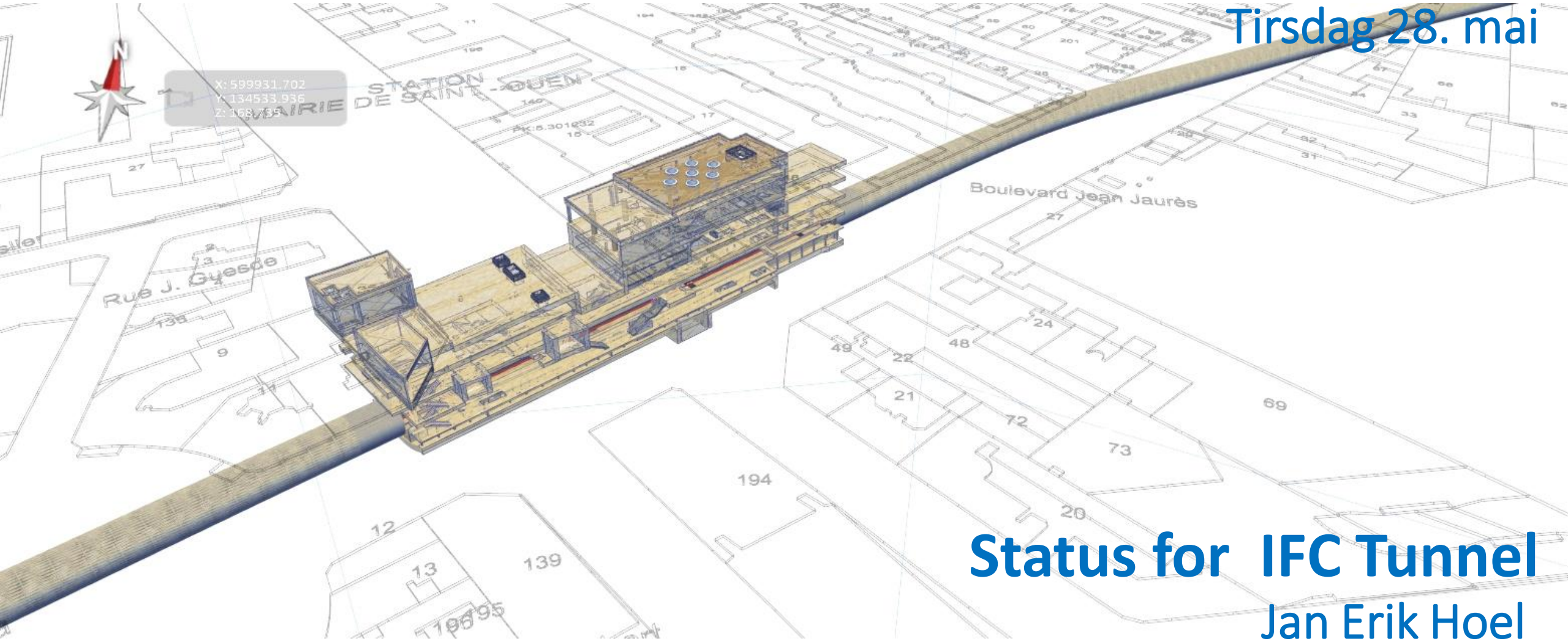
Digital temakveld 2024

Tirsdag 28. mai



Status for IFC Tunnel

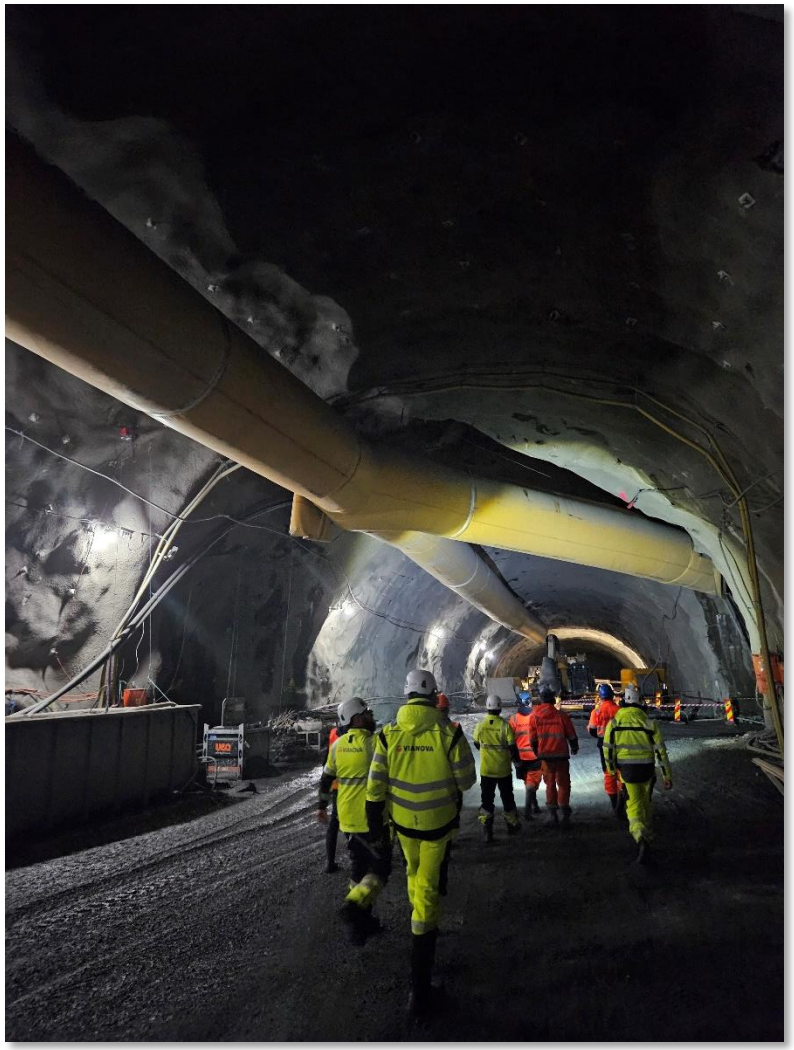
Jan Erik Hoel

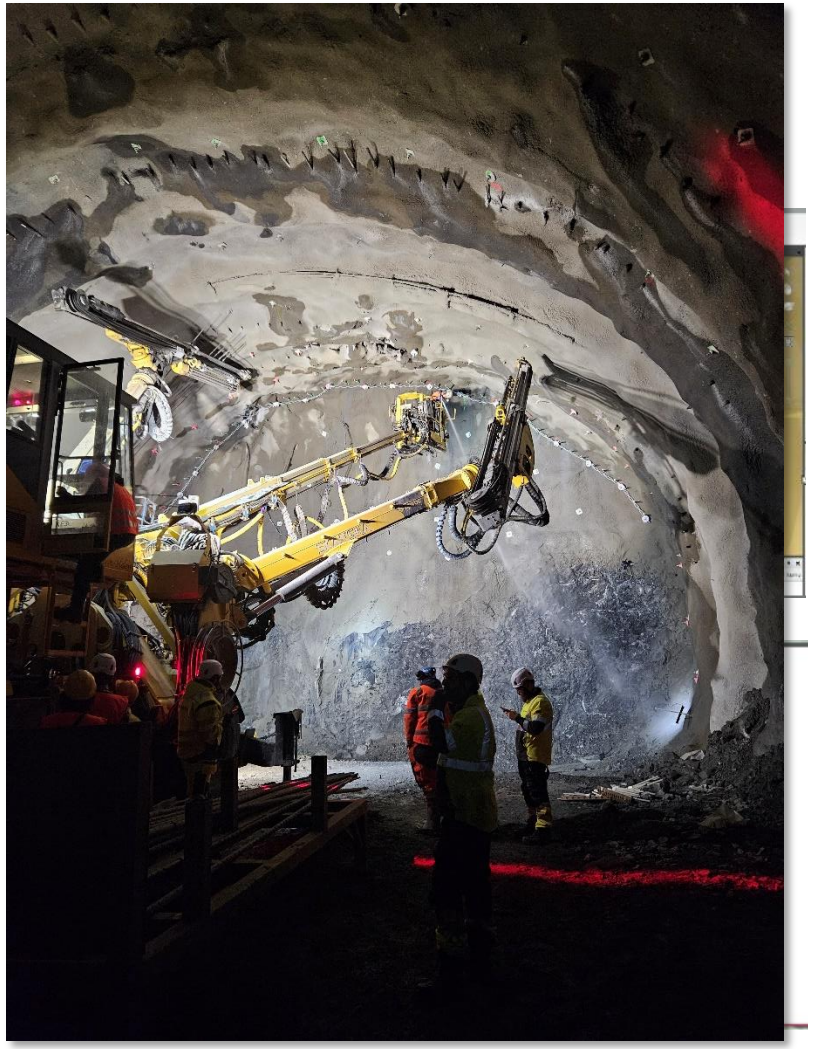
buildingSMART International

Agenda

- Prosjektdeltakere og prosessen
- Kravinnsamling
- Konseptuell modell
- Viktigste aspekter med skjemautvidelsen
- Geometriske tillegg
- Uttestingsprosjektet

Ifc-for-Tunnelling (Ifc4-T) – Besøk på Vestkorridoren





Ifc-4-T – Bidragsytere 2020-2024

Infrastruktureiere:

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

Geoteknikk og design ingeniører:

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

Nasjonale organisasjoner:

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

Forskning og utviklingsorganisasjoner:

