COGITO Digital Twin Platform & Data Visualization Tool

31st October 2023 / 11.00H – 12.00H CET
## AGENDA

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<tr>
<th>Presentation</th>
<th>Speaker(s)</th>
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<tr>
<td>Project overview and Q&amp;A</td>
<td>Giorgos Giannakis, PhD at Hypertech Energy Labs</td>
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<tr>
<td>Digital Twin Platform with demonstration and Q&amp;A</td>
<td>Kyriakos Katsigarakis, Research Fellow in BIM Platforms and Data Integration at the University College London</td>
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<td>Data Visualization Tool with demonstration and Q&amp;A</td>
<td>Giorgos Giannakis, PhD at Hypertech Energy Labs</td>
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<tr>
<td>Poll</td>
<td>Moderated by BUILD UP</td>
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<tr>
<td>Thank you from BUILD UP</td>
<td>BUILD UP</td>
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BUILD UP

The European portal for energy efficiency and renewable energy in buildings.
COGITO Digital Twin Platform & Data Visualization Tool

COGITO series of webinars 2023
Introduction

Project Innovations and Goals

Giorgos Giannakis

Hypertech SA

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958310
COGITO in a nutshell

- The construction phase has so far been overlooked by the Digital Twin community;
- Lack of commonly agreed standards and low interoperability among collected data reveal a major drawback to the enterprises’ digital transformation.
COGITO in a nutshell

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- Lack of commonly agreed standards and low interoperability among collected data reveal a major drawback to the enterprises’ digital transformation.

- Going beyond “static” Building Information Modelling (BIM) is required by leveraging technologies like IoT, Cloud Computing and Artificial Intelligence;
- Construction projects require collaboration between many parties -> transparent platforms for digital data handling are needed;
- Automated progress and resource tracking, automated quality assessment, safety measures planning, and hazardous areas detection -> need for a CONstruction-phase diGital Twin mOdel (COGITO).
COGITO in a nutshell

- The construction phase has so far been overlooked by the Digital Twin community;
- Lack of commonly agreed standards and low interoperability among collected data reveal a major drawback to the enterprises’ digital transformation.

- Going beyond “static” Building Information Modelling (BIM) is required by leveraging technologies like IoT, Cloud Computing and Artificial Intelligence;
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- Development and delivery of (1) a transparent digital data management platform and (2) digital Construction 4.0 toolbox that contributes to productivity improvement and increased safety.
Objective 1
Delivery of a Construction Digital Twin platform
COGITO Goals

Objective 1
Delivery of a Construction Digital Twin platform

Objective 2
Delivery of digital tools for Quality Control and Workflow Management
COGITO Goals

**Objective 1**
Delivery of a Construction Digital Twin platform

**Objective 2**
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**Objective 3**
Delivery of digital tools for Health and Safety Management
COGITO Goals

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Objective 4
Demonstration on actual construction sites to quantify the benefits of the COGITO tools
COGITO Goals

Objective 1
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Objective 2
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Objective 3
Delivery of digital tools for Health and Safety Management

Objective 4
Demonstration on actual construction sites to quantify the benefits of the COGITO tools

Objective 5
Research, design and promotion for standardization data exchange formats
COGITO Goals

**Objective 1**
Delivery of a Construction Digital Twin platform

**Objective 2**
Delivery of digital tools for Quality Control and Workflow Management

**Objective 3**
Delivery of digital tools for Health and Safety Management

**Objective 4**
Demonstration on actual construction sites to quantify the benefits of the COGITO tools

**Objective 5**
Research, design and promotion for standardization data exchange formats

**Objective 6**
Promotion of the COGITO solution’s adoption through intense dissemination
COGITO solution

Reality capture tools
- Satellite images
- 3D scanning & photogrammetry
- Unmanned Aerial Vehicles
- Devices and Sensors
- Weather forecasts

As-planned data
- 3D geometry
- Activities scheduling
- Budget and Costs

Data Pre-processing

Construction Phase Digital Twin Platform

Digital Twin Applications
- Health & Safety
- Quality Control
- Adaptive Workflow Mngmnt
- GUI & support Apps

Linked data
COGITO technologies and services
COGITO technologies and services
Digital Twin Platform

Kyriakos Katsigarakis
University College London

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DTP’s central role in the COGITO solution

**COGITO Applications**

- Process Modeling
- Quality Control
- Visualisation
- Health & Safety

**Digital Twin Platform**

- Authentication Layer
- Data Management Layer
- Data Persistence Layer
- Messaging Layer
- Data Ingestion Layer
- Data Post-Processing Layer

**COGITO Ontology**

**COGITO Data Pre-Processing Tools**

- Imagery & Visual Defects
- Location Tracking Data
- Point Cloud

**External Input Data Sources**

- 3D BIM
- Construction Schedule
DTP’s overall architecture

Authentication Layer:
- Identity Provider

Data Ingestion Layer:
- Input Data Management
- BIM Management component
- Knowledge Graph Generator

