Use Cases Railway

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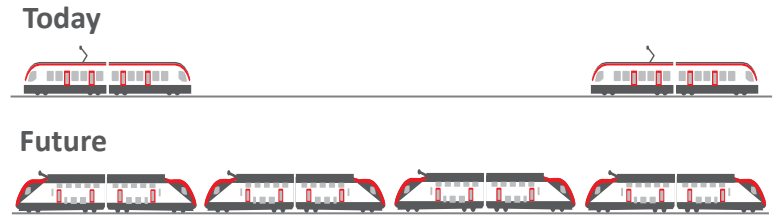
Scope: AI supported Traffic Management in Railways

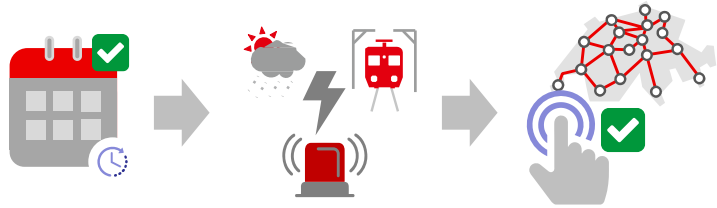
CONTEXT

- Traffic density on the European rail networks is constantly increasing.
- The complexity of rail traffic management in operations is increasing (e.g. more traffic, more maintenance).
- Operators monitor, control and secure train traffic on remotely controlled operating points from the operations center (4 in CH, 8 in DE).



ISSUE / PROBLEM FORMULATION

- Railway operations is disturbed by unexpected events (e.g. delays, infrastructure defects, weather impacts or short-term maintenance).
- Operators currently decide on how to manage such disturbances (e.g. delay) or other events. They already use a computerized dispatching system that is based on manually defined decisions.



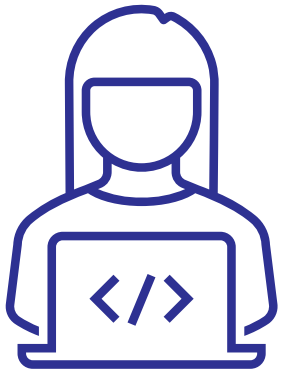
VISION

- An AI assistant can support the human dispatcher in analyzing the real-time state of all the trains and tracks in the dispatcher's area and derive possible dispatching options in case of deviations from the pre-planned schedule.
- The vision goes from AI supported to fully automated decision making system.

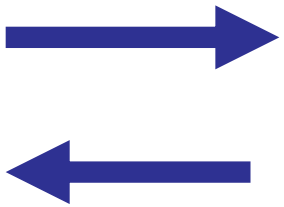
Approach in Detail: Prototyping potential future AI supported decision making with two use cases

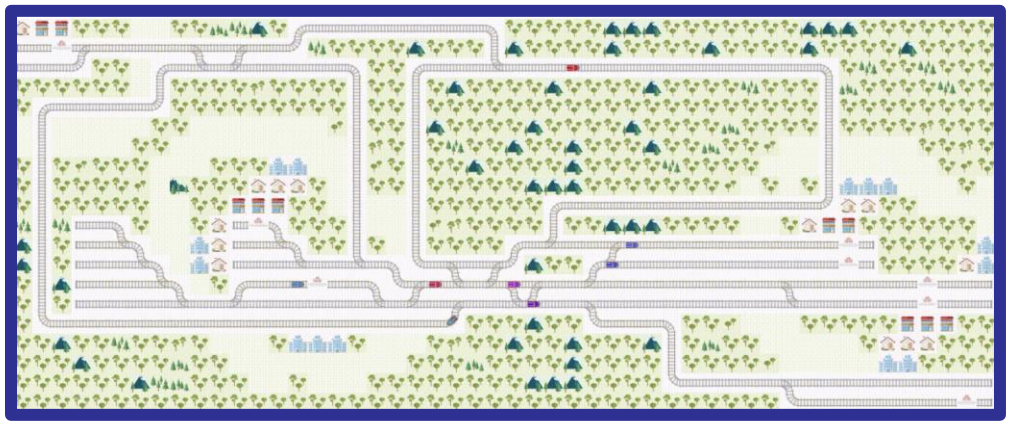
- Human Operators most likely will benefit in the future from novel AI based support systems
- We combine our requirements in the case of disturbances, **„Human in the loop“** approaches and state of the art **simulation environment to prototype and experiment** future traffic management systems
- Flatland is a open source simplifed railway simulation tool to develop and compare algorithms in the field of automated dispatching