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

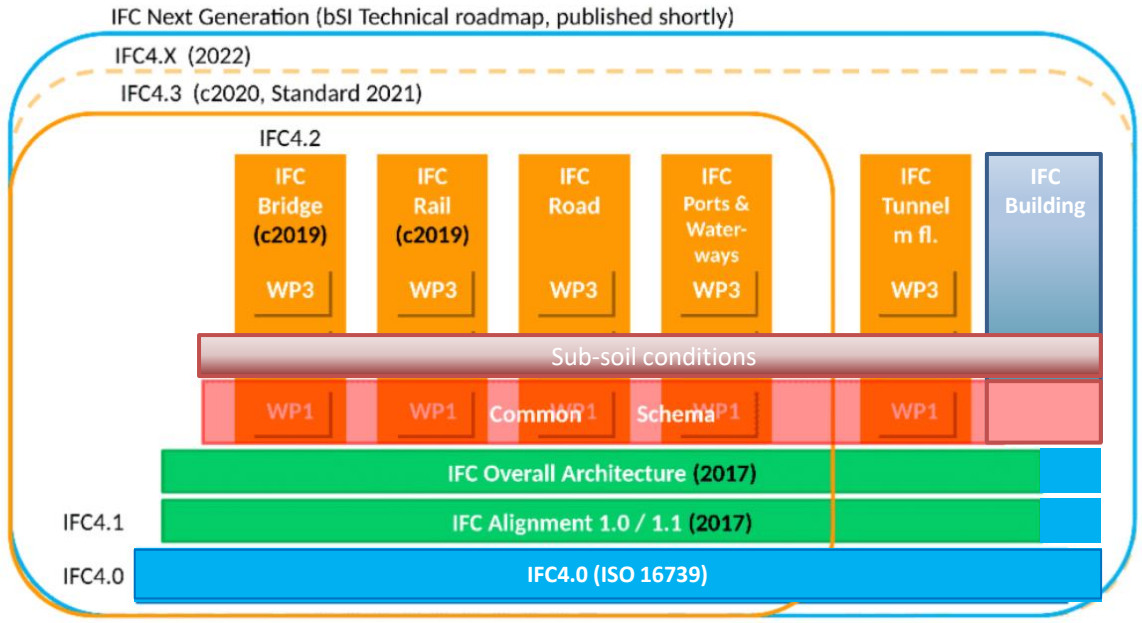
Samarbeide med internasjonale organisasjoner:

ITA – Modellering av tunneler
IAEG – Modellering av ingeniørgeologi
OGC/ISSMGE – OpenGIS Consortium

3x domeneksperт team
1x Ifc ekspert team

Σ = 55+ personer (“in-kind” 1.5m€)

bSI – IFC/ISO for infrastruktur prosjekter

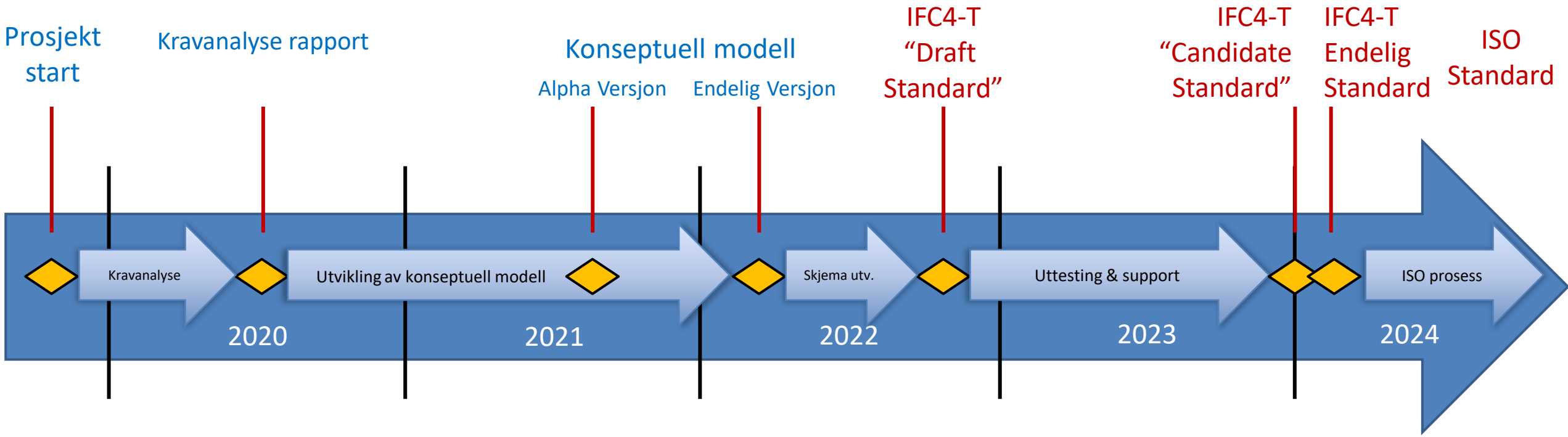


ETT samlet skjema for bygget miljø

International Organization for Standardization

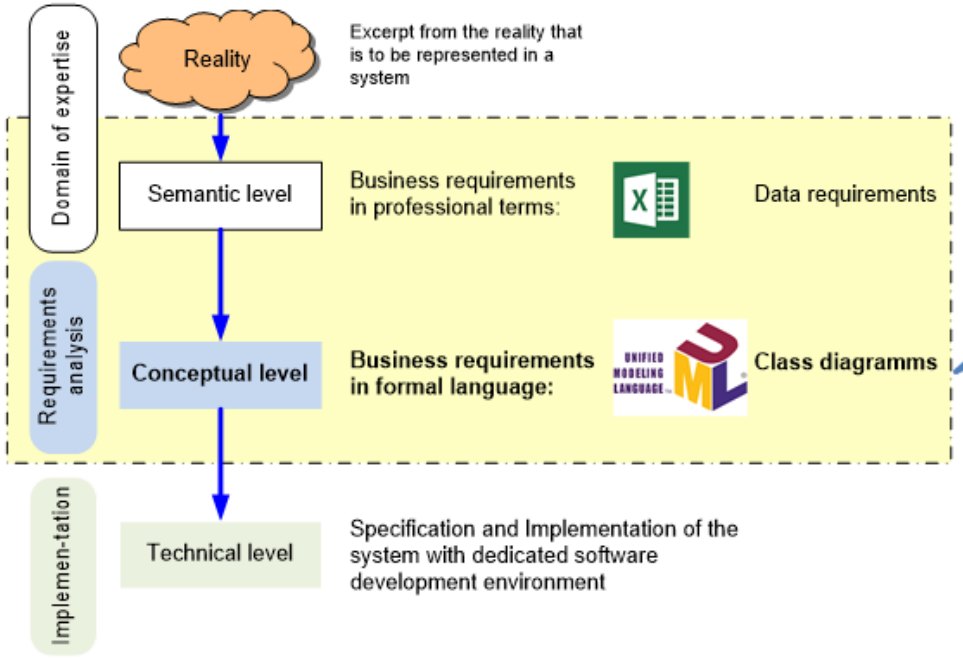
ISO 16739 IFC inkl. IFC4.3

Ifc-4-T – Prosjekt framdrift



https://www.buildingsmart.org/about/bsi-process/

IfcTunnel – Brukerhistorier



Geologi/geoteknikk	
- Initial state modelling	High Priority
– Geologic modelling	High Priority
– Geotechnical modelling for design	High Priority
– Geotechnical modelling for construction	High Priority
Design	
- Exchange of alignment and major roadrailway parameters	High Priority
– Technical visualization	High Priority
- Realistic Visualization	Low Priority
– Safety viszualisation	Low Priority
- Design coordination	High Priority
– Design to design w. reference models	High Priority
– Design to design w. full model logic	Out of Scope
Simuleringer og byggefaser	
- Structural & geomechanical analysis	Low Priority
- Air flow simulation	Low Priority
- Standards compliance	Low Priority
– Quantity take-off	High Priority
– Construction sequencing	High Priority
Anbud	
a – Design to tender: Construction Model	High Priority
b – Design to tender: Geotechnical Model	High Priority
– Design to construction – DONE	High Priority
Bygging og statusoppfølging	
– Prefabrication	Low Priority
a – Progress monitoring	High Priority
b – Geological monitoring – DONE	High Priority
c - Scanning during construction	Low Priority
d - Quantity determination for billing / payment	High Priority
– Machine guidance & control	Low Priority
– Damages recording	Low Priority
– Settlement monitoring	Low Priority
Overlevering	
– Handover to GIS	High Priority
– Handover to AM	High Priority

