CCAM

CONNECTED, COOPERATIVE
& AUTOMATED MOBILITY

# Cluster 2
# Vehicle technologies

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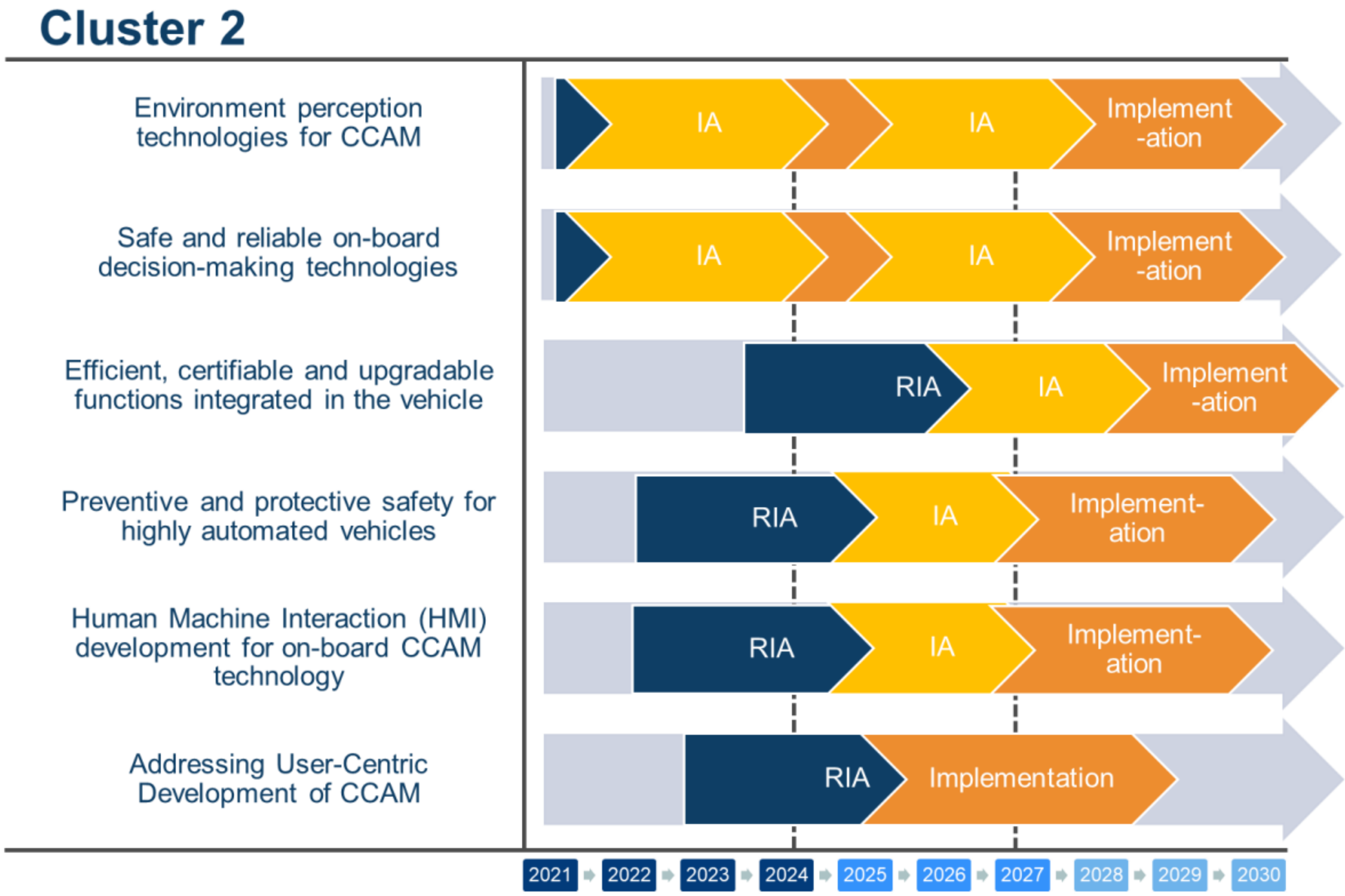
# Cluster 2: SRIA Actions & Call Topics to Date




