Central system for supporting automated vehicle testing and operation

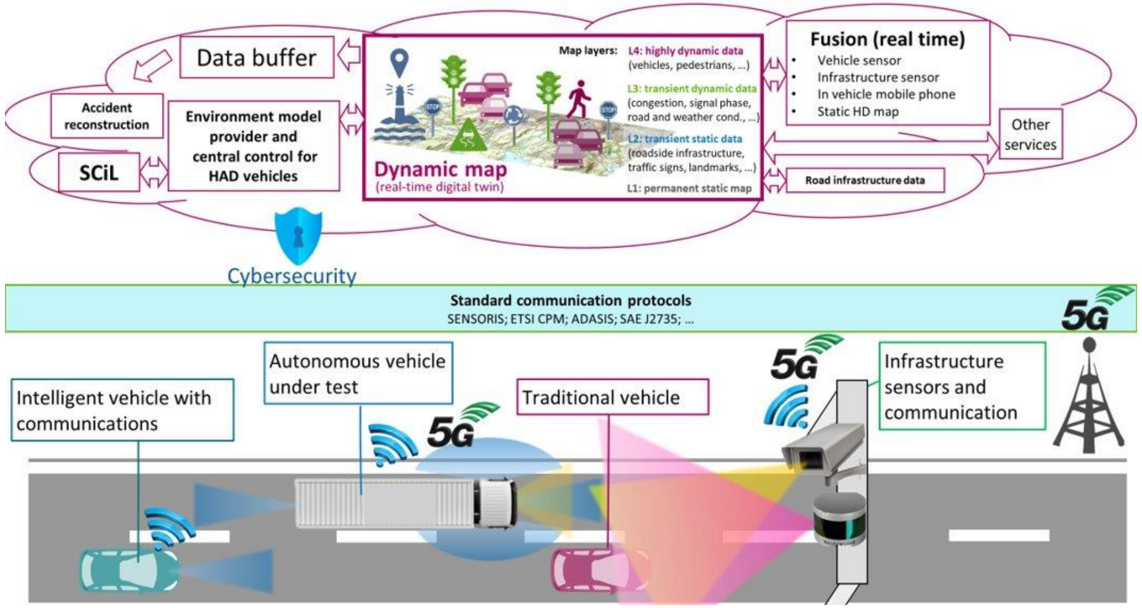
BME
AUTOMATED
DRIVE

Dr. Viktor Tihanyi
20.04.2023

Project vision

Central System Features

- Real time digital world model including
  - Static 3D map
  - Low dynamic information (road works, weather, traffic..)
  - High dynamic information, vehicles, pedestrians…
- Central, real time fusion combining in vehicle and infrastructure sensor set
- Data record buffer
  - Supporting automated vehicle testing
  - Accident reconstruction support
  - GDPR compliant solution
- Using international standards for overall system (OpenDrive, Sensoris, Adasis..)
- Supporting automated vehicles (first testing and later operation) with real time environment data
- Ability to control automated vehicles and infrastructure elements (e.g. traffic lights)
- Supports mixed reality testing
- Cloud based scalable, distributed system

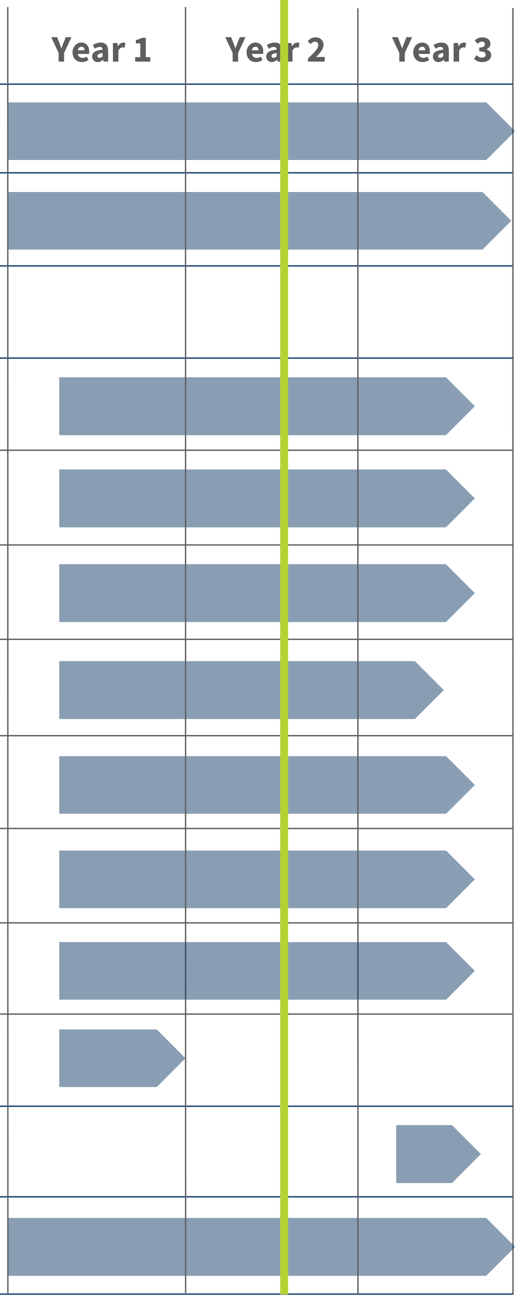


Project partners – phase 2

Hungary		Austria	
Műegyetem 1782	Eureka & Hungarian flag – Lead	TU Graz – Graz University of Technology	Austrian flag – Lead
BOSCH		virtual vehicle	
Magyar Közút	Test region support: ZalaZONE	Joanneum Research	Test region support: ALP.Lab
Budapest Közút		TU Wien – Technische Universität Wien, Vienna | Austria	
Magyar Telekom		STARD – Advanced Research and Development	
BIMFRA		TOM ROBOTICS	

Workpackages, schedule

Workpackage	Lead partner
WP1 Project management	MŰEGYETEM 1782
WP2 Requirement management, specification	BOSCH
WP3 Technical development	
WP3.1 Central system core	MŰEGYETEM 1782
WP3.2 Static UHD map	JOANNEUM RESEARCH
WP3.3 Cloud control	TU WIEN TECHNISCHE UNIVERSITÄT WIEN Vienna | Austria
WP3.4 Simulation	TU Graz Graz University of Technology
WP3.5 CAV test and integration	BOSCH
WP3.6 5G communication	T Magyar Telekom
WP3.7 Traffic control	MAGYAR KÖZÚT
WP4 Infrastructure improvement	MAGYAR KÖZÚT
WP5 Demonstrations	MŰEGYETEM 1782
WP6 Dissemination and exploitation	MŰEGYETEM 1782



R&D and infrastructure project roadmaps

System R&D and exploitation

2020

Exploratory project (AT-HU)

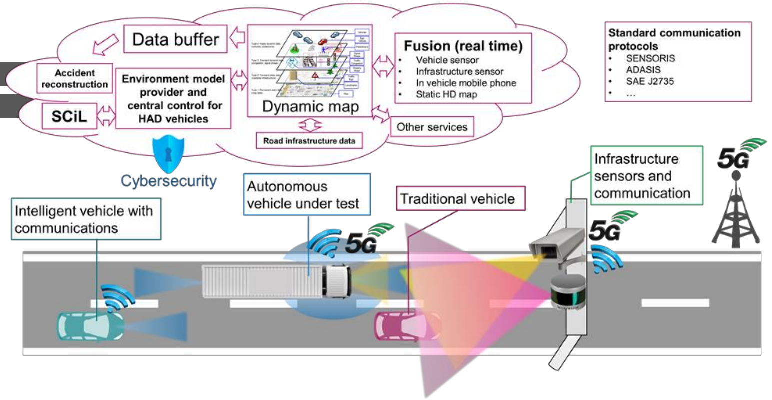
- Measurement campaign
- Functional sample
- State of the overview
- System architecture definition

2021-2024

Follow up project (AT-HU)

Target:

- Realization of system
- First services



2024- Expanded services and R&I infrastructure support

Build up infrastructure (HU)

2020

Small scale flexible installation

- M86 campaign
- BME campus

2023

M1-M7, ZalaZONE

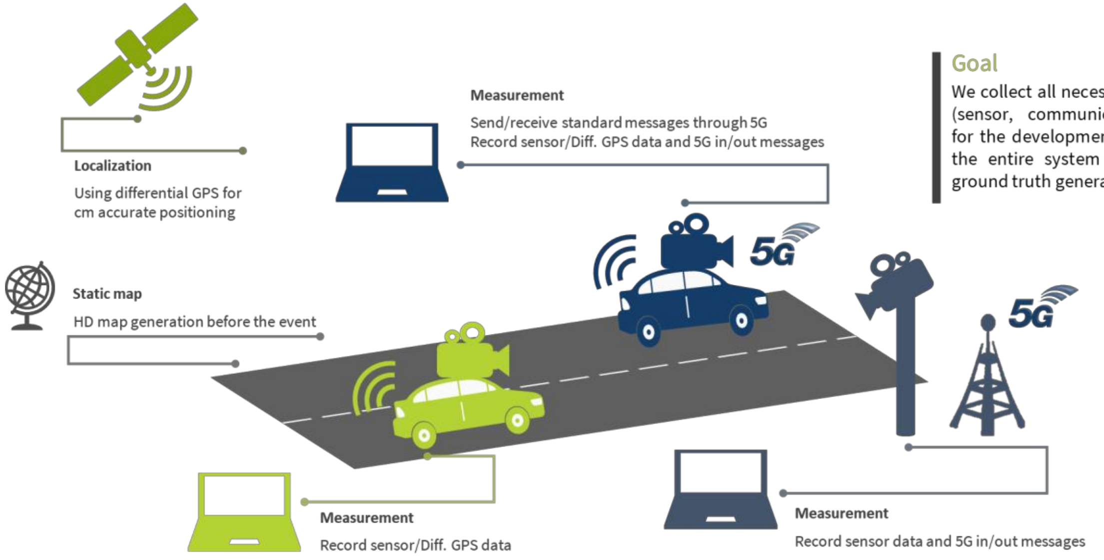
- M1-M7 common section
- ZalaZONE fix and flexible infrastructure

2024- Further locations

Results

Existing results from phase 1 (2020)

Measurement campaign



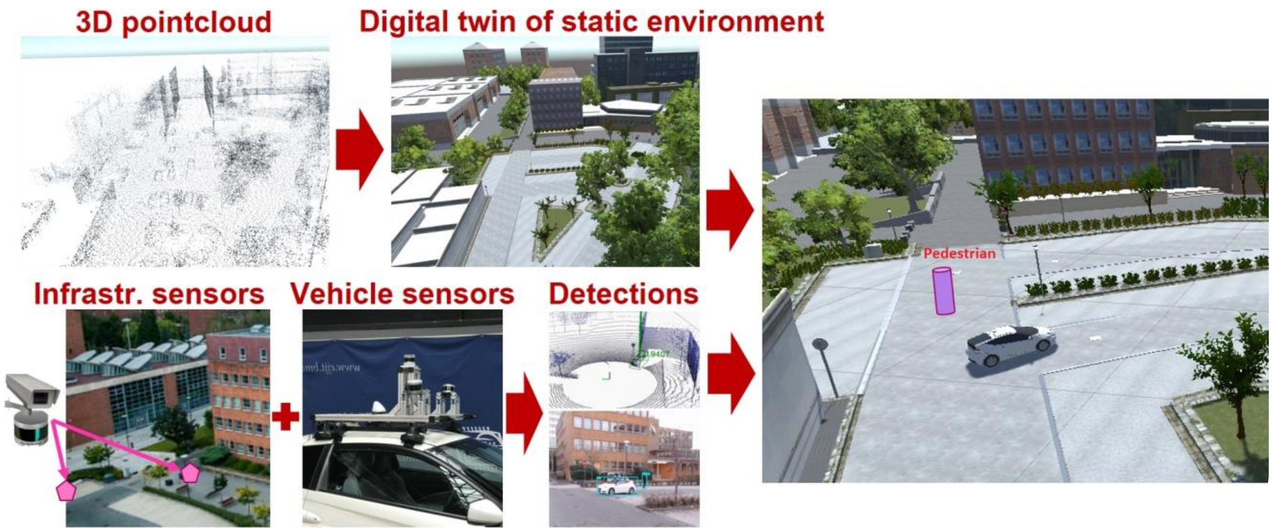
Goal

We collect all necessary information (sensor, communication network) for the development process about the entire system with automatic ground truth generation


index

Magyar úton készülnek fel az önjáró autók hadára

Functional prototype – collaborative perception



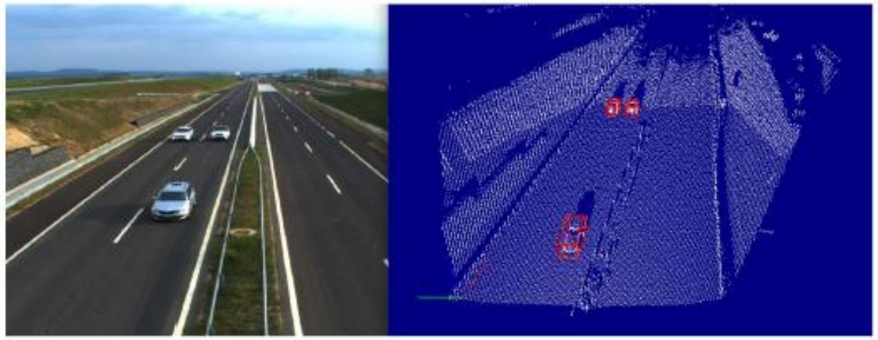
Implementation done

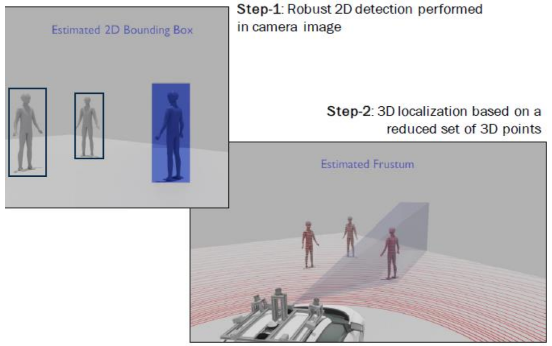
https://youtu.be/gzYuXbttmuU

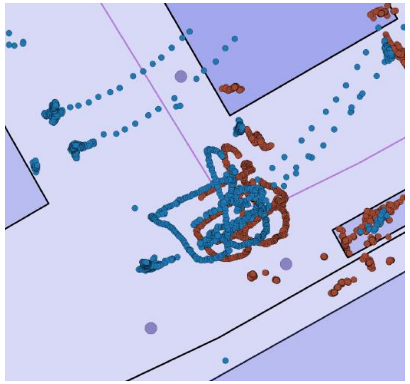
Existing results from phase 2

Central system core and perception

Perception development results

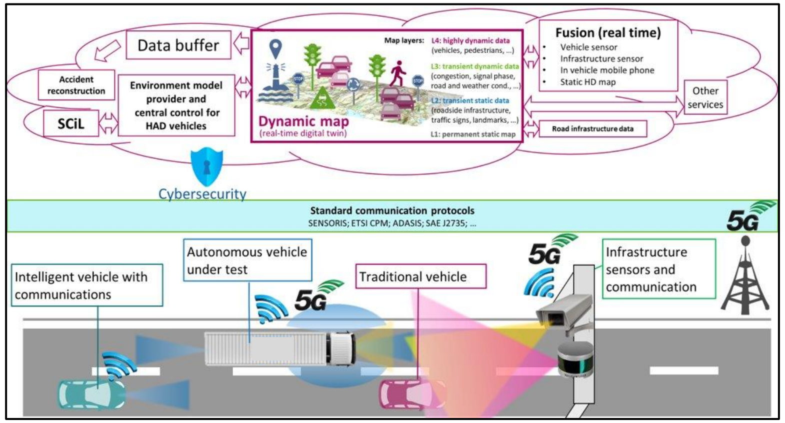






Central system cloud SW development

- **Supported information exchange**
  - Exchange raw data, Exchange localization data, Exchange detections data, Exchange control data, Exchange monitoring data, Exchange traffic light control data, Exchange mission data
- **Supported standards:**
  - SENSORIS, ETSI CPM, ASAM OSI export (soon interface)
- **Supported data integration:**
  - Object-level sensor fusion, Map-based fusion (started), Situational awareness (geofence entry)
- **Supported autonomy functions:**
  - Teleoperation, Cloud Control (path planning), Decision support layer



