



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



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COGITO

CONSTRUCTION PHASE
DIGITAL TWIN MODEL

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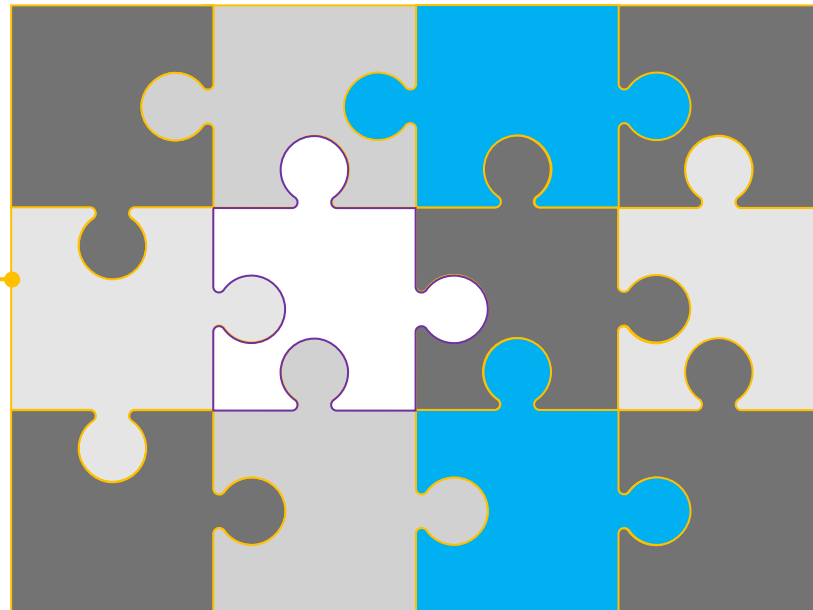


COGITO in a nutshell



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 in a nutshell

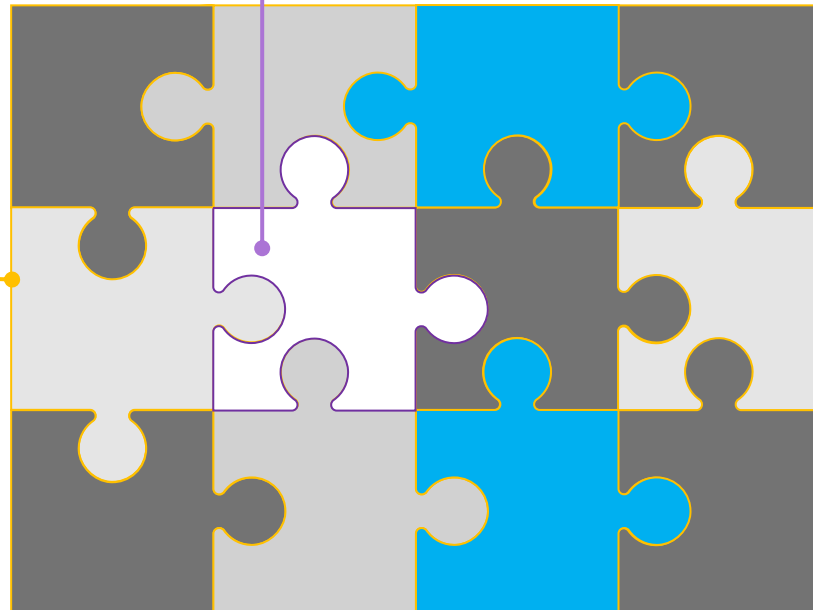


Problem

- The construction phase has so far been overlooked by the Digital Twin community;
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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 in a nutshell



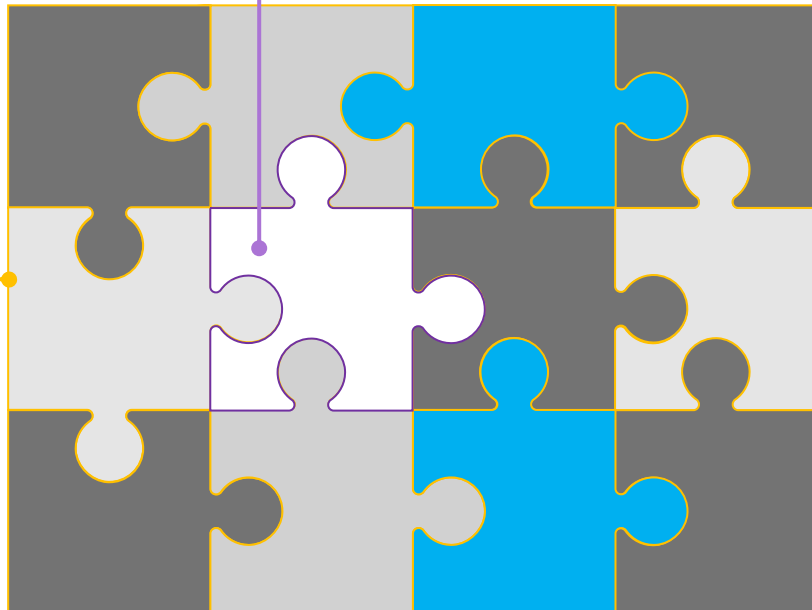
Problem

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- Automated progress and resource tracking, automated quality assessment, safety measures planning, and hazardous areas detection -> need for a COstruction-phase diGital Twin mOdel (COGITO).
- 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.

