



STATUS OF THE AUTONOMOUS VEHICLE TESTING ZONE PROJECT

Project presentation, October 18, 2017

Content

Status of the project

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What steps led till today?
Project overview
Services and business model

What can be tested?

2

Functional overview
Test track modules
Services in detail

Model of operation

3

Business model principles
Service portfolio
Status of business development
Principles of operation

Scientific and social environment

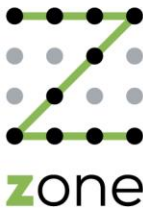
4

Platform concept
Education and R&D initiatives
Legal background
Cross-boarder co-operation



Content

2





Status of the project

Co-operating industrial partners in requirement definition

Industry demand is fulfilled

Automotive Working Group, 2015:

Almotive, AVL, BME GJT, BOSCH, Commsignia, Knorr-Bremse, Continental, EVOPRO, NKH, NI, SZTAKI, ThyssenKrupp Presta, TÜV Rheinland, ZF

- Detailed **technical specification** of the classic elements of vehicle dynamics and physical structure of the automated vehicle tests
- Draft **specification of the autonomous environment** and related communication infrastructure
- Technical proposal for autonomous vehicle **public road testing**

ICT Working Group, 2017:

BME HIT, BME KJIT, BPC, Ericsson, HUAWEI, Kapsch, Magyar Közút, Magyar Telekom, NFM, NMHH, Nokia, Oracle, RWE, Siemens, SWARCO, T-Systems, Vodafone (compared to the new members of the automotive working group)

- Detailed specification of the autonomous vehicle environment and related **communication infrastructure**



Status of the project



Decision on Public Investment – Testing Zone

Government of Hungary is Committed to Innovative Industries

Capacity constraints in Europe in area of vehicle dynamic testing

Technology change in vehicle industry – single vehicle vs. co-operative vehicle control: different development environment is required

Decision of Hungarian Government in 2016: „contribution to the European automotive community”

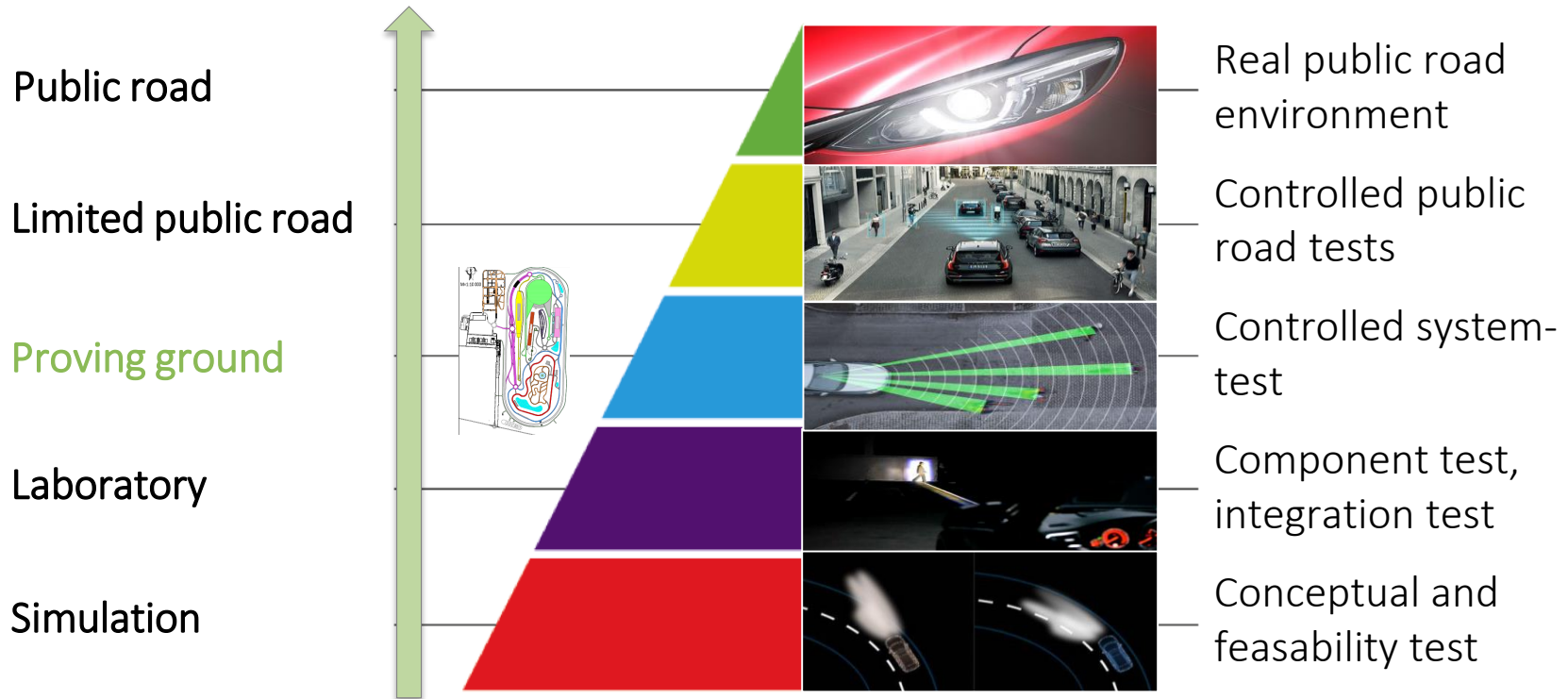
Test field for classic and automated and connected vehicles in Hungary



Status of the project

Multi-level testing environment

From computer to real traffic – essential for automated driving



Status of the project

Overview of the Layout of the Unique Proving Ground

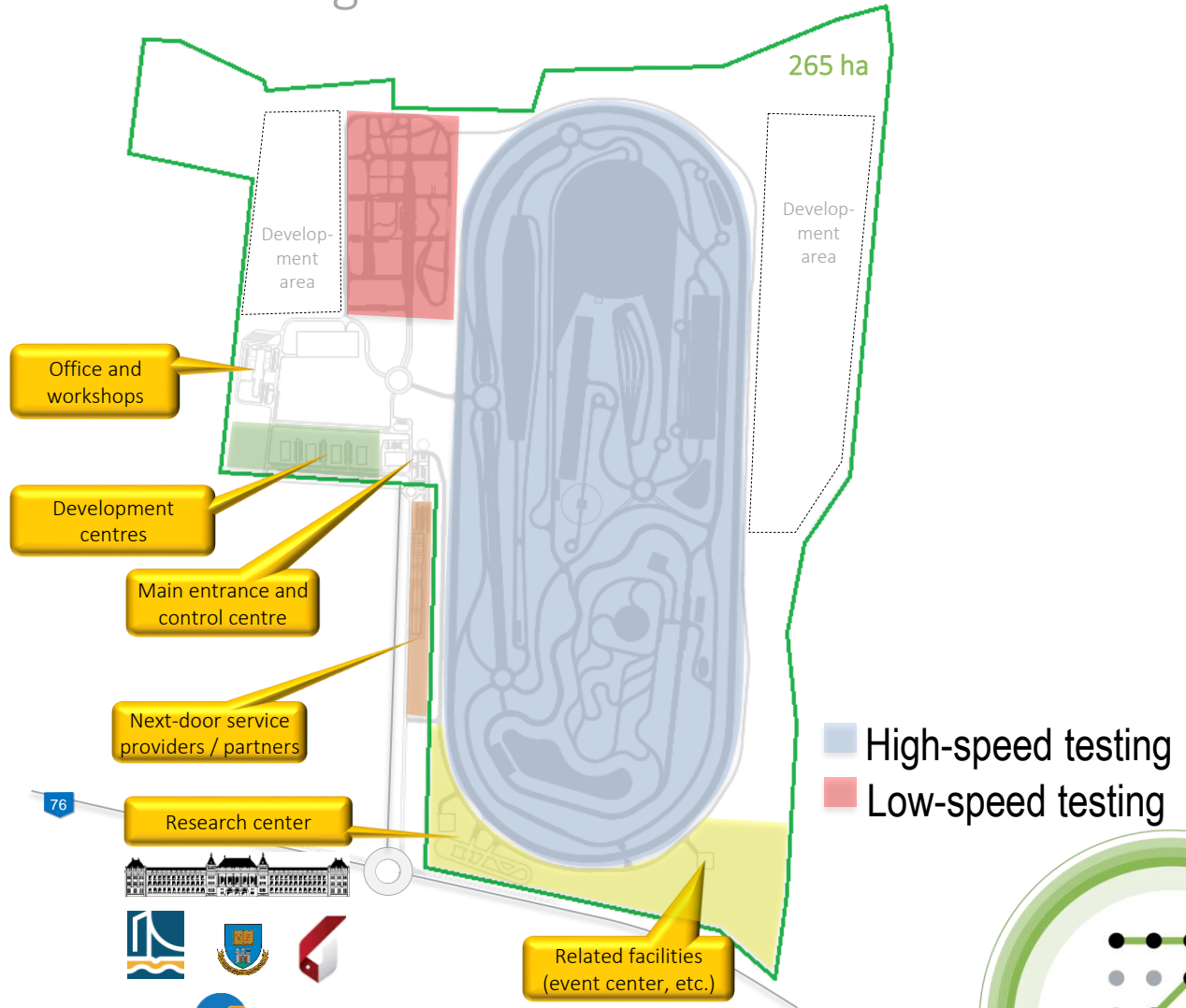
Traditional and autonomous testing modules



Concept is based on:

- Best practices from other similar facilities
- Business studies
- Environmental studies

