KI in der Disposition für eine modernere Bahn

German Data Science Days 2024

March 7th, 2024 | Munich

AI in dispatching for a more modern railroad

Agenda


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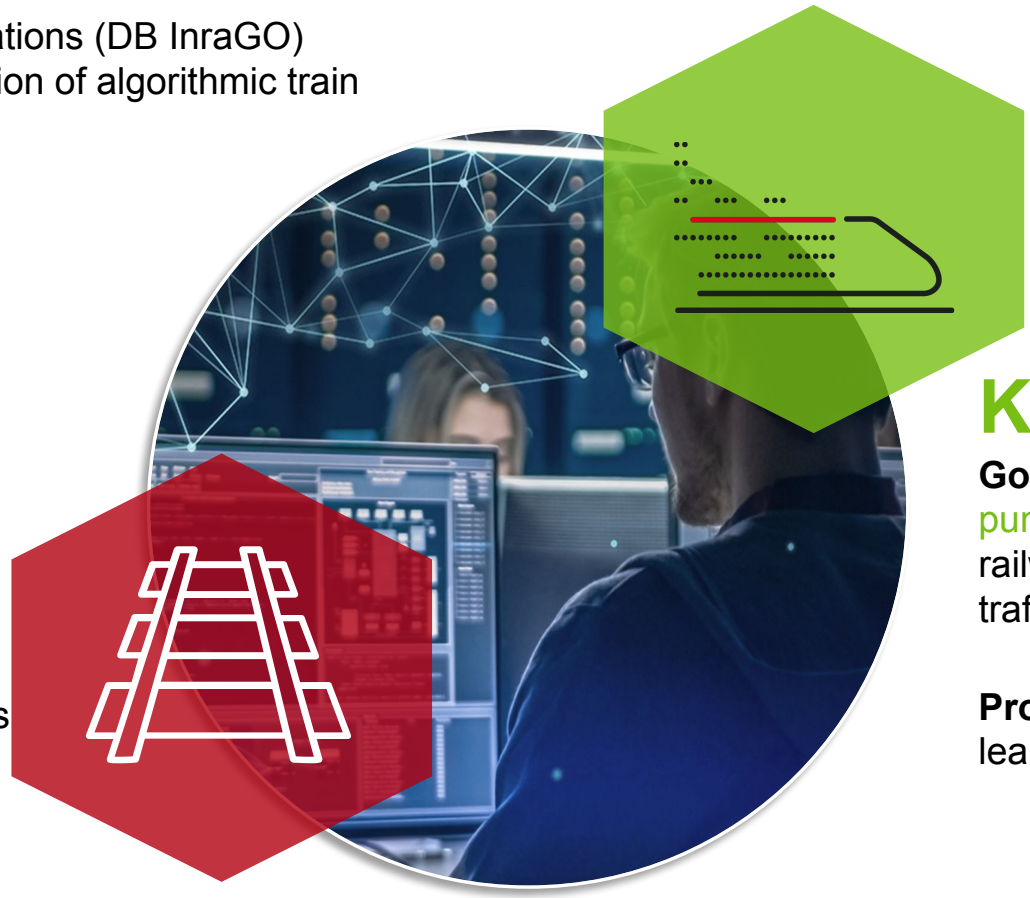
While ADA-PMB aims to improve overall punctuality within the railway network, KI Dispo improves passenger/customer punctuality

Goals & Procedures of KI Dispo & ADA-PMB

Dr. Hannah Richta
Head of Algorithms for Operations (DB InraGO)
Responsible for implementation of algorithmic train scheduling in the network

Torsten Deutsch
Head of Lane Rail Operations, AI Factory
Responsible for expansion of existing AI approaches in dispatching



ADA-PMB

Goals: Improving overall punctuality within the railway network through algorithm-based dispatching re-commendations for infrastructure dispatchers

