

Heritage-BIM

FAIR implementation for NI4OS-Europe
service providers

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Industry standards



Figure 4 – IFC classes and types diagram

ISO 16739, Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries, International Standardisation Organisation, Geneva, Switzerland (2013).

ISO 10303-11, Industrial automation systems and integration – Product data representation and exchange – Part 11: Description methods: The EXPRESS language reference manual, 2004, International Standardisation Organisation, Geneva, Switzerland.

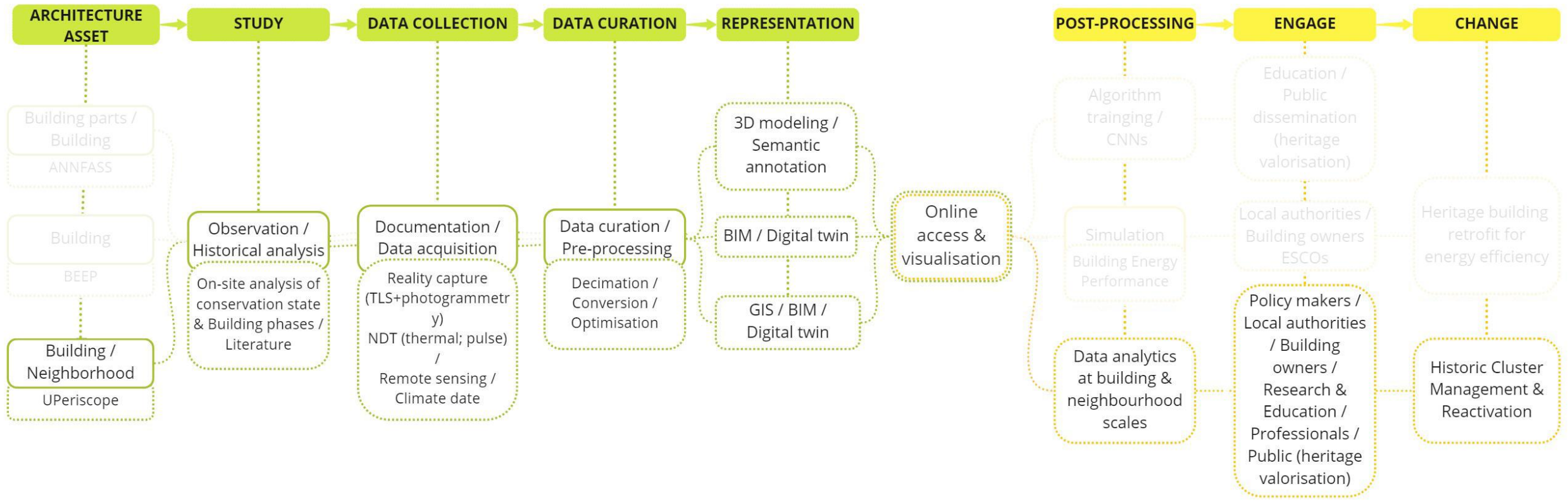
Needs

- Semantic interoperability Use of a set of interoperable, flexible, and open, standards covering different domains;
- Technical interoperability Support of distributed data integration, linking and tracking at data level.

