Innovation Action H2020-ICT-2018-2

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

1st Open Annual Workshop on Future ICT

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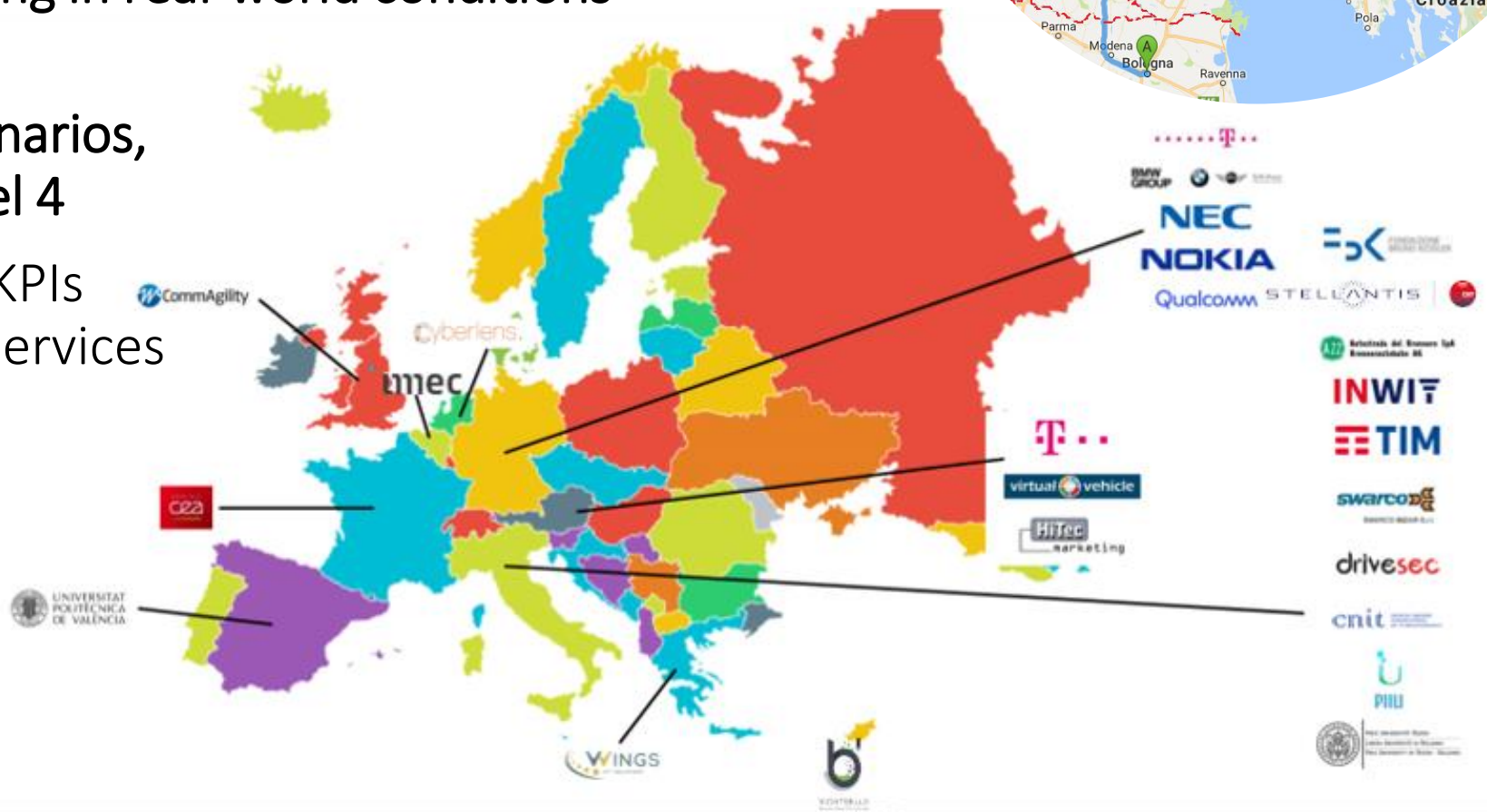
25.05.2022

