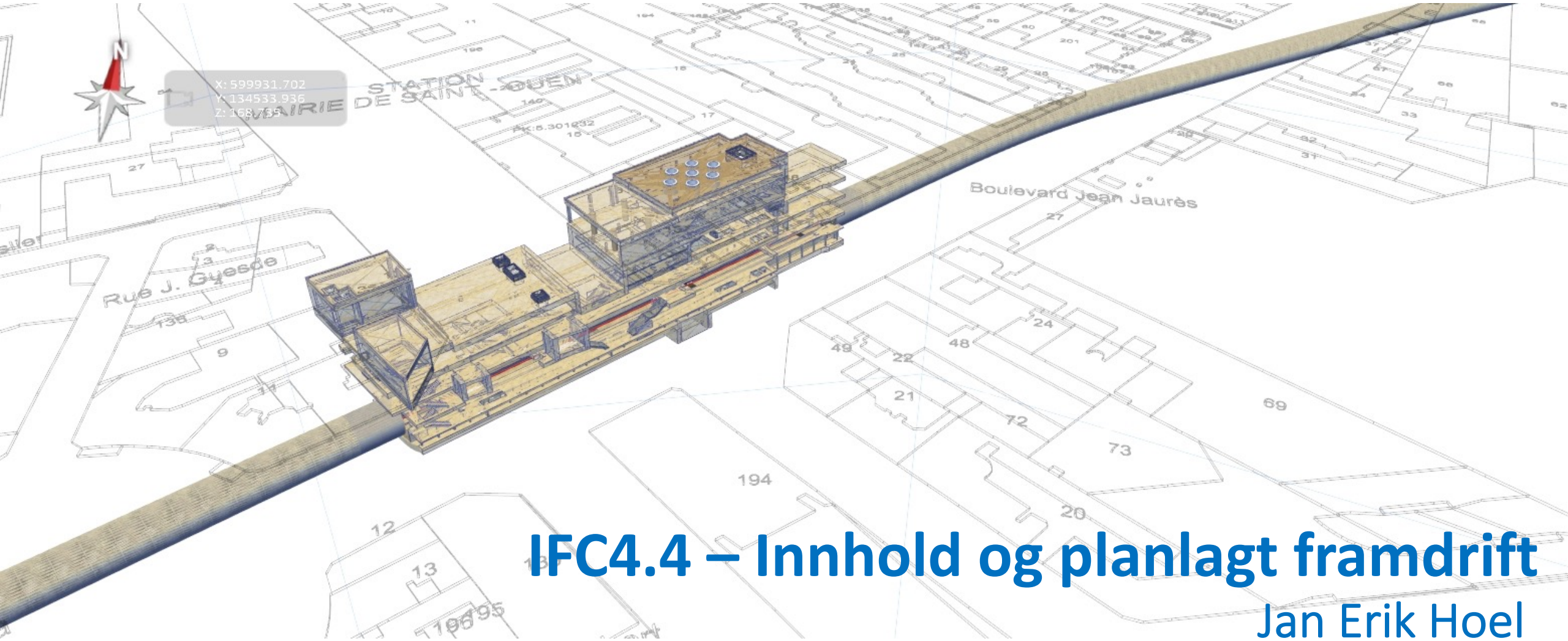


IFC4.4 – Innhold og planlagt framdrift

Jan Erik Hoel

buildingSMART International

Agenda

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

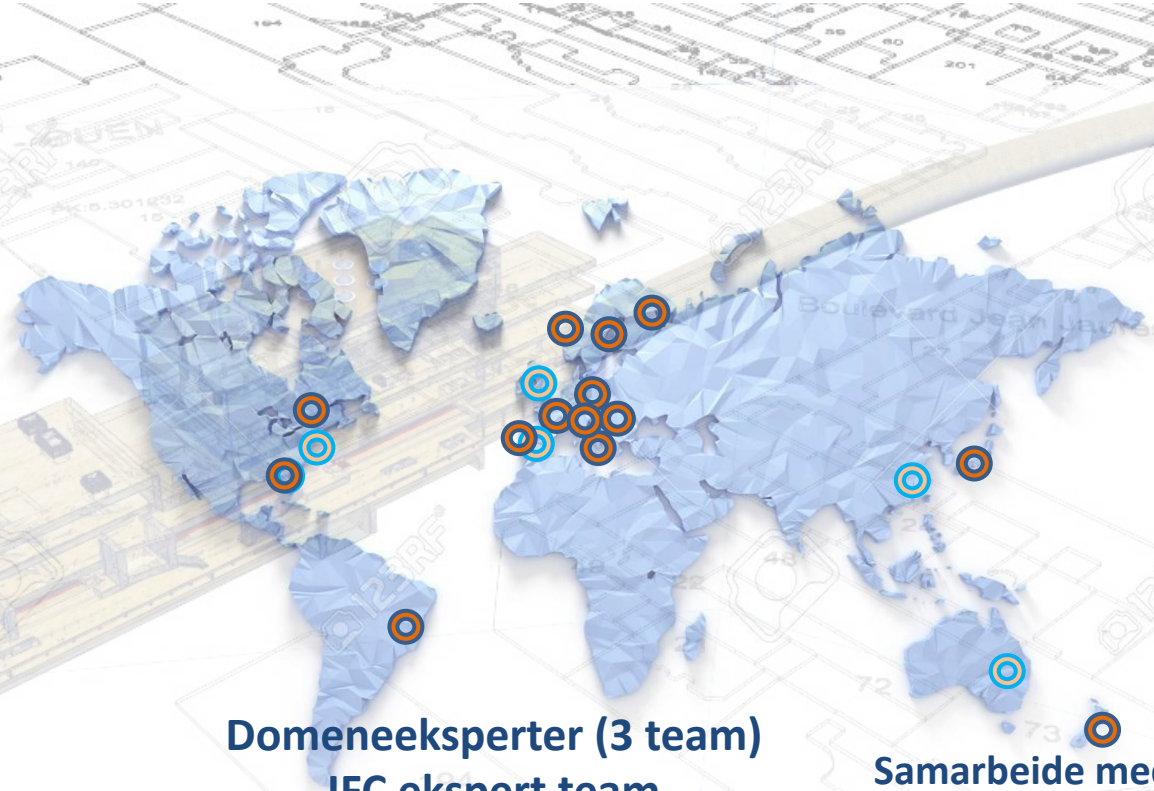
ifcTunnel – Bidragsytere 2020-2023

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

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

Nasjonale organisasjoner:
- DGTIM-CETU (F)
- **NFF (N)**
- PTC (P)

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



Domeneeksperter (3 team)
IFC ekspert team
55+ personer - 1.2m€

Samarbeide med internasjonale organisasjoner:
- **ITA –** The International Tunnelling and Underground Space Association
- **IAEG –** The International Association for Engineering Geology and the Environment
- **OGC –** OpenGIS Consortium

bSI – IFC/ISO for infrastruktur prosjekter

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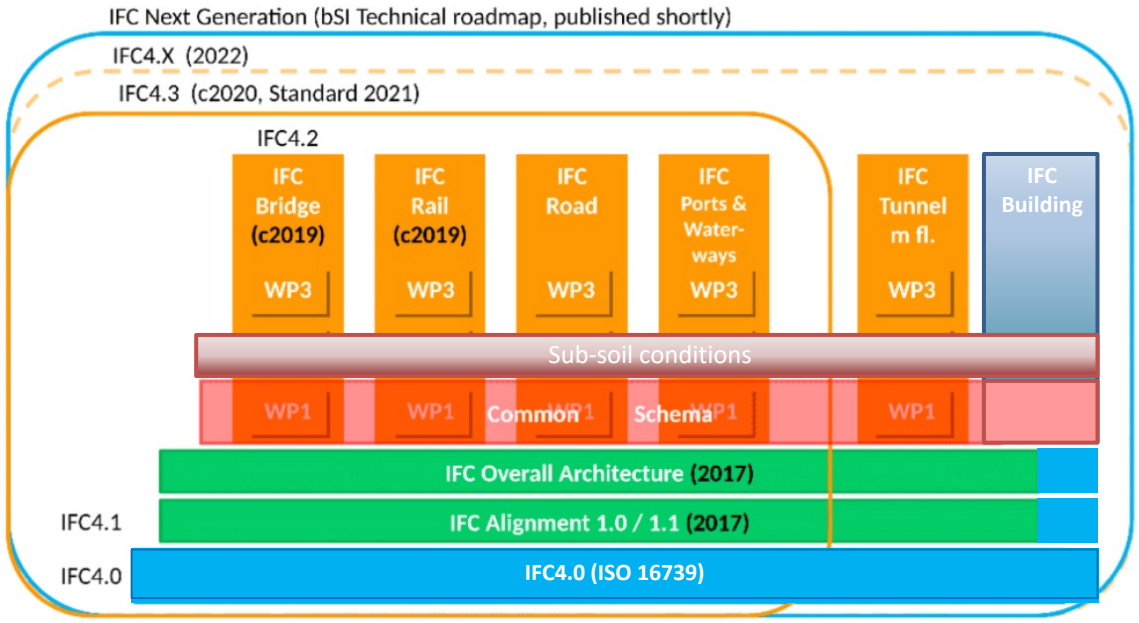

