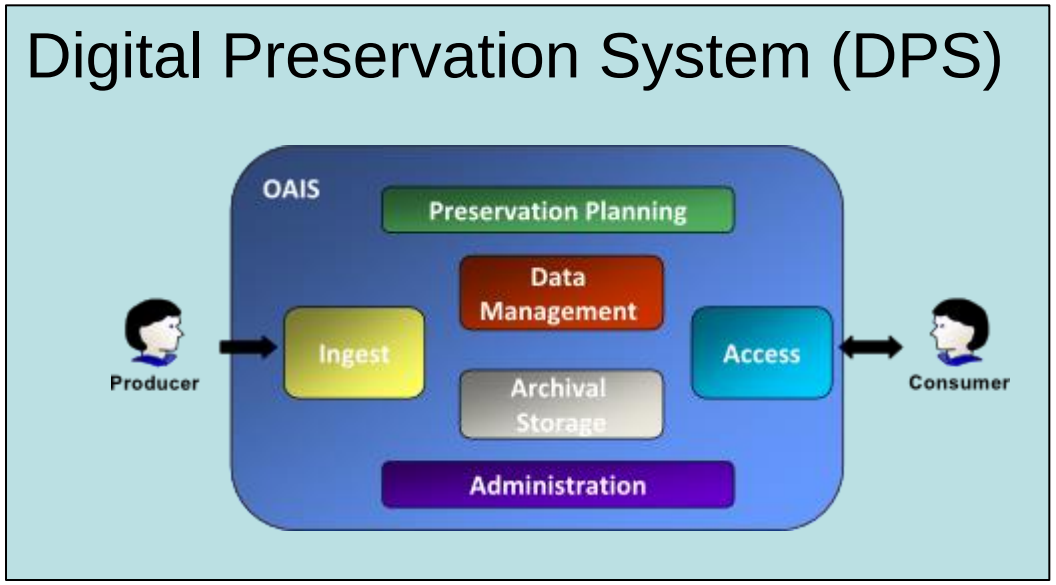
Use Case: Deposit 3D architectural objects



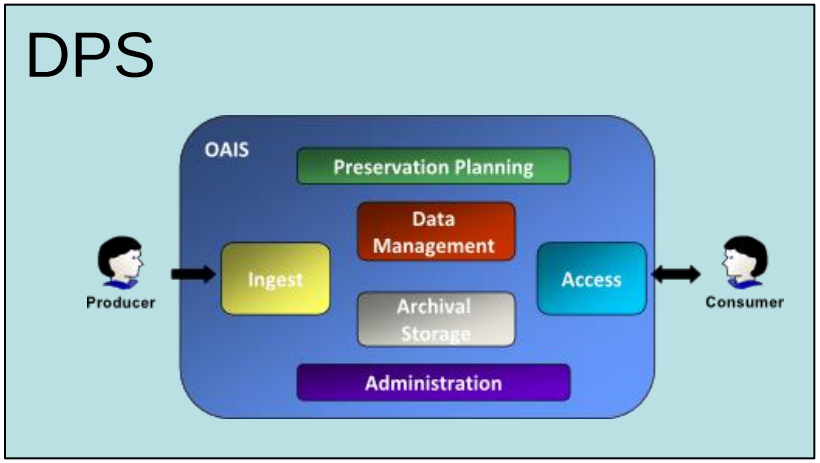


Select (architectual) data to preserve → Verify file format → Extract metadata → Quality control by user → Ingest

