

Lukas Pirl

Introduction of IoT Lab in Lecture on Distributed Dependable Embedded Systems

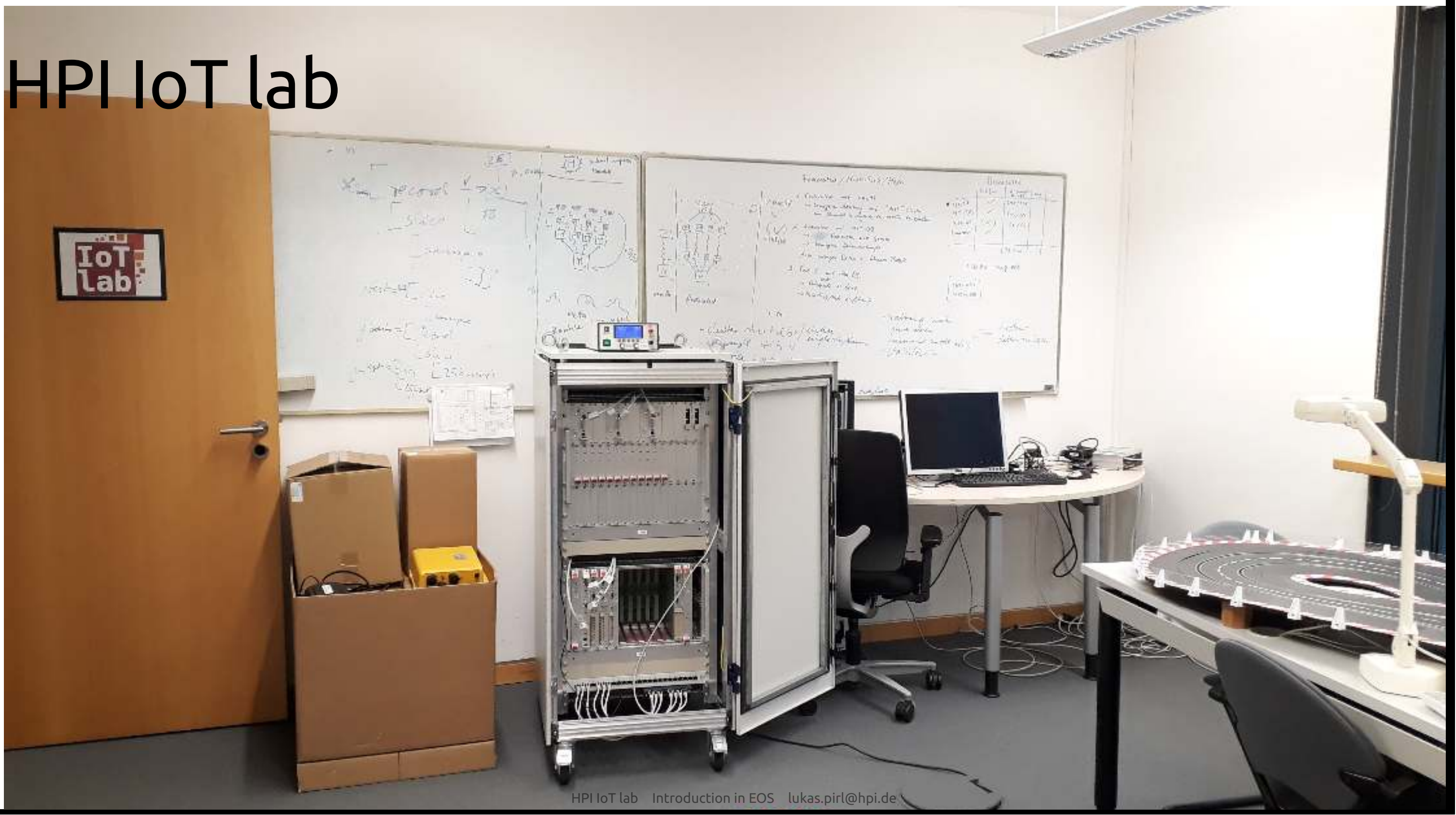
Professorship for Operating Systems and Middleware of Prof. Andreas Polze

Hasso Plattner Institute, University of Potsdam

HPI IoT lab



HPI IoT lab



HPI IoT lab



workshop

general tools

soldering

electronics components

bulk & DIY cables, connectors, etc.

power supply

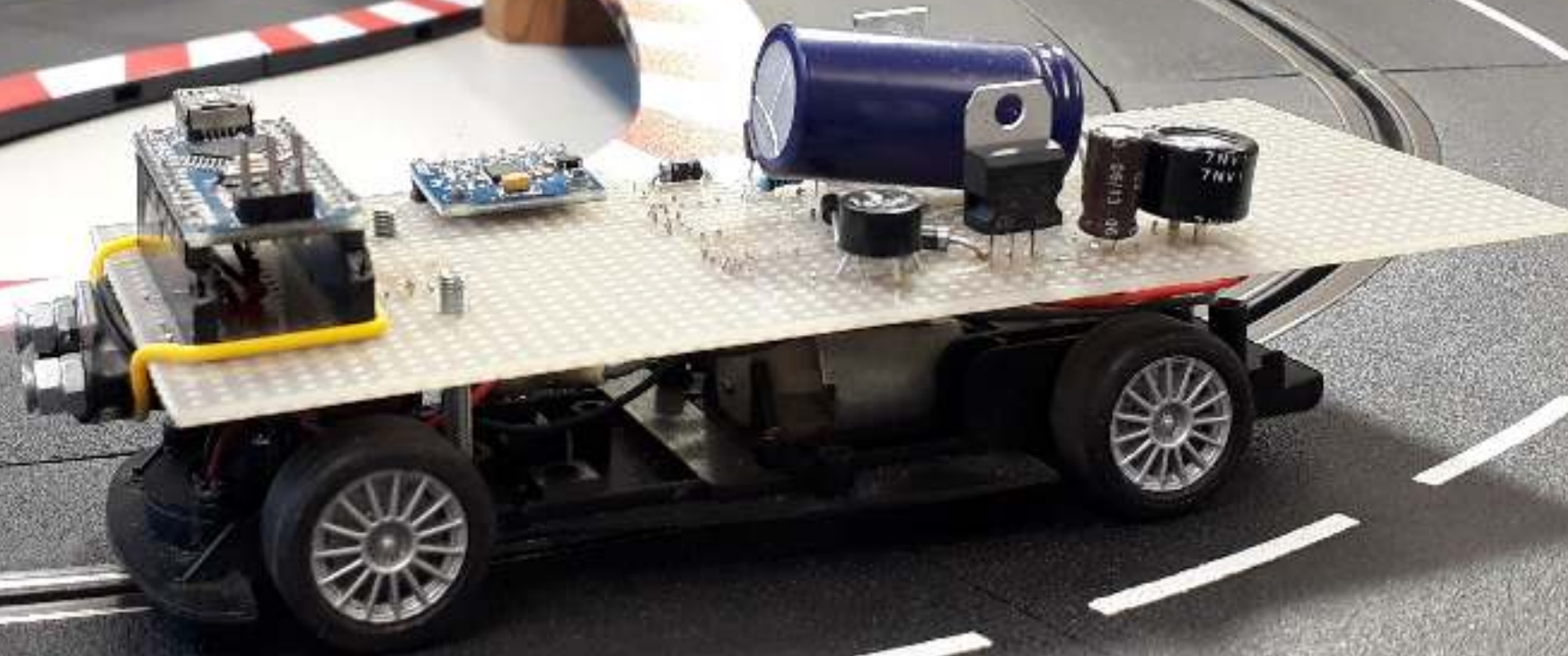
measurement

...



