



# MINISTÈRE CHARGÉ DES TRANSPORTS

*Liberté  
Égalité  
Fraternité*



## ITA COSUF WORKSHOP DIGITALIZATION OF TUNNELS



**ITA COSUF**  
Operational Safety of  
Underground Facilities



**MINISTÈRE  
CHARGÉ  
DES TRANSPORTS**

*Liberté  
Égalité  
Fraternité*



# **DIGITALIZATION OF TUNNELS TOWARDS BIM-BASED OPERATION AND MAINTENANCE**

## **BIM IN TUNNELLING - WHERE WE ARE AT?**

**Dr Florent ROBERT, CETU, France**

06/12/2023

# What is BIM?

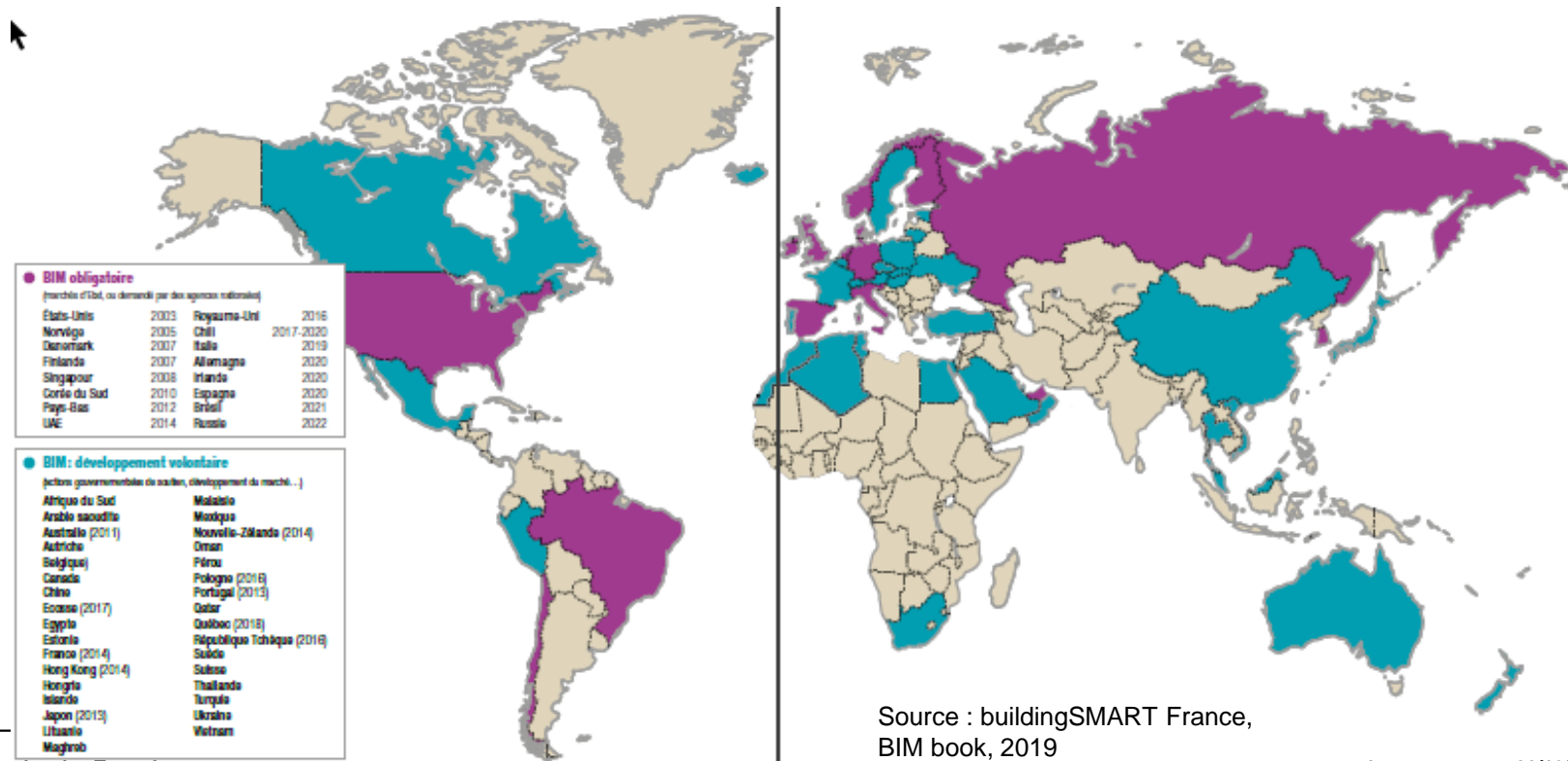
BIM is the “use of a shared digital representation of a built asset to facilitate design, construction and operation processes to form a reliable basis for decisions”

