FIG NL THE NETHERLANDS

e WORKING WEEK 2021 20-25 JUNE

SMART SURVEYORS FOR LAND AND WATER MANAGEMENT

CHALLENGES IN A NEW REALITY

10 YEARS OF DEVELOPMENT IN MODEL-BASED OPENBIM WORKFLOW IN INFRASTRUCTURE SURVEYING IN FINLAND FROM A SURVEYOR'S PERSPECTIVE

MIIKA KOSTAMO & PETTERI PALVIAINEN

24.06.2021

www.novatron.fi

Xsite® MACHINE CONTROL

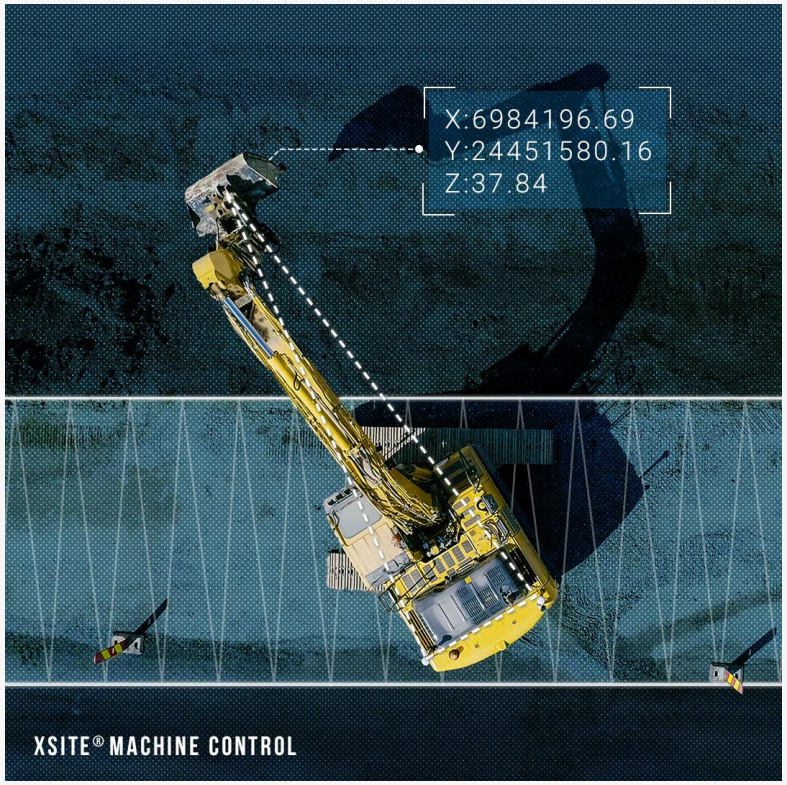
INFRABIM

BACKGROUND

Early 2000's

Contractors has been forerunners in model based actions

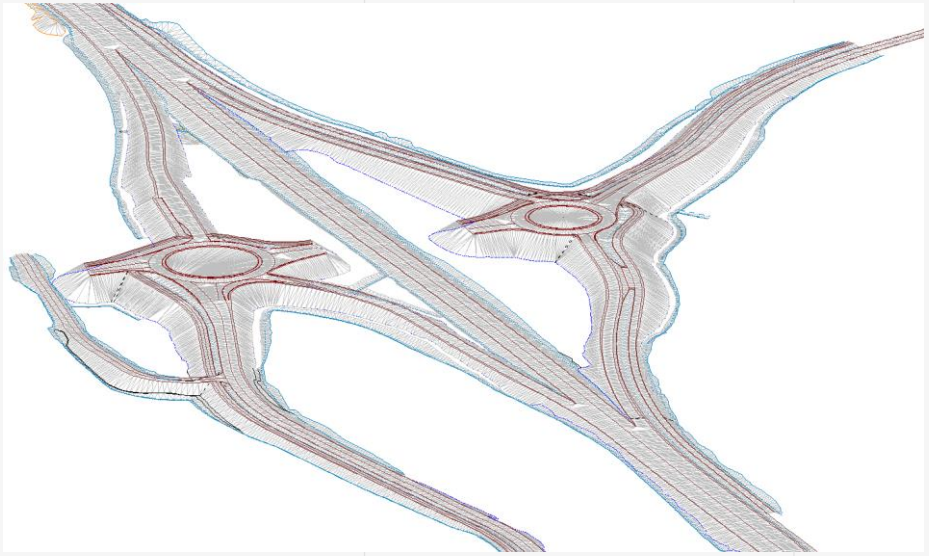
- More efficiency for work site
  - ➢ Using Machine Control on jobsite



2008 ->

Demands for 3D models from designers by contractors

- Models for Machine Control



INFRABIM

BACKGROUND

2010 - 2014

PRE RYM InfraFINBIM -Research Program

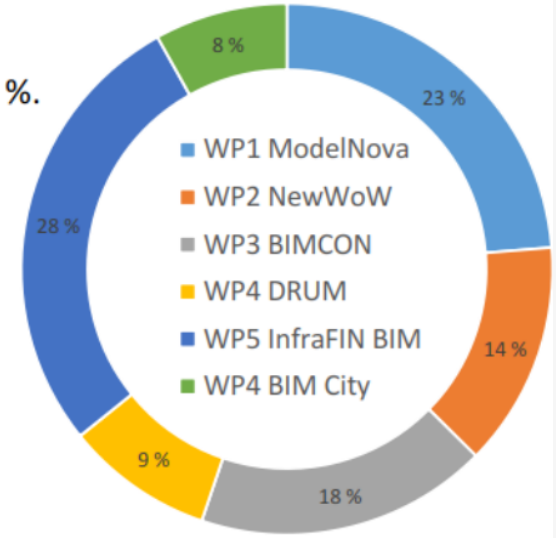
- Infra owners involved
  - ➢ Lots of benefits for infra asset lifecycle
- Demands for 3D models by infra owners
- Finnish Common Regulations as results:
  - ❑ Common InfraBIM Requirements
  - ❑ InfraBIM Classification System
  - ❑ Inframodel Data Exchange

PRE 2010 - 2014

PRE Actuel Cost 22,24 million €

- Involved 37 companies and 6 research institutes.
- Public Fund with Tekes < 51 %.

- **Infra FINBIM** 6,1 m€
  Future innovation-based delivery chain of the infra sector
  - 13 companies, 6 research institutes
  - 6 infra clients
  - 30 pilot projects



"An outstanding example of the radical change in the markets"