- Customer zone
- R&D campus
- Service zone



Status of the project



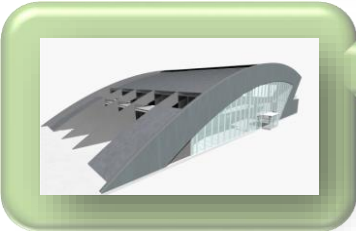
Multi-level testing environment

Buildings and modules

Control center



Workshops and offices



Main entrance building

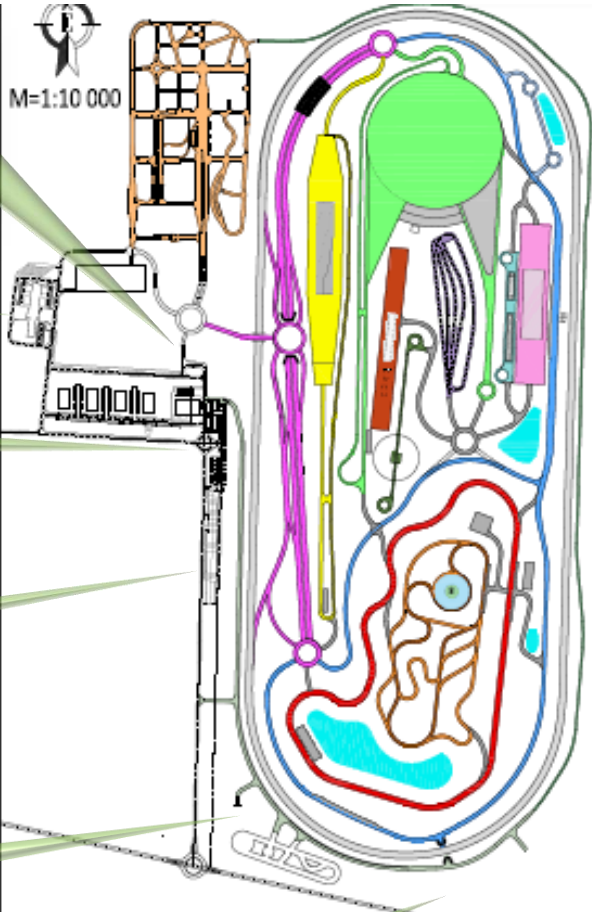


Service providers

Research center, University building



Related buildings



Status of the project



Definition of Project Phases

Phase 1: 2017-2018
(70MEUR)



Phase 2: 2018-2020
(70MEUR)



Status of the project



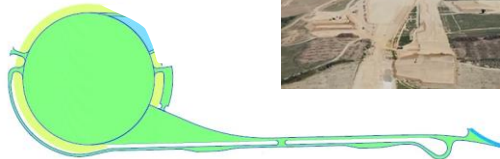
Project Milestones and Basic data

Preparations



Status of the project

Project milestones and basic data

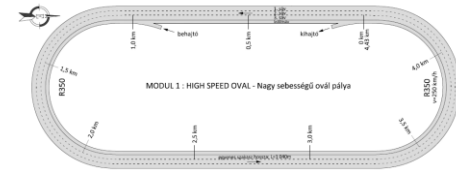


Dynamic platform

May-Dec, 2017



[VIDEO](#)



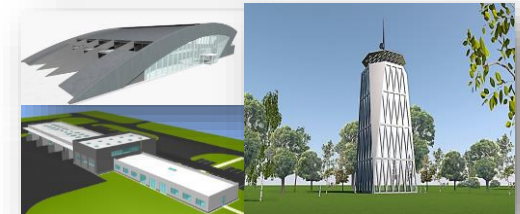
High speed oval preparation PART I
Oct, 2018

End of Phase 1
**Jun,
2018**

Aug, 2017-Jun, 2018



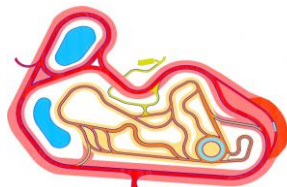
Braking platform



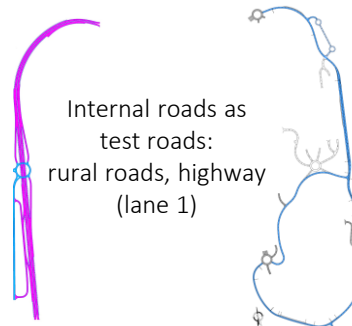
Buildings:
main entrance,
technical building,
control center



Smart City Zone I.
completion



Handling course



Internal roads as
test roads:
rural roads, highway
(lane 1)

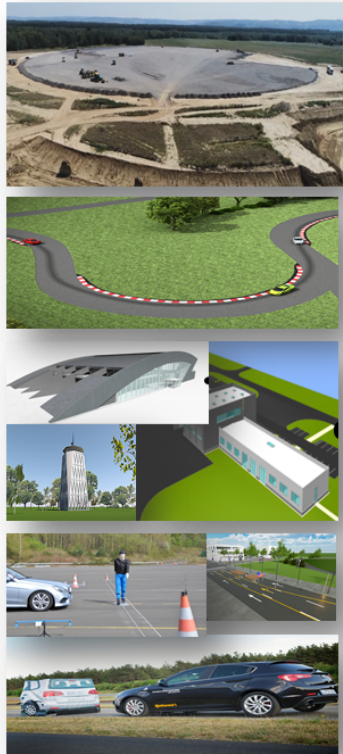


Status of the project



Project milestones and basic data

Actual status – runs according to project plan



ELEMENTS	CONTENT	PROGRESS
Basic construction works	<ul style="list-style-type: none"> - Dynamic platform - Braking platform - Handling course - Smart City Zone - Internal roads – Part 1 	▶▶▶
Final construction works	<ul style="list-style-type: none"> - 4 modules completion - Public utilities - Internal roads – Part 2 	▶▶
Buildings	<ul style="list-style-type: none"> - Main entrance building - Technical building 	▶▶▶
Buildings	<ul style="list-style-type: none"> - Control center 	▶
Technology	<ul style="list-style-type: none"> - Test tracks technology - Watering technology I - AD technology: Scenario simulation equipment - AD technology: Sensor cluster I - AD technology: Data management basic system - Operation equipment 	▶



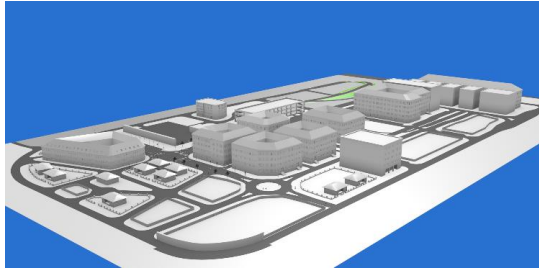
Status of the project

- ▶▶▶ Contracted
- ▶▶ Tender running
- ▶ Tender preparation



Project milestones and basic data

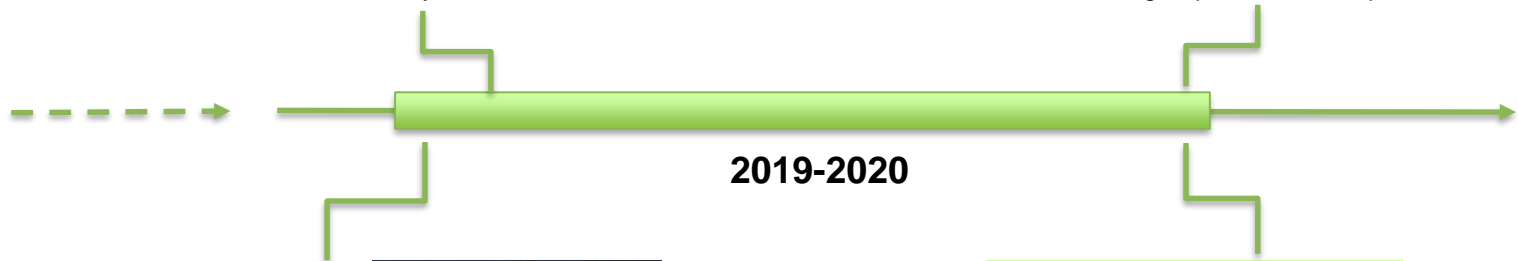
PHASE 2



Smart City Zone II.



High-speed oval completion



2019-2020

Additional moduls:

- Slopes
- Kick-plate
- Bad roads
- Aquaplaning
- Noise measurement plate



Additional buildings:

- University Research Center
- Related buildings



Status of the project



A hand in a white suit jacket points towards a futuristic, semi-transparent interface. The interface features a central blue circle containing a white car icon with four wireless signal symbols (two above and two below) radiating from it. This central element is surrounded by various geometric shapes: a large green circle at the bottom left, a smaller green circle at the top left, and another green circle at the bottom right. The background is a blurred image of a person in a suit, suggesting a professional or technological setting.

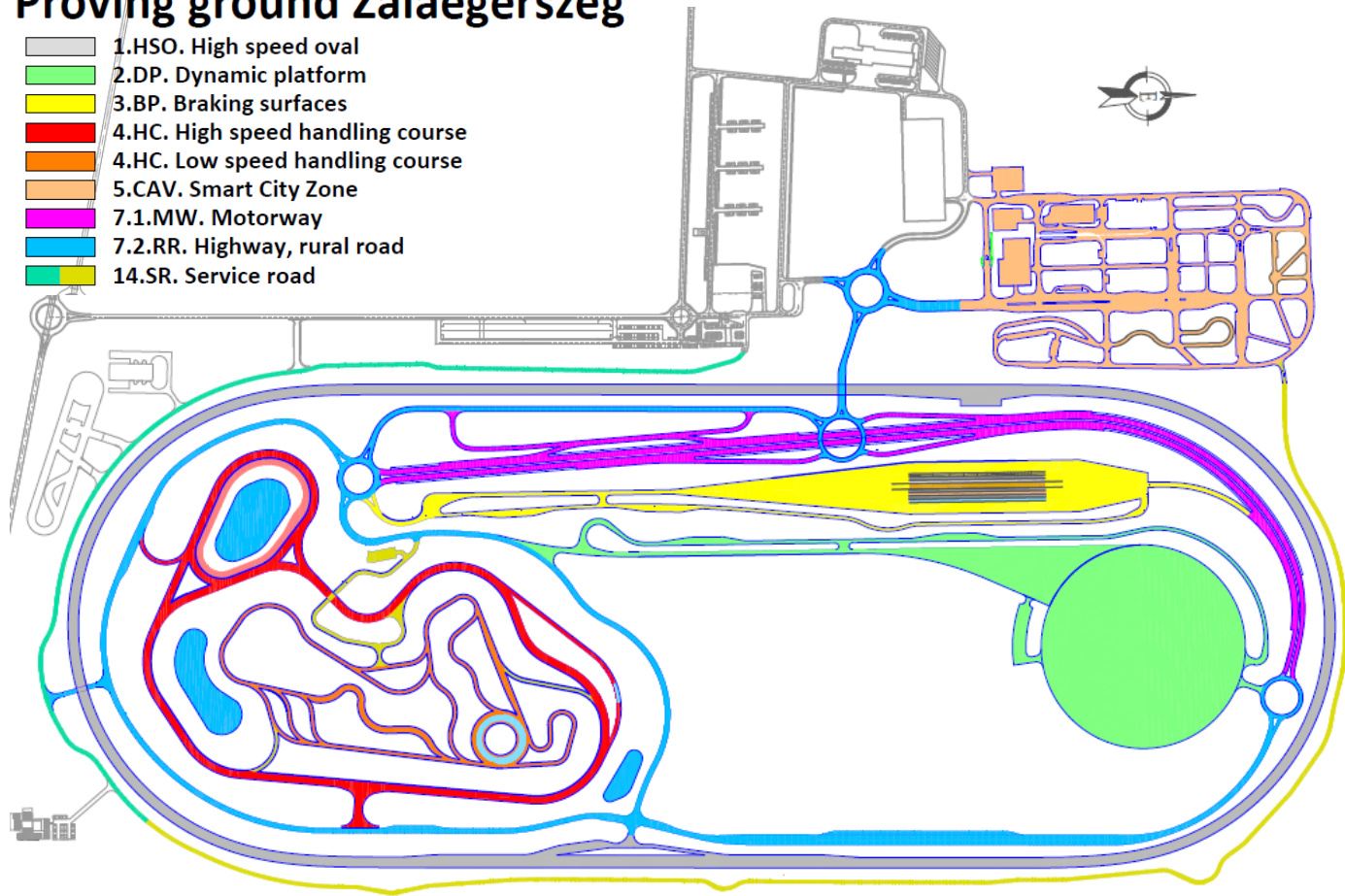
What can be tested?

