# Accelerating Railway Digitization – scaling up MBSE in a high paced organization

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# Agenda

1. Introduction

2. MBSE at Digitale Schiene Deutschland

3. Scaling up MBSE - our challenges and way forward

   1. Easy co-working on models across teams and organizations

   2. Making models useful for general engineering crowd

   3. Hands-on experience for project teams

4. What's next?

# → Introduction

# Government and society expectations require profound technological innovations of the railway system

## Expectations towards the railway system

→ **Doubling passenger numbers** in long-distance transport by 2030

→ **Increasing** market share of **freight transport** to 25 %

→ Significant contribution to **climate protection**

## Mission of Digitale Schiene Deutschland

- To achieve this, the railway must increase **rail capacity by up to 35%**

- The **digitization of the rail system** is the biggest lever for this

- Digitale Schiene Deutschland makes this lever **available for the railway system**

# The target picture is achieved via various fields of activity- for more capacity, quality and efficiency

## Basic Digitalisation (Stage 1 plus)
## Advanced Digitalisation (Stage 2)

| BASIS DIGITALIZATION OF INFRASTRUCTURE | HIGHLY AUTOMATED DRIVING | FULLY AUTOMATED DRIVING | ADVANCED DIGITAL INFRASTRUCTURE | INTELLIGENT PLANNING AND DISPATCHING |
|---|---|---|---|---|
| • Equipping the infrastructure with ETCS L2 without signals (oS) and digital signaling technology (DSTW)<br><br>• Introduction of an integrated control and operating system<br><br>• Equipping vehicles with digital technologies | • Introduction of GoA 2-operations:<br><br>  – Trains drive, brake and stop automatically<br><br>  – Train operation is stable and predictable<br><br>  – Train operator remains on board and intervenes in case of irregularities | • Introduction of GoA 4-operations :<br><br>  – Trains run fully automated and are aware of their surroundings<br><br>  – Trains react automatically to disruptions<br><br>  – Driverless driving is possible | • Introduction of a train centric protection logic<br><br>• Allows driving at optimal distance (Moving Block)<br><br>• Allows more trains to run on the same track | • Timetables are recalculated in seconds by AI in the event of deviations<br><br>• Automated capacity planning occurs throughout Germany<br><br>• Increases network utilization and reliability |
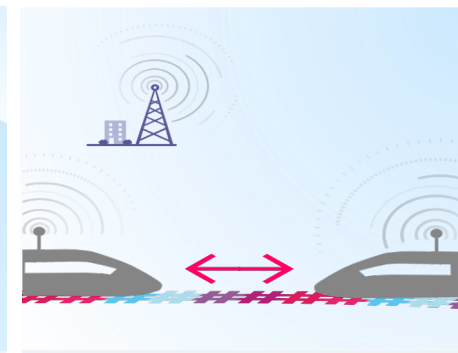
**Future Railway Mobile Communication System (FRMCS) based on 5G technology**

# Digitization of the rail system requires new, cross-industry and cross-border partnership models

**Digitale Schiene Deutschland = Sector Initiative**

**So far...** | **In the future**

From classic relationships between client and contractor... → ... to **development partnerships** with industry and joint piloting in projects

DB as a mere user of technologies... → ... becomes an **active co-developer**

From closed systems... → ...to **open platforms**

Strong focus on latest railroad technologies .... → ... is extended by technical solutions from **other industries**

Historically evolved national railway systems with different technical standards... → ... are aligned within the framework of **standardization** and **harmonization** at European level

# To achieve the target picture, a structured description of the overall system is necessary

## TODAY

Variety of grown systems, interfaces and rules

## OUR TARGET

Clearly structured system architecture
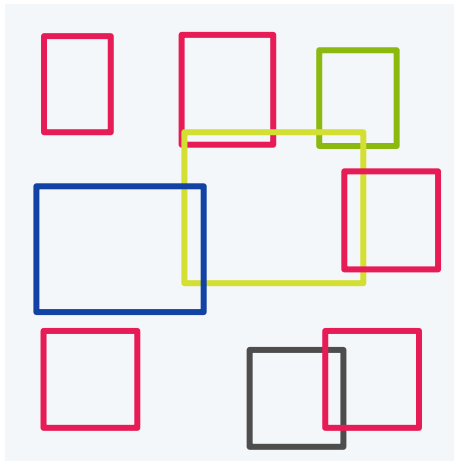
**model-based system description**

with defined design guidelines:

**System can be automated and simulated** →

**System can be modularized and standardized** →

**Safety-relevant functions can be encapsulated** →
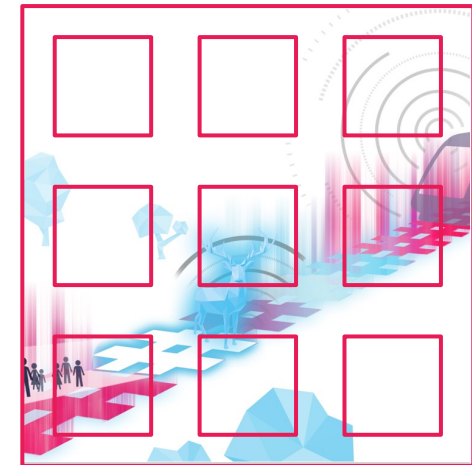
# → MBSE @ Digitale Schiene Deutschland

# We use Model-based Systems Engineering (MBSE) to …

**…create common understanding** of the railway domain, operational processes and needs. This helps us to define and specify future railway systems and interfaces. We do this together with our European partners within Europe Rail Joint Undertaking to ensure interoperability
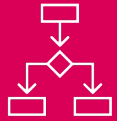
**…analyse the needs and specify our systems**, create architectures and use products of that work to support specification and integration work in real life projects.

**…validate our specifications and designs** through simulation and prototyping

external collaboration models

Feature Model

Reference architecture

PoC / Tech. demo projects

Other formal spec. projects

Sys ML

Simulation projects (Simulink & co.)
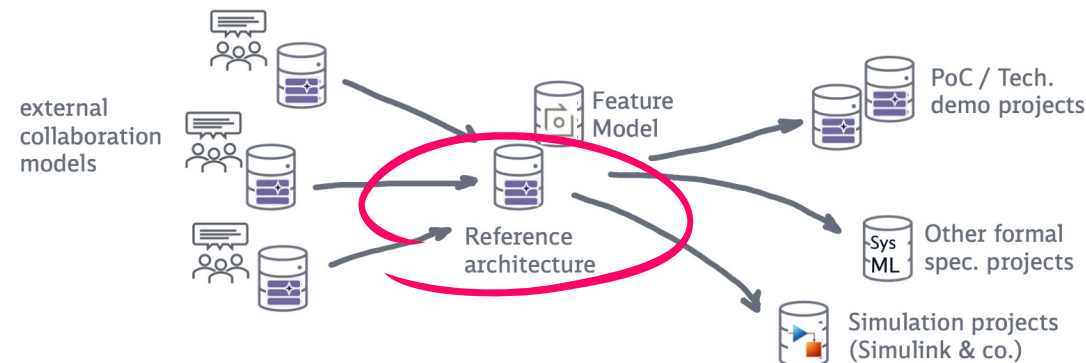
# Challenges for scaling-up MBSE @DigitaleSchieneDeutschland

DBS is **launching and preparing a wide range of projects**, including both pilot and development initiatives, as well as full-scale rollouts.

To scale-up for that challenge we need to:

- **enable collaboration** on models across different teams and organizations

- **make MBSE contents easy** to work with for non-MBSE stakeholders

- **on-board and train** a large number of project engineers.

As **Capella is the central MBSE tool** used in numerous DBS projects, adequate **tooling & training is crucial to ensure project deliverables**.