ETT samlet skjema for bygget miljø

ISO International Organization for Standardization

cen

ISO 16739 IFC inkl. IFC4.3

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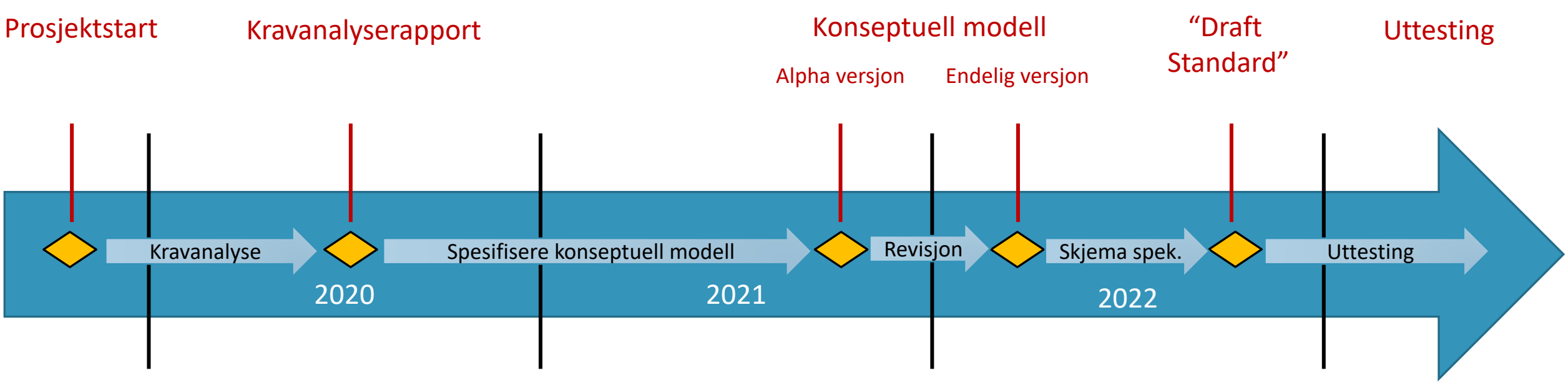
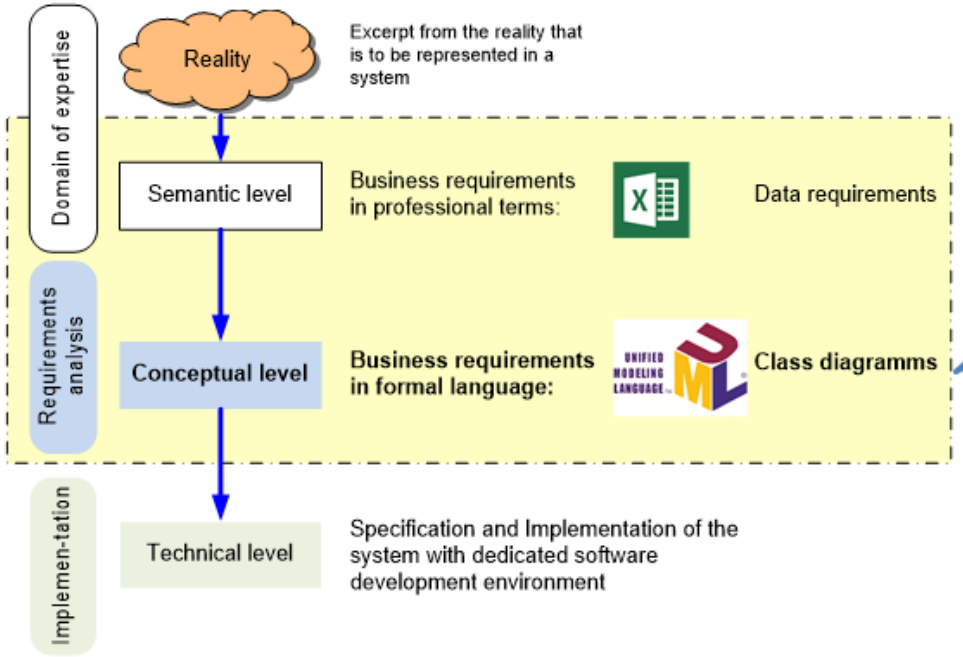
Framdrift


Prosjektstart
Kravanalyserapport
Konseptuell modell
Alpha versjon
Endelig versjon
"Draft Standard"
Uttesting
Kravanalyse
Spesifisere konseptuell modell
Revisjon
Skjema spek.
Uttesting
2020
2021
2022