Modules to be realized with Priority 1

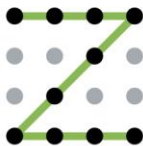
Priority is defined with future customers

Proving ground Zalaegerszeg

- 1.HSO. High speed oval
- 2.DP. Dynamic platform
- 3.BP. Braking surfaces
- 4.HC. High speed handling course
- 4.HC. Low speed handling course
- 5.CAV. Smart City Zone
- 7.1.MW. Motorway
- 7.2.RR. Highway, rural road
- 14.SR. Service road



What can be tested?



Proving Ground Modules

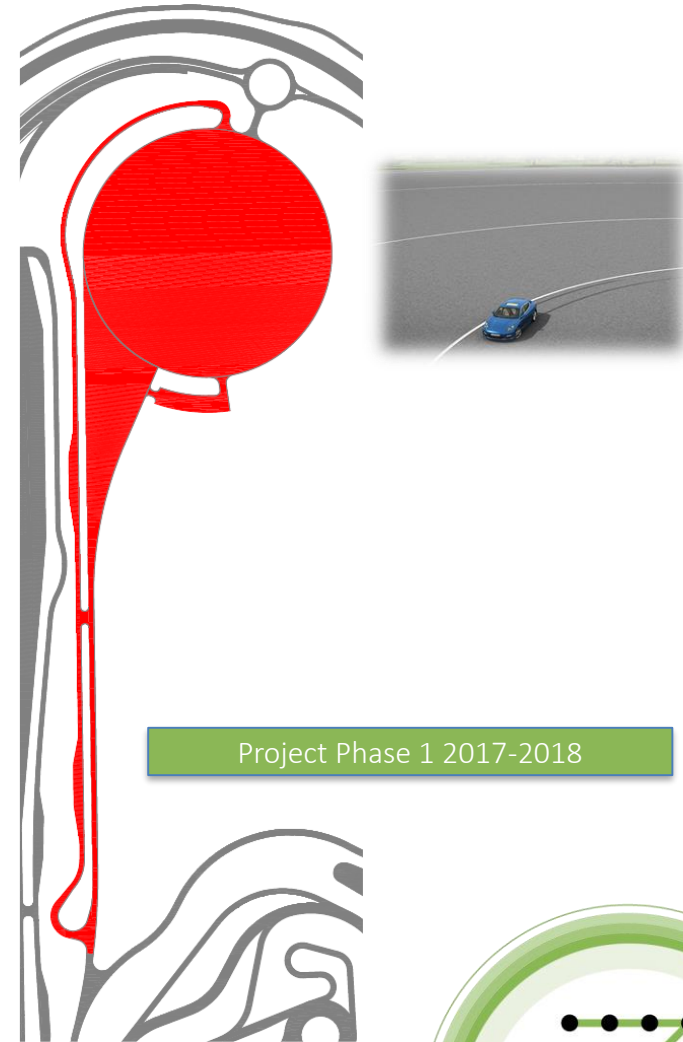
Dynamic platform

Physical parameters:

- 300m diameter asphalt surface
- Acceleration lane 760m and 400m long
- 20m wide FIA emergency area
- Watered surface (optional)
- Watered basalt surface at easter acceleration lane (phase 2.)
- 1% inclination to south
- Separated return way

Autonomous vehicle test cases:

- Platooning at free trajectory
- Cooperative vehicle control at high and medium μ with different trajectories (double lane change, J-turn etc.) at stability limit (ABS, ESP activity)
- Fix position obstacle (dummy car or pedestrian)
- Euro NCAP scenarios



What can be tested?

Proving Ground Modules

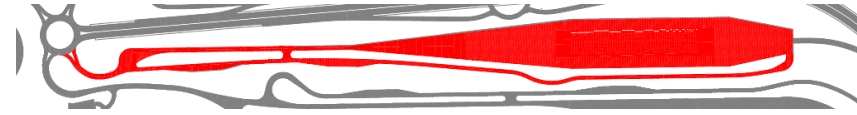
Braking platform

Parameters:

- 6 different surfaces:
 - Chess surface: asphalt/tiles
 - asphalt $\mu_{e} \approx 1$ (optional watering)
 - tiles $\mu_{e} \approx 0.1$ (wet)
 - Blue basalt $\mu_{e} \approx 0.3$ (wet)
 - Treated concrete $\mu_{e} \approx 0.6$ (wet)
 - aquaplaning basin (max. 5cm wet depth)
- 200m surface length
- 750m acceleration lane
- 20m safety area at both side, 150m at the end

Autonomous vehicle test cases:

- Platooning at physical limits; drive through or braking at various surfaces up to high speed
- Cooperative vehicle control at physical limit, moving or static obstacle, at various speeds during ABS, ATC, ESP activity

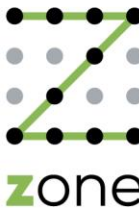


Project Phase 1 2017-2018



What can be tested?

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Proving Ground Modules

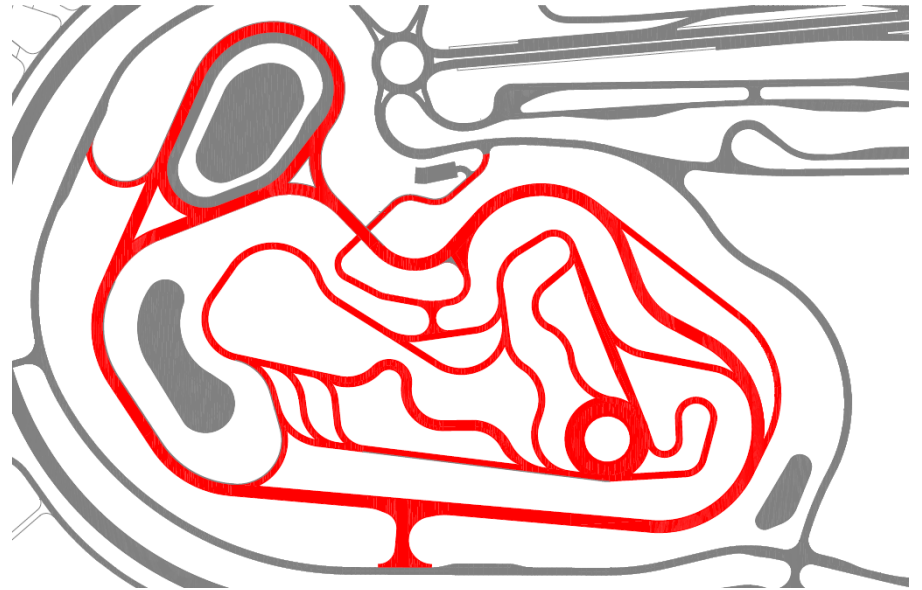
Handling course

Parameters:

- Low (60km/h) and high speed (120km/h) section
- 1.300m and 2000m length
- width: 6 and 12m
- 20m wide gravel covered safety zones
- Various topography
- V2X coverage for communication tests at various terrain

Autonomous vehicle test cases:

- Platooning at medium speeds at diverse topography
- Cooperative vehicle control at diverse topography and limited visibility

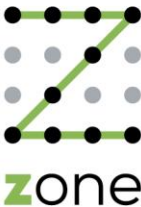


Project Phase 1 2017-2018



What can be tested?

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Proving Ground Modules

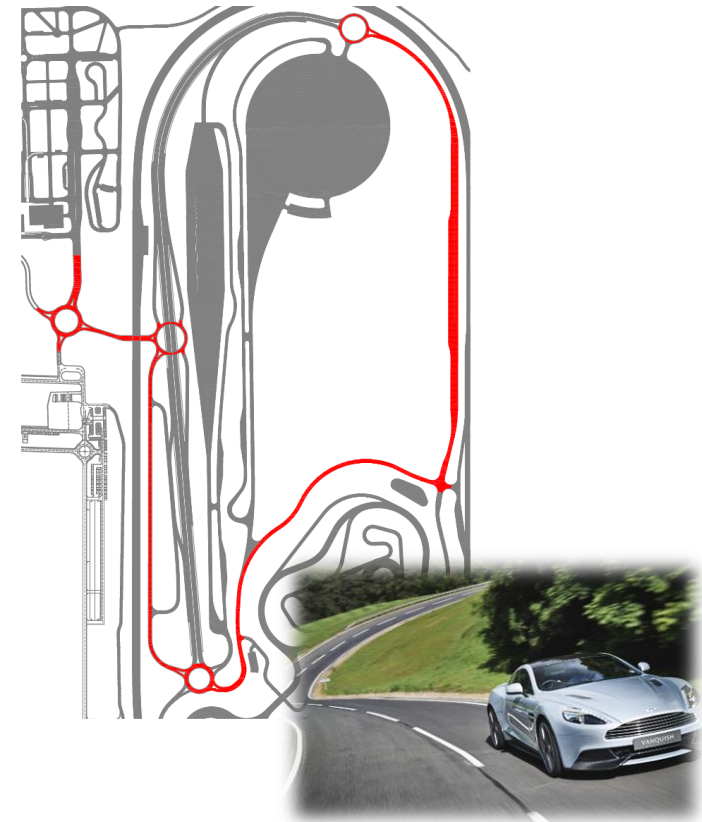
Rural road

Parameters:

- 500m 2x2 lane motorway
- 2500m 2x1 lane rural road
- Partly watered surface
- 5G test network
- V2X communication coverage
- GPS base station
- Public road like layout (junctions, road surface, geometry)

Autonomous vehicle test cases:

- Platooning on rural road at realistic conditions, various type of junctions, roundabouts
- Diverse lane layout: 2x1, 2x2, 2+1,
- Diverse topography
- Moving and static obstacles
- Construction site situation
- Various road side elements: trees, fences, grass etc.



