REAKTOR Projekt

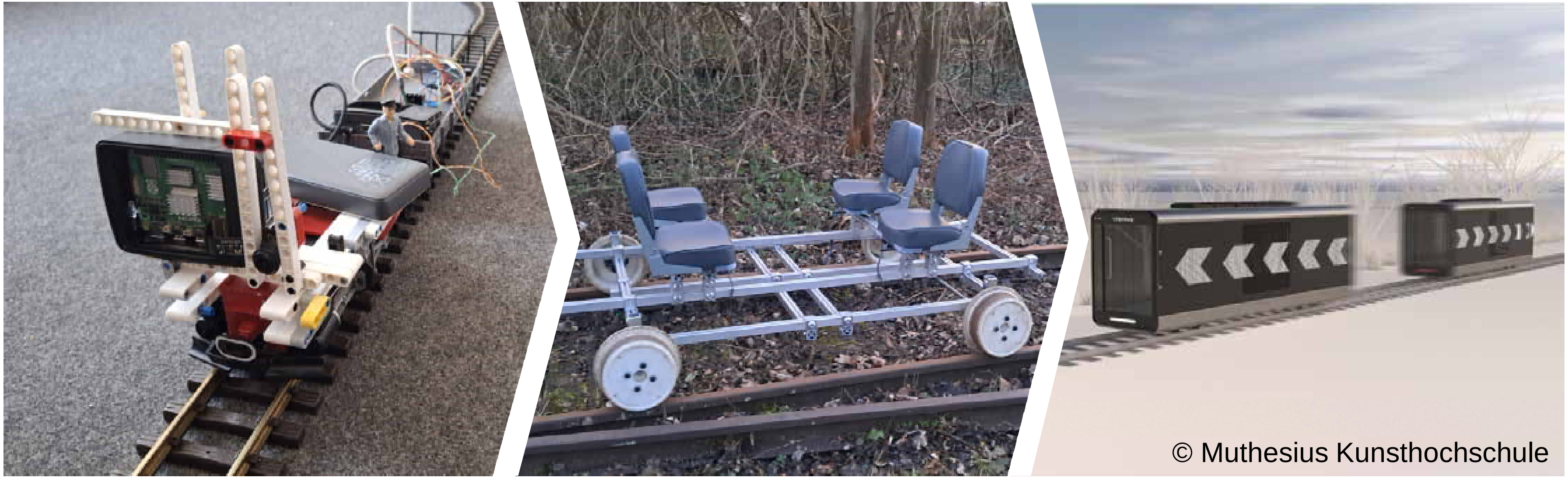
Wintersemester 24/25 CAU

AG Echtzeitsysteme und Eingebettete Systeme
AG Verteilte Systeme

Christian-Albrechts-Universität zu Kiel

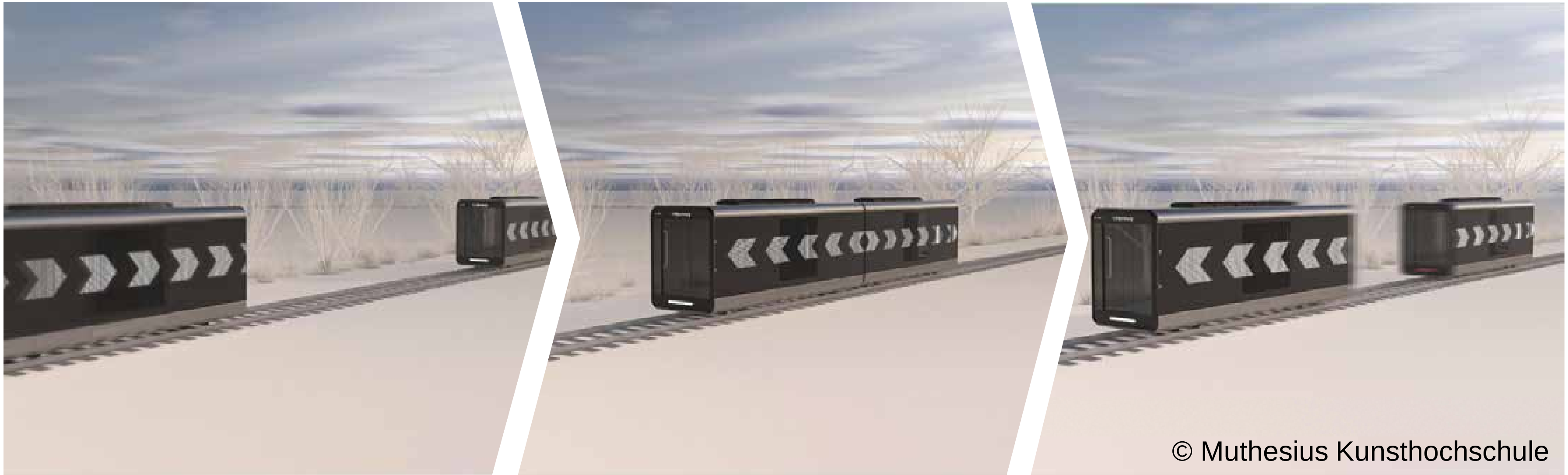
Institut für Informatik

REAKTOR Prototypen



© Muthesius Kunsthochschule

Begegnungsverkehr



© Muthesius Kunsthochschule

Das Team

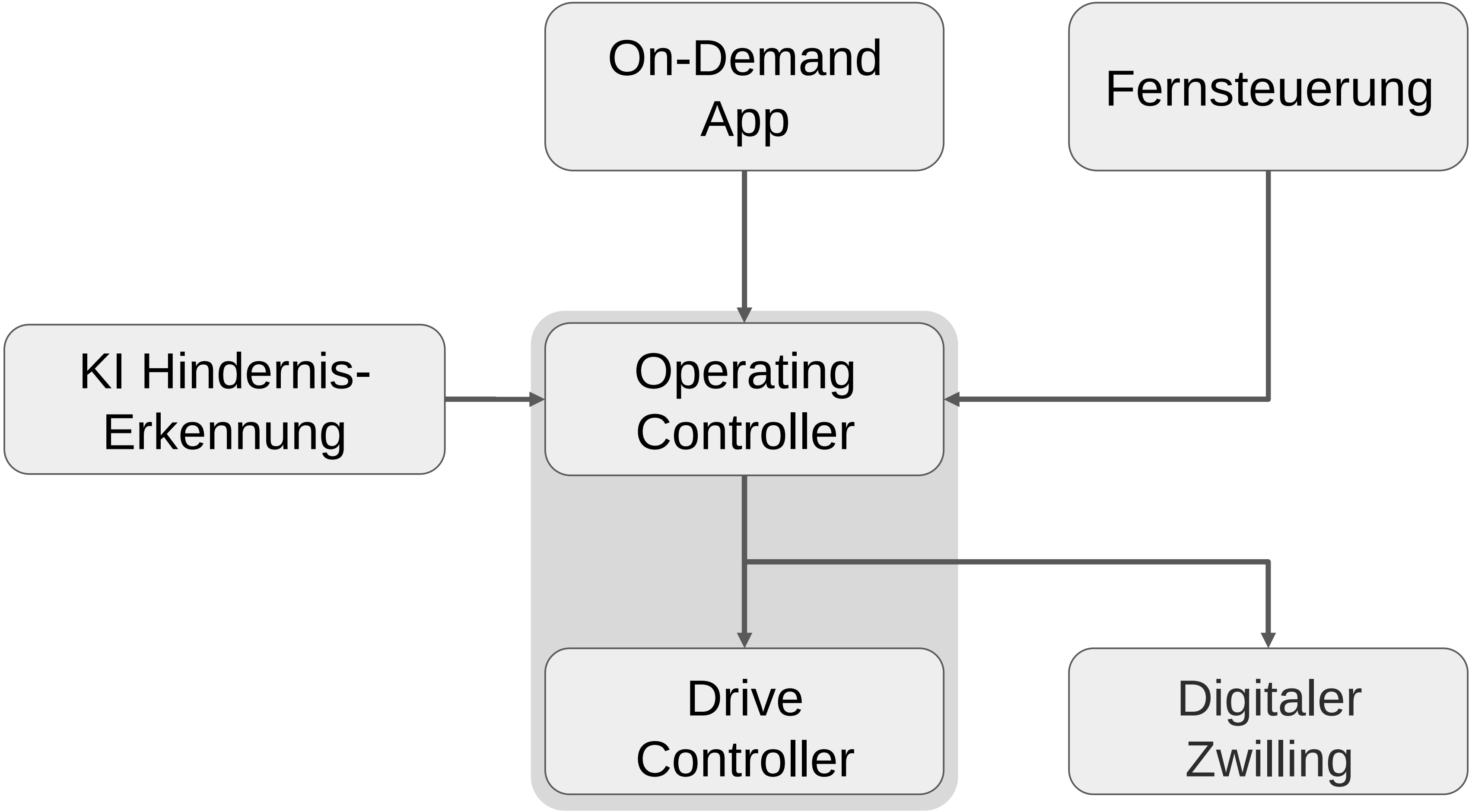
Studierende
Kevin Ebsen
Lorenz Tiedemann
Nig Rambow
Simon Jürgensen
Rasmus Janssen