IfcTunnel – Krav konsensus

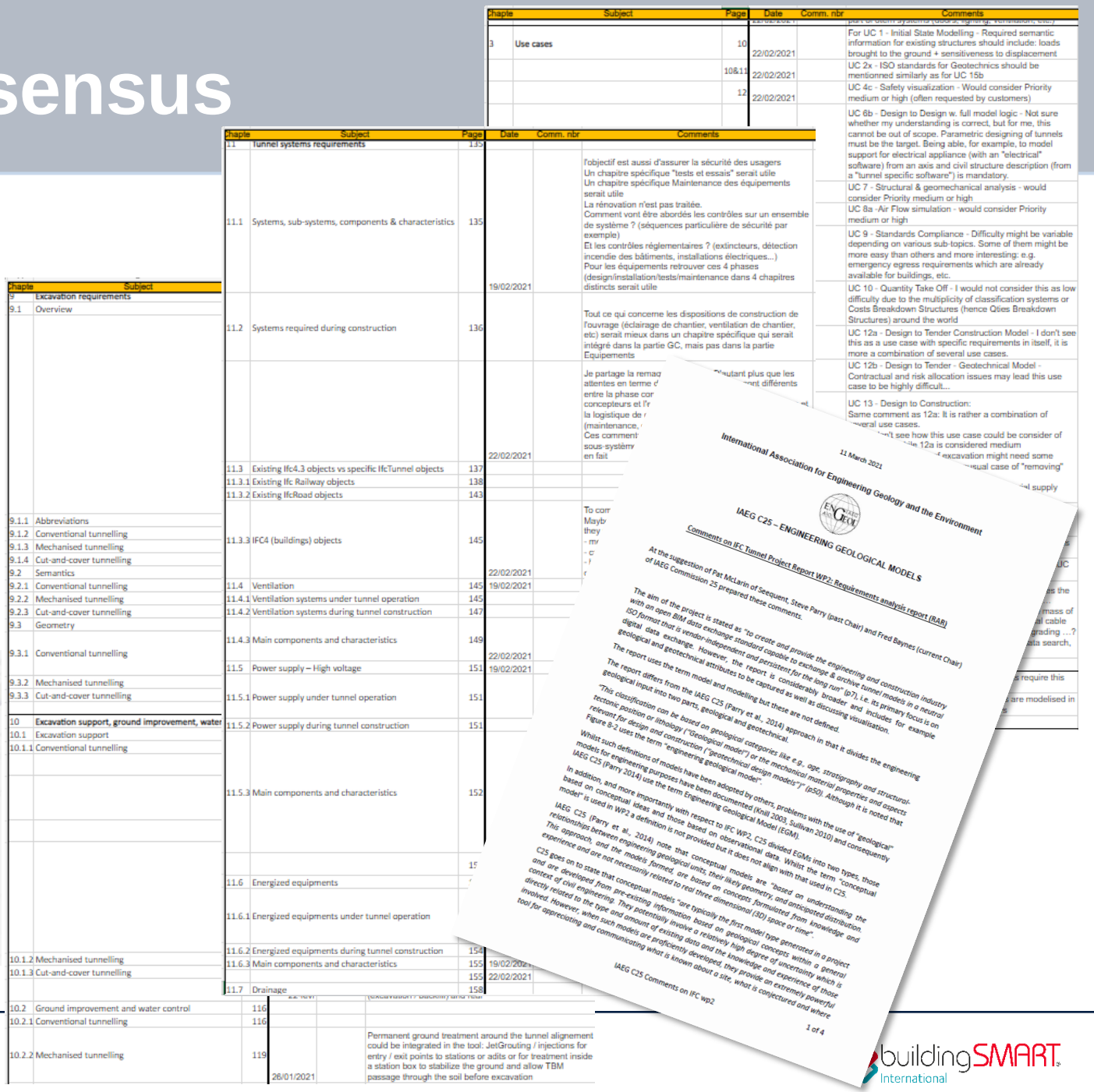
Revisjonsprosessen for krav

3 måndeder/ 10 land

200+ kommentarer/forslag

⇒ Justerte krav

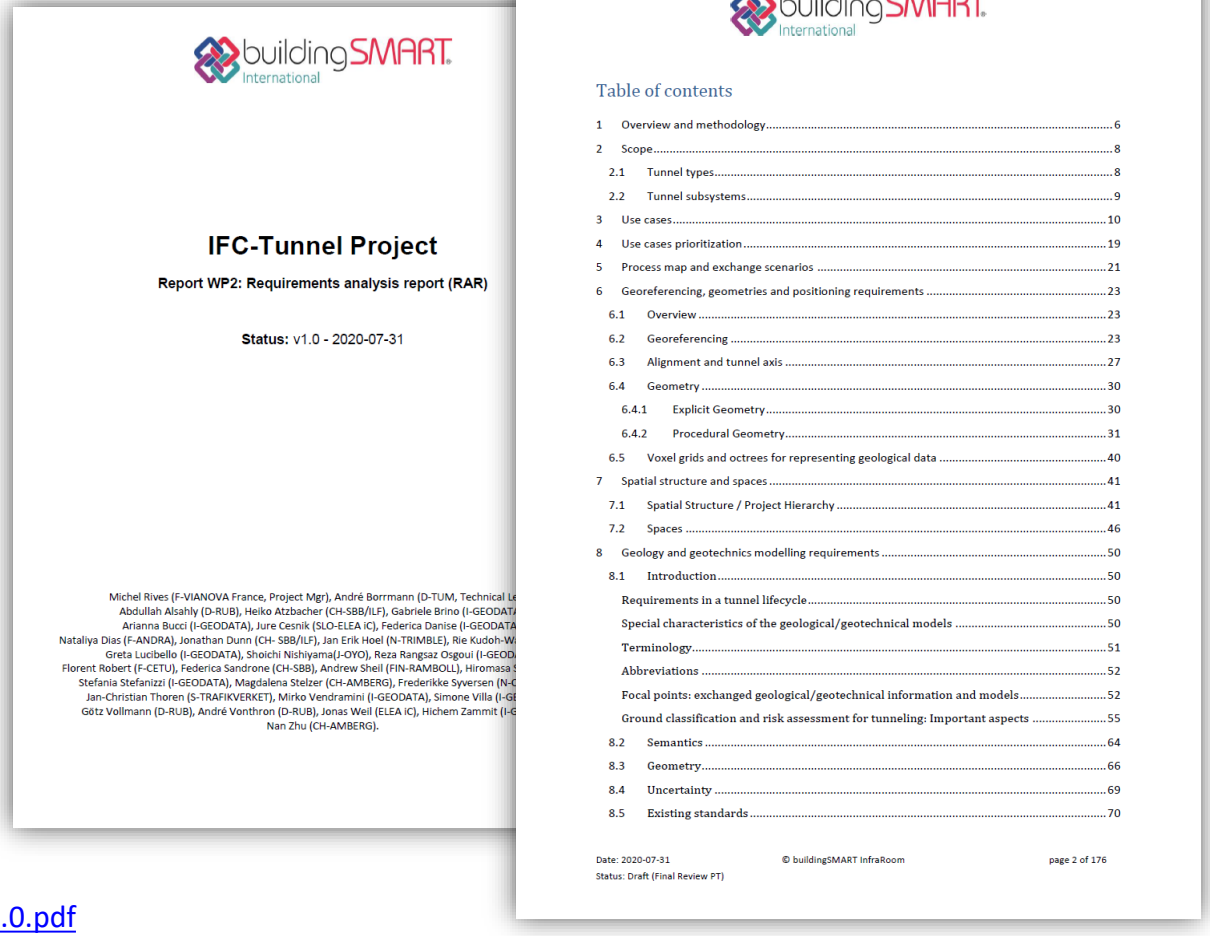
Feedback:	ITA	IAEG	DACH	F	I	JPN	N	NZ	S	US
Subjects:										
Geometry & geopositioning										
Spatial structure & project structure										
Geology & geotechnics	X	X	X	X	X	X	X	X	-	X
Excavation	X	-	X	X	X	X	X	-	X	-
Excavation support	X	-	X	X	X	X	X	-	X	-
Lining & water proofing	X	-	X	X	X	X	X	-	X	-
Tunnel subsystems	X	-	X	X	X	X	-	-	-	-



IfcTunnel – Kravanalyse rapport

- **Kravanalyserapporten** baserte seg på input fra domeneekspertene.

- Dokumenterte
  - Prioriterte brukerhistorier
  - Prosesser
  - Dataoverføringscenarier
  - Generelle konsepter
    - Georefering, Geometri, Linjeberegning, …
  - Detaljert beskrivelse av spesifikke temaer:
    - Geologi/geoteknikk
    - Tunneldriving, sikring, innerkledning
    - Systemer



buildingSMART International

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 Le
Abdullah Alsahly (D-RUB), Heiko Atzbacher (CH-SBB/ILF), Gabriele Brino (I-GEODATA
Arianna Bucci (I-GEODATA), Jure Cesnik (SLO-ELEA iC), Federica Danise (I-GEODATA
Nataliya Dias (F-ANDRA), Jonathan Dunn (CH- SBB/ILF), Jan Erik Hoel (N-TRIMBLE), Rie Kudoh-W
Greta Lucibello (I-GEODATA), Shoichi Nishiyama(J-OYO), Reza Rangsaz Osgoui (I-GEOD
Florent Robert (F-CETU), Federica Sandrone (CH-SBB), Andrew Sheil (FIN-RAMBOLL), Hiromasa S
Stefania Stefanizzi (I-GEODATA), Magdalena Stelzer (CH-AMBERG), Frederikke Syversen (N-G
Jan-Christian Thoren (S-TRAFIKVERKET), Mirko Vendramini (I-GEODATA), Simone Villa (I-GE
Götz Vollmann (D-RUB), André Vonthron (D-RUB), Jonas Weil (ELEA iC), Hichem Zammit (I-G
Nan Zhu (CH-AMBERG).

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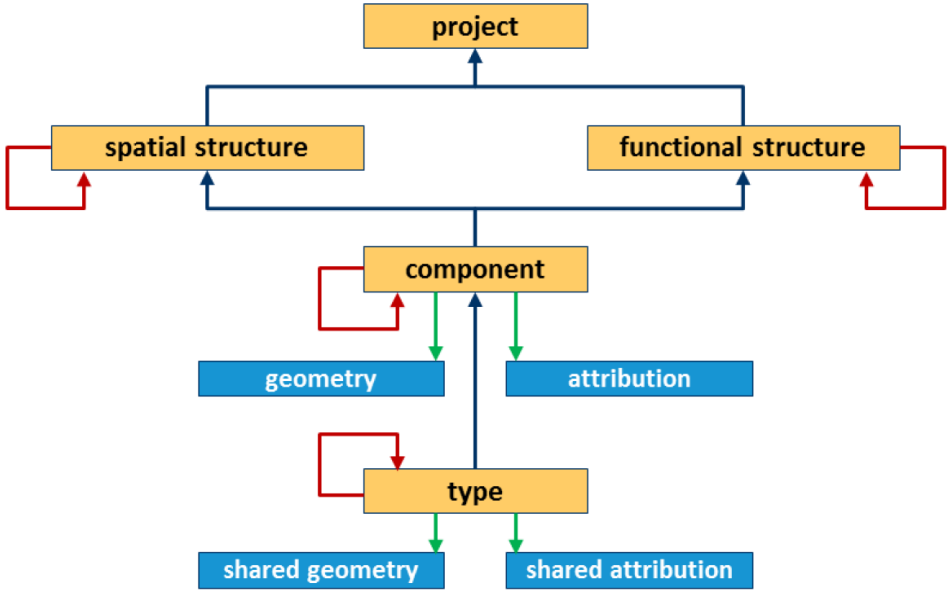
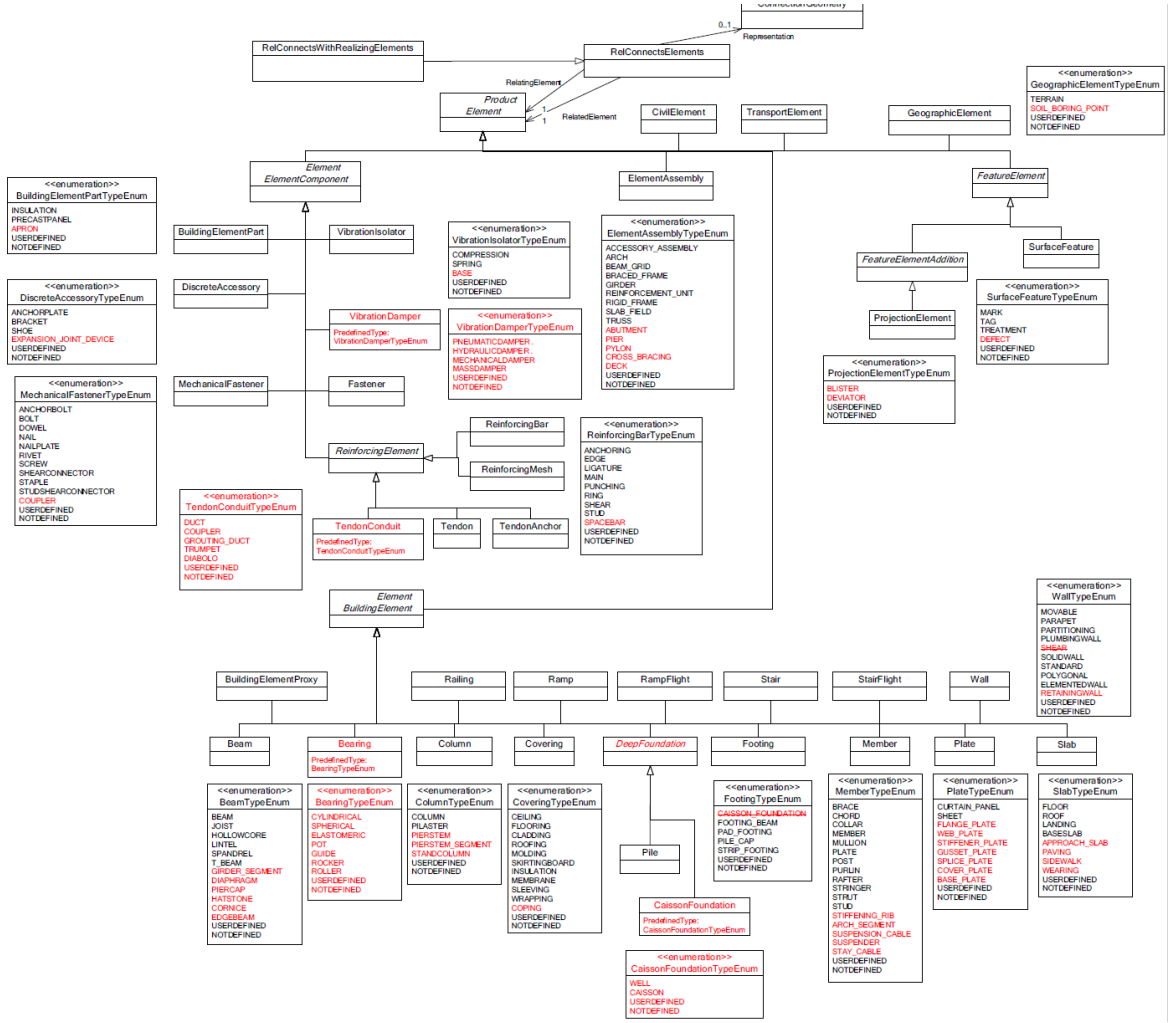
Table of contents

