4 CONFERENZA NAZIONALE

31 MARZO
1 APRILE
2021
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BIM e l'evoluzione digitale nell'industria delle costruzioni

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IFC Tunnel: uno standard internazionale come guida all'approccio Open BIM aziendale

G.Brino – G.Lucibello

Geodata Engineering

Gabriele Brino_Geotechnical and Tunnel Design Engineer

He has been responsible as head of a design team for the development of infrastructural projects, most of all tunnels excavated in mechanized and conventional methods in different countries. He is interested in the development of the BIM methodology in tunnelling and within Geodata company, according to international standards and recommendations.

Greta Lucibello_BIM Coordinator

She coordinates the development of BIM infrastructural projects, starting from the definition of standards up to the application of the methodology in the different phases of the project.

From 2020, they represent Geodata within the IFC Tunnel group, one of the Infrastructure Room of buildingSMART International.

IFC TUNNEL: The team

Geotechs, C.E. & systems engineers:

GEODATA
ILF CONSULTING ENGINEERS
OYO oyo corporation
iC consulenten
SEEQUENT

Infrastructures owners:

TRAFIKVERKET
SBB CFF FFS
ANDRA

National (prescriptive) agencies:

NORWEGIAN TUNNELLING SOCIETY
CETU

Research bodies:

RUHR UNIVERSITÄT BOCHUM
RUB
Technische Universität München

LOADING

IFC TUNNEL: Planning

Phase 1: Requirements

Scope:

- Geopositioning & geometries
- Soil/rock conditions
- Construction methods
- Systems serving the function

Uses cases (30u)

Requirements refinement (v2)

Phase 2: Specifications (4.3+)

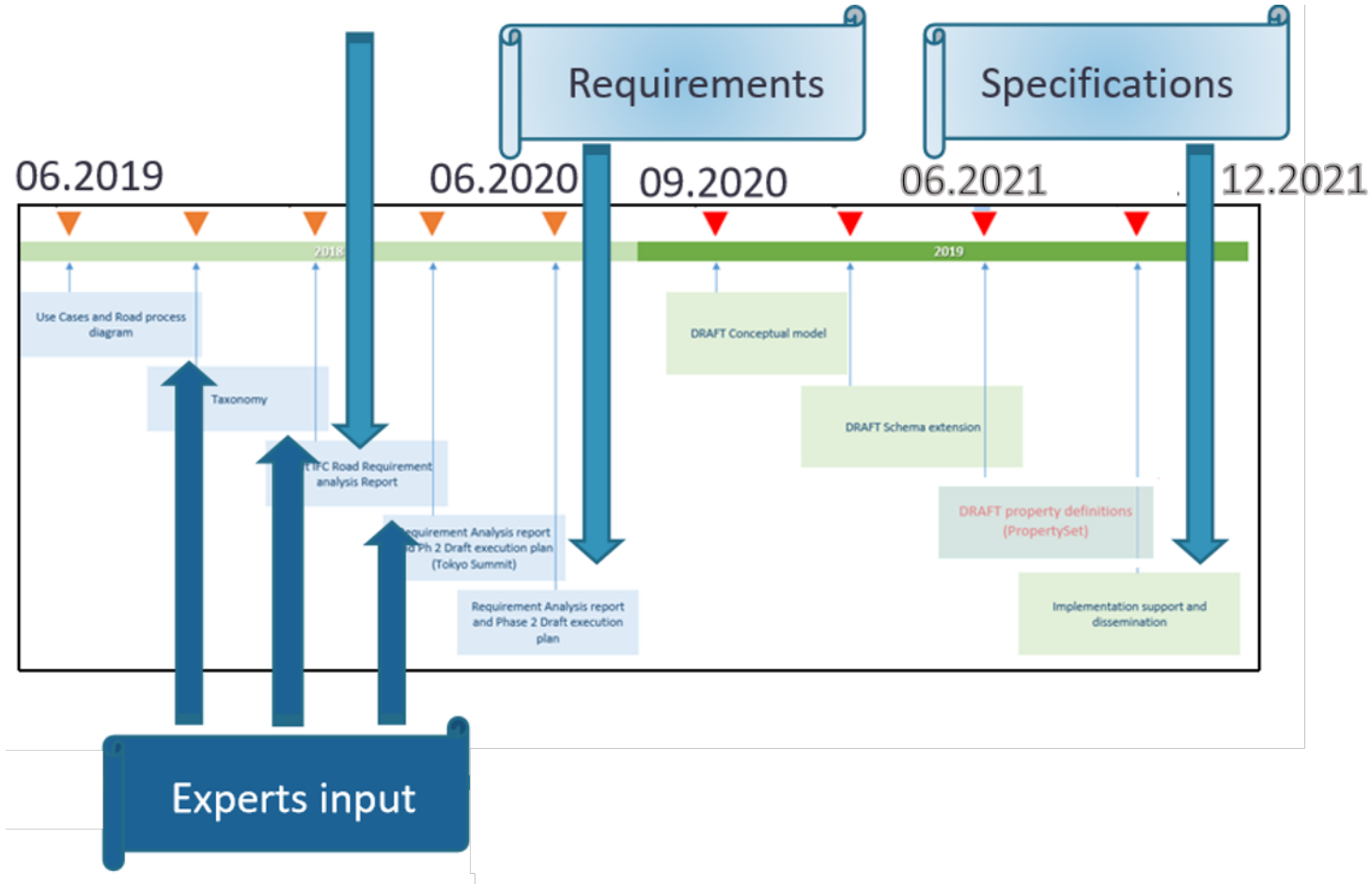
Domains taxonomies (DD)