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825012

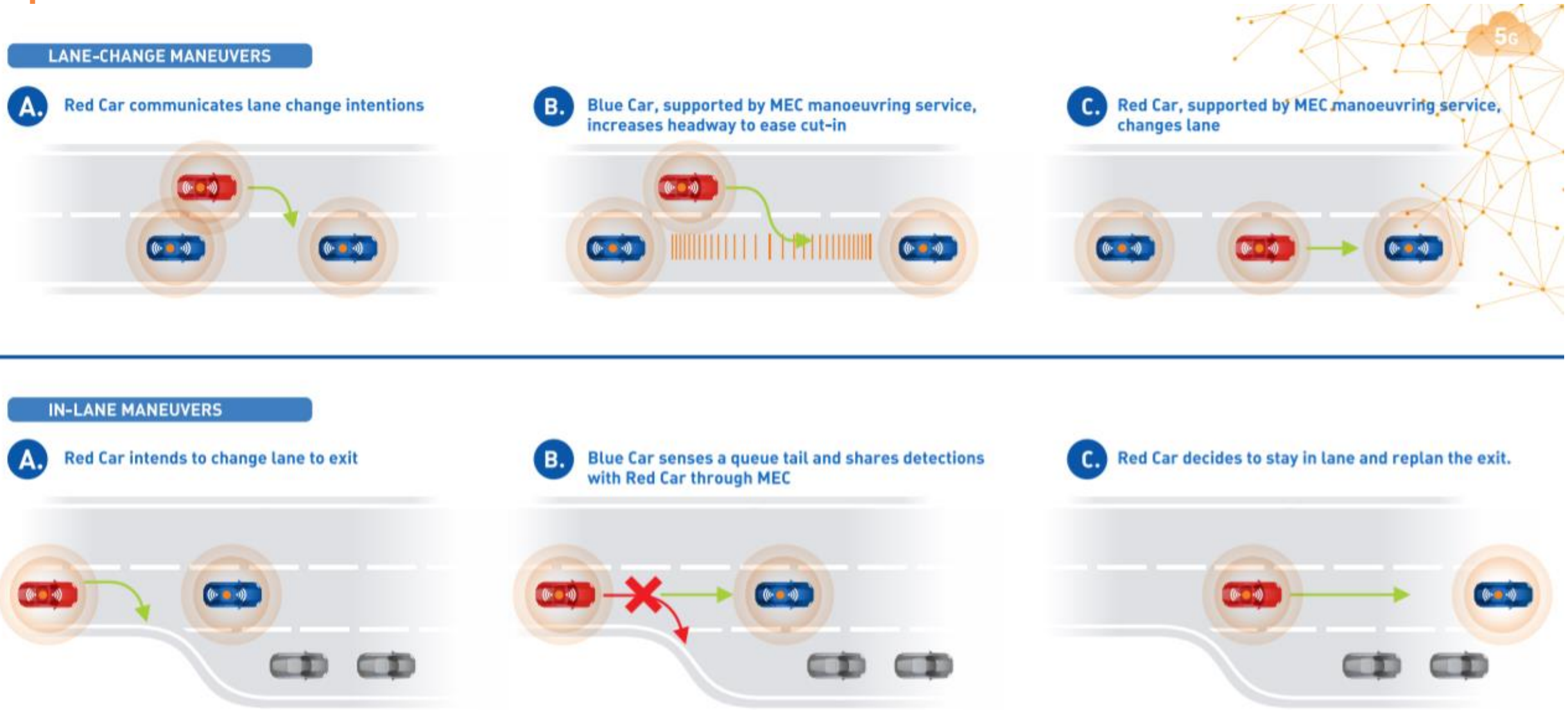
Project Overview and Objectives

- The Bologna-Munich Corridor: ~600 Km across IT-AT-DE, interconnecting two-major industrial poles
- Elaborating and evaluating the **benefit of 5G and related Services for Automated Driving in real-world conditions**
- **Ensuring Service Continuity in different cross-border scenarios, enabling CCAM and SAE Level 4**
- Assessment of essential 5G KPIs for vehicle and MEC-based services **to pave the road for European Mobility**