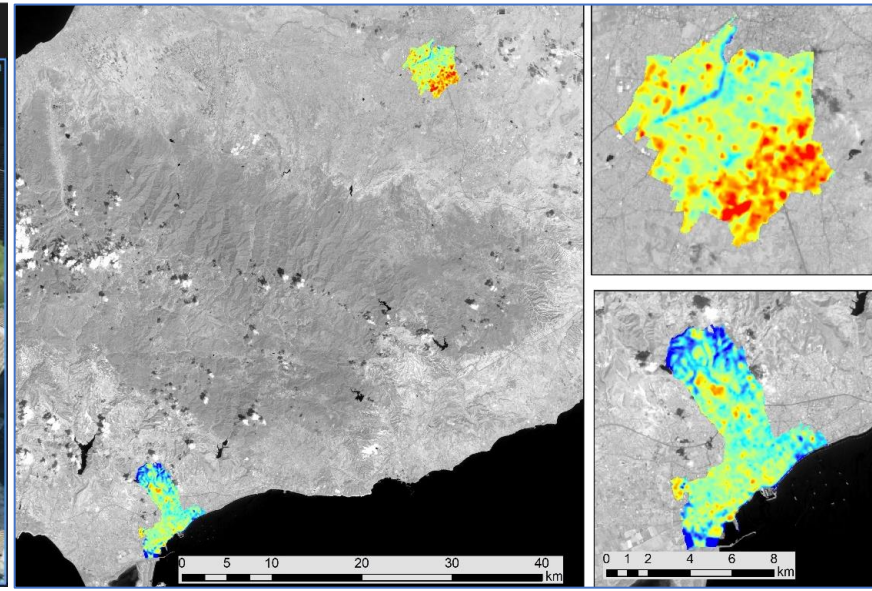
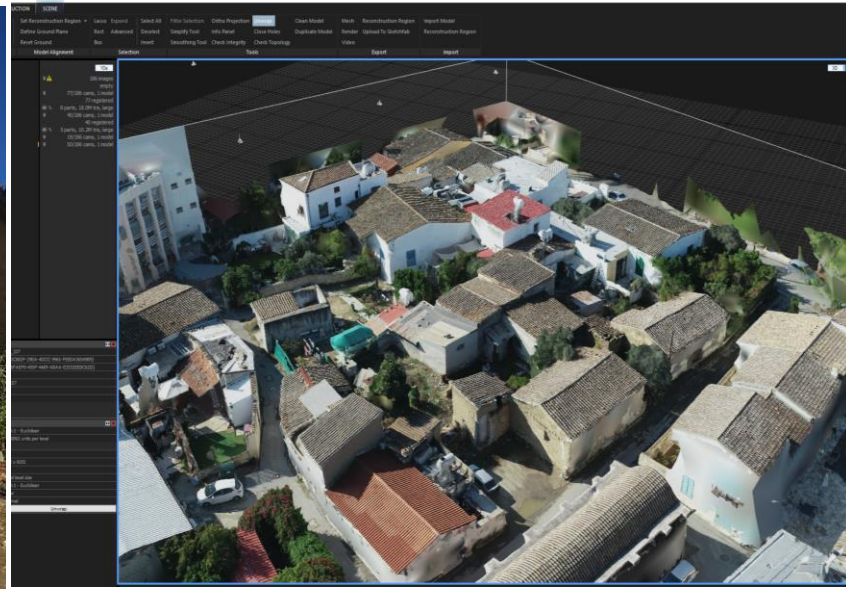
Suggested framework for the implementation of standards



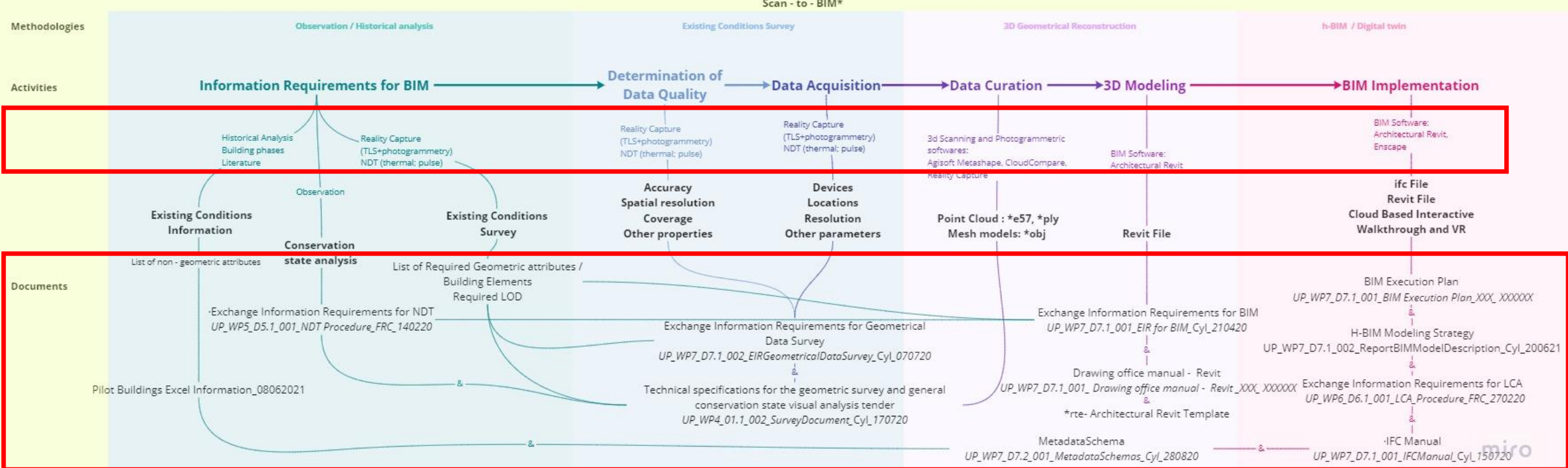
- Communication across platforms requires:
- a) the provision of “meaningful” metadata
 - b) the use of standardised ontologies and controlled vocabularies
 - c) the use of widely adopted knowledge representation languages
 - d) the compliance of metadata with a specific encoding and
 - e) the introduction of a common set of principles for data interlinking in the Semantic Web.



