



C-MOBILE

Supporting large-scale deployment of
cooperative intelligent transport systems
and services across Europe



Accelerating **C-ITS Mobility** Innovation and dep**L**oyment in **E**urope



Supporting large-scale deployment of
cooperative intelligent transport systems
and services across Europe

The C-MobILE Project (Accelerating C-ITS Mobility Innovation and deployment in Europe) has deployed Cooperative Intelligent Transport Systems and Services (C-ITS) designed to deal with specific mobility challenges in complex urban areas across Europe. The project also helped local authorities deploy the C-ITS services they need and raised awareness of the potential benefits for all road users.

A total of eight C-ITS equipped cities and regions have been involved in the project, all of which have had previous experience in small scale pilot testing of C-ITS services for sustainable deployment. This experience, together with a common approach, ensured that interoperability and seamless service availability could be achieved at an acceptable cost for end-users.

MAIN OBJECTIVES

Up-scale the deployment
of integrated real-world
C-ITS services across
Europe

Demonstrate the economic,
social and environmental
value of C-ITS services for
users

Assess the impact of C-ITS
applications on road safety,
social and economic
sustainability, and the
environment

DEPLOYMENT SITES

C-MOBILE builds upon existing equipment and services deployed in the eight deployment sites across Europe.



INTERNATIONAL COOPERATION

- Twinning with the US Department of Transport

NEWCASTLE

 **39** ITS-G5 intersections
 region-wide 4G cellular services

VIGO

 **95** intersections
 **108** inductive loop traffic detectors
 **60** bluetooth traffic detectors, acoustic signal for blind users activated by Bluetooth (81 intersections)
 **100+** km of interurban roads

BORDEAUX

 **583** intersections, Bordeaux parking areas
 **11** urban RSUs
 **30** inter-urban RSUs
 **52** variable message signs

BILBAO

 **20** km of roads with CCTV cameras
 **180** truck parking spots
 **1390** street parking bays
 **12** PTZ cameras
 **20** APLR cars





