Deutsches Zentrum für Luft- und Raumfahrt
DLR
German Aerospace Center
Institute of Transportation Systems

SuMoCoS
Sustainability and Mobility in the Context of Smart Cities

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New intelligent control methods for traffic light systems (TLS) evaluated with DLR's microscopic traffic simulator SUMO

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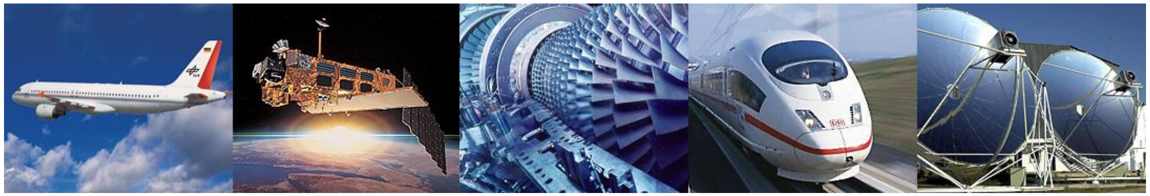
Tashkent, October 7-12, 2019

https://uol.de/se?sumocos

German Aerospace Center (DLR)
at a glance



- Research focuses on the following areas
  - *Aeronautics*
  - *Space*
  - *Energy*
  - *Transport*
  - *Security and Digitalization*
- Approx. 8200 employees across 40 institutes and facilities at 20 sites
- Offices outside Germany in Brussels, Paris, Washington and Tokyo

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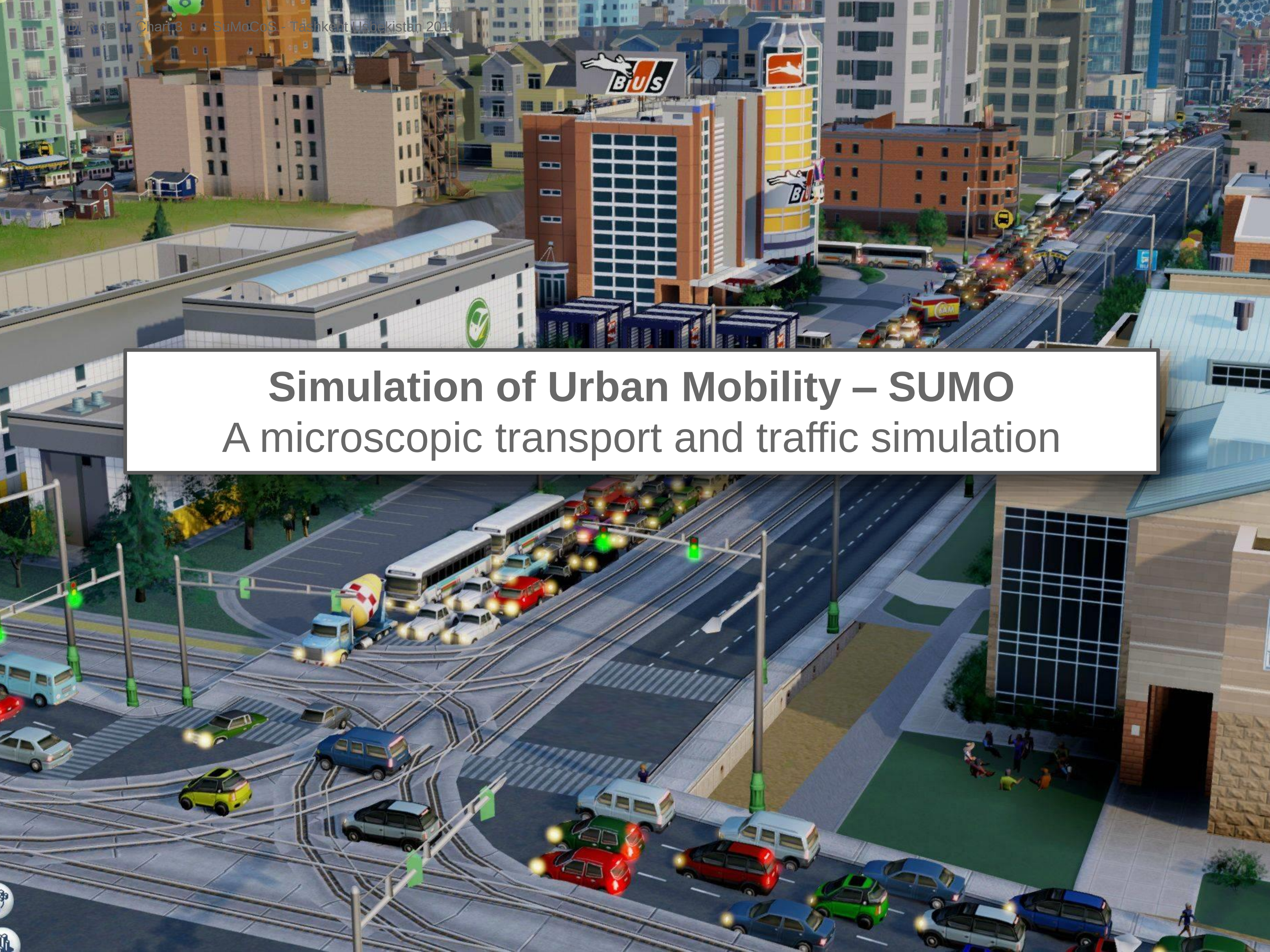
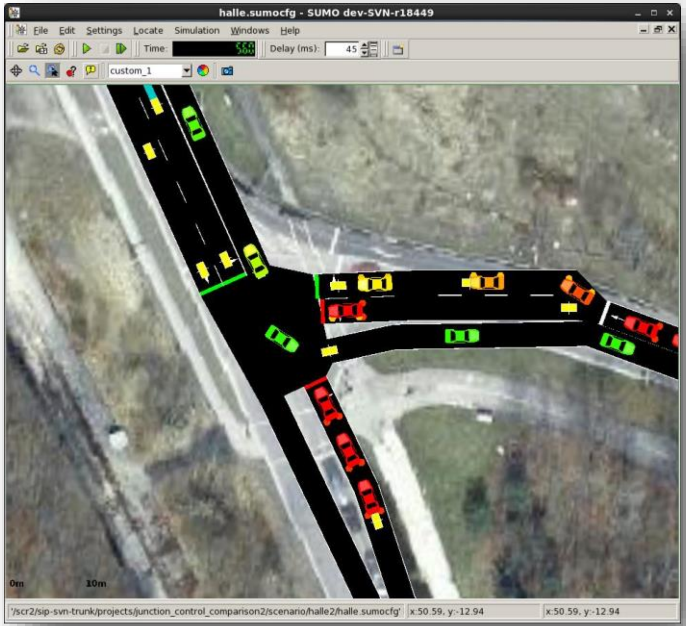


