Digibus® Austria

Austrian flagship project for
automated driving in public transport.

Digibus® Austria - Automated shuttles for the first/last mile in public transport

Thomas Piribauer
PRISMA solutions, Austria

Presentation at CIVINET webinar, May, 19th 2021

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Coordinator

salzburgresearch

Associated Partners

LAND SALZBURG

Partners

virtual vehicle, kapsch, easymile, COMMEND, AIT Austrian Institute of Technology, ÖBB, PRISMA solutions, HERRY Verkehrsanalyse - Beratung - Forschung, Center for Human-Computer Interaction University of Salzburg, BOKU, Fluidtime, FACTUM Mobility - Research - Innovation

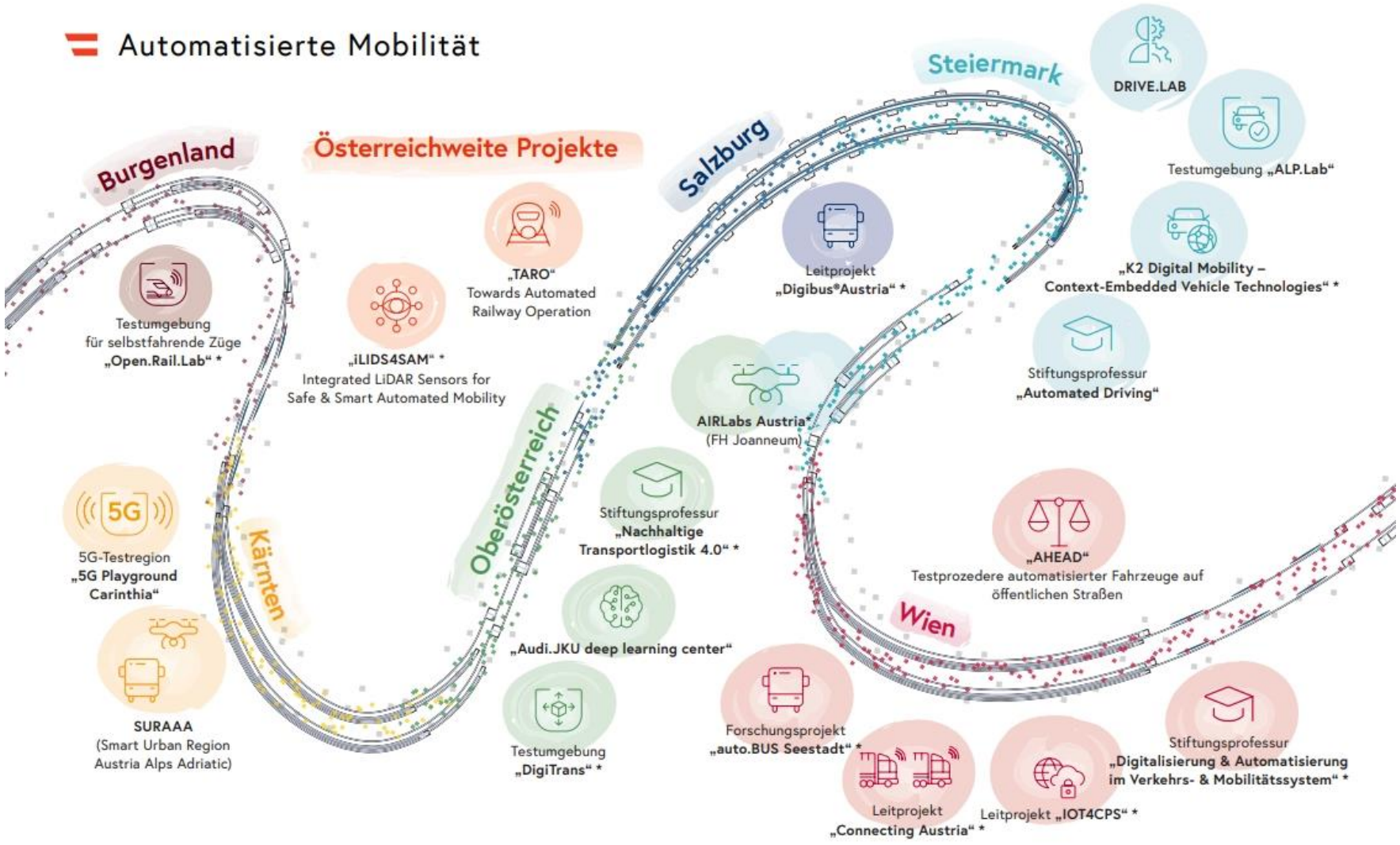
Funded by

Federal Ministry
Republic of Austria
Climate Action, Environment, Energy, Mobility, Innovation and Technology

FFG Austrian Research Promotion Agency

Automated mobility in Austria

Digibus® Austria



* Die aufgelisteten Projekte stellen einen Auszug aller BMK-unterstützten Projekte zur automatisierten Mobilität in Österreich dar. Darüber hinaus unterstützt das BMK eine Vielzahl an interdisziplinären Projekten aus den Bereichen Informations- und Kommunikationstechnologien, Mobilität und Sicherheitsforschung.

Besuchen Sie uns doch auf der Website des BMK zu automatisierter Mobilität!

Federal Ministry
Republic of Austria
Climate Action, Environment,
Energy, Mobility,
Innovation and Technology

Source: https://www.bmk.gv.at/themen/mobilitaet/alternative_verkehrskonzepte/automatisiertesFahren/kompetenzkarte.html

36 Months of Research with the Digibus®

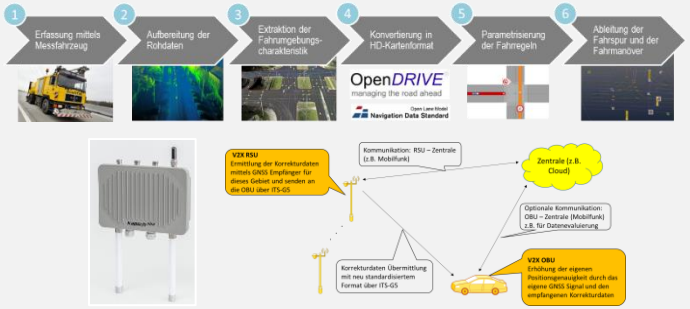
Digibus® Austria

salzburgresearch · AIT Austrian Institute of Technology · virtual vehicle · BOKU · Center for Human-Computer Interaction, University of Salzburg · FACTUM Mobility · Research · Innovation · kapsch >>> · ÖBB · Fluidtime · PRISMA solutions · HERRY Verkehrsanalyse · Beratung · Forschung · COMMEND · easymile

The flagship project Digibus® Austria

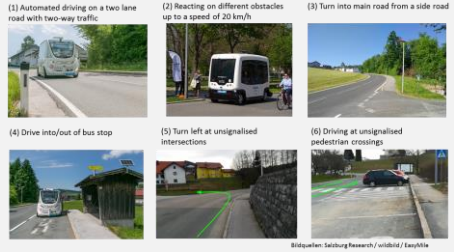
Digibus® Austria

Digital infrastructure & connectivity



AIT Austrian Institute of Technology · salzburgresearch · kapsch >>> · easy MILE · PRISMA solutions

