C-ROADS ITALY2 ITALY3

EVENTO FINALE 23 NOV 2023

Co-funded by the European Union

Cooperative Systems for Safer and More Efficient Driving

Stellantis-CRF in C-ROADS Italy 2

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Introduction: C-ITS in Europe

Where we are

- Vehicle connected Services are widespread. Some are based on V2X standard (enabling «Cooperative» - ITS)
- Standard V2I (C-ITS) is being deployed and tested on a set of roads/corridors [1]
- Short range communication has two technology solutions, and EU has the Tech neutrality principle [2].
- «Hybrid communication» adds vehicle-to network (V2N). Some stakeholders and countries rely on V2N.
- C-ITS-based Day 1 and day 1.5 use cases are have been tested by European, national and local projects.
- C-ROADS gives a key contribution on service harmonization, cross-border interoperability and pilot activity.

Introduction: C-ITS in Europe

Where we are going

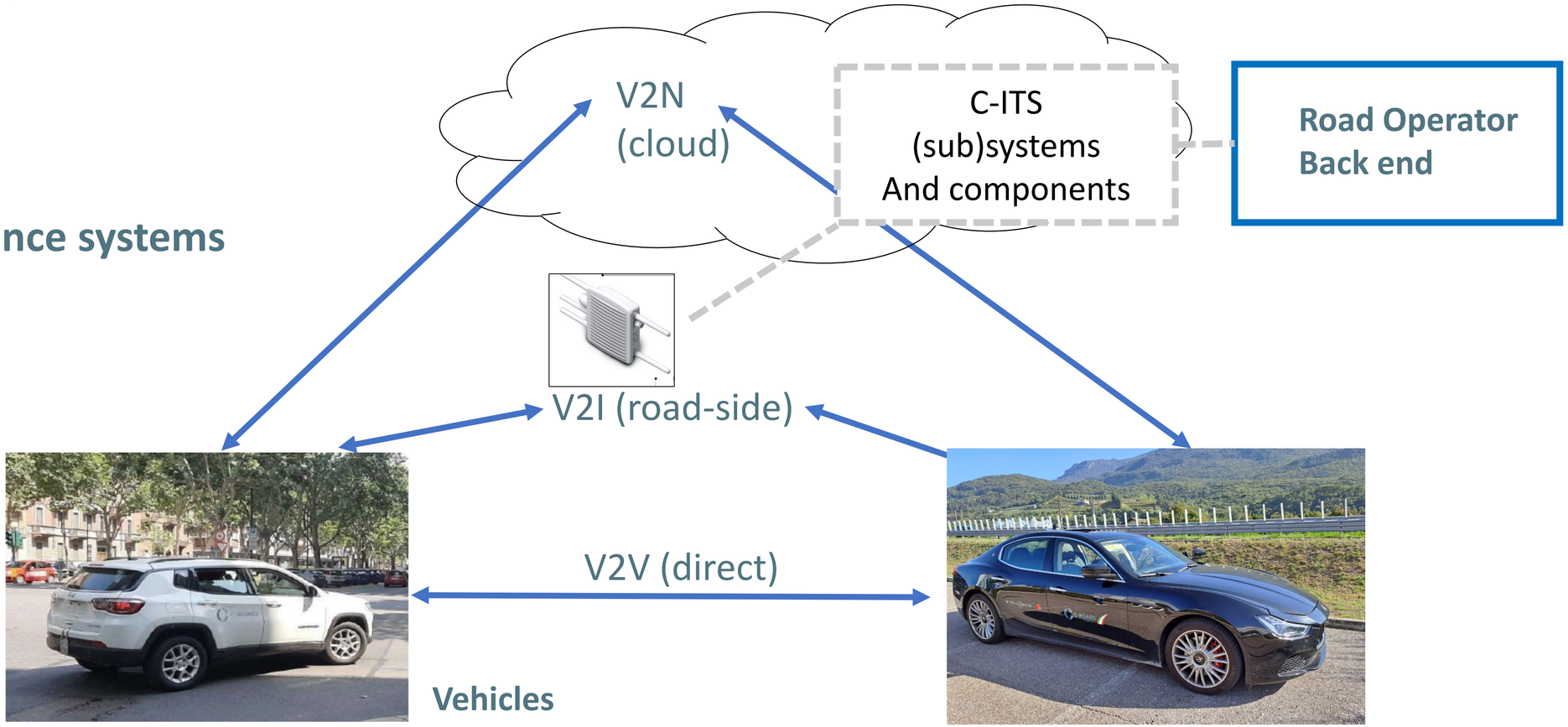
- EU-NCAP now includes «local hazards» and envisages more V2X features in 2030 vision [3,4]
- EU regulation (new C-ITS Directive), Oct ’23 sets targets for the digitalization of *crucial* information [5]
- Informative C-ITS applications (e.g. hazard warning in standard format) may increase in the next future
- Advanced / Day2,3 use cases envisaged for ADAS and Automated Driving (AD) by experts associations [6,7]
- Vehicle manufacturers address C-ITS data quality and performance, especially for AD [8]

