5G for Connected and Automated Road Mobility in the European Union

Deliverable D7.3
Second dissemination, impact assessment and exploitation report
### Project Details

<table>
<thead>
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<th><strong>Call</strong></th>
<th>H2020-ICT-18-2018</th>
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<td><strong>Type of Action</strong></td>
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</tr>
<tr>
<td><strong>Project start date</strong></td>
<td>01/11/2018</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>36 months</td>
</tr>
<tr>
<td><strong>GA No</strong></td>
<td>825012</td>
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### Deliverable Details

<table>
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<th>WP7</th>
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<tr>
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</tr>
<tr>
<td><strong>Reviewer(s):</strong></td>
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</tr>
<tr>
<td><strong>Contractual Date of Delivery:</strong></td>
<td>31/01/2021</td>
</tr>
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<td>31/01/2021</td>
</tr>
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<td>PU</td>
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Executive Summary

The 5G-CARMEN project aims at producing valuable know-how and tangible results for all the involved partners, the scientific community, the industrial world and - ultimately - the general public that will be affected by the deployment of effective and secure Cooperative, Connected and Automated Mobility (CCAM) services. Continuous dissemination is essential to grant the widest and maximum impact on the project. Already in its first year, 5G-CARMEN has pushed its dissemination, standards contributions, and exploitation activities, to reach all the relevant stakeholders and increase their awareness on the use cases, trials and technological components that will be delivered by the project. These activities are summarised in this report.

The long-term success of a research project like 5G-CARMEN relies on a fruitful activity on standardisation and dissemination in scientific and industrial fora, and by exploiting synergies with other 5G-PPP initiatives and projects, so as to make the most of the community consensus. This very complex period in which humanity is embarking has undoubtedly affected the way in which this dissemination has been carried out in a conventional way to date. We have all had to redefine our way of communicating, and in the same way 5G-CARMEN has had to reorient its activity to continue building consensus and contributing to science a significant technical advance from an online dissemination approach. This deliverable summarizes the measures to disseminate the project results and create awareness, ensuring contributions to international Standards in the field both of telecommunications and automotive sectors. Moreover, the experience gained by the first trials made with our wireless solutions and the insights gained in the adopted technologies through these trials, represent a central exploitation opportunity in the project in which the partners are starting to figure out how the research done can be transformed in business opportunities.

This deliverable reports the complete set of activities performed in the project until the second year related to dissemination, standardisation, impact assessment and a refined view of the achieved objectives of exploitation of the partners.

First, the webpage of the project remains the main dissemination channel, including the collecting all the news, events, and publications relevant to the project. Moreover, the interaction in the Twitter and LinkedIn accounts has significantly raised, with more than 550 followers in Twitter and 254 in LinkedIn. Three newsletters have been published, reaching more than 250 subscribers, with important interactions to receive more information about the trials launched in October 2020.

Dissemination in the scientific community was achieved through 14 contributions to conferences (speeches, demos or panels), four workshops and four Industrial Fairs, with two tutorials delivered in these events and 9 journal articles published or accepted for publication.

During this lifetime of the project, 5G-CARMEN collaborated with the other corridors projects, 5GCroCo and 5G-MOBIX, to organise a common booth in two important events, the EUCAD 2019 and the EuCNC 2019 where the booth won the Best Booth award. Moreover, during the EuCNC 2019 5G-CARMEN strongly contributed to the organisation of the «5G in the Era of Connected Cars» workshop. The tight interaction continued even during the pandemic, including the joint writing of a white paper, the alignment for the SDA action and trials, and the organization in November 2020 of a joint webinar.

In terms of standardization, the project has monitored the main standard bodies and industrial organizations that should be monitored, and where the highest impact can be achieved. Contributions to the IETF and ETSI standards were submitted, and several partners are strongly active in both 3GPP and the 5GAA initiative.

Within the 5G-PPP framework, the most relevant 5G-PPP working groups for 5G-CARMEN have been followed, with intense participation in the preparation of the 5GPPP Verticals Whitepaper, and with the leading role of 5G-CARMEN in the Strategic Deployment Agenda study that the European Commission is promoting for the allocation of funds in the CEF plan 2021 to 2027.

The exploitation of project results from partners is a central goal of 5G-CARMEN, and a summary of the progress of the innovation plans of the different partners is also reported in this document. SME interaction has been also promoted with two big events and an online platform for the collection of new business ideas.
1 Introduction

Dissemination and communication activities in 5G-CARMEN were arranged to contain four phases. Each of these phases has its own objectives and target audience groups and has to perform the activities using the most suitable channels.

Phase 1, ranging the first year of the project, was based on the need to create awareness about the 5G-CARMEN’s objectives and expected results for as many 5G Stakeholders as possible. Several workshops and dissemination activities were organized to leverage the awareness that has already been created around the 5G-PPP programme.

The second phase of the dissemination plan, is about to increase the potential impact of the project. It is precisely this report the one in charge of summarizing this phase of the dissemination plan that ends by the second year of the execution of the project. During this phase, the objective is to kick-start the potential impact of the project through the elaboration of the four use cases. This phase leverages the achieved awareness of Phase 1 to reach out the target stakeholder groups. The facility usage and testing in the pilots will provide the main material for dissemination and communication. Workshops have been arranged to attract the key stakeholders and boost the dissemination and communication process. Unfortunately, the situation of the pandemic reduced the expectations of this second phase, but the project managed to fulfil the objectives and create the ecosystem required to increase the project potential thanks to the successful deployment of the four use cases in trials.

Phase 3 and phase 4 are out of the scope of this deliverable and will be treated in D7.4, but basically refer to emphasise the use of the projects results by external entities and highlight the commercial offerings plus, finally, obtain the maximum valorisation of the project ideas. The ambition here is to attract potential users and customers of 5G-CARMEN, increasing the impact through the collaboration with external partners.

With the aim of summarizing the effort and the results of the phase 2 of the dissemination plan, this deliverable reports the complete set of activities performed in the project until the second year related to dissemination, standardisation, impact assessment and a refined view of the achieved objectives of exploitation of the partners.

Section 2 reviews how the dissemination policy has been modified in the project to adapt it to the situation of the health alert that has occurred. An analysis is made of how COVID19 has affected the project and what actions have been carried out to solve the setbacks caused in the best possible way.

Section 3 details activities carried out for dissemination, describing the main events 5G-CARMEN participated to, its main results, the established social media presence and the tools used to track dissemination. The next steps in the plan for dissemination are also indicated.

Section 4 specifically focuses on the important advocacy work in SMEs that has been done since the project. Two major events in which this facet has been worked are described and details are given about the platform for collecting good ideas in creating new business opportunities based on the research carried out in the project.

Section 5 focuses on standardization bodies and associations relevant for 5G-CARMEN, describing those monitored, the standards contributions and where the strongest impact can be achieved.

Section 6 describes the 5G-PPP specific activities where 5G-CARMEN is a part of, highlighting the executed activities and the impact of them so far, in particular with the other corridor projects.

Section 7 enlists the first view of the progress of the exploitation plans for each partner of the project, highlighting results that were achieved already in this first two years of execution.

Finally, Section 8 concludes the deliverable, drawing the main lessons learnt and the way forward.
2 Modifications of the communication strategy due to the COVID-19 pandemic situation

As it can be expected, the lockdown caused by the COVID-19 pandemic that spread worldwide from February 2020 strongly impacted dissemination activities originally planned in 2020, making it impossible to participate in physical events. The last significant event that 5G-CARMEN was able to participate to, was the 5GAA exhibition organized in Brussels in February 2020. After that, several events where 5G-CARMEN was supposed to be present have been cancelled or heavily downscaled, including e.g. the Mobile World Congress 2020 (where a joint booth with 5G MOBIX and 5G CroCo was originally organized), the EuCNC 2020, the Vehicle and Transportation Technology Innovation Meeting 2020, the IOThings in Milan which was also supposed to host the first SME workshop organized by 5G-CARMEN.

In order to compensate for the lack of physical events, the project has pushed its online presence, preparing content that could be shared online. Right from the start, the project’s visibility through online channels has been ensured, creating the project website and setting up the social media channels (through Twitter, LinkedIn, and YouTube videos), as described in Deliverable D7.1 [41]. WP7 has continued to work on the project’s visibility in social media increasing its base to more than 230 connections on LinkedIn and more than 500 on Twitter, and keeping on advertising its activities on the project Website. The project website has been in particular completely restructured following the COVID-19 outbreak, including more information on the use cases, links to the public deliverables, links to the articles and presentations prepared by the project. The publication section has been extended to host the open source software made available by partners, and it also includes the latest videos that were prepared to advertise the project activity. In particular, a set of videos have been prepared to advertise the project and show the demos that were originally planned to be presented at the EuCNC 2020. These videos have been made available online during the virtual edition of EuCNC 2020 on the project YouTube playlist, and advertised through the project social channels, tagging the EuCNC 2020 event to reach a large audience.

As will be detailed hereafter, as a further way to widen the scope of the online dissemination, 5G-CARMEN also contributed to different whitepapers, and jointly with the other corridor projects, 5GCroCo and 5G-Mobix, has submitted a dedicated whitepaper and an accompanying webinar to describe the challenges of cross-border deployment of 5G enabled CCAM use cases.
3 Second assessment of the dissemination activities

This section covers the Dissemination and Communication activities performed in the last period.

3.1 Dissemination activities

The impact of the project is supported by the implementation of a dissemination and communication plan that is maintained throughout the end of the project.

This section outlines how the project has organised its dissemination and communication actions to promote the project and the adoption of its outcomes beyond the project’s lifetime, despite the COVID-19 pandemic that affected the dissemination activities of this year.

The year 2020 have seen the cancellation of the exhibitions at MWC 2020 in Barcelona and EuCNC 2020 in Dubrovnik (exhibition proposal submitted). To compensate for the lack of physical events due to COVID-19 restrictions, the project has pushed its online presence by the production of online material and by the organization of and participation in online events, also in collaboration with the other corridors projects.

In the following pages are described the ongoing activities in the last 12 months and the foreseen next steps

It is also then described how 5G-CARMEN will coordinate with other projects of the 5G-PPP programme in order to contribute to and benefit from the related activities at the 5G-PPP programme level.

Furthermore, 5G-CARMEN has identified channels for dissemination of the project results to scientific, technology and industry communities. The specific activities will be tailored to the needs, clients and events that will be used for dissemination. More specifically, the target audience and the dissemination channels will be actively monitored and selected to achieve the highest possible impact in geographic areas relative to the partners own planned activities.

In the Table 1, we identified the target audience of the 5G-CARMEN communication strategy and sets out the communications objectives to maximise the 5G-CARMEN project's exposure. These are the groups that have been targeted through the various dissemination actions that will be detailed in the following sections of this report.