○ ● **Infrastructure projects**

○ ● **Pilot and development projects**

Advanced Digital Infrastructure

AutomatedTrain

Digital Register

Automated Rail@DKS
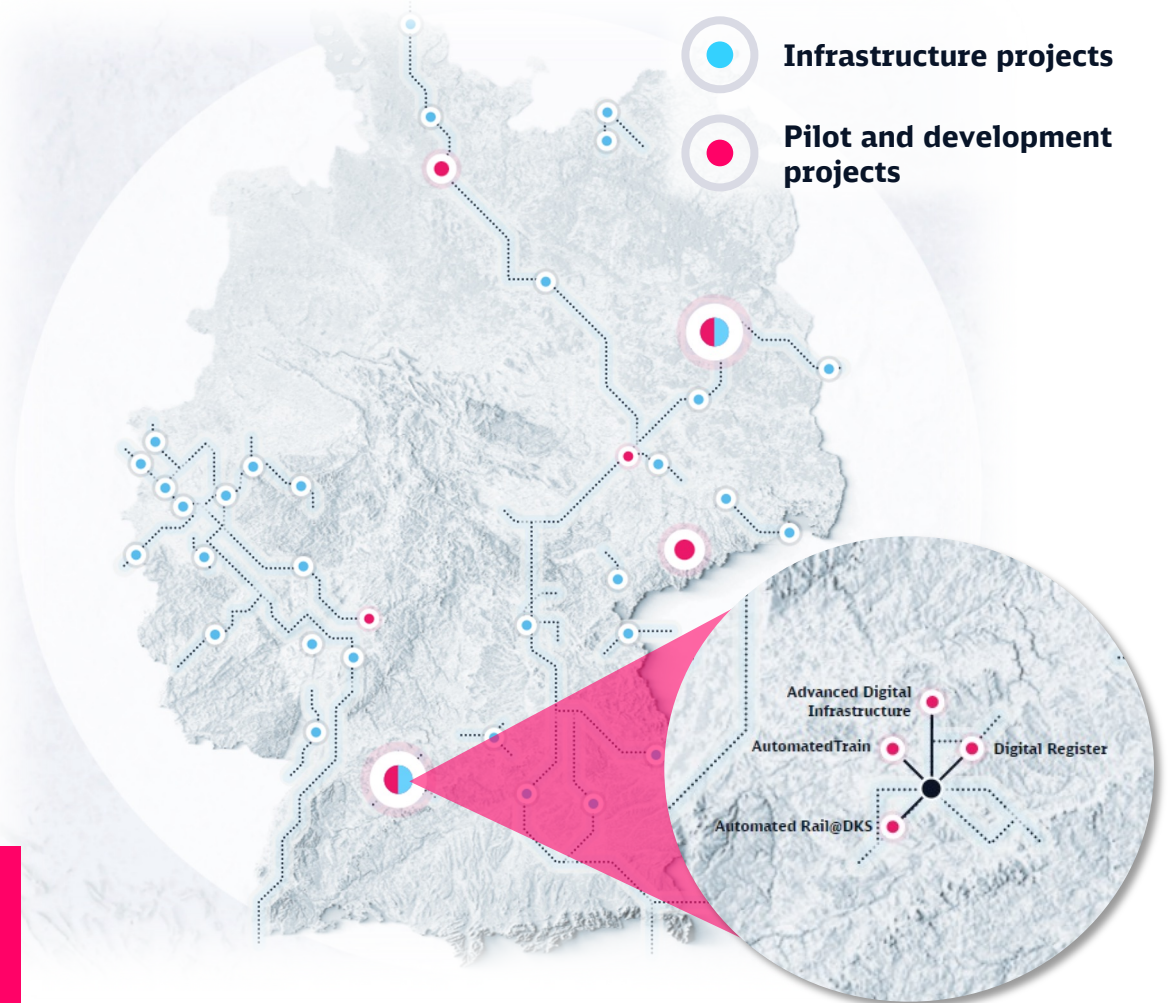
*Example: Cluster Stuttgart*

→ Easy co-working on models across teams and organizations

# *Our motivation for a custom solution*

## BEFORE

Capella installed
locally on devices

## AFTER

Capella managed
centrally
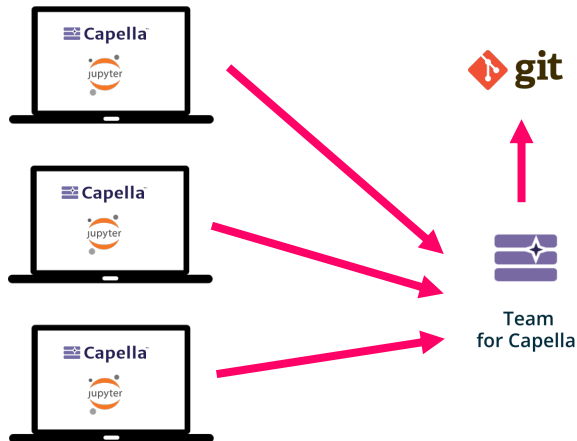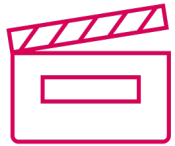
| | |
|---|---|
| Local installation | → Access via Browser |
| Different dropins and dependencies | → Same dropins and dependencies |
| Local logs | → Central log collection |
| Manual roll-out of updates and fixes | → Automatic roll-out of updates and fixes |
| Working together via Screen sharing | → Active co-working via session sharing |
| Different fonts in diagrams | → One common font for all users |

git

Team
for Capella

jupyter

git

Capella

Team
for Capella

# Demo Time

## Enable easy co-working on model across organizations
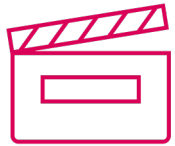
# Demo Time

Capella / TeamForCapella management made easy

→ **Making models useful for general engineering crowd**

# Why aren't MBSE models more useful to the general engineering crowd?

**Models aren't easy to approach for non-MBSE experts** – many engineers find MBSE tools complex, unintuitive and time consuming leading to resistance in adoption.

