Innovation Action H2020-ICT-2018-2

5G-CARMEN Connected and Automated Road Mobility in the European union

5G-PPP TB

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DTAG

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Agenda

- Overview

- Use Cases

- 5G Enablers and CCAM platform

- Trials

- Cross-border issue

Project Overview
Facts and Figures

- PM: R. Riggio (FBK), TM: A. Heider-Aviet (DT)

- Corridor total length: ~600 km across 3 countries (DT, AT, IT)

- 3 telco equipment vendors (NEC, Nokia, Qualcomm)

- 3 Network Operators (DTAG, MTA, TIM)

- 2 Automotive OEMs (BMW, Fiat/CRF)

- 20+ SMEs and Academia

- 2 cross-country trials in 2021

- 3 single-country trials for pre-integration H2 2020
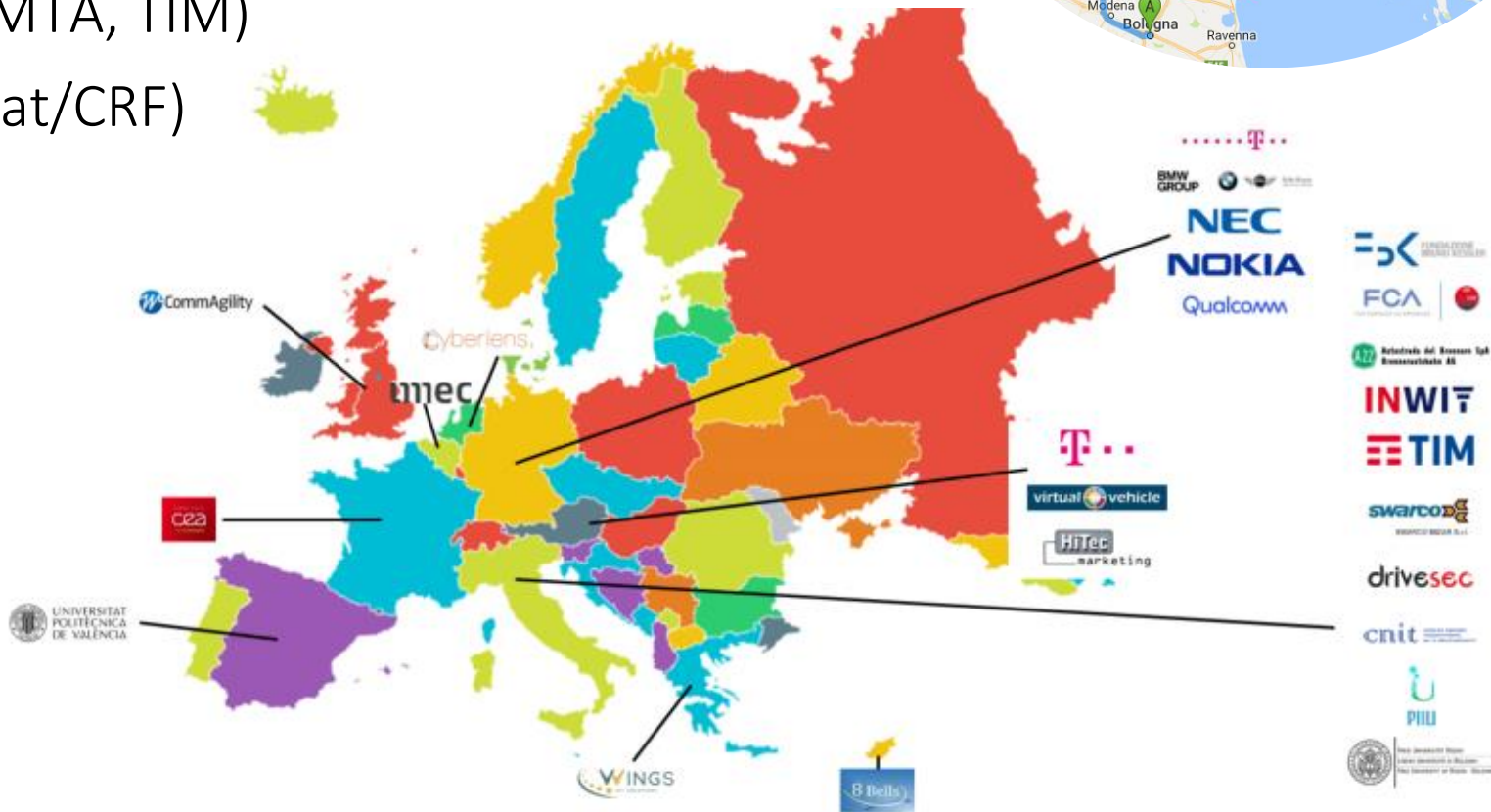
5G CARMEN