![Table 1 Targets for the communication strategy](image)

<table>
<thead>
<tr>
<th>Target Group</th>
<th>Description</th>
<th>Interest in the project</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - Industry, SMEs and Entrepreneurs</td>
<td>Stakeholders from industry, especially from the automotive and telecom sectors, network operators, SMEs and entrepreneurs, operating in the 5G infrastructure domain.</td>
<td>• Utilisation of project's results in operations and in their R&amp;D activities for new service and product development; • Amplify innovation in 5G infrastructure by blending 5G-CARMEN results with in-house artefacts.</td>
</tr>
<tr>
<td>B - 5G Infrastructure PPP Programme Stakeholders</td>
<td>Participants, project partners and relevant stakeholders active in the 5G Infrastructure PPP</td>
<td>• Identification of common topics; • Synergies and collaborations for results promotion; • Enhancing innovation through results combination; • Co-organisation of events.</td>
</tr>
<tr>
<td>C - Technology Clusters</td>
<td>European initiatives and clusters, research communities, associations, (e.g. NetWorld2020, ETNO, Digital Business Innovation, Digital Agenda, Innovation Union, etc.)</td>
<td>• Inclusion of project's results to collaborative research activities (roadmap, white papers, etc.); • Dissemination of project's results to their members and stakeholders; • Participation in project's events for knowledge exchange.</td>
</tr>
<tr>
<td>D - Researchers and Academics</td>
<td>Objectives Description</td>
<td>A</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------------------------</td>
<td>---</td>
</tr>
<tr>
<td>Researchers and academics working in universities, research centres, R&amp;D departments of industry</td>
<td>• Advancing research post-project; • Training personnel &amp; students; • Porting results to real-life industry cases through the re-use of results.</td>
<td>✓</td>
</tr>
<tr>
<td>E - Policy Makers</td>
<td>Policy-makers at any level like EC Directorates and Units, Ministries and Governments, Regulatory Agencies</td>
<td>• Evaluation of the project's techno-economic and regulatory aspects; • Definition of future research and innovation directions based on project's acquired knowledge;</td>
</tr>
<tr>
<td>F - Standards bodies and for a</td>
<td>Standards bodies and industry fora (3GPP, ETSI, SAE, IETF, NGMN, IEEE, ITU-T, etc.)</td>
<td>• Development of roadmaps for standards development; • Pre-standardisation workshops; • Input for standardisation activities.</td>
</tr>
<tr>
<td>G - General Public</td>
<td>General public and anyone interested in the project</td>
<td>• Understand the value of European research; • Stimulate innovation in unexpected groups of society.</td>
</tr>
</tbody>
</table>

Based on the target groups identified above and their expected interest in the project, the objectives of communication and their relation to the aforementioned target groups are identified in Table 2.

**Table 2 Objectives of the dissemination activities with respect to the target groups**

<table>
<thead>
<tr>
<th>Objectives Description</th>
<th>Target Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide a clear view of the project goals and its results, including the 5G infrastructure PPP perspective.</td>
<td>A</td>
</tr>
<tr>
<td>Create an active community of interested stakeholders and potential users and collect knowledge and requirements to be taken into account by the project's activities.</td>
<td>✓</td>
</tr>
<tr>
<td>Prepare the ground for the exploitation of project’s results towards the industry.</td>
<td>✓</td>
</tr>
<tr>
<td>Create awareness of the project among the full range of stakeholders impacted by the results.</td>
<td>✓</td>
</tr>
<tr>
<td>Establish liaisons with other projects and initiatives for knowledge and innovation transfer.</td>
<td>✓</td>
</tr>
<tr>
<td>Support the dissemination and exploitation of results (including the 5G-PPP programme results) by formulating adapted key messages and prepare adapted communication material.</td>
<td>✓</td>
</tr>
<tr>
<td>Recognition of the results (including the 5G-PPP programme results) among the research communities, standardisation bodies, potential users, policy-maker institutions.</td>
<td>✓</td>
</tr>
</tbody>
</table>
3.2 Dissemination in numbers

Dissemination and communication activities focused on increasing the potential impact of our results. In Table 3, we are presenting the main metrics related to our dissemination and communication activities.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Number</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization of workshops</td>
<td>2</td>
<td>EuCNC 2019, SME Workshop IOTHINGS/5G 2020</td>
</tr>
<tr>
<td>Press releases</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Journal publications</td>
<td>9</td>
<td>6 published, 3 accepted, 1 on IEEE Communications Magazine, 2 on IEEE Vehicular Technology Magazine</td>
</tr>
<tr>
<td>Whitepapers</td>
<td>4</td>
<td>1 joint whitepaper with cross-border projects, 3 contributions to others</td>
</tr>
<tr>
<td>Non-scientific and non-peer reviewed publications (popularised publications)</td>
<td>1</td>
<td>Article on “Strade &amp; Autostrade”</td>
</tr>
<tr>
<td>Exhibition</td>
<td>4</td>
<td>EUCAD2019, EuCNC2019, FWM2019, 5GAA Exhibition</td>
</tr>
<tr>
<td>Flyer</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>2</td>
<td>IEEE WCNC 2019, EuCNC 2019</td>
</tr>
<tr>
<td>Participation to an event other than a conference or a workshop</td>
<td>12</td>
<td>Including MWC2019, IEEE WCNC 2019, ITS World Congress 2019</td>
</tr>
<tr>
<td>Video/Film</td>
<td>5</td>
<td>See <a href="https://5gcarmen.eu/publications/">https://5gcarmen.eu/publications/</a></td>
</tr>
<tr>
<td>Website</td>
<td>1</td>
<td><a href="https://5gcarmen.eu">https://5gcarmen.eu</a></td>
</tr>
<tr>
<td>Social media interactions</td>
<td>1150+</td>
<td>Twitter and LinkedIn</td>
</tr>
</tbody>
</table>

3.3 Conference, Events and Presentations

The list below presents the third-party events that 5G CARMEN took part with a presentation to conferences, workshops, industrial fairs, a paper and/or a demo as well as journal contributions, tutorials, panel participations, project presentations and demos in academia or industrial events.

<table>
<thead>
<tr>
<th>TITLE</th>
<th>VENUE</th>
<th>LOCATION</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leveraging MEC in a 5G System for Enhanced Back Situation Awareness</td>
<td>2020 IEEE 17th Annual Consumer Communications &amp; Networking Conference (CCNC)</td>
<td>Las Vegas, USA</td>
<td>01/10/2020</td>
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</tr>
<tr>
<td>Analyzing the impact of VIM systems over the MEC management and orchestration in vehicular communications</td>
<td>5th International Workshop on Vehicular Networking and Intelligent Transportation Systems</td>
<td>Virtual conference</td>
<td>08/06/2020</td>
</tr>
<tr>
<td>Demo Abstract: Assessing MANO Performance based on VIM Platforms within MEC Context</td>
<td>IEEE INFOCOM 2020 - IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS)</td>
<td>Virtual conference</td>
<td>07/06/2020</td>
</tr>
<tr>
<td>Enabling Computation Offloading for Autonomous and Assisted Driving in 5G</td>
<td>IEEE Globecom 2019</td>
<td>IEEE GlobeCOM</td>
<td>09/12/2019</td>
</tr>
<tr>
<td>Gossip-based monitoring of virtualized resources in 5G networks</td>
<td>The Third International Workshop on Flexible and Agile Networks: 5G and Beyond (FlexNets 2019, IEEE Infocom Workshop)</td>
<td>Paris</td>
<td>29/04/2019</td>
</tr>
<tr>
<td>Addressing Bitrate and Latency Requirements for Connected and Autonomous Vehicles</td>
<td>IEEE Infocom (Demo session)</td>
<td>Paris</td>
<td>29/04/2019</td>
</tr>
<tr>
<td>Participation to panel &quot;Bringing URLLC solutions to market reality&quot;</td>
<td>5G Briefing</td>
<td>Frankfurt</td>
<td>26/03/2019</td>
</tr>
<tr>
<td>Characterization and Performance Evaluation of IEEE 802.11p NICs</td>
<td>ACM MobiHoc 2019</td>
<td>Catania, Italy</td>
<td>07/02/2019</td>
</tr>
<tr>
<td>Panelist</td>
<td>Network Analytics and Automation</td>
<td>IEEE CSCN 2019</td>
<td>Granada, Spain</td>
</tr>
<tr>
<td>Maturing E2E network and cloud slicing: Where are the frontiers?</td>
<td>IEEE WCNC 2019</td>
<td>Marrakech, Morocco</td>
<td>17/04/2019</td>
</tr>
<tr>
<td>Demo</td>
<td>Open source platform for IEEE 802.11p NICs evaluation</td>
<td>IEEE WoWMoM 2019</td>
<td>Washington, USA</td>
</tr>
<tr>
<td>Open source testbed for vehicular communication</td>
<td>ACM MobiHoc 2019</td>
<td>Catania, Italy</td>
<td>07/02/2019</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exhibition/demo/booth</th>
<th>Booth with dissemination material (leaflets and notebooks distributed to attendees), UPV interactive demo, institutional video.</th>
<th>5GAA Exhibition February 2020</th>
<th>Brussels</th>
<th>06/02/2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Booth with dissemination material (leaflets, pens, and stickers distributed to attendees), two demos (UPV interactive simulator and Drivesec smart Bracelet), institutional video.</td>
<td>Future Mobility Expoforum</td>
<td>Torino, Italy</td>
<td>18/11/2019</td>
<td></td>
</tr>
<tr>
<td>Booth with dissemination material (leaflets, pens, and stickers distributed to attendees), two demos (UPV interactive simulator and Drivesec smart Bracelet), institutional video.</td>
<td>EuCNC 2019</td>
<td>Valencia, Spain</td>
<td>18/06/2019</td>
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</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Industrial faire</th>
<th>Participation to the 5G Corridors booth shared with 5G-MOBIX and 5G CroCo</th>
<th>EUCAD 2019</th>
<th>Brussels</th>
<th>02/04/2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence at the 5G-PPP booth with leaflets material (about 500 leaflets, pens, and stickers have been distributed to MWC attendees)</td>
<td>Mobile World Congress Barcelona 2020</td>
<td>Barcelona</td>
<td>24/02/2019</td>
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### Journal contribution

<table>
<thead>
<tr>
<th>Title</th>
<th>Journal/Academic Publication</th>
<th>Volume/Issue/Publication Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharing Distributed and Heterogeneous Resources toward End-to-End 5G Networks: A Comprehensive Survey and a Taxonomy</td>
<td>IEEE Communications Surveys &amp; Tutorials</td>
<td>IEEE 19/06/2020</td>
</tr>
<tr>
<td>Network Service and Resource Orchestration: A Feature and Performance Analysis within the MEC-Enhanced Vehicular Network Context</td>
<td>MDPI - Sensors Special Issue Sensor and Communication Systems Enabling Autonomous Vehicles</td>
<td>MDPI 31/05/2020</td>
</tr>
<tr>
<td>Predictive Voice-Over-Internet Protocol Fallback Over Vehicular Channels: Employing Artificial Intelligence at the Edge of 5G Networks</td>
<td>IEEE Vehicular Technology Magazine</td>
<td>IEEE 02/04/2020</td>
</tr>
<tr>
<td>Benchmarking open source NFV MANO systems: OSM and ONAP</td>
<td>Elsevier Computer Communications</td>
<td>ECC 07/03/2020</td>
</tr>
<tr>
<td>MEC support for Network Slicing: Status and Limitations from a Standardization Viewpoint</td>
<td>IEEE Communications Standards Magazine</td>
<td>IEEE 06/01/2020</td>
</tr>
<tr>
<td>MANOaaS: A Multi-tenant NFV MANO for 5G Network Slices</td>
<td>IEEE Communications Magazine</td>
<td>IEEE 01/05/2019</td>
</tr>
<tr>
<td>A Future-proof Architecture for Management and Orchestration of Multi-domain NextGen Networks</td>
<td>IEEE Access</td>
<td>IEEE Access 07/01/2019</td>
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</table>