Procedure: Mix of different AI methods with a focus on mathematical optimization

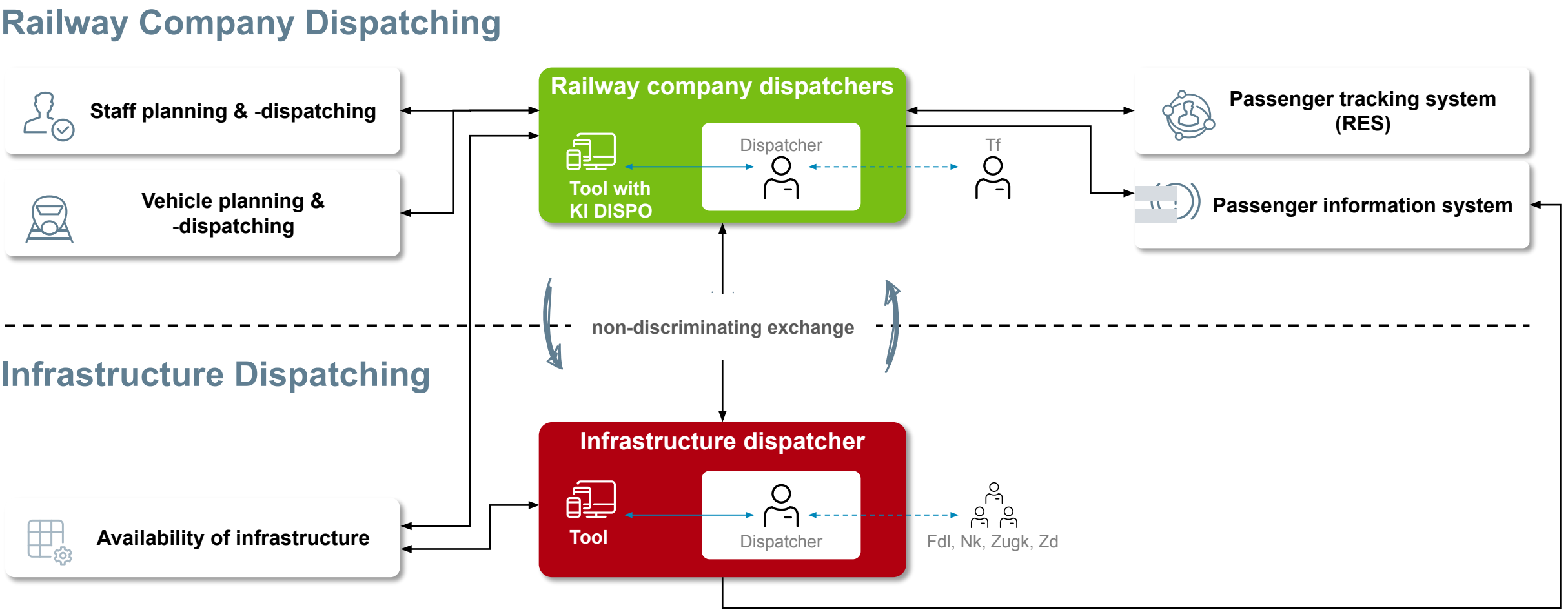
KI Dispo

Goals: Improving of passenger/customer punctuality by dispatching suggestions for railway company dispatchers with a focus on traffic and resource dispatchment

Procedure: Artificial intelligence/ reinforcement learning in combination with simulation

Dispatching is a team sport – decision-making and data are distributed between railway and infrastructure companies

Overall Dispatching Process



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AI in dispatching 1

KI Dispo – railway undertaking dispatching 2

ADA-PMB – railway infrastructure 3

Status Quo: the typical tasks and challenges of a traffic dispatcher in a railway company

Traffic Dispatcher railway company

TASKS

- Monitoring of the current operational situation to secure the traveller chain
- Responsible for train changes & schedule to increase the punctuality