Cooperative Manouvering

- Vehicles orchestrate a lane merging operation by exchanging information via PC5 direct communication (localized case) and via network using MEC-based Services (centralized case)

- The 5G-CARMEN platform acts as a supervisor, blocking the operation in unsuitable situations
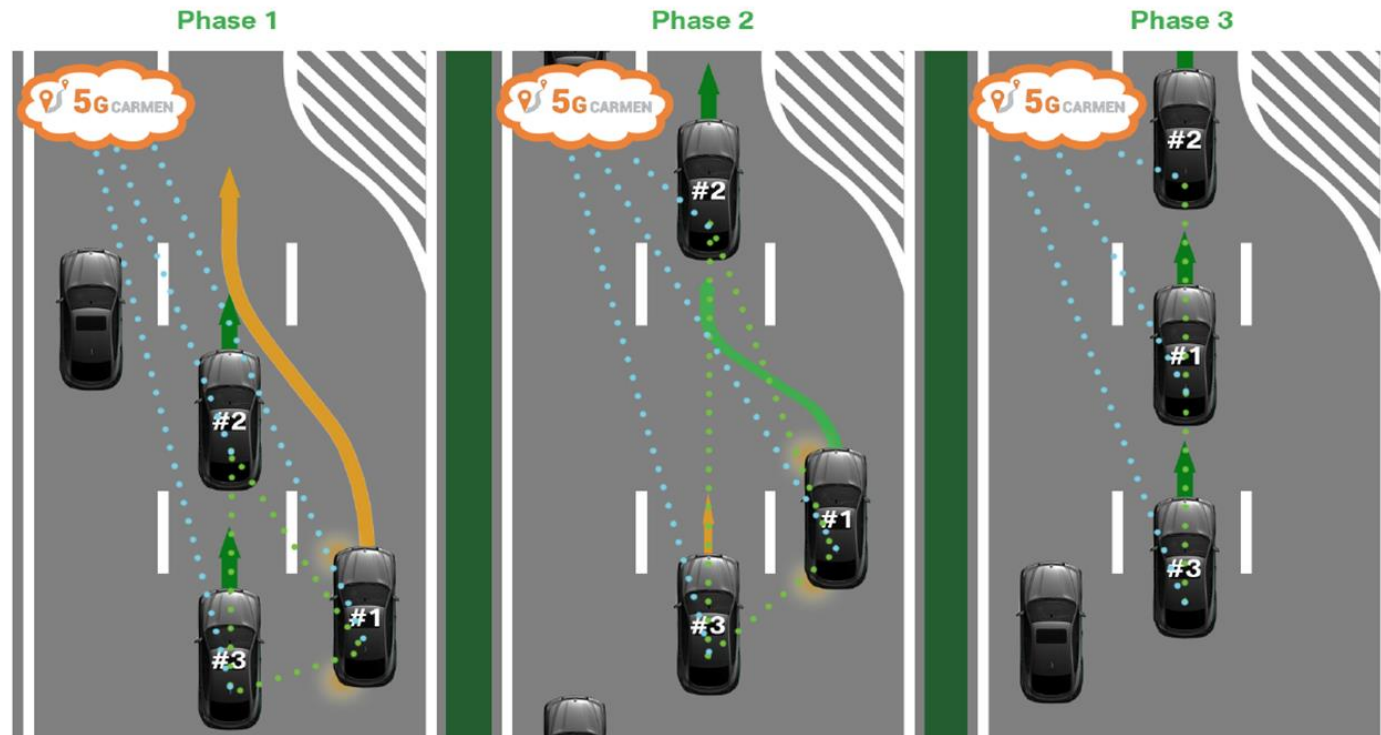
Phase 1 — Identifiy the need for action