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

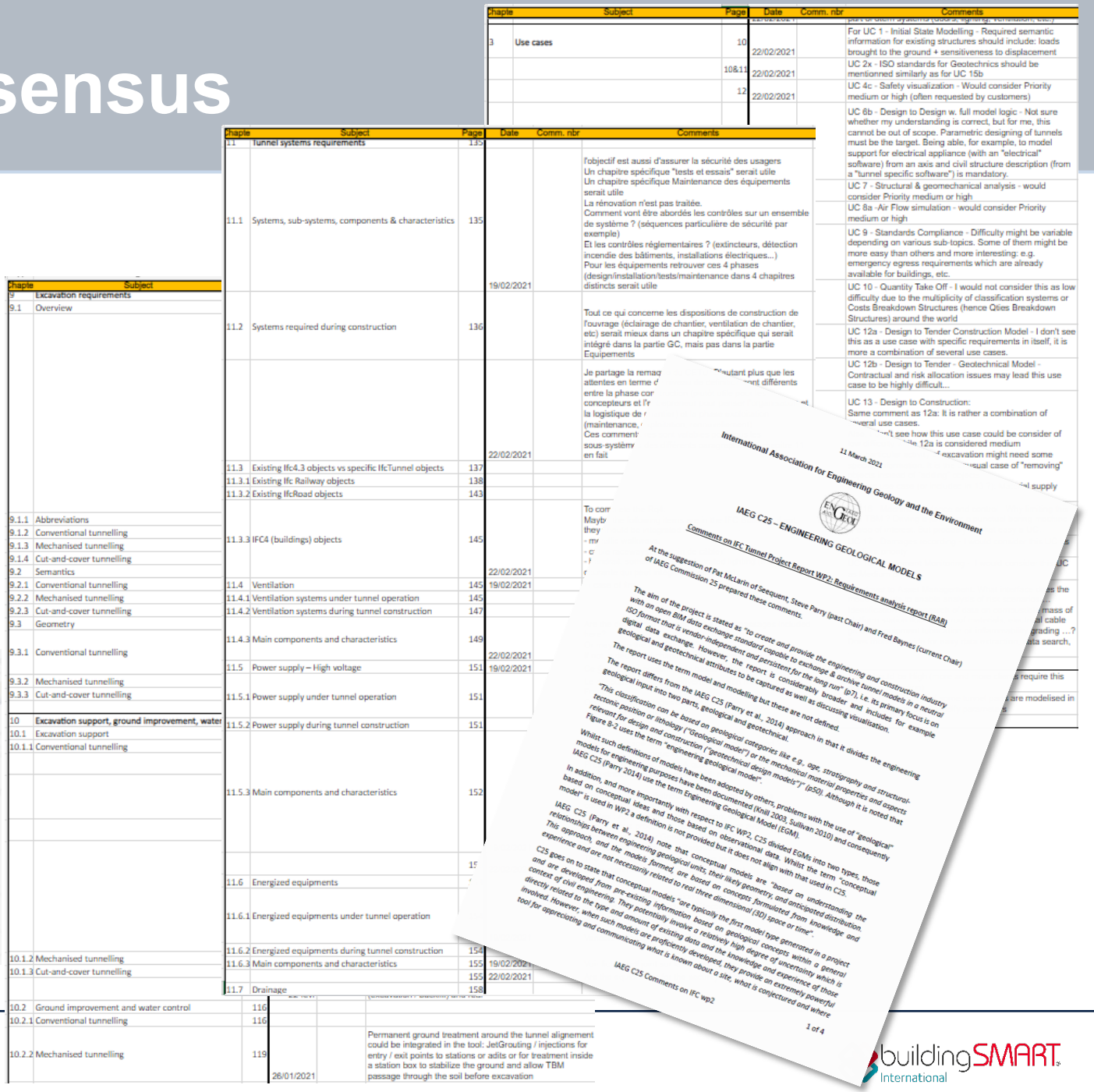
Revisjonsprosessen for krav

3 måndeder/ 10 land

200+ kommentarer/forslag

⇒ Justerte krav

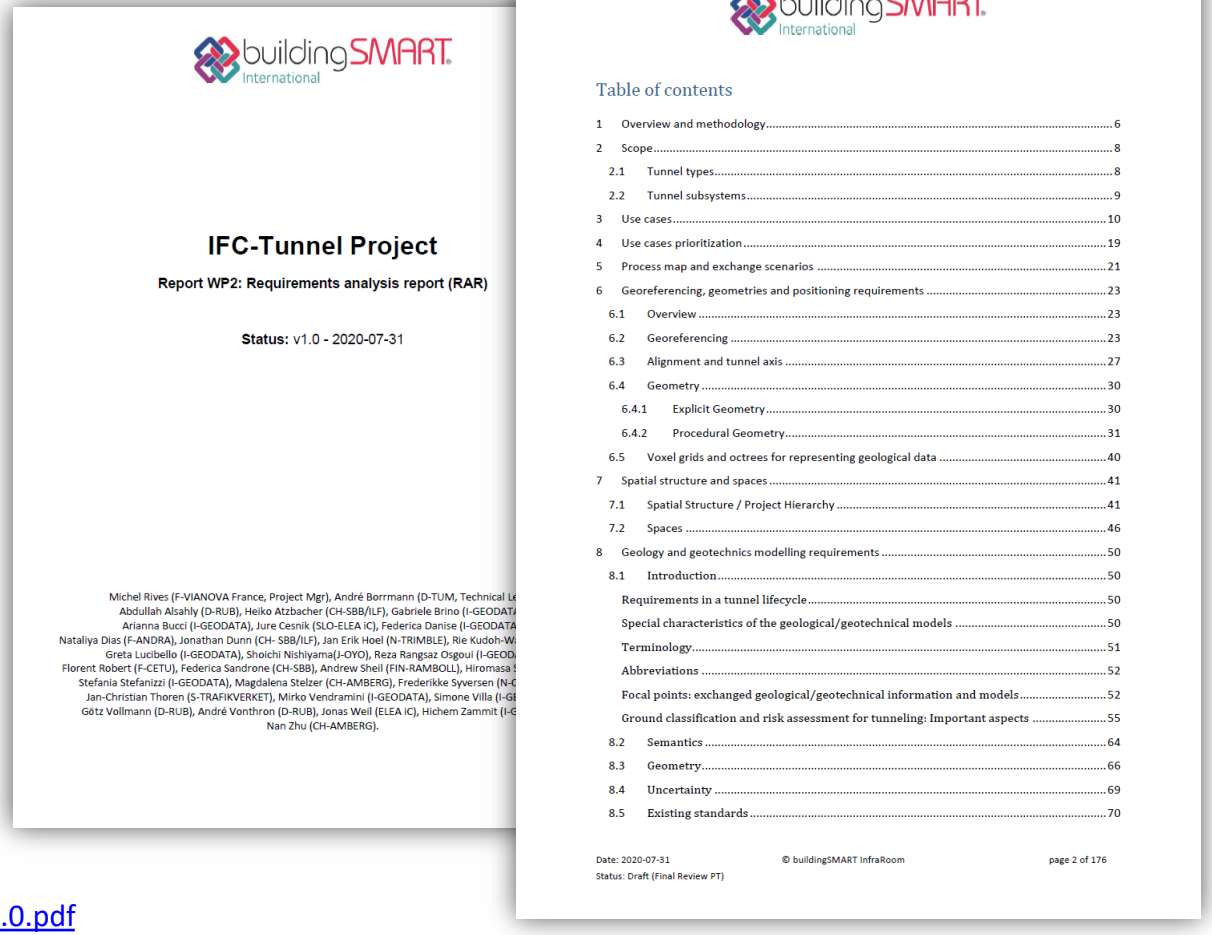
Feedback:	ITA	IAEG	DACH	F	I	JPN	N	NZ	S	US
Subjects:										
Geometry & geopositioning										
Spatial structure & project structure										
Geology & geotechnics	X	X	X	X	X	X	X	X	-	X
Excavation	X	-	X	X	X	X	X	-	X	-
Excavation support	X	-	X	X	X	X	X	-	X	-
Lining & water proofing	X	-	X	X	X	X	X	-	X	-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