HORIZON-CL5-**2021**-D6-01-01

HORIZON-CL5-**2024**-D6-01-01

HORIZON-CL5-**2022**-D6-01-02

HORIZON-CL5-**2023**-D6-01-01

HORIZON-CL5-**2021**-D6-01-01

# More powerful and reliable on-board perception and decision-making technologies addressing complex environmental conditions

## Expected Outcomes

- Determination of the appropriate compositions of **cost-efficient sensor suites** that most effectively and reliably deliver the lateral, spatial and temporal resolution needed for **real-time driving decision-making** of Connected and Automated Vehicles (CAVs).
- Ability to perform **advanced environment and traffic recognition and prediction**, limiting false detections and non-detections of obstacles, with particular attention to Vulnerable Road Users (VRU), in order to reduce existing disparities in the harm-to-exposure ratios of these vulnerable groups.
- Ability to determine the **appropriate course of action** of a CAV in a **real-world environment** with a wide range of traffic scenarios and identify use cases in which the vehicle's decision-making might be contradictory to existing traffic rules (e.g. to make way for a priority vehicle, to obey police officers directing traffic).
- Availability of robust, transparent and accurate systems to enable the safe and reliable operation of automated vehicles in expanding Operational Design Domains (ODDs) including **all weather conditions, complex urban environments, challenges in rural environments**, etc.
- **Standardization mandate for performance requirements** for environment perception systems with respect to different automation levels and ODDs.

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# Projects in Cluster 2

| Coordinator | Project | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 |
|---|---|---|---|---|---|---|---|
| ICCS Greece | **EVENTS** *ReliablE in-Vehicle pErception and decisioN-making in complex environmenTal conditionS"* | | | | | | |
| HOGSKOLA N I HALMSTA Sweden | **ROADVIEW** *Robust Automated Driving in Extreme Weather* | | | | | | |
| Vicomtech Spain | **AWARE2ALL** *Safety systems and human-machine interfaces oriented to diverse population towards future scenarios with increasing share of highly automated vehicles* | | | | | | |
| CERTH Greece | **AutoTRUST** *Autonomous self-adaptive services for TRansformational personalized inclUsivenesS and resilience in mobiliTy* | | | | | | |
| VTT Finland | **OptiPEx** *Optimizing Passenger Experience in Public Transport* | | | | | | |

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HORIZON-CL5-**2022**-D6-01-02

# Reliable occupant protection technologies and HMI solutions to ensure the safety of highly automated vehicles

## Expected outcomes

- **Protection systems** in Connected and Automated Vehicles (CAVs) designed for a greater variation of **unconventional seating positions and body postures**, including gender, age and ability differences, to be sufficiently inclusive to encompass the diversity of the occupant population, considering all situations and conditions for the application of such systems and taking into account different accident configurations with a higher market penetration of CAVs.
- New, **advanced Human-Machine-Interface (HMI) solutions** as enablers for the safe and efficient co-existence and interaction of CAVs with other road users (including Vulnerable Road Users and non-automated vehicles). Interfaces should be reliable and seamless, based on comprehensive knowledge and models of individual human behaviour and capabilities.
- **Advanced driver/passenger condition monitoring** and improved HMI functionalities to prepare the **driver to take control** as may be necessary when the vehicle reaches the **limits of its Operational Design Domains** (ODD).
- Consistent design methodologies and tools for **performance assessment** of the new protection systems.
- Delivering evidence-based **support to the regulatory bodies** for the potential adaptation of traffic rules.

