INTERNATIONAL UNION
OF RAILWAYS

unity, solidarity, universality

4th UIC RailTopoModel and railML® Conference

Towards to International Railway Standards of Infra-structure Topology Model and Data Exchange Format

UIC HQ, Paris April 28th/29th, 2015

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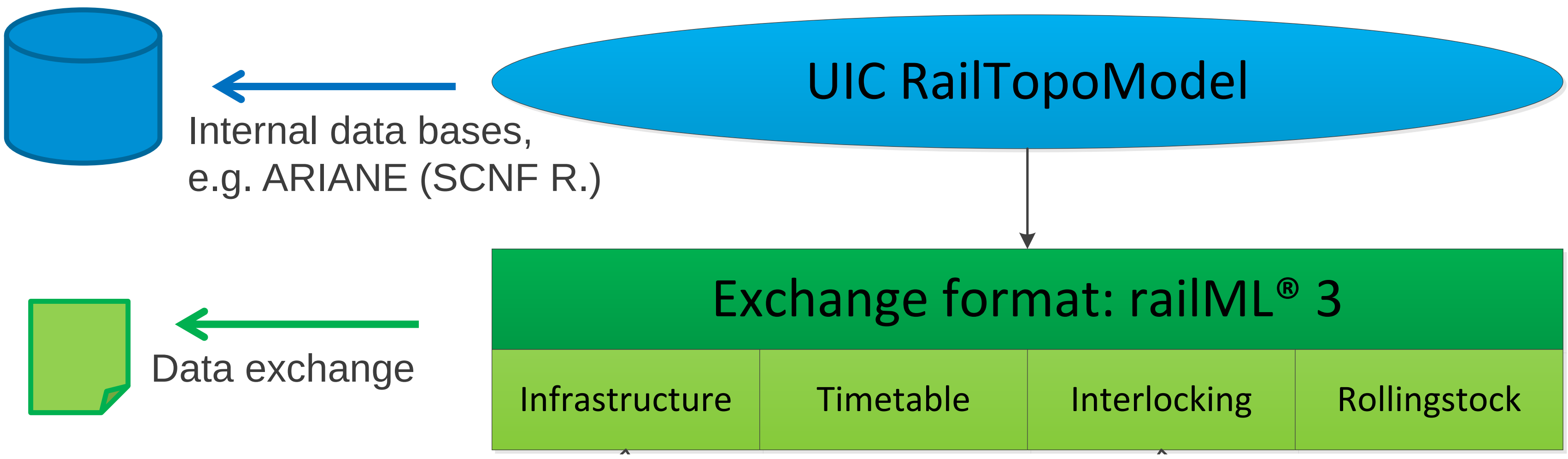
Data exchange in the rail industry, a global view:
10 use cases – one solution

Winfried Stix (ÖBB Infrastruktur AG)

Data exchange in rail industry

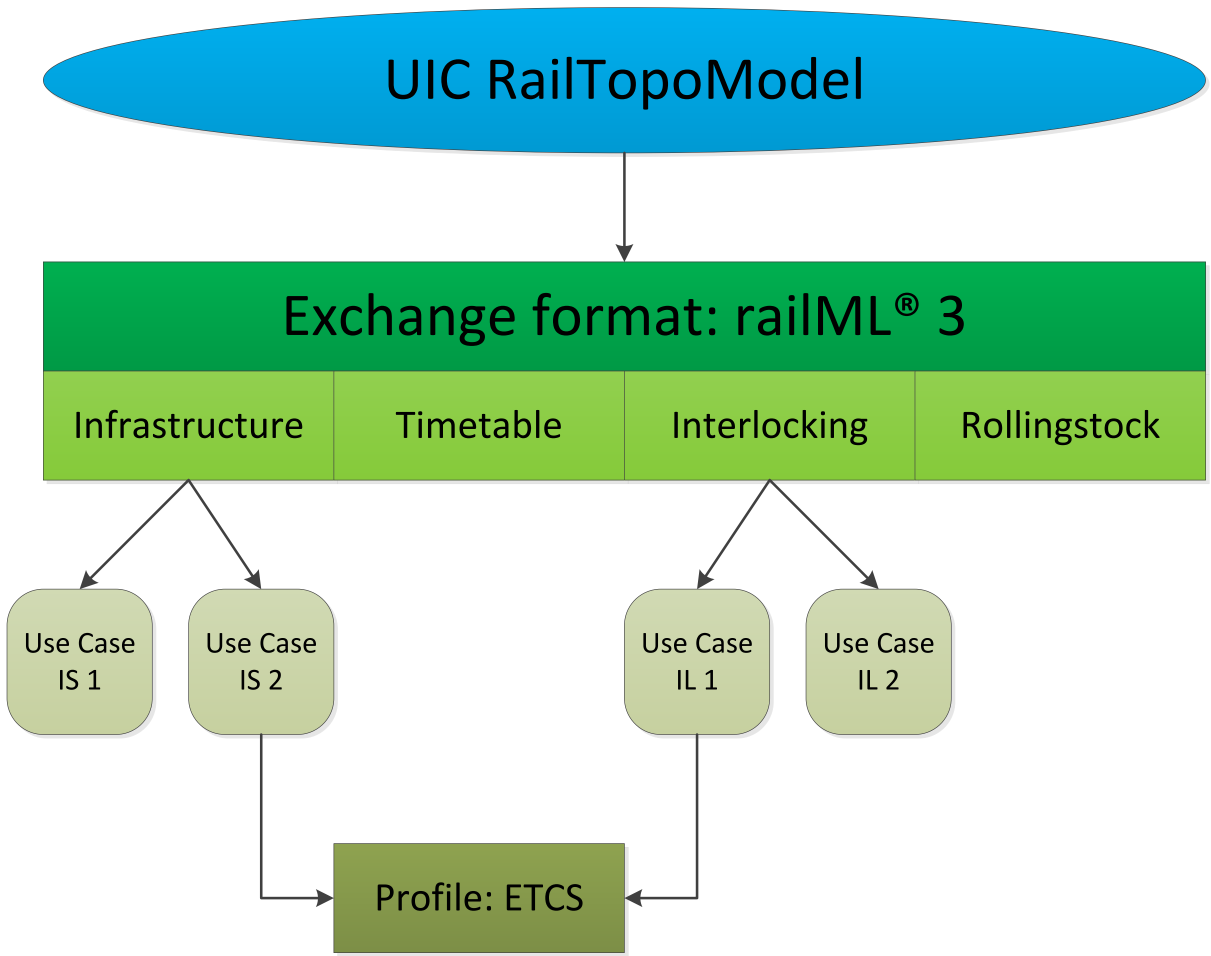
- railML® use case approach
- Infrastructure use cases

Data exchange in rail industry
railML® 3 use case approach



Data exchange in rail industry
railML® 3 use case approach

- **Concept:**

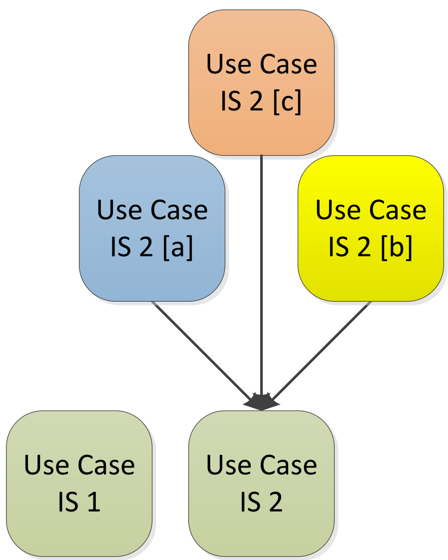


Data exchange in rail industry
railML® 3 use case approach

> **Concept:**

Your Input

We encourage you to provide us your data exchange use cases!



