



# IMPACT OF DIGITAL TRANSFORMATION TO THE HUNGARIAN AUTOMOTIVE SECTOR

# Automotive Background

Strong scientific community for autonomous vehicle technology research

„Hungary’s automotive sector quietly goes on growing” Financial Times\*

- Annual revenues: 12,7 bn EUR
- 10% of the GDP, 20% of the export
- 600+ automotive companies and suppliers
- **100,000+ jobs**

## Automotive production and development figures

- 4 OEMs and 15 of the top 20 TIER1s are present in Hungary
- Continuous need for qualified engineers
- Currently almost 6.000+ engineers in the automotive R&D demand is beyond **10.000 qualified engineers**
- **Complex, interdisciplinary** domain specific knowledge
- New dedicated programs in higher education



Why Hungary?





# Mobility as social challenge

## Inspiring factors for development

### 1 Zero Emission

- Fuel-consumption reduction
- Reducing emission



### 2 Demographic pressure

- Support of insecure leaders
- Increase the elderly mobility



### 3 Risk of accidents

- Avoidance of the accidents by reducing the effect of human mistakes



### 4 Increasing traffic density

- Management of transport process
- Comfortable, time-saving travel



### 5 Assistance systems

- Intelligent sensors for appropriate process
- Intelligent actuators (steering, brakes, etc.)

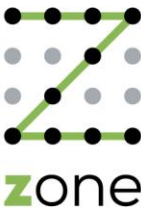


Source: VDA



What is the challenge?

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# RECAR Education program

Strong scientific community for autonomous vehicle technology research

## Long term competency in electronic vehicle control

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



## Market demand

- Global trends and actual developments in automotive
- 4 OEM's and 15 TIER1 companies from Hungary
- Constant need for qualified engineers



## 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, 2018, Budapest, BME
- Computer Science for Autonomous Driving MSc in English 2018, Budapest, ELTE
- Vehicle Test Engineer Beng in Hungarian 2018, Zalaegerszeg



Why Hungary?

# RECAR Education program

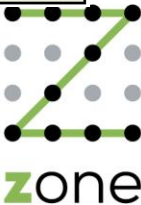
Strong scientific community for autonomous vehicle technology research

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



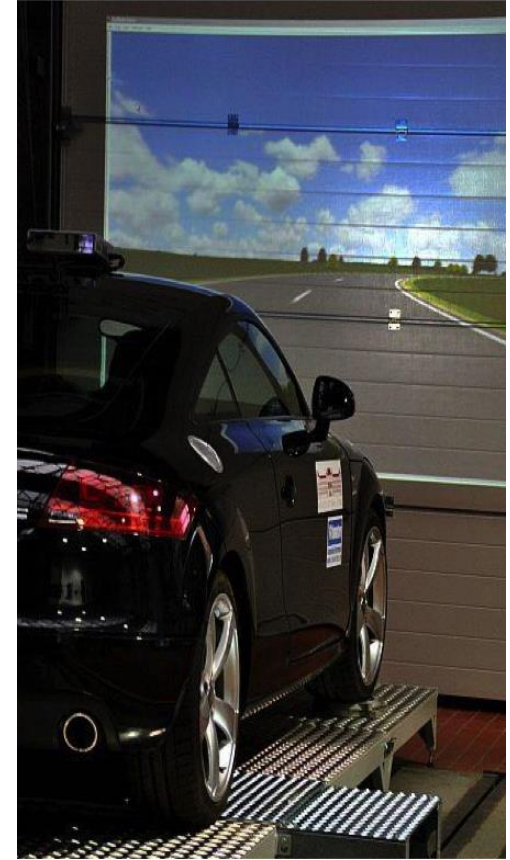
Why Hungary?

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# RECAR Research program

- 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



Why Hungary?