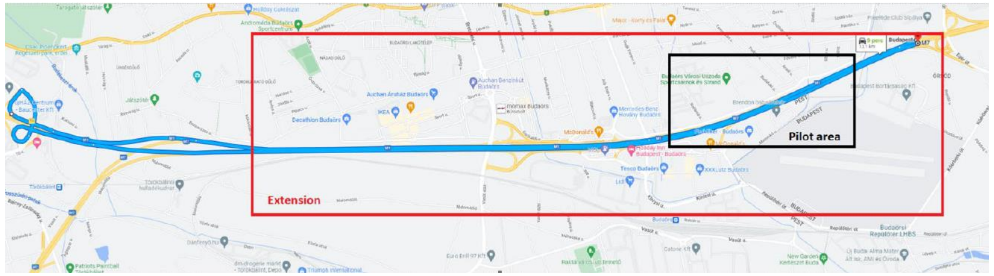
Supported communication:
DSRC radio
4G / 5G
Redundancy necessary

- **Supported async API-s:**
  - gRPC, Python, Matlab/Simulink, C#, C++
- **Supported synchronous API-s:**
  - Goalpoint server
- **Supported robotic platforms:**
  - RTMaps-based perception systems, AB Dynamics steering & pedal robots, iMAR dGPS+IMU localization units
- **Supported HMI:**
  - Unified visualization apps (refactored), Monitoring & diagnostics (hiring)
- **Internal architecture:**
  - Messaging fw. Independence, Process and data model

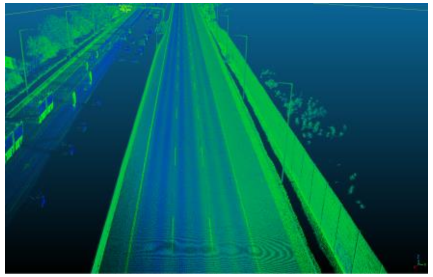
Existing results from phase 2

Static UHD map

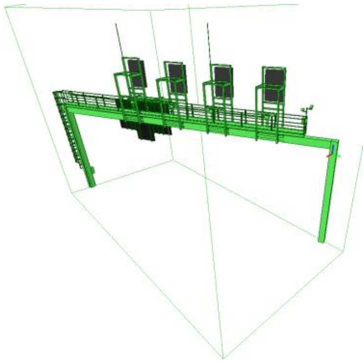
Mobile mapping of M1-M7

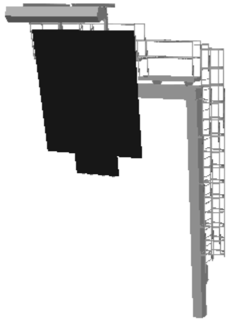


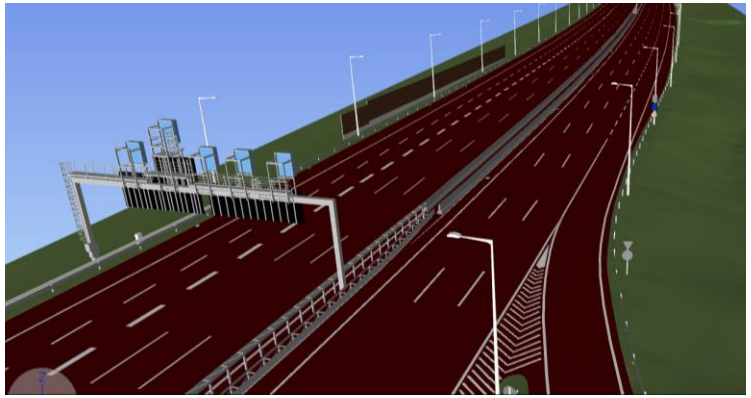
Automated UHD map creation workflow



3D reconstruction



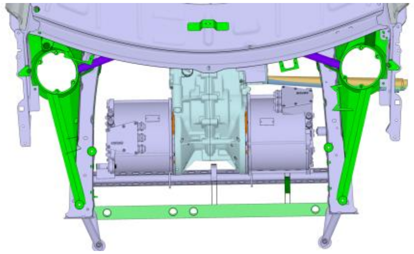


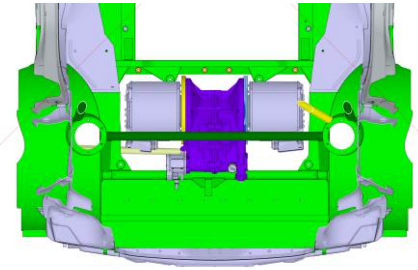


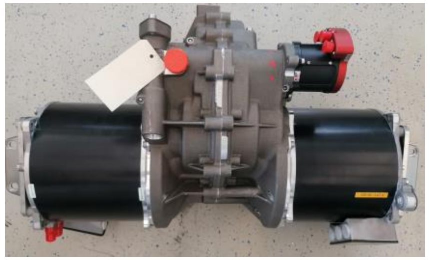
Existing results from phase 2

Cloud control

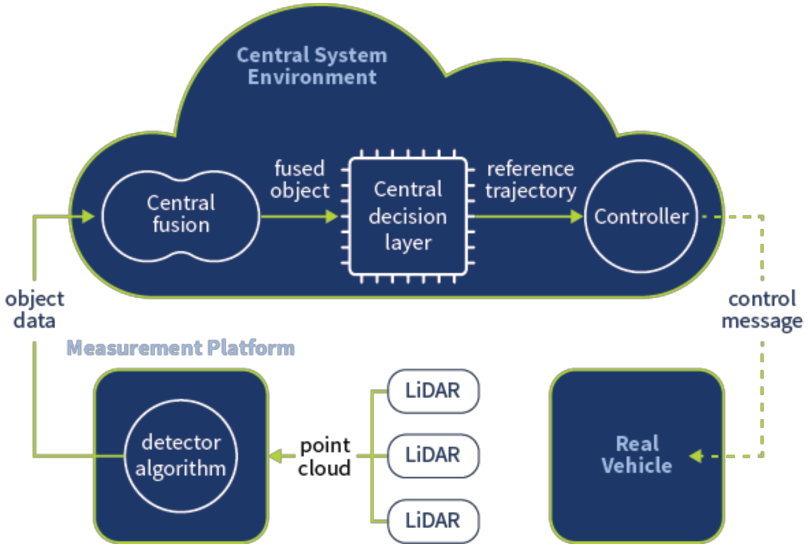
Vehicle platform development

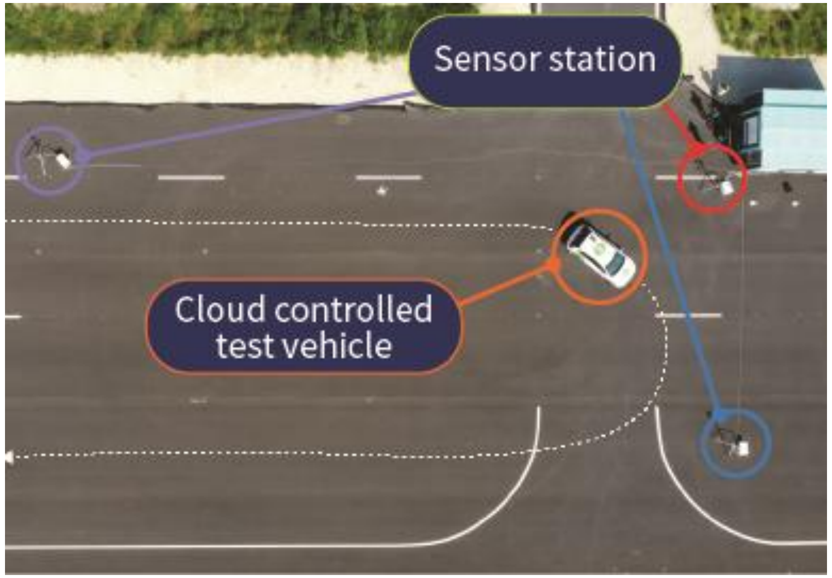


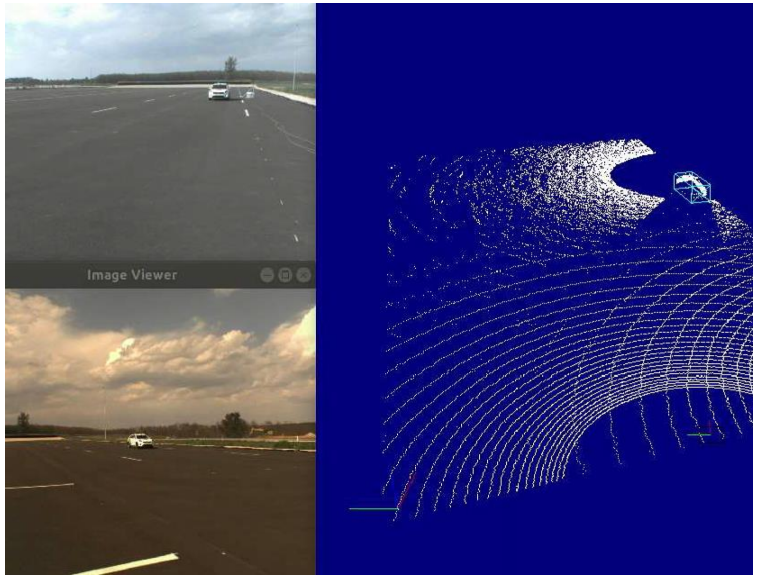




Functional tests of cloud based control







Existing results from phase 2

Simulation

- Digital twin of selected test site

- Vehicle dynamics
- Vehicle control
- Sensor suit

Environment Model

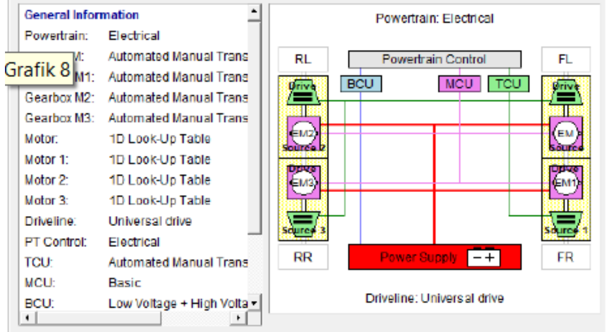
Vehicle Model

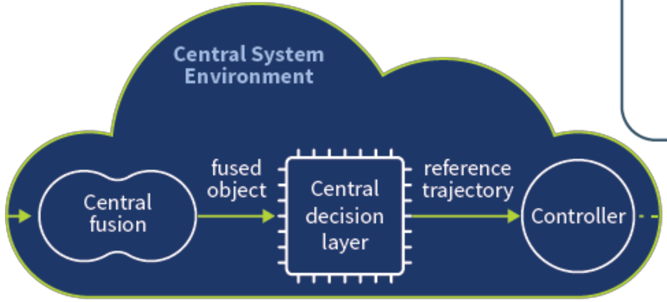
V2X

Traffic Model

- Cloud based services for trajectory planning

- Calibrated traffic flow model of selected test site

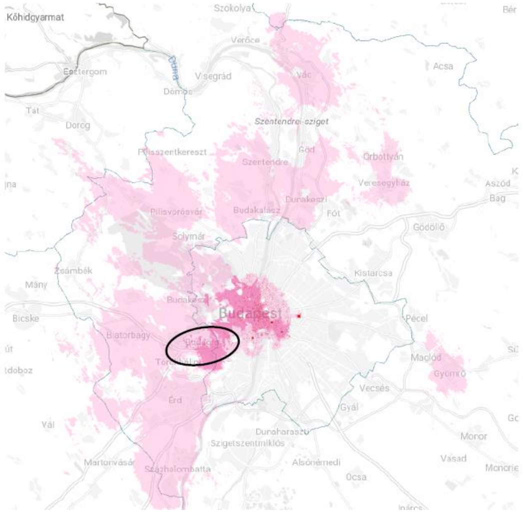


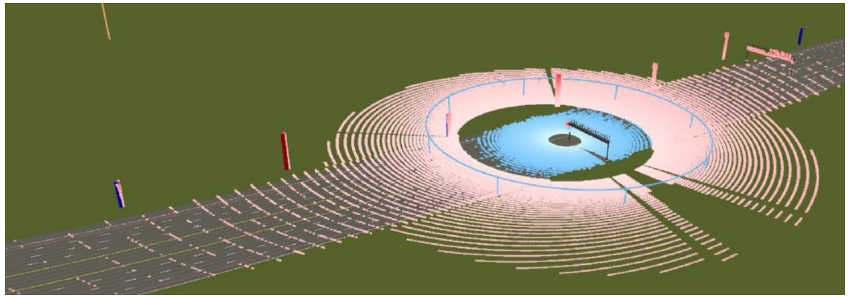


Existing results from phase 2

Infrastructure improvement

5G Coverage MAP





8+246 km Lat 47,455212 Lon 18,974693

8+646 km Lat 47,45385 Lon 18,969789

7+935 km Lat 47,456174 Lon 18,978569

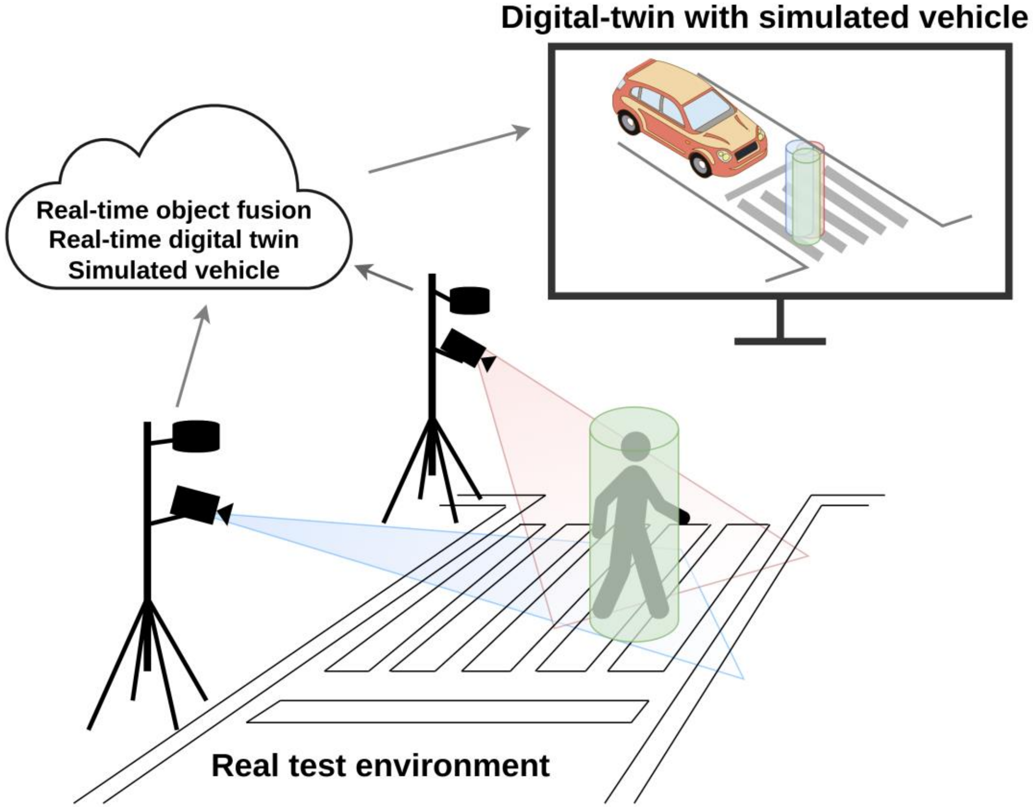
8+356 km Lat 47,454633 Lon 18,973469

9+190 km Lat 47,452743 Lon 18,963347

Highlights

ITS World Hamburg 2021

Real time digital twin, Central fusion, Visualization (incl. AR)

