



Fifth Generation Communication Automotive Research and innovation

Deliverable/Report D6.1

Intermediate Report on Standardization, Dissemination and Exploitation Activities

Version: v1.0

2018-05-31

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 761510. Any 5GCAR results reflects only the authors' view and the Commission is thereby not responsible for any use that may be made of the information it contains.



<http://www.5g-ppp.eu>

Deliverable/Report D6.1

Intermediate Report on Standardization, Dissemination and Exploitation Activities

Grant Agreement Number:	761510
Project Name:	Fifth Generation Communication Automotive Research and innovation
Project Acronym:	5GCAR
Document Number:	5GCAR/D6.1
Document Title:	Intermediate Report on Standardization, Dissemination and Exploitation Activities
Version:	v1.0
Delivery Date:	2018-05-31
Editors:	Mikael Fallgren (Ericsson), Taimoor Abbas (Volvo Cars)
Authors:	Mikael Fallgren (Ericsson), Taimoor Abbas (Volvo Cars), Nadia Brahma (Bosch), Tommy Svensson (Chalmers), Diego Bernardez (CTAG), Jesus Alonso-Zarate, Ricard Vilalta, Charalampos Kalalas (CTTC), Mate Boban, Apostolos Kousaridas (Huawei), Toktam Mahmoodi (KCL), Remi Theillaud, Karine Berger (Marben Products), Zexian Li (Nokia), Sylvain Allio (Orange), Antonio Eduardo Fernandez (PSA), Guillaume Vivier (Sequans), Kai Cordes (VISCODA).
Keywords:	5GCAR, dissemination, exploitation, standardization, events, impact
Status:	Final
Dissemination level:	Public

Abstract

This deliverable reports the dissemination and exploitation activities conducted in the 5GCAR project during its first year, from June 2017 to May 2018. A complete list of workshops and conferences, presentations and panels, as well as publications is provided, together with per partner-based exploitation. It highlights the presence of 5GCAR at the social media to enhance the impact. Finally, it lists the 5GCAR participation to industrial alliances, standardization and regulation bodies meetings.



Executive Summary

The objective of this deliverable is to report the 5GCAR achievements in terms of dissemination of the 5GCAR results, contribution to the standardization and exploitation activities carried out during the first year of the project, from June 2017 to May 2018. The 5GCAR ambition is to conduct and contribute with significant research activities for the 5G V2X topic in the H2020 collaborative framework.

5GCAR has prepared and attended a several communication and automotive workshops, conferences and events already at the writing of this deliverable. All these dissemination and exploitation activities have been attended with focus on technical objectives and performance research as well as on better understanding societal impacts of various complexity levels of autonomous driving systems. In doing so, 5GCAR can bring relevant knowledge into the collaboration with other significant 5G-PPP projects, for instance in the 5G Automotive WG. The main events and dissemination activities were made available on the project website and were also advertised through 5G-PPP channels and social media.

5GCAR has addressed multiple topics towards the standardization and regulation both from ICT and automotive domain. The bodies and alliances where the members of 5GCAR consortium have been active were mainly the 3GPP, ITU, CEPT, ETSI, 5GAA and partnership project forums like 5G-PPP.

Up until now, 5GCAR has contributed according to its dissemination and exploitation plan. In addition, the deliverable contains an intermediate project exploitation of each consortium partner as well.



Contents

1	Introduction	11
1.1	Objective of the document	11
1.2	Structure of the document.....	11
2	5GCAR and its Relevant Dissemination Activities	12
2.1	The 5GCAR project.....	12
2.2	Relevant dissemination activities identified for 5GCAR	12
2.2.1	Workshops and conferences.....	13
2.2.2	Industry forums and events.....	13
2.2.3	Publications	14
2.2.4	Talks and presentations.....	14
2.2.5	Panels and summer schools	15
3	5GCAR Dissemination Activities	16
3.1	Workshops and conferences.....	16
3.2	Industry forums and events.....	16
3.3	Publications	17
3.4	Talks and presentations.....	17
3.5	Panels and summer schools	17
3.6	Public website and social channels.....	17
3.6.1	5GCAR website	18
3.6.2	Social media and YouTube representation	18
3.7	On some future 5GCAR dissemination activities.....	18
4	Standardization, Regulation and Industrial Alliances Impact	19
4.1	Standardization bodies relevant for 5GCAR.....	19
4.1.1	3GPP.....	19
4.1.2	ETSI	20
4.1.3	IEEE	20
4.1.4	SAE	21
4.2	Regulation bodies relevant for 5GCAR	21
4.2.1	CEPT.....	21
4.2.2	ITU.....	21



4.3	5GAA.....	21
4.4	Cooperation in 5G-PPP	22
5	References to the Project.....	23
6	Exploitation of 5GCAR Activities	24
7	References	26
A	Relevant Dissemination Activities Identified for 5GCAR	28
A.1	Workshops and conferences.....	28
A.1.1	European Conference on Antennas and Propagation (EuCAP)	28
A.1.2	European conference on networks and communications (EuCNC)	28
A.1.3	From ADAS to Automated Driving.....	28
A.1.4	IEEE Global Communications Conference (Globecom)	29
A.1.5	IEEE International Conference on Communications (ICC)	29
A.1.6	IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC)	29
A.1.7	IEEE Vehicular Technology Conference (VTC).....	29
A.1.8	IEEE Vehicular Networking Conference (VNC)	29
A.1.9	IEEE Wireless Communications and Networking Conference (WCNC).....	29
A.1.10	Intelligent and Connected Vehicles Symposium.....	30
A.2	Industry forums and events.....	30
A.2.1	5G-PPP workshops and events	30
A.2.2	Industry fora and events	30
A.2.3	Other events	30
A.3	Publications	30
A.3.1	EURASIP Journal on Wireless Communications and Networking	31
A.3.2	IEEE Communication Letters	31
A.3.3	IEEE Communication Magazine.....	31
A.3.4	IEEE Journal of Selected Areas in Communications	31
A.3.5	IEEE Transactions on Vehicular Technology	31
A.3.6	IEEE Transactions on Wireless Communications	31
A.3.7	IEEE Transactions on Signal processing	31
A.3.8	IEEE Vehicular Technology Magazine	32
B	5GCAR Dissemination Activities	33



B.1	Workshops and conferences.....	33
B.1.1	2017-10 Workshop in PIMRC	33
B.1.2	2017-10 Workshop in WWRF	34
B.1.3	2018-04 Panel in WCNC.....	36
B.2	Industry forums and events.....	38
B.2.1	2017-11 SIA dissemination event.....	38
B.2.2	2018-02 Booth at MWC	38
B.3	Publications	40
B.3.1	Conference papers	40
B.3.2	Journal papers	42
B.4	Talks and presentations.....	43
B.5	Panels and schools.....	45
B.5.1	Panels.....	45
B.5.2	Schools.....	46
B.6	On some future 5GCAR dissemination activities	47
B.6.1	2018-06 Workshop in BMSB.....	47
B.6.2	2018-06 5G V2X Summer School.....	47
B.6.3	2018-06 Workshop at EUCNC	48
B.6.4	2018-06 Panel at EUCNC	48
B.6.5	2018-06 Special session at EUCNC	49
B.6.6	2018-09 Workshop in PIMRC	50
B.6.7	2018-10 Special Issue in MDPI Sensor.....	50
C	References to the Project.....	52
C.1	5GCAR press releases	52
C.2	Other references to the project.....	52
D	Individual Exploitation Plans	55
D.1	Telecom infrastructure providers.....	55
D.1.1	Ericsson.....	55
D.1.2	Huawei.....	55
D.1.3	Nokia	56
D.2	Telecom operator.....	56
D.2.1	Orange.....	56



D.3	Car manufacturers	57
D.3.1	PSA	57
D.3.2	Volvo Car Corporation	57
D.4	Industrial equipment vendor	58
D.4.1	Bosch	58
D.5	Academics	58
D.5.1	Centre Tecnològic de Telecomunicacions de Catalunya	58
D.5.2	Centro Tecnológico de Automoción de Galicia.....	59
D.5.3	Chalmers University of Technology.....	59
D.5.4	King's College London	60
D.6	Small to medium sized enterprises	60
D.6.1	MARBEN	60
D.6.2	SEQUANS	60
D.6.3	VISCODA	61



List of Abbreviations and Acronyms

3GPP	Third Generation Partnership Project
5G	Fifth Generation
5G-PPP	5G Private Public Partnership
5GAA	5G Automotive Association
5GCAR	5G Communication Automotive Research and innovation
AD	Autonomous Driving
ADAS	Advanced Driver Assist Systems
BMSB	International Symposium on Broadband Multimedia Systems and Broadcasting
C-V2X	Cellular V2X
CEPT	European Conference of Postal and Telecommunications Administrations
EC	European Commission
ECC PT1	Electronic Communications Committee Project Team 1
eMBB	enhanced Mobile Broadband
eNB	enhanced Node B
ERTICO	European Road Transport Telematics Implementation Co-ordination Organisation
ETSI	European Telecommunications Standards Institute
ETSI ITS	European Telecommunications Standards Institute Intelligent Transportation Systems
ETSI TC ITS	European Telecommunications Standards Institute Technical Committee for Intelligent Transportation Systems
EU	European Union
EuCNC	European conference on networks and communications
EURASIP	European Association for Speech Signal and Image Processing
Globecom	Global Communications Conference

ICC	International Conference on Communications
IEEE	Institute of Electrical and Electronics Engineers
ICT	Information and Communications Technology
ITU	International Telecommunication Union
ITU-R	ITU Radiocommunication Sector
IWPC	International Wireless Industry Consortium
KPI	Key Performance Indicator
LTE	Long Term Evolution
MDPI	Molecular Diversity Preservation International
MWC	Mobile World Congress
NR	New Radio
OBU	On-board Unit
OEM	Original Equipment Manufacture
PC5	ProSe direct communication interface 5
PIMRC	International Symposium on Personal, Indoor and Mobile Radio Communications
QAM	Quadrature amplitude modulation
QoS	Quality of Service
R&D	Research and Development
RAN	Radio Access Network
RAT	Radio Access Technologies
Rel	Release
SAE	Society of Automotive Engineers
SE24	Spectrum Engineering Working Group 24
SIA	Sustainable Industrial Areas
SME	Small and medium-sized enterprises
UE	User Equipment
URLLC	Ultra-Reliable Low Latency



	Communication
Uu	Air interface between base station and UE
V2I	Vehicle-to-Infrastructure
V2N	Vehicle-to-Network
V2P	Vehicle-to-Pedestrian
V2V	Vehicle-to-Vehicle
V2X	Vehicle-to-Anything
VDTK	Vilnius Design and Technical

	College
VNC	Vehicular Networking Conference
VTC	Vehicular Technology Conference
WCNC	Wireless Communications and Networking Conference
WG	Working Group
WRC	World Radiocommunication Conferences



1 Introduction

In this 5GCAR deliverable the intermediate dissemination outcomes of the project is presented, such as listing the contributions to conferences, workshops, industrial alliances, standardization and regulation bodies up until the finalization of this report.

