Such solution will allow exchange of all types of information, in all dimensions and life cycle of the rail sector using a standard format: infrastructure semantic nor accuracy, no risk for misinterpretation between sender and receiver.

Together, those 3 components will provide an efficient data exchange toolset to ensure quality in all data transfer within the rail sector: no loss of semantic nor accuracy, no risk for misinterpretation between sender and receiver.

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The vision for a standardized data exchange process requires at least 3 components:

1. A toolset for translation: to ensure consistent data representation and exchange.
2. A model for objects: to ensure consistent and accurate representation of objects and their relationships.
3. An exchange format: to ensure that data is exchanged consistently and accurately between systems.

As an example, a major short term benefit could be to provide a common view and optimize communication for works planning, managed by maintenance teams (infrastructure), and impacting Capacity teams (routes).

Another direct use case of RailTopoModel® in the coming Digital projects is for implementation of BIM. RailTopoModel® incorporates natively most dimensions related to each trades and craft categories, and facilitates their collaboration on multiple aspects (topology, geography, geometry, consistency, behavior, finance, project cycle,?). Additionally it allows easy enrichment with new dimensions.

RailTopoModel® aims to define railway objects and events in a standard and widely used form, UML, to describe how they interact with each other, and how they are expected to be used. By standardizing the semantic and data structure to be used for the railway network, it contributes to the standardizing of software and data flows in the railway industry.

One of the first deliverables based on RailTopoModel® is the enhanced version of the standard exchange format railML®, with the announcement of railML® 3.0.

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### Motivation

Current national situation (© IIRC)

One of the greatest challenges for railway sector is to improve the performance and quality of end to end business processes through multiple organizations (e.g. BIM projects involving numerous actors along a multi-annual process).

One major contribution to this challenge is about sharing high quality information between partners of a project /process. This goes through 4 mains steps:

- Business Semantic: A common meaning behind each word, each concept; e.g. what is a track? What is not a track?
- Object Model: A shared object model of our common systems; what is common should be uniquely described, and consistently declined in what is specific (e.g. fundamental and shared principles for interlocking should be commonly described, and applicable to each local specificities).
- Data Format: each data, derived from the semantic and object model, should be described using a standard format, to avoid translation and ease industrialization.
- System Interpretation: complex systems should be documented and equipped as necessary to avoid any misinterpretation of the exchanged data (e.g. ensure no room for interpretation when sending a data file with detailed description of a complex ETCS network).

To date, there has been little coordination or consensus within the railway community over a standard for the exchange of information.

Thus multiple ?standards? have been developed for specific purposes, each with its own semantic, model, and file format. Consequentially, each ?standard? cannot be used for purposes other than the original one. Examples include formats designed for RINF, INSPIRE, ETCS projects, etc.

The consequence of this situation is:

- Labor-intensive, repetitive developments in IT,
- Long project lead times, and
- Incompatibility between different standards, which has prevented the development of transformation software in a competitive market.

### A standardised model

Ideal national situation with the RailTopoModel® and railML® (© IIRC)

The vision for a standardized data exchange process requires at least 3 components:

- A logical model: to describe the railway system, network topology, infrastructure objects, interlocking rules, their semantic and attributes.
- An exchange format: to represent objects and attributes as structured data, typically in text format with a defined schema.
- A toolbox for translation: to ensure consistency and quality in multiple translations from one format to another. i.e. for export/import between in-house IT solutions and the standard exchange format.

Together, those 3 components will provide an efficient data exchange toolset to ensure quality in all data transfer within the rail sector: no loss of semantic nor accuracy, no risk for misinterpretation between sender and receiver.

Such solution will allow exchange of all types of information, in all dimensions and life cycle of the rail sector using a standard format: infrastructure semantic nor accuracy, no risk for misinterpretation between sender and receiver.
The collaboration between RailTopoModel® Project team and the railML® initiative aimed at providing this complete toolbox for data exchange as a first priority.

There are currently two components available to support the exchange of information the domain of railway infrastructure.

**Semantic model**

- **RailTopoModel®** is a generic railway data model designed to support current and future business needs. It is particularly useful for engineering activities mainly dealing with installations and components.
- **railML®** is the latest evolution of the standard format created by railML.org.

**railML®**

- **railML® 3** is design is total compliancy with RailTopoModel®.

The third component, toolbox for translation, should be published early 2017.

