5G for cooperative & connected automated MOBILITY on X-border corridors

5GTNF Results and Demo Seminar

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Background and motivation of 5G-MOBIX
Higher Levels of Vehicle Automation with 5G

**ADAS+ - Partial automation**
Driver supervises the ADS

**Conditional automation**
Driver “out of the loop” but need to take control on request by the ADS

**High/Full automation**
Driver out of the loop & no need to take control – can be driverless

In-vehicle sensors and ADS

Higher environment perception using connected sensors and computing outside the vehicle

**SAE automation levels**
- **L2**
- **L3**
- **L4/L5**

**SAE: Society of Automotive Engineers**

**ADS: Automated Driving System**

**eMBB**
**uRLLC**
**eMTC**

Artificial intelligence
Mobile Edge Compute
Sensor Fusion
Multimode 4G/5G
C-V2X Direct Communications
Precise positioning
Computer vision
Power management
Security

5G MOBIX
5G-MOBIX Background

- A 3-year project (11/2018-10/2021) funded within H2020 framework (ICT-18 call)
- 5G-MOBIX evaluates **automotive use cases** leveraging **5G technologies** with a specific focus on cross-border areas
- Cross-border environment presents a **number of challenging issues** for 5G use cases with L4/L5 vehicles
- Run cross-border experimental trials to test and validate potential solutions

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**5G-MOBIX - Two cross-border corridors (CBCs)**

**Spain - Portugal**
- Private Automated vehicles (SC1: Lane merge, SC2: Automated overtaking, SC3: HD MAPS)
- Public transport
- EV automated shuttle vehicles (SC1: Automated operation. SC2: Remote control.)

**Use cases**
- Porto – Vigo is a Pan-European X-Border 5G corridor for Connected and Automated Mobility

**Greece - Turkey**
- Truck Platooning with “see what I see”
- Assisted Truck border crossing

**Use cases**
- Kipoi - Ipsala site is a main entry point into EU territory for cargo, with heavy customs operations
5G-MOBIX - Six Local Trial Sites (TS)
55 partners from 10 countries

Telecom & Connectivity

ERTICO
ITS Europe

Automated driving
5G-MOBIX use cases and addressed cross-border issues categorisation
5G-MOBIX Use Case Categorisation

Use case categorisation essential in 5G-MOBIX to **enhance synergy between CBCs and TSs** experimenting on common automotive use cases.

<table>
<thead>
<tr>
<th>5G-MOBIX Use Case Categories</th>
<th>Brief description</th>
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</thead>
<tbody>
<tr>
<td>Advanced driving</td>
<td>Vehicles (and/or RSU) in proximity <strong>share driving intentions and local sensor data obtained</strong>, thus allowing <strong>vehicles to coordinate their trajectories or maneuvers</strong>.</td>
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<tr>
<td>Vehicles platooning</td>
<td>Enables the vehicles to <strong>dynamically form a group</strong> travelling together.</td>
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<tr>
<td>Extended sensors</td>
<td>Exchange of <strong>raw or processed data gathered through local sensors or live video data</strong> among vehicles, RSUs, devices of pedestrians and V2X application servers.</td>
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<tr>
<td>Remote driving</td>
<td>A <strong>human driver or a V2X application is able to remotely operate</strong> an autonomous vehicle.</td>
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<tr>
<td>Vehicle QoS Support</td>
<td>A **V2X application is timely notified of expected or estimated change of QoS before actual change occurs and/or mobile network able to modify the QoS in line with V2X application’s QoS needs.</td>
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</tbody>
</table>

QoS: Quality of Service  
RSU: Roadside Unit  
V2X: Vehicle to Everything

3GPP TS 22.186 (2018-12). Enhancement of 3GPP support for V2X scenarios; Stage 1
5G-MOBIX work on Cross-border issues

- Cross-border operation is the focus of 5G-MOBIX
- Addressed cross-border issues in four main categories
  - Telecommunication Issues
  - Application issues
  - Security and data privacy issues
  - Regulatory issues
- Distinct solutions to be applied and tested at the different cross-border corridors (CBCs) and local trial sites (TSs)
### 5G-MOBIX CBCs / TSs - Linking User Stories

- **Focus on cross-border operation at the two CBC**
  - Spain-Portugal (ES-PT)
  - Greece-Turkey (GR-TR)
- Local TS (e.g. FI) have been selected to **contribute and enable** the CBC trials (providing SW, components, alternatives, etc.)
- **Extended evaluations requiring more controlled environments also performed at the TS**

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**Table: Trial Site User Stories**

<table>
<thead>
<tr>
<th>Trial site</th>
<th>Advanced Driving</th>
<th>Vehicles Platooning</th>
<th>Extended Sensors</th>
<th>Remote Driving</th>
<th>Vehicle QoS Support</th>
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</thead>
<tbody>
<tr>
<td>ES-PT</td>
<td>Complex manoeuvres in cross-border settings</td>
<td>Platooning with &quot;see what I see&quot; functionality in cross-border settings</td>
<td>Extended sensors enabling complex manoeuvres</td>
<td>Automated shuttle remote driving across borders</td>
<td>Public transport with HD media services and video surveillance</td>
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<tr>
<td>GR-TR</td>
<td>Platooning</td>
<td></td>
<td>Extended sensors for assisted border crossing</td>
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<tr>
<td>DE</td>
<td></td>
<td>eRSU-assisted Platooning</td>
<td>EDM-enabled extended sensors with surround view generation</td>
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<td>FI</td>
<td>Infrastructure-assisted driving</td>
<td></td>
<td>Extended sensors with redundant Edge processing</td>
<td>Remote driving in a redundant network environment</td>
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<tr>
<td>FR</td>
<td>Infrastructure-assisted advanced driving</td>
<td></td>
<td>QoS adaptation for security check in hybrid V2X environment</td>
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<tr>
<td>NL</td>
<td>Cooperative Collision Avoidance</td>
<td>Extended sensors with CPM messages</td>
<td>Remote driving using 5G positioning</td>
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<td>CN</td>
<td>Cloud-assisted Advanced Driving</td>
<td>Cloud-assisted platooning</td>
<td>Remote driving with data ownership focus</td>
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<tr>
<td>KR</td>
<td>Advanced Driving</td>
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<td>Remote driving over mmW</td>
<td>Tethering via Vehicle over mmW</td>
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**Legend:**
- **CBC:** Cross-Border Corridor
- **TS:** (Local) Trial Site

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