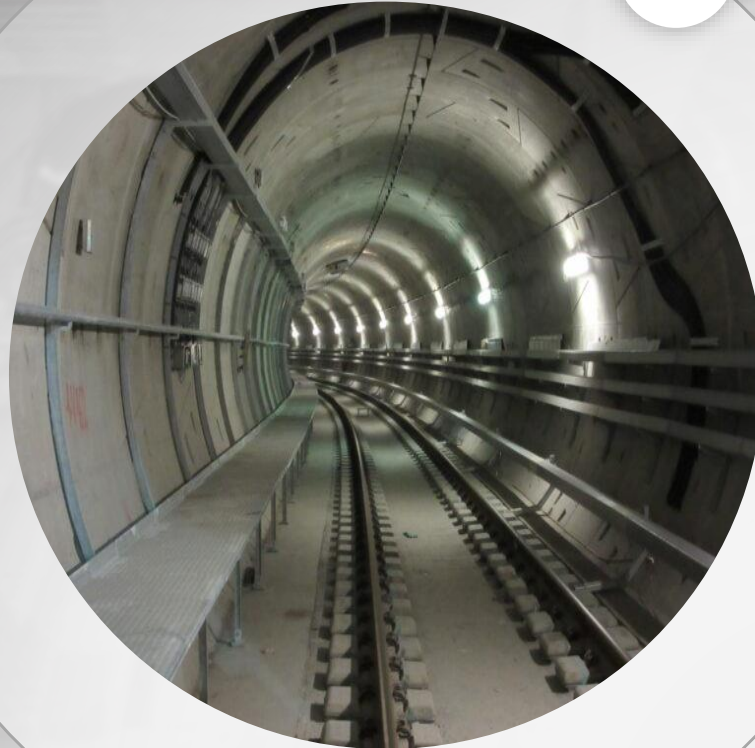
Solution



COGITO Goals

Objective 1

Delivery of a Construction
Digital Twin platform



COGITO Goals



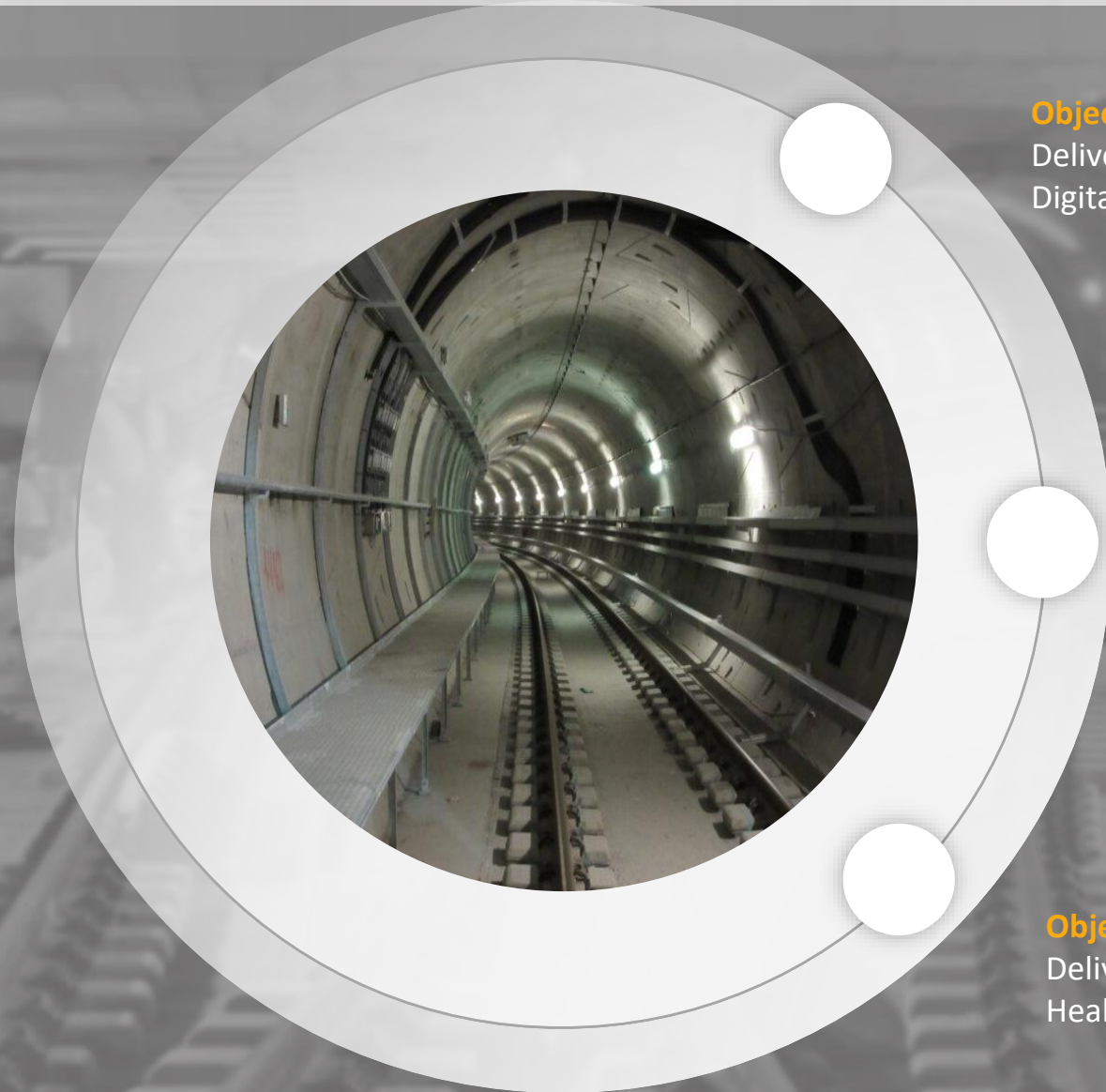
Objective 1

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

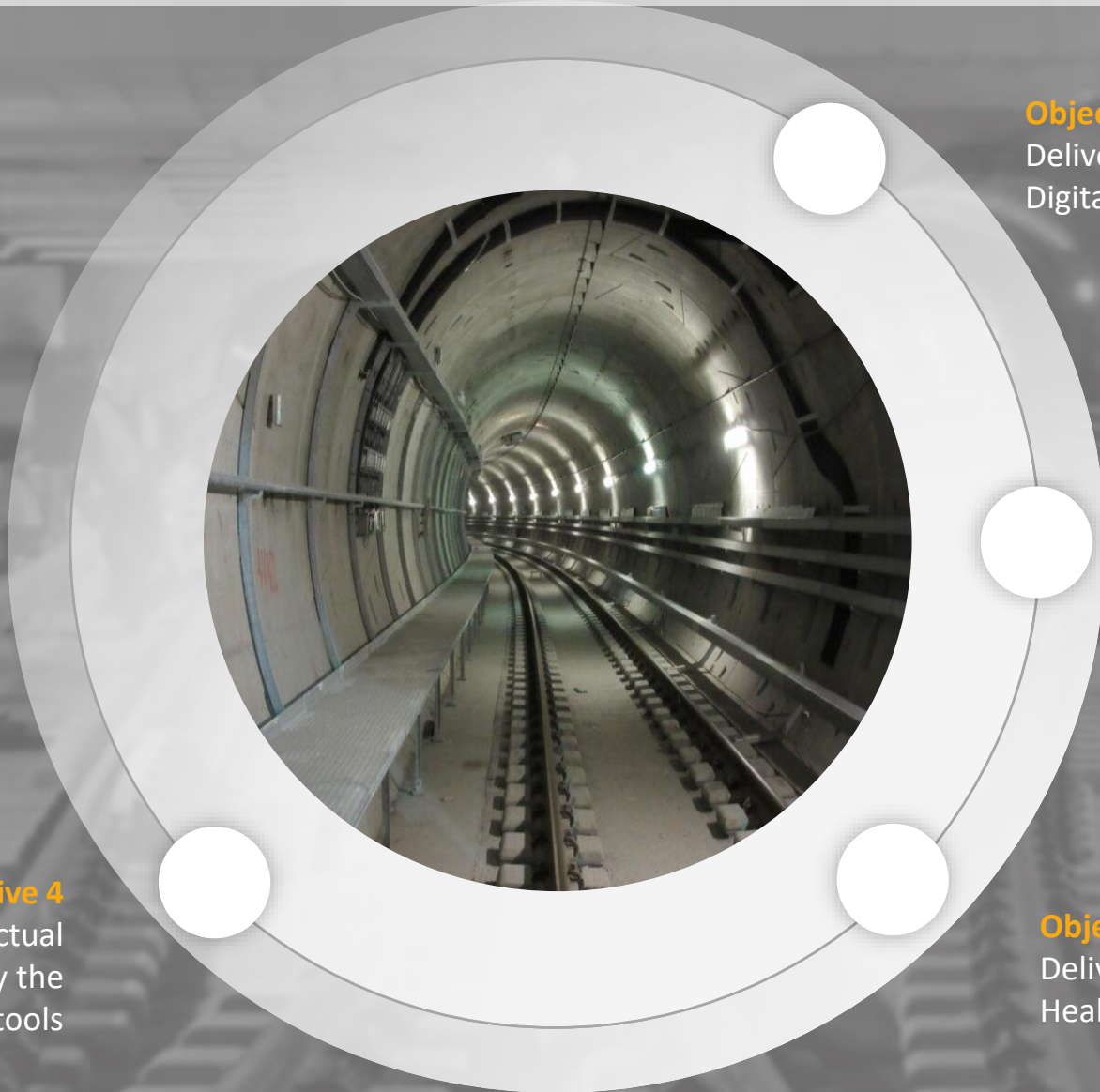
Objective 2

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

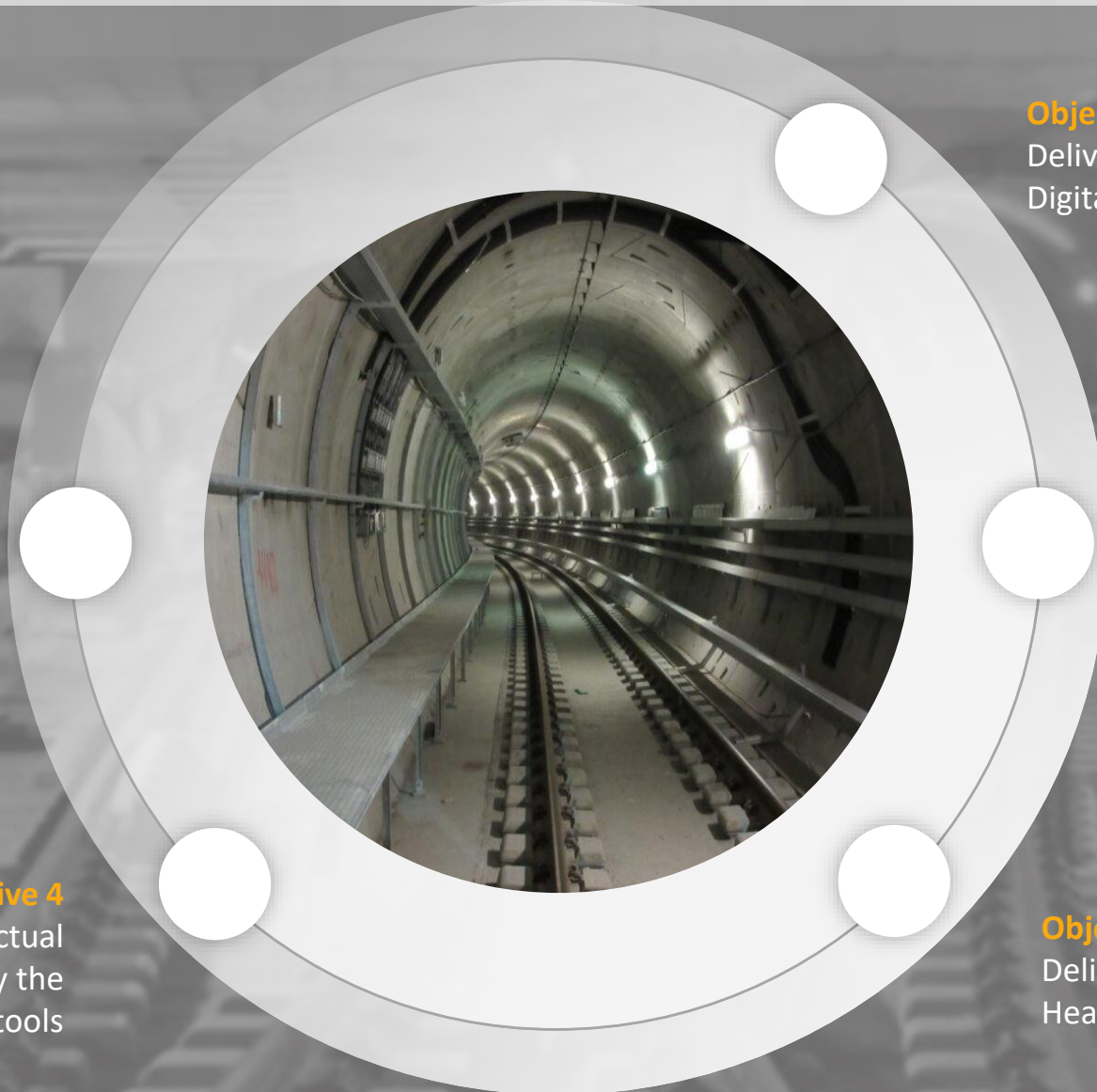
Objective 3

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 5

Research, design and promotion for standardization data exchange formats

Objective 4