UML Conceptual model

Xpress schema

HTML documentation

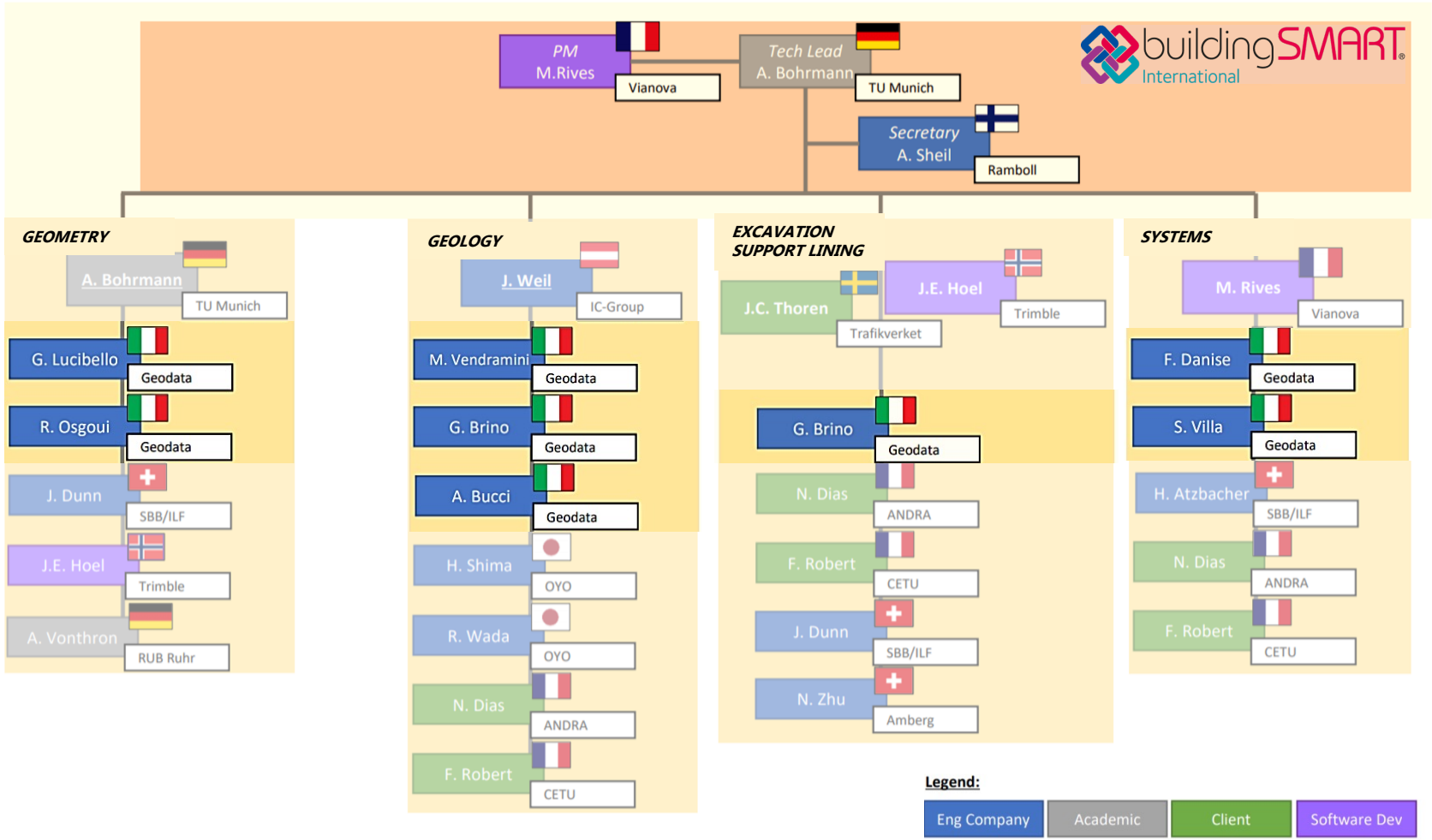
SW implementers support

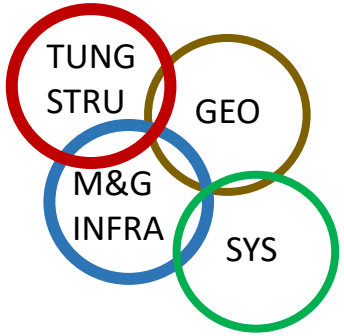


GEODATA Sectors

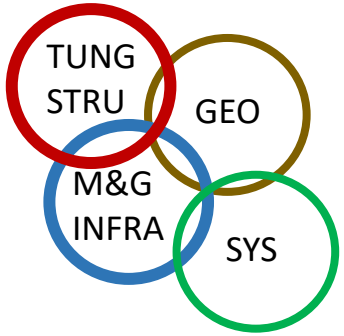
TUNG STRU	Design of underground and geotechnical structures – Design of excavation support/temporary structures – Excavation monitoring and follow-up – BIM record control – BIM design authoring - Digital Fabrication
M&G INFRA	2D Drawings development – Design assistance - BIM Modeling - BIM developments for infrastructural and multidisciplinary projects - BIM training - Space Management / Tracking
GEO	Geological and Geotechnical modelling - Geological and geotechnical Analysis - Monitoring - Geological factual data analysis
SYS	Design of electro-mechanical installations M&E - Design of rail system installations – System integration
CMS	Construction Supervision and Management – Healt and Safety Management Design and Follow up – BOQ – O&M Integration – Contract and Claim Management – Constructability Review - Contractual and Technical specification preparation

PHASE 1: GEODATA Contribution





PHASE 1: Use Cases



- Geotechnics
- Design
- Simulation & sequencing
- Tender
- Construction & monitoring
- Handover

1 – Initial state modelling	High Priority
2a – Geologic modelling	High Priority
2b – Geotechnical modelling for design	High Priority
2c – Geotechnical modelling for construction	High Priority
3 – Exchange of alignment and major roadrailway parameters	High Priority
4a – Technical visualization	High Priority
4b - Realistic Visualization	Low Priority
4b – Safety viszualisation	Low Priority
5 – Design coordination	High Priority
6a – Design to design w. reference models	High Priority
6b – Design to design w. full model logic	Out of Scope
7 – Structural & geomechanical analysis	Low Priority
8 – Air flow simulation	Low Priority
9 – Standards compliance	Low Priority
10 – Quantity take-off	High Priority
11 – Construction sequencing	High Priority
12a – Design to tender: Construction Model	High Priority
12b – Design to tender: Geotechnical Model	High Priority
13 – Design to construction – DONE	High Priority
14 – Prefabrication	Low Priority
15a – Progress monitoring	High Priority
15b – Geological monitoring – DONE	High Priority
15c - Scanning during construction	Low Priority
15d - Quantity determination for billing / payment	High Priority
16 – Machine guidance & control	Low Priority
17 – Damages recording	Low Priority
18 – Settlement monitoring	Low Priority
19 – Handover to GIS	High Priority
20 – Handover to AM	High Priority

IFC Tunnel

G. Brino - G.Lucibello, Geodata Engineering

PHASE 1: Use Cases

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Use Case 17: Damages recording

Purpose

Damages control is done during construction, at acceptance of works and during opera

It aims at recording the damages affecting the quality of the structure during construc operation.