Phase 2 — Create a gap for merging

Phase 3 — Resume regular traffic flow

Situation Awareness (1/2)
## Vehicle Sensors and State Sharing

- Dangerous conditions (e.g. fog, icy roads, traffic jam) are detected by sensors in Road Side Units (RSU) or vehicles on the road, and communicated to nearby vehicles using hybrid communication

- Cross-border communication via 5G connectivity and MEC V2X (AMQP) broker
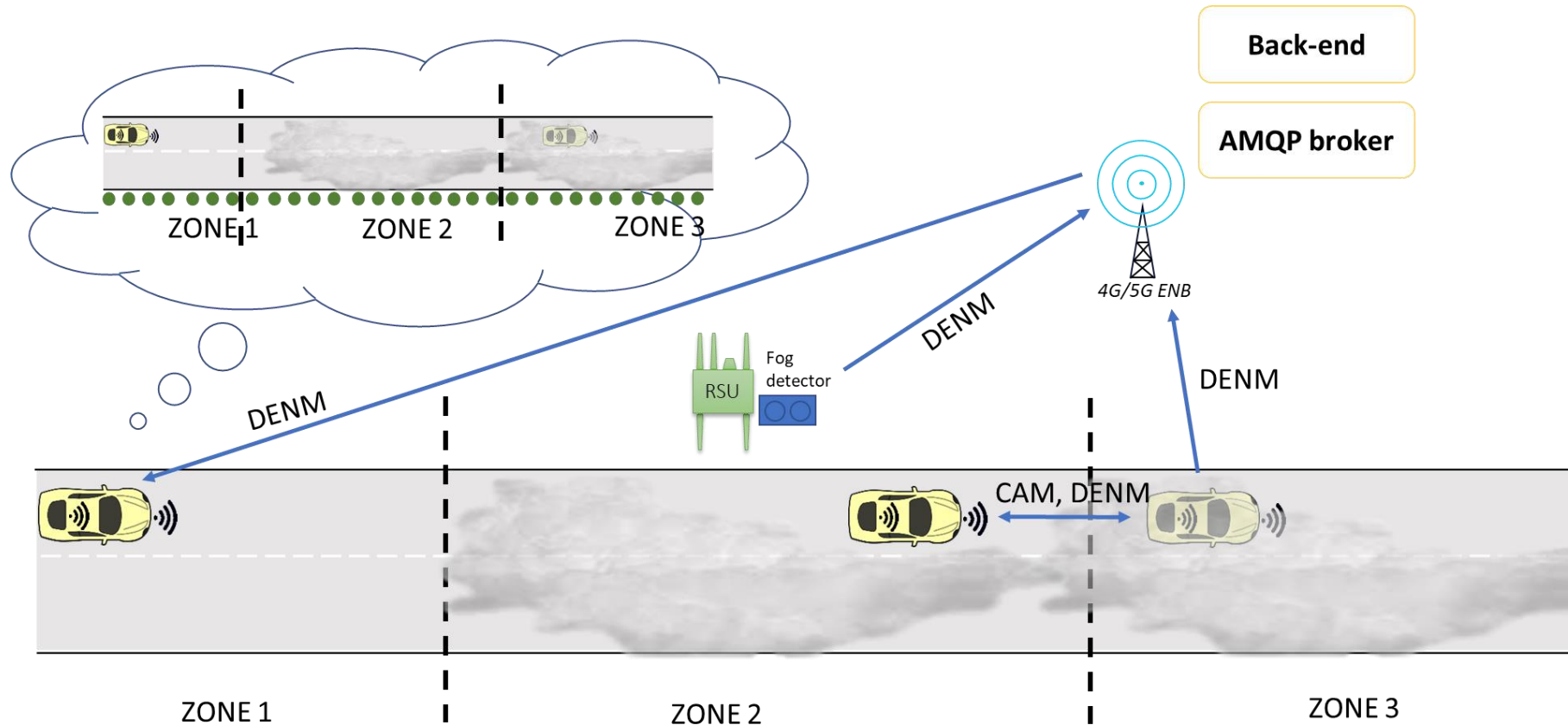
Situation Awareness (2/2)
Back-situation awareness

