BUILD UP
The European portal for energy efficiency
and renewable energy in buildings
WEBINAR

COGITO Digital Twin Platform & Data Visualization Tool

31st October 2023 / 11.00H – 12.00H CET

BUILD UP
The European portal for energy efficiency and renewable energy in buildings

AGENDA

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

COGITO Digital Twin Platform & Data Visualization Tool

COGITO series of webinars 2023

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

COGITO

CONSTRUCTION PHASE
DIGITAL TWIN MODEL

cogito-project.eu

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

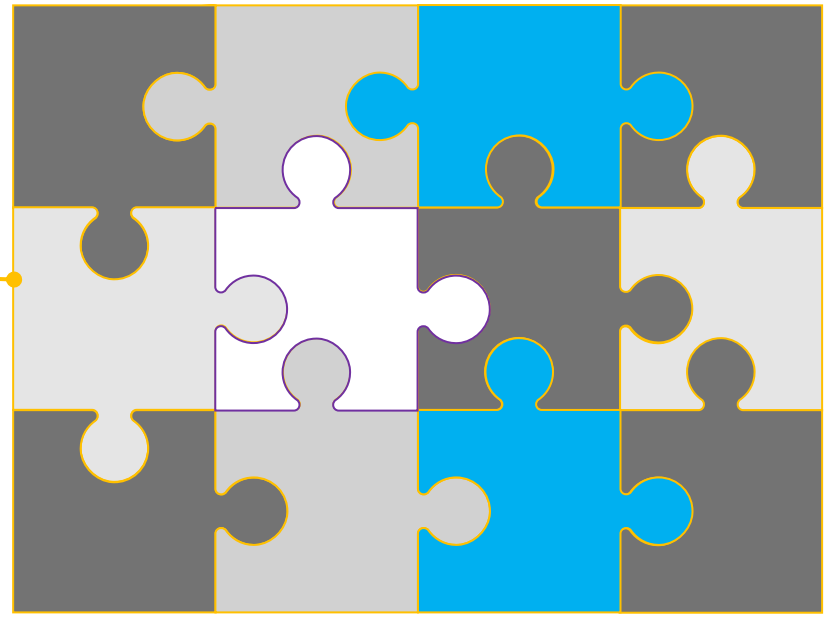
CONSTRUCTION PHASE
DIGITAL TWIN MODEL

cogito-project.eu

COGITO in a nutshell

Problem

- 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

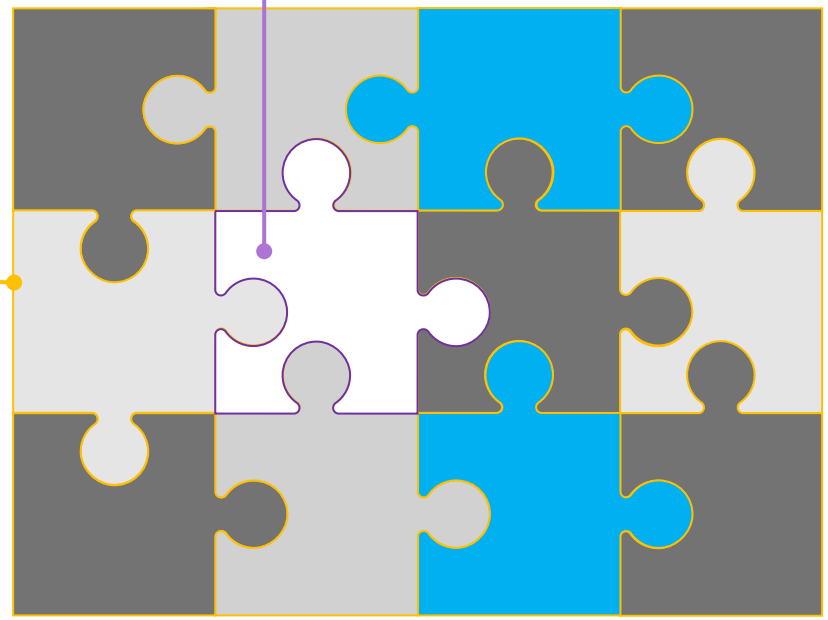
COGITO in a nutshell

Problem

- 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.

Need

- 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

COGITO in a nutshell

Problem

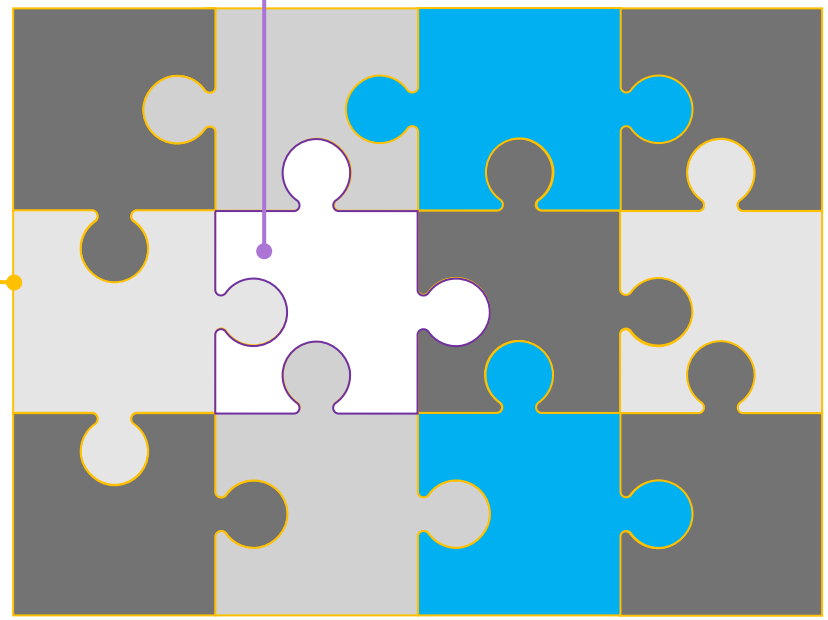
- The construction phase has so far been overlooked by the Digital Twin community;
- Lack of commonly agreed standards and low interoperability among collected data reveal a major drawback to the enterprises' digital transformation.

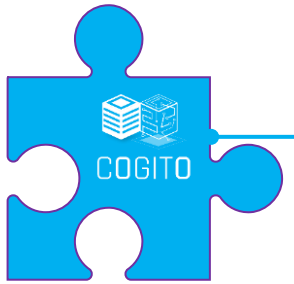
Need

- 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).