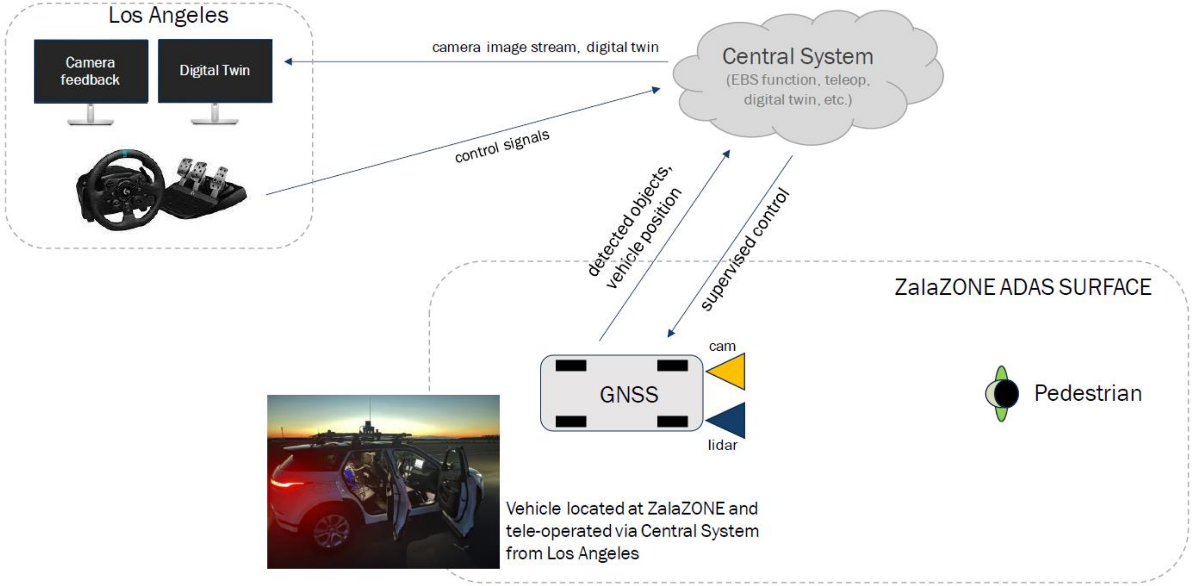


Highlights

ITS World Los Angeles 2022

Teleoperation of real vehicle 9 time zones (10000 km) away, with AEB function also provided by Central System

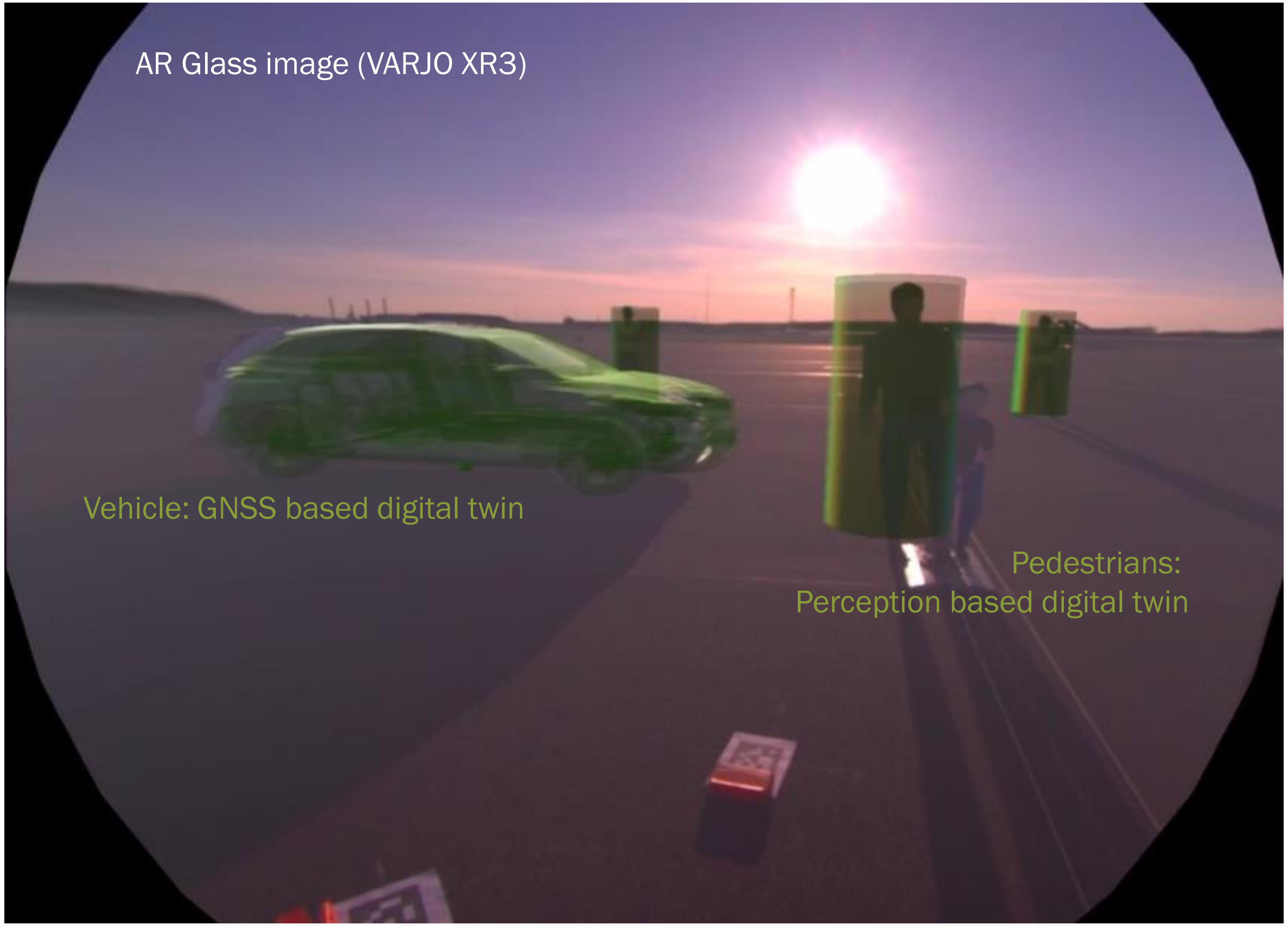
Bernd Datler Managing Director at ASFINAG Maut Service



Highlights

Digital twin in Augmented Reality

Real time rendering of the 3D Digital Twin environment



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THANK YOU FOR YOUR ATTENTION

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This project has received funding from the Eurostars-2 joint programme with co-funding from the European Union Horizon 2020 research and innovation programme

The project Test.EPS is funded by the Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK/FFG) and the Hungarian National Research, Development and Innovation Office (DRPI) via the EUREKA network.

EUREKA Test.EPS

TESTING AND VERIFICATION METHODS FOR AUTOMATED DRIVING FUNCTIONS AND EPS

EUREKA Test.EPS

Current Developments and Future Outlook

20/04/2023

P. Innerwinkler, J. Reckenzaun

Virtual Vehicle Research GmbH

Trilaterale Konferenz

Agenda

1) Brief project Introduction
2) Current challenges for the approval of automated vehicles
3) Approaches for handling of complexity of automated vehicles
4) Intermediate Results of the EUREKA TestEPS project for virtual testing
5) Introduction to Demos displayed during afternoon session
6) Global Trends for autonomous systems
7) Wrap Up and Recommendations

Today's Speakers

DI Jakob Reckenzaun
Virtual Vehicle Research GmbH
Project Coordinator
Jakob.Reckenzaun@v2c2.at

Mag. Pamela Innerwinkler
Virtual Vehicle Research GmbH
Lead Virtual Testing
Pamela.Innerwinkler@v2c2.at

Vision

Certified automated driving functions and environmental perception systems (EPS) for robust and safe operation of automated mobility

Mission

Development of virtual and real cross-border testing approaches enabling certification of driving functions with special focus on EPS including regulatory and legal aspects

2018 – Ministerial Agreement

Memorandum on cooperation on cross-border testing between Austria & Hungary

2019–2020 – Exploratory Projects

Execution of exploratory phase to

2021 – Kick-Off EUREKA projects

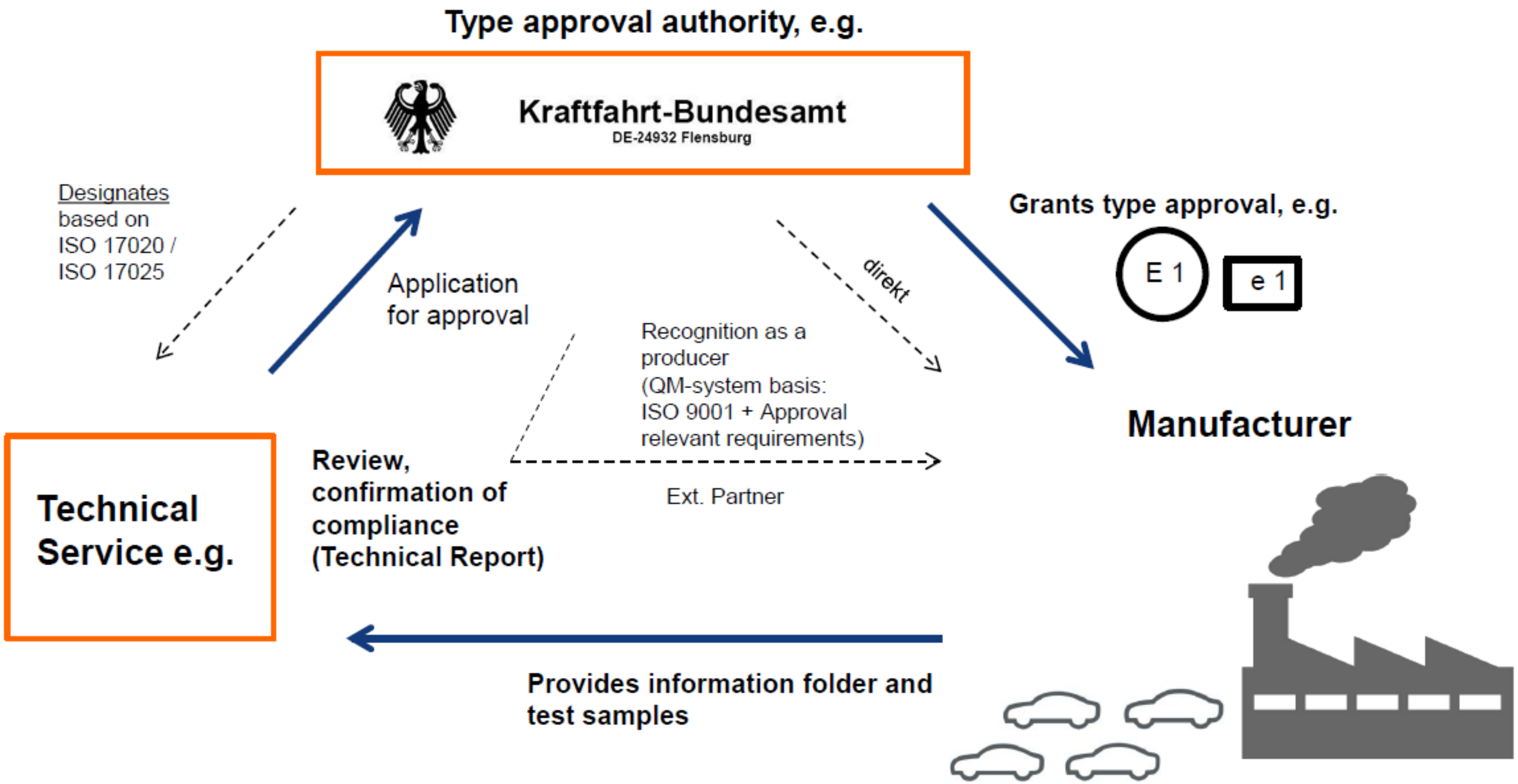
Kick-Off of EUREKA TestEPS and Central System

2022–2023 – Mid-term EUREKA projects

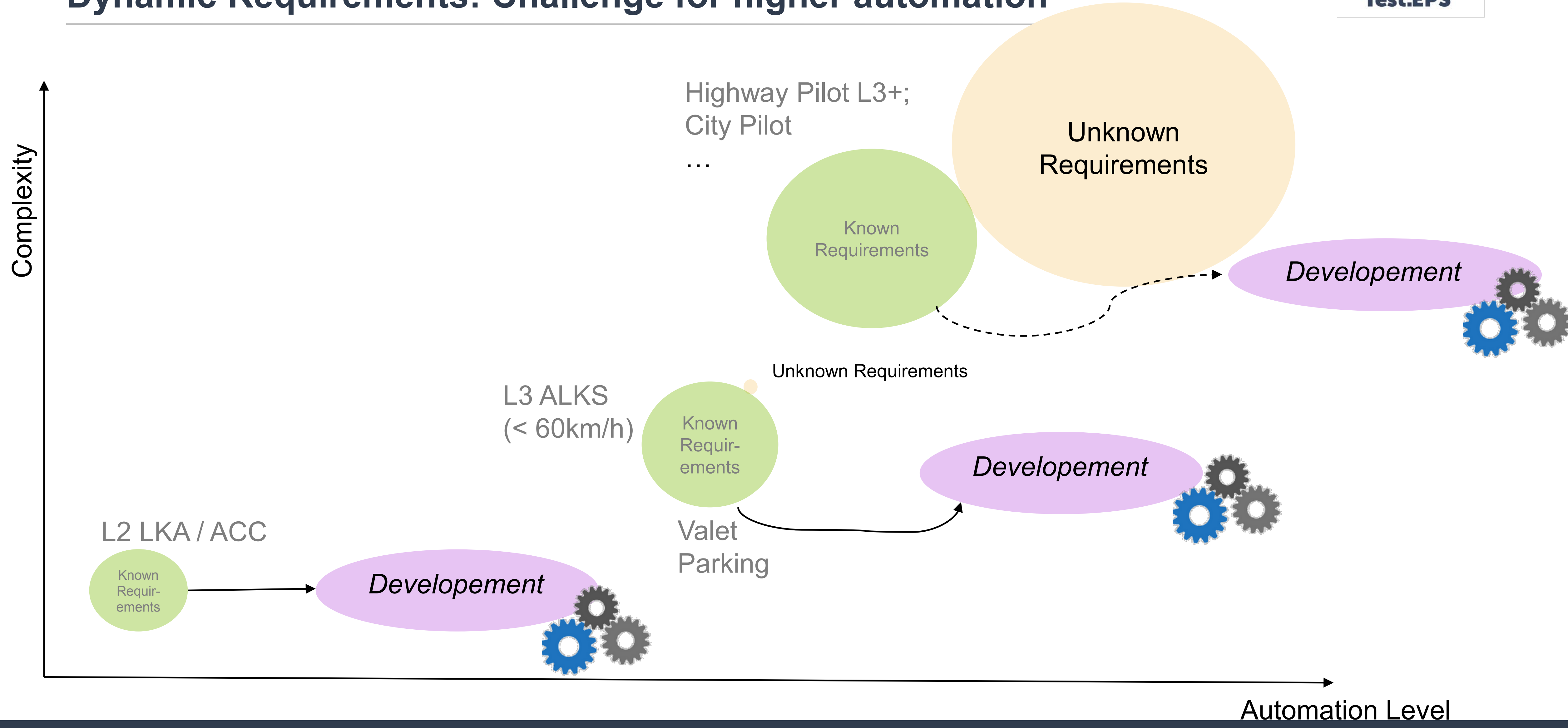
MidTerm Webinar
6th Trilateral Conference

2018 2019 2020 2021 2022 2023

Industrial Homologation Process (Germany)



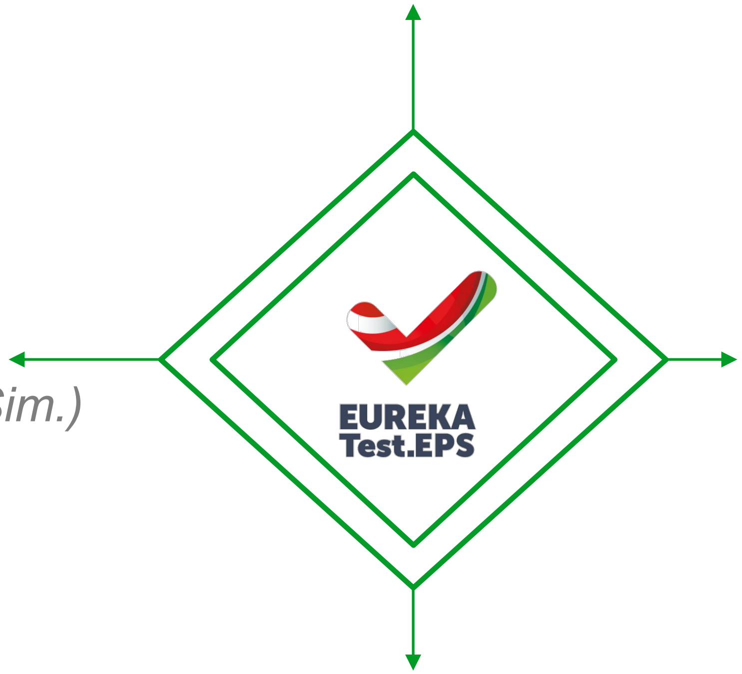
Dynamic Requirements: Challenge for higher automation



Challenges for ADAS Approval

Rules & Regulations, (Safety) Argumentation

Test Methods & Traceability
(Proving Grounds, Real World, Sim.)

