

5GCroCo Use Cases and Key Performance Indicators for Cross-border Trials

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Abstract— The provision of Cooperative, Connected, and Automated Mobility (CCAM) services across different countries when vehicles traverse various national borders has a huge innovative business potential. However, the seamless provision of connectivity and the uninterrupted delivery of real-time services across borders also pose technical challenges which 5G technologies promise to solve. The situation is challenging given the multi-country, multi-operator, multi-telco-vendor, multi-car-manufacturer, and cross-generation scenario of any cross-border layout. The 5GCroCo project is piloting use cases for Automated Driving (AD) in 1) Tele-operated Driving, 2) High Definition (HD) map generation and distribution for automated vehicles, and 3) Anticipated Cooperative Collision Avoidance (ACCA). The results will help reduce the uncertainties associated with enhanced Vehicle-to-Anything (eV2X communications) across borders in Europe in preparation for commercial 5G deployment.

Keywords—5G, connected and automated mobility, V2X, automotive use cases, cross-border, CCAM, trials, QoS.

I. INTRODUCTION

For the success of connected, cooperative and automated mobility (CCAM) services, it is necessary that both the telecom and the automotive industry cooperate together to shape the future by addressing all the challenges that CCAM brings into the innovation arena. One of these challenges consists in ensuring that CCAM services, which often require real-time response and ultra-high reliability, can be provided along different countries when vehicles traverse various national borders.

There are still standardization or regulatory gaps in areas like roaming and inter-Mobile Network Operator (MNO) interaction, end-to-end Quality of Service (QoS) management, QoS prediction, Network Slicing, Mobile Edge Computing/Cloud (MEC), safety, applications based on vehicle-to-anything (V2X) communications, data management, and security & privacy. This is the motivation for 5GCroCo [1], where key European partners from both the telco and automotive industries join efforts to trial and validate 5G technologies. at large scale in a cross-border setting with the mission to reduce uncertainties before CCAM services running on top of 5G

communication infrastructures are commercially offered. 5GCroCo aims at testing and trialing advanced 5G features in a cross-border context; features such as New Radio, MEC, QoS prediction, Software Defined Networking (SDN), Network Slicing, and improved positioning systems, all combined together to guarantee that innovative use cases for CCAM can be enabled. 5GCroCo aims at conducting large-scale pilots that will be prepared through small-scale tests and pilot activities conducted in Germany, Spain, France, and Sweden.

5GCroCo validation will focus on three use cases: 1) Tele-operated Driving, 2) HD map generation and distribution for automated vehicles, and 3) Anticipated Cooperative Collision Avoidance (ACCA).

This paper described the trials planned

II. 5G CROCO OVERVIEW PILOT ACTIVITIES

5GCroCo is an innovation action partially funded by the European Commission (EC) under the umbrella of the 5G Public Private Partnership (5G-PPP). 5GCroCo is devoted to conduct large-scale trials of 5G technologies for CCAM in the European 5G cross-border corridor connecting the cities of Metz (in France), Merzig (in Germany), and Luxembourg. In addition to the large-scale trials in the 5G corridor, 5GCroCo will also conduct small scale pilots in Barcelona, Montlhéry, Munich, AstraZero, and the German A9 5G-ConnectedMobility testbed.

III. 5GCROCO USE CASES AND THERE KPI'S

5GCroCo aims at validating 3 CCAM use cases: 1) Tele-operated Driving, 2) HD map generation and distribution for automated driving, and 3) ACCA. While the actual trials and validations in 5GCroCo will be focused on these particular use cases with envisioned high potential market opportunities, the activities of 5GCroCo aim at deriving recommendations and insights which can be valid for a wider set of CCAM use cases. In the following, we define the use cases and identify the KPIs.

A. Tele-operated Driving (ToD)

Tele-operated Driving is defined as the remote control of automated vehicles by a human or by an artificial intelligence over mobile radio network. The emphasis in 5GCroCo is set to

remote control by a human. ToD in the context of automated driving can be deployed in different traffic situations.

Based on the discussions and work conducted in 5GCroCo, the main KPIs and requirements that have been identified for ToD are: payload uplink 10 – 50 Mbit/s, service latency 40 ms, service reliability downlink 99,9% and maximum network provider handover time of 50 ms.