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## HORIZON-CL5-**2023**-D6-01-01

# User-centric development of vehicle technologies and solutions to optimise the on-board experience and ensure inclusiveness

## Expected outcomes:

- Advanced vehicle technologies and solutions which optimise **usability, perception and experience** on-board, and when boarding/off-boarding, in terms of security, privacy, well-being, health and assistance.
- **Enhanced inclusiveness and trust** in the interaction between users and new automated modes of road transport and mobility services in the transition from human-driven to automated vehicles.
- Safety and security of vehicle occupants in all circumstances even when the vehicle is driverless by helping to **prevent dangerous and inconvenient situations**, also when boarding/off-boarding.
- Strengthened cooperation between users, vehicle manufacturers, suppliers, researchers and other stakeholders to **co-design vehicles to optimise the on-board experience**.
- Better **understanding of the benefits** of new vehicle technologies and solutions in terms of on-board experience, inclusiveness and trust to enable wider user acceptability and hence contribute to the creation of future standards.
- Full exploitation of the new opportunities offered by automated vehicles to provide **user-centric, accessible and inclusive mobility for all**.

# Projects in Cluster 2

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HORIZON-CL5-**2024**-D6-01-01

# Centralised, reliable, cyber-secure & upgradable in-vehicle electronic control architectures for CCAM connected to the cloud-edge continuum

## Expected outcomes

- New, centralised, reliable, cyber-secure and upgradable **in-vehicle electronic control architectures** for CCAM based on the application of co-designed hardware, software and big or smart data flows in combination with over-the-air updates.
- Widespread deployment of level 4 automation in road vehicles by **expanding the ODDs** (Operational Design Domains) of the control system towards **higher complexity** (city traffic, adverse weather conditions etc.) or greater scale.
- Safe operation of Connected and Automated Driving (CAD) functions e.g. regarding Vulnerable Road Users (VRUs) and ODD transitions through **system agility, experience-based decision-making and access to cloud intelligence**.
- Paradigm shift from human-based and component-supported vehicle control to a more **integrated, resource-efficient and reliable system** for the control of CCAM systems.
- Strengthened cooperation of European OEMs and suppliers to **co-design a standard cyber-secure electronic architecture layout** with harmonised interfaces.

# Next-generation environment perception for real-world CCAM operations: Error-free, secure technologies to improve energy-efficiency, cost-effectiveness, and circularity

## Expected outcomes

- **Availability of validated prototypes** of next-generation vehicle and infrastructure-based environment perception technologies for robust, reliable and trustworthy CCAM operation to anticipate and avoid foreseeable risks and unexpected safety-critical situations in complex real-world conditions (e.g., at pedestrian crossings, in construction sites, during interactions with emergency vehicles, etc.);
- Understanding the degree (and limits) to which automated CCAM perception systems can **anticipate, process, and respond to on-site 'early-warnings'** (e.g., street design, sounds and smells from the environment, intentions of pedestrians cyclists and other active mobility users, etc.)
- Improvement of the **energy-efficiency** of the sense-think-act systems of CCAM considering the vehicle, the infrastructure, the cloud at-the-edge, while at the same time **increasing the performance to guarantee security and error-free reliability**; these developments will contribute to the reduction of the potential climate and environmental footprints of CCAM systems.
- Standardisation and adoption of **modular, reusable, and upgradable software and hardware platforms**, investigating scalable deployment concepts that lead to cost reduction and improved affordability, while adopting a circular, eco-design approach based on efficient materials use and reduced waste.

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# EVENTS project

HORIZON-CL5-**2021**-D6-01-01

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# EVENTS @CCAM Multi-Cluster Meeting

**Dr. Panagiotis Lytrivis, ICCS**
**Dr. Bill Roungas, ICCS**
**10/10/2024,** Brussels, Belgium

EVENTS

# EVENTS Facts

- **Full Title:** ReliablE in-Vehicle pErception and decision making in complex environmenTal conditions
- **Project ID:** 101069614
- **Funded Under:** Horizon Europe
- **Funding Scheme:** IA –Innovation Action
- **Duration:** 36 months, 01 September 2022 – 31 August 2025
- **Total Cost:** EUR 6.920.598
- **EU Contribution:** EUR 5.534.448
- **Project Coordinator:** Institute of Communication and Computer Systems (ICCS)

Funded by the European Union

EVENTS project has received funding under grant agreement No 101069614. It is funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Commission. Neither the European Union nor the granting authority can be held responsible for them.