Project Phase 1 2017-2018



What can be tested?

Proving Ground MModules

Motorway

Parameters:

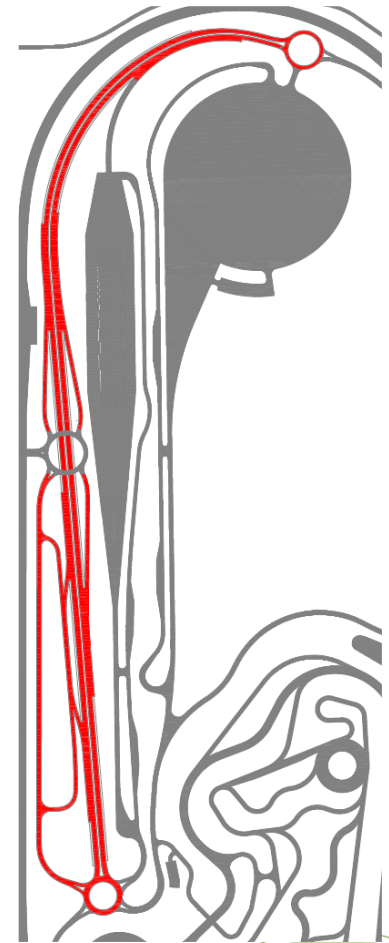
- 1500m 2 x 2+1 lane motorway
- 100m real tunnel
- Partly watered surface
- VMS, 5G test network
- V2X communication coverage
- GPS base station
- Public road like layout (junctions, road surface, geometry)

Autonomous vehicle test cases:

- Platooning on motorway at realistic conditions, exits and entrances
- Platooning and cooperative control with limited communication (tunnel)
- Moving and static obstacles
- Construction site situation
- Multi level junction



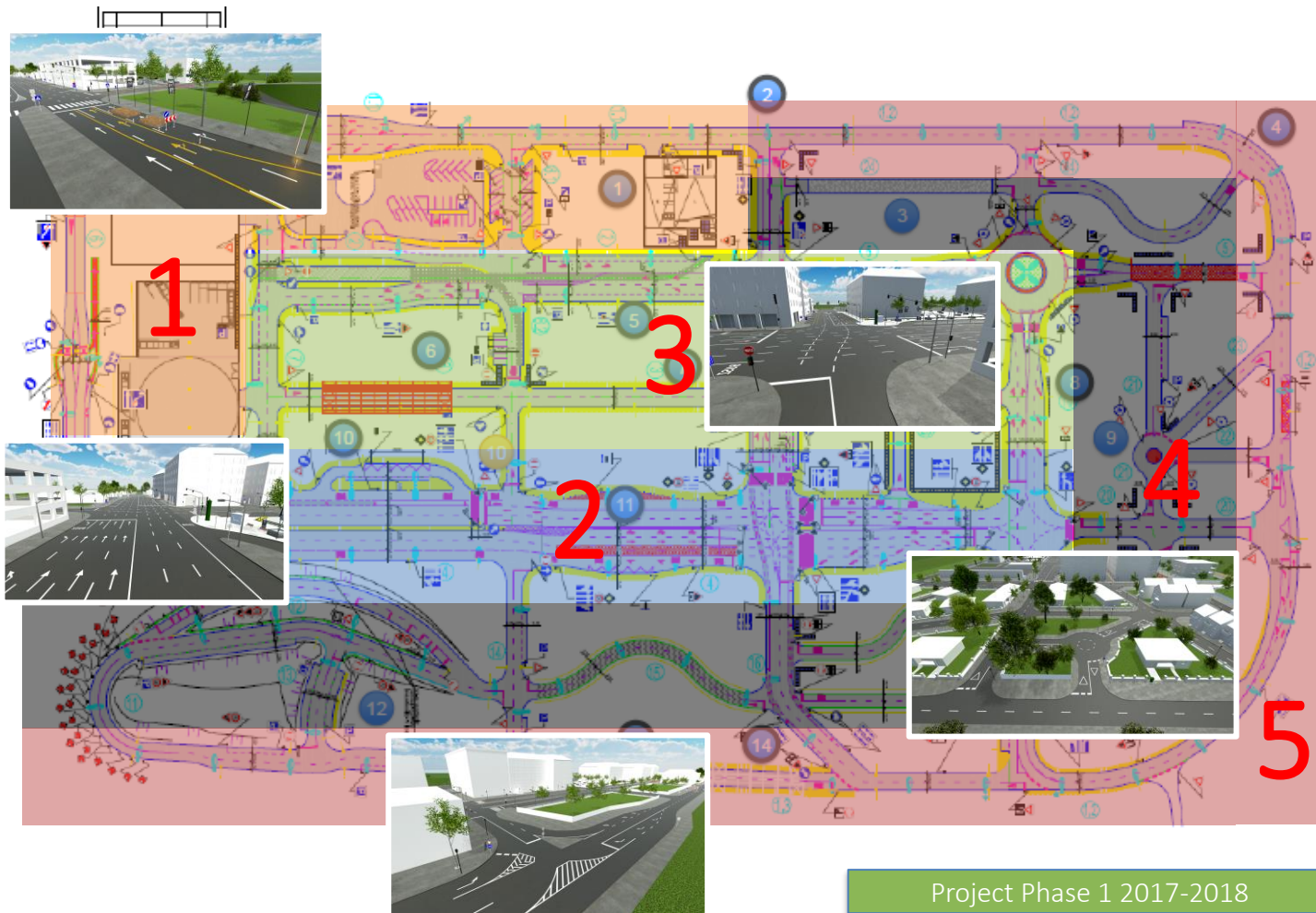
Project Phase 1 2017-2018



What can be tested?

Proving Ground Modules

SMART City Zone – Separated Function Zones



1. Low-speed, parking area
2. Multi-lane high speed area
3. Downtown area
4. Suburban area
5. T-junction area



What can be tested?

Proving Ground Modules

Communication network

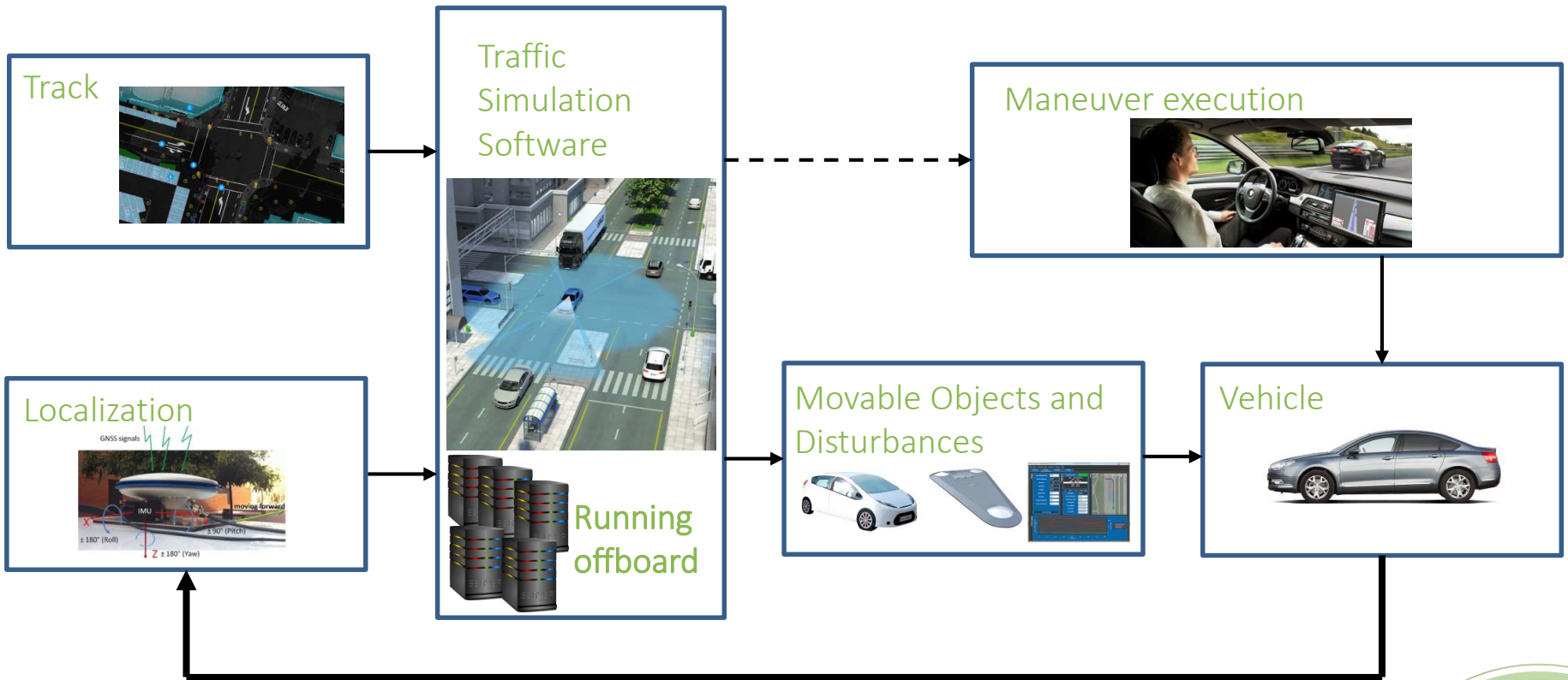
- 3 level approach:
 - 1st level: ITS G5 basic V2X test environment
 - 2nd level: V2X developer environment: **freely configurable**, open interface for application developers, full data logging infrastructure
 - 3rd level: fully **customer defined** test environment
- 5G cellular test network for future ITS applications
- **Redundant layout** for parallel customer networks



What can be tested?