Use case: Search and retrieve archived objects

Search/Browse

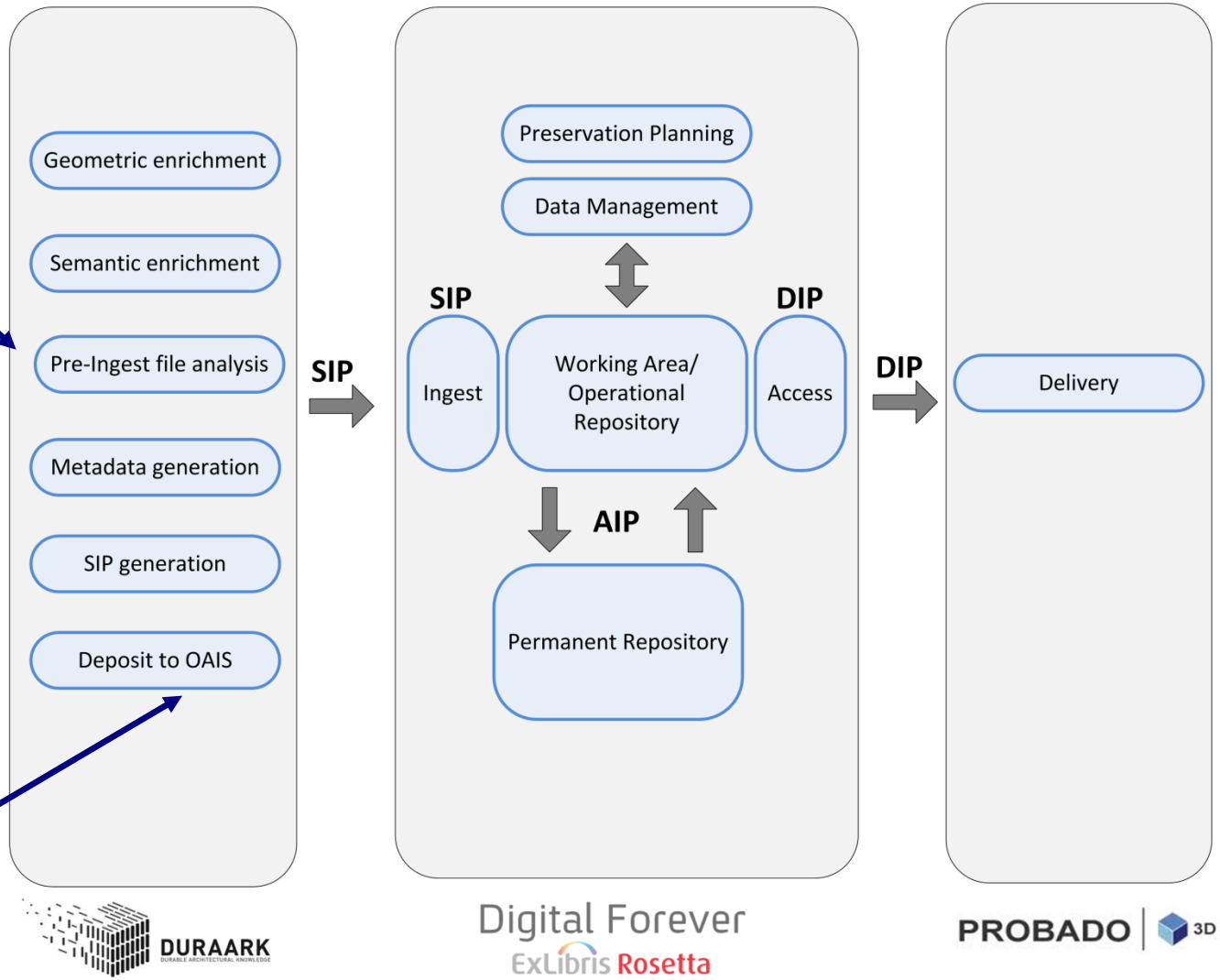
Results



Enriching SIP with preservation metadata

Extend existing preservation Tools (DROID, Jhove)

Receiving data from producer and submitting it to the OAIS compliant system



Technical Implementation

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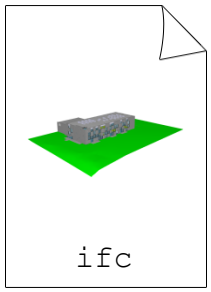
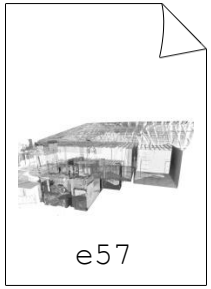
IFC and E57 metadata extraction + schema definition