B. High definition (HD) map generation and distribution for automated driving

Intelligent and dynamic HD maps provide highly accurate position and traffic information of dynamic and static objects which enable optimal route and lane selection by an autonomously or semi-autonomously driven vehicle. Such maps could be constructed by smartly fusing all the available data collected from different sources at and along the roads, e.g. the sensor data shared by the vehicles, the data shared by the road infrastructure, or by the map content providers, among others.

The main KPI for this use case is the service level reliability, which should be of 99,9% or greater.

C. Anticipated Cooperative Collision Avoidance (ACCA)

5GCroCo will define and trial cooperative solutions to anticipate the detection and localization of dangerous events and to facilitate smoother and more homogeneous vehicle reaction. This is called the ACCA and can be useful in a number of situations, such as:

- Temporarily static events like traffic jams.
- High deceleration, emergency breaking, or unexpected maneuver of vehicles in front (with or without visibility for the ego vehicle).
- Cut-in anticipation, e.g., when a vehicle suddenly comes in from another lane.

The main KPI for ACCA use case in 5GCroCo is to ensure the notification of a new hazard event in less than 2 seconds.

IV. TEST APPROACH FOR 5G TECHNOLOGIES IN 5GCROCO

5GCroCo has identified a set of key 5G technologies which will become enablers for CCAM:

- 5G New Radio,
- Guaranteed service continuity,
- MEC,
- End-to-end and predictive QoS (including slicing),
- Virtualization (Management and Orchestration (MANO) & Software Defined Networking (SDN)) (incl. slicing),
- Network support for precise positioning, and
- Security.

These key functions will be tested in large-scale trials conducted in the 5G European corridor connecting the cities of Metz-Merzig-Luxembourg, across France, Germany and Luxembourg.

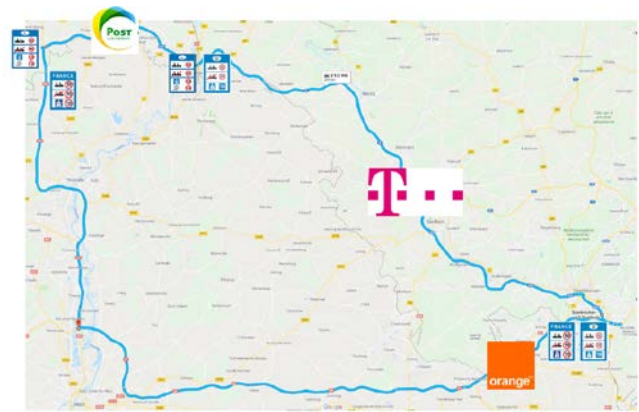


Figure 1 Map of the 5G Corridor where 5GCroCo will conduct transnational CCAM 5G-enabled trials

In addition to the large-scale trials at the corridor, 5GCroCo also plans to deploy local pilots, as a step before large-scale deployment in the corridor. These pilots will be deployed in Montlhéry (South of Paris, France), two in Germany (in a section of the motorway A9 and a test-site in the Munich city center), in Sweden – AstaZero, and one in the city of Barcelona (Spain) where a cross-border city setting will be emulated.

The key 5G technologies listed before will be implemented to test them in small- and the large-scale cross-border trials. Trials will be executed periods in the second half of 2020 and the summer of 2021.

The detailed schedule as foreseen in February 2020 for the project year 2020 is as following. The tests are planned for the small-scale test sites in Munich for ToD in June, for HD Mapping at Asta Zero and A9 in respectively March and May and for ACCA at Barcelona and Montlhéry respectively in June and May. The first round of trials demonstrating a selection of user stories on the large scale cross-border corridor connecting the cities of Metz, Merzig, and Luxembourg will be performed from July to September 2020. Concerning the second year of trials, they are planned to be demonstrated in August to September 2021.

V. SUMMARY

The poster will display the main objectives of 5GCroCo, the selected use cases that will be implemented for the tests and trials, the main KPIs and identified requirements, and the time plan of the trials, which are planned for the summer period of both 2020 and 2021. Details will be provided on what will be tested at small-scale, and what will be tested at large-scale at the cross-border corridor across France, Germany and Luxembourg.

ACKNOWLEDGMENT

This work is part of 5GCroCo project that has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No825050.

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- [1] 5G Cross Border Control (5GCroCo), <https://5gcroco.eu/>