The railML® coordinators review all use cases and create generic samples

Data exchange in rail industry
railML® 3 use case approach

> **Use case:**

Description: application behind the use case

Data flows and interfaces

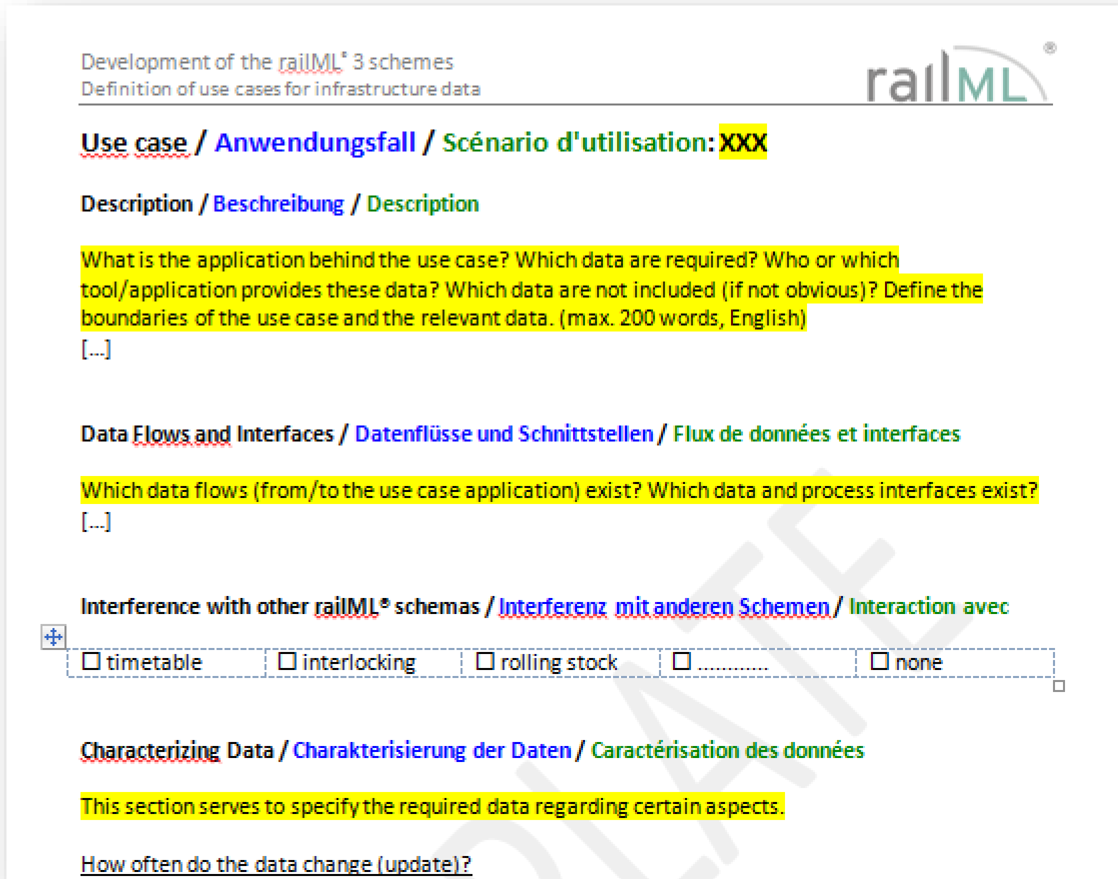
Interference with further railML® schemas

Characterizing data

- How often do the data change (update)?
- How big are the data fragments to be exchanged (complexity, granularity)?
- Which views are represented by the data (focus)?
- Specific elements

Data exchange in rail industry
railML® 3 use case approach

- > **MS Word template**
- > **Wiki page**



Development of the railML® 3 schemes
Definition of use cases for infrastructure data

Use case / Anwendungsfall / Scénario d'utilisation: XXX

Description / Beschreibung / Description

What is the application behind the use case? Which data are required? Who or which tool/application provides these data? Which data are not included (if not obvious)? Define the boundaries of the use case and the relevant data. (max. 200 words, English)
[...]

Data Flows and Interfaces / Datenflüsse und Schnittstellen / Flux de données et interfaces

Which data flows (from/to the use case application) exist? Which data and process interfaces exist?
[...]

Interference with other railML® schemas / Interferenz mit anderen Schemen / Interaction avec

☐ timetable	☐ interlocking	☐ rolling stock	☐	☐ none

Characterizing Data / Charakterisierung der Daten / Caractérisation des données

This section serves to specify the required data regarding certain aspects.

How often do the data change (update)?

What we‘ve so far collected

USE CASES

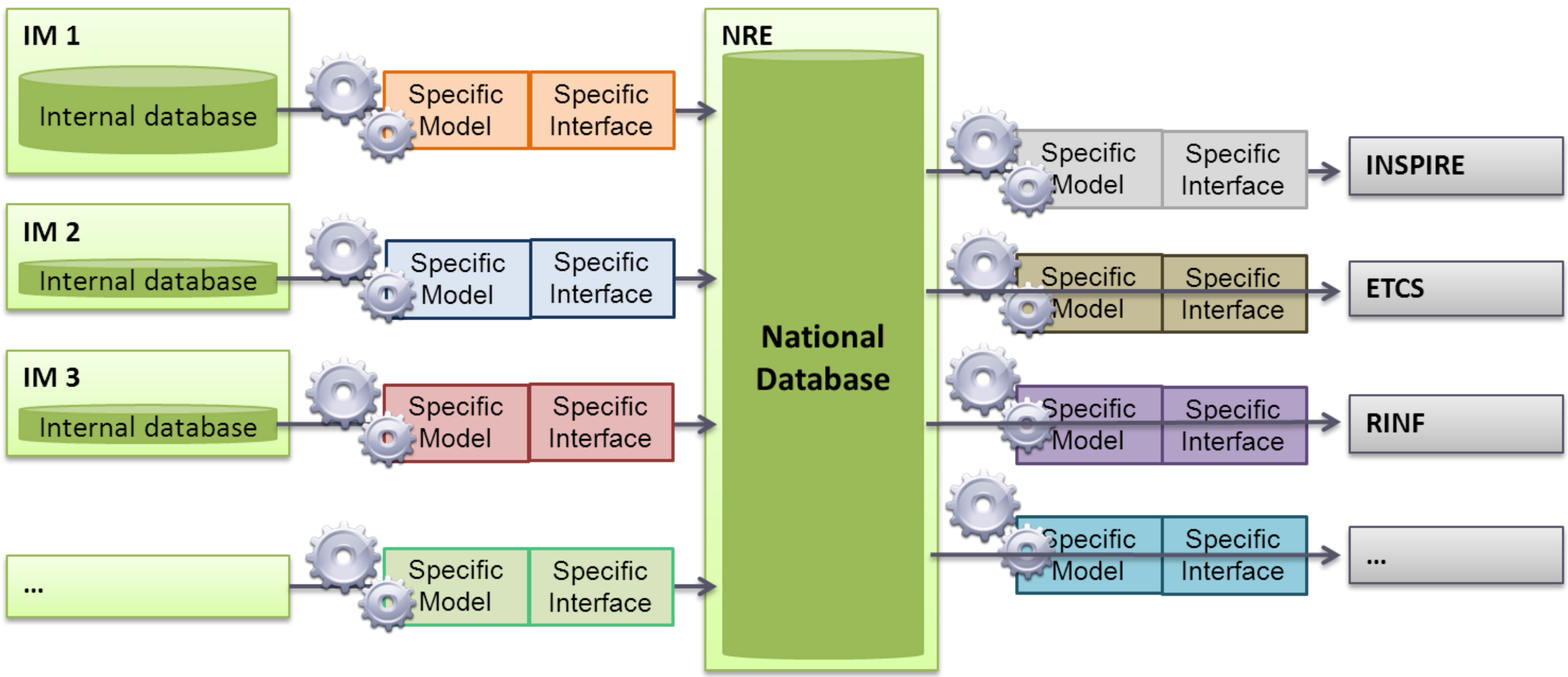
Data exchange in rail industry
Use case overview

> **Infrastructure use cases:**

Use Case	Responsible
RINF	SNCF Réseau
NRE Reporting	ÖBB
ETCS	Infrabel
Speed Directory	ÖBB
Capacity Planning	Jernbaneverket
Positioning System	DLR
Interlocking	DB
Driver Advisory System	Network Rail
Infrastructure Recording	Bahnkonzept
Passenger Information	BLS
Maintenance Planning	SBB, BLS