### Presentation

<table>
<thead>
<tr>
<th>Title</th>
<th>Event/Session/Location</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellular networks to enable V2X</td>
<td>V2X - LE OPPORTUNITA NELLE SFIDE DEL FUTURO. ANALISI E TESTIMONIANZE PER SCOPRIRE NUOVI BUSINESS</td>
<td>Webinar 16/07/2020</td>
</tr>
<tr>
<td>Reply LS to 5GAA’s ‘LS on technical solutions for inter-MNO operation in V2X scenarios’ (S-200070)</td>
<td>5GAA electronic meeting #14 Online Standard Meeting</td>
<td>11/05/2020</td>
</tr>
<tr>
<td>Presentation titled &quot;5G-CARMEN: 5G for Connected and Automated Road Mobility in the European union” during the SMART ROAD &amp; SMART TRAFFIC session</td>
<td>Future Mobility Expoforum Torino, Italy</td>
<td>18/11/2019</td>
</tr>
<tr>
<td>The industrial Internet of Things: Self-Driving Vehicles</td>
<td>The Way towards the Internet of Things: Open Standards vs Silos</td>
<td>Fiesole, Italy</td>
</tr>
<tr>
<td>SDxCentral video series on NFV</td>
<td>SDxCentral</td>
<td>SDxCentral</td>
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### Standard Contribution

<table>
<thead>
<tr>
<th>Title</th>
<th>Contribution Type/Location</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submitted 06 technical contributions to the work-item EVE017 &quot;Report on the support of real-time/ultra-low latency aspects in NFV related to service and network handling Low latency MANO&quot;</td>
<td>ETSI NFV#28 Fukuoka, Japan</td>
<td>12/03/2019</td>
</tr>
<tr>
<td>Data plane policy management for MEC relocation</td>
<td>ETSI MEC#145-Tech Online Standard Meeting</td>
<td>10/01/2019</td>
</tr>
</tbody>
</table>
## 3.4 Whitepapers

5G CARMEN has also published a white paper that was presented in a 5G PPP webinar on the 6th of November 2020. The white paper was entitled "5G Trials for Cooperative, Connected and Automated Mobility along European 5G Cross-Border Corridors".

Moreover, 5G CARMEN also contributed to the other 3 following white papers:

- White paper on Verticals “Empowering Verticals industries through 5G Networks - Current Status and Future Trends”
- White Paper on “Edge Computing for 5G Networks”
- White Paper from World Bank on “5G enabled Transport”

## 3.5 Newsletters

Three editions of the newsletters have been distributed to stakeholders through 5G CARMEN’s mailing lists as well as made available on the project website. So far, 350+ stakeholders have subscribed to receive 5G CARMEN’s newsletters. All issues of the newsletter so far released are available on the 5G-CARMEN website where they will be accessible as long as the website is online.

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Subscription to the newsletter is possible through the web portal to all visitors.

![Capture of the third 5G-CARMEN newsletter](image)

3.6 Implementation of the project website and social media channels

The 5G CARMEN project website has been heavily restructured, providing more information on the project scope, the use cases that will be tested, including all the public deliverables and publications that have been provided so far, links to the video demos produced by the project, an area to host open source code and open data that will be generated in the project, and in general increasing the available material to provide a more detailed view of the project results so far.
Social media channels have been widely used to always widen the reach of the audience and to facilitate an interactive dialogue with relevant stakeholders.

Altogether, 5G-CARMEN has extensively promoted its results and activities to more than 1,000 users, 500+ Twitter followers, 230+ Linkedin followers (including subscribers to social media channels, mailing lists and website visitors).

Moreover, social media has been chosen to promote the SME’s call for ideas, webinars and online workshops

Figure 2 Captures of the 5G-CARMEN website https://5gcarmen.eu
3.7 Videos

The YouTube Channel (https://youtube.com/playlist?list=PLY3KsH4giNpSENkDBAtyoUirk1xpacw) currently has the following videos:

- **5G CARMEN | 5G for Connected and Automated Road Mobility in the European Union**

  This is the institutional video for the project: it provides key facts and figures about the Consortium, the goal of the project, and it describes the four main use cases that were originally planned to be tested in the Bologna-Munich corridor.

- **5G CARMEN | 5G for Connected and Automated Road Mobility in the European Union (short version)**

  This is the first video that was produced for the project. It provides a very short overview of the project goals and context.

- **5G-CARMEN - Demonstration of Green Driving use case**

  This video was prepared to be disseminated through the project social channels during the EuCNC 2020, in order to show one of the demos that would have been presented at the exposition, if it had not been cancelled. It describes the hardware components and the service platform that have been developed to support the green driving use case.
• **5G-BSA-ID. A cryptoband for secure identity management in emergency vehicles interventions**

In addition, this video shows a concept that was originally prepared to be presented at EuCNC 2020. It presents the cryptoband solution that has been developed to secure the identity of the driver of an emergency vehicle in the context of the Back Situation Awareness use case.

• **5G-CARMEN Visualization Tool**

This video presents the simulation platform developed to showcase the four original use cases that were planned for the project. It includes a 3D reconstruction of the Brenner Pass, and for each use case shows how the cars and the network interacts to provide the expected service. The simulator is not only a mere 3D representation of the use cases, but it includes a propagation engine that allows to evaluate the intensity of the 5G radio signal, based on the positions and characteristics of the 5G Base Stations provided by network operators, thus providing insight on the quality of the connection to the network.

For the green driving use case, it is also possible to drive the simulated car with a game controller, making the simulator interactive and particularly effective for demo purposes in live events.

Some additional videos are also available on YouTube, which shows presentations done during some of the events where 5G-CARMEN participated.

• **5G-CARMEN @ EuCNC 2019 - Booth #32: EU 5G Cross Border Corridor Projects**
  
  https://www.youtube.com/watch?v=BtjRkRXnXS0
3.8 Dissemination activities in the frame of 5G-PPP

The three cross-border projects, that is 5G-CARMEN, 5G-CroCo and 5G-MOBIX, worked together in the preparation of the white paper entitled “5G Trials for Cooperative, Connected and Automated Mobility along
European 5G Cross-Border Corridors - Challenges and Opportunities”3. This white paper is a common effort of those projects and presents preliminary results, based on currently available technological enablers that have the capacity to mitigate and/or resolve these challenges.

The white paper first introduces use cases, trial sites and particularities of each of the three corridor projects. Then, the paper focuses on identifying and elaborating on the main concerns and challenges that arise from attempting to perform advanced CCAM use cases at the borders, from a technological, administrative, security and legal perspective. It is also established that the collaboration of all CCAM stakeholders at the borders is essential for a consistent ecosystem in order to overcome the obstacles behind topics such as protocol interoperability, communication security, spectrum harmonization and data management. Finally, all three projects emphasize the fact, that besides the technical challenges, there is a strong need for more EU steering (beyond systematic and purposeful funding) in terms of regulatory, security/privacy and stakeholder integration, since private and public projects face ambiguity, uncertainty and/or considerable non-technical efforts when attempting to deploy such services at/across the border - which in turn has an adverse effect on potential business motives, further/faster rollouts and after all the European economy.

This white paper was presented in a 5G PPP webinar that was organized on November the 6th. More than 200 people connected to the event, it was well received, and feedback was highly positive.

3.9 Next Steps

For the whole duration of the project, the strategic perspective of the 5G CARMEN dissemination and communication effort will continue serve the overall success of the 5G CARMEN project and maximizing the dissemination and communication impact within the communities of target stakeholders.

In Table 4, we outline the next planned events to ensure the continued effective dissemination of the project’s activities.

<table>
<thead>
<tr>
<th>#</th>
<th>Name of Event</th>
<th>Location</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Future Mobility Forum 2020</td>
<td>Turin, Italy</td>
<td>April-May 2021</td>
</tr>
<tr>
<td>2</td>
<td>Vehicle and Transportation meeting (VTM)</td>
<td>Turin, Italy</td>
<td>June 2021</td>
</tr>
<tr>
<td>3</td>
<td>EuCNC 2021</td>
<td>Porto, Portugal</td>
<td>8-11 June 2021</td>
</tr>
<tr>
<td>4</td>
<td>MWC#21</td>
<td>Barcelona</td>
<td>June-July 2021</td>
</tr>
<tr>
<td>5</td>
<td>ITS WORLD CONGRESS 2021</td>
<td>Hamburg, Germany</td>
<td>11-15 October 2021</td>
</tr>
</tbody>
</table>

The project will continue monitoring to find further opportunities to disseminate project results and will maintain the main communication channels such as the web portal and social media, assessing potential further events for active participation.

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3 https://5g-ppp.eu/white-paper-5g-trials-for-cooperative-connected-and-automated-mobility-ccam-along-european-cross-border-corridors/
4 Assessment of impact on SMEs

The activities in the Work Package 7 are complemented by the management of the SMEs involvement in the interactions with the project partners.

The overall goal of 5G-CARMEN is to accelerate the European ICT ecosystem by creating and supporting new businesses by unlocking the commercial potential of high-value solutions. SMEs are important stakeholders in the overall development chain towards future communication networks.

Small and medium enterprises have long been accepted as the engines of economic growth and development. The impact of SMEs in the European economy is very crucial towards the construction of a society that is free of poverty. The reason is that they not only provide ample job opportunities to the different strata of the society but also ensure the flow of money across the various levels of society.

SMEs also play a very critical role in 5G-related business by contributing to the employment scenario along with the input and output. There are certain points to be understood here. Predominantly, most of the formal jobs that are available in developing ICT segments of the European markets are created by the SMEs.

In particular, the development of innovative applications for the support of vertical sectors requires SME involvement.

This is why they are a priority in the planning of the experiments in the 5G_CARMEN corridor. High-tech SMEs will be early adopters of 5G technology and will build the future market of 5G mobility services.

SMEs have a great added value in providing innovative concepts and solutions that could be used in various places of the 5G value chain.

These arguments led us to include the activities planned by 5G-CARMEN (in Task 7.2) that enable us to identify the right stakeholders in order to reach the most relevant SMEs.

This activity is a major contribution to achieve the impact challenges of the project.

Moreover, the participation of additional SMEs selected, as described in the next paragraphs, are continuously monitored and the lessons learnt will provide inputs for the overall analysis and for future similar initiatives. Specific attention is given to IPR issues.

5G-CARMEN CALL for Ideas in the YouNoodle platform

Business-fit between SMEs and 5G-CARMEN Consortium Members are triggered through the “Call for Ideas” concept, in which the applying SMEs are be able to propose their Product/Service concept, using the 5G platform made available by 5G-CARMEN. Idea proposals are managed with periodic application campaigns with the aim to collect and evaluate best ideas to be presented in specific event to the 5G PPP community and to 5G-CARMEN project members.

SME involvement is primarily focused to interact with SMEs and Startups who already have a working solution, and which should see 5G-CARMEN more as a market opportunity and are really interested in:

- develop a competitive advantage on 5G technology applied to assisted driving
- concrete opportunity to meet new potential customers
- increase market visibility in 5G field
- opportunity to promote their business.

Ideas and concept application are managed via the YouNoodle, a platform supporting “a community with over 15,000 subscribers where makers, entrepreneurs and innovators meet, interact and collaborate to build growth connections and win equity free funding to catalyse their growth”, launching specific calls for proposal. In each event Call for Ideas are proposed to collect application proposals of best 5G products and solutions. Ideas will be evaluated by partners and selected SMEs are invited to present their idea in events dedicated to SMEs.