NEWCASTLE

COPENHAGEN

NORTH BRABANT REGION

BORDEAUX

BARCELONA

THESSALONÍKI

COPENHAGEN

 **49** intersections

 **8** km (inter-) urban roads

 **9.3** km urban roads

NORTH BRABANT REGION

 **50** intersections

 **20+** km of roads

 **50** km of motorway

BARCELONA

 **165** intersections

 **107** variable message signs

 **1050** km²

 **15** emergency vehicles

THESSALONÍKI

 **17** intersections

 **10** km of roads

 **10** km of motorway

 C-Mobile Partner Countries



ARCHITECTURE



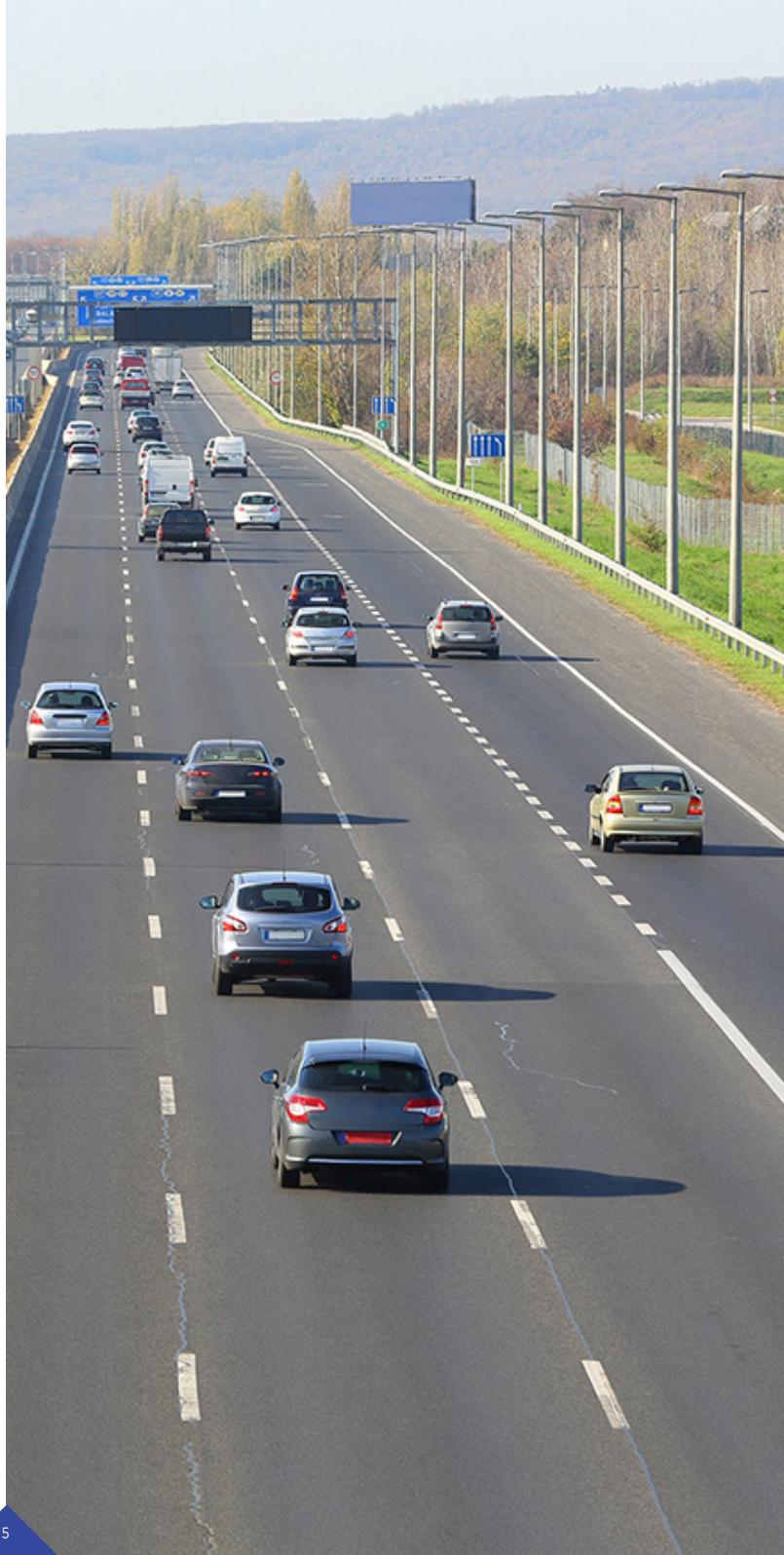
The C-Mobile architecture in the deployment sites connects back-end facilities and mobile nodes, such as vehicles and vulnerable road users, through hybrid communication using Wi-fi and cellular technologies.

METHODOLOGY

C-Mobile uses state-of-the-art communication, roadside architecture, and service delivery technologies to define an interoperable architecture. Within this architecture, a series of C-ITS applications are demonstrated and tested in eight deployment sites across Europe for specific combinations – or bundles – of services.

Harmonisation at European level of communication protocols, technical and functional specifications and interfaces allows for interoperability, even when services and architectures are adapted to legacy systems existing locally.

Results collected by the deployment sites are assessed, taking into account technical aspects and user/societal impacts, in order to define a deployment process and best practices for establishing C-ITS services. The result is a successful C-ITS rollout and a set of deployment guidelines allowing other cities and regions to deploy the C-ITS services they need.



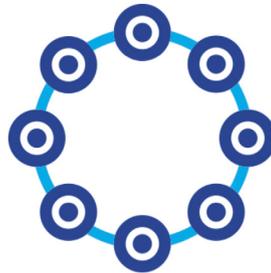


APPROACH



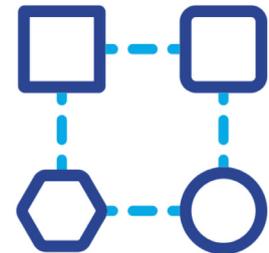
CONNECTIVITY

Enabling C-ITS services to support applications both in-vehicle and on personal nomadic devices (smartphones) and two-way communication with the road infrastructure (such as traffic lights or VMS), based on appropriate data access and sharing



INTEROPERABILITY

Full interoperability across Deployment Sites will provide a seamless user experience for supported services. Interoperability testing will be conducted by the consortium to ensure end-to-end compatibility and functionality