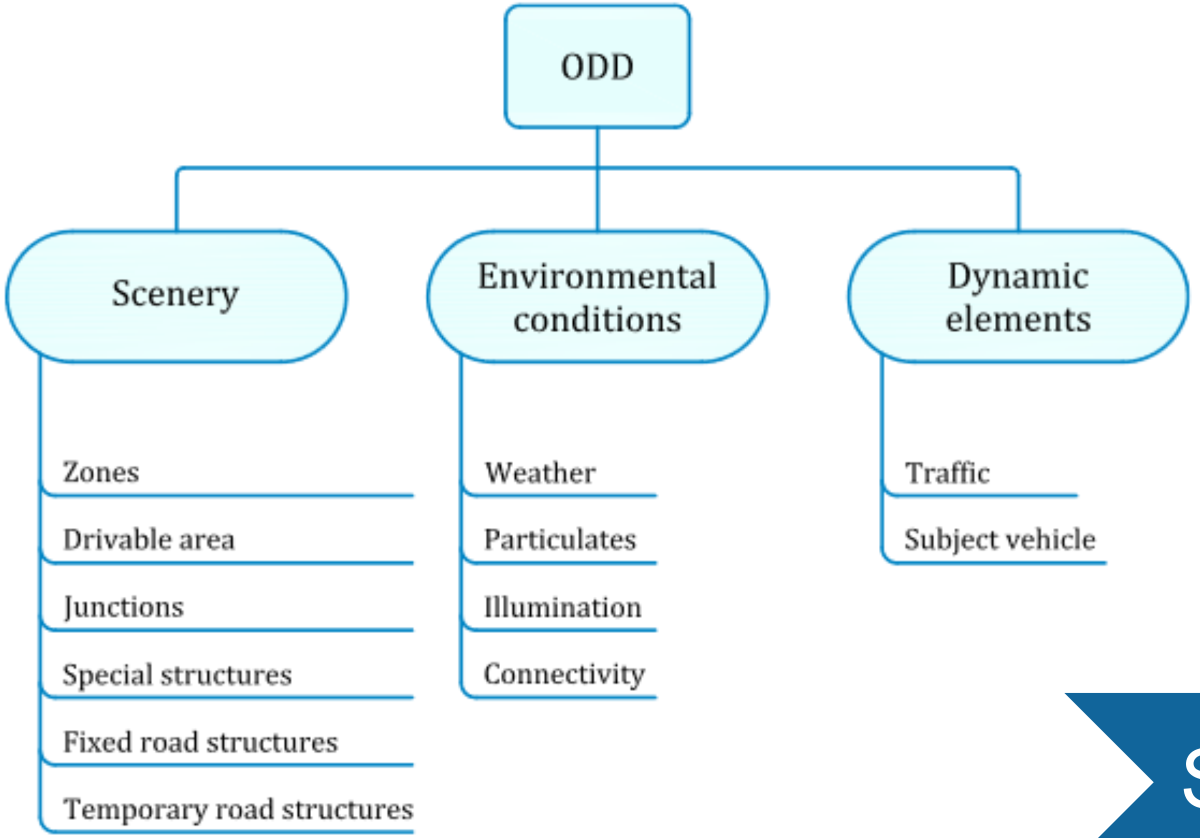


Process Thinking (Feedback-Loop resp. CI/CD)

Virtual Testing, Fidelity Levels & Credibility of Simulation

ODD Introduction

operating conditions under which a given driving automation system or feature thereof is specifically designed to function, ISO PSI Pas



ODDs Highway (ALKS) & Parking Area (AVP)

Scenery

- ❑ High-Way
- ❑ On- & Off Ramps

Dynamic Elements

- ❑ Passenger Vehicles
- ❑ Separated Lanes
- ❑ VRUs (Pedestrians)

Environmental Conditions

- ❑ Daytime
- ❑ Good weather

Scenery

- ❑ Parking Area
- ❑ Ramps between floors
- ❑ Drop-Off

Dynamic Elements

- ❑ Passenger Vehicles
- ❑ VRUs
- ❑ Passengers as recommended by

Environmental Conditions

- ❑ Indoor Conditions
- ❑ Artificial light sources

TestEPS Testing Certification Process

- ✓ **Scenario A**
  - ✓ Test A – Variation 1
  - ✓ Test A – Variation 2
- ✓ **Scenario B**
  - ✓ Test B – Variation 1
  - ✓ Test B – Variation 2

….

EUREKA Test.EPS

ALP.Lab Austrian Light Vehicle Proving Region for Automated Driving

Digitrans

zone

- ✓ **Scenario A**
  - ✓ Test A – Variation 1
  - ✓ Test A – Variation 2
- ✓ **Scenario B**
  - ✓ Test B – Variation 1
  - ✓ Test B – Variation 2

This project has received funding from the Eurostars-2 joint programme with co-funding from the European Union Horizon 2020 research and innovation programme

eurostars™

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EUREKA Test.EPS

TESTING AND VERIFICATION METHODS FOR AUTOMATED DRIVING FUNCTIONS AND EPS

Intermediate Results Virtual Testing

20/04/2023

Pamela Innerwinkler

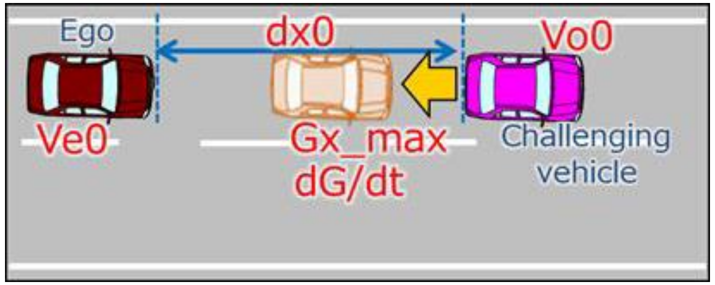
Team Lead Reliable Control Systems

Virtual Vehicle

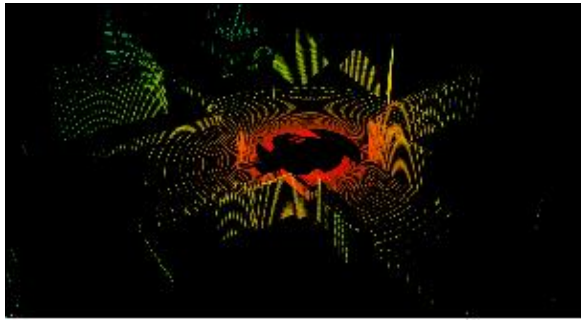
Three Use Cases

- Automated Valet Parking (AVP)

- Automated Lane Keeping System (ALKS)



- Environmental Perception Systems (EPS): Object Perception Algorithm Testing



Automated Valet Parking (AVP)

- Vision-based parking slot detection
- Forward and reverse perpendicular parking (easily extendable)
- Re-planning to new parking slot in case of unsuccessful parking
- Collision avoidance and Emergency Braking
- Maneuvering around obstacles on the route
- Home parking: Record visual feature-based map, global route planning on recorded map
- Valet parking: Support of third-party parking lot maps
- Virtual testing supported in aiSim®
- Developed in-line with ISO23374

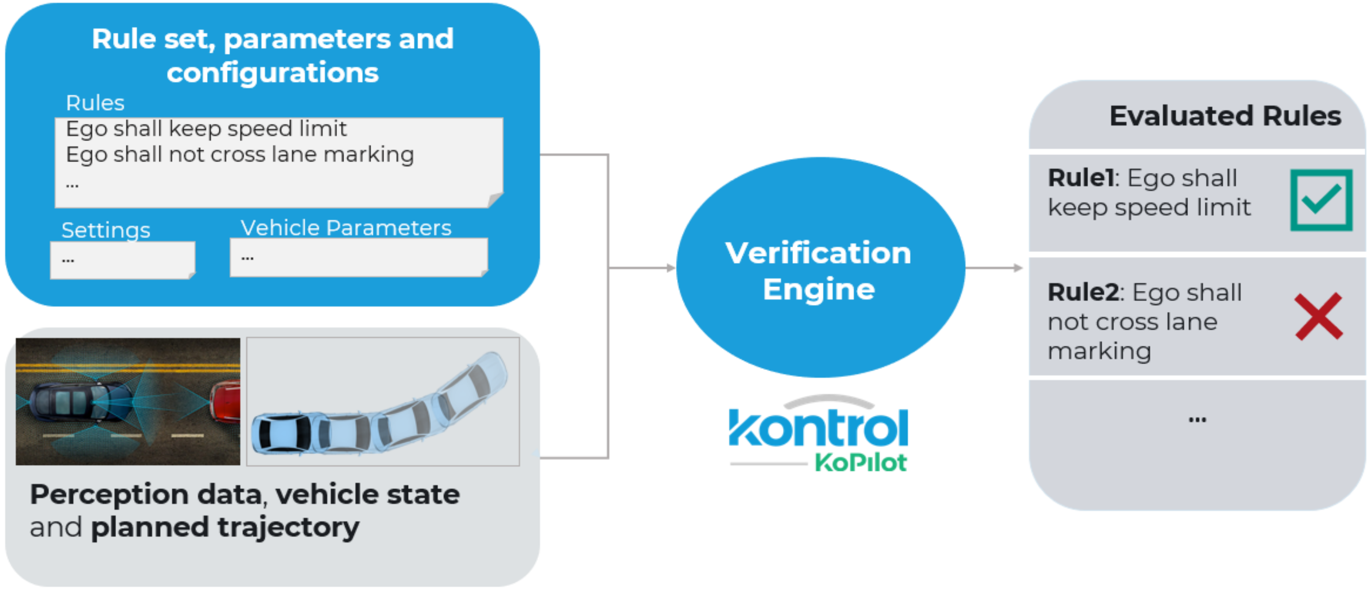
Runtime verification of rules – legal compliance

Exemplary derivation of formalized technical requirements

Mathematical formulation $d_{xsafe} = d_0 + v_{ego0} \cdot t_{resp} - \frac{v_{ego0}^2}{2 \cdot a_{ego,brake,des}} + \frac{v_{lead0}^2}{2 \cdot a_{lead,brake,exp}}$

Input	Description	Variable
1	Messung: Abstand zu vorausfahrendem Fahrzeug	$d_{x,lead}$
2	Messung: Geschwindigkeit Ego	v_{ego0}
3	Messung: Geschwindigkeit vorausfahrendes Fahrzeug	v_{lead0}
4	Konfig. Para: Maximale Verzögerung moderner Fahrzeuge mit ABS (Annahme -9m/s²)	$a_{lead,brake,exp}$
5	Konfig. Para: Gewünschte maximale Verzögerung des Ego	$a_{ego,brake,des}$
6	Konfig. Para: Gewünschte Stillstand-Abstand zu vorausfahrendem Fahrzeug	d_0
7	Konfig. Para: Gewünschte maximale Reaktionszeit des System	t_{resp}

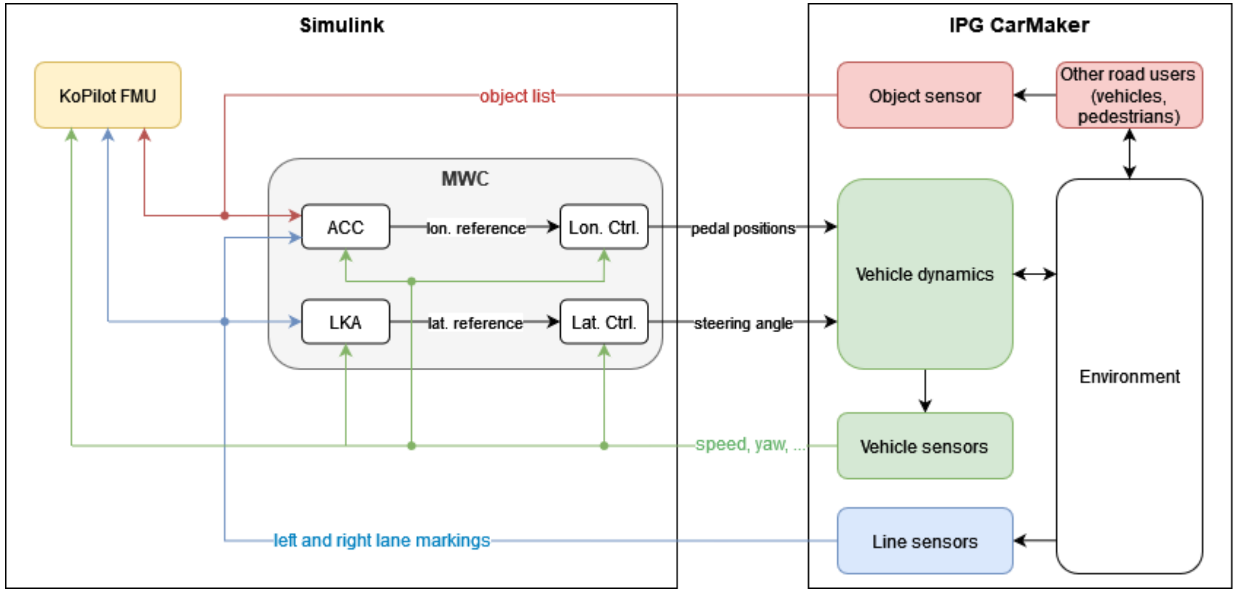
- R157 amendment series 00,01
- Austrian traffic Act
- Hungarian traffic Act



Virtual testing of ALKS

Simulation environment

- Environment Simulation: IPG CarMaker
- Motorway Chauffeur (MWC)
  - ACC: **target-to-lane allocation**, target selection, speed reference computation
  - LKA: mainly **geometric path calculation** from lane markings
- **KoPilot FMU**: checking for compliance with ALKS requirements