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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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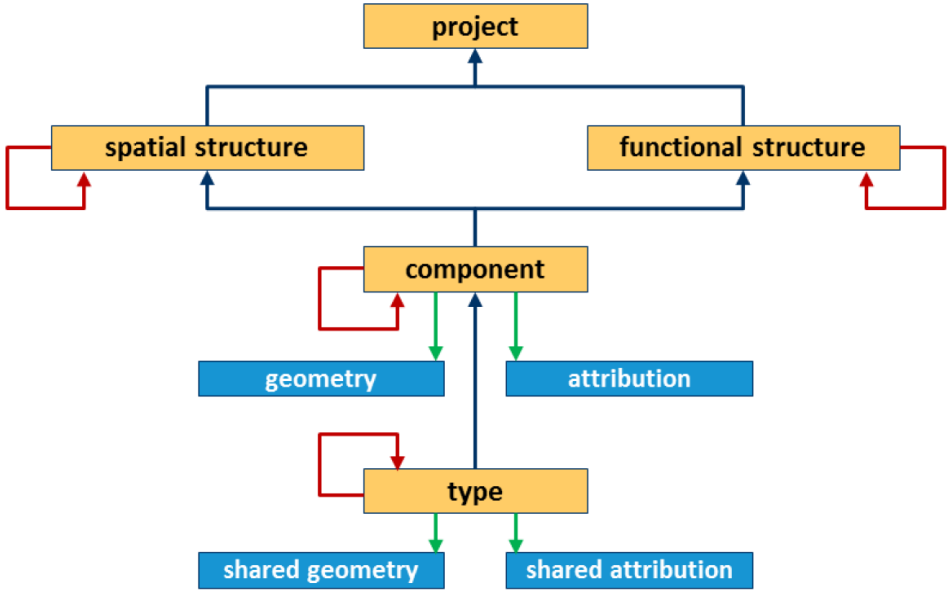
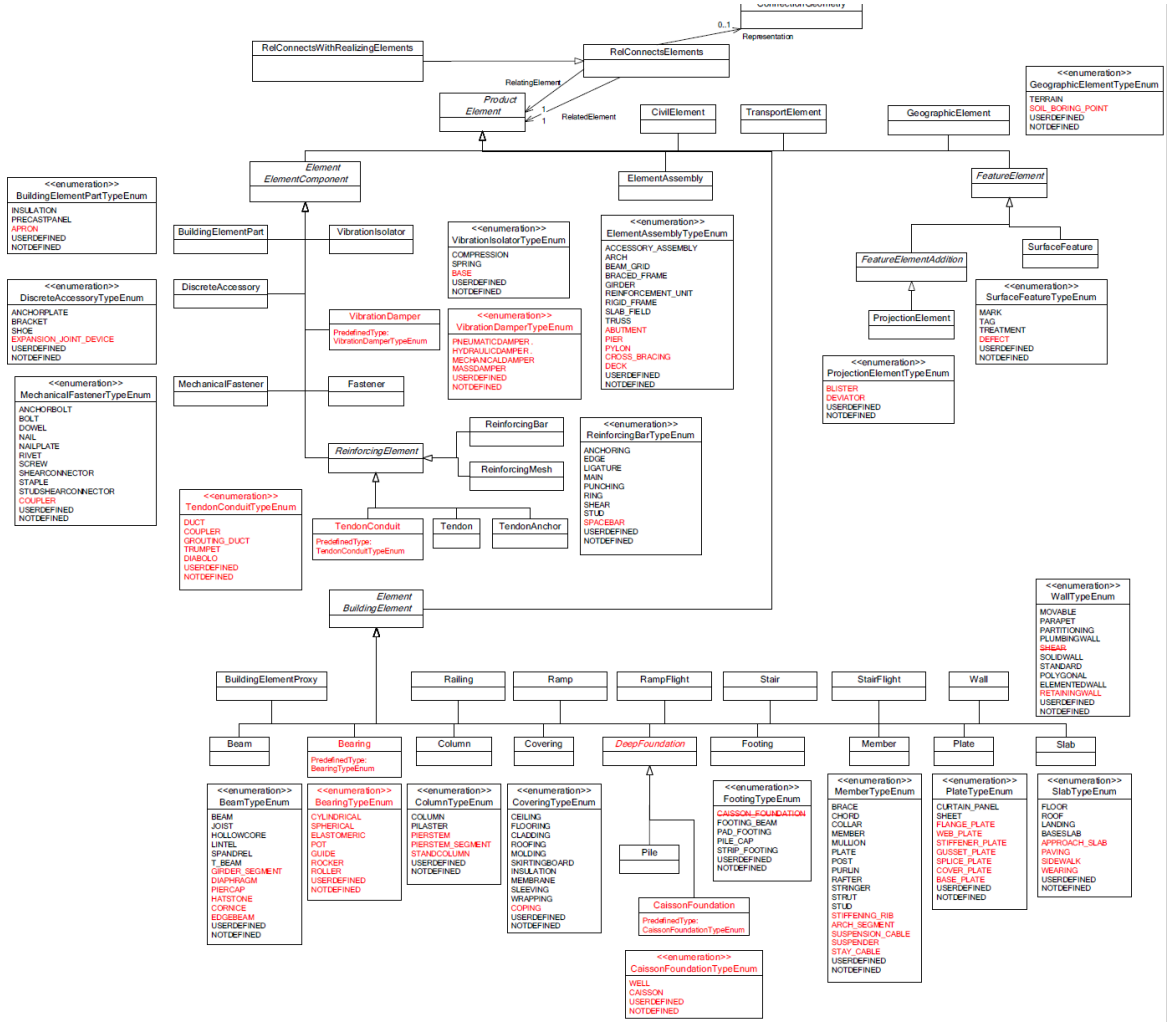
Table of contents

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

IfcTunnel – Konseptuell modell

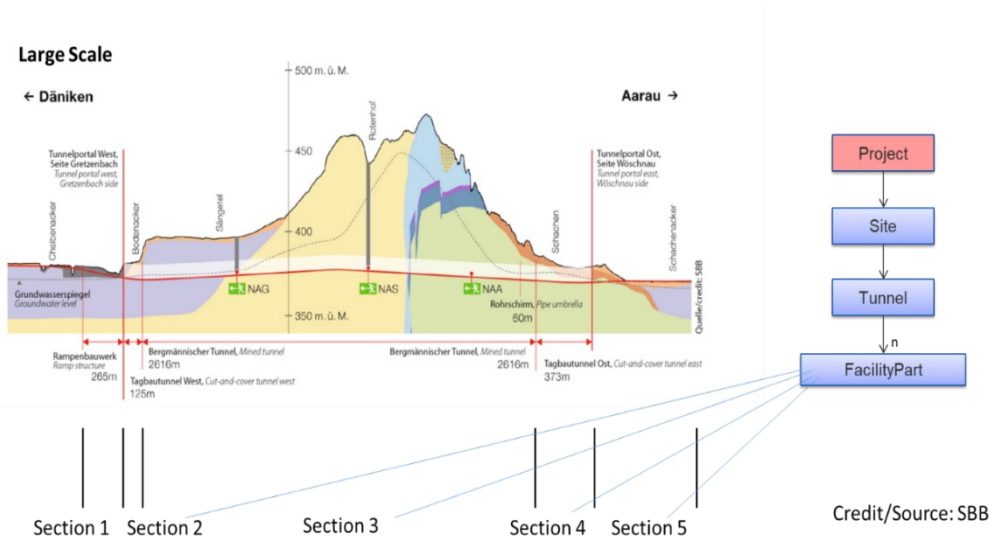
- UML = Unified Modeling Language
- Standardisert **visuell representasjon** av objektorienterte datamodeller
- Basis for konseptuell modellering