Data exchange in rail industry
RINF

> **Register of Railway Infrastructure (EU):**

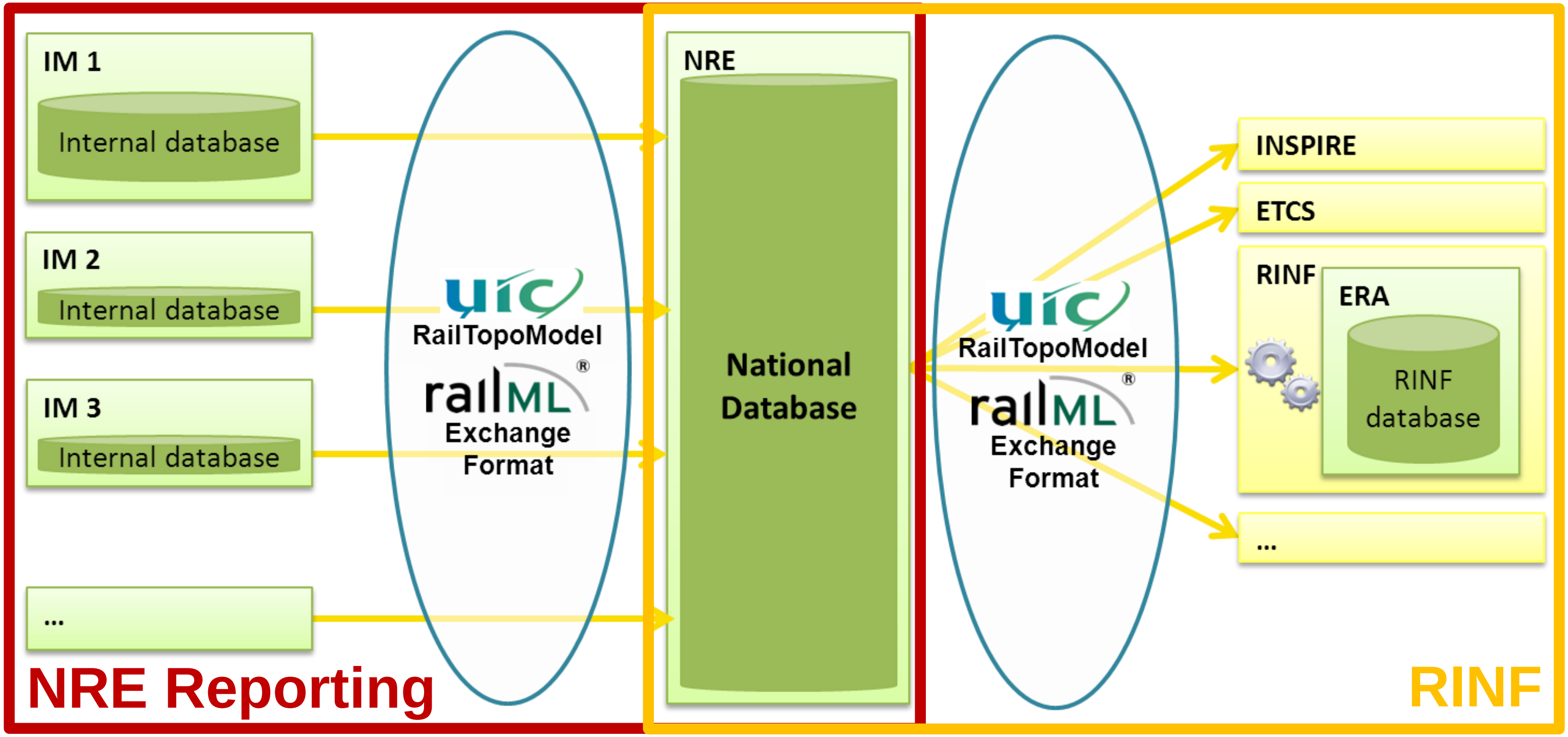


Data exchange in rail industry
NRE Reporting

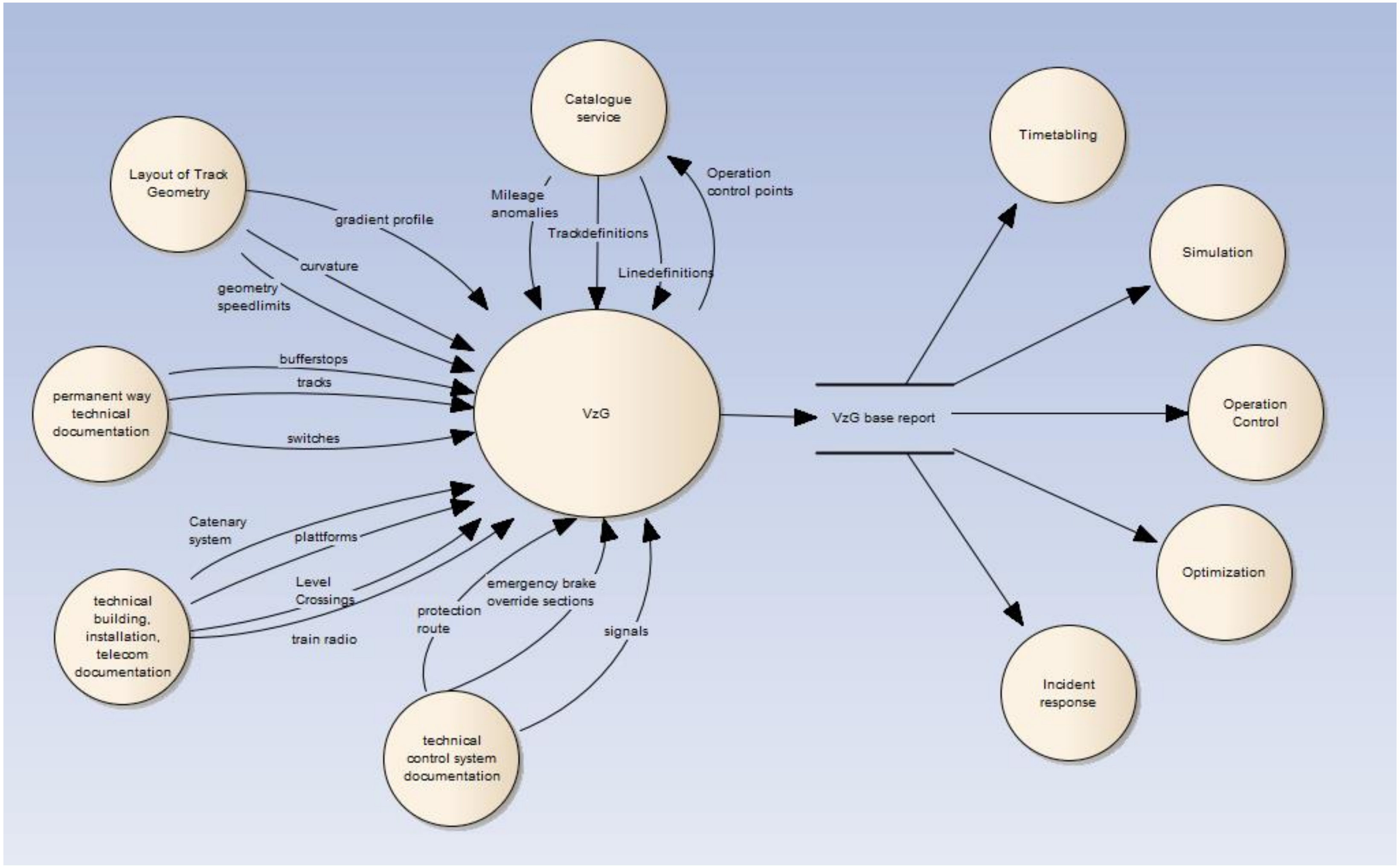
- **Application: All infrastructure managers have to report their infrastructure to the national railway entity (NRE), which collects the information for the national RINF**
- **Example Austria: NRE = SCHIG**