Simulation of Urban Mobility – SUMO

A microscopic transport and traffic simulation

SUMO – what is it?

- Is **open source**, licensed under the EPL (Eclipse Public License) v 2.0
- Comes with a complete suite of **helper programs** like TraCI
- Allows to:
    - simulate large cities and areas in **real-time**
    - import **travel demand** from external sources
    - import formats for **networks**: OpenStreetMap, PTV VISUM, PTV VISSIM, HERE, NavTeq



Current Version: 1.2.0

Website / Download: http://sumo.dlr.de/

Contact: sumo@dlr.de

Under development: Since 2001

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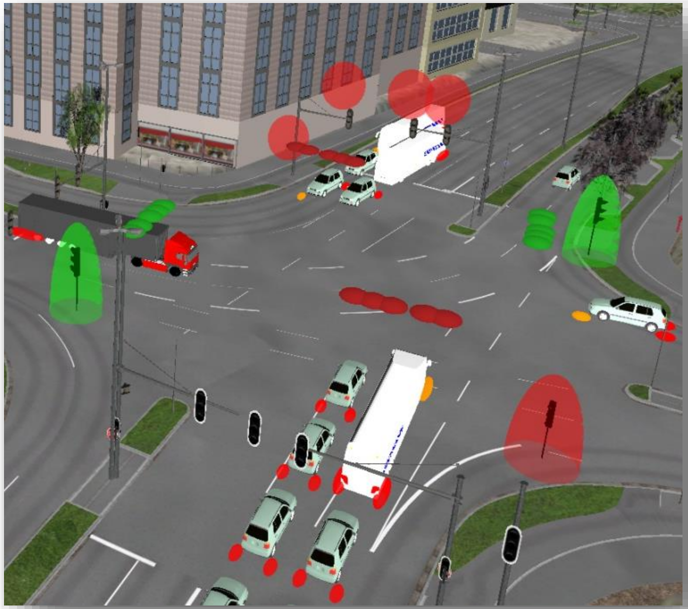
SUMO SIMULATION OF URBAN MOBILITY

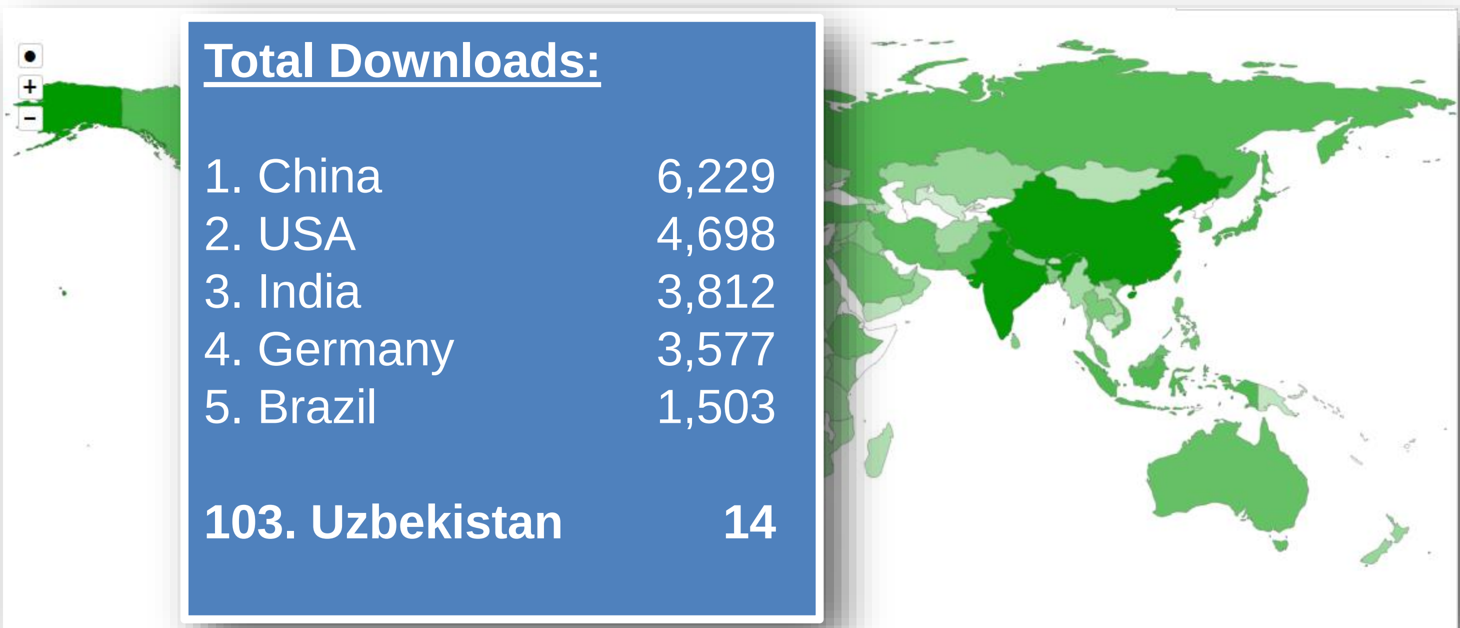
SUMO – what can be run?