1.1 Objective of the document

The main objective of this deliverable is to enlist and evaluate the intermediate dissemination activities and outcomes of the 5GCAR project during its first year. The aim of the project is to achieve high visibility and maximized impact. The report outlines the disseminating of 5GCAR results to standards, regulatory bodies, workshops, industrial alliances, scientific journals and conferences. The report pinpoints important events, meetings and workshops in which the 5GCAR project has participated and provided contributions.

1.2 Structure of the document

Section 1 gives a general introduction. Section 2 provides an overview of the 5GCAR project, and its relevant dissemination activities. Section 3 and Section 4 list the dissemination activities, and standardization and regulation activities, where 5GCAR has participated and provided contributions, respectively. Section 5 provides references to the project and press. Section 6 discusses the exploitation of 5GCAR results. References are provided in Section 7, whereas more details are provided in Annex A to Annex D.

2 5GCAR and its Relevant Dissemination Activities

This section gives a brief 5GCAR overview and lists dissemination activities that are identified relevant for the project.

2.1 The 5GCAR project

The 5GCAR project [5GCAR] aims to design, develop and showcase a system for a mobile Radio Access Network (RAN) that is efficient, secure and allow interworking of multiple Radio Access Technologies (RAT) to support advanced Vehicle-to-Anything (V2X) communication needs (e.g., for automation levels 4-5) [SAE14], build the technical foundation for 5G V2X standardization, and build a common understanding across the telecommunications and automotive sectors. The 5GCAR project key components are illustration in Figure 2.1.

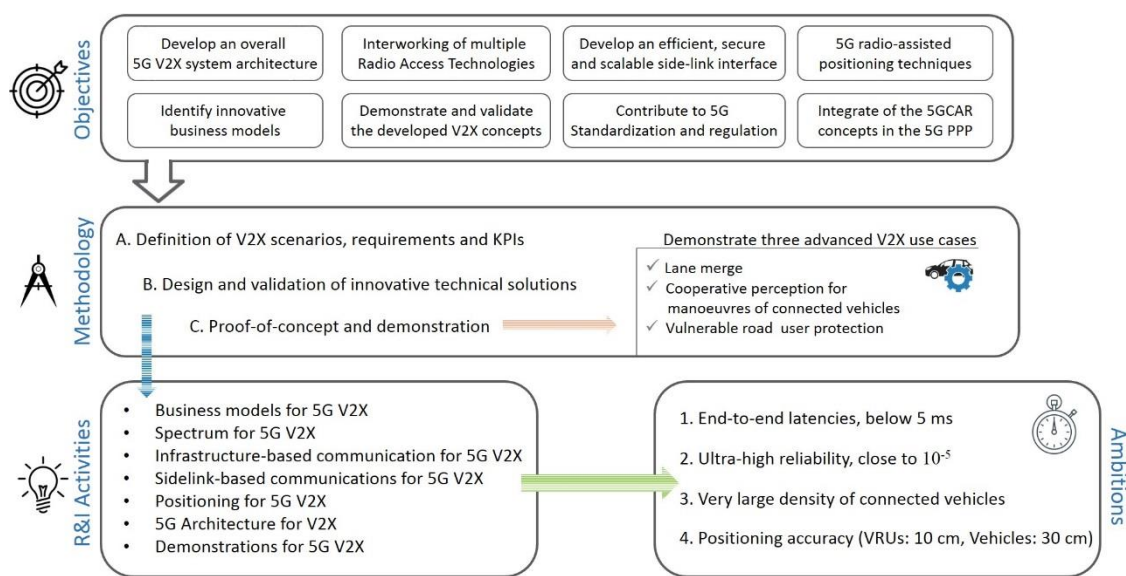


Figure 2.1: 5GCAR project overview.

2.2 Relevant dissemination activities identified for 5GCAR

The 5GCAR project has adopted and implemented a coordinated dissemination strategy to spread project results in academic and industry forums, workshops, conferences, journals and standardization bodies through regular partner-specific activities. To stay relevant, it has identified and selected the appropriate events to be visible and get the most significant impact. In this section we present all the potential 5GCAR dissemination activities whereas Section 3



contains the dissemination activities where 5GCAR has participated or contributed up until the finalization of this report.

Details of all the relevant dissemination activities identified can be found in Annex A.

2.2.1 Workshops and conferences

The focus of 5GCAR project is the coordination, publication and presentation of 5GCAR contributions to high quality international conferences, as well as workshops. A number of relevant international conferences with high impact have been identified by the consortium members. Most of these selected conferences have major focus on connectivity and telecommunication, as they do have dedicated tracks for connected vehicle domain. Whereas most of the legacy automotive conferences targeting purely automotive domain are without similar tracks addressing connectivity, with some exceptions. Some selected examples of important workshops and conferences are listed in Table 2.1.

Table 2.1: List of some relevant workshops and conferences for 5GCAR.

Publisher	Conference name	Occurrence
EC	European conference on networks and communications (EuCNC)	Annual
IEEE	Global Communications Conference (Globecom)	Annual
IEEE	International Conference on Communications (ICC)	Annual
IEEE	International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC)	Annual
IEEE	Vehicular Technology Conference (VTC)	Bi-Annual
IEEE	Wireless Communications and Networking Conference (WCNC)	Annual
IQPC	Testing ADAS and Self-driving Cars Conference	Annual
SAE	From ADAS to Automated Driving	Annual

Detail of the selected conferences are provided in the Annex A.1, whereas Section 3.1 is focused on the conferences and workshops where 5GCAR has participated.

2.2.2 Industry forums and events

The 5GCAR consortium has clear commitment to organize and to participate in workshops, summer schools, panels and training events mainly targeting stakeholders, end users and industrial organizations. The intention is also to be visible in high level industry forums for example the Mobile World Congress (MWC).

Identified industry forums and events relevant for 5GCAR are listed in the Annex A.2, whereas Section 3.2 highlights where 5GCAR already has been present.

2.2.3 Publications

The 5GCAR consortium is targeting to contribute to well reputed peer reviewed conferences, journals and magazines that have good impact factor so that the results achieved in the project could get a good visibility. A number of conferences, journals and magazines are identified as potential candidates in the area of wireless communications in general and vehicular communication in particular where the results of 5GCAR are published. All these conferences and journals have a very diverse readership with good balance among academic and industrial participants and readers. Examples of some relevant workshops and conferences for 5GCAR are provided in Table 2.1 whereas a few names of relevant journals are provided as examples in Table 2.2.

Table 2.2: List of some relevant journals for 5GCAR.

Publisher	Journal name	Peer reviewed
EURASIP	Journal on Wireless Communications and Networking	Yes
IEEE	Communication Magazine	Yes
IEEE	Transactions on Signal processing	Yes
IEEE	Transactions on Vehicular Technology	Yes
IEEE	Transactions on Wireless Communications	Yes
IEEE	Vehicular Technology Magazine	Yes
MDPI	Sensors	Yes

Details of the selected journals and magazines are provided in the Annex A.3, whereas Section 3.3 presents the publications produced by 5GCAR.

2.2.4 Talks and presentations

The larger industrial and academic forums and events especially those organized by IEEE, 5G-PPP and SAE often are great medium of communication where it is very convenient to reach out to larger groups of people to disseminate project results.

Keynotes and invited talks as well as presentation in the form of small demos and posters are very effective to showcase achieved results in the project. A number of forums and events were identified initially where 5GCAR is aiming to participate regularly such as MWC, EuCNC, and other relevant international IEEE and SAE conferences.

5GCAR has participated in a number events with talks and presentations. Information is provided in Section 3.4.



2.2.5 Panels and summer schools

The organization of panels and summer schools play an important role. It is a way to highlight project outcomes and to share knowledge among academic and industry peers.

5GCAR has already organized a couple of panels and a short course. More information on those events are provided in Section 3.5.



3 5GCAR Dissemination Activities

All participants are actively contributing to the dissemination efforts, e.g. by publishing project results at scientific conferences, workshops, in journals and magazines, as well as giving customer presentations and participating in industry groups, and by contributing to inter-project orchestration. Both the telecom and automotive industries members of 5GCAR have regular participation at conferences, journals and industrial forum and most of these forums have major focus on connectivity addressing the need from both horizontal such as telecom and vertical sectors such as automotive and smart cities by having dedicated tracks for each sector.

3.1 Workshops and conferences

The consortium has been focused on providing presentations as well as the organization of workshops in the highly impacting conferences. In addition, key members of the 5GCAR consortium already being part of the organization committees of prestigious conferences and chairs of several workshops have been promoting the 5GCAR results within these conferences and workshops. The 5GCAR has organized two workshops during the first year. The First International Workshop on V2X Channel Measurements and Modeling at the 28th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), 8-13 October 2017 and a 5GCAR workshop at the 39th Wireless World Research Forum (WWRF), 18-20 October 2017. Besides that, 5GCAR organized the “5G and Verticals: The Connected and Automated Driving (CAD) Case” panel at the IEEE Wireless Communications and Networking Conference (WCNC), 15-18 April 2018.

Details of these events are provided in Annex B.1.