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

COGITO Goals

Objective 6

Promotion of the COGITO solution's adoption through intense dissemination

Objective 1

Delivery of a Construction Digital Twin platform

Objective 5

Research, design and promotion for standardization data exchange formats

Objective 2

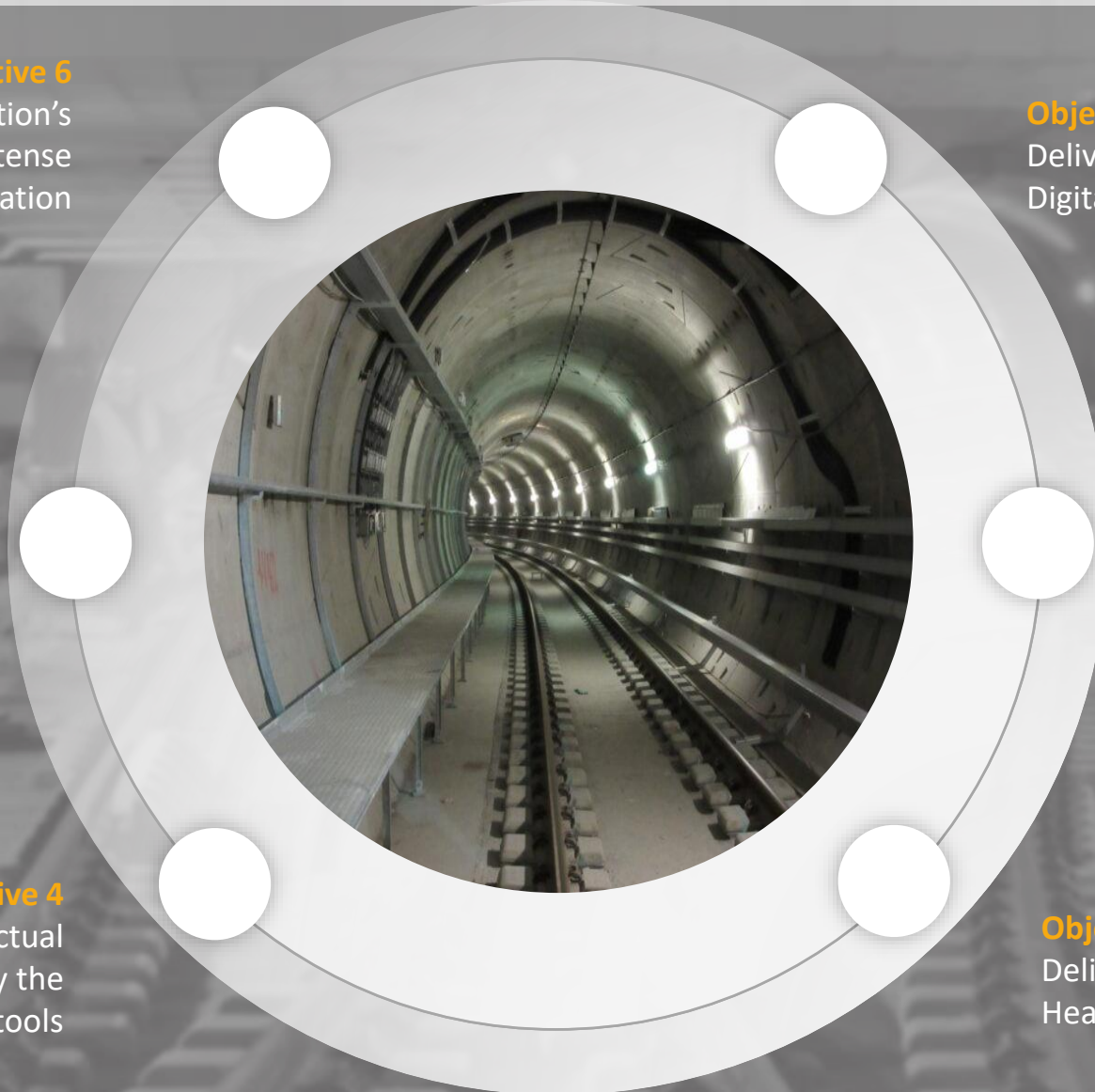
Delivery of digital tools for Quality Control and Workflow Management

Objective 4

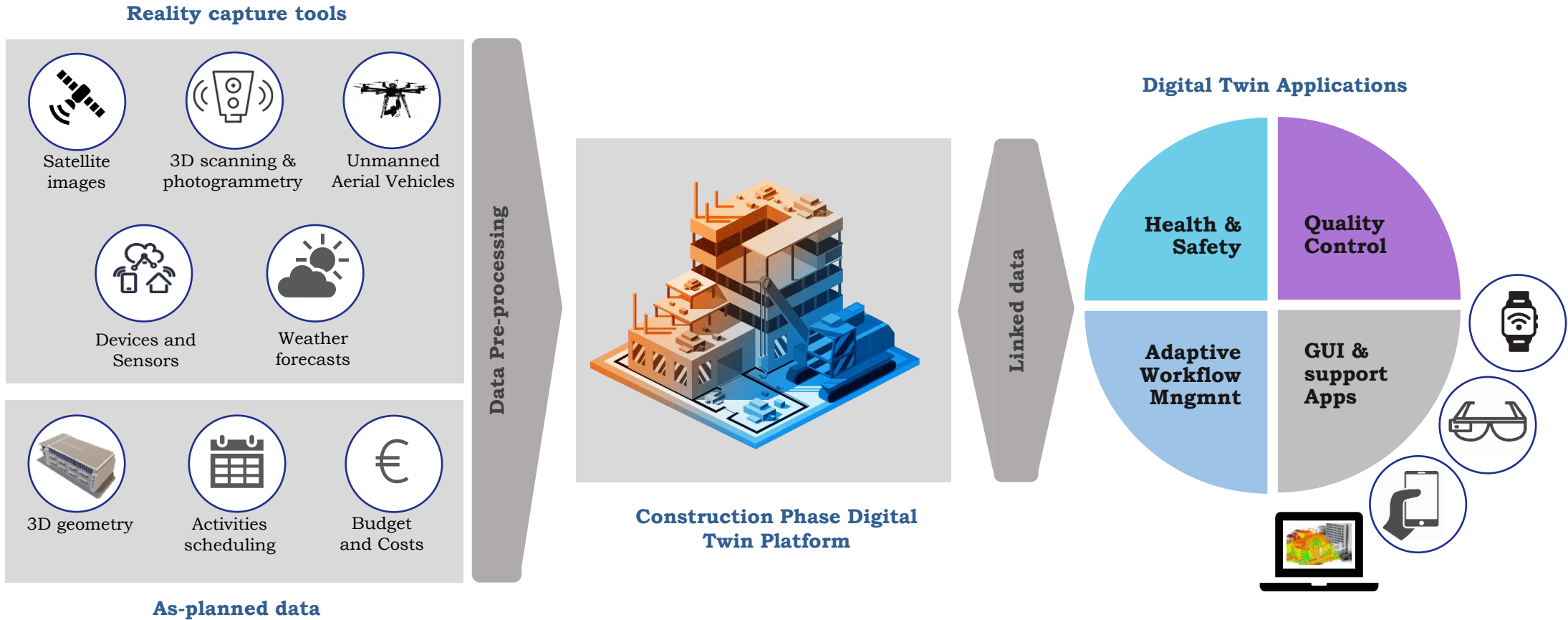
Demonstration on actual construction sites to quantify the benefits of the COGITO tools