- Exaggeration: ***"Any moving object in a city can be simulated with SUMO!"***
- SUMO allows modelling of intermodal and multimodal traffic systems:
    - Cars,
    - Busses, Passengers,
    - Bicycles, Pedestrians,
    - Ships, Goods traffic,
    - Transport Chains (Containers etc.)



SUMO – who use it?

- Used world-wide, especially in the scientific community
- Active community with approx. 40,000 downloads in year 2019



Source: sourceforge.net

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VITAL - Vehicle-Actuated Intelligent Traffic Signal Control

Two new approaches for optimized signal control

Motivation / Expected advantages of the new approach

Reduction of Waiting and Travel Times for all traffic participants

Avoidance of Emissions in terms of Climate Protection and a healthier Urban Environment

Reduction of Financing Costs for Traffic Infrastructure by Municipalities

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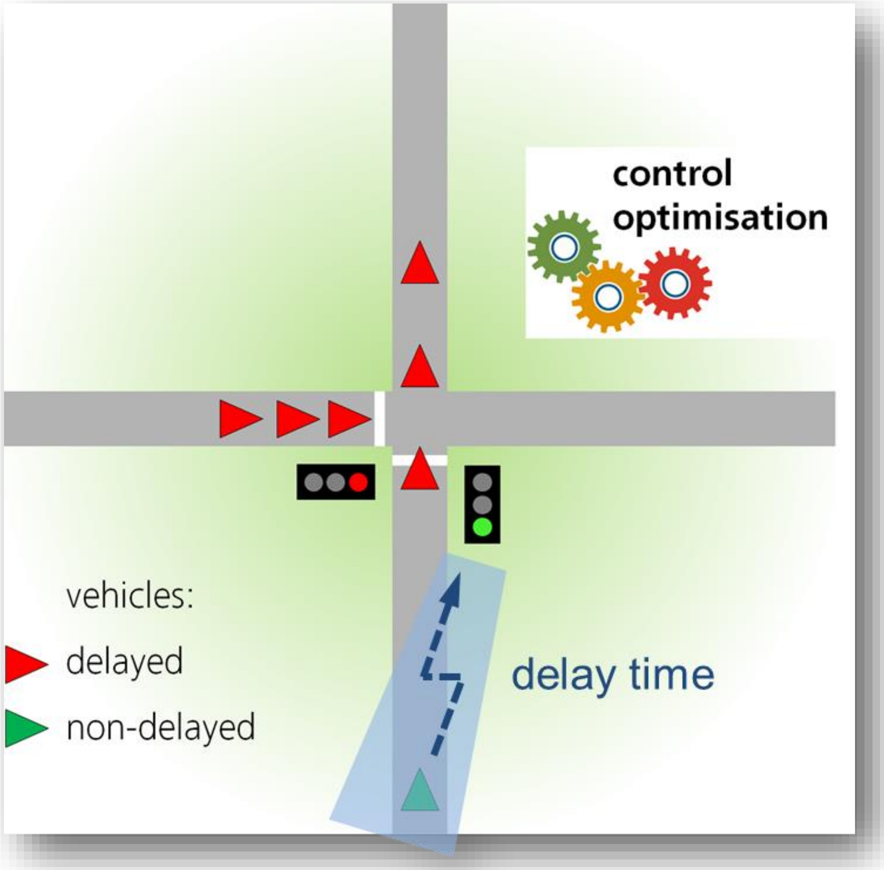
Delay-based control

- Initial point: New ICT data sources
    - **V2X communication**
    - Video capturing
    - Wireless in-road detectors
- **Delay time**: is the additional travel time compared to the uninterrupted passing of an intersection
- Idea: **Stop a running green phase** as soon as all delayed vehicles on an approach have been served



GLOSA (Green Light Optimized Speed Advisory)

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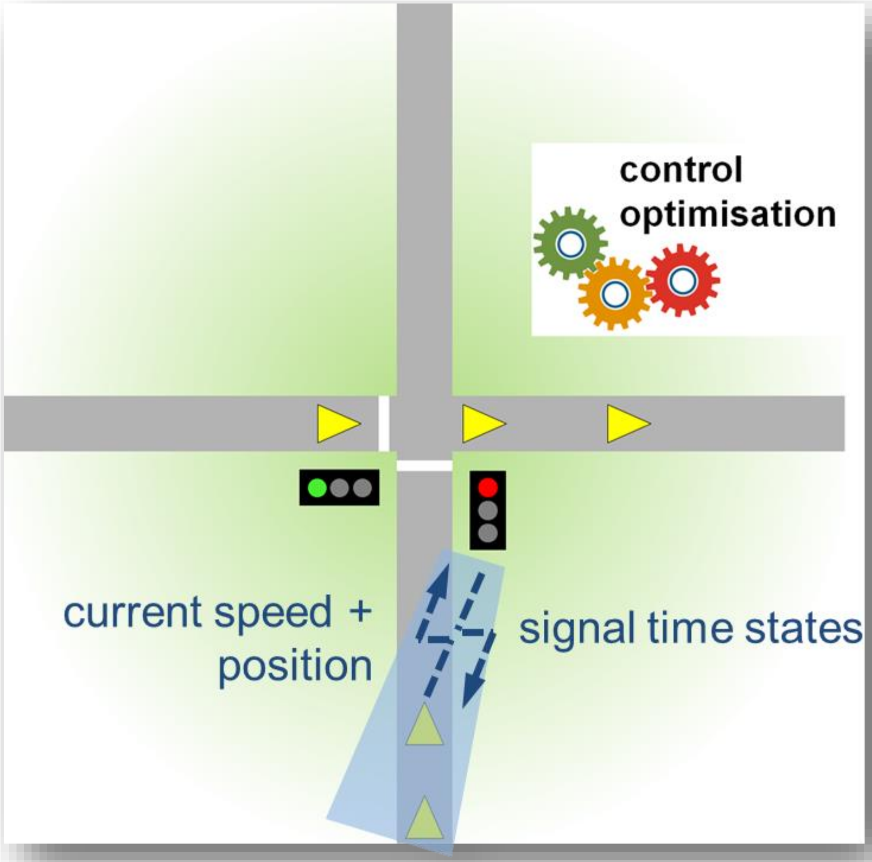
Co-operative control

