



PROVING GROUND PROJECT HUNGARY

Project summary

July/2018



CONTENT

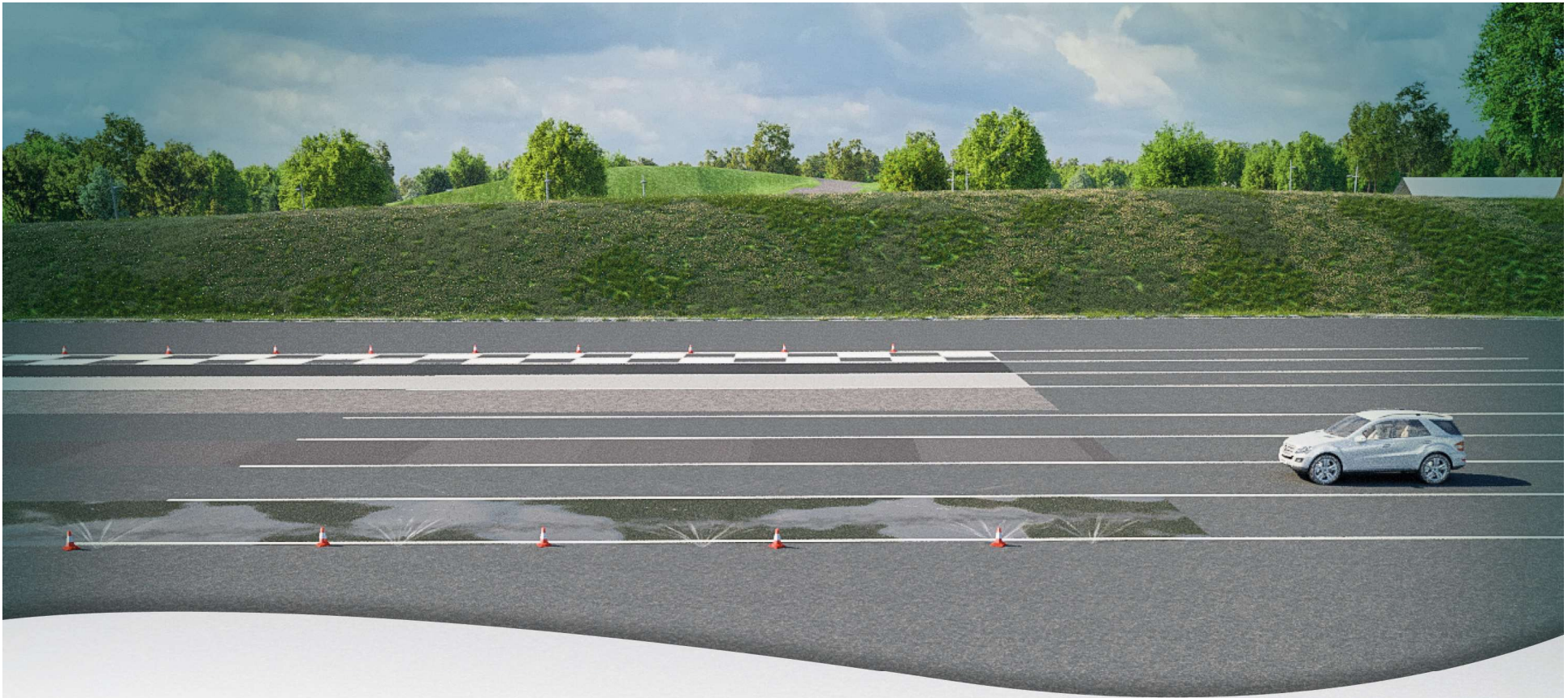
Project concept

Unique services

Proving Ground development

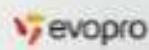
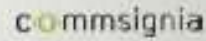
What can be tested