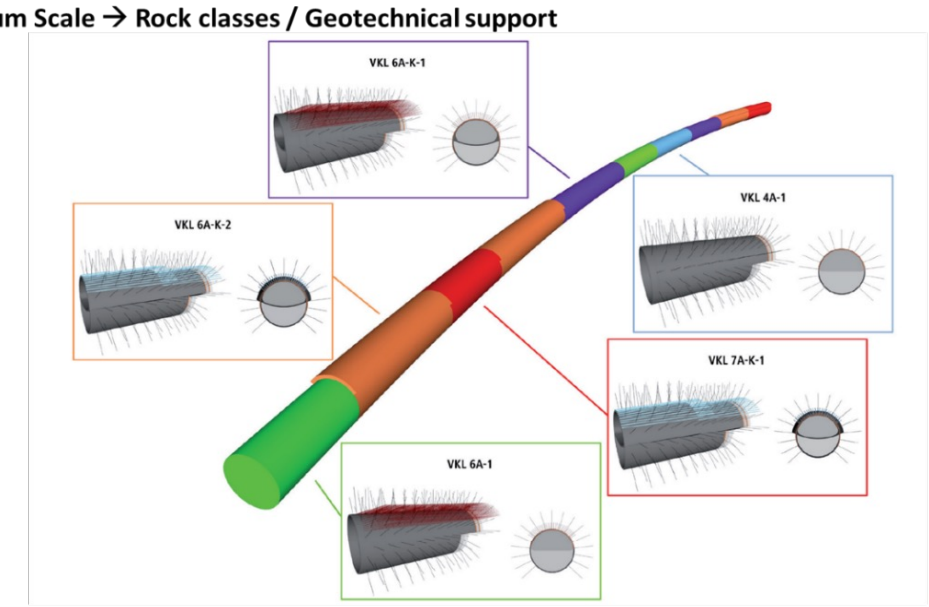


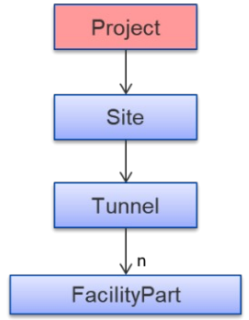


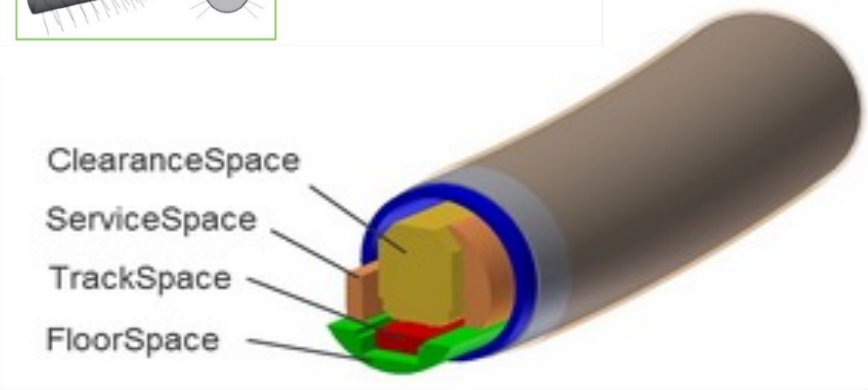
IfcTunnel – Romlig nedbrytning

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

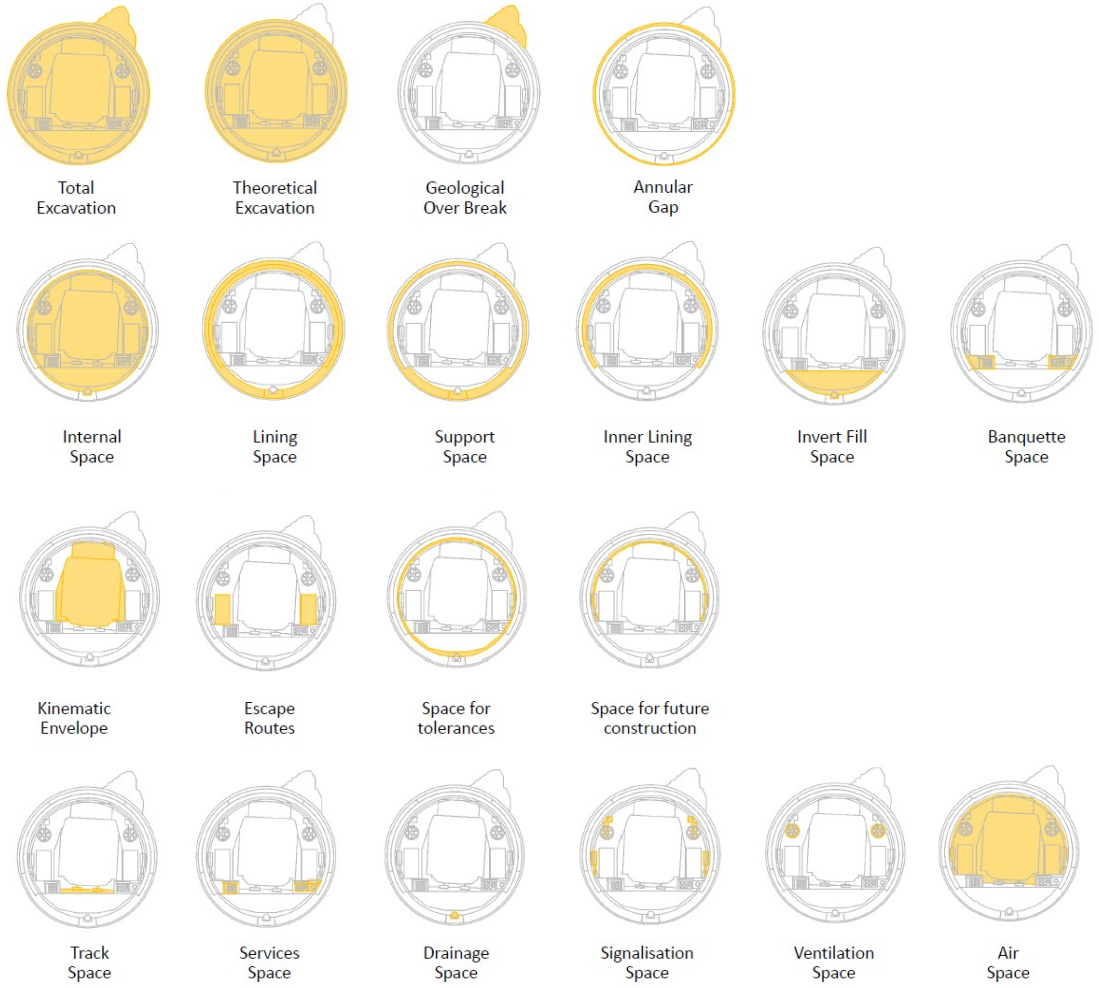








IfcTunnel – Romlige definisjoner

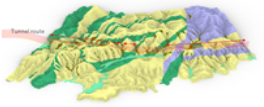
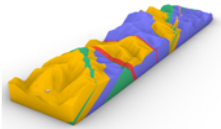
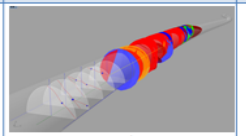
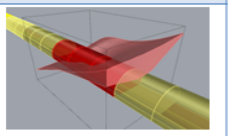
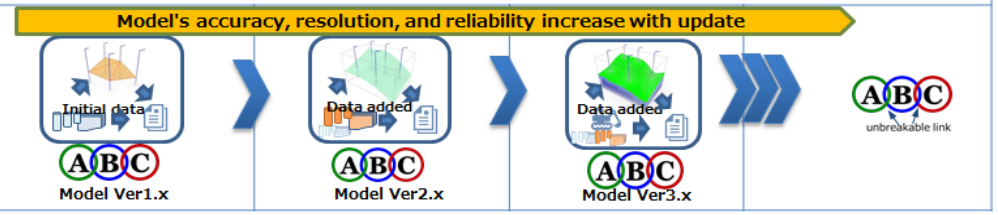


Romlige definisjoner som kan benyttes for beskrive
Tunneldriving-, sikring- og innerkledningsprosesser

Romlige definisjoner som kan inneholde
systemer og utstyr

IfcTunnel – Geologi og geoteknikk

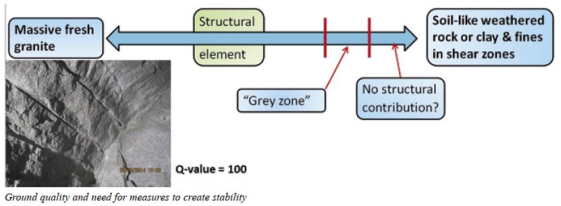
- Geologi/getoteknikk er ikke godt nok definert i IFC4.3 eller av OGC
- Beskrivelse av **lag og diskontinuiteter** (slepper, sprekker osv)
- Sentrale utfordringer: **Usikkerhet** som fører til **risiko**
- Skiller klart på:
  - Registrerte data: “Bok A”
  - Tolkede data: “Bok B”
  - Prosjekterte tiltak: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

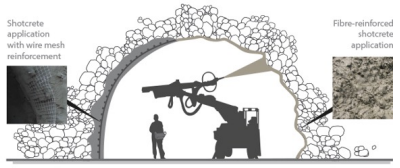
IfcTunnel – Tunneldriving

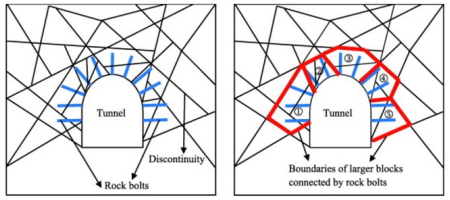
- Tunneldrivingsmetoder
  - Tunnelboremaskin (TBM)
  - Boring og sprengning
  - “Cut and cover“

Boring og sprengning



Ground quality and need for measures to create stability





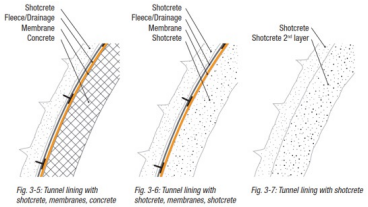
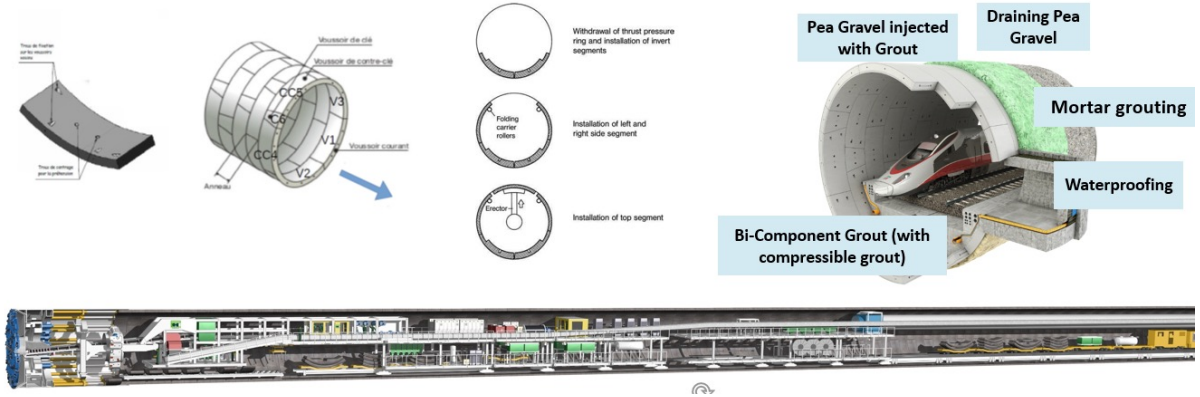