Solution

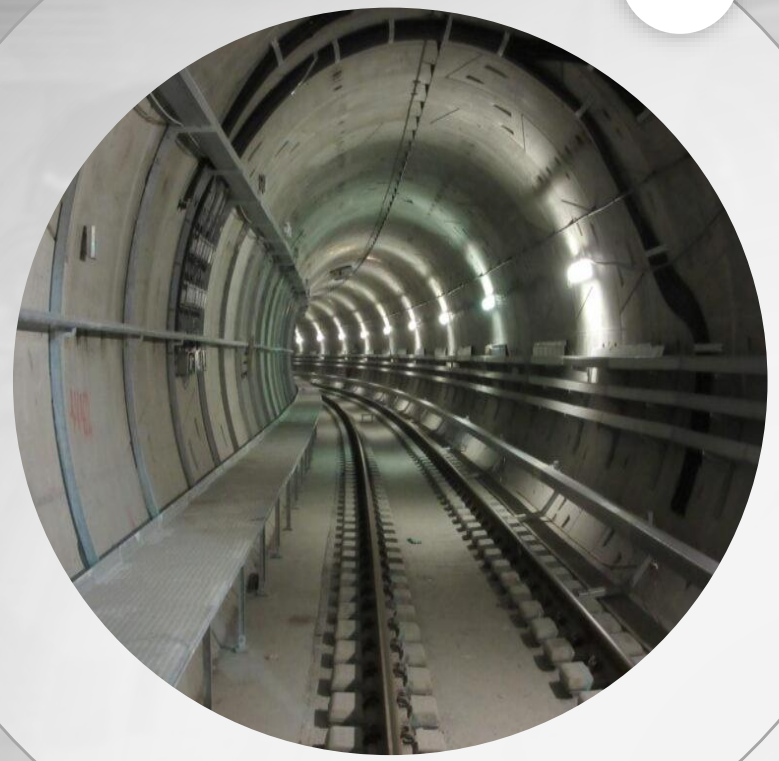
- Development and delivery of (1) a transparent digital data management platform and (2) digital Construction 4.0 toolbox that contributes to productivity improvement and increased safety.





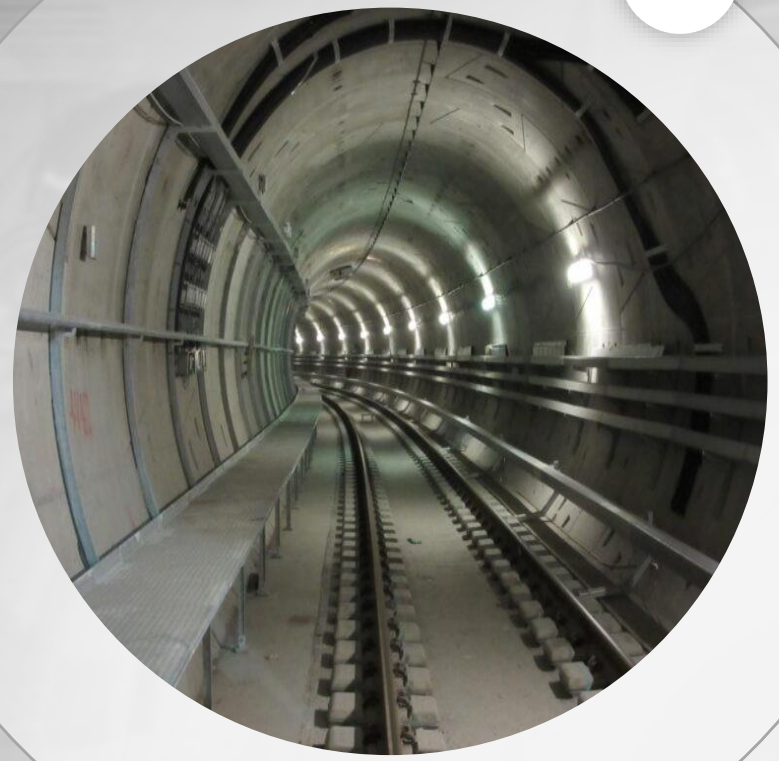
COGITO

COGITO Goals



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
Delivery of digital tools for Quality Control and Workflow Management

Objective 3
Delivery of digital tools for Health and Safety Management

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

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

COGITO Goals

Objective 1
Delivery of a Construction Digital Twin platform

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

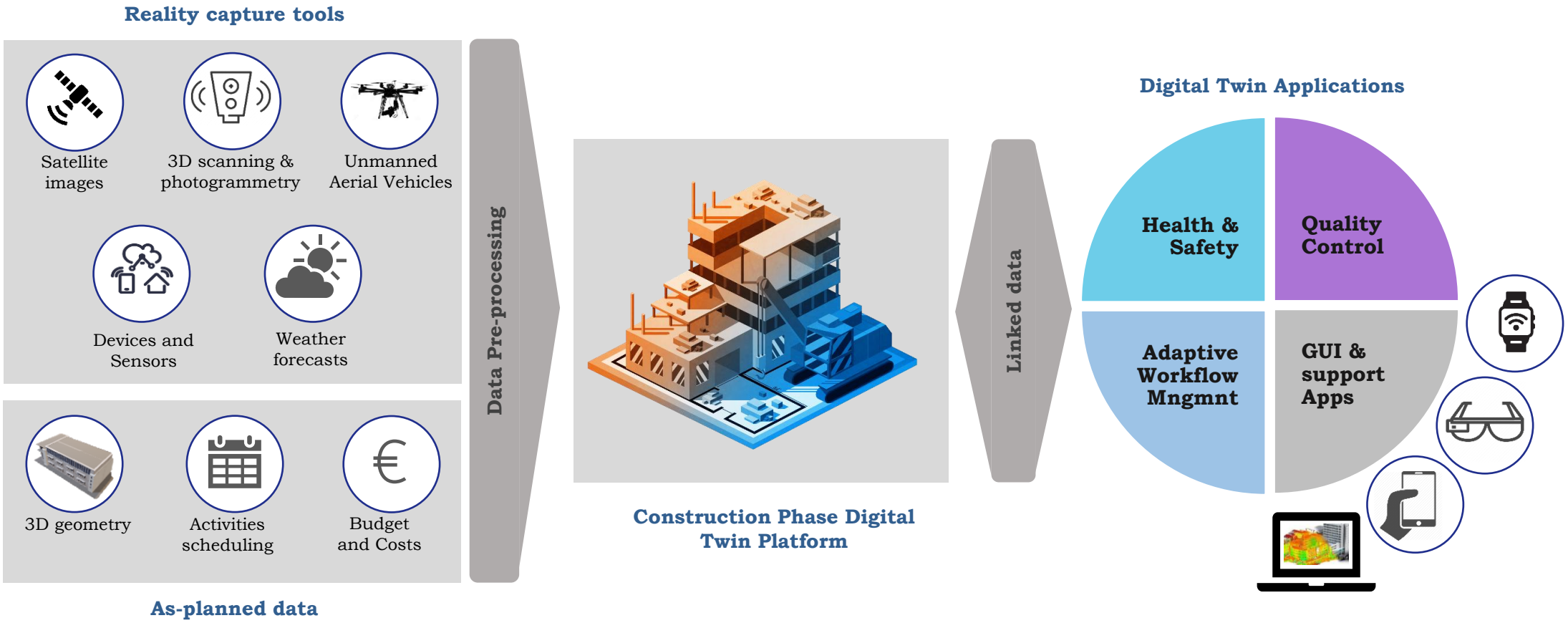
Objective 3
Delivery of digital tools for Health and Safety Management