Objective 3

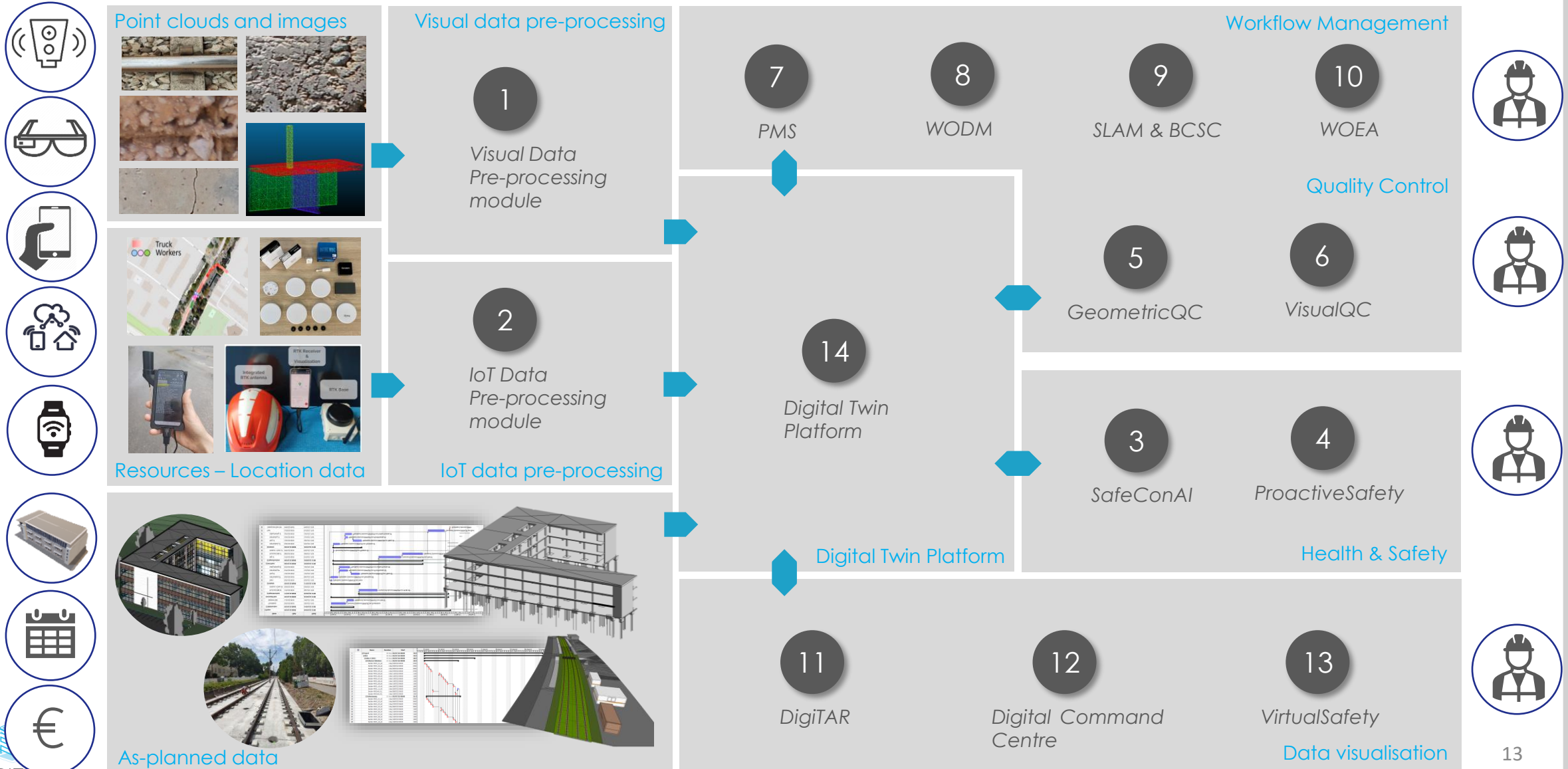
Delivery of digital tools for Health and Safety Management



