Safe and sustainable CCAM through multi-actor orchestration: The CHORUS approach

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CHORUS Overview

- **Topic**: HORIZON-CL5-2024-D6-01-03
- **Duration**: Jul 2025 – Dec 2028 (42 months)
- **Partners**: 35
- **Demo sites** (7):
  - Paris (Paris-Saclay Community)
  - Oxfordshire
  - Trikala
  - Bern
  - Geneva
  - Zurich
  - Helsinki

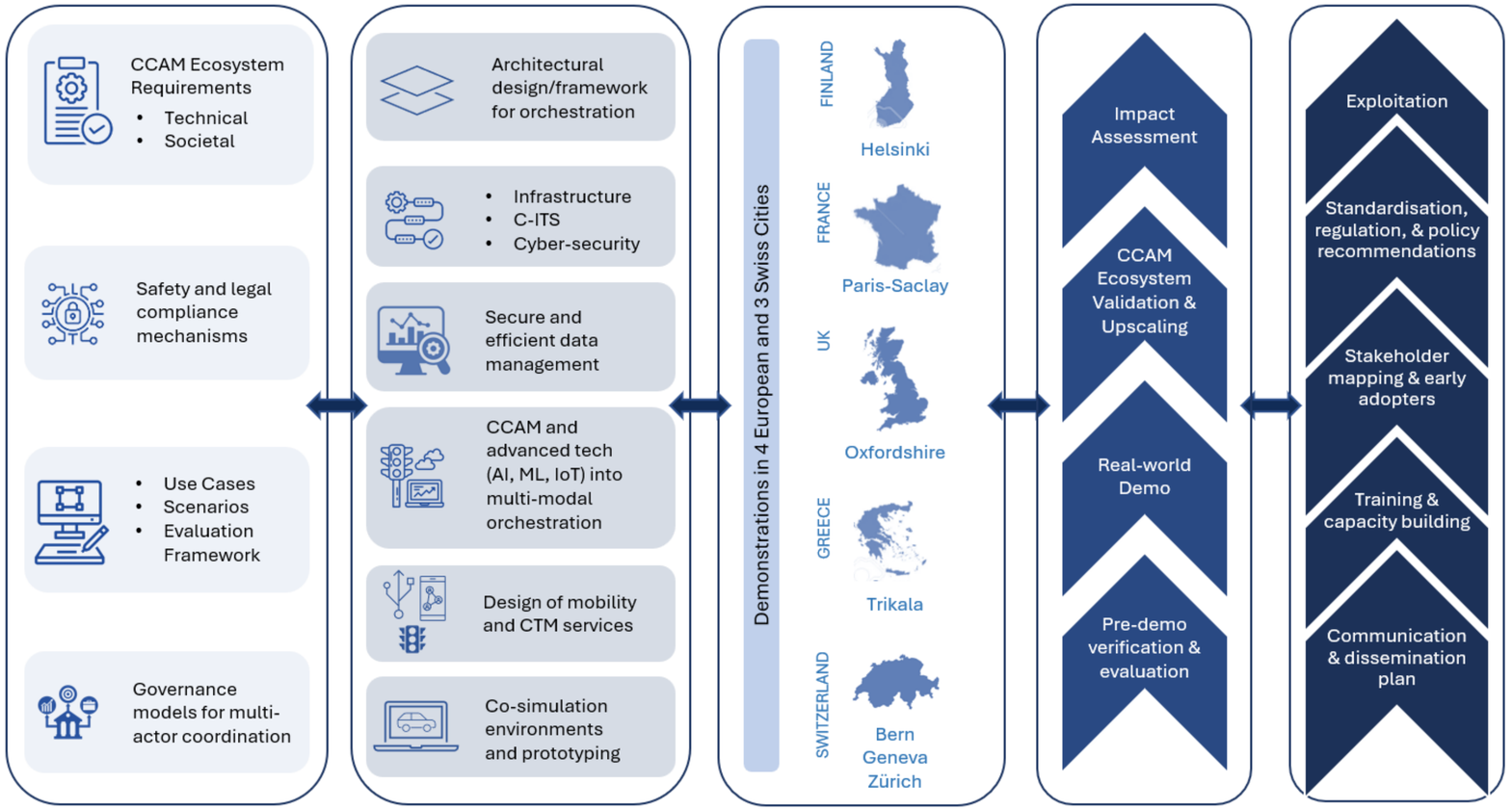
- **Total cost**: 6,787,528.75€
- **EC contribution**: 5,985,012.63 €