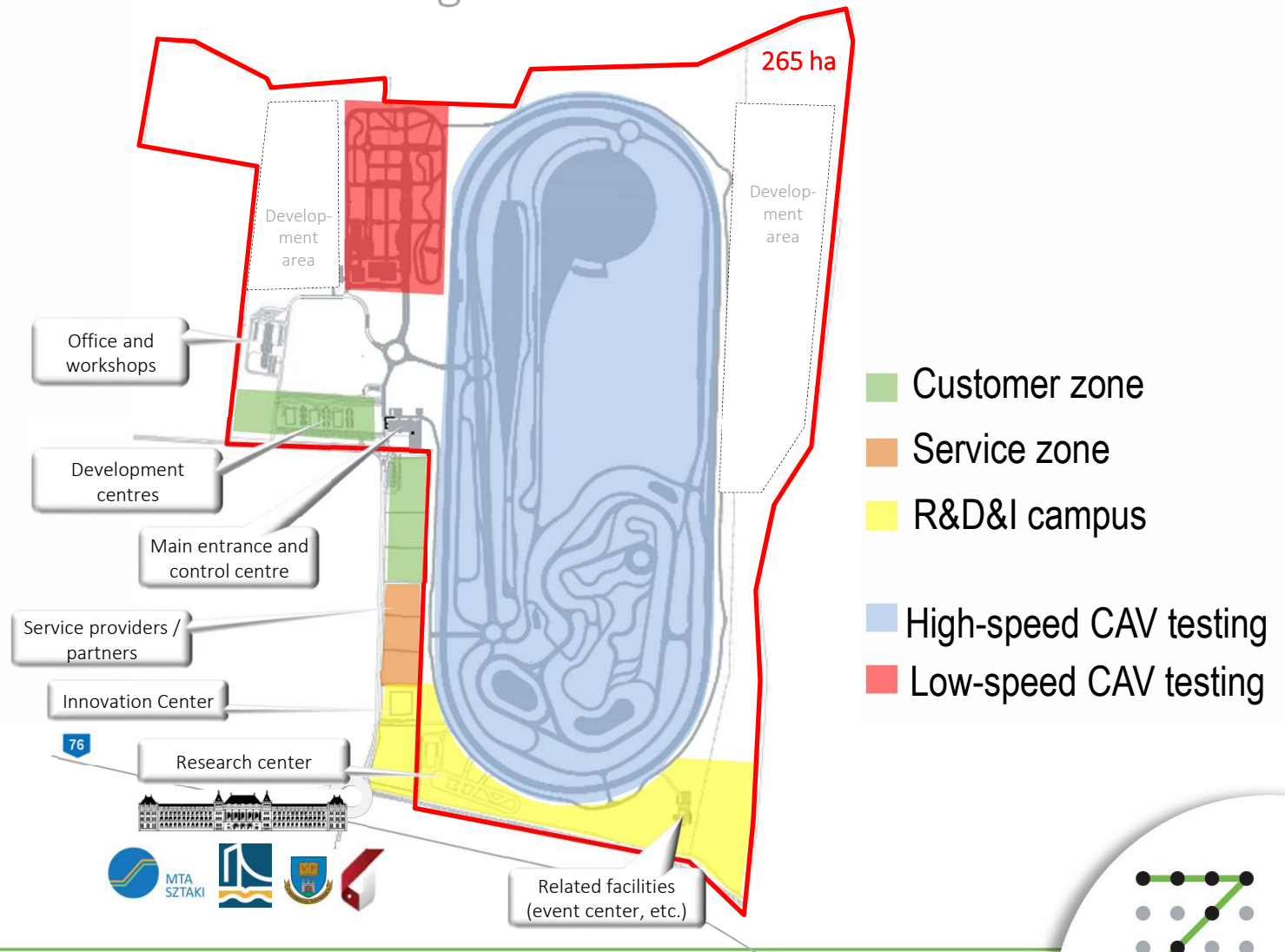
PROJECT CONCEPT

2014-2017
Industrial inputs
Iparági inputok



Layout of the Proving Ground

Traditional and autonomous testing modules



Test track vision





Test + simulation **Teszt + szimuláció** 149

ZALAEGRSZEG REALITY VALÓSÁG INTELLIGENCE INTELLIGENCIA

AUTOMATED TESTS AUTOMATIZÁLT TESZTEK SIMULATION SZIMULÁCIÓ

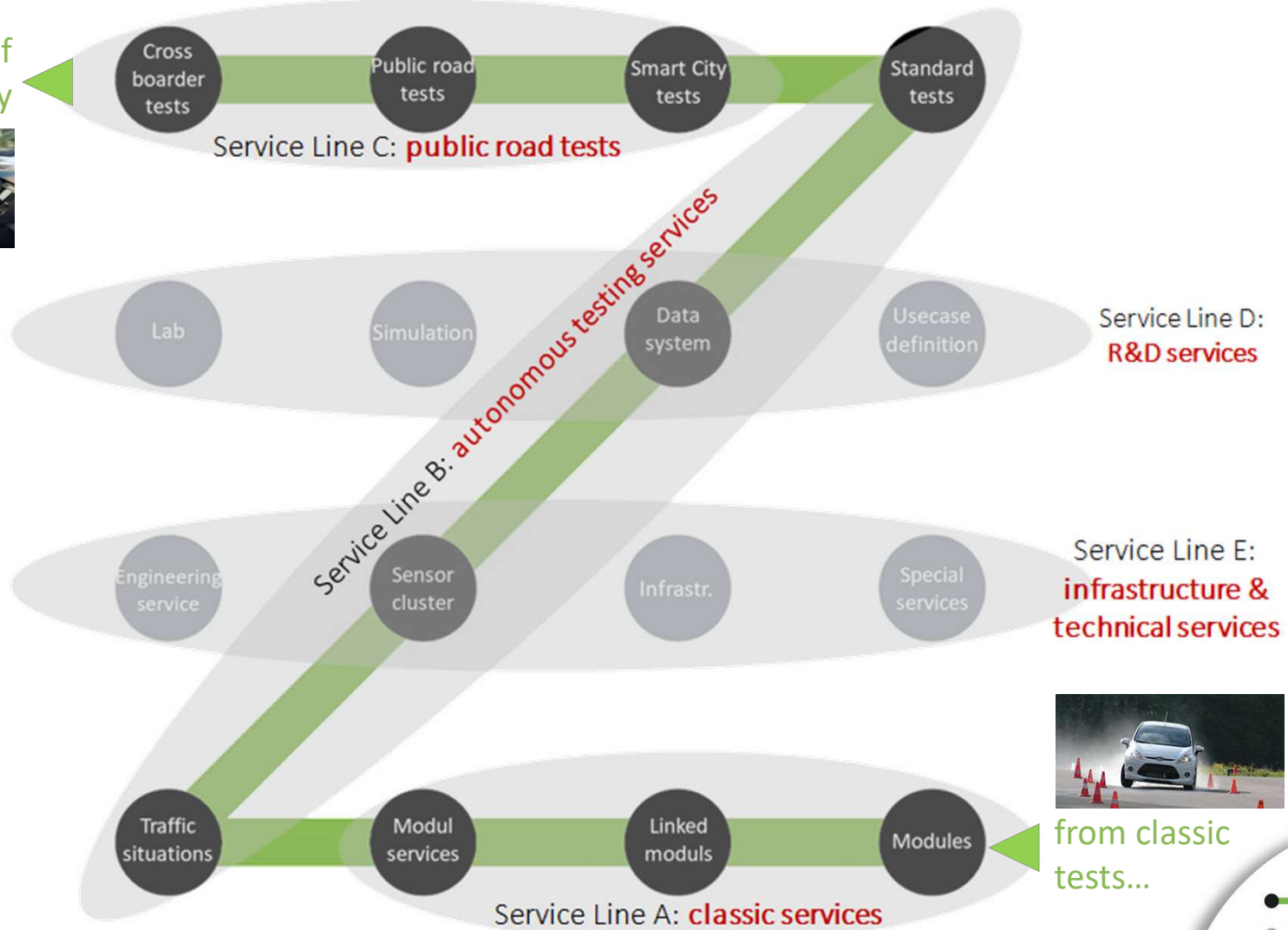
PROVING GROUND VIRTUALITY VIRTUALITÁS

UNIQUE SERVICES



Proving ground service portfolio

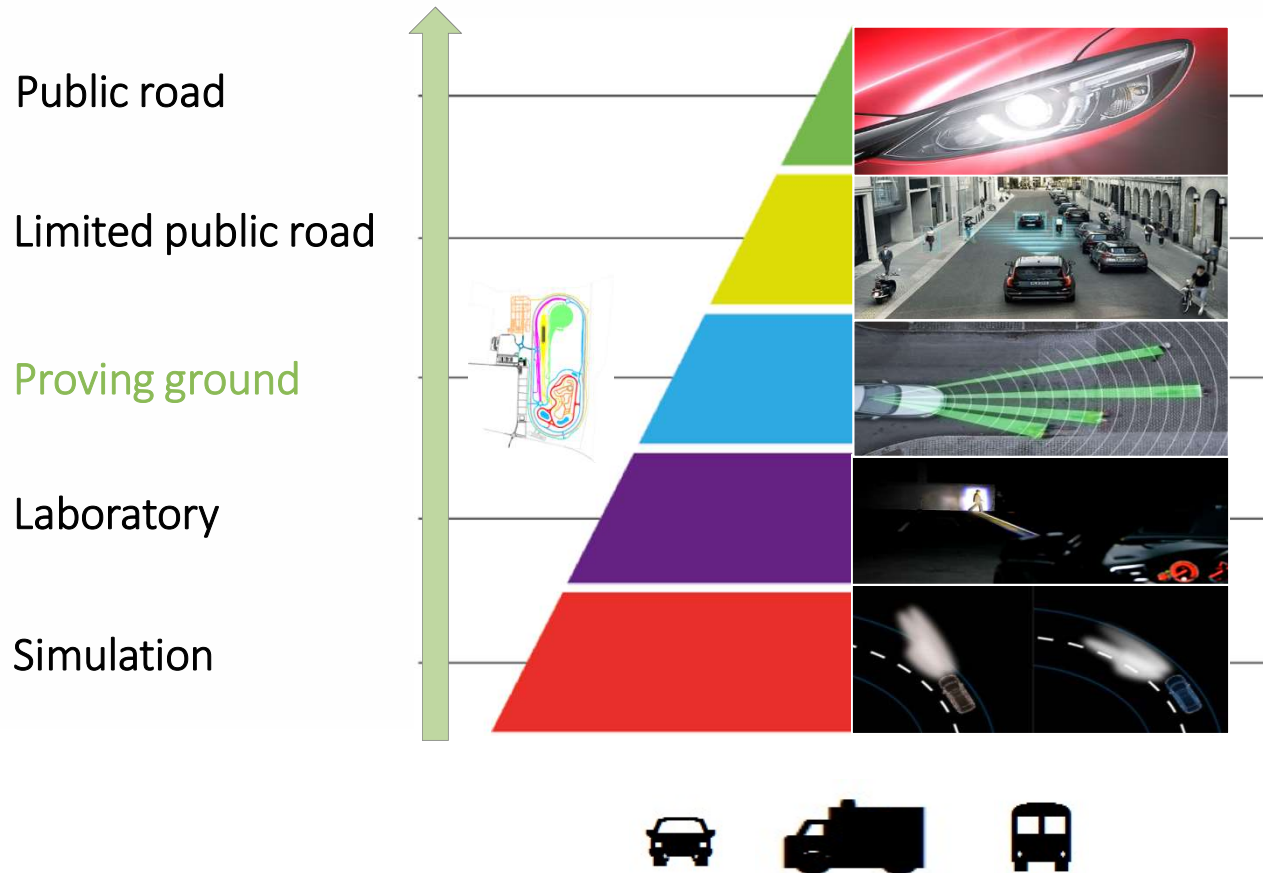
...till future of mobility



from classic tests...

Multi-level testing environment

From computer to real traffic – essential for automated driving

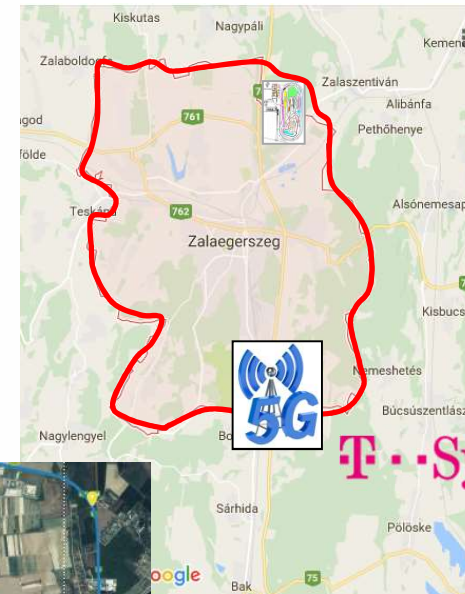


Leaving the closed testing environment ...