Betreuer
Dr.-Ing. Alexander Schulz-Rosengarten
Jette Petzold
Momin Ali
Birkan Denizer

Arbeitsgruppen
Echtzeitsysteme und Eingebettete Systeme
Prof. Dr. Reinhard von Hanxleden

Verteilte Systeme
Prof. Dr. Olaf Landsiedel

Institut für Informatik
Christian-Albrechts-Universität zu Kiel



On-Demand App

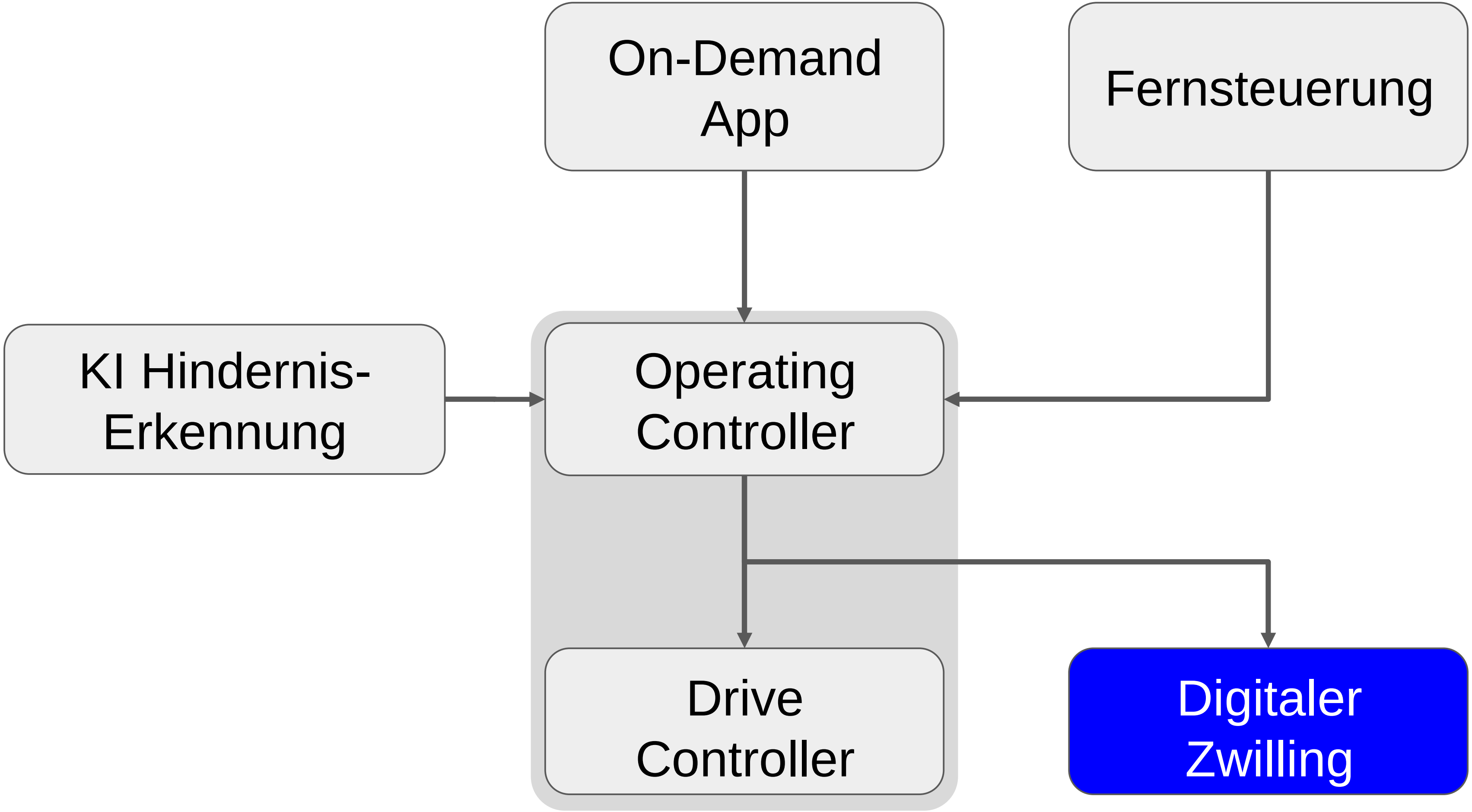
Fernsteuerung

KI Hindernis-Erkennung

Operating Controller

Drive Controller

Digitaler Zwilling


On-Demand App
Fernsteuerung
KI Hindernis-Erkennung
Operating Controller
Drive Controller
Digitaler Zwilling