This platform can be reached at: https://5gcarmen.eu/news/
Eligibility Criteria

All applicants have to abide to all the general requirements described below in order to be considered eligible for the SME Involvement. Call for Ideas must respond to the following criteria:

- be an active legal entity located in eligible Countries
- be considered as an SME according to the Commission Recommendation 2003/361/EC.

English is the official language for the “5G-CARMEN Call for Ideas”.

The information that are collected through this platform are described in Annex 1
4.1 Events for SMEs organized by 5G-CARMEN

We promoted the project results in public programmes for SME support, especially through 2 specific workshops dedicated to SMEs.

IOTHINGS 2020 Event

To maximise focus and participation of 5G-CARMEN SME target audience, the 5G-CARMEN - SME Involvement program event was hosted in a major program focused on Technology and Innovation, within the framework of IOTHINGS/5G 2020 (www.iothingsmilan.com) with the vision to be “the place where to experience new ways of working, of doing research, of living and of being together”.

In a more general view, IOTHINGS events target several vertical topics related to the Internet of Things and the 5G technology, including CCAM platforms.

Innovability, the organiser of the IOTHINGS events, is known to be, since 2000, the reference point for all the players in the digital “disruptive” technologies field - such as M2M / Internet of Things, Robotics, Wearable and Wireless in the organization of trade shows, events, conventions and workshops, which offer occasion for debate, commercial exchange and networking among companies, institutions and market stakeholders.

Innovability and PIIU have particularly developed a deep and continuous knowledge of the M2M/IoT market, both in Italy and in the international arena, which allows offering marketing services, research and consultancy also in collaboration with prestigious scientific partners and associations.

Specific 5G-CARMEN Workshop for external SMES involvement

The slot dedicated to the 5G-CARMEN - SME Involvement program features the “5G” conference track, covering the technology deployment as well as the governance and services topics. Organization of the parallel session was held by PIIU and provided a dedicated area, with reserved access to SME representatives invited to the event.

The planned agenda of the event included the following presentations:

- Overall presentation of 5G-CARMEN and 5G PPP initiative
- Description of 5G-CARMEN use cases
- How to access 5G-CARMEN results
- Funding tools in 5G domain

During this Conference TIM, CRF and PIIU presented opportunities and services provided by 5G-CARMEN to Innovative SMEs, high-tech Startups and other interested SMEs through a webinar on the 30th of October 2020, under the name of “5G-CARMEN - SME Involvement program”.

“5G-CARMEN SME Involvement” program and agenda of the event has been promoted by PIIU and by Innovability:

- on the website (http://www.iothingsmilan.com/)
- in the printed program
- in the newsletter campaign
- in the social media news
- with a dedicated e-mail blast to Innovability’s SME contact database

Additionally, the event launch has been promoted during Italia 5G IOTThings Rome event with a specific 15 minutes’ presentation. Additional promotion actions were managed by 5G-CARMEN dissemination team via:

- LinkedIn and twitter posts
- 5G Vertical Community on Fundingbox, managed by the partner PIIU
The first Workshop held on the 30th of October 2020 had 65 expert attendees, which can be considered a big success of this kind of events.
The event has been registered and available at [https://www.iotthingsmag.com/iotthings-replay-italia-5g/](https://www.iotthingsmag.com/iotthings-replay-italia-5g/).

All proceeding of the Workshop are available at [https://iotthings.world/iotthings-2020-proceedings/#5gcarmen](https://iotthings.world/iotthings-2020-proceedings/#5gcarmen).

**AUTOTEQ 2020 Event**

A second workshop has been performed during the AUTOTEQ Conference on the 2\textsuperscript{nd} of December.

During this event, organised by PIU, SMEs got the chance to discuss potential use cases and future collaborations in direct contact with key European industry players after the event.
Target audience included Start-ups and SMEs from all vertical sectors willing to learn about 5G-CARMEN functionalities and proposing ideas for innovative applications or services that could use the 5G-CARMEN results.

The AUTOTEQ 5G-CARMEN workshop represented a valuable opportunity for SMEs and startups to get to know 5G-CARMEN and to understand how to profit from testing opportunities as well as leverage 5G-CARMEN’s physical resources and technical materials.

The two-hour event showed how to get exposure, virtually meet and get essential information to develop potential collaborations with some of the major industrial players in the 5G Ecosystem.

SMEs got the chance to get in direct contact with 5G-CARMEN managers after the event and discuss about technical aspects, requirements and potential use cases to be developed through the 5G-CARMEN platform.

First field test on Autonomous Driving using 5G

December 2, 2020 - 11:30 am - 1:00 pm

PROGRAM

- 5G-CARMEN as one of the leading European initiatives of autonomous driving
  Roberto Fantini, TIM

- Video about the initiative

- Evolution of 5G technology for autonomous driving and new International Standards
  Roberto Fantini, TIM

- First Autonomous Driving field test
  Gianfranco Burzio, Drivesec

- Guide about how SMEs may benefit from next Programs funded by the European Commission
  Maurizio Cecchi, Istituto PIIU

4.2 Contribution to the SME Working Group of NetWorld 2020

5G CARMEN partners contributed to the NetWorld2020 SME Working Group, which is the voice of the NetWorld2020 SME community. It has been officially endorsed by the NetWorld2020 Steering Board with the following mandate:
Specific contributions by 5G-CARMEN regard the Call for Ideas previously described. The IOTHINGS and the AUTOTEQ events (see above) have been promoted by this community.

Since its inception, SME Working Group activities have been mostly focusing on promoting the skills and expertise of SMEs in the telecommunications domain, especially towards larger companies and research organisations, and on supporting the engagement of SMEs in collaborative projects and cooperation with those players, via networking and exchange of information amongst SME representatives.

The main activities of the SME WG include: quarterly telephone conferences plus ad-hoc telcos whenever required; regular updates of the “Find your SME” web page, including the SME brochure and the SME success stories; interaction amongst SMEs; participation in events e.g. with dedicated SME-related presentations; and other SME promotional activities e.g. report to NetWorld2020 Steering Board and the 5G Initiative Steering Board meetings. The SME WG also has a strong link to the 5G Infrastructure Association, with two of its representatives in the Board of the Association.

The number of members in the SME Working Group has been regularly increasing since its inception. By end of October 2020, there were 193 members, including 163 SMEs.
5 Impact on standardization and industrial associations

As detailed in Deliverable D7.2 [41], one of the key objectives of 5G-CARMEN is to ensure that the fundamental experience built in the project can be exploited to drive the development of relevant standards, and to enrich the discussion ongoing inside the main industry associations related to connected and automated driving.

To reach the maximum impact on standardisation and relevant bodies 5G-CARMEN has defined a four-step strategy (see D7.2 [41] for details):

- Observation of available standards.
- Deriving required standards from 5G-CARMEN use cases.
- Identification of gaps.
- Recommendation to standardisation organisations.

The outcome of the first step was also presented in Deliverable D7.2, where an overview of the main bodies dealing with connected and autonomous driving was presented, highlighting the main activities relevant for 5G-CARMEN carried out in these entities.

As activities have progressed in the project, the subsequent steps were also triggered: the most relevant bodies have been identified and some gaps have been found that led to contributions and discussions inside the relevant working groups of these bodies.

Figure 8 shows the activities that are planned as a result of the work carried out on the different work packages.

Table 5 summarizes the main contributions that have been already achieved from the project.

Table 5 Main contributions to Standards and relevant organizations
<table>
<thead>
<tr>
<th>SDO</th>
<th>Topic</th>
<th>Working Group / Tracks</th>
<th>Impact achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>5GAA</td>
<td>V2X Network Reselection Acceleration</td>
<td>V2X Network Reselection Improvements (NRI)</td>
<td>Liaison Statement (LS) on technical solutions for inter-MNO operation in V2X scenarios (S-200070)</td>
</tr>
<tr>
<td>ETSI</td>
<td>Support of real-time/ultra-low latency aspects in NFV related to service and network handling Low latency MANO</td>
<td>NFV Evolution and Ecosystem (NFV-EVE)</td>
<td>Autonomous management of tenant resources in ETSI NFV-EVE 018. Contributions to the now published ETSI NFV-EVE 017</td>
</tr>
<tr>
<td>ETSI</td>
<td>Data plane policy management for MEC relocation</td>
<td>MEC ISG</td>
<td>Contribution to ETSI MEC 031 about MEC-5G integration</td>
</tr>
<tr>
<td>IETF</td>
<td>Control-/Data-Plane for N6 traffic steering -- Applicability to MEC for Automotive Use Cases</td>
<td>Distributed mobility management</td>
<td>5G mobile data plane optimization</td>
</tr>
<tr>
<td>ETSI</td>
<td>V2X sidelink for direct communication</td>
<td>ETSI TC ITS</td>
<td>Support for the adaption of the ITS System Profile for LTE-V2X direct communication specification ETSI TS 103 723</td>
</tr>
</tbody>
</table>

As shown in Table 5, 5G-CARMEN has created an important link towards 5GAA activities. 5GAA is a global, cross-industry organization of companies from the automotive, technology, and telecommunications industries, working together to develop end-to-end solutions for future mobility and transportation services. 5GAA supports the idea that 5G will be the ultimate platform to enable C-ITS and the provision of V2X: in fact, 5G will be able to better carry mission-critical communications for safer driving and further support enhanced V2X communications and connected mobility solutions.

Created in September 2016, 5GAA has a large member base, including 8 founding members: AUDI AG, BMW Group, Daimler AG, Ericsson, Huawei, Intel, Nokia, and Qualcomm Incorporated. Since its inception, 5GAA has rapidly expanded to include key players with a global footprint in the automotive, technology and telecommunications industries. At the time of writing this document, more than 130 companies have joined 5GAA, including automotive manufacturers, tier-1 suppliers, chipset/communication system providers, mobile operators and infrastructure vendors. Diverse both in terms of geography and expertise, 5GAA’s members are committed to helping define and develop the next generation of connected mobility and automated vehicle solutions. Thanks to the activities of its partners that are also members of 5GAA, 5G-CARMEN received the “LS on technical solutions for inter-MNO operation in V2X scenarios (S-200070)” sent by 5GAA, which identified several V2X use cases having stringent latency requirements. With the objective of ensuring such use cases’ latency requirements to be effectively met also in case of inter Mobile Network Operator (inter-MNO) scenarios - both national and international (e.g. cross-borders) - 5GAA started a Cross Working Group Work Item (X-WG WI) on V2X Network Reselection Improvements (NRI).
This X-WG WI is evaluating benefits and drawbacks of technical solutions as per currently available 3GPP standards specifications (refer to TS 23.401 for the 4G system and TS 23.501 for the 5G system) being able to minimize the loss of connectivity, communication and service provisioning towards V2X devices when operating in inter-MNO scenarios. Since 5GAA was made aware that similar technical discussions are also ongoing in the context of EU-funded 5G-PPP Phase 3 projects - 5GCroCo, 5G-CARMEN and 5G-MOBIX - for European cross-border corridors, in order to find synergies and exploit the technical expertise of partners in both 5GAA and the above-mentioned projects, an exchange of information related to the technical solution(s) under discussion within these projects was envisaged as a valuable input for the NRI findings. To be specific, the description of the technical solution(s) implemented (or being implemented) with related technical hurdles, along with performed measurements (if available), was considered of high interest for 5GAA NRI activities. Moreover, 5GAA was especially interested in becoming aware of the organizational implications encountered during the Projects’ activities that made co-operation between MNOs problematic or cumbersome.