Role of Stellantis-CRF in C-ROADS Italy 2

Our main role is to evaluate **data exchanged received from the road infrastructure for V2X-based applications**

We address

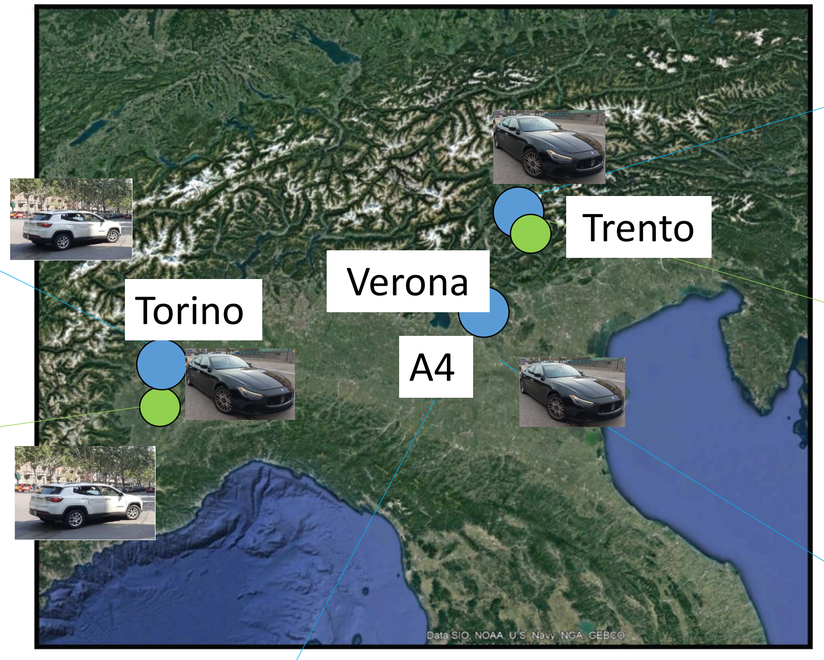
- **Driver Warning**
- **Advanced Driver Assistance systems**
- **Automated Driving**
- **Energy-Efficient Driving**



Pilot experiments in the Italian Sites with vehicle prototypes

Traffic Jam Ahead Warning
GLOSA
eCoasting
Road Works Warning

In-Vehicle Speed Limit
In-Vehicle Signage
GLOSA

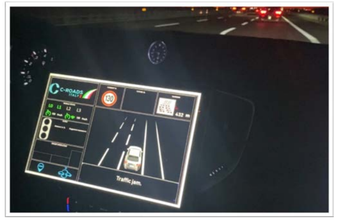


GLOSA/SPAT
Signal Violation
VRU protection

Emergency Electronic Brake Light
Slow or Stationary Vehicle
Emergency Vehicle approaching

Emergency vehicle approaching
Traffic Jam Ahead Warning
GLOSA/SPAT
Road Works Warning
Smart Routing

Weather Condition Warning
In-Vehicle Speed Limit
Road Works Warning
Traffic Jam Ahead Warning



C-ROADS official test Site

Additional testing locations

Cooperative Systems
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Green Light Optimal Speed Advisory (GLOSA) application

- States depend on SPAT/MAP data received and GNSS positioning quality:

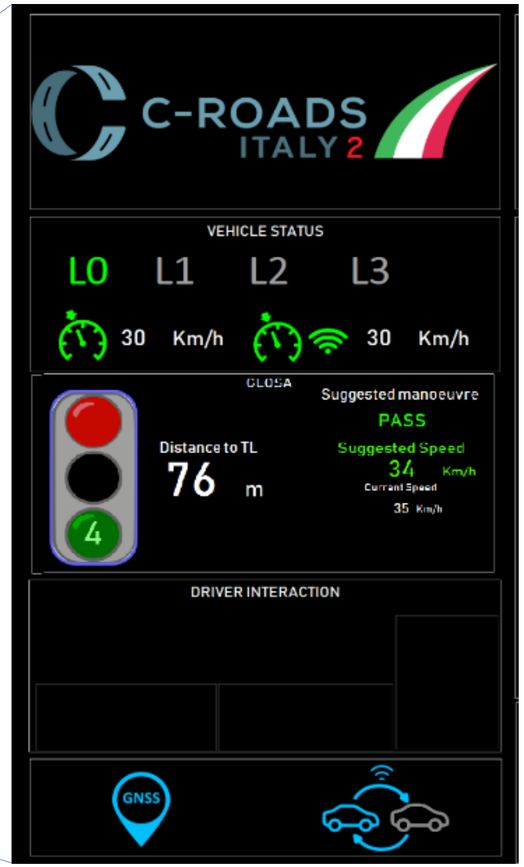
  (1) Unavailable

  (2) Traffic light current state (red/green)

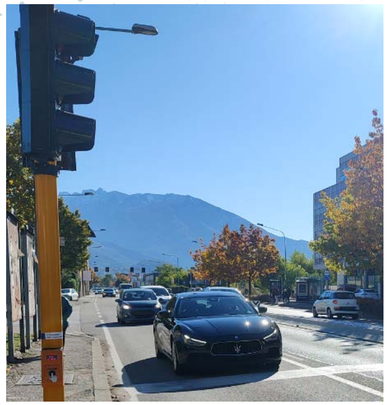
  (3) + Time to Change

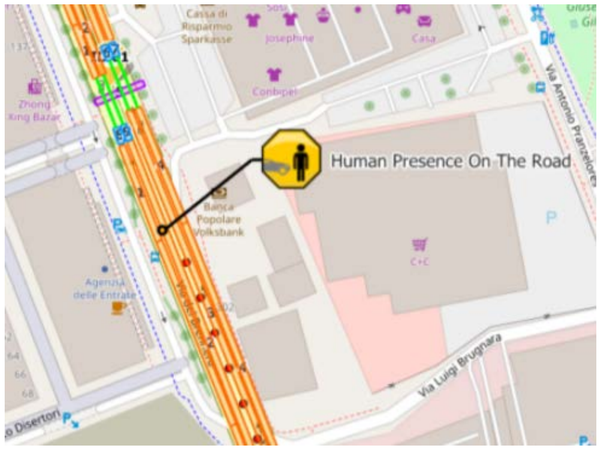
  (4) + Green Light Optimal Speed Advisory

- Tested interoperability in all 3 cities

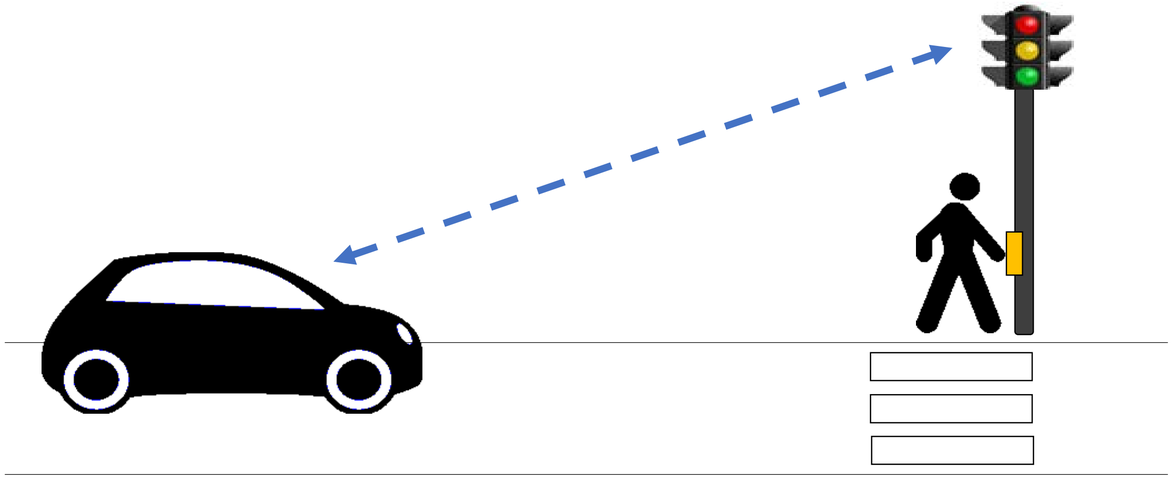


Traffic Light C-ITS information in Comune di Trento





- SPATEM: Current traffic phase and time of change
- MAPEM: Local map of the intersection
- DENM: Notification of pedestrian booking