Urban PERISCOPE: “Portal for heritage buildings integration into the contemporary built environment”. This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 857645 and under INTEGRATED/0918/0034 and the Government of the Republic of Cyprus through the Directorate-General for European Programmes, Coordination and Development. <https://uperiscope.cyi.ac.cy/>



NDT at Strovolos pilot building. TLS 3D documentation. Aerial documentation of pilot building block at Strovolos. Surface temperatures over Limassol and Strovolos pilot areas



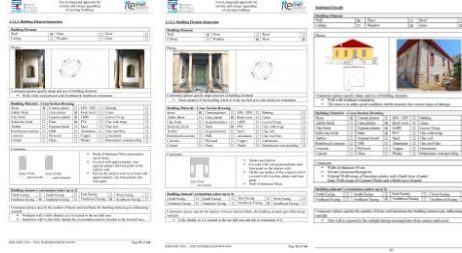
H-BIM Modeling Strategy

INPUT

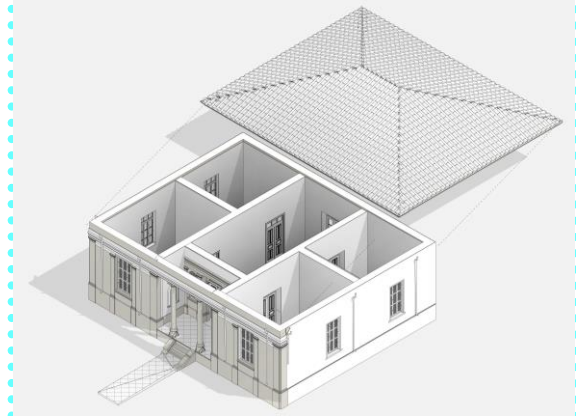
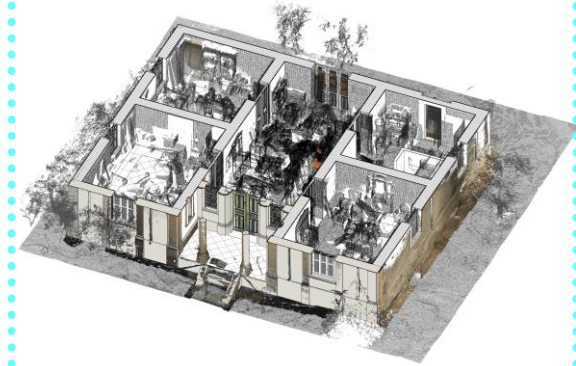
Existing Conditions Information



