The European 5G Annual Journal 2023

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5G PPP PHASE 3, PART 5: 5G FOR CONNECTED AND AUTOMATED MOBILITY

Four Projects[32] were selected in response to the 5G PPP ICT-53-2020 call: 5G PPP 5G for Connected and Automated Mobility (CAM) started late in 2020. Some will be active since mid-2024.

32. https://5g-ppp.eu/5g-ppp-phase-3-5-projects/

5GBLUEPRINT

Next generation connectivity for enhanced, safe & efficient transport & logistics

Coordinated by Wim Vandenberghe (MIW Netherlands)
September 2020-August 2023
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Objectives

In 1995, the "No Hands Across America" experiment by Carnegie Mellon University's Robotics Institute managed to tackle 98.2% of an over 2800-miles trip via autonomous driving: since then, the entire industry has been working hard to identify, test and optimise upon that remaining 2% of traffic situations, where unusual operating circumstances may take place, to guarantee safety. That's where 5G-Blueprint comes in, focusing on an alternative approach to these challenges: direct control teleoperation and automation complementing each other. Direct control teleoperation can allow splitting up L4 vehicle trajectories in different segments with different Operational Design Domains and assign each of them to either automated driving or remote driving – where humans perform the actual dynamic driving task – depending on how difficult they are to automate. This would also reduce personnel costs, as human drivers will not need to be physically present in the vehicle anymore and could remotely jump in and out to take over whenever needed. 5G finally made this concept feasible, but the seemingly needed combination of eMBB and URLLC – alongside seamlessly cross-border connectivity for international transport – might be still too challenging to realise. It is 5G-Blueprint's mission then to validate in depth if and how 5G can provide the connectivity needed for direct control teleoperation, from the technology, business, and governance standpoints.

To validate the performance of use cases and enabling functions over the 5G network, we created three pilot sites. These pilots are benchmarked on the basis of the current network solutions (e.g. LTE) in order to validate 5G advantages on a full-scale level on both private and (cross-border) public roads within the designated pilot areas.

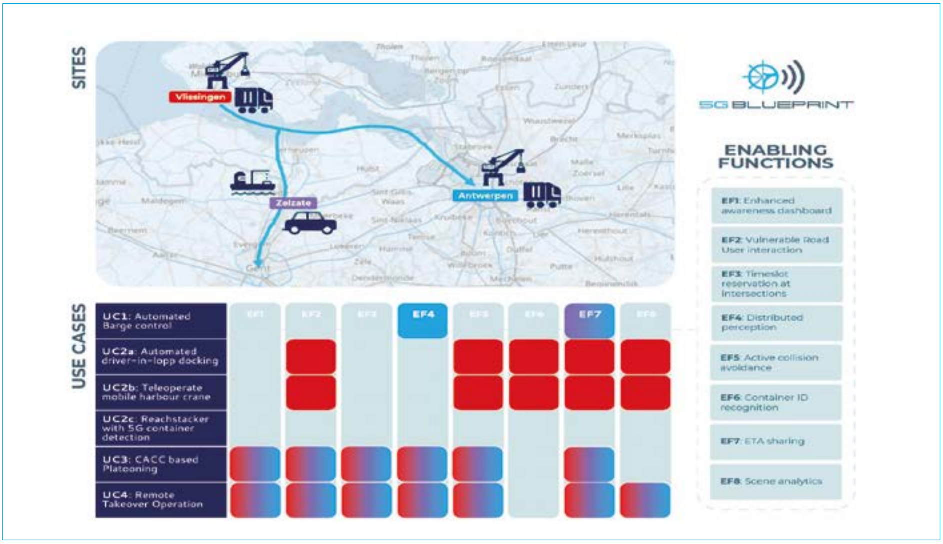

Fig. 30: 5GBLUEPRINT use cases

Major results and innovations

One of the main achievements is the **techno-economic analysis of teleoperated transport using 5G technology**, aimed at evaluating its feasibility, particularly in a cross-border setting. The results showed that it is not possible to identify a single network deployment approach that is the most cost-effective approach for all possible deployment scenarios. Other main recommendations from the study can be summarised as follows:

- **Reduce the use case requirements for the uplink capacity** to save (connectivity) costs taking into consideration also the potential additional cost for such development/implementation.
- **Smart deployment of small cells in addition to macro cells** for enhancing uplink capacity in a network deployment, but not without limitations.
- **Adopting cost saving strategies for network deployment** such as passive and active network sharing to significantly reduce the network overall deployment cost.