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

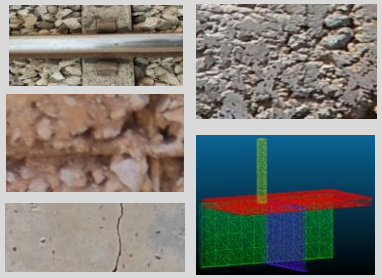
Objective 6
Promotion of the COGITO solution's adoption through intense dissemination

COGITO solution



COGITO technologies and services

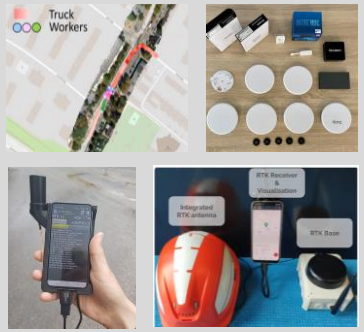
Point clouds and images



Visual data pre-processing

1 *Visual Data Pre-processing module*

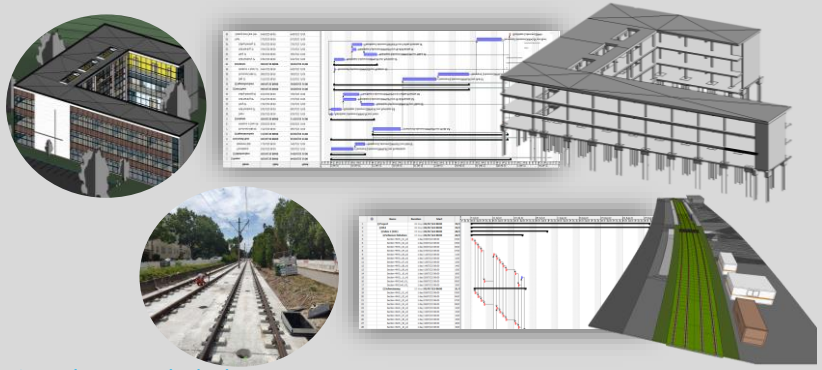
Resources – Location data



IoT data pre-processing

2 *IoT Data Pre-processing module*

As-planned data



Workflow Management

7 *PMS*

8 *WODM*

9 *SLAM & BCSC*

10 *WOEA*

Quality Control

5 *GeometricQC*

6 *VisualQC*

14 *Digital Twin Platform*

Digital Twin Platform

Health & Safety

3 *SafeConAI*

4 *ProactiveSafety*

11 *DigiTAR*

12 *Digital Command Centre*

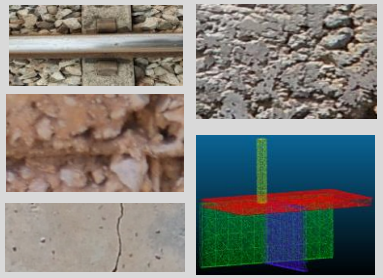
13 *VirtualSafety*

Data visualisation

COGITO

COGITO technologies and services

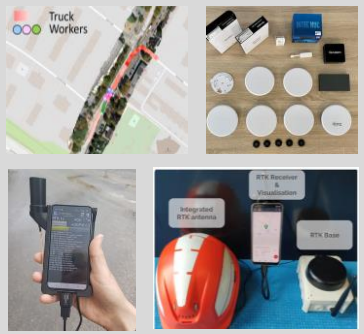
Point clouds and images



Visual data pre-processing

1 *Visual Data Pre-processing module*

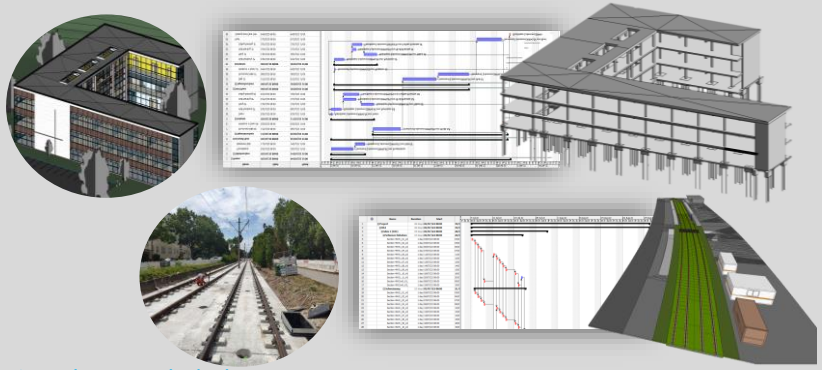
Resources – Location data



IoT data pre-processing

2 *IoT Data Pre-processing module*

As-planned data



Workflow Management

7 *PMS*

8 *WODM*

9 *SLAM & BCSC*

10 *WOEA*

Quality Control

5 *GeometricQC*

6 *VisualQC*

14 ***Digital Twin Platform***

Digital Twin Platform

3 *SafeConAI*

4 *ProactiveSafety*

Health & Safety

11 *DigiTAR*

12 ***Digital Command Centre***

13 *VirtualSafety*

Data visualisation

COGITO

Digital Twin Platform

Kyriakos Katsigarakis

University College London