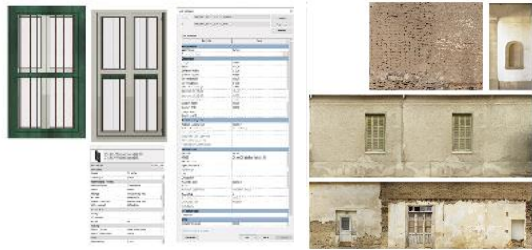
Conservation state analysis



Existing Conditions Survey



3D Geometrical Reconstruction of Cultural Asset

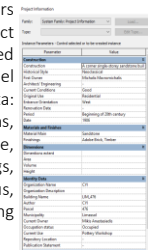


Families Generation / Classification & Material Composition



Structural and thermal condition integration with NDT

A series of project parameters are imported to Revit -Project information section as shared parameters to enrich the model with all the historical data: Construction, Current conditions, Owner, Original Use, Date, Period, Main material, Finishings, Municipality, Occupation Status, Repository Location, Listing Status etc.



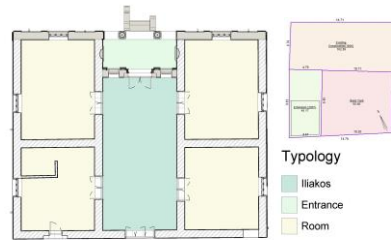
Historical Data Integration



H-BIM Model- ifc file



2D drawings



4D typology

5D-BOQ

Life-Cycle Assessment for Level(s) in compliance with EN 15978							
Result category	Global warming potential	Biogenic carbon storage	Other carbon storage	Acidification potential	Eutrophication potential	Formation of ozone layer depletion	Abiotic depletion (ADP, element) for non fossil resources
	kg CO ₂ e	kg CO ₂ e	kg CO ₂ e	kg SO ₂ e	kg PO ₄ e	kg CFC11e	kg tce
A1-A3 Construction in use	1,183	1,548	1,28-3	3,992	3,928	3,183	8,183
A4 Construction in use	3,283	6,296-4	1,438	3,183	2,038-1	2,283	
B1 Use Phase	6,983	9,588-1	2,483	2,783	2,383	1,883	
B2 Repair and replacement	0E0	0E0	0E0	0E0	0E0	0E0	
B3 Material replacement and refurbishment	0E0	0E0	0E0	0E0	0E0	0E0	
B6 Energy use							
B7 Water use							
C1-C4 Total of life cycle	1,543	1,738-1	1,783	3,783	1,683	1,183	
Total	1,248	1,548	1,988-3	4,983	4,973	3,81	3,773

6D-LCA












H-BIM - Digital twin

OUTPUT

Layers

 Add layers

-  Streets 
-  Periscope Buildings_Multipatch 
-  Area Buildings_Multipatch 
- ∨ Ground 

