



**La.Pi.S.**  
The 1<sup>st</sup> Smart cities, towns, rural  
and mountain villages international Congress



Smart strategies to mitigate causes and effects of climate  
change and reduce the environmental footprint  
**RESTRUCTURA - 21 November 2024**  
Lingotto Exhibition Center - Oval Pavilion - Turin

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1 – SYSTRA S.p.A.

# Exploring Linked Building Data: Enhancing Urban Development with Semantic Web Technologies for the integrated cities of tomorrow



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## What is Linked Building Data (LBD)?

- is a concept that involves the integration of data from various sources related to buildings and urban environments
- this integration is facilitated by the use of standardised formats and ontologies, which enable different systems to communicate and share information seamlessly
- by applying the principles of web pages, LBD allows for the creation of rich and interoperable datasets that can be used for a wide range of applications



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Which kind of **data** do we have?

- Environmental data (temperature, humidity, air quality, water level, etc.)
- Imagery data & 3D mapping data (aerial)
- Building performance data (energy consumption, occupancy levels, etc.)
- Structural data (sensors for health monitoring that detect stress, strain, deformation, etc.)
- Mobility data (real-time traffic detection, crowd detection, etc.)

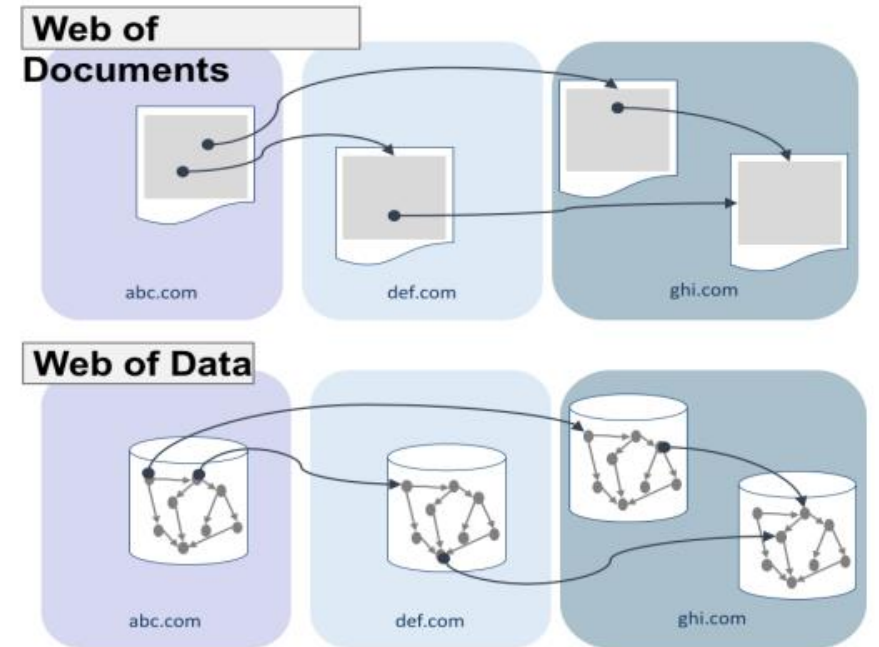


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How can be possible to **integrate different kind of data** in a comprehensive, interconnected view of the built environment?

## SEMANTIC WEB PRINCIPLES!

- **Uniform Resource Identifiers (URIs)**: these provide unique identifiers for data objects, ensuring that each element can be referenced unambiguously across datasets
- **Resource Description Framework (RDF)**: a graph-based data representation format that allows for flexible and interlinked data structures
- **SPARQL**: a query language for RDF data, facilitating complex queries across linked datasets