Prototype & Experiment



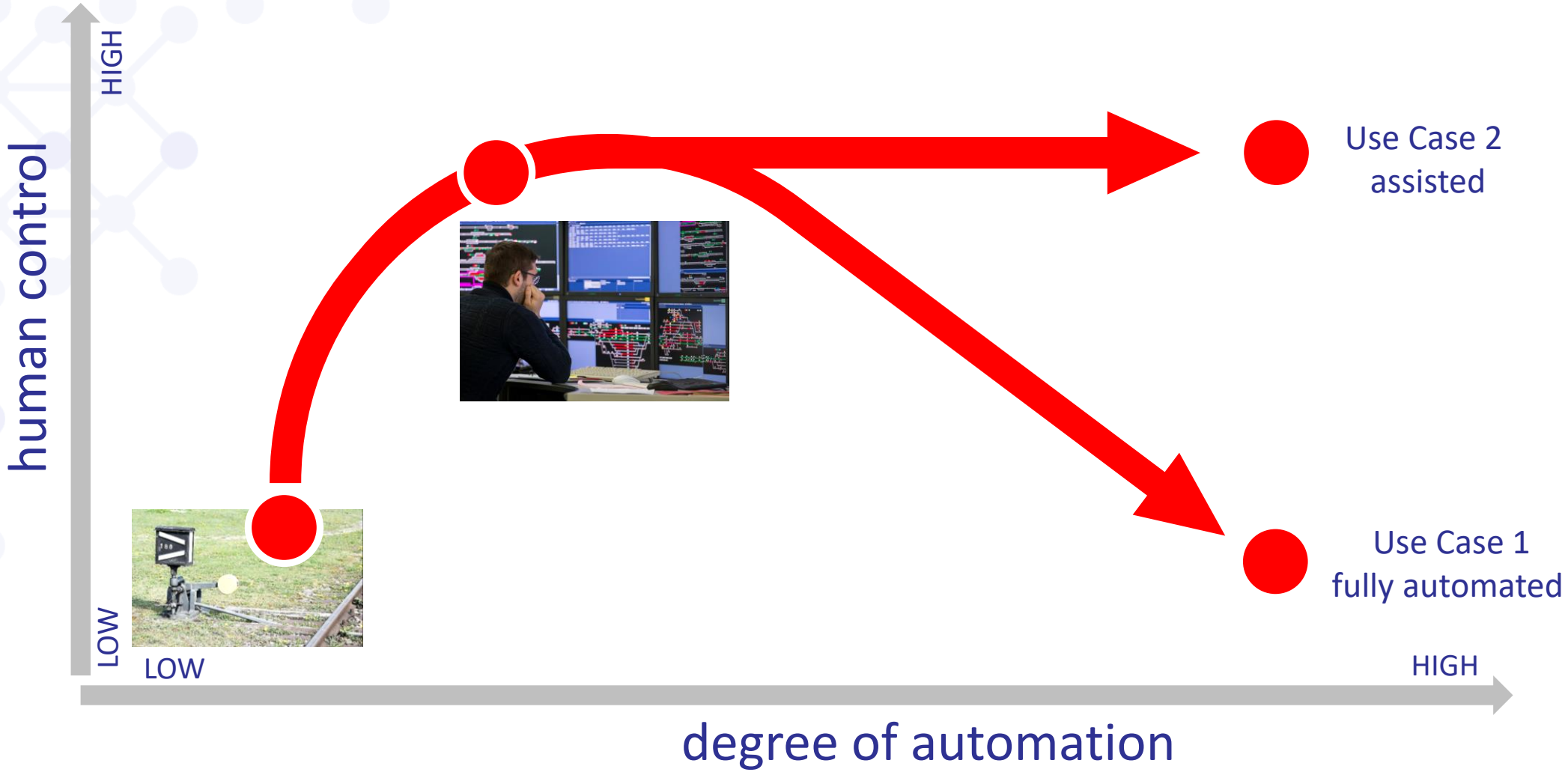
Human Dispatcher



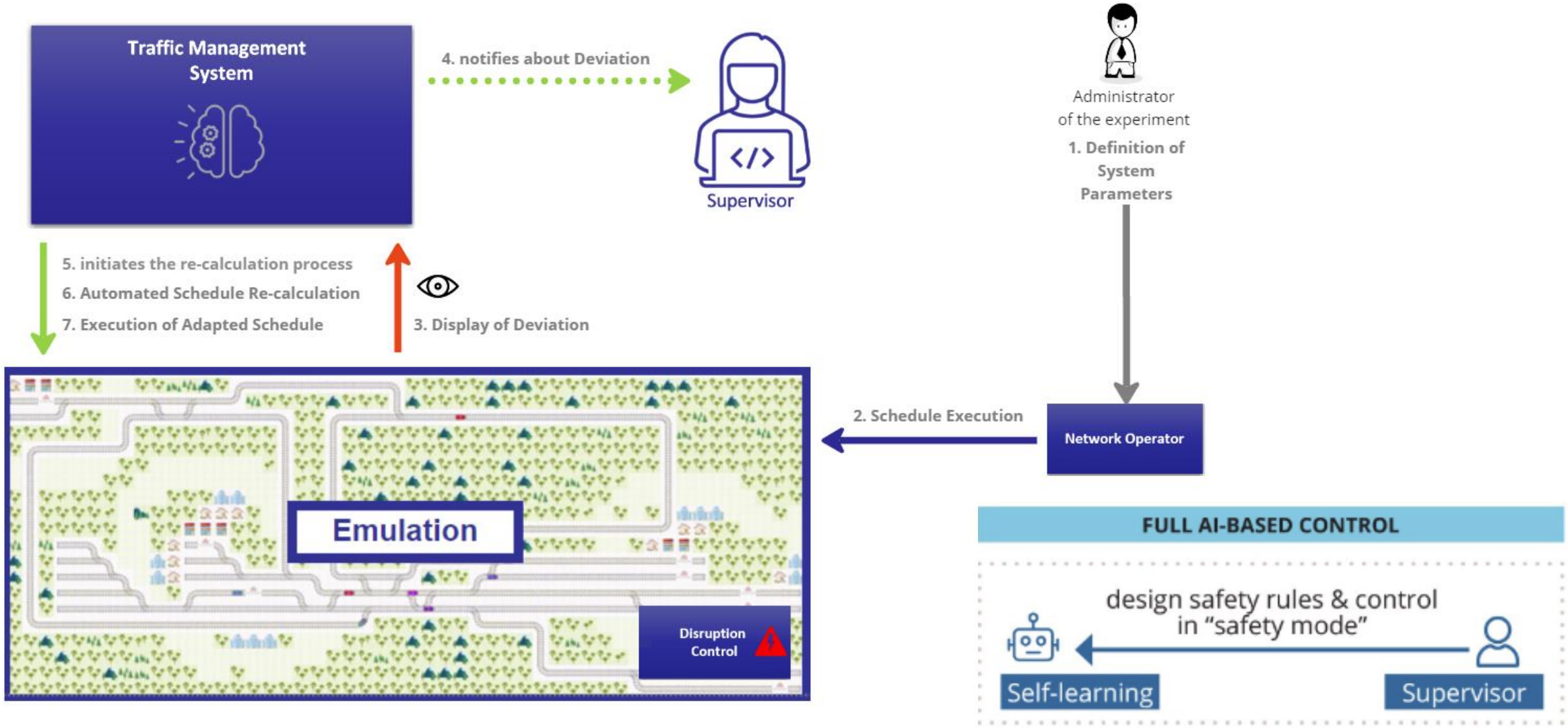


Emulation / Simulation

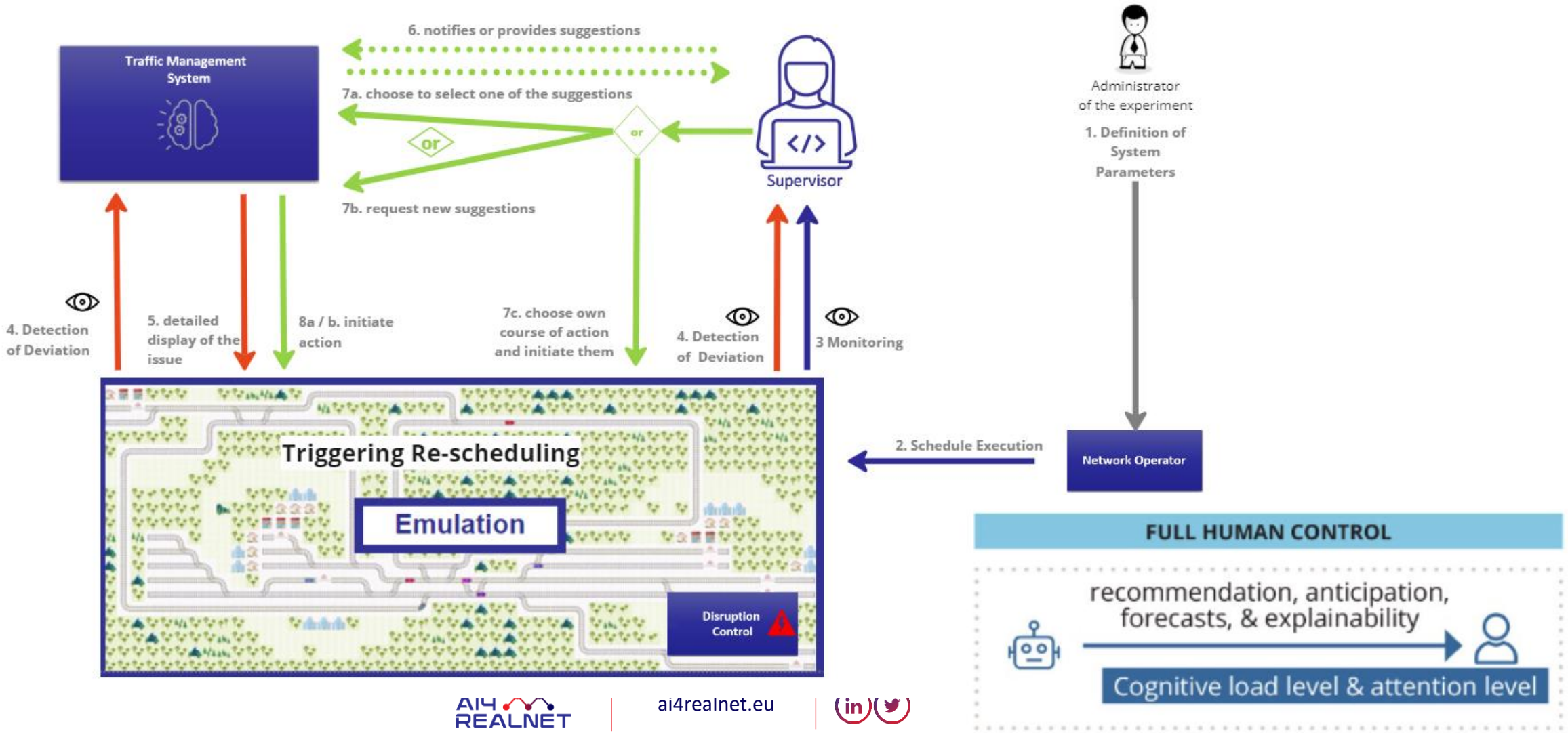
Use Cases Overview



Use Case 1 – Fully automated



Use Case 2 – Assistant AI



