ABSOLUT

Automated **B**us Shuttle
self-**o**rganising between **L**eipzig and (**u**nd) BMW-**T**erminal

Automated Public Transport

- Automated driving for Public Transport: Motivation and strategic approach of LVB
- Objectives, scope of work, consortium and test tield
- Latest results and outputs
- Conclusions and Perspective

Mario Nowack
Projectlead ABSOLUT

Leipziger Verkehrsbetriebe

Supported by:
Federal Ministry for Economic Affairs and Energy
on the basis of a decision by the German Bundestag

Our Motivations as PTA

More mobility with less traffic

- Higher efficiency in exploitation of public traffic spaces
- Customer-tailored mobility services for better quality of life

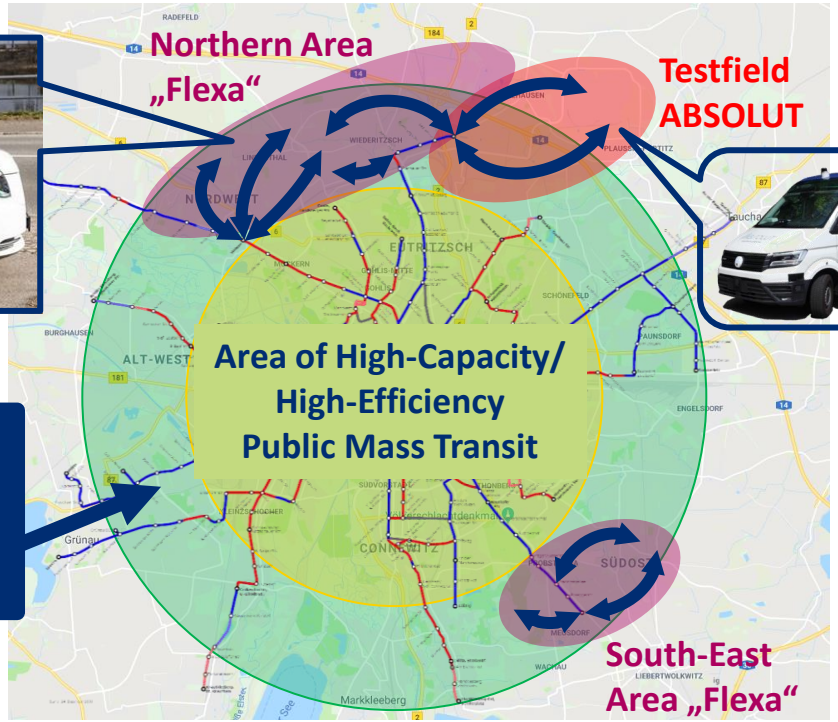
Drive the Traffic turnaround sustainable

- Creating alternatives to private cars and massive robotaxi services

Increase Attractiveness and Market Shares of Public Transport

- Strengthening PT as a main pillar of mobility and desirable employer

Automated Public Transport – The LVB-Approach



Innovative On-Demand-Public-Transport-Services for improved coverage of sub-urban areas

Sources:
https://de.wikipedia.org/wiki/Datei:Tramnetz_Leipzig.svg
https://www.google.de/maps/

Primary Concept – Use Cases derived from Customer Requirements

All-embracing Approach
„Automated Public Transport“
(as an addition to existing services)

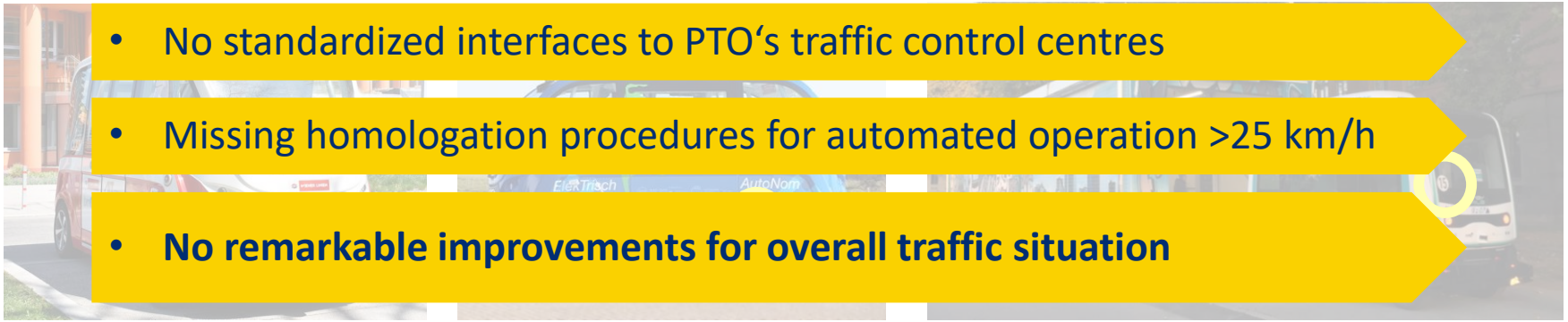
Comfortable and flexible user interfaces and booking channels