CHORUS in a nutshell…



Multi-layer architectural framework for the orchestration of heterogeneous actors in mixed traffic environments



Project Management & Coordination (WP6) / Dissemination and Communication (T5.1)

Innovation Pillars

IP1 – Data-driven CCAM ecosystem

IP2 - CCAM-enabled mobility **services**

IP3 - Strategic **CCAM**-enabled **traffic** management

IP4 - CCAM technologies & other road user interactions

IP5 - Governance and operational models

Expected societal impacts by 2028

Improvements in urban mobility efficiency
traffic congestion, travel times, public transport efficiency, fleet operations, traffic speed, public transport service offerings

Improvements in traffic safety
traffic accidents, VRU safety perception

Improvements in environmental impact
CO2 emissions, low-emission vehicles, noise and PM emissions, reduction in traffic volume

Improvements in user exp & data management
CCAM user acceptance, data collection efficiency, next generation city services efficiency, VRU accessibility

Multi-layer architecture

Traffic Management (Level 1)

- **Traffic flow** regulation
- Central Traffic Control **Centres**
- **Intermodal** coordination platforms (**MaaS**/**LaaS**)
- Transport **network-wide optimisation** & strategies
- **Infrastructure** & **communications** networks support (C-ITS)
- **Real-time** decision support
- **Proactive** traffic management
- Performance **monitoring** & **evaluation**
- Third-party data providers

Multimodal Mobility Management (Level 2)

Fleet Management Services

- Demand Responsive Transport (**DRT**)
- **Dynamic** routing and scheduling
- Smart **parking** management
- **Environmental** fleet management strategies
- **Dynamic** dispatching
- **Load balancing** and optimisation
- CAVs **remote management** and control
- Capacity-aware **demand** management

CTM Services

- **Adaptive** traffic signals and control
- Eco-routing
- **Safety-related** C-ITS services (incl. VRU)

End-user Apps (road users)

- **Mobile apps** for end-users
- Public **information** displays and alert systems
- **VRUs** warning methods
- **Customer experience** & personalisation services

Vehicles Local Coordination & Management (Level 3)

CAVs

Perception

- **Cooperative perception**
- Contextual/**situational awareness**
- Data **fusion**
- Localisation
- Risk assessment

Planning

- **Predictive** analytics
- Path and manoeuvre planning
- **Handover** strategies
- Traffic analysis and optimisation strategies

Decision making & orchestration

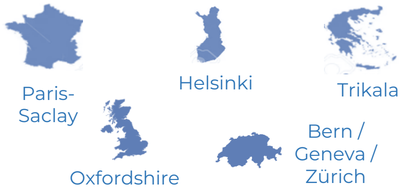
- **Adaptive control strategies**
- Coordinated interactions/**manoeuvres**
- **GLOSA** and speed adaptation
- **Safety** critical systems
- **HMIs** and shared control

Conventional vehicles (drivers)

- Advanced Driver Assistance systems (**ADAS**)

CHORUS Monitoring Dashboard

Demonstrators



Simulation-based validation & optimisation

- Traffic Ecosystem
- Multimodal Fleets and CAVs
- Infrastructure
- Communications
- Human-in-the-loop
- Service optimisation
- What-if analysis
- Risk analysis
- Impact assessment

Learning & Adaptation

- ML/AI tools
- Models training management
- Anomaly detection & handling
- Model deployment & distribution

Demonstration sites & Use Cases

Demonstration Sites	Use Cases
Paris	UC1: Integration and orchestration of electric car sharing service
	UC2: Autonomous shuttle services in metro mode
	UC3: Autonomous shuttle services on demand
Oxford	UC1: Orchestration of passenger transportation using autonomous shuttles and shared mobility services
	UC2: Orchestration of last-mile logistics services using heterogeneous autonomous fleets and e-cargo bikes
	UC3: Holistic orchestration of passenger and freight services towards fully connected network management
Trikala	UC1: Orchestration of goods transportation using off-street delivery robots
	UC2:Enhancing CAV navigation and VRU safety through collective perception systems
Bern	UC1: Optimised autonomous middle-mile delivery for enhanced urban logistics
Geneva	UC1: Enhancing seamless passenger travel with multi-modal transport integration
	UC2: Leveraging shared fleet resources for dynamic goods and passenger transport
	UC3: Predictive transport optimisation
Zurich	UC1: Last mile delivery dynamic Pick-Up Drop-Off (PUDO) boxes
Helsinki	UC1: Orchestrating urban data for CCAM-enabled smart urban logistics and vulnerable user-centric services