# RECAR Research program



## Scientific Areas

Artificial Intelligence	Control Theory and Energy Management	Software and System Integration	Data Science and Communication Technologies	Safety, Security, Privacy
<ul style="list-style-type: none"> <li>Knowledge representation</li> <li>Intelligent Data Analytics</li> <li>Machine Learning and Conclusions</li> <li>Human- Machine- Interaction</li> </ul>	<ul style="list-style-type: none"> <li>Autonomous, Distributed, Hierarchic and Cooperative Modeling and Control</li> <li>Human- Machine- Interaction</li> <li>Energy Management</li> </ul>	<ul style="list-style-type: none"> <li>Platforms and Standards</li> <li>Design, Testing and Validation</li> <li>Reliability</li> <li>Virtualization</li> </ul>	<ul style="list-style-type: none"> <li>Data Mining and Analytics</li> <li>Cloud Technologies</li> <li>Internet, <u>IoT</u></li> <li>Sensor Fusion</li> <li>Mobile Technologies</li> <li>Wired and Wireless Communication</li> </ul>	<ul style="list-style-type: none"> <li>Functional Safety</li> <li>Cyber Security</li> <li>Data Ownership and Access Control</li> <li>Privacy</li> <li>Traffic Safety</li> <li>Accident reconstruction</li> </ul>

## Research Directions

### Vehicle

- Automated Vehicle Control (Level2-5)
- Drivetrain
- Human Factors
- Testing and Validation

### Vehicle-Environment Connection

- Environment Sensing
- Cooperative Control
- V2X Communication

### Environment

- Intelligent Transportation Systems
- Mobile Communication Systems
- Smart Infrastructure
- Electromobility

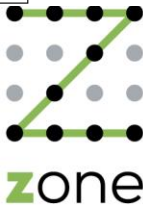
## Knowledge, Competence and Applications

Scientific Publications and Know-how



Why Hungary?

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# Proving Ground - industrial background

Close co-operation with the industry – specification of requirements

**Automotive Working Group:** 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:** BME HIT, BME KJIT, BPC, Ericsson, HUAWEI, Kapsch, Magyar Közút, Magyar Telekom, NFM, NMHH, Nokia, Oracle, RWE, Siemens, SWARCO, T-Systems, Vodafone

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

Boundary less organizational approach



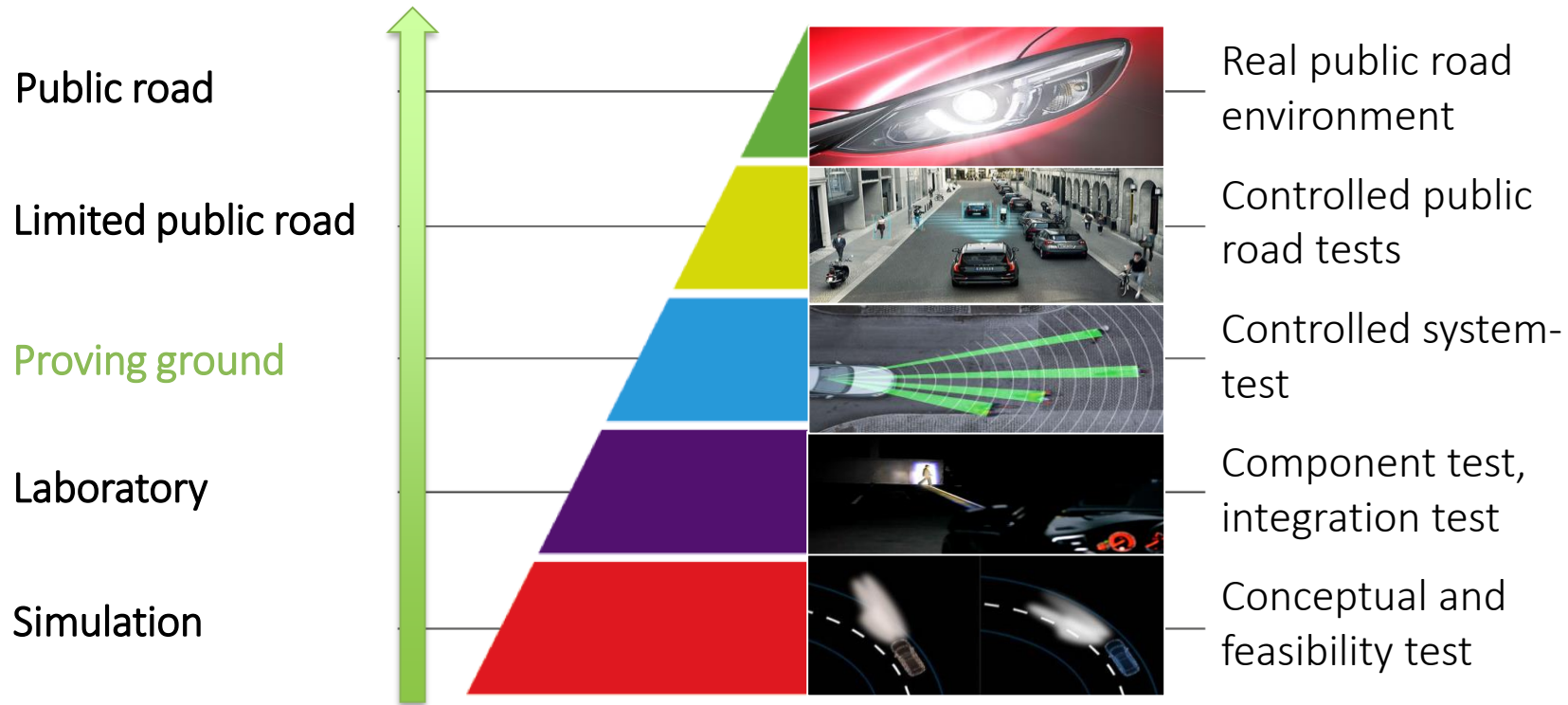
Why Hungary?