- GLOSA – **signal time states** are send back to the vehicle
- **A**GLOSA (Agent-Aware) – combination of **vehicle-actuated traffic signal control** and vehicle-given speed recommendations
- V2X standard enables cooperative **bi-directional communication**
- Works with **short time prediction** of further movements and trajectories



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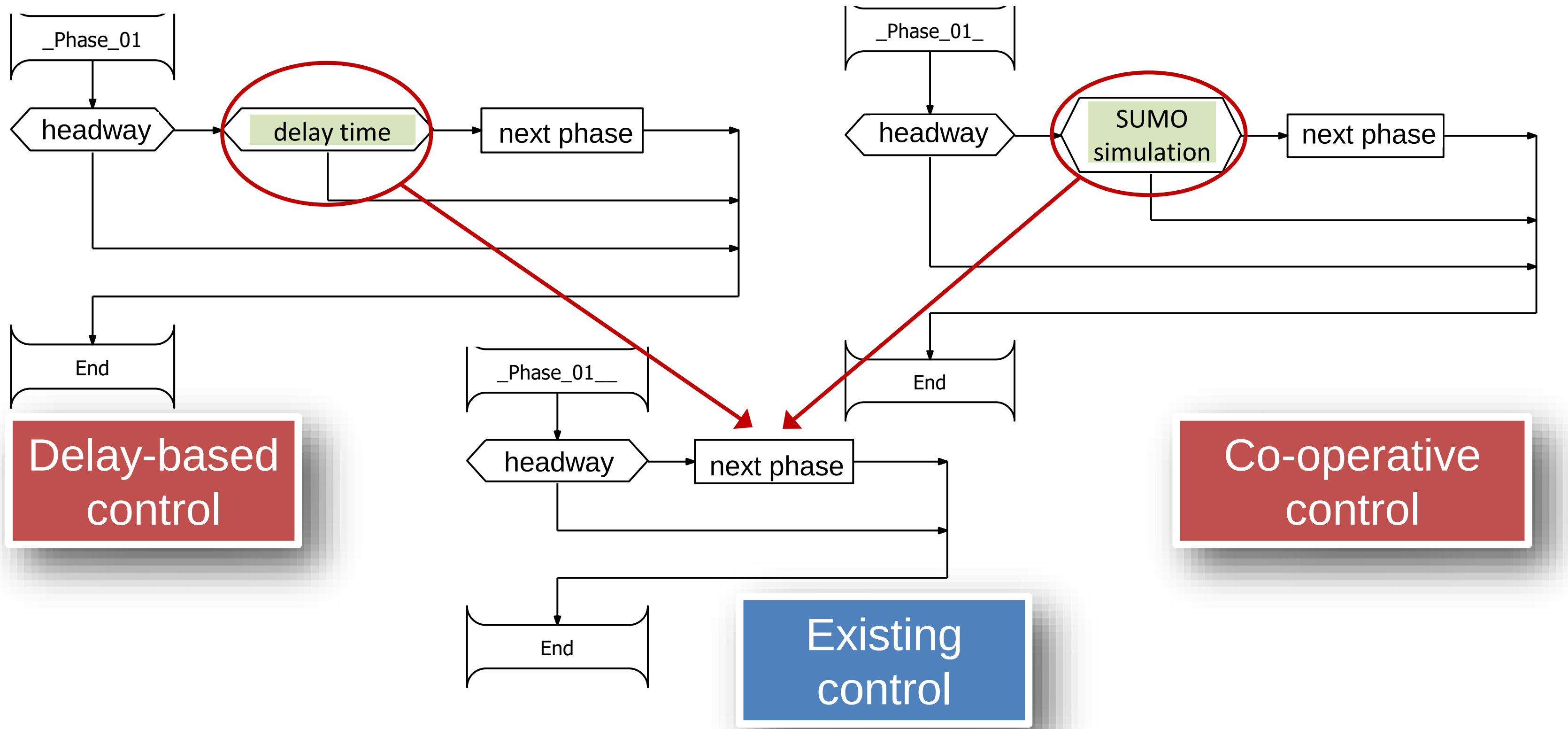
Modified control logics

- Straightforward modification of the existing control strategy
- Only the criteria for **<u>stopping a running green phase</u>** is replaced



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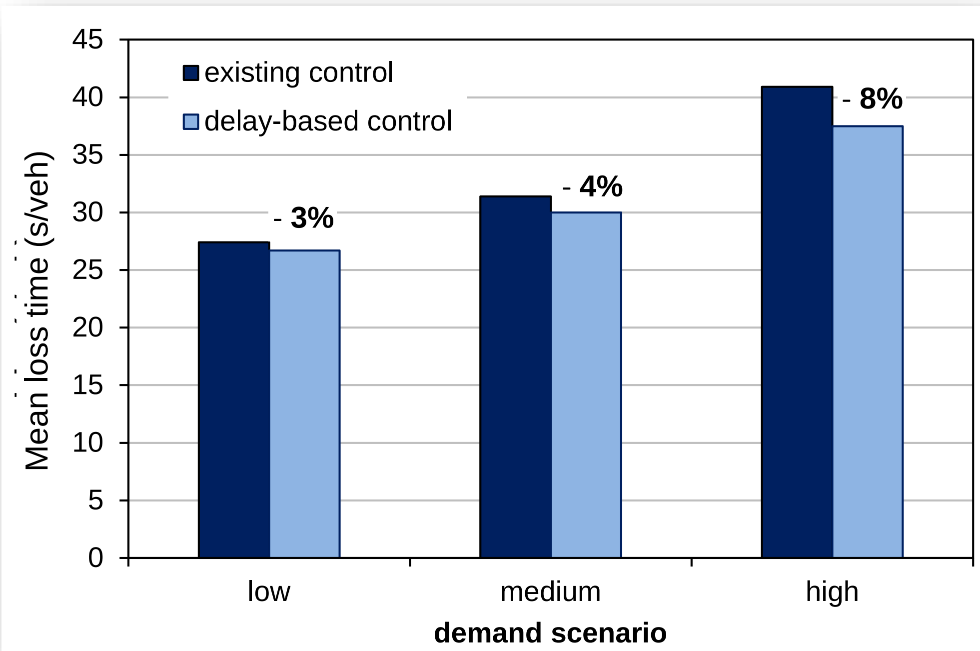
Delay-based control
First simulation results