- Emergency vehicles inform other vehicles of their arrival through V2V and 5G connectivity, giving them enough time to take relevant actions (create a clear corridor for the emergency vehicle)

- The 5G-CARMEN platform dynamically orchestrates the MEC Service cross-country
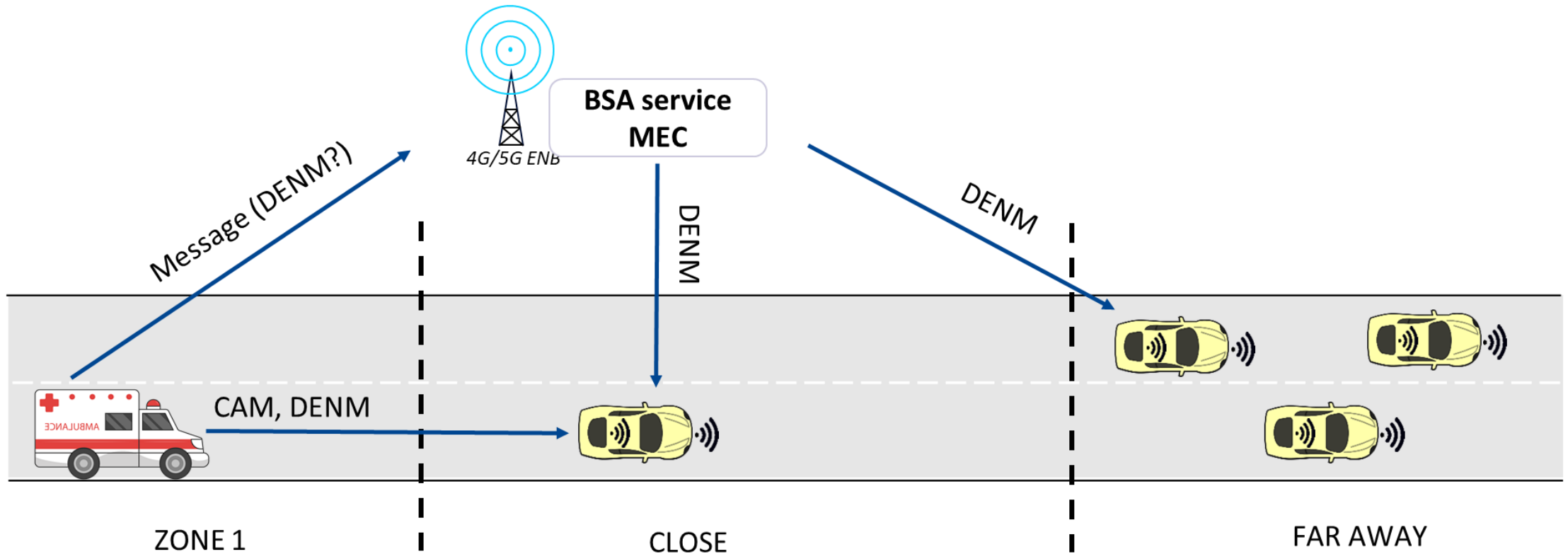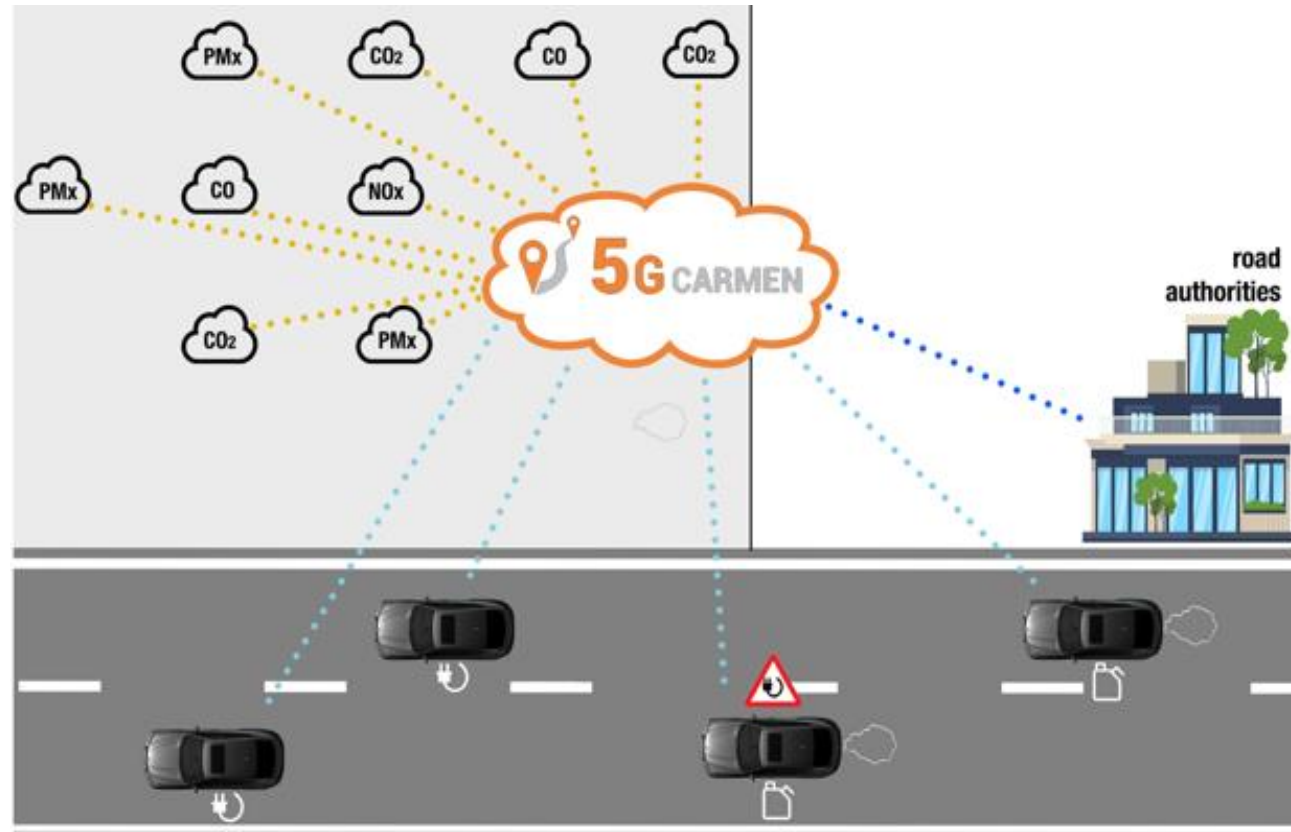
Video Streaming

- Using Predictive (network) Quality of Service capabilities (QoS), more pleasant experience on board can be granted to passengers (higher and more stable Quality of Experience (QoE) in the fruition of multimedia content)

- Proactive adaptation of streaming to minimize interruptions of service or low data-rate conditions, especially at country borders