Carrera slot car

self-driving slot car
gyroscope, Lidar, ...



Carrera slot car

custom PCBs



Björn Daase
Leon Matthes

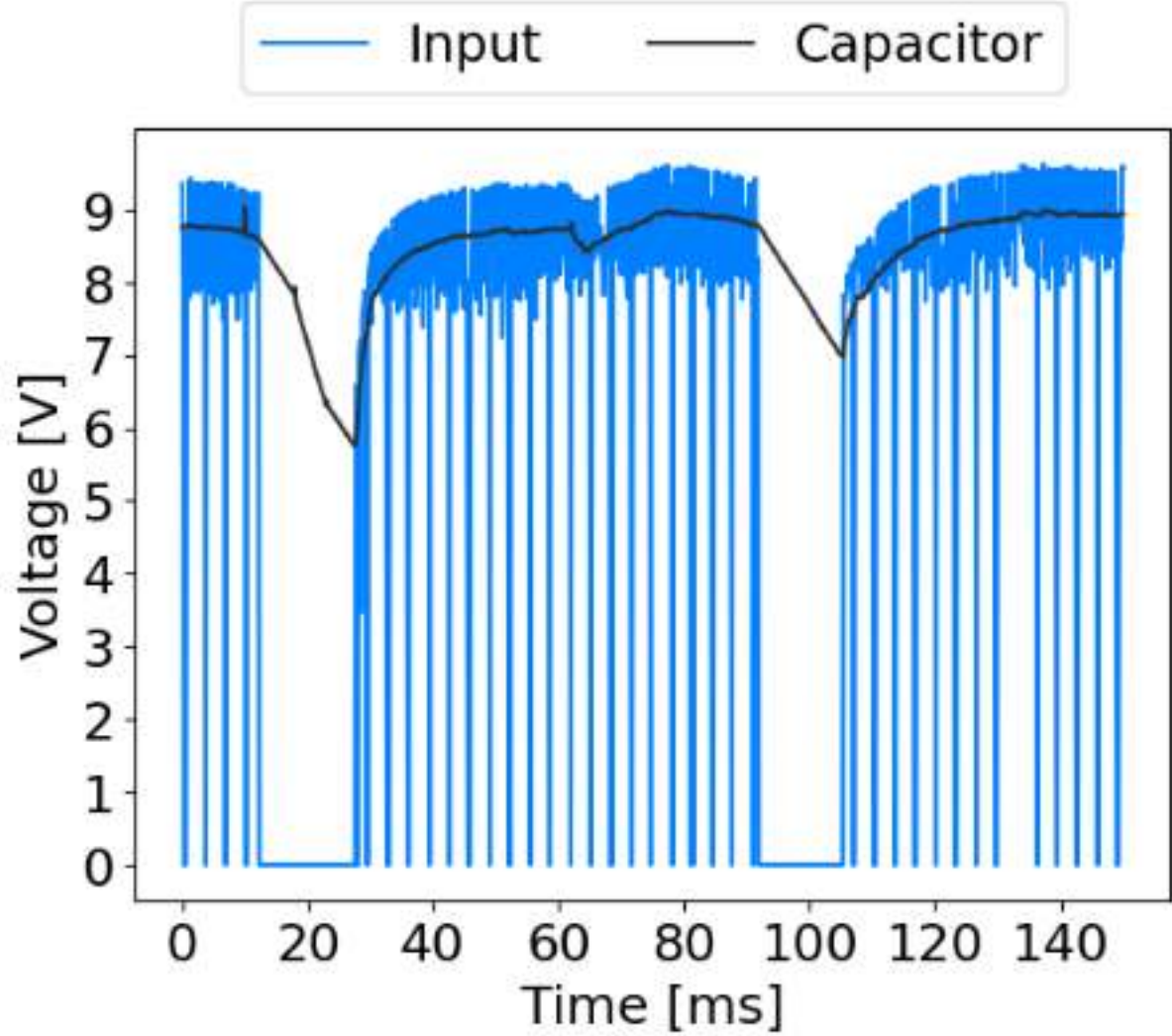
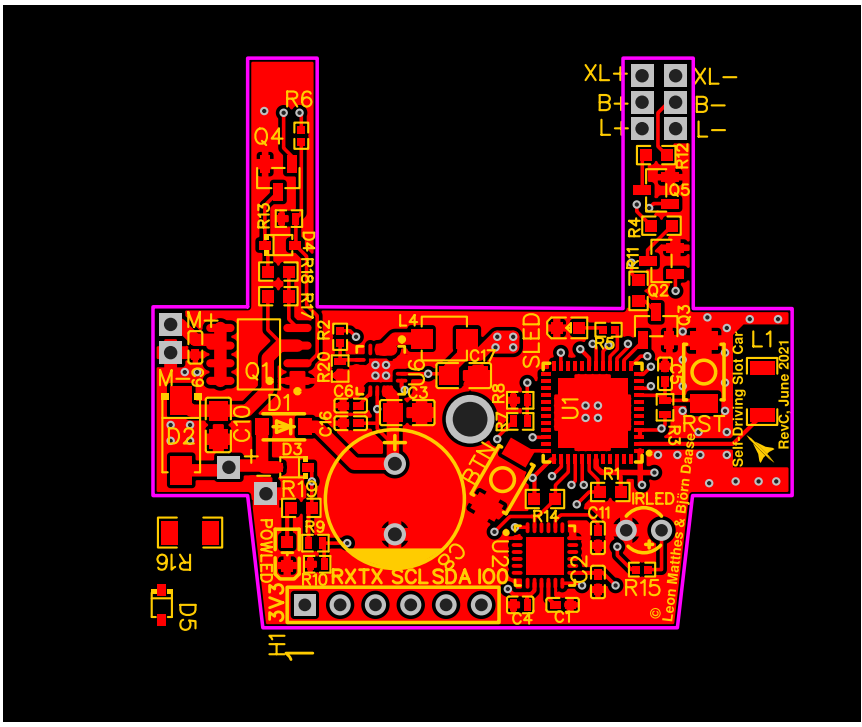
Carrera slot car