- Several simulation studies on abstract systems in SUMO had been done



Simulation

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Co-operative control

Additional Hardware

- **AGLOSA** algorithm requires a lot of computing resources
- **Embedded PC** is directly placed in the control cabinet
- SUMO is modelling the **state of traffic** in **real-time**
- **Point-based** vehicle detections will be transformed into **continuous** floating car data (FCD)

Embedded PC

SUMO simulation

Signal and detector states

Stop running green phase

TLC

Signal control logic

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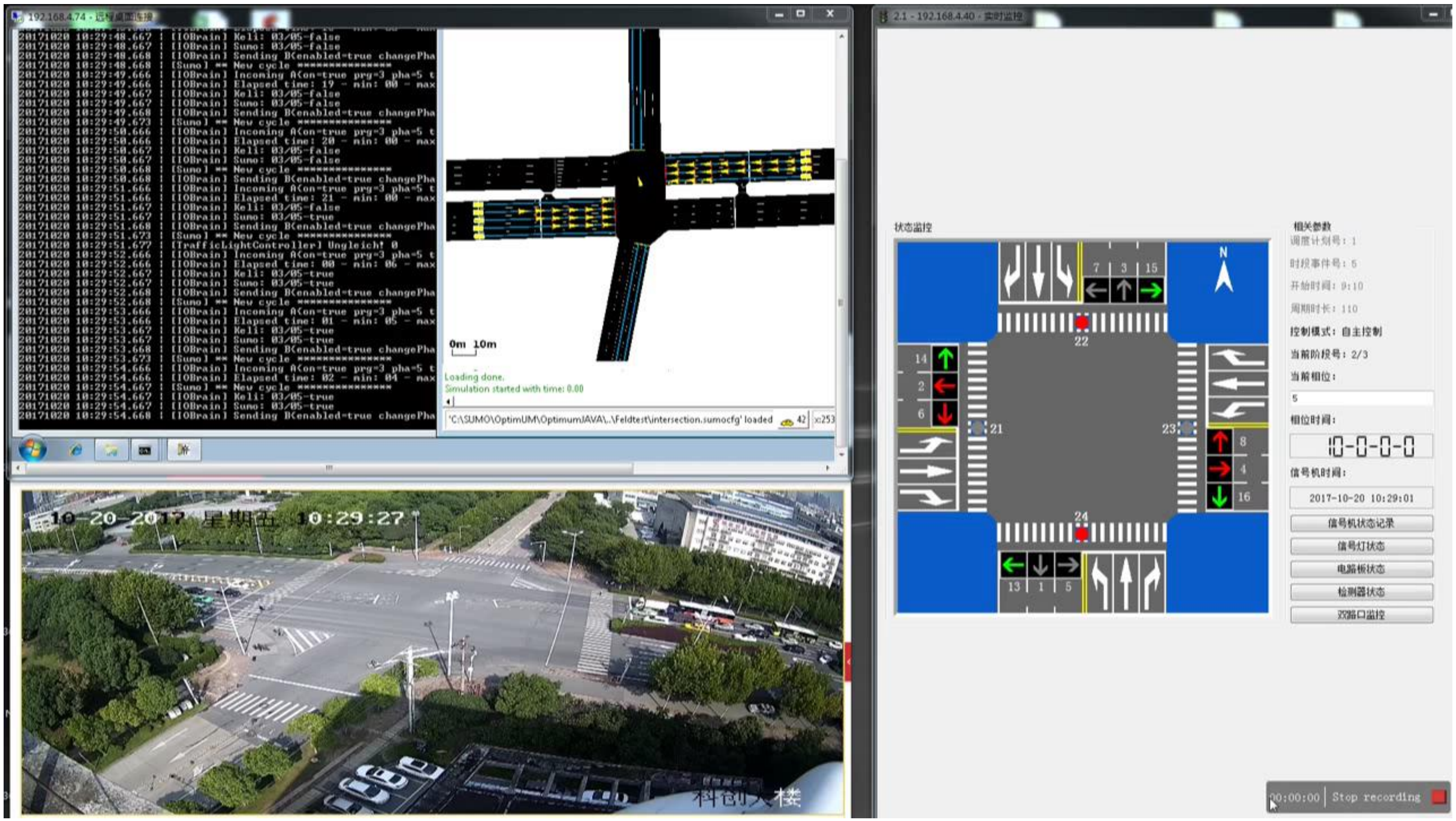
Real-time simulation with SUMO

Example: Traffic light optimization / City of Hefei (China)