Zalaegerszeg as Smart/Digitalized City environment for Testing



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



T Systems



City environment for random **real-life testing**

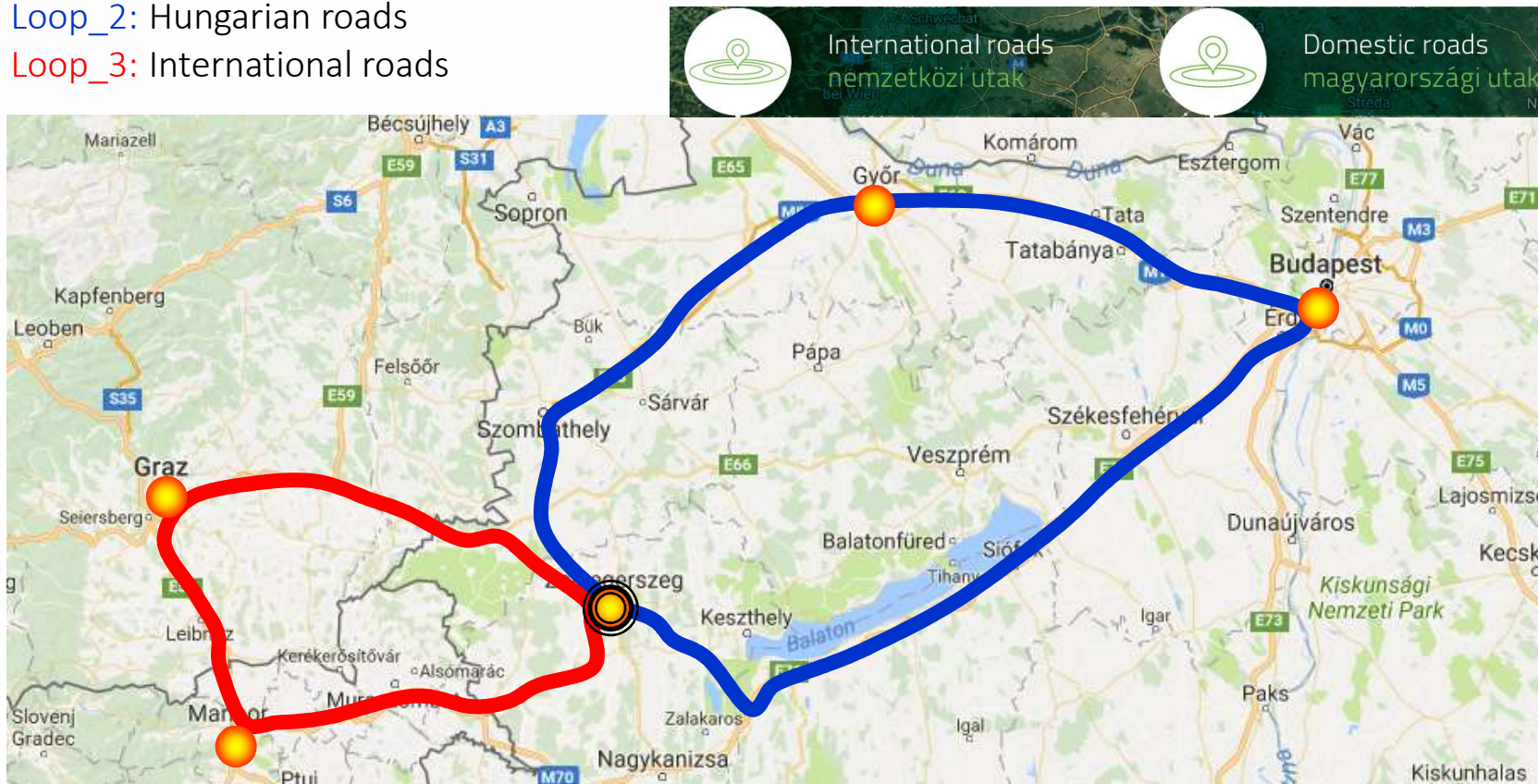
Leaving the closed testing environment ...

High speed testing in real environment – “Triple loop”

Loop_1: City local roads – smart infrastructure

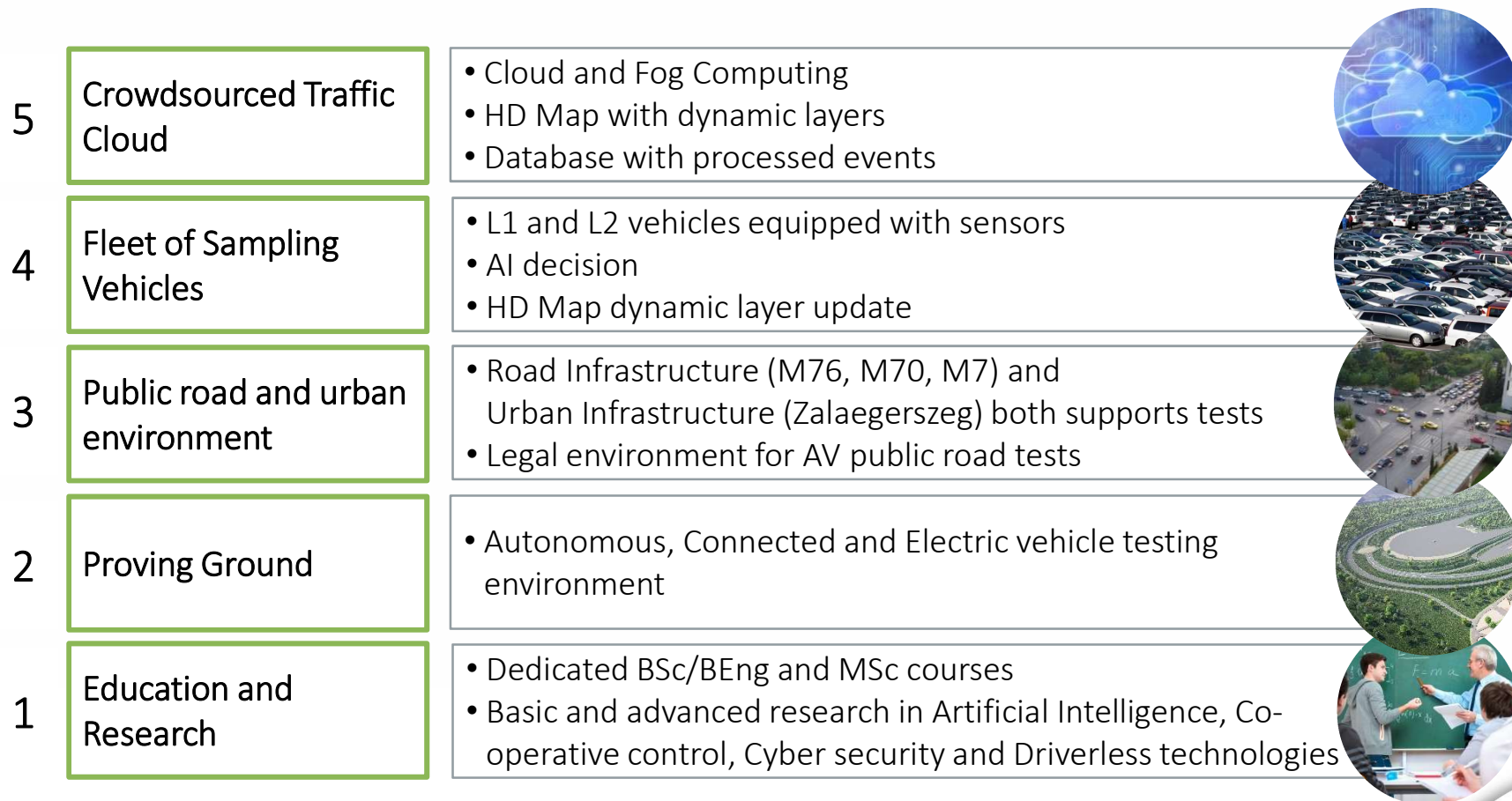
Loop_2: Hungarian roads

Loop_3: International roads



Autonomous Vehicle Ecosystem

Concept of Multi-layer Autonomous Transport Support System





PROJECT DEVELOPMENT



Phases of the project

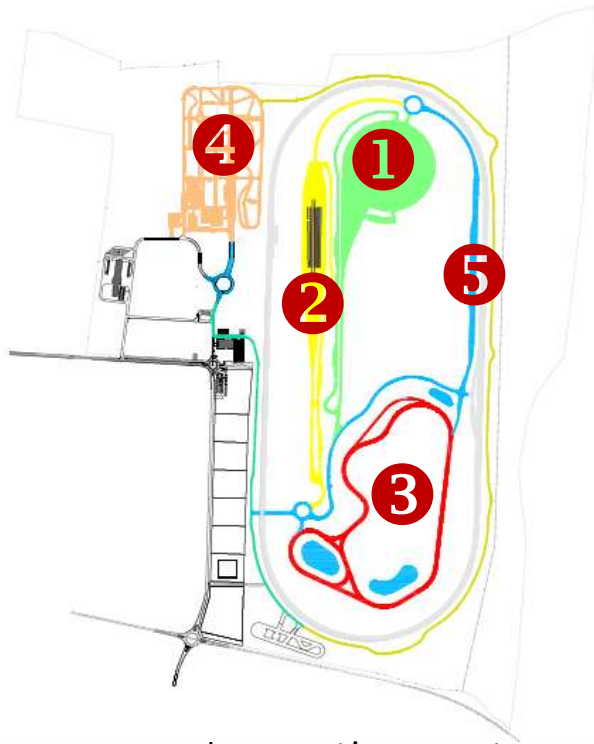
Phase 1: 2018 Q3-2019 Q1

Phase 2.a: 2019 Q4

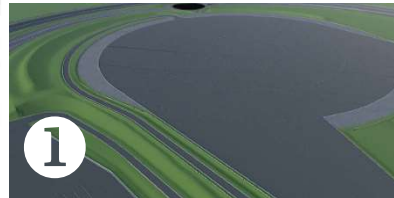
Phase 2.b: 2020 Q2



Ambition by end of 2018, start of 2019



Dynamic platform



Braking surfaces



Handling course (HS)