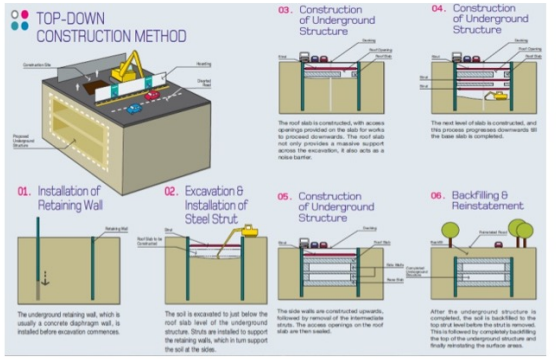
Fig. 3-5: Tunnel lining with shotcrete, membranes, concrete
Fig. 3-6: Tunnel lining with shotcrete, membranes, shotcrete
Fig. 3-7: Tunnel lining with shotcrete

Lining types

TBM

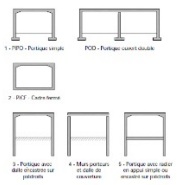


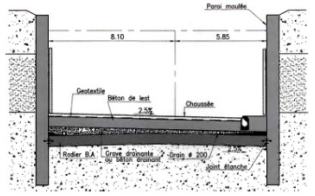
Cut & cover



Retaining walls

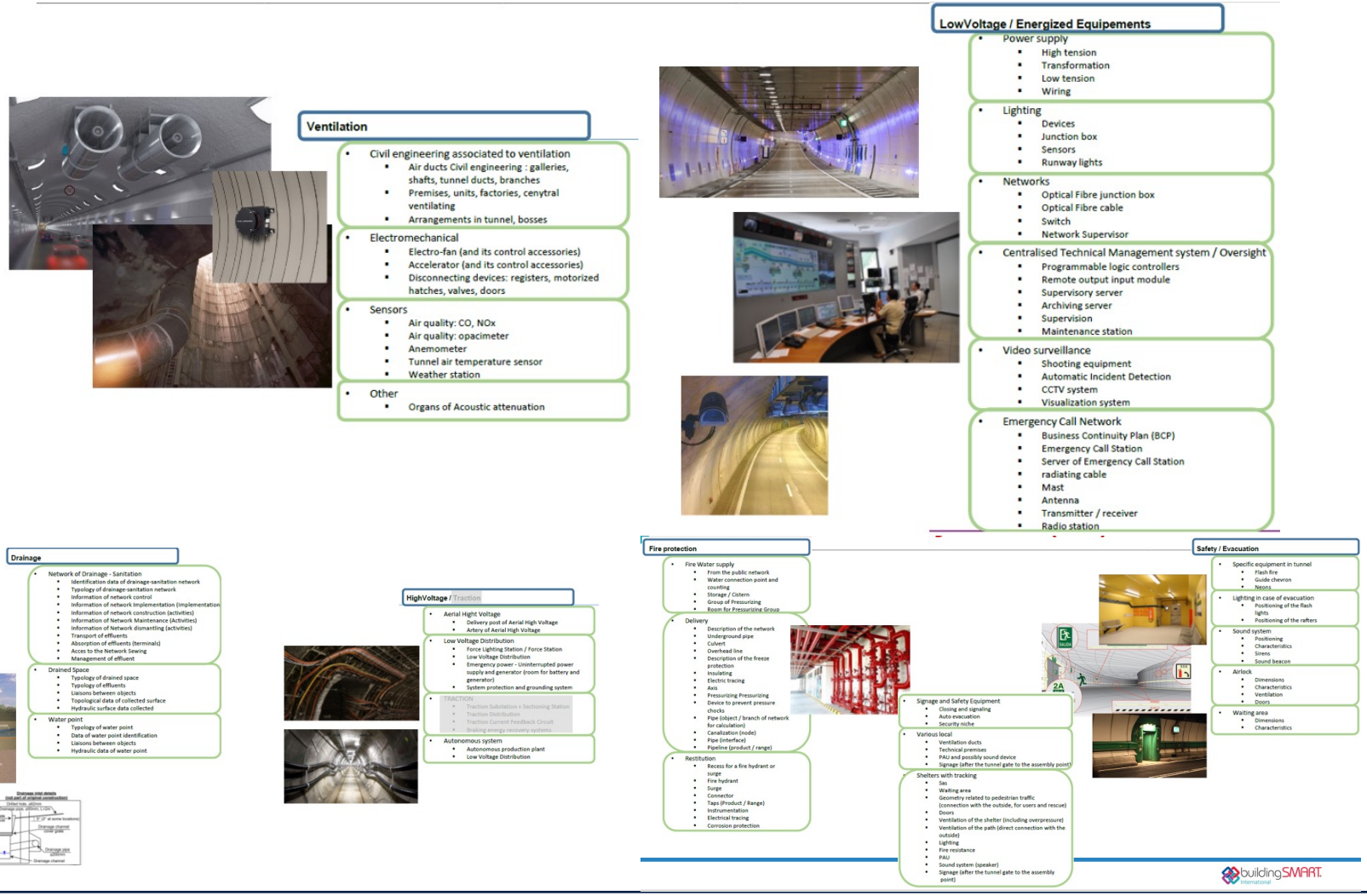
Covered structures





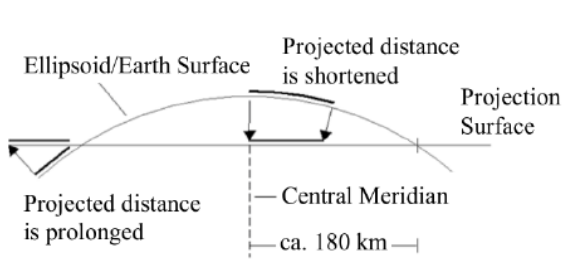
IfcTunnel – Tekniske systemer

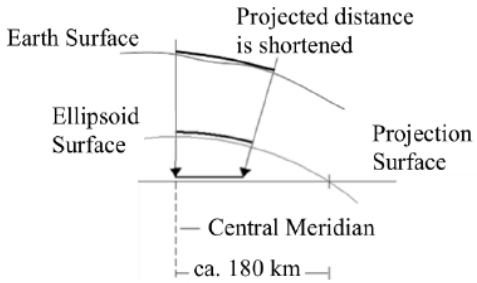
- Ventilasjon
- Brann
- Drenering
- Elektrisitet
  - Lav- og høyspenning
- Sikkerhet og evakuering
- Kommunikasjon

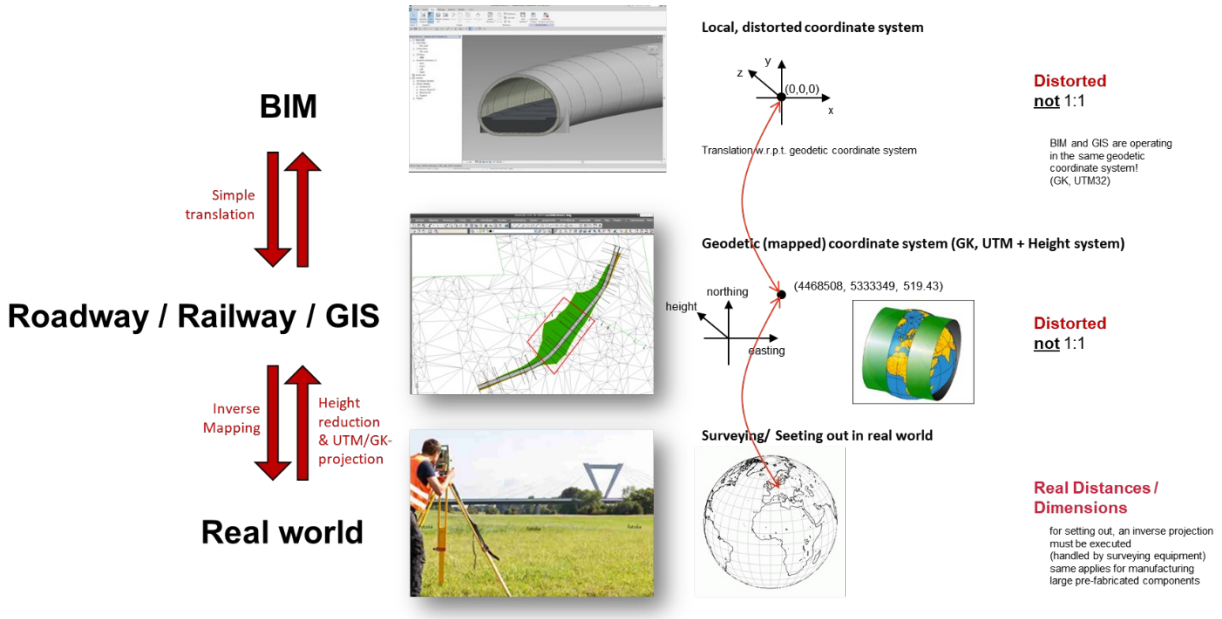


IfcTunnel – Koordinatreferanser

- 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.