The Reply LS sent by 5G-CARMEN to 5GAA addressed the above requests from 5GAA by reporting, at the beginning of the presentation, a brief overview of the use cases taken into account within the 5G-CARMEN Consortium. This was then followed by an insight of the technical solutions allowing for cross-border scenarios to be properly addressed: the main solution considered in 5G-CARMEN for the case of very stringent latency requirements of V2X use cases, as discussed in more details in Deliverable D2.3 of the project [43], is based on a solution similar to the Release with Redirect (as foreseen by 5GAA NRI) with the exception of not deploying the S10 interface between MMEs of the involved operators.

As this topic strongly involves MNOs and their mutual relations, activity is currently ongoing to move the discussion also towards GSMA, the industry association that represents the interests of mobile operators worldwide, unifying more than 750 operators with almost 400 companies in the broader mobile ecosystem.

Finally, the Consortium also provided to 5GAA a brief description of an alternative solution - which was left for further study - based on the permanent roaming for each vehicle crossing the border (meaning that the vehicle is always in roaming, regardless of the serving PLMN) and the use of at least two transmission (TX) chains on the vehicle side.

Collaboration with 5GAA is expected to continue during the whole project life span, as 5GAA CTO is also a member of 5G-CARMEN Advisory Board, and he has shown interest on data and results that will be generated from Work Package 5 during test execution in the project pilots.

Another major impact to SDOs has been achieved thanks to the work carried out in WP4.

5G-CARMEN has proposed a CCAM architecture for the management and orchestration of specific 5G CARMEN use cases with different service requirements, with special emphasis on mission critical and low-latency service instances that require support of the 5G Infrastructure.

As a result of this work, several contributions have been made to ETSI NFV. The ETSI ISG NFV, founded in November 2012, is mandated with the definition and development of specifications for the NFV technology. It has published over 100 specifications covering Release 2 and Release 3. Work is now progressing to develop Release 4. The work in ETSI ISG NFV the technical work is undertaken in different working groups (WG) namely NFV-IFA WG, NFV-REL WG, NFV-SOL WG, NFV-TST WG, NFV-SEC WG and NFV-EVE WG.

From the perspective of 5G-CARMEN, technical contributions were presented in the NFV-EVE WG.

The NFV-EVE, standing for “NFV Evolution and Ecosystem”, is mandated with the studies to address new use cases, interworking with other technologies, etc. The Terms of Reference (ToR) for the NFV-EVE WG is available at [44], but one of the main responsibilities of NFV-EVE working group is to develop feasibility studies and requirements in relation to:

- new NFV use cases and associated technical features, and
- new technologies for NFV.

In this context, 5G-CARMEN activities strongly contributed to ETSI GR NFV-EVE 017 work-item titled “Report on the support of real-time/ultra-low latency aspects in NFV related to service and network handling”. This is an informative document mandating the analysis of the impact on management and orchestration of
Network Service instance supporting low latency services from the perspective of the NFV-MANO architectural framework. In this document, the following 5G CARMEN relevant use cases have been proposed and analyzed:

1. Re-routing a low latency network service due to, for example, a network element failing, the topology change inside the NFVI, congestion event.
2. Mobility for a low latency network service, where the clients (e.g. vehicles) consuming the service changes their respective service access point.
3. Supporting low latency application function overlaying the Network Service within the infrastructure, where the application function and/or the supporting network service may impact the low-latency guarantees.

Based on the analysis of the above use cases, potential requirements were derived and appropriate recommendations have been made. These recommendations have also been taken into consideration in the design of the CCAM system platform. The ETSI GR NFV-EVE 017 document was approved and published in summer 2020.

Activity in WP4 also triggered discussion about Control-/Data-Plane for N6 traffic steering, and its applicability to MEC for Automotive Use Cases. This has been originally discussed in IETF in the Distributed mobility management Working Group, and it was then further discussed in the ETSI MEC ISG, where it contributed to the ETSI MEC 031 Group Report about MEC-5G integration. In particular, the UPF selection process goes under the control of the 5G System's Session Management Function (SMF's N4 reference point to UPF); control of traffic treatment between a UPF and an Application Service (AS), which is denoted as N6 reference point, can be deployment specific. In this context, the MEC system can represent a Data Network (DN) for the 5G System, hence the SMF can select a suitable UPF according to the MEC system that holds the application server (AS) being relevant to the mobile client. In addition, a set of UPF instances might be available for load balancing in the same location of the MEC hosts, which provide the ASs.

As a general activity to create a common ground to use V2X sidelink for direct communication between vehicles (V2V), as well as between vehicles and infrastructure (V2I), employing the PC5 interface in mode 4 according to the access layer specification ETSI EN 303 613, different new specifications have been analysed, including the LTE-V2X specifications for media-dependent geonetworking ETSI TS 102 636-4-3 and congestion control ETSI TS 103 547. Moreover, devices could be prepared to pass the certification of the Radio Equipment Directive 2014/53/EU by complying with the RF requirements in the harmonized standard ETSI EN 302 571. In this context, feedback was also given to ETSI TC ITS, which helped to adapt the ITS System Profile for LTE-V2X direct communication specification ETSI TS 103 723. By following the LTE-V2X System Profile, it can now be ensured that current and future deployment activities use the same base configuration guidelines when employing ITS use cases with the PC5 sidelink.

Besides these first contributions, new ones are expected in the near future, as the project moves toward the execution of on-field test. A new exchange with 5GAA to share the first results on Precise Positioning generated within WP3 activities will start in the first half of 2021. As the on-field testing will ramp up new finding and results will be generated, that will help steering the activities and discussions inside these SDOs and Organizations, giving new insights about what is actually achievable nowadays on-field and what should be improved to meet the most challenging requirements of advanced CCAM services. Besides sharing technical results generated in WP5 with different SDOs (a first contact with 5GAA has been already set up, as previously mentioned), also the Business modelling and SDA deployment plans being studied in WP6 are good candidate to be exploited towards stakeholders in different associations, as for example GSMA and 5G PPP.
6 Collaboration with other corridors and 5G-PPP projects

This section discusses the collaboration of the 5G-CARMEN project with other 5G-PPP projects, mainly phase 2 and corridors. Projects may have a one to one relationship in sharing some research results, use cases and developing joint testbeds. Some projects may provide joint contributions to working groups in a particular area such as a joint technical feature or a common view on spectrum use. This section describes the collaboration of 5G-CARMEN with other 5G-PPP initiatives projects in the following areas:

- Project collaboration in research results.
- Project collaboration in test beds and demonstration developments.
- Joint dissemination/communication events.

6.1 Other 5G-PPP initiatives

The 5G Public Private Partnership (5G-PPP) is an initiative to secure Europe’s leadership in 5G applications where there is a potential for creating new markets such as smart cities, e-health, intelligent transport, education or entertainment & media. After two successful initial phases, Phase 3 was divided into 4 parts, ranging from infrastructure, automotive (also known as corridors), other verticals and complimentary. Three projects were selected for infrastructure 5G-EVE, 5G-VINNI, and 5Genesis, and three other for corridors: 5G-CARMEN, 5G-MOBIX and 5GCroCo.

A key part of the 5G PPP working structure is a set of cross projects and cross working groups. The working groups are the means to establish and publish program level opinions, as well as positions on issues that impact all of the projects and/or can be the basis for liaison or interaction with external bodies such as other Global regions or standards bodies.

The 5G PPP Working Groups (WGs) can be categorised as ‘Technical Work Groups’ or ‘Policy-Oriented Work Groups’ depending on the ambition of the group and the impact expected from their results. Technical Work Groups tend to be organised by 5G PPP projects themselves to facilitate inter-project cooperation while Policy-oriented Work Groups are mostly initiated by the 5G Infrastructure Association to capture the specific European 5G Industry position on strategic issues such as Spectrum, Vision & Societal Challenges, Pre-standarization preparations, and European 5G Trials and demonstrations. The relation between WGs in the 5G 5G-PPP ecosystem is depicted in Figure 9.

Phase 2 and Phase 3 projects are encouraged by the 5G initiative Steering Board to maximize the collaboration to develop a homogeneous solution for 5G. The projects are also expected to interact with the working groups whenever possible to communicate the results and how they will be used across all the working groups as part of the whole 5G initiative.

5G-CARMEN is one of the Phase 3 projects and focuses on the support of 5G technologies to cross-border mobility management of connected and autonomous cars. The 5G-CARMEN Consortium is comprised of multiple partners with strong expertise in 5G-PPP projects and a long track record of successful collaborations with key industry players. Many of the 5G-CARMEN partners are actively involved in 5G-PPP Phase 2 and Phase 3 projects and will act as liaisons between 5G-CARMEN and these projects, to ensure a smooth flow of information among the projects, in addition to the successful integration of relevant outputs from other projects, to the 5G-CARMEN work packages. This knowledge transfer, from the ongoing or recently finished 5G-PPP projects, is the key to ensure a cutting-edge autonomous driving system, with the use of the most recent 5G technological developments and a safeguard of the smooth transition of automotive communications to the 5G era.
6.2 Interaction with 5G-PPP WGs

In the first months of the 5G-CARMEN project, the WP7 identified the main WGs to liaise with the project and nominated people to take the liaison role with them. Next table highlights the revision of the WG activity and the role of 5G-CARMEN on them.

Table 6 Revision of WG with 5G-CARMEN interaction

<table>
<thead>
<tr>
<th>WG</th>
<th>Description</th>
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<tbody>
<tr>
<td>Software Networks WG</td>
<td>The purpose of this WG is to analyse and address unification and applicability of key research topics related to Software Networking including software defined concepts, infrastructures, systems and components for Wire and Wireless Networks, including Networked Clouds, IoT and Services, e.g. Software Defined Networks (SDN) and Network Function Virtualization (NFV) as developed and promoted by the 5G PPP projects. 5G-CARMEN activity in this group is mainly oriented to the definition of open source MANO solutions for orchestration between MEC centers.</td>
</tr>
<tr>
<td>Bessem Sayadi, Nokia</td>
<td></td>
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<tr>
<td>Cristian Patachia, Orange</td>
<td></td>
</tr>
<tr>
<td>Trials WG</td>
<td>The Trials Working Group was launched by 5G Infrastructure Association in September 2016 after the publication of the 5G Manifesto of industry in Europe and in the context of the 5G Action Plan of the EU Commission. According to the 5G Manifesto industry in Europe developed by beginning of 2017 a European trial roadmap on technology trials and Pan-European trials with vertical sector use cases. 5G Infrastructure Association is hosting this Working Group in order to provide a neutral place for such discussions. The objectives of the Working Group are as follows:</td>
</tr>
</tbody>
</table>
To develop the European Trial Roadmap based on the 5G Manifesto.

To facilitate the involvement of verticals in the trial’s roadmap.

To discuss and define business principles underpinning the economic viability of trials.

To consider and coordinate the activity on trials with other relevant initiatives at international level to investigate and propose how to link trials to Horizon 2020 5G PPP Phase 3 in order to get funding for parts of the overall trial roadmap.

Cooperation in the Working Group is by e-Mail, conference calls and where needed by physical meetings.

Expected deliverables were:

- The European trial roadmap.
- An intermediate deliverable on business viability of trials and how to leverage public funds.

The 5G Pan-EU Trials Roadmap Version 4.0 was released in November 2018. Expected sources not found.

5G-CARMEN is participant in this WG with the definition of automotive use cases and trials and is reporting periodically about the main advances in the Munich-Bologna trial.