3.2 Industry forums and events

A high level of visibility is achieved for the project by organizing and participating in public exhibitions and fairs, organized by industry and telecom operators. The main focus in such events has been the demonstrations of project achievements to approach business stakeholders. The 5GCAR has participated at a number of such events. To name a few, e.g. 5GCAR has presented a demo of the lane-merge use-case at the Mobile World Congress (MWC) in Barcelona in February 2018.

5GCAR dissemination activity at SIA conference was mainly focused on two presentations: one devoted to the use cases and requirements and a second one mainly focused on the technology communications and evolution.

The complete list of events is provided in Annex B.2.



3.3 Publications

The 5GCAR has actively contributed to journals and magazines dedicated to 5G networking and vehicular networks. The 5GCAR consortium members not only published articles in journals with good impact but have also been promoting the 5GCAR results within special issues being published on the topic of 5G V2X Communications. So far 5GCAR has published 9 papers in the conference proceedings and 10 papers in various journals whereas more than 12 conference and journal manuscripts are already submitted and being reviewed. In addition, 5GCAR members have organized a special issue in the MDPI Journal named Sensors, on “Enhances in V2X Communications for Connected Autonomous Vehicles”.

Details of already published and submitted journals is provided in Annex B.3.

3.4 Talks and presentations

5GCAR members have been participating both as invited speakers and keynote speakers at several conferences, workshops, industrial technical and regulatory body events. To name a few of these events are ET5GB workshop at Globecom, Automated Road Transports cluster meeting, China-EU Workshop, URLLC conference, and WWRF meeting.

Details of already given talks and presentations are provided in Annex B.4.

3.5 Panels and summer schools

5GCAR members have been invited to several panels, both in terms of participating as panelist as well as organizing and moderating the panels. The examples include panels at IEEE WCNC, TU-Automotive Europe, WWRF and so forth, as outlined in Annex B.5.1.

In addition, 5GCAR has been active and organized training events and summer school that are an important format for raising awareness of project knowledge and results to a wider audience within both industry and academia. Such events are used as a training means for the younger, and future, generation of researchers in the field. 5GCAR has organized a short-term course on the topic of “5G for connected vehicles” at Vilnius Design and Technical College (VDTK) in Vilnius in November 2017 and already announced a Summer School on 5G V2X Communications to be held in June 2018 at KCL in London.

Details of already conducted 5GCAR school activities are provided in Annex B.5.2, whereas details on upcoming 5GCAR dissemination activities, such as the Summer School in London, are provided in Annex B.6.

3.6 Public website and social channels

The 5GCAR public website and other of its social channels are presented in this section.



3.6.1 5GCAR website

The 5GCAR website (<https://5gcar.eu>) is maintained and updated during the project [5GC-D11]. The website contains relevant project information, such as the project vision and objectives, and consortium details. The relation of the project to the funding program as well as to other projects in the same domain is also visible. The site is continuously updated with the project public deliverables, publications, and public material. Relevant events are also being made more visible through the website.

3.6.2 Social media and YouTube representation

Different social networking groups (e.g., Twitter, LinkedIn and Facebook) complement 5GCAR's website. Through social networks, the project advertises its results, announce events, inform about the most recent results and reports, and provides a platform for discussion. Other fora, such as Wikipedia, will also be considered for 5GCAR project information sharing. In addition, 5GCAR will set up a YouTube channel.

Twitter account

Twitter, is used to inform about ongoing activities. The Twitter account is constantly used for online messaging of news (like conference participation etc.). 5GCAR has already got a few followers and is following the relevant groups and societies for constant updates. The account is also a good means for the cross-project interaction (Re-Tweets by 5G-PPP and other related Twitter accounts).

Link to 5GCAR twitter account: https://twitter.com/H2020_5GCAR.

LinkedIn group

The 5GCAR LinkedIn group is used to spread technical and workshop/panel announcements and technical content among stakeholders, academia, industry etc. The group is created are used to share latest news and events organized by 5GCAR.

3.7 On some future 5GCAR dissemination activities

This deliverable marks the first year and also the mid-term of the 5GCAR project. In the second half of the project, yet to come in the writing of this deliverable, the number of dissemination events and publications are foreseen to increase further when more results will be communicated as well as discussed in various fora.

Some of the future 5GCAR dissemination events to take place in the second half of the project is listed in Annex B.6.



4 Standardization, Regulation and Industrial Alliances Impact

The 5GCAR project partners have been participating continuously to the standardization and regulation bodies meetings such as 3GPP and ETSI, industrial alliances such as 5GAA and EU project partnerships such as 5G-PPP and so forth.

4.1 Standardization bodies relevant for 5GCAR

The 5GCAR project addressed multiple topics from telco industry to car industry. Standardization and regulation bodies are also dealing either directly or indirectly with V2X. Even before the project officially started, the consortium identified a list of possible relevant bodies, to be monitored and for contribution, to promote project outcome at a standardization level). After one year of activity, it is time to revisit the initial list and to make a status on what is on-going on the standardization and regulation space.

4.1.1 3GPP

From Rel-14 and onwards, Third Generation Partnership Project (3GPP) has been working on the development of cellular based V2X (C-V2X) technologies. The outcome until now covers V2X support with both Uu air interface (i.e. air interface between eNB and UE) based solutions and/or sidelink based solutions (i.e. PC5 interface). Within 5GCAR, we have continued monitoring the evolution and preparing to bring the research outcome from the project to future releases based on 5G NR.

Regarding to 5G design, 3GPP has been focus of the basic design of the system. Supporting of verticals including V2X applications mainly from the enhancement of LTE system. For example, topics include carrier aggregation, supporting 64-QAM, resource pool sharing between mode-3 and mode-4 users, feasibility study about transmit diversity over sidelink etc. are under discussion. Considering the future release, especially from 5G, 5GCAR partners are actively involved in the discussion on evaluation methodology, channel modeling etc.

With regards to the overall 5G definition, during the last year 3GPP activity focused on the completion of the first flavor of “5G”, so called New Radio in 3GPP naming. The very first version of NR specifications (Rel-15) were approved in Dec 2017, thanks to the hard work of technical groups (there were many ad-hoc meetings to speed up the standardization work). It has to be noted that this early version, dedicated to NSA mode, is focusing on the eMBB use case while including hooks for URLLC support. With respect to 5GCAR, we identified URLLC as a key enabler of V2X, providing low latency and reliable communication between devices and network. As a result, the project did contribute in this area.

Relevance for future activities. 3GPP remains a body of interest for the project. The study item will be most likely transferred into a work item after June 2018 opening the opportunity to



directly impact the standard. The V2X development has attracted attention and is foreseen to be one of the major topics to be specified in Rel-16. The following topics have been discussed and will most likely be the essential topics for V2X support:

- NR sidelink design
- Uu enhancement
- Uu-based sidelink scheduling
- Radio Access Technology (RAT) selection
- QoS management (both Uu and sidelink)

while it is still debated what bands for sidelink frequency should be part of the study (i.e. only <10 GHz or both <10 GHz and mmWave) as well as whether the following topics should be covered by Rel-16 work:

- V2X positioning (could be studied in parallel within Rel-16 due to big scope)
- Relay/Range extension solutions
- Feasibility of coexistence mechanisms

Partner companies have been actively involved and contributed to the discussion.

4.1.2 ETSI

5GCAR will monitor standardization activities of ETSI, gathering the efforts from standardization bodies around the world, to ensure that the outcome of the project is aligned and compatible with the progress of ETSI standards. The network architecture considered for the contributions of 5GCAR is fully aligned with the end-to-end vision of ETSI TC ITS, which addresses direct communication between vehicles and the core networks.

The contributing partners will be able to provide the 5GCAR project with recommendations to the revision process of the ETSI ITS reference architecture and ITS sub-systems, e.g. with the integration of the connectivity framework. The main objective of this standardization task is to integrate the new connectivity framework into the ITS reference architecture and to study the impact of the mapping of the new technology into each ITS stack layer. This improved architecture will be promoted in the scope of the ETSI ITS Release 2 standard development, currently being discussed by ETSI TC ITS with the aim of providing a new enhanced architecture enabling additional applications and use cases for future deployments. 5GCAR will foresee to animate a liaison with ETSI TC ITS to give information on relevant outcomes of the project to the ITS community.

4.1.3 IEEE

While 3GPP technology is a central pillar of this project, an interworking with existing or future extensions of IEEE standards is also important to understand. Heterogeneous access strategies are studied and designed to make sure that all available technologies are efficiently put to



service to meet the QoS and security requirements of those applications requiring critical delay guarantees, high reliability, energy efficiency and scalability. 5GCAR members are constantly monitoring the developments in IEEE standards so that their impacts on the development of 3GPP standards could be taken in to account as early as possible.

4.1.4 SAE

SAE International is a global association of more than 128,000 engineers and related technical experts in the aerospace, automotive and commercial-vehicle industries. SAE International's core competencies are life-long learning and voluntary consensus standards development. SAE International's charitable arm is the SAE Foundation, which supports many programs, including "A World In Motion" and the "Collegiate Design Series". SAE is highly relevant for the automotive sector, 5GCAR members from the automotive sector are following developments and discussions within SAE.

4.2 Regulation bodies relevant for 5GCAR

4.2.1 CEPT

The contributing partners have been participating at the European level to CEPT, especially through ECC PT1 and SE24 (Short Range Devices), at which the European administrations are jointly preparing the agreed European contributions to the ITU-R. The aim of participating is mainly to follow up the activities and to contribute to European harmonization.

4.2.2 ITU

ITU is an important regulation body. In WRC 2019, additional frequency bands will be identified. This provides an opportunity to argue for new frequency bands for future V2X communications, in which the 5GCAR spectrum work [5GC18-D22] can be considered.

4.3 5GAA

5GAA, www.5gaa.org, is working on several parallel activities that will allow automotive and telecommunications industries embrace and accelerate the global deployment of intelligent transport and communications solutions. The activities of 5GAA is organized into five Working Groups:

- WG1: Use Cases and Technical Requirements
- WG2: System Architecture and Solution Development
- WG3: Evaluation, Testbeds, and Pilots
- WG4: Standards and Spectrum
- WG5: Business Models and Go-To-Market Strategies

Many of the ongoing activities fall into 5GCAR project interests. 5GCAR partners (that are also 5GAA members) are actively involved in these activities. Several active work items (WI) of the



“Use Cases and Technical Requirements” and “System Architecture and Solution Development” working groups are relevant for the research work that is being conducted in the 5GCAR project. The definition of use cases and automotive requirements, the elaboration on technology solutions and a roadmap evolution strategy including spectrum allocation requirements are examples of the abovementioned activities in 5GAA.