5G CARMEN

Automated Vehicles Use Cases to enable SAE L4

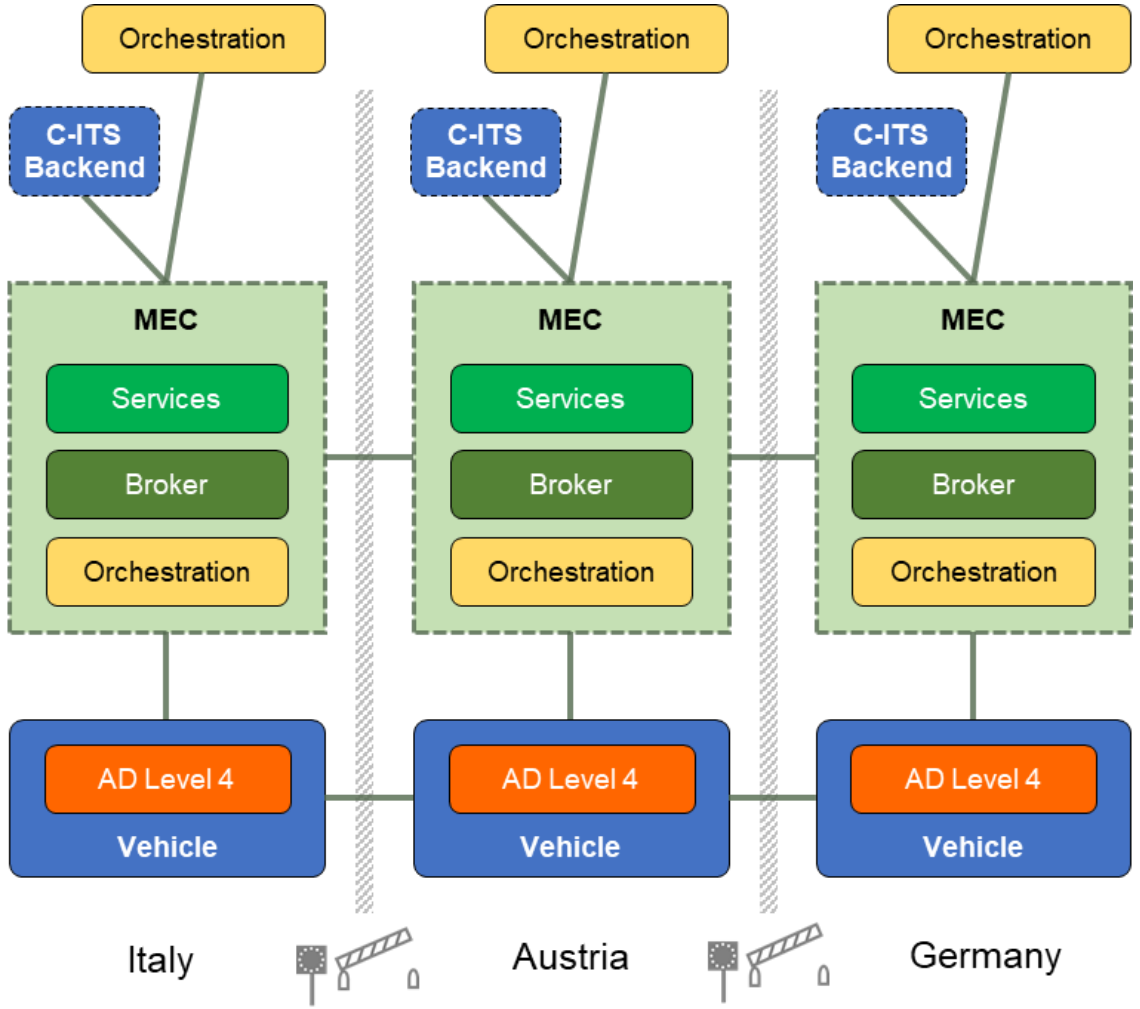


5G CARMEN pilots

- 2 preparatory local pilots: Munich, Trento
- 2 target cross-border pilots: Italy- Austria (Brenner), Austria-Germany (Kufstein)
- Integration and functional tests on both local pilot and cross-border sections completed
- Demonstration in cross border scenarios and KPI evaluation ongoing

5G-CARMEN Architecture

- The pilot are based on vehicles with SAE level 4 autonomous driving capabilities that exchange information through both V2V communication and the 5G network.
- Mobile Edge Computing (MEC) platforms in the three countries host the services necessary to run the selected use cases.
- In order to manage these services and support service continuity when crossing the border an orchestration platform has been developed.
- MEC platforms interact with each other and with other services hosted in the cloud, e.g. precise positioning service, Predictive QoS service or the road operators backends.



5G Deployments

- 5G coverage for the trial was provided in **Brennero** and **Kufstein** with **commercial networks** based on a Non Stand Alone (NSA) architecture and 5G Spectrum at 3.x GHz.
- MEC platforms have been deployed in Turin, Vienna and Munich.
- 5G Networks have been configured with:
  - **Local Break Out** to reduce latency in roaming
    - Tests show that roaming users latency is comparable to national users
  - **Fast Network Reselection** to reduce the communication gap when crossing the border
    - session interruption reduced to **~3 sec** instead of 60-90 sec

First results

- First round of **network and connectivity enablers**, plus **parts of the service** tests successfully completed.
- **Network throughput** and **roundtrip latency** measured on field
  - 5G throughput **>300Mbps DL** and **>60Mbps UL**
  - Round Trip Time varies a lot depending on location and NW configuration (from **20ms to 60 ms**).
- **Maneuvering Service** was able to send instructions to 3 BMW prototype vehicles and lane change maneuver was successfully executed
  - average time to complete the maneuver goes from 20 seconds to 150 seconds depending on vehicles proximity
- 2 **CRF prototype vehicles** have been **tested in L4 SAE level** (up to decision making) **enabled by 5G and PC5 redundant communication**
  - The two vehicles drove at 80 -130 km/h, **with Cooperative Adaptive Cruise Control** system enabled. With just one remote sensing vehicle **the number of perceived objects is almost doubled**, and the **perception range extends up to more than 160 m**.
- **Precise positioning** has been thoroughly validated by OEMs,
  - horizontal position error is **smaller than 20 centimetres**

Outlook

- Deployment of infrastructure and architecture is completed
  - Deployment of features to allow better cross-border and roaming behavior completed
- Completion of service integration with both vehicles and the distributed orchestrated edge cloud ended in 2021
- First testing of functional elements both in lab and on field completed
- Pilot operations, network and service optimizations plus KPI collection ongoing, followed by assessment and (final) reporting
- Project ends in July 2022. Find more here:
  - WWW - www.5gcarmen.eu
  - Twitter - @5g_carmen
  - LInkedIn - https://www.linkedin.com/company/5g-carmen/
  - Youtube - https://www.youtube.com/watch?v=ls3vlNRzGy4

Thanks!

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This work has been performed in the framework of the European Union Horizon 2020 project 5G-CARMEN co-funded by the EU under grant agreement No. 825012. The views expressed are those of the authors and do not necessarily represent the project. The Commission is not liable for any use that may be made of any of the information contained therein.