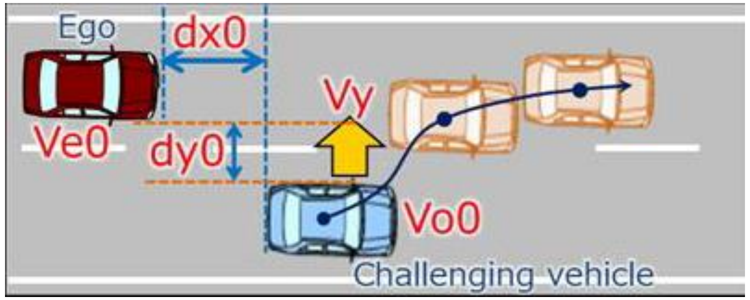


Test execution

•Automatic execution of ALKS scenarios on different road networks

•Perform parameter variations

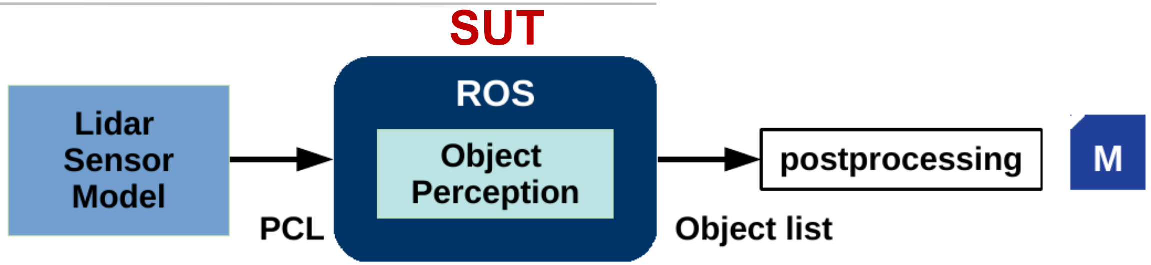
•Automatic evaluation based on FMU output

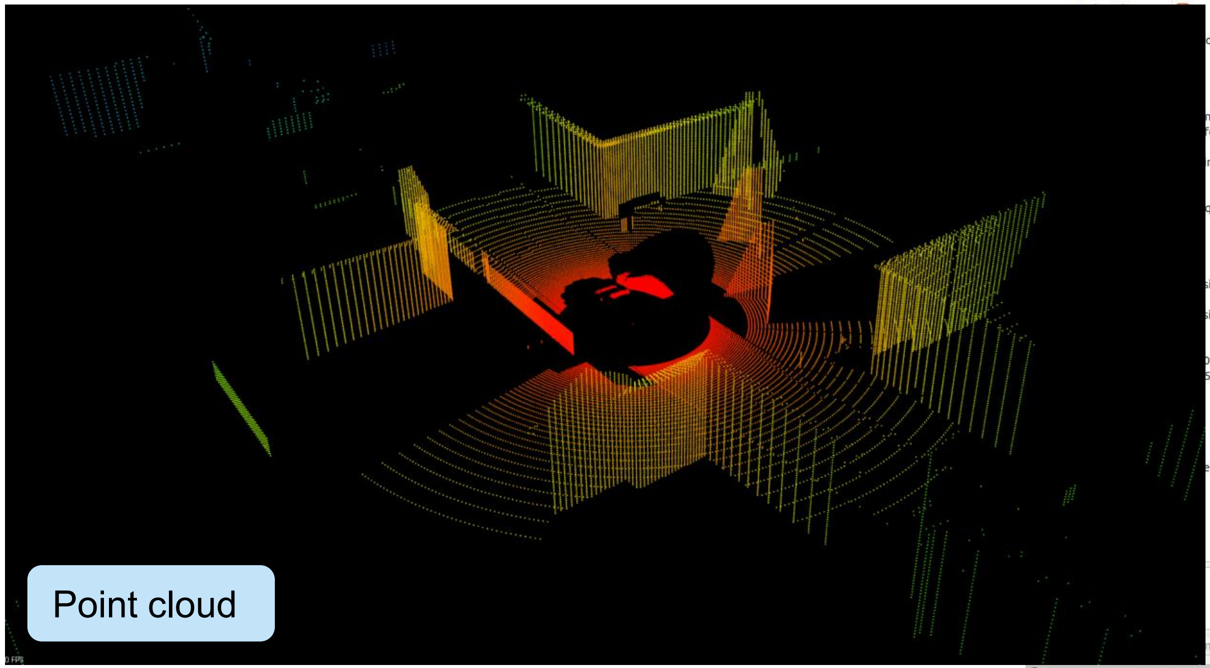


Source. United Nations, "UN Regulation No. 157 - Uniform provisions concerning the approval of vehicles with regard to Automated Lane Keeping Systems," 2021.

EPS: Object Perception Algorithm Testing

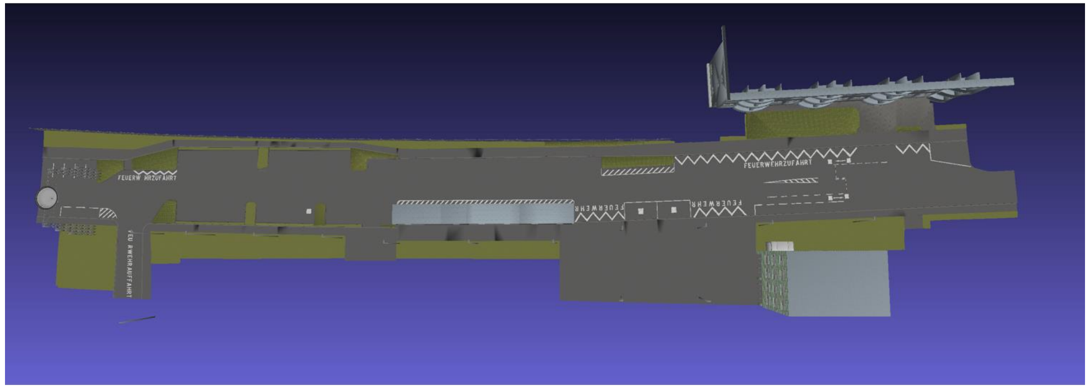
- **Virtual environment perception sensor models**
  - e.g., synthetic Lidar point cloud
- **Object perception algorithm (SUT)**
- **Comparison: ground truth – detected objects**

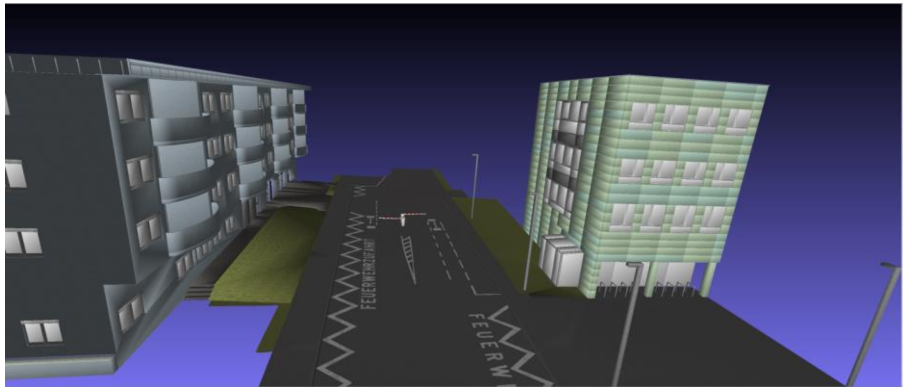


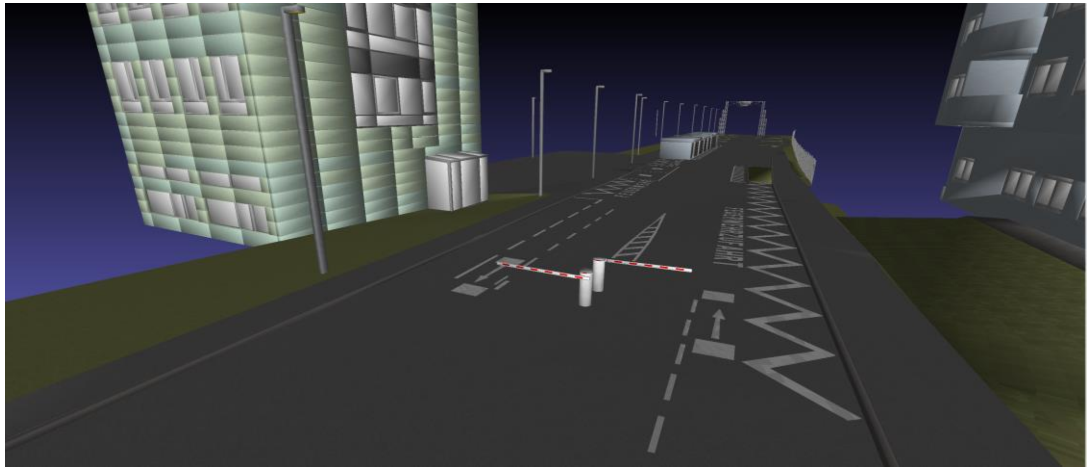


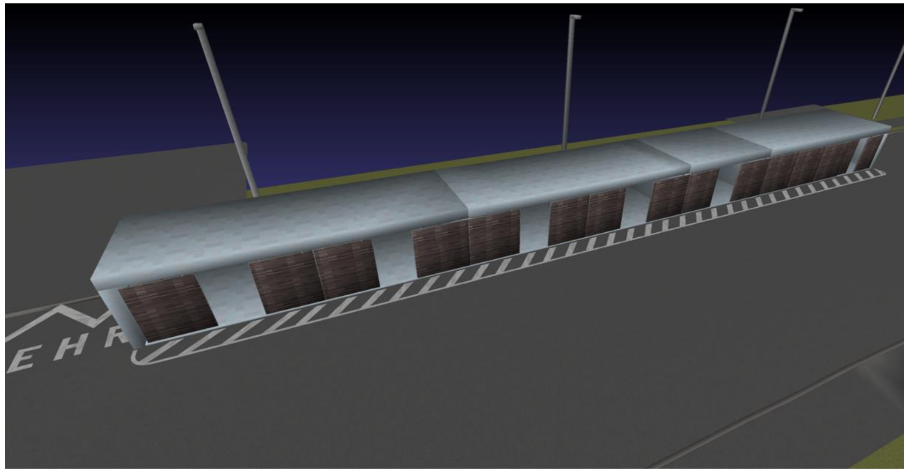
VIRTUAL TESTING: Digital Twins for Simulation and Testing

3D Reconstruction of TUG Campus Inffeldgasse for Sensor Simulation







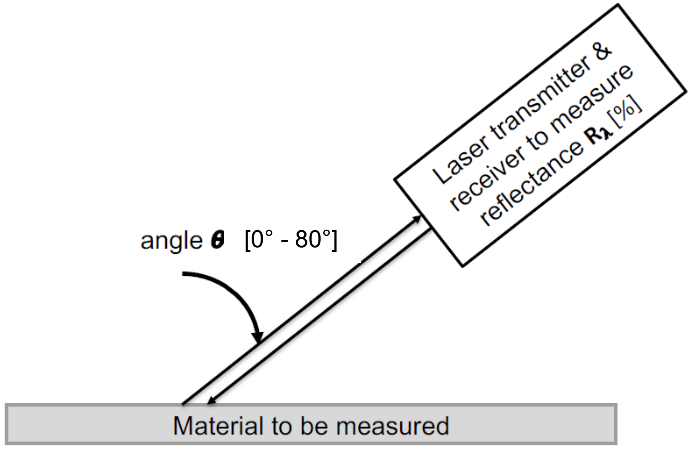


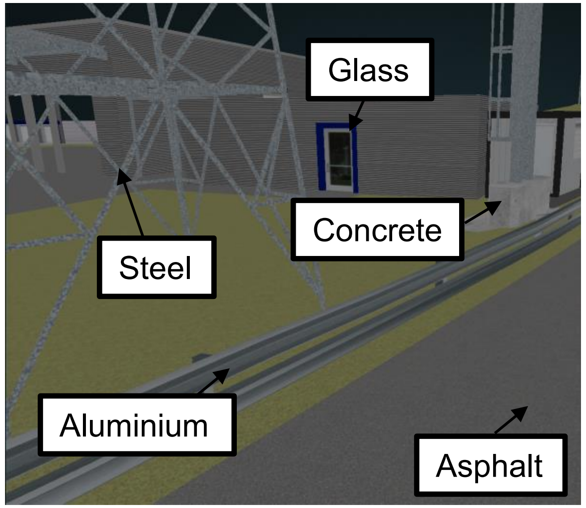
EPS: Enhance UHD Map - Material Properties for Lidar Sensor Models

- Radiometric response mainly depends on wavelength λ & incidence angle θ
- Establishment of angle dependent material reflectance database in the lidar spectrum
- Material database classification based on material details in four different levels

Level 1 material class → **Level 2** material type → **Level 3** specific material → **Level 4** further details

- Mapping of the material property to the meshes of the UHD map





Data set available (open access):

Ritter, David J., et al. *"Angle-Dependent Spectral Reflectance Material Dataset based on 945 nm Time-of-Flight Camera Measurements." Data in Brief* (2023): 109031. https://doi.org/10.1016/j.dib.2023.109031

Data SETS

Check out our recently published data sets

Main features are:

- 280+ spectral reflectance values of materials
- Angular resolution from 0° to 80° in 10° steps
- Measurements taken at wavelength range similar to most common automotive lidar sensors

☑ We see a lot of relevant applications of the dataset like improved environmental simulations, material property mapping and lidar-raytracing models of higher fidelity.

Main features are:

- dGPS Ground Truth
- Measurements taken on Hungarian Motorway
- Different scenarios motivated by relavant standards (R157 and specific sensor model features)
- Comes with high-ranked journal publication

☑ We see a lot of relevant applications of the dataset for ADAS and sensor model devs

Both datasets are published open access on the repository Zenodo

This project has received funding from the Eurostars-2 joint programme with co-funding from the European Union Horizon 2020 research and innovation programme

eurostars™

The project Test.EPS is funded by the Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK/FFG) and the Hungarian National Research, Development and Innovation Office (DRPI) via the EUREKA network.

EUREKA Test.EPS

TESTING AND VERIFICATION METHODS FOR AUTOMATED DRIVING FUNCTIONS AND EPS

Introduction to Afternoon Demonstrators

20/04/2023

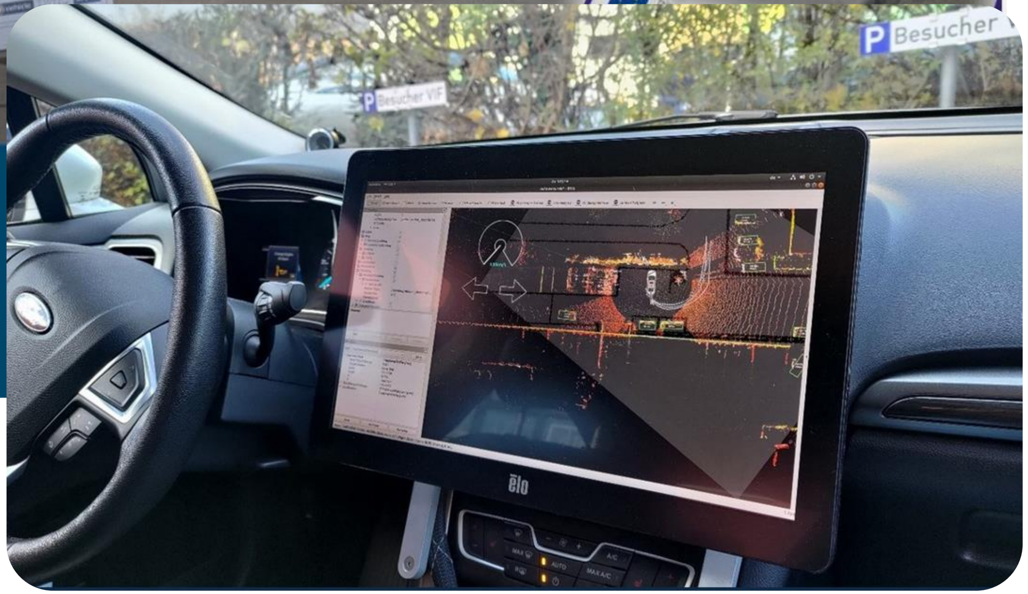
Jakob Reckenzaun

Senior Researcher

Virtual Vehicle

Experience Automated Driving

- Experience the techincal readiness of ***VIFs ADD Vehicle***
- Same technology was demonstrated in Graz city traffic
- This demonstration makes use of JR LiDAR UHD Maps