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

COGITO

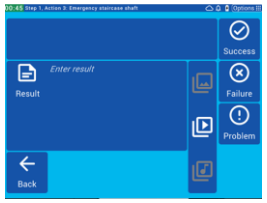
CONSTRUCTION PHASE
DIGITAL TWIN MODEL

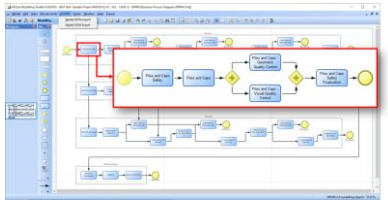
cogito-project.eu

DTP’s central role in the COGITO solution

COGITO Applications

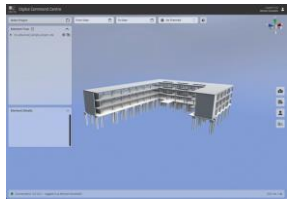
Process Modeling



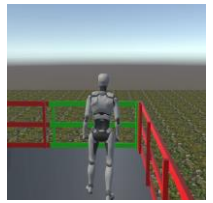


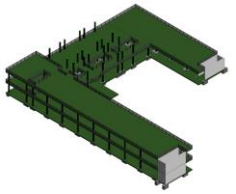
Quality Control

Visualisation



Health & Safety





Digital Twin Platform

Authentication Layer

Data Management Layer

Data Persistence Layer

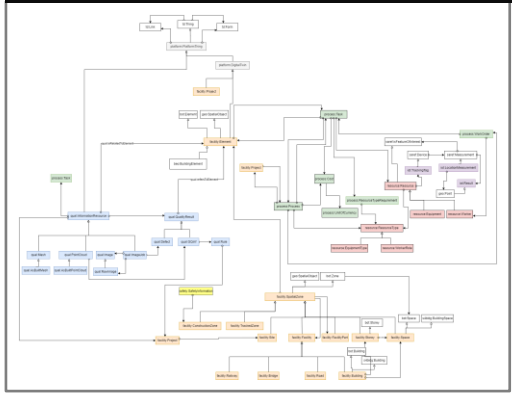
Data Ingestion Layer

Messaging Layer

Data Post-Processing Layer

COGITO

COGITO Ontology

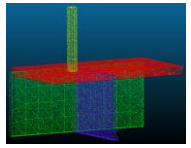


COGITO Data Pre-Processing Tools

Imagery & Visual Defects

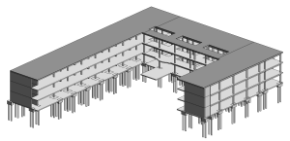
Location Tracking Data

Point Cloud



External Input Data Sources

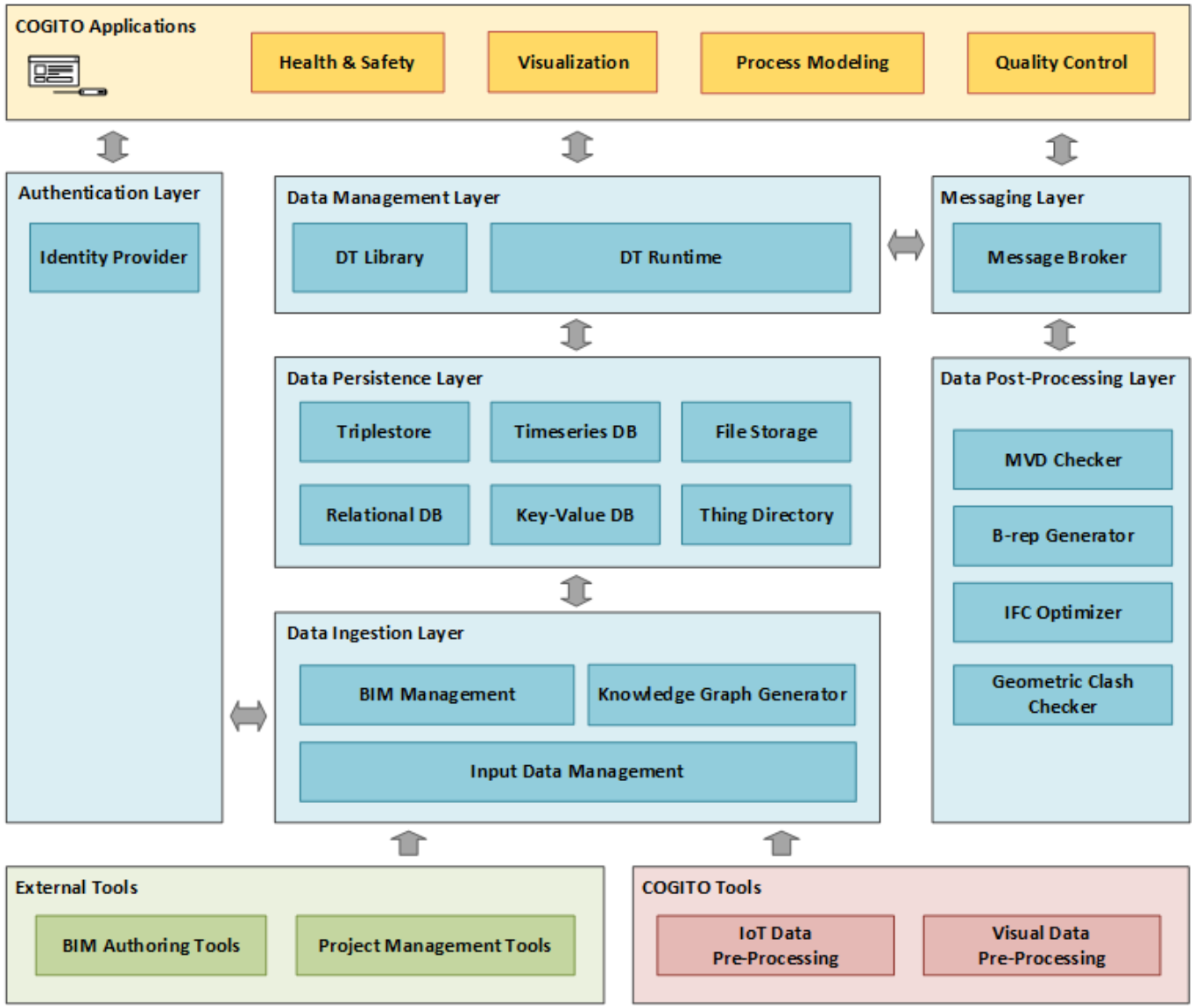
3D BIM



Construction Schedule

COGITO

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*

COGITO

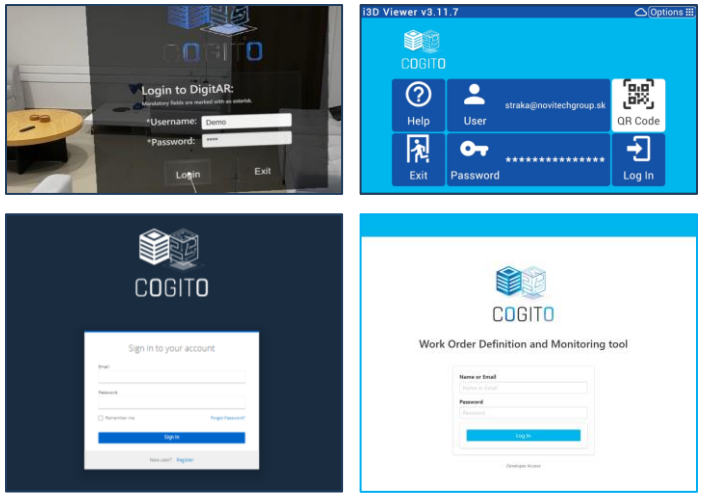
Project Creation & User Management

DTP is a data integration middleware responsible for:

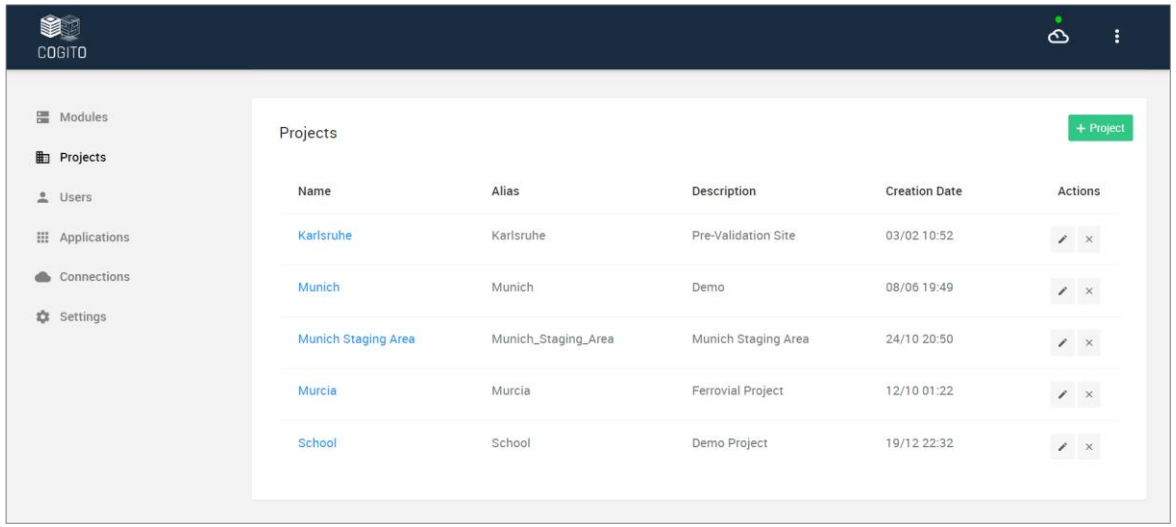
- Registering external applications, providing configurable endpoints, registering users and configuring their roles, creating and configuring construction projects;
- Loading the as-designed, as-built and real-time IoT data to the internal relational and graph databases;
- Orchestrating the executions 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.