Data exchange in rail industry
RINF / NRE Reporting

> **Register of Railway Infrastructure (EU):**



Data exchange in rail industry
Speed Directory

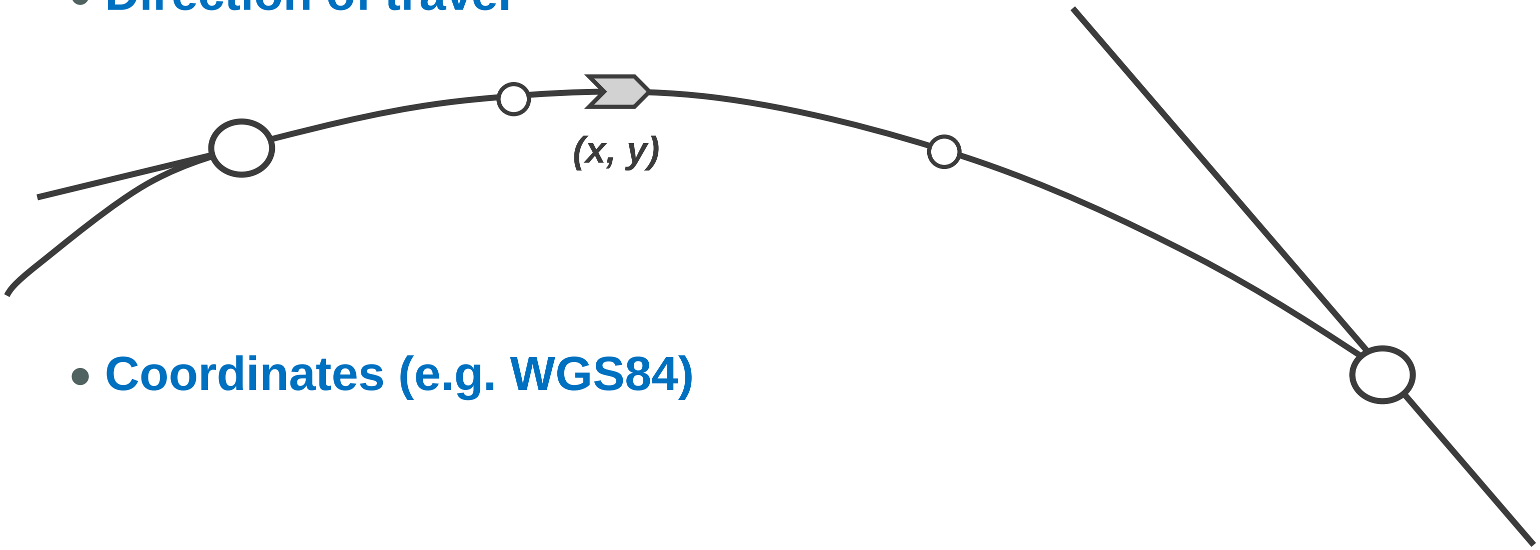


Data exchange in rail industry
On-board positioning system

> **Application: determining the train‘s position on-board the vehicle**

> **Position = position in the railway track network**

- **trackID**
- **Relative Position on the track**
- **Direction of travel**



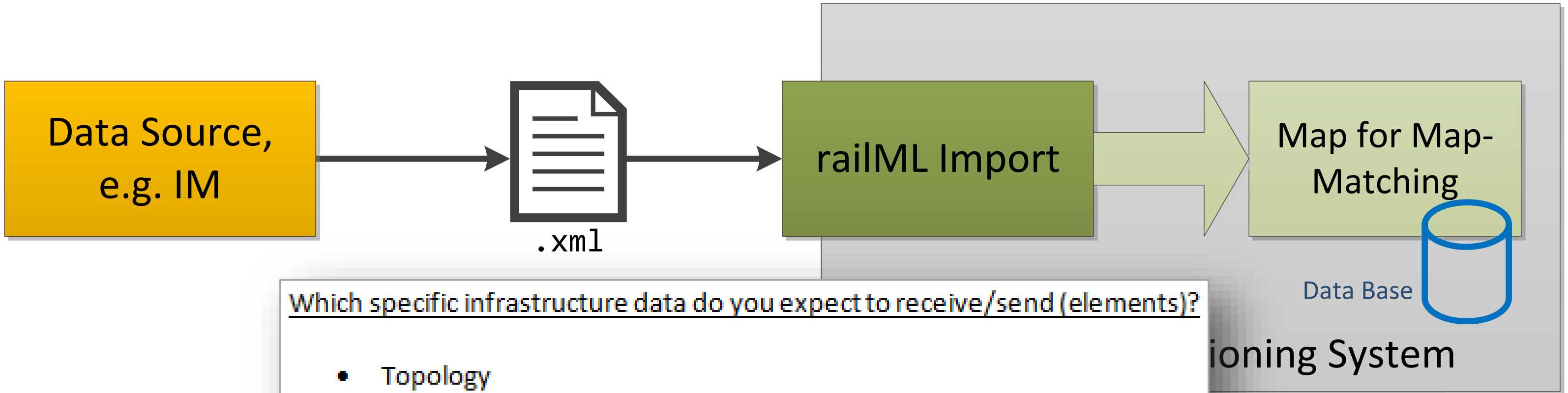
- **Coordinates (e.g. WGS84)**

Data exchange in rail industry
On-board positioning system

> **Considering the position of the train in the track network, the map shall contain the following elements:**

- **Drivable topology**: tracks, which are connected with each other.
- **WGS84 coordinates**: all elements need coordinate positions, which are required for referencing GNSS positions
- Coordinates and logical positions of **positioning-relevant infrastructure objects**: balises, signals, platform edges, switches, crossings, etc.
- Coordinates and logical positions of **operation-relevant infrastructure objects**: stations, stop-posts, etc.
- **Track geometry**: 3-dimensional alignment of the railway.

Data exchange in rail industry
On-board positioning system



Which specific infrastructure data do you expect to receive/send (elements)?

- Topology
  - Nodes, Edges
  - Inner topology: connections
  - Macroscopic topology: grouping of topology elements
- Geometry
  - Radius / curvature
  - Gradient profile
  - Superelevation profile
- Operational infrastructure elements
  - Platform edges: *position, height, length*
  - Signals: *position, direction, type*
  - Stop posts: *position*
  - Bridges, tunnels: *position, length, height, cross section profile*
  - Level crossings: *position, width*

With a train-bo … sor on-board
positioning devi … The digital map
is a key compo … as it enables
the usage of ma … the position of
the vehicle in th … osition is given
by a track identi … and a direction
of travel related …

Data exchange in rail industry
Interlocking

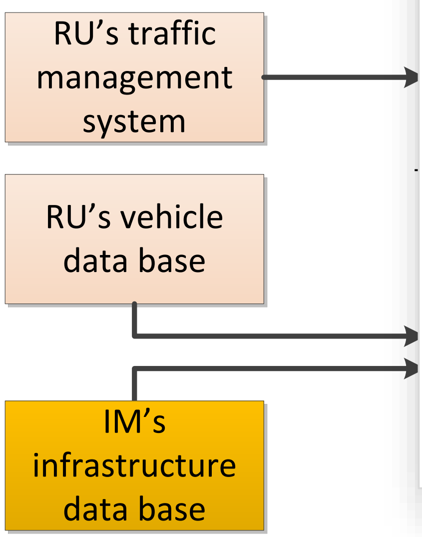
Which specific infrastructure data do you expect to receive/send (elements)?

- Topology of the track network
  - Nodes, edges
  - Inner topology: connections between edges or marker at edges for correct routing at switches
- Geometry of the track network and lines
  - Nodes, edges
  - For edges: length, radius/curvature
  - Additional: punctual information about height and superelevation
- Infrastructure elements, e. g.
  - Platforms and platform edges: *position, height, length, identifier for user (e.g. "Bahnsteig A")*
  - Signals: name, *position, effective direction, type, operational function, signaling system, construction details (e. g. height, fundament type, height of light point, diffusion disc), functional details (e g. passing non-stop allowed, clearance of overlap), energy and information supply*
  - Switches: e. g. name, type, basic form, isolation, kind of switch signal, operation mode, priority position, radius and possible speed per leg, kind of point machine(s), *energy and information supply*
  - Level crossings: *name, position, construction details, functional details, energy and information supply*
  - Elements of automatic train control: *position, construction details, functional details, energy and information supply*
  - Key locks or lock combination: *name, position, energy and information supply*
  - Bridges, tunnels: *position, length along the topology*

All the planning pa
(hard- and software
exchange is the res
specialized plannin

Data exchange in rail industry
Driver Advisory System

The Driver Advisory System (DAS) is an **on-train driver support system** which advises a driver on the most energy-efficient speed profile with which to meet the train's current schedule. The DAS receives as input the current schedule (which may
or near-static data rel
locations and speed r
vehicle itself.