Utility libraries extract metadata from IFC and point cloud files.
Metadata is stored in **buildm metadata schema.**



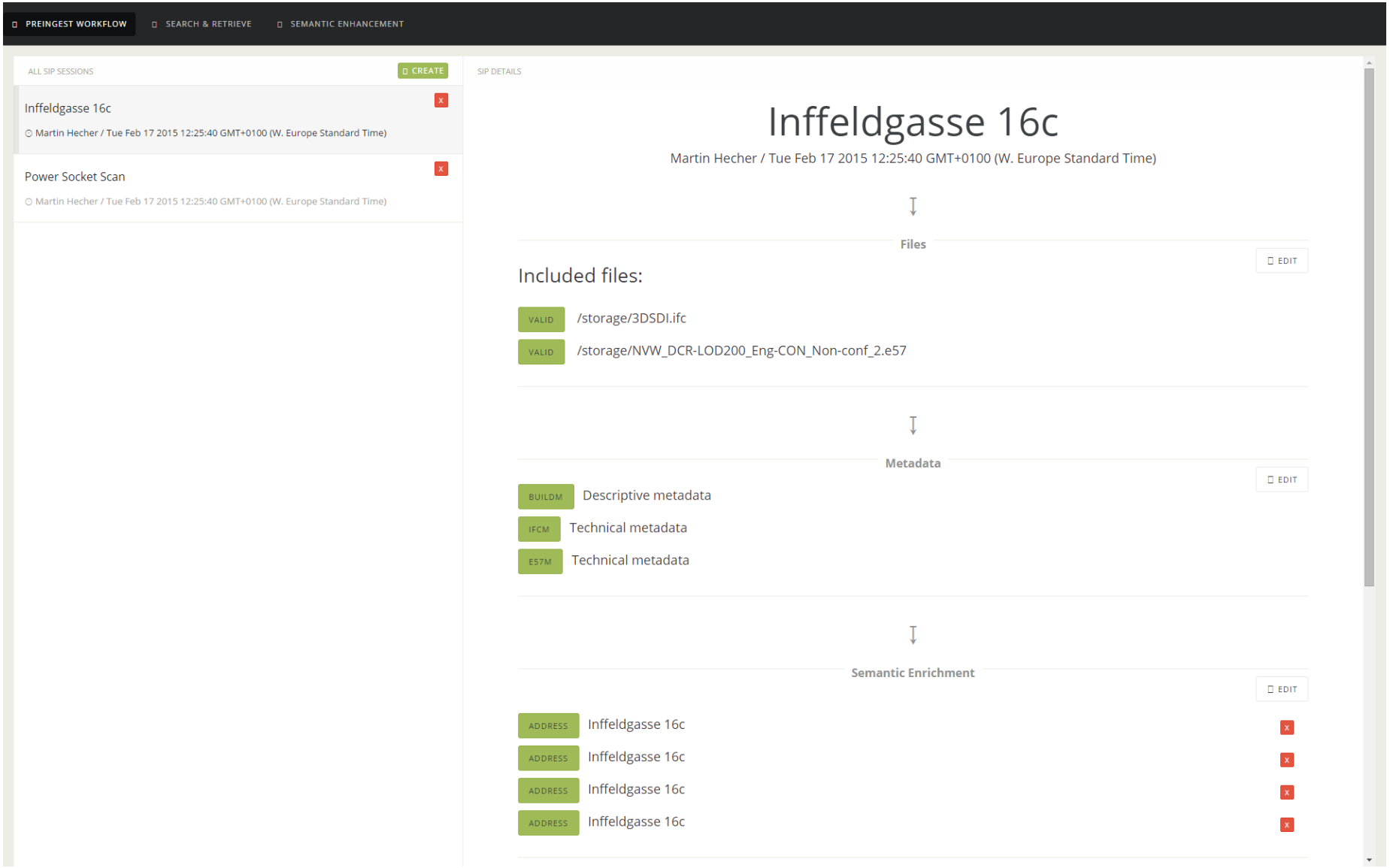


creation date
project name
length unit
floor count
average room volume
...

number of scans
sensor vendor
sensor model
temperature
relative humidity
...