**Documents, not models are seen as the real deliverables** – Stakeholders prefer familiar formats like Word, PDF, Confluence, DrawIO and even Polarion LiveDocs could cause discomfort in some user groups.

**Teams align around "multiplayer" tools** like Confluence, Polarion or Word + Sharepoint, leaving models disconnected from team workflows.

**Model-derived products lack automation**, existing solutions for make of model-derived products aren't CI-CD friendly and require manual efforts.

# How do we make models useful for a wider audience?

## An easy approach to model-centric engineering! ☺
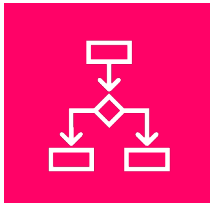
**Engage users in familiar contexts** – we deliver model-derived products into the tools and environments that they rely on, like Gitlab, Confluence or Polarion

Let **users review model-derived products right where they work** and use the collected comments / change requests to improve models

**Continuously update all derived products** - a model change event triggers related Gitlab CI pipelines that result in derivative work updates. And even though there is so much automation all basic **change control and quality management concerns are addressed**

Crowd-source and continuously improve a collection of "good by default" templates so that every new project gets a head-start

# So how do we actually get there?

## 1. Rapid prototyping
py-capellambse + jupyter-lab gives us space to quickly sketch new model-derived products (html, xlsx, IDLs, ...)
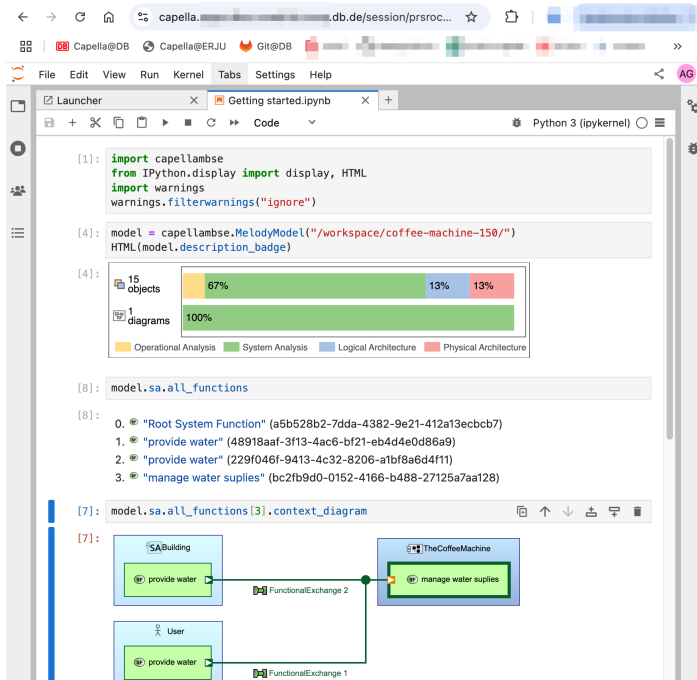


## 2. Model Explorer
A lightweight web app provides instant access to on-the-fly generated documents for any Capella model
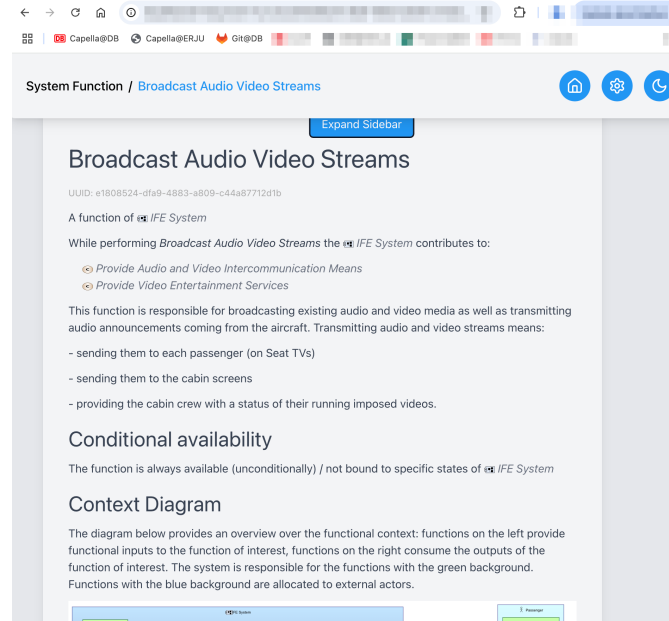