Smart City
Basic road grid



Rural road
Eastern section



Innovation center
(by Industrial Park)



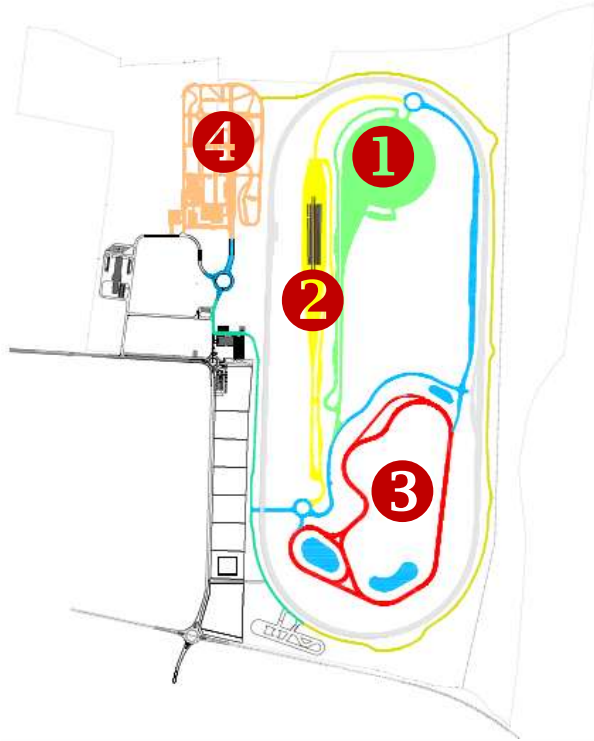
Main entrance building



Technical building



Status 2018 beginning of June





WHAT CAN BE TESTED

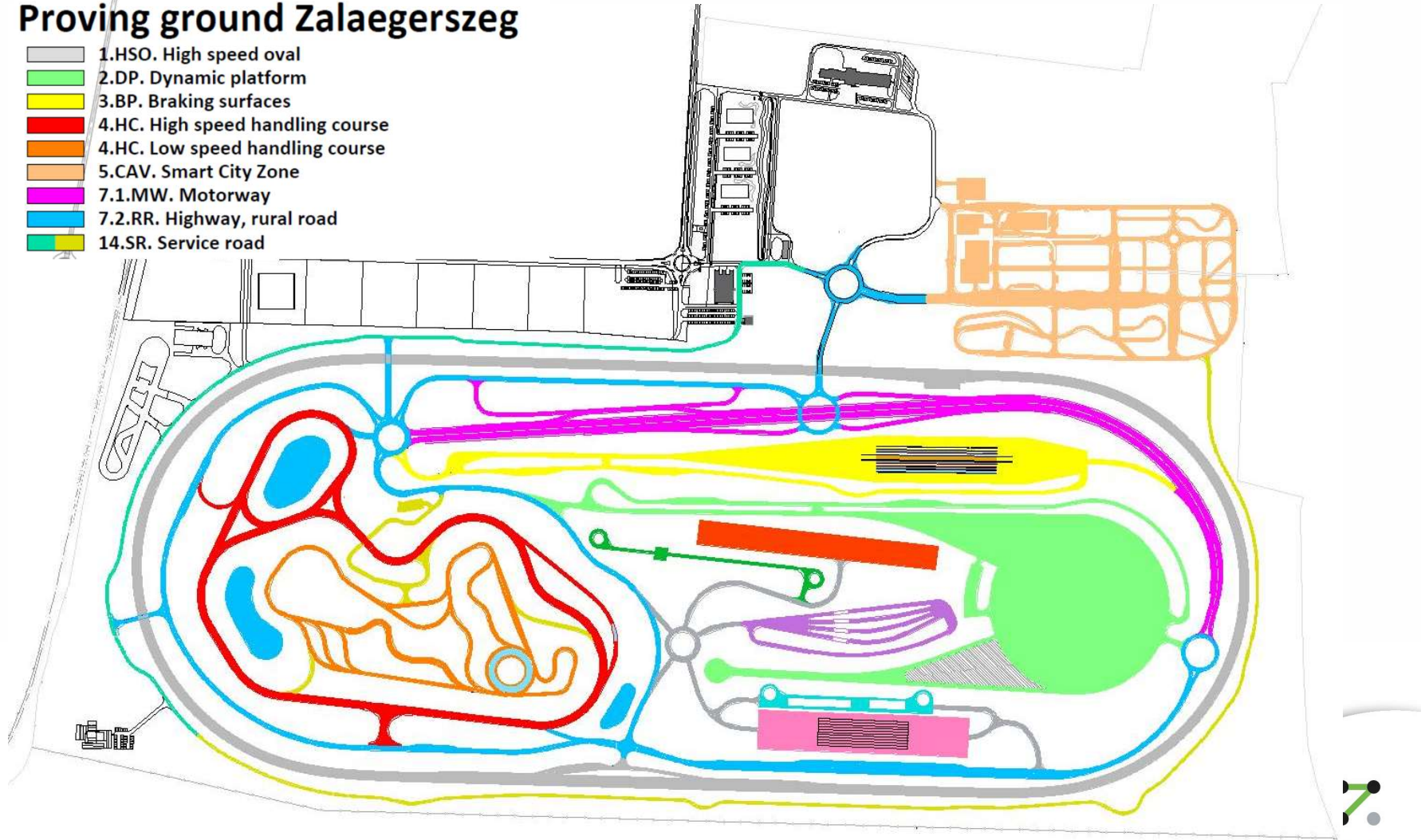


Modules to be realized with Priority 1

Priority is defined with potential 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





DETAILS OF THE MODULES



Proving Ground modules

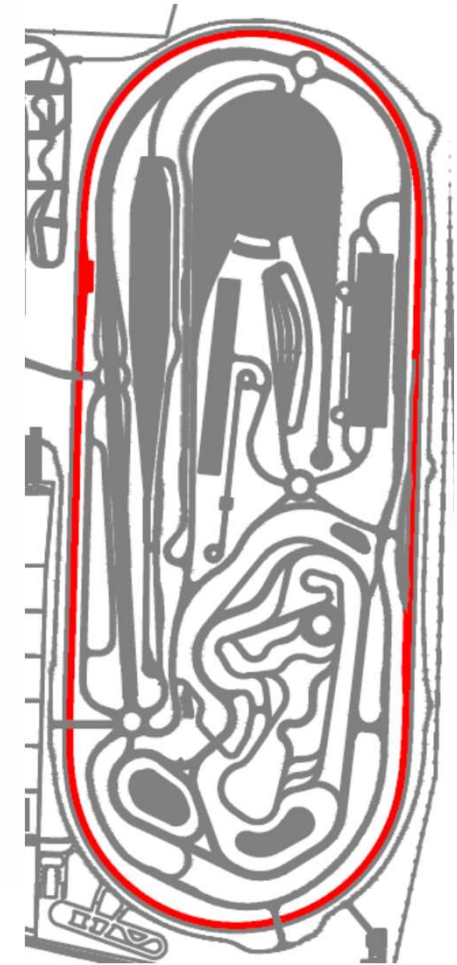
High speed oval

Physical parameters:

- 4.400m length
- 920m straight section
- Curve radius 350m
- Neutral speed 200km/h at curves
- 1% inclination to south
- 3+1 lanes
- V2X infrastructure for communication test at high speed



Project Phase 2 2020



Autonomous vehicle test cases:

- **Platooning** at high speed motorway situations
- **Cooperative vehicle** control at high speed
- Fix position and moving **obstacles** (dummy car or pedestrian)
- **V2I, V2V** communication tests at high vehicle speed