challenges

- unusual power supply characteristics

- remote/mobile debugging

PCB design

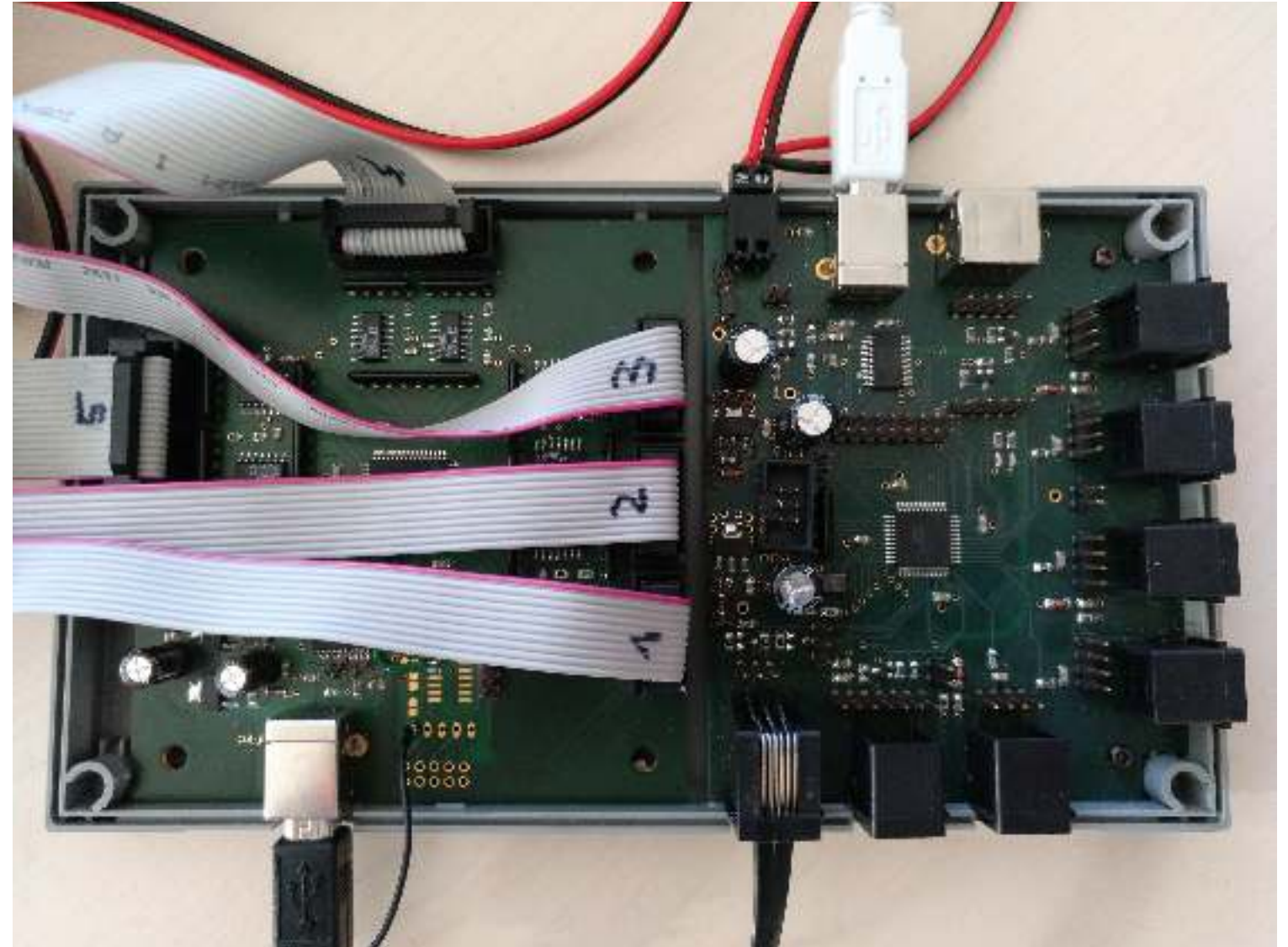


Carrera sensor & actuator board

working with the digital protocol

firmware level

e.g., prevent overtaking the safety car



single-board computers

distributed computing

energy-aware computing

heterogeneous computing

(GP)GPU, big.LITTLE, ...