CHALLENGES

- Increasing traffic volume
- Network extensions
- Limited ressources

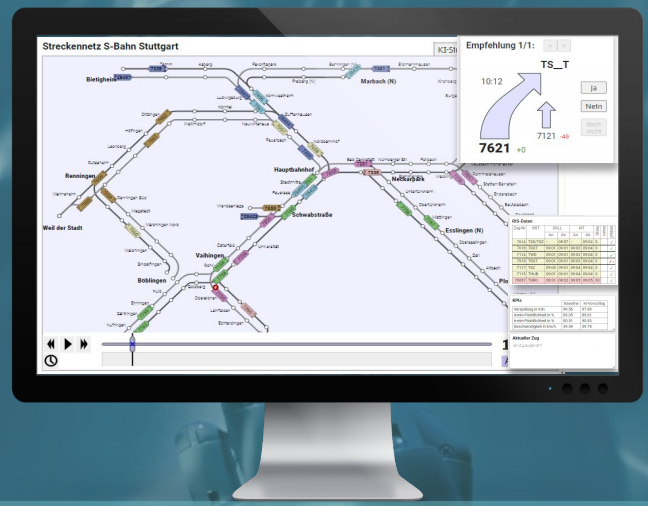
RESULTS

The traffic dispatcher is under **high pressure**. At some point, the human eye is **no longer able to keep track of everything** and calculate the impact of every decision.

Current tools **only help to a limited extent** in finding the „best“ decision.

AI SUPPORTS VIA…

1. Creation of **recommendation** through learning algorithms
2. Data-based and quantitative **evaluation** of recommendation
3. **Integration** in the relevant IT-Landscape of the DB

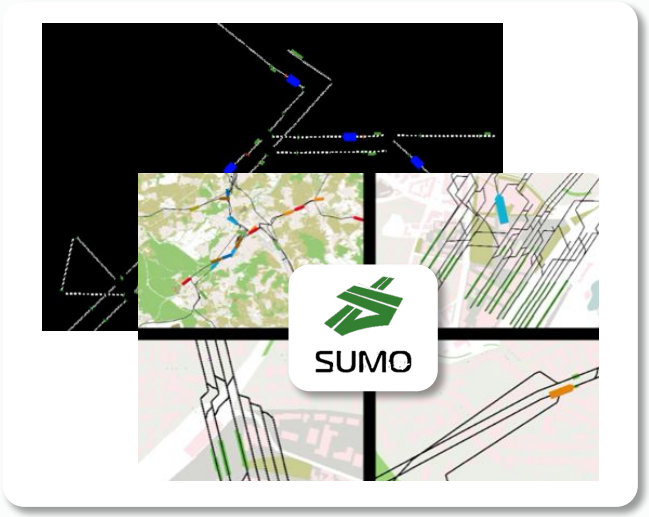


THE DISPATCHER RETAINS FULL AUTHORITY TO ACT

Clear structuring of the system reduces complexity

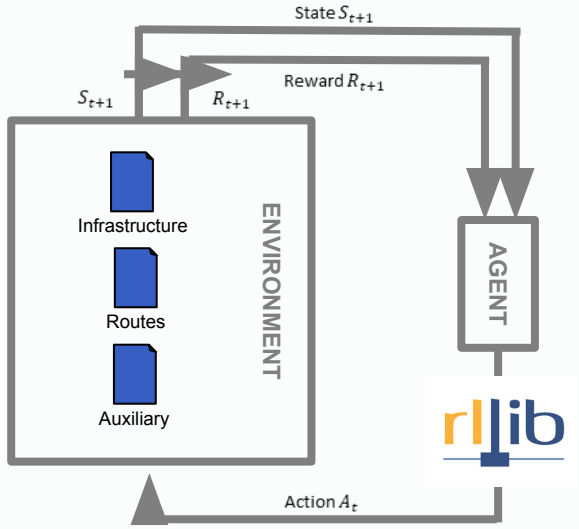
Digital Twin

- **Digital twin** of the railway network
- Analysing **optimal traffic flow**
- Identification of **conflicts**



