CCAM

CONNECTED, COOPERATIVE & AUTOMATED MOBILITY

From Cluster 4 “Integrating CCAM in the Transport System“ to Large-scale Demonstrations

Break-out-session @ MCM

ccam.eu

Goal of this session

- What are the major results of currently running Cluster 4 research projects?

- Which of those require scaling-up and future investigations?

- What – in terms of the Cluster 4 topic "Integrating CCAM into the transport system" – are further important aspects?

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CONNECTED, COOPERATIVE & AUTOMATED MOBILITY

Approach

11:10 Introduction (5 Min)

11:15 Current project insights of Cluster 4 projects (10 Min)

- Augmented CCAM
- CONDUCTOR
- IN2CCAM

11:25 Audience inputs – Mentimeter. In parallel: Q&A to coordinators

11:35 Discussion, Clarification & Priorities (15 Min)

11:50 Wrap up (5 Min)

Projects in Cluster 4

Augmented CCAM, HORIZON-CL5-2021-D6-01-03, Area A
Understand, harmonise and evaluate in an augmented manner adapted and novel support solutions of Physical, Digital and Communication Infrastructure (PDI), to advance its readiness for large scale deployment of CCAM solutions for all.
(01/09/2022 – 31/12/2025), coordinated by Thierry Goger, FEHRL

PoDIUM, HORIZON-CL5-2021-D6-01-03, Area B
Connectivity and cooperation enablers to reach higher levels of automation and advance important PDI technologies
(01/10/2022 – 30/09/2025), coordinated by Angelos Amditis, ICCS

CONDUCTOR, HORIZON-CL5-2022-D6-01-04
Design, integrate and demonstrate advanced, high-level traffic and fleet management that will allow efficient and globally optimal transport of passengers and goods
(01/11/2022 – 31/10/2025), coordinated by Flavien Massi, Netcompany-Intrasoft SA

IN2CCAM, HORIZON-CL5-2022-D6-01-04
Develop, implement and demonstrate innovative services for connected and automated vehicles, infrastructures and users
(01/11/2022 – 31/10/2025), coordinated by Maria Pia Fanti, Politecnico di Bari

FRODDO, *HORIZON-CL5-2023-D6-01-03*
Robust, safe, secure and seamless connectivity and automation that can adapt to physical, technological and social challenges and support user centric mobility and development
(01/06/2024 – 31/05/2027), coordinated by Nikolaos Tsampieris, ERTICO

[second project of HORIZON-CL5-2023-D6-01-03, about to start soon]

FEHRL – CCAM Multiclusters Meeting

10/10/2024

Dr Thierry GOGER

FEHRL Secretary-General

AUGMENTED CCAM

Augmenting and Evaluating the Physical and Digital Infrastructure for CCAM deployment

Our Vision: Types of infrastructure support to CCAM

DUBAI ITS World Congress
16-20 September 2024
Mobility Driven by ITS

AUGMENTED CCAM

Objective

ROAD MARKINGS AND SIGNS

Need for qualified, geolocalized & updated signalling

CONNECTIVITY (C-ITS)

Need for interoperable V2X connectivity to send safety alerts

CONNECTIVITY + ROADSIDE PERCEPTION

Need to extend vehicle perception to prevent risky situations (see *beyond the horizon*)

CONNECTIVITY + ROADSIDE PERCEPTION + HYPERVISION

Need to organize vehicles flow to improve Quality Of Service on dedicated section