# EVENTS Consortium

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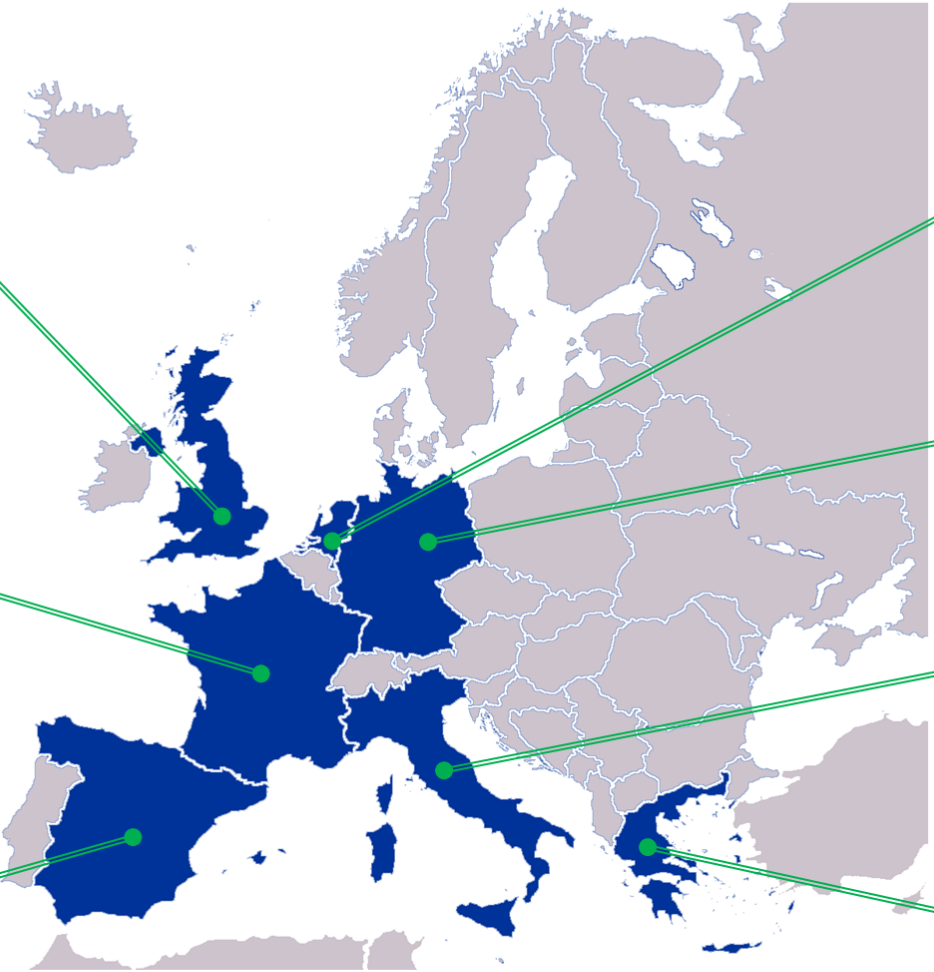
MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE



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PERCIVAI

universität ulm
APTIV

STELLANTIS
CRF

ICCS
SEAbility

**12 partners within 6 EU Member States and UK**

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# EVENTS Results

## Self-Assessment of Collective Perception

- Probabilistic fusion for collective perception with plausibility/consistency checks
- Adaptive Kalman Filtering Based on Subjective Logic Self-Assessment
- Hybrid simulation, in which the demo vehicle exchanges information with the simulations