Track attributes (*Infrastructure*):

- Track Centre Line (as a polyline)
- Track altitude (polyline)
- Geometry: Track curvature
- Topology: Node-link model
- Route IDs
- Track IDs
- Mileposts / kilometre posts id, location
- Junctions id, location
- Loop ends id, location
- Platform ends platform ids, location
- Tunnels id, location (,envelope)
- Signals id, location, signal type
- Permissible speeds including permanent speed restrictions (PSRs), qualified by direction of travel and train type
- Temporary speed restrictions (TSRs), qualified by direction of travel and train type
- Emergency speed restrictions (ESRs)
- Locations of the following may also be required in the future (TBD):
  - Signal berths id, location
  - Bridges id, location
  - Road crossings id, location

Data exchange in rail industry
Infrastructure Recording

There are several systems
visualize railway infrastruc
way. Information about the t
infrastructure elements are c
measurement unit and comb
railway track will be visualize
simulation. Further, measure
railway applications.

Which specific infrastructure data do you expect to receive/send (elements)?

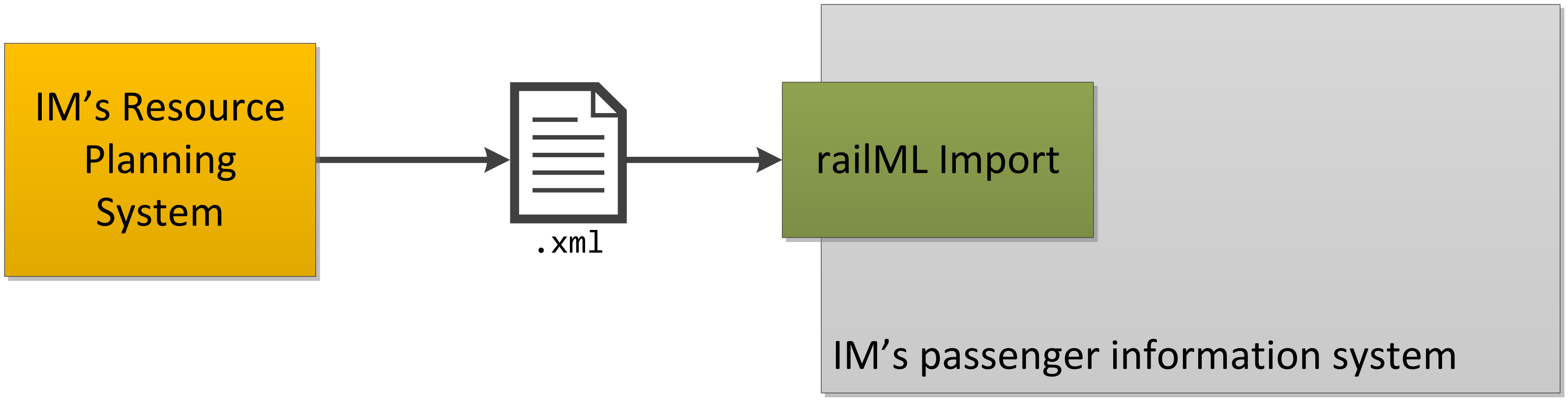
- **Topology**
  - <connections> <switch> *(id, pos, absPos, model, length, type, trackContinueCourse)*
  - <crossSections> *(id, pos, absPos, dir, ocpRef)*
  - <trackBegin>, <trackEnd> *(id, pos, absPos)*
  - <mileageChanges> *(id, pos, absPos, absPosIn)*

- **Track elements**
  - <gradientChanges> (id, pos, absPos, Slope)
  - <speedChanges> (id, pos, absPos, dir, signalised, vMax)
  - <electrificationChanges> (id, pos, absPos, type, voltage, frequency)
  - <platformEdges> (id, pos, absPos, length, dir, height, side, ocpRef, parentPlatformEdgeRef)
  - <radiusChanges> *(id, pos, absPos, dir, radius, superelevation, *Übergangsbogentyp, *Übergangsbogenparameter)*
  - <geoMappings> *(id, pos, absPos)*
    - <geoCoord> (coord, extraHeight, epsgCode)
  - <bridges> (id, name, pos, absPos, length, dir, kind, *Name der überquerten Straße)
  - <tunnels> (id, name, pos, absPos, length, dir, crossSection, kind, name, *Name der unterquerten Straße bzw. Flusses)
  - <levelCrossings> (id, name, pos, absPos, angle, protection, ocpStationRef, *Bezeichnung der kreuzenden Straße)

- **Operational infrastructure elements**
  - <operationControlPoints> (id, name)
    - <propOperational> (operationalType)
    - <propService> (passenger)
    - <designator> (register, entry)

- **Operation and control system elements**
  - <signals> (id, name, pos, absPos, dir, type, function, ocpStationRef)

Data exchange in rail industry
Passenger Information System

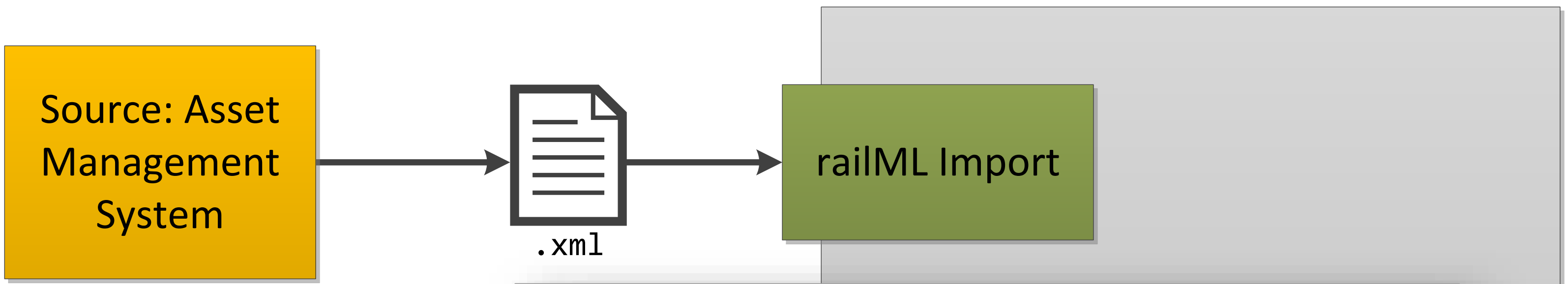


The application focuses the transfer of timetable, traction and topology information from the resource planning system of the railway infrastructure manager to the passenger information system of the same (or another) infrastructure manager.

Which specific infrastructure data do you expect to receive/send (elements)?

- Macroscopic topology:
  - Lines
  - Operational points (stations)

Data exchange in rail industry
Maintenance Planning System



Which specific infrastructure data do you expect to receive/send (elements)?

- Topology:
  - Lines
  - Operational points
  - tracks
- Asset types:
  - Trackbed ("Fahrbahn")
  - Railway electrification system ("Bahnstrom")
  - Signaling (interlockings, signals, signalling components)
  - Bridges, tunnels
  - Walls, sewing systems
  - Station building infrastructure
  - Platforms
  - Telecommunication infrastructure
- Special railway vehicles:
  - Maintenance railway vehicles

The application focuses th
management source system
planning system of the infra

Thank you for your kind attention

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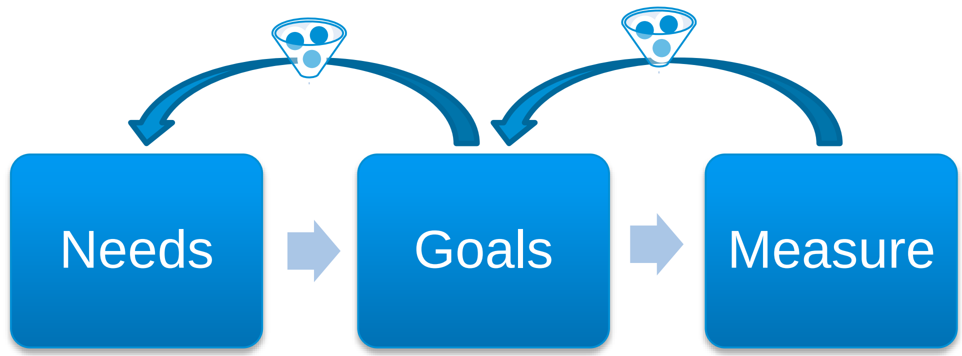
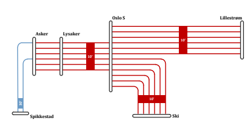
Business cases & processes

The Norwegian case: Capacity planning and the added value of standardized data

Jernbaneverket

Multiple workflows, partners and iterations creates a lot off data movement





Solution

A unified database model and data language containing all necessary data attributes for capacity work univocally, such as **UIC RailToppoModel, RailML 3.0**, and tools that support these.