Cellular-V2X (C-V2X) is used in 5GAA to describe the technologies that will be used to achieve the level of connectivity required for V2X communication. C-V2X defines the unified technology platform for short range and long-range communication that is scalable and concurrently supports KPIs of demanding services. It provides one solution for integrated V2V, V2I and V2P operation with V2N by leveraging cellular network infrastructure. 5GCAR research directions and objectives are well aligned with the C-V2X framework.

The outcomes of 5GCAR could be contributed to 5GAA in the form of a liaison or in the form of individual (or joint) contributions by involved partners. A first joint contribution about “Service Level Requirements for the See-through Use Case” has been prepared by 5GCAR partners and contributed to 5GAA. In the See-Through use case, which is also part of the 5GCAR target use cases [5GC17-D21], a cooperative perception system exploits the exchange of video between vehicles via wireless communication to increase safety either by facilitating automated driving or by assisting the driver during maneuvers. The data representing the scene in front of the vehicle ahead of a line is captured by a camera vision system and transferred to the rear vehicle to allow it to see through the forward vehicle and bypass the occluded area. In this contribution, Service-level requirements for the see-through use case described in [5GC17-D21], have been contributed to 5GAA taking into consideration the list of Service-level requirements that have been defined in 5GAA WG1.

4.4 Cooperation in 5G-PPP

5GCAR is cooperating with 5G-PPP in various ways, ranging from more direct discussions with other projects on specific topics to being involved and contributing to many of the working groups. Here some 5GCAR members contributed significantly to the first 5G Automotive WG white paper [5GA18-WP] that was released just before the Mobile World Congress 2018.



5 References to the Project

As a strong impacting V2X project for the 5G-PPP Phase 2, 5GCAR has been mentioned in the press quite often. The 5GCAR visibility has been further increased through its first project press release [5GC17-press].

The complete list issues press releases together with what has been presented in the press is given in Annex C.



6 Exploitation of 5GCAR Activities

The exploitation activities in 5GCAR is bringing seemingly diverse areas together given the diversity of partners' sectors in the project. When it comes to understand the various types of challenges that these industries are facing in terms of coming together as well as to address these challenges these different perspectives is a great strength.

Telecom infrastructure providers involved in the 5GCAR project acknowledge the importance of 5G wireless communications in the future automotive industry and business landscape in Europe V2X communication and collaboration. In this context, the manufacturers need to have an influence on early harmonization and system specifications, in order to create the corresponding markets and address them with competitive products at the appropriate time.

Telecom operator involved in 5GCAR recognize the potentials the automotive sector offers to expand their total service offering, thereby increasing their market size and growth rate. The need to enhance existing infrastructure or functions has also been identified in order to achieve V2X Services' QoS metrics.

Car manufacturers in the 5GCAR consortium are interested in embedding both intelligence and communication components in vehicles. Vehicles that are smoothly collaborating with other vehicles or devices will enhance awareness and problem-solving functions for safety, automation and traffic efficiency, under very strict time/space performance requirements.

Vendors of OBUs that participate in 5GCAR and provide V2X solutions recognize the need for de-virtualization. The generation and ownership of intellectual property is essential to ensure profitability of the manufacturer's business, and at the same time, to provide incentives for competition through open platforms or cross-license agreements on fair and reasonable terms.

Academic partners in the 5GCAR consortium are interested in building on and further developing existing research strength in V2X systems. The gained expertise will permeate into the daily university life and will be disseminated within academic education as preparation of future European ITS and 5G experts.

Finally, there are three **Small to medium sized enterprises (SME)** partners in the 5GCAR who mainly devote their exploitation plan to create strong R&D links with both academia and leading industrial entities. The SMEs at the same time provide an innovative character with necessary edge competence, services and products.

In Table 6.1 an indication of where the different sectors are mainly contributing in terms of exploitation activities are categories. Naturally the sectors can also contribute in other areas than what the table indicates.



Table 6.1: Different categories of exploitation activities.

Sector	Exploitation Category	Details
Telecom infrastructure provider, mobile operator,	Standardization	3GPP, ETSI
Vendors of OBU, telecom infrastructure provider	Future product development	OBU, telecom equipment
Academia	Educational material	Course material, dissertation subjects

Individual exploitation plans from each partner is provided in Annex D.



7 References

- [5GA18-WP] 5G Automotive WG White Paper, "A study on 5G V2X Deployment", February 2018. https://5g-ppp.eu/wp-content/uploads/2018/02/5G-PPP-Automotive-WG-White-Paper_Feb.2018.pdf
- [5GC17-D21] 5GCAR Deliverable 2.1, "5GCAR Scenarios, Use Cases, Requirements and KPIs", August 2017.
- [5GC17-press] 5GCAR consortium: "The 5GCAR EU initiative pushes for future wireless vehicular communication", October 2017. https://5gcar.eu/wp-content/uploads/2017/11/First-5GCAR-Press-release_20171017.pdf
- [5GC18-D22] 5GCAR Deliverable 2.2, "Intermediate Report on V2X Business Models and Spectrum", March 2018.
- [5GCAR] The official 5GCAR project website, <https://5gcar.eu/>
- [SAE14] SAE, "J3016: Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems", 2014.



Annex

A Relevant Dissemination Activities Identified for 5GCAR

Dissemination activities that has been identified as highly relevant for 5GCAR is presented in this Annex, Annex A, whereas the conducted 5GCAR dissemination activities up until the writing of this deliverable is presented in Annex B. 5GCAR press releases as well as other references to the project from the press is presented in Annex C. Finally, Annex D contains individual exploitation plans from each 5GCAR consortium partner.

The relevant dissemination activities in terms of workshops and conferences, industry forums and events, and publications are presented in the following three subsections.

A.1 Workshops and conferences

To disseminate the results of the 5GCAR project, a number of journal publications as well as conferences, workshops and events have been identified and selected.

This section contains the list of conference events identified as relevant to 5GCAR. In addition, there are several smaller-scale events where 5GCAR results also can be presented, for simplicity those are not included.

In Annex B.1 the 5GCAR workshops and conferences from June 2017 to May 2018 are presented.

A.1.1 European Conference on Antennas and Propagation (EuCAP)

EuCAP is one of the flagship conferences on antennas and propagation that has been attracting researchers across the world from last many year. With approximately 1200 attendees it is the largest conference of its type outside of the USA.

A.1.2 European conference on networks and communications (EuCNC)

The EuCNC is a conference that is supported by the European Commission and is one the main venues for showcasing the results of research projects, mainly from, but not limited to EU projects. The event brings together researchers from all over the world to present their latest research.

A.1.3 From ADAS to Automated Driving

From ADAS to Automated Driving is the symposium organized annually by the SAE to support the industry in its efforts to move toward more Advanced Driver Assist Systems (ADAS) with the goal of fully automated driving. The technical program offers intuitive and vital sessions on



intelligent and automated driving aspects related to vehicle electronics, sensor and cooperative communications.

A.1.4 IEEE Global Communications Conference (Globecom)

The Globecom is an annual international conference organized by IEEE and is one of the few IEEE Communication Society's conferences dedicated to driving innovation in nearly every aspect of wireless communications. This 5-day event includes several keynote speeches, panels and forums, technical sessions, technical papers, workshops and tutorials by researchers and experts in respective disciplines.

A.1.5 IEEE International Conference on Communications (ICC)

This is one of the IEEE Communication Society's flagship conferences held annually, featuring the latest developments in telecommunication. Subjects include communications theory, wireless communications, wireless networking, signal processing and so forth.

A.1.6 IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC)

The PIMRC is one of the premier conference in the wireless research arena that has now emerged as one of the IEEE Communication Society's flagship conferences in telecommunications. It has a long history of bringing together academia, industry, and regulatory bodies. It includes plenary keynote speech session, panel discussions, tutorials and workshops featuring world-class innovators.

A.1.7 IEEE Vehicular Technology Conference (VTC)

The IEEE VTC is the Vehicular Technology Society's flagship conference held semi-annually since 1999 bringing together experts, and researchers from academia, industry and international standardization bodies to exchange latest findings and ideas.

A.1.8 IEEE Vehicular Networking Conference (VNC)

IEEE Vehicular Networking Conference (VNC) is sponsored by the IEEE Communications Society (ComSoc) and the IEEE Intelligent Transportation Systems Society (ITSS). IEEE VNC brings together these generally distinct communities to discuss recent developments and challenges in vehicular networking technologies and their applications.

A.1.9 IEEE Wireless Communications and Networking Conference (WCNC)

The IEEE WCNC is the world premier wireless event that brings together industry professionals, academics, and individuals from government agencies and other institutions to exchange information and ideas on the advancement of wireless communications and networking technology.



A.1.10 Intelligent and Connected Vehicles Symposium

Intelligent and Connected Vehicles Symposium is organized by SAE that provides valuable insight into the development of technologies impacting intelligent and connected vehicles. Participants of these events are usually the engineering professionals, industry leaders and students from all sectors such as OEMs R&D, telecom industry, and academia.

A.2 Industry forums and events

This section contains a list of industry forums and events that have been identified as relevant to 5GCAR. In Annex B.2 the 5GCAR industry forums and events from June 2017 to May 2018 are presented.

A.2.1 5G-PPP workshops and events

5GCAR takes active part and contribute to 5G-PPP events and workshops in the V2X field.

A.2.2 Industry fora and events

The Mobile World Congress (MWC) is the biggest industry event in the mobile telecommunication field. It is hosted once a year in Barcelona with around 100.000 professional visitors.

The International Wireless Industry Consortium (IWPC) facilitates knowledge capital collaboration and delivers vital insight into emerging wireless technologies, as well as market and ecosystems evolution. The community's focus is all things wireless but their approach is technology neutral.