Driving scenarios & interaction with other road users

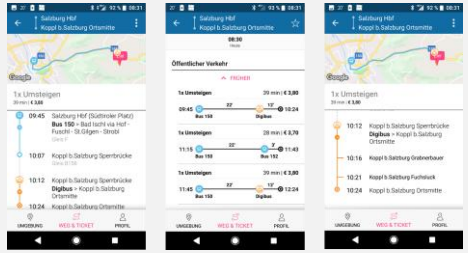


virtual vehicle · Center for Human-Computer Interaction University of Salzburg · FACTUM Mobility · Research · Innovation · easy MILE

Source: Salzburg Research / wildbild

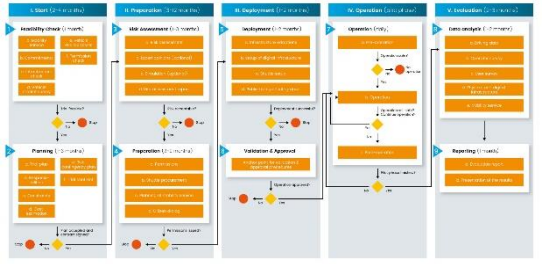
3 years runtime (2018-2021)
13 partners
4.2 million EUR budget

Automated mobility system & passenger interaction



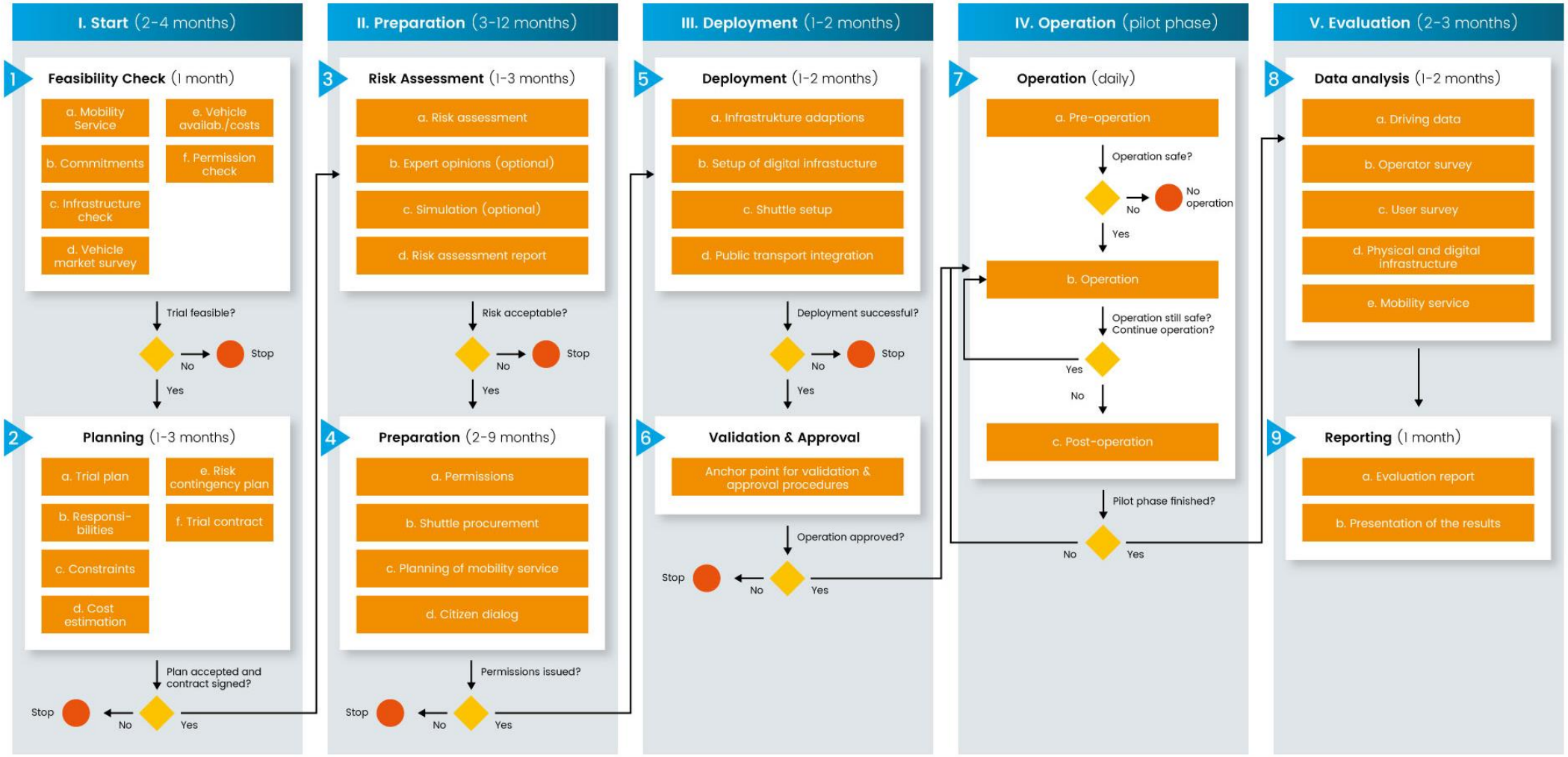
ÖBB · Fluidtime · BOKU · AIT Austrian Institute of Technology · COMMEND

Reference model for deployment & operation of automated shuttles

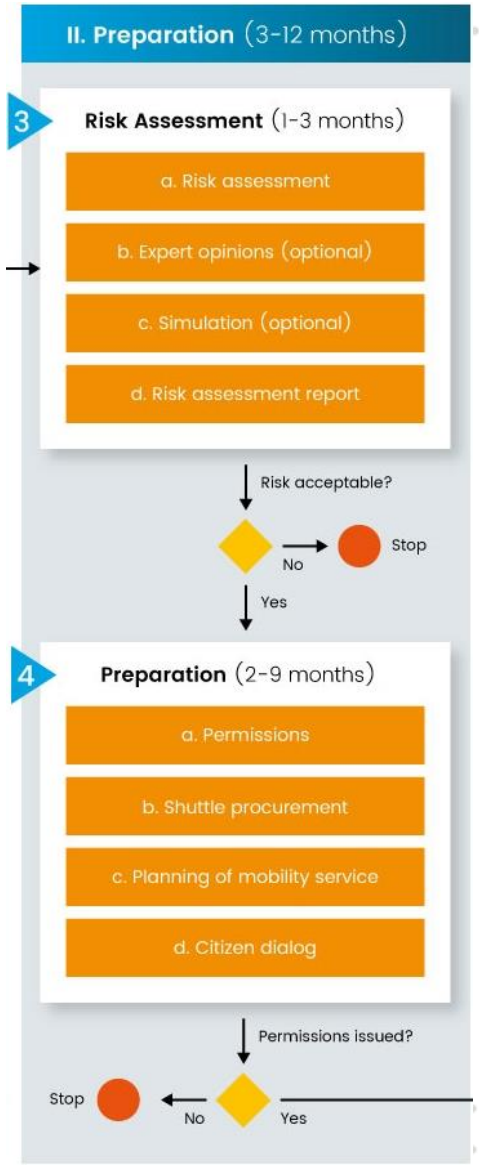


salzburgresearch · HERRY Verkehrsanalyse - Beratung - Forschung · PRISMA solutions