ISO 19650-1, December 2018

BIM = digital model + cooperative method + data base

BIM = one single source of truth

# Is BIM compulsory worldwide?



Source : buildingSMART France,  
BIM book, 2019

# BIM in ITA-AITES

2017: creation of WG22 about BIM in Tunnelling

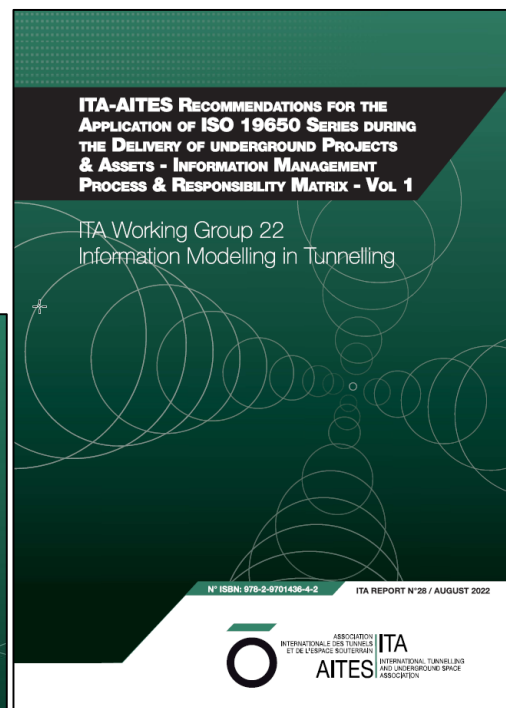
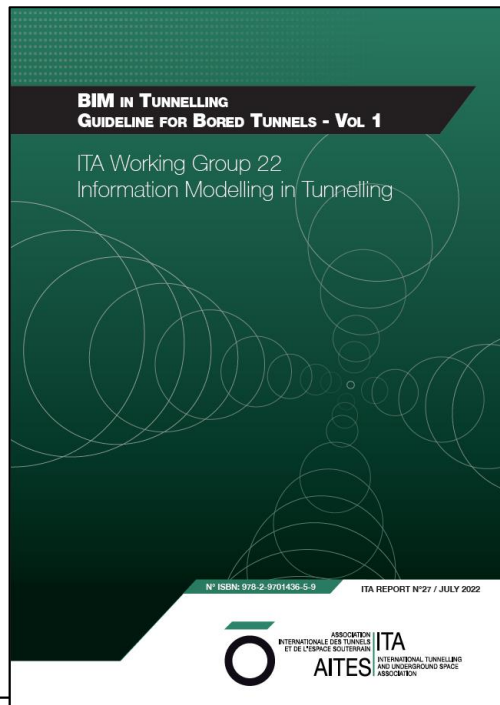
Animateur : F. Robert since 2022 (J. Karlovsek before)

Vice-animateur : A. Menozzi since 2022

2 guides published in 2022

1 guide being drafted about Sustainability

Extension to conventional tunnelling and mining sector in progress



# BuildingSMART International

2019: launch of the IFC Tunnels project

Implementation in progress

3 subgroups (Geotech, Excavation, Systems)

1 Requirements analysis report

Development of property sets

IFC Tunnels available in release IFC 4.4



## IFC-Tunnel Project

Report WP2: Requirements analysis report (RAR)