Smooth connections to high-performance Public Transport
(via traffic control center)

Safe automated operation
(area-customary speeds, multi-sensor perception, adaptive maneuvre-planning, connection to infrastructure

Available Automated Shuttles

- Vehicle sensor systems do not support object classification
- Very low velocities (< 20 km/h) due to pure collision avoidance
- Simplified track routing adjusted to vehicle‘s capabilities!

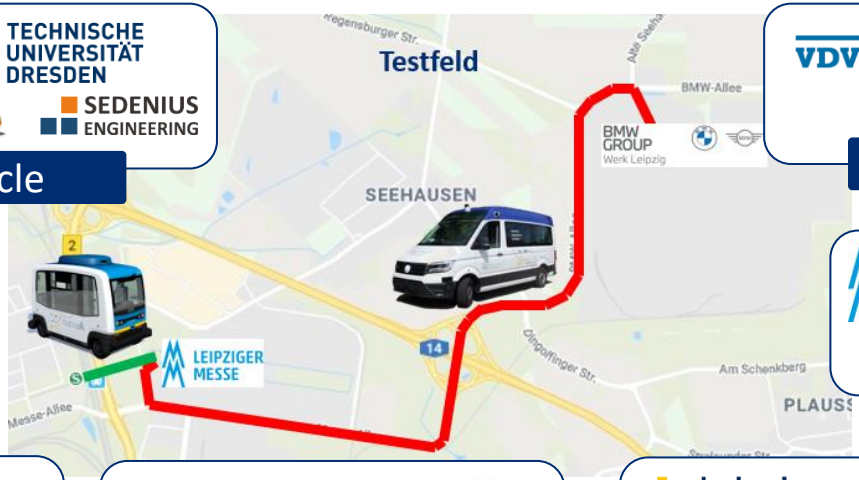


- No standardized interfaces to PTO‘s traffic control centres
- Missing homologation procedures for automated operation >25 km/h
- **No remarkable improvements for overall traffic situation**

Project Summary

Funding Organization:	Federal Ministry for Economic Affairs and Energy, Strategic Individual Project „ICT for Electric Mobility III“
Duration:	January, 1st 2019 – September, 31st 2022
Members:	14 Partners from industry, research and municipality: • 9 active partners with own sponsorship contract • 2 active partners as sub-contractors • 3 associated partners
Consortia Leader:	Leipziger Verkehrsbetriebe (LVB) GmbH

ABSOLUT: Portfolio – Partners - Testfield



Vehicle

Networking

Infrastructure

Associated Partners

Control Center

Homologation

Customer Interface

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Making the eCrafter ready

eCrafter: Homologation done - AD implemented

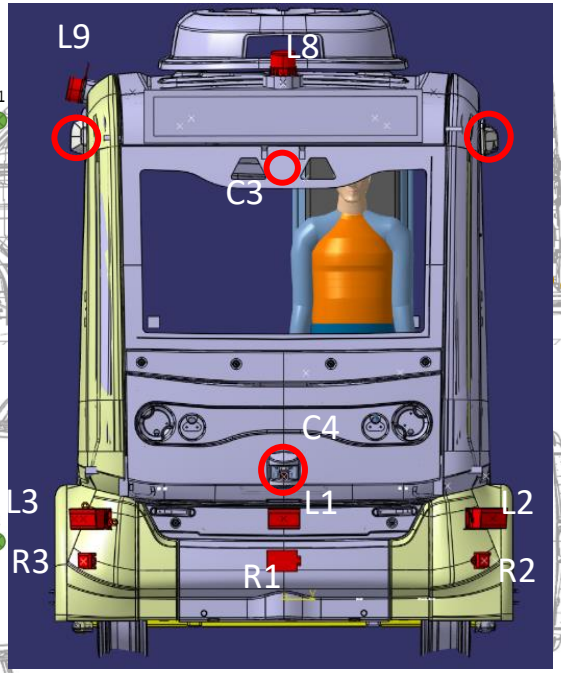
Zulassungsbescheinigung
(Fahrzeugschein)
L-S-0-258/21-0003
Europäische Gemeinschaft
D
Bundesrepu
Deutschland
Amtliches Kennzeichen
L DE29E
1.1 Name oder Firmenname
Leipziger Verkehrsbetriebe (LVB)
Gesellschaft mit beschr. Haftung
1.2 Vorname(n)
1.3 Anschrift
Georgiring 3
04103 Leipzig
Nächste HU (Monat und Jahr) 08.22 LEIPZIG
1 Datum: 15.09.2021
4c Der Inhaber der Zulassungsbescheinigung wird nicht als Eigentümer des Fahrzeugs ausgewiesen.