Digibus® Austria Process Model for the Operation/Trial of Automated Shuttles

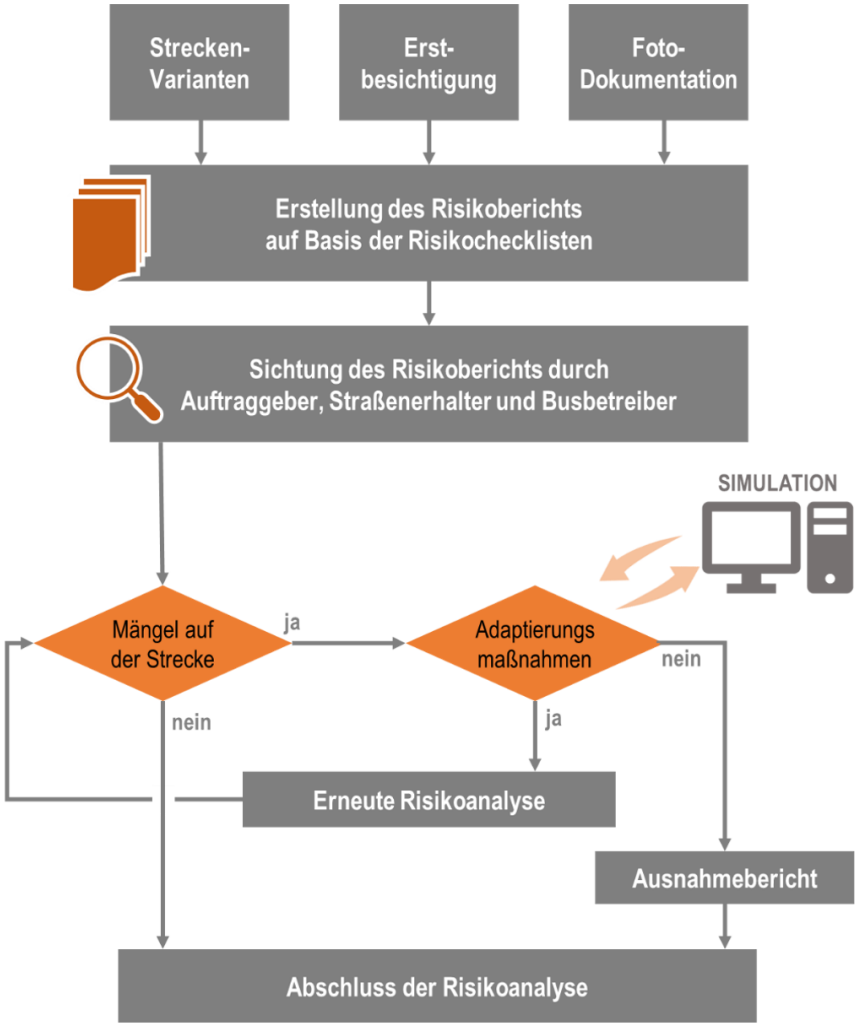


Phase II: Risk Assessment



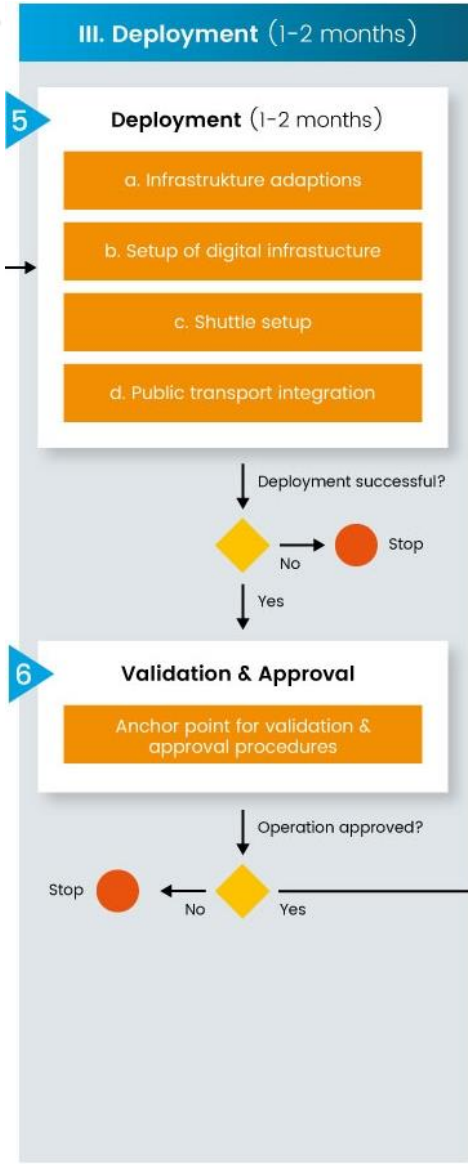
- How can the risk for operating an automated shuttle be systematically assessed?
- How can simulation contribute to virtual risk assessment?

Phase II: Risk Assessment - Method



- Collection of data
  - Selection of route variants
  - Local inspection
  - Photo documentation
- Risk assessment based on risk checklists
  - Definition of risk mitigation measures
  - Optional: Virtual risk assessment for risky route parts (simulation)
- Several iterations if necessary

Phase III: Deployment / Virtual Infrastructure



- How can virtual infrastructure support an automated shuttle?

Phase III: HD Map – Methodology

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Methodology for generating a lane-accurate road model and driving path for automated passenger shuttles

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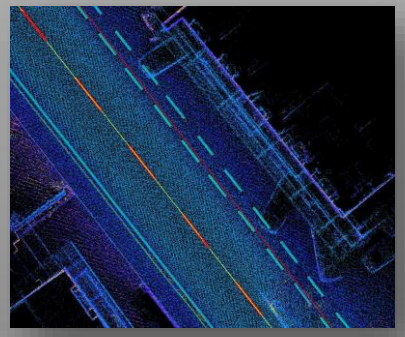
1 Feature catalogue