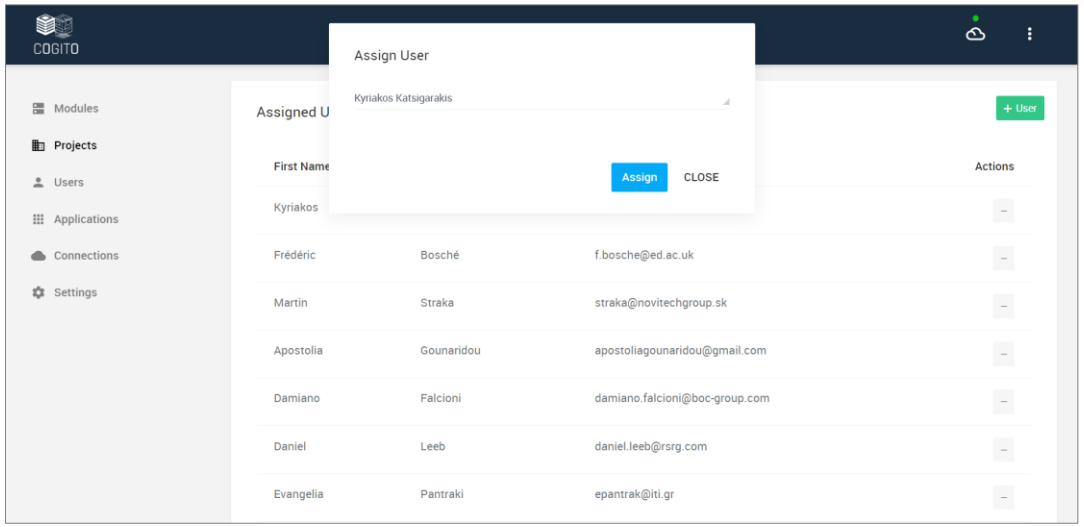
Authentication and Authorization Infrastructure



Project Creation



User Management



COGITO

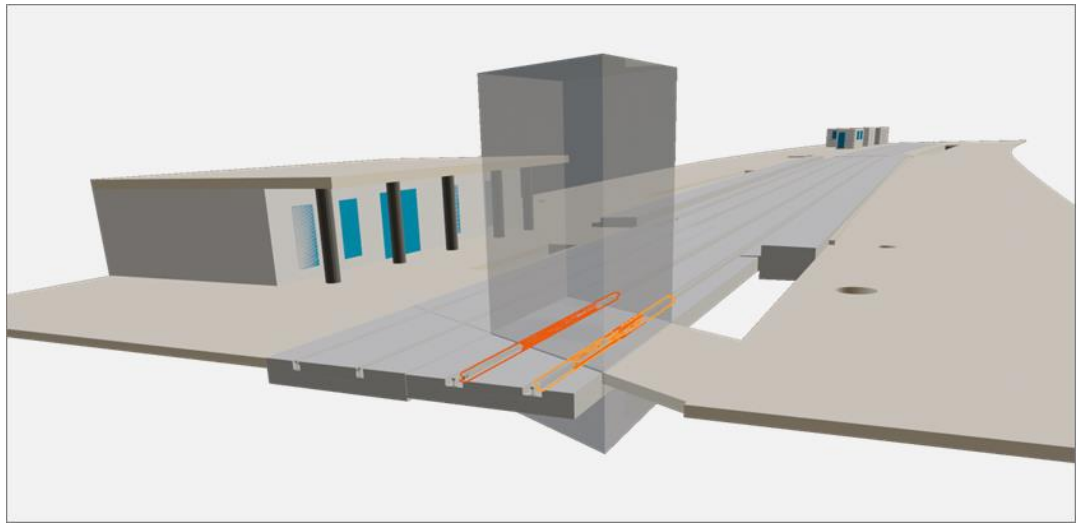
Input Data Quality Assurance

The **Geometric Clash Checker (GCC)** detect 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.

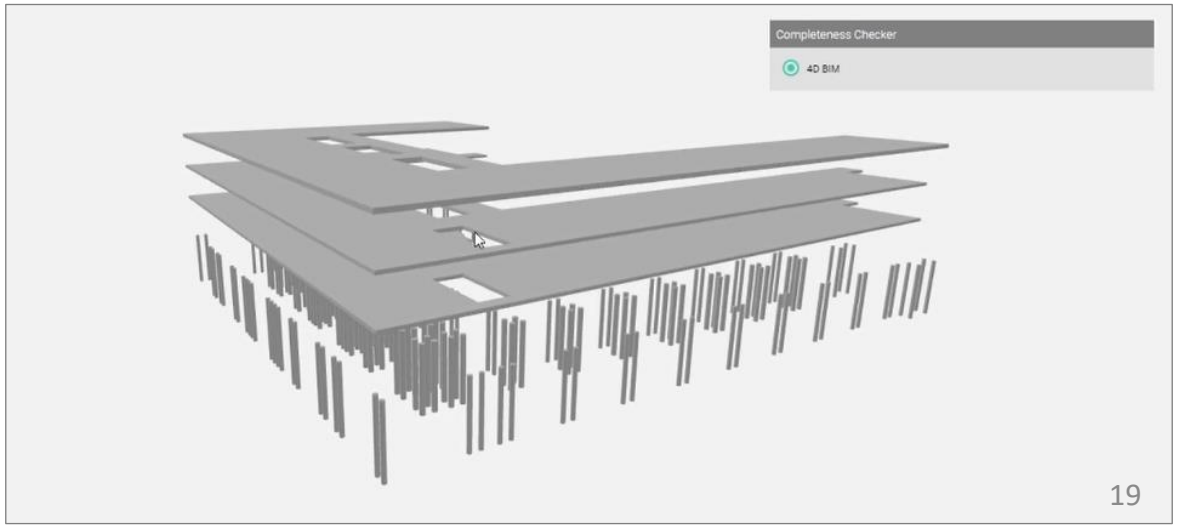
The **Model View Definition (MVD) Checker** checks the correctness and completeness of input data according to predefined rules specified in design guidelines that have been issued.