- In case of mechanized excavation: damages to segments (due to casting, dem handling, overturning, preliminary and final storage , transportation, installati grouting and operational life), to gaskets (improper installation, damage durin installation, gap, offset) and other accessories;
- In case of conventional excavation: damages to temporary support during exc lining, to waterproofness systems (water ingress, cracks, deformations, draina waterproofing failure, etc.)

Such conditions usually could arise from a combination of adverse ground and ground (i.e., high overburden, rockburst events, swelling and creep behaviour, high water loa technological aspects (i.e. realization, installation, curing,...)

During the operation, with time, these deformations in the lining can be considered n for the road/train tunnels or hydraulic galleries from geometrical, structural and esthe view. These aspects are more driven by observation (surveys), as well as by measurem proper monitoring (cracks width, clearance,..)

Three actions are required in the framework of quality plan for damage control and m considered in any phase, with information that would have to be recorded:

- traceability and data record: location and time history recording (for precast e presence of an identification label)
- inspection: identification, type, location, description of damages (quantitative qualitative)
- acceptance/repair works: analysis of causes and selection of mitigation measu actions performed

GEODATA TBM SEGMENT LINING SURVEY - Data Dahboard

Figure 1: Example of damage data recording and integration with GIS, courtesy Geodat

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Figure 2: Example of damage data recording and integration with BIM, courtesy Geodata

The IFC exchange scenario has to take into account:

- BIM as-designed application to field application
- Field application to BIM as-built application

In IFC, component-specific condition information has to be transported, including a high-lev description of damages and geotechnical conditions, documentation (photos, survey forms)

Figure 3: Example of tool for damage data recording on-site by a mobile phone app, courtesy Geodat

Where no fine-grained components are available, linear referencing along the tunnel is req localization of damages.

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Figure 4: Example of damage data collection with pictures, courtesy Geodata

Requirements for IFC-Tunnel:

- Tunnel itself at different stages (initial – state 0 and through operational lifecycle)
- Terrain
- Information related to construction process
- Geophysical property and deformation of lining and surrounding ground
- Links to UC7, 8b, 15b, 18

Coordinate Systems: Whereas some BIM software provide 1:1 modeling, BIM for Infrastructure solutions and professional GIS systems operate in projected coordinate system. Thus, a transformation might be necessary, and all required parameters must be provided by the IFC format.

Geometry:

Particular attention must be paid to the interface with GIS systems. For surveys, information about geometry could be transferred through identification numbers or volumetric representations. In case a laser scanner survey for cracks recognition, points-clouds could be included.

Semantics:

All existing entities must be described with appropriate semantics. Information to be exchanged is well defined by rigid forms, whose information must be structured for sharing., Link to documentation in other format must be supported (photos, videos)

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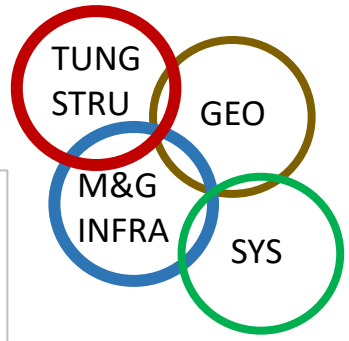
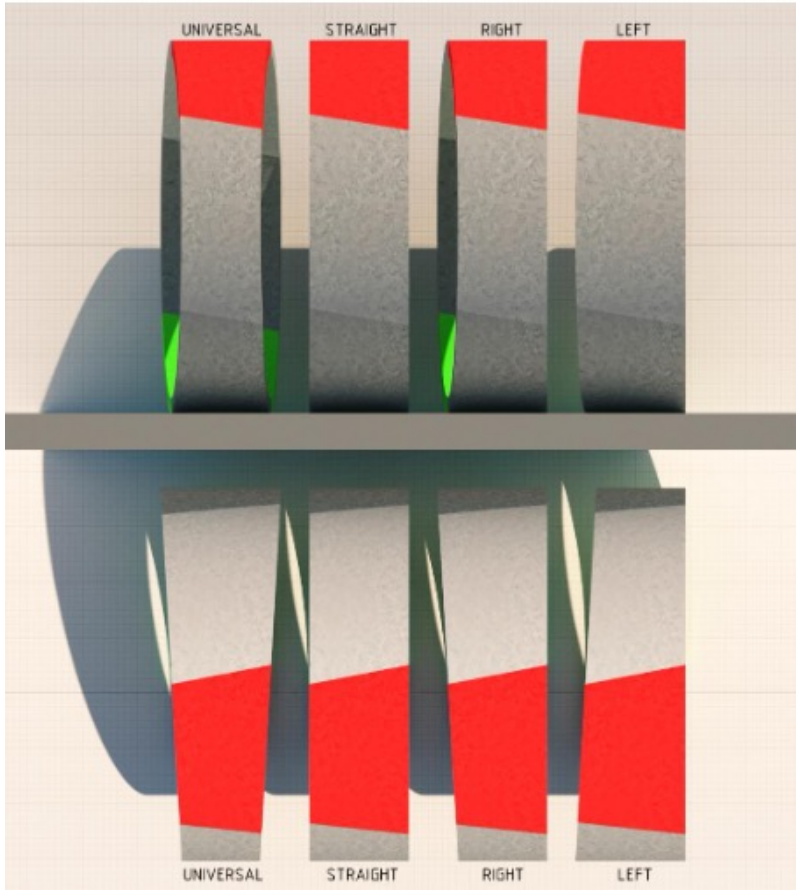