Rückblick Bahntechnik 2024

NEXUS
muthesius kunsthochschule

13:14

Distance traveled 4.3 km

Next vehicle 153 m

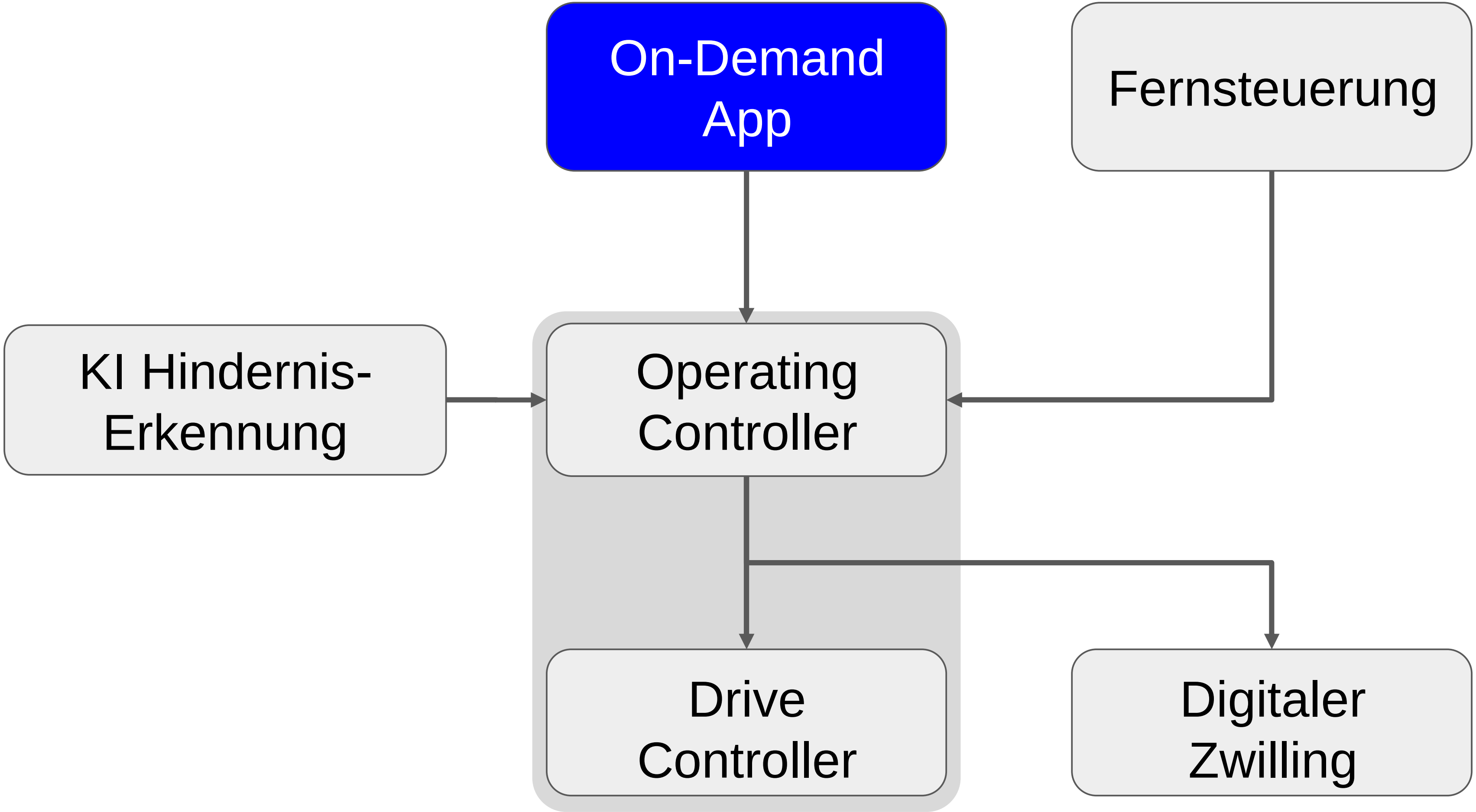
Speed 5 km/h

Next level crossing 91 m

Vehicle Number: B

Warning
Level crossing in 91 m

Digitaler Zwilling



On-Demand App

Fernsteuerung

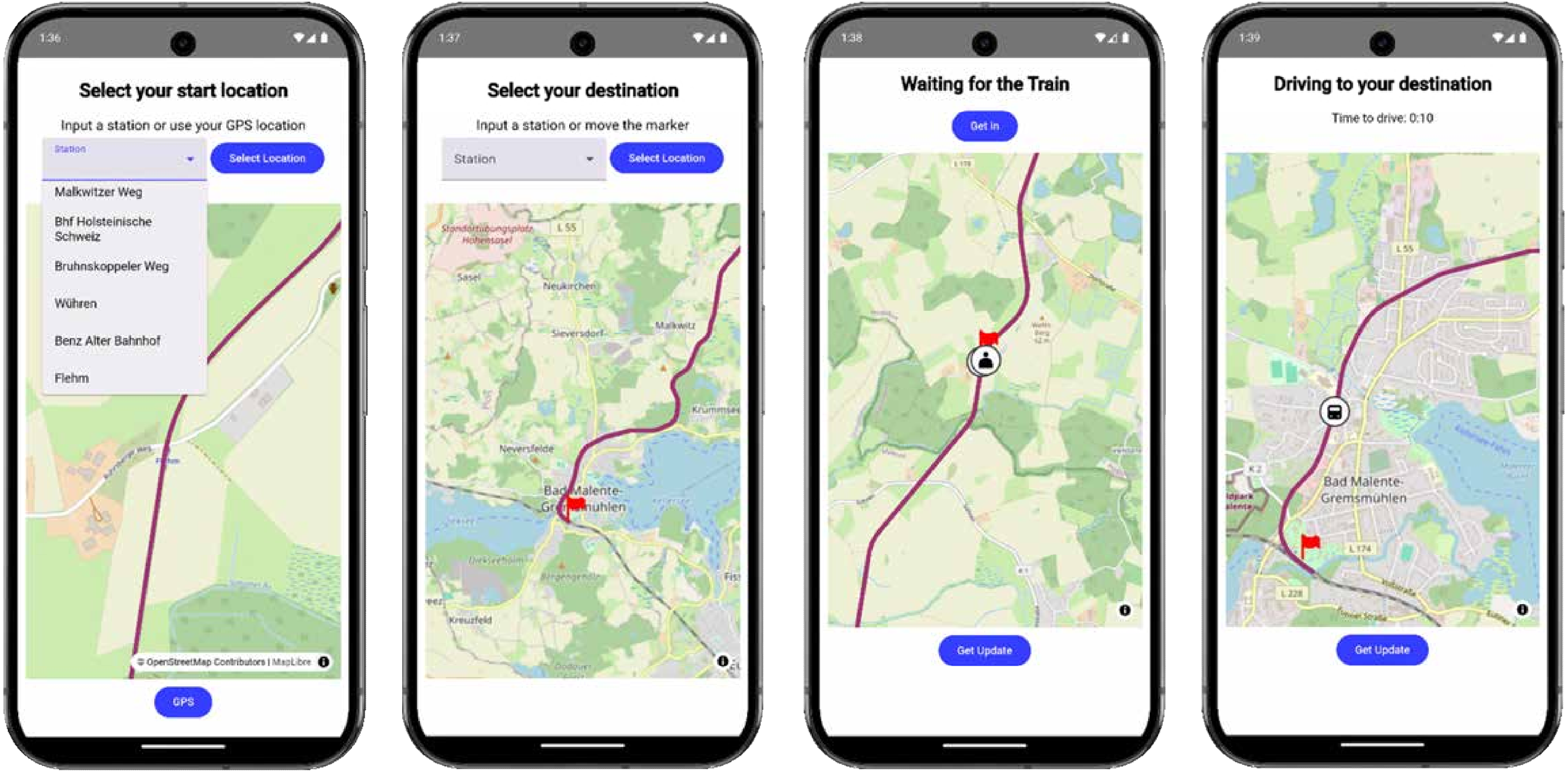
KI Hindernis-Erkennung

Operating Controller

Drive Controller

Digitaler Zwilling

On-Demand App



1:36

Select your start location

Input a station or use your GPS location

Station
Select Location
Malkwitzer Weg
Bhf Holsteinische Schweiz
Bruhnskoppeler Weg
Wühren
Benz Alter Bahnhof
Flehm
© OpenStreetMap Contributors | MapLibre
GPS

1:37

Select your destination

Input a station or move the marker

Station
Select Location
L 55
Sasel
Neukirchen
Sieversdorf
Malkwitz
Krummsee
Neversfelde
Bad Malente-Gremsmühlen
Kreuzfeld