Equipment

- Smart lane markings
- Connected road signs

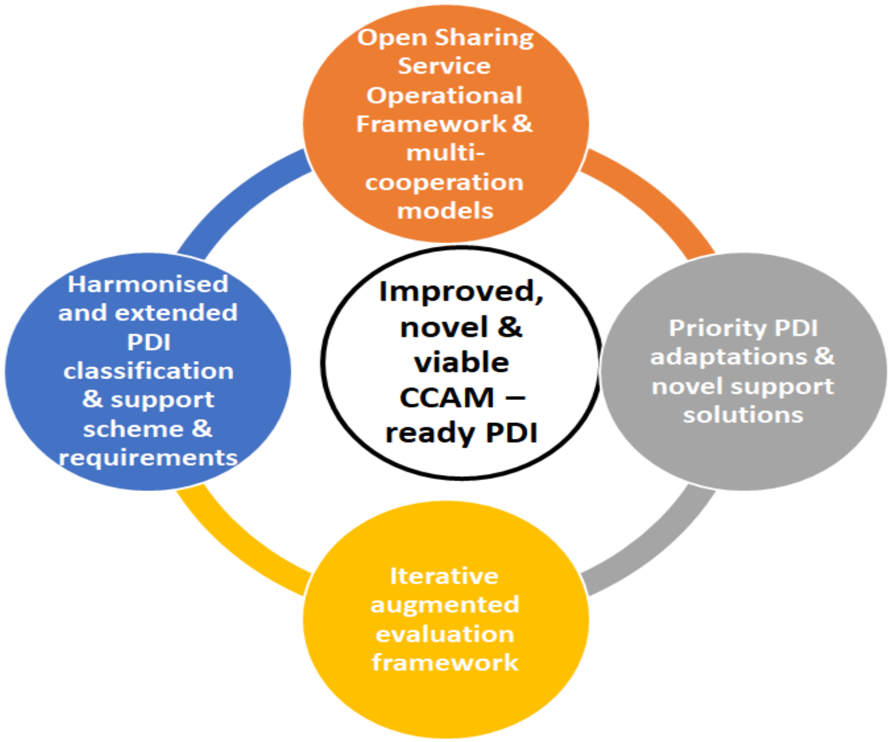
- Short range w/ Road Side Units
- Long range w/ cellular

- Roadside perception

- Roadside perception (multi-sensors)
- Redounded connectivity

INCREASING INFRASTRUCTURE ASSISTANCE TO VEHICLE

APPROACH



A. New PDI Classification & Support Scheme for CCAM
B. Technology agnostic "We Share What we See" Service Operational Framework and Architecture
C. Priority adaptations & new/ optimised PDI support solutions for CCAM services
D. Augmented (in physical and virtual world) iterative implementation and validation to feed impact assessment

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Augmented-CCAM – PDI support classification schema for CCAM

- ✓ a common understanding of infrastructure support for CCAM
- ✓ a guideline for road authorities when designing or evaluating their network

ACCAM PDI Support Classification Schema

Need & objectives identification → *Build upon past classification efforts with more completeness and agnosticism*

Key definitions & State-of-the-art alignment → *Strong effort to align on clear definitions & terms*

PDI Registry construction along clusters → *81 PDI elements clustered in 10 categories (e.g. "Traffic conditions", "Road pavement", "Digital services", etc.)*

PDI Registry mapping with use cases & services → *All PDI elements mapped along 5 layers, depending on their expected CCAM support*

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Augmented-CCAM – ACCAM Schema PDI support layers

81 PDI elements structured across five escalating Layers of Infrastructure Readiness for CCAM

Layer E	**Conventional sensing and planning infrastructure** → all elements below: **Only physical elements**, no digital nor communication elements are included. Infrastructure can support : **perception of the physical environment** of the drivers (manual driving mostly)
Layer D	**Anticipated sensing infrastructure** → all elements of Layer E + below: Infrastructure can support : drivers and vehicles to **understand earlier their environment**. **HD maps** : **static information only**, essential element in this layer
Layer C	**Enhanced sensing and primary planning support infrastructure** → all elements of Layer D + below: Infrastructure can support : drivers and vehicles to understand earlier their environment **and in a more reliable and complementary manner**. **HD maps** : incorporate **semi-dynamic information**.
Layer B	**Enhanced Planning and Actuation support infrastructure** → all elements of Layer C + below: Infrastructure can support : drivers and vehicles to make **better planning of their path** in view of safer and more efficient driving by providing all types of **dynamic information**. **HD maps** : **update the dynamic environment** and together with the **physical environment per road section**.
Layer A	**Augmented/ orchestrated acting infrastructure for mixed fleets operation** → all elements of Layer B + below: Infrastructure can support: **all road users on the network** → This layer enables **full operation of CCAM** **Digital Twins :** are fully detailed.