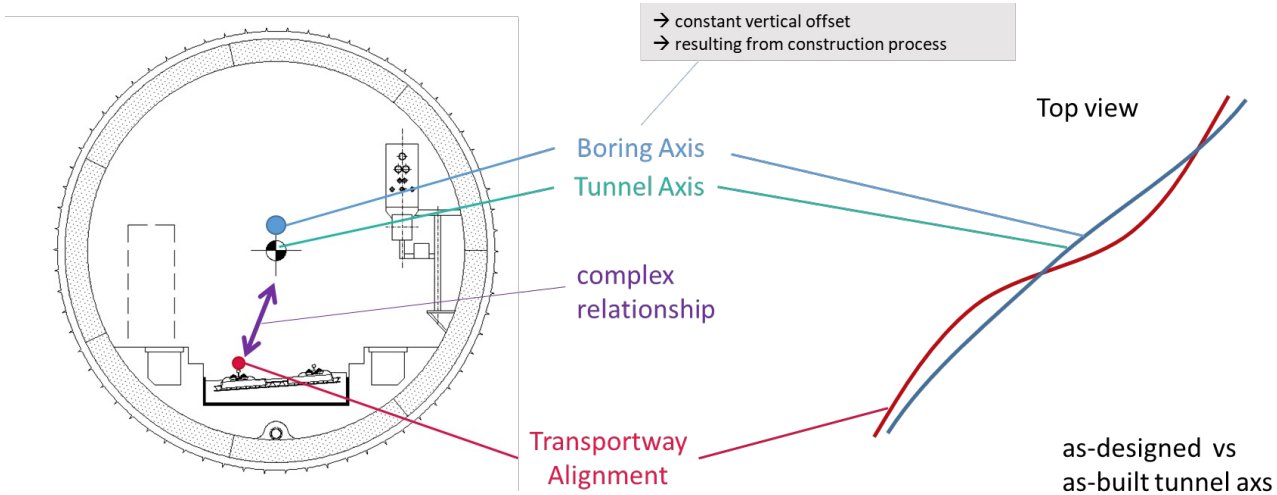


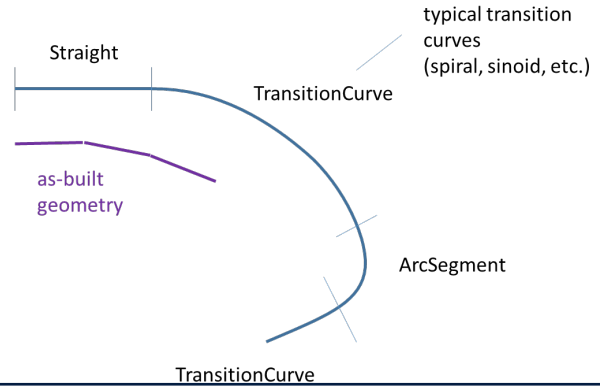




IfcTunnel – Geometri: Referanselinjer

- 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

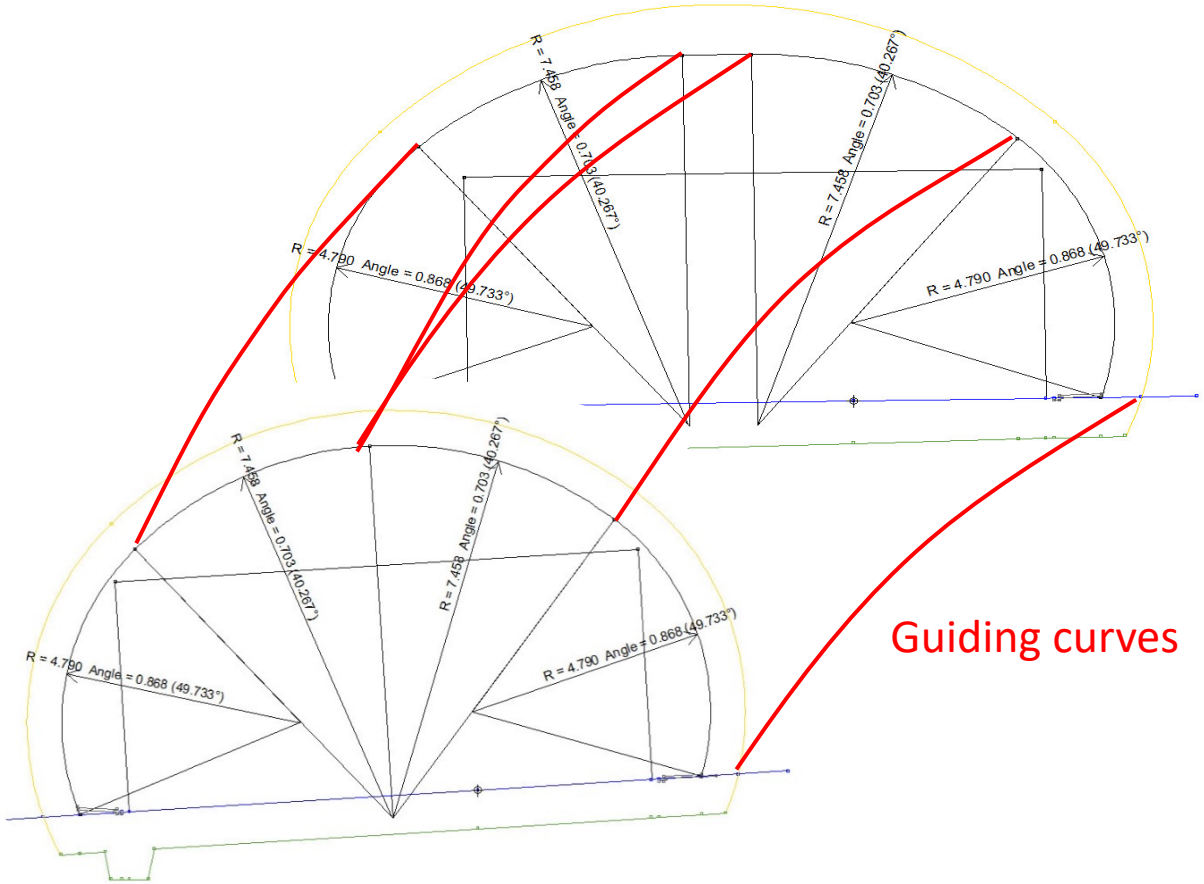




IfcTunnel – Geometri: “Guided Sweep”

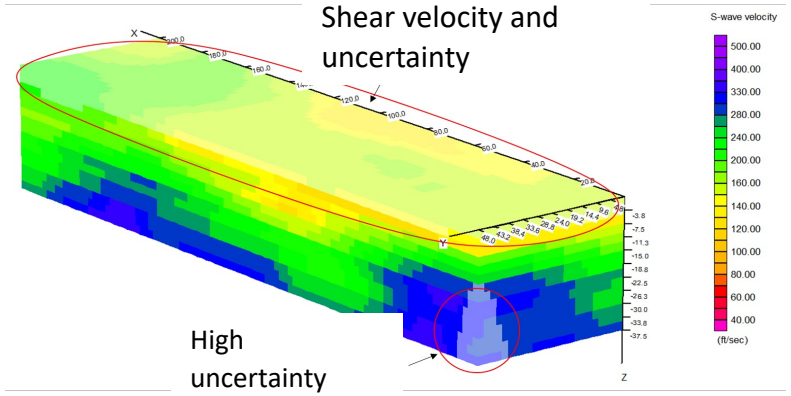
“Guided Sweep”