Type	Property Set	Property / Entity Name	Comment
Construction Zones	-	IfcSpatialZone	The spatial zone entity should have geometric representation.
	Construction	4D_Task_ID	Can be a list of schedule activities. Multiple Ids using t ";" delimiter.
	Identity Data	COGITO_ZoneType	Construction, Fall_Hazard_Space, Mover
Element	Identity Data	COGITO_ElementUniclass Type	The Uniclass Id of the element type
	Identity Data	COGITO_ElementType	The COGITO Id if the Uniclass Id is not a
	Construction	4D_Task_ID	The Id of the task which adds the eleme
	Material and Finishes	COGITO_MaterialUniclass Type	The Uniclass Id of the material

Geometric Clash Checker



MVD Completeness Checker



Data Transformation & Semantic Enrichment

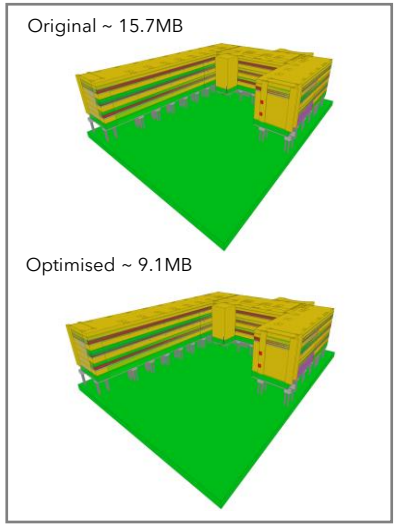
The **IFC Optimiser** performs lossless compression of an IFC file to speed up loading and data transformation processes.

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

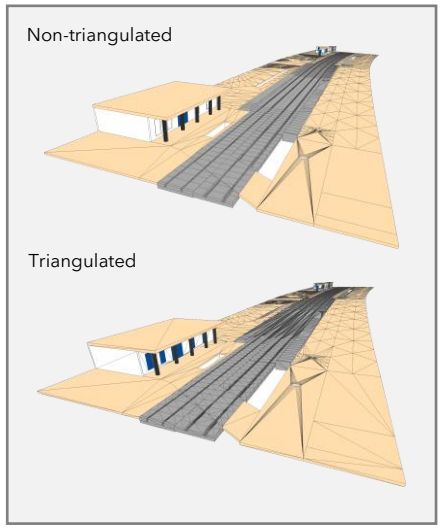
The **Knowledge Graph Generator** is responsible for populating the COGITO ontology, validating the knowledge graph and generating the Thing Descriptions. It supports the transformation of heterogeneous data such as IFC, JSON, XML and CSV coming from various input data sources.

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.

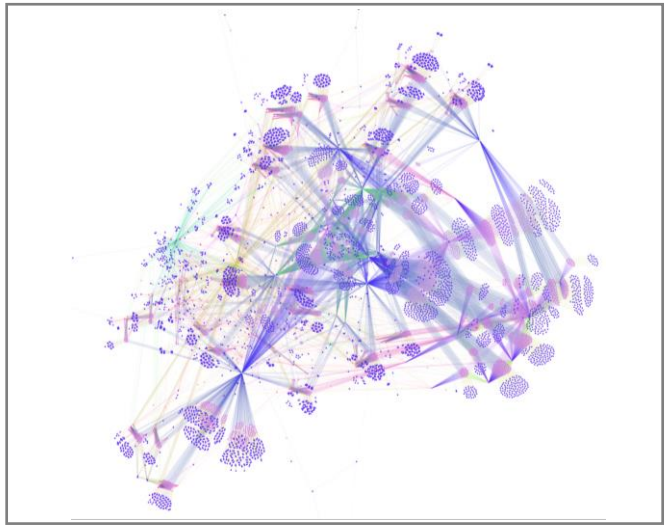
IFC Optimiser



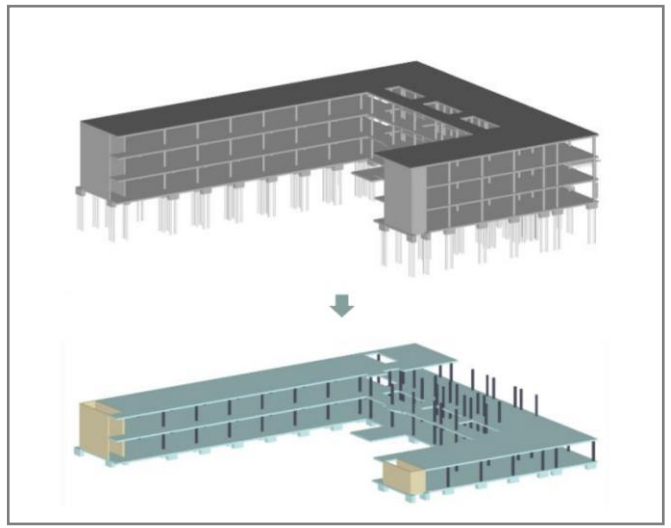
B-Rep Generator



Knowledge Graph Generator (KGG)