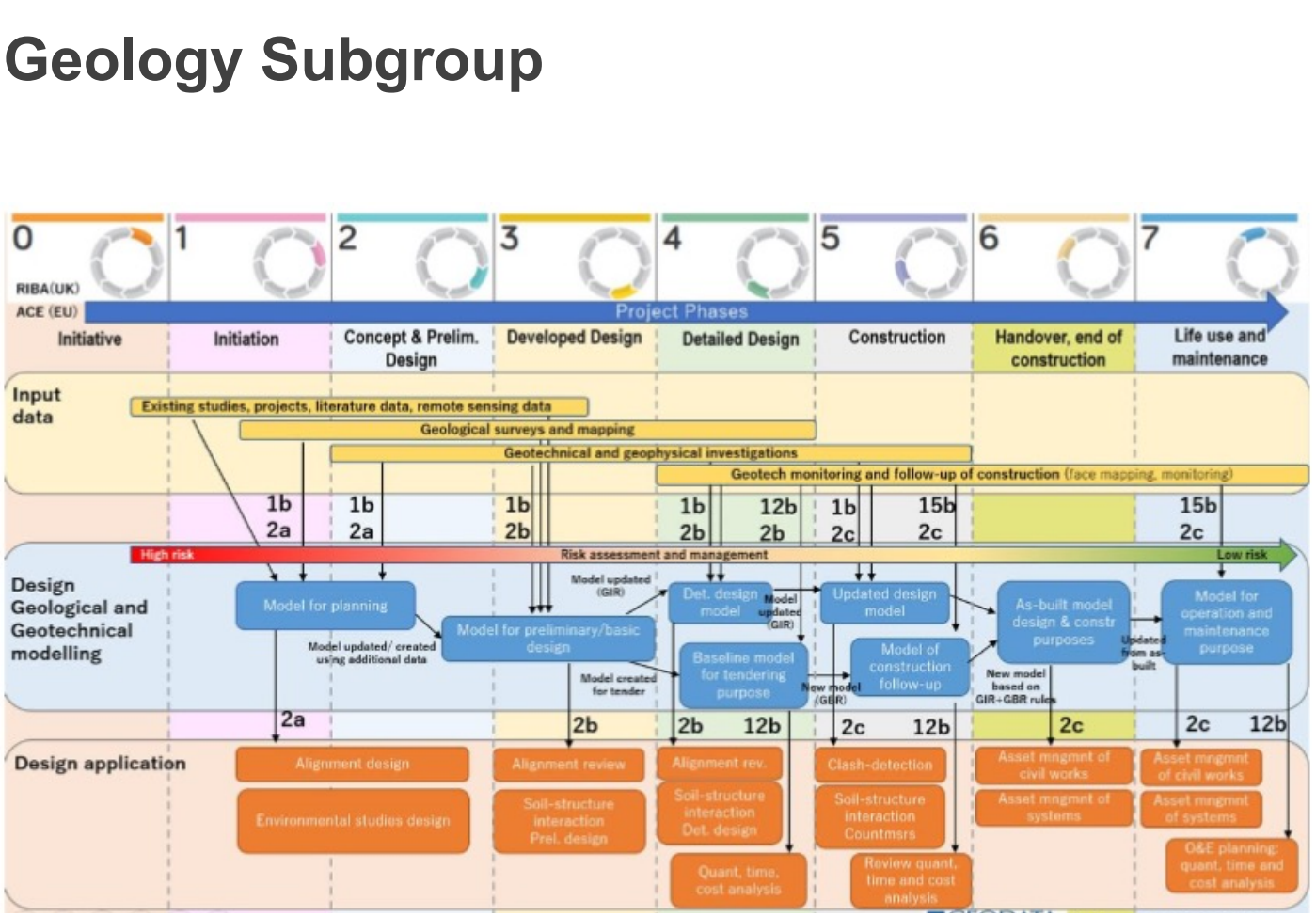
Geometry Subgroup

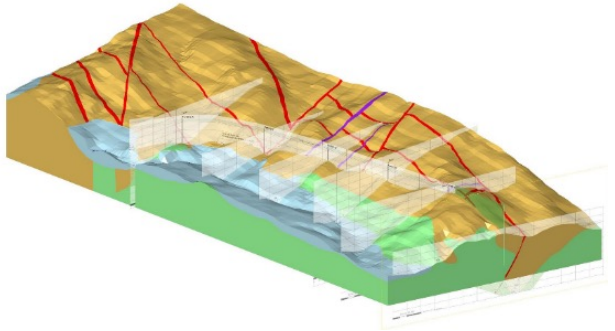


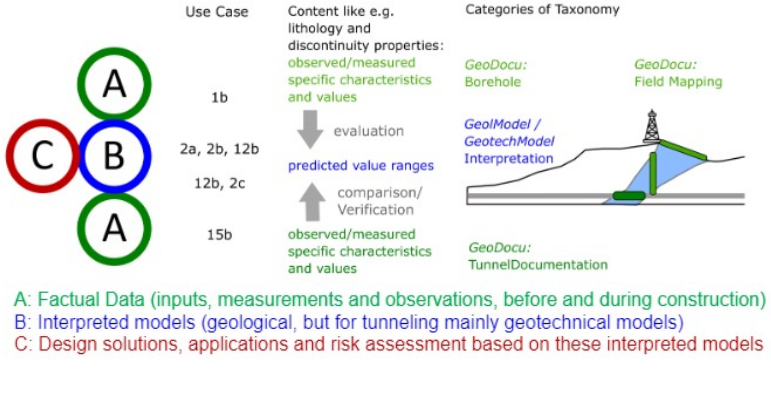
TUNG
STRU

M&G
INFRA

Geology Subgroup



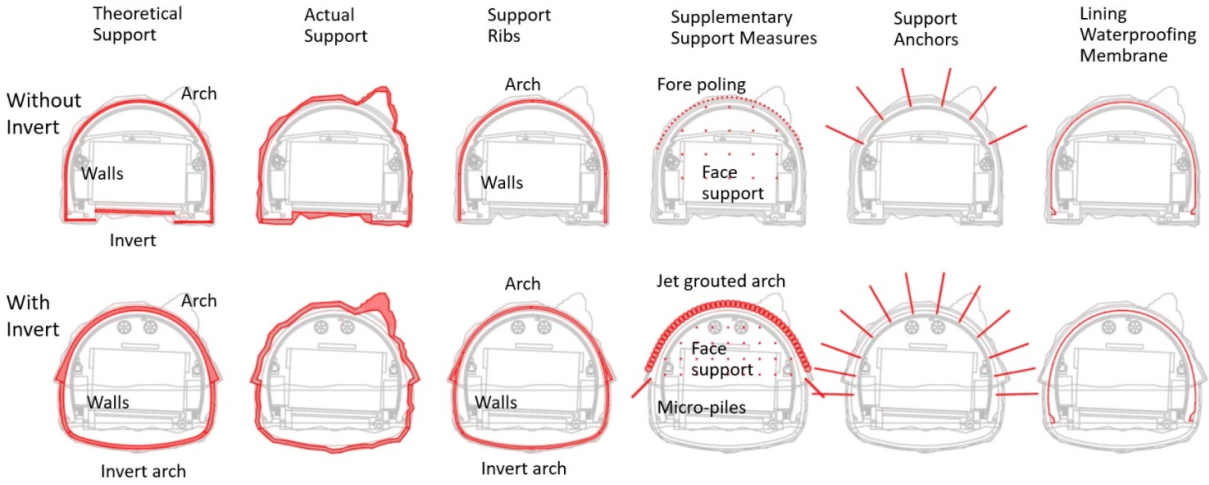


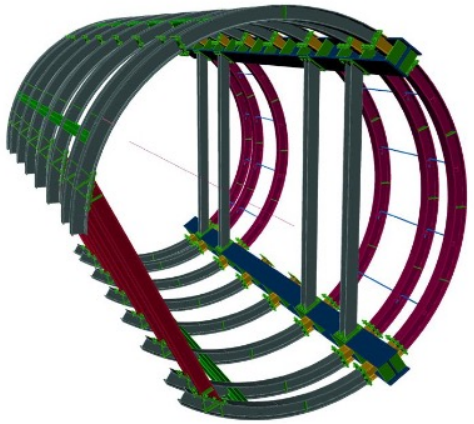


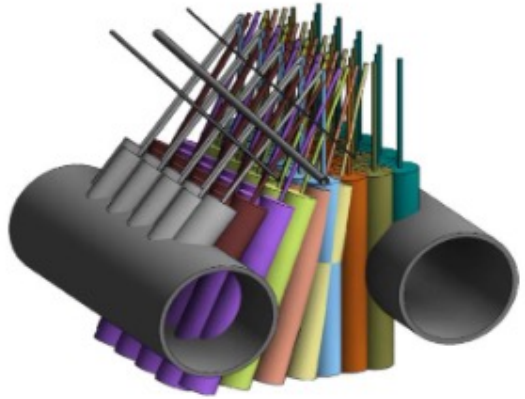
A: Factual Data (inputs, measurements and observations, before and during construction)
B: Interpreted models (geological, but for tunneling mainly geotechnical models)
C: Design solutions, applications and risk assessment based on these interpreted models