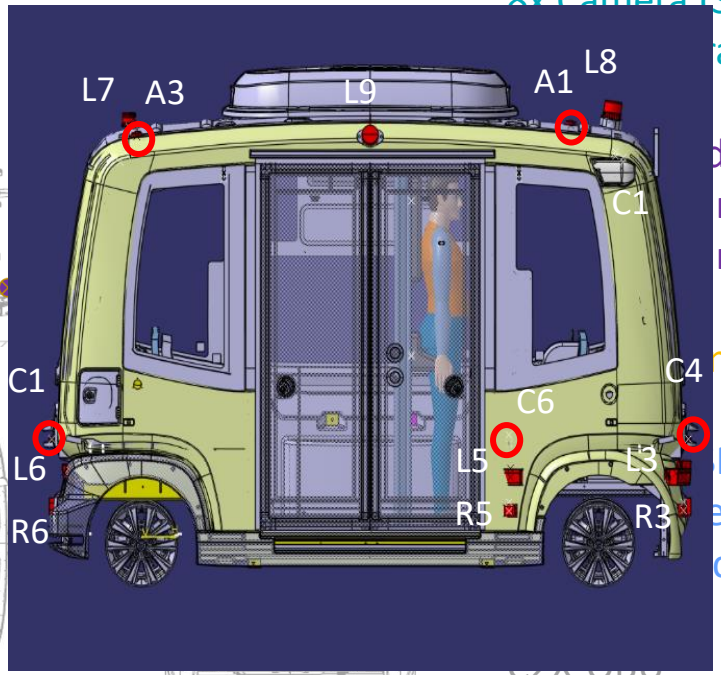
Mehrzweckfahrzeug
715/2007*2016/646ZX
459/2012;reine Elektrofz
Elektro
0004 30ZX -
Batterieakapazität35.8kWh*EZ BIS 31.08.2020 ZULÄ
SN.(§8 ABS.2 EG-FGV)D.KBA VOM 01.10.2019**Fz gi
Erprobungsfahrzeug nach §19(6) StVZO*zu J:Fz.au
et mit Seitenscheiben u.Heckscheiben,mit elektr
etür rechts i.V.m. ausfahrb.Trittstufe*zu S.1:c
resitz,m.4 Einzelsitzen ausgerüstet*Fz ausgerüs
ensorikpaket (9xLidar,5xRad ** SIEHE ALLONGE **
WEISS
e1*2007/46*1613*0
17.08.18 A

Retrofitting the EasyMile EZ10 chassis for higher driving agility

EZ10: Capable for 70 km/h and ready for adding the AD

Multi-Sensor Configuration





Sensors:

8x Camera (Sekonix)

a (Flir)

dar (Ibeo)

re (Ouster)

r (Velodyne)