<table>
<thead>
<tr>
<th>5G Automotive WG</th>
<th>The 5G Automotive Working Group focuses on connected and automated mobility and serves as a common platform between 5G-PPP projects developing V2X and Vehicle-as-Infrastructure concepts and components. The aim is to consider a wide range of automotive related topics, such as use cases and KPIs, business aspects, spectrum usage, infrastructure capabilities, security and safety. 5G-CARMEN is an active participant in this WG and has joined the SDA activity, with the leadership of this action and the participation in the white paper specific to the automotive sector published by the 5G-PPP.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jesús Alonso-Zarate, CTTC</td>
<td></td>
</tr>
<tr>
<td>Apostolos Kousaridas, Huawei</td>
<td></td>
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</table>

So far, the main interactions with WGs were based on the outcome of 5G Strategic Deployment Agenda (SDA) for CAM but we can also highlight the 5G-Prestandardisation WG activity on Verticals. In addition, 5G-CARMEN members actively contributed to the preparation of Phase 3 (Part 2) Pre-structuring Model Version 2.0, mainly addressing the description of the call ICT-53-2020 (5G for Connected and Automated Mobility). 5G-CARMEN will keep on attending WG specific events and contribute resources and research results to the activities requested by them.

### 6.3 Interaction with other corridors

Two projects are of particular interest for their interaction with 5G-CARMEN.

- **5GCroCo:** The objective is to validate advanced 5G features, such as New Radio, MEC-enabled distributed computing, Predictive QoS, Network Slicing, and improved positioning systems, all combined together, to enable innovative use cases for CCAM. 5GCroCo aims at defining new business models that can be built on top of this unprecedented connectivity and service provisioning capacity while ensuring that relevant standardization bodies from the two involved industries are impacted. Among the use cases of interest, 5GCroCo can highlight Tele-driving, CCA and High definition maps. The coordinator is Jesús Alonso (CTTC), and Dirk Hetzer (DT) is the Technical Manager of the project, making DT the natural liaison for 5G-CARMEN.

- **5G-MOBIX:** Aims at executing CCAM trials along x-border and urban corridors using 5G core technological innovations to qualify the 5G infrastructure and evaluate its benefits in the CCAM context.
as well as defining deployment scenarios, identifying and responding to standardisation and spectrum gaps. The following use cases are considered: cooperative overtake, highway lane merging, truck platooning, valet parking, urban environment driving, road user detection, vehicle remote control, see-through, HD map update, media & entertainment. The coordinator is François Fisher (ERTICO ITS - Brussels), main liaison for 5G-CARMEN will be through WiNGS, that is also Technical Manager of this Consortium.

The interaction with the other corridor project has occurred not only in the framework of the 5G-PPP WGs, but also through joint events, such as the common poster at EUCAD 2019 and the joint booth at EuCNC 2019 in Valencia, which received the best booth awards. A joint workshop on «5G in the Era of Connected Cars» has been also organized during the EuCNC 2019.

All three corridor projects have just exceeded the first half of their duration (month 18 out of 36) and are eagerly preparing the start of their trialling activities. Since all three projects (with slight scheduling differentiations) are now entering the beginning of their trial phase, starting from initial local trials in controlled environments and moving towards the full-scale cross border experiments, the alignment between the projects with respect to the evaluation has become a fundamental task.

The three projects elaborated in this direction a common white paper (see Section 3.8) in which together we have specified and developed the main elements of the 5G architecture from the point of view of the automotive vertical sector needs.

The three corridor projects have investigated a multitude of potentially viable solutions to address the above-identified challenges and will progress with testing the most prominent ones in the field during their trials. The proper deployment, configuration and use of edge computing, depending on the specific cross-border conditions as well as on the type of CCAM use case supported, has emerged as one of the key enabling factors to reduce end-to-end latency and to provide the necessary computational resources where and when needed. Special attention has to be given to the edge computing system interconnection and integration into an automated inter-domain service management and orchestration architecture coupled with the 5G systems. Careful, per case data routing (e.g. LBO) and specialized 5G features available in latest 3GPP releases help mitigate the effects on mobility interruption and contribute towards service and session continuity, while the use of direct V2V communications (sidelink) offers an alternative connectivity option to battle the effects of network-based communication interruption.

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7 First view on partners’ exploitation progress

Expected exploitation activities and the progress so far have been collected partner by partner and are reported hereafter divided by stakeholder groups. Table 7 refers to vehicle manufacturers and road operators, Table 8 refers to Telecom Operators and Vendors, Table 9 collects information regarding Small and Medium Enterprise, while Table 10 refers to research institutions and others.

Table 7 Exploitation for vehicle manufacturers and road operators

<table>
<thead>
<tr>
<th>Exploitation plan</th>
<th>BMW</th>
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<tbody>
<tr>
<td></td>
<td>BMW will leverage the trial; the experimental results and know-how generated throughout the 5G-CARMEN project to expand and consolidate its expertise in C-V2X/V2N communications.</td>
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<tr>
<td></td>
<td>It will evaluate C-V2X and 5G connectivity as an additional information source in higher levels of automation (SAE L3/L4).</td>
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<td></td>
<td>It plans to leverage successful interoperability results into possible new features for Advanced and Driving Assistance Systems (ADAS).</td>
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</table>

<table>
<thead>
<tr>
<th>Exploitation activities already done</th>
<th>BMW</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>First implementation results were presented internally to product pre-development, highlighting the benefits of 5G features such as Precise Positioning. Discussions on next steps ongoing.</td>
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<table>
<thead>
<tr>
<th>Exploitation plan</th>
<th>CRF</th>
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<tbody>
<tr>
<td></td>
<td>CRF will transfer know-how, findings and components developed within 5G-CARMEN to FCA global innovation activities for vehicle connectivity and ADAS. Key topics are: in-vehicle applications for situation awareness and lane merging, vehicle and infrastructure data fusion for adverse weather conditions; 5G-CARMEN precise positioning solution; predictive quality of service in infotainment; motorway speed advisory; connectivity aspects when crossing the border.</td>
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<tr>
<td></td>
<td>CRF will exploit 5G-CARMEN results to keep competitive edge on C-V2X in view of possible EU regulation and the planned inclusion of V2X in EU-NCAP rating after 2024.</td>
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</table>

<table>
<thead>
<tr>
<th>Exploitation activities already done</th>
<th>CRF</th>
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<tbody>
<tr>
<td></td>
<td>5G-CARMEN corridor plans were presented to FCA top management. 5G-CARMEN use cases are being presented to FCA product development and planning (ongoing activity).</td>
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</table>

<table>
<thead>
<tr>
<th>Exploitation plan</th>
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<tbody>
<tr>
<td></td>
<td>AUTOSTRADA DEL BRENNERO will exploit the results achieved within the 5G-CARMEN project by improving its traffic management system, integrating them into the technological solutions already in place to keep the pace with the evolutions of CAV from the infrastructural point of view.</td>
</tr>
<tr>
<td></td>
<td>Thanks to the tests carried out within the pilots, Autostrada del Brennero will have the opportunity to gain experience in the hybrid communication approach at local and cross-border level and to benefit from the advantages of using 5G, integrating the new knowledge gained to improve its C-ITS communication system.</td>
</tr>
<tr>
<td></td>
<td>It will also take advantage of the feedback of the OEMs, who will test along its route the reception of safety messages triggered by the C-ITS-S, to fine-tune the infrastructure put in place within the project.</td>
</tr>
</tbody>
</table>
AUTOSTRADA DEL BRENNERO will also share the results of the project with the C-Roads Platform.

**Exploitation activities already done**

Autostrada del Brennero participated in technical and plenary meeting and thanks to the cooperation with other project partners, it is improving its infrastructure, to make it more flexible and modular for the deployment of CAV in the pilots.

It purchased PC5 roadside units to integrate them into the existing infrastructure so as to make the whole improved system available for tests within the pilot.

Autostrada del Brennero regularly reports relevant progress achieved within the project to the company’s Board of Directors.

### Table 8 Exploitation for Telecom Operators and Vendors

**DTAG and TMA**

**Exploitation plan**

DTAG and TMA aim to establish 5G NR and Multi-Access Edge Computing.

They will iterate (inter-) MEC infrastructure and services to optimize customer experience and new business (e.g. enable Low Latency cross-border Applications) and provide E2E Services for Automated Driving (Technology Enablers and Use Cases).

**Exploitation activities already done**

MobileEdge X cloud has been installed on Magenta’s edge computing server and the Geoservice (Nokia) and AMQP broker (Asfinag) applications have been installed. The construction of the 5G Radio sites on the borders between Austria-Germany and Austria-Italy is ongoing. First site to go on air in January, second site to go on air end of December.

**TIM**

**Exploitation plan**

TIM will exploit internally the results from 5G-CARMEN, using the knowledge gained throughout the project to feed TIM Technology Plan, an internal document that tracks available new technologies in order to drive the Investment Plan for the subsequent years.

It will also help defining key positioning inside different associations and standard bodies relevant for CCAM services that TIM is involved in (e.g. 3GPP, NGMN, 5GAA).

TIM expects that the experience gained through trials can also help in the definition of the most suitable network architecture for the deployment of these services, in particular in a cross-border scenario, and to gain on-field expertise on the management of MEC solutions for vehicular services.

**Exploitation activities already done**

Exploitation activities already done: contribution to 5GAA Cross Working Group Work Item (X-WG WI) on V2X Network Reselection Improvements (NR1). Contribution to “Notes on Innovation”, an internal document addressed to TIM Top Management to present the most important innovation trends. Sharing with the engineering department of the experience gained in the deployment of the MEC architecture used in the trials.

**NOKIA**

**Exploitation plan**

NOKIA expects the elicitation, refinement and validation of requirements for inter-MEC / inter-operator / cross border communication scenarios, including related E2E use cases, in order to apply collected knowledge and findings to MEC and GeoService implementations.
It aims to verify architectural and operational MEC concepts to refine product, solution and operational descriptions for commercial deployments, and obtain proof points for MEC and 4G/5G being technologies of choice in V2X scenarios. NOKIA expects to derive from 5G-CARMEN qualified inputs for standardization activities.

| Exploitation activities already done | Due to shift of trials by COVID-19 related discussions just started and ongoing. Thus, currently results as input for standardization not yet available. |

### NEC

**Exploitation plan**

NEC aims to evolve the current MEC product portfolio towards a twofold strategy:

- Enhance the architecture/networking aspects of the MEC system, i.e., integration of 5G radio components and integration of 5G core functionalities and extending/defining existing/new interfaces and reference points.
- Augmenting the capabilities of the edge cloud computing platform.

It expects to develop value-added MANO features for its SDN/NFV line of products, aiming at improving the capabilities of edge resource orchestration.

Solutions and expertise developed in the project will be transferred to NEC’s carrier business divisions for what concerns radio and transport technologies, and to NEC/Netcracker for the MANO related findings.

Automotive-centric applications and technologies are envisioned to be transferred to NEC’s enterprise business units, which are engaged with intelligent transportation and future mobility solutions.