Status: v1.0 - 2020-07-31

Michel Rives (F-VIANOVA France, Project Mgr), André Borrmann (D-TUM, Technical Lead),  
Abdullah Alsaahy (D-RUB), Heiko Atzbacher (CH-SBB/ILF), Gabriele Brino (I-GEODATA),  
Arianna Bucci (I-GEODATA), Jure Cesnik (SLO-ELEA IC), Federica Danise (I-GEODATA),  
Natalya Dias (F-ANDRA), Jonathan Dunn (CH-SBB/ILF), Jan Erik Hoel (N-TRIMBLE), Rie Kudoh-Wada (JPN-OYO),  
Greta Lucibello (I-GEODATA), Shoichi Nishiyama (I-OYO), Reza Rangszar Osgoui (I-GEODATA),  
Florent Robert (F-CETU), Federica Sandrone (CH-SBB), Andrew Shell (FIN-RAMBOLL), Hiromasa Shima (I-OYO),  
Stefania Stefanizi (I-GEODATA), Magdalena Stelzer (CH-AMBERG), Frederikke Syversen (N-CITY OSLO),  
Jan-Christian Thoren (S-TRAFIKVERKET), Mirko Vendramini (I-GEODATA), Simone Villa (I-GEODATA),  
Götz Vollmann (D-RUB), André Vonthron (D-RUB), Jonas Weil (ELEA IC), Hichem Zammit (I-GEODATA),  
Nan Zhu (CH-AMBERG).



# IfcTunnel – Stakeholders 2020-2023

## Infrastructures owners :

- ANDRA (F)
- CFF-SBB (CH)
- TVK (S) / FTIA (FIN)

## 3x Domain experts Teams

- bSI Ifc experts Team
- $\Sigma = 55+$  pax (in-kind 1.5m€)

## Collaboration with international

### associations:

- ITA – Modelling in tunnelling
- IAEG – Modelling in engineering geology
- OGC/ISSMGE – OpenGIS Consortium

## Geotechs, C.E. & systems engineers :

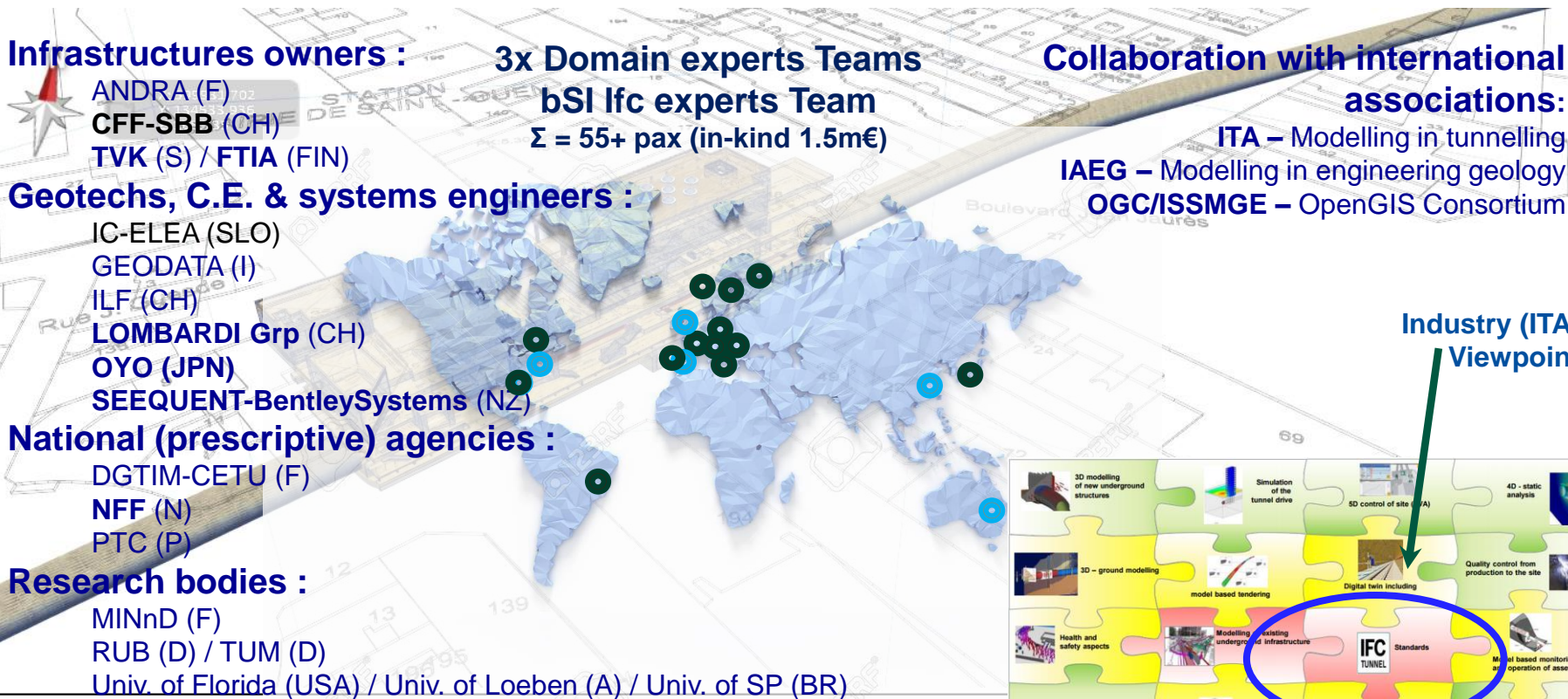
- IC-ELEA (SLO)
- GEODATA (I)
- ILF (CH)
- LOMBARDI Grp (CH)
- OYO (JPN)
- SEQUENT-BentleySystems (NZ)