Scenarios to explore and learn about the use cases during operations

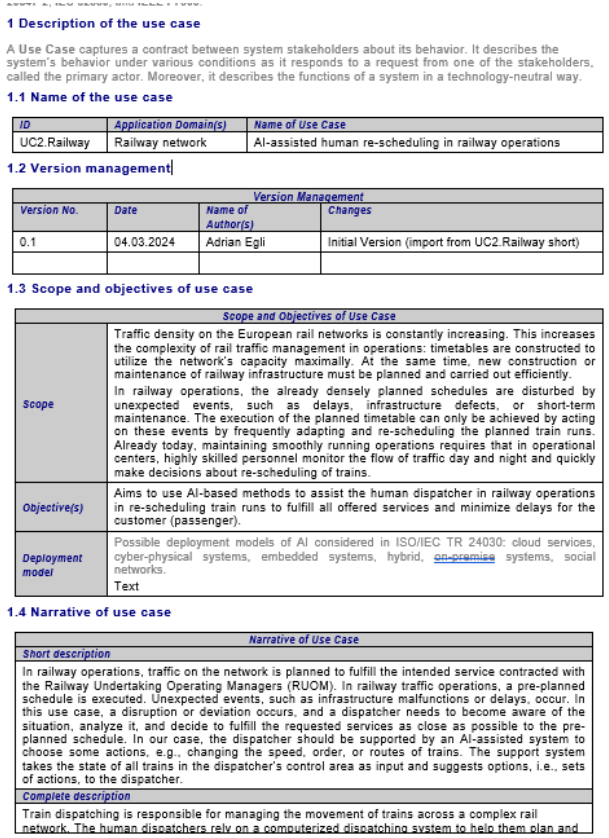
No.	Scenario name	Scenario description	Triggering event
1	Reactive Re-Scheduling	The reactive re-scheduling by the human-AI team once a deviation or disturbance has already occurred.	An emerging disruption or deviation occurring (e.g. blocked track, malfunction train)
3	Proactive re-scheduling	Proactive re-scheduling by the human-AI team upon detection of weak signals.	Detection of precursors or weak signals indicating a probability of larger disruptions and deviation in the future

