Content

Status of the project
1. What steps led till today?
2. Project overview
3. Services and business model

What can be tested?
2. Functional overview
3. Test track modules
4. Services in detail

Model of operation
3. Business model principles
4. Service portfolio
5. Status of business development
6. Principles of operation

Scientific and social environment
4. Platform concept
5. Education and R&D initiatives
6. Legal background
7. Cross-borderer co-operation
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

- **Public road**
  - Real public road environment

- **Limited public road**
  - Controlled public road tests

- **Proving ground**
  - Controlled system-test

- **Laboratory**
  - Component test, integration test

- **Simulation**
  - Conceptual and feasibility test

Status of the project
Overview of the Layout of the Unique Proving Ground

Status of the project

Office and workshops
Development centres
Main entrance and control centre
Next-door service providers / partners
Research center
Related facilities (event center, etc.)

Concept is based on:
- Best practices from other similar facilities
- Business studies
- Environmental studies

Customer zone
R&D campus
Service zone

High-speed testing
Low-speed testing

265 ha

Development area

Development area
Multi-level testing environment

Buildings and modules

- Control center
- Main entrance building
- Service providers
- Workshops and offices
- Related buildings
- Research center, University building

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

Announcement
May 19, 2016

Project start – fixed HSO position
Sept 14, 2016

Registration of Automotive Proving Ground Ltd. (project company)
Jun-Jul, 2016

Publication of 292/2016 (VI.13.) and 1319/2016 (VII.1.)
Governmental Decisions

Agreement of Ministry & City
Nov 04, 2016

Oct, 2016

Feb-Apr, 2017

Pre-design activities:
- Proving Ground concept
- Earthwork plans
- Utility plans
- AD test zone concept
- Buildings concept
- Environmental design

Feb-Apr, 2017

Project preparation:
- Ground mechanics
- Geodesia
- Archeologic study
- Environmental study
- Ground-protection plans
- Ammunition discharge
- Parcel creation (zone plan)

Agreement with lead-designer
Apr 19, 2017

Feb-Apr 2017

Groundbraking ceremony / Start of construction
May 19, 2017

Status of the project
Project milestones and basic data

May-Dec, 2017

End of Phase 1
Jun, 2018

High speed oval preparation PART I
Oct, 2018

Aug, 2017-Jun, 2018

Smart City Zone I. completion

Braking platform

Handling course

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

Buildings: main entrance, technical building, control center

Dynamic platform

End of Phase 1

Status of the project
# Project milestones and basic data

Actual status – runs according to project plan

<table>
<thead>
<tr>
<th>ELEMENTS</th>
<th>CONTENT</th>
<th>PROGRESS</th>
</tr>
</thead>
</table>
| Basic construction works | - Dynamic platform  
                       | - Braking platform  
                       | - Handling course  
                       | - Smart City Zone  
                       | - Internal roads – Part 1 | >>>>>> |
| Final construction works | - 4 modules completion  
                       | - Public utilities  
                       | - Internal roads – Part 2 | | >> |
| Buildings           | - Main entrance building  
                       | - Technical building | >>>>>> |
| Buildings           | - Control center         | | >> |
| Technology          | - Test tracks technology  
                       | - Watering technology I  
                       | - AD technology: Scenario simulation equipment  
                       | - AD technology: Sensor cluster I  
                       | - AD technology: Data management basic system  
                       | - Operation equipment | | >> |
Project milestones and basic data

PHASE 2

Smart City Zone II.

High-speed oval completion

2019-2020

Additional modules:
- Slopes
- Kick-plate
- Bad roads
- Aquaplaning
- Noise measurement plate

Additional buildings:
- University Research Center
- Related buildings

Status of the project
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 mue 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 mue=\sim 1 \text{ (optional watering)}
  - tiles mue=\sim 0.1 \text{ (wet)}
  - Blue basalt mue=\sim 0.3 \text{ (wet)}
  - Treated concrete mue=\sim 0.6 \text{ (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

What can be tested?
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

What can be tested?
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.

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

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?

Project Phase 1 2017-2018
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

Dummys 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
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)
Public Road Tests
Public roads with autonomous test focus: R76, newly built
Public Road Tests
Short-term potential – M7, M70, ALP.LAB (A)
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.

Number of test/use cases can exponentially increase

Model of operation

Source: Technologiereview, VDA
Business & Operation Model

Operation models will change

Vehicle partners (OE, Tier1, …)

Communication partner

System partner

Testing ZONE

Modules (with classic services)

Simulation (scenarios, cases, disturbances)

Data collection (operation of sensory system)

Data management (operation of cloud)

Engineering Services

SERVICE CONTENT

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**

<table>
<thead>
<tr>
<th>Block</th>
<th>Property developer</th>
<th>Technological operator</th>
<th>Business organizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classics</td>
<td>Logistics, safety and security, storage, special module operation (e.g. watering), offices and workshops, basic IT and communication, repair, authorities, event organization, hotel, etc.</td>
<td></td>
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</tr>
<tr>
<td>Simulation</td>
<td>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</td>
<td></td>
<td></td>
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<tr>
<td>Data collection</td>
<td>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.</td>
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<tr>
<td>Data management</td>
<td>Data center with different service opportunities (simulation, computer cluster), cloud at the test track</td>
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</tr>
<tr>
<td>Research and Engineering Services</td>
<td>Depending on the demand and the capabilities of universities and other research partners</td>
<td></td>
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</tr>
</tbody>
</table>
Actual Partner Overview

Letter of Intent (LoI)

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

CONTROL

Industry policy
LEPSÉNYI I.