Finally, it will exploit the findings developed in the project to relevant fora e.g. standard organizations, conferences and journals.

| Exploitation activities already done | In the context of the NFV/MEC management and orchestration of automotive services, NEC has already proposed several extensions to the standard MEC system architecture and its coupling with the 5G system. For instance, it has proposed new reference points like the Mv1’ between the MEC level orchestrator (NFV-LO) and the top-level orchestrator (NFV-SO), and Lo-Lo reference point between the peering NFV-LO in different admin domains for low-latency operations. It has also extended the standard ETSI NFV Or-Or reference point with the interfaces for supporting federation and negotiating Management Level Agreement (MLA) between federating NFV-SOs. In this regard, contributions have been made in relevant ETSI NFV documents, like ETSI GR NFV-EVE018 and ETSI GR NFV-EVE017. The context of networking, NEC has also extended the open source Kubernetes networking interface (CNI) to support fast data plane operation, thereby enabling the coupling of the 5G UPF with the MEC platform. This new extension has been contributed to both IETF and ETSI ISG MEC standard organizations. NEC has already published papers, also jointly with partners, in IEEE conferences/journals and the results have also been communicated internally to relevant business units within NEC Corporation. |

### QUALCOMM

**Exploitation plan**

Qualcomm will provide 9150 based C-V2X platform for PC5 use case development and testing in 5G CARMEN. Similarly, for Uu communication, QCGER will explore the 5G NR - Qualcomm Snapdragon X50 based 5G platform for in-vehicular usage.
Exploitation activities already done | Delivery and OEM integration of the 9150 C-V2X platform in vehicles along with successful functional testing and use case implementation. Delivery of the 5G NR - Qualcomm Snapdragon X50 5G modem for car OEMs in 5G CARMEN. QCCGER has also been working with 5G-CARMEN members in providing technical review inputs, recommendation for C-V2X system setup/integration, and C-V2X / 5G NR technology testing methodology.

### SWARCO

**Exploitation plan**

SWARCO plans to exploit the results and experience gained during 5G-CARMEN to better address its traffic management strategies and products innovation for traffic monitoring and control, and their evolution towards the connected vehicle. Key experience will be gained through the pilots, which will help get a better understanding of the network architecture for the deployment of C-ITS services, in particular in a cross-border scenario, and to gain on-field expertise on the development of MEC solutions.

SWARCO also expects to establish strategic partnerships and to push forward the readiness of the infrastructure for traffic management solutions based on the paradigm of connected vehicle.

**Exploitation activities already done**

Thanks to the work carried out in 5G CARMEN so far, SWARCO is gaining a lot of experience on the network architecture for the deployment of C-ITS services using 5G technology. This is already helping the company improve products to better address traffic management strategies and push the readiness of the infrastructure for connected and automated vehicles.

Some activities have been a bit delayed due to the COVID-19 crisis, but more exploitation will be carried out once pilot sites will be fully operational again.

SWARCO is also carrying out liaison activities with other research and innovation projects - e.g. C-ROADS and ICT4CART.

In addition, the company represented the project at the Future Mobility Week 2019, and prepared a paper on the Green Driving use case for the ITS European Congress 2020 (ITS Virtual Congress).

### INWIT

**Exploitation plan**

INWIT is the leading tower company in Italy developing infrastructure (towers, small cells, DAS) that enables the development of MNOs’ 5G networks in any scenario. Tower companies have a role to play beyond their core business in the ecosystem of connected drive. As other tower companies, we are in the stage of exploration of our new potential role. However, we may reasonably plan to exploit results of the 5G-CARMEN project in at least two areas:

- Working in close collaboration with MNOs at the deployment of neutral host infrastructure open to multiple players for C-V2X solutions;
- Raising the awareness of the groups operating in the sectors of motorway and road management with whom we can work at providing innovative neutral host models to drive value to multiple public and private stakeholders, helping to deliver safety and mobility services with C-V2X.

**Exploitation activities already done**

INWIT has progressed on the definition of the exploitation targets and the areas in which exploitation of 5G-CARMEN results would be more interesting.
### Table 9 Exploitation for Small and Medium Enterprise

<table>
<thead>
<tr>
<th>Company</th>
<th>Exploitation plan</th>
<th>Exploitation activities already done</th>
</tr>
</thead>
<tbody>
<tr>
<td>CommAgility Ltd (CMA)</td>
<td>CMA will consider the requirements of the CCAM use cases for developing and customization of SW for their commercial base stations for cellular radio access. CMA will include selected 5G-CARMEN results from the demonstration phase to the next evolutions of CMA product portfolio. CMA also plans to accelerate 5G development by doing integration with 5G equipment/software from other project partners (e.g. 5G modem UEs, 5G-EmPOWER) during the project.</td>
<td>5G-CARMEN results helped CMA to learn and better understand CCAM requirements on RAN related to future 5G business opportunities. CMA realized promising benefits of Radio Network Information Service (RNIS) for CCAM use cases and customized CMA’s commercial base stations to support RNIS that will be potentially included in future products.</td>
</tr>
<tr>
<td>WINGS</td>
<td>WINGS is developing the STARLIT platform for realizing the vision of a city with optimized livability, with the aim is to impact the environment, the infrastructure and mobility services, assisted living and health aspects, people security/safety. In 5G CARMEN, WINGS works in the context of Green Driving in which it provides solutions for monitoring, analyzing and predicting air quality with the usage of 5G devices and functionality. Moreover, it participates in the Video Streaming use case to enhance the security as well as content provisioning.</td>
<td>WINGS provided the top-level orchestrator (NFV-SO) as well as the implementation and testing of the interface between different countries/domains (Or-Or) for realizing cross-border orchestration. Also, provided and tested locally a 5G air monitor device for Green Driving use case, to be deployed in the Austrian border (near Italy and near Germany in collaboration with Swarco and T-Mobile Austria/Magenta). WINGS, provided the integration of different components including 5G air monitor devices that will be used in the Austrian part of the corridor, cloud analytics component, integration with Swarco’s backend, reliable message delivery to cars via 5G and dashboard for visualization of results/recommendations related to Green Driving aspects. All these activities are leading to the enhancement of the 5G solutions portfolio provided by the company towards electro-mobility and future eco-friendly automotive cross-border use cases enhanced with 5G functionality.</td>
</tr>
<tr>
<td>CLS</td>
<td>CLS aims at improving its proprietary and open-source software tools for assessing 5G, IoT, and EPES systems, especially for resource constraint devices and virtualized assets. CLS will improve its open source tool DiscØvery, which is used for graph-based security analysis, to facilitate security analysis in EPES systems. The tool is licensed under MIT and is freely available. Furthermore, CLS is focused on the development of Nightwatch, its proprietary security solution for intrusion detection. Through the SDN-microSENSE, CLS will be able to develop bespoke intrusion detection solutions for SDN networks and increase its portfolio of services.</td>
<td>CLS already developed a directory of threats based on signal indicators specific to the use cases of 5G systems, which is incorporated in CLS’s open-source security analysis Discovery. Apart from this, no other activities have been performed so far.</td>
</tr>
<tr>
<td>8BELLS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Exploitation plan

8BELLS aims at passengers’ privacy preservation. It will analyze CAPEX- and OPEX-based cost-benefit models for 5G automotive use cases, and study realistic market opportunities leveraging on existing projections and conducting market analysis.

8BELLS expects a reinforcement of company position through contacts with potential stakeholders (technology providers, integrators and Original Equipment Manufacturers (OEMs)).

### Exploitation activities already done

Through its participation in 5G-CARMEN activities 8Bells already received valuable feedback over the possible architectures that can be used for the implementation of 5G-CARMEN. 8Bells has focused on the cross-border aspect of the project. Upon receiving this feedback, 8Bells has provided valuable input on possible business models aiming at maximizing the commercial value of the product, minimizing the investment risks and aligning 5G-CARMEN with the modern market needs. Through those interactions 8Bells managed to acquire a deeper understanding of this industry to suggest the optimum architecture choices from a commercial side.

The rest of the activities towards exploitation will be executed in Q1 or Q2 2021 as soon as we have some real field trials data, so that 8Bells can tune the models.

### DSEC

**Exploitation plan**

DSEC plans to extend and apply Drivesec methodology for the certification of cybersecurity to complex systems like Connected Autonomous Vehicles and relative infrastructures, where the level of cybersecurity has to be very high since people safety is concerned. Extend existing products to improve security in specific safety critical applications, with the support of 5G network.

**Exploitation activities already done**

DSEC has applied the cryptoband to emergency vehicle intervention, for vehicle/driver secure authorisation and identification.

### FBK

**Exploitation plan**

FBK is targeting to exploit the knowledge and expertise gained through 5G-CARMEN for both internal and external exploitation.

For internal exploitation, FBK will target strengthening the capabilities of its experimentation labs and its knowledge base on 5G technologies for connected cars and future mobility. In particular, FBK will integrate the 5G-CARMEN knowledge and expertise into its flagship project, 5G-Challenger, that is aimed at making FBK the European hub for experimentation of 5G networks technologies in general, and R&D on automotive verticals in particular. To this end, FBK will facilitate cross research centre dissemination and knowledge transfer and develop a strong base on realistic connected mobility pilots and experimentations.

For external exploitation, FBK will use the 5G-CARMEN results for creating potential commercial spin-offs, establish new academic links, supporting new projects and pursue knowledge dissemination. FBK has previously established five spin-offs from its involvement in FP7 research projects with encouragement and support from local public bodies. Moreover, FBK is an official EIT Digital initiative member and it is the host of the Italian EIT Node and together with key stakeholders, it will identify exploitation opportunities on the 5G-CARMEN developed concepts and technologies.

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**Table 10 Exploitation for Research Institutions and others**
Exploitation activities already done
For what concerns internal exploitation, FBK reports progresses both for what concerns 5G networks technologies and for what concerns the automotive vertical.

For the former, FBK leveraged the 5G-CARMEN CCAM platform development activity in order to progress and mature its internal assets LightEDGE and LightMANO: the development of these software components are essential to enable the orchestration of edge-virtualized infrastructures, and to promote the "Intelligence at the Edge" research priority of FBK. In this context, FBK has recently acquired a 5G-PPP project "AI@EDGE", which FBK coordinates, that further pushes this concept is a variety of application domains, including automotive. In addition, thanks to the work done in 5G-CARMEN, FBK also launched new collaboration with other institutions, mainly NEC and IMEC.

For the automotive vertical, FBK has exploited 5G-CARMEN in the context of the digitalization of the Brenner corridor, where FBK is defining new initiatives is partnership with 5G-CARMEN project partners and with local agencies and administrations: in this context, 5G networks technologies are integrated with other technologies (including AI and motivational digital systems) to ensure stronger impacts on mobility and green drive.

These achievements on internal exploitation are posing the basis for FBK’s external exploitation objectives - in particular for what concerns the collaboration network and the identification of suitable technology/application areas for business creation. FBK will increase the focus on external exploitation in parallel with the maturation of project results.

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**UPV**

**Exploitation plan**

UPV expects to improve the capabilities of the simulation platform developed internally for its future licensing.

Through 5G-CARMEN it will increase the level of expertise in the field of air interfaces for 5G systems, which could result in further opportunities for consultancy on the design, testing and evaluation of similar solutions.

Its participation in the project can eventually lead to the production of joint patents with other partners, and it will bring worldwide visibility by publishing in the main journals of the field. 5G-CARMEN will enforce know-how and indeed help the creation of novel courses on 5G and beyond technologies.