## National (prescriptive) agencies :

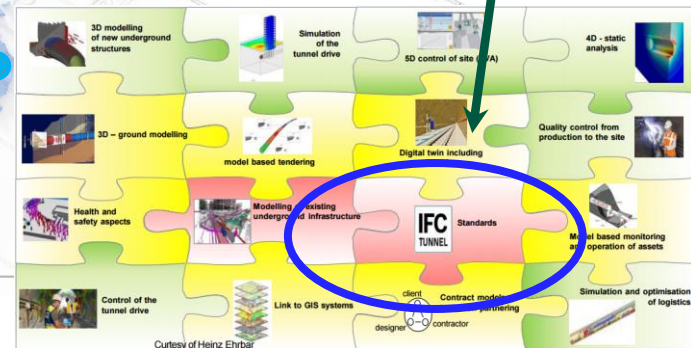
- DGTIM-CETU (F)
- NFF (N)
- PTC (P)

## Research bodies :

- MINnD (F)
- RUB (D) / TUM (D)
- Univ. of Florida (USA) / Univ. of Loeben (A) / Univ. of SP (BR)



## Industry (ITA) Viewpoint



# At European level

EUTF Steering Committee  
dedicated to BIM since 2021

5 meetings/year

A forum for exchanging best  
practices and sharing national  
practices, but not for developing  
doctrine

Chair : R. Galler

Animation: F. Robert

## European Underground & Tunnel Forum



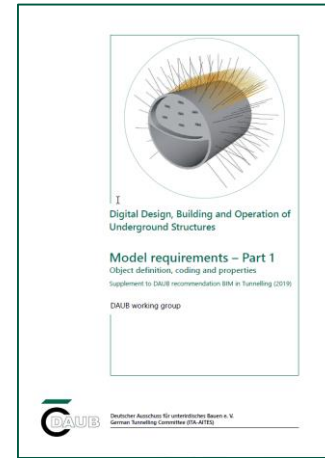
Austria • Belgium • France  
Germany • Italy • Portugal  
Netherlands • Spain • Switzerland



# At country level (non-exhaustive)

Germany:

DAUB published 6 guidelines



France:

MINnD research project - > IFC

AFTES is up to publish 1 guideline



# CETU's experiment

Is BIM relevant for:

- designing a new tunnel?
- supervising its construction?
- monitoring and maintaining an existing tunnel?
- operating an existing tunnel?

# CETU's experiment

Is BIM relevant for:

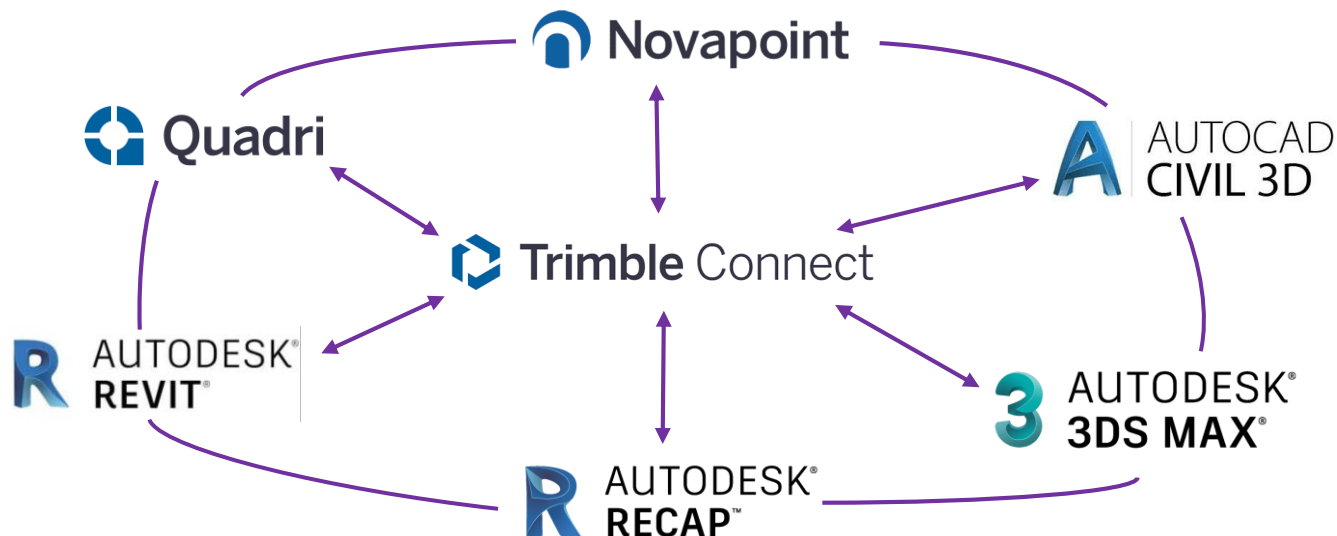
- designing a new tunnel?
- supervising its construction?
- monitoring and maintaining an existing tunnel?
- operating an existing tunnel?

Oloron tunnel

Butte d'Osse tunnel

# CETU's experiment

Collaboration with Vianova Systems France (BIM Modelers and Managers)



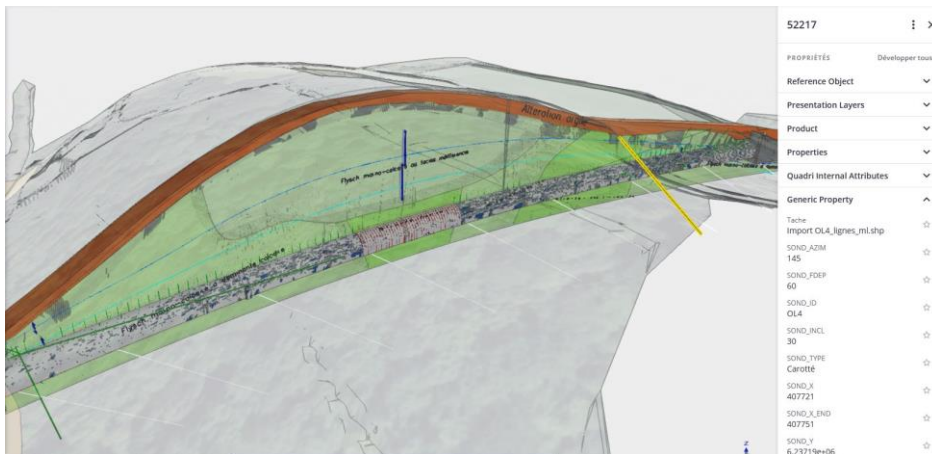
# Design of a new project

## Geotechnics

2D longitudinal profile filling the digital terrain model

Position of the various site investigations with attributes

Geotechnical homogeneous zones and uncertainties under the form of strips with attributes