A. From silos to orchestration

CCAM calls for a paradigm shift in how traffic is managed

	Today: siloed, mode-specific	CCAM era: orchestrated, multimodal
Decisions	Each operator optimises its own mode or fleet	**Coordinated decisions** across traffic management, mobility services and vehicles
Data	Little real-time data exchange between TMC, PT, fleets and vehicles	**Real-time data sharing** across infrastructure, vehicles and operators via C-ITS / V2X
Management	Reactive response to incidents and congestion	**Predictive, proactive management** supported by AI and simulation
Perception	Automated vehicles rely on their on-board sensors only	**Cooperative perception** extends what vehicles and operators can see
Road users	VRUs and conventional traffic handled separately	**All road users in one system**, incl. VRUs and conventional vehicles

B. From data to coordinated decisions

How AI and cooperative ITS work together in the CHORUS orchestration loop

STEP 1
Sense & share

- Vehicle, infrastructure and fleet data
- Cooperative perception
- Third-party data (e.g. weather, events)

STEP 2
Understand & predict

- Data fusion & situational awareness
- Predictive analytics of demand and traffic
- Risk assessment & anomaly detection

STEP 3
Decide & orchestrate

- Real-time decision support for operators
- What-if simulation before acting
- Coordination across the three levels

STEP 4
Act

- Adaptive signals, GLOSA, eco-routing
- Dynamic dispatching & routing of fleets
- Traveller information & VRU warnings

STEP 5
Learn & adapt

- KPIs on the CHORUS Monitoring Dashboard
- Models retrained and redeployed
- Performance evaluation per site

Feedback loop: measured outcomes feed back into models, services and traffic strategies

AI as decision support: operators stay in the loop, road users stay informed.

C. Safety through orchestration

How CHORUS addresses safety in mixed traffic

Cooperative perception & situational awareness

Extending awareness from various sources, focusing on VRUs.

Safety-related C-ITS & cooperative interactions

V2X-enabled information exchange supporting safer interactions and coordinated manoeuvres.

Risk-aware vehicle operation

Risk assessment and safety-critical functions supporting adaptation to traffic and operating conditions.

Safe operation for automation

Shared control, handover strategies and remote management supporting safe fallback when needed during automated driving operations.

CHORUS extends the safety perspective

from the individual automated vehicle → **to coordinated safety across vehicles, infrastructure, traffic management and road users**

Autonomous vehicles

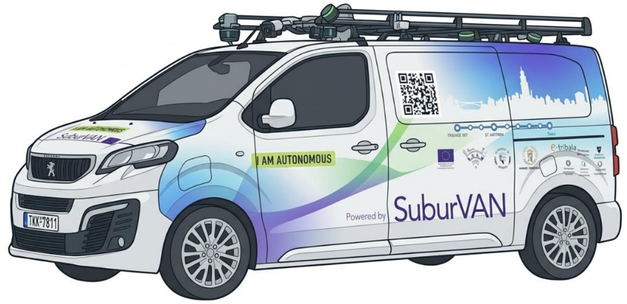
Milla SAE Level 4 Automated Shuttle



WeRide SAE Level 4 Shuttles



ICCS CAV (Peugeot eTraveller SAE Level 4)



LOXO SAE Level 4 Autonomous Delivery Vehicle



UDELV SAE Level 4 Driverless Freight Vehicle



Fusion Processing SAE Level 4 Autonomous Minibus



Autonomous Delivery Bots (Off-street logistics)



Key takeaways

1. **Orchestrate across layers, not within silos**
   Safety and efficiency gains come from coordinated decisions across traffic management, mobility services and vehicles.

2. **Data sharing comes first – governance makes it work**
   Standards-based C-ITS interfaces and agreed data rules are prerequisites for AI-driven management.

3. **AI supports operators, it does not replace them**
   Predictive analytics, what-if simulation and decision support keep humans in the loop.

4. **Safety is a property of the whole system**
   Cooperative perception, VRU services and safe fallback extend safety beyond the individual vehicle.

5. **Validate in simulation, prove on the road**
   A common architecture and evaluation framework across 7 European sites makes results transferable.

The transition to CCAM is about making the entire transport ecosystem work as one

CHORUS

Thank you!

Any questions?

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