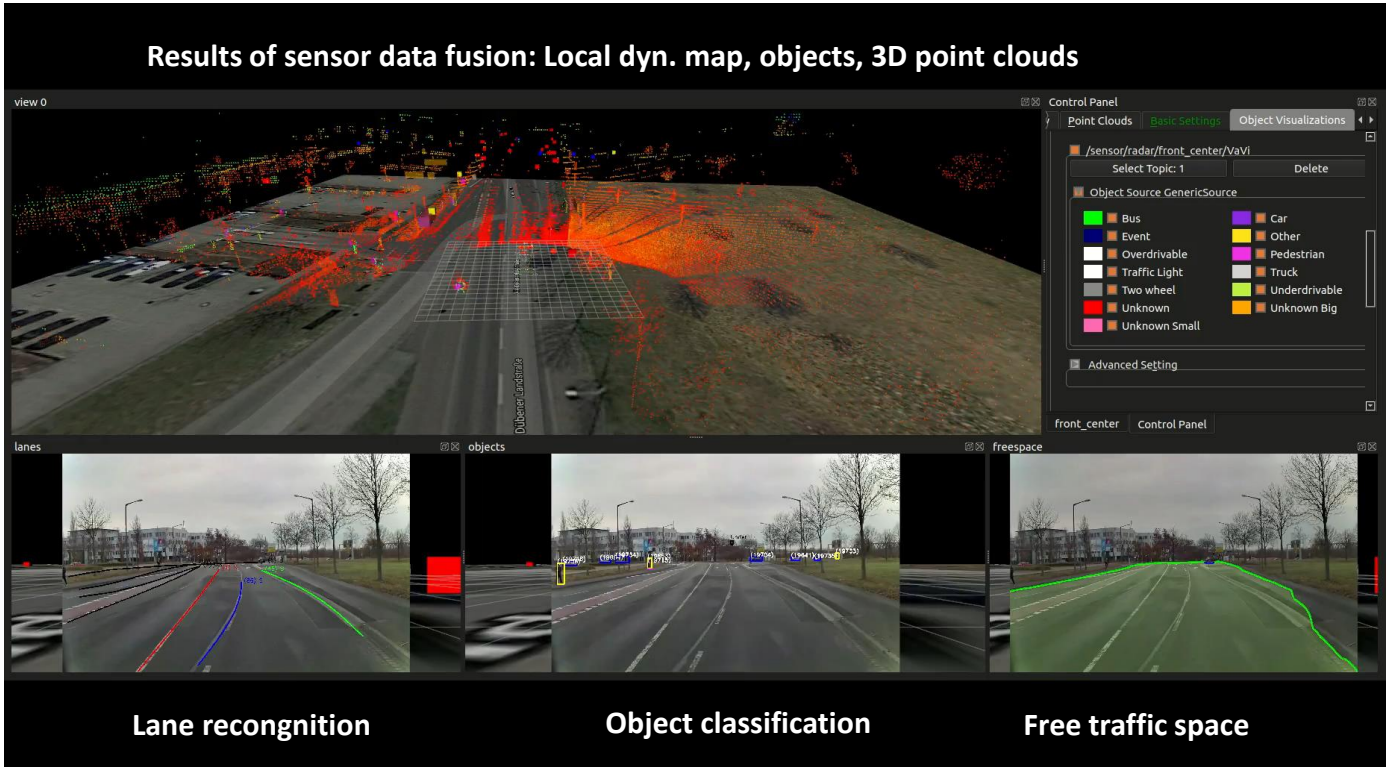
nti ARS)

RTK incl.