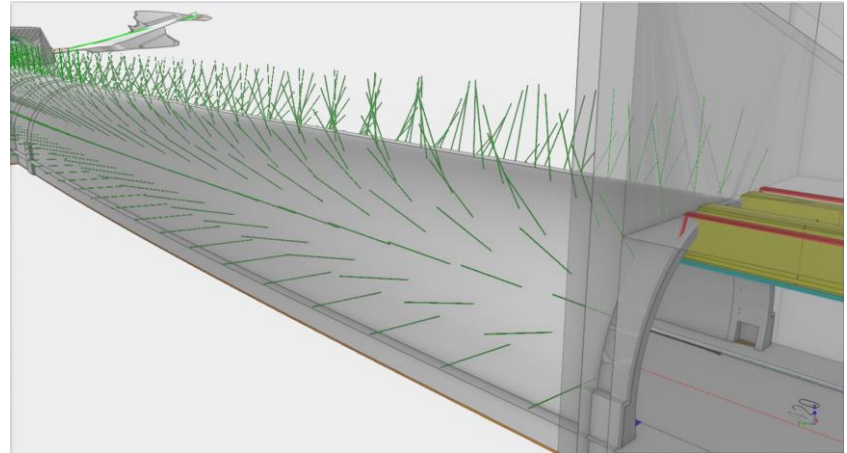
✗ No clear benefit compared with a classical representation

✓ IFC 4.4 should improve the representation

# Design of a new project

Excavation and support classes:

- support
- waterproofing
- lining
- recesses
- portals

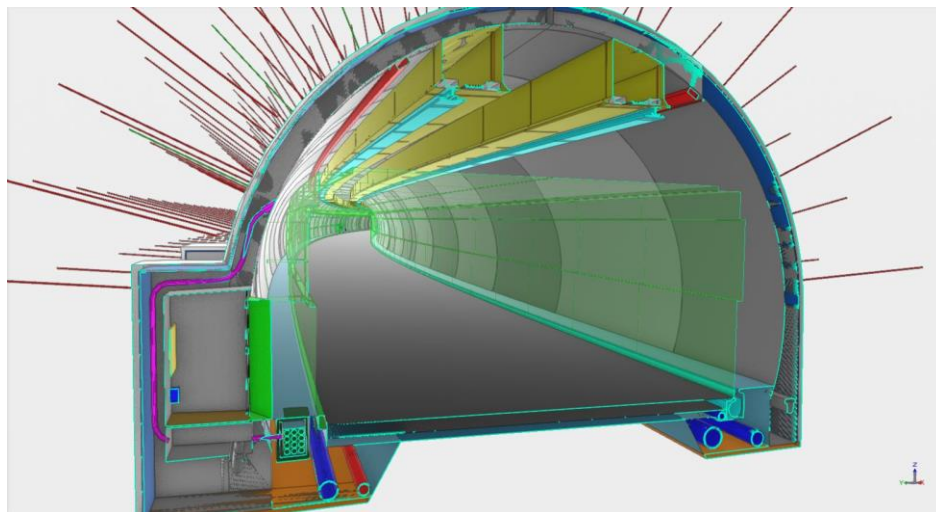


- ✓ Exhaustive representation
- ✗ Falsely precise information

# Design of a new project

## Systems and clearances

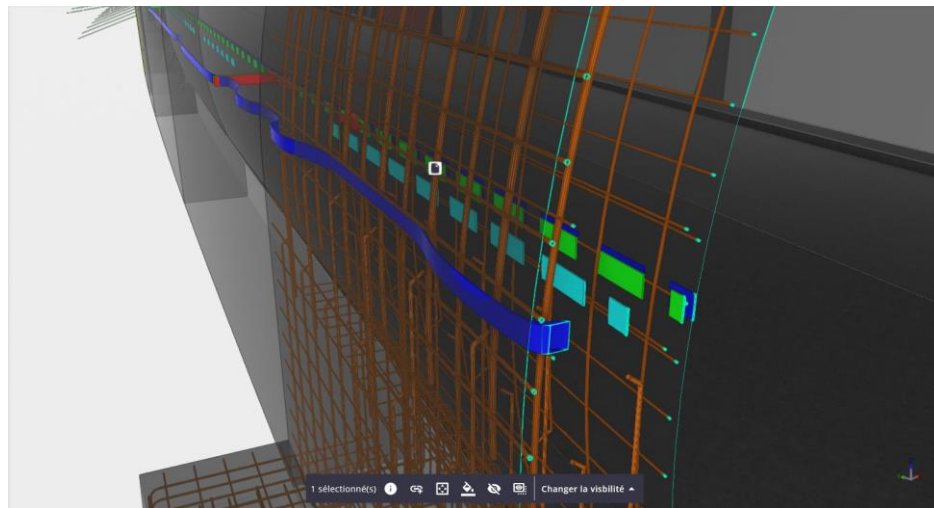
- BIM is well suited to represent equipment
- Representation of the clearances for circulation and systems protection
- Potential benefits for visibility assessment?