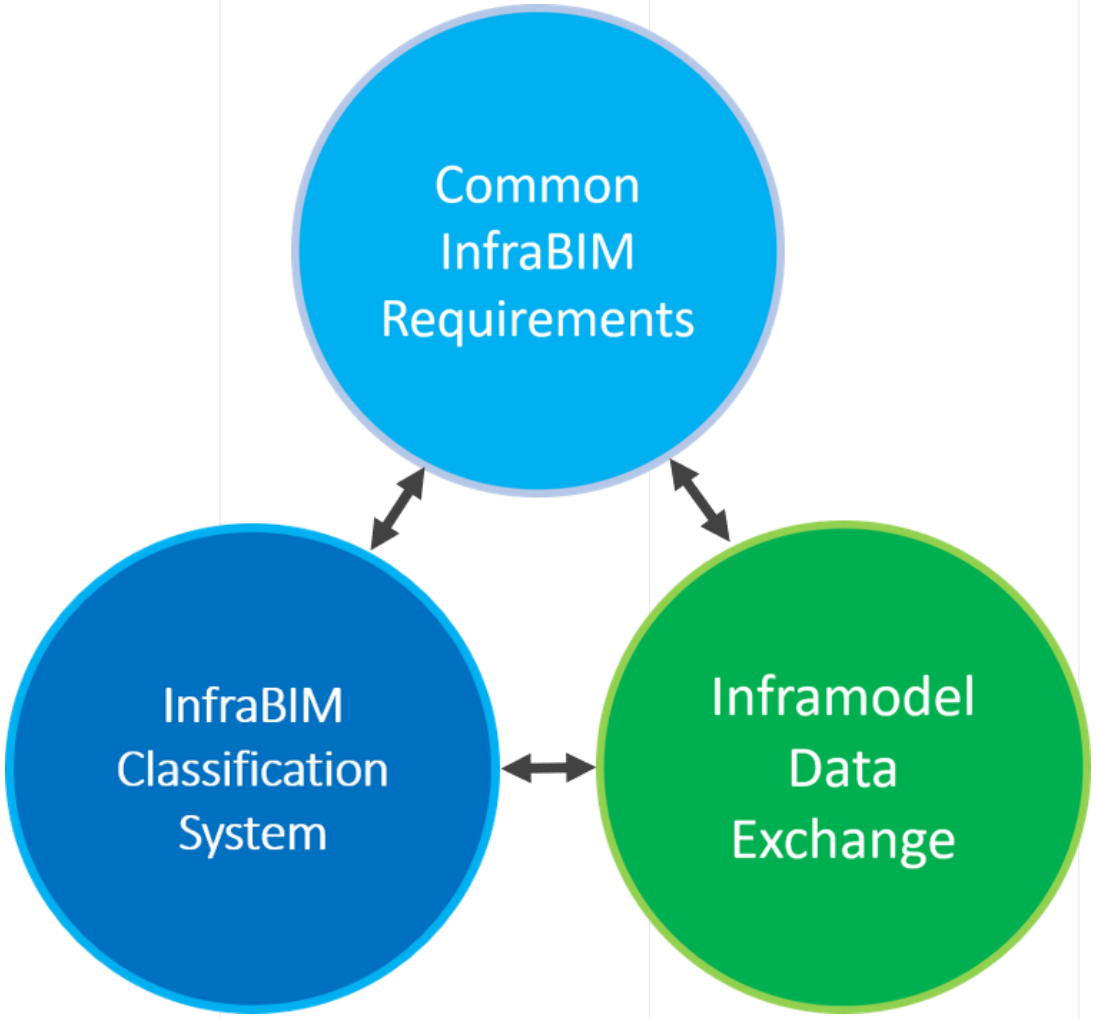
buildingSMART FINLAND

Full report in English:
https://buildingsmart.fi/wp-content/uploads/2019/10/RYM_PRE-Results-Report.pdf

INFRABIM

COMMON REGULATIONS

- Based on **real projects**
- Developed by **whole industry**
- **Required** by infra owners



Common InfraBIM Requirements

REQUIREMENTS

Current version YIV2019

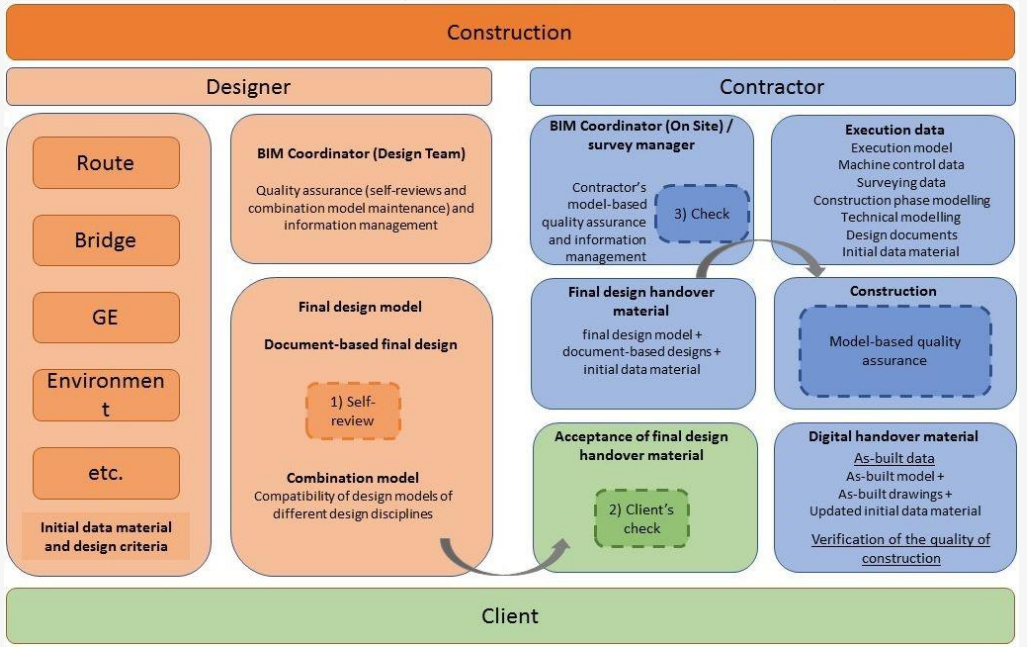
Technical requirements for **information modeling**

Technical documentation for **procurement**

Common rules for different actors

- Common understanding of modeling
- Harmonize the common modeling practices

Frequent updates for industry demands



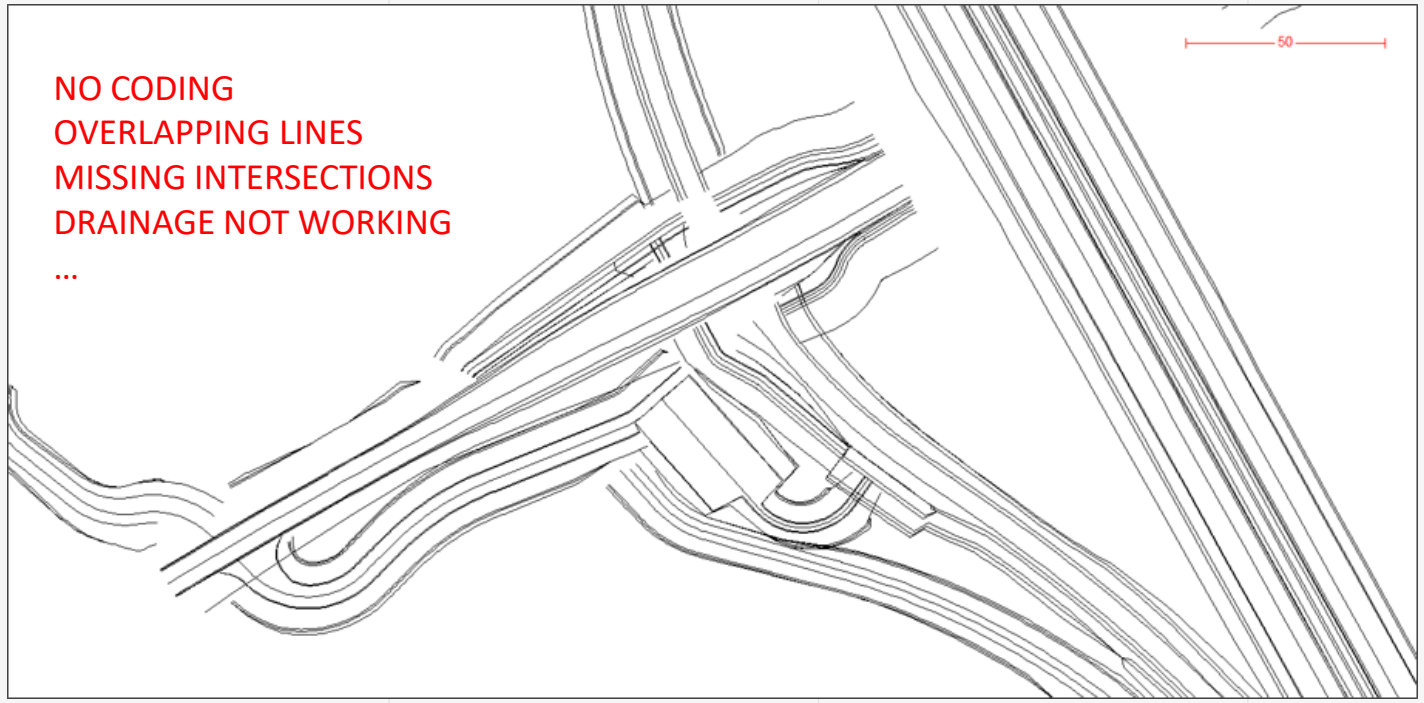
English version available:
https://buildingsmart.fi/en/common-infrabim-requirements/