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Augmented-CCAM – Structuring each PDI element to characterize their support to CCAM

Layer	PDI element	Type of PDI (*Physical, Digital services, Comm. enabler*)	Addressed Vehicles (*L0, CV, L1-L3, L4-L5*)	PDI support or impact on ODD	Requirements and recommendations on PDI	Key restrictions
E	Lane width	Physical Infrastructure	All vehicles	Lane width adherence to standards & regulations is critical for safe driving conditions in mixed traffic conditions (manual and automated)	Recommended lane width 2.8-4.2m Wider lanes allow distribution of vehicles within the lane	Safe and appropriate navigation plans → no width <2.5m Narrow-lanes (<2.8 m) impact AD vision
D	ACCAM Service – MRM	Digital enablers: RSP + RSU	L3-L5	Information about presence of the nearest available safe zones for stopping in order to provide most suitable options for CCAV in case it decides to trigger a minimum risk maneuver MRM	Automatic detection of all availability at specific safe stop area V2X communication for transmission to vehicles	CAV aiming to launch a MRM still is able to receive V2X info (loss of V2X comm. is NOT the reason for MRM)
B	ACCAM service – Insertion	Digital enablers: RSP + RSU	All connected vehicles *(up to L5)*	Aims to provide collision warning & dynamic traffic info to help CCAV anticipate the situation at highway insertions, extend its ODD and enhance its behaviour to handle the insertion situation smoothly and safely	Automatic detection of all vehicles around the insertion area V2X communication for transmission to vehicles	Insertion situation in CAV's ODD and thus AD mode active when approaching an insertion zone

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Augmented-CCAM – Priorizing each PDI element based on multiple key criteria

Key criteria considered for PDI priorization:

- **Enabling AD** (*1-5 scaling*)
- **Enhancing Safety** (*1-5 scaling*)
- **Enhancing Efficiency** (*1-5 scaling*)
- Wish for **financial investment** (*1-5 scaling*)

- ***Mixed traffic*** *(Y/N)*
- ***Minimizing/ mitigating unexpected MRMs***
- ***Readiness*** *of the service*
- ***Key application context****: Highway / Urban / Rural / Specific areas (e.g. presence of traffic lights, road works, restricted areas, low GNSS signal, etc.) / Other special infrastructures*

Layer	PDI element	Type of PDI	Enabling AD	Safety	Traffic Efficiency	Costs
E	Lane markings	Physical infra	4	5	2	3
D	ACCAM Service – MRM	Comm. enabler	3	5	3	3
B	ACCAM service – Insertion	Digital services	3	4	3	4

KEY EXPECTED OUTCOMES & IMPACTS - ECONOMICAL/BUSINESS

- At least 5 new CCAM services deployed in the project test contexts
- At least 1 new business model emerging in each project test context
- Endorsement of new classification schema by at least 5 road operators /constructors/owners and 10 Cities in the project - *multiplied by 10 within 3 years after the end of the project.*
- Adoption/application of the new service framework by at least 15 implementers (road operators, Cities)
- At least 2 new corridors created in the project

- Proactive decisions on CCAM planning and PDI investments towards 'no-regret' measures in alignment with local policy goals, to the benefit of the society
  - Outcomes endorsed in the R&D agendas (CCAM SRIA), the CAD.eu Knowledge Base & CCAM SUMP Topic Guide

- ≈ 50% increase of probability for PDI investments
- ≈ 10% saving for investors

AUGMENTED CCAM

THANK YOU!

Thierry GOGER

FEHRL

Funded by European Union

The AUGMENTED CCAM Project has received funding from the European Union's Horizon Europe programme under Grant Agreement No. 101069717.

CONDUCTOR

Fleet and traffic management systems for conducting future cooperative mobility

conductor-project.eu

36 months

November 2022 – October 2025

15 partners

From 7 EU Member States

3 Use Cases

5 Pilot sites

CONDUCTOR project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101077049.