Digital Rail Lab



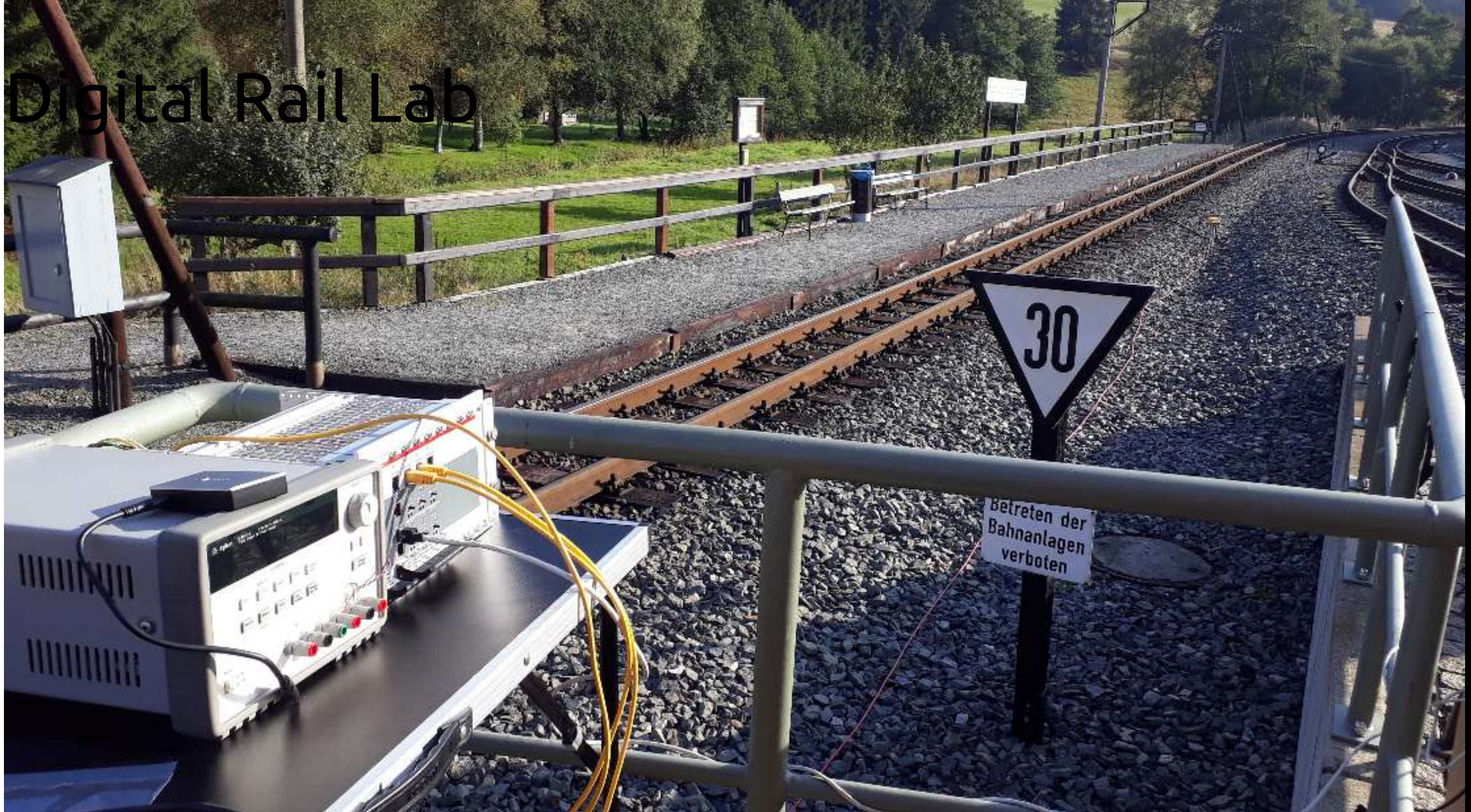
level crossing, color light signal

Digital Rail Lab

point machines



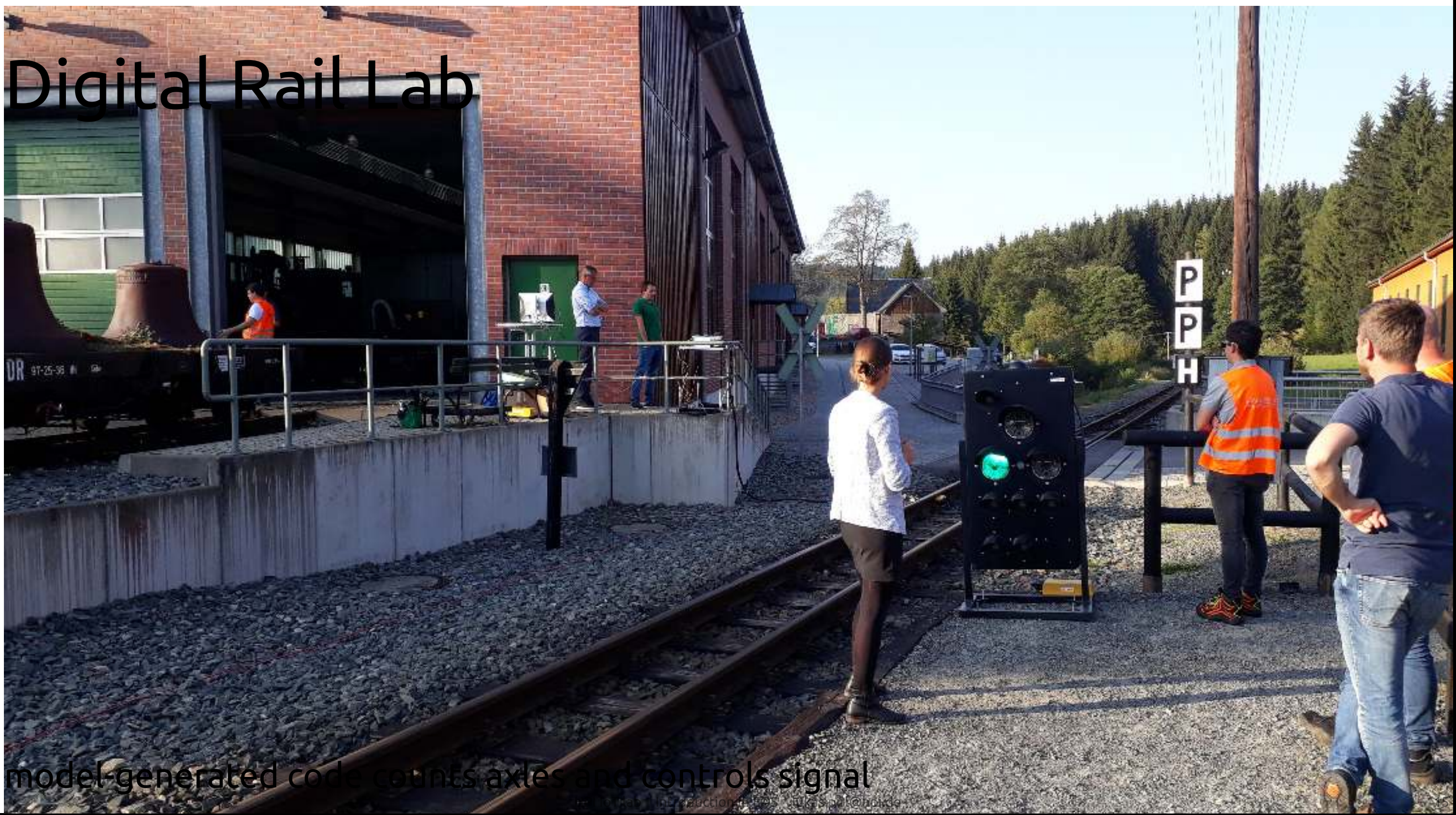
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model-generated code counts axles and controls signal

DRSS

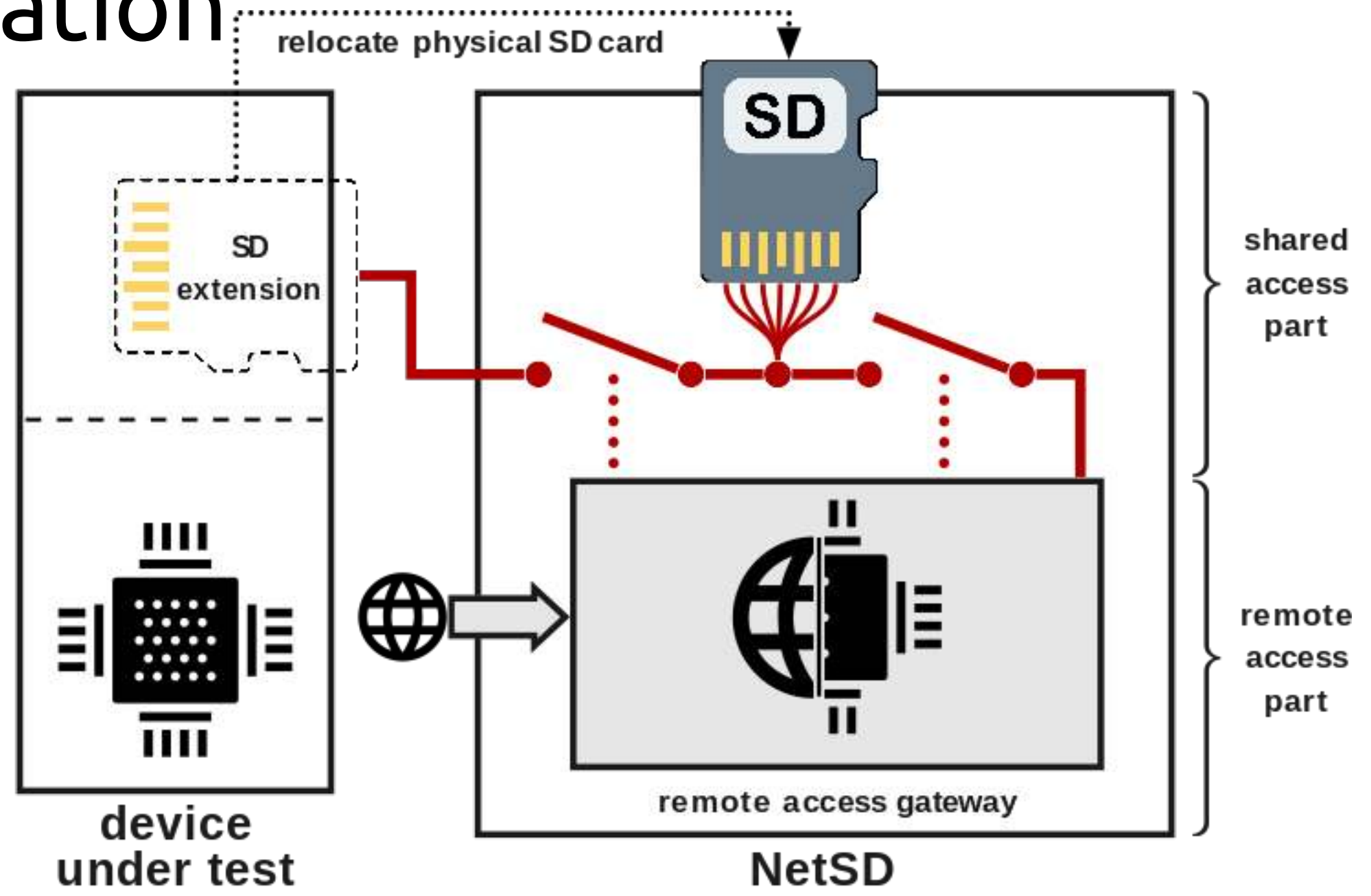
Digital Rail Summer School



DRSS 2023 already done, join 2024! :)