1:38

Waiting for the Train

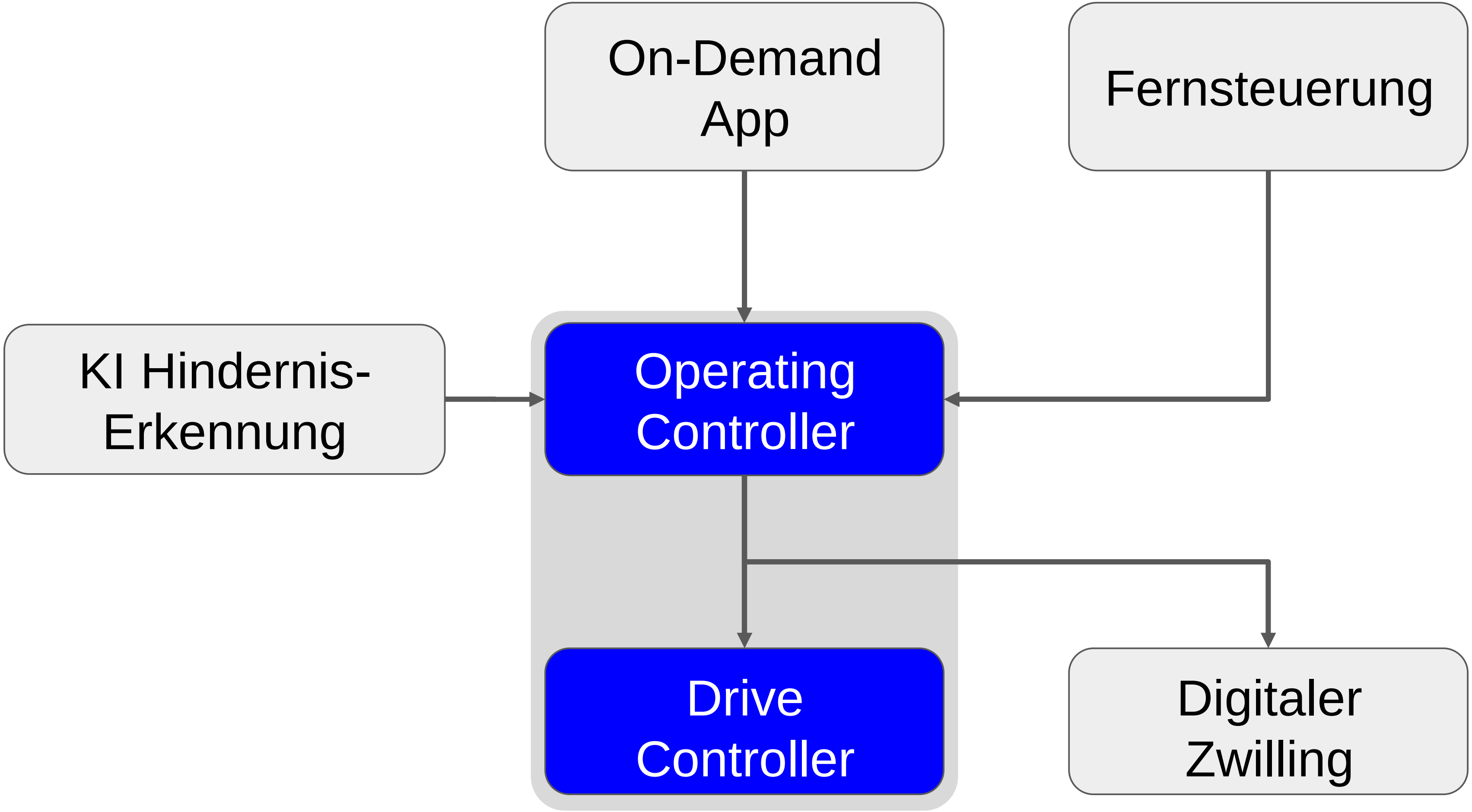
Get In
Get Update

1:39

Driving to your destination

Time to drive: 0:10

L 55
Bad Malente-Gremsmühlen
L 174
L 228
Get Update



On-Demand App

Fernsteuerung

KI Hindernis-Erkennung

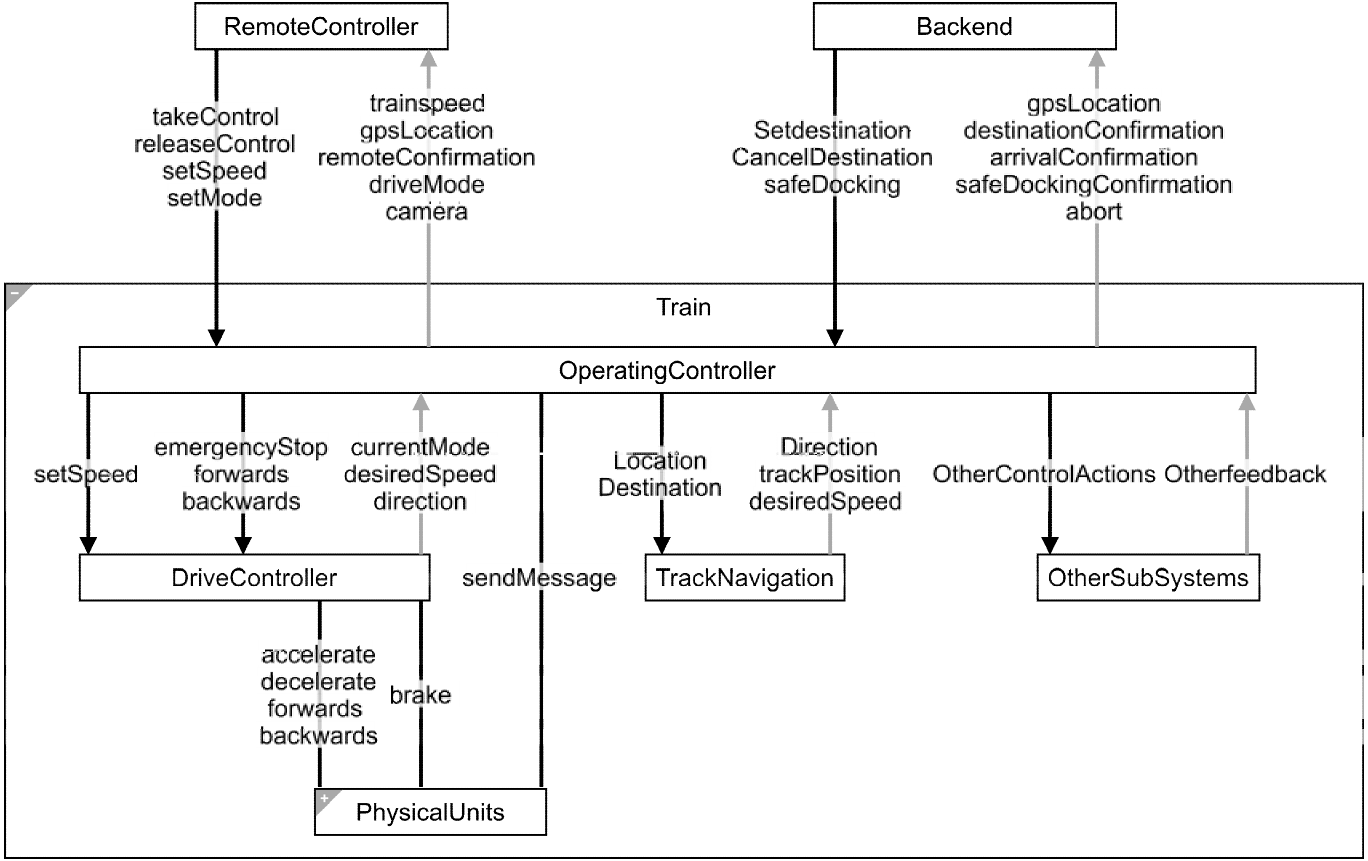
Operating Controller

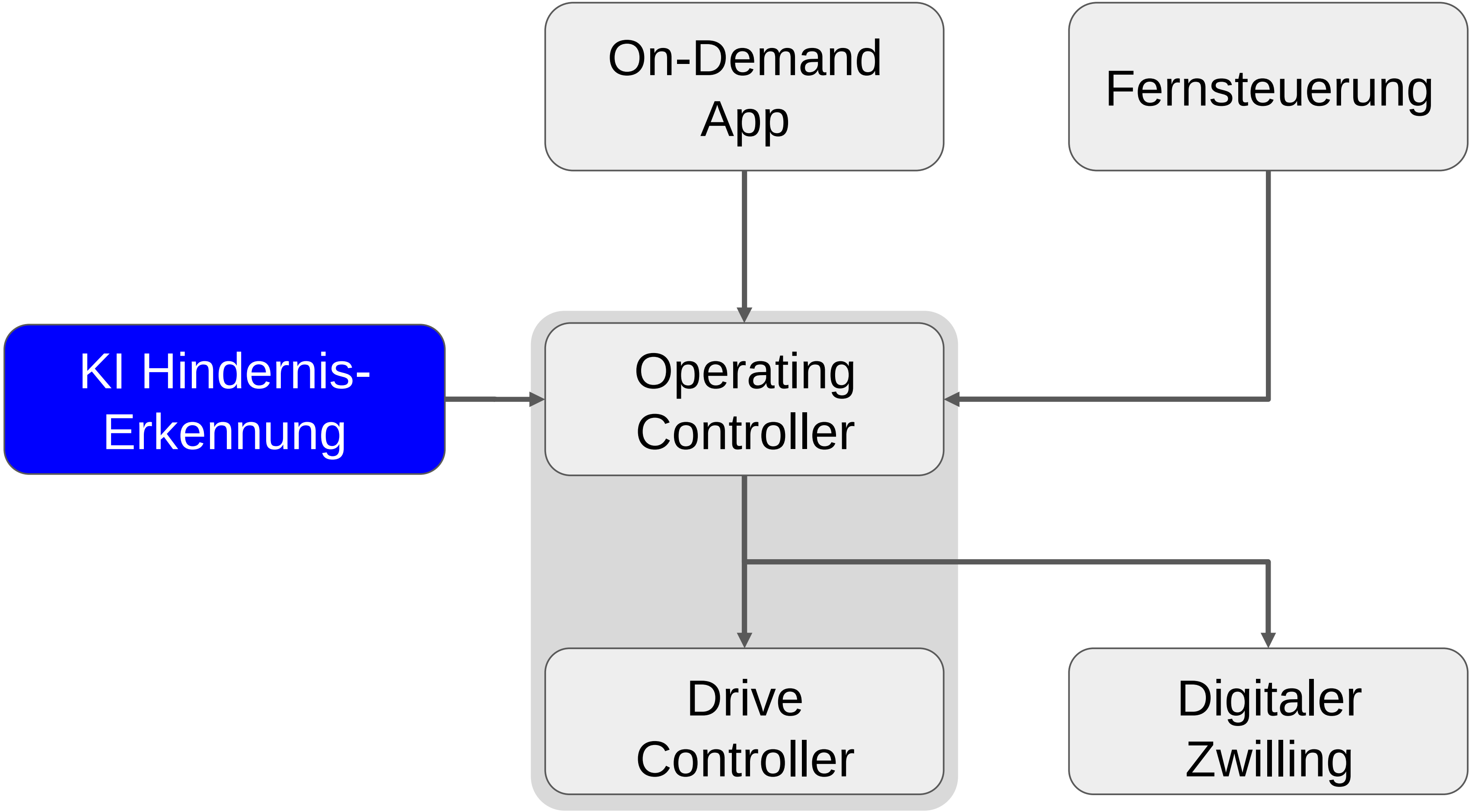
Drive Controller

Digitaler Zwilling

Sicherheitsanalyse

System-Theoretic Process Analysis


RemoteController
Backend
takeControl
releaseControl
setSpeed
setMode
trainspeed
gpsLocation
remoteConfirmation
driveMode
camera
Setdestination
CancelDestination
safeDocking
gpsLocation
destinationConfirmation
arrivalConfirmation
safeDockingConfirmation
abort
Train
OperatingController
setSpeed
emergencyStop
forwards
backwards
currentMode
desiredSpeed
direction
Location
Destination
Direction
trackPosition
desiredSpeed
OtherControlActions
Otherfeedback
DriveController
sendMessage
TrackNavigation
OtherSubSystems
accelerate
decelerate
forwards
backwards
brake
PhysicalUnits