# Multi-level testing environment

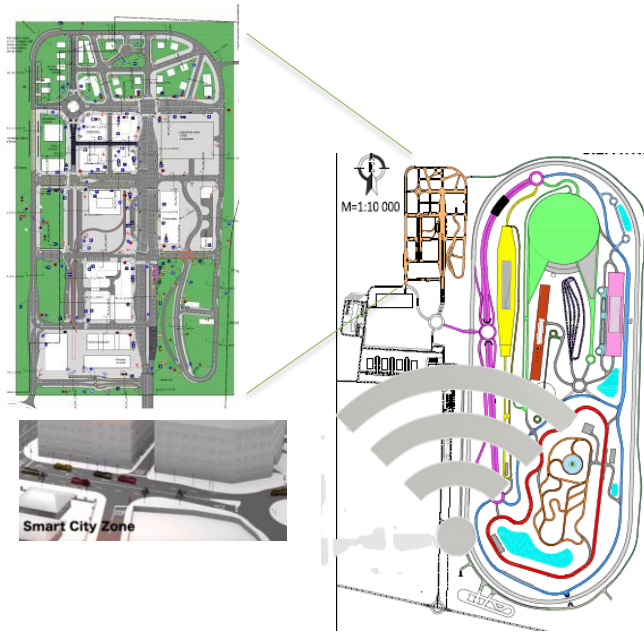
From computer to real traffic – essential for automated driving



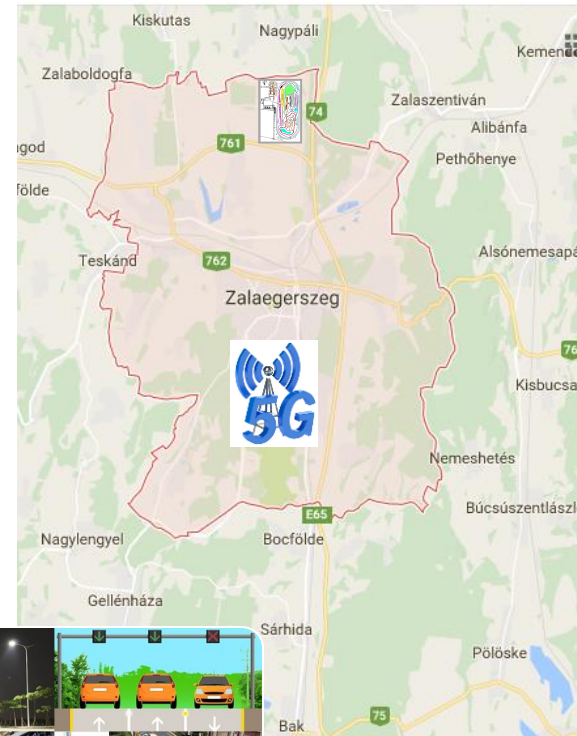
What do we offer?