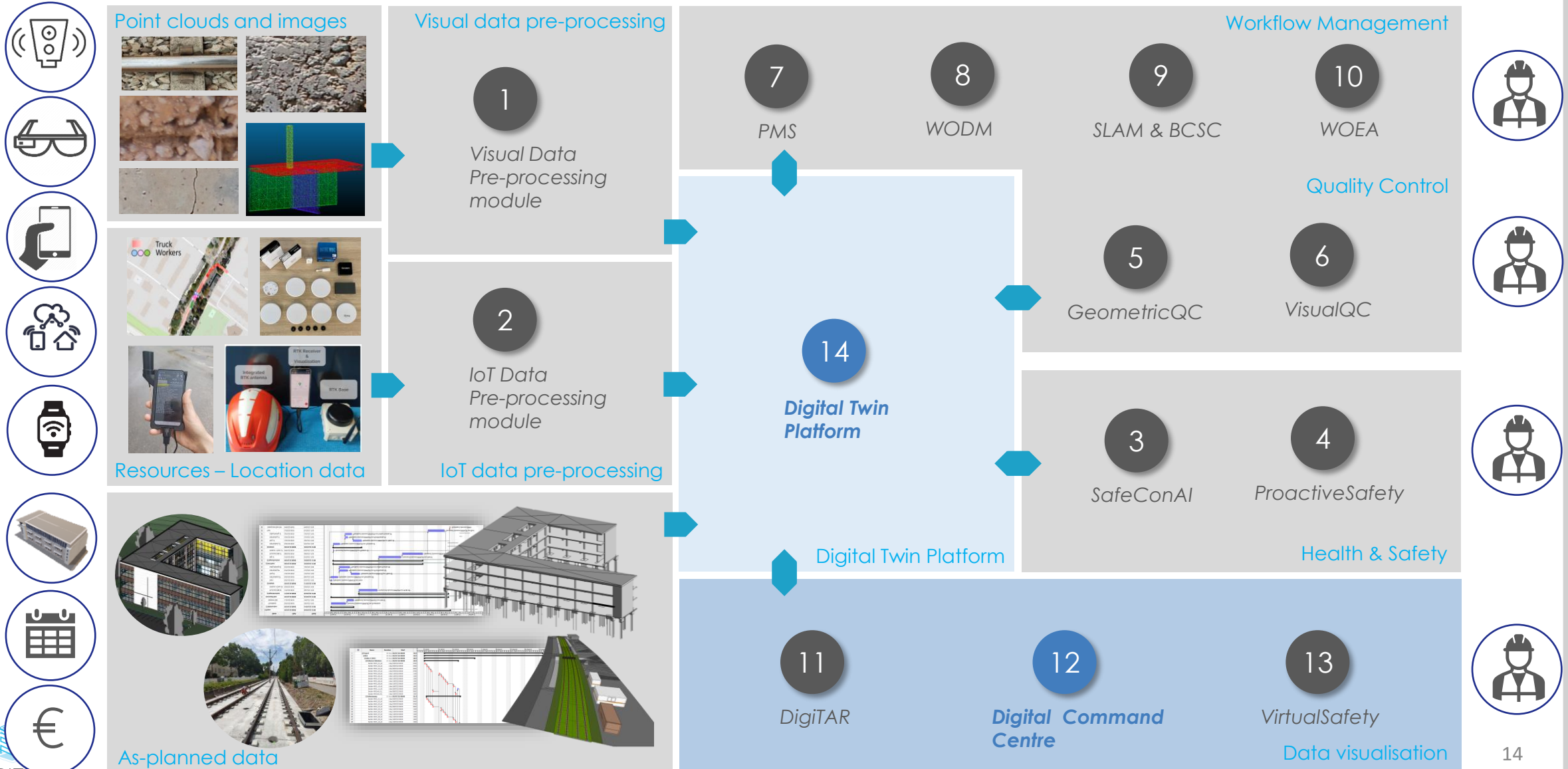
COGITO solution



COGITO technologies and services



COGITO technologies and services



Digital Twin Platform

Kyriakos Katsigarakis

University College London



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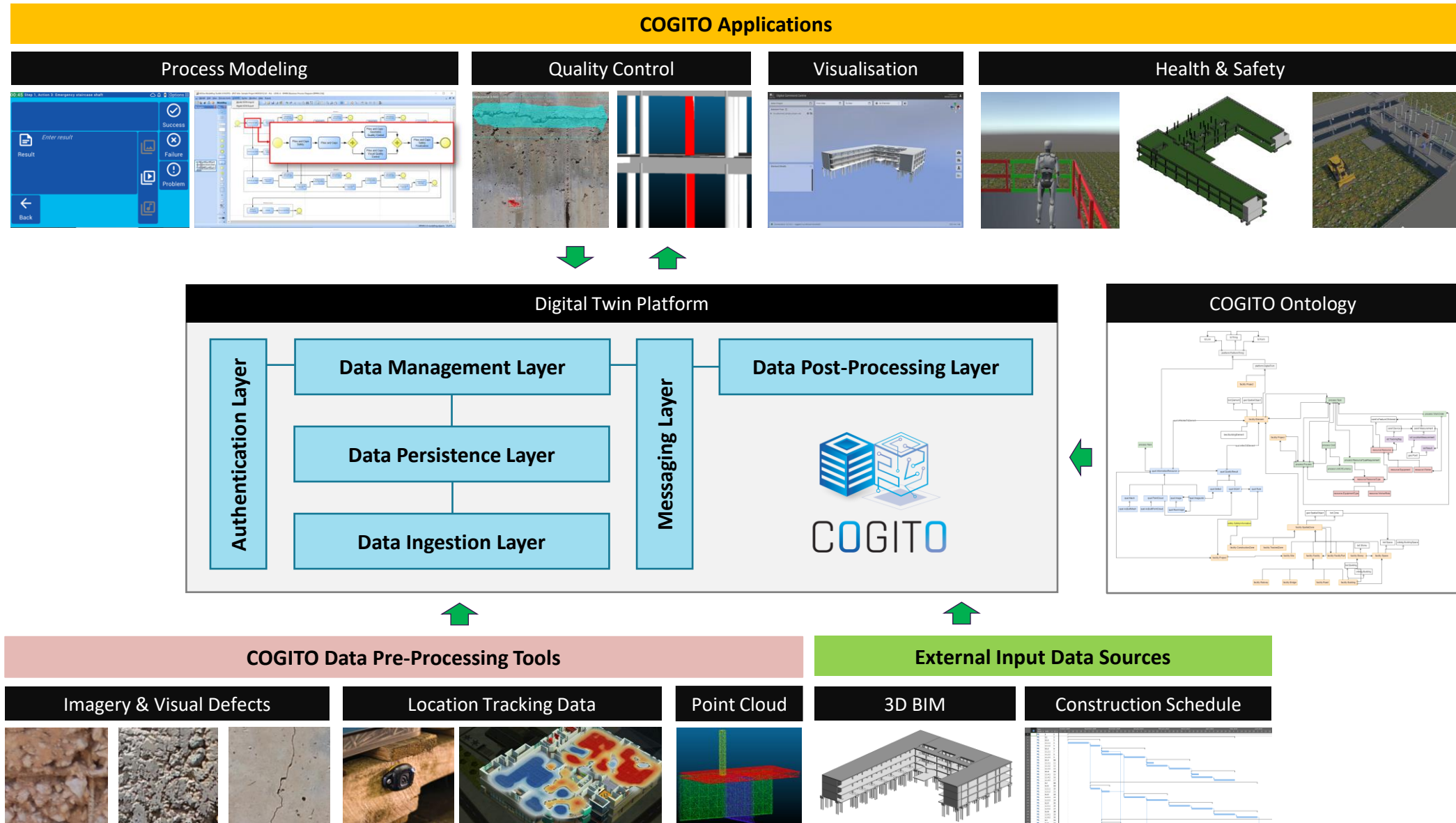
COGITO

CONSTRUCTION PHASE
DIGITAL TWIN MODEL

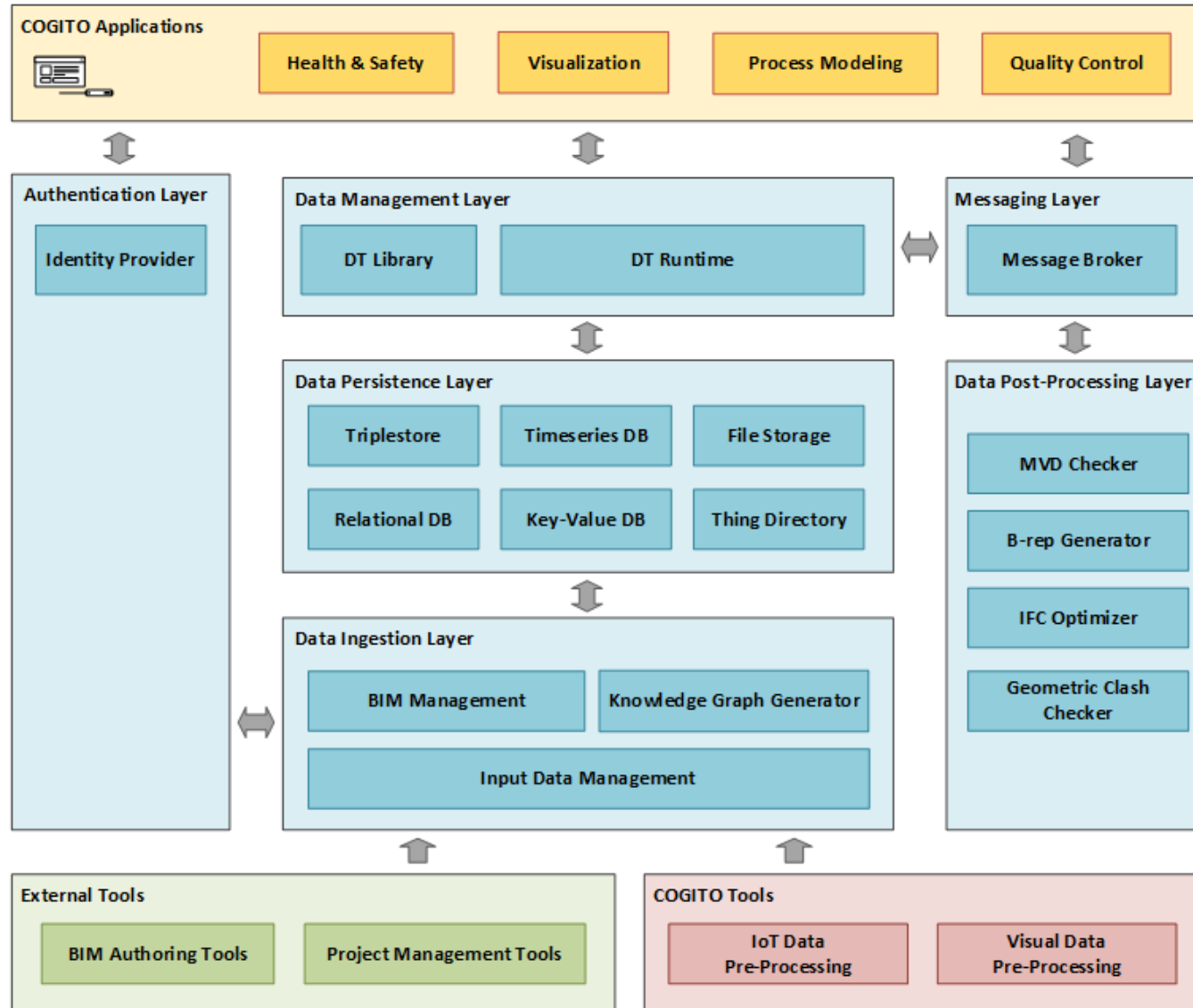
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DTP's central role in the COGITO solution



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:

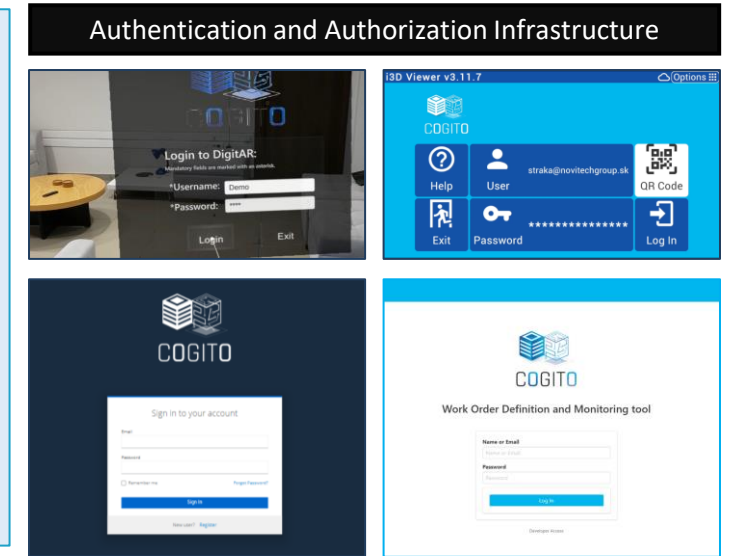
- *Message Broker*

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.



Project Creation

The screenshot shows the 'Project Creation' interface. On the left, there is a sidebar with navigation options: Modules, Projects, Users, Applications, Connections, and Settings. The main area displays a table of projects with columns for Name, Alias, Description, Creation Date, and Actions. A '+ Project' button is visible in the top right corner of the table area.

Name	Alias	Description	Creation Date	Actions
Karlsruhe	Karlsruhe	Pre-Validation Site	03/02 10:52	[edit] [delete]
Munich	Munich	Demo	08/06 19:49	[edit] [delete]
Munich Staging Area	Munich_Staging_Area	Munich Staging Area	24/10 20:50	[edit] [delete]
Murcia	Murcia	Ferrovial Project	12/10 01:22	[edit] [delete]
School	School	Demo Project	19/12 22:32	[edit] [delete]

User Management

The screenshot shows the 'User Management' interface. On the left, there is a sidebar with navigation options: Modules, Projects, Users, Applications, Connections, and Settings. The main area displays a table of users with columns for First Name, Last Name, and Email. An 'Assign User' dialog box is open, showing a search for 'Kyriakos Katsigarakis' and an 'Assign' button. A '+ User' button is visible in the top right corner of the table area.