From the perspective of use cases and piloting activities, the first stage of the project has been entirely focused on the design, testing and validation of the Minimum Viable Platform for all use cases and enabling functions. In terms of 5G network deployment for testing, the project focused first on the 5G NSA network, due to the availability of radio spectrum. Although more testing on 5G SA, leveraging on eMBB and URLLC network slices are currently ongoing, the MVP phase of piloting activities showed already enhancements of the network performance and on teleoperation-specific KPIs (such as accuracy in steering angles, throttle positions, brake positions, and the distance between lead and ego vehicles in CACC-based platooning scenarios).

For a brief breakdown of setups and main takeaways:

- **A driver-in-the-loop docking test** in the Vlissingen pilot site, featuring a scaled truck trailer combination and 5G equipment. The results show the maximum value of tracking error is 1.3cm, with the average of 0.4cm: a promising result, as it meets the requirements of less than 2.5cm.
- **Tests including 5G-enhanced CACC-based platooning** integrated with the enabling functions, performed in shadow-mode (sending teleoperation commands to the teleoperated vehicle, without application to the UE side). The enabling functions provided an extended and enhanced awareness to the teleoperator to increase safety of teleoperation,

with less than 5% error between lead and follower vehicle (target value domain), and maximum achievable speed of 90km/h.

- **Remote takeover tests**, where remote driving enhanced by enabling functions was tested over 5G connectivity. The results that were achieved in the Vlissingen pilot site show, throttle (obtained error 3%, required less than 6%), and brake accuracy (obtained error 5%, required less than 6%).
- A promising **cellular-based automated barge control system** created in the real-life environment of the Port of Antwerp Bruges, featuring a sailing barge, connecting dynamically to the available 5G NSA network. Based on the results registered, 5G outperforms 4G both in terms of latency (~15ms vs. 27ms), and bandwidth on the uplink (24Mbps vs. 36Mbps).

In general, all these results from the MVP (Minimum Viable Product) phase are showing good consistency between the KPI target values and data measured in the pilot sites using the 5G network. The main focus of our ongoing testing and validation is on the challenging cross-border scenarios for barge/vehicles/trucks sailing/driving between Belgium and the Netherlands, thereby testing and validating the impact of enhancements on the 5G SA roaming on achieving the service continuity for cross-border teleoperation. In addition, more tests with higher traffic load (e.g., multiple camera feeds), and various weather conditions, are planned.

Vertical use cases addressed in 5G PPP

Automotive,Transport and logistics

5GMED

Sustainable 5G Deployment model for future mobility in the Mediterranean cross-border corridor

Coordinated by Jose Lopez Luque (Cellnex)
September 2020-September 2024
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Objectives

The 5GMED Project aims to bring a sustainable 5G deployment model for future mobility in the Mediterranean Cross-Border Corridor.

5GMED will demonstrate advanced Cooperative Connected, and Automated Mobility (CCAM) and Future Railway Mobile Communications System services (FRMCS) along the "Figueres Perpignan" cross-border corridor between Spain and France, enabled by a multi-stakeholder compute and network infrastructure deployed by MNOs, neutral hosts, and road and rail operators, based on 5G.

The main target of the 5GMED project is to design a common roads/railways 5G infrastructure architecture, with proven sustainable business models, demonstrated investment viability and scalability potential.

The architecture will be suited by design to pervasively respond to both CCAM and FRMCS functional requirements, with cross-border, shared, and secured services' functional continuity.

Major results and innovations

5GMED aims to design a network architecture to meet the strict performance requirements of the use cases in terms of service end-to-end latency, data-rate, reliability, and mobility interruption time. This architecture is composed of three strata: (i) infrastructure, (ii) functional, and (iii) management and orchestration.

The infrastructure stratum is designed to provide seamless high-quality connectivity and

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5G PPP

More information at
https://5g-ppp.eu

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