On-Demand App

Fernsteuerung

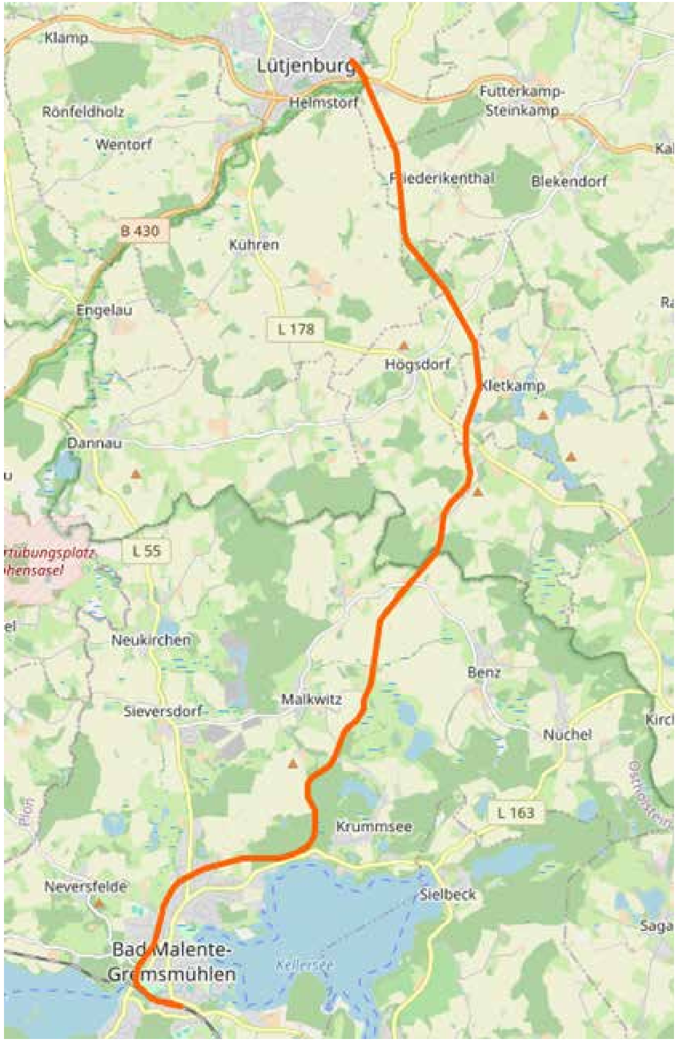
KI Hindernis-Erkennung

Operating Controller

Drive Controller

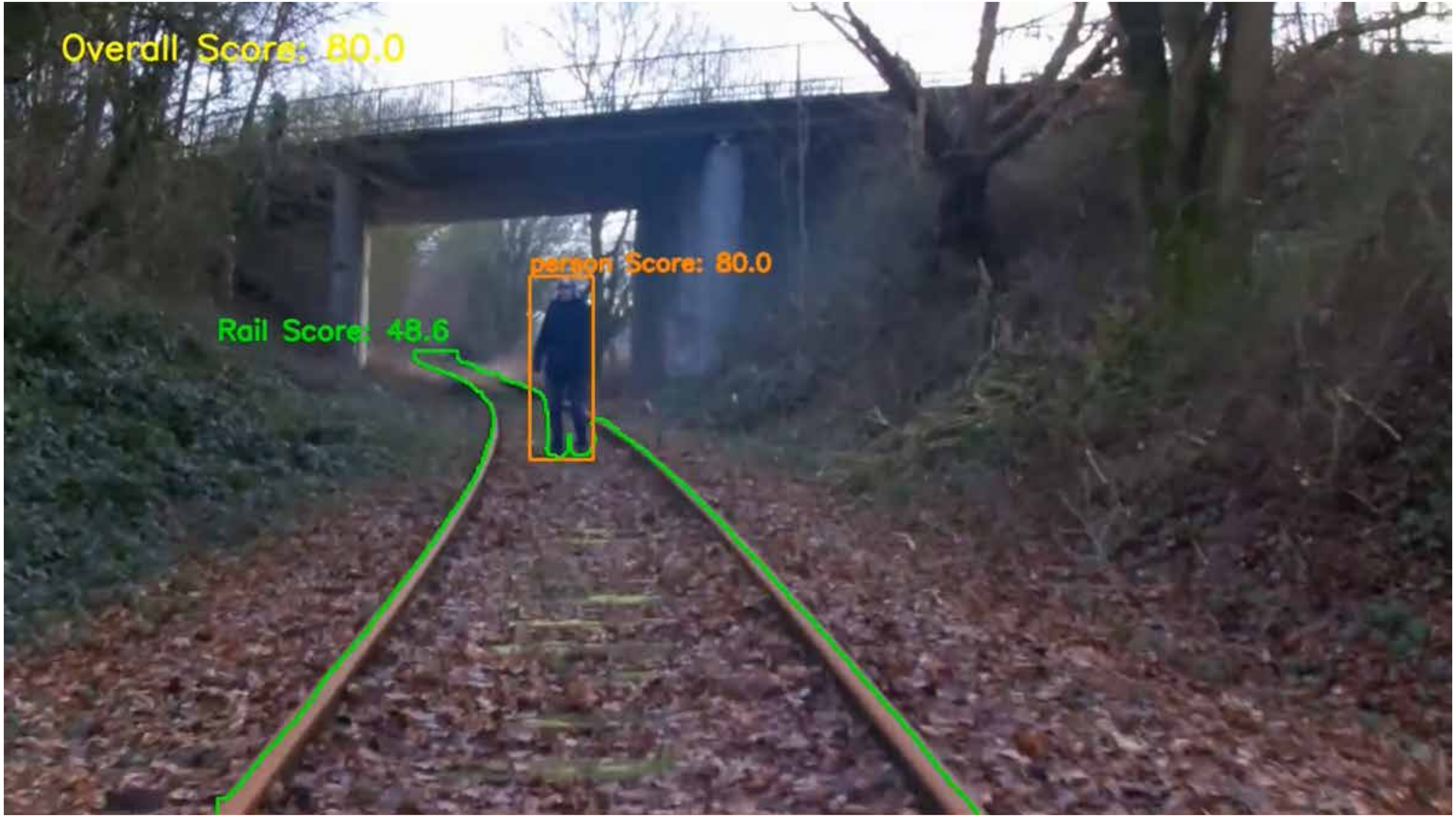
Digitaler Zwilling

Die REAKT-Strecke

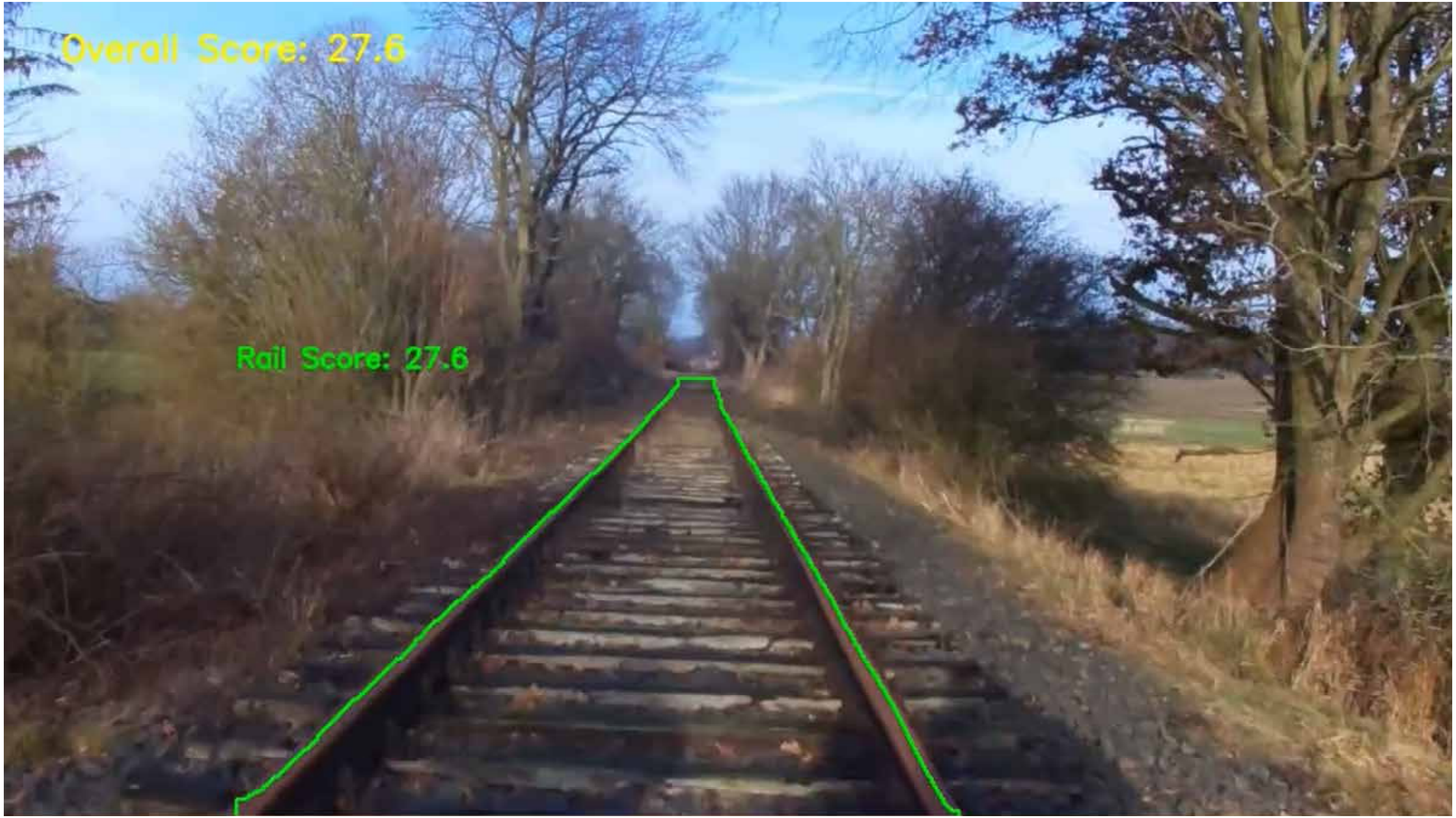

Klamp
Lütjenburg
Helmstorf
Futterkamp-Steinkamp
Rönfeldholz
Wentorf
Friederikenthal
Blekendorf
B 430
Kühren
Engelau
L 178
Högsdorf
Kletkamp
Dannau
L 55
Neukirchen
Benz
Malkwitz
Sieversdorf
Nüchel
L 163
Krummsee
Neversfelde
Sielbeck
Bad Malente-Gremsmühlen
Kellersee