Proving Ground modules

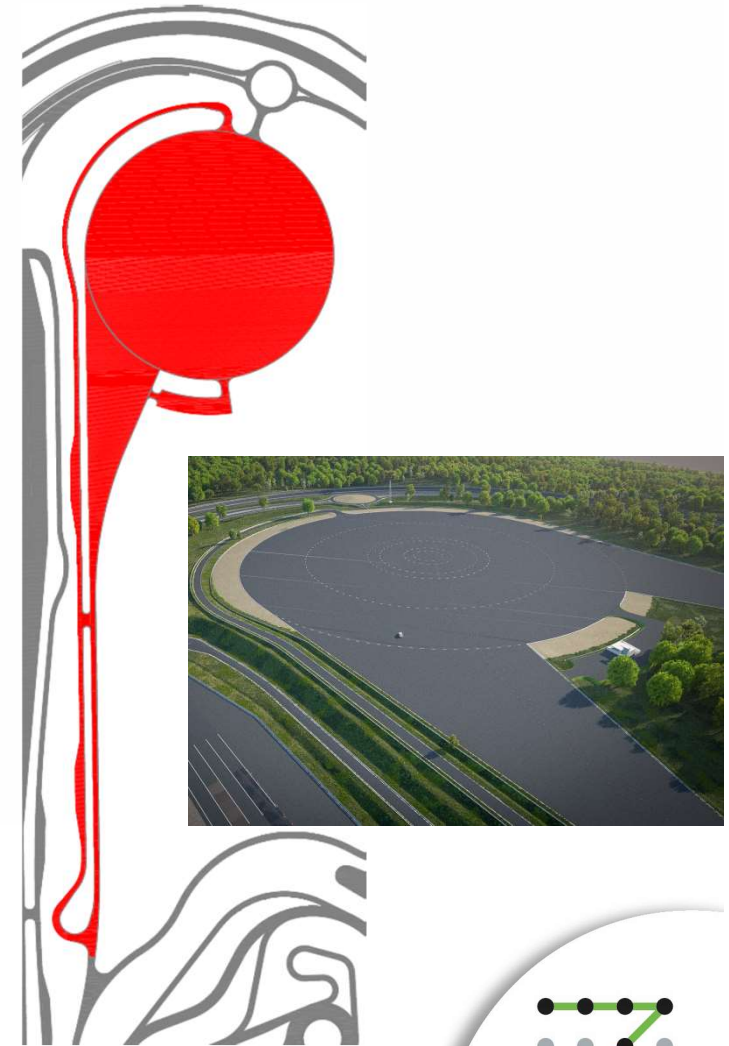
Dynamic platform

Physical parameters:

- 300m diameter asphalt surface
- Acceleration lane 760m and 400m long
- 20m wide FIA emergency area
- Watered surface (optional)
- Watered basalt surface at eas 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 mu 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

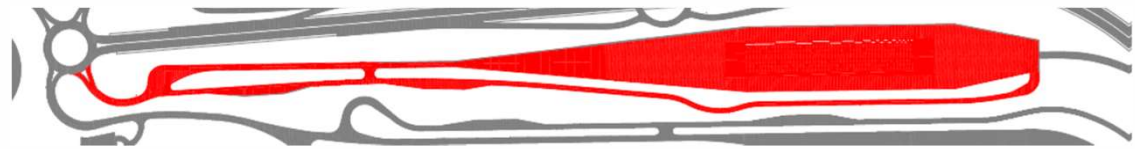


Proving Ground modules

Braking platform

Physical parameters:

- 8 different surfaces:
 - *Chess* surface: asphalt/tiles
 - *Asphalt* $\mu = \sim 1$ (optional watering)
 - *Tiles* $\mu = \sim 0.1$ (wet)
 - *Blue basalt* $\mu = \sim 0.3$ (wet)
 - *Asphalt* $\mu = \sim 0.8$ (optional watering)
 - *Treated concrete* $\mu = \sim 0.6$ (wet)
 - *Asphalt* $\mu = \sim 0.8$ (reserve surface)
 - *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

Proving Ground modules

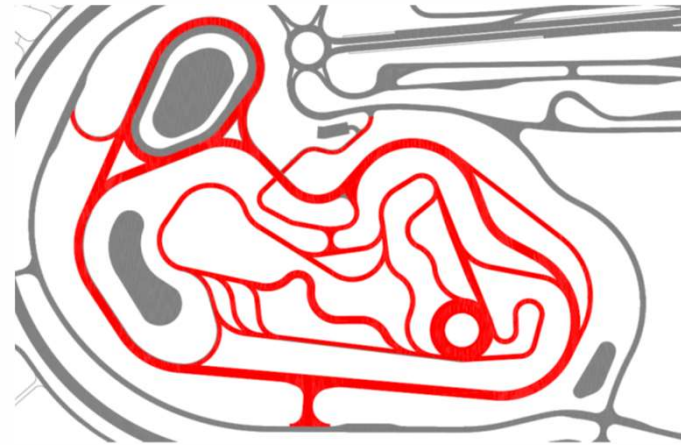
Handling course

Physical 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

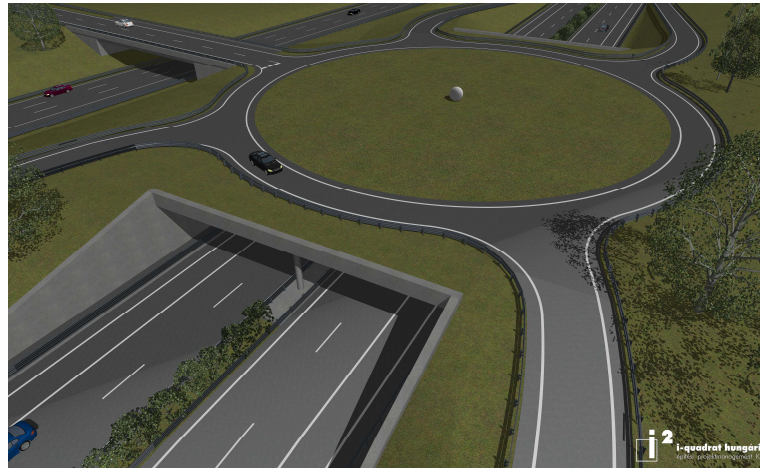


Proving Ground modules

Motorway

Physical parameters:

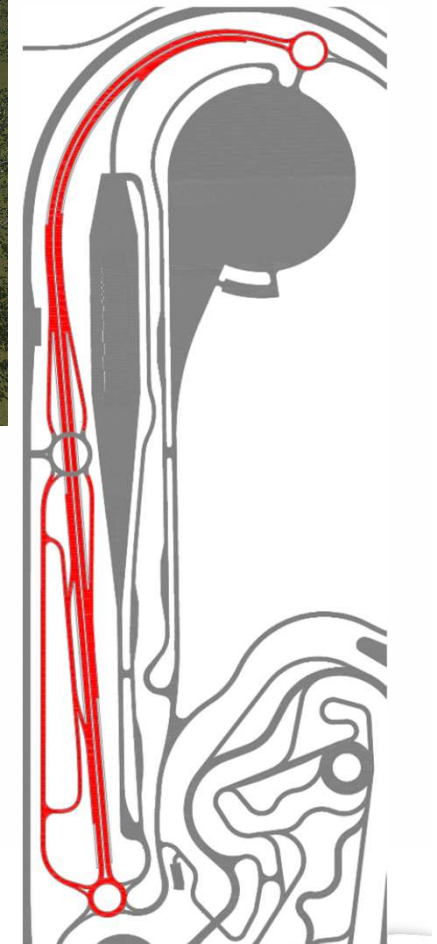
- 1500m 2 x 2+1 lane motorway
- 100m real tunnel
- Partly watered surface
- VMS, 5G test network
- V2X communication coverage
- GPS base station
- Public road like layout (junctions, road surface, geometry)



Project Phase 2 2019

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

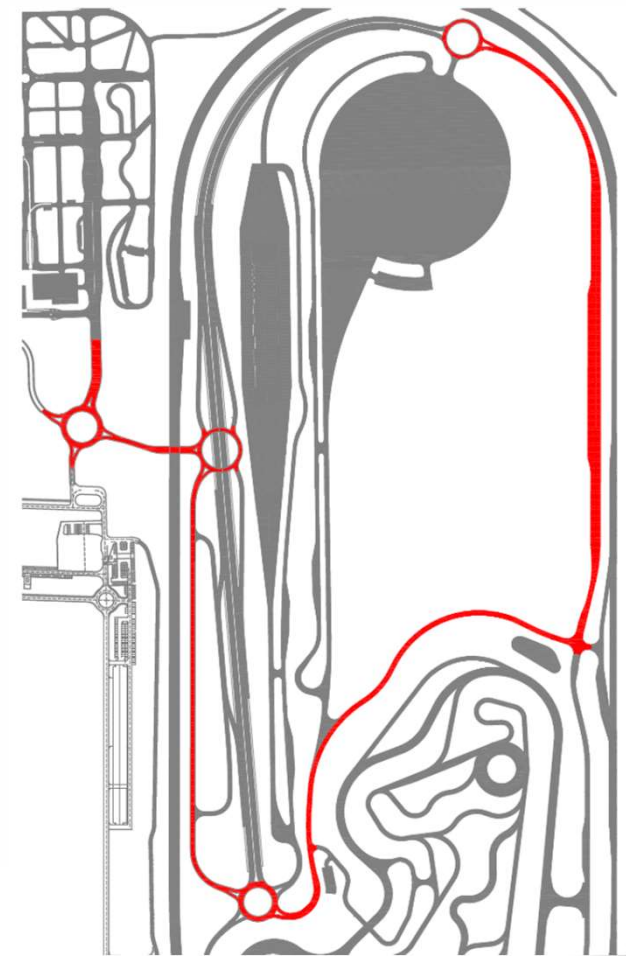


Proving Ground modules

Rural road

Physical 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.