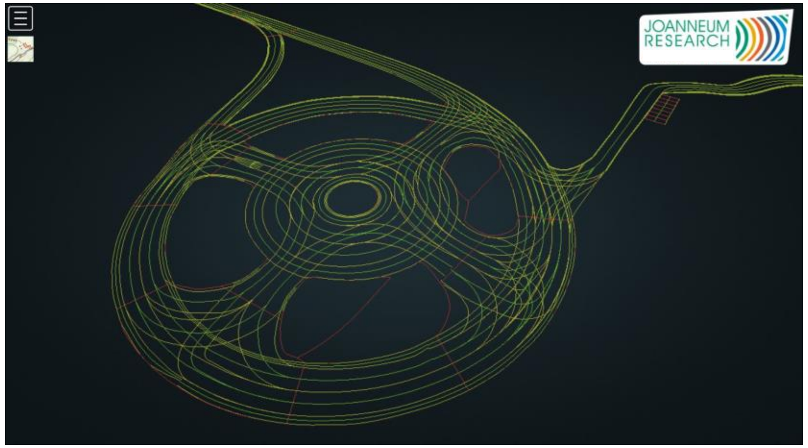


JOANNEUM RESEARCH – DIGITAL TWIN LAB - DEMO

- Experience how the ***3D digital twin of the DigiTrans proving ground*** was created
- Showcasing how digital twins are used for test and simulation in...
  - Project TestEPS & Project CentralSystem
  - VIF automated driving demonstration
  - TUG/DIGITRANS Radar Rain testing demonstration

VIRTUAL TESTING: Digital Twins for Simulation and Testing

Showcasing the process from Survey Pointcloud Data to UHDmaps®



JOANNEUM RESEARCH – DIGITAL TWIN LAB - DEMO

Exhibition of unique survey-grade 3D laser-scanning systems

- Operation of best-in-class survey-grade 3D measurement devices
- Combining aerial, on-road and off-road mapping methods for full 3D coverage
- Automated fusion of point cloud data and imagery

➔ ***Gapless Digital Twins for Advanced Testing and Simulation***

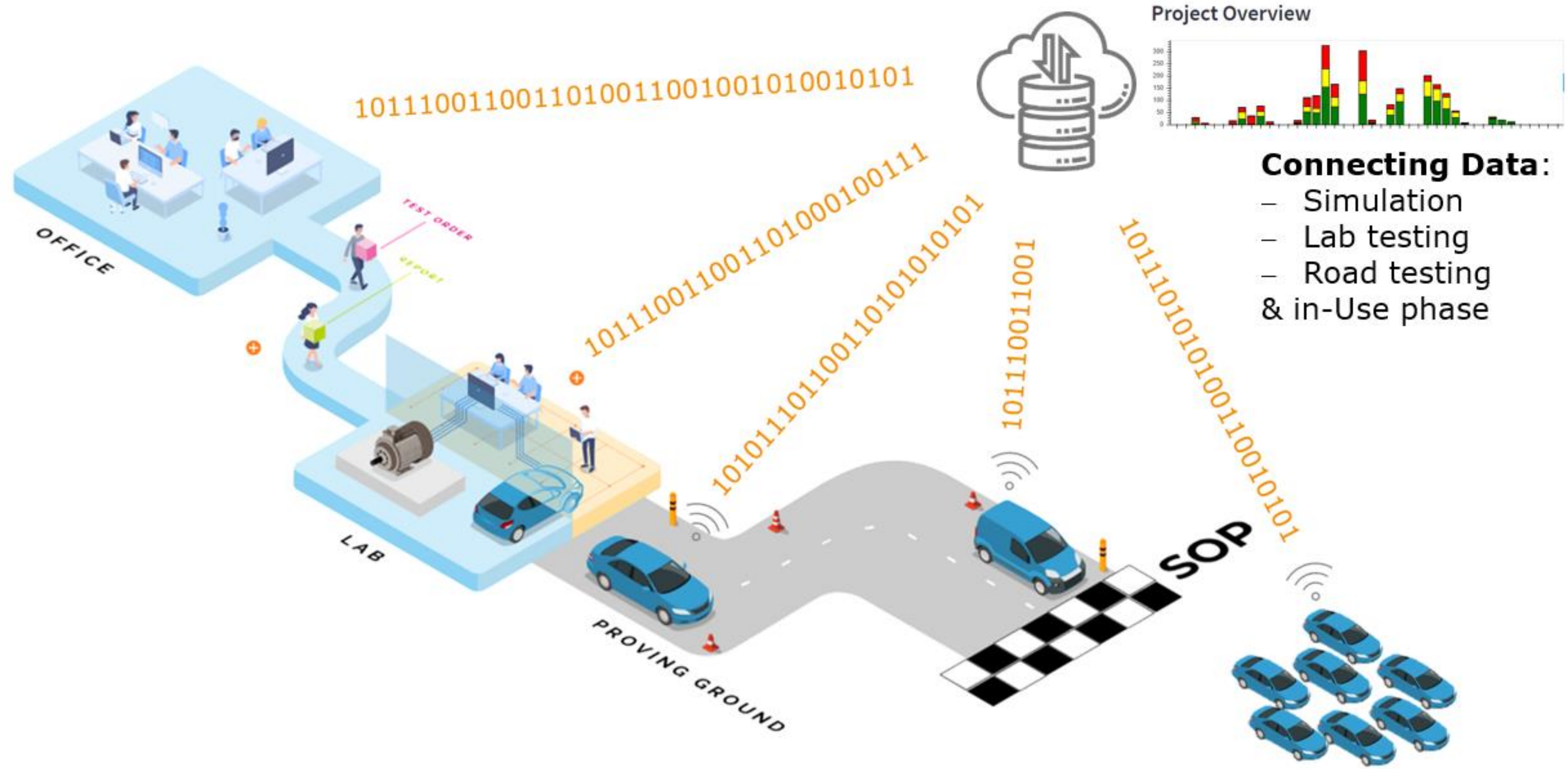
VIAmetris Backpack

Riegl VZ400i

Riegl VMX-2HA

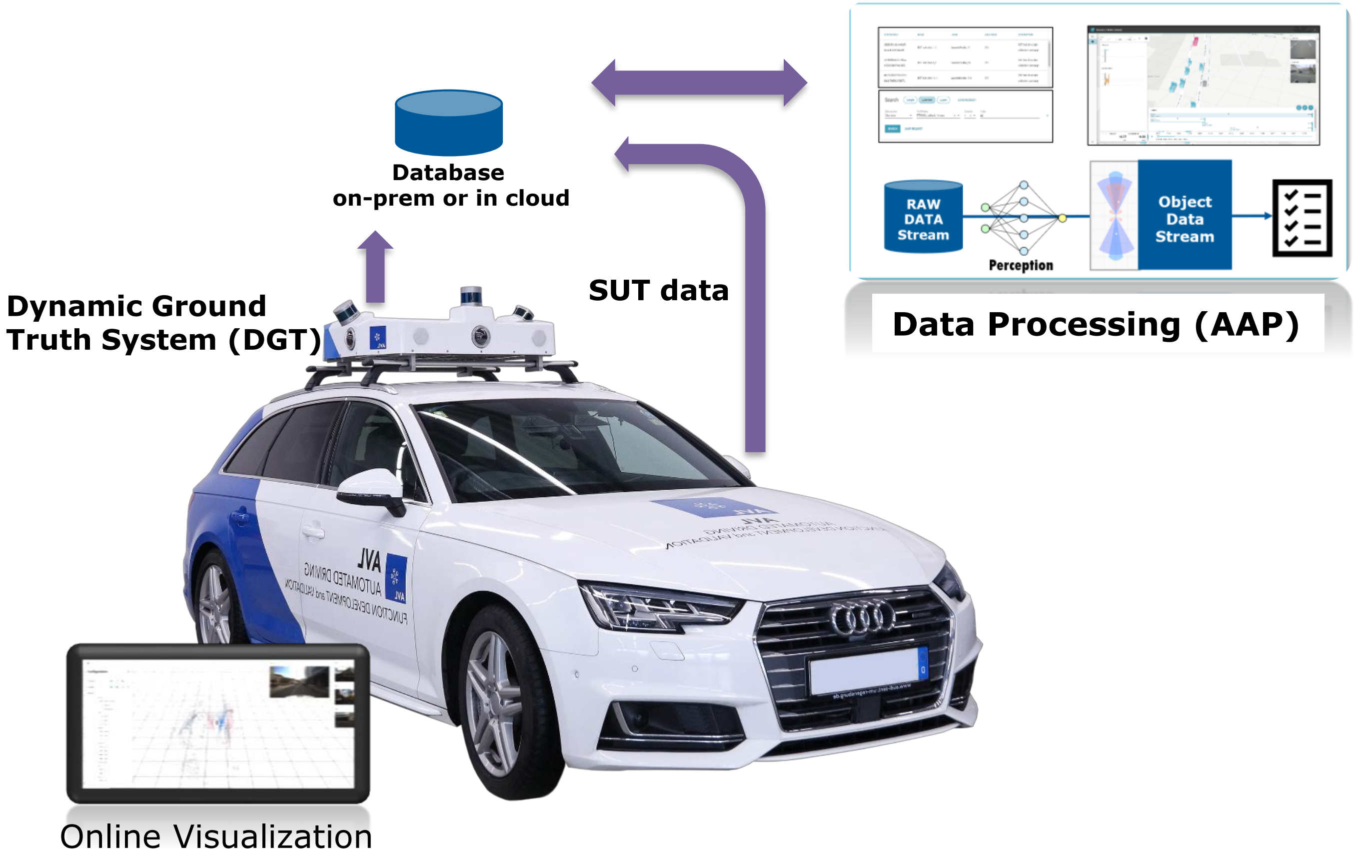
Riegl RiCopter VUX-SYS

AVL Demo: Dynamic Ground Truth System



AVL Demo: Dynamic Ground Truth System – Key use-cases

Detecting and recording of moving objects in highly accurate reference quality with online data visualization and offline data processing in the cloud.



Key use-cases:

- Vehicle Certification
- Perception Performance
- Scenario Generation
- Perceived Safety and Comfort
- Sensor model calibration (digital twin)

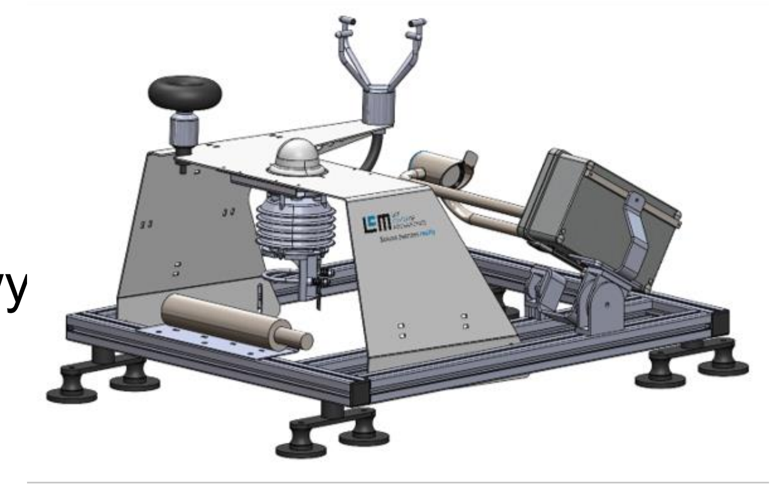
LCM Demo: Rack for environmental conditions

Important information for Testing and Certification:

- Environmental conditions which may influence ADF
- Measurement with a mobile environmental sensor rack
- Continuous data acquisition during test drives

Measured Parameters

- Wind (speed & direction)
- Precipitation (quantity & type)
- Road conditions (wet, dry, icy, snowy
- Temperature
- Humidity



Autonomous is not dead…

…instead, the use cases are becoming targeted!

Autonomous shared mobility

ZF Group
https://hubs.ly/Q01xhmP20

BENTELER Group HOLON
https://hubs.ly/Q01xhmC-0

Zoox
https://hubs.ly/Q01xhmWD0

Waymo new prototype
https://lnkd.in/gsnykW65

Autonomous trucks

Waymo, **Waabi**, **Gatik**, **PACCAR** showed their trucks
https://hubs.ly/Q01xhmHv0

Autonomous boats

Brunswick Corporation showed a self-docking boat and Hyundai subsidiary **Avikus** announced an autonomous boat including collision avoidance, fish finder, fishing spot and autonomous sunset locator
https://hubs.ly/Q01xhmC10

US market and China have priority

Reference: see the new McKinsey & Company report on shared autonomous mobility - https://hubs.ly/Q01xhmL20

Envisioned transnational testing of ADF & EPS

Transnational test area for AD
- Real test drive
- Virtual test drive

Test track Digitrans

Digitrans

Traffic rule compliance
- Real tests
- Virtual test

kontrol

Dynamic Ground Truth
- Infrastructure DGT
- Real Time DGT

EUREKA

MŰEGYETEM 1782

Border Crossing

AD Vehicles
- Driving functions
- Trusted Simulation Core

AIMOTIVE aiDrive aiSim

AVL

System & components
- Analytics cloud
- AVL DGT vehicle
- Onboard weather data

LINZ CENTER OF MECHATRONI

AVL

Test track AlpLab
- traffic monitoring
- Data management

ALP.Lab Austrian Light Vehicle Proving Region for Automated Driving

BERNARD GRUPPE

Test track Zala Zone

zone

Transnational test track
- Interurban roads
- border crossing
- ODD transitions

Virtual test area
- Simulation framework
- Sensor simulation

virtual vehicle

UHD® Maps
- Static GT for
- Simulation
- Real test

Boundary conditions
- legal aspects
- organisational structure
- business challenges

IESTA

Goal: ADAS certification Process
- Real tests
- Virtual test

TÜVRheinland

KTI Alapítva - Since 1938

EUREKA Test.EPS

Wrap-Up: Key Take Aways & Recommendations

- Transnational ODD definition is crucial factor for the development in Europe
- Validation of simulation also with real-world data and meaningful matrices are needed
- Simulation needs to be accurate & credible
- New cooperations are forming with the main focus on return of investment
- Transnational cooperation in Europe is key to compete in global competition
- A multi-national extension to ongoing R&D activities is the logical next step

EUREKA Test.EPS

TESTING AND VERIFICATION METHODS FOR AUTOMATED DRIVING FUNCTIONS AND EPS

Coordinated by

virtual vehicle

Partners

aiMotive™

AVL

BERNARD GRUPPE

BME AUTOMATED DRIVE

IESTA

JOANNEUM RESEARCH DIGITAL

kontrol

LCM LINZ CENTER OF MECHATRONICS

Enjoy our demonstrations in the afternoon!

iDREAMS
www.idreamsproject.eu

An overview of Safety Tolerance Zone for driver-vehicle-environment interactions under challenging conditions

Univerza v Mariboru

Prof. dr. Matjaž ŠRAML

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 814761

Table of contents

Project info and team

iDREAMS

Work programme

Smart, green & integrated transport (subtopic A)