Green Driving

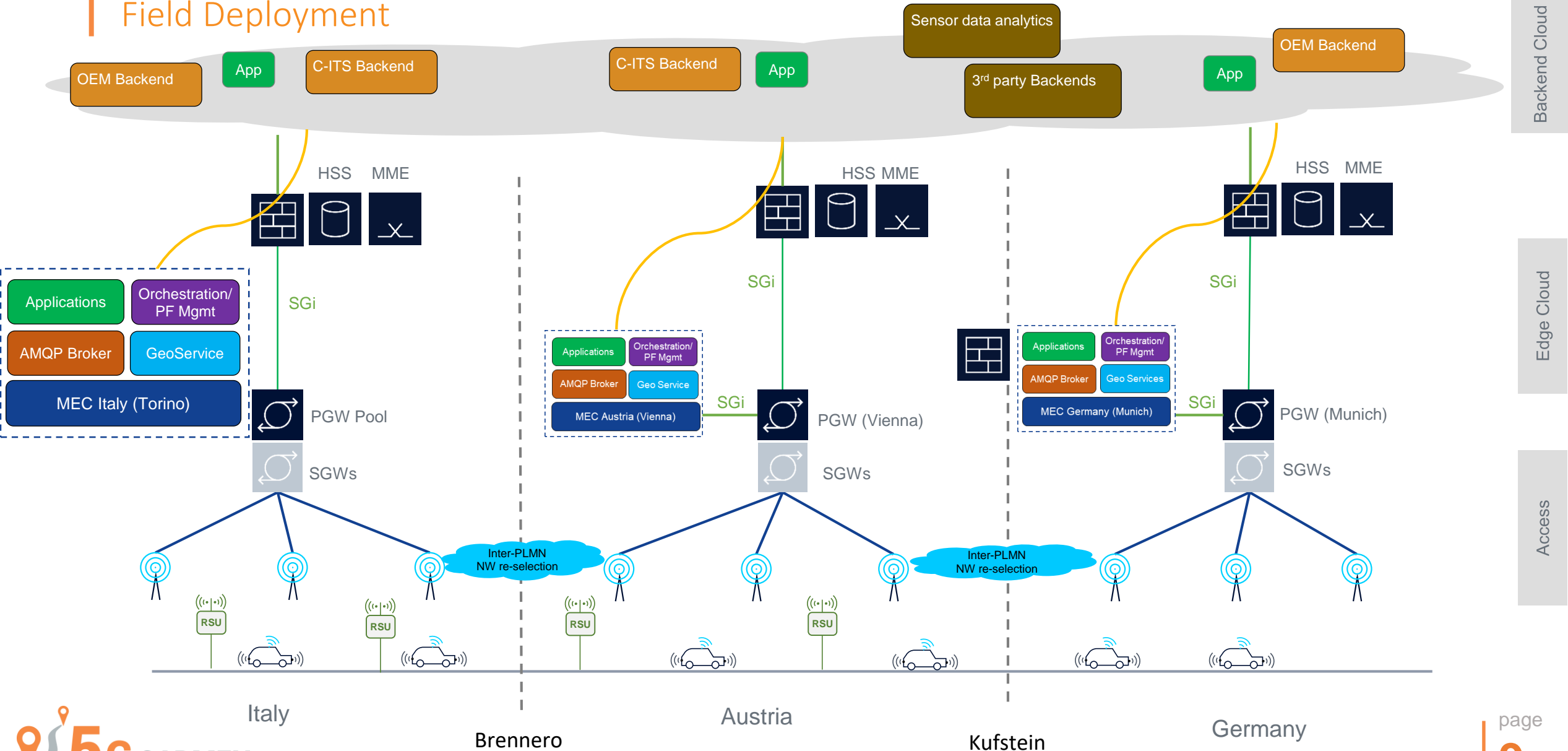- Increasing the sustainability of mobility, suggesting virtuous driving behavior (e.g. via speed recommendations), based on the environmental and traffic characteristics of the motorway section that is being traversed (IVI messages transferred cross-border via MEC Services)