### Benefits from a standardised model

Investing in standardized railway model and data exchange format will provide multiple benefits for the sector, including:

- Improved business performance, by ensuring a shared semantic between multiple actors, and speeding up collaborative processes.
- Higher quality in data exchanges, avoiding losses or mismatches.
- Reduced lead times and overhead in data transformation.
- Streamlined and re-usable development, by providing a universal data structure and clarifying its semantics.
- Integrated IT systems, by providing standard interfaces for data exchange.

A significant return on investment can be expected.

Detailed Information about railML® can be found on the [railML® website](http://www.railML.org).

### Goals

The ultimate goal is to provide a standardized master model for the railway system which supports a common representation of a railway network and events, and facilitates the exchange of data within the rail sector.

For this purpose, RailTopoModel® proposes the use of a graph topological model, as such a model is commonly used to display networks for a range of sectors, including railways. One of the main reasons for its wide past adoption is that a graph model is systemic, i.e., it is independent of any particular use or application. This choice guarantees sustainability and scalability, meaning that the Model can evolve as business needs change. It also ensures the integrity, quality and dimension of data is not compromised due to the usages and evolutions.

The first objective is to ensure that this model supports the railway business needs, today and tomorrow. In order to achieve this, the model fulfills the following criteria:

- Provide a topological representation of the iron network which is fully connected and can be visualized schematically. It supports the description of the network at multiple scales, from the most detailed level (track), up to higher levels such as “line” and “corridor”.
- Enable data to be aggregated and disaggregated from one level to another, to ensure consistency across all scales.
- Support route definition, based on network topology, infrastructure characteristics (gauges), signaling, works, etc.
- Support multiple referencing systems, ensuring consistency during transformation. Primary examples include:
  - Linear referencing using mileposts and ?rail addresses?,
  - Positioning using geographic reference systems,
  - Screen (schematic) coordinates.
- Locate punctual, linear and areal entities, including:
  - Points / nodes, such as any installation, equipment, event, etc.
  - Lines / edges, such as speed limits, slopes, platforms, etc. (attributes which are the same along a linear feature).
  - Areal objects, such as track circuits, tunnels etc.

Finally, as it is important to ensure scalability and future-proof the model, RailTopoModel® is designed to be enriched progressively with new concepts, and to support business usages as they evolve.

### History

The RailTopoModel® initiative originates from a small group of EIM/CER representatives involved in the European Register of Infrastructure (“RINF”) project with the European Railway Agency (ERA), or local ETCS works with industrial partners.

In 2012, these actors shared the fact that the whole sector is permanently facing the two following issues:

- Repetitive development of multiple flows of infrastructure data exchange with all kinds of partners;
- Difficulties to manage both concepts of “network routes” and “infrastructure equipment and characteristics” in a unique and consistent set of data.

This shared observation, enriched with some local initiatives, has led to the creation of a working group whose aim was to design a robust model to support these needs, and which could evolve over time.

Considering the ambition of this group and the expected benefits to the whole community, UIC was asked to support this initiative and make it publicly available.

By the same time railML.org which was also facing limitation on its current solution to support network topology was proposed to join the RailTopoModel® workgroup.

The collaboration between these two teams will lead to the delivery of a consistent set of solutions, consisting in a data model and a matching data exchange format.

RailTopoModel® and railML® are two separate initiatives that, although complementary, will remain separate offers:

- RailTopoModel® is defined as a public good, designed by the railway community to support their long term needs. As such, it should and will remain independent of any usage.
- railML® is one use case of RailTopoModel®, supported by an open source railway community, and driven by their interest and priorities.
Feasibility Study
Before launching the RailTopoModel® project, a feasibility study was performed by TrafIT on behalf of UIC. The results were presented at a UIC conference in Paris on 17 September 2013 and then published in a PDF. The output of this work was a schema for an "off the shelf" network model which describes the topology and basic elements of a railway’s iron network, and related assets such as track, signals etc. The model should be designed to be independent of any particular usage, and can therefore be used for multiple applications.

The vision is for this model to be adopted by the rail sector to design future applications and support collaborative processes between industrial partners. The first deliverable will be to support the exchange of data within and between organizations. The study confirmed that it was indeed achievable, and put together a roadmap for successful implementation.

What you should have learned

- RailTopoModel® is a universal and generic approach to the modeling of a railway system (a universal language to describe the rail system and its life cycle).
- railML® 3 is the latest evolution of the railML® data exchange standard format. Its infrastructure scheme is based on the RailTopoModel® concept.
- RailTopoModel® and railML® 3 together form a standard for railway infrastructure data modelling and data exchange.
- The topology is the basis for the railway network model that can be applied by many different use cases.
- In comparison to other models (dedicated to one project, one usage), the RailTopoModel® approach aims at supporting the specific needs of the whole railway sector.