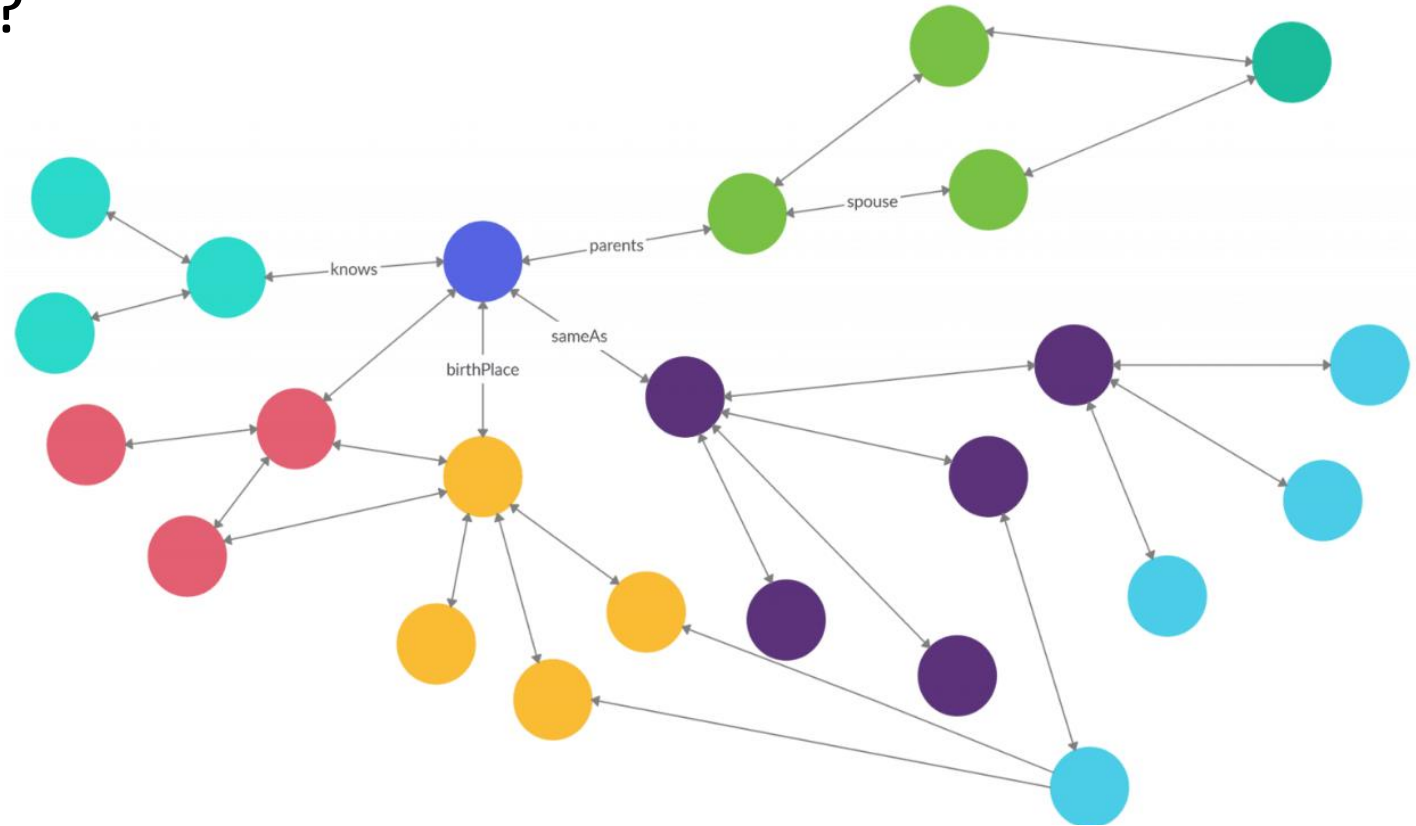


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How can we **associate attributes and logical relationships** with data?

## ONTOLOGIES!

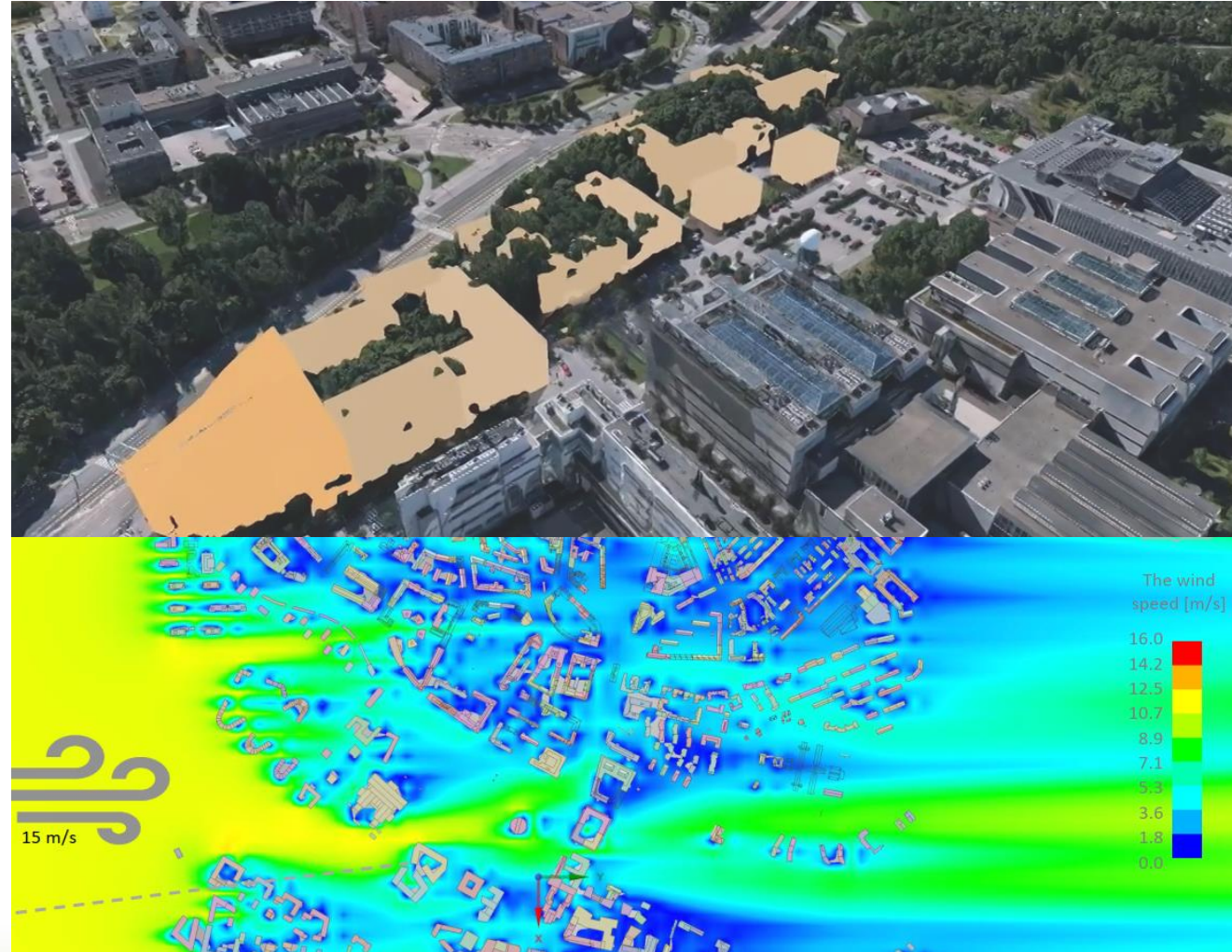
- **Industry Foundation Classes (IFC)**: a standard for BIM that has been extended to the web as ifcOWL, enabling its integration with other web data.
- **Building Topology Ontology (BOT)**: a lightweight ontology for describing the topological aspects of buildings.
- **BRICK Schema**: an open-source effort to standardize metadata for buildings, particularly focusing on operational data
- and others