Integrated Prototype

- Graphical User Interface
- Service Platform



WorkbenchUI

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- Comparable to popular web services like Facebook, Twitter, Youtube, Paypal, etc., which are providing services in their field

- DURAARK provides services for long-term archival of architectural data:

    - Geometric Enrichment
    - Semantic enrichment
    - Long-time Preservation of architectural data
    - Search & Retrieval of archived architectural data

Different use case scenarios for users, contributors, research groups:

Convenience

Flexibility

•If you like the workflows provided in the Workbench UI, **setup and use** it in our company.

•You like the functionality provided by the DURAARK system and want to extend your current workflow with parts of it. You can install a set of the **provided services** and **integrate them into our existing workflow** via the exposed and documented APIs.

•You like a **specific component** of the DURAARK system and have a great idea on how to extend it. You can download the source code and **extend the component with your knowledge**. Maybe you are willing to contribute back the changes to the openly available system.

•You have a better idea on how to create a GUI for your workflow and you do not want to use the Workbench UI. You can download a set of the provided services, add a new one and **build a better user interface to the components**. Afterwards you can host the system on your company servers and **provide it as a (paid) service**.

How can <u>you</u> as a stakeholder use the system?

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Thank you for your attention!
Questions?

fluentstream.com

Demo: http://workbench.duraark.eu

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Backup Slides

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UC7: Plan, document and verify retrofitting/ energy renovations

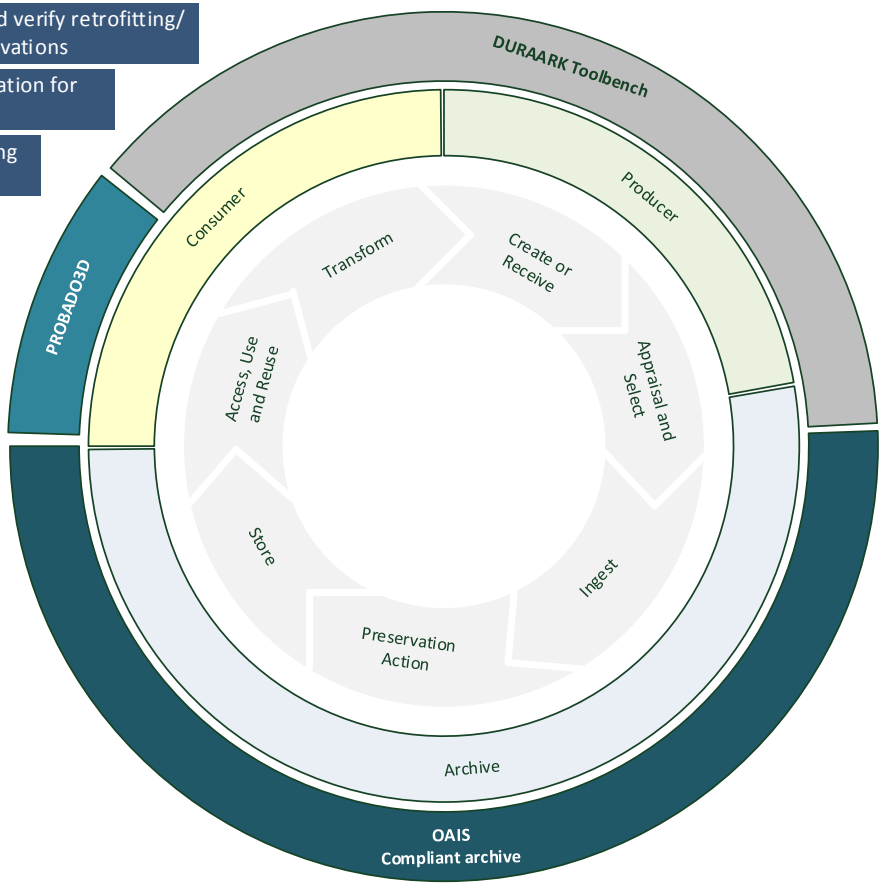
UC8: Exploit contextual information for urban planning