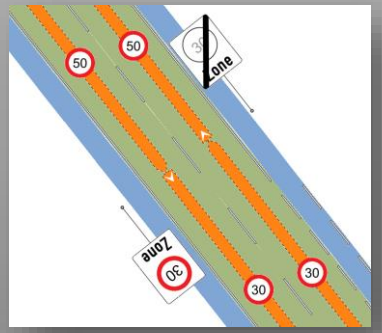
Datenkategorie	Strecken-planung	Risikobe-wertung und Simulation	Fahrun-terstüt-zung [1]	ETSI ITS-GS Map [2]
Verkehrsflächen				
Fahrstreifen	✓	✓	✓	✓
Bushaltestelle	✓	✓	✓	
Gehsteig und Fahrradweg, Fußgängerübergang und Fahrradüberfahrt	✓	✓	✓	✓
Sperrfläche, Grünfläche		✓	✓	
Parkplatz, Parkstreifen		✓	✓	
Abgrenzungen zwischen Verkehrsflächen				
Mittel- und Begrenzungslinie	✓	✓	✓	
Begrenzungsinfrastruktur	✓	✓	✓	
Verkehrsregeln				
Verkehrszeichen	✓	✓	✓	
Stopp- und Haltelinien, Vorrangregeln, Richtungspfeile	✓	✓	✓	✓
Lichtsignalanlage	✓	✓	✓	✓
Infrastruktur				
Tunnel und Brücke	✓	✓	✓	
Leitpfock, Straßenlaterne		✓	✓	
Gebäude		✓	✓	
Andere Objekte		✓	✓	

2 Data collection

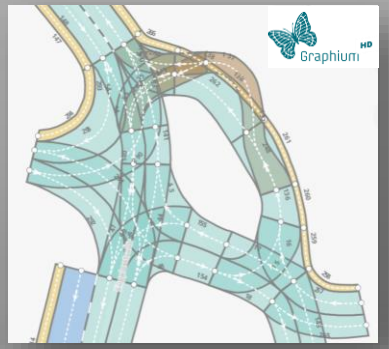
3 Feature extraction



4 Map composition



5 Centerline generation



Phase III: HD Map – Map Composition

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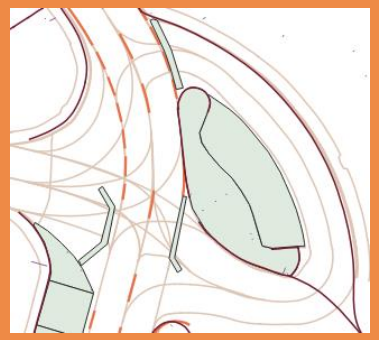
Extracted Features

HD Geometries

(Curbstones and road borders, Road Markings, Objects, …)



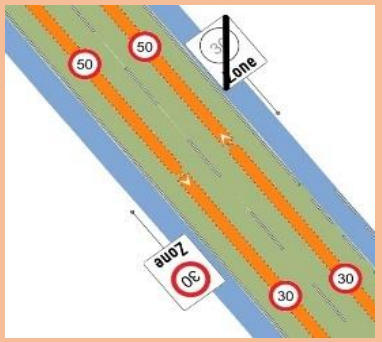
Topological Road Modelling

Roads, cross-sections, intersections

MODAL-X (PRISMA)

Modelling of Regulatory Elements

Speed Limits, Driving Rules, Traffic Signals



HD Map Formats

OpenDRIVE®

https://www.asam.net/standards/detail/opendrive/

ASAM Association for Standardization of Automation and Measuring Systems

Opendrive 2 lanelet

Lanelet2

FZI

Research Center for Information Technology (Karlsruhe)

https://www.fzi.de/

lanelet2 graphium

Graphium

https://github.com/graphium-project

Graphium

Hintergrund Luftbild: © basemap.at

Phase III: Digital Infrastructure / V2X / C-ITS

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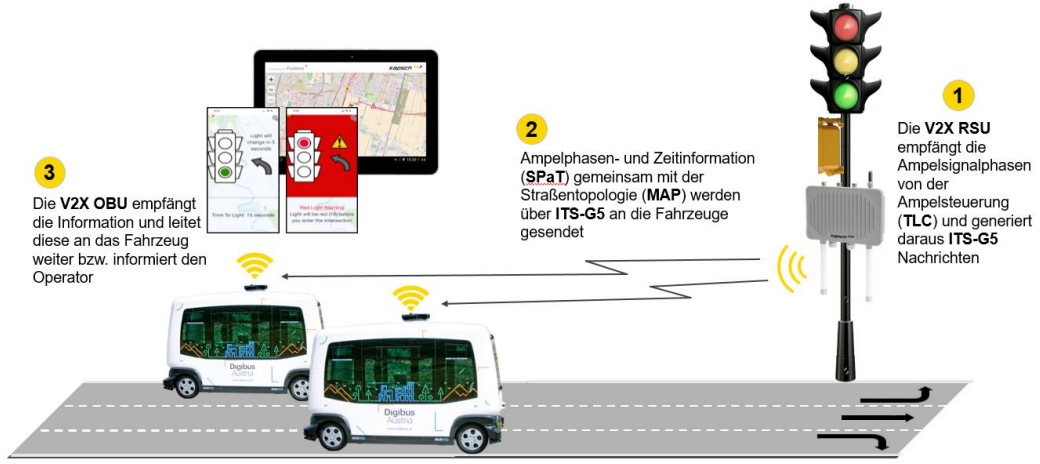
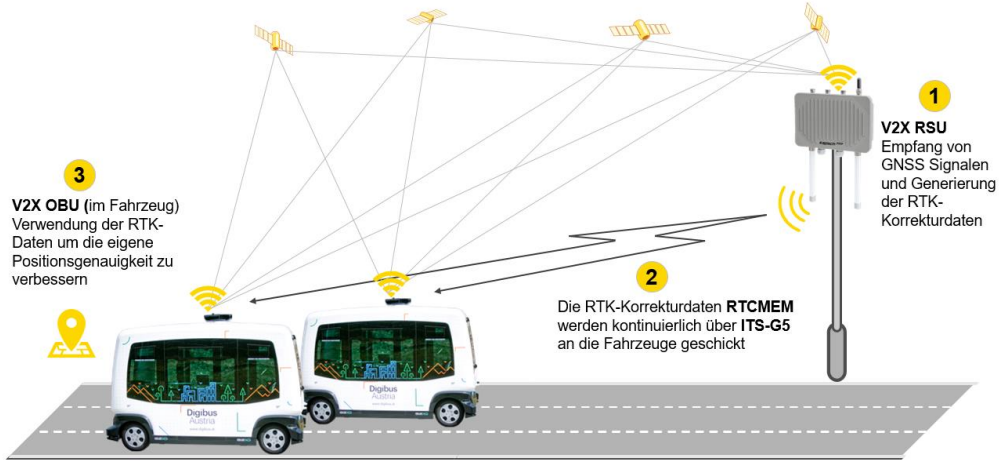
Warnings: ITS-G5 DENM