 -  WorldElevation3D/Terrain3D 

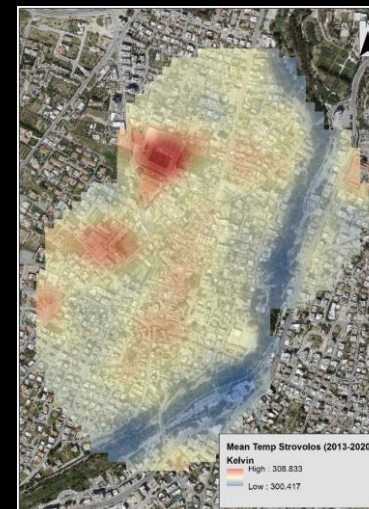
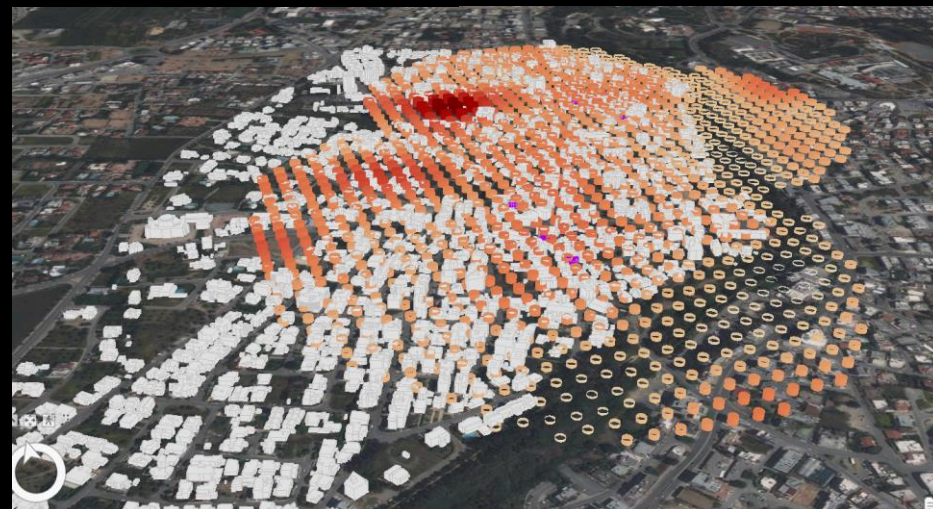
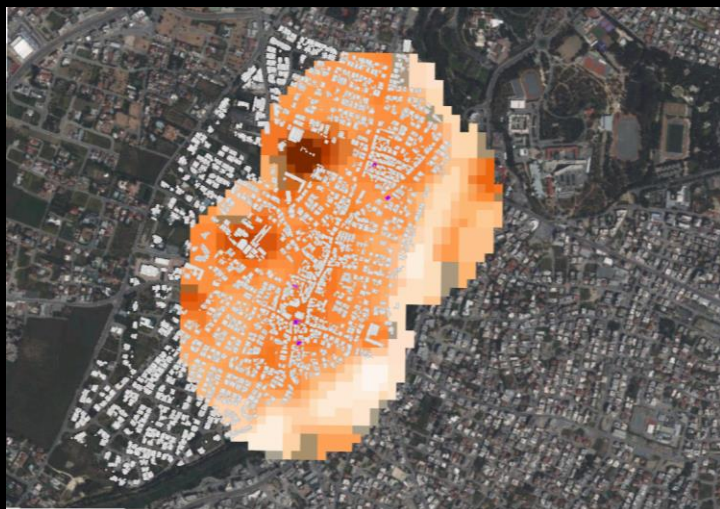


Online access to Digital Twins and environmental data at historic cluster scale.



Pilot
buildings

*Dynamic
exploration of
surface
temperatures
in 3D GIS.*



Metadata in IFC files

- J. Beetz, W. van den Braak, R. Botter, S. Zlatanova and R. de Laat, Interoperable data models for infrastructural artefacts: a novel IFC extension method using RDF vocabularies exemplified with quay wall structures for harbors, in eWork and eBusiness in Architecture, Engineering and Construction, CRC Press, 1146 Vienna, Austria, 2014, pp. 135–140.

Metadata

The built environment, environmental conditions and architectural records can be grouped as:

- information about identification of the asset,
- information about the location and environment,
- data about documentations and source of the asset,
- information about the structure of the building and its component parts,
- information about activities occurred at the moment of the survey
- restrictions of use,
- administrative information.