BIM Management

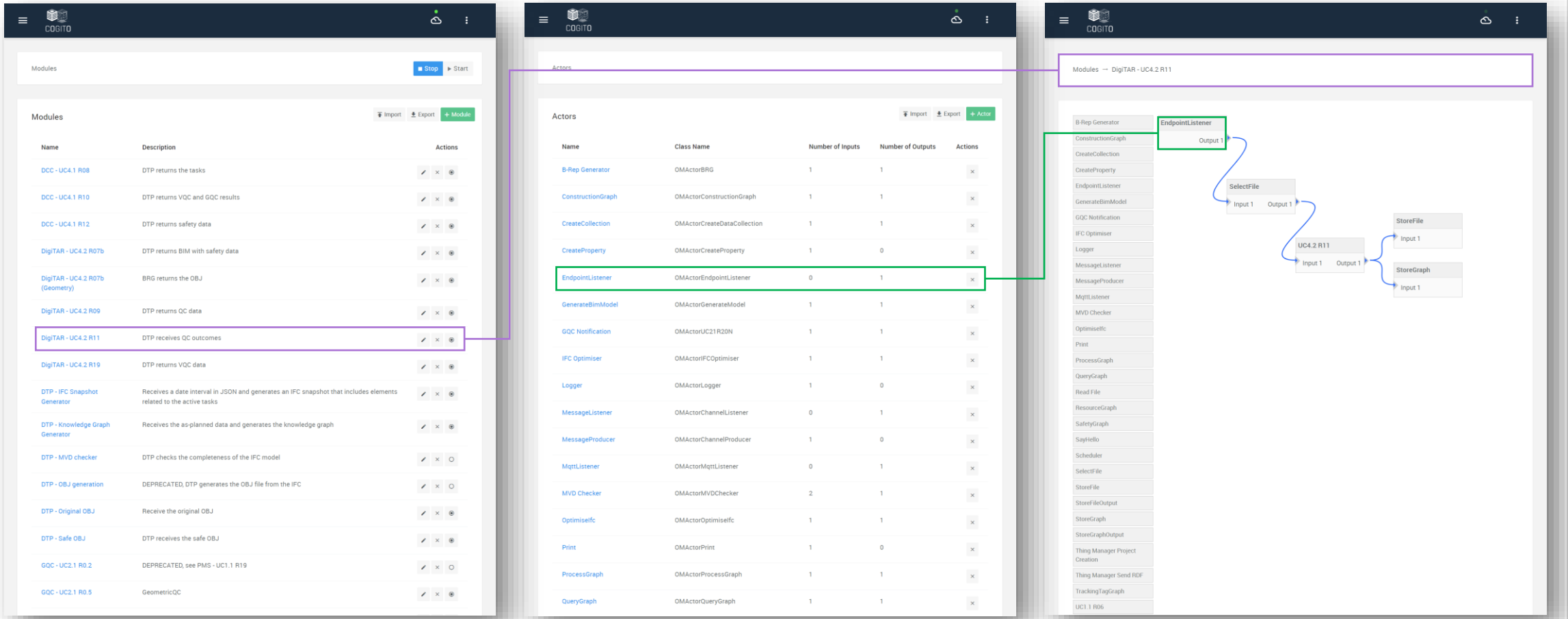


COGITO

Data Integration & Interoperability Framework

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.



COGITO

Questions & Answers

COGITO

CONSTRUCTION PHASE
DIGITAL TWIN MODEL

cogito-project.eu

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

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

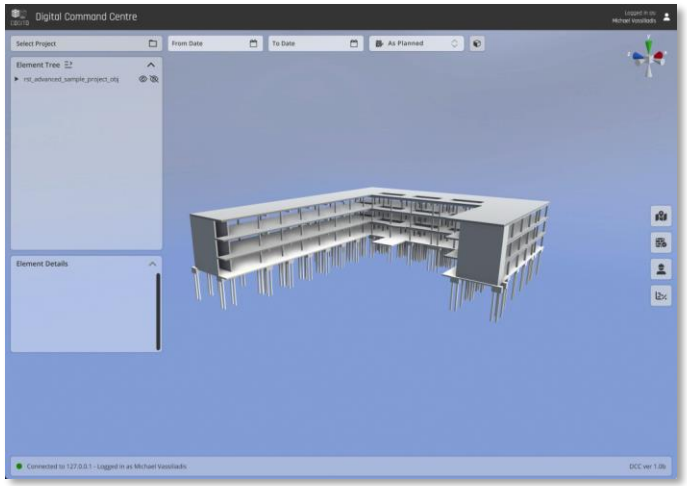
COGITO

CONSTRUCTION PHASE
DIGITAL TWIN MODEL

cogito-project.eu

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

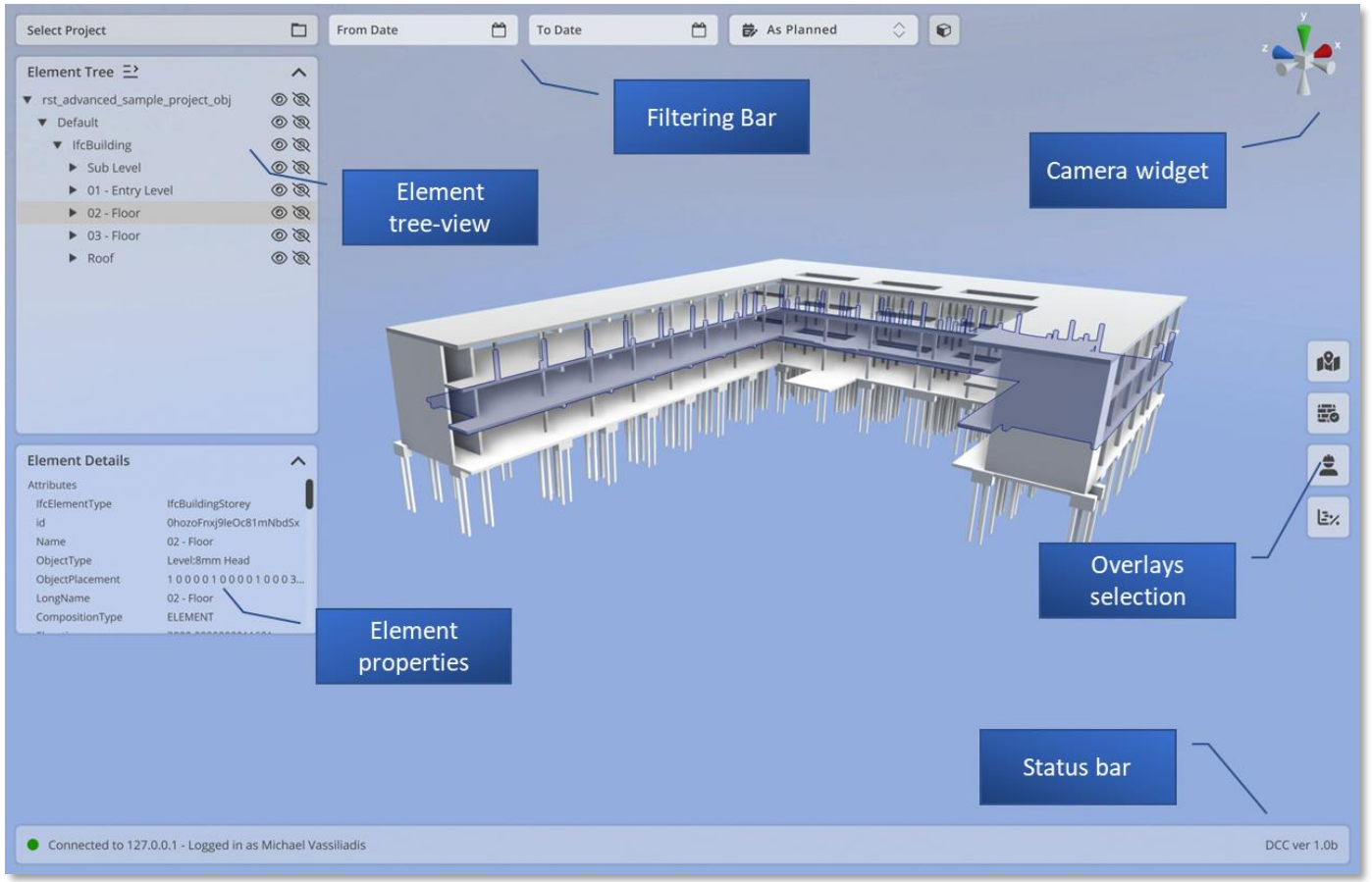
Visual overlays to report on:

- the accomplished **work progress**
- the potential **health and safety issues or hazards**
- the **quality of the work** performed
- location/**IoT data**