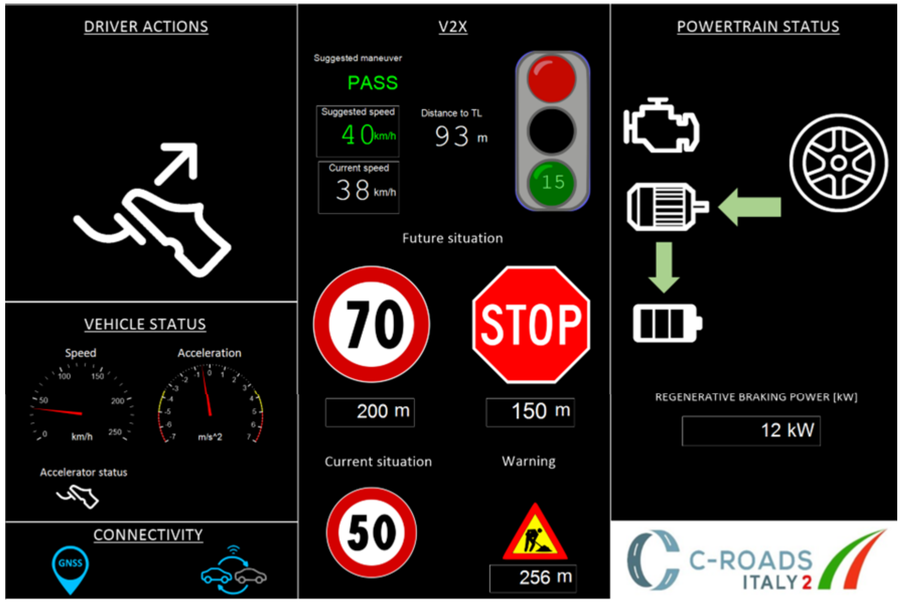


Enabled use cases

- Green Light Optimal Speed Advisory
- Traffic Light Violation (preventive) Warning
- Pedestrian Notification

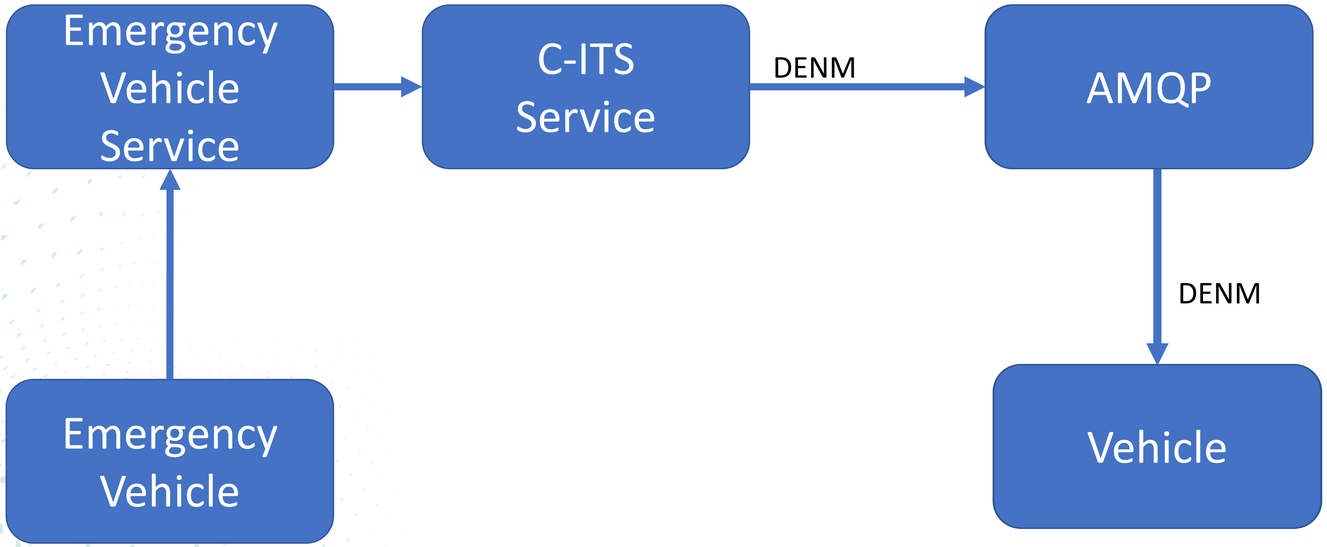
V2X-enhanced Smart eCoasting in Torino

- e-Coasting: energy recovery through regenerative braking during coasting maneuvers
- “Smart” e-Coasting uses SPAT, MAP, IVIM information to avoid sudden acceleration and braking
- Integrated in a Plug-in Hybrid Electric Vehicle
- In-vehicle signage (IVS) with information about speed limit notifications, stop signs and obstacles
- Information about Traffic Light phases and timing information