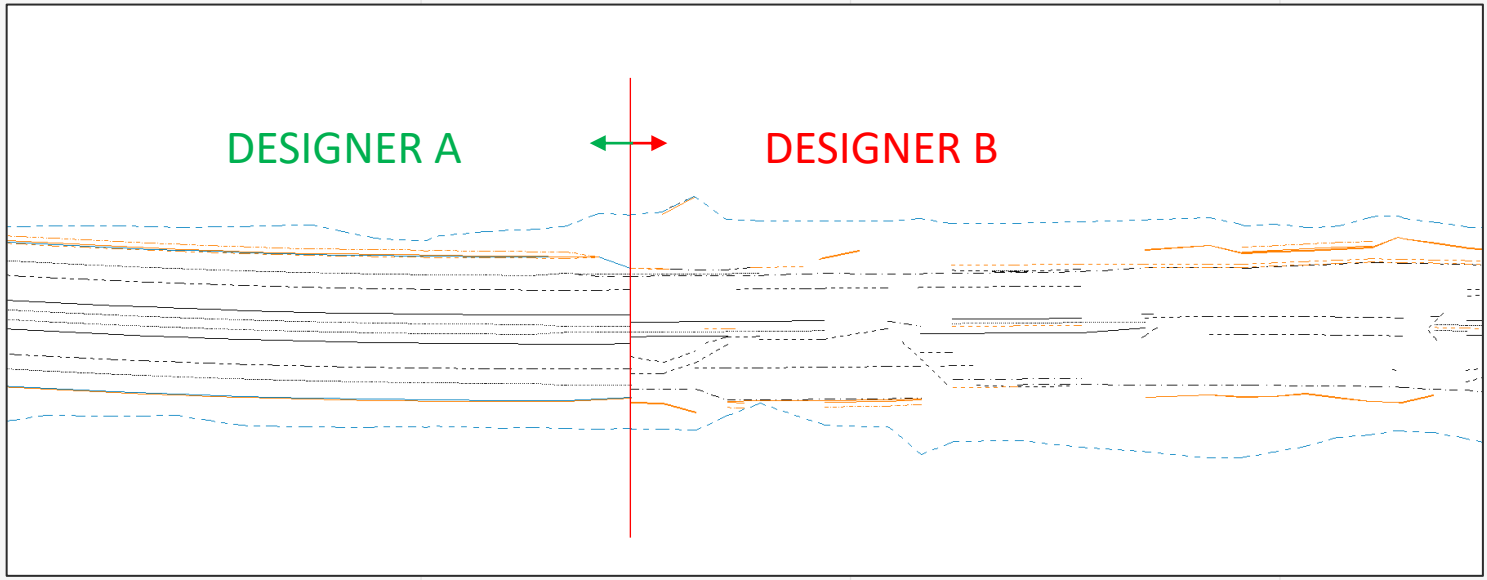
REQUIREMENTS

BEFORE INFRABIM

Projects without common rules

- Not usable without editing
  - Responsibility?
  - Quality assurance?





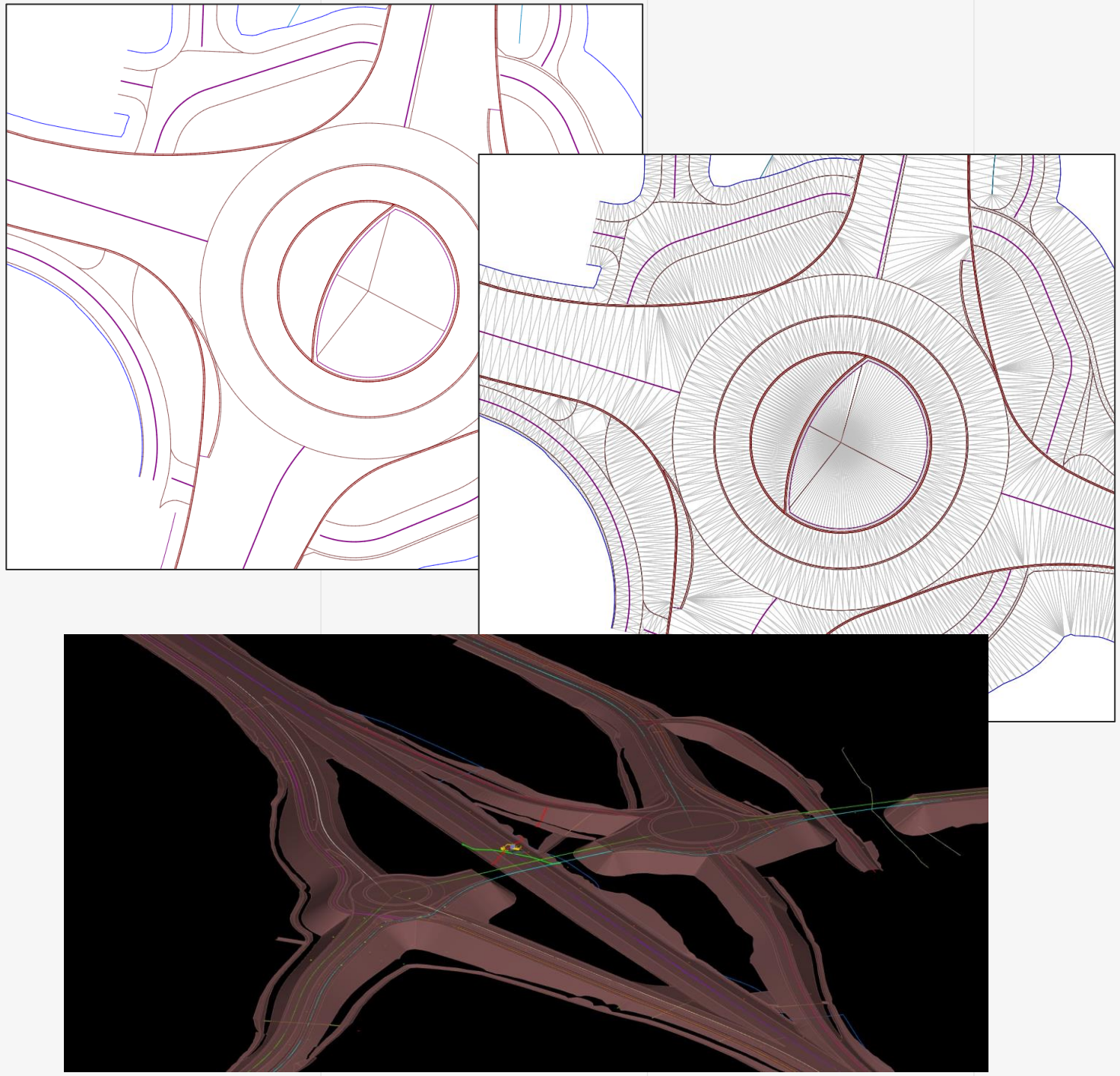
Common InfraBIM Requirements

REQUIREMENTS

WITH INFRABIM

Examples with common rules

- Harmonized data
- Coded data
- Quality assurance by designer
- Usable on jobsite



