

Research into optimised and future railway infrastructure

S2R-CFM-IP3-01-2020 Innovation Action

Appendix 4.1.1 Track information model

Confidentiality level: CO

Project information

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# Appendix a- task approach and methodology

The objectives of task 4.1.1 titled “Track information model” will be met using various methods, and the activities will be grouped into three distinct phases. The first phase aims to develop an artificial environment, namely a Building Information Model (BIM), to capture the necessary information regarding the Track superstructure. In the second phase, Trafikverket's relevant infrastructure regulations that govern Track structure will be defined and digitized using the “Semantic web” technology (W3C, 2015). Lastly, in phase three, a virtual environment will be created to serve as a digital information carrier.

It is noteworthy that some activities will overlap and be performed simultaneously to identify technical challenges early in the process. This approach will allow for the re-evaluation of methods or modifications to working methods if necessary. By doing so, it will ensure that the activities are executed efficiently and effectively to achieve the desired results.

## Phase 1: The development of a track based building Information Model (TIM)

### Define model structure (systems and components)

In this activity, an information model for the artificial environment (BIM model) of a Track superstructure will be established. Unified Modeling Language (UML) will be used to generate and configure the information model. The information model will be structured based on the following concepts:

* Using the standard "IFC-Rail 4x3" model structure developed by the "buildingSMART" group. (~~reference~~)
* Using the information model for "Reference facility" developed by Trafikverket in connection with the feasibility study "Virtual Master facility". (~~reference~~)
* Using the information model for "Reference ID", Trafikverket's common hierarchy and reference designations system for assets in a facility. (~~reference~~)

The purpose of the information model is to identify the different systems and component types that exist in a Track Structure environment. The information model will describe a combination of spatial structure and a physical structure, displaying the relationships between objects and how they are (de)composed using “Aggregation” (i.e. part of, composed of) and “Generalization”. The model will be expressed in structural diagrams based on IFC-Rail 4x3 and IFC 4 (the current official release) schema. (~~Referents detailed description of the working methods~~)

### Define a data structure (types and information structure)

In this activity, a definition will be established for the different properties that different types of facilitys, systems or components have. The activity is performed in parallel with activity "Phase 1: 1" and will generate data for the UML model. In addition to the geometric properties, properties defined in the feasibility study "Virtual Master Plant" will be used. Information stored in Trafikverket's various IT systems can then (theoretically) be linked to the BIM model in the next phases of the task with the help of a unique "Object Key".

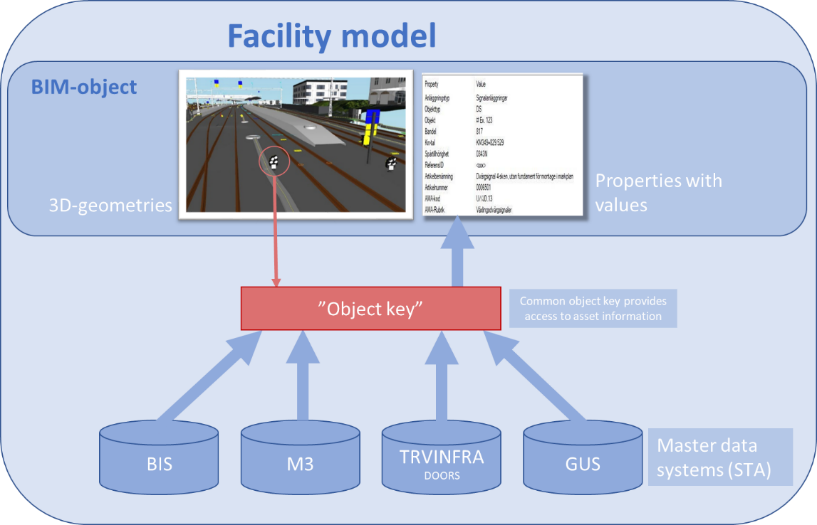


Figure 2 An "object key" enables access to data.

### Identify, collect or create 3D profiles and 3D objects needed to create the BIM model (Object Library)

Create or collect 3D geometries (BIM objects) for the components defined by the UML model in Phase 1: 1. The BIM objects must be parametric and contain the attributes corresponding properties defined in Phase 1: 2. Different types of CAD / BIM tools will be evaluated to perform this activity.

### Collect input data for the model (sample data)

In this activity, sample data is collected from the Trafikverket's various databases to use in the BIM model. The goal is that all the properties defined in the UML model will contain data. In the event that the information is missing from Trafikverket's databases, a fictitious but “reality-based” data will be created to ensure that all aspects of the UML model are tested in the BIM model to guarantee a high quality of our proof-of-concept.

### Define appropriate tools for creating the artificial environment (BIM model / database)

In this activity different types of CAD / BIM tools will be evaluated to define the most suitable tool that can be used to create a BIM model for the entire Track superstructure part of a railway Track. The tools must meet the following criteria to qualify for use as a BIM design tool:

* Has tools for performing parametric design
* Has tools for performing graphical programming to maximize the efficiency of the design process.
* Can export the design to an IFC file format.