DEPLOYMENT

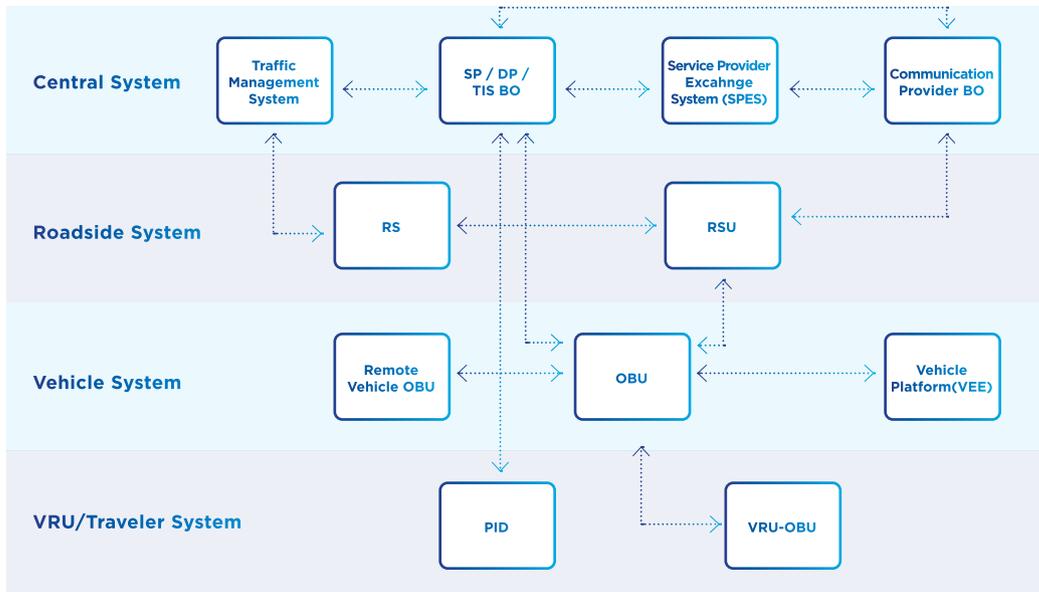
Demonstrating, assessing and evaluating the benefits of C-ITS services for urban mobility

REFERENCE ARCHITECTURE

The architecture from the projects CONVERGE, MOBINET and DITCM forms the starting basis of the C-MobILE architecture, with further adaptations to ensure interoperability with initiatives such as C-ROADS and InterCor.

The main functions of the systems are sensing, communication, situation monitoring and assessment, and acting and trust management.

BDD(Package) Design Model (Functional Components)



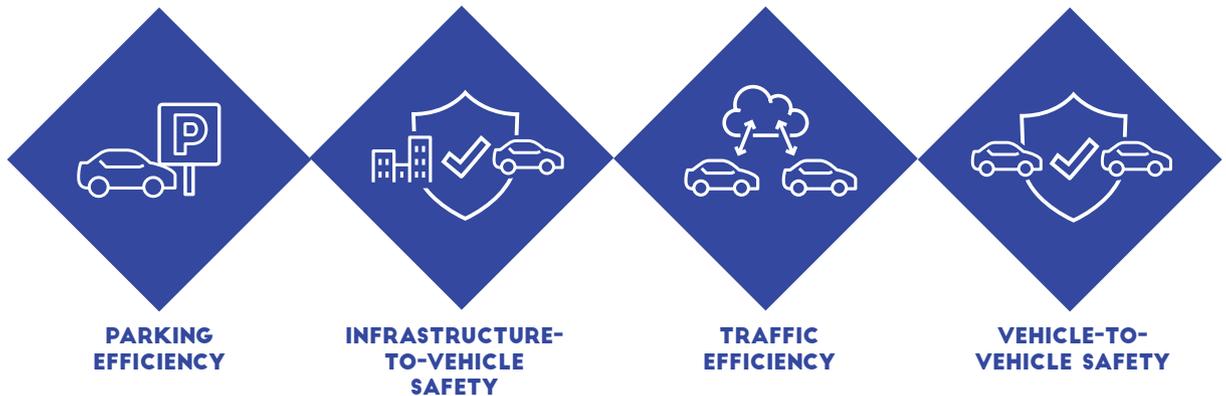
High-level functional architectural model for the C-MobILE applications



THE BUNDLE APPROACH

APPLICATION BUNDLES

Based on a stakeholder assessment, C-MobILE provides several C-ITS services in the form of open, modular and extendable bundles creating one common C-ITS user environment with rich user experience features:



The objective of the C-MobILE service bundles is to:

- Provide end-users with a single C-ITS application covering multiple C-ITS services
- Assist infrastructure operators/traffic managers in integrating C-ITS into operational traffic management, as a solution to congestion.

Services are grouped into four thematic application bundles based on relevance to deployment sites, feasibility and potential for market uptake. They use hybrid communication and address a range of use cases and different road-users.

The bundles will be able to operate either in one of two modes:



AUTOMATED MODE

Uses C-ITS services automatically to provide context, location and user-preference based information and guidance to the end user.