## 3. Capella2Polarion
Built for formal project work, makes model objects and derived documents available in Polarion. Fully automated operation via CI/CD
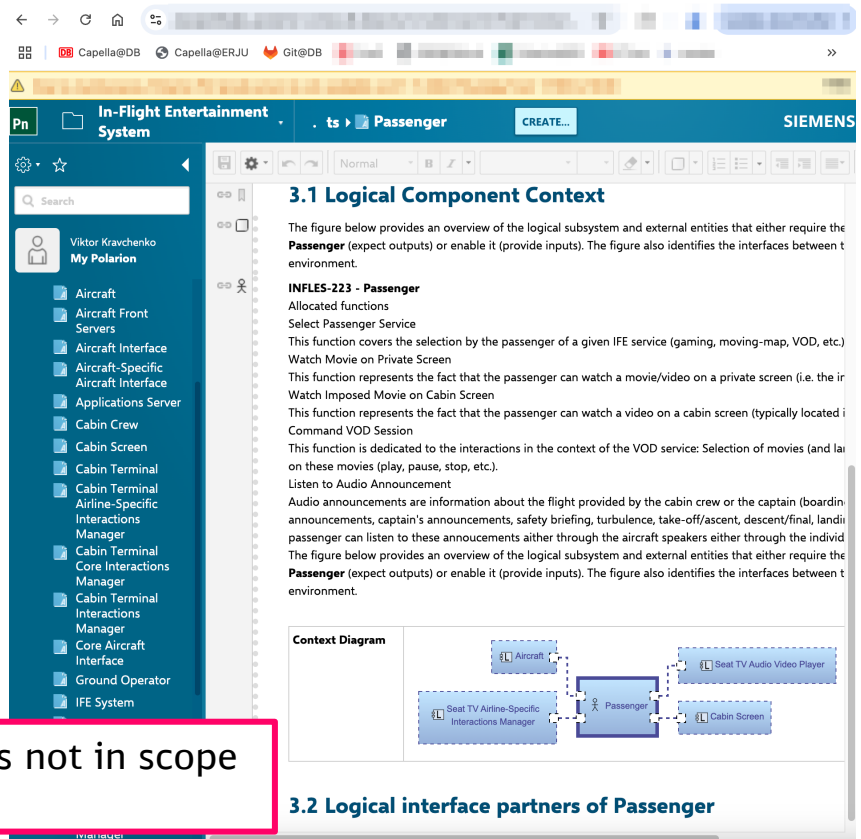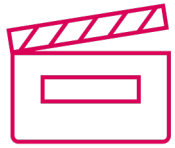


For some projects we also **export model-derived content to Confluence**, but this part is not in scope today and it is also pretty simple, since Confluence provides a **nice REST API** ☺
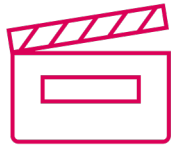
# Demo Time

Exploring Capella models as documents

# Demo Time

## Using Capella models in Polarion

# Demo Time

Model automation - The journey of modelling to artifacts

**Digitale Schiene Deutschland**

→ Hands-on experience for project teams
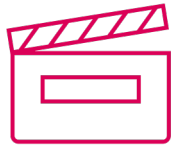
# Demo Time

## Delivering hands-on experience via self-led trainings

→ What's next

# What's next

→ Visit our GitHub profile and try out our tools:
They are open source and available to everyone!

→ We are constantly expanding our tools with additional features.
If you have bugs or feature requests, open GitHub issues.

**If you are interested in contributing to our tools, get in touch!**

https://github.com/DSD-DBS/
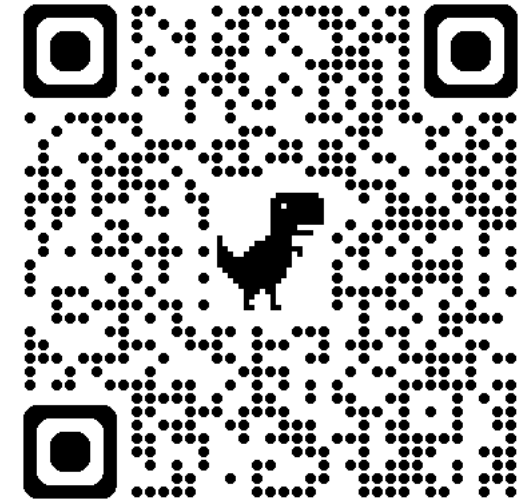
# Thanks for your attention & feel free to get in touch

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