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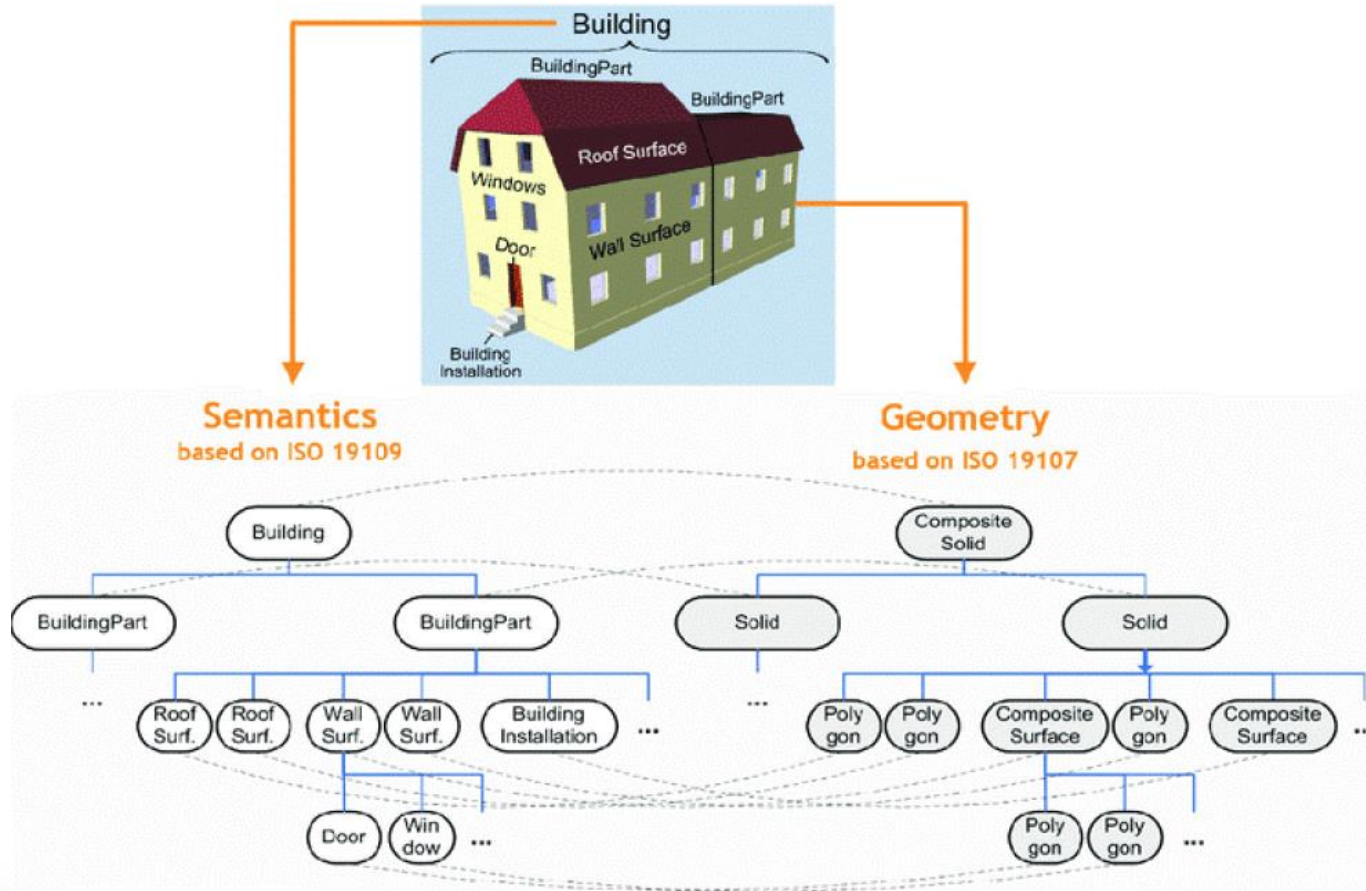
## Benefits of Linked Building Data