USER-SELECTED MODE

The end user can select specific services relevant to their needs.

DATA SHARING AND ACCESS:

ensured by standard, open interfaces and in line with C-ITS Platform recommendations and C-Roads Platform harmonisation.

CROSS-MODAL INTEGRATION:

some service bundles will include pedestrians, cyclists, motorcyclists and multimodal public transport (train and bus).

CROSS-MODAL APPLICATION:

a single smartphone app or on-board unit covers multiple use cases for a range of users such as drivers, cyclists, or pedestrians.

CROSS-MODAL SERVICE BUNDLES:

the same services cover different users groups.



BUNDLE 1

PARKING EFFICIENCY

MOTORWAY PARKING AVAILABILITY

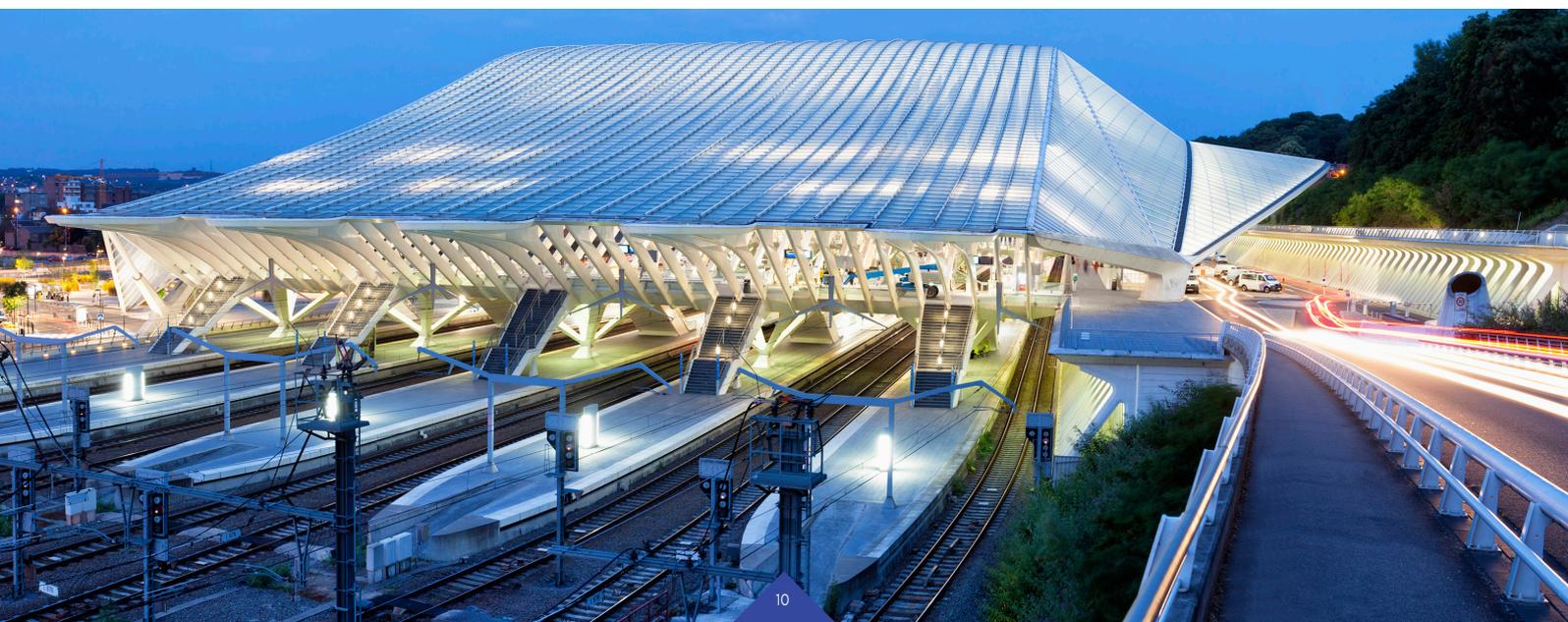
Information for truck and coach drivers on parking lots location, availability and services, via mobile internet or infrastructure-to-vehicle technology.

- ✓ *Information on roadside truck parking spaces released by another user*
- ✓ *Driver guidance for port terminal and truck parking access*

URBAN PARKING AVAILABILITY

This service provides parking availability information and guidance for drivers to make informed choices about available parking places. This service aims to reduce congestion, time loss, pollution, and stress caused by cruising for parking.