https://publications.cms.bgu.tum.de/reports/IR-TUN_Requirement-Analysis-Report_v1.0.pdf

IfcTunnel – Konseptuell modell

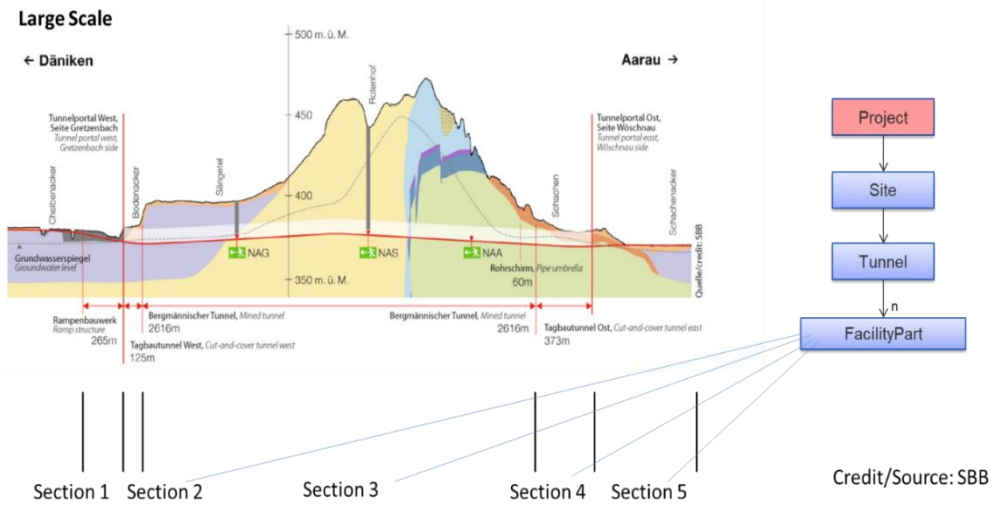
- UML = Unified Modeling Language
- Standardisert **visuell representasjon** av objektorienterte datamodeller
- Basis for konseptuell modellering

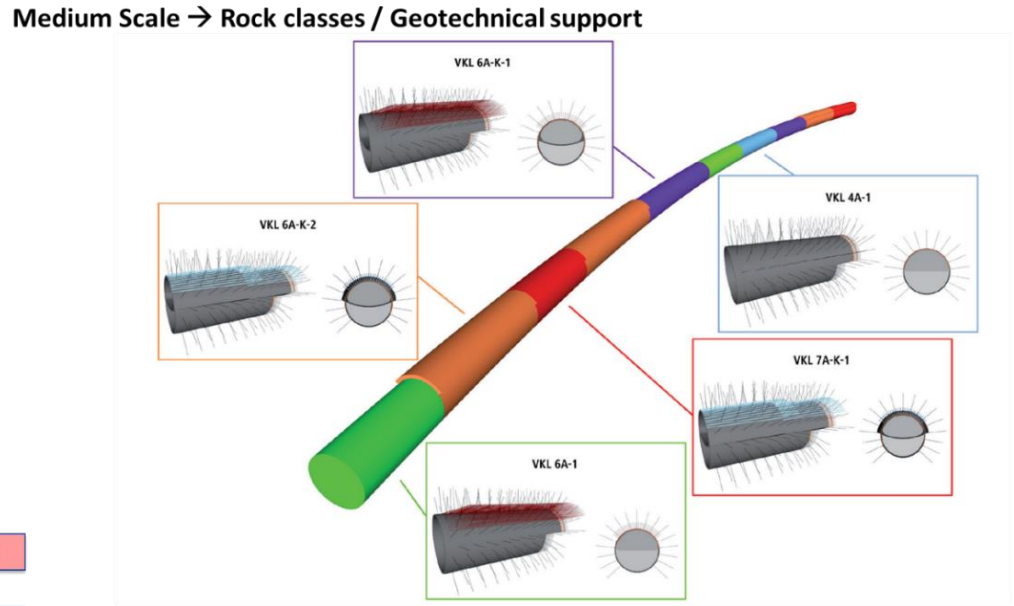


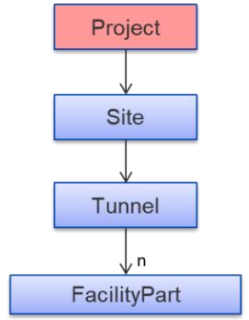


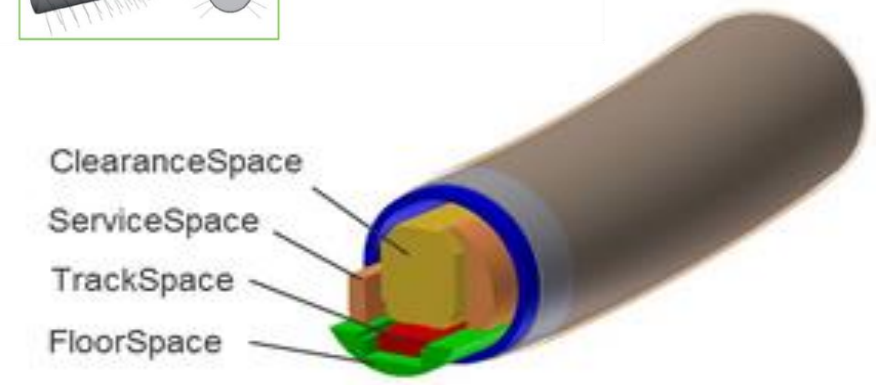
IfcTunnel – Romlig nedbrytning

- Fleksibel nedbrytningsstruktur krever:
  - Ulike skalaer:
    - Stor / medium / liten
  - Ulike retninger:
    - Langsgående / på tvers / vertikalt









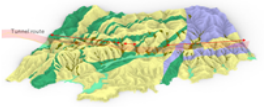
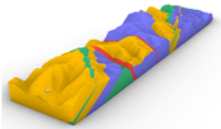
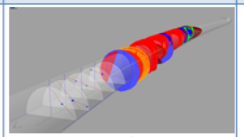
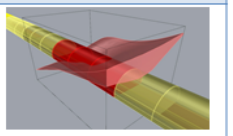
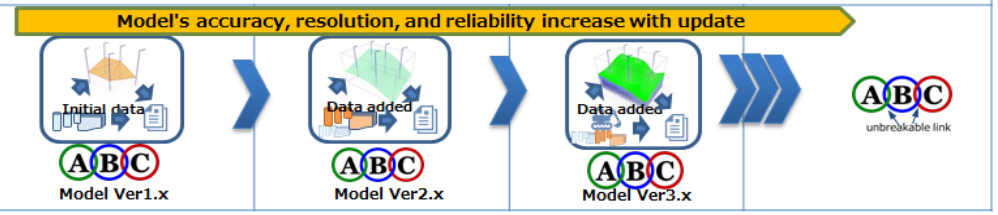
IfcTunnel – Romlige definisjoner

Romlige definisjoner som kan benyttes for beskrive
Tunneldriving-, sikring- og innerkledningsprosesser

Romlige definisjoner som kan inneholde
systemer og utstyr

IfcTunnel – Geologi og geoteknikk

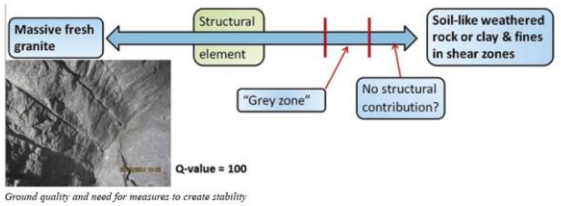
- Geologi/getoteknikk er ikke godt nok definer i IFC4.3 eller av OGC
- Beskrivelse av **lag og diskontinuiteter** (slepper, sprekker osv)
- Sentrale utfordringer: **Usikkerhet** som fører til **risiko**
- Skiller klart på:
  - Registrerte data: “Bok A”
  - Tolkede data: “Bok B”
  - Prosjekterte tiltak: “Bok C”
- Kobler og harmoniserer mot eksisterende standarder:
  - OGC GeoSciML, DIGGS, AGS