Construction of Complex Test Scenarios

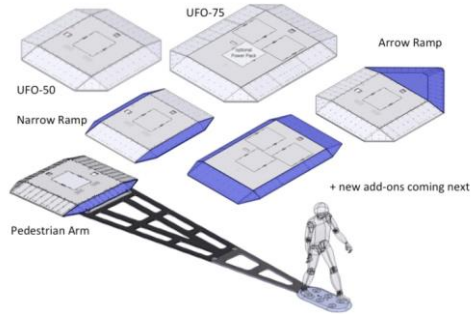
Opportunities for the Scenario-in-the-Loop (SciL) Simulation



What can be tested?

Construction of Complex Test Scenarios

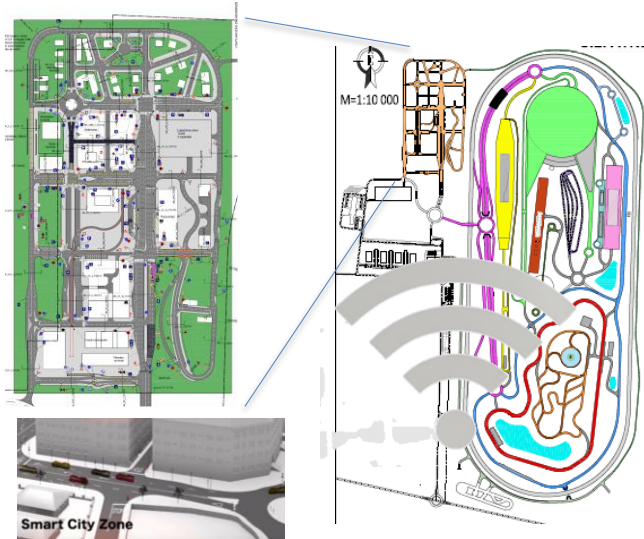
Dummies and UFO's



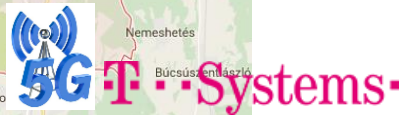
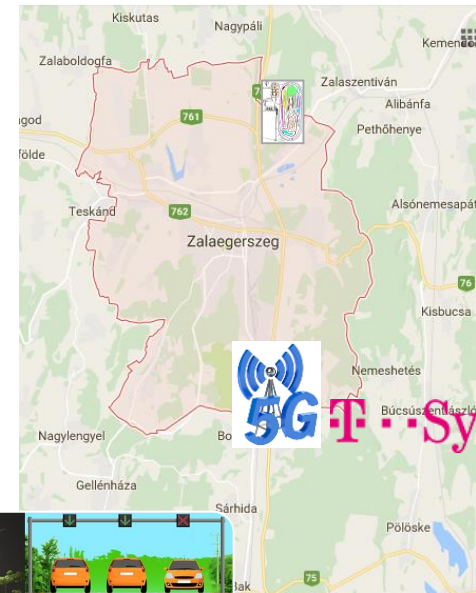
What can be tested?

Leaving the Closed Testing Environment ...

Zalaegerszeg as Smart/Digitalized City environment for Testing



Test track modules and scenarios for controlled and repeatable tests in a safe environment



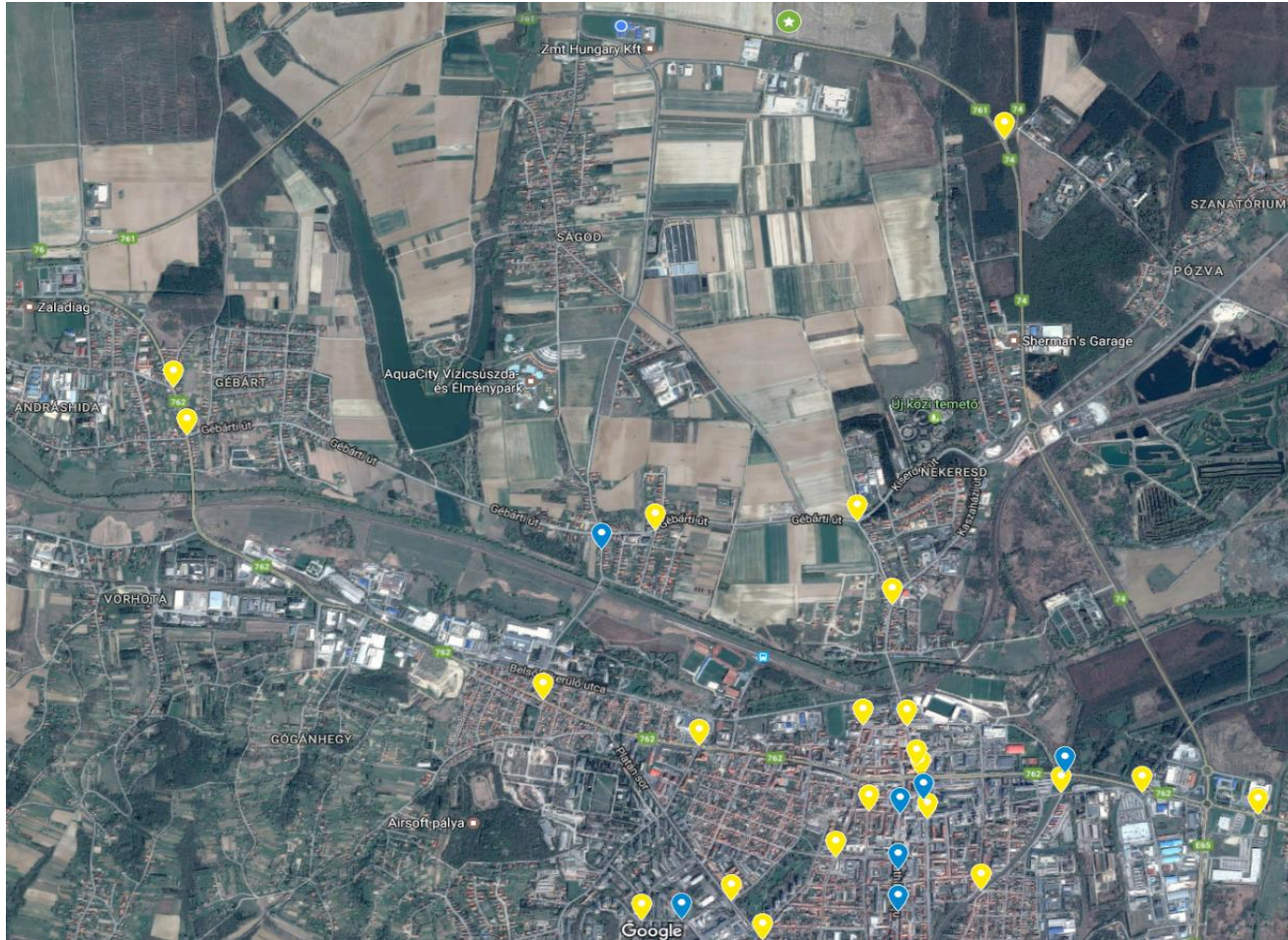
City environment for random real-life testing



What can be tested?

Public Road Tests

Possible test sites in Zalaegerszeg



What can be tested?



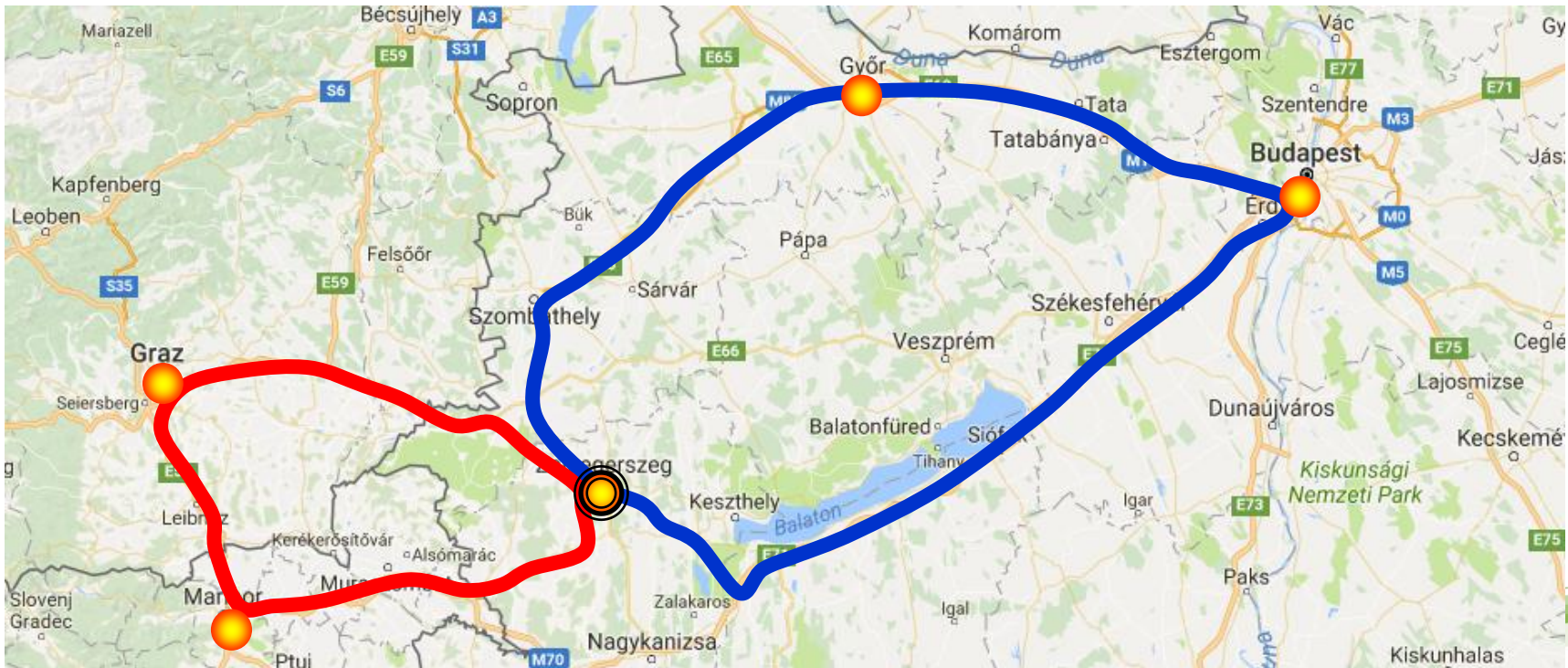
Leaving the Closed Testing Environment ...