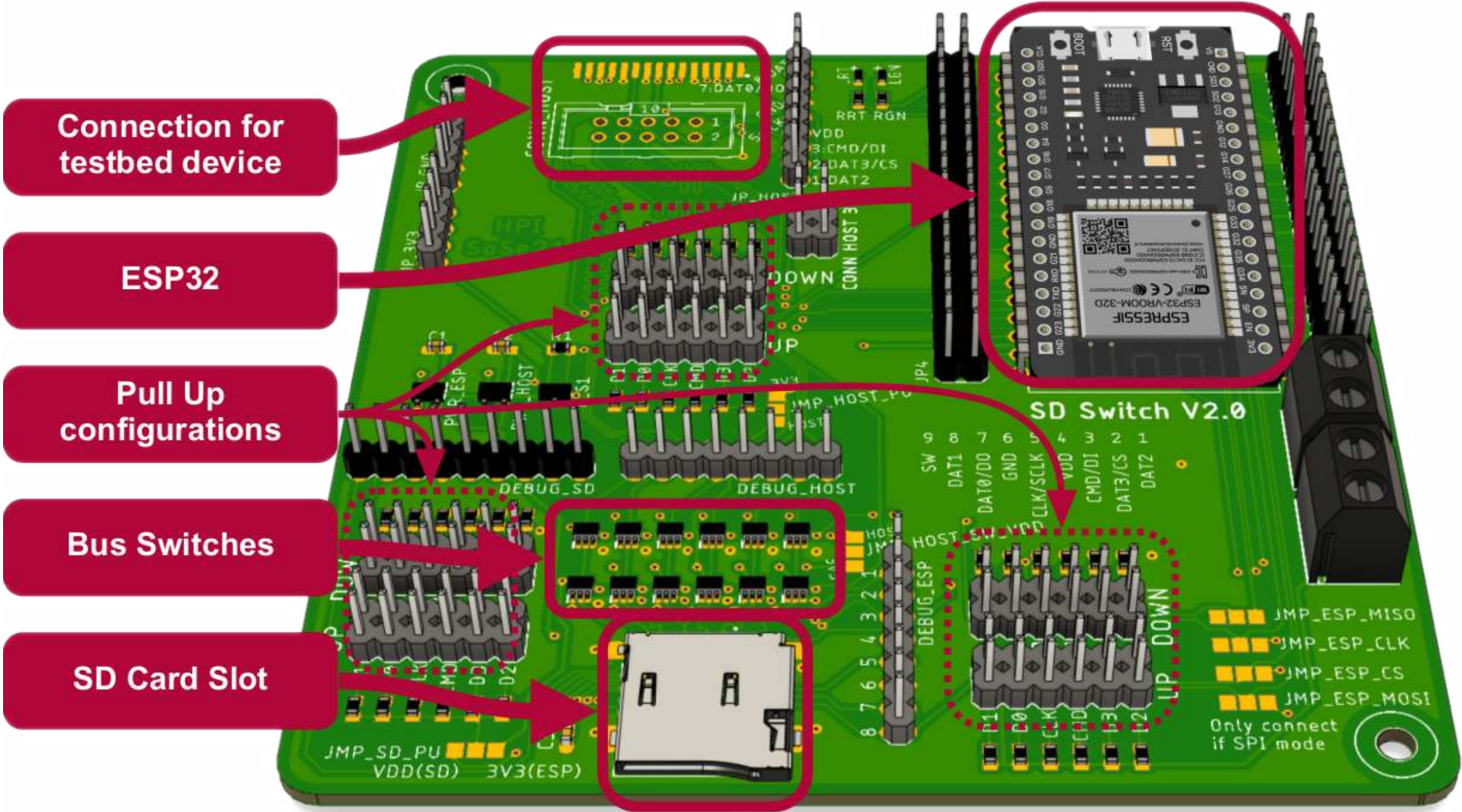
<https://hpi.de/drss>

testbed automation



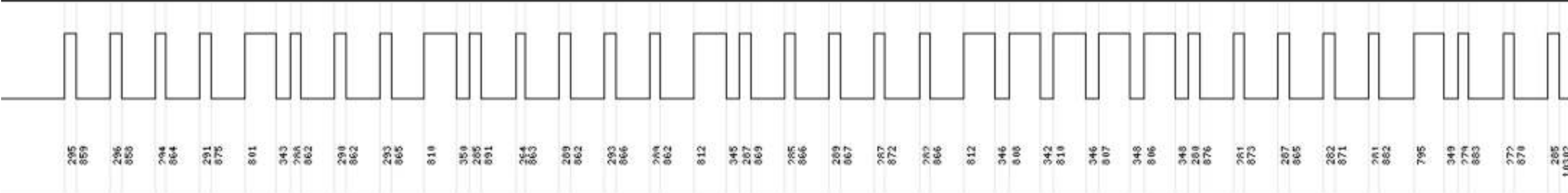
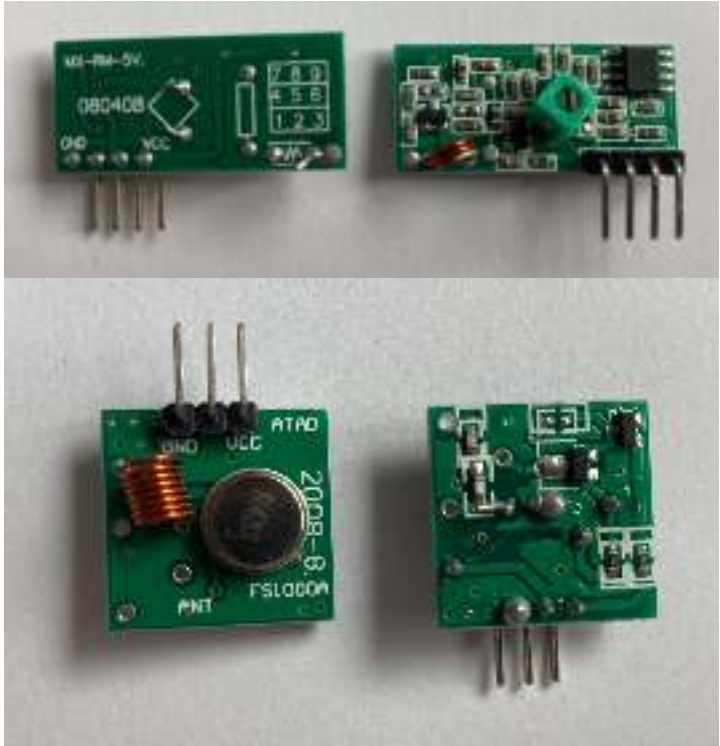
Schröter, V., Boockmeyer, A., & Pirl, L.
NetSD: Remote Access to Integrated
SD Cards of Embedded Devices.

testbed automation



testbed automation

reverse engineering of switchable power sockets



embedded devices & OS

devices

Arduino

ESP32

Beckhoff SPS

Lego

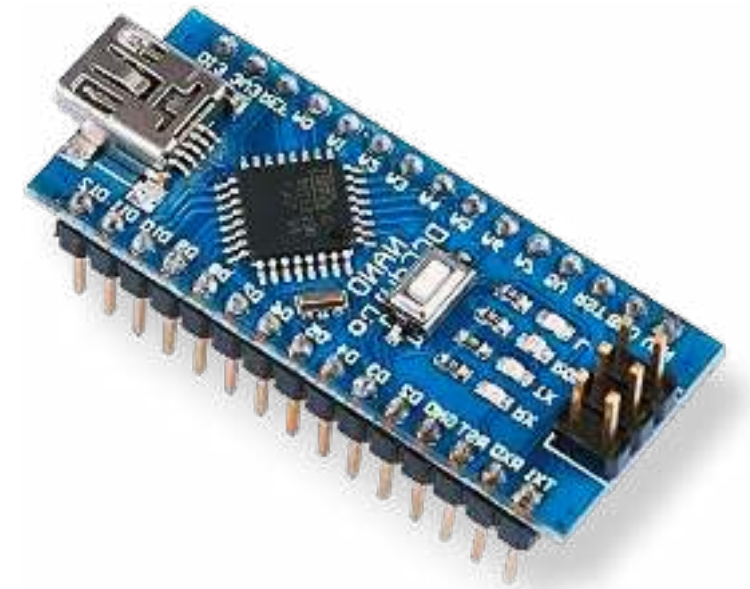
Fischertechnik

... open to suggestions! :)