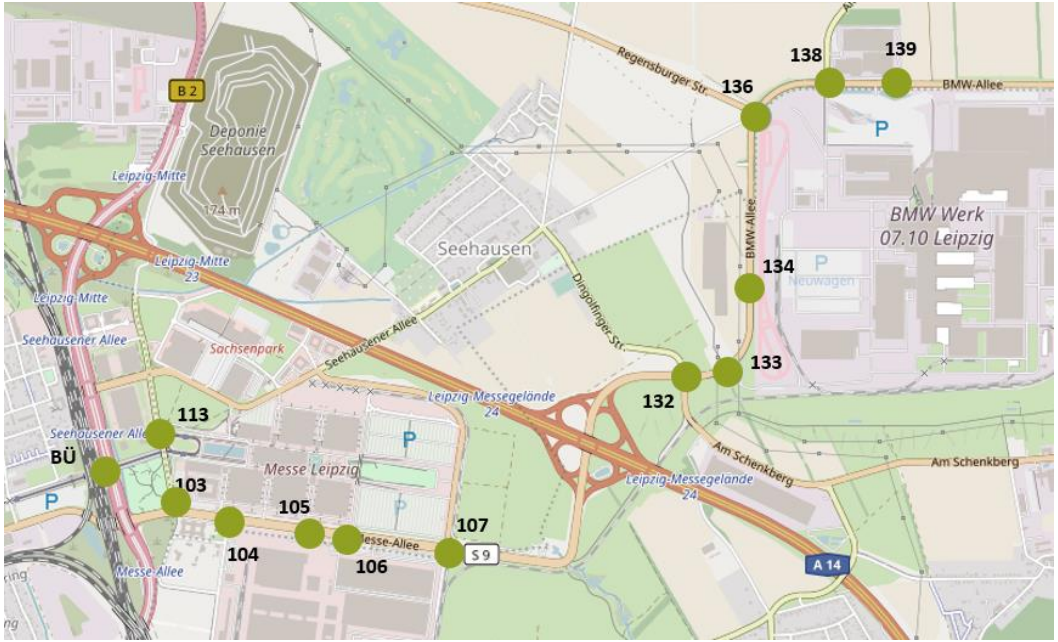
ensor, IMU,

c sensor

Sensor Processing & Data Fusion



Digital Testfield – Northern Leipzig

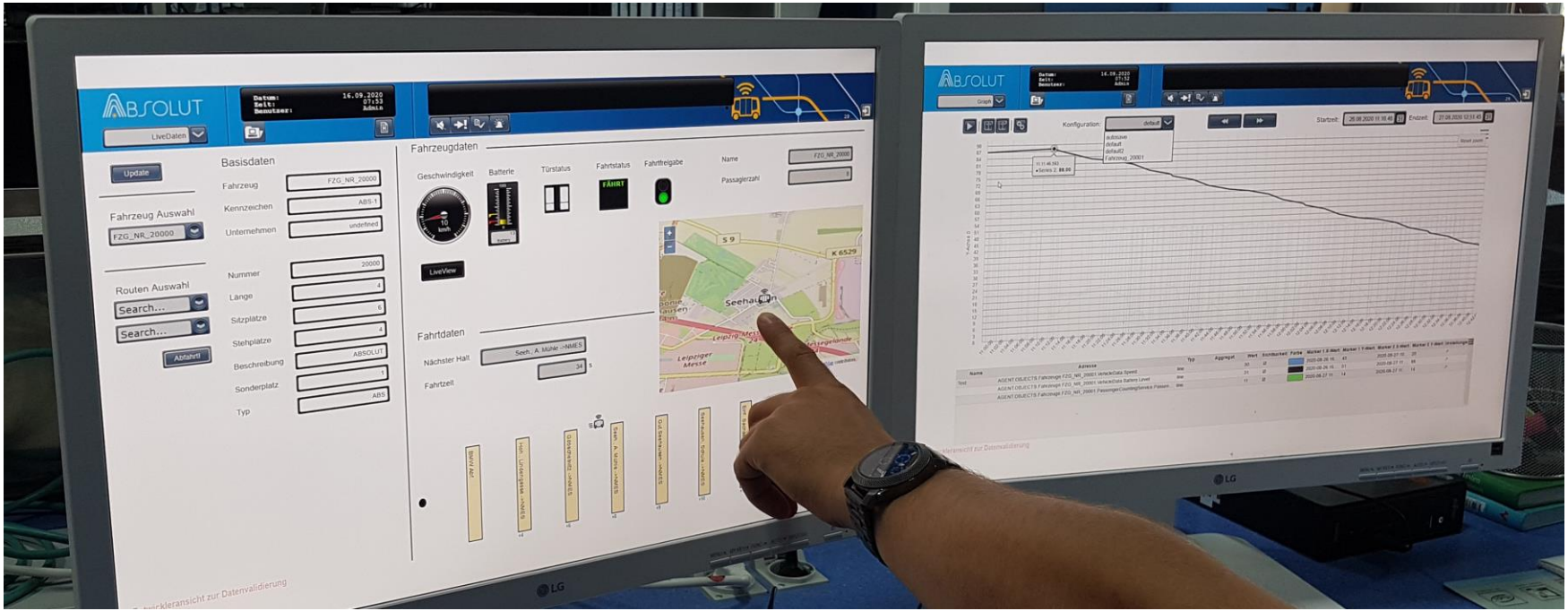


Infrastructure measures:

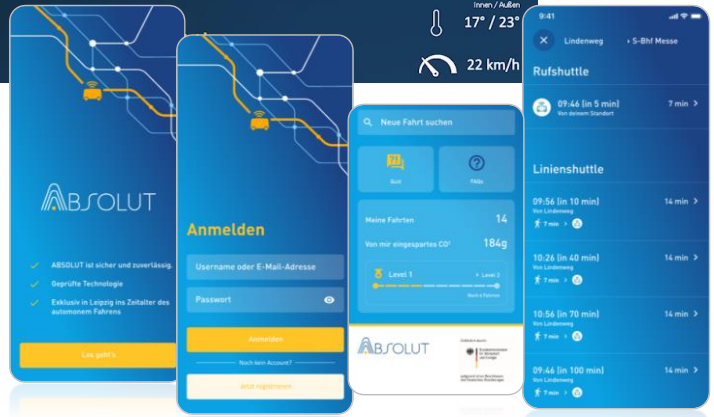
- GNSS-reference station at exhibition centre (correction data to vehicle)
- Adaption of bus stop “Seehausener Allee”
- Upgrading (C2X) of 11 traffic lights and 1 tramway overpass
- Lidar-Reference markers at the Messe turning ramp and BAB 14 underpass
- Supplementary 5G coverage (Tri5G project)