- Better exploiting the hybrid traction systems on hybrid vehicle (e.g. switching to electric driving in restricted areas)

Architectural Overview
Field Deployment

Backend Cloud

OEM Backend

App

C-ITS Backend

Sensor data analytics

C-ITS Backend

App

3rd party Backends

App

OEM Backend

Edge Cloud

Access

HSS MME

HSS MME

HSS MME

SGi

SGi

SGi

SGi

SGi

Applications | Orchestration/ PF Mgmt
AMQP Broker | GeoService
MEC Italy (Torino)

Applications | Orchestration/ PF Mgmt
AMQP Broker | Geo Service
MEC Austria (Vienna)

Applications | Orchestration/ PF Mgmt
AMQP Broker | Geo Services
MEC Germany (Munich)

PGW Pool

PGW (Vienna)

PGW (Munich)

SGWs

SGWs

SGWs

Inter-PLMN NW re-selection

Inter-PLMN NW re-selection

RSU

RSU

RSU

RSU

Italy

Brennero

Austria

Kufstein

Germany

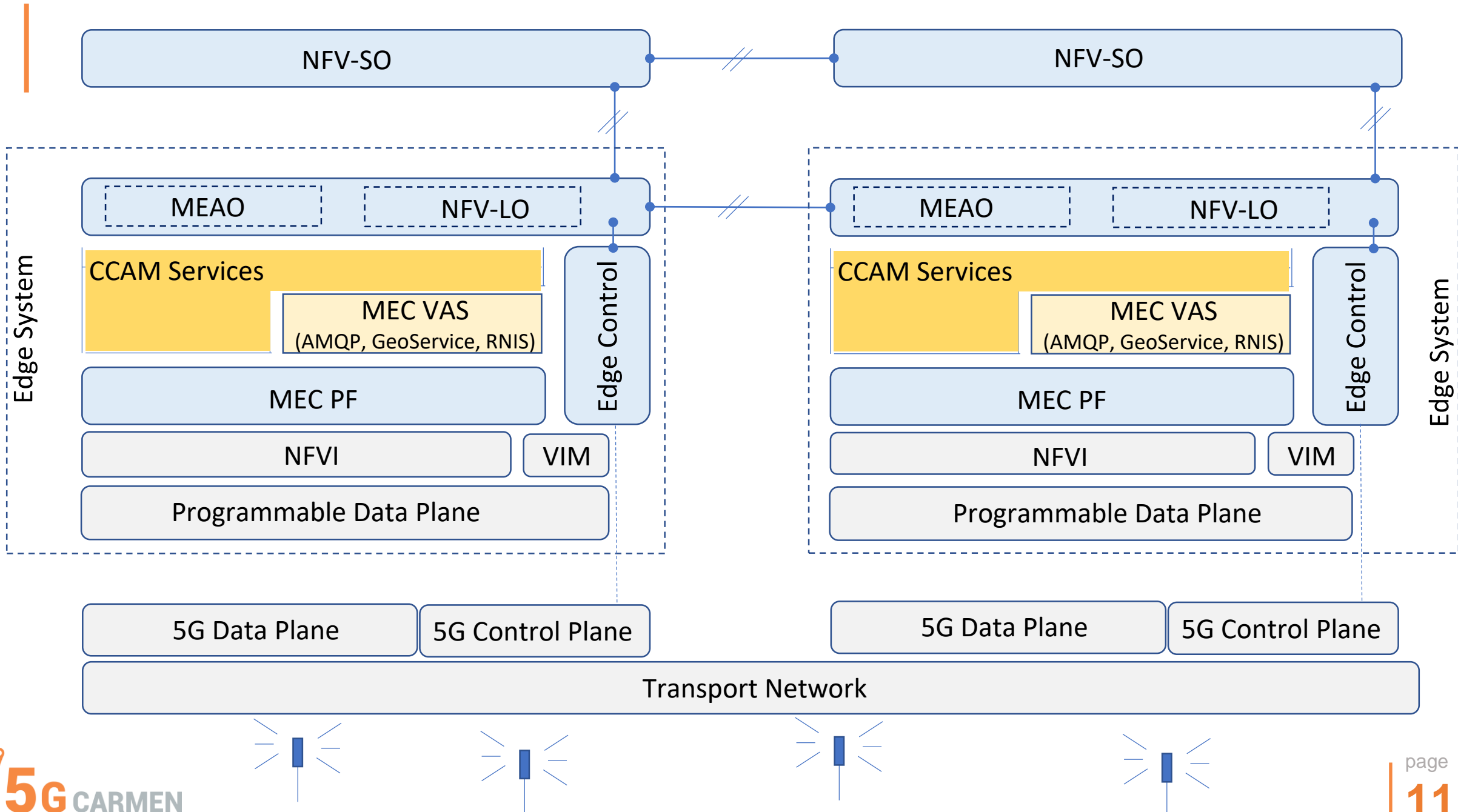5G CARMEN

5G CCAM Platform
Overview

- Cloud-native edge platform, Deployment of CCAM services along network edges
  - Persistent, e.g. AMQP or GeoServices for dissemination of ITS messages in an area of interest
  - On-demand, e.g. Situation Awareness or mission-critical services

- Reference points between local edge orchestrators

- Modular suppport for Identity Management and Intrusion Detection

- Context-based admission of autonomous edge operations and orchestration

- Value-added services to support CCAM services and platform operations

- Service continutity for a variety of services and vehicles
  - Intra-domain and cross-border

- Coupling of Multi-Access Edge Computing (MEC), NFV and 5G Systems
  - Collaborative systems rather than dependeny between fully integrated architecture

5G CARMEN pilots

- 3 preparatory local pilots: Munich, Trento, Modena
- 2 target cross-border pilots: Italy- Austria (Brenner), Austria-Germany (Kufstein)

- Integration and functional tests in local pilots
- Intermediate results Q4 2020
- Demonstration in cross border scenario and KPI evaluation