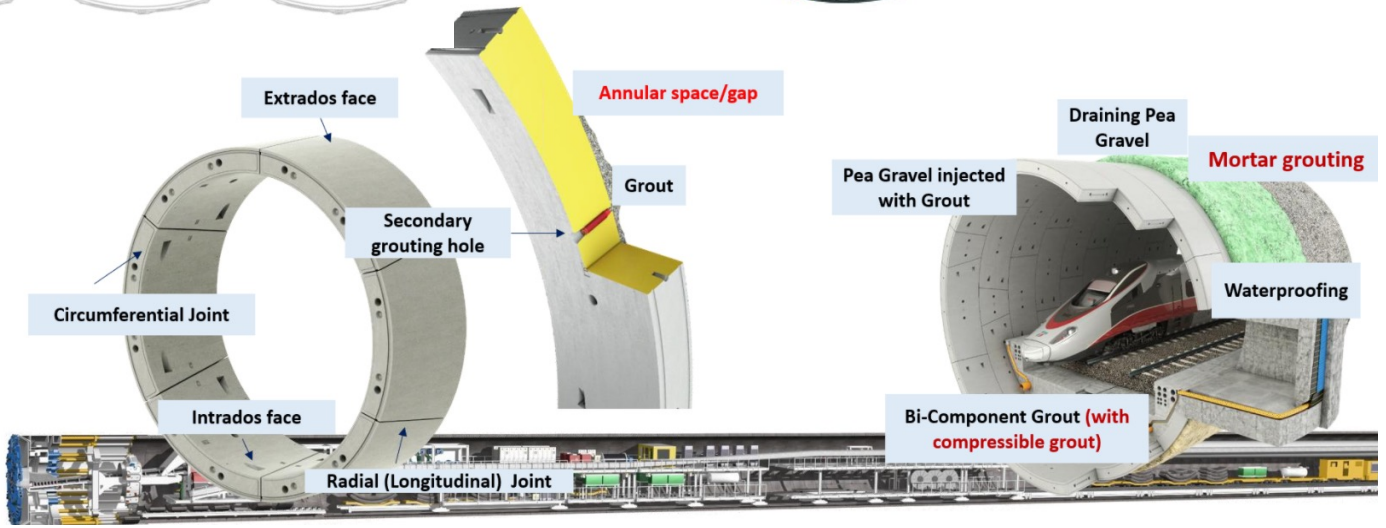
Excavation Support Lining Subgroup

TUNG
STRU
M&G
INFRA



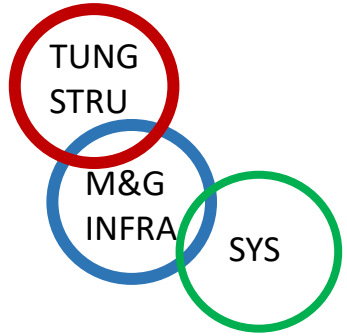


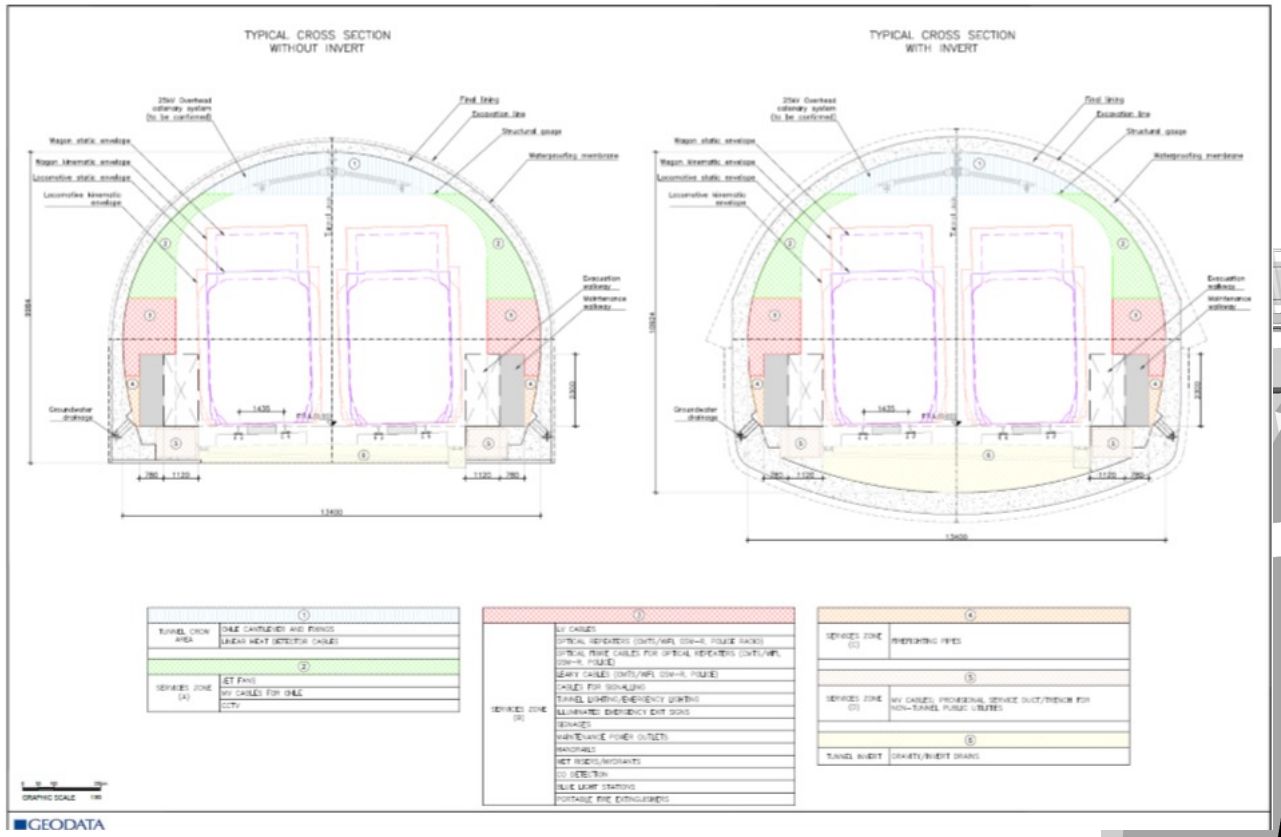


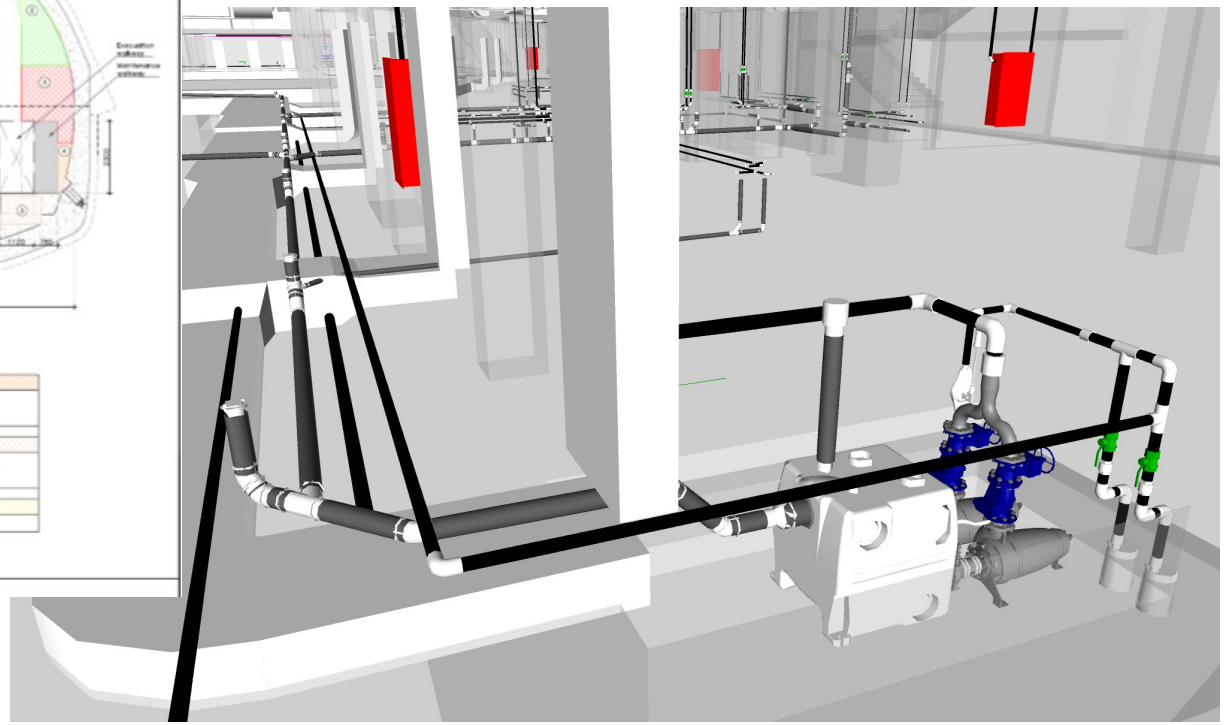


Systems Subgroup

- Ventilation
- Power Supply
- GeoEnergized equipments
- Drainage
- Safety and evacuation
- Fire Protection







IFC Tunnel

G. Brino - G.Lucibello, Geodata Engineering

PHASE 1: Requirements Analysis Report

CONTENT

- Tunnel types
- Use cases
- Geometry and Positioning
- Spatial structure / Project structure
- Geology and geotechnics
- Excavation
- Excavation support
- Tunnel subsystems

Loading

Reviews

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IFC-Tunnel Project

Report WP2: Requirements analysis report (RAR)

Status: v1.0 - 2020-07-31

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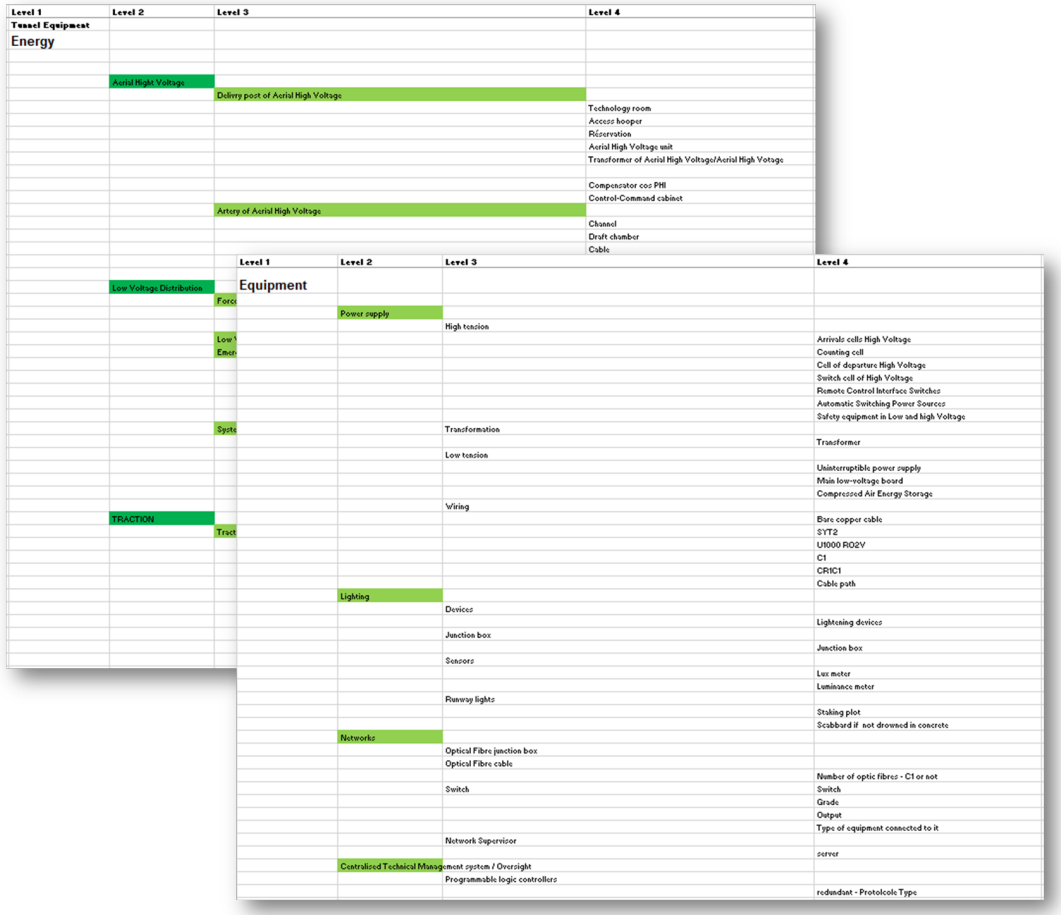
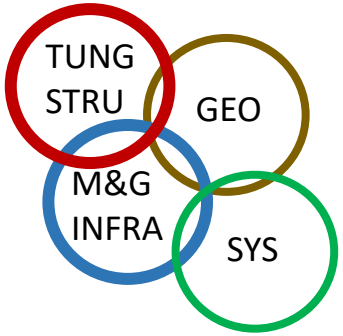
IFC TUNNEL: Phase 2



Level 1	Level 2	Level 3	Level 4
Tunnel Equipment			
Energy			
	Aerial High Voltage		
		Delivry post of Aerial High Voltage	
			Technology room
			Access hooper
			Réservation
			Aerial High Voltage unit
			Transformer of Aerial High Voltage/Aerial High Voltage