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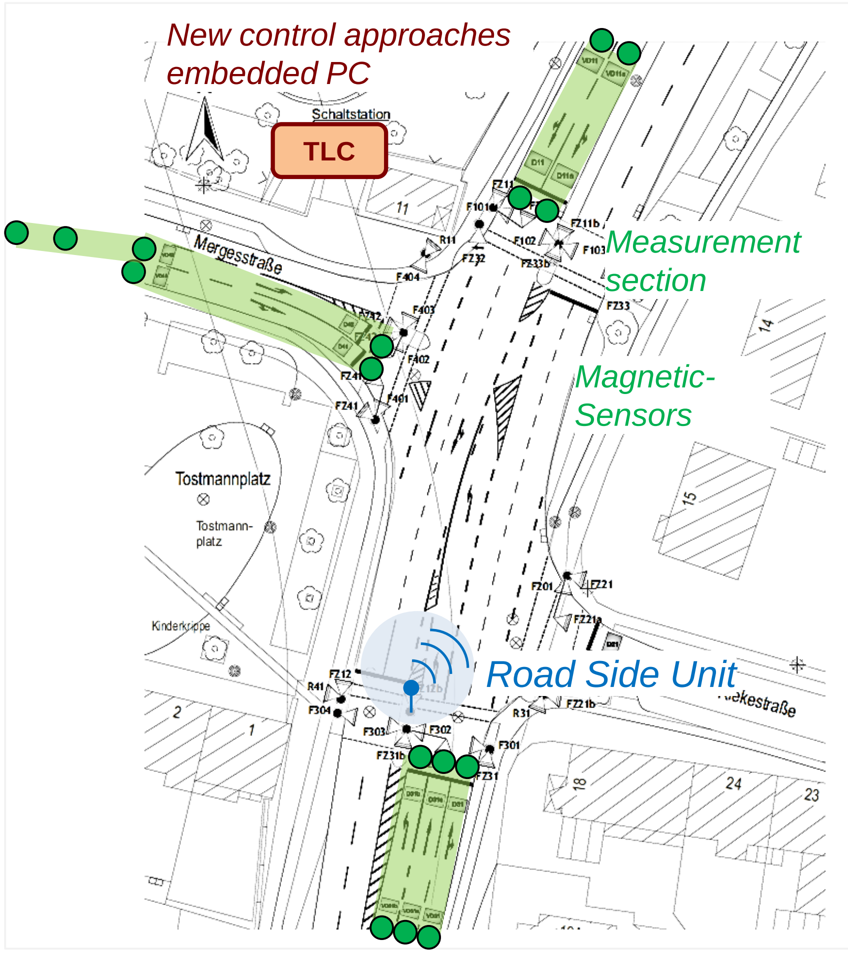
Implementation in the Field

Field study: Two test Intersections in Germany

	Braunschweig	Halle (Saale)
Control Mode	vehicle-actuated green time adjustment with <u>**static**</u> signal program selection	vehicle-actuated green time adjustment with <u>**dynamic**</u> signal program selection
Detection equipment	<u>**induction loops**</u> (vehicle presence and headway detection)	<u>**induction loops, radar and video detectors**</u> (vehicle presence and headway detection)
Bus pre-emption	No	Yes
Traffic load	Medium	Low
Typ of vehicles	cars, cyclists and pedestrians	cars, less cyclists and pedestrians

Implementation in the Field

Braunschweig Die Löwenstadt



- Complexity: Medium
- Existing TLC (Siemens C900V) and equipment was used
- Additional Hardware:
  - 16 wireless magnetic in-road sensors for vehicle detection
  - 1 additional embedded PC for the co-operative control
  - 1 Road Side Unit for Car-to-Infrastructure Communication (V2X Protocol IEEE 802.11p)

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Simulation demo case

Braunschweig Die Löwenstadt

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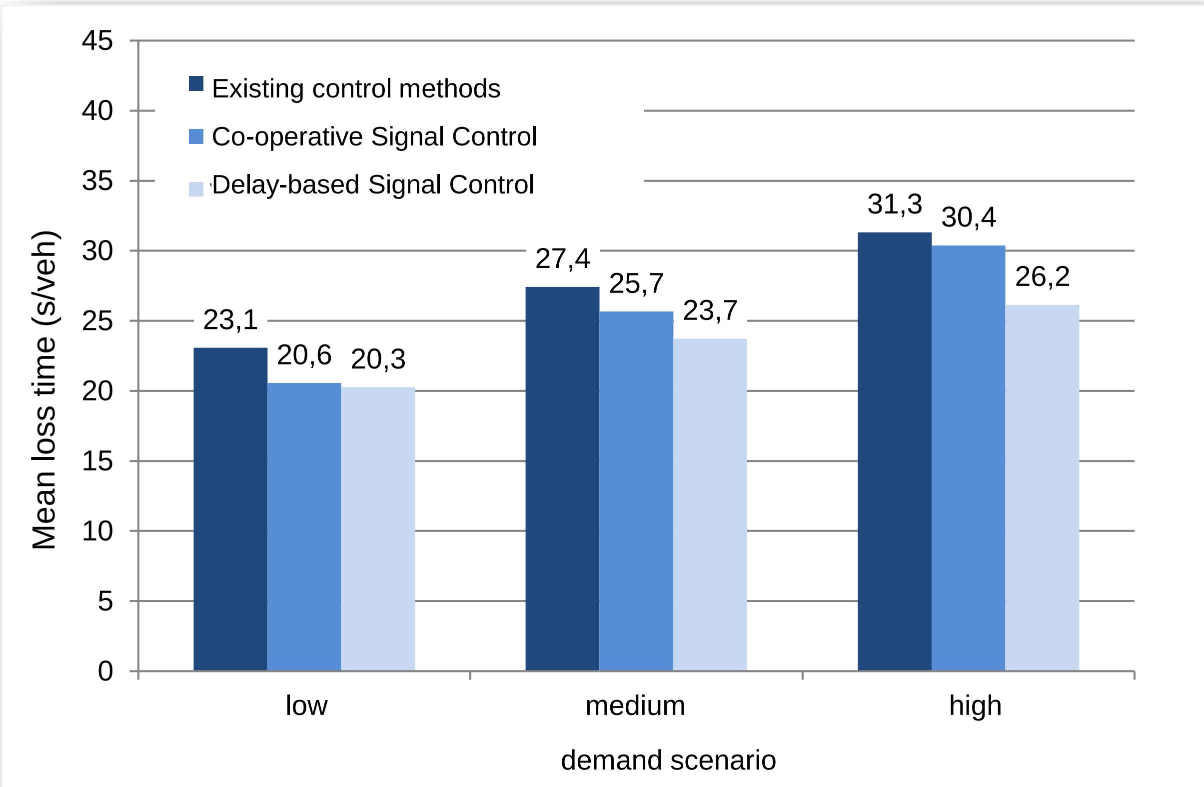
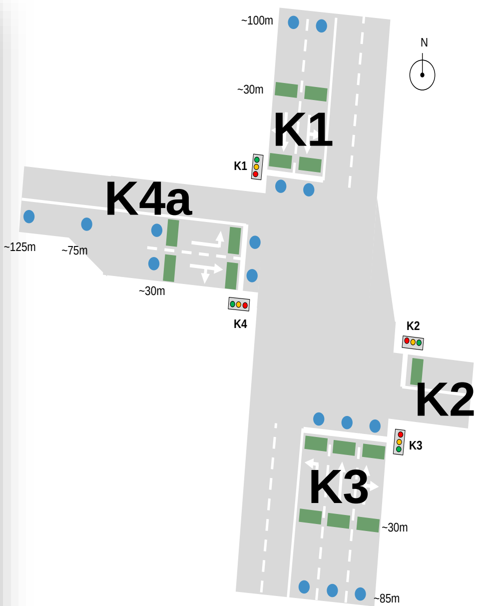
Measured values
Mean loss time vs. demand