# Multi-level testing environment

**Not only a proving ground for automated driving but also a complex test environment for new info-communication technologies**



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



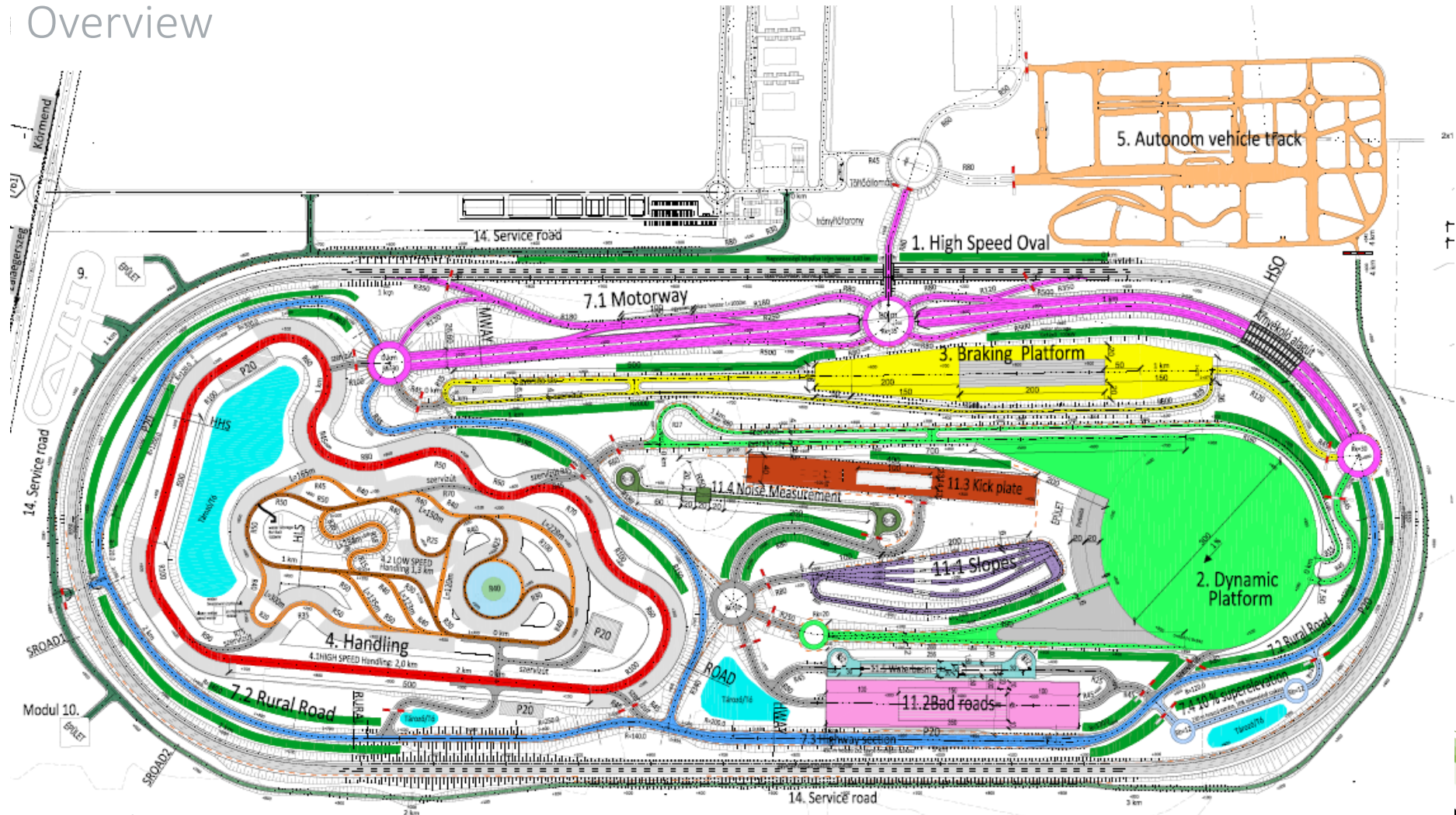
City environment  
for  
real-life testing