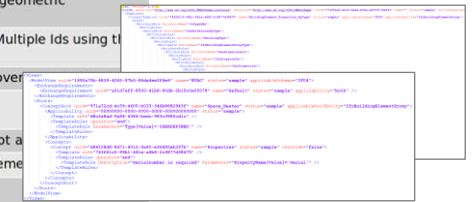
First Name	Last Name	Email	Actions
Kyriakos	Katsigarakis		[edit] [delete]
Frédéric	Bosché	f.bosche@ed.ac.uk	[edit] [delete]
Martin	Straka	straka@novitechgroup.sk	[edit] [delete]
Apostolia	Gounaridou	apostoliagounaridou@gmail.com	[edit] [delete]
Damiano	Falcioni	damiano.falcioni@boc-group.com	[edit] [delete]
Daniel	Leeb	daniel.leeb@rsrg.com	[edit] [delete]
Evangelia	Pantraki	epantrak@iti.gr	[edit] [delete]

Input Data Quality Assurance

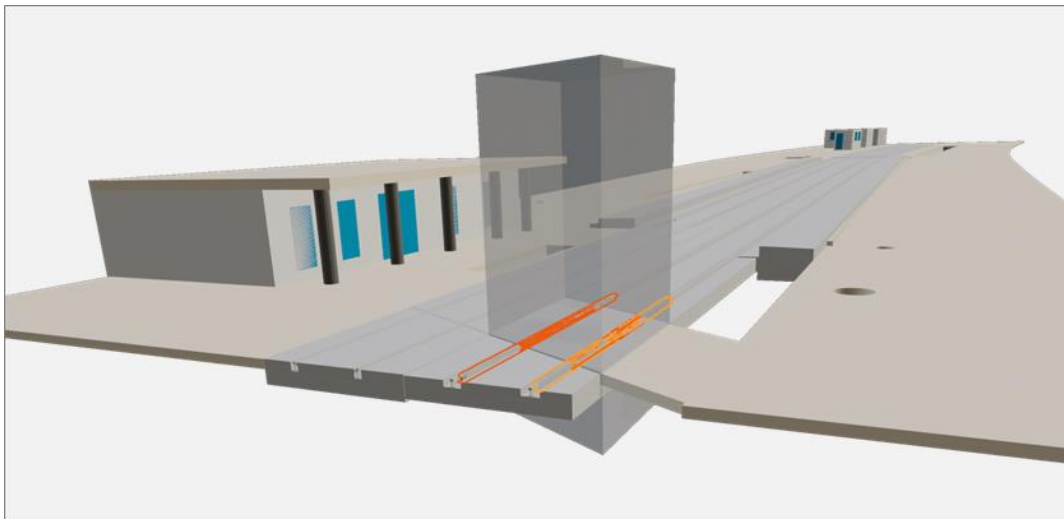
The **Geometric Clash Checker (GCC)** detect clashes among the geometric representations of construction zones and BIM elements, verifies the containment relations among these elements, and fills in missing semantics based on the verified containment relationships.

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.

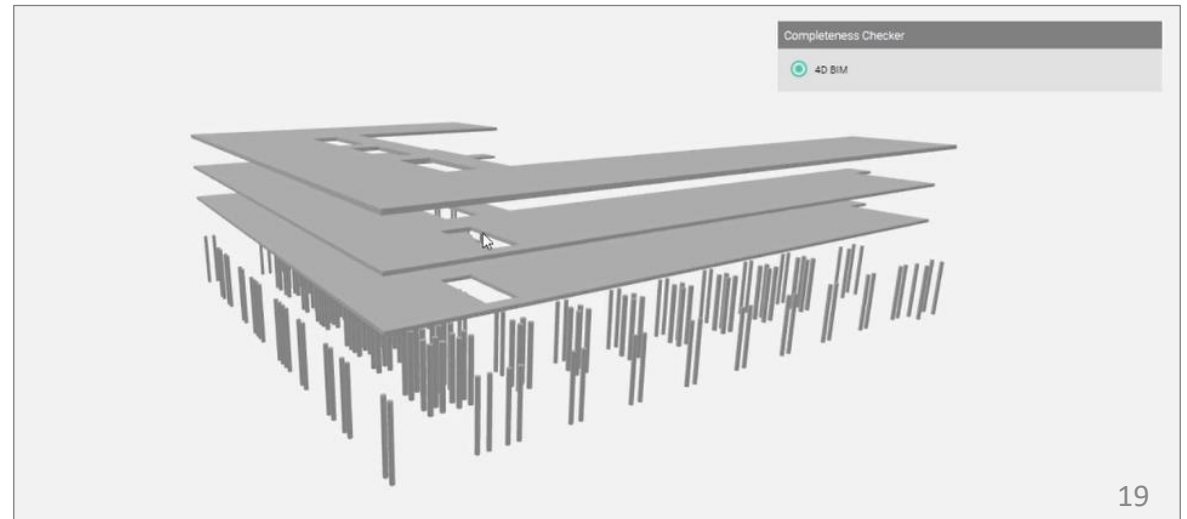
Type	Property Set	Property / Entity Name	Comment
Construction Zones	-	IfcSpatialZone	The spatial zone entity should have geometric representation.
	Construction	4D_Task_ID	Can be a list of schedule activities. Multiple ids using the ";" delimiter.
	Identity Data	COGITO_ZoneType	Construction, Fall_Hazard_Space, 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 element
	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.

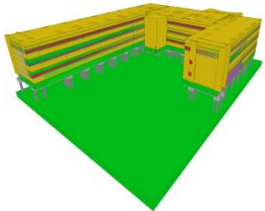
The **B-Rep Generator** produces graphics-friendly triangulated boundary representations of BIM elements for rendering purposes from their parametric and non-parametric descriptions.

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.

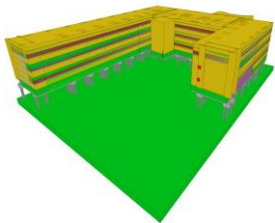
The **BIM Management** component is responsible for parsing IFC data and loading the corresponding objects into the key-value database of the Persistence Layer. It is responsible for serializing, deserializing, querying, updating, merging and splitting the IFC data.

IFC Optimiser

Original ~ 15.7MB

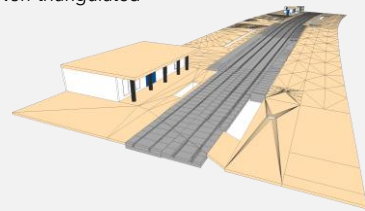


Optimised ~ 9.1MB

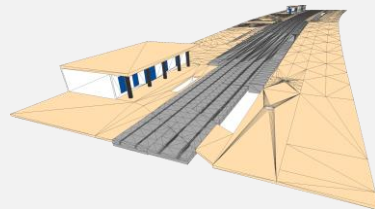


B-Rep Generator

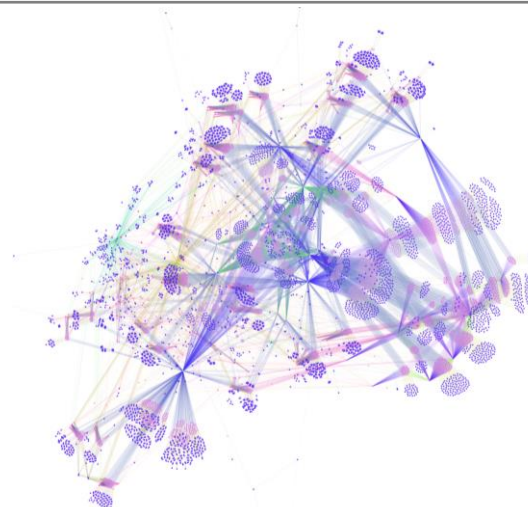
Non-triangulated



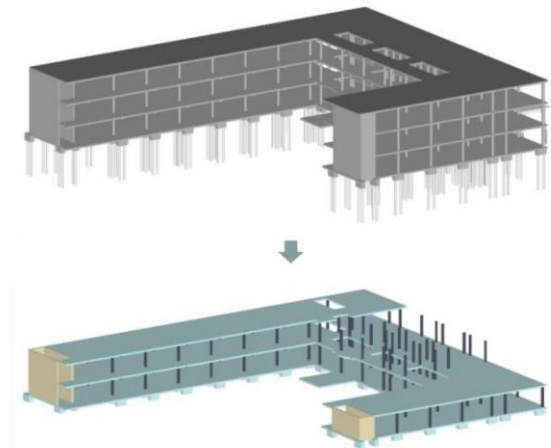
Triangulated



Knowledge Graph Generator (KGG)