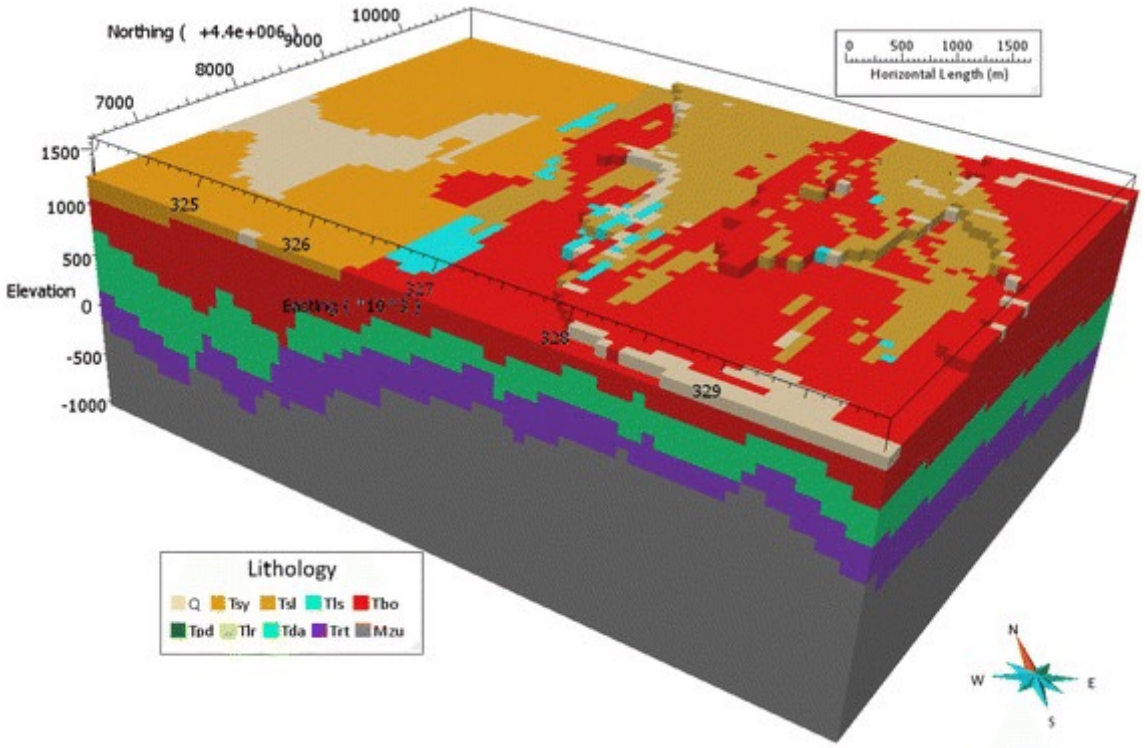
- Varierende tverrsnitt langs referanselinja.
- Definerer interpolasjonen mellom tverrsnitt med “Guiding Curves”.
- “Guiding Curves” kobler tilhørende punkter i to etterfølgende tverrsnitt.



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

IfcTunnel (IFC4.4) – Uttesting

Målsetning: Teste ut dataoverføring og dokumentasjon, skjemavalidering

Deltakere:

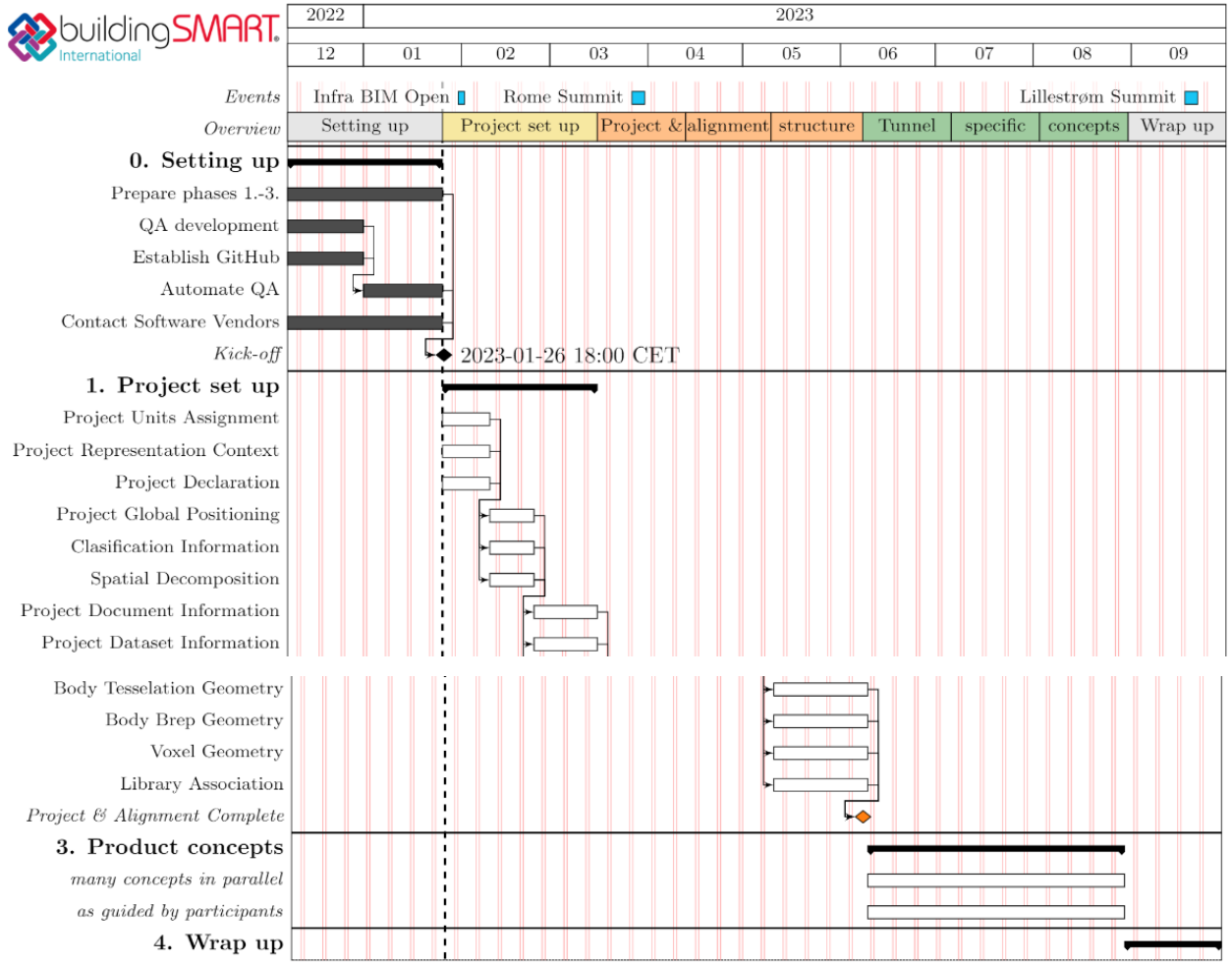
- Leverandører av kommersiell prosjekteringsprogramvare
- Leverandører av kommersielle databaseløsninger
- Leverandører av kommersielle bibliotek:
  GeometryGym / ODA / RDF / Rhino / SafeSoftware / THC / Unity3D
- Konsulentfirma som utfører løsningsintegrasjoner
- Skreddersømløsninger
- Maskinstyringsprogramvare
- Valideringsløsninger for IFC-filer:
  ACCA / IfcOpenShell / THC
- BIM Innsynsverktøy
- BIM samordningsplattformer

Pr. i dag er det 9 firma som deltar aktivt.

https://github.com/bSI-InfraRoom/IFC-Tunnel-Deployment

IfcTunnel (IFC4.4) – Uttesting

Tidsplan



- Uttesting gjennomføres i sprinter
- Produserte filer valideres automatisk ved innsjekk i GitHub
- Ukentlige møter