InfraBIM Classification System

CLASSIFICATION

InfraBIM Classification has been created for modeling purposes

- All surface/layer/object has an own ID

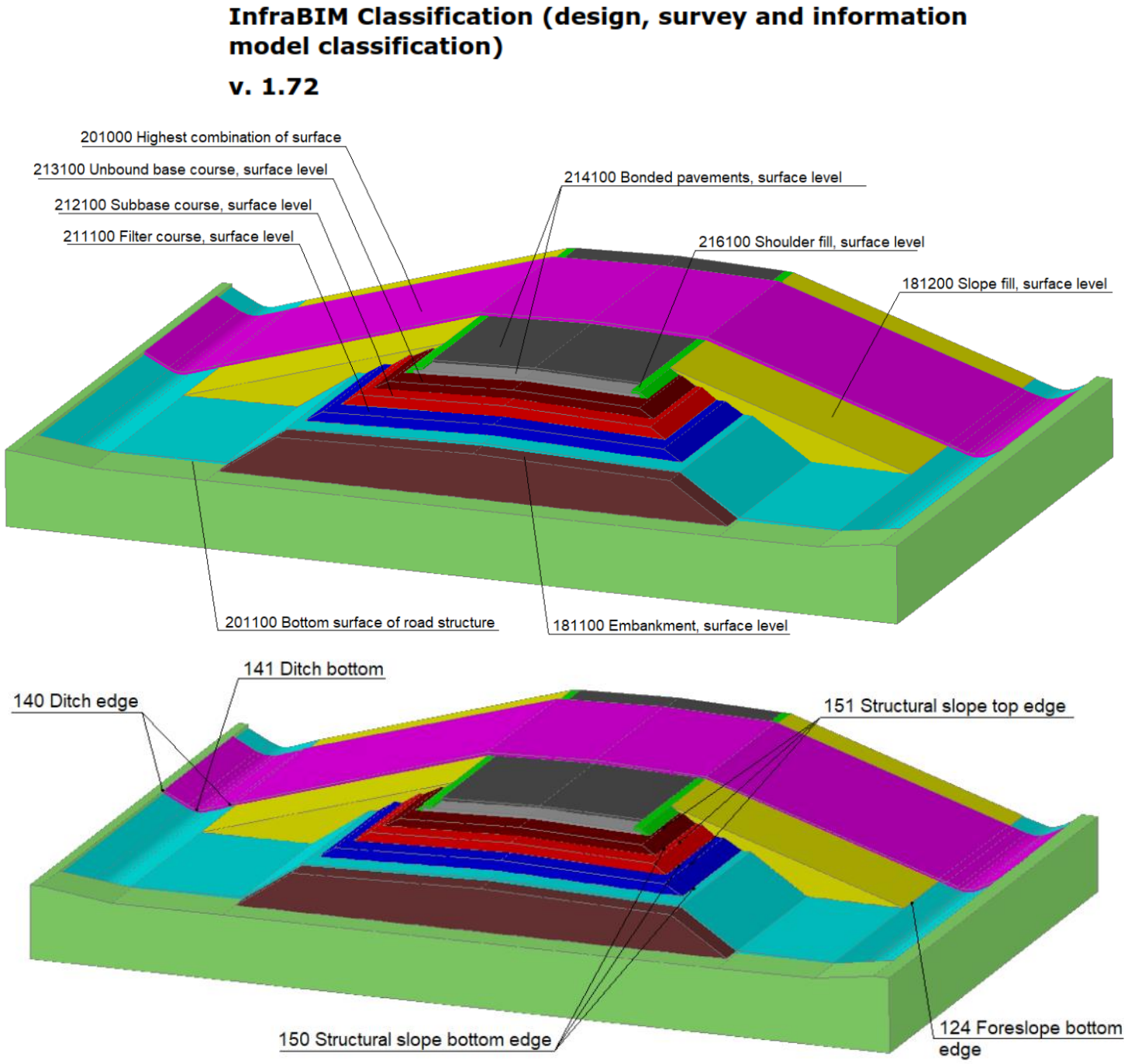
Divided in Surface ID and Feature Coding

Surveyor point of view:

Classification System = Coding System

Same coding for different infra owners

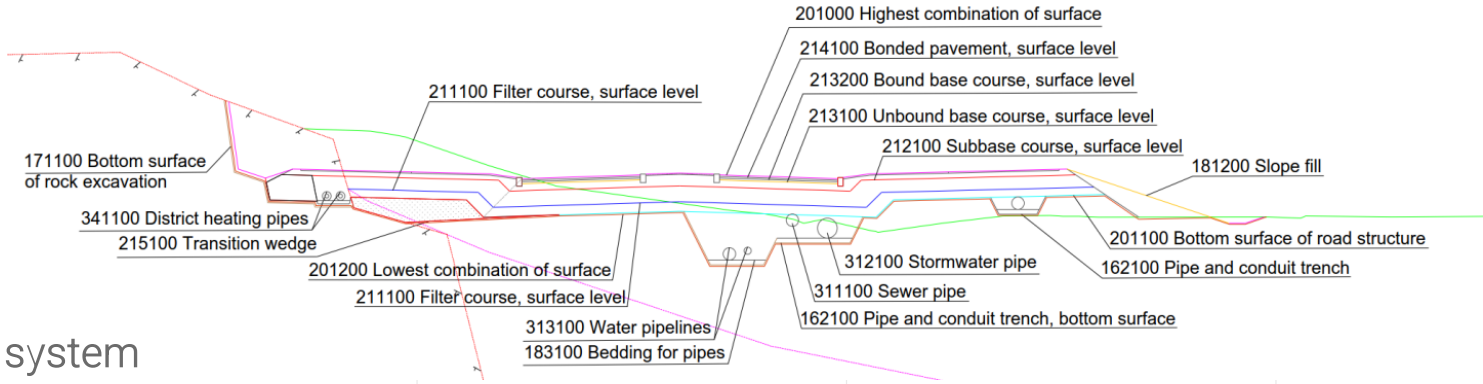
English version:
https://buildingsmart.fi/en/classification/



InfraBIM Classification System

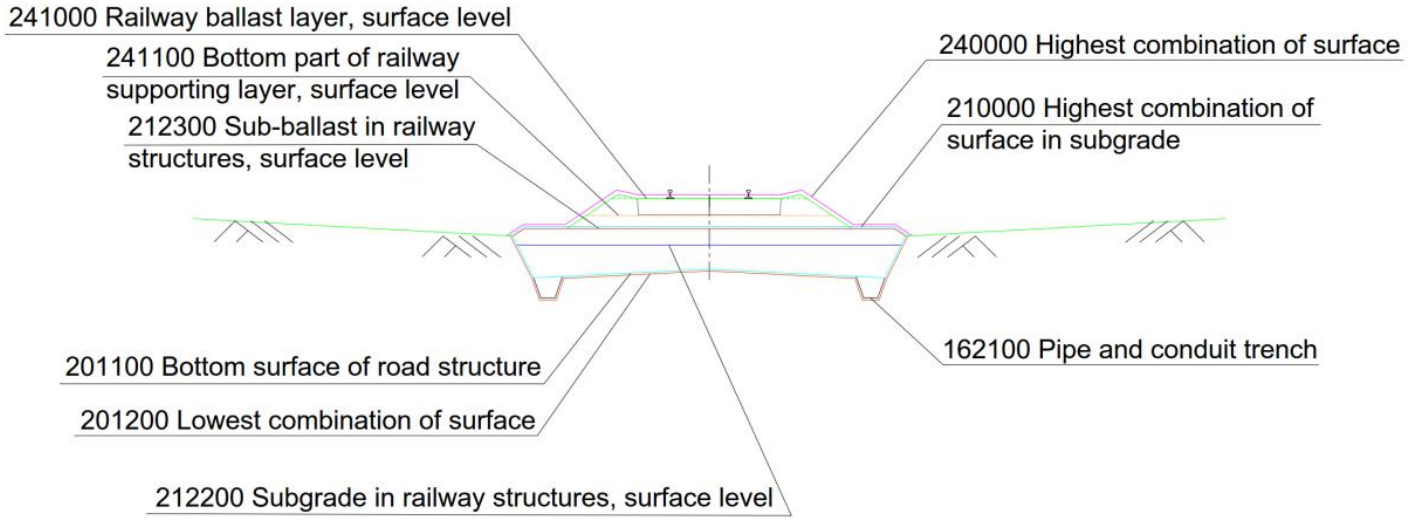
CLASSIFICATION

SURFACE ID



Connecting all actions inside **one classification system**

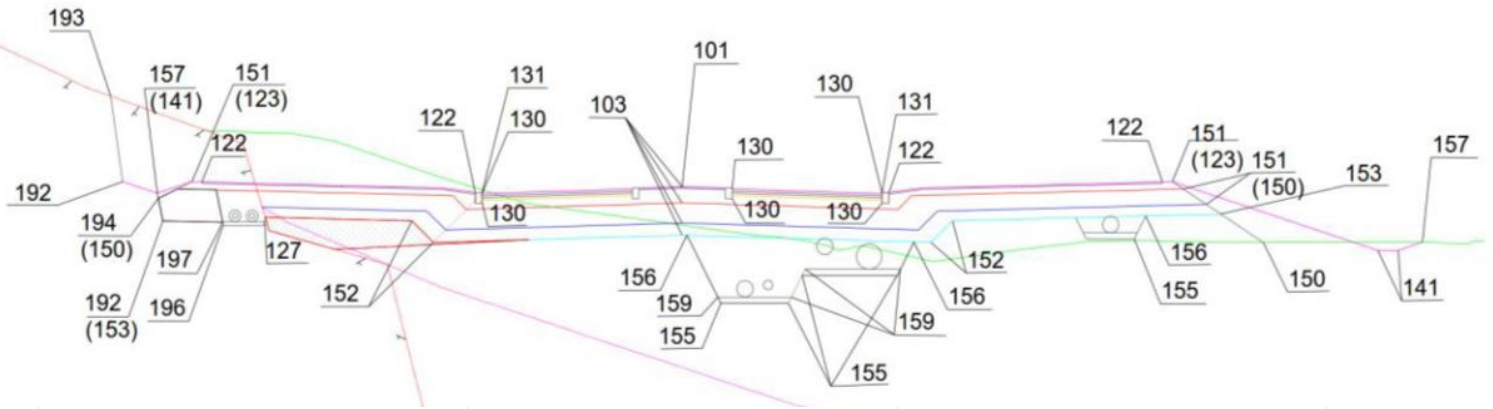
- Connect **Common Quality Requirements** with ID number
- Connect **As-Built Data** with ID number
  - No extra manual work
- Connect **tolerances** with ID number
- Connect Surface **Colors** with ID number
  - Easy for human eyes
- Connect **group of files** to one surface
- **Data flow actions** based on ID number
  - No conversions
  - Design <-> Construction <-> Asset Management