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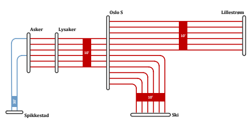
Business cases & processes

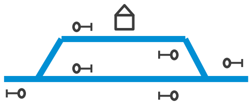
The Norwegian case: Capacity planning and the added value of standardized data

Jernbaneverket

The capacity workflow

Needs → Goals (Society | User | Provider) → Measure





Political requirements
Market
Scope
…

Demand
Transport capacity
Cost/Benefit

Traffic capacity
Service concept

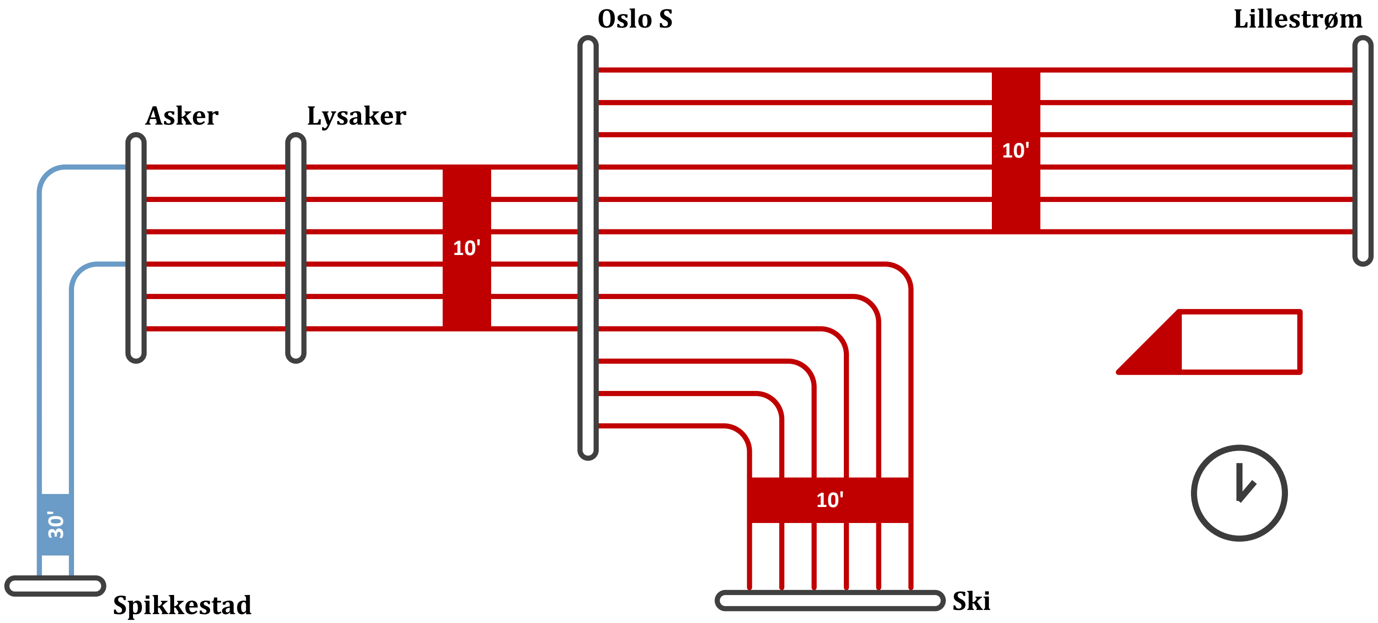
Functional requirements
Infrastructure dimension

Infrastructure
Infrastrucure design

Business cases & processes

The Norwegian case: Capacity planning and the added value of standardized data

The Service concept



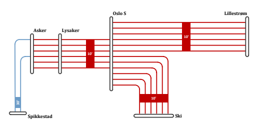
Business cases & processes

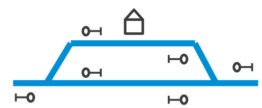
The Norwegian case: Capacity planning and the added value of standardized data

Jernbaneverket

The capacity workflow

Needs → Goals (Society | User | Provider) → Measure





- Needs:
  - Political requirements
  - Market
  - Scope
  - …
- Goals:
  - Demand
    - Transport capacity
    - Cost/Benefit
  - Traffic capacity
    - Service concept
  - Functional requirements
    - Infrastructure dimension
- Measure:
  - Infrastructure
    - Infrastrucure design

Business cases & processes

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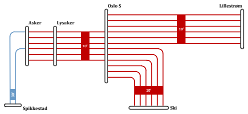
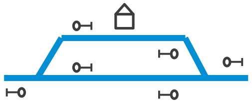
Jernbaneverket

The capacity workflow

Needs	Goals: Society	Goals: User	Goals: Provider	Measure
				
Political requirements	Demand	Traffic capacity	Functional requirements	Infrastructure
Market	Transport capacity	Service concept	Infrastructure dimension	Infrastrucure design
Scope	Cost/Benefit			
…				

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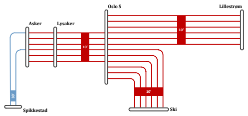
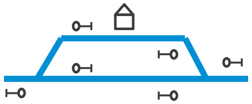
Business cases & processes

The Norwegian case: Capacity planning and the added value of standardized data

Jernbaneverket

The capacity workflow



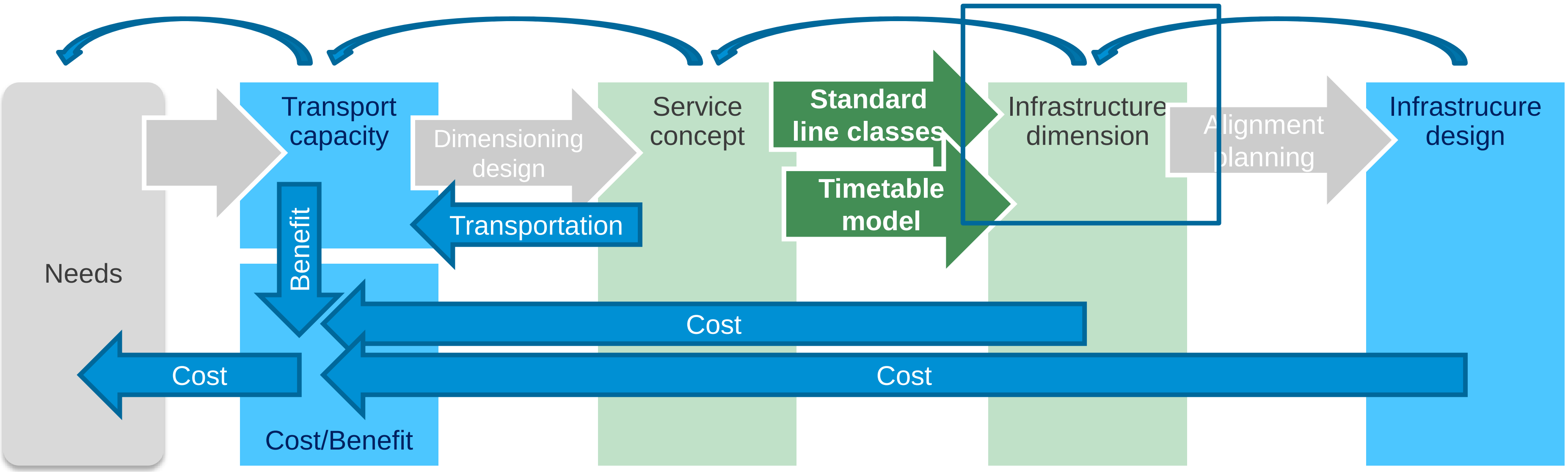


Needs → Transport capacity → Dimensioning design → Service concept → **Standard line classes** / **Timetable model** → Infrastructure dimension → Alignment planning → Infrastrucure design