- ✓ *Information about a vehicle parking space released by another user*
- ✓ *Loading zone availability information for urban freight*
- ✓ *On-street parking availability information*





BUNDLE 2

INFRASTRUCTURE-TO-VEHICLE SAFETY

ROAD WORKS WARNING

This service provides in-vehicle information and warnings about road works and changes to the road layout, reducing accident risk for drivers and workers.

- ✓ *Road Works Warning: provides awareness messages and instructions to adapt speed, change lanes, etc, using mobile internet or 802.11p*



SIGNAL VIOLATION WARNING

Provides timely in-vehicle information on a red light violation downstream.

- ✓ *Red light warning provides information on status of traffic signals ahead*
- ✓ *Own violation warning to the driver and to other vehicles*
- ✓ *Emergency vehicle warning - when an approaching emergency vehicle is expected to run a red light*
- ✓ *Turning warning - oncoming traffic*
- ✓ *Turning warning - vulnerable users crossing at an intersection*

ROAD HAZARD & TRAFFIC JAMS WARNING

Provides advance warnings about dangerous situations such as objects on the road, potholes, traffic jams, or extreme weather.

- ✓ *Hazardous Location Notification*
- ✓ *Traffic Conditions Warning*
- ✓ *Weather Conditions Warning*



EMERGENCY VEHICLE WARNING

Delivers in-vehicle information and warnings about approaching emergency vehicles from behind, from the front or from the side at an intersection, before they become visible or audible.

WARNING SYSTEM FOR PEDESTRIANS

Detects risky situations for pedestrians at intersections and warns drivers accordingly. Can be extended to cover cyclists.

- ✓ *Safe travelling experience by warning signage: Vulnerable Road User presence detected by VRU beacon system, roadside pedestrian presence, bicycle-to-car Communication, or Pedestrian-to-Car Communication, and warning issued to approaching drivers.*



BUNDLE 3

TRAFFIC EFFICIENCY

GREEN PRIORITY FOR DEDICATED VEHICLES

Green Priority aims to increase punctuality and response time for public transportation and service and emergency vehicles, holding off conflicting traffic and ensuring continued right-of-way.

- ✓ *Green Priority for Dedicated Vehicles*

GREEN LIGHT OPTIMAL SPEED ADVICE (GLOSA) / 'DYNAMIC ECO-DRIVING'

Provides drivers with an optimal speed advice when they approach a controlled intersection equipped with traffic lights, ensuring a smoother traffic flow and reducing unnecessary stops, fuel consumption and noise pollution.

- ✓ *Optimized Driving Experience with GLOSA*

COOPERATIVE TRAFFIC LIGHTS FOR VULNERABLE USERS

Also known as Traffic Light Prioritisation for Designated Vulnerable Road Users, it adapts the length of red/green phases to provide cyclists and pedestrians with a safer and smoother travel experience.

- ✓ *Traffic Light Prioritisation for Designated VRUs equipped with a dedicated smartphone application*
- ✓ *Cooperative Traffic Light with VRU Counting, using VRU detection and counting*



FLEXIBLE INFRASTRUCTURE (PRIORITY LANES)

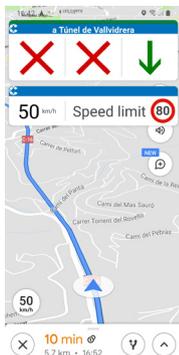
Informs drivers about the status of reserved lanes throughout the day.

- ✓ *Dynamic Lane Management – Lane Status Information allows operators to open and close traffic lanes and notify users*
- ✓ *Dynamic Lane Management – Reserved Lane (with or without use of vehicle probe data) notifies users about upcoming reserved lanes and whether or not their vehicle is allowed in.*

IN-VEHICLE SIGNAGE (DYNAMIC SPEED LIMIT)

Shows both static and dynamic information of road signs inside the vehicle, including speed limits.

- ✓ *In-Vehicle Signage, dynamic traffic signs: includes dynamic speed limits and instructions to change lanes.*
- ✓ *In-Vehicle Signage, static traffic signs*



MODE & TRIP TIME ADVICE

Provides itinerary for multimodal passenger transport with real-time travel information.

- ✓ *Mode and Trip Time Advice for Event Visitors*
- ✓ *Mode and Trip Time Advice for Drivers*
- ✓ *Mode and Trip Time Advice for Cyclists*

PROBE VEHICLE DATA

Probe vehicle data, or Floating Car Data, generated by vehicles can be used as input for real-time operational traffic management, long-term strategic planning, and traveller information services. Includes position, speed, direction, and additional information such as windscreen wiper status, ABS, ESP, etc. This data can serve to warn drivers about disruptions ahead, traffic jams, slippery surfaces.