Proving Ground Program

# Proving Ground Concept plan - layout

## Overview



Technical plans

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# Testing and Validation ZONE concept

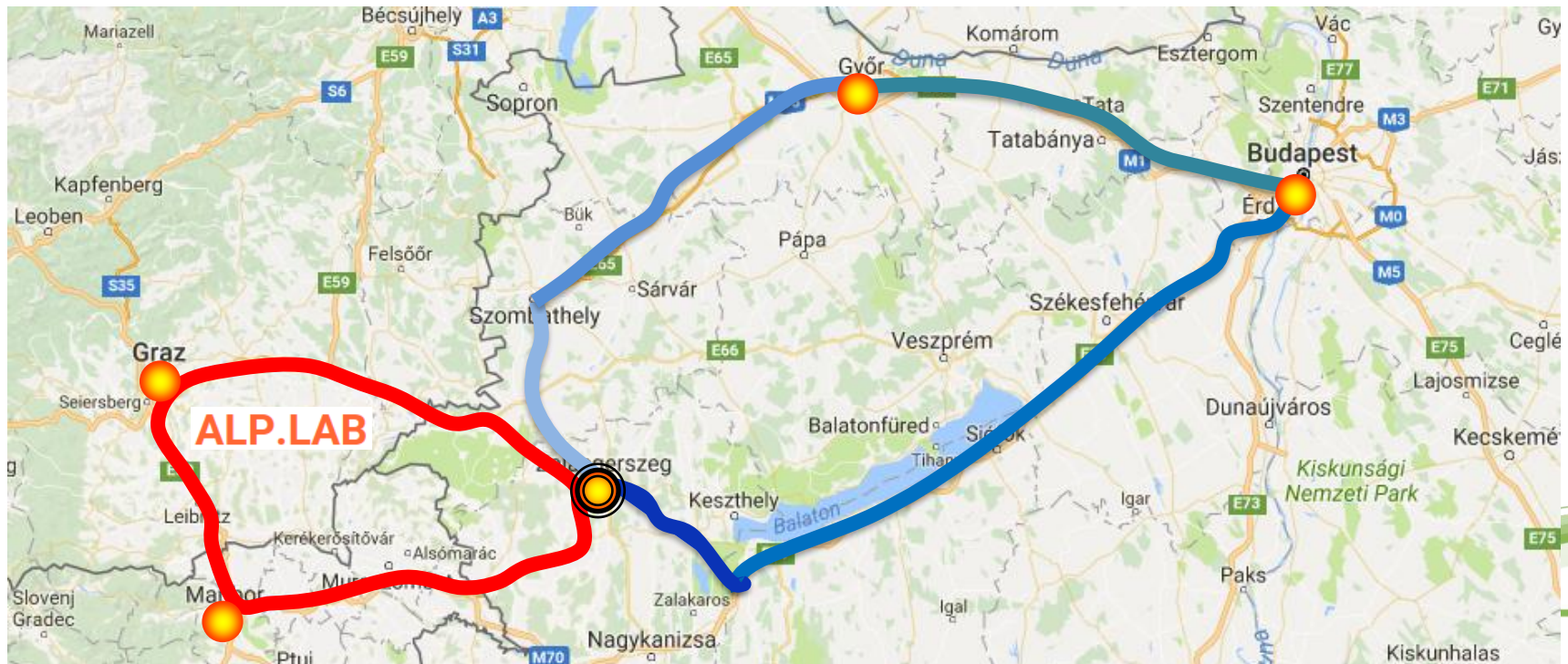
Extended testing zone – test field *to city to public roads*