Similarly, the world congress on ITS is an annual conference and trade show to promote development in ITS technologies with the main sponsors being, ERITCO (ITS Europe), ITS America, ITS AsiaPacific.

A.2.3 Other events

In many occasions, additional workshops or tutorial sessions are collocated with the main conference event the day before or after. These are great opportunities to present 5GCAR results and to receive feedback, such as the ET5GB workshop at Globecom'2017, <http://www.et5gb.com/program.html>.

A.3 Publications

This section contains a list of all the important peer reviewed journals that are considered relevant to 5GCAR project.

In Annex B.3 the 5GCAR publications from June 2017 to May 2018 are collected.



A.3.1 EURASIP Journal on Wireless Communications and Networking

The EURASIP Journal on Wireless Communications and Networking brings together science and applications of wireless communications and networking technologies by publishing peer-reviewed articles that emphasize original results relating to theory and/or applications of wireless technologies.

A.3.2 IEEE Communication Letters

The IEEE Communication Letters publishes original but short articles in a timely manner, with much shorter review time, on the frontiers of research within the areas of interests of the IEEE Communications Society.

A.3.3 IEEE Communication Magazine

The IEEE Communication Magazine has similar structure and aims as IEEE Vehicular Technology Magazine, but it is run by the IEEE Communication Society with a much broader scope in the area of communications and much larger audience.

A.3.4 IEEE Journal of Selected Areas in Communications

The IEEE Journal of Selected Areas in Communications is keen to provide its readers a collection of up-to-date papers on specific technical topics. Since the selected topics are valuable to the research community and thus become valuable references.

A.3.5 IEEE Transactions on Vehicular Technology

The IEEE Transactions on Vehicular Technology is a peer-reviewed journal dedicated to the publication of original contributions in the area of vehicular technology. It published research articles, surveys and tutorials in the area of communications for transportation systems and vehicular electronics.

A.3.6 IEEE Transactions on Wireless Communications

The IEEE Transactions on Wireless Communications is a Communication Society's major archival journal that focuses on timely published of original papers after a peer-review to ensure high-quality. The main tracks include the theory and applications of wireless communications systems and networks.

A.3.7 IEEE Transactions on Signal processing

The IEEE Transactions on Signal Processing is a peer-reviewed journal of IEEE Signal Processing Society that covers novel theory, algorithm, performance analyses and applications of techniques for the processing. The term signal includes, among others, audio, video, speech, communication, radar and medical signals.



A.3.8 IEEE Vehicular Technology Magazine

The IEEE Vehicular Technology Magazine is a quarterly magazine publishing research articles in three main areas of interest: mobile radio, automotive electronics and transportation systems. The magazine is aiming to become an established international technical reference in the area of vehicular communications as it does not only publish technical papers but also features editorial columns describing the latest news and developments in the area.



B 5GCAR Dissemination Activities

The 5GCAR dissemination activities from the project start June 2017 until May 2018 are collected here. Organized workshops and panels in conference events are presented in Annex B.1, organized events in industry fora are presented in Annex B.2, publications in conference papers and in journal papers are presented in Annex B.3, given talks and presentations in various events are presented in Annex B.4, panel participation in various events and school organization are presented in Annex B.5. Finally, Annex B.6 contains information on some future 5GCAR dissemination activities that will take place after May 2018.

B.1 Workshops and conferences

The 5GCAR workshops and conferences from June 2017 to May 2018 are collected here.

B.1.1 2017-10 Workshop in PIMRC

In the 28th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), 8-13 October 2017, 5GCAR organized the First International Workshop on V2X Channel Measurements and Modeling.

Date	11 October 2017
Location	Montreal, Canada
Website	https://wvcm2017.wordpress.com/
Organization committee	Mate Boban (Huawei Technologies Duesseldorf GmbH, Germany) Prof. Fredrik Tufvesson (Lund University, Sweden) Prof. Reiner S. Thomä (TU Ilmenau, Germany) Jian Luo (Huawei Technologies Duesseldorf GmbH, Germany) Taimoor Abbas (Volvo Cars, Sweden)
Contributions	5GCAR partners conceived, organized, and attended the workshop
Scope	Vehicular communication is characterized by diverse environments, high mobility of both the communicating entities and their surroundings, and comparatively low antenna heights on vehicles. These characteristics are very different from classical cellular cases and make the vehicular propagation and channel modeling particularly challenging. Additionally, the ultimate goal of next generation Vehicle-to-everything (V2X) communication systems is enabling accident-free cooperative automated driving. To achieve this goal, the communication system will need to enable a diverse set of use cases, which can result in channel conditions not fully explored in the past (e.g., blockage effects caused by densely packed platooning vehicles, communication between vehicles and vulnerable road users such as pedestrians and cyclists, etc.).



	<p>Finally, in recent years, different frequency bands have been proposed for V2X communications (e.g., in centimeter wave bands, millimeter wave bands, and in visible light spectrum). The impact of frequency band and the propagation characteristics of high frequency (millimeter wave) V2X channels, etc. become very important objects of investigation.</p> <p>Consequently, this workshop solicits papers that address the following V2X channel measurement and modeling issues:</p> <ul style="list-style-type: none">• Channel models and measurements for V2V, V2I, V2P, and V2N communication• Measurement campaigns in: Sub-6 GHz (centimeter wave in 700 MHz – 6 GHz) and higher frequencies incl. millimeter wave (6 GHz – 100 GHz)• Measurement campaigns indifferent radio environments• Effects of highly mobile scatterers on V2X channels• Impact of dual mobility on V2X channels• Blockage modeling• Channel modeling and characterization in platooning scenarios• Modeling spatial and temporal consistency for V2X channels
--	--

B.1.2 2017-10 Workshop in WWRF

In the 39th Wireless World Research Forum (WWRF), 18-20 October 2017, 5GCAR organized a workshop.

Date	18 October 2018
Location	CTTC, Castelldefels, Barcelona, Spain
Website	http://www.wwrf39.ch
Organization committee	Jesus Alonso-Zarate and Mikael Fallgren
Contributions	Mate Boban (HUAWEI), Taimoor Abbas (Volvo Cars), Tommy Svensson (Chalmers University), Ricard Vilalta (CTTC), Andres Laya (Ericsson), Mikael Fallgren (Ericsson)
Scope	<p>This special session, organized by the 5GCAR Project consortium, was devoted to discuss the role of 5G technologies for the connected car.</p> <p>5G technologies will enable cars and vehicles to be connected to the networks and also to be able to talk to each other ensuring low</p>



	<p>reliability and ultra-low latency. Enabling such kind of connectivity will leverage disruptive new applications that will allow to improve driving efficiency and boost road safety.</p> <p>The session was split in two parts. First, a series of talks were provided introducing key topics related to the topic of 5G and the automotive vertical sector. Then, a panel discussion was initiated for a highly interactive discussion about the topic.</p> <p>FORMAT</p> <p>Talks (60 minutes) + discussion panel (30 minutes)</p> <p>Session Moderator: Ricard Vilalta (CTTC)</p> <p>TALKS</p> <p>16h – 16h12 Speaker: Mikael Fallgren (Ericsson)</p> <p>Title: "The 5GCAR Project".</p> <p>Senior Researcher at Ericsson Research, Stockholm, Sweden.</p> <p>METIS project he led the work on scenarios and requirements as well as on dissemination and standardization</p> <p>Dr Fallgren is the 5GCAR project coordinator.</p> <p>16h13 – 16h24 Speakers: Mate Boban (Huawei) and Taimoor Abbas (Volvo Cars)</p> <p>Title: "V2X channel measurements and modeling"</p> <p>Research Engineer at Huawei German Research Center, Munich</p> <p>Before joining Huawei, he worked for NEC Labs Europe, Carnegie Mellon University, and Apple. He has been involved in EU-funded projects on V2X communication (WP leader in DRIVE-C2X and TEAM, 5G CAR). He actively participates in 5GAA, ETSI, and 3GPP.</p> <p>Taimoor Abbas is a project leader for 5G and V2X development at Volvo Car Corporation.</p> <p>His research interest include cooperative Intelligent transportation, multi-antenna and 5G systems as well as the estimation and modeling of radio channels for wireless vehicular communications.</p> <p>16h25 – 16h36 Speaker: Tommy Svensson (Chalmers University)</p>
--	--



	<p>Title: "Integrated Moving Networks"</p> <p>Professor in Communication Systems at Chalmers University of Technology in Gothenburg, Sweden</p> <p>European WINNER and ARTIST4G projects that made important contributions to the 3GPP LTE standards, the EU FP7 METIS and the EU H2020 5GPPP mmMAGIC 5G projects, and currently in the EU H2020 5GPPP 5GCar project</p> <p>16h37 – 16h48 Speaker: Ricard Vilalta (CTTC)</p> <p>Title: "Fog computing and the connected car".</p> <p>Senior Researcher at CTTC.</p> <p>Involved in ONF, and ETSI.</p> <p>Communication manager of 5GTANGO.</p> <p>16h49 – 17h Speaker: Andres Laya (Ericsson)</p> <p>Title: "5G and the transformation of the automotive ecosystem"</p> <p>Experience Researcher at Ericsson Research, Stockholm,</p> <p>His research interests are in the area of the Internet of Things, and the business implications of connected devices in different industries.</p> <p>DISCUSSION PANEL (30 minutes)</p> <p>Moderator: Ricard Vilalta. Panelists: Mikael Fallgren (Ericsson), Mate Boban (HUAWEI), Taimoor Abbas (Volvo Cars), Tommy Svensson (Chalmers University), and Andres Laya (Ericsson).</p>
--	---

B.1.3 2018-04 Panel in WCNC

In the IEEE Wireless Communications and Networking Conference (WCNC), 15-18 April 2018, 5GCAR organized the "5G and Verticals: The Connected and Automated Driving (CAD) Case" panel.