Lifecycle stage	Plan & Investigation	Investigation & Design	Construction	Maintenance
Primary objective of modeling	Tunnel routes / alignment studies (UC 2a)	Tunnel Design (UC 2b, 12b)	Construction management (UC 15b, 2c, 12b)	Measures to deformation and damage (2C)
Model example	 Regional-scale engineering-geological model	 Tunnel-scale engineering-geological model	 Geol. Tunnel Docu. /as-built model	 As-built model for specific area
Modeling area	Relatively wide area including potential tunnel routes	Around the tunnel corridor	Around the tunnel excavation	Selection of previous models around zones of interest
Approx. resolution required to the model	>10m mesh	<10m mesh	Down to 0.1m mesh	Down to 0.1m mesh
Input data for modeling Book A: Factual Data	• Previously existing data and first project-specific site investigation results	• Pre-existing data • Mainly project-specific site investigation results (including field mapping)	• Pre-existing data • Site investigation results • Geol. tunnel (and other) documentation, additional investigation	• Pre-existing data • Site investigation results • Data obtained during construction • maintenance data
Model content Book B: Interpreted models	• Regional topography, geology, hydro-geology, etc. • Engineering-geological aspects to be considered for tunnel route selection (potential hazards)	• Geological conditions and geotechnical design parameters (like rock mass strength, permeability, discontinuity pattern etc.) • Engineering-geological aspects to be considered for tunnel design and construction (potential hazards)	• Encountered geological and geotechnical conditions • Potential hazards during construction	• Relationship among damage area, geotechnical condition and tunnel
Implications Book C: Design solutions and applications based on the interpreted models	• Decisions on alignment, land acquisition, etc.	• Ground behaviour, construction method, support measures, ground improvement, system behaviour, excavation classes etc.	• Observation and interpretation of displacements • Adjusted prediction of expected geotechnical conditions • Safety management • Comparison to predicted conditions	• Safety monitoring, routine maintenance works, counter measures for damages etc.
Remarks	• The model (B) should be accompanied by the base data (A) to enable an update with new data and to evaluate the model's uncertainty • The implications (C) depend on the model and should be linked to it • Consequently, ABC should be linked as one package and be delivered next phase.			
Schematic drawing of the inheritance of the geological/Geotechnical models through the life cycle of a tunnel.				

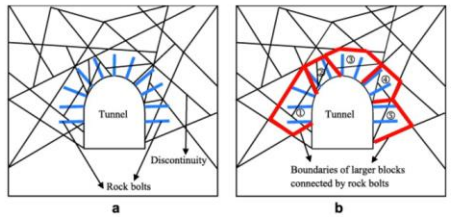
IfcTunnel – Tunneldriving

- Tunneldrivingsmetoder
  - Tunnelboremaskin (TBM)
  - Boring og sprengning
  - “Cut and cover“

Boring og sprengning



Ground quality and need for measures to create stability



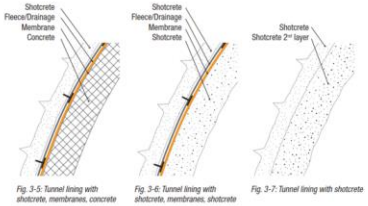
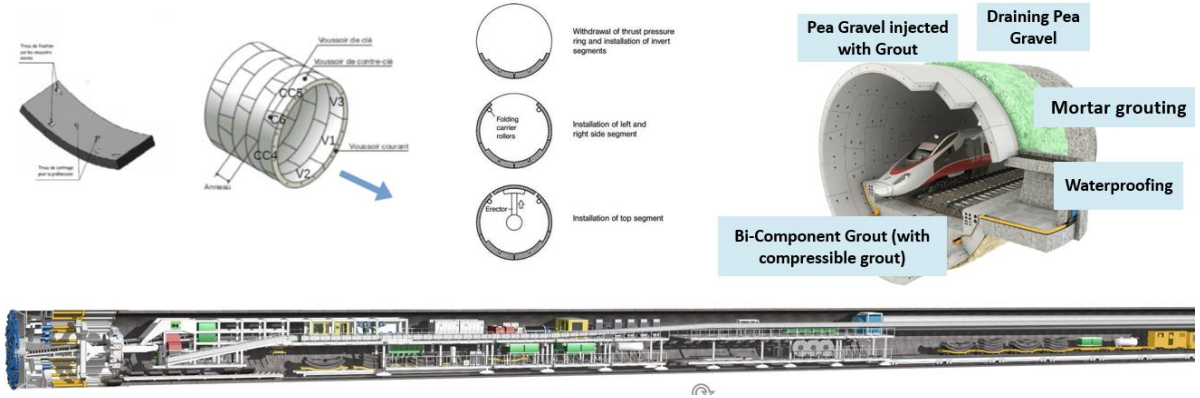


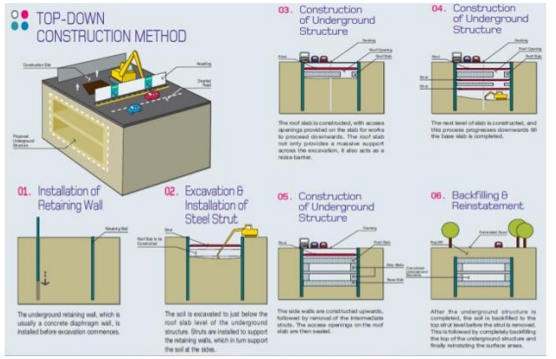
Fig. 3-5: Tunnel lining with shotcrete, membranes, concrete
Fig. 3-6: Tunnel lining with shotcrete, membranes, shotcrete
Fig. 3-7: Tunnel lining with shotcrete

Lining types

TBM

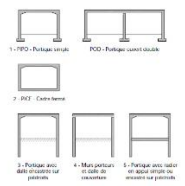


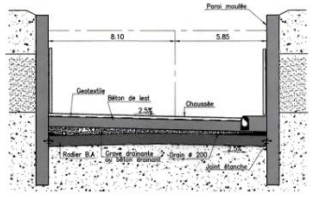
Cut & cover



Retaining walls

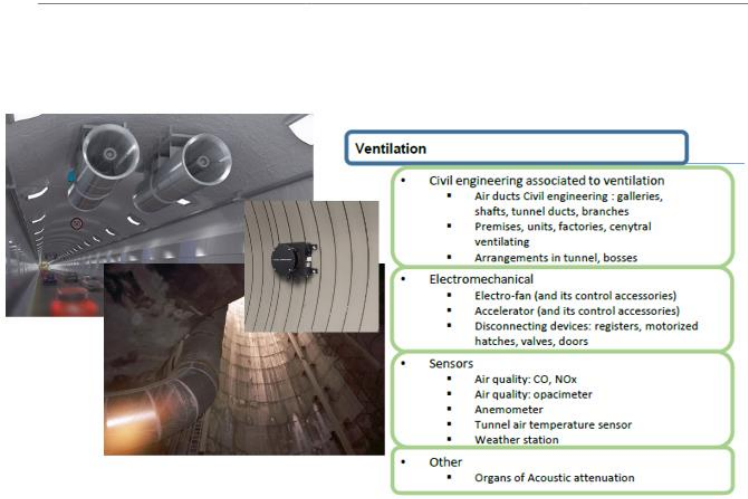
Covered structures





IfcTunnel – Tekniske systemer

- Ventilasjon
- Brann
- Drenering
- Elektrisitet
  - Lav- og høyspenning
- Sikkerhet og evakuering
- Kommunikasjon

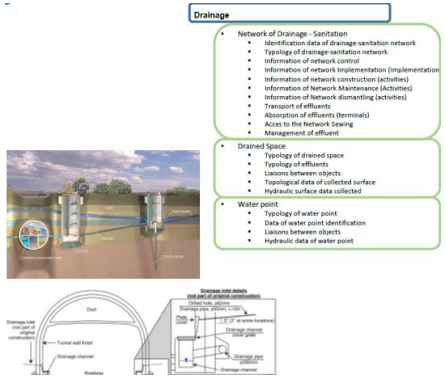


Ventilation

- Civil engineering associated to ventilation
  - Air ducts Civil engineering : galleries, shafts, tunnel ducts, branches
  - Premises, units, factories, cenytral ventilating
  - Arrangements in tunnel, bosses
- Electromechanical
  - Electro-fan (and its control accessories)
  - Accelerator (and its control accessories)
  - Disconnecting devices: registers, motorized hatches, valves, doors
- Sensors
  - Air quality: CO, NOx
  - Air quality: opacimeter
  - Anemometer
  - Tunnel air temperature sensor
  - Weather station
- Other
  - Organs of Acoustic attenuation

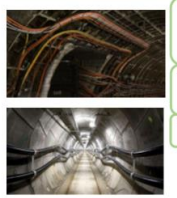
LowVoltage / Energized Equipements

- Power supply
  - High tension
  - Transformation
  - Low tension
  - Wiring
- Lighting
  - Devices
  - Junction box
  - Sensors
  - Runway lights
- Networks
  - Optical Fibre junction box
  - Optical Fibre cable
  - Switch
  - Network Supervisor
- Centralised Technical Management system / Oversight
  - Programmable logic controllers
  - Remote output input module
  - Supervisory server
  - Archiving server
  - Supervision
  - Maintenance station
- Video surveillance
  - Shooting equipment
  - Automatic Incident Detection
  - CCTV system
  - Visualization system
- Emergency Call Network
  - Business Continuity Plan (BCP)
  - Emergency Call Station
  - Server of Emergency Call Station
  - radiating cable
  - Mast
  - Antenna
  - Transmitter / receiver
  - Radio station



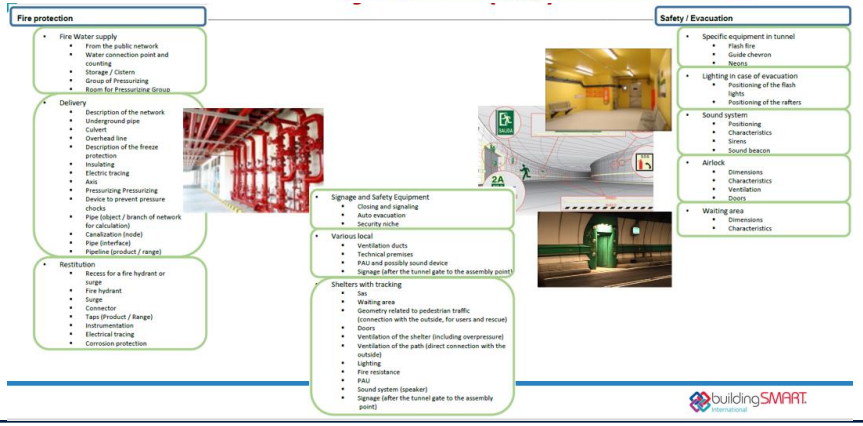
Drainage

- Network of Drainage - Sanitation
  - Identification data of drainage-sanitation network
  - Typology of drainage-sanitation network
  - Information of network control
  - Information of network Implementation (implementation
  - Information of network construction (activities)
  - Information of Network Maintenance (Activities)
  - Information of Network dismantling (activities)
  - Transport of effluents
  - Absorption of effluents (terminals)
  - Acces to the Network Sewing
  - Management of effluent
- Drained Space
  - Typology of drained space
  - Typology of effluents
  - Liaisons between objects
  - Topological data of collected surface
  - Hydraulic surface data collected
- Water point
  - Typology of water point
  - Data of water point identification
  - Liaisons between objects
  - Hydraulic data of water point