**Loop\_1** Local roads (City Zalaegerszeg – being turned into “smart city”)

**Loop\_2** Hungarian roads (Zalaegerszeg-Gyor-Budapest) – Actually designed R76 for automated driving, M7 with modified communication

**Loop\_3** International roads (Graz-Zalaegerszeg-SI zone)

- Test road (R76) **plan**
- High level communication technologies for test (M7) **plan**
- Highway with RSUs (M1)
- Normal highway (M85-86)
- Normal road (86/76)



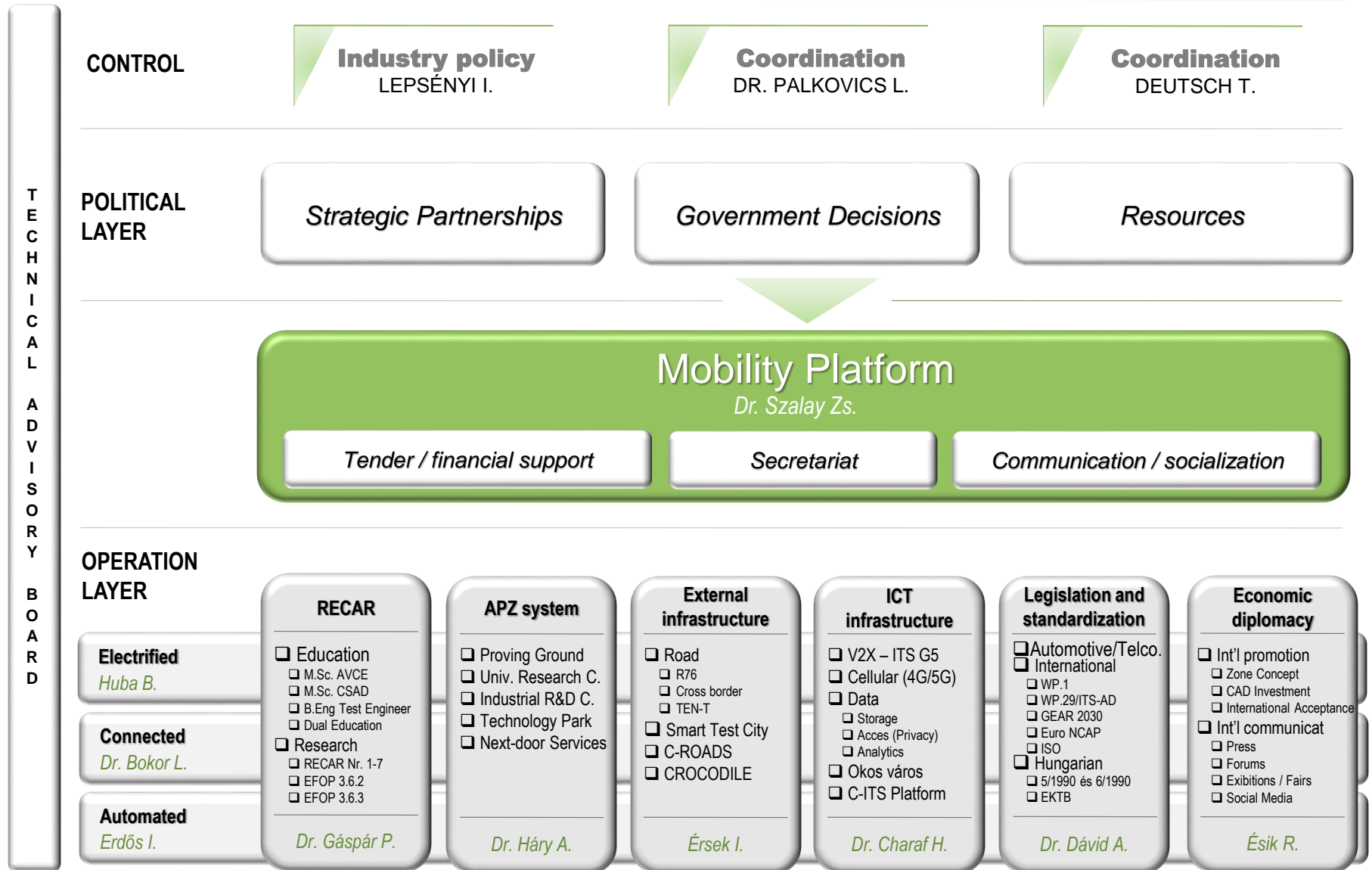
What do we offer?