**Exploitation activities already done**

The simulation tool has been extended with the inclusion of an autonomous car model and also with the capability of planning and making an accurate radio characterization. UPV is also working in the SDA of the DG CONNECT to increase its expertise on 5G systems and will drive the study on deployment cost, which will give a lot of visibility to our activities. UPV is continuously making a major effort of dissemination, like at EuCNC 2019 with a big demo portfolio or at EuCNC where a video with the progress of the simulation tool was presented. On 2019, this resulted in the best booth prize of EuCNC. Jose F. Monserrat from UPV participated as a teacher in the 1st Wavecombe summer school, made in U. Twente from the 4th to the 6th of September, which was a training activity of 5G-CARMEN.

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**UNIBZ**

**Exploitation plan**

University of Bolzano expects to use the knowledge gained from 5G-CARMEN locally to develop new courses within the university and provide technology transfer services through the local technology park NOI. It will bring acquired expertise into applied local research programmes.
### Exploitation activities already done

Knowledge gained from 5G-CARMEN has already been used to support courses in dependable systems engineering at the Free University of Bolzano.

### PIIU

**Exploitation plan**

5G-CARMEN results will be exploited by PIIU in the context of specific offers to Italian Industries, especially SMEs, through which are envisaged significant advantages for the delivery of services to the end users.

To this end, PIIU will contribute to the protection of the industrial rights of its partners.

**Exploitation activities already done**

PIIU is examining how the generated know-how may be utilized to facilitate the development of new businesses, especially toward the SMEs segment of the market. Our activity in the project reinforces our understanding of 5G network in different verticals and further consolidate expertise in 5G, ITS and relevant areas.

5G CARMEN results will be exploited by PIIU in the context of specific offers to Italian Industries, especially SMEs, through which are envisaged significant advantages for the delivery of services to the end users. PIIU aims at leveraging and extending its current expertise in the 5G business cases, with respect to market dynamics, business models and value chains. The acquired knowledge will be used to setup advanced workshops and management courses that are part of PIIU current activities.

In terms of business impact, most of our efforts are dedicated to our future potential clients: European SMEs.

PIIU is planning specific workshops to promote the project results in public programs for SME. Business talks between SMEs and us will be triggered by these workshops based on the “Call for Ideas” concept, in which the applying SMEs will be able to propose their Product/Service concept to be applied, using the 5G platform made available by 5G CARMEN. Idea proposals will be managed with periodic application campaigns with the aim to collect and evaluate best ideas to be presented in specific event to the 5G PPP community and to 5G CARMEN project members.

SME involvement will be primarily focused to interact with SMEs and Startups who already have a working solution, and which should see 5G CARMEN more as a market opportunity and are really interested in:

- develop a competitive advantage on 5G technology applied to a specific vertical
- concrete opportunity to meet new potential customers
- increase market visibility in 5G field
- opportunity to promote their business.

Ideas and concept application will be managed via a platform supporting “a community where makers, entrepreneurs and innovators meet, interact and collaborate to build growth connections and win equity free funding to catalyze their growth”, launching specific calls for proposal. In each event, a Call for Ideas will be proposed to collect application proposals of best 5G products and solutions. These ideas will be the basis of business discussions between PIIU and its future potential clients.

### CNIT

**Exploitation plan**

CNITS has great expectation from the usage of the knowledge acquired in design and experimental activities carried out in the framework of 5G-CARMEN project to...
improve its competitiveness in the area of interworking of heterogeneous radio vehicular technologies, their MEC-assisted coordination, as well as lightweight orchestration of MEC applications and MNOs federations. The acquired knowledge will be used in design and experimental activities to engage Italian stakeholders and public administrations. In addition, it will reinforce its competitiveness in the EU research arena, especially in light of the forthcoming Horizon Europe Work Programme. Collection of real-road measurements in pilots has been delayed by Covid-19 pandemic. Nevertheless, when available, these datasets will be used for benchmarking theoretical work in the field of vehicular networks and connected/automated vehicles, as well as for extracting requirements for new (vehicular) applications to be run in edge nodes of 5G networks. 5G-CARMEN results will be included in training activities for undergraduate students in participating CNIT universities, as well as in PhD courses.

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<tr>
<th>Exploitation activities already done</th>
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<tbody>
<tr>
<td>5G-CARMEN was already used as a 5G and cross-border use case in dissemination venues, such as papers and demos presented at international conferences, and journal publications. The Edge-based architecture used in 5G-CARMEN has provided a useful template for the deployment of vehicular use cases for the “Smart Roads” initiative fostered by the Municipality of Turin and lead by Politecnico di Torino, one of the CNIT Universities who is actively participating in 5G-CARMEN. This engagement has led to a live demonstration of a vehicular use case during the 5GAA Meeting held in Turin in November 2019, together with TIM and CRF, also partners in the 5G-CARMEN project. University of Perugia, one of the CNIT Universities who is actively participating in 5G-CARMEN, already started including project results in training activities of the Master degree in Computer Engineering and Robotics and of the Master degree in Electronics for IoT.</td>
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| HIT |
| Exploitation plan |
| HIT serves as a Task Leader in task T6.3 exploitation and will coordinate and enhance the individual exploitation activities of 5G-CARMEN partners. This involves commitment building for exploitation within different task forces within CRF, BMW, all road operators and telecom operators. HIT will also organize joint workshops with ICT and innovation working groups within CEDR and ASECAP, as well as with the 5GAA. On top of this, HIT’s exploitation activities will leverage 5G-CARMEN potential by openly exchanging with other ongoing 5G-automation projects and initiatives. Guiding role model for this is an open innovation lab approach for exploitation purposes, as HIT had set up within the various ITS-corridor projects that participates. |

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<th>Exploitation activities already done</th>
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<tr>
<td>Joint orientation on exploitation process activities with CRF, BMW, Austrian road operator ASFINAG and Autostrade del Brennero experts in 2019. Three joint workshops with experts from a road operator (together with SWARCO, Virtual Vehicle and HiT). Sounding out opportunities for joint activities preparing effective exploitation during Digital Transport Days 2019 in Helsinki as well as during several ARCADE workshops and during a DG-CONNECT workshop in Brussels on the 13th of February 2020. Ongoing preparation for co-aligning with CEDR and ASECAP, as well as with individual road operators and traffic management authorities as one pre-requisite for addressing key value-propositions and key opportunities and concerns.</td>
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<td><strong>VIF</strong></td>
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<td><strong>Exploitation plan</strong></td>
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<td><strong>Exploitation activities already done</strong></td>
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| **CEA** |  
|---|---|
| **Exploitation plan** | As an expected outcome (in WP6 and WP5), CEA’s been developing 2 system-level simulation frameworks to evaluate the potential of 5G-oriented connectivity (incl. combinations of V2N/V2V/V2I technologies) to support use cases and services mainly relying on cooperative position awareness. Being a non-profit public research institute, CEA helps companies to increase their competitiveness through technological innovation and transfer. Both the achieved simulation results and the developed simulation framework (e.g. simulation tools, flow and methodology) will be exploited as a basis for future bilateral contracts between CEA and its industrial partners, particularly in the automotive domain (incl. OEMs), as well as for scientific resourcing in the context of new collaborative research programs at both European and national levels. |
| **Exploitation activities already done** | The preliminary simulation results fed into D6.2 have been subject to the submission of a joint conference paper to IEEE VTC-Spring’21 (together with UPV); One more joint journal submission is currently in preparation on a related topic. Besides, one simulation block developed in 5G-CARMEN WP6 (e.g. C-V2X sidelink ns-3 block) has been partly re-used and upgraded in the context of another H2020 project currently in progress, namely 5G-HEART, covering different use cases and applications (e.g. RSU-based cooperative fusion of LiDAR occupancy maps at urban intersections to improve the safety of vulnerable road users). |

| **IMEC** |  
|---|---|
| **Exploitation plan** | IMEC plans to further advance its expertise on experimental validation of V2X technologies built on top of 5G. Through 5G-CARMEN, IMEC plans to extend IMEC’s Smart Highway testbed capabilities with multi-layer and distributed cloud computing architecture, service transfer in multi-operator scenarios and latest positioning technology. The infrastructure will enable IMEC as an important hub in research and validation of 5G and CCAM that attracts future projects with industry. The project’s results can trigger the establishment of spin-off companies through IMEC’s Incubation and Entrepreneurship Programs. In addition, the knowledge gained from this project can be used to support advanced engineering master courses and Ph.D. programs. |
| Exploitation activities already done | Components developed during 5G-Carmen have been incorporated in the testbed to provide new features, especially providing one of edge computing features in IMEC’s Smart Highway testbed (MEC application orchestrator). The results obtained from the work in 5G-Carmen have also been presented in conferences such as ICCCN, LCN, and INFOCOM workshop, in which BSAF application’s concept was disseminated. The expertise gained from this project allowed IMEC to get new national and European projects proposal submitted and recently accepted. The knowledge obtained from the project supported PhD and Master thesis activities and in creation of new topics. |
8 Conclusions

This Work Package 7 deliverable summarized the different dissemination activities conducted in the first two years of the project and detailed the next steps regarding dissemination and the progress of the exploitation activities so far.

The dissemination activities conducted by 5G-CARMEN so far aimed at creating awareness on 5G-CARMEN activities, to set a footprint in the scientific and industrial community as well as the general public, and at increasing the potential impact of the project. The best booth award obtained at the 2019 EUCNC in Valencia can be considered a landmark achievement in that sense and all the different dissemination activities have contributed to this goal. A strong web and social presence have been continuously maintained, through a dedicated website and the creation of dedicated profiles in the main social platforms, to make the project known to the general public and facilitate the participation to online discussion with other stakeholders.

Through the presence of its partners on several key standard bodies or industrial association, 5G-CARMEN already started having an impact in the industry domain. The project is tightly working with other initiatives in the 5G-PPP framework, with several partners active in other 5G-PPP projects, facilitating the flow of information between the different projects. The Consortium of 5G-CARMEN has a particularly strong connection with the other corridor projects, 5GCroco and 5G-MOBIX, with whom it recently shared workshops and booths in different dissemination events. Two white papers in 5G-PPP, one specific on the corridors and another about the vertical services, have been produced, highlighting the strong implication of the project in the joint 5G-PPP research and communication activities.

The significance of the project activities is also reflected by the partners’ significant progress on their exploitation plans. Results achieved within the first two years of the project have boosted strongly because of the trials and demos conducted along the fall of 2020.

During the last part of the project, WP7 will aim at emphasising the use of the projects results by external entities and highlight the commercial offerings plus, finally, at obtaining the maximum valorisation of the project ideas. Testing in the pilots has provided enormous amount of material for dissemination and communication that will be properly processed in the following months and used to further increase the attention in the scientific community, vertical industries, and potential customers and adopters of 5G-CARMEN technology. With the consolidation of the projects’ solutions developed in the technical work packages and the results from use cases deployed in the pilots, it is expected that a good number of contributions will be submitted to high-quality venues during the last part of the project.
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Annex 1 - Data collected during the “Call for Ideas” for SMEs

Application Form

Startup Name

APPLICATION FORM

Startup name:

ABOUT SME INVOLVEMENT IN 5G AUTONOMOUS DRIVING

Information package

5G Carmen Information Package.pdf
SME legal name: *

Country: *

Legal address:

Number of employees: *

Do you have a website for your business? Please share the address.

Startup Website

Share the main website of your business, if you have one.
IDEA DESCRIPTION

Name of the idea *

Short text

Insert the name of your project idea

Describe your business *

Business Description

Give us a more detailed description of what you are building and what problem you are solving, in less than 350 words.

PRESET FIELD

Idea Presentation *

BROWSE

Select a file

Upload a presentation of your business idea

Link a video to introduce your idea (optional)

URL