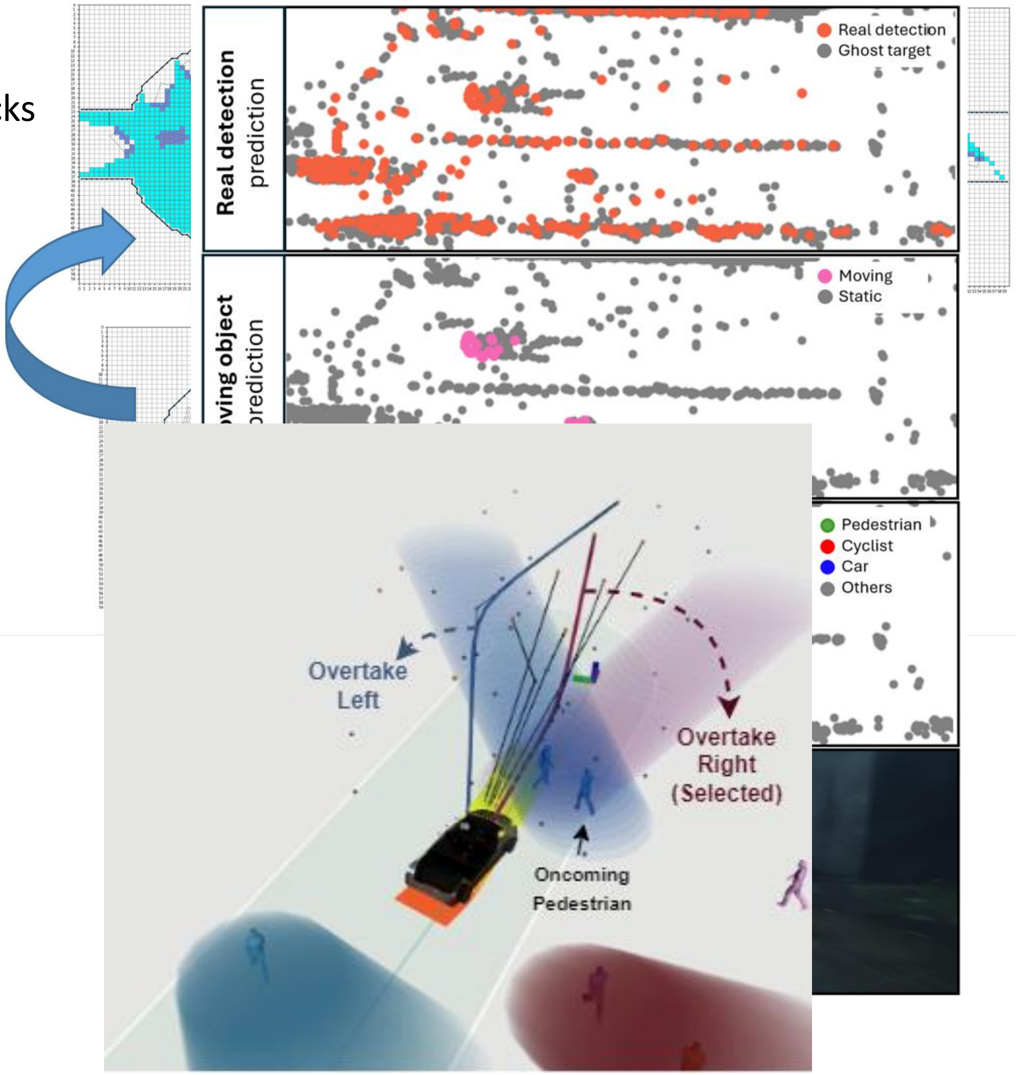
## 4D Radars for Perception in Adverse Weather

Novel multipurpose network designed to do:

- Noise rejection (real vs ghost radar targets)
- Movement detection (static vs moving radar targets)
- Semantic segmentation (targets from cars vs bikes vs pedestrians vs background)

## VRU Prediction & Planning

- Development of accurate deep learning-based prediction methods taking into account class info and map-data
- Investigation of domain transfer capabilities of motion models
- Motion planner with decision making that computes whether to overtake or stop

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# EVENTS - Lessons Learned

## Overall

- Even slightly adverse conditions (e.g., light rain) can significantly degrade the sensors' performance.
- Significantly more expensive sensors (e.g., Lidars) do not necessarily perform better than more inexpensive but state-of-the-art solutions (e.g., Radars).
- The challenges do not end on the implementation and integration of the algorithms but also extend to the evaluation of each layer (perception & decision-making) as well as the AD system as a whole