- ✓ *Basic probe vehicle data*
- ✓ *Extended probe vehicle data*



BUNDLE 4

VEHICLE-TO-VEHICLE SAFETY

EMERGENCY BRAKE LIGHT

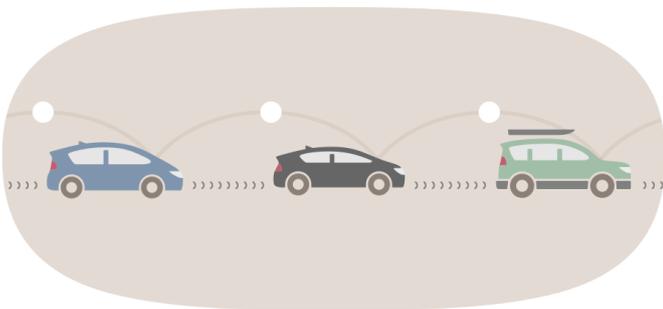
Warns drivers about vehicles ahead braking abruptly, and operators about sudden slowdowns.

- ✓ *Emergency electronic brake lights*

COOPERATIVE ADAPTIVE CRUISE CONTROL (URBAN ACC)

CACC-equipped vehicles improve traffic flow through inter-vehicle information exchange.

- ✓ *CACC passenger vehicles approaching urban or semi-urban environment (small-scale demonstration)*



SLOW OR STATIONARY VEHICLE WARNING

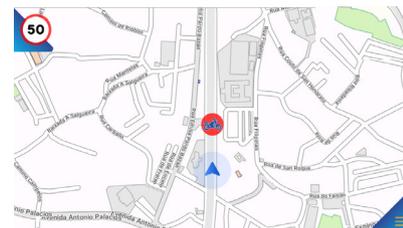
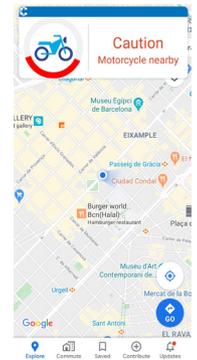
Helps drivers avoid or mitigate rear-end collisions with stopped or slow traffic ahead.

- ✓ *Slow or stationary vehicle warning*

MOTORCYCLE APPROACHING INDICATION (INCLUDING OTHER ROAD USERS)

Based on broadcasted messages, a driver is able to identify an approaching two-wheeler, and both vehicles can determine whether a critical situation can occur.

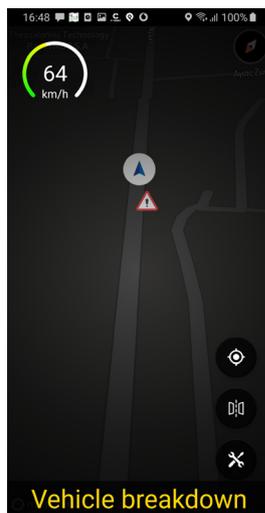
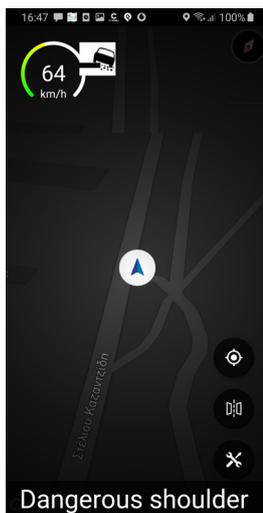
- ✓ *Two-Wheeler Approaching Warning (V2V & V2I)*



BLIND SPOT DETECTION & WARNING

Blind spot detection/warning warns drivers about other vehicles of any type located out of sight.

- ✓ *Digital Road Safety Mirror (V2I): detects other vehicles of any type located in predefined blind spot locations, using ITS-S*
- ✓ *Digital Road Safety Mirror for VRU (V2I): detects other vehicles of any type located in predefined blind spot locations, using ITS-S*