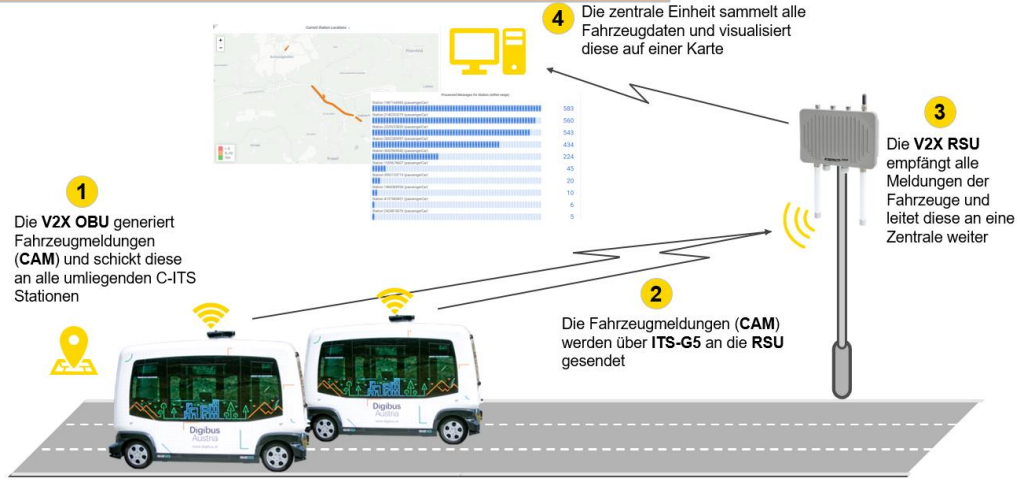
Signal Phases: ITS-G5 SPaT/MAP



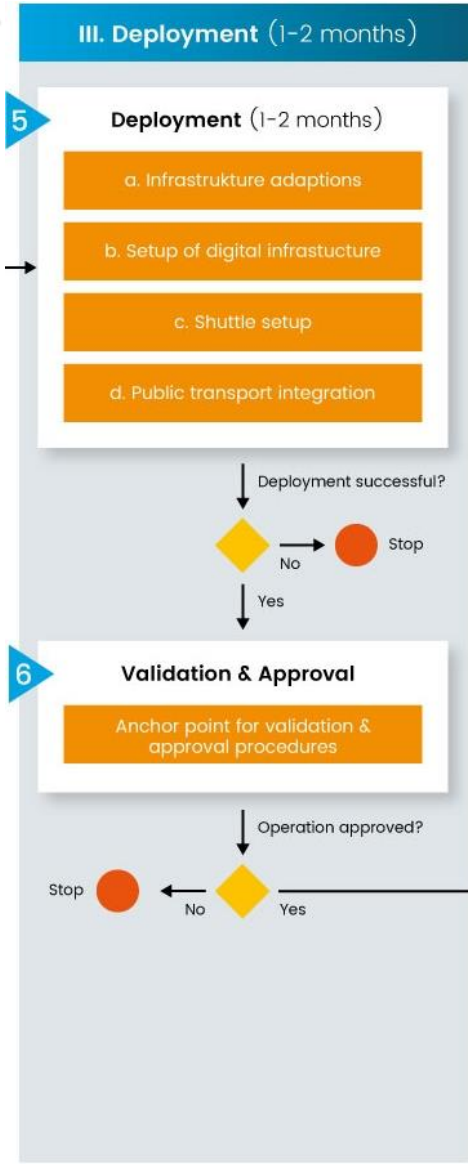
Accurate positioning: ITS-G5 RTCMEM



Vehicle Awareness: ITS-G5 CAM



Phase III: Integration into the Mobility System



- How can an automated shuttle be integrated into a regional mobility system?

Phase III: Integration into the MaaS-App wegfinder

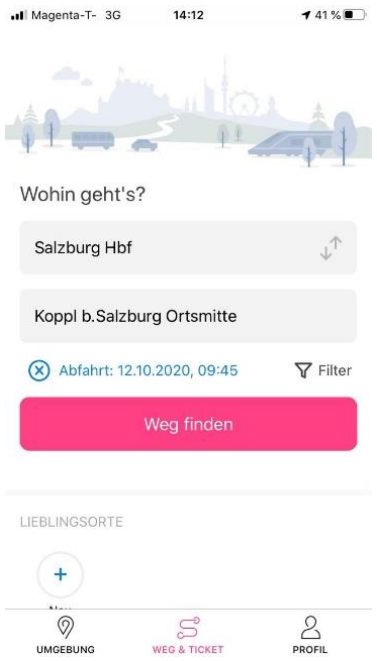
Digibus® Austria

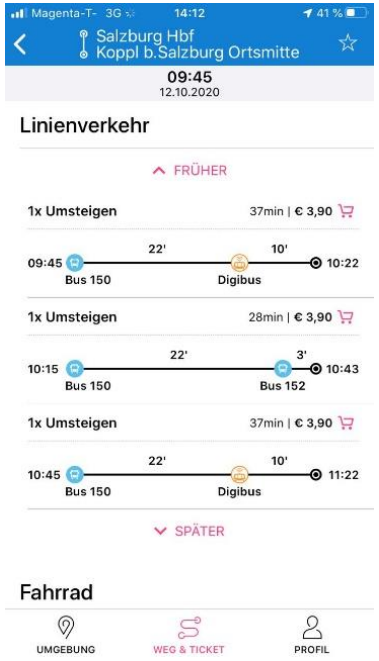
wegfinder

1) Choose start and end to caculate possible routes

2) Digibus® is displayed as part of the routes (overview and detailed view) ©ÖBB

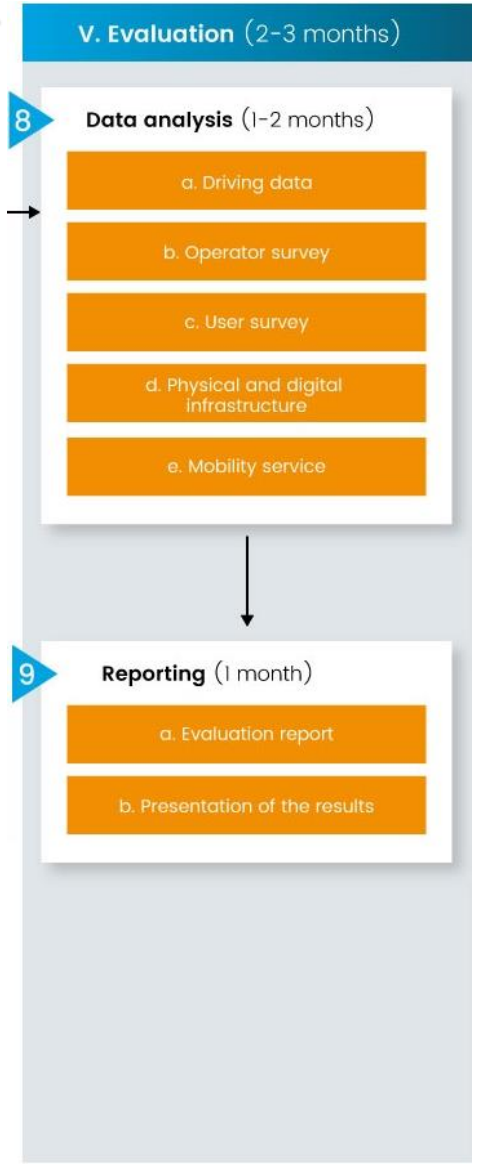
3) Integrated booking of ticket © ÖBB





- ✓ Successful demonstration of the whole digital mobility chain
- ✓ **Real life demonstration** in Koppl 2020 (Connection to regional transport line, operators from Postbus, 7 weeks trial)
- ✓ Integration of realtime-data (ÖBB - ITCS)