## Experiment-specific

- The 4D radar AI approach allows seamless switching between sensors from different vendors, offering flexibility and requiring much less training data.
- Many innovative AI methods are too research-focused, not real-time, and work only on specific datasets—real-world implementation is much tougher.
- Automated driving in complex scenarios with many VRUs is achievable, but performance is affected by many components, from perception accuracy to delays in actuator commands. Full-stack integration and testing is a complex and time consuming process that is often underestimated

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# EVENTS – Hinders & Work to be done

## Hinders

- Testing scenarios in adverse weather conditions in the real world, can be very time consuming, especially when you have to wait months to have the appropriate conditions.
- Specialized personnel, even at a junior level, is scarce throughout Europe.

## Work to be done

- Integration with control solution to test the end-to-end weather robust safety system live.
- With regards to VRUs, robustness is the key challenge, especially if some VRUs suddenly change their behaviour (e.g. cyclist cut in the automated vehicle).

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www.events-project.eu

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EVENTS project

# Thank you for your attention!

**Dr. Panagiotis Lytrivis, Dr. Bill Roungas**
**ICCS**

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# ROADVIEW project

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# ROADVIEW

## Robust Automated Driving in Extreme Weather

https://roadview-project.eu/

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HALMSTAD UNIVERSITY

FORD OTOSAN

CARISSMA

Technische Hochschule Ingolstadt

Cerema

CLIMAT & TERRITOIRES DE DEMAIN

accelopment takes you further

konrad technologies


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AVL

WARWICK THE UNIVERSITY OF WARWICK

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NLS FINNISH GEOSPATIAL RESEARCH INSTITUTE FGI

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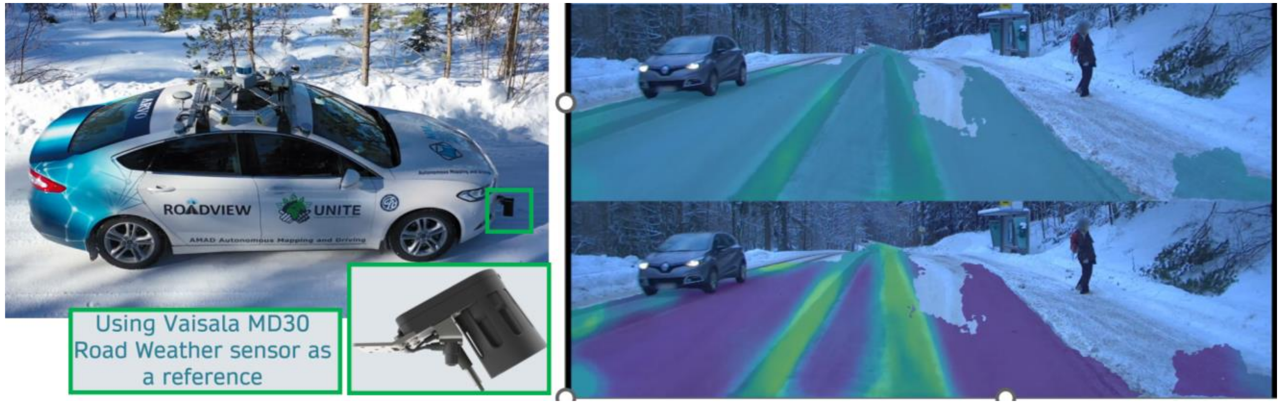
# ROADVIEW Innovations

1. ROADVIEW introduces ***a fast and efficient unsupervised snow removal algorithm*** for 3D LiDAR point clouds captured in adverse weather.


2. ROADVIEW proposes a novel ***multimodal slipperiness estimation model*** coupled with a camera-based drivable area segmentation method.




3. ROADVIEW demonstrates a ***weather-conditional navigation system*** by receiving the MRM request via V2X.

# ROADVIEW Videos

https://www.youtube.com/watch?v=sryAabk77N0&list=PLPRufXlEiQvov-qaGRPg30w7rQzqyYGYW

# ROADVIEW: Lessons learned

1. Having a vehicle-agnostic innovation is a big challenge. Most of our AI-based innovations are vehicle-specific. When we move between different vehicles, for example, from a car to a truck, the domain shift becomes an obstacle, so additional data needs to be logged and annotated in the new domain.
2. Having a comprehensive plan of what/when/where to log data will go a long way in overcoming most of the technical challenges.