● Traffic lights fully upgraded for C2X

ABSOLUT-Control Center: Graphical Dispatcher Interface



Passenger-Interaction



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How far do we have to go? Special Advantage for Public Transit:

Automatiserungs-Level	Stufe 0	Stufe 1	Stufe 2	Stufe 3	Stufe 4	Stufe 4 ÖV	Stufe 5
Stufenbeschreibung	Keine Automation	assistiert	teilautomatisiert	hochautomatisiert	vollautomatisiert	fahrerlos im spezifischen ÖV-Anwendungsfall	fahrerlos
technische Fahreraufgaben	Fahrer führt dauerhaft längs- **und** Querführung aus	Fahrer führt dauerhaft längs- **oder** Querführung aus	Fahrer muss das System dauerhaft überwachen	Fahrer muss das System dauerhaft nicht mehr dauerhaft überwachen aber potentiell übernehmen.	Kein Fahrer erforderlich im spezifischen Anwendungsfall (bsp. Autobahn-Pilot, Staupilot, einparken)	Kein Fahrer im Fahrzeug im **ÖV-Betrieb auf spezifischer Linie oder im spezifischen Bedienungsgebiet** anwesend	Von **„Start" bis „Ziel"** ist kein Fahrer erforderlich
technische Systemaufgaben	Kein eingreifendes Fahrzeugsystem aktiv	System übernimmt die jeweils andere Funktion	System nimmt L und Querführun einem spezifischer Anwendung			System **kann** im ÖV-Betrieb auf her Linie hen ngsgebi nisch gabe isch en. und wir itstelle v tzt	Das Sy übernimmt Fahraufgabe voll-umfäng bei Straßen-typ Geschwin-digkeitsbere und Un Bedingunge

State of the Art: Driver Assistence in mass production)

Target Public Transit: „Driverless in specific application and area (ODD)"

Target Private Transit: „Fully Autonomous, everywhere" is a MUST

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Automated Public Transport

LVB‘s Strategy Path „Highly-automated Public Transport“

Flexa
Leipziger verbinden.

Ridepooling

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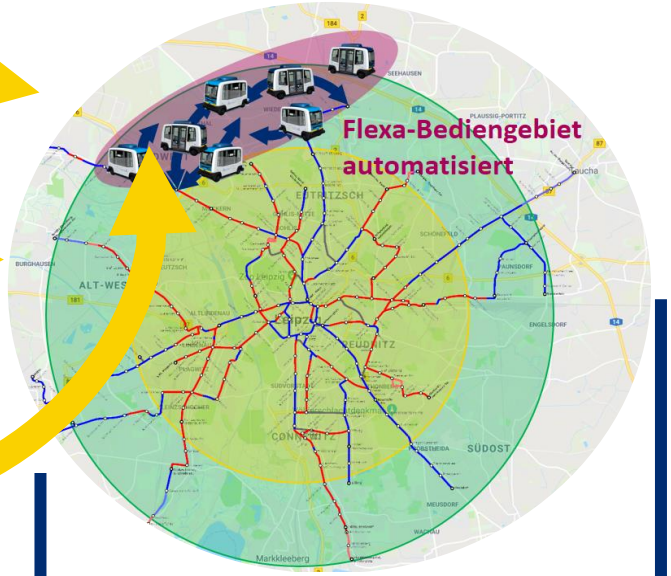
ABSOLUT II

TRI 5G
STRASSE
SCHIENE
LUFT

Remote
Assistance



ABSOLUT

ABSOLUT 2

ABSOLUT-Flexa

What has to be done for „real-driverless“?

- **Homologation for driverless vehicles**
- **24/7 & All seasons/weather driving capabilities**
- **Development of driverless operations** (Remote Operator, service staff, technical support, automated mini-hubs within operational area
- **Transfer of demonstrator vehicles into prototypes**

- **Remote Assistance via 5G**
- (Supervisor at Remote Control Center)
- **Integration of ABSOLUT customer interface into already operational mobility platform „LeipzigMOVE“**
- **Redundancy for vehicle‘s safety and communication systems**
- (mandatory for driverless operation!!)
- **Connecting infrastructure via 5G** (Smart-RSU, Realtime-Updates for local dynamic vehicle map)

Thank you for your kind attention!

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