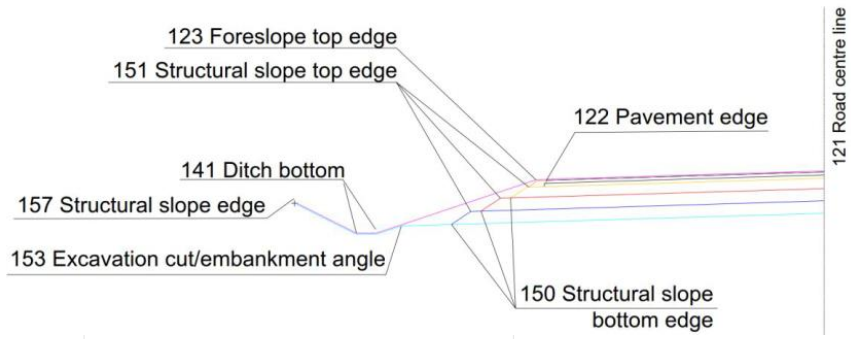
InfraBIM Classification System

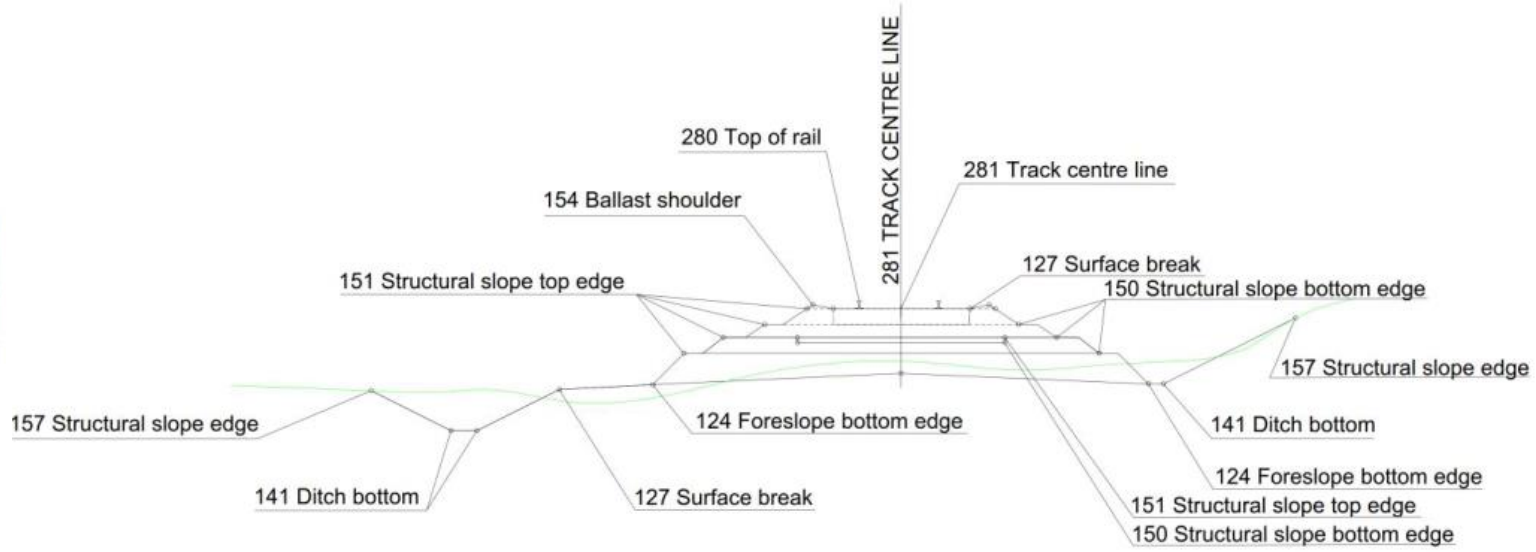
CLASSIFICATION

FEATURE CODING



- Coding inside surface/layer/object
- Most common features are breaklines
- Feature coding is based on national terrain surveying coding





CLASSIFICATION

In the old days…

- Everyone had their own code lists
- Different code list in different project
- How to exchange data?
  - Multiple swap tools…

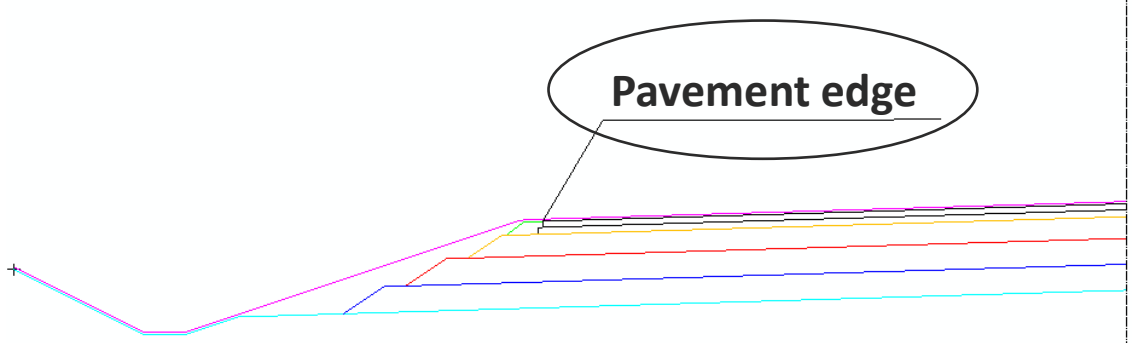
Municipality A
Code for pavement edge = 10

Municipality B
Code for pavement edge = 40100

Municipality C
Code for pavement edge = ASF

Municipality D
Code for pavement edge = 10AF100

Road Administration
Code for pavement edge = 521



Designer A
Code for pavement edge = 6001102

Designer B
Code for pavement edge = 135110

Designer C
Code for pavement edge = H5110P

Designer D
Code for pavement edge = 101

Surveyor A
Code for pavement edge = 3

Surveyor B
Code for pavement edge = 35

Surveyor C
Code for pavement edge = A

Surveyor D
Code for pavement edge = 150

InfraBIM Classification System

CLASSIFICATION

Same code for all actors

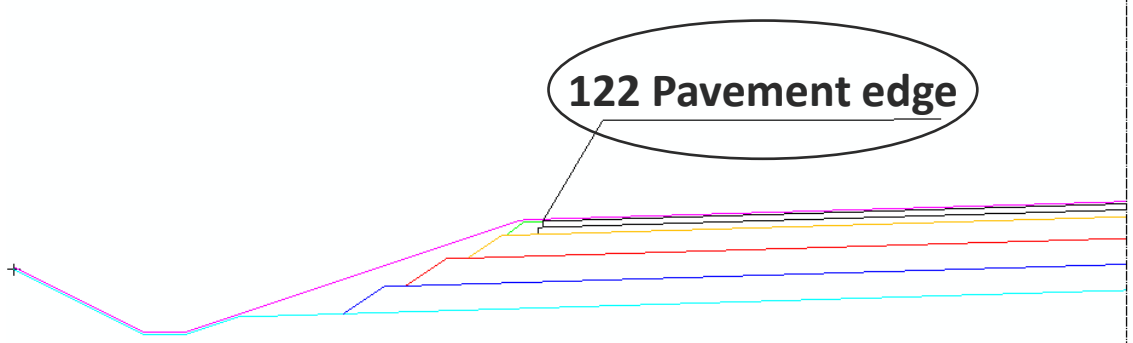
Municipality A
Code for pavement edge = 122