Business cases & processes

The Norwegian case: Capacity planning and the added value of standardized data

The capacity workflow



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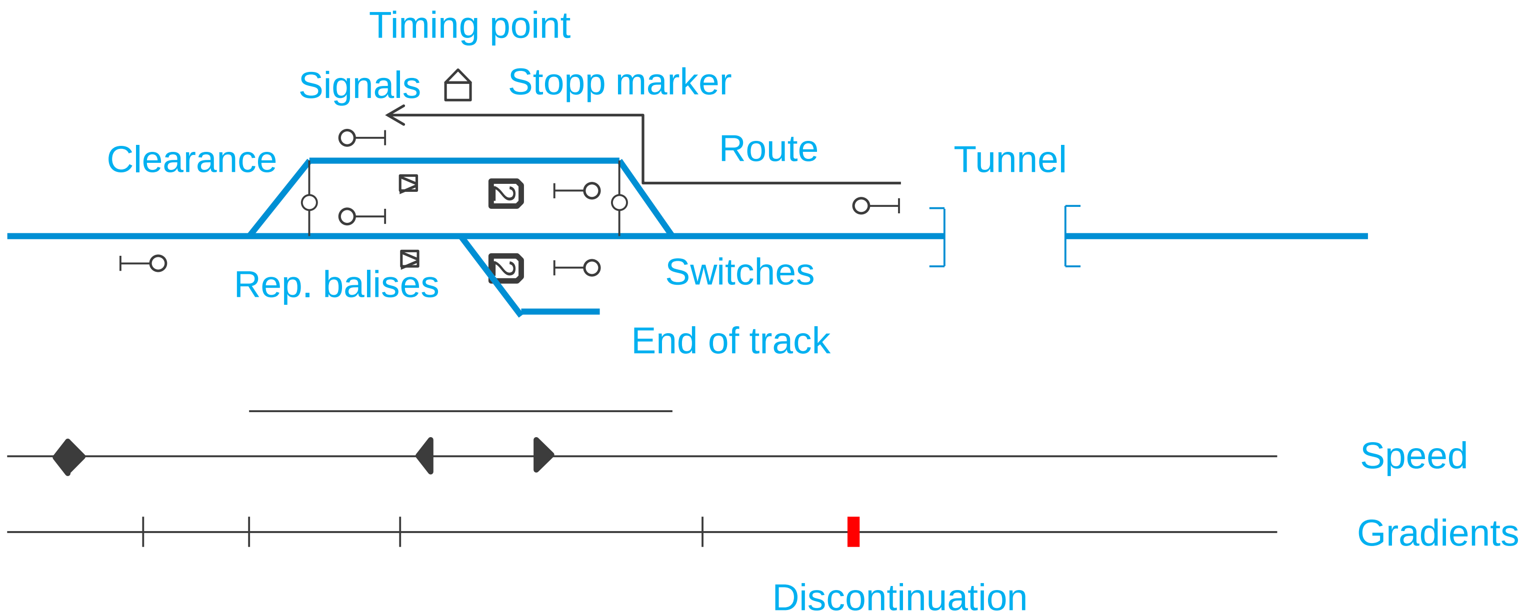
Capacity infrastructure description

Remember valid timeframe!

Microscopic level only uses12 data object types, with a total of 155 attributes.



Business cases & processes

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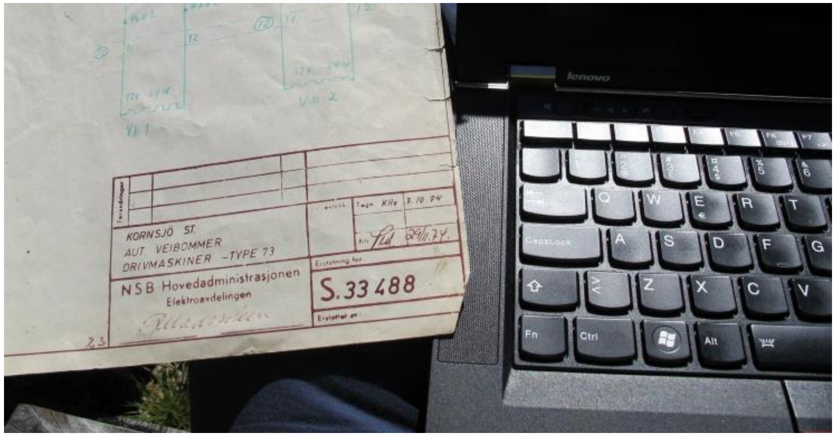
Other issues

Concept management

Multiple Timeframes, scenarios, alternatives and versions

One project example: 3x3x5x10=450 datasets



Solution

- Tools that connect themselves to a common database model
- Above capabilities in tools for RailML – possible, but lots of work
- Standard declarations

Business cases & processes

The Norwegian case: Capacity planning and the added value of standardized data

Other issues

Merging

Objects in as built-scenario change that influence the same object types in other scenarios. Updating those scenarios means merging the data.

1. Compare
2. Check
3. Merge

Solution

- Tools that connect themselves to a common database model
- Above capabilities in tools for RailML – possible, but lots of work

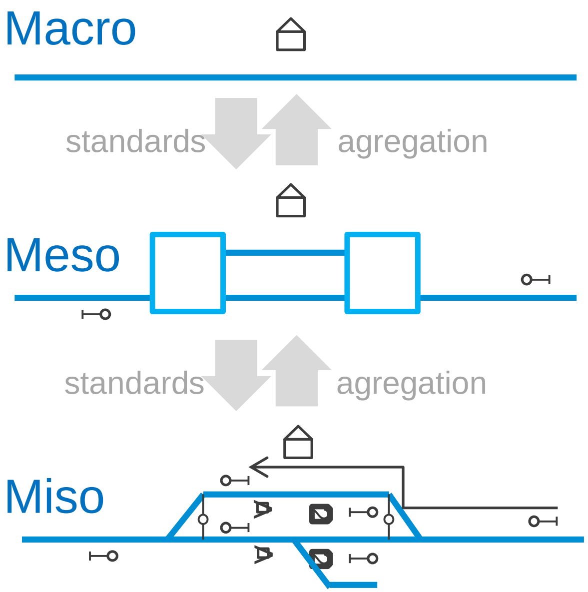
Business cases & processes

The Norwegian case: Capacity planning and the added value of standardized data

Jernbaneverket

Other issues

Agregation transfer
We need to work seamless between the different detail levels.



Solution

- Tools that connect themselves to a common database model
- Above capabilities in tools for RailML – possible, but lots of work

Business cases & processes

The Norwegian case: Capacity planning and the added value of standardized data

Other issues

Vendor & Consultant lock inn
Proprietary formats, uncompleted development and implementation of standards hinders a functioning free market for capacity work.

Solution
A unified database model and data language containing all necessary data attributes for capacity work univocally, such as **UIC RailToppoModel, RailML 3.0**, and tools that support these.

Thank you for your kind attention

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Photos: Hilde Lillejord/Jernbaneverket

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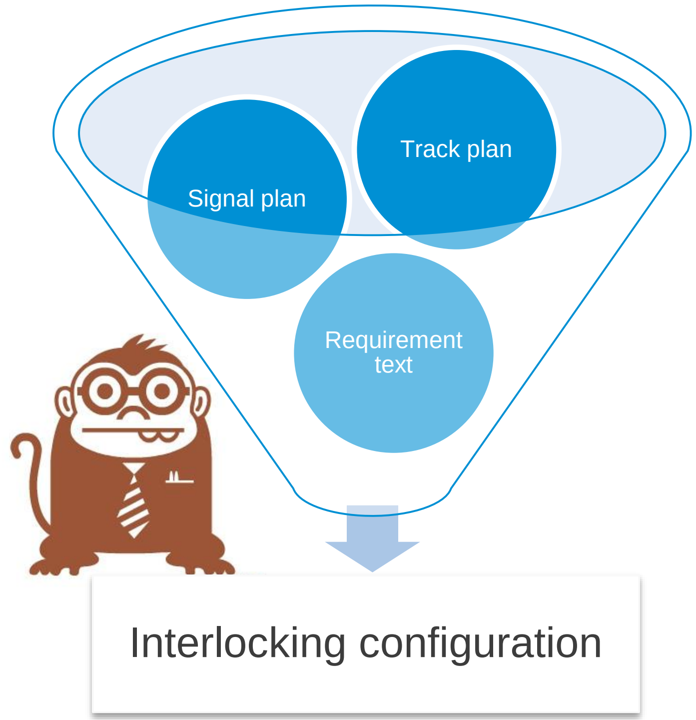
Formalizing Interlocking model in railML®
state of the art

Message / Problem
Interlocking data are processed manually from paper.