Coordination
DR. PALKOVICS L.

Coordination
DEUTSCH T.

POLITICAL LAYER

Strategic Partnerships

Government Decisions

Resources

Mobility Platform
Dr. Szalay Zs.

Tender / financial support

Secretariat

Communication / socialization

OPERATION LAYER

RECAR

- Education
- M.Sc. AVCE
- M.Sc. CSAD
- B.Eng Test Engineer
- Dual Education
- RECAR Nr. 1-7
- EFOP 3.6.2
- EFOP 3.6.3

APZ System

- Proving Ground
- Univ. Research C.
- Industrial R&D C.
- Technology Park
- Next-door Services

External infrastructure

- Road
- R76
- Cross border
- TEN-T
- Smart Test City
- C-ROADS
- CROCODILE

ICT infrastructure

- V2X – ITS G5
- Cellular (4G/5G)
- Data
- Storage
- Access (Privacy)
- Analytics
- Okos város
- C-ITS Platform

Legislation and standardization

- Automotive/Telco. International
- WP.1
- WP.29/ITS-AD
- GEAR 2030
- Euro NCAP
- ISO
- Hungarian
- EKTB

Economic diplomacy

- Int'l promotion
- Zone Concept
- CAD Investment
- International Acceptance
- Int'l communicat
- Press
- Forums
- Exhibitions / Fairs
- Social Media
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
### RECAR Education program

Strong scientific community for autonomous vehicle technology research

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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</thead>
<tbody>
<tr>
<td><strong>Numerical mathematics</strong></td>
<td><strong>Industrial image processing</strong></td>
<td><strong>Automotive R&amp;D processes and quality systems</strong></td>
<td>Diploma thesis</td>
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<tr>
<td><em>Vajta László</em></td>
<td><em>Tevesz Gábor</em></td>
<td><em>Wahl István</em></td>
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<td>ELTE</td>
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<tr>
<td><strong>Control theory and system dynamics</strong></td>
<td><strong>High performance microcontrollers and interfaces</strong></td>
<td><strong>Project management</strong></td>
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<tr>
<td><em>Bokor József-Gáspár Péter</em></td>
<td><em>Tevesz Gábor</em></td>
<td><em>Szirányi Tamás</em></td>
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<tr>
<td><strong>Intelligent systems</strong></td>
<td><strong>Human factors in traffic environment</strong></td>
<td><strong>Legal framework of autonomous vehicles</strong></td>
<td><em>Gáspár Balázs</em></td>
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<td><em>Dobrowiecki Tadeusz</em></td>
<td><em>ELTE</em></td>
<td><em>ELTE</em></td>
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<td><strong>Compensation block</strong></td>
<td><strong>Localization and mapping</strong></td>
<td><strong>Design and integration of embedded systems</strong></td>
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<td><em>Barsi Árpád</em></td>
<td><em>BME</em></td>
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<tr>
<td><strong>Autonomous robots and vehicles</strong></td>
<td><strong>Traffic modelling, simulation and control</strong></td>
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<td><em>Kiss Bálint</em></td>
<td><em>Varga István</em></td>
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<td><strong>Automotive environment sensors</strong></td>
<td><strong>Automotive network and comm. systems</strong></td>
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<td><em>Bécsi Tamás</em></td>
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<td><strong>Vehicle dynamics</strong></td>
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<td><em>Németh Huba</em></td>
<td><em>Szalay Zsolt</em></td>
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<td><strong>Vehicle testing and validation</strong></td>
<td><strong>Automated vehicle design project</strong></td>
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<td><em>Gáspár Péter</em></td>
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</tbody>
</table>

Scientific and Social Environment
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**
RECAR Research program

### Scientific Areas

|------------------------|--------------------------------------|-------------------------------|---------------------------------------------|--------------------------|
| • Knowledge representation  
  • Intelligent Data Analytics  
  • Machine Learning and Conclusions  
  • Human-Machine Interaction | • Autonomous, Distributed, Hierarchic and Cooperative Modeling and Control  
  • Human-Machine Interaction  
  • Energy Management | • Platforms and Standards  
  • Design, Testing and Validation  
  • Reliability  
  • Virtualization | • Data Mining and Analytics  
  • Cloud Technologies  
  • Internet, IoT  
  • Sensor Fusion  
  • Mobile Technologies  
  • Wired and Wireless Communication | • Functional Safety  
  • Cyber Security  
  • Data Ownership and Access Control  
  • Privacy  
  • Traffic Safety  
  • Accident reconstruction |

### Research Directions

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Vehicle-Environment Connection</th>
<th>Environment</th>
</tr>
</thead>
</table>
| • Automated Vehicle Control (Level 2-5)  
  • Drive train  
  • Human Factors  
  • Testing and Validation | • Environment Sensing  
  • Cooperative Control  
  • V2X Communication | • Intelligent Transportation Systems  
  • Mobile Communication Systems  
  • Smart Infrastructure  
  • Electromobility |

### 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
  - 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

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