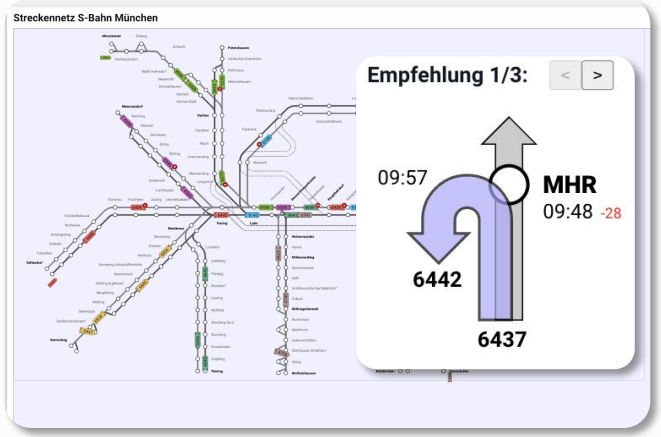
Recommender

- **Training and evaluation workflow** that interacts with the Simulation
- Generation of **proposals** to solve possible conflicts in advance through **preventive actions**



User Interface

- Integrate the tool into the **daily routine of the dispatcher**
- Combination of **simulation and AI** enables to visualize the impact of an action **up to one hour in the future**



Continuous collaboration with end users

AMBITION

Acceptance and **enthusiasm** by creating an aligned understanding of AI solutions

Ensure effective project support through **user-centric product development**

Connecting train production and AI **expertise** for a sustainable process integration

Product is effective and accepted

User involvement from day one!

PATH

Bringing together the experts of train production and AI within different formats

- Intensive test phases
- Visit control centres on a monthly basis
- Integration of feedback opportunities in UI

Sharing information via different channels to ensure knowledge exchange

- Online updates
- Tutorials
- E-learning videos

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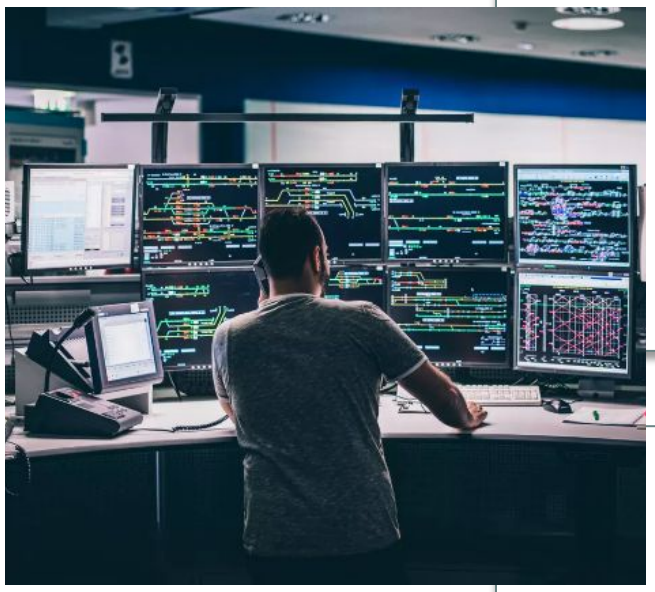
Dispatching is a key factor for short-term optimization of railway infrastructure – main challenge is the lack of systemic assistance

Dispatching Goals & Challenges



Goals & functions[1]

Ensuring maximum operational quality to achieve a high level of overall planning reliability

dispatchers…

- determine the order of trains & monitor the execution of their decisions
- give advice on the operating behavior of trains & pay attention to the dispatching implementation
- inform the traffic controller and the infrastructure dispatcher in the case of delays & transmit traffic controller requests for deviations from train characteristics to the dispatcher

Challenges

- No systemic support for conflict detection and optimized dispatching solutions
- Complexity of the situations to be managed not represented in the dispatching system
- High workload under time pressure, especially in degraded situations
- Loss of expertise due to demographic change & shortage of skilled professionals

ADA-PMB calculates the minimum delay solution and translates dispatching recommendations into comprehensible displays