HighVoltage / Traction

- Aerial Hight Voltage
  - Delivery post of Aerial High Voltage
  - Artery of Aerial High Voltage
- Low Voltage Distribution
  - Force Lighting Station / Force Station
  - Low Voltage Distribution
  - Emergency power - Uninterrupted power supply and generator (room for battery and generator)
  - System protection and grounding system
- TRACTION
  - Traction Substation + Sectioning Station
  - Traction Distribution
  - Traction Current Feedback Circuit
  - Braking energy recovery systems
- Autonomous system
  - Autonomous production plant
  - Low Voltage Distribution



Fire protection

- Fire Water supply
  - From the public network
  - Water connection point and counting
  - Storage / Cistern
  - Group of Pressurizing
  - Room for Pressurizing Group
- Delivery
  - Description of the network
  - Underground pipe
  - Culvert
  - Overhead line
  - Description of the freeze protection
  - Insulating
  - Electric tracing
  - Axis
  - Pressurizing Pressurizing
  - Device to prevent pressure shocks
  - Pipe (object / branch of network for calculation)
  - Canalization (node)
  - Pipe (interface)
  - Pipeline (product / range)
- Restitution
  - Recess for a fire hydrant or surge
  - Fire hydrant
  - Surge
  - Connector
  - Taps (Product / Range)
  - Instrumentation
  - Electrical tracing
  - Corrosion protection

Safety / Evacuation

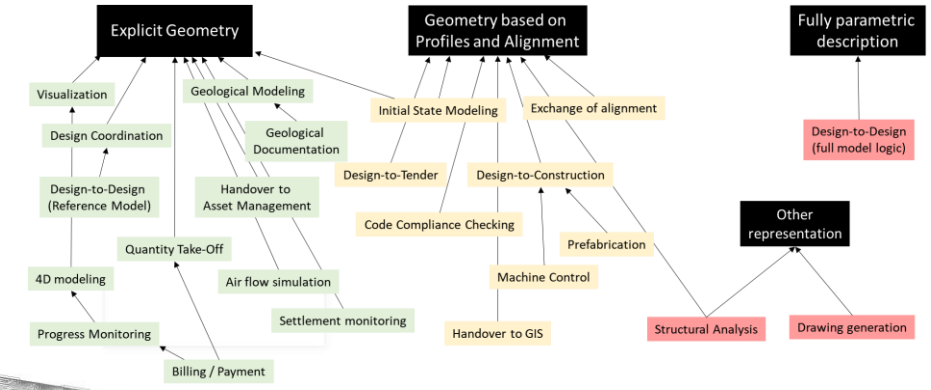
- Specific equipment in tunnel
  - Flash fire
  - Guide chevron
  - Neons
- Lighting in case of evacuation
  - Positioning of the flash lights
  - Positioning of the rafters
- Sound system
  - Positioning
  - Characteristics
  - Sirens
  - Sound beacon
- Airlock
  - Dimensions
  - Characteristics
  - Ventilation
  - Doors
- Waiting area
  - Dimensions
  - Characteristics

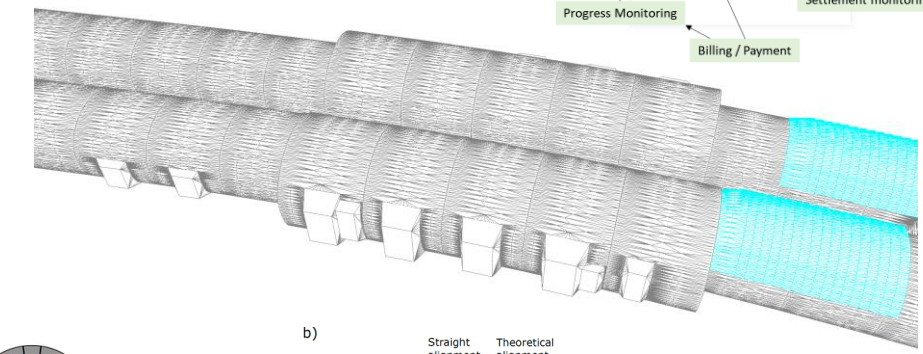
- Signage and Safety Equipment
  - Closing and signaling
  - Auto evacuation
  - Security niche
- Various local
  - Ventilation ducts
  - Technical premises
  - PAU and possibly sound device
  - Signage (after the tunnel gate to the assembly point)
- Shelters with tracking
  - Sas
  - Waiting area
  - Surge
  - Geometry related to pedestrian traffic (connection with the outside, for users and rescue)
  - Doors
  - Ventilation of the shelter (including overpressure)
  - Ventilation of the path (direct connection with the outside)
  - Lighting
  - Fire resistance
  - PAU
  - Sound system (speaker)
  - Signage (after the tunnel gate to the assembly point)

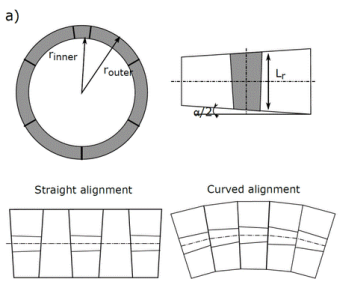
IfcTunnel – Geometrirepresentasjon

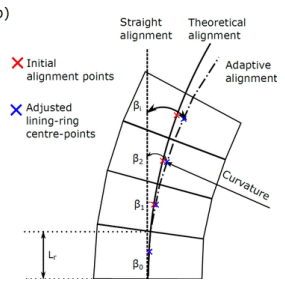
S

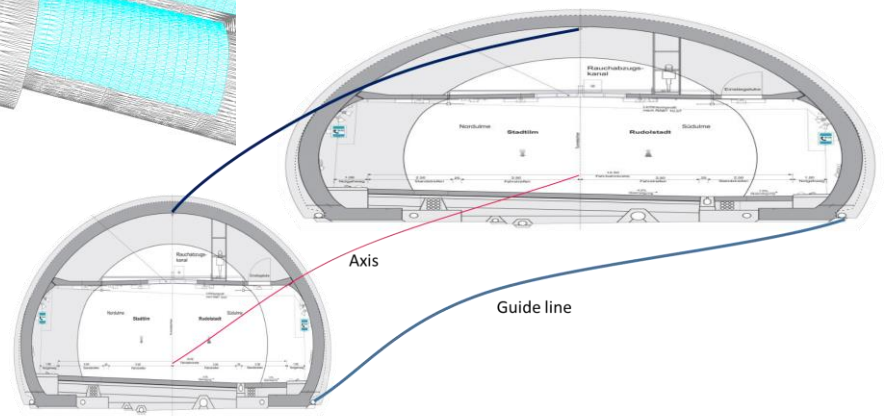
- Brukssituasjonen avgjør hvilken geometritype som bør benyttes.
- Geometritype varianter:
  - Eksplisitt geometri (trianglmodell, NURBS)
  - Prosessert geometri
    - Sweep
    - Boolske operasjoner (CSG)
    - …
  - Parameterbestemt geometri





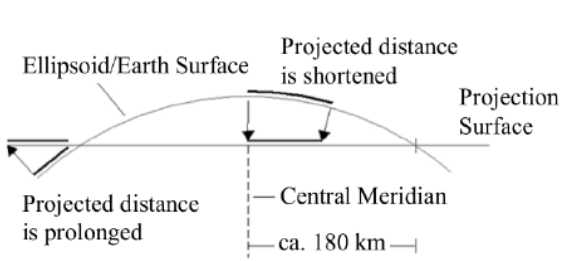


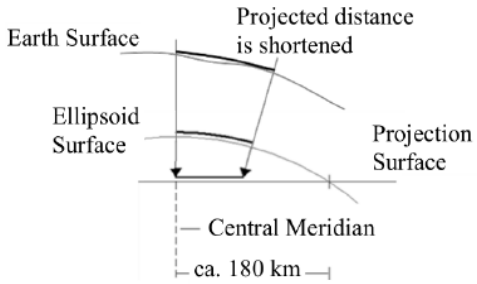


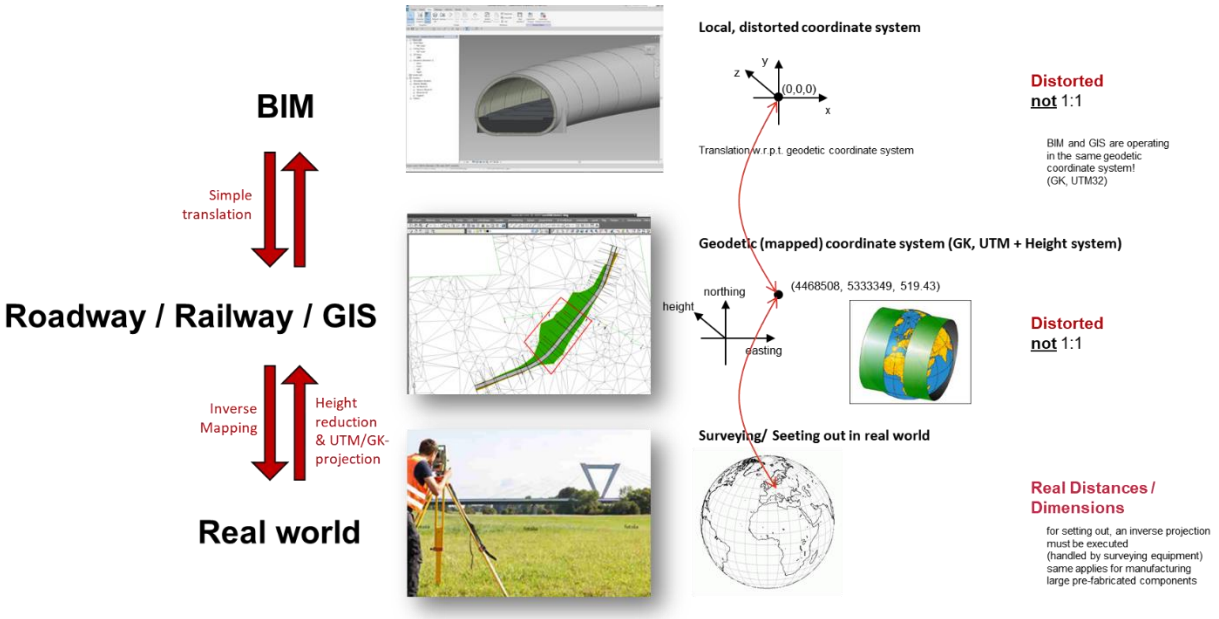


IfcTunnel – Koordinatreferanser

- Lange tunneler er typisk prosjektert basert på et geodetisk koordinatreferansesystem.
- Geodetisk koordinatreferansesystem er basert på en projeksjon.
  → De har en fordreining
- IFC må tilby en klar og utvetydig definisjon for å unngå feiltolkninger.