Errare Humanum est



Solution
railML can capture the data that an Interlocking needs.
Configuration are produced automatically.

Computers don’t err

Use Cases and Business Cases

Data preparation

- Quick
- Remove humans from the loop → fewer errors makes cheaper validation

Hardware engineering

- Calculate and engineer hardware layout and cabling

Simulation

- Timetable testing
- Capacity testing

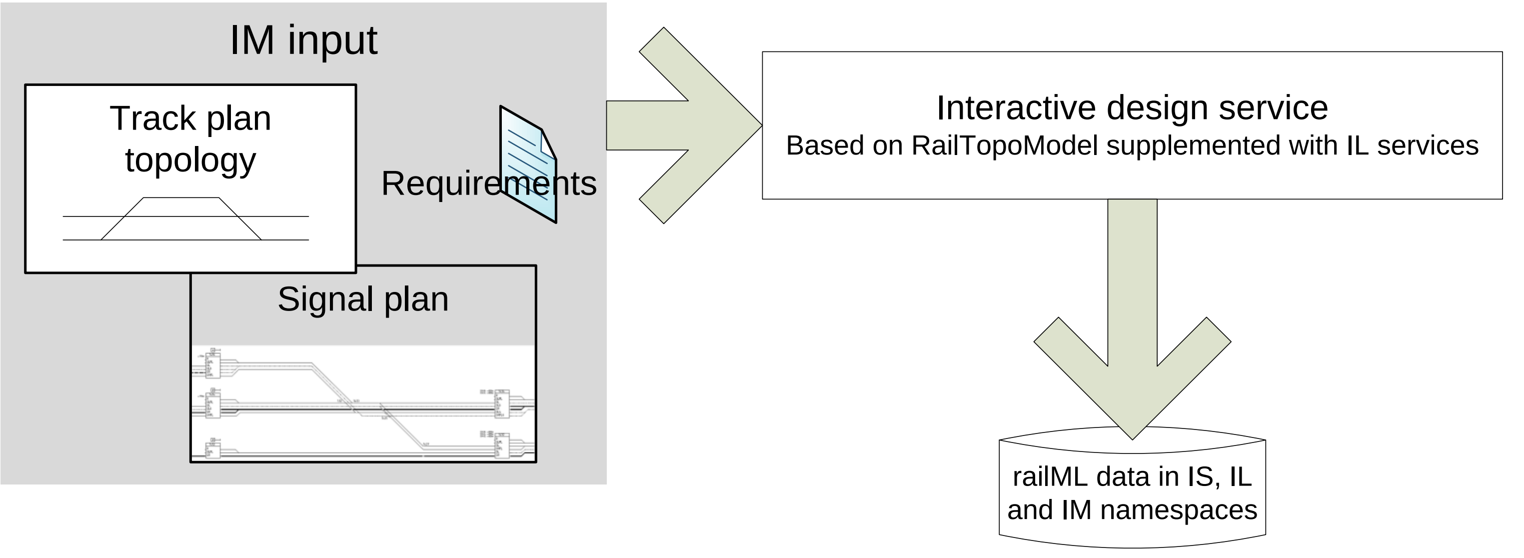
Operation & Control interface

- Single source for route information

Eulynx for peripheral systems

- Standardised interfaces IL ↔ (field elements, RBC, block, working gang warning systems)

Migrating to railML



Visual tools are essential for acceptance

Use RailTopoModel as a base for tools

IL model sits on top of Infrastructure data

Infrastructure Manager’s own schema

- Schema defines <u>specifics</u> such as signal aspects

railML IL Interlocking schema

- extends points, ATP, signals…
- New elements route, tvdSection, shunting area
- interlocking relations
- Signal plans and Control tables

THE innovation

railML RailTopoModel defines the track plan

- Defines track elements
- topology

The railML IL Schema will not do all

IL will not capture

- Rules and Regulations (BO)
- National specifics such as signal aspects
- National defaults

IL will capture

- Static properties of the interlocking (e.g. Timers)
- Interlocking relations

The making of the IL model

Analyse the Present Situation

- Can we reuse elements from RailTopoModel?
- What extra information does an interlocking need ?

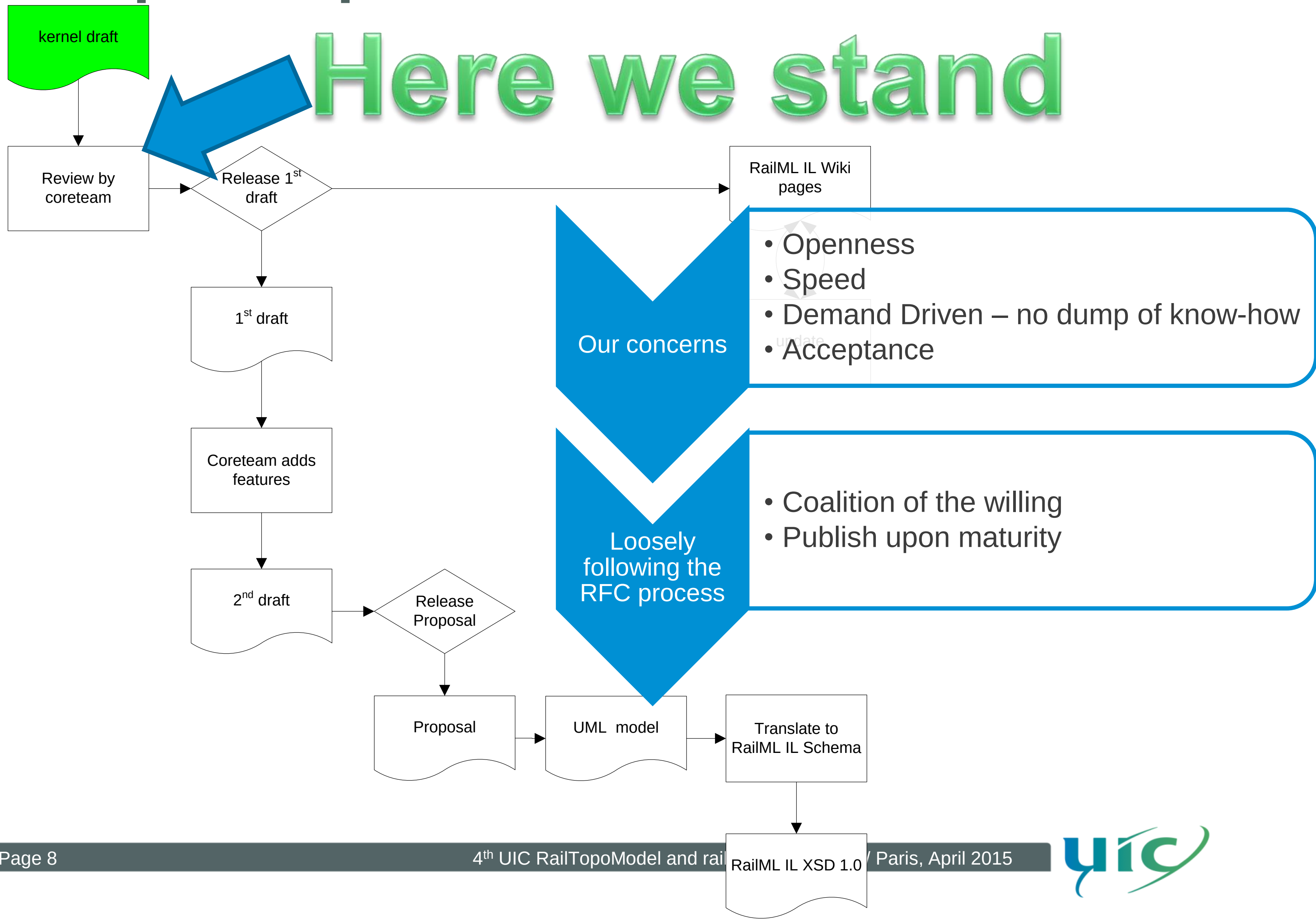
Make Informed Design Decisions

- Based on analysis
- Substantiate the decisions
- Make In/Out or Include/Delegate decisions
- Retain the history that lead to the model – avoid repeating discussions
- Document the design and elements on the go

Model driven by Need

- Avoid dropping assorted elements in a bucket schema

Development process



■ ■ ■ Thank you for your attention and now back to work

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