BIM Management



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

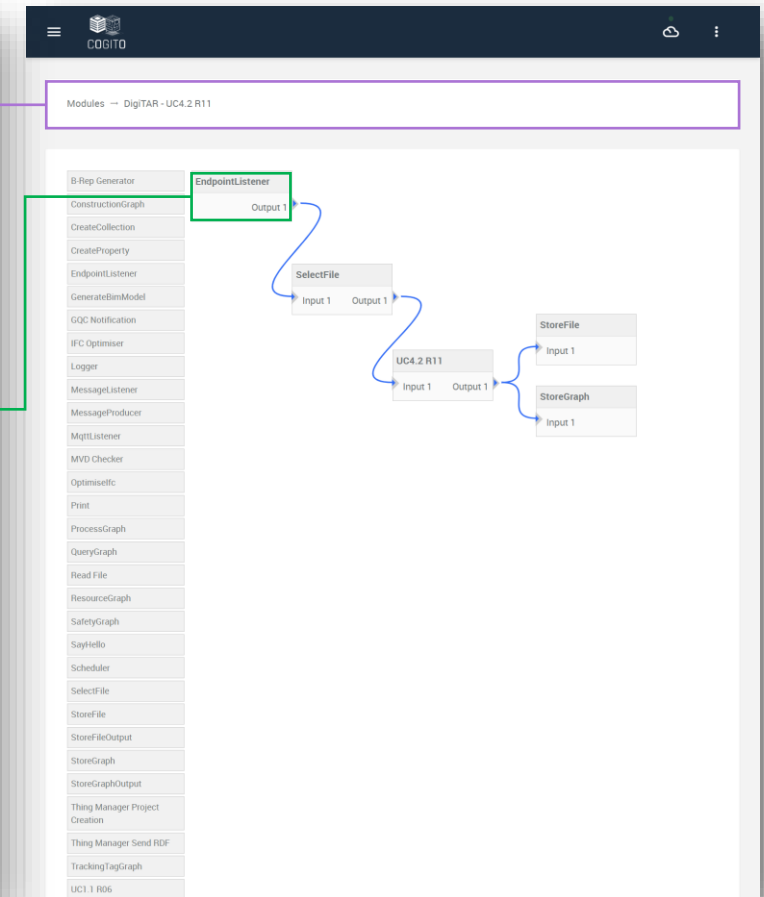
The **DT Runtime** implements the Actor-Model and is responsible for hosting various modules used for executing DTP's data processing operations. Furthermore, it ensures that the data coming from the Persistence Layer are synchronised and harmonised before being forwarded to the COGITO tools.

The screenshot shows the COGITO web interface with a list of modules. The 'Modules' section is active, displaying a table with columns for Name, Description, and Actions. A purple box highlights the 'DigITAR - UC4.2 R11' module.

Name	Description	Actions
DCC - UC4.1 R08	DTP returns the tasks	✓ ✕ ⦿
DCC - UC4.1 R10	DTP returns VQC and GQC results	✓ ✕ ⦿
DCC - UC4.1 R12	DTP returns safety data	✓ ✕ ⦿
DigITAR - UC4.2 R07b	DTP returns BIM with safety data	✓ ✕ ⦿
DigITAR - UC4.2 R07b (Geometry)	BRG returns the OBJ	✓ ✕ ⦿
DigITAR - UC4.2 R09	DTP returns QC data	✓ ✕ ⦿
DigITAR - UC4.2 R11	DTP receives QC outcomes	✓ ✕ ⦿
DigITAR - UC4.2 R19	DTP returns VQC data	✓ ✕ ⦿
DTP - IFC Snapshot Generator	Receives a date interval in JSON and generates an IFC snapshot that includes elements related to the active tasks	✓ ✕ ⦿
DTP - Knowledge Graph Generator	Receives the as-planned data and generates the knowledge graph	✓ ✕ ⦿
DTP - MVD checker	DTP checks the completeness of the IFC model	✓ ✕ ⦿
DTP - OBJ generation	DEPRECATED, DTP generates the OBJ file from the IFC	✓ ✕ ⦿
DTP - Original OBJ	Receive the original OBJ	✓ ✕ ⦿
DTP - Safe OBJ	DTP receives the safe OBJ	✓ ✕ ⦿
GQC - UC2.1 R0.2	DEPRECATED, see PMS - UC1.1 R19	✓ ✕ ⦿
GQC - UC2.1 R0.5	GeometricQC	✓ ✕ ⦿

The screenshot shows the COGITO web interface with a list of actors. The 'Actors' section is active, displaying a table with columns for Name, Class Name, Number of Inputs, Number of Outputs, and Actions. A green box highlights the 'EndpointListener' actor.

Name	Class Name	Number of Inputs	Number of Outputs	Actions
B-Rep Generator	OMActorBRG	1	1	✕
ConstructionGraph	OMActorConstructionGraph	1	1	✕
CreateCollection	OMActorCreateDataCollection	1	1	✕
CreateProperty	OMActorCreateProperty	1	0	✕
EndpointListener	OMActorEndpointListener	0	1	✕
GenerateBimModel	OMActorGenerateModel	1	1	✕
GQC Notification	OMActorUC21R20N	1	1	✕
IFC Optimiser	OMActorIFCOptimiser	1	1	✕
Logger	OMActorLogger	1	0	✕
MessageListener	OMActorChannelListener	0	1	✕
MessageProducer	OMActorChannelProducer	1	0	✕
MgttListener	OMActorMgttListener	0	1	✕
MVD Checker	OMActorMVDChecker	2	1	✕
OptimiseIfc	OMActorOptimiseIfc	1	1	✕
Print	OMActorPrint	1	0	✕
ProcessGraph	OMActorProcessGraph	1	1	✕
QueryGraph	OMActorQueryGraph	1	1	✕



Questions & Answers



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Digital Command Centre

Giorgos Giannakis

Hypertech SA



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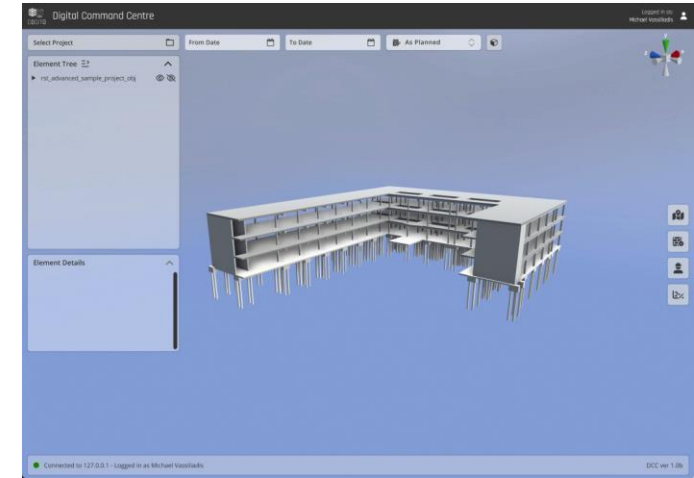
CONSTRUCTION PHASE
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Digital Command Centre - DCC





- 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:

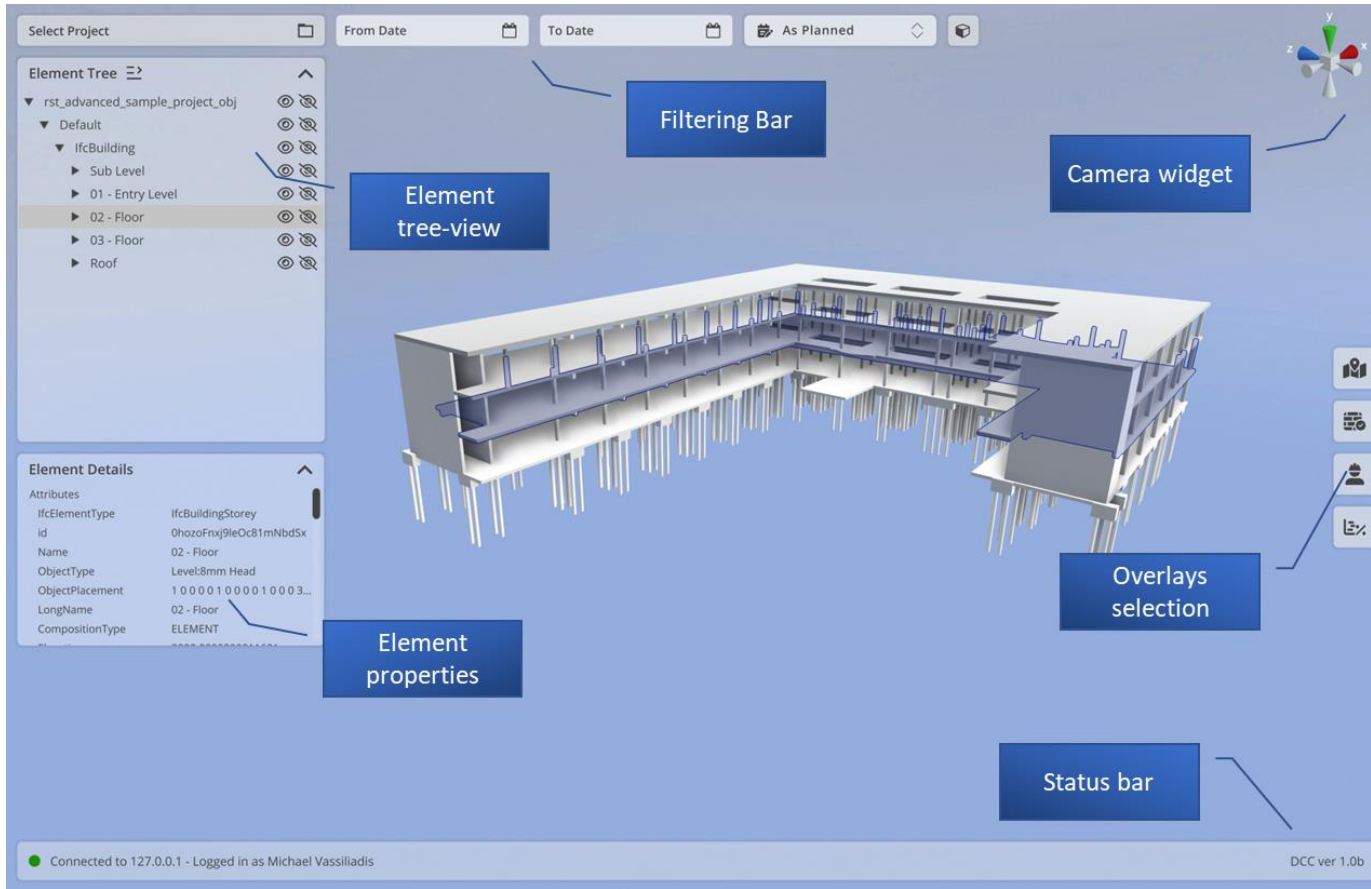
- **as-planned** 4D data
the geometrical representation
filtered by the work execution time schedule
- **as-built** data
what has actually been constructed/implemented
in a particular time frame