Display of Dispatching Recommendations

Overtaking

Remaining time for communication with traffic controller

Track change

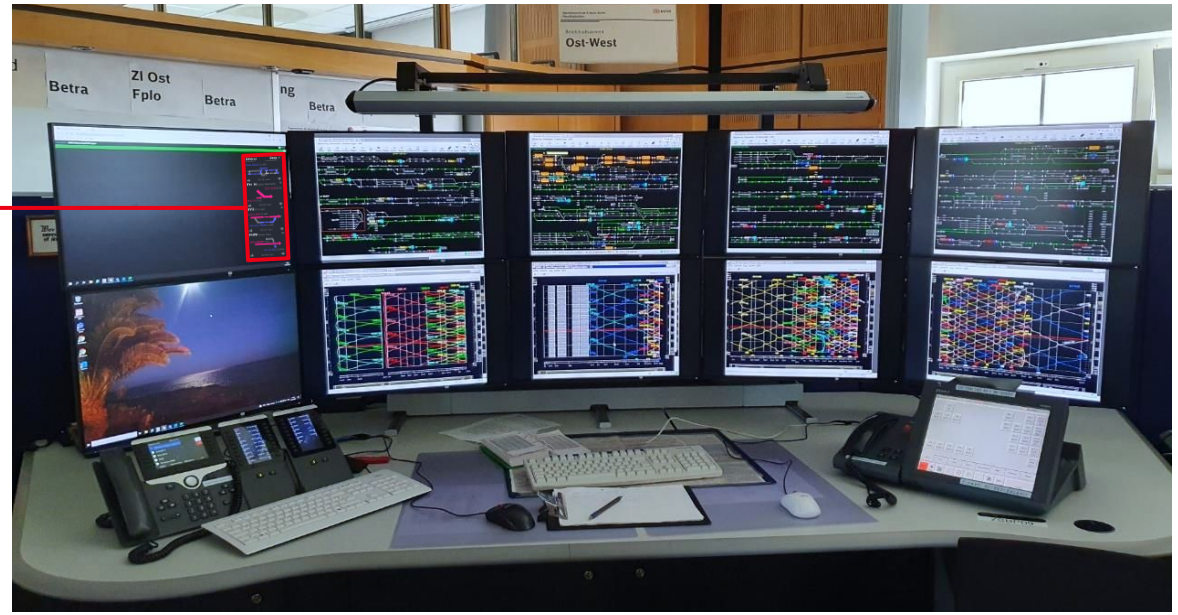
Anonymous feedback for further improvement

Dispatching center

Train & delay

Crossove

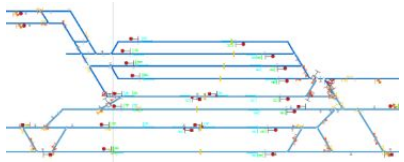
Threading

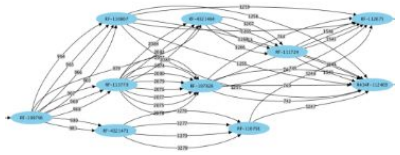


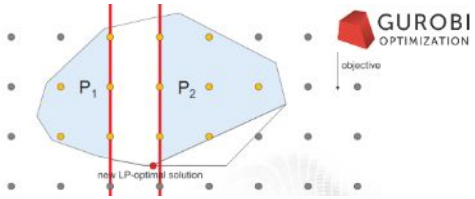
In the function of a **co-pilot**, **ADA-PMB** indicates **conflicts** and offers a **recommend-dation** for an optimized **solution**.