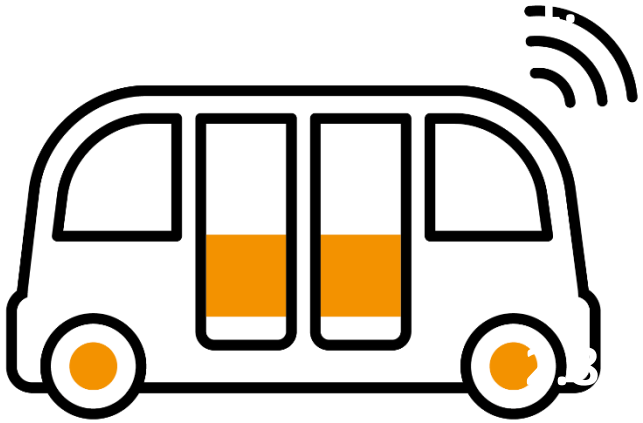
Phase V: Evaluation



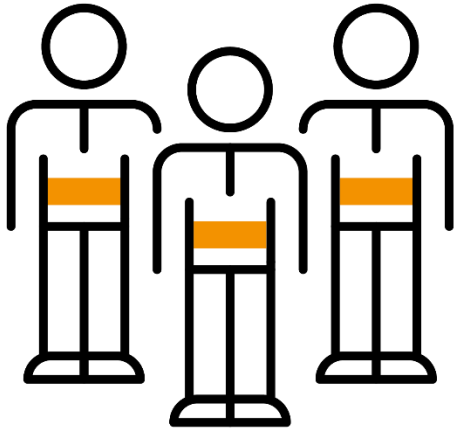
- Which potentials exist for automated shuttles?
- What did we learn from the trials?

Phase V: Real-world Trials

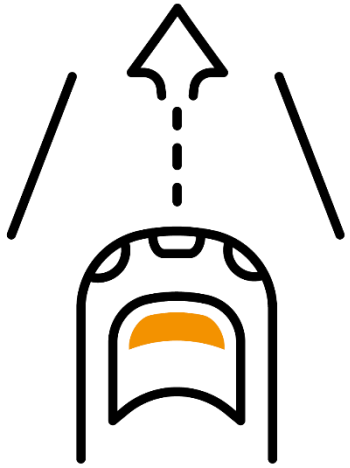
Digibus® Austria



1.423
test drives



2.895
passengers

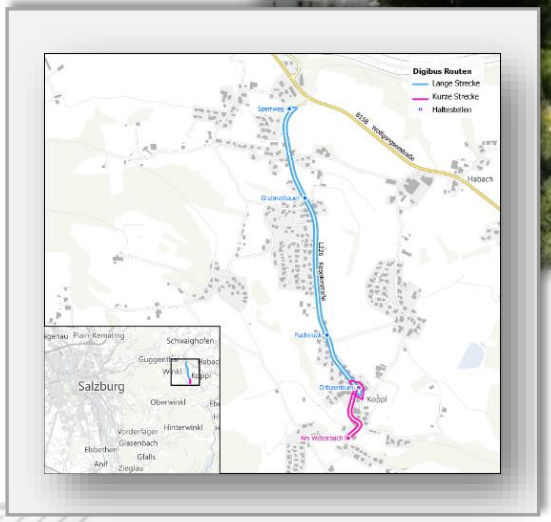


1.290
kilometer

Phase V: Trial on public roads

Digibus® Austria

331 test drives
467 passengers
659 km



2021/05/19

Koppl, Salzburg

Phase V: Trial on public roads

Digibus® Austria

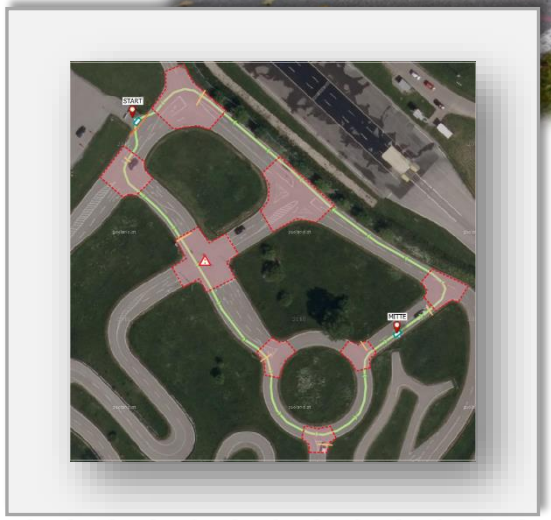
969 test drives
2.243 passengers
620 km

Wiener Neustadt, Lower Austria

Phase V: Trial on non-public test track

Digibus® Austria

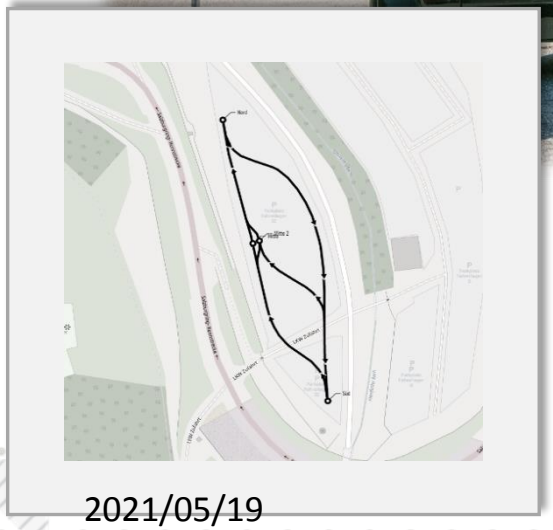
55 test drives
136 passengers



ÖAMTC Drive Center Teesdorf, Lower Austria

Phase V: Trial on non-public test track

Digibus® Austria



68 test drives
49 passengers
10,5 km

Salzburgring, Koppl, Salzburg

Phase V: Trial on private parking site

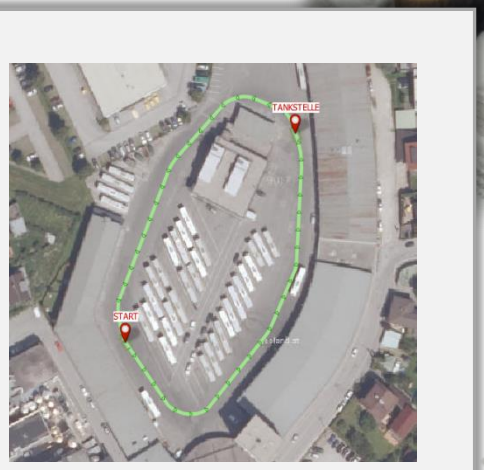
Digibus® Austria

20 test drives
29 passenegers
4,6 km

Private parking of Commend International, Salzburg

Phase V: Trial in bus depot

Digibus® Austria



24 test drives
13 passenegers
7,7 km

Bus depot of Postbus, Salzburg

Phase V: Learnings (condensed)