- provides a common framework for data exchange, thus fostering collaboration among different stakeholders (architects, engineers, contractors, facility managers, etc.)
- leads to more efficient project delivery and reduces the risk of errors and misunderstandings
- informs decision-making in areas such as site selection, building design, and operational strategies to minimize environmental impact
- monitoring and managing facilities more effectively (detailed analysis, optimization, predictive maintenance & reduced downtimes)



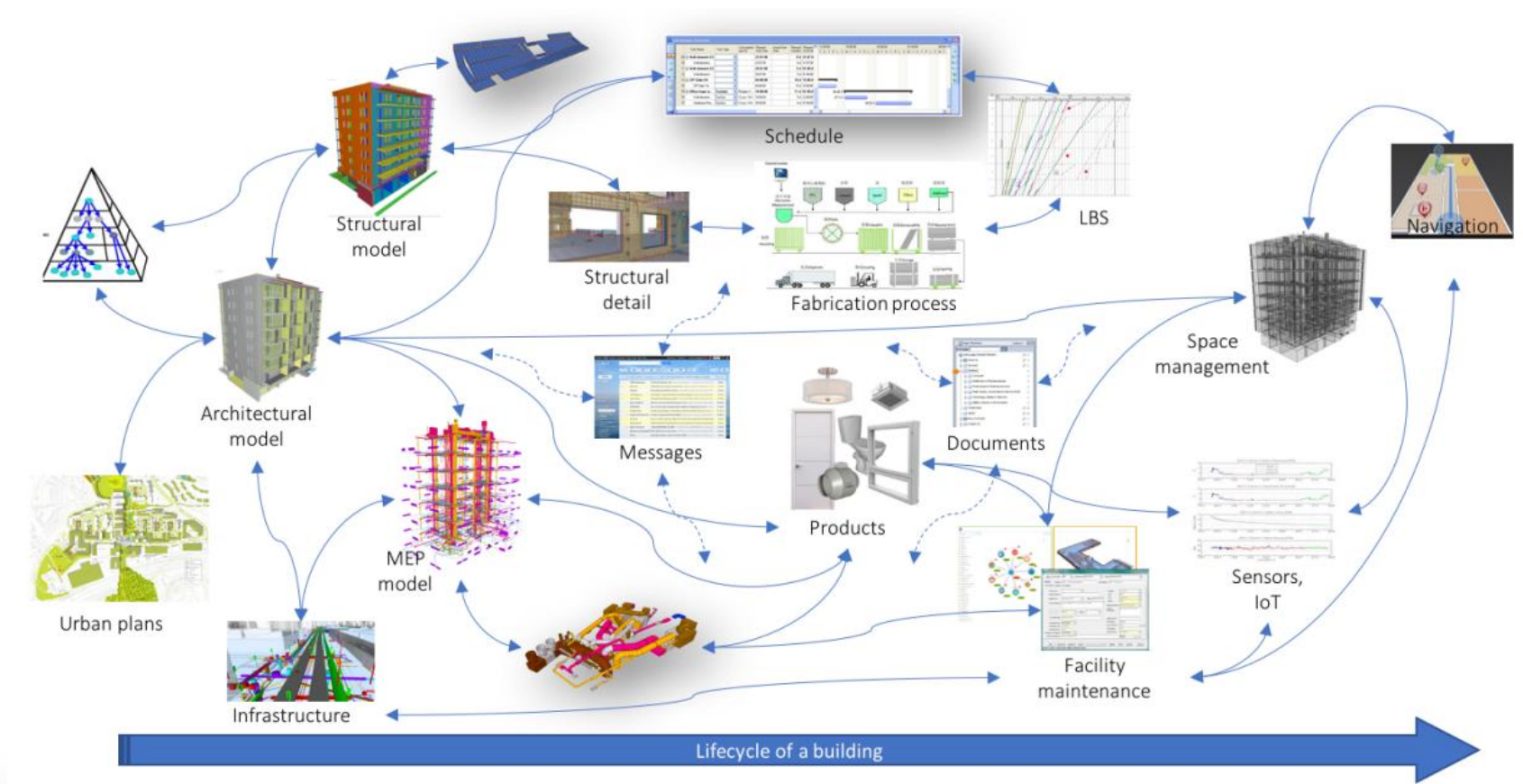
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## A Scenario of Linked Data in the Building Domain



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## A Scenario of Linked Data in the Building Domain





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## Implementation of Linked Data on an Urban Scale

The objective of a **smart city based on the linked data concept** is to develop a model that allows a type of interrogation that can be done by streaming over the internet, thereby providing considerable opportunities and access to this type of data.