High speed testing in real environment – “Triple loop”

Loop_1: In city Local roads (City Zalaegerszeg) – smart infrastruktúra

Loop_2: Hungarian roads (Zalaegerszeg-Gyor-Budapest)

Loop_3: International roads (Graz-Zalaegerszeg-Maribor zone)



What can be tested?

Public Road Tests

Public roads with autonomous test focus: R76, newly built

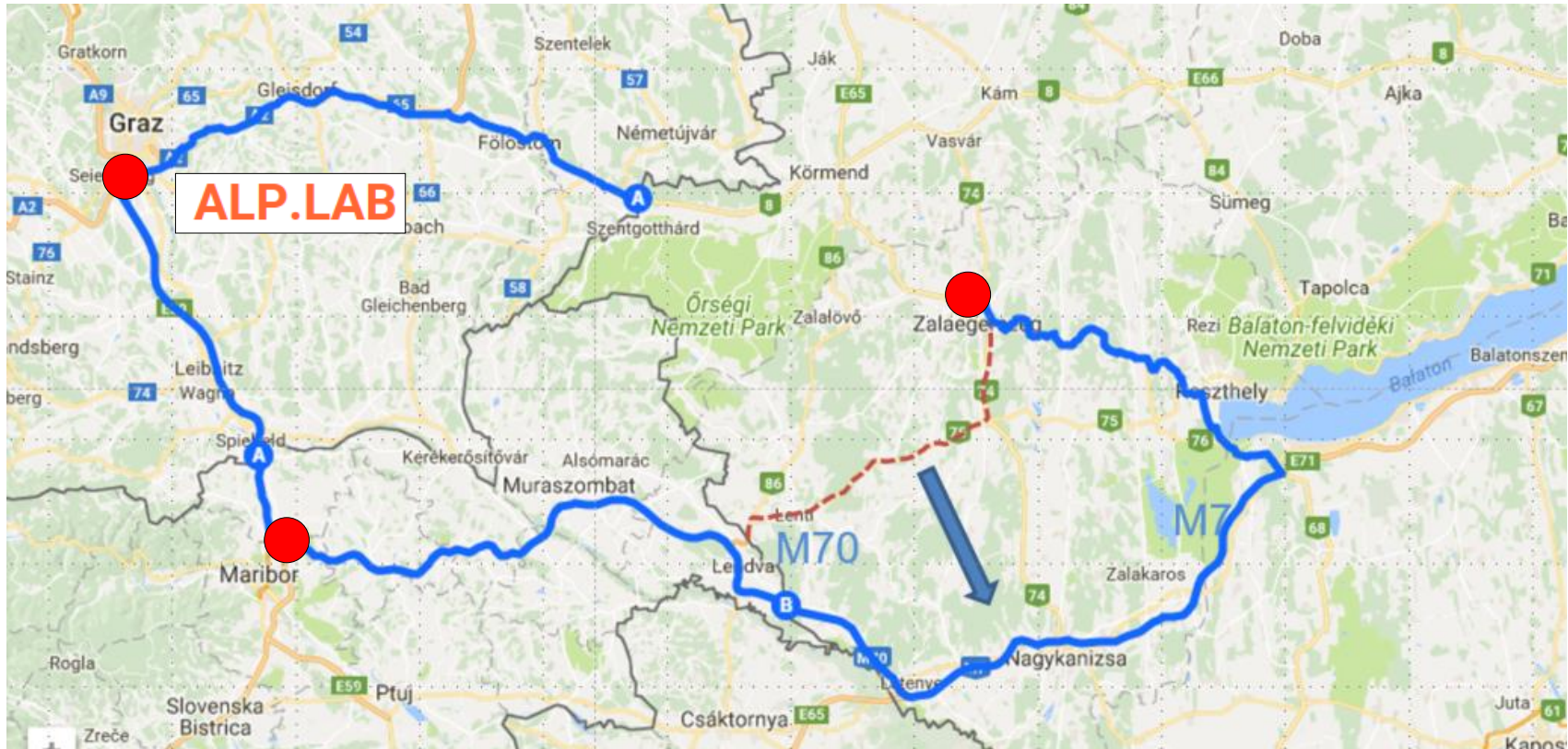


Testing opportunities



Public Road Tests

Short-term potential – M7, M70, ALP.LAB (A)



What can be tested?





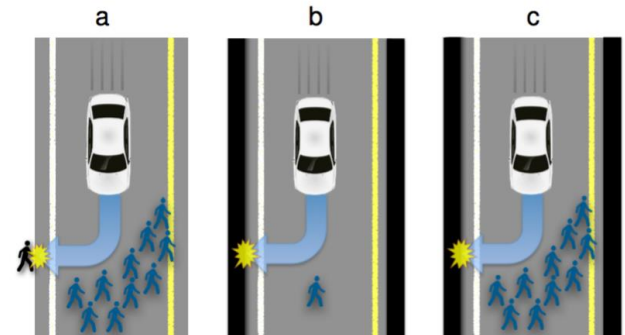
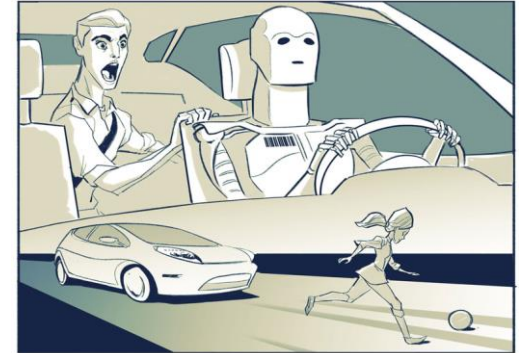
Model of Operation

Models of Mobility will Change...

Non-technical questions will also appear

- Can we take away the enjoyment of driving from the driver?
- As different to the other co-operatively drivable vehicles (plane, boat, rail) we must be ready to manage the vehicles to handle the dangerous situations while having human participants with unperfect and very different abilities?
- What is the base of decision if we must choose from two bad options?
- Liability and legal concerns remain open for a while...
- New business models/players will appear
- New concerns will rise: how can we guarantee, that autonomous vehicles will not be put in non-proper use, etc.