- Final result Q3 2021

The cross-border issue

- 5G-CARMEN is considering the cross-border issue for both the Italian-Austrian and the Austrian-German borders

- Discussions on the technical solutions to be adopted is still ongoing and depends on the networks' current implementations/configurations of the involved operators

- As per D3.1, in principle procedures for a "standard 3GPP seamless handover" will not be put in place to reduce the interruption in the cellular communication when crossing the border due to PLMN change

- In case the interruption is too long for certain use cases we consider to adopt a solution similar to Release with Redirect with the exception of not deploying the S10 interface between MMEs, hence only relying on a RAN ad-hoc configuration (both sides) along with PLMNs being declared as Equivalent

More information
Public activity

- 5G-CARMEN web presence, social profiles (Twitter and Linkedin), Youtube videos and newsletter

- Dissemination through traditional channels :
  - 10+ Participation to conferences and industrial fairs with contributions, panels, tutorial, presentation, demos, e.g. Infocom2019, IEEE WCNC 2019, ACM MobiHoc 2019, ITS World Congress 2019, Mobile World Congress 2019, EUCAD 2019, 5GAA Exhibition February 2020, IEEE CSCN 2019, IEEE Globecom 2019, IEEE VTC-Fall 2019
  - 6 accepted contributions to Journals an 1 article for a newspaper, e.g. IEEE Communications Magazine, IEEE Access 2019, IEEE Communications Standards Magazine, IEEE Vehicular Technology Magazine
  - 4 workshops in relevant events: EUCNC 2019, 5G Strategic Deployment Agenda (SDA) for CAM, BrennerLEC 2° workshop, TOP-CARS workshop

- Active in different SDOs or industrial association: ETSI MEC, ETSI NFC, IETF, 5GAA

- Cross-cross-border project alignment: Joint whitepaper and expositions (EUCNC best booth award)

Thank you

https://www.5gcarmen.eu/