Proving Ground modules

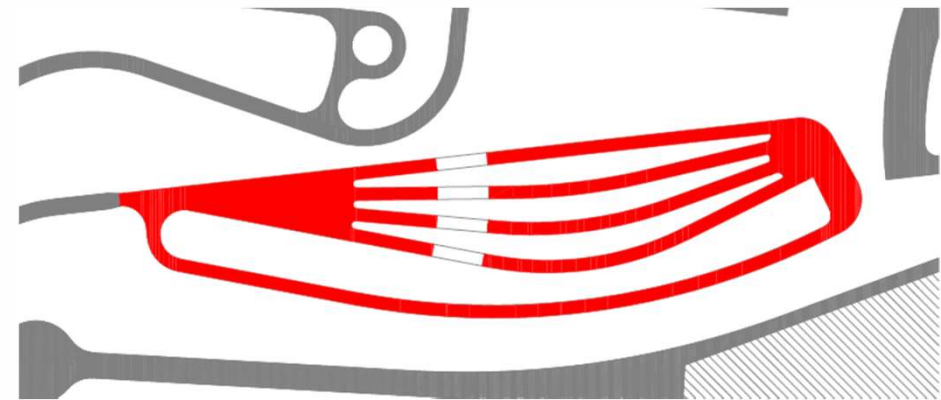
Slopes

Physical parameters:

- 100m length
- 20m height
- Low μ -split surface with a 25m length
- 5 different slopes: 5%, 12%, 18%, 25%
- Homogenous low friction surface, and diff. adherence test option on sides
- Integrated watering system
- Safety zone and reinforced guard rail

AD vehicle test cases:

- Platooning at low speeds up and downhill and various friction conditions with limited visibility
- Cooperative vehicle control at low speed up and downhill and various friction conditions with limited visibility



Project Phase 2 2020

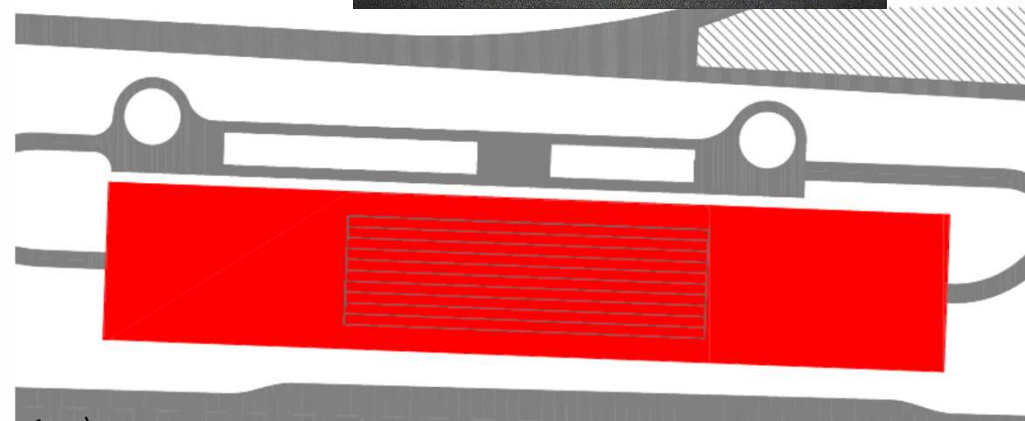
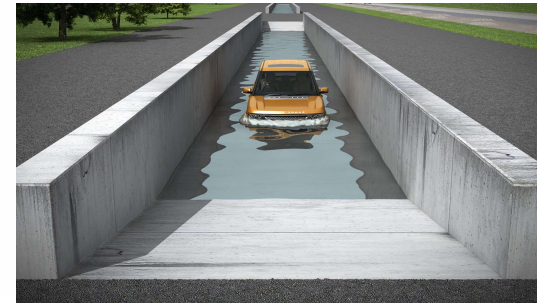


Proving Ground modules

Bad roads

Physical parameters:

- 8 different surfaces: Belgian pavement (2 diff. profile):
 - Spanish road
 - Washboard road
 - Road bumps, step-down
 - Block pave (3 kbz. profile)
- 150m length
- Acceleration lane 100m
- Safety zone 50m at the end
- 2 different water basin (max. 0.3 and max. 1m)



Project Phase 2 2020

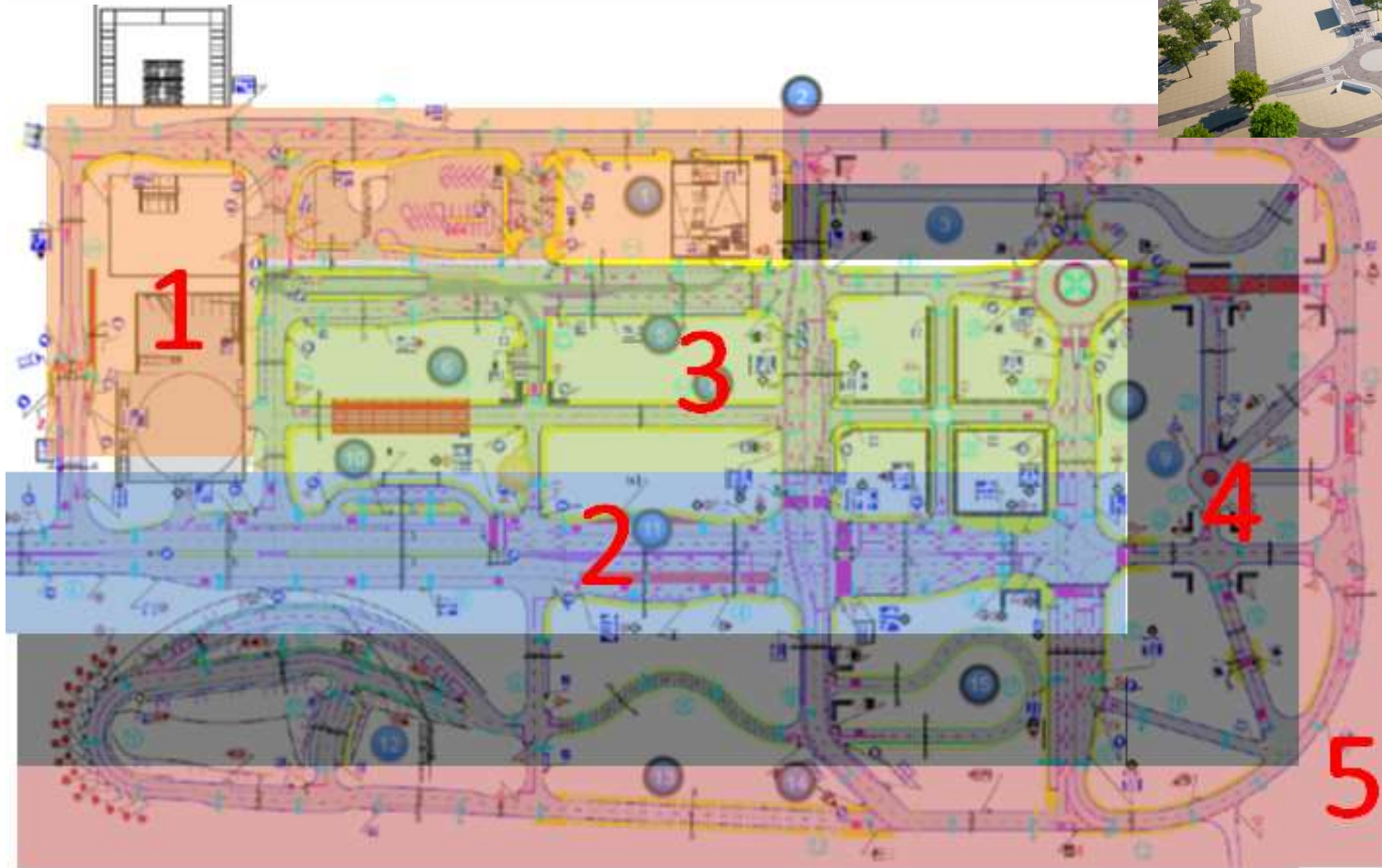
AD vehicle test cases:

- Platooning at low speed on extremely bad road quality
- Cooperative control at low speed on extremely bad road quality
- Moving and static obstacles



Proving Ground modules

SMART City Zone – Separated Function Zones



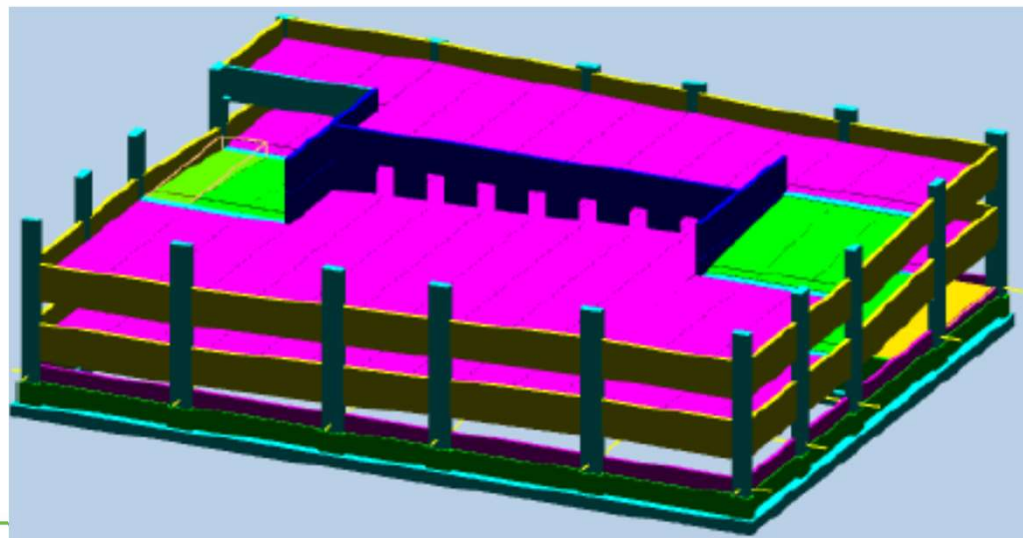
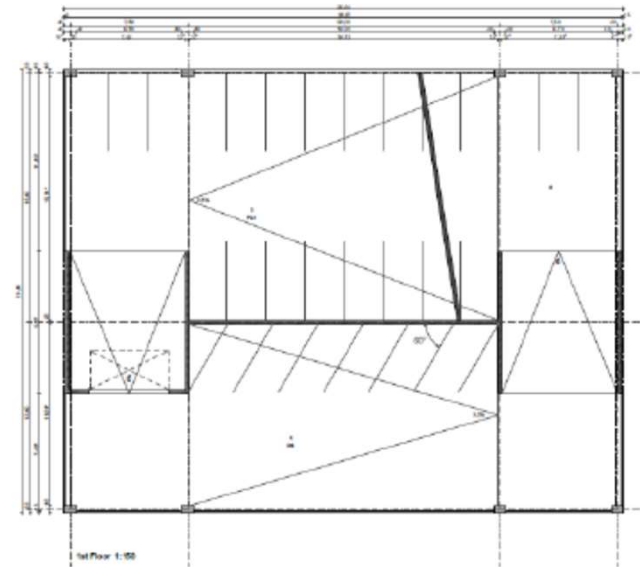
- 1. Low-speed, parking area
- 2. Multi-lane high speed area
- 3. Downtown area
- 4. Suburban area
- 5. T-junction area



Construction of Complex Test Scenarios

SMART City Zone – Parking house

- capacity for **60 cars**
- **3 levels:**
 - 1. level **wo natural light**
 - 2. level **open** concrete walls
 - 3. level: **open air** design
- **local V2X** network for wallet parking
- **configurable** parking place layouts



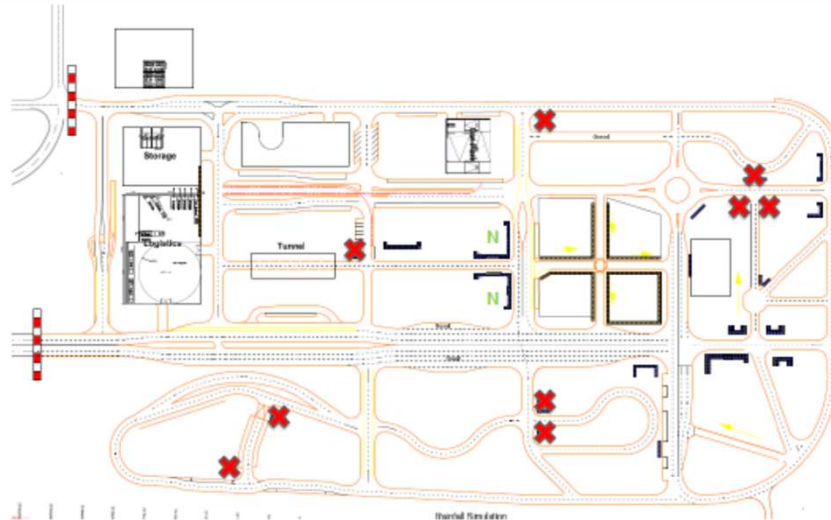
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Details of the modules

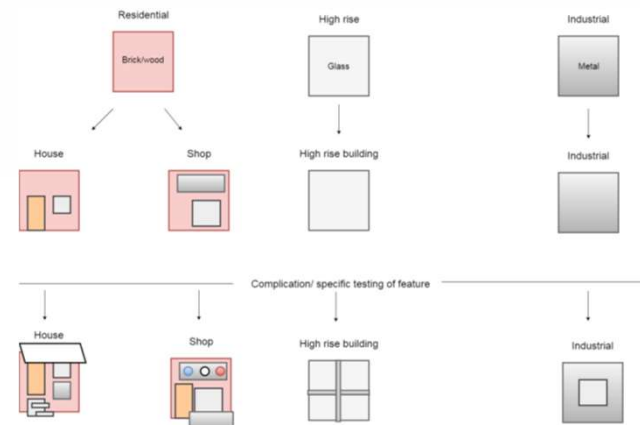
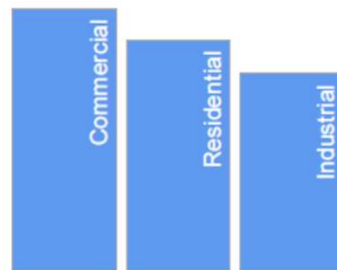


Construction of Complex Test Scenarios

SMART City Zone – Buildings



- Urban
 - High rise / office
 - Townhouse
 - Shop
- Sub-urban
 - Detached house
- Rural
 - Cottage
- Industrial
 - Warehouse
 - Hanger



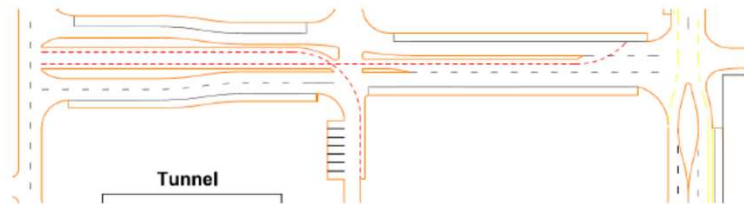
Construction of Complex Test Scenarios

SMART City Zone – Special features



Technical parameters:

- Sticky lane markings
- Real test vehicles
- Old cars for scenery, special cars
- Traffic gantry with variable message sign
- Railway crossing, construction zone, pedestrian crossings, trees, moveable road signs, tunnel,, roadside objects, various street lights, SMART City features