Finally, a BIM model of a limited area will be created to use as a basis for the artificial environment (Digital Twin).

### Evaluation of the design concept (gap analyzes)

A gap analysis will be used to follow up the progress and success of the various above-mentioned activities in Phase 1 and activities in Phases 2 and 3. The analysis will describe the desired result at the end of the project (2023) compared to the start of the project. The analysis will also be used to identify future measures and recommendations for further work.

## Phase 2: Incorporation of the infrastructure regulations (TRVINFRA)

### Define the model's governing infrastructure regulations.

During the project, we will use the new regulations for New mainlines "Technical system requirements New mainlines" version 1.0 (TSK\_NS\_1.0). "Technical system requirements New mainlines" (TSK NS) is a Trafikverket’s document which together with existing regulations (TDOK / TRVINFRA) contains Trafikverket's technical requirements for planning, design, construction, operation and maintenance for the high-speed system on the Stockholm-Gothenburg / Malmö mainlines. TSK NS will be used for ballasted track system for speeds up to and including 250 km / h and ballast-free track system for speeds up to and including 320 km / h. (reference). For the purpose of this task, we will only focus on Chapter 8 of the regulations "Track superstructure and track design".

### Develop IT concepts to link the regulations to BIM objects

The regulations "TSK NS" will be converted to a digital format and stored in a database that can then later be linked to an object-oriented model. The purpose is to be able to refer via the BIM model to different regulations that govern the design of the systems / objects.

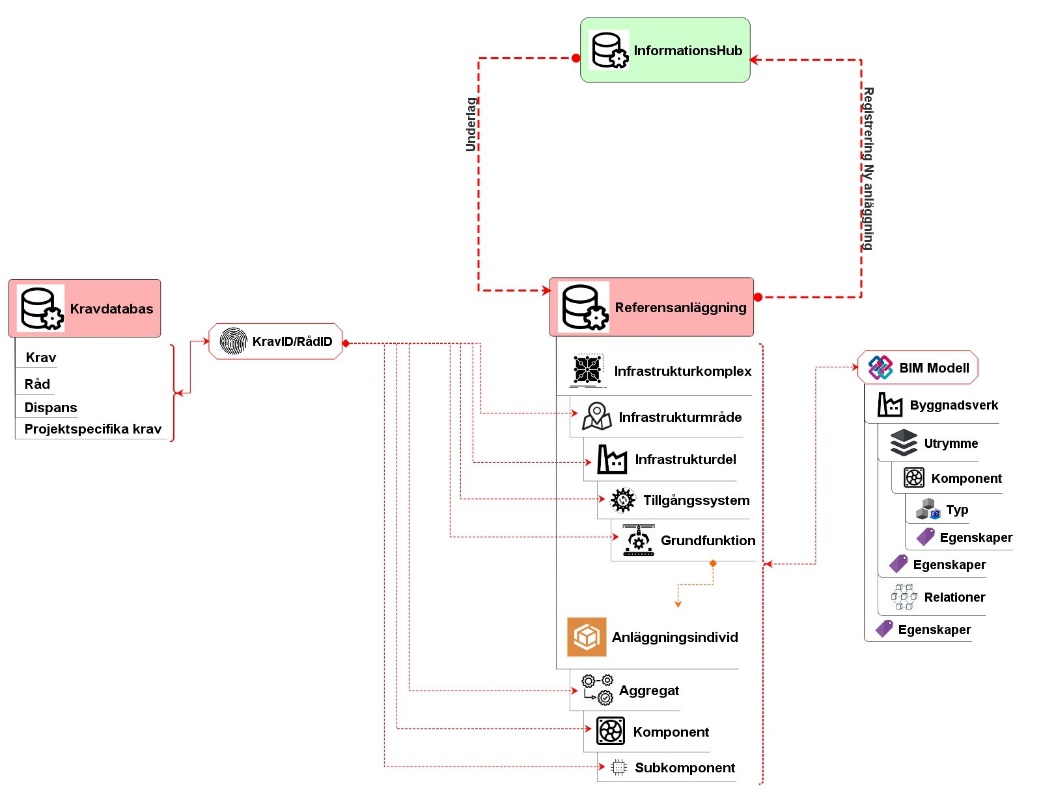


Figure 3 Principle for linking regulations to different objects in the BIM model

## Phase 3: The development of a virtual environment as a digital information carrier

### Combine data and 3D objects to create BIM model

The last activity in the task is to put all the data together with a corresponding 3D object and create a complete BIM model according to the structure defined in Phase 1. In connection with this activity, different types of "Model Viewer" will also be tested to decide which is best for:

* Visualization of information and 3D
* Export of information in other formats for further analysis with other tools
* User friendliness