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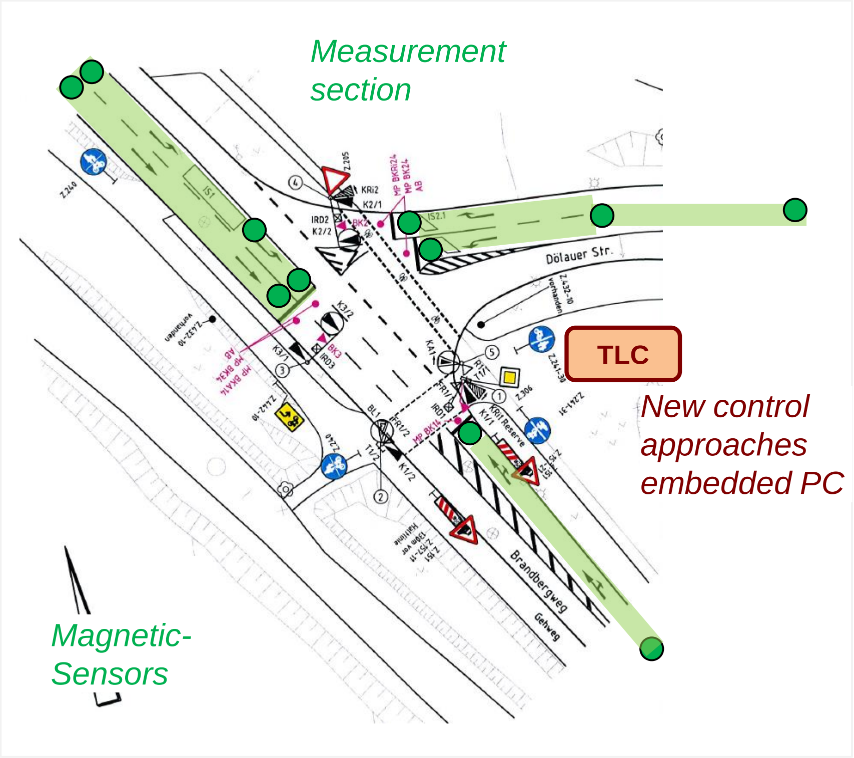
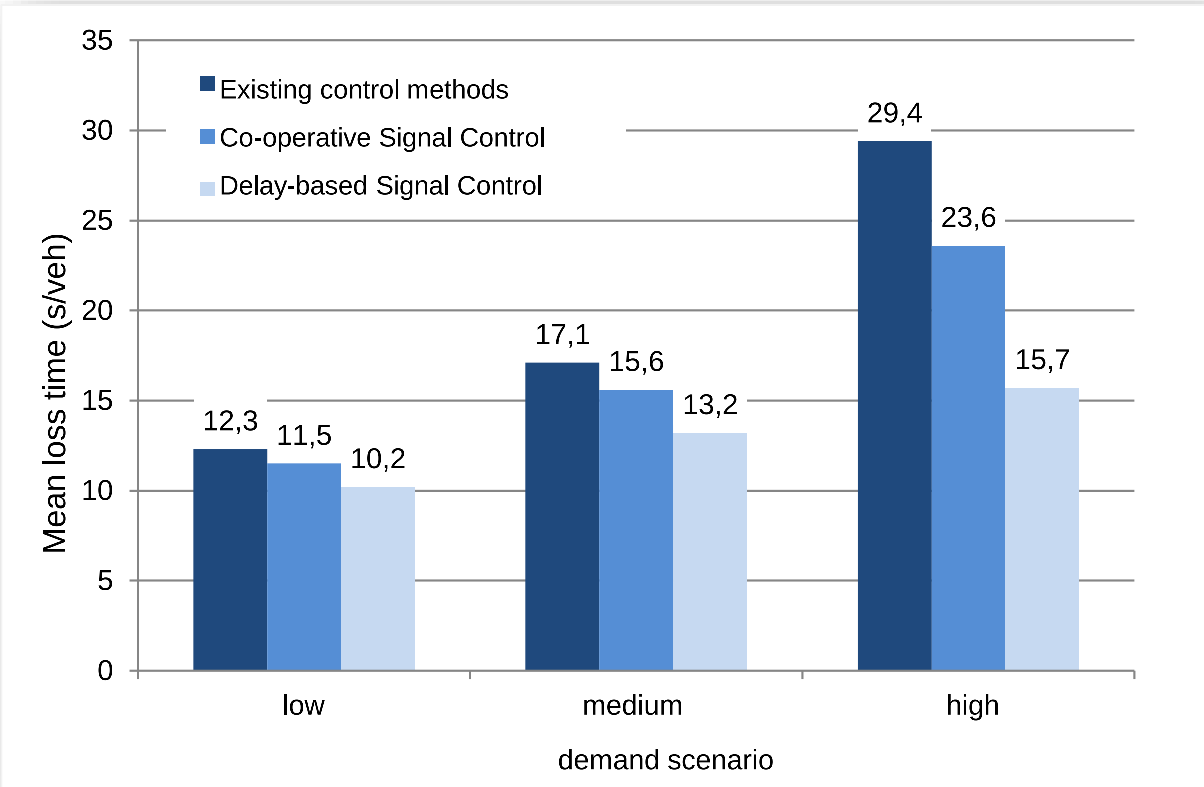
Implementation in the Field