Date	17 April 2018
Location	Barcelona, Spain
Website	http://wcnc2018.ieee-wcnc.org/program/panels#p3
Organization committee	Markus Dillinger
Contributions	5GCAR Panelists: Taimoor Abbas, Mikael Fallgren, Jesus Alonso



	Other Panelists: Xavier Costa, Andreas Kwoczek
Scope	<p>5G V2X will provide the long awaited service level agreements and features for mobile networks and the so-called vertical industry will strongly benefit from these new capabilities. In particular the automotive industry is on a path where vehicles are continuously becoming more aware of their environment, due to a permanent increase in various types of integrated sensors, machine learning or should be say advances in artificial intelligence and an increasingly intelligent network and road infrastructure.</p> <p>Autonomous-driving is already here and in its maturing phase. As a consequence, the significance and reliance on capable communication systems for vehicle-to-anything (5G-V2X) communication is becoming a key asset with new requirements on traffic safety. This, combined with sensor-based technologies will enhance the performance of automated driving and increase further traffic safety. Ever changing situations — traffic and weather conditions.</p> <p>The truly intelligent, fully connected car will require a massive amount of computing power and super-high-speed communications systems such as 5G V2X.</p> <p>Whereas, the mobile communications industry is striving towards targeting communication needs of vertical industry with corresponding requirements being set for the standardization of 5G V2X until 2020 (3GPP Rel16 completed) with large commercial launches around 2025. The size and potential impact of the automotive revolution requires more than gut feeling to drive the right decisions for a successful mobility strategy. Only a good understanding of the potential outcomes and a data-driven mind-set can enable actors to adjust to the full impact of the disruption on their business. Therefore, navigating what's ahead will require a long-term vision with developing connectivity platforms, creating in-vehicle-services ecosystems, or even unique car features with respect to applications, data, and media besides efficiently support a wide range of 5G V2X services and business models.</p> <p>This panel will discuss how the Automotive Industry can best benefit from 5G V2X that is flexible in its functional and topological configuration. What are the missing components, where more research and innovative solutions would be appreciated. As well as, what are the actions required consisting primarily of accompanying measures such as Industry fora solutions, standardization or policy and the time lines for execution.</p> <p>Connected and Autonomous Driving supported by radio technologies is one of the most challenging market and research</p>



	fields today. To jointly identify standardization requirements for 3GPP, ETSI, SAE, etc. and certification challenges is key in next 1-2 years. In addition, spectrum usage modalities between car and classical telecom industry will be a prerequisite to implement CAD in coming years. The panelist from car, telecom industry and academia will elaborate on technical and regulatory challenges to help identify the barriers for a smooth market introduction.
--	---

B.2 Industry forums and events

5GCAR industry forums and events from June 2017 to May 2018 are collected here.

B.2.1 2017-11 SIA dissemination event

In the SIA (Société des Ingenieurs de l'automobile) dissemination event, 29 November 2017, 5GCAR contributed with the organization.

Date	29 November 2017
Location	Paris, France
Website	http://www.sia.fr/evenements/105-technologies-telecommunication-pour-automobile
Organization committee	Bernadette Villeforceix, Antonio Eduardo Fernandez
Contributions	Bernadette Villeforceix, Antonio Eduardo Fernandez
Scope	5GCAR organized a dissemination event in Paris, 29 November 2017, with the SIA (Société des Ingenieurs de l'automobile). This is an association of French engineers, managers and technicians working in the automotive sector in France. Its main goal is to promote innovation and technical exchange between automotive professionals. The event was mainly addressed to people involved in electronics both for OEMs and providers in order to remark the possibilities of 5G in the connected and autonomous vehicle ecosystem.

B.2.2 2018-02 Booth at MWC

In the Mobile World Congress (MWC), 26 February to 1 March 2018, 5GCAR organized a booth.

Date	26 February to 1 March 2018
Location	Barcelona, Spain
Website	https://www.mobileworldcongress.com/
Organization	Ricard Vilalta (CTTC), Mikael Fallgren (Ericsson), Kai Cordes (Viscodia), Jamie Slome (KCL), Selva Vía, Fermín Mira, Juan Luis



committee	de la Cruz, Jesús Alonso-Zarate (CTTC).
Contributions	5GCAR booth and 5GCAR presentation.
Scope	<p>5GCAR presented a demo at this edition of the Mobile World Congress (MWC18). As part of the 5GBarcelona initiative, aimed at promoting the city of Barcelona as a 5G hub in Europe, the Mobile World Capital invited the 5G Infrastructure Association (5GIA), the private sector side of the 5G-PPP, to have a space at its booth at MWC18. The space showed demos of key projects now being undertaken under the 5G-PPP umbrella.</p> <p>5GCAR MWC18 demo, led by Dr. Ricard Vilalta and a team of engineers and researchers brought together by CTTC, with the collaboration from other partners in the project (Ericsson, Huawei, VISCODA, and King’s College London (KCL)), staged a fully operational demo showcasing some of the key innovations being explored in the project. These include the use of IoT-based V2X communications, Software-Defined Networking (SDN), Mobile Edge Computing (MEC), and Advanced Real-Time Image Processing, all orchestrated from a central computing “brain”.</p> <p>The demo illustrated how all these technologies can be combined to enable safer driving in city streets. While the project is preparing a real demo using actual cars that will be ready by the end of the project, the demo presented by CTTC at this edition of the MWC18 was based on small-sized cars intended to validate the ideas explored in the project.</p> <p>The demo was held at the Mobile World Capital booth during all four days of MWC18. Visitors where able to see the demo and chat with experts from CTTC and other 5GCAR partners involved in the design and implementation of the demo, to learn more details about the technology being developed and ask any questions they may have.</p> <p>This demo at MWC18, the biggest event devoted to telecommunications worldwide, aimed to show just one of the potential benefits 5G technology can bring. The positive impact that 5G-enabled connected cars can have on traffic efficiency and safety is just one of the benefits 5G technologies will have on the economy and society overall.</p>

In Figure B.1 two pictures are used to visualize the scenery of the 5GCAR demo from this MWC event.



Figure B.1: 5GCAR demo at 5G-PPP booth in MWC 2018.

B.3 Publications

5GCAR conference paper publications and journal paper publications from June 2017 to May 2018 are collected here.

B.3.1 Conference papers

5GCAR conference paper publications from June 2017 to May 2018 are collected here.

Date	Author(s)	Title of paper	Publisher	Conference	Location
2018, May 26-28	M. Deghel, S. E. Elayoubi, A. Galindo-Serrano, R. Visoz	Joint Optimization of Link Adaptation and HARQ Retransmission for URLLC Services	IEEE	25th International Conference on Telecommunication (ICT), 26-28 May 2018	Saint Malo
2018, April 15-18	G. Destino, J. Saloranta, H. Wymeersch, and G. Seco-Granados	Impact of Imperfect Beam Alignment on the Rate-Positioning Trade-Off	IEEE	Wireless Communications and Networking Conference (WCNC), 15-18 April 2018	Barcelona
2018, April 15-18	Z. Abu-Shaban, X. Zhou, T. Abhayapala, G. Seco-	Location and Orientation Estimation Performance with Uplink and Downlink 5G mmWave	IEEE	Wireless Communications and Networking Conference (WCNC), 15-18	Barcelona



	Granados, and H. Wymeersch	Multipath Signals		April 2018	
2018, March 14-16	D.-T. Phan-Huy, S. Wesemann, J. Bjorsell, M. Sternad	Adaptive Massive MIMO for fast moving connected vehicles: It will work with Predictor Antennas!	IEEE	22nd international workshop on smart antennas (WSA), 14-16 March 2018	Bochum
2017.12.08	Ghizlane Mountaser, Massimo Condoluci, Toktam Mahmoodi, Mischa Dohler, and Ian Mings	Cloud-RAN in Support of URLLC	IEEE	GLOBECOM, 4-8 December 2017	Singapore
2017.12.08	J. Talvitie, M. Valkama, G. Destino, and H. Wymeersch	Novel Algorithms for High-Accuracy Joint Position and Orientation Estimation in 5G mmWave Systems	IEEE	GLOBECOM, 4-8 December 2017	Singapore
2017, November 22-24	Ricard Vilalta, Selva Via, Fermín Mira, Luis Sanabria, Ricardo Martínez, Ramon Casellas, Raul Muñoz, and Jesus Alonso-Zarate	Control and Management of a Connected Car Using YANG/RESTCONF and Cloud Computing	IEEE	8th International Conference on Network of the Future (NoF), 22-24 November 2017	London
2017.10.10	H. Guo, B. Makki, and T. Svensson	A Comparison of Beam Refinement Algorithms for Millimeter Wave Initial Access	IEEE	28th annual international symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), 8-13 October 2017	Montreal



B.3.2 Journal papers

5GCAR journal paper publications from June 2017 to May 2018 are collected here.

Date	Author(s)	Title of paper	Publisher	Journal
2018, June	M. Fallgren et al.	5GCAR contribution to 5G Annual Journal	Euro 5G	The European 5G Annual Journal
2018, May (to appear)	H. Guo, B. Makki, T. Svensson,	Genetic-Algorithm Based Beam Refinement for Initial Access in Millimeter-Wave Mobile Networks	Wiley-Hindawi	Wireless Communications and Mobile Computing: Special Issue on Recent Advances in 5G Technologies: New Radio Access and Networking
2018	J. Zhao, T. Mahmoodi	Energy and Latency Control for Edge Computing in Dense V2X Networks	IEEE	Transactions on Vehicular Communications
2018, May	M. Buehrer, H. Wymeersch, and R. Vaghefi	Collaborative Sensor Network Localization: Algorithms and Practical Issues	IEEE	Proceedings of the IEEE
2018, May	G. Fodor	Mode Selection Schemes for Unicasting Device-to-Device Communications Supported by Network Coding	Wiley	International Journal of Communication Systems
2018, April	R. Muñoz, R. Vilalta, N. Yoshikane, R. Casellas, R. Martínez, T. Tsuritani, I. Morita	Integration of IoT, Transport SDN and Edge/Cloud computing for Dynamic Distribution of IoT Analytics and Efficient Use of Network Resources	IEEE	Journal of lightwave Technologies, Vol. 36, No. 7, pp. 1420 – 1428, April 2018.
2018, March	P. Zhao, G Fodor, G. Dan, and M. Telek	A Game Theoretic Approach to Setting the Pilot Power Ratio in Multi-User MIMO Systems	IEEE	Transactions on Communications
2018, January	G. Fodor	Performance Comparison of Practical Resource Allocation Schemes for Device-to-Device Communications	Wiley	Wireless Communications and Mobile Computing
2017, December	Henk Wymeersch, Gonzalo Seco-Granados, Giuseppe Destino,	5G mm-Wave Positioning for Vehicular Networks	IEEE	Wireless Communication Magazine



	Davide Dardari, and Fredrik Tufvesson			
2017, September	B. Martinez de Aragon, J. Alonso- Zarate, and A. Laya	How Connectivity is Transforming the Automotive Ecosystem	Wiley	Transactions on Emerging Telecommunications Technologies (ETT) Technology Letters

B.4 Talks and presentations

5GCAR talks and presentations from June 2017 to May 2018 are collected here.