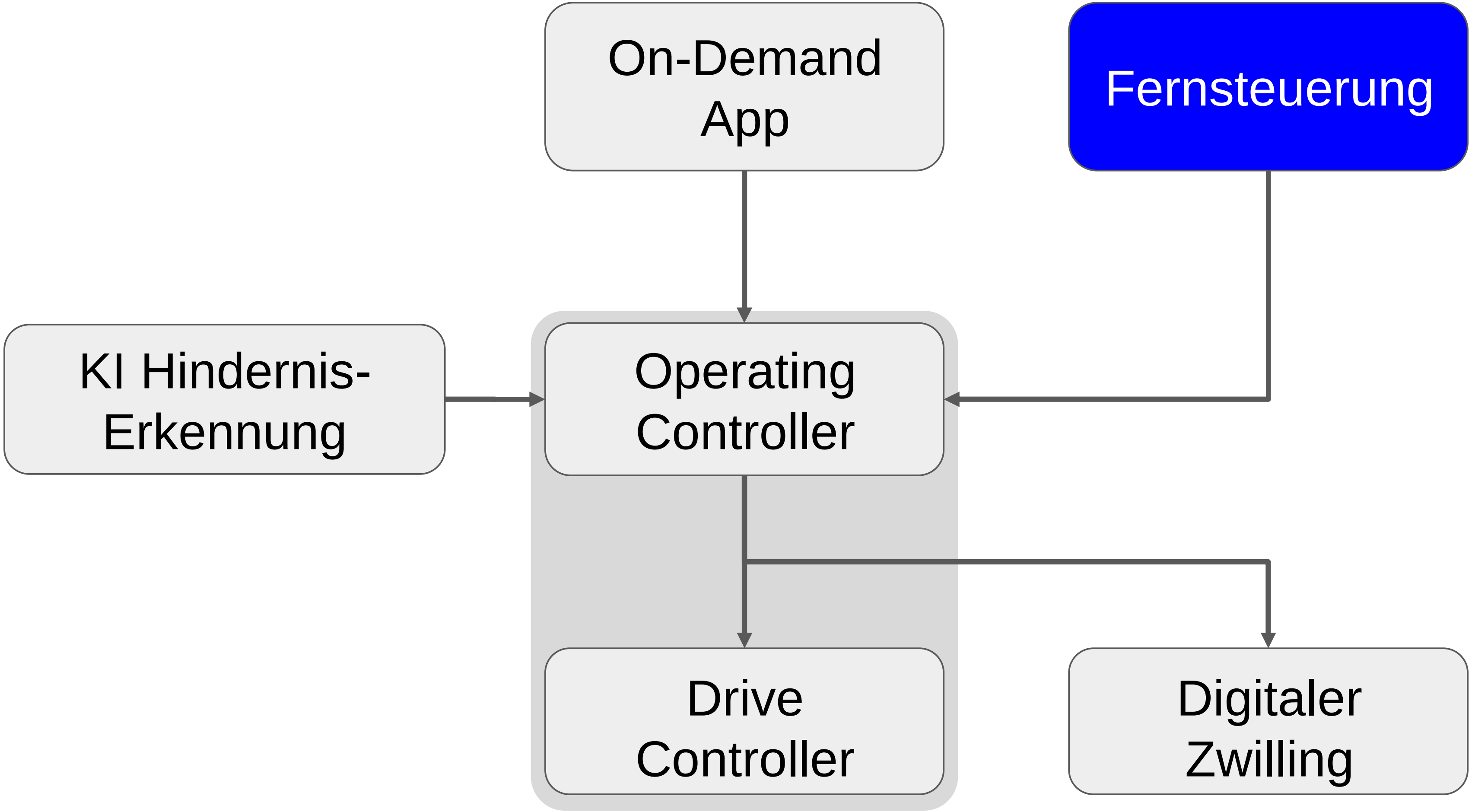
Bilder von der Datensammlung

KI Hindernis-Erkennung

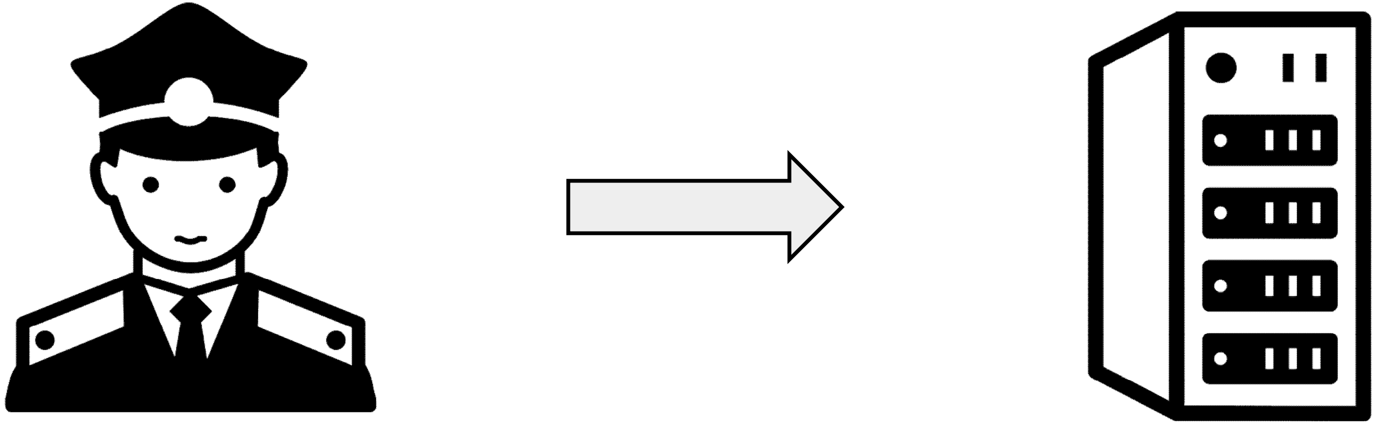

Overall Score: 80.0
person Score: 80.0
Rail Score: 48.6

Herausforderungen

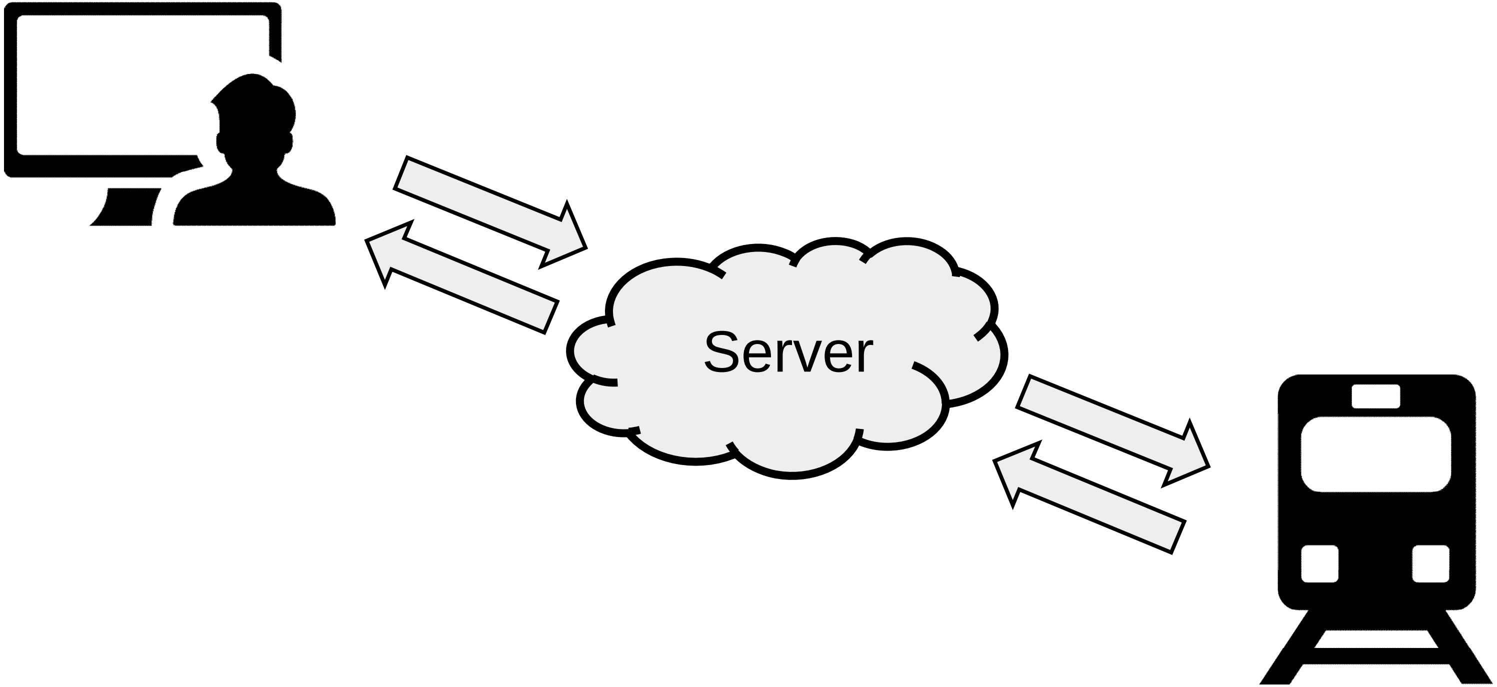

Overall Score: 27.6
Rail Score: 27.6


On-Demand App
Fernsteuerung
KI Hindernis-Erkennung
Operating Controller
Drive Controller
Digitaler Zwilling

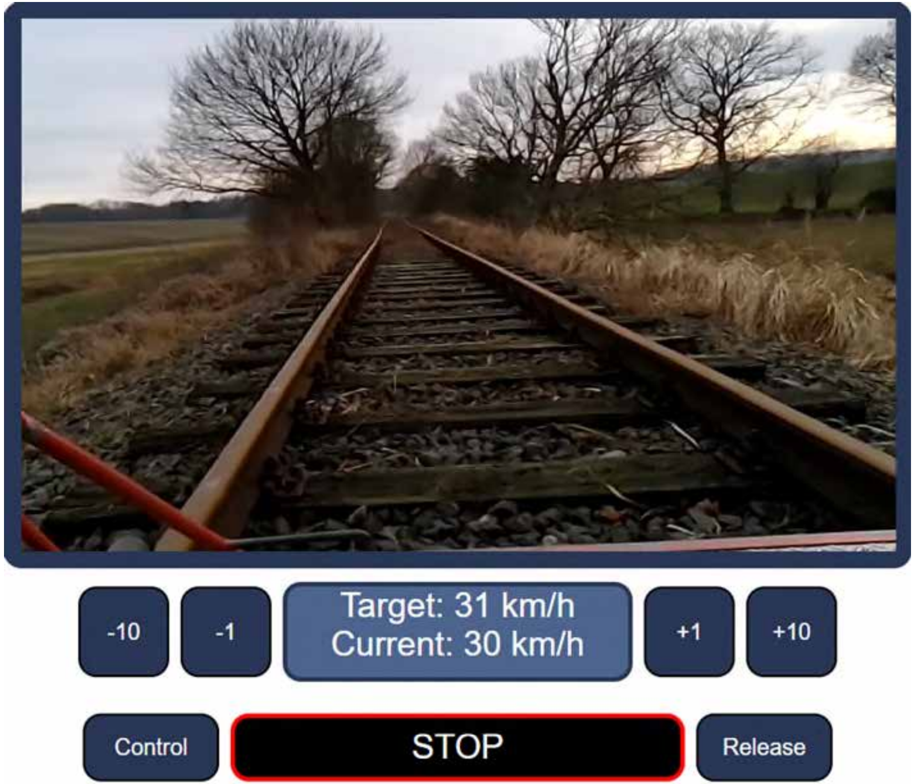