- ✓ Automatic clash detection
- ✓ Representation of complex sections
- ✓ Interface civil eng./systems

# Tunnel in operation

- Level of detail and accuracy of the representation
  - Possible to represent any element with a high level of details
- > user's needs?
- > can be resource-consuming!
  - How to represent non-reliable data?





# Tunnel in operation

Comparison of 3D models from as-built records and a points cloud generated via a laser scan

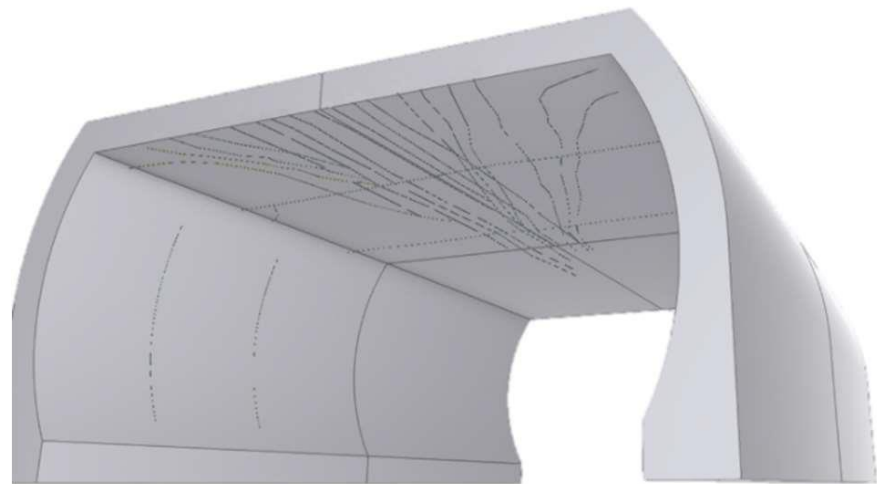


# Tunnel in operation

## Civil engineering inspection results

- ✗ Complex representation of defects (done manually)
- ✗ Dimensions of defects not representative of the reality
- ✗ Difficult comparison of the evolution of a defect (different IDs)

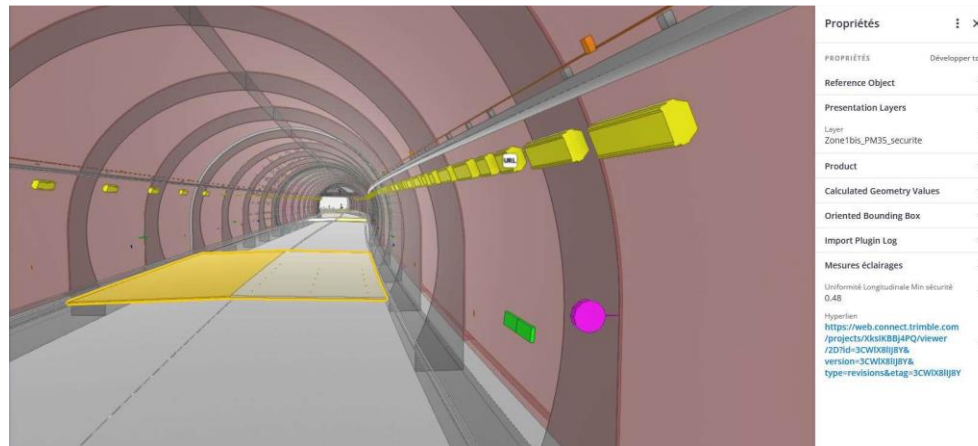
=> No clear benefit yet



# Tunnel in operation

## Equipment inspection results

- Representation of real and fictive systems
- Extraction of a simplified description of the installations
- Possibilities of embedding the data into an mobile app
- Capitalization of the inspection results in the attributes
- How to store data relative to several elements?