# ROADVIEW: What is hindering / what still needs to be done?

1. Domain shift is still an issue. Even switching to a new sensor with a different resolution requires additional data. We will focus on this problem in the next phase of the project.

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# AWARE2ALL project

## HORIZON-CL5-**2022**-D6-01-02

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AWARE2ALL

# AWARE2ALL Project

**Safety system and human machine interfaces oriented to diverse population towards future scenarios with increasing share of highly automated vehicles**

Address the **new safety challenges** posed by the **introduction of HAVs** in **mixed road traffic**, through the **development** of inclusive and **innovative safety** (passive and active) and **HMI** (internal and external) systems that will consider the variety of population and will objectively demonstrate relevant improvements in mixed traffic safety.

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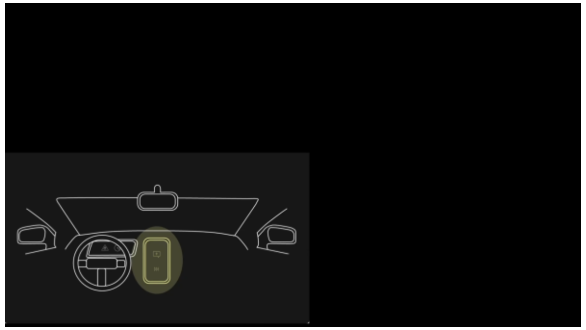
# Key results of AWARE2ALL

## Occupant Monitoring System (OMS)

In-cabin sensors to measure and evaluate the state of the driver/occupant, including prediction of intentions and estimation of behaviour patterns

- Key point detection (Pose estimation, Seat occupancy detection, Passenger classification)
- Radar-based (Passenger classification, Seat occupancy estimation, Occupant health estimation)
- Image-based (Driver gaze estimation, Driver identification, Driver distraction detection)
- EEG-based (Driver cognitive load estimation)



## Driver Monitoring Dataset (DMD)

26TB of raw data
Multi-domain data
Multi-camera (body, face and hands)
Multi-channel (RGB,IR, depth)
Multi-label annotations

- Temporal Levels of annotation (>1 labels per each frame): Actions, hands position, occlusions, eyes state, objects in scene, etc
- Logical relations between them
- Context annotations such as: Gender, weather, driver wearing glasses

This allows to have a better and more comprehensive understanding of the state of the driver

Public on dmd.vicomtech.org


## external Human Machine Interface (eHMI)

Surround View System (SVS) with a multimodal eHMI interface, AI-driven HRU detection, and use photorealistic synthetic data for enhanced VRU representation.

- The situation in the interior of the vehicle is shared with HRUs via the eHMI in case that has safety implications (e.g., transition from autonomous mode to manual mode).
- Interaction with HRUs using multi-modal interfaces
  - Exterior lighting
  - Sounds and the use of the AVAS (Acoustic Vehicle Alerting System)

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# OptiPEx project

HORIZON-CL5-**2023**-D6-01-01

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# OptiPEx in a nutshell

- Topic: Horizon-CL5-2023-D6-01-01
- Type of Action: Research & Innovation Action
- Duration: 42 months (May 2024 - October 2027)
- Total budget: 4 083 231€
- Total workload: 545.5 PMs
- Consortium: 11 partners from 7 countries
  - 3 RTOs: VTT Technical Research Centre of Finland (FI), University of Zaragoza (ES), Johannes Kepler University Linz (AT)
  - 6 large companies: Ingenieurgesellschaft Auto und Verkehr (DE), Teleste (FI), Teleste Video Networks (PL), Teleste Information Solutions (FI), Škoda Transtech (FI), Škoda Digital (CZ)
  - 2 SMEs: HI Iberia Ingenieria y Proyectos (ES), Carr Communications (IE)
- Coordinator: Dr. Johanna Kallio, johanna.Kallio@vtt.fi, mobile +358 50 527 0180