Date	Presenter(s)	Title of talk	Event	Location
2018.04.13	T. Svensson	Integrated Moving Networks – Mutual Opportunities for Connected Vehicles and Mobile Networks	Vehicle Electronics and Connected Services (VECS) 2018	Gothenburg
2018.03.06	T. Mahmoodi	What we really can do with 5G ultra-low latency	IEEE 5G Summit	Trento
2018.02.28	M. Fallgren	5GCAR	Speaker at the Mobile World Capital in Mobile World Congress, 26 February to 1 March 2018	Barcelona
2017.12.12	M. Fallgren	H2020 5G-PPP Phase 2 Project 5GCAR	Invited speaker at Automated Road Transports cluster meeting	Brussels
2017.12.12	T. Abbas	H2020 5GCAR Project: Objectives, Methodology and R&I Activities	IEEE VTS Workshop on Wireless Vehicular Communications	Halmstad
2017.12.08	M. Fallgren	5G Connected Vehicles	Invited workshop keynote speaker in ET5GB at IEEE GLOBECOM, 4-8 December 2017	Singapore
2017.11.14	A. Servel	Vertical spotlight – highlighting the requirements of the automotive industry	Invited keynote speaker at Ultra Reliable Low Latency Communications (URLLC) 2017 Conference Summary, 14 November 2018	London



2017.11.09	T. Abbas	5G connected cars for sustainable society	International conference on technological innovation and sustainable society	Vilnius
2017.11.01	T. Svensson	Integrated Moving Networks	Invited speaker at Beijing University of Posts and Telecommunications (BUPT), High-Performance Computing and Networking Laboratory	Beijing
2017.10.30	T. Svensson	Integrated Moving Networks	Invited speaker at Beijing University of Posts and Telecommunications (BUPT), WTI Lab	Beijing
2017.10.26	T. Svensson	Integrated Moving Networks	Invited speaker at Tsinghua University	Beijing
2017.10.18	A. Laya	5G and the transformation of the automotive ecosystem	Invited speaker at Wireless World Research Forum (WWRF) Meeting 39, 18-20 October 2017	Castelldefels
2017.10.18	R. Vilalta	Fog computing and the connected car	Invited speaker at Wireless World Research Forum (WWRF) Meeting 39, 18-20 October 2017	Castelldefels
2017.10.18	T. Svensson	Integrated Moving Networks	Invited speaker at Wireless World Research Forum (WWRF) Meeting 39, 18-20 October 2017	Castelldefels
2017.10.18	M. Boban and T. Abbas	V2X channel measurements and modeling	Invited speaker at Wireless World Research Forum (WWRF) Meeting 39, 18-20 October 2017	Castelldefels
2017.10.18	M. Fallgren	The 5GCAR Project	Invited speaker at Wireless World Research Forum (WWRF) Meeting 39, 18-20 October 2017	Castelldefels
2017.10.18	M. Fallgren	On 5G Connected Cars	Invited keynote speaker at Elastic Networks organizes a series of free tutorials on 5G topics	Castelldefels
2017.10.09	T. Mahmoodi	Shaving the Milliseconds of Communication and Networking Protocols	Invited speaker at IEEE 5G Summit	Montreal
2017.07.12	T. Abbas	5G connected cars - From myth to	Invited speaker at China-EU Workshop	Brussels



		reality		
2017.07.12	M. Fallgren	The 5G Infrastructure Public-Private Partnership: 5G and Connected Car in EU	Invited speaker at China-EU Workshop	Brussels
2017.06.14	M. Fallgren	5G-PPP: Introduction of Phase 2 - 5GCAR	Invited speaker at 5G-PPP session in European Conference on Networks and Communications (EuCNC), 12-15 June 2017	Oulu
2017.06.01	M. Fallgren	Fifth Generation Communication Automotive Research and innovation	Invited speaker at Phase 2 introduction day	Brussels

B.5 Panels and schools

5GCAR panels and schools from June 2017 to May 2018 are collected here.

B.5.1 Panels

5GCAR panelists and moderators from June 2017 to May 2018 are collected here, whereas details on organized 5GCAR panel events are given in Annex B.1 and in Annex B.6.

Date	Panelist, or Moderator	Title	Event	Location
2018.04.20	M. Fallgren as panelist	Connectivity	Interactive Symposium on Research & Innovation for Connected and Automated Driving in Europe, 19-20 April 2018	Vienna
2018.04.17	M. Fallgren as panelist	New Perspectives on Wireless Communications and Networking for Industrial Automation	IEEE Wireless Communications and Networking Conference (WCNC), 15-18 April 2018	Barcelona
2018.04.17	M. Dillinger as moderator	5G and Verticals - The Connected and Automated Driving (CAD) Case	IEEE Wireless Communications and Networking Conference (WCNC), 15-18 April 2018	Barcelona
2018.04.17	M. Fallgren	5G and Verticals - The Connected and Automated	IEEE Wireless Communications and	Barcelona



	as panelist	Driving (CAD) Case	Networking Conference (WCNC), 15-18 April 2018	
2018.04.17	T. Abbas as panelist	5G and Verticals - The Connected and Automated Driving (CAD) Case	IEEE Wireless Communications and Networking Conference (WCNC), 15-18 April 2018	Barcelona
2017.11.06	M. Fallgren as panelist	5G: Rolling Out the Network for True Connectivity	TU-Automotive Europe, 6-7 November 2017	Munich
2017.10.18	R. Vilalta as moderator	5G Connected Car: Discussion panel	Wireless World Research Forum (WWRF) Meeting 39, 18-20 October 2017	Castelldefels
2017.10.18	M. Fallgren as panelist	5G Connected Car: Discussion panel	Wireless World Research Forum (WWRF) Meeting 39, 18-20 October 2017	Castelldefels
2017.10.18	T. Abbas as panelist	5G Connected Car: Discussion panel	Wireless World Research Forum (WWRF) Meeting 39, 18-20 October 2017	Castelldefels
2017.10.18	M. Boban as panelist	5G Connected Car: Discussion panel	Wireless World Research Forum (WWRF) Meeting 39, 18-20 October 2017	Castelldefels
2017.10.18	T. Svensson as panelist	5G Connected Car: Discussion panel	Wireless World Research Forum (WWRF) Meeting 39, 18-20 October 2017	Castelldefels
2017.10.18	A. Laya as panelist	5G Connected Car: Discussion panel	Wireless World Research Forum (WWRF) Meeting 39, 18-20 October 2017	Castelldefels

B.5.2 Schools

5GCAR schools and training events from June 2017 to May 2018 are collected here.

Event	Short Course
Date	6-17 November 2018
Location	Vilnius, Lithuanian
Organization Team	Vilnius Design and Technical College (VDTK)
Teacher	Taimoor Abbas (VCC)
Participation	Open to all students at VDTK college
Title	Connected Cars Towards Autonomous Driving



B.6 On some future 5GCAR dissemination activities

Some future 5GCAR dissemination activities to take place after the finalization of this report (May 2018) are collected in this section.

B.6.1 2018-06 Workshop in BMSB

In the IEEE International Symposium on Broadband Multimedia Systems and Broadcasting, 6-8 June 2018, 5GCAR is organizing the 5G Connected Cars: Vehicular-to-Everything Communications workshop.

Date	7 June 2018
Location	Valencia, Spain
Website	https://www.mcg.upv.es/en/bmsb2018/workshops/
Organization committee	Mikael Fallgren
Contributions	Mikael Fallgren
Scope	<p>This workshop, organized by the 5GCAR project consortium, is devoted to discussing the role of 5G technologies for the connected car. 5G technologies will enable vehicles to be connected to the networks and to be able to talk to each other ensuring low reliability and ultra-low latency. Disruptive new applications enabled from improved connectivity will allow improving driving efficiency and boosting road safety.</p> <p>The session will be split into two parts. First, a series of talks will be provided based on the accepted papers. Then, an interactive panel discussion will follow.</p>

B.6.2 2018-06 5G V2X Summer School

5GCAR is organizing a two-day summer school dedicated to 5G V2X communications. The first day will provide detailed academic advances in the 5G V2X and the second day will focus on more applied and industry visions.

Date	11-12 June 2018
Venue	London
Website	https://nms.kcl.ac.uk/toktam.mahmoodi/v2x-summer-school/index.htm
Organization Team	King's College London
Contributions	By invitation



Participation	Open to all with free registration (200+ registered)
Scope	V2X communications, URLLC, Machine Learning, NFV, Positioning, Techno-economics

B.6.3 2018-06 Workshop at EUCNC

In the 27th European Conference on Networks and Communications (EuCNC), 18-21 June 2018, 5GCAR is organizing the Workshop on Vertical Industries & Services for 5G.

Date	18 June 2018
Location	Ljubljana, Slovenia
Website	https://www.eucnc.eu/workshops/workshop-1/
Organization committee	Erik Ström and Mikael Fallgren from 5GCAR, as well as Woon Hau Chin, Chiara Buratti, Laura Baracchi, Stephanie Parker, Belkacem Mouhouche
Contributions	By invitation
Scope	A full day workshop with four keynote speeches, several project presentations, and two panels

B.6.4 2018-06 Panel at EUCNC

In the 27th European Conference on Networks and Communications (EuCNC), 18-21 June 2018, 5GCAR is organizing the Workshop on Vertical Industries & Services for 5G.