SERVICE DEPLOYMENT 2019-2021

Services	Barcelona	Bilbao	Bordeaux	Copenhagen	Newcastle	North Brabant	Thessaloniki	Vigo
Motorway Parking Availability		☑	☑					
Urban Parking Availability		☑	☑					
Road Works Warning	☑	☑	☑	☑	☑	☑	☑	☑
Road Hazard Warning	☑	☑	☑	☑	☑	☑	☑	☑
Emergency Vehicle Warning	☑		☑			☑	☑*	☑*
Signal Violation Warning	☑		☑			☑	☑*	☑
Warning System for Pedestrians	☑		☑*	☑*	☑*	☑	☑*	☑*
Green Priority			☑*	☑*	☑	☑	☑*	☑*
Green Light Optimal Speed Advice	☑		☑	☑	☑	☑	☑	☑
Cooperative Traffic Light for VRUs			☑*	☑		☑	☑*	
Flexible Infrastructure	☑		☑				☑	
In-Vehicle Signage	☑		☑		☑		☑	☑
Mode & Trip Time Advice			☑				☑	
Probe Vehicle Data	☑		☑*		☑		☑	☑
Emergency Brake Light			☑*					☑*
Cooperative Adaptive Cruise Control			☑*			☑*		☑*
Slow and Stationary Vehicle Warning			☑*					☑
Motorcycle Approaching Indicator	☑		☑*					☑
Blind Spot Detection		☑	☑*			☑		

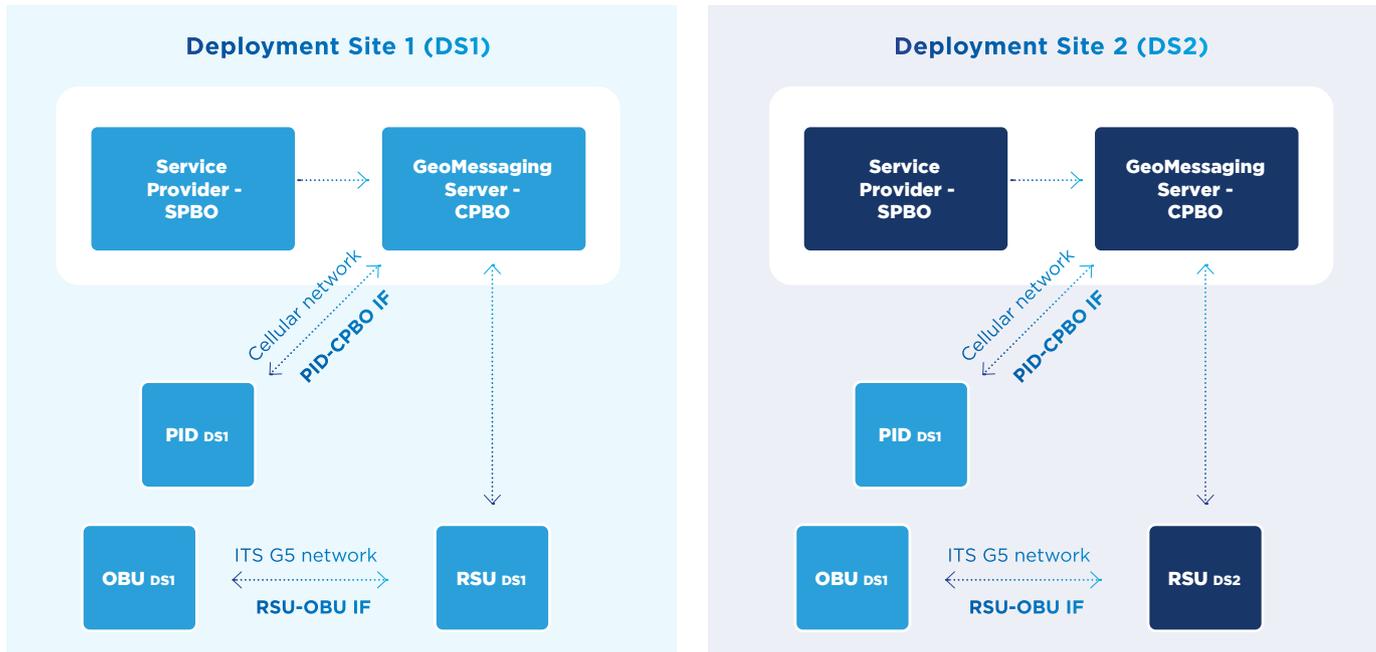
* service deployed as a proof of concept

INTEROPERABILITY

Full interoperability allows users traveling from one C-MOBILE Deployment Site to another to benefit from available services using their PID (Personal Information Device) and OBU

(On-Board Unit), together with local Roadside Units (RSU) and local data provided by their usual GeoMessaging Server.

The interoperability approach



CPBO: Communication Provider Back Office

SPBO: Service Provider Back Office

PID: Personal Information Device

Interfaces required for service interoperability:

RSU-OBU IF: interface on the ITS G5 channel. Based on existing European standards and profiles.