OPTIPEX

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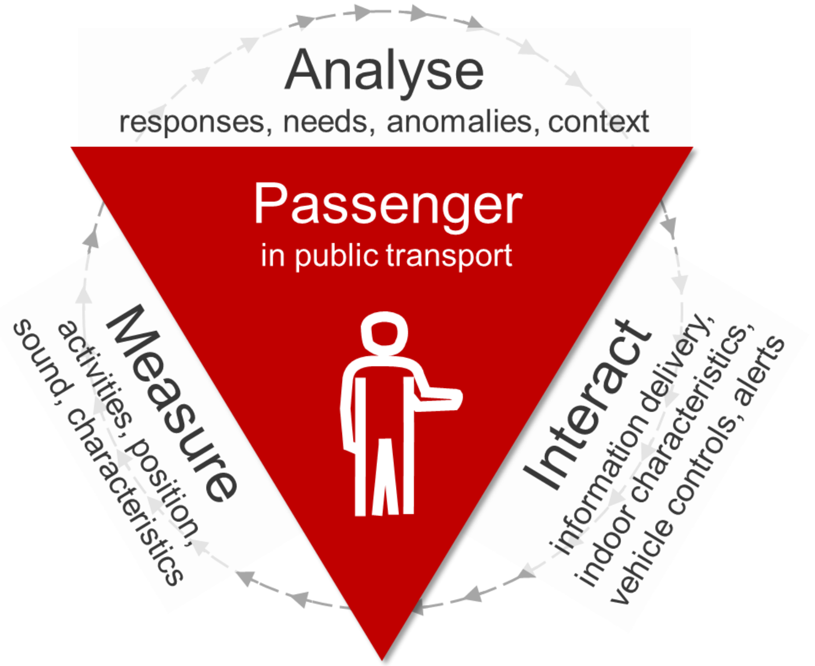
# OptiPEx - Optimising Passenger Experience in Public Transport

- OptiPEx will **create ethical, passenger-aware interactive and adaptive public transport services** built on advanced vehicle technologies that assess passenger experience and adjusts the conditions to improve the sense of comfort, safety, and ease of travelling
- OptiPEx will enhance passenger experience by **co-creating** vehicle technologies and mobility solutions together with specific user groups, including wheelchair users, passengers with large objects, fragile passengers with limited mobility, tourists and students
- Three **key exploitable results**
    - **Passenger perspective and service concepts** for the future autonomous public transport services aimed at increasing perceived well-being, comfort, safety, and security
    - **Privacy-preserving data analytics methods** for continuous passenger experience assessment and situational awareness on-board, and when boarding/off-boarding
    - **Advanced vehicle technologies** for data-driven optimisation of on-board passenger experience in real-time accordance with privacy and security standards
- The developed solutions will be demonstrated and validated with the target groups and other stakeholders in three living labs: Lyyli tram (FI), IAV shuttle bus (DE) and Linz tram (AT).

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# OptiPEx - Optimising Passenger Experience in Public Transport

- Lessons learned
  - The call required to **involve passengers in co-creating solutions to improve inclusiveness and trust**. **Recruiting passenger** representatives from different passenger groups (e.g., wheelchair users and passengers with mobility or vision restrictions) **has been challenging**.
  - It would be good if we could **provide some incentives for participants**. However, currently incentives (such as gift vouchers or transport costs) are not eligible costs: incentive costs can be susceptible to misuse, but for participant commitment, it would be highly beneficial.
  - All in all, **a lot of effort should be invested in passengers' and other stakeholders' commitment** during the co-creation process.
- What is hindering / what still needs to be done?
  - OptiPEx develops AI methods and algorithms to assess passenger experience on board. However, **not many suitable real-life datasets are available**, including specific passenger group representatives. Thus, before actual AI development work, **datasets need to be collected, which is time-consuming and requires efforts to guarantee the representativeness of data**.