			Compensator cos PHI
			Control-Command cabinet
		Artery of Aerial High Voltage	
			Channel
			Draft chamber
			Cable
	Low Voltage Distribution		
		Forc	
			Power supply
			High tension
		Low V	
		Emerg	
			Arrivals cells High Voltage
			Counting cell
			Cell of departure High Voltage
			Switch cell of High Voltage
			Remote Control Interface Switches
			Automatic Switching Power Sources
			Safety equipment in Low and high Voltage
		Syste	
			Transformation
			Transformer
			Low tension
			Uninterruptible power supply
			Main low-voltage board
			Compressed Air Energy Storage
			Wiring
	TRACTION		
		Tract	
			Bare copper cable
			SYT2
			U1000 RO2V
			C1
			CR1C1
			Cable path
			Lighting
			Devices
			Lightening devices
			Junction box
			Junction box
			Sensors
			Lux meter
			Luminance meter
			Runway lights
			Staking plot
			Scabbard if not drowned in concrete
			Networks
			Optical Fibre junction box
			Optical Fibre cable
			Number of optic fibres - C1 or not
			Switch
			Switch
			Grade
			Output
			Type of equipment connected to it
			Network Supervisor
			server
			Centralized Technical Management system / Oversight
			Programmable logic controllers
			redundant - Protolcole Type