Visual overlays to report on:

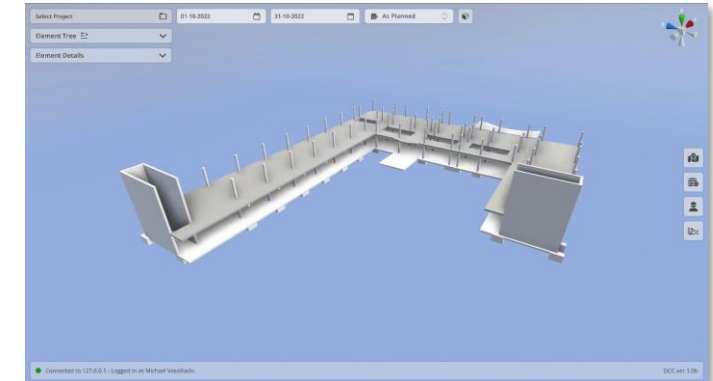
- the accomplished **work progress** 
- the potential **health and safety issues or hazards** 
- the **quality of the work** performed 
- location/**IoT data** 

DCC in a nutshell

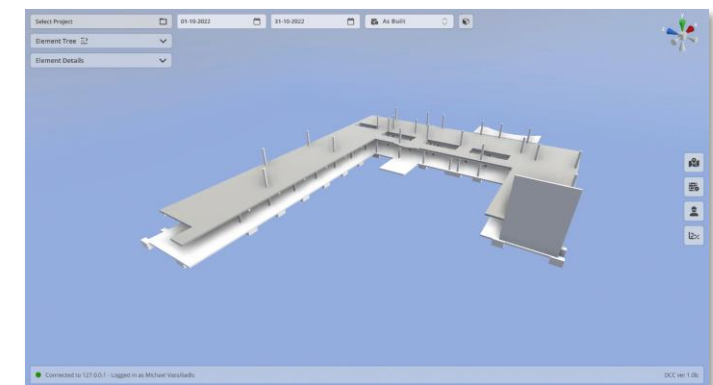
- UI overview:



As-planned filtering:

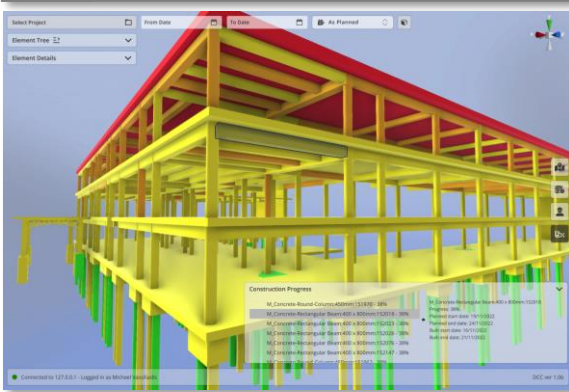


As-built filtering:

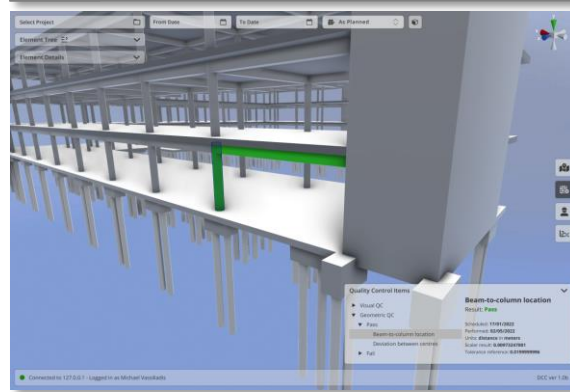


DCC in a nutshell

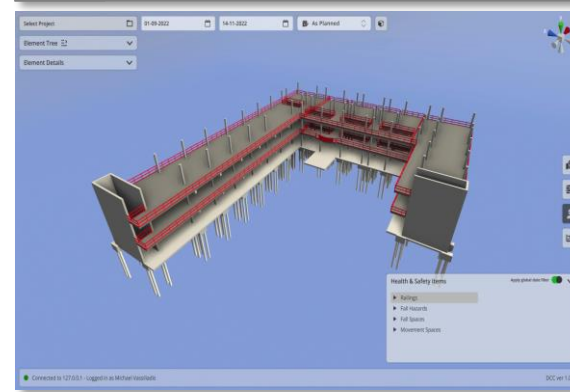
WODM overlay



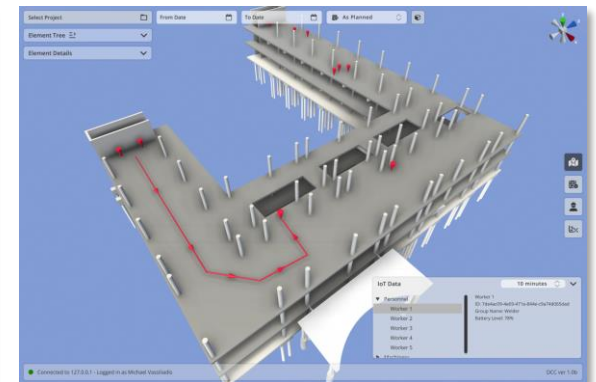
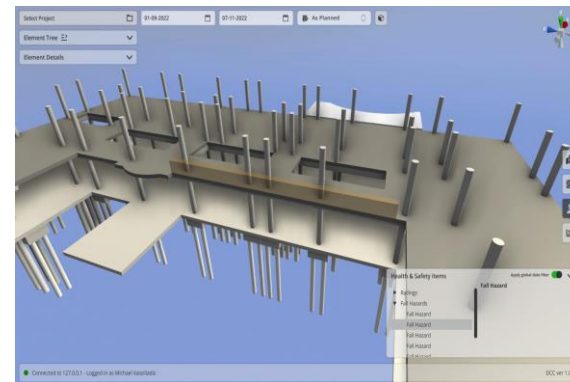
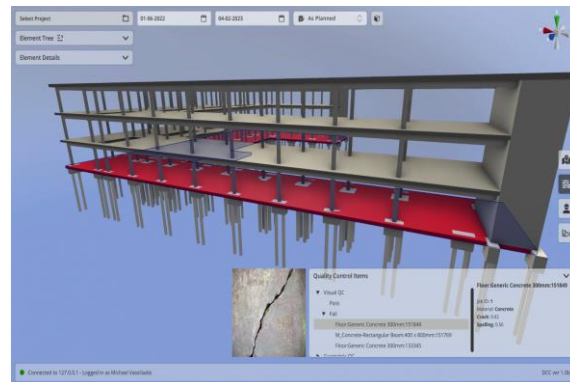
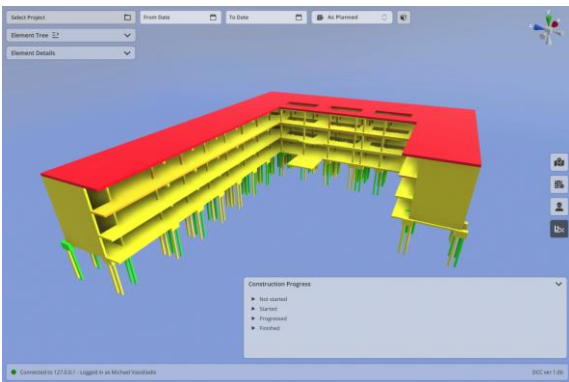
QC overlay



HSE overlay



IoT overlay



Questions & Answers



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Thank you!

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