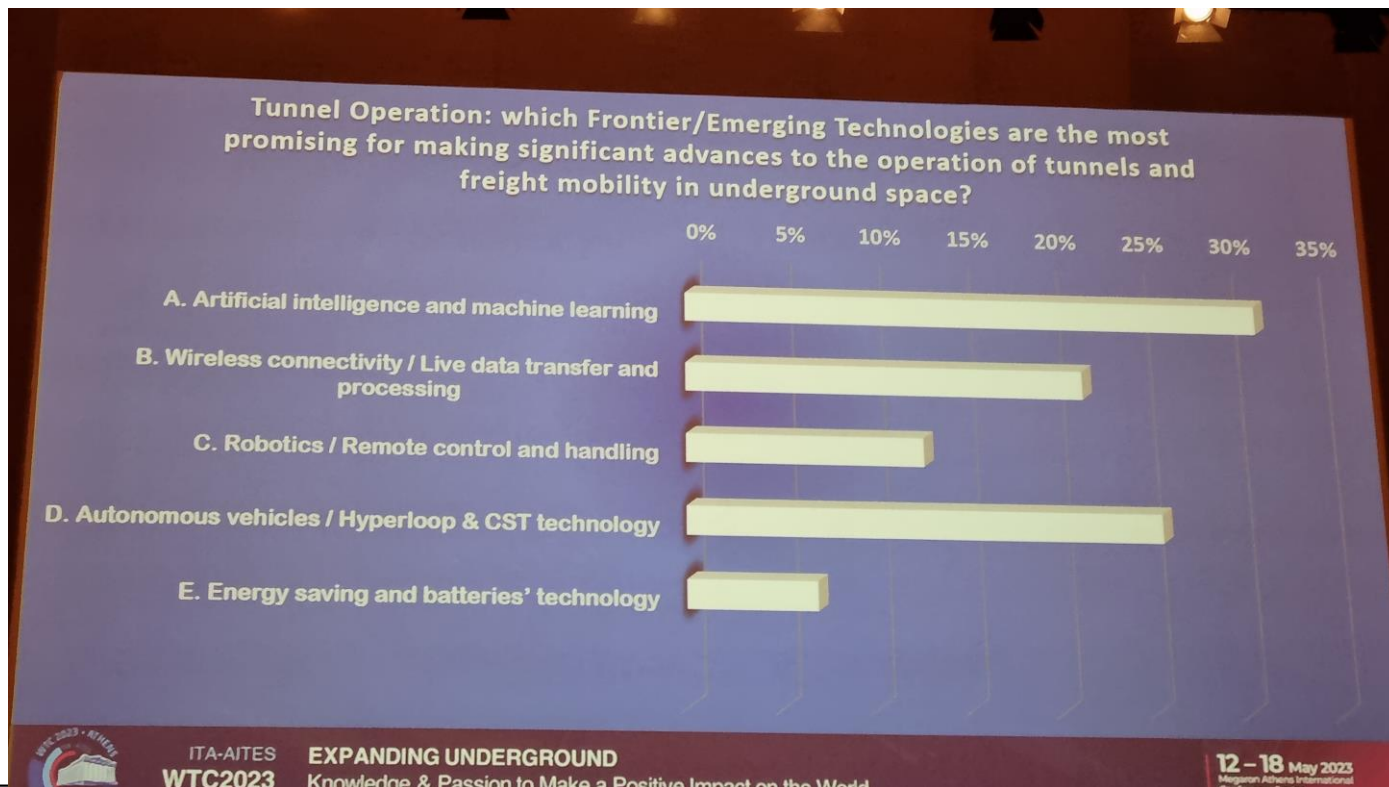


- ✓ Benefits for equipment inspection:
  - ✓ from the model to the tunnel: preparation of inspections
  - ✓ from the tunnel to the model: quantitative exploitation of inspection results

# Challenges

- Convincing owners of the added value of BIM in spite of the initial investment
- Dealing with asset management issues (digitisation of existing built and natural assets, optimisation of operation, etc.) with a view to its digital twin
- Moving from Project Information Model (PIM) to Asset Information Model (AIM)
- Reducing the environmental footprint of projects
- Providing project owners with the tools/methods to express their requirements in terms of BIM: management of the internal approach and projects, hosting of EDM data - collaborative BIM platform, expectations in terms of Quality Assurance via BIM by project managers and contractors, etc.
- Accelerating pragmatic uses, federating uses

# Perspectives for operation



# Thank you for your attention



WG22 – WTC 2023 – Athens