- Many more stakeholders
- Extended and/or different time spans
- Clear management framework to establish:
  - ownership and responsibility of the data,
  - centralized urban data platform
  - advanced tools to implement data analytics, visualization and interactions among data on the centralized platform



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## Practical applications around the globe

### 1) HELSINKI'S DIGITAL TWIN

1 PRODUCTION OF THE TWIN MODELS

2 SHARING THE TWIN MODELS AS OPEN DATA

3 TWIN MODELS AS A SMART DEVELOPMENT PLATFORM

4 TWIN MODELS AS A SIMULATION PLATFORM

5 TWIN MODELS IN CITY PROCESSES



CityGML City Information Model



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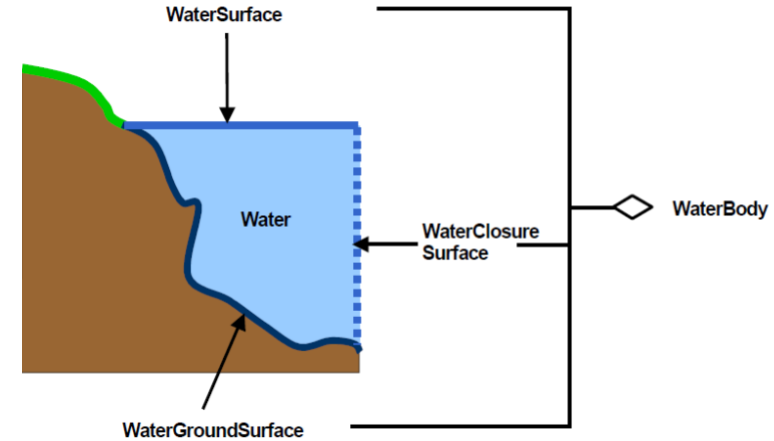


Figure – The three semantic parts of the *WaterBoundarySurface* class

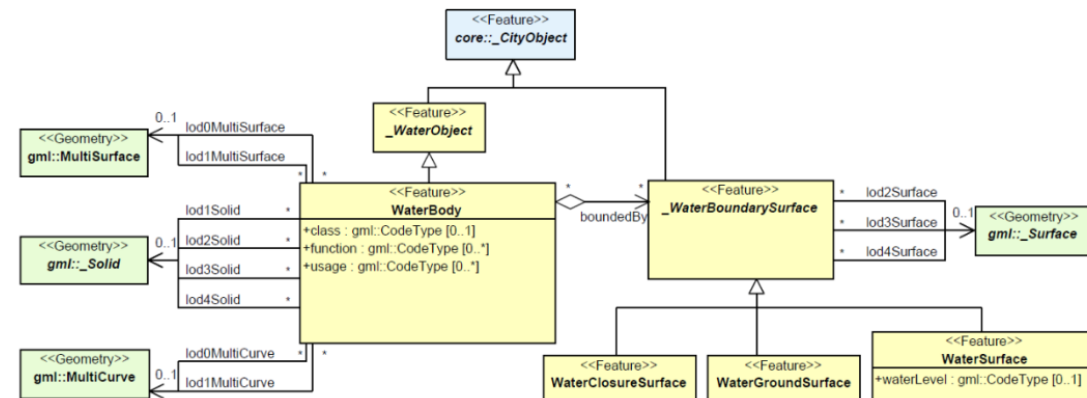


Diagram – UML diagram of CityGML waterbody

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Diagram – Overall architecture of CityGML model's data infrastructure