Approaching Emergency Vehicle in Verona

- Gives way when Emergency Vehicle is coming from behind
- Standard notifications (DENM) generated from Emergency Services fleet GPS Tested in Verona
- Need to warn with 15 seconds advance



Warning on motorway and motorway-city connection on A4 and Verona

- On board Unit uses ETSI standard Notification (DENM) coming from road operators (A4, Verona City)
- Inside the DENM parameter to filter messages
- Trace definition is key factor for warning correctness and advance

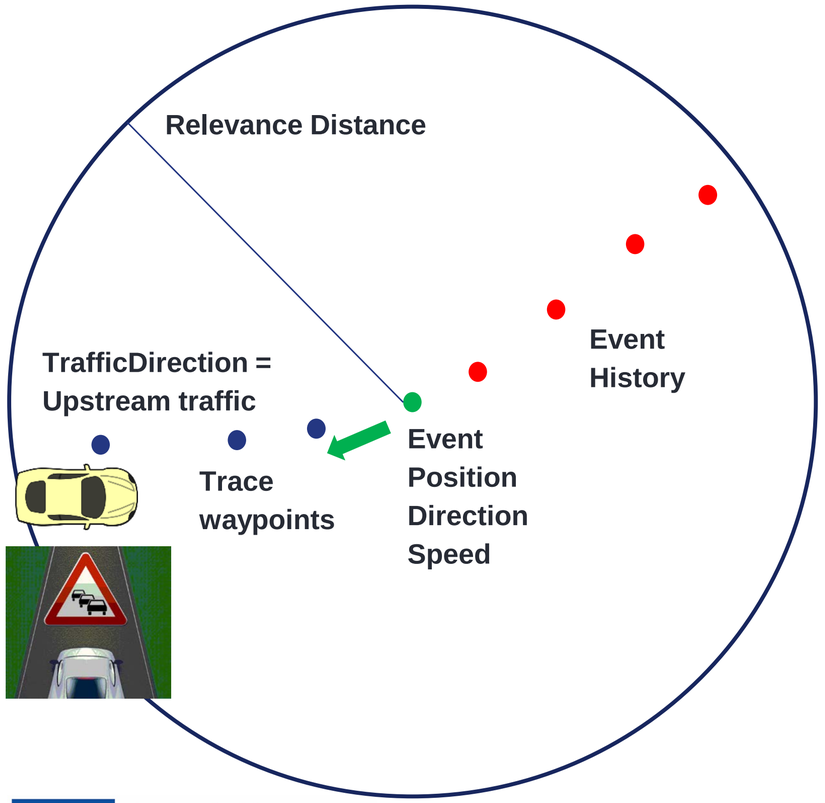
GeoBroadcast **validity area** — Network layer

Management.**relevanceDistance**
Management.relevance**TrafficDirection**
Management.**validityDuration**

Situation.**CauseCode;**
Situation.**SubCauseCode;**
Situation.**EventHistory**

Location.traces.**PathHistory**
Location.**eventSpeed;**
Location **eventHeading**