Semantic Models for Architectural Heritage Documentation

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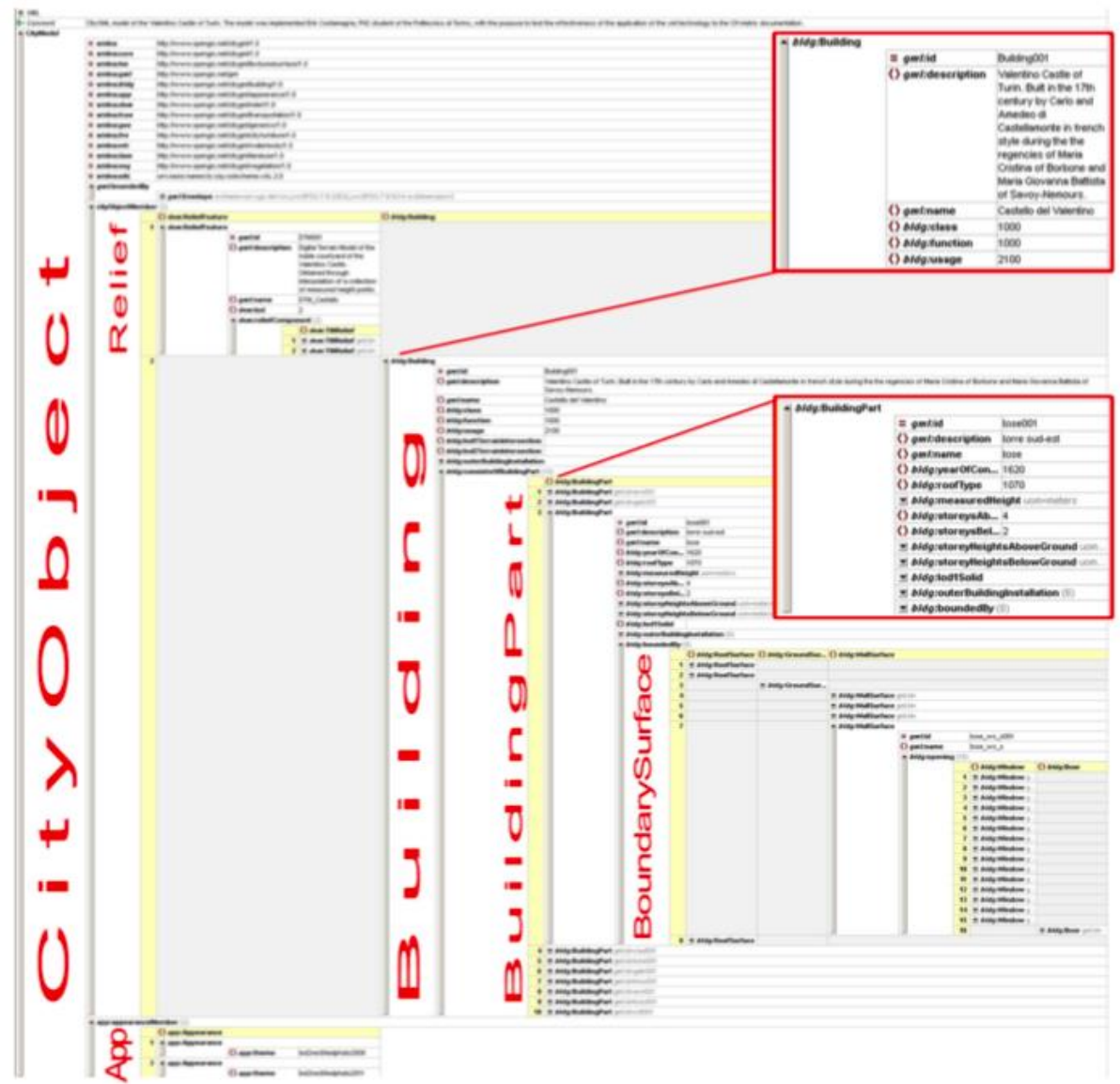
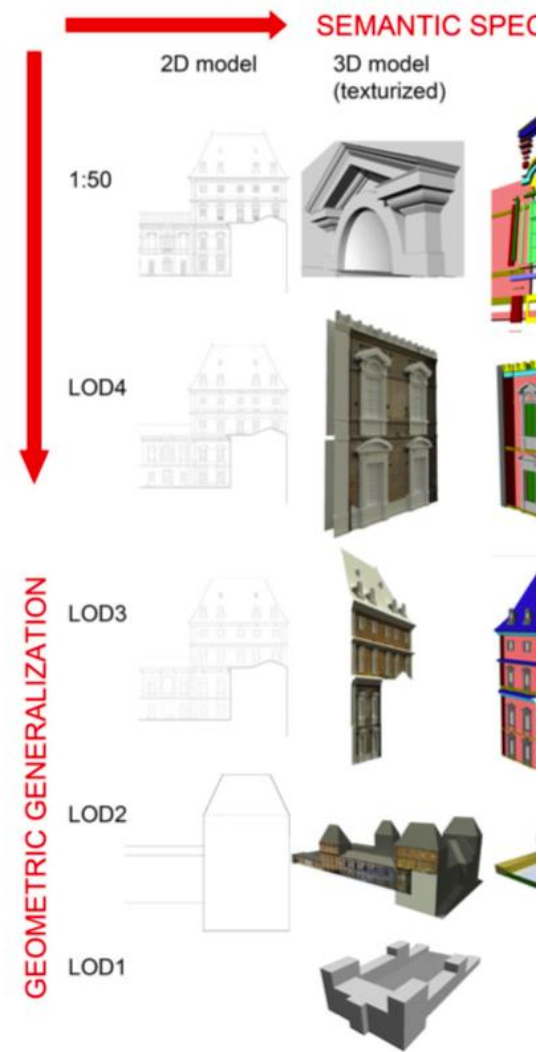
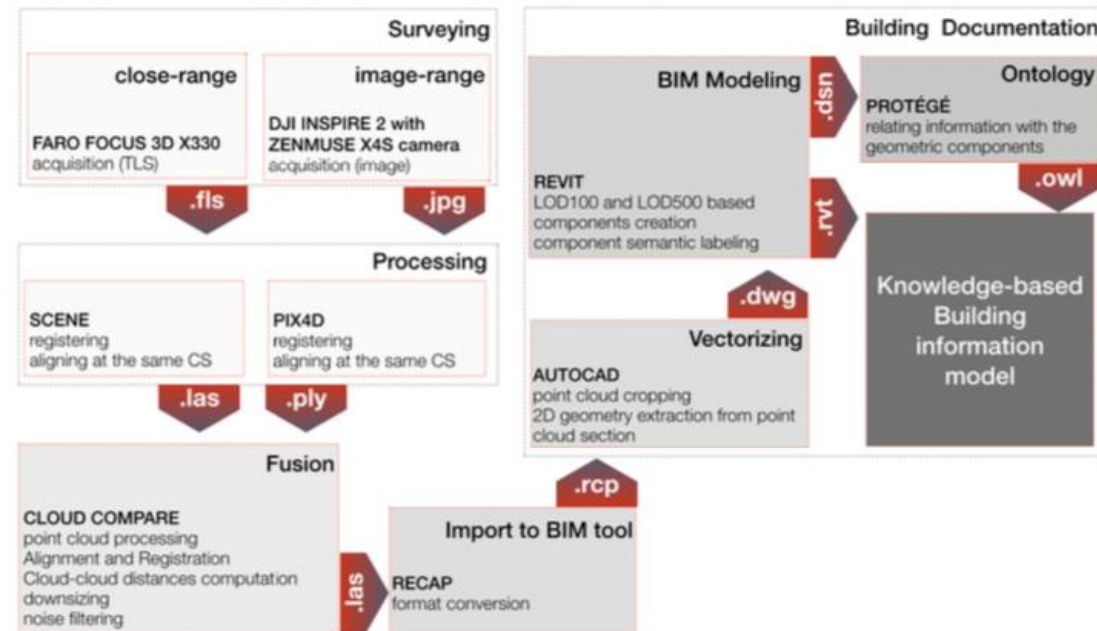