Digibus® Austria

- Planning/preparation
  - Clear vision and driving factors needed
  - Collaboration of all stakeholders
  - Minimization of risks
  - High personal demand
  - Proprietary methods, missing standards
- Vehicles
  - Prototypes
  - High costs
- Test drives
  - Low speed (< 20km/h)
  - High complexity of driving maneuvers
  - Manual interventions needed
  - Highly demanding for operators
  - Mixed traffic as challenge
  - Challenges from environmental conditions
- Passengers
  - Variety of reactions (enthusiastic to denial)
  - 90% of passenger felt safe (most probably because of the operator onboard)

Phase V: Potentials of automated shuttles

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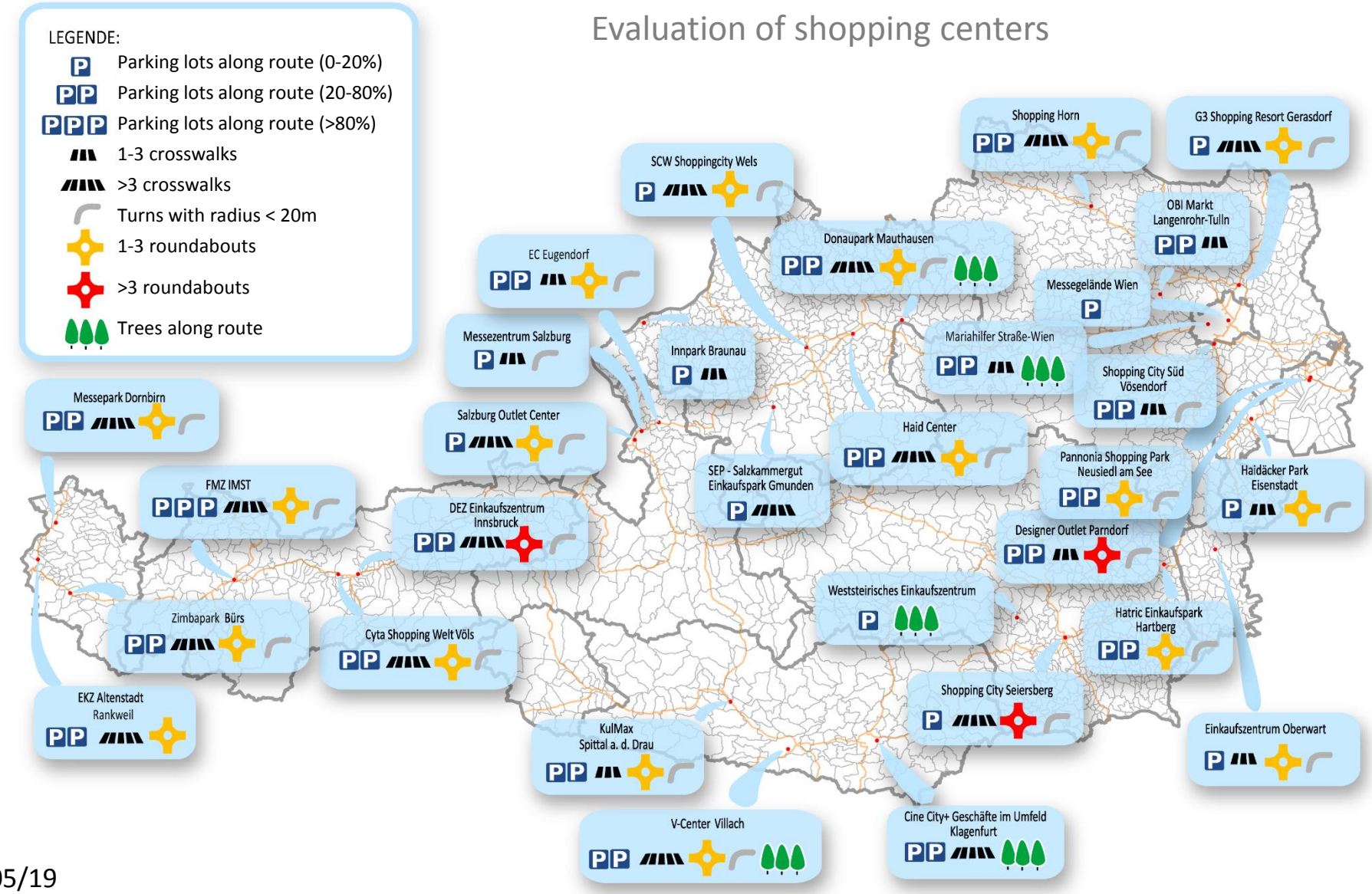
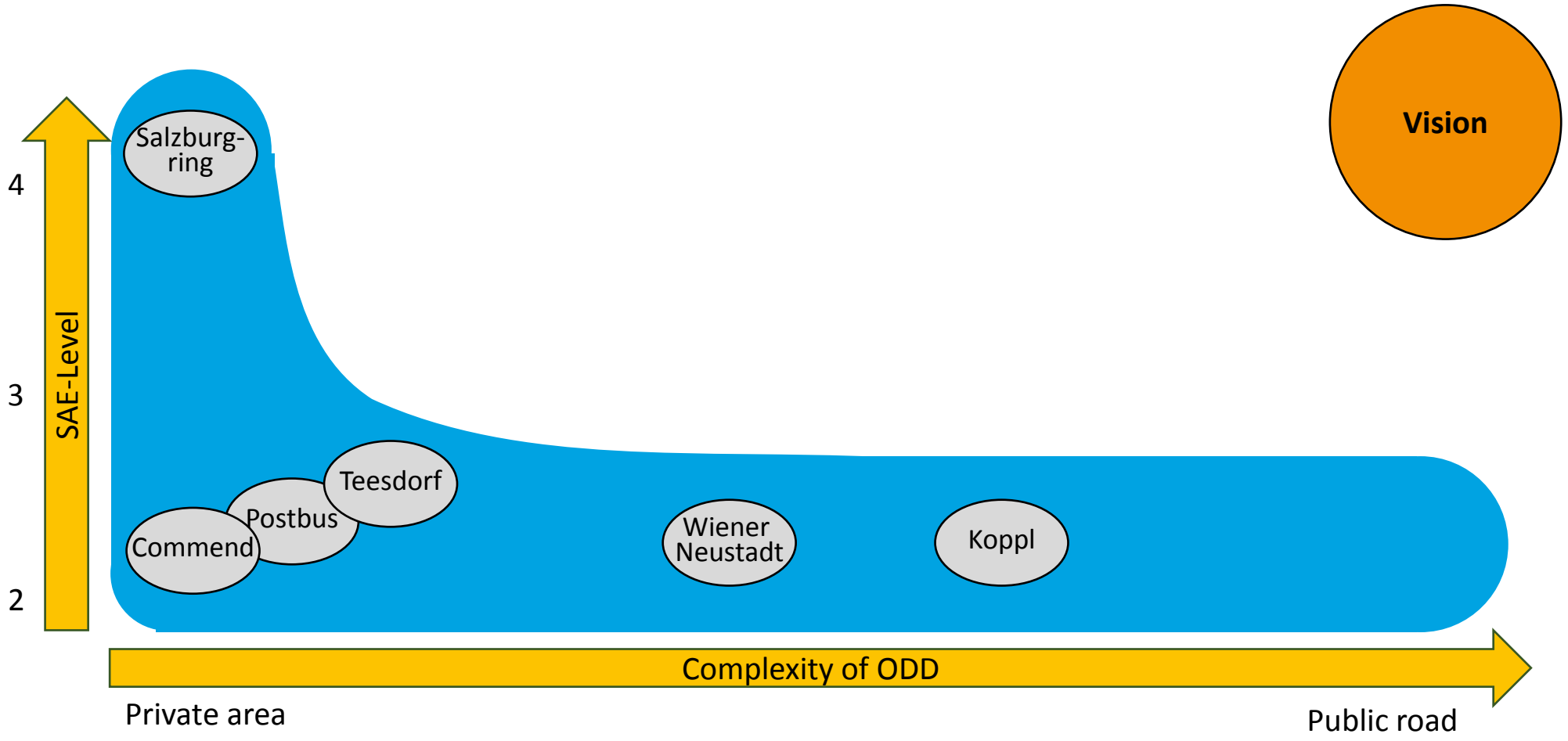
Evaluation of shopping centers