incl. designing own PCBs

operating systems

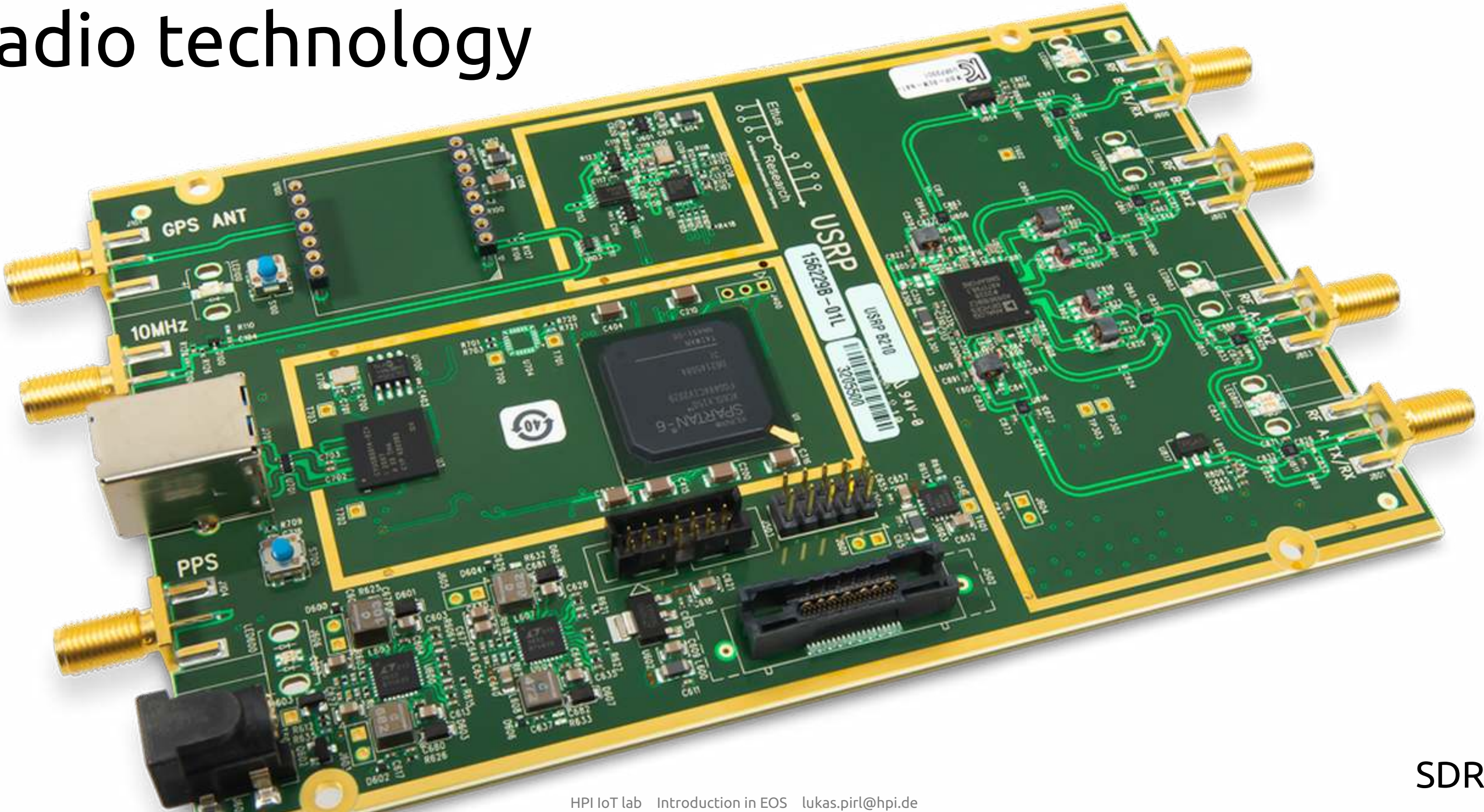
RIOT, *RTOS, OpenWRT, embedded Linux, Contiki, Android, ...



radio technology

LoRa-WAN

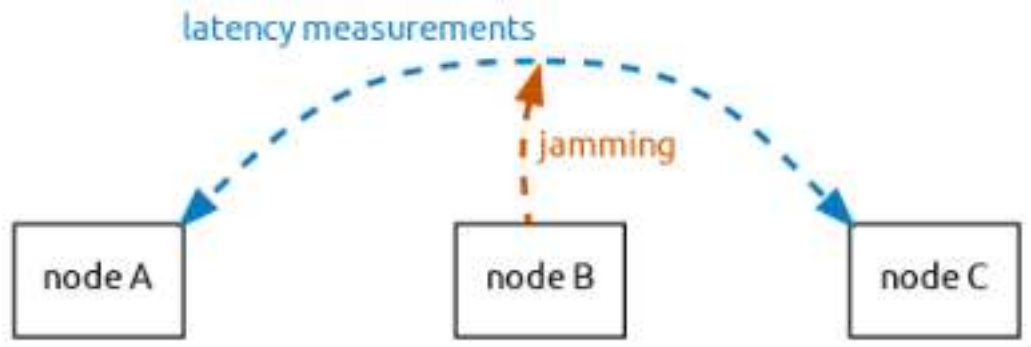
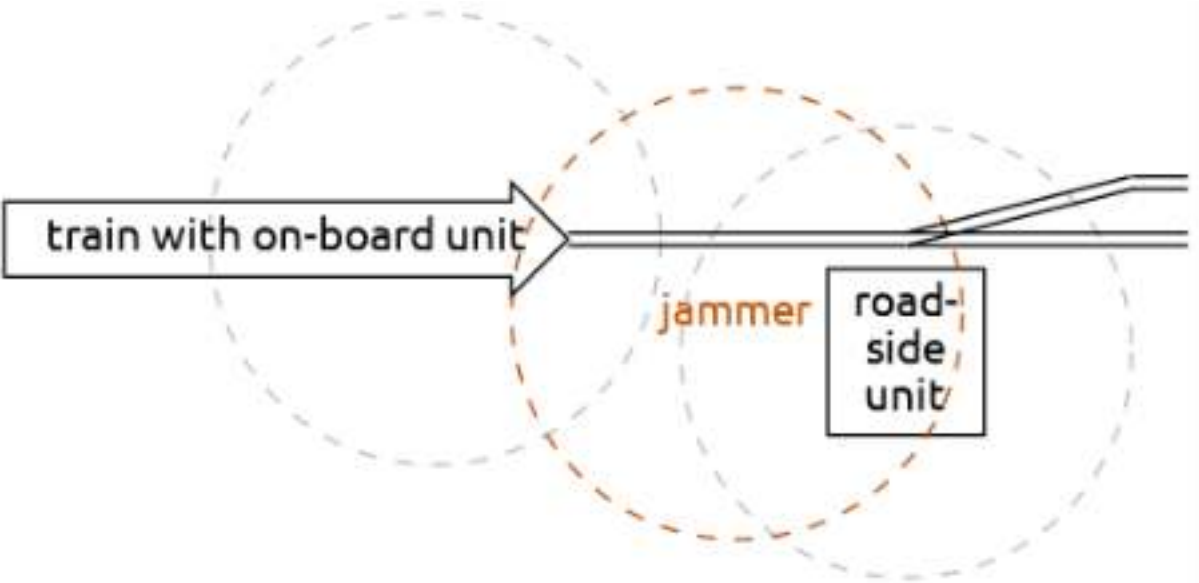
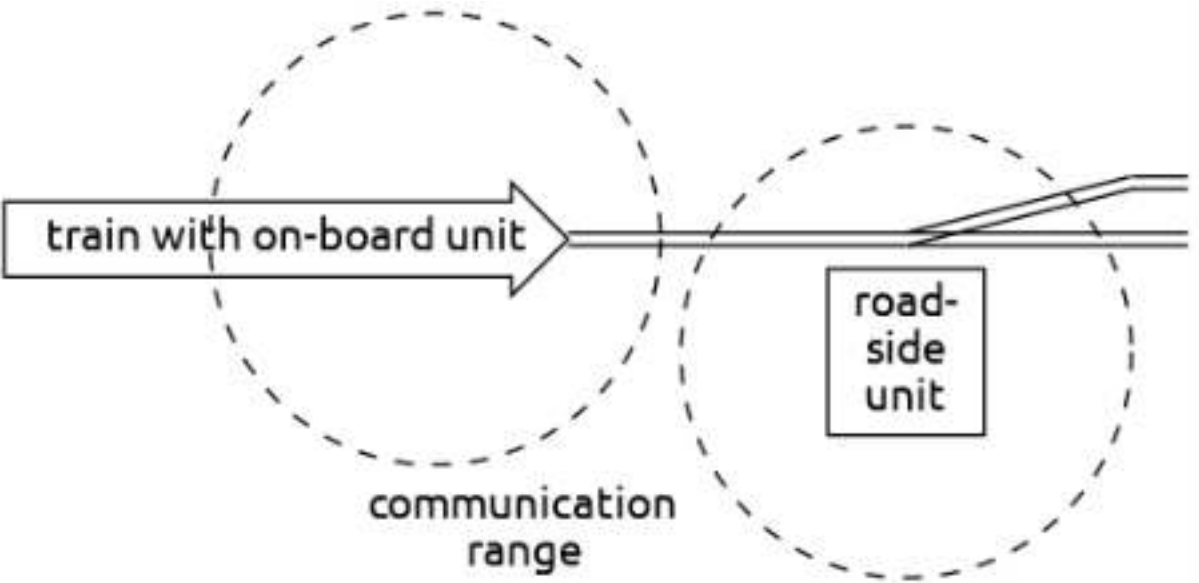
radio technology