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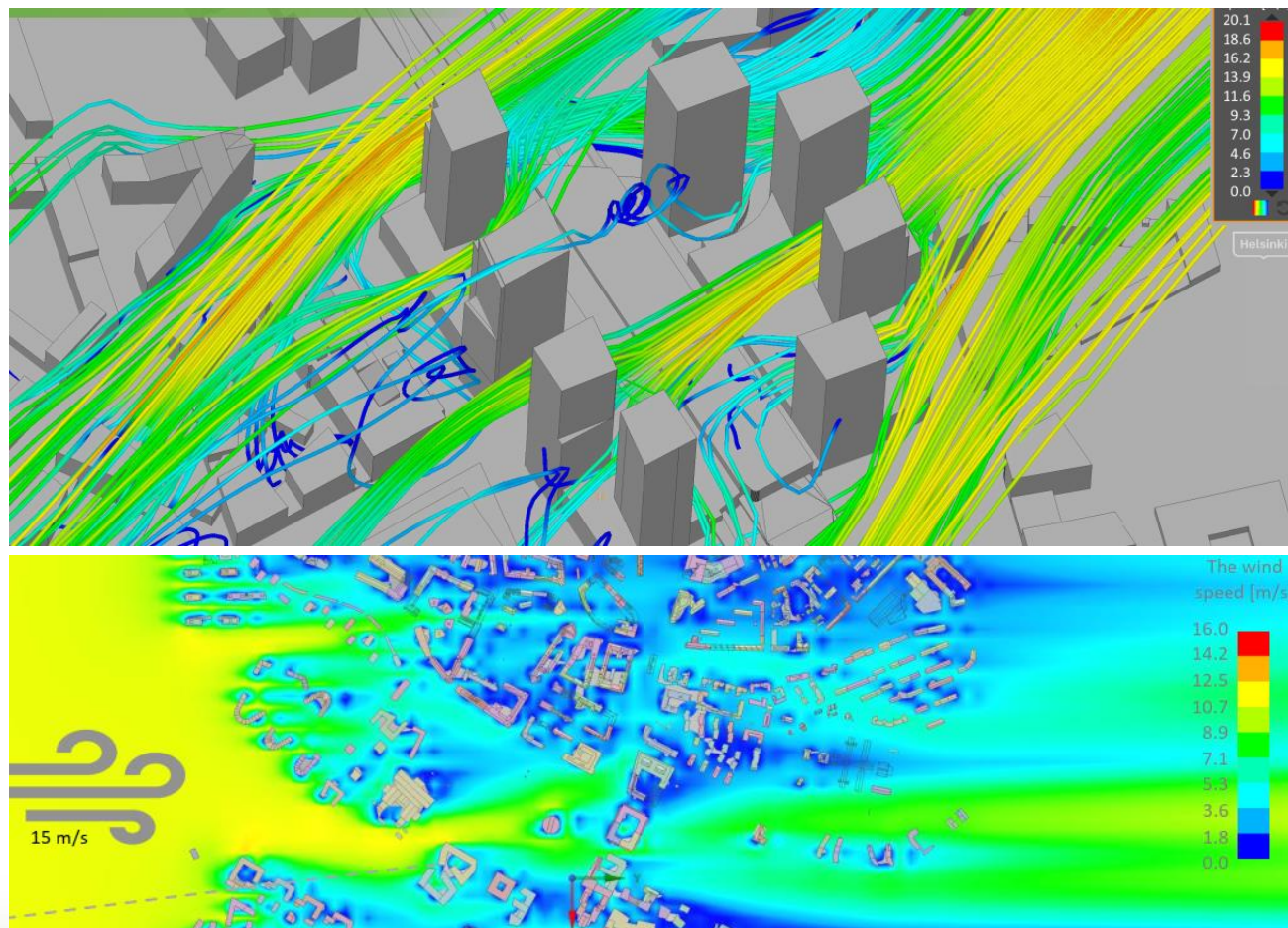


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Figures – Twin model as a simulation platform (wind)