PID-CPBO IF: emulates RSU-OBU IF based on MQTT over the cellular channel.

PROJECT RESULTS

- ✓ **C-ITS reference architecture** enabling interoperable, large-scale deployments in Europe.
- ✓ **Cooperative Urban Mobility Portal (CO-UMP.eu)** aimed at raising awareness and providing deployment guide & support to transport authorities and operators interested to make mobility more efficient, safer and greener thanks to digital solutions accessible to everyone everywhere.
- ✓ **Strategic Research Agenda** that promotes C-ITS deployments and leads towards automated transport. Future challenges and needs identified, such as data access and new public-private relationships to be addressed.
- ✓ Assessment of the **real-life benefits of C-ITS** applications for users and key stakeholders, as well as their impact on the road network.

GLOSA

- ✓ Clear increase in efficiency
 - Reduction in the number of stops of up to 30% (maximum benefits achieved in off-peak traffic conditions)
 - Up to 20% less energy and fuel consumption from acceleration and decelerations
- ✓ Additional safety benefits:
 - Up to 15% lower speed variance during intersection passage

- Braking earlier: up to 10% increase in distance to stop line of first braking action
- Braking smoother: up to 3% decrease in the maximum deceleration values

IVS (speed limit)

- ✓ Safety benefits:
 - Speed reductions of up to 10% or 5km/h on average
 - Up to 5% fewer speed limit violations

RHW and RWW

- ✓ Safety benefits:
 - Average speed reductions of up to 6% (or 2 km/h)
 - Up to 3% decrease in the maximum deceleration values
 - Up to 30% decrease in hard braking frequency

Green Priority

- ✓ Granted conditional priority leads to over 90% of vehicles passing the intersections freely
- ✓ Emergency vehicles with absolute priority have to cross a red light in less than 5% of cases (down from 20% in baseline)
- ✓ Demonstration of an open and secure large-scale deployment of C-ITS applications, in complex urban environments, interoperable across countries, and involving large groups of end-users.

STAKEHOLDERS ENGAGEMENT

C-Mobile has offered opportunities for engagement for experts, researchers, public authorities and policy-makers, with:

- ✓ *Local consultations*
- ✓ *C-ITS Training Sessions*
- ✓ *Online Surveys*
- ✓ *Webinars and Seminars*
- ✓ *TESTFEST*
- ✓ *C-ITS City Pool Workshops for public authorities*

To continue the work of C-Mobile in making urban mobility more efficient, safer and greener, the project has launched a new website. CO-UMP objective is to create awareness and provide guide and support to transport authorities and operators in deploying digital mobility solutions accessible to everyone everywhere. For more information, visit the new CO-UMP website: <https://co-ump.eu/>

C-ITS CITY POOL

Through regular workshops, the C-ITS City Pool has provided a space where transport authorities can share real-life experiences, receive feedback and learn about best practices and business opportunities for the deployment of C-ITS. C-Mobile hosted 5 workshops (September 2018 - Copenhagen, June 2019 - Helmond, November 2019 - Barcelona, June 2020 and April 2021 - virtual) which brought together tens of city authorities discussing C-ITS and what it can bring to you're their community, but also what hurdles they should expect when trying to implement. More info: <http://c-mobile-project.eu/citypool>

STRATEGIC AGENDA FOR FUTURE DEPLOYMENT OF C-ITS

This Strategic Agenda highlights the main recommendations for the further uptake of C-ITS beyond the project scope.

RECOMMENDATION

1

C-ITS benefits for transport decarbonisation need to be highlighted so that C-ITS can be seen as a tool to deliver on the targets of the European Green Deal

2

C-ITS benefits to additional road users (especially cyclists) need to be promoted

3

Interest for C-ITS is very high, thus further awareness, education and training actions on C-ITS are needed

4

Identify and promote C-ITS services that can support cities in better understanding travel patterns

5

Future work on C-ITS needs to address closer connectivity of C-ITS services with open data portals on city level. On national level, connection with National Access Points needs to be considered

6

The term “C-ITS” should continue to be used as it is generally seen as ready for deployment, even though CCAM is being used for research topics

CONSORTIUM



 June 2017 - May 2021

 15 million

 Applus+ IDIADA

 c-mobile-project.eu

 [CMobile_Project](https://twitter.com/CMobile_Project)

 C-MobILE Project

 info@c-mobile-project.eu



This project is co-funded by the European Union's Horizon 2020 Research and innovation Programme under Grant Agreement N°723311

© C-MobILE | May 2021