ADA-PMB uses live data from the dispatching system to generate recommendations based on optimization with additional AI input

ADA-PMB Process Steps







1 Input data

- **Original data from dispatching centers**
- Infrastructure, its availability restrictions, schedule and train data

2 Pre-process

- **Setting up the optimization model** (mathematical model of variables and inequalities)
- Supplementary creation of hints to accelerate optimiza-tion using heuristics and machine learning (AI method mix)

3 Optimizer

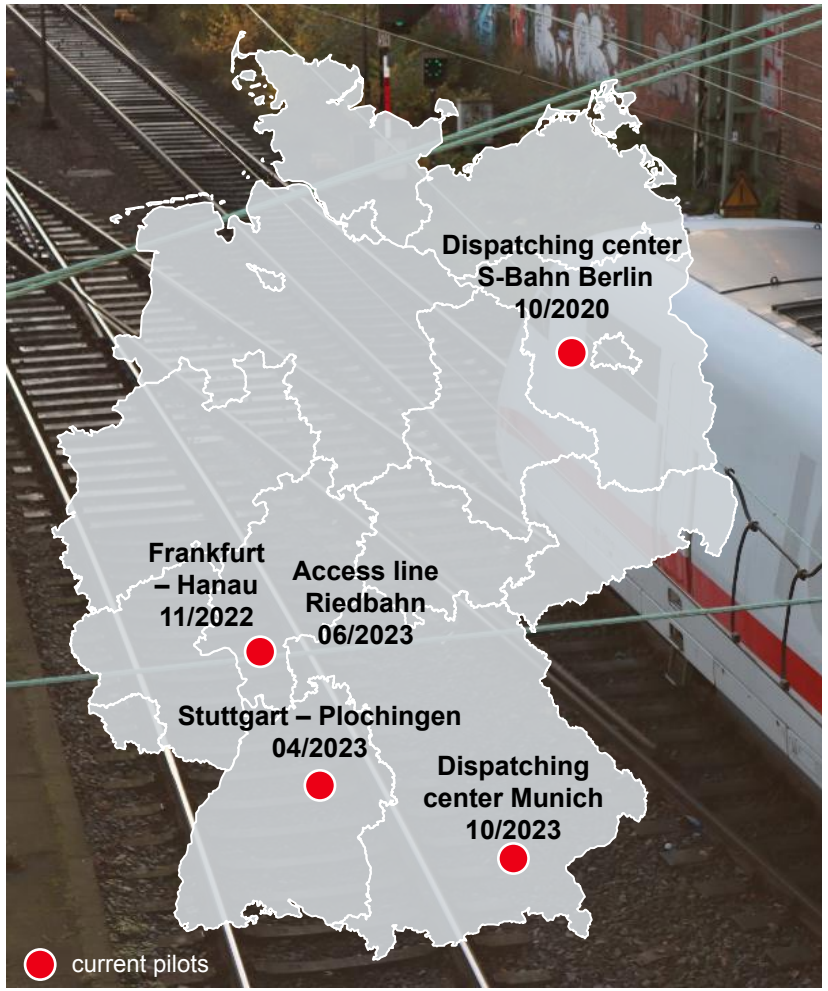
- **Minimization of the total delays through mixed integer optimization**
- Optimal solution in the operating area
- Complies with non-discrimination requirements

4 Post process

- **"Translating" the solution into comprehensible dispatching recommend-dations**

ADA-PMB implemented in 4 regions – measurable reduction of delay minutes & positive feedback from dispatchers

ADA-PMB in Practice



2020 first pilot with S-Bahn Berlin dispatching center on a section of the Berlin S-Bahn network launched

2022 Pilot Frankfurt – Hanau: first time use of a dispatching assistance system in **mixed traffic** in Germany and extension by the **Riedbahn access line** in **June 2023**

2023 further expansion of piloting with the support of the "Digitaler Produktionsverbund" (DPV): **Stuttgart – Plochingen** and **Munich S-Bahn main line**

Mainly **positive feedback** from dispatchers. Continuous development of ADA-PMB based on the feedback.

Measurement of effectiveness in Frankfurt/Main based on threading recommendation shows:

- In **70%** of the cases analyzed, **trains were dispatched** as suggested by ADA-PMB
- Disposition according to the order suggested by ADA-PMB leads to an **improvement** of the **relative position by 100 seconds** compared to an order deviating from the recommendation

Thank you.
Any questions?

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