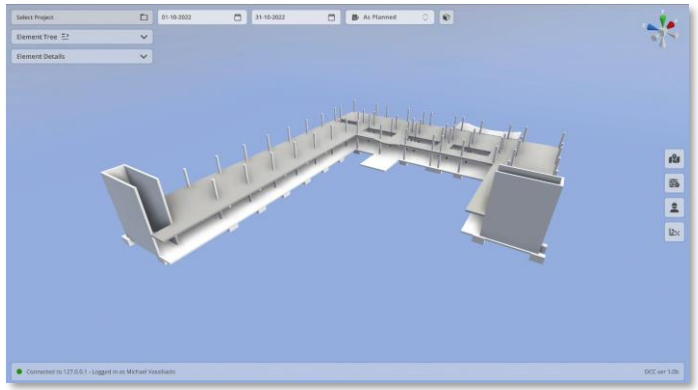
COGITO

DCC in a nutshell

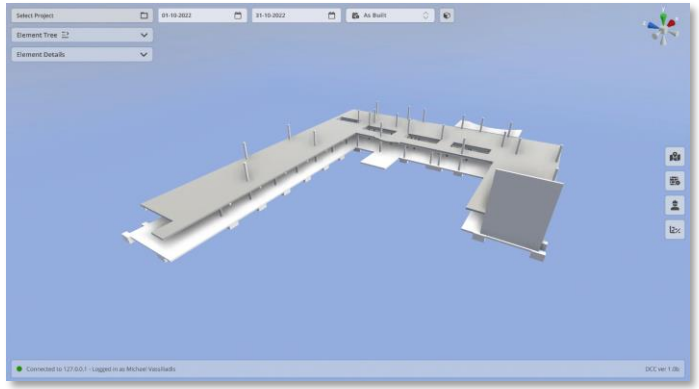
- UI overview:



As-planned filtering:

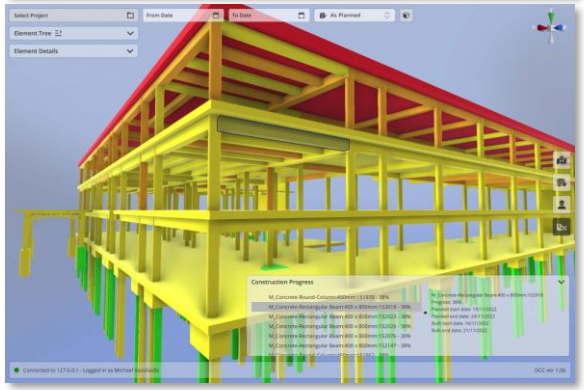
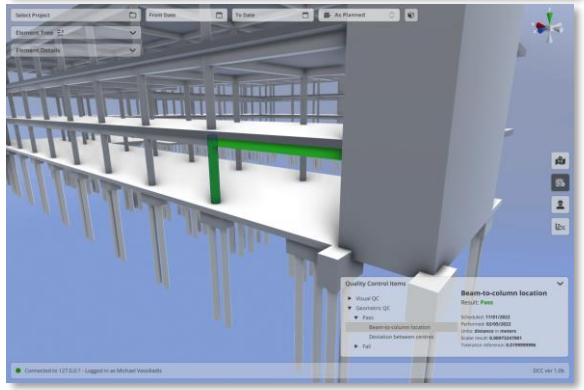
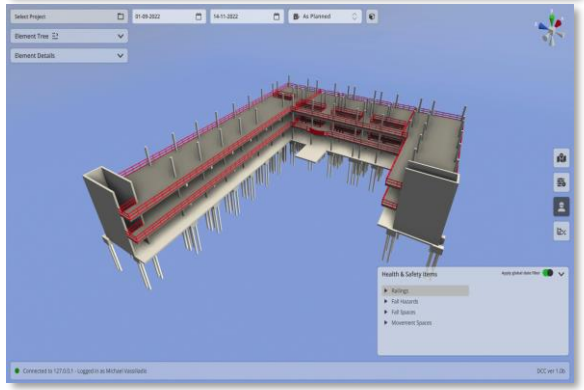
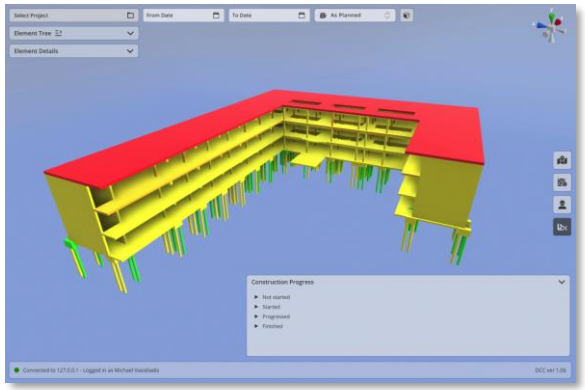
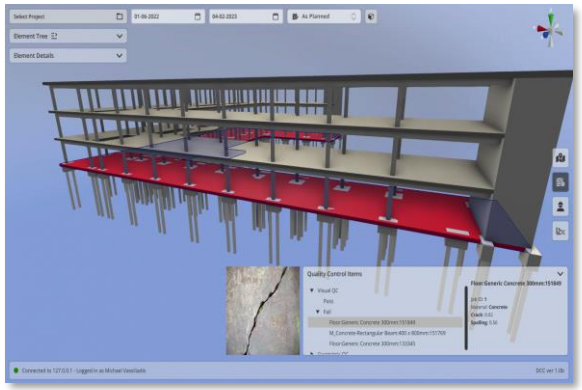
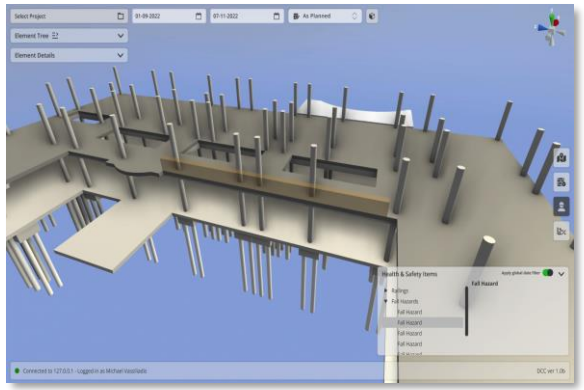
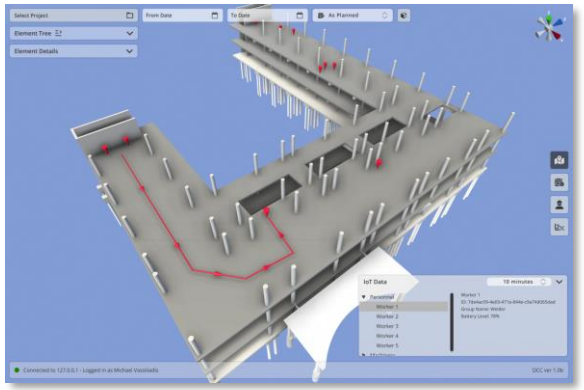


As-built filtering:



COGITO

DCC in a nutshell

WODM overlay	QC overlay	HSE overlay	IoT overlay
			
			

Questions & Answers

COGITO

CONSTRUCTION PHASE
DIGITAL TWIN MODEL

cogito-project.eu

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

Poll

Thank you!

BUILD UP
The European portal for energy efficiency
and renewable energy in buildings