Figure 1. workflow of discrete LODs mo

Workflow for knowledge-based BIM



Map common fields of metadata attributes

Metadata Schemas -- Matching of elements

CARARE2.0.*	MIDAS XML - Monument Schema.**	IFC	CityGML	CityJSON
Record information: Unique ID assigned by the content provider.	Asset ID	Parcel: Unique code assigned by the public authorities. New Project information parameter: Data - Parcel.		
Designation: The name of the spatial asset and the identifier (ID) and may be repeated if, for example, a building/spatial structure is known by more than one name or has more than one ID number.	Building name	Building name: The name of the cultural heritage building assigned by the UP team. Default Project information parameter: Identity Data - Building Name.		
Description: Includes the features of the site, building, and the born-digital 2D or 3D models.		Description: Includes the typology of the cultural heritage building. New Project information parameter: Construction - Description.		
General type: A broad classification of the general type of the physical asset or born-digital record intended to enable spaces, buildings and landscape sites to be distinguished from other objects.	Monument type	Historical style: A classification related to both general type and main features of a building that make the cultural heritage asset notable and historically identifiable. New Project information parameter: Construction - Historical Style.		

Building construction:

the IFC schema of the construction industry

<https://technical.buildingsmart.org/standards/ifc/ifc-schema-specifications/>

Built heritage , monuments and sites:

MIDAS (English Heritage Listed Building System) & the CARARE2.0 metadata schema, which is based on MIDAS schema for built heritage and monuments: https://www.jiscmail.ac.uk/cgi-bin/filearea.cgi?LMGT1=FISH&a=get&f=/MIDASXMLCaseStudy_LBS.htm and https://pro.carare.eu/documents/8/the_carare_metadata_schema2.pdf

Historic cluster & neighbourhood scale:

the CityGML & recently CityJSON metadata schema for building (<http://schemas.opengis.net/citygml/building/2.0/>);

New schema

The Built Env_Asset information set would include the following elements:

- Record_information: unique ID assigned by the content provider;
- Designation: the name of the spatial asset and the identifier (ID) and may be repeated if, for example, a building/spatial structure is known by more than one name or has more than one ID number;
- Description: includes the features of the site, building, and the born-digital 2D or 3D models;
- General_type: is a broad classification of the general type of the physical asset or born digital record intended to enable spaces, buildings and landscape sites to be distinguished from other objects.
- Actors: represents the actors involved with this place; actors include for example creators, builders, owners, inhabitants and individuals who have an association with the site or building.
- Listing: is an information about any designations for a site or building which provide it with protection in law;
- Conditions: is about the condition of a site or building;

...

New schema

- Provenance: (source = DCMI Terms) is a free-text statement of any changes in ownership and custody of the resource since its creation that are significant for its authenticity, integrity, and interpretation, e.g., transformations of the site of building as originally produced, addition of auxiliary structures, or other changes; note that this ‘administrative’ provenance has nothing to do with the digital provenance concept, nor with construction material provenance.
- Characters: is a set of information to describe the character of the space. The information includes:
 - o Structure_asset_type classifies the site or building with respect to its function or use, e.g., house;
 - o Temporal; about time;
 - o Materials: is about the basic materials of which a spatial asset is composed, e.g., brick, stone, tile, paper etc. Use of a controlled vocabulary is recommended, and the vocabulary used may be indicated using an attribute;
 - o Dimensions:
 - Extent is to note the part of the spatial asset being measured, e.g. foundations;
 - Measurement type is referred to height, length, width, depth, shape;
 - Units e.g. metres, centimetres;
 - Scale;
 - Value is an attribute registering the accuracy of the measurement to be indicated (exact, approximate);

New schema

- Spatial: is information about the place at which the spatial asset is located, included named places, postal address, the map coordinates and geometry of the asset.
- Repository_location: identifies the institution which custodies the artefact and possibly the current location;
- Publication_statement;
- Rights: is a statement about any rights associated with the asset;
- References: are sources of information about the asset in publications and archival sources (for example, bibliographic references etc.). The information includes:
 - Appellation: is the name given to the information source;
 - Actors: is the creator, author, contributor, editor, etc.;
 - Type includes archive, file, record, book, chapter, article etc.;
 - Rights:
 - Publication statement:
 - Note
 - Link is the URL where users can find the reference online;
 - has_representation: is the relationship between an asset and a digital resource/repository in which it is represented.

Semantic web

- ifcOWL ontology:
<https://standards.buildingsmart.org/IFC/DEV/IFC4/ADD2/TC1/OWL/index.html>
P. Pauwels and W. Terkaj, EXPRESS to OWL for construction industry: Towards a recommendable and usable ifcOWL ontology, *Automation in Construction* 63 (2016), 100–133.
- BOT ontology BOT: the Building Topology Ontology of the W3C Linked Building Data Group
M.H. Rasmussen, P. Pauwels, M. Lefrançois, G.F. Schneider, C. Hviid and J. Karlshøj, Recent changes in the Building Topology Ontology, in: 5th Linked Data in Architecture and Construction Workshop, Dijon, France, 2017.



- Project email: info.UPeriscope@cyi.ac.cy
- Project website (M6): <http://uperiscope.cyi.ac.cy/>

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