Data Persistence Layer:
- File Storage System
- Relational database
- Key-value database
- Timeseries database
- Triplestore
- Thing Descriptions Directory

Data Management Layer:
- DT Runtime
- DT Library

Data Post-Processing Layer:
- MVD Checker
- IFC Optimiser
- B-rep Generator
- Geometric Clash Checker

Messaging Layer:
- Message Broker
DTP is a data integration middleware responsible for:

- Registering external applications, providing configurable endpoints, registering users and configuring their roles, creating and configuring construction projects;
- Loading the as-designed, as-built and real-time IoT data to the internal relational and graph databases;
- Orchestrating the executions of the **Model Checking (MC)** and **Extract, Transform and Load (ETL)** data processing algorithms.

DTP provides a fully functional Identity and Access Management. It ensures that access is restricted to specific users and applications with the appropriate permissions.
Input Data Quality Assurance

The Geometric Clash Checker (GCC) detects clashes among the geometric representations of construction zones and BIM elements, verifies the containment relations among these elements, and fills in missing semantics based on the verified containment relationships.

The Model View Definition (MVD) Checker checks the correctness and completeness of input data according to predefined rules specified in design guidelines that have been issued.

<table>
<thead>
<tr>
<th>Type</th>
<th>Property Set</th>
<th>Property / Entity Name</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Zones</td>
<td></td>
<td>4D_SpatialZone</td>
<td>The spatial zone entity should have geometric representation.</td>
</tr>
<tr>
<td>Construction</td>
<td>4D_Task_id</td>
<td></td>
<td>Can be a list of schedule activities. Multiple IDs using &quot;,&quot; delimiter.</td>
</tr>
<tr>
<td>Element</td>
<td>CDDGDZ_ZoneType</td>
<td></td>
<td>Construction, Fall_Hazard_Space, Model</td>
</tr>
<tr>
<td>Identity Data</td>
<td>CDDGDZ_ElementClass Type</td>
<td></td>
<td>The Uniclass Id of the element type.</td>
</tr>
<tr>
<td>Identity Data</td>
<td>CDDGDZ_ElementType</td>
<td></td>
<td>The CDDGDZ Id if the Uniclass Id is not available.</td>
</tr>
<tr>
<td>Construction</td>
<td>4D_Task_Id</td>
<td></td>
<td>The Id of the task which adds the element in the model.</td>
</tr>
<tr>
<td>Material and finishes</td>
<td>CDDGDZ_Material/Uniclass Type</td>
<td></td>
<td>The Uniclass Id of the material.</td>
</tr>
</tbody>
</table>
Data Transformation & Semantic Enrichment

The **IFC Optimiser** performs lossless compression of an IFC file to speed up loading and data transformation processes.

The **B-Rep Generator** produces graphics-friendly triangulated boundary representations of BIM elements for rendering purposes from their parametric and non-parametric descriptions.

The **Knowledge Graph Generator** is responsible for populating the COGITO ontology, validating the knowledge graph and generating the Thing Descriptions. It supports the transformation of heterogeneous data such as IFC, JSON, XML and CSV coming from various input data sources.

The **BIM Management** component is responsible for parsing IFC data and loading the corresponding objects into the key-value database of the Persistence Layer. It is responsible for serializing, deserialising, querying, updating, merging and splitting the IFC data.
The **DT Library** provides a set of reusable ready-made coding blocks (Actors) facilitating developers to create their own modules using a web-based GUI.

The **DT Runtime** implements the Actor-Model and is responsible for hosting various modules used for executing DTP’s data processing operations. Furthermore, it ensures that the data coming from the Persistence Layer are synchronised and harmonised before being forwarded to the COGITO tools.
Questions & Answers
Digital Command Centre

Giorgos Giannakis
Hypertech SA

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 958310
Digital Command Centre - DCC

• DCC is a 3D visualisation module:
  ▪ off-site graphical representation of a construction site Digital Twin
  ▪ based on data readily available from COGITO’s Digital Twin Platform
  ▪ intuitive UI based on the popular 3D game engine Unity
  ▪ web-based
    ▪ remote - yet detailed - view of the construction site
    ▪ regardless of device or operating system

Detailed view of:
  ▪ as-planned 4D data
    the geometrical representation filtered by the work execution time schedule
  ▪ as-built data
    what has actually been constructed/implemented in a particular time frame

Visual overlays to report on:
  ▪ the accomplished work progress
  ▪ the potential health and safety issues or hazards
  ▪ the quality of the work performed
  ▪ location/IoT data
DCC in a nutshell

- UI overview:

As-planned filtering:

As-built filtering:
DCC in a nutshell

- WODM overlay
- QC overlay
- HSE overlay
- IoT overlay
Questions & Answers
Thank you!