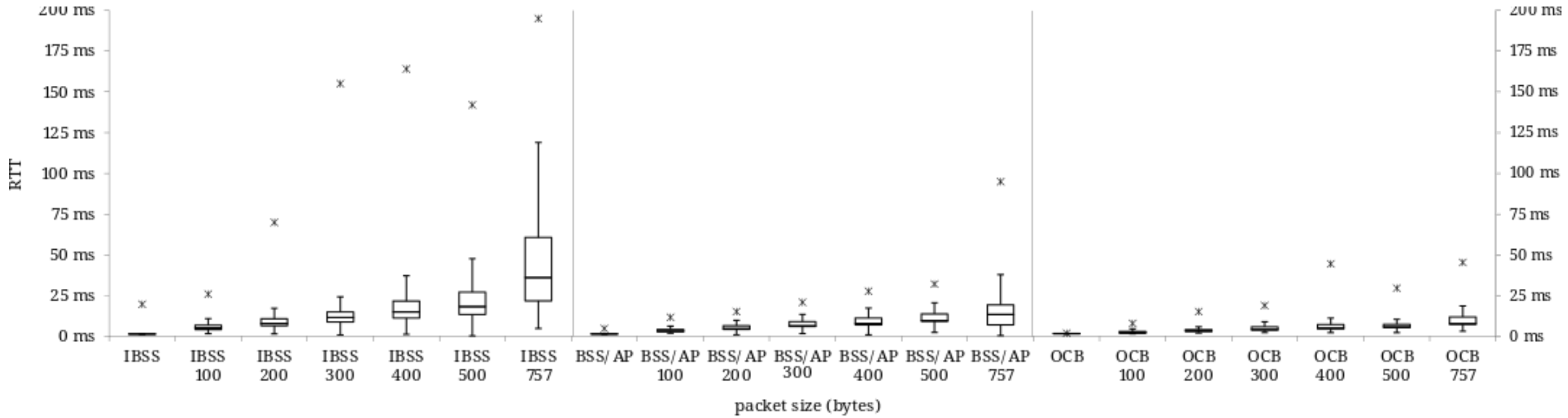
radio technology



Rail2X

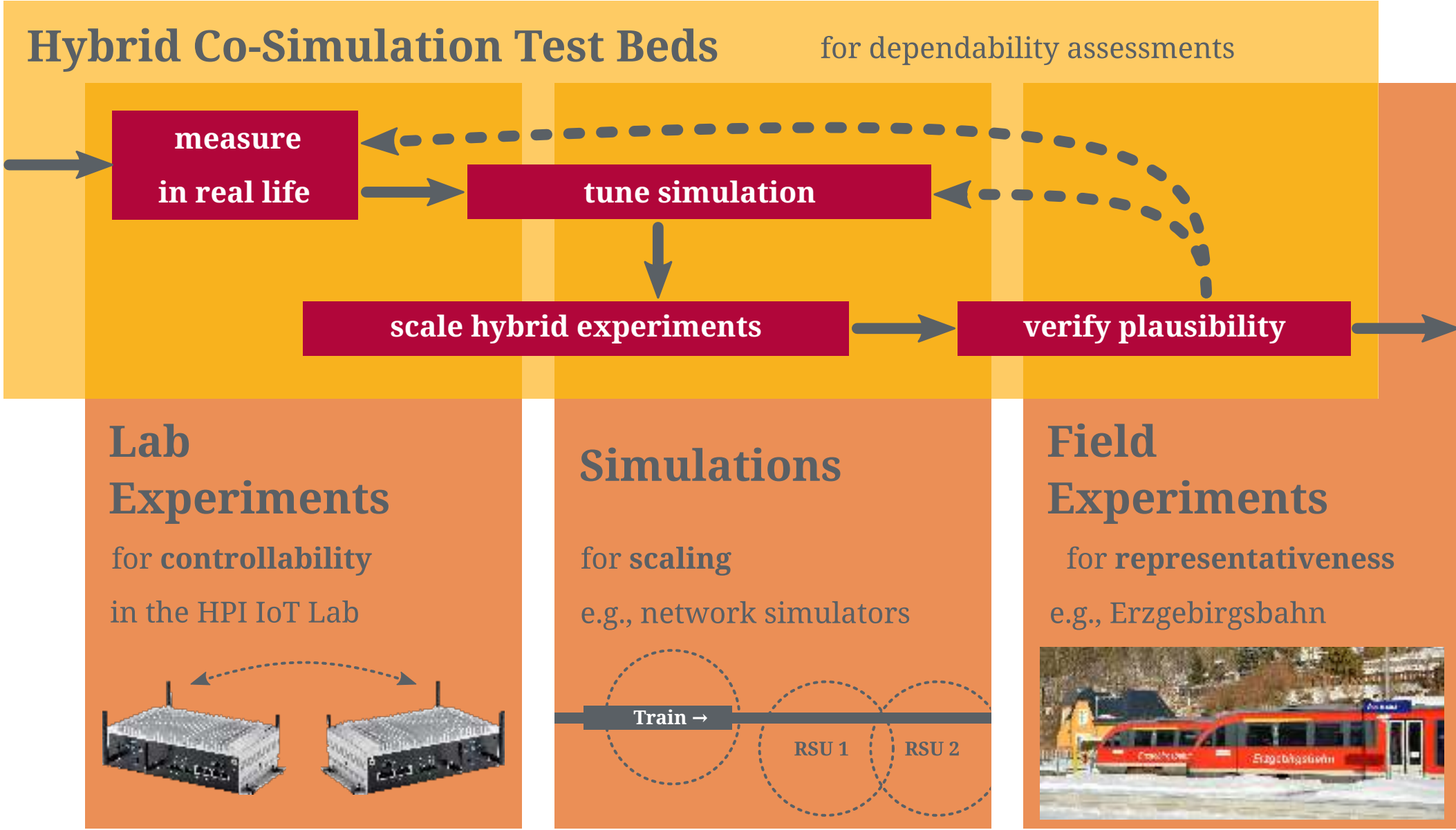


IEEE 802.11p packet round trip times while jamming



packet round trip times are lowest using IEEE 802.11p OCB mode
esp. with lowest standard deviation
desirable for soft real-time applications