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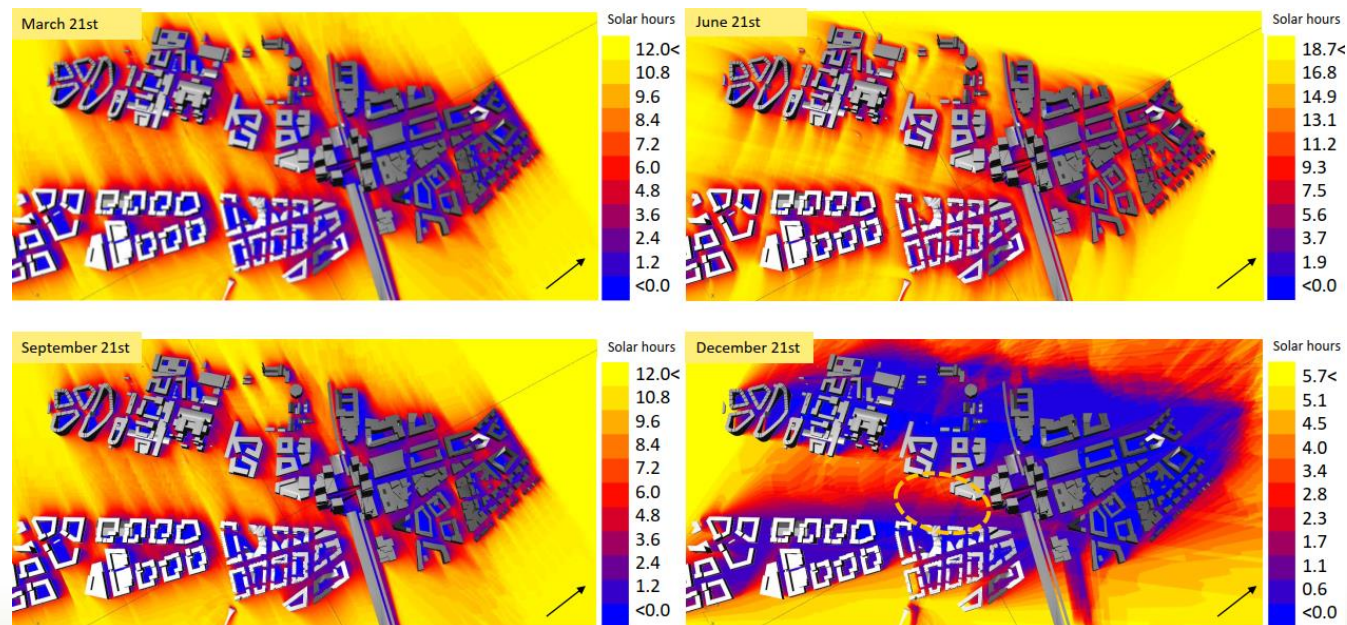
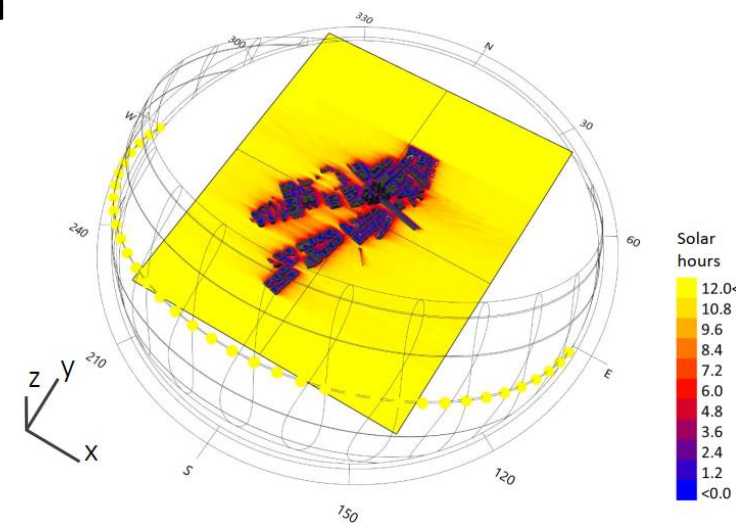


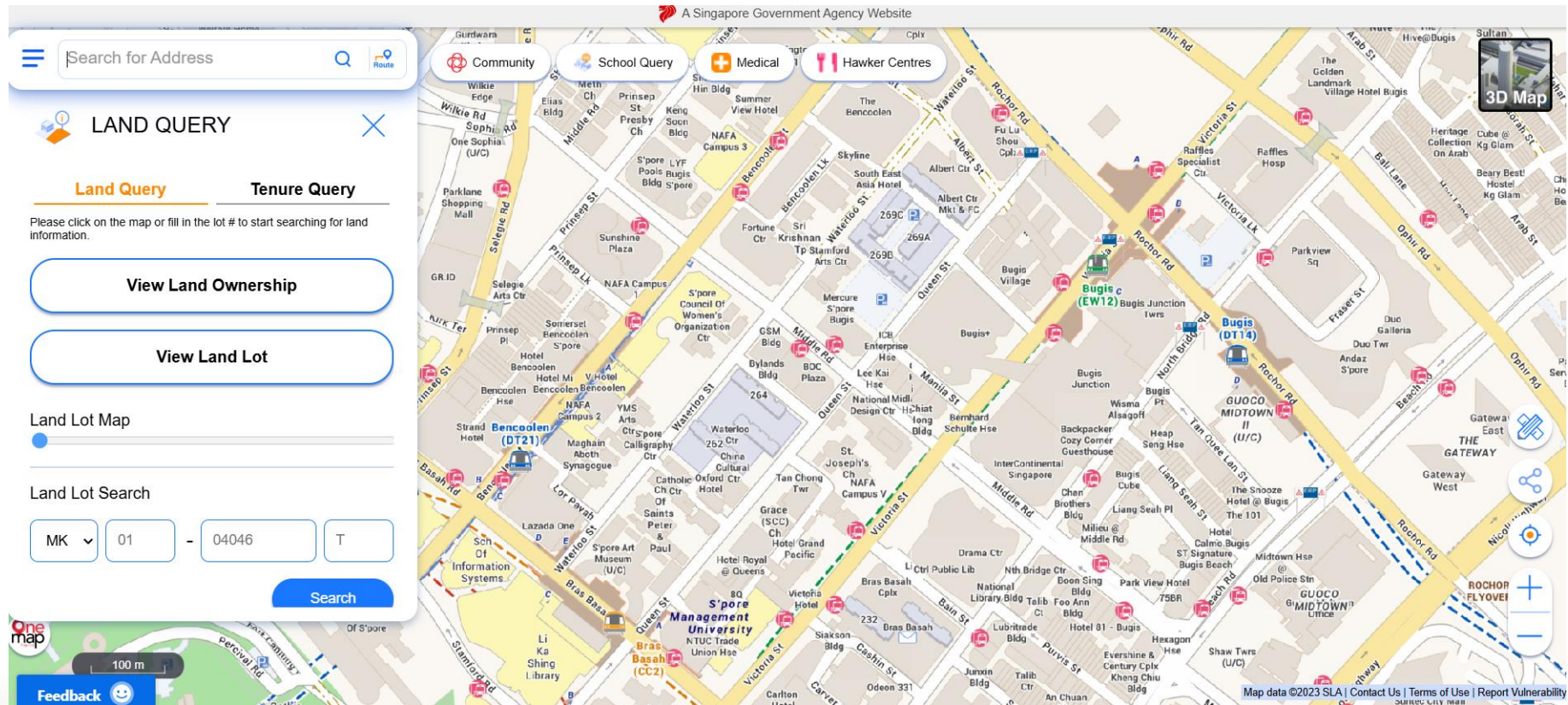
Figure – Twin model as a simulation platform (solar analysis)