Type of action

Research & Innovation Action

Call name

Mobility for Growth

Call topic

Human Factors in Transport Safety

Project info and team

iDREAMS

7 engineering universities & research centres

4 companies & ICT groups

2 partners with links to transport safety stakeholders

KFV Kuratorium für Verkehrssicherheit

imob Transportation Research Institute UHASSELT

TUM Technische Universität München

Univerza v Mariboru

National Technical University of Athens

Loughborough University

TU Delft

DriveSimSolutions

oseven

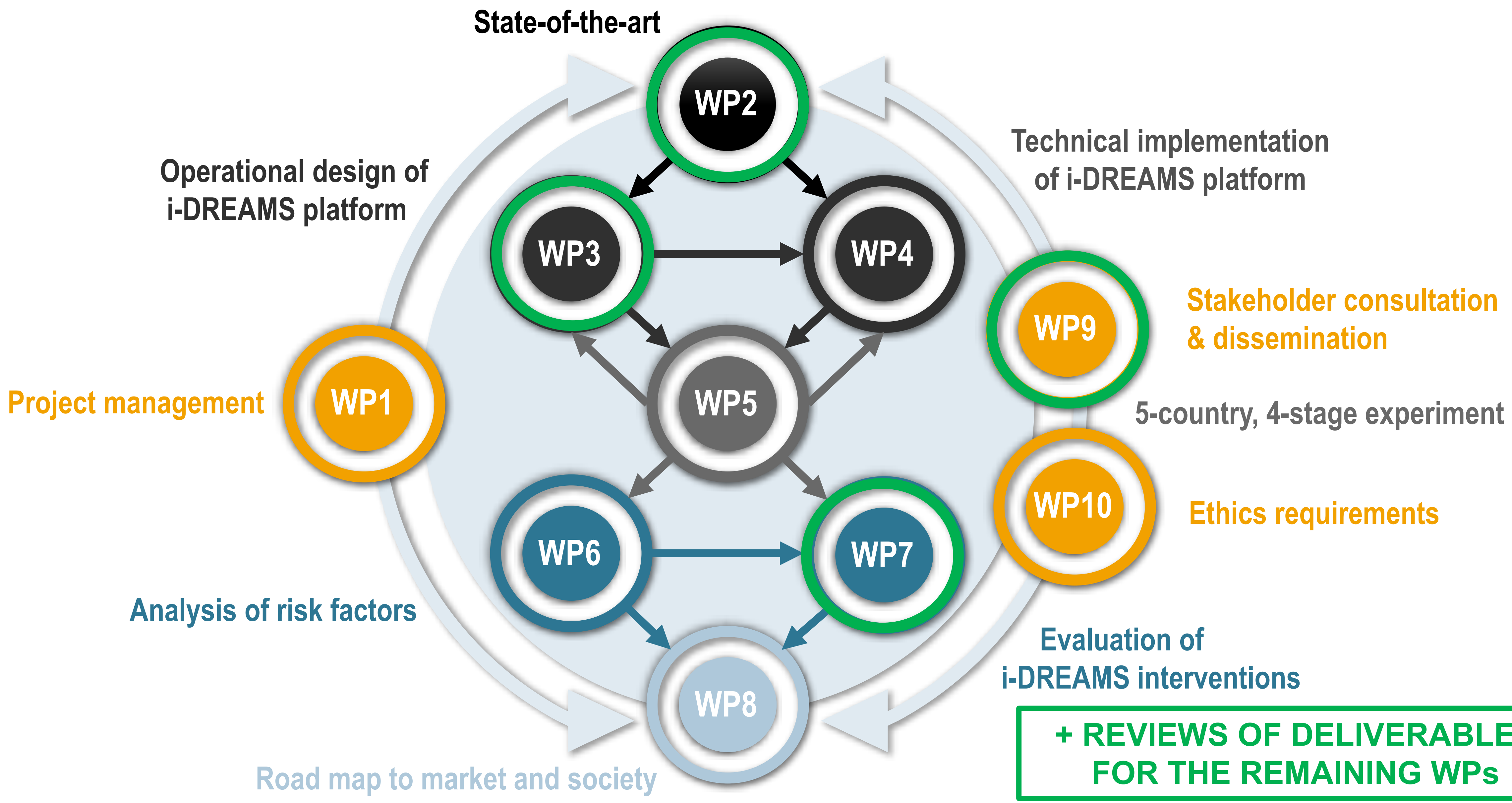
Barraqueiro Transportes, SA

cardioid your heart is unique

POLIS Cities and Regions for Transport Innovation

ETSC European Transport Safety Council

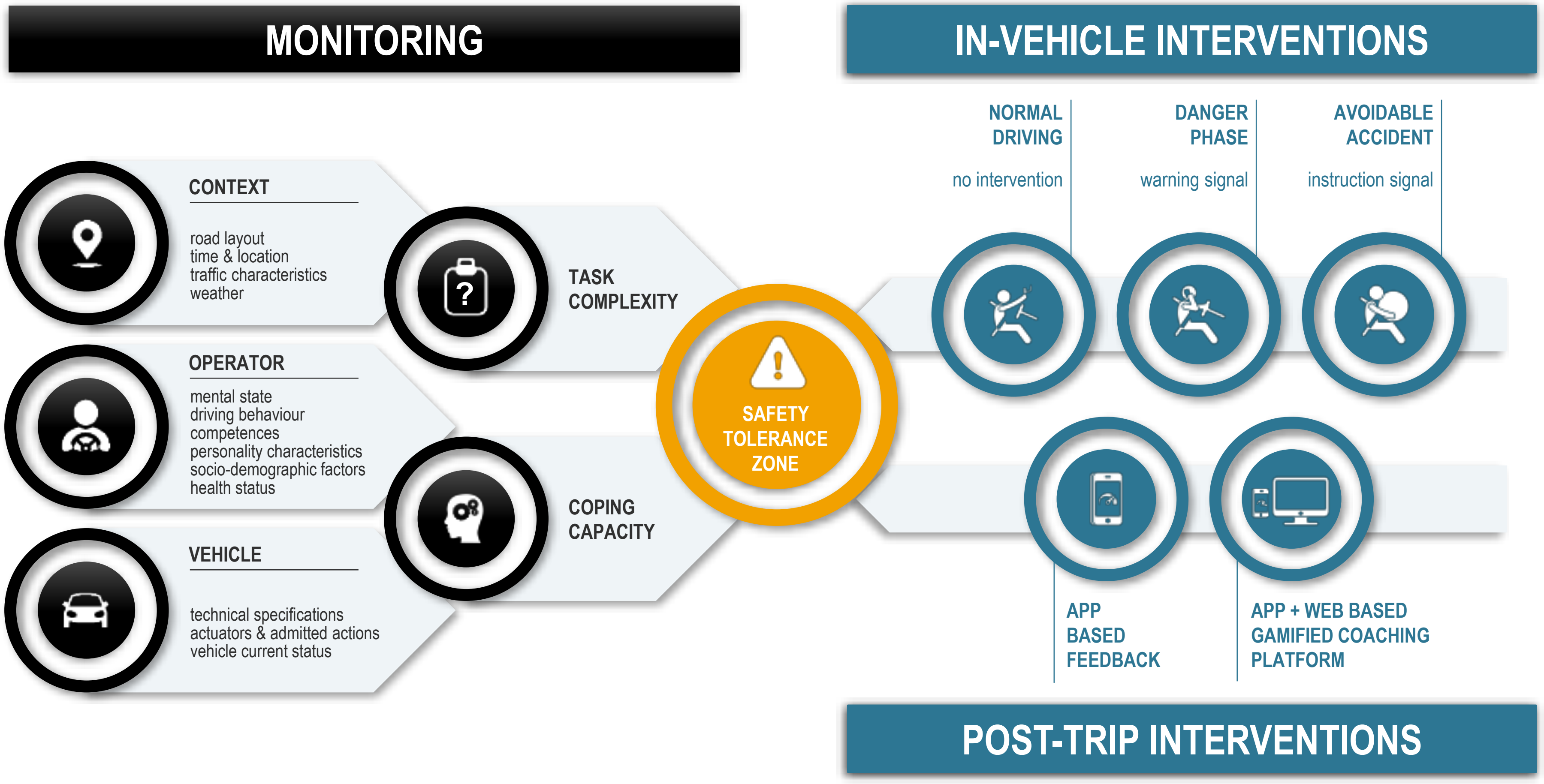
Work packages and UM



+ REVIEWS OF DELIVERABLES
FOR THE REMAINING WPs

The Safety Tolerance Zone concept

The Safety Tolerance Zone concept



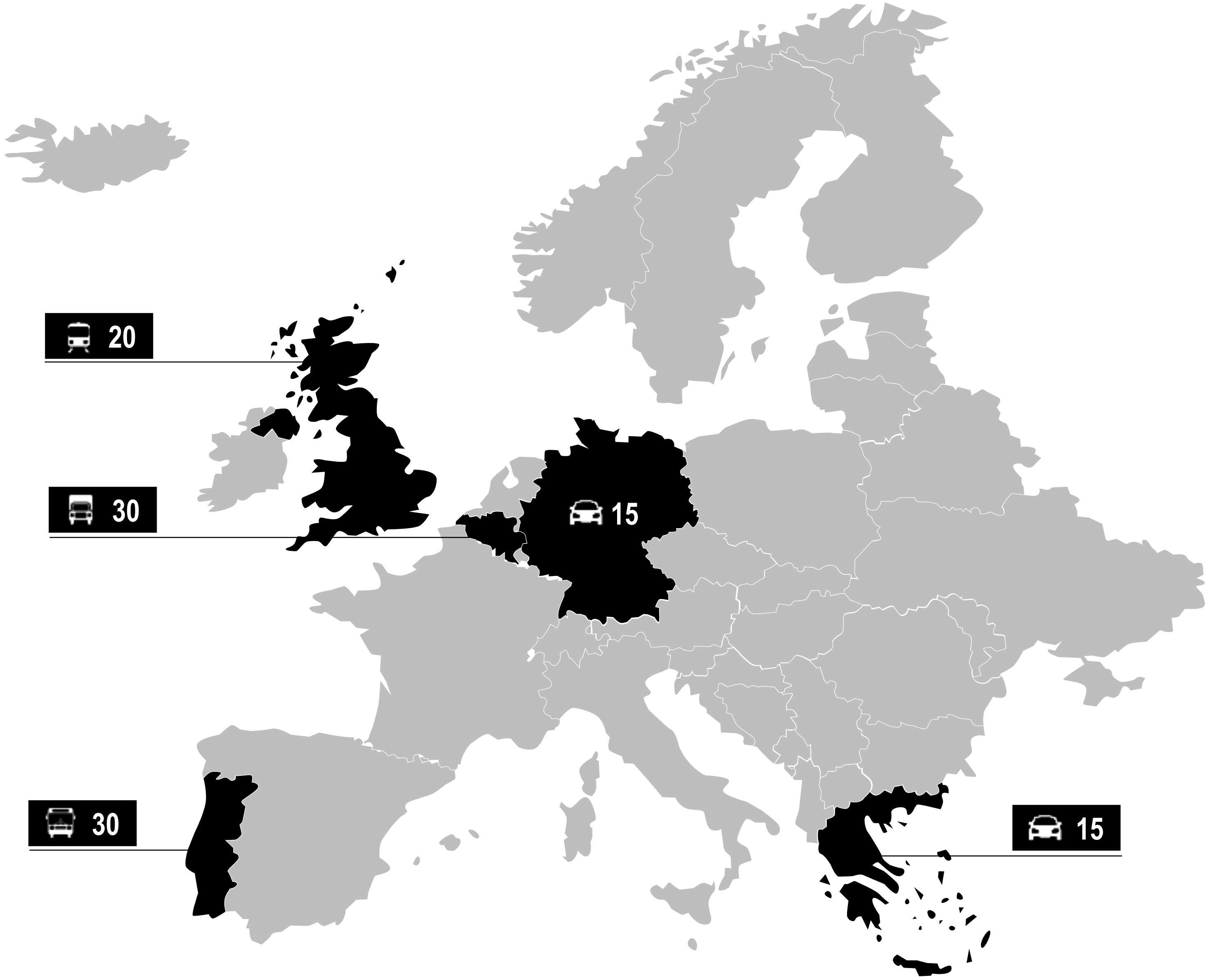
The system and the trials

The system and the trials

iDREAMS

STAGE 1

SIMULATOR
2 months



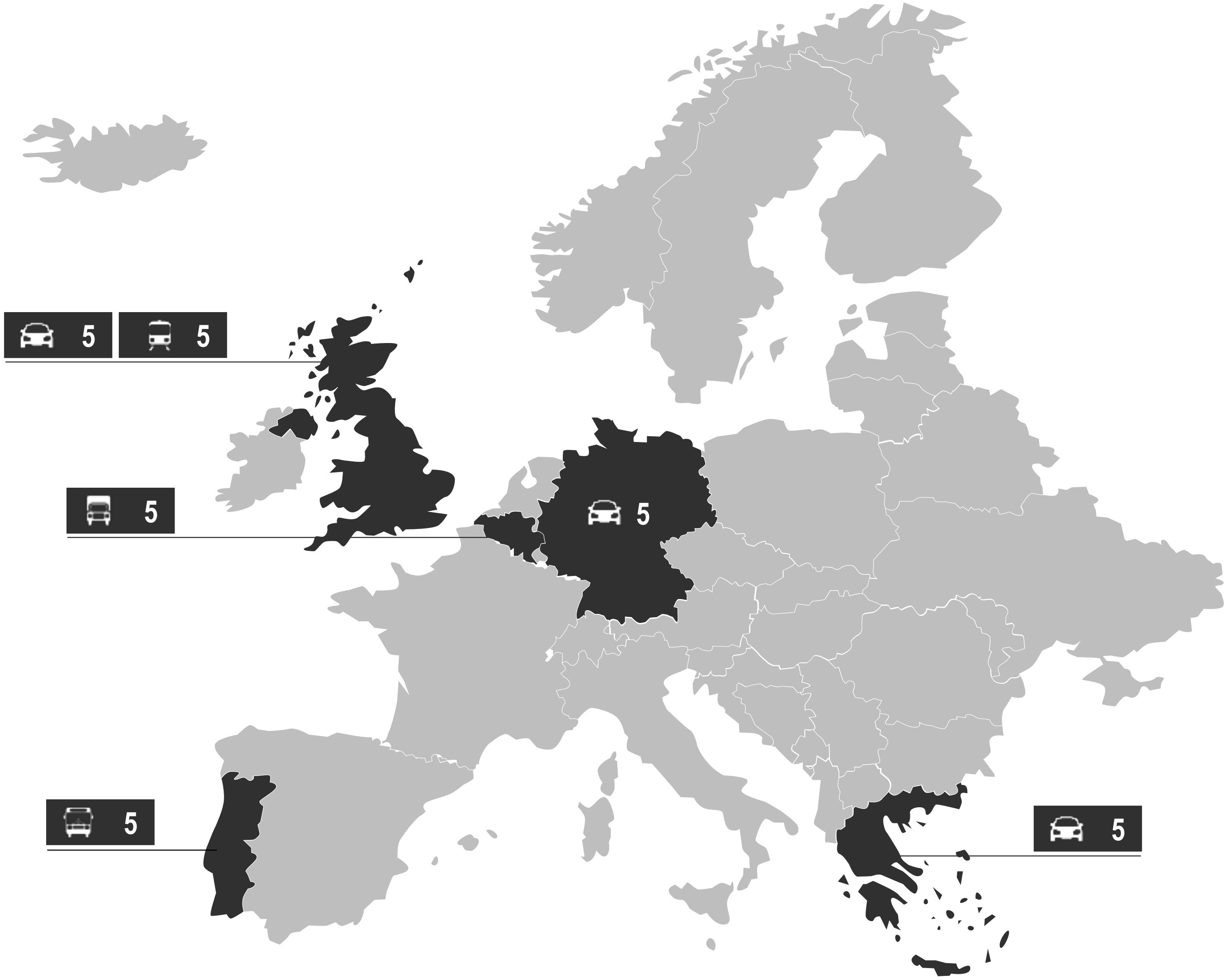
5-Country 4-Stage study

STAGE 1

SIMULATOR
2 months

STAGE 2

PILOT
1 month



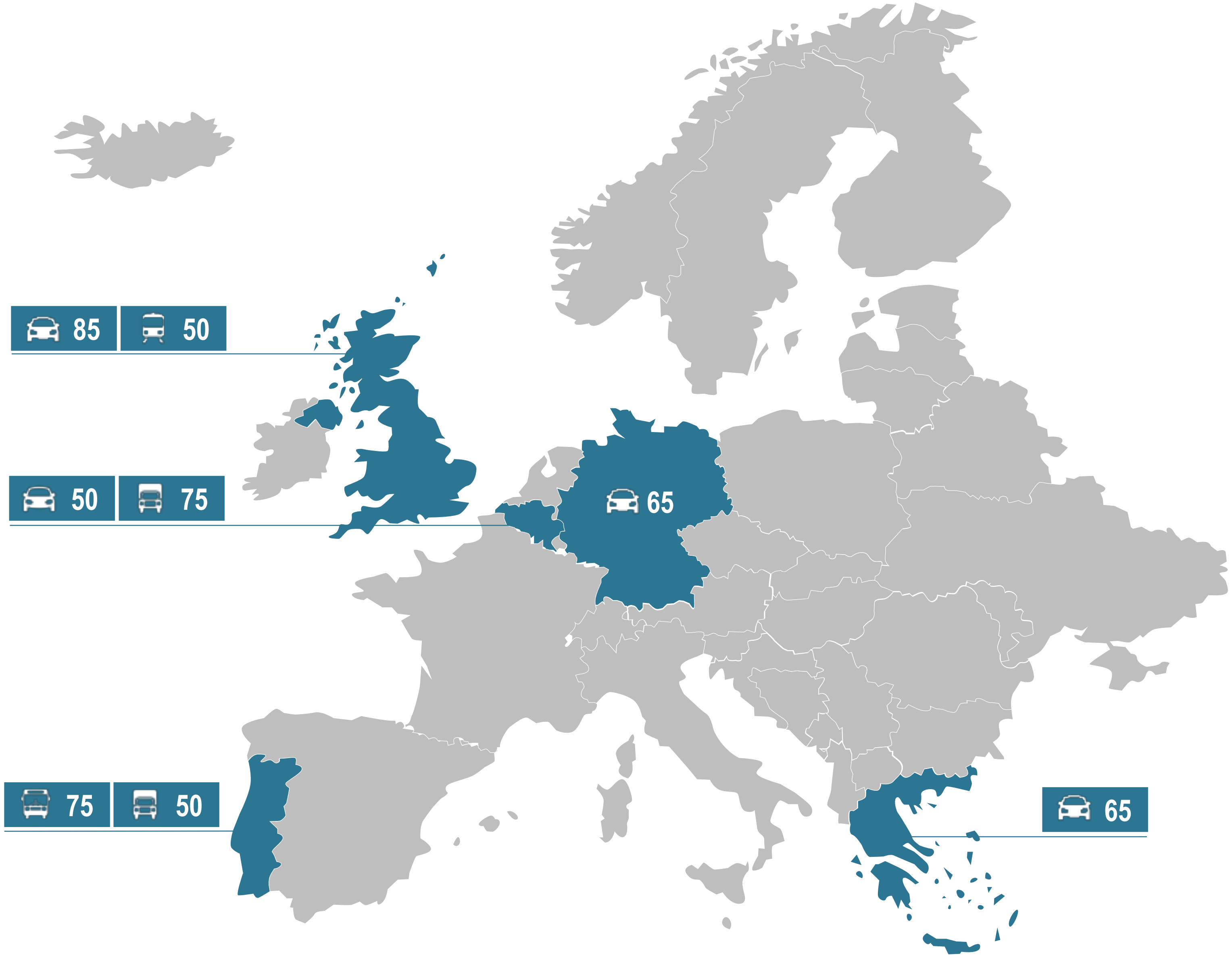
5-Country 4-Stage study

iDREAMS

STAGE 1 — **SIMULATOR**
2 months

STAGE 2 — **PILOT**
1 month

STAGE 3 — **BASELINE**
3 months



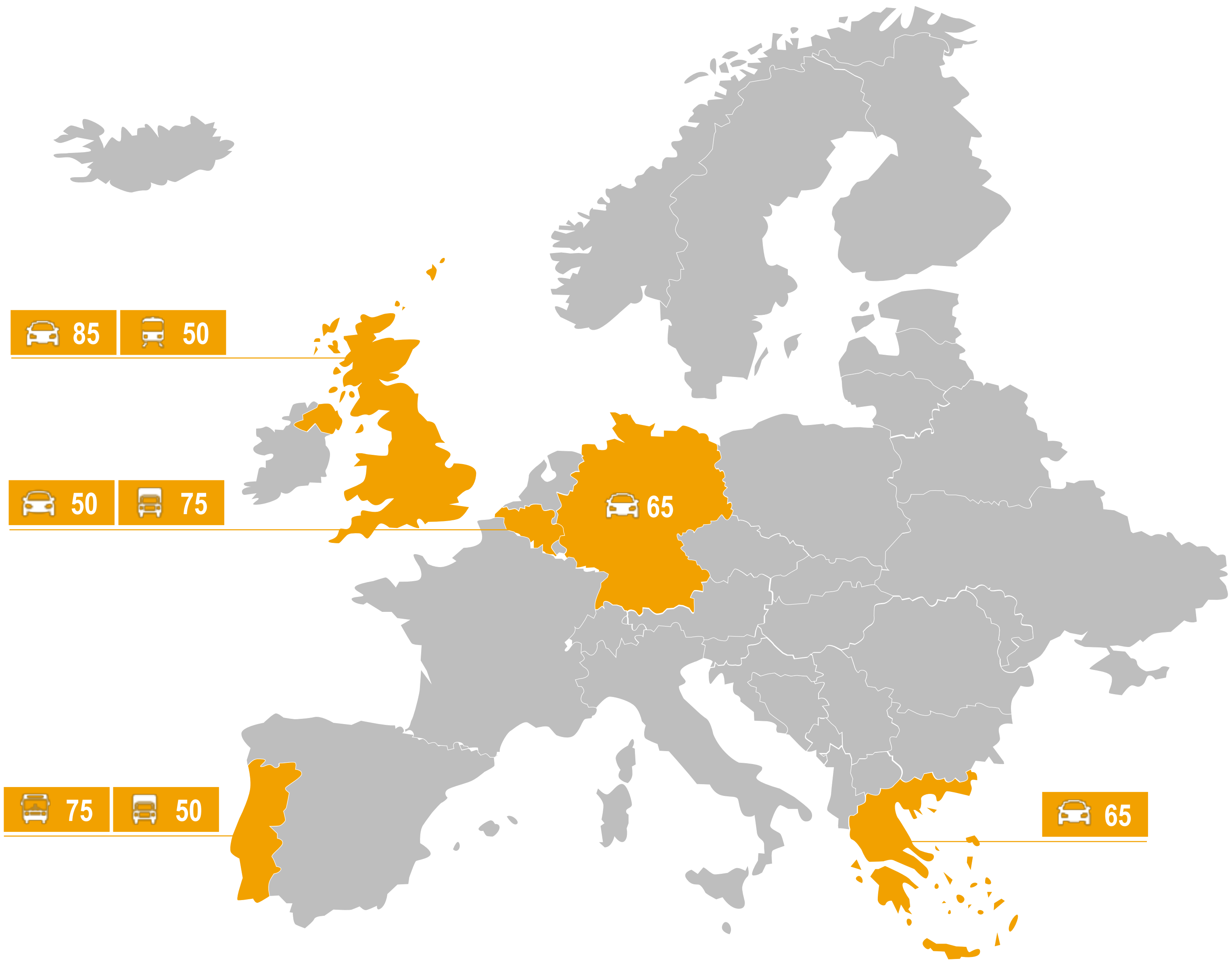
5-Country 4-Stage study

STAGE 1 — **SIMULATOR**
2 months

STAGE 2 — **PILOT**
1 month

STAGE 3 — **BASELINE**
3 months

STAGE 4 — **INTERVENTIONS**
6 months



An insight in the evaluation results

iDREAMS

PHASE1
Baseline
4 weeks

Intervention: NO

PHASE2
4 weeks

Intervention: YES
Real-time feedback

PHASE3
4 weeks

Intervention: YES
Real-time feedback
+ app (feedback)

PHASE4
6 weeks

Intervention: YES
Real-time feedback
+ app & dashboard
(feedback + gamification)

OUTCOME EVALUATION + **PROCESS EVALUATION**

Outcome evaluation

Outcome evaluation investigate whether the intervention had an impact on SO, SPG and PO

Preliminary Results (Descriptive Statistics)

- Belgian Car drivers (wave 1 & 2)
- UK Car drivers (wave 1 & 2)
- Belgian Truck drivers (wave 1)

Events/100km Frequency

- Medium level intensity
- High level intensity

Analysis on question such as

- What is the effect of the i-DREAMS intervention platform on driver behaviour at SPG and PO level?

Key findings

iDREAMS

Results **more significant and consistent** for all SPG and PO

Events/100km have **decreased** with the intervention phases

Mixed results
→ Varying levels of exposure due to COVID

High level events **decreased** consistently in the intervention phases

Reduction in events/100km from phase 3 to phase 4

→ Vital role of **gamification app features** along with other interventions

Key findings

Significantly less events/100km than car drivers (as expected)

Events/100km decreased in interventions phases