Level 1	Level 2	Level 3	Level 4
Equipment			



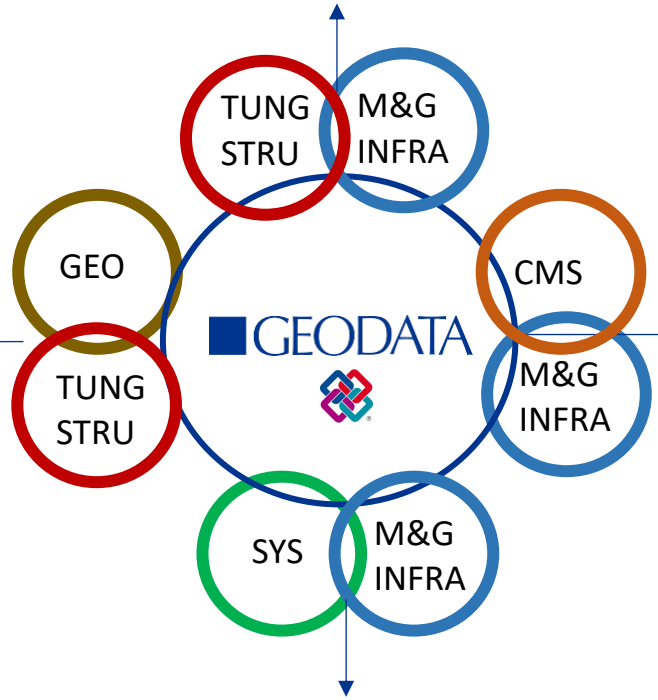
SPECIFICATIONS

- Domain taxonomies
- UML Conceptual model
- Xpress schema
- HTML documentation
- SW implementers support

GEODATA Developments

Study of Geodata tool for segmental lining design and analysis on the alignment based on geometry (conicity, alignment,…)

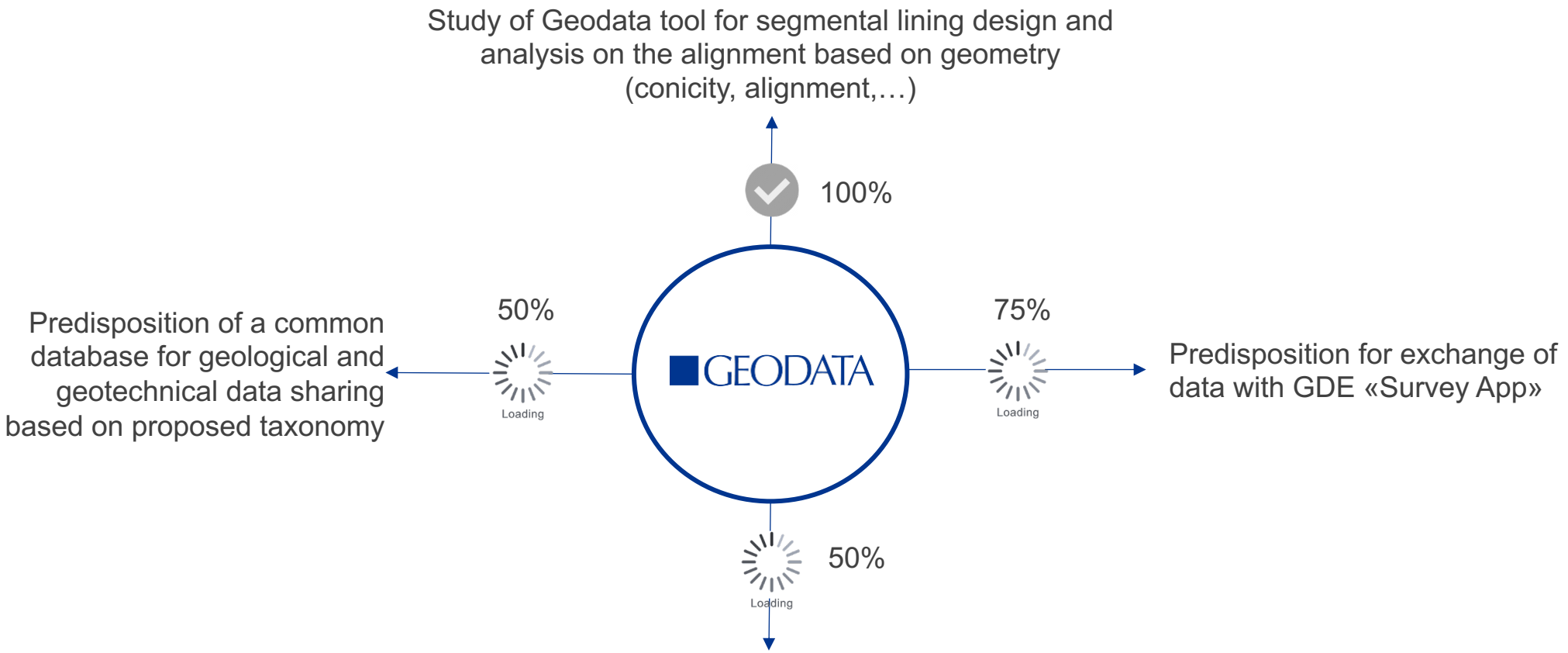
Predisposition of a common database for geological and geotechnical data sharing based on proposed taxonomy



Predisposition for exchange of data with GDE «Survey App»

Development of a process map for data exchange between systems design software and BIM oriented tools

GEODATA Developments – State of art



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