development of methodologies



hybrid testbeds & co-simulation

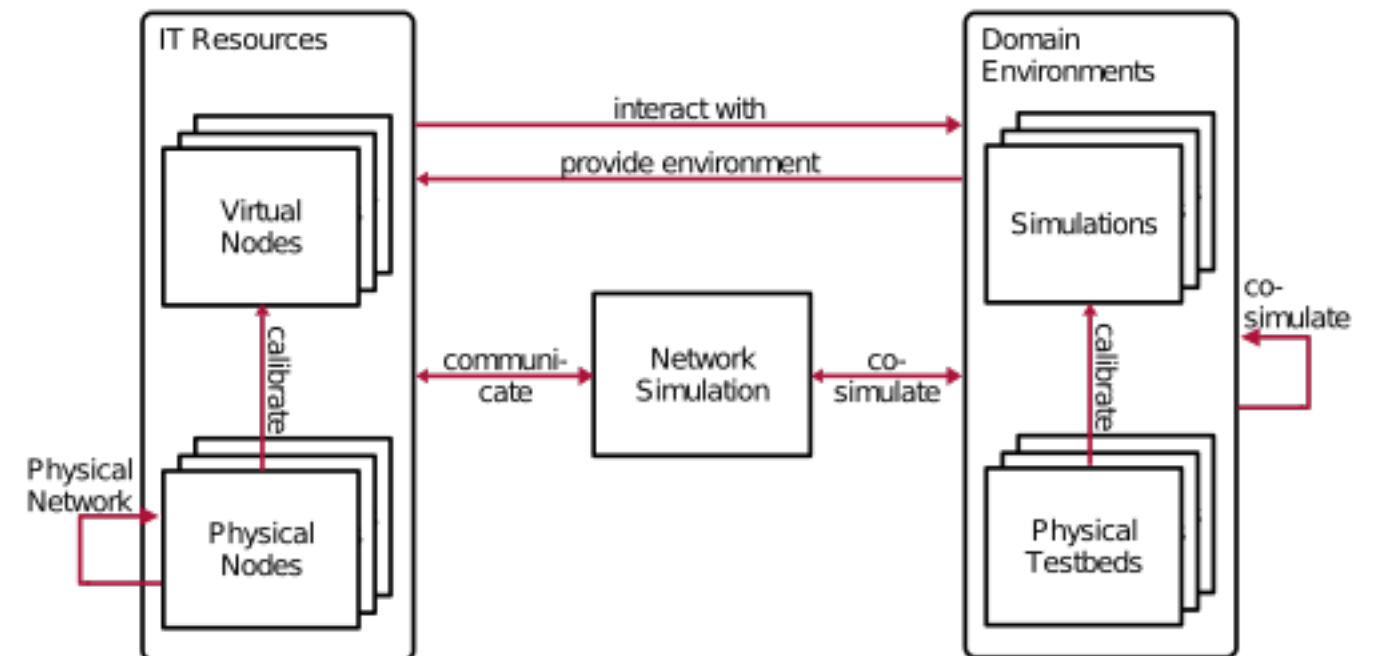
hybrid: software, hardware, and models “in-the-loop”

e.g., simulated wireless & physical wireless network

co-simulation: coupling of multiple domain-specific simulations

e.g., *SUMO* for traffic & *ns-3* for networking

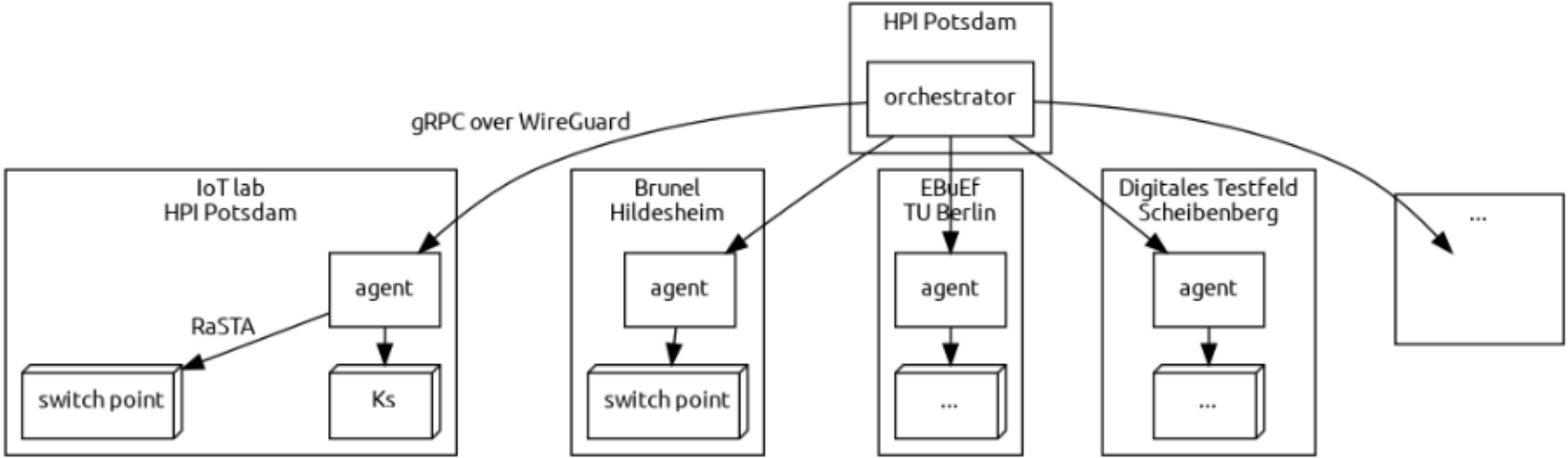
<https://github.com/diselab/marvis>



distributed testbeds

EULYNX live lab: distributed test environment

Kubernetes + Akri, generated interlocking software, automated tests, ...



HPI IoT lab

... an environment for prototyping and assessments

building, DIY, testing, ...

hybrid, co-simulated, and distributed setups

across/coupling of different domains

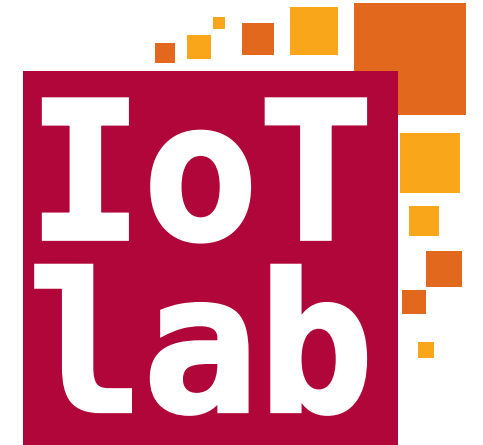
model-driven and -supported approaches

alternatives to specialized (test) hardware

hardware, software and model “in the loop”

simulated environment

dependability



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