UC4: Detect differences between planning and as-built-state

UC5: Monitor the evolution of a structure over time

UC6: Identify similar objects within a point cloud scan

UC2: Search and retrieve archived objects



UC9: Enrich BIM/IFC model with meta-data from a repository

UC1: Deposit 3D architectural objects

UC3: Maintain semantic digital archive

Curation Lifecycly Model

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Building and construction

- **PROBADO** [DFG 2007-2011]
  - Music and 3D geometry
  - No BIM models
  - OAIS compliant
- **FACADE** [US 2006-2009]
  - Proprietary CAD models of buildings
  - No BIM Models
  - Identifies BIM as next necessary step

Other engineering domains

- **LOTAR**
  - Remove dependence from proprietary software formats
  - Aerospace and defense
  - STEP
  - OAIS
- **SHAMAN** [EU-funded 2007-2011]
  - Various engineering domains
  - PLM-centric independent of format
- **VDA 2958**
  - Long-term archiving of STEP domain-based schemas by German Association of the Automobile Industry

Digital preservation: past efforts

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Stakeholders

Use Cases

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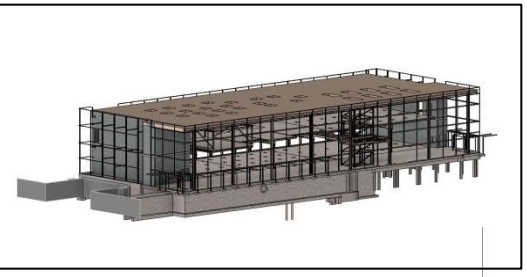
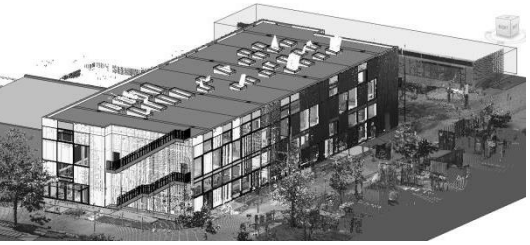


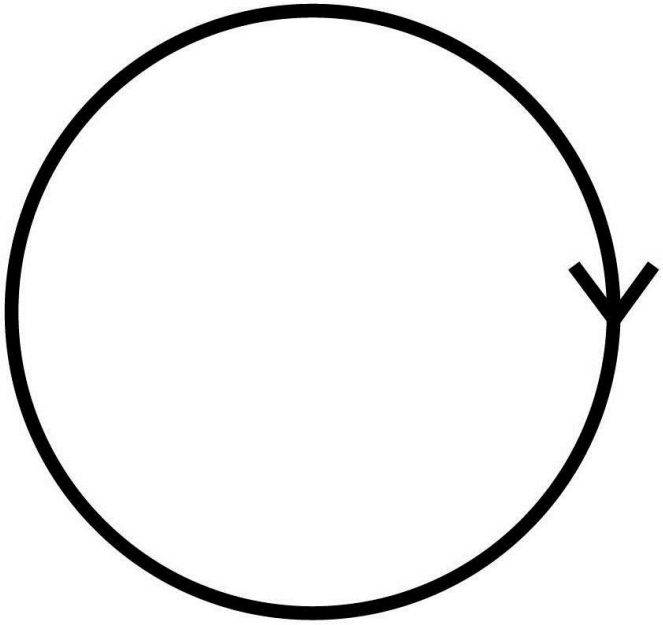
Engineers

Architects



Land Surveyors

Production



Design

Construction Companies

Building Owners

Cultural Heritage Institutions

Stakeholder definition from D2.2.1

Core long-term preservation

- Deposit 3D architectural objects
- Search and retrieve archived objects
- Maintain Semantic Digital Archive

Production/Consumption

- Detect differences between planning state and as-built state
- Monitor the evolution of a structure over time
- Identify similar objects within a point-cloud scan
- Plan, document and verify retrofitting/energy renovations
- Exploit contextual information for urban planning
- Enrich BIM/IFC model with metadata from a repository