Fernsteuerung



Kommunikation



Anwendung

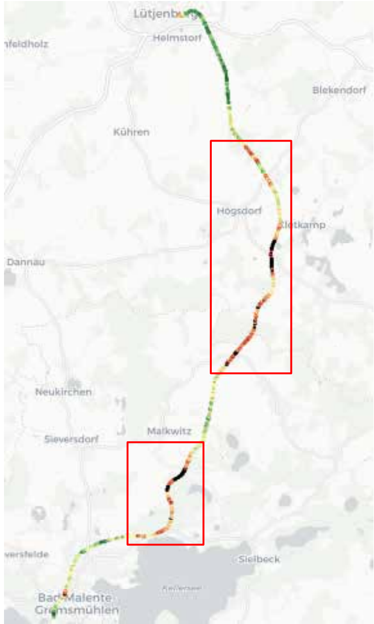

-10
-1
Target: 31 km/h
Current: 30 km/h
+1
+10
Control
STOP
Release

pacity
ing infrastructure with ATO over ETCS

Foto: R.v.H., Siemens Mobility GmbH auf der InnoTrans 2024

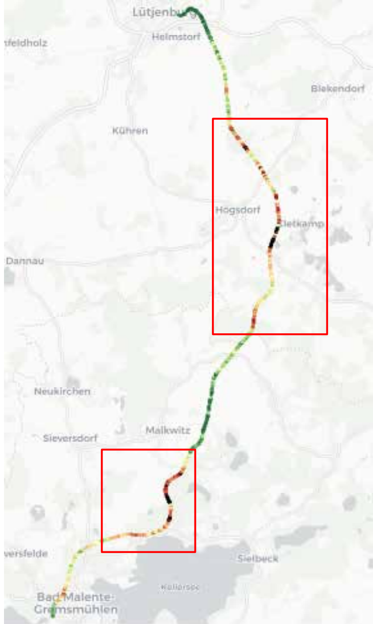
Netzwerkabdeckung

Messeinrichtungen auf wissenschaftlichen und öffentlichen Fähren auf der Kieler Förde