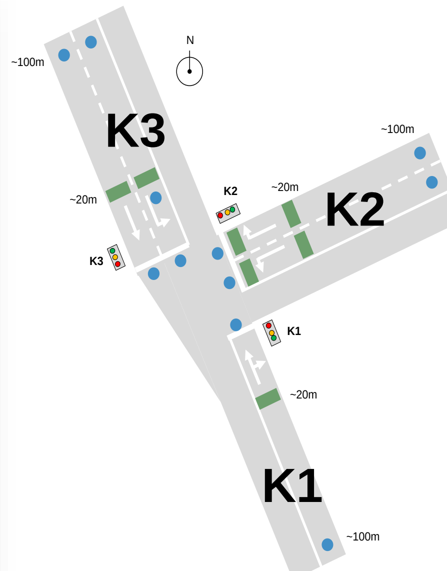


- Complexity: Low
- Existing TLC (Siemens C900V) and equipment was used
- Additional Hardware:
  - 11 wireless magnetic in-road sensors for vehicle detection
  - 1 additional embedded PC for the co-operative control

Simulation demo case

Measured values
Mean loss time vs. demand





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Consideration of Vulnerable Road Users (VRU)

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Consideration of Vulnerable Road Users (VRU)

- Interactive integration of **VRU Mobile Devices**
- Localization of non-motorized road users with **Bluetooth beacons**
- Provision of **GNSS correction data** via V2X protocol
- Data fusion enables **high-precision position information** from VRU

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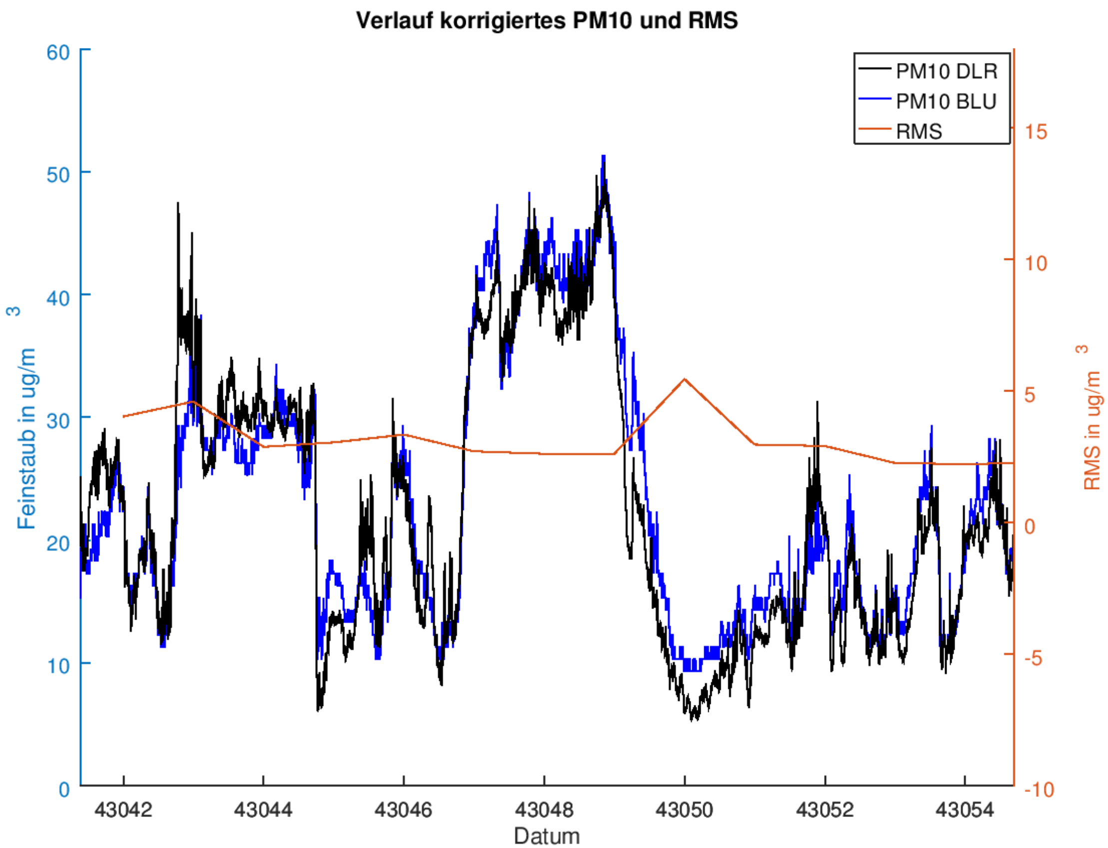
Environmentally-oriented traffic control

SMartAiRTracer for measuring fine dust (PM_{10})



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Conclusion

Two new methods **reducing waiting and travel times** for **all** traffic participants significantly

Environmentally oriented traffic management **decrease vehicular emissions**

Increasing V2X equipment rates (above 15%) will **reduce costs for municipalities**

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Thank you for your attention!

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