Use-cases

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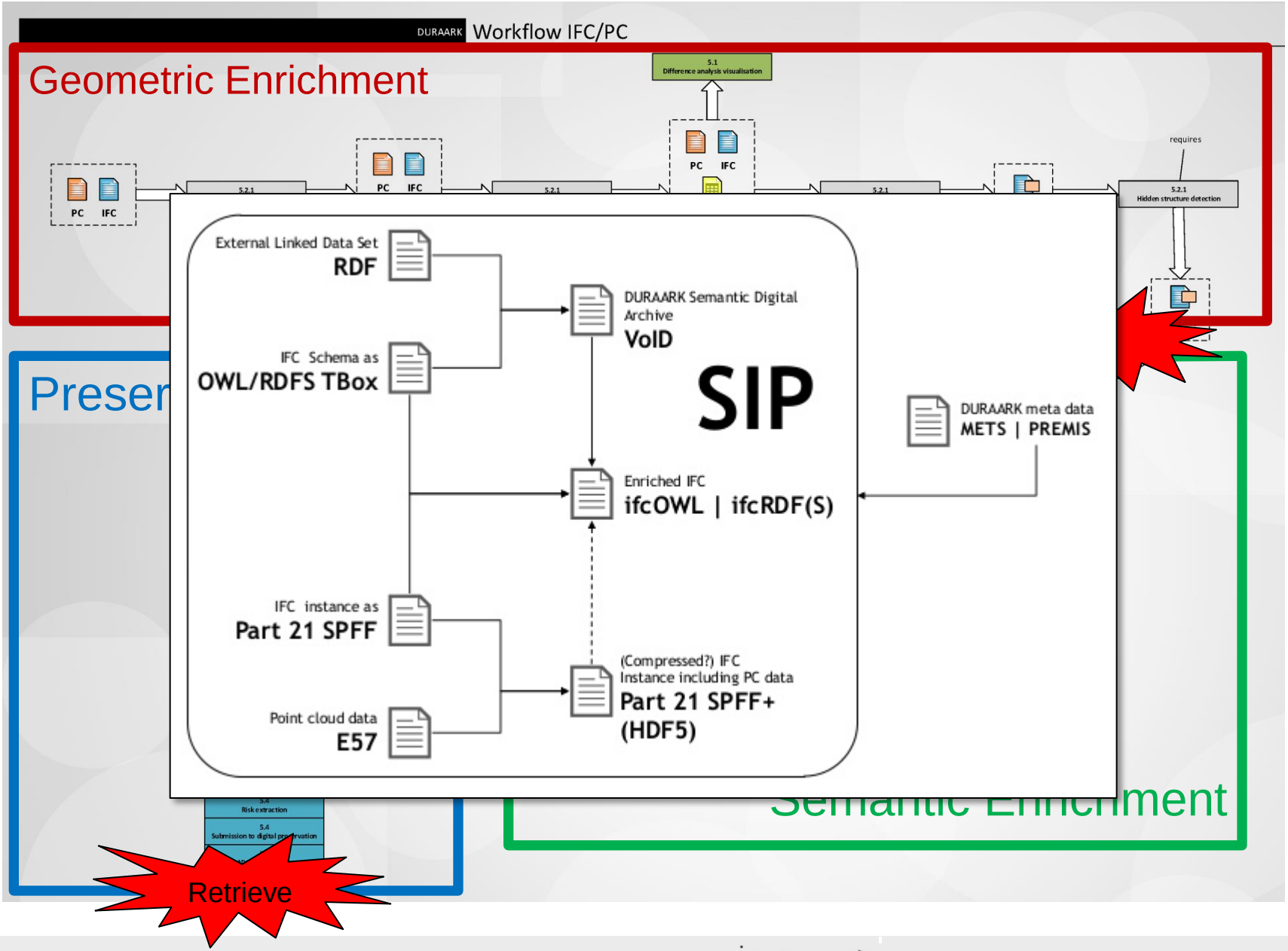

D2.2.2 Revisited - Components

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