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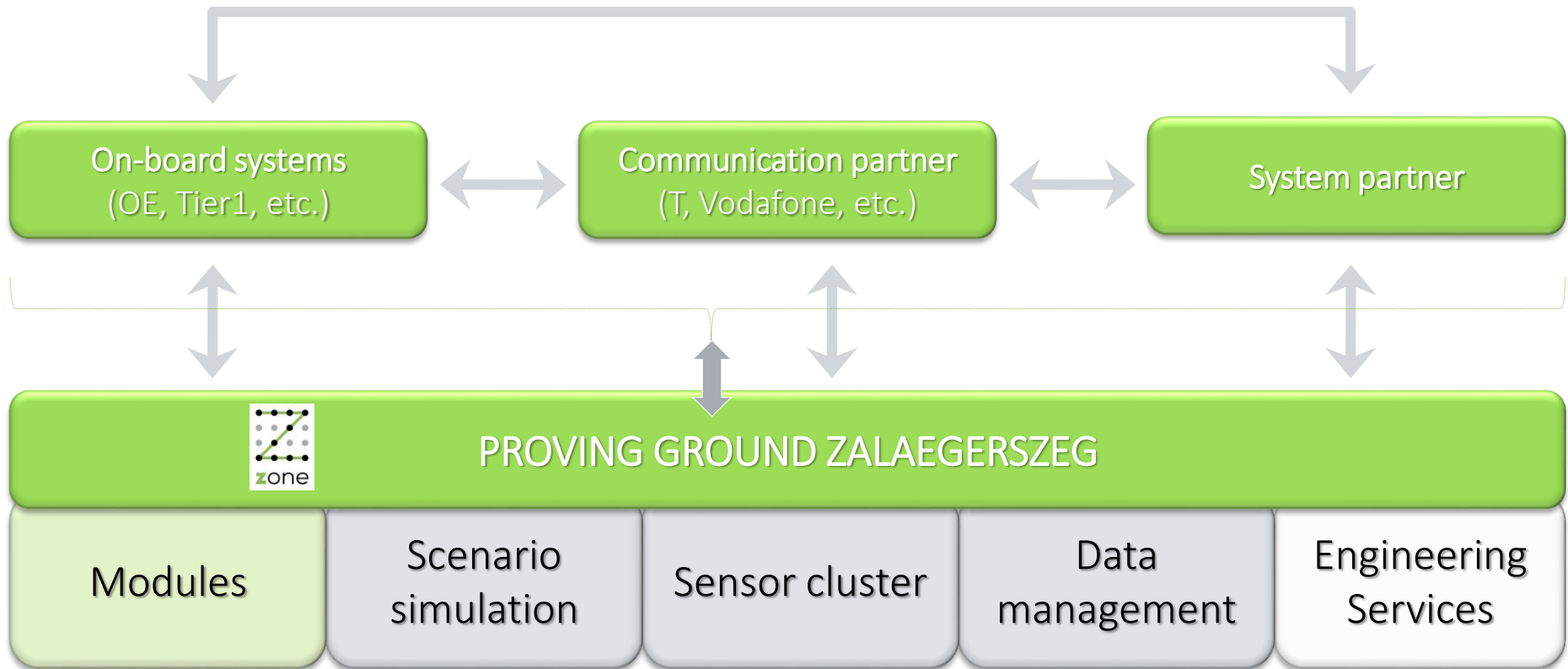


# Commitment of the Hungarian Government

## Investment into a European level RD infrastructure



# Business model



Project status





THANK YOU FOR YOUR  
ATTENTION