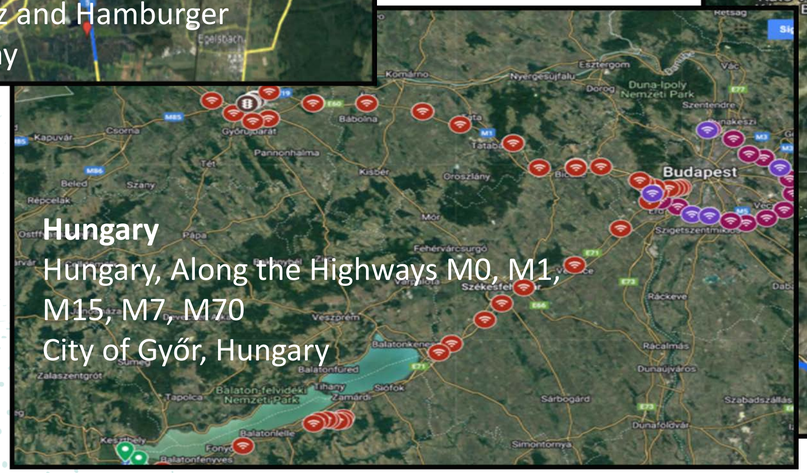
Facility layer
DENM containers



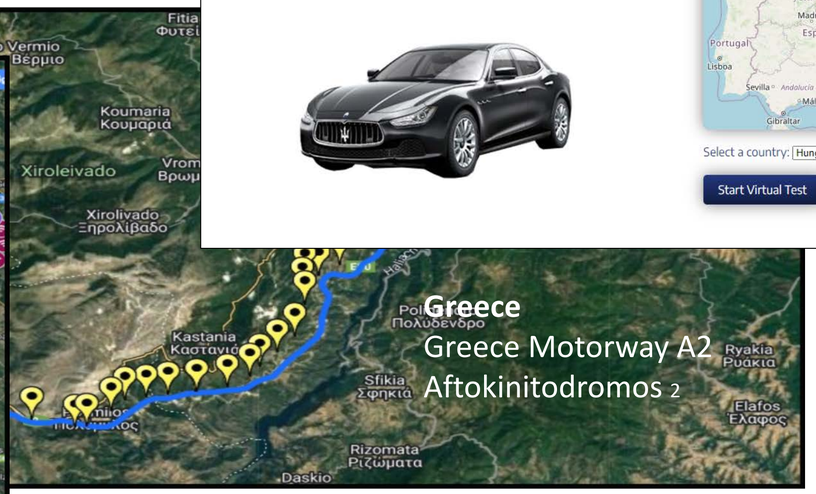
Virtual Test Site in other Member states

Germany
German motorway A5 Between Nordwestkreuz and Hamburger Kreuz, Germany

C-ITS of other member states were tested virtually, with our On-board unit in the loop.



Hungary
Hungary, Along the Highways M0, M1, M15, M7, M70
City of Győr, Hungary



Greece
Greece Motorway A2 Aftokinitodromos 2

Key results from the Italian pilot

- Lane-level vehicle positioning is needed in intersections, and urban roads are often not in open-sky conditions
- Traffic Light V2X (SPATEM) sent every second. Data content should also follow this periodicity.
- Periodic Traffic Light phases ease on-board speed advisory/eCoasting. Optimal advisory with TL predictability
- Completely adaptive phases prevent from advisory, but still allow on-board update display and warning
- Message geo-referencing (MAPEM, DENM, IVIM) vs ground truth has strong impact on processing/filtering
- Understanding of event attribute (SubCause Codes) usage is key for on-board function design

More results on C-ITS impact will be available thanks to the collaboration with Politecnico di Milano

Conclusions

- C-ITS allow to send, via V2X, road events, hazards and signage from the infrastructure to the vehicles
- We have tested Day1 & 1.5 C-ITS services on vehicle prototypes in Italian cities and highways
- We have performed Virtual Tests (with V2X Hardware in the loop) in other member states
- Interoperability and harmonization, as addressed in C-ROADS, are key for the deployment of C-ITS

References

Public documents by the C-ROADS platform are available on https://www.c-roads.eu/platform/documents.html

Other sources mentioned in the presentation:

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[2] **Directive (EU) 2018/1972 of the European Parliament and of the Council,** Dec. 2018
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[3] **European New Car Assessment Programme, Assessment Protocol – Safety Assist Safe Driving, Implementation 2023, V10.1.2,** Feb. 2023
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[4] **Euro NCAP Vision 2030: a Safer Future for Mobility,** Nov. 2022
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[5] **Directive on the deployment of Intelligent Transport Systems,** Oct. 2023
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[6] **5G Automotive Association, A visionary roadmap for advanced driving use cases, connectivity technologies, and radio spectrum needs**, Nov. 2022
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[7] **CAR 2 CAR Communication Consortium,** Guidance for day 2 and beyond roadmap, Sept 2021
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[8] **Addressing challenges towards the deployment of higher automation**, Hi-Drive project Presentation, Sept 2023
https://www.hi-drive.eu/app/uploads/2023/05/230502-Hi-Drive-standard-presentation_v1.1.pdf

Thanks for your attention

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