Helmstorf
Blekendorf
Kühren
Högsdorf
Dannau
Neukirchen
Malkwitz
Sieversdorf
Sielbeck
Kellersee
Bad Malente-Gremsmühlen

Netzqualität - Betreiber 1

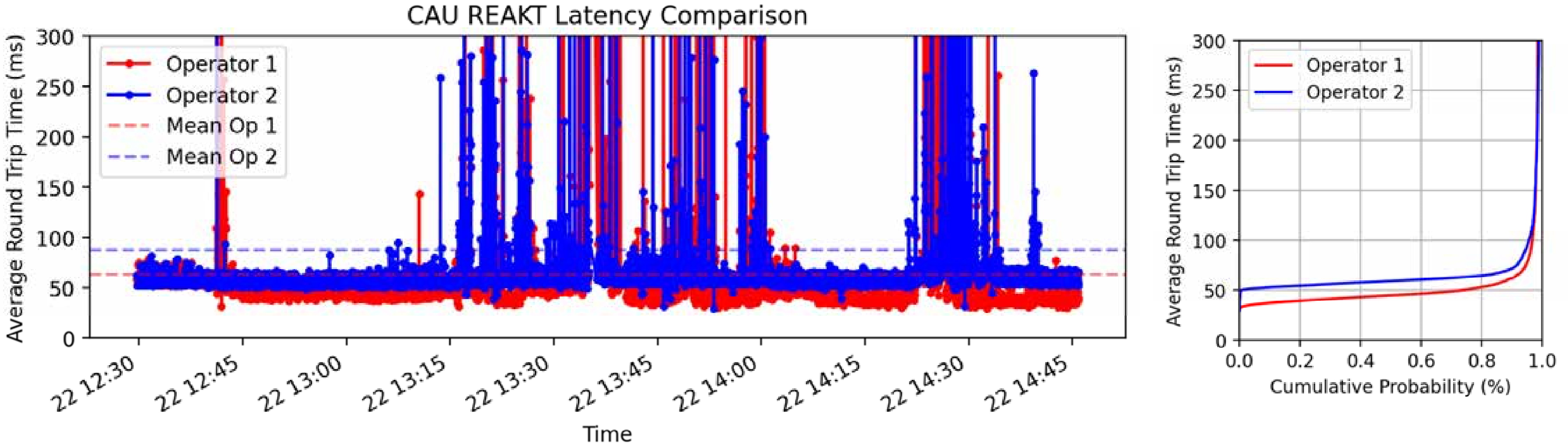
5G Abdeckung - 60%
4G+5G Abdeckung - 97,7%


Helmstorf
Blekendorf
Kühren
Högsdorf
Kletkamp
Dannau
Neukirchen
Malkwitz
Sieversdorf
Sielbeck
Kellersee
Bad Malente-Gremsmühlen

Netzqualität - Betreiber 2

5G Abdeckung - 65%
4G+5G Abdeckung - 99,8%

Latenzmessungen

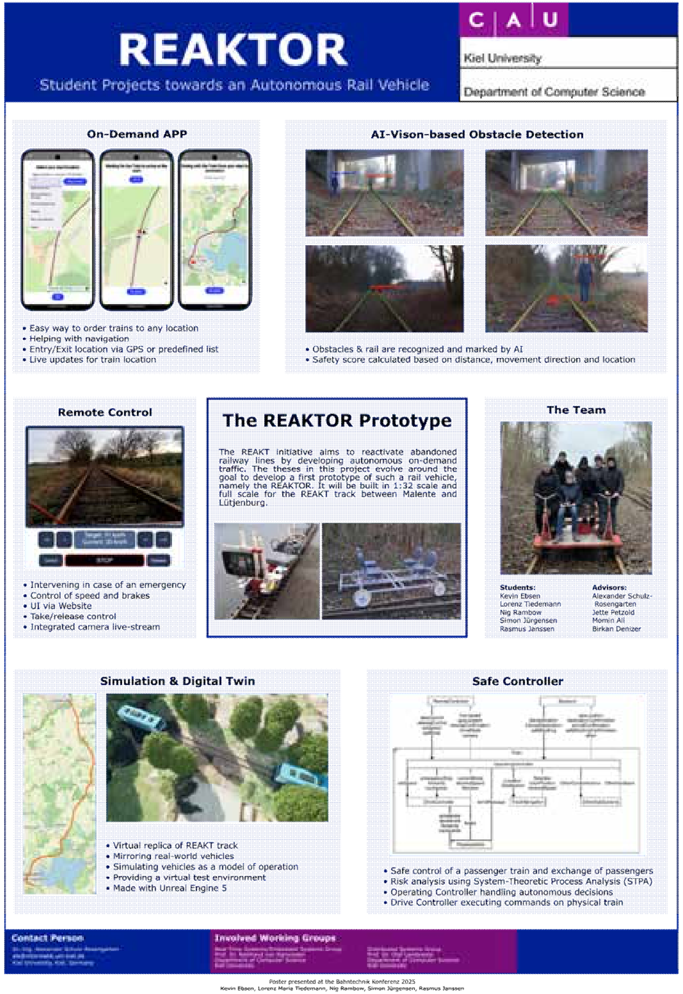


Durchschnitt

- Betreiber 1 – 63 ms Latenz
- Betreiber 2 – 87 ms Latenz
- Unter 100 ms Gesamtlatenz

Worst case

- 98% der Zeit unter 300 ms Latenz
- 99.7% der Zeit unter 1 s Latenz



REAKTOR

Student Projects towards an Autonomous Rail Vehicle

Kiel University

Department of Computer Science

On-Demand APP

- Easy way to order trains to any location
- Helping with navigation
- Entry/Exit location via GPS or predefined list
- Live updates for train location

AI-Vison-based Obstacle Detection

- Obstacles & rail are recognized and marked by AI
- Safety score calculated based on distance, movement direction and location

Remote Control

- Intervening in case of an emergency
- Control of speed and brakes
- UI via Website
- Take/release control
- Integrated camera live-stream

The REAKTOR Prototype

The REAKT initiative aims to reactivate abandoned railway lines by developing autonomous on-demand traffic. The theses in this project evolve around the goal to develop a first prototype of such a rail vehicle, namely the REAKTOR. It will be built in 1:32 scale and full scale for the REAKT track between Malente and Lütjenburg.

The Team

Students:	Advisors:
Kevin Ebsen	Alexander Schulz-Rosengarten
Lorenz Tiedemann	Jette Petzold
Nig Rambow	Momin Ali
Simon Jürgensen	Birkan Denizer
Rasmus Janssen	

Simulation & Digital Twin

- Virtual replica of REAKT track
- Mirroring real-world vehicles
- Simulating vehicles as a model of operation
- Providing a virtual test environment
- Made with Unreal Engine 5

Safe Controller

- Safe control of a passenger train and exchange of passengers
- Risk analysis using System-Theoretic Process Analysis (STPA)
- Operating Controller handling autonomous decisions
- Drive Controller executing commands on physical train

Contact Person

Involved Working Groups

Poster presented at the Bahntechnik Konferenz 2025

Kevin Ebsen, Lorenz Maria Tiedemann, Nig Rambow, Simon Jürgensen, Rasmus Janssen