Source: Technologiereview, VDA

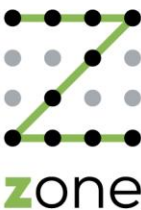


Number of test/use cases can exponentially increase



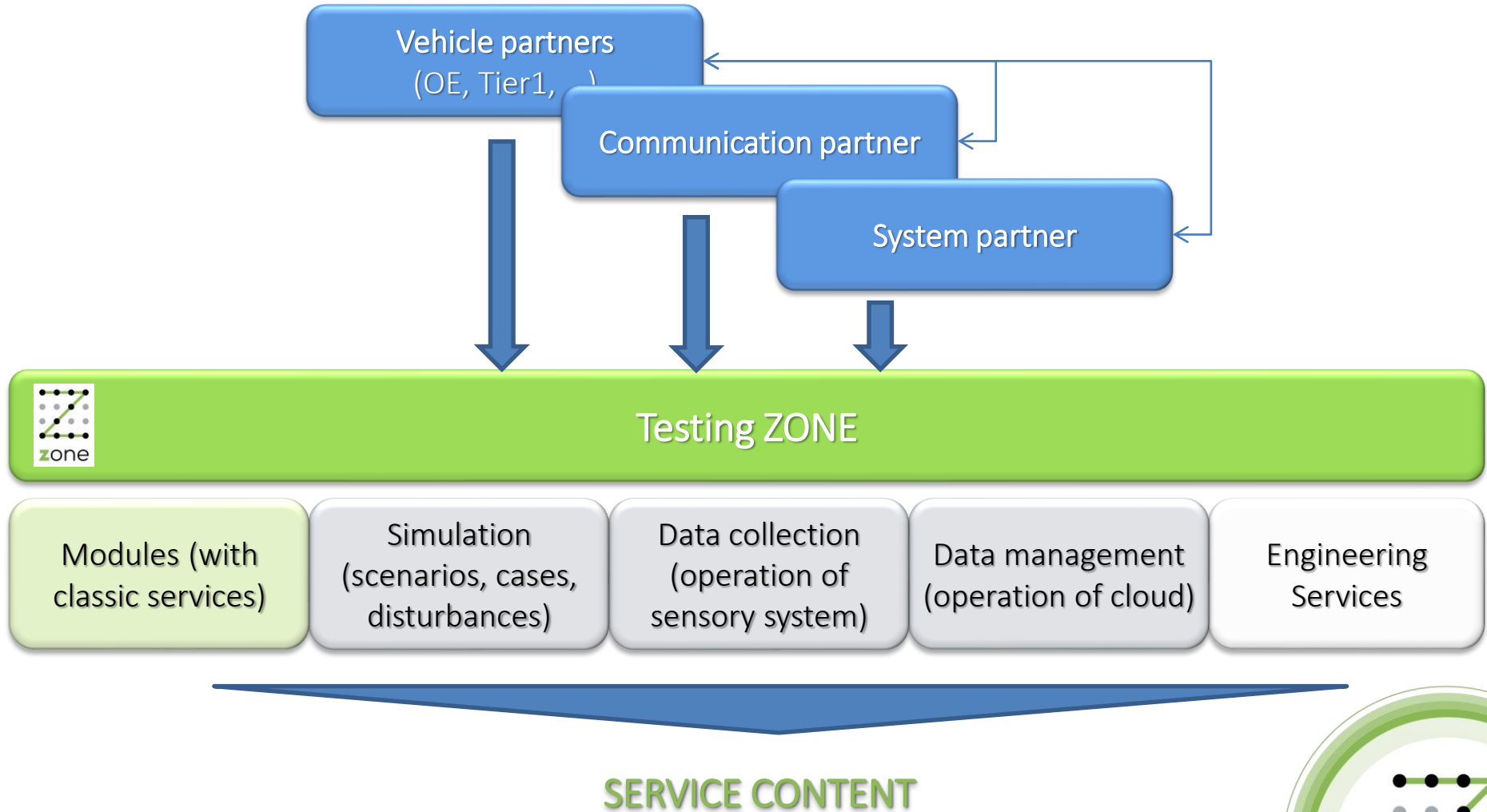
Model of operation

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Business & Operation Model

Operation models will change

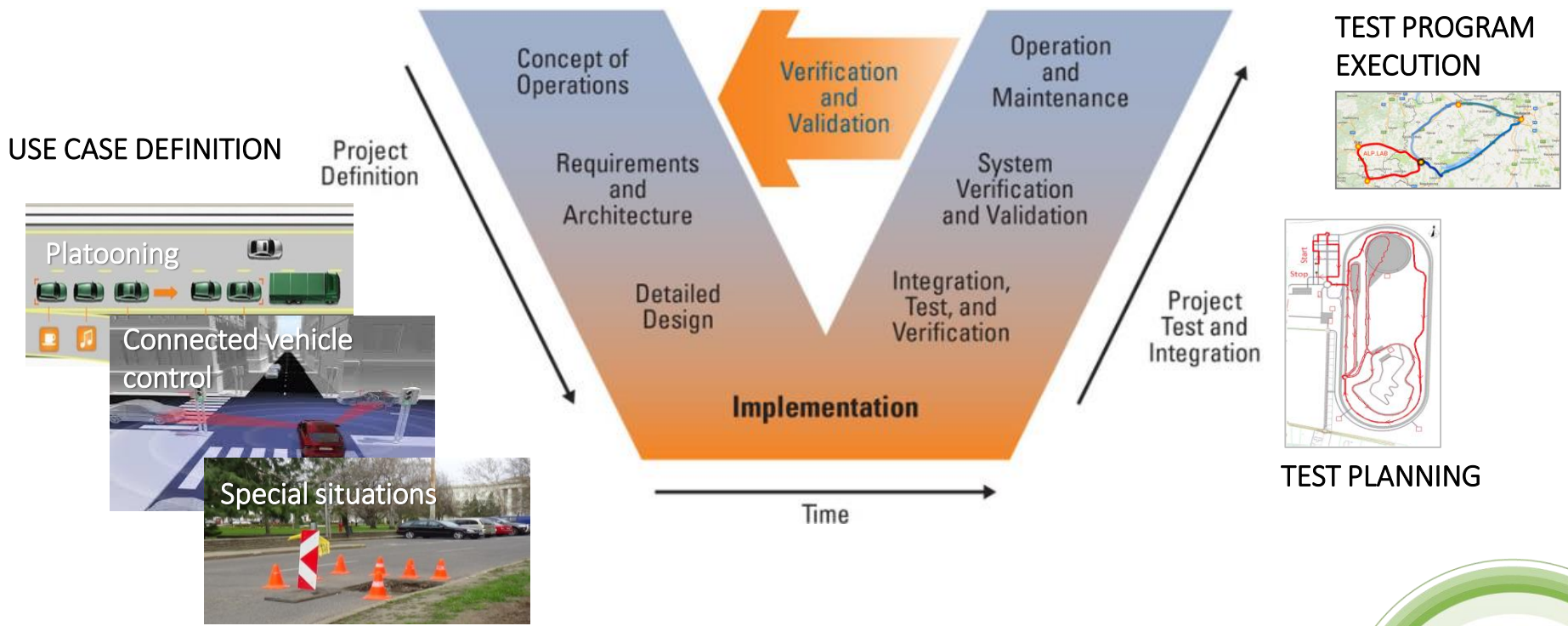


Model of operation



Participation of the Testing Zone in the “V-Model”

Services planned



 Model of operation

Types of Services and Providers

Flexible business model – not defined yet, open for proposals

	Property developer	Technological operator	Business organizer
Classics	Logistics, safety and security, storage, special module operation (e.g. watering), offices and workshops, basic IT and communication, repair, authorities, event organization, hotel, etc.		
Simulation	Developing scenarios, providing traffic simulation services (other cars, pedestrians, etc.), simulation of different kind of disturbances (rain, EMD, light, interferences, visual, etc.), access to full vehicle simulation bench		
Data collection	Installed sensor system for test data collection, special data services (e.g. drone or other robot based data acquisition), offering own data collection system installation opportunities.		
Data management	Data center with different service opportunities (simulation, computer cluster), cloud at the test track		
Research and Engineering Services	Depending on the demand and the capabilities of universities and other research partners		



Model of operation

Actual Partner Overview

Letter of Intent (LoI)

T · · Systems ·

Memorandum of Understanding (MoU)

Memorandum of Understanding (MoU) WG



Non-Disclosure Agreement (NDA)



Non-Disclosure Agreement (NDA) WG



Indication of Interest...



Need follow-up...



Model of operation

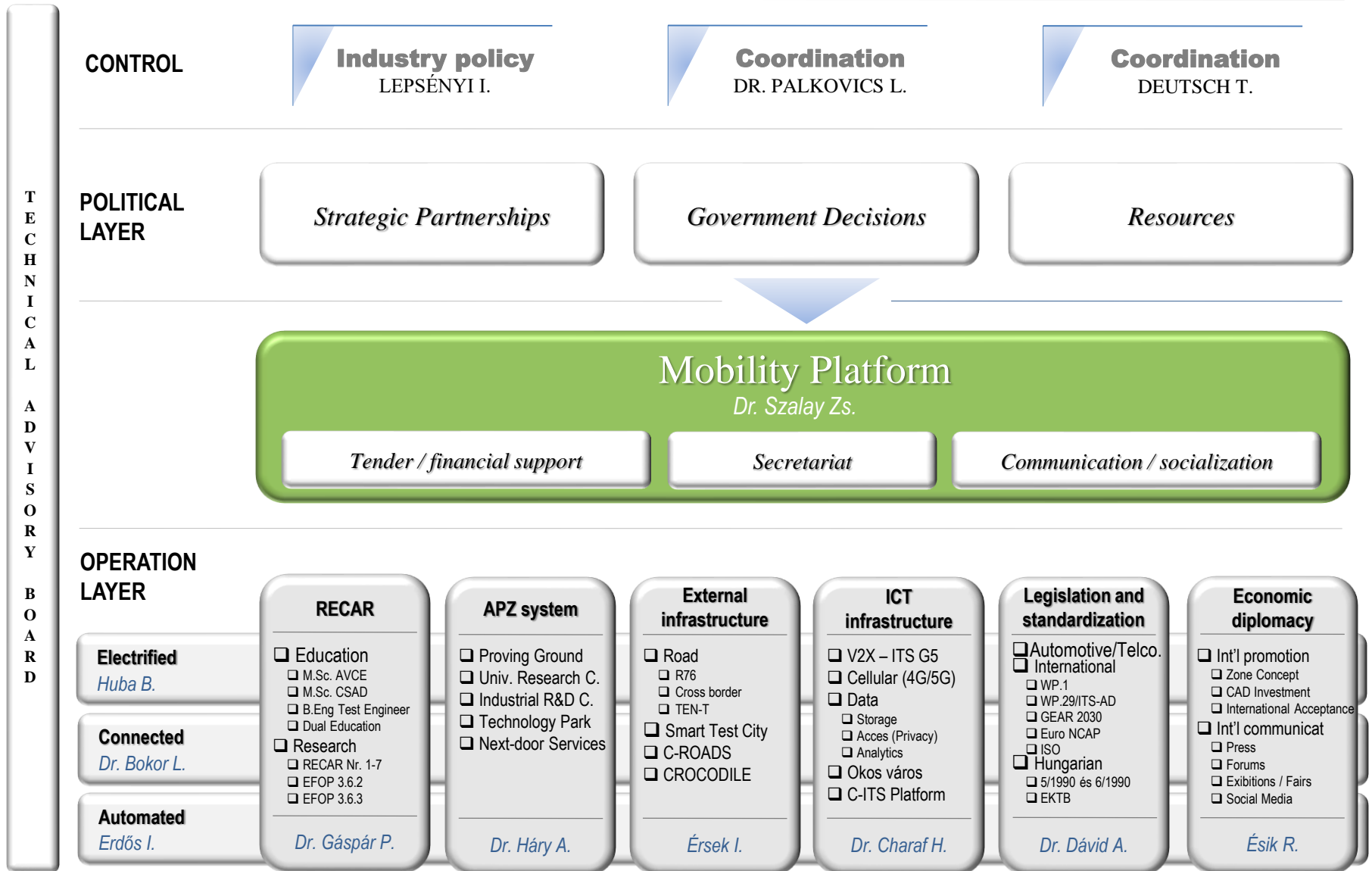




Scientific and social
environment

Strong Community Network

Stakeholders are identified and contacted



RECAR Education program

REsearch Center for Autonomous Road vehicles

Long term competency in electronic vehicle control

- Industrial partners (BOSCH and Knorr-Bremse)
- Academic partners (BME, ELTE, MTA SZTAKI)

Strong government support

- Higher added value compared to manufacturing
- ROI calculation at national economy level
- Special research funding programs

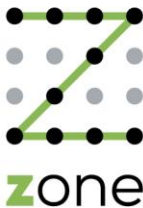
Dedicated BSc/BEng and MSc courses

- Autonomous Vehicle Control Engineer MSc in English, starting in February 2018, Budapest, BME
- Computer Science for Autonomous Driving MSc in English, starting in September 2018, Budapest, ELTE
- Vehicle Test Engineer BEng in Hungarian, starting in September 2018, Zalaegerszeg



Scientific and Social Environment

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RECAR Education program

Strong scientific community for autonomous vehicle technology research

	1	2	3	4
1	Numerical mathematics	Industrial image processing	Automotive R&D processes and quality systems	Diploma thesis
2		Vajta László	Wahl István	
3	ELTE	BME	BME	
4	2 0 1 f 4 TT IK	3 1 0 v 4 TT VIK	3 0 0 f 4 GH GJT	
5	Control theory and system dynamics	High performance microcontrollers and interface	Project management	
6	Bokor József-Gáspár Péter	Tevesz Gábor	2 0 0 f 2 GH GTK	
7	BME	BME	Machine vision	
8	2 0 2 v 4 TT KJIT	2 1 0 f 4 TT VIK	Szirányi Tamás	
9	Intelligent systems	Human factors in traffic environment		
10	Dobrowiecki Tadeusz	2 0 0 f 2 GH IK	2 0 2 v 4 SZT ALRT	
11	BME	Legal framework of autonomous vehicles	Safety and security in vehicle industry	
12	3 0 0 f 4 TT VIK	2 0 0 f 2 GH IK	Sághi Balázs	
13	Compensation block	Localization and mapping	Design and integration of embedded systems	
14		Barsi Árpád	Majzik István	
15		BME	BME	
16		2 0 2 f 4 SZT EMK	2 1 0 v 3 SZT VIK	
17		Autonomous robots and vehicles	Traffic modelling, simulation and control	
18		Kiss Bálint	Varga István	
19		BME	BME	
20		2 1 0 v 4 SZT VIK	2 0 2 f 4 SZT KJIT	
21		Automotive environment sensors	Automotive network and comm. systems	
22		Bécsi Tamás	Szalay Zsolt	
23			BME	
24	6 0 6 f 12 SZV BME		2 0 2 v 4 SZI GJT	
25	Vehicle dynamics	2 0 2 v 5 SZI KJIT	Automated vehicle design project	
26	Németh Huba	Automated driving systems	Gáspár Péter	
27	2 0 1 v 3 SZI GJT	Szalay Zsolt	BME	
28	Vehicle testing and validation		1 0 2 3 SZI KJIT	
29	Szabó Bálint		Németh Huba	
30	0 0 3 f 3 SZI GJT	2 0 2 v 5 SZI GJT	1 0 2 v 3 SZI GJT	
			0 30 0 f 30 ÖP	