Municipality B
Code for pavement edge = 122

Municipality C
Code for pavement edge = 122

Municipality D
Code for pavement edge = 122

Road Administration
Code for pavement edge = 122



Designer A
Code for pavement edge = 122

Designer B
Code for pavement edge = 122

Designer C
Code for pavement edge = 122

Designer D
Code for pavement edge = 122

Surveyor A
Code for pavement edge = 122

Surveyor B
Code for pavement edge = 122

Surveyor C
Code for pavement edge = 122

Surveyor D
Code for pavement edge = 122

Inframodel Data Exchange

DATA EXCHANGE

Common data exchange format **Inframodel**

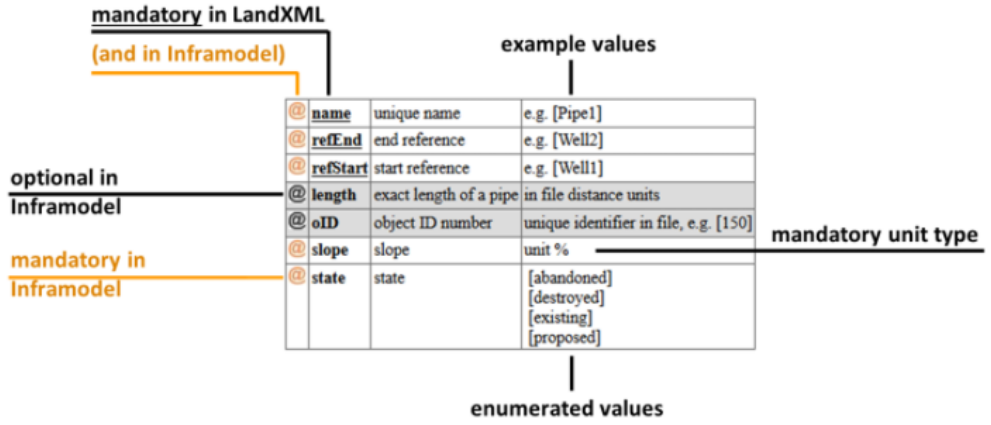
- A subset of international LandXML v1.2 specification
- Connection with InfraBIM Classification System
- History of Inframodel starts in 2001
- Current specification version is Inframodel 4

Finnish Inframodel application documentation for LandXML v1.2

Version 4 : 2020

schema version 4.0.4

version 4.0.4 changes



@	name	unique name	e.g. [Pipe1]
@	refEnd	end reference	e.g. [Well2]
@	refStart	start reference	e.g. [Well1]
@	length	exact length of a pipe	in file distance units
@	oID	object ID number	unique identifier in file, e.g. [150]
@	slope	slope	unit %
@	state	state	[abandoned] [destroyed] [existing] [proposed]