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Practical applications around the globe

## 2) SMART NATION SINGAPORE



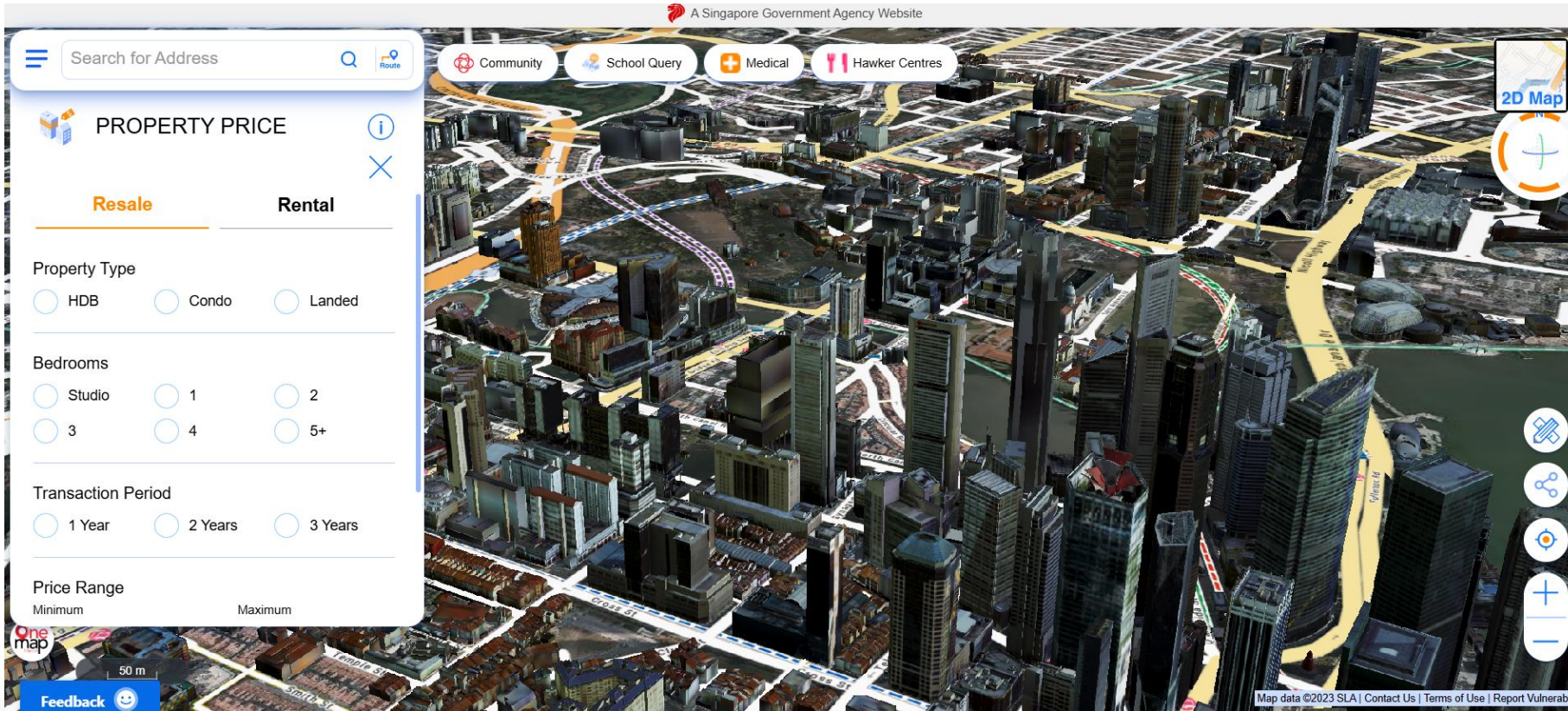
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## SCIENTIFIC PARTNERS



## COMMUNICATION PARTNER