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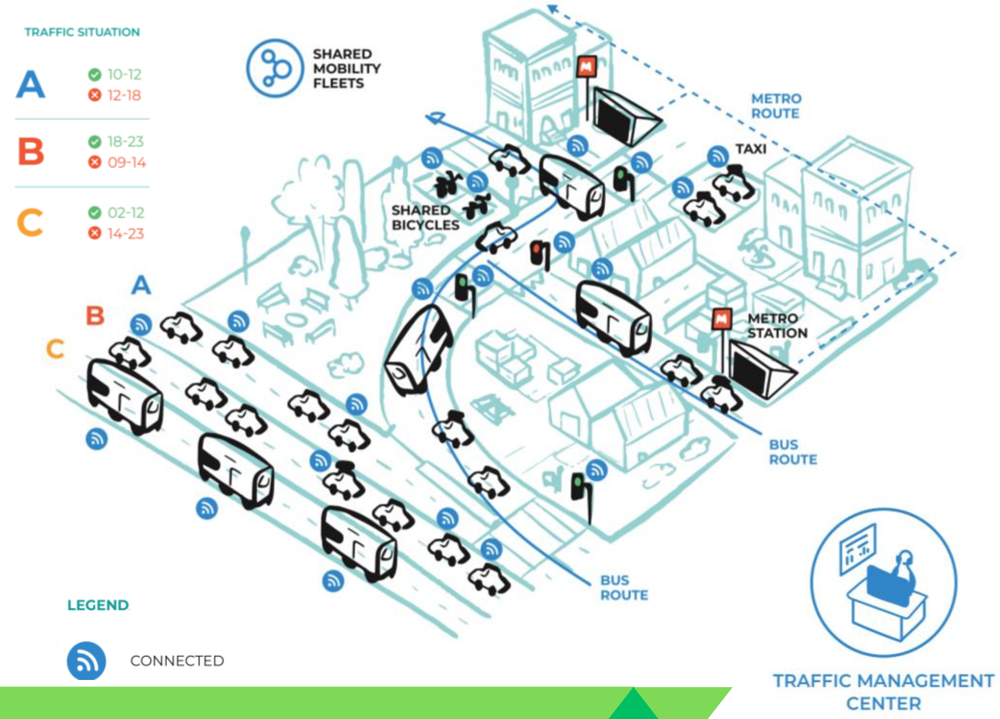
Project results

- **Innovative models:**
  - Traffic management (e.g. CTMS, Real-time traffic information for multi-purpose CCAM services)
  - Fleet management (e.g. Pickup and Delivery Problem with Cross-dock, Real-time FMS with incident management)
  - Multimodality (e.g. demand prediction method using a probabilistic transit assignment model, multi-modal journey planning solution, novel ETA model for bus lines)
  - Inter-operability (e.g., Agent-based interoperability framework) and Multi-resolution simulation (e.g. Aimsun-FleetPy bridge for co-simulation and a calibrated traffic simulation model using real-world data).
- **Data handling solutions:**
  - Data gathering and Data fusion (e.g. Space-time context graph as a data source, ML-based fusion pipeline for the identification of unusual traffic patterns caused by large-scale events)
  - Optimization-related techniques: Network load balancing, Dynamic optimization model for DRT and ML-based anomaly detection for transport supply and demand.

Project results

- So far, the CONDUCTOR project developed a total of 37 individual models and methods that have been integrated as component of our system which is currently tested and validated within 3 Use Cases:
  1. *Integrated traffic management (Athens, Almelo, Madrid)*
  2. *Demand-response transport (Slovenia)*
  3. *Urban logistics (Madrid)*
- Our components are in average at TRL 6-7 which are good candidates for large-scale demonstration and/or can be scaled or adapted for different urban or regional environments.
- The actual challenge of integrating CCAM in the transport system lies in integration of highly complex scenarios or that require significant infrastructure changes.



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Thank you for your attention!

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