Full documentation:
https://buildingsmart.fi/infra/inframodel/index.html

Inframodel
Data
Exchange

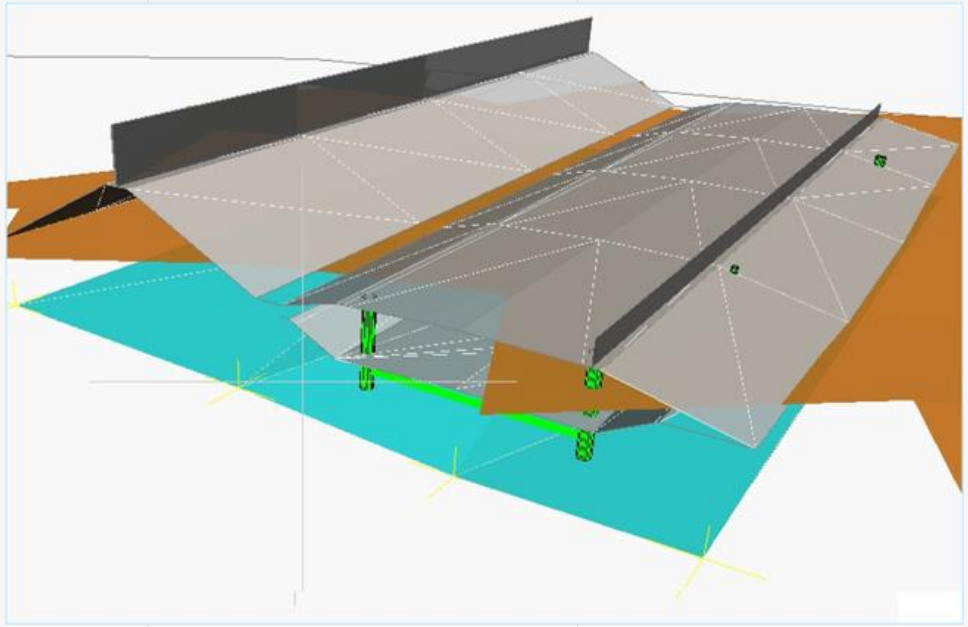
DATA EXCHANGE

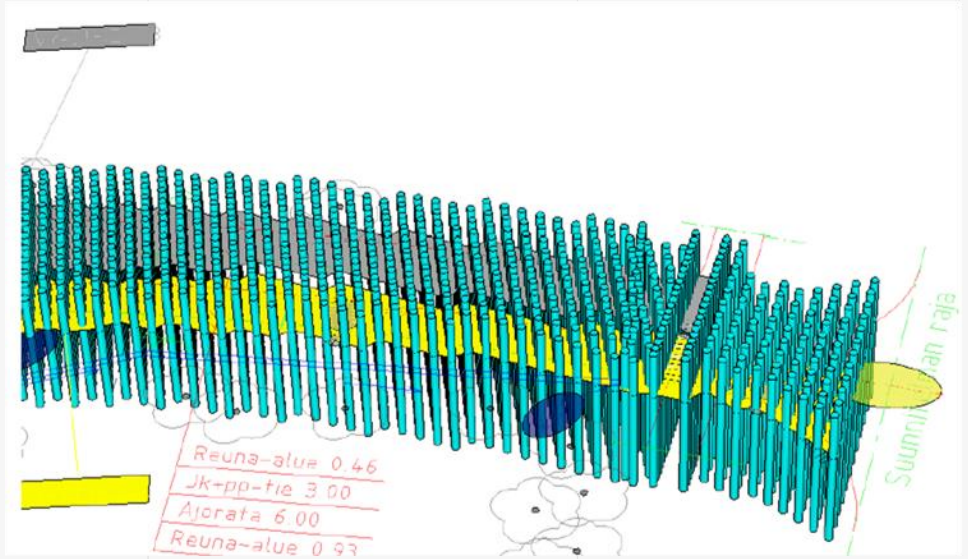
In the old days…

- vgp, vg, vg2, vg3, pg, pg2, pg3, xrd, gt, kof, pxy, xci, dxf, dwg, dgn…

Today…

- Inframodel, IFC





HOLY TRINITY

Human

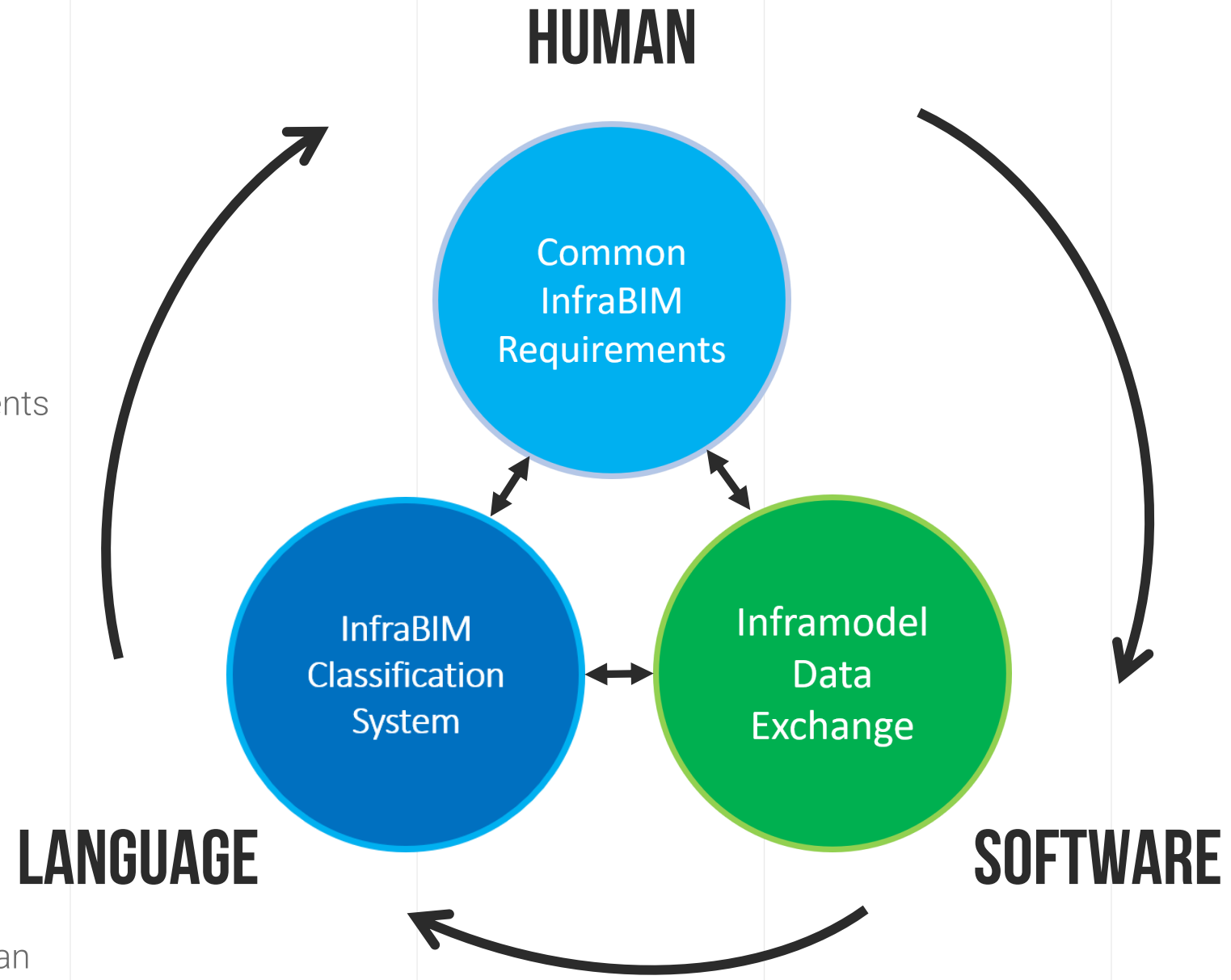
- BIM process guidelines and requirements
- How-to