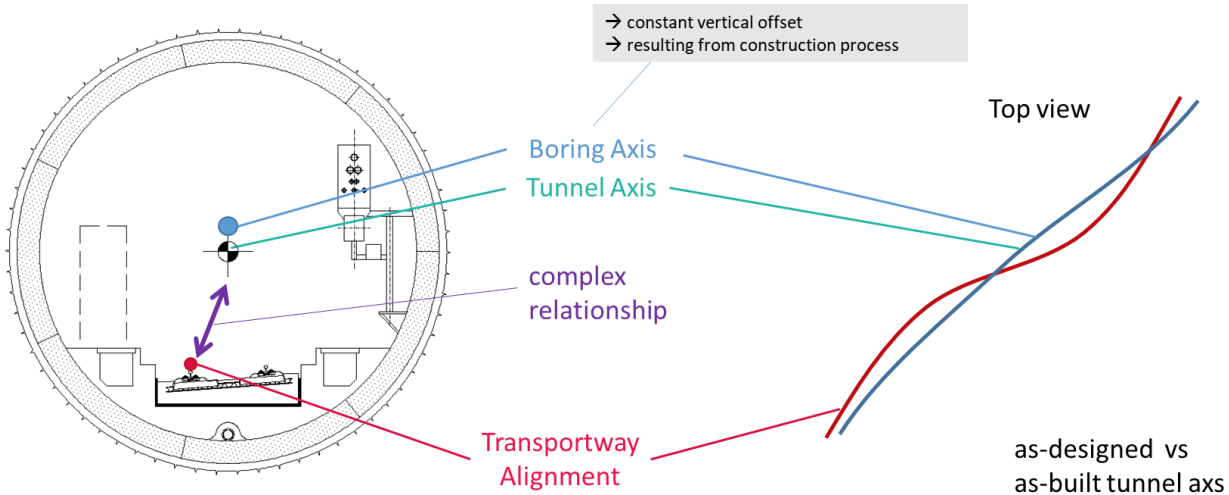


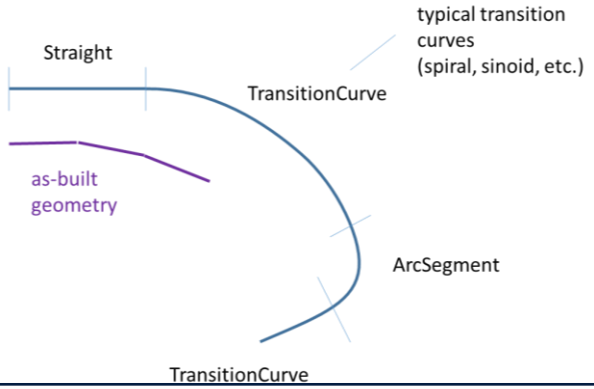




IfcTunnel – Geometri: Referanselinjer

- Referanselinjer er viktige for:
  - Tunnel akse
  - Basis for “swept” geometri
  - Plassering av elementer lang aksen
- Skiller mellom:
  - Referanselinjen for vei/ jernbane
  - Bore aksen (som prosjektert)
  - Tunnel aksen (som bygget)
- IFC 4.3 oppfyller alle kravene:
  - Ikke nødvendig med utvidelser i IFC4.4

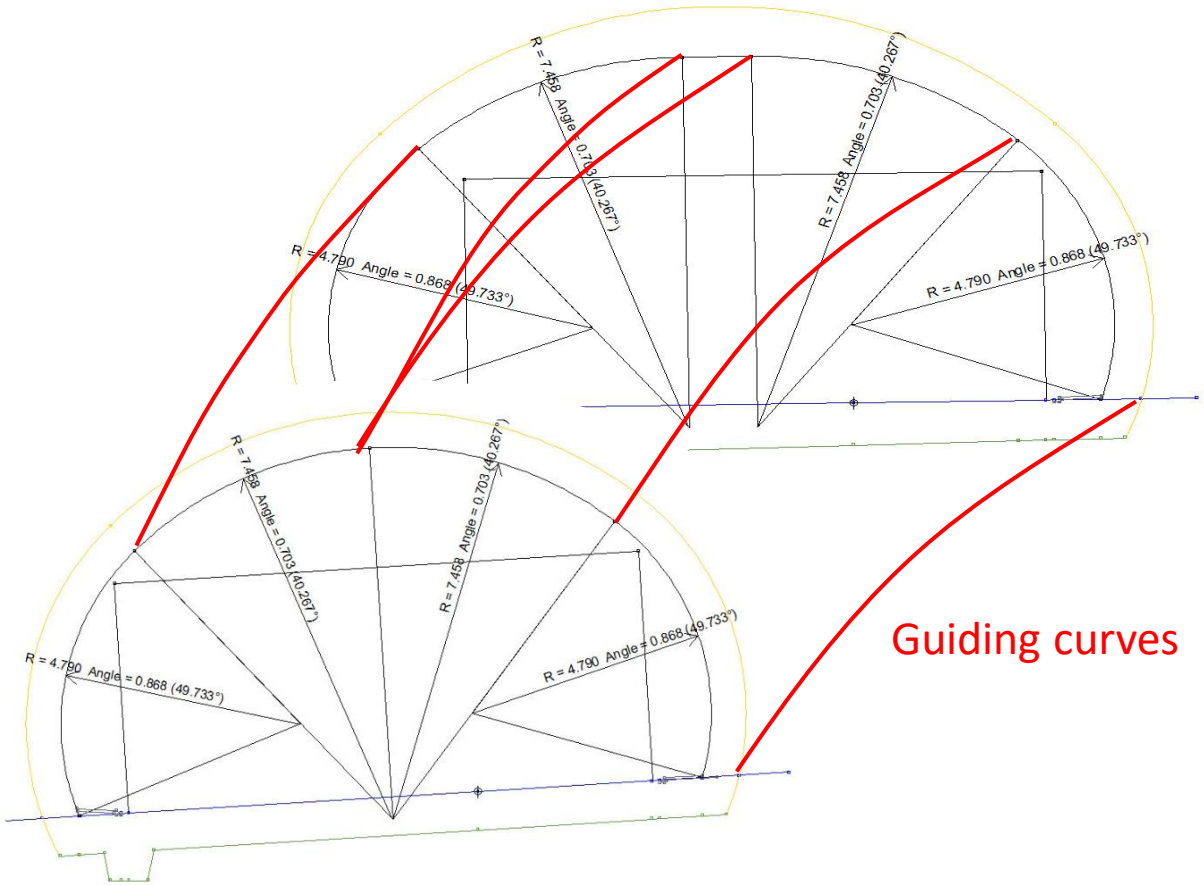




IfcTunnel – Geometri: “Guided Sweep”

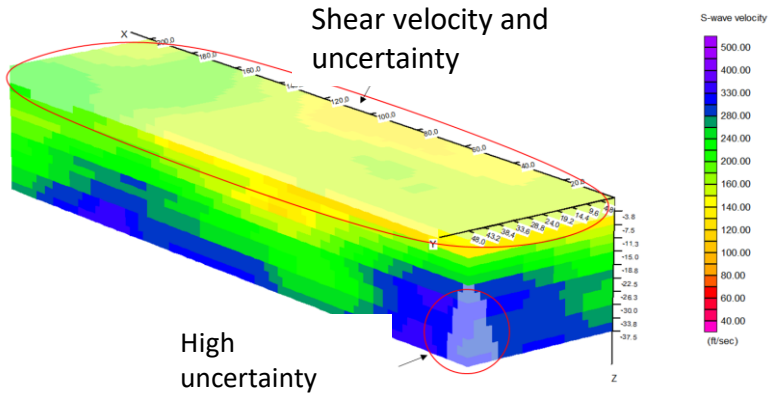
“Guided Sweep”

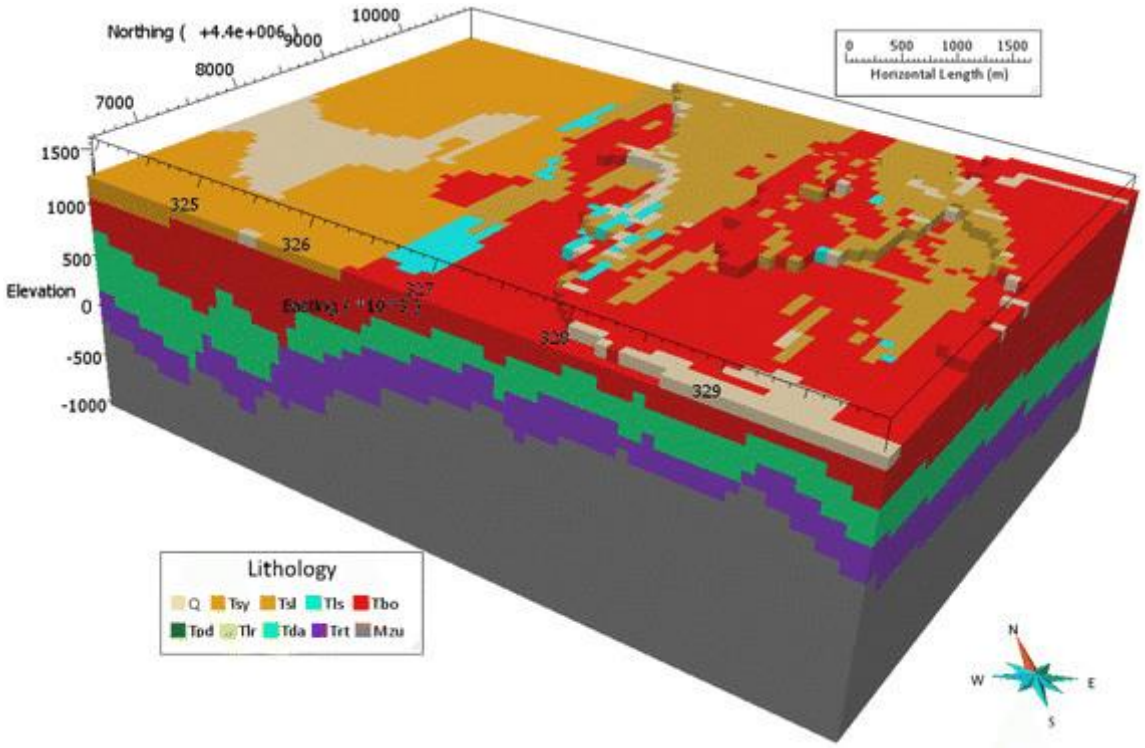
- Varierende tverrsnitt langs referanselinja.
- Definerer interpolasjonen mellom tverrsnitt med “Guiding Curves”.
- “Guiding Curves” kobler tilhørende punkter i to etterfølgende tverrsnitt.