Scenarios to explore and learn about co-learning

No.	Scenario name	Scenario description	Triggering event
2	Co-learning for reactive re-scheduling	The co-learning process initialized by the reactive re-scheduling by the human-AI team once a deviation or disturbance has already occurred.	Human and AI action and interaction during the re-scheduling process occurring after a disruption or deviation.
4	Co-learning for proactive re-scheduling	Co-learning process initialized by the proactive re-scheduling By the human-AI team	Human and AI agent action and interaction during the detection and rescheduling phases.

Fully fledged use cases with further information

- **Stakeholders**, their assets and value: Railway network operators, network supervisors, Railway Undertaking Operation Manager
- **KPI** about human and system performance, like assistant relevance, punctuality, acceptance, trust, comprehensibility
- **Standardization opportunities and requirements**
- **Societal Concerns**, like transparency & accountability, safety & security, employment & skill shift



1 Description of the use case

A Use Case captures a contract between system stakeholders about its behavior. It describes the system's behavior under various conditions as it responds to a request from one of the stakeholders, called the primary actor. Moreover, it describes the functions of a system in a technology-neutral way.

1.1 Name of the use case

ID	*Application Domain(s)*	*Name of Use Case*
UC2.Railway	Railway network	AI-assisted human re-scheduling in railway operations

1.2 Version management

Version Management			
Version No.	*Date*	*Name of Author(s)*	*Changes*
0.1	04.03.2024	Adrian Egli	Initial Version (import from UC2.Railway short)

1.3 Scope and objectives of use case

Scope and Objectives of Use Case	
Scope	Traffic density on the European rail networks is constantly increasing. This increases the complexity of rail traffic management in operations: timetables are constructed to utilize the network's capacity maximally. At the same time, new construction or maintenance of railway infrastructure must be planned and carried out efficiently. In railway operations, the already densely planned schedules are disturbed by unexpected events, such as delays, infrastructure defects, or short-term maintenance. The execution of the planned timetable can only be achieved by acting on these events by frequently adapting and re-scheduling the planned train runs. Already today, maintaining smoothly running operations requires that in operational centers, highly skilled personnel monitor the flow of traffic day and night and quickly make decisions about re-scheduling of trains.
Objective(s)	Aims to use AI-based methods to assist the human dispatcher in railway operations in re-scheduling train runs to fulfill all offered services and minimize delays for the customer (passenger).
Deployment model	Possible deployment models of AI considered in ISO/IEC TR 24030: cloud services, cyber-physical systems, embedded systems, hybrid, ~~on-premise~~ systems, social networks. Text

1.4 Narrative of use case

Narrative of Use Case
Short description
In railway operations, traffic on the network is planned to fulfill the intended service contracted with the Railway Undertaking Operating Managers (RUOM). In railway traffic operations, a pre-planned schedule is executed. Unexpected events, such as infrastructure malfunctions or delays, occur. In this use case, a disruption or deviation occurs, and a dispatcher needs to become aware of the situation, analyze it, and decide to fulfill the requested services as close as possible to the pre-planned schedule. In our case, the dispatcher should be supported by an AI-assisted system to choose some actions, e.g., changing the speed, order, or routes of trains. The support system takes the state of all trains in the dispatcher's control area as input and suggests options, i.e., sets of actions, to the dispatcher.
Complete description
Train dispatching is responsible for managing the movement of trains across a complex rail network. The human dispatchers rely on a computerized dispatching system to help them plan and