RECAR Research Program

Defined by University and Industry, financed by the Community

Basic and advanced research in **artificial intelligence**

Co-operative control applications to vehicles

Redundant technologies (sensors, actuators, energy and communication networks, software)

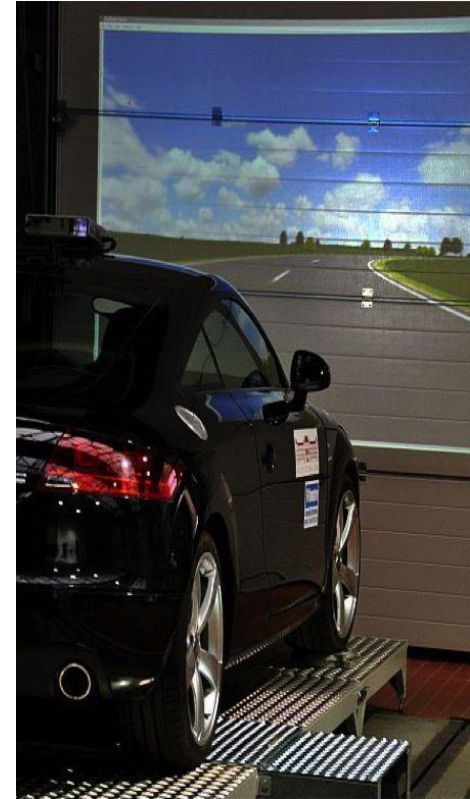
Insurance/reliability: how can reliability be tested and improved?

Data acquisition/property rights: how is it possible to make data access and management transparent? Personal data - how can the protection of personal data be guaranteed?

Cyber security: how is it possible to avoid illegal use of intelligent functions?

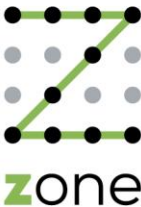
Driverless technologies: how can test and approval processes be improved to make autonomous vehicles safe and reliable?

Accident investigations with involvement of automated vehicles

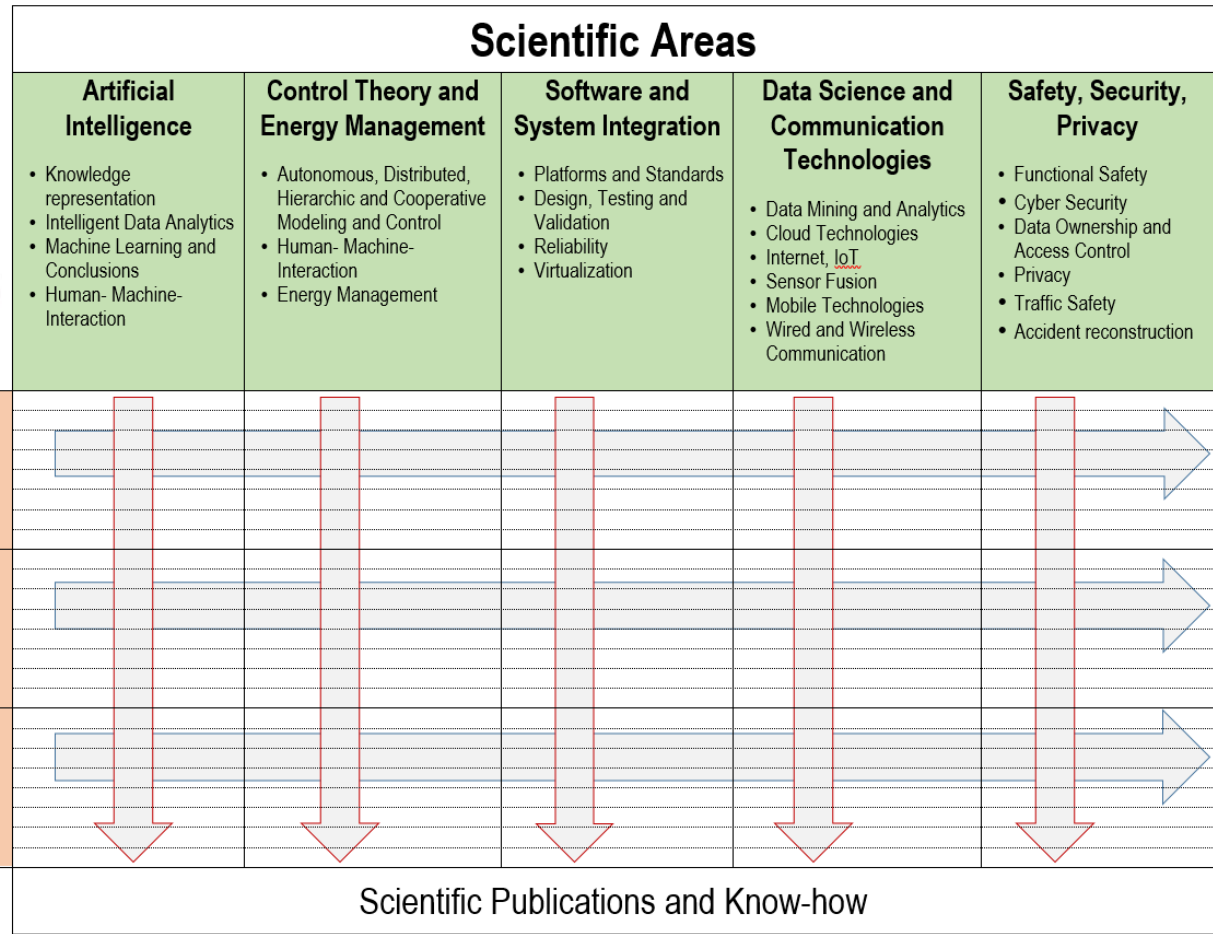


Scientific and Social Environment

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RECAR Research program



Already started

- EFOP 3.6.2 (BME, SZE, PE)
- EFOP 3.6.3 (SZE, BME, ELTE)

In preparation

- H2020 D-ART
- CEF, Interreg

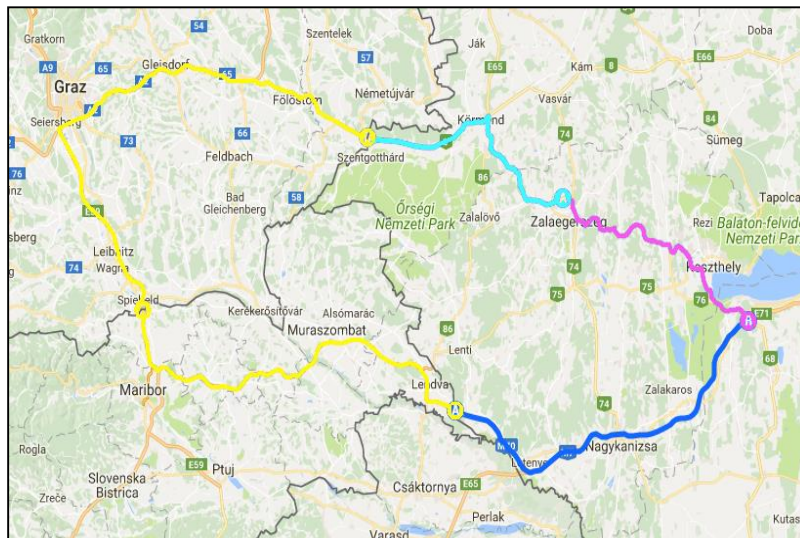
Scientific and Social Environment



Public Road Tests in Hungary

Today...

- Public road tests are allowed in Hungary since 12th of April
 - 11/2017. (IV.12.) NFM decree (5/1990, 6/1990 KöHÉM)
 - Anywhere in Hungary for automotive R&D companies after registration at Ministry



... and tomorrow

- Specific routes on public road with enhanced services for automated and connected vehicle tests
- Integration to Prove Ground in Zalaegerszeg
- Smart city zone in Zalaegerszeg
- Part of cross-border cooperation between Zalaegerszeg-Graz-Maribor
 - 2018 Q2: M7 highway
 - 2019: M70
 - 2020: Zalaegerszeg smart city
 - 2021-2022: R76 highway



Public Road Tests in Hungary

Intelligent Road Features

- Full coverage with ETSI ITS G5 station
- Full coverage with cameras
- 5th generation mobile (cellular) networks
- Meteorology stations
- High speed (>200 km/h) test section
- Varied
- Variable Message Sign, road signs
- Complex – full services – rest areas
- Wrong way warning system
- Heavy truck park system
- Traffic management systems
- High precision GPS (DGPS, RTK)
- High speed data connection (internet) at services points, WLAN
- 3D digital map
- C-ITS Day-1 Services



Cross-Boarder Cooperation Pillars

Level	Purpose	Party HUNGARY	Party AUSTRIA	Party SLOVENIA	Status of preparation
Government/ State	Set-up governmental and diplomacy support to the cross-boarder initiative	Hungarian Government Ministry: NGM/KKM	Austrian Government	Slovenian Government	LoI is being agreed via diplomatic channels
University	Establish education and R&D co-operation in fields of autonomus and electric vehicles	Budapest University of Technology & Economics	Teschnische Universitat Graz	University of Maribor	Signed
Association	Connect professional networks to enhance opportunities in the tri-lateral co-operation	„MAGE”	Autocluster Styria	Slovenian Automotive Cluster	Beeing prepared
Business	Utilize synergies of business programs in testing of autonomous and electric vehicles	Automotive Proving Ground Ltd.	Alp.Lab Gmbh	„Living.Lab”	Beeing prepared
Public road authorities	Align legal environment making optimal public road test environment	Magyar Közút Zrt.	ASFINAG	DARS	Beeing prepared



ZALAZONE - Region Zala