IfcTunnel – Geometri: Voxel representasjon

- Voxel representasjon støtter romlig variasjon av vareierende grunnforhold **uten å måtte definere spesifikke avgrensninger**.
- Kan benyttes for å modellere usikkerhet og risiko bl.a..





Source: Witter et al. 2016

Ifc-4-T – Uttesting

Programvareløsninger som dekker hele livsløpet:

- Prosjekteringsverktøy:
  - Geoteknikk
  - Tunnelprosjektering
  - Systemprosjektering (VA, El osv)
- Maskinstyring og som-bygget registrering
- BIM samhandling & IFC valideringsverktøy
- Drift og vedlikeholdsystemer
- Bibliotek-/komponentleverandører

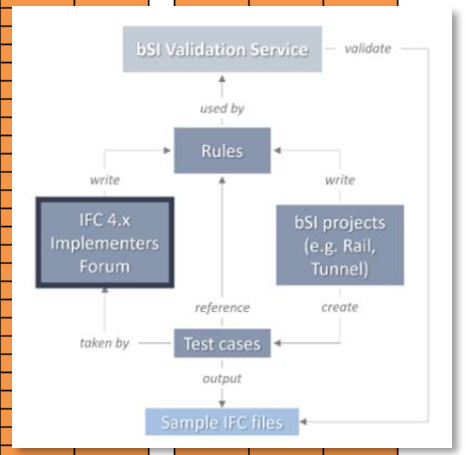
Konsept forståelse/Implementasjon/Sjekker:

- Sprints 1.1 / 1.2 / 1.3 : √
- Sprints 2.1 / 2.2 / 2.3 : √
- Sprint 3.x : Pågående

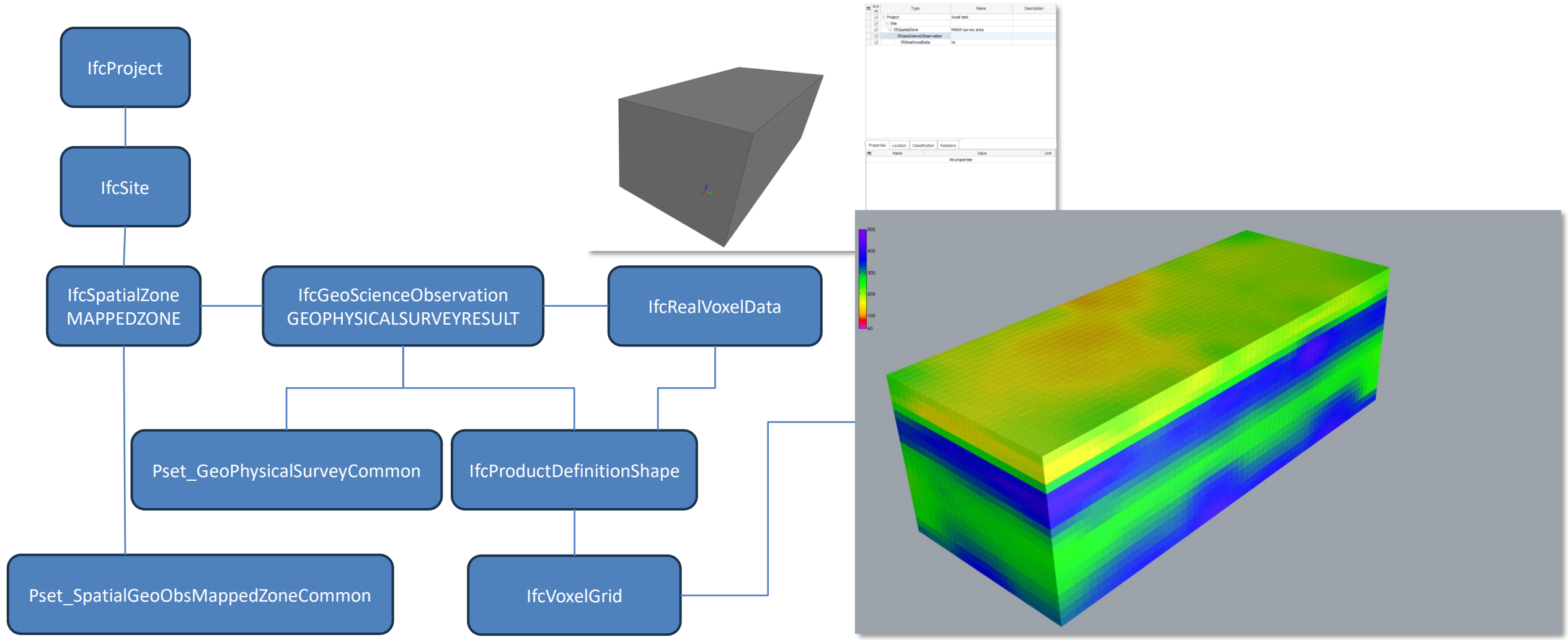
Implementasjon beviser at skjemaet er OK

bSI IFC-for-Tunnelling - Deployment prgm

Cmpy/Product Teams	Domains		Agreemt.	KickOff	Fork	R/W		S-1.1	S-1.2	S-1.3		S-2.1	S-2.2	S-2.3		S-3.A	S-3.B	S-3.C
								Jan 26	Feb 9	Feb 23		Mar 16	Apr 13	May 11		June 15	June 15	June 15
ACCA Software	Excavation-CivilWorks		Signed	Attended	Done	R/W		Passed	Passed	Passed		Passed	Passed	Passed				
ACCA Software	Collaborative platforms		Signed	Attended	Done	R		Passed	Passed	Passed		Passed	Passed	Passed				
Amberg-NO	Excavation-CivilWorks		Signed	Attended	Done	R/W		Passed	Passed	Passed								
Autodesk-C3D	Excavation-CivilWorks			Attended	Done	R/W		Checked										
Autodesk-RVT	Systems for operation			Attended	Done	R/W		Checked										
Autodesk-A360	Collaborative platforms			Attended	Done	R												
Bentley-Civil	Excavation-CivilWorks		Signed	Attended		R/W												
Bentley MEP	Systems for operation																	
Bentley-Seequent	Geotechnics		Signed	Attended	Done	R/W		Passed	Checked	Checked								
Bentley-Seequent	Collaborative platforms		Signed	Attended	Done	R		Checked										
BeverControl	Excavation-CivilWorks		Signed	Attended	Done	R/W		Passed	Passed	Passed		Passed	Passed	Passed			Passed	Passed
Bridge SWI	Excavation-CivilWorks			Attended	Done	R/W		Passed	Passed									
Catenda	Collaborative platforms		Signed	Attended	Done	R		Checked	Checked	Checked								
Dassault Systems	Excavation-CivilWorks		Signed	Attended	Done	R/W		Passed	Passed									
Dassault Systems	Systems for operation		Signed	Attended	Done	R/W		Passed	Passed									
Dassault Systems	Collaborative platforms		Signed	Attended	Done	R		Passed	Passed									
Datacomp	Collaborative platforms			Attended		R												
Deep Excavation	Geotechnics		Signed	Attended	In-Progres:	R/W												
Deep Excavation	Excavation-CivilWorks		Signed	Attended	In-Progres:	R/W												
Dibit Messtechnik	Excavation-CivilWorks			Attended		R/W												
eCassini	Collaborative platforms			Attended		R												
Epiroc	Excavation-CivilWorks																	
ESRi	Geotechnics			Attended	Done	R		Checked	Checked	Checked								
ESRi	Collaborative platforms			Attended	Done	R		Checked	Checked	Checked								
Geoconsult	Geotechnics		Signed	Attended	In-Progres:	R												
GeometryGym	Lib/Tkt providers		Signed	Attended	Done	R/W		Passed	Passed									
Geovita	Geotechnics			Attended		R/W												
Herrenknecht	Excavation-CivilWorks			Attended	Done	R/W		Passed	Checked	Checked		Checked						
Igutech	Geotechnics		Signed	Attended	Done	R/W		Passed	Passed	Passed								
Infrakit	Collaborative platforms			Attended		R												
Leica Geosystems	Excavation-CivilWorks																	
MapInfo	Geotechnics			Attended		R												
Maxwell Geosystems	Geotechnics			Attended	Done	R/W		Checked										
Maxwell Geosystems	Excavation-CivilWorks			Attended	Done	R/W		Checked										
Maxwell Geosystems	Collaborative platforms			Attended	Done	R		Checked										
Nemetcheck-Allplan	Excavation-CivilWorks			Attended	Done	R/W		Passed	Passed									
Nemetcheck-MEP	Systems for operation			Attended	Done	R/W												
Nemetcheck-Solibri	Collaborative platforms			Attended	Done	R												
ODA	Lib/Tkt providers			Attended	Done	R/W		Passed	Passed	Checked		Checked	Checked	Checked		Checked		
OYD corporation	Geotechnics			Attended	Done	R/W		Passed	Passed	Passed		Checked	Checked	Checked		Checked		
RDF	Lib/Tkt providers			Attended	Done	R/W		Passed				Checked	Checked	Checked				
Trimble-Geo	Geotechnics		Signed	Attended	Done	R/W		Passed	Passed	Passed		Checked	Checked	Checked		Checked		
Trimble-NP	Excavation-CivilWorks		Signed	Attended	Done	R/W		Passed	Passed	Passed		Passed	Passed	Checked				
Trimble-TKL	Excavation-CivilWorks			Attended	Done	R/W		Passed	Passed	Passed		Passed	Passed	Checked			Checked	
TwelveD	Excavation-CivilWorks			Attended	Done	R/W		Passed	Passed	Passed		Passed	Checked	Checked				Checked
Vektor.io	Collaborative platforms			Attended		R												
Vizerra	Collaborative platforms			Attended		R												
Volue	Excavation-CivilWorks			Attended	Done	R/W		Passed	Passed	Passed		Checked						



Demo – Voxel data/grid
Oyo, Japan



Demo – Oloron – Conversion IFC4.1 => IFC-4-Tunnelling
ViaNova France/CETU France