Process evaluation

Process evaluation investigate the use and interaction with the i-DREAMS app.

- ❑ **App usage frequencies** for Belgian, German and UK private and truck drivers.
- ❑ **Time trends** for Belgian, German and UK private and truck drivers.

  - ➢ days of the trial
  - ➢ days of the week
  - ➢ hours of the day

In the following and example of the results from Belgian car driver sample.

App usage frequencies

iDREAMS

Wave 1
Open app: N= 1127
Total interactions: N= 3437

Wave 2
Open app: N= 1641
Total interactions: N= 5207

Total
Open app: N= 2768
Total interactions: N= 8644

	W1 (N=26 drivers)		W2 (N= 23 drivers)		Total	
Functionalities within the app	**N**	**Percentage**	**N**	**Percentage**	**N**	**Percentage**
Open the app	1127	32.79%	1641	31.52%	2768	32.02%
Open the trend menu	38	1.11%	68	1.31%	106	1.23%
Open the goal menu	202	5.88%	377	7.24%	579	6.70%
Join a goal	71	2.07%	156	3.00%	227	2.63%
Open the con menu	116	3.38%	141	2.71%	257	2.97%
Open the fact menu	247	7.19%	321	6.16%	568	6.57%
Open the pro menu	122	3.55%	163	3.13%	285	3.30%
Open the tip menu	155	4.51%	209	4.01%	364	4.21%
Open the leaderboard menu	158	4.60%	362	6.95%	520	6.02%
Open the message menu	198	5.76%	230	4.42%	428	4.95%
Open the scores menu	334	9.72%	497	9.54%	831	9.61%
Open the trip menu	669	19.46%	1042	20.01%	1711	19.79%
Grand Total	3437	100.00%	5207	100.00%	8644	100.00%

goals

fact

leaderboard

scores

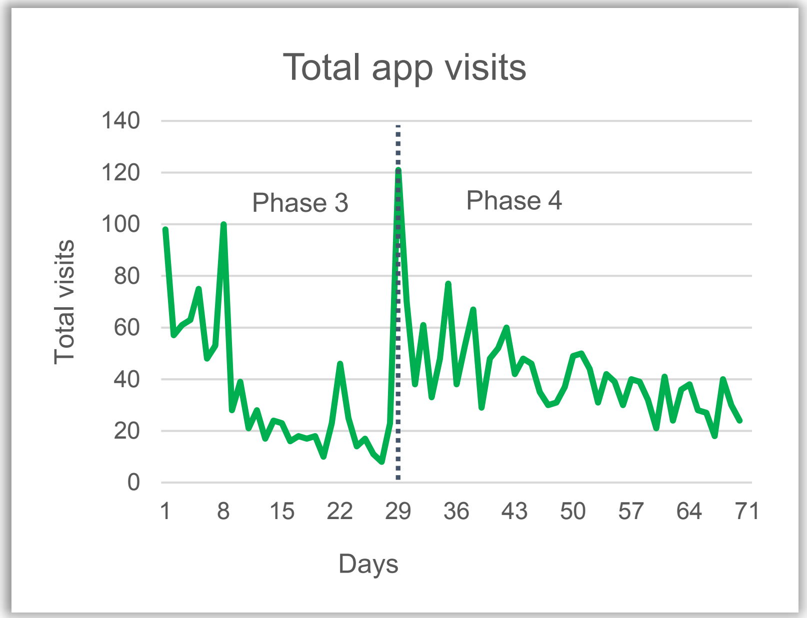
trips

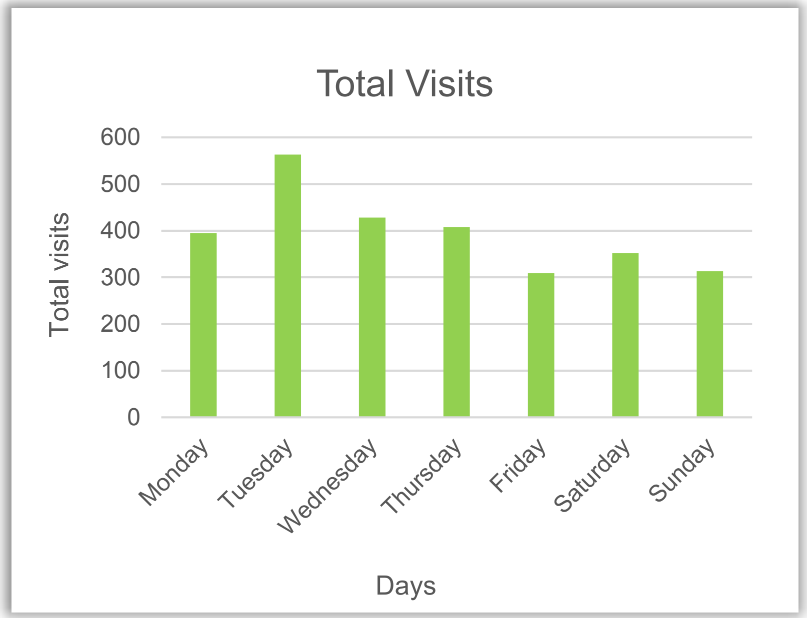
Time trends

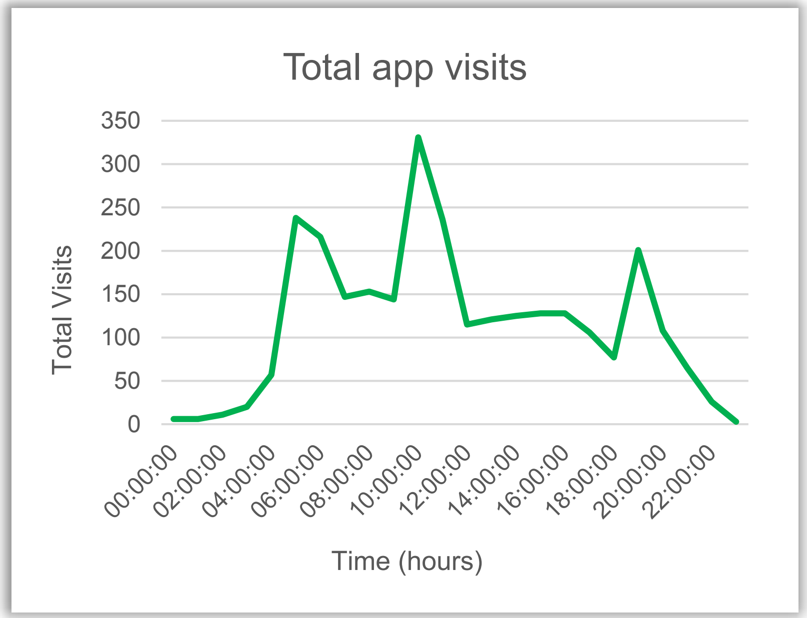
Total visits vs days (general trend for the trial duration)

Total visits vs days of the week

Total visits vs hours







Similar trends were found for professional drivers.

Key findings

- Most popular features: trips, goals, leaderboard, scores
- App use increases from phase 3 to phase 4 in both waves
  → gamification
- App use higher in mid-week period
- App use higher at 06:00-07:00, noon, 21:00
  → push notifications

Project Leader Institution

Prof. dr. Tom Brijs
Project co-ordinator
Transportation Research Institute (IMOB)

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www.idreamsproject.eu
@iDREAMS_project
i-Dreams
i-Dreams

UM FGPA active projects

- **National projects:**
  - Guidelines for the correct planning and design of pedestrian infrastructure; (MINISTRY)
  - Analysis of vehicles driving in the opposite direction on highways; (DARS)
  - Road traffic safety – Development of new road traffic safety assessment methodology; (ARRS and AVP)
- **International projects:**
  - Development of a prediction model for pedestrian children behavior in the urban transport network; (BILATERAL SLO-HR);

Thank you for your attention.

prof. dr. Matjaž Šraml

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This project has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No 814761