Construction of Complex Test Scenarios

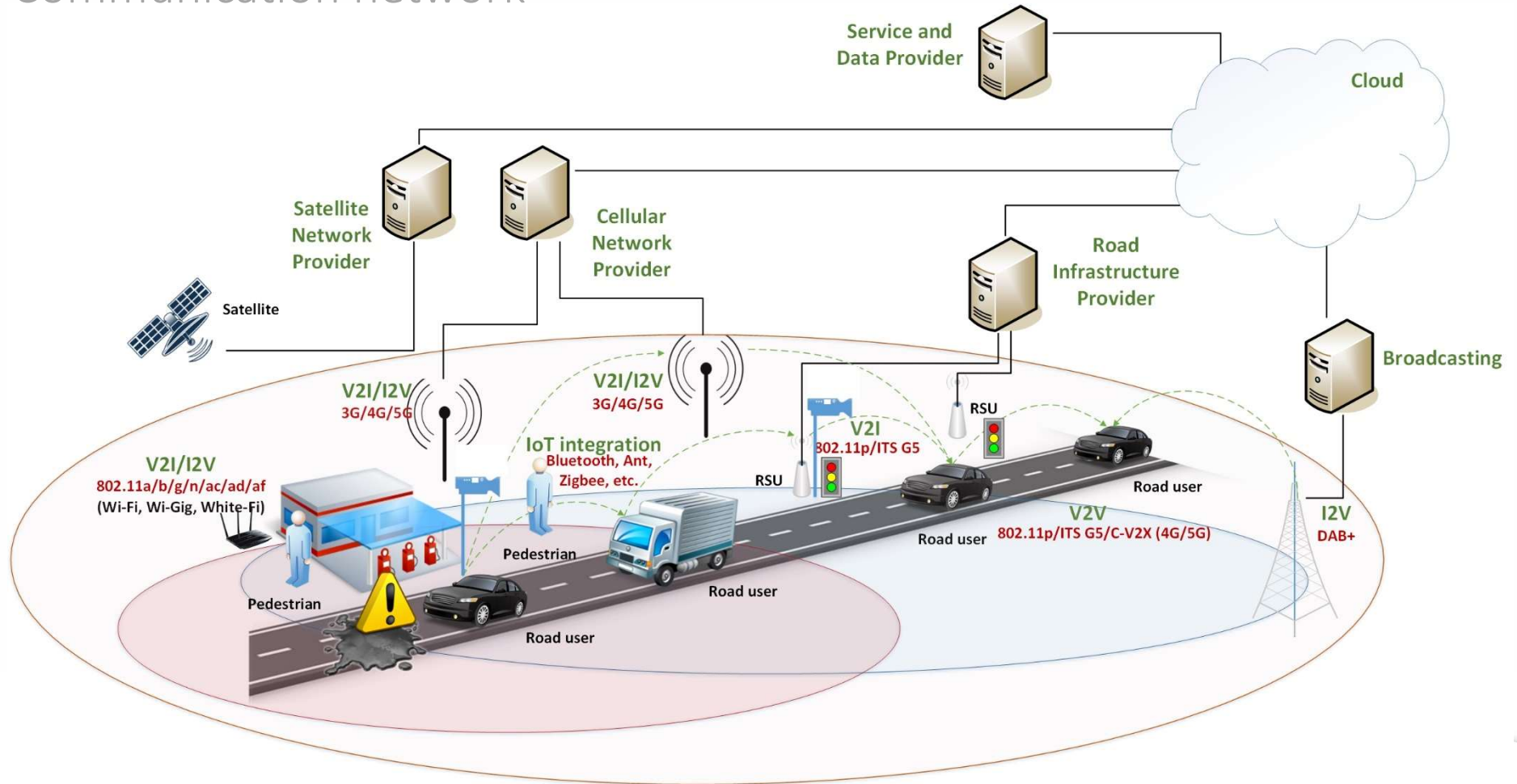
SMART City Zone – Test cases

- **Low-speed platooning** at various junctions and lane layout
- **Emergency braking** in city environment with different barriers (static, moving) on high and low friction surface
- **Cooperative tests** with vehicles, pedestrians, bikers etc.
- Different **parking situations**: parking house, valet parking, park assistant, different layouts, smart parking
- Intelligent **logistic yard**
- Different road **construction zone** scenarios in city environment
- Different **road side objects**: buildings, trees, parking cars, used road signs, fences, dust-bin etc.
- Changing **weather** conditions (rain)



Proving Ground modules

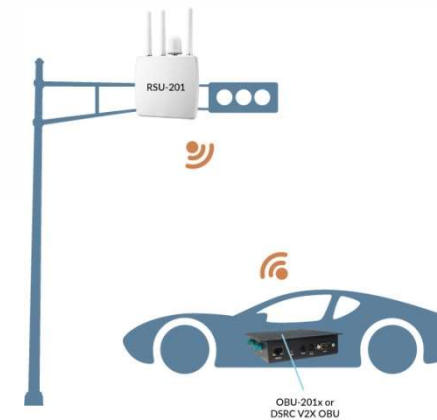
Communication network



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



Proving Ground Modules

DSRC/ITS G5 network

Main desired system features:

- EU/US standards conformance
- Support for hybrid radio
- Message, event and activity logging
- Time stamping, time synchronization capabilities
- Multi-vendor interoperability
- Authentication, Authority Center
- Traffic Management Center integration



What can be tested?



Proving Ground Modules

5G cellular network

Main desired system features:

- **Coverage** of the Test Proving Ground and the designated Smart City Area
- **Handover** capability
- **Network slicing** capability (e.g. one slice for C-ITS communication another for Mobile Broadband)
- Feature set evolution towards **5G** (invoking frequent NW upgrade)
- **Flexible** architecture (virtualized network functions)
- **Local** computing capability (a.k.a. edge computing)
- **Security** including system access, usage logging, communication encryption
- Massive **IoT support** (primarily for the Smart City Area)
- Message, event and **activity logging**
- Time stamping, time **synchronization** capabilities
- **Multi-vendor** interoperability



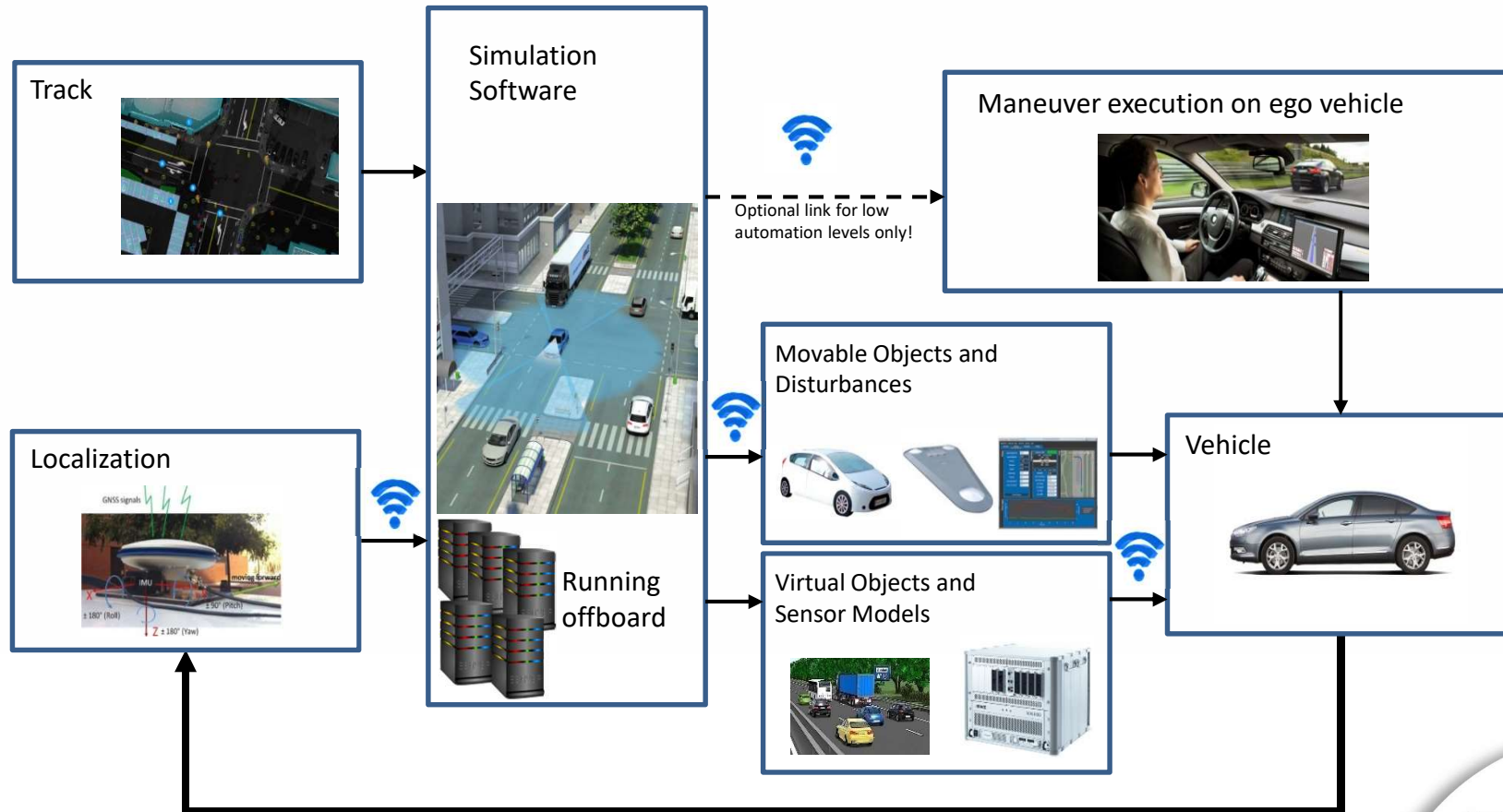
What can be tested?



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Construction of Complex Test Scenarios

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



Construction of Complex Test Scenarios

Dummies and UFO's



ZALAZONE - Region Zala