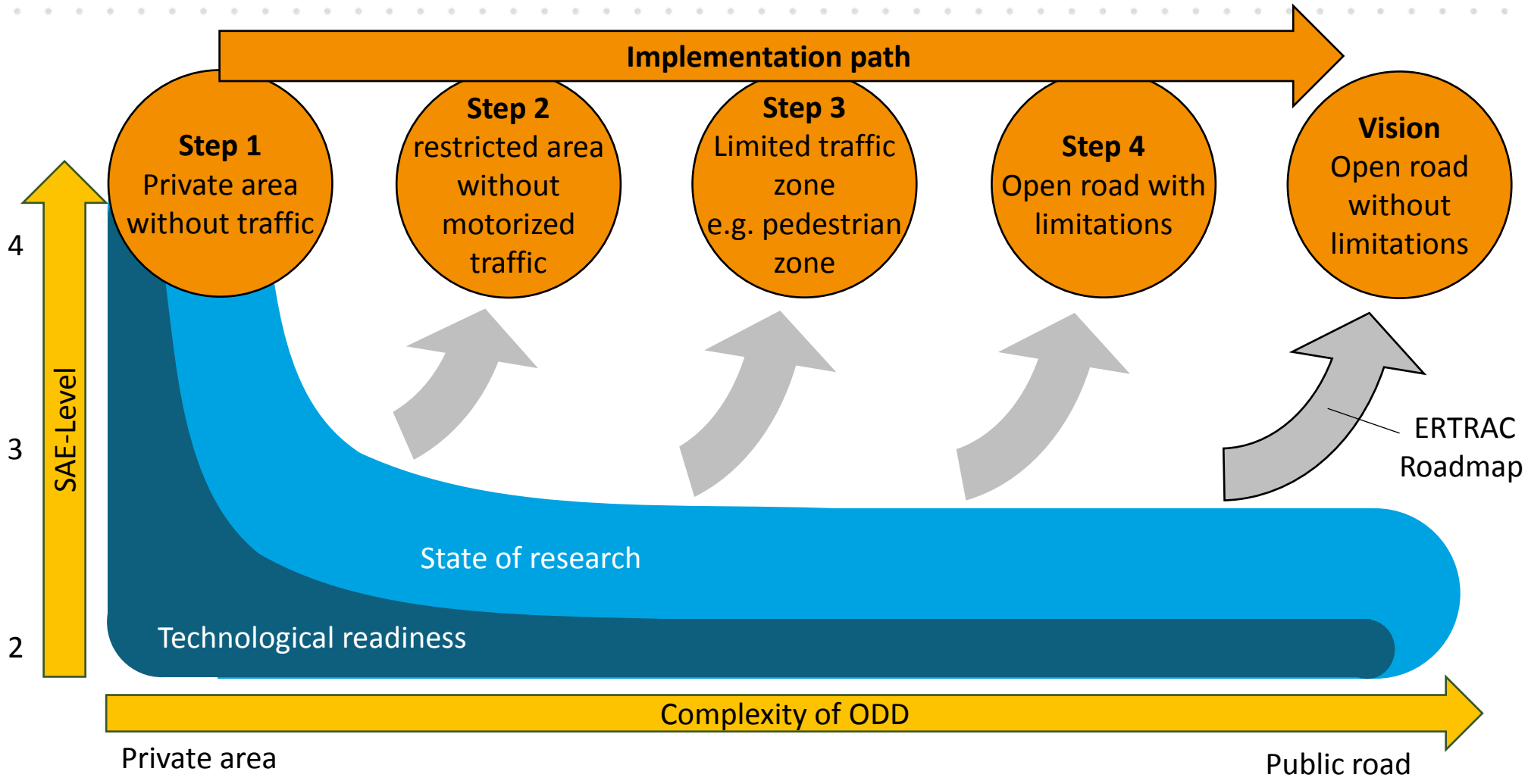


Phase V: The next steps – Vision and Status Quo

Digibus® Austria



Phase V: The next steps – Vision and Status Quo



Results and experiences

https://www.digibus.at/en/results-and-experiences/

Results and experiences

Results from the Austrian flagship project Digibus® Austria incl. predecessor project:

Project Video with Results

Publications

Organisation	Zitat	Konferenz	Download
Salzburg Research	Cornelia Zankl, Karl Rehrl (2018): **Digibus 2017: Experiences with the first self-driving shuttlebus on open roads in Austria.**	Paper und Vortrag bei Transport Research Arena (TRA) in Wien, Session: Automated Transport: Concepts, Applications, Results	Siehe Seitenende
Salzburg Research	Rehrl, K., Zankl, C. **Digibus©: results from the first self-driving shuttle trial on a public road in Austria. Eur. Transp. Res. Rev. 10, 51 (2018).**	Paper publiziert bei ETRR (European Transport Research Review) als eines der Top paper der TRA	HTTPS://DOI.ORG/10.1186/S12544-018-0326-4
Salzburg Research	Rehrl, K. (2018): Special Interest Session; **"EU SIS23 Deployment of autonomous shuttles on public roads Experiences from five different countries".**	ITS World Congress 2018, Copenhagen	[coming soon]

Digibus® Austria

Austrian flagship project for **automated driving** in public transport.

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salzburgresearch

Associated Partners

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Bundesministerium Verkehr, Innovation und Technologie

FFG