Softwares

- Readable data for softwares
- OpenBIM Data Exchange
  - IFC, XML, GML

Common Language

- Readable data for softwares and human
- Classification Systems

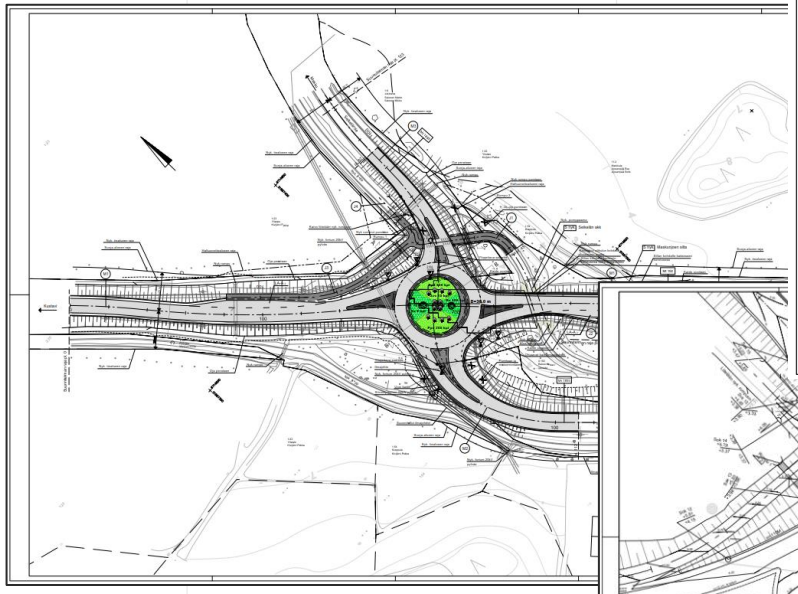


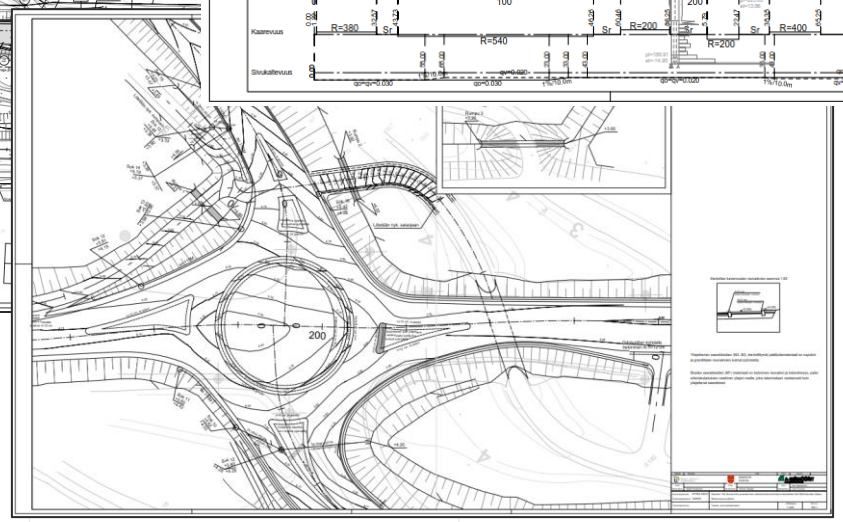
CASE EXAMPLE

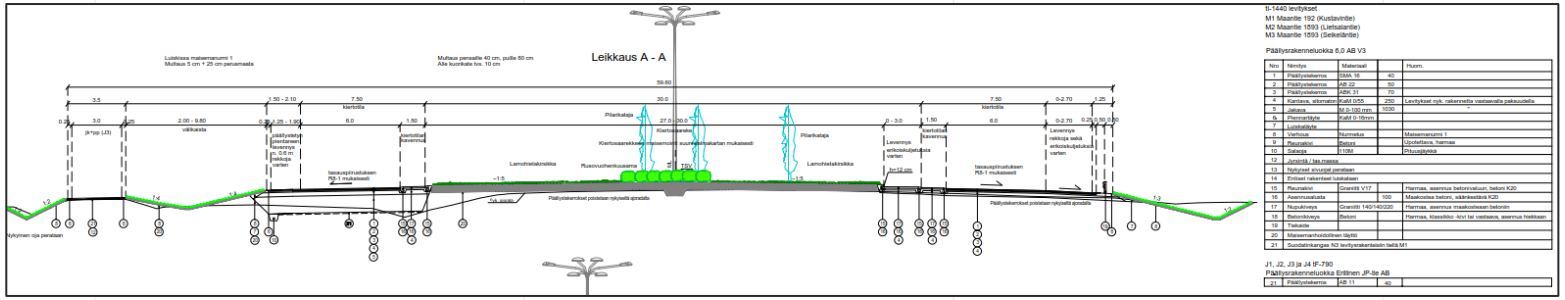
TRADITIONAL VS. INFRABIM

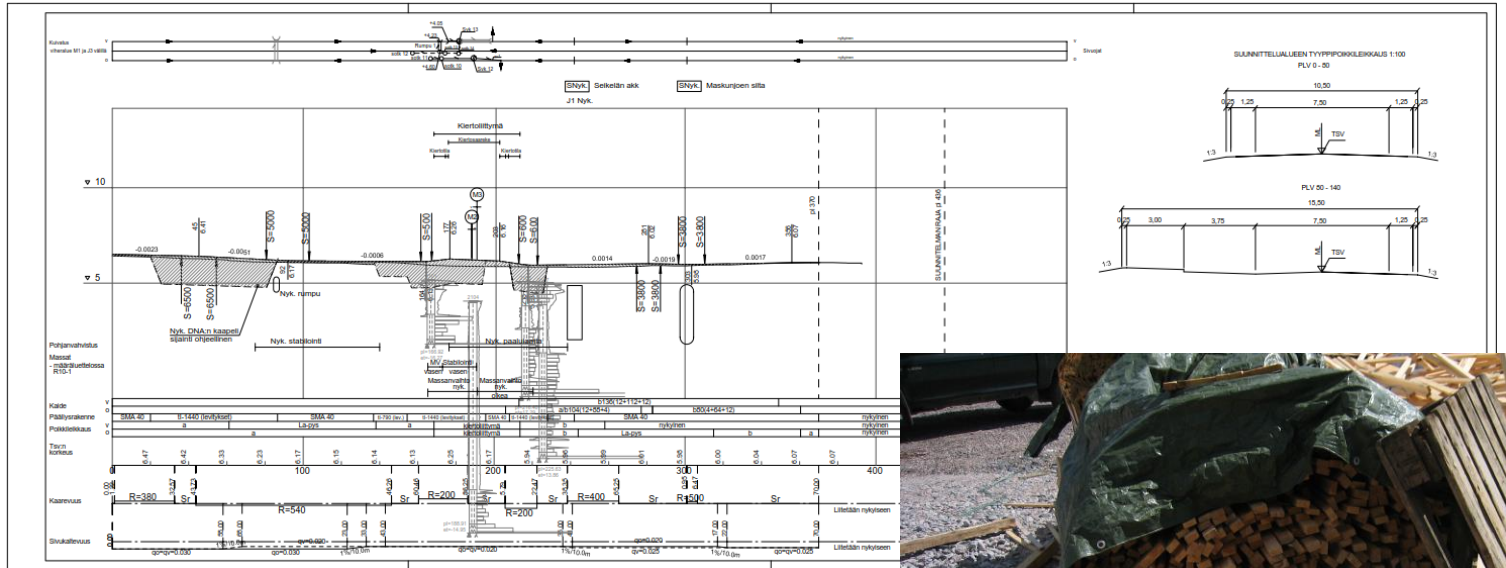
Traditional

1. Prepare









CASE EXAMPLE

TRADITIONAL VS. INFRABIM

Traditional

2. Stake-out

CASE EXAMPLE

TRADITIONAL VS. INFRABIM

Traditional

3. New stake-out for next phase

...and if stakes has fallen

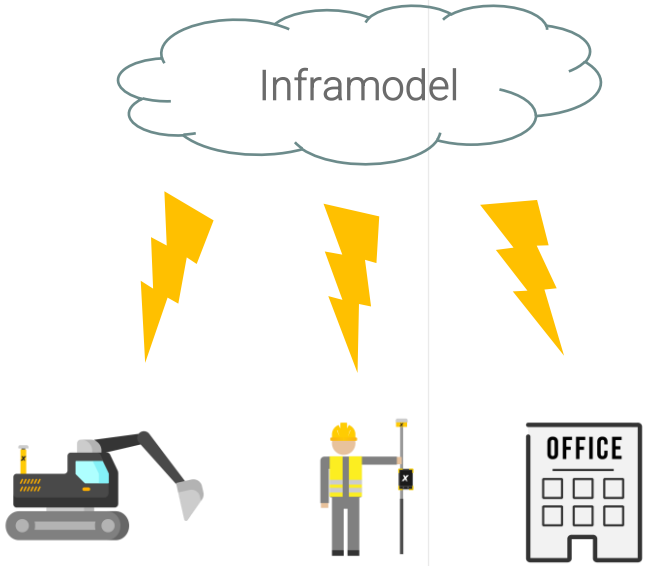
...and if there are design changes

CASE EXAMPLE

TRADITIONAL VS. INFRABIM

InfraBIM

1. Prepare
    - Quality assurance for models
    - Share models for different users



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Infrastructure information model / checklist
(Common InfraBIM Requirements YIV 2019)

Annex 4.3. An example of a final design model checklist.

Quality check parameters (tables 1 - 6): Check the box of each checked item.

Table 1. Naming and Headers

Code / Item to be checked	
1.01. ☐	Information breakdown structure
1.02. ☐	Naming of files
1.03. ☐	Time stamp
1.04. ☐	Units
1.05. ☐	Coordinate system
1.06. ☐	Elevation system
1.07. ☐	EPSG code
1.08. ☐	Design application and version
1.09. ☐	Designer's contact information
1.10. ☐	
1.11. ☐	
1.12. ☐	
1.13. ☐	
1.14. ☐	
1.15. ☐	
1.16. ☐	

Table 2.Break lines

Code / Item to be checked	
2.01. ☐	Data exchange format
2.02. ☐	Surface codes
2.03. ☐	Type codes
2.04. ☐	Line type (Break line / Irregular line)
2.05. ☐	Discontinuities
2.06. ☐	Intersecting lines
2.07. ☐	Overlapping/reversing lines
2.08. ☐	Zero heights
2.09. ☐	Uniform direction of lines
2.10. ☐	Too long point spacing >10m
2.11. ☐	Too short point spacing <0,5m
2.12. ☐	Unnecessary lines (no change of inclination)
2.13. ☐	Lines not belonging to a surface
2.14. ☐	Triangulation
2.15. ☐	
2.16. ☐	

Table 3. Triangulated networks

Code / Item to be checked	
3.01. ☐	Data exchange format
3.02. ☐	Surface codes
3.03. ☐	Holes
3.04. ☐	Zero-height points
3.05. ☐	"Spikes" deviating from the surface
3.06. ☐	Abnormal slopes
3.07. ☐	Consistency between break lines and triangulated network (inc. same points)
3.09. ☐	

Table 4. Geometric lines and other lines

Code / Item to be checked	
4.01. ☐	Data exchange format
4.02. ☐	Horizontal geometry of the alignment
4.03. ☐	Vertical geometry of the alignment
4.04. ☐	Kerb lines
4.05. ☐	Line markings
4.06. ☐	
4.07. ☐	
4.08. ☐	
4.09. ☐	

Table 5. Drainage, Water supply and severage systems

Code / Item to be checked	
5.01. ☐	Data exchange format
5.02. ☐	Culverts
5.03. ☐	Side ditches
5.04. ☐	Drainage ditches
5.05. ☐	Drains
5.06. ☐	Stormwater wells
5.07. ☐	Stormwater pipes
5.08. ☐	Sewer wells
5.09. ☐	Sewer pipes
5.10. ☐	
5.11. ☐	

Table 6. Compatibility

Code / Item to be checked	
6.01. ☐	Vertical alignment of routes and areas
6.02. ☐	Connection points of routes (discontinuities)
6.03. ☐	Wedges at structure transitions
6.04. ☐	Structure Thicknesses
6.05. ☐	Connection to existing structures
6.06. ☐	Combatibility of side ditches of different routes
6.07. ☐	Fit of point data (3D) to other material
6.08. ☐	
6.09. ☐	
6.10. ☐	

CASE EXAMPLE

STAKE-OUT VS. MACHINE GUIDANCE

2. Work with machine

EDUCATION AS PART OF THE INDUSTRY CHANGE

USER TRAINING FOR INFRABIM WORKFLOWS

User training has been one of the key reasons for digital workflow adaptation in Finland

- Academic studies in universities and universities of applied sciences only fill the needs for managerial level education
- Vocational schools train the future talents for the digital construction sites
- In-house and company specific training have been filling the know-how gap on construction sites

COOPERATION IS THE KEY TO ON JOB LEARNING


FUTURE OF INFRABIM?

OPEN STANDARDS AND CONNECTED CONSTRUCTION SITES

- InfraBIM is being updated and modified all the time as more needs emerge (Geotechnical BIM added in June 2021)
- First step of IFC for infrastructure (IFC 4.3 release candidate)
- Coming ISO standard for design model communication between MC systems (ISO TC127/SC3)
- CEN proposal for BIM in Infrastructure needs mapping (in voting)
- Fully autonomous worksites in near future? (lot of work still to be done)

THANK YOU, ANY QUESTIONS?

MIIKA KOSTAMO

BUSINESS DEVELOPMENT MANAGER | NOVATRON OY

- Surveyor and project manager 2003-2016
  - City of Vantaa 2003-2005
  - Aerial photogrammetry and LiDAR 2005-2010
  - Underwater surveying 2013-2014
  - E16 Motorway in Norway in 2014
  - Infrastructure and BIM projects in Finland 2014-2016
  - Member of buildingSMART Finland since 2015
  - Member of ISO standardization since 2019
- BDM in Novatron since 2018
- Co-Chair of Airport Room bSI since 2019

PETTERI PALVIANEN

BIM DEVELOPMENT MANAGER | NOVATRON OY

- Surveyor and Survey Manager 1995 - 2016 on site
  - E18 Motorway in Finland 1998 - 2014
  - E6 Motorway in Norway 2007 - 2009
  - Developing digital ways of working on site level
  - ~50 model-based projects
  - Expert in InfraFINBIM Research Program 2010 - 2014
  - Member of buildingSMART Finland since 2014
  - Member of CEN standardization
- BIM Development Manager at Novatron since 2016
- Founder of InfraBIM Open