Date	19 June 2018
Location	Ljubljana, Slovenia
Website	https://www.eucnc.eu/panels-1/
Organization committee	Markus Dillinger
Contributions	Chair: Markus Dillinger. Panelists from 5GCAR: Zexian Li, Mikael Fallgren, Mikael Nilsson. Other panelists: Andreas Mueller, Bo Andersson
Scope	Vertical industries like Automation Industry and Car Industry are expected to be the major topics in coming years for 5G networks. However, requirements are still evolving and sustainable business models and cases are still to be developed. An important ingredient are spectrum requirements for verticals in terms of licensed or unlicensed spectrum and the targeted amount of bandwidth. Cooperation models and business cases between involved stakeholders need to be created and monetized. Moreover, to jointly identify standardization requirements roadmaps



	<p>for 3GPP, ETSI, SAE, etc. and certification challenges is key in coming years. The panelist from verticals (e.g. car industry), telecom industry and academia will elaborate on business, technical and regulatory challenges to help identify the barriers for a potential market introduction.</p> <p>Questions</p> <ol style="list-style-type: none">1. What are the potential business cases and roles for 5G vertical stakeholders?2. What is the role between public and private 5G networks?3. What is the business model for service providers (e.g. drones, connected and autonomous driving, etc.)?4. What are the spectrum licensing options and spectrum usage models for verticals?5. What role and timeframe do you see for communication technologies and 5G to impact vertical business?
--	--

B.6.5 2018-06 Special session at EUCNC

The 5GCAR project organizes a special session dedicated to advances in 5G V2X communications and the vision of deploying such advances in connected and autonomous cars, at EUCNC in Ljubljana, 18-21 June 2018.

Date	21 June 2018
Location	Ljubljana, Slovenia
Website	https://www.eucnc.eu/special-sessions/special-session-6/
Organization committee	Toktam Mahmoodi (King's College London, UK) Mikael Fallgren (Ericsson, Sweden) Tommy Svensson (Chalmers University of Technology, Sweden) Erik Ström (Chalmers University of Technology, Sweden) Jesus Alonso-Zarate (CTTC, Spain) Taimoor Abbas (Volvo Car Corporation, Sweden) Mate Boban (Huawei European Research Center, Germany)
Contributions	Keynote speech and panel discussions on advances in 5G V2X communications and the vision of deploying such advances in connected and autonomous cars.
Scope	With the development of ultra-low latency, extremely high reliability and massive device access in 5G, the ambitions for smart driving applications will soon become reality. Therefore, the session brings together experts from telecom and automotive industry to discuss:



	<ul style="list-style-type: none"> – What are the desired use cases in the connected and autonomous cars and when are we expecting them? – What are the challenges for telecommunication network, for device manufacturers as well as car manufacturers, and how each sector is addressing those? – What is the status of current standards and spectrum regulations in supporting those challenges? – What are the lessons learnt from experimentations?
--	---

B.6.6 2018-09 Workshop in PIMRC

In the 29th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), 9-12 September 2018, 5GCAR will organize the Second International Workshop on V2X Communications and Channel Modeling.

Date	9 September 2018
Location	Bologna, Italy
Website	https://wvcm2018.wordpress.com/
Organization committee	Christian Schneider, Massimo Condoluci, Taimoor Abbas, Mate Boban, Apostolos Kousaridas, Tommy Svensson, Fredrik Tufvesson, Toktam Mahmoodi
Contributions	5GCAR partners conceived, organized, and attended the workshop
Scope	V2X communications, channel measurements and modeling

B.6.7 2018-10 Special Issue in MDPI Sensor

5GCAR is organizing a special issue in MDPI Sensors, with deadline in October 2018. This special issue is dedicated to “Enhances in V2X Communications for Connected Autonomous Vehicles.”

Date	Submission deadline October 2018 and publication in the last quarter of 2018
Venue	MDPI Sensors
Website	http://www.mdpi.com/journal/sensors/special_issues/V2X_communications_autonomous_vehicles
Guest Editors	Toktam Mahmoodi, Massimo Condoluci, Taimoor Abbas, Apostolos Kousaridas, Jesus Alonso-Zarate
Contributions	Open to all
Scope	V2X communications
CFP Summary	This Special Issue will be dedicated to advances in 5G V2X communications and the vision of deploying such advances in connected and autonomous cars. With



Document: 5GCAR/D6.1

Status: Final

Version: v1.0

Dissemination level: Public

Date: 2018-05-31

	the development of ultra-low latency, extremely high reliability and massive device access in 5G, the ambitions for smart driving applications will soon become a reality
--	---



C References to the Project

The 5GCAR related press releases together with some press references to the 5GCAR project from the start in June 2017 until the finalization of this report in May 2018 is presented in this Annex.

C.1 5GCAR press releases

The first, and so far only, 5GCAR project press release [5GC-press17] was made publicly available on 17 October 2017, and marked the release of the 5GCAR use cases in [5GC-D21] which was made publicly available at the same time.

Other press releases on 5GCAR that has been made by partners within the consortium, are

2018-03-23, CTAG: “Meeting at CTAG on 5GCAR: Fifth Generation Communication Automotive Research and innovation project” <http://ctag.com/en/reunion-en-ctag-del-proyecto-5gcar-fifth-generation-communication-automotive-research-and-innovation/>

2018-03-22, Orange: “Network slicing: ‘Innovation 5G connectivity for connected vehicles’” <https://hellofuture.orange.com/en/network-slicing-innovative-5g-connectivity-connected-vehicles/>

2018-02-23, CTTC: “5G Technology for the Connected Car: CTTC researchers Demonstrate the 5GCAR Research Project at the 2018 Mobile World Congress in Barcelona” <http://www.cttc.es/5g-technology-for-the-connected-car-cttc-researchers-demonstrate-the-5gcar-research-project-at-the-2018-mobile-world-congress-in-barcelona/>

2017-09-12, Chalmers: “The project that sets the standard for 5G in vehicles” <https://www.chalmers.se/en/departments/e2/news/Pages/The-project-that-sets-the-standard-for-5G-in-vehicles.aspx>

2017-06-07, Ericsson Press Release, “Ericsson leads European 5GCAR project” <http://mb.cision.com/Main/15448/2293682/691493.pdf>

<https://www.ericsson.com/au/en/press-releases/2017/6/ericsson-leads-european-5gcar-project>

C.2 Other references to the project

In this section we list references to 5GCAR that is coming from outside the project consortium.

2018-05-17, European Commission: “COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE, THE COMMITTEE OF THE REGIONS” https://ec.europa.eu/transport/sites/transport/files/3rd-mobility-pack/com20180283_en.pdf



2018-03-08, 5G-PPP, "5G – THE megatrend at the MWC 2018" <https://5g-ppp.eu/5g-the-megatrend-at-the-mwc-2018/>

2018-02-23, 5GBarcelona, "Get to know the 5GBarcelona strategy at MWC 2018" <https://5gbarcelona.org/5gbarcelona-at-mwc-2018/>

2017-10-19, wi360: "5GCar Defines Five V2X Use Cases" <http://5gsmarts.com/5g-tech/5gcar-v2x-use-cases/>

2017-09-26, Ny Teknik: <https://www.nyteknik.se/digitalisering/chalmers-ar-med-och-satter-standarden-for-5g-i-fordon-6873672>

2017-09-14, Science Business: "5GCAR project to set the standard for 5G in vehicles" <https://sciencebusiness.net/network-news/5gcar-project-set-standard-5g-vehicles>

2017-09-14, SAMENA Daily: "5GCAR project to set the standard for 5G in vehicles" https://samenaouncil.org/samena_daily_news?news=64326

September 2017, GSMA: "SAFER AND SMARTER DRIVING: The Rollout of Cellular V2X Services in Europe" https://www.gsma.com/iot/wp-content/uploads/2017/09/GSMA-position-on-C-V2X-in-Europe_Final.pdf

2017-06-20, Above Ground Level (agl) Media Group, "Ericsson leads European 5GCAR Project" <https://www.aglmediagroup.com/ericsson-leads-european-5gcar-project/>

2017-06-12, Digital Terminal (DT), "Ericsson Leads European 5GCAR Project" <http://digitalterminal.in/news/ericsson-leads-european-5gcar-project/9807.html>

2017-06-12, FierceWireless: "Ericsson-led 5GCAR project gets EU funding" <https://www.fiercewireless.com/wireless/ericsson-led-5gcar-project-gets-eu-funding>

2017-06-09, Auto connected car news: "5GCAR Project will develop 5G optimized for V2X" <http://www.autoconnectedcar.com/2017/06/5gcar-project-will-develop-5g-optimized-for-v2x/>

2017-06-09, Telematics wire: "Ericsson led consortium awarded 5GCAR project" <http://telematicswire.net/tag/5gcar/>

<http://telematicswire.net/ericsson-led-consortium-awarded-5gcar-project/>

2017-06-09, Thestack: "Ericsson 5GCAR project wins EU funding" <https://thestack.com/iot/2017/06/09/ericsson-5gcar-project-wins-eu-funding/>

2017-06-08, Emergent Tech: "Ericsson leads 5G connected car gang towards pot of EU gold" <http://telematicswire.net/tag/5gcar/>

2017-06-08, Enterprise iot insights: "Ericsson 5GCAR project wins EU funding" <https://enterpriseiotinsights.com/20170608/news/ericsson-5gcar-project-wins-eu-funding-tag4>

2017-06-07, DQChannels: "Ericsson LEADS European 5GCAR PROJECT" <https://www.bnamericas.com/en/news/ict/ericsson-leads-5gcar-project/>

2017-06-07, BNamericas: "Ericsson leads 5GCAR project" <https://www.bnamericas.com/en/news/ict/ericsson-leads-5gcar-project/>



2017-06-07, Telecoms.com: “Ericsson gets green light for connected car initiative”
https://samenacouncil.org/samena_daily_news?news=64326

2017-06-07, Evertiq: “Ericsson leads European 5GCAR project”
<https://evertiq.com/design/41817>

2017-06-07, Telecomstechnews: “Ericsson takes pole position on 5GCAR project”
<https://www.telecomstechnews.com/news/2017/jun/07/ericsson-takes-pole-position-5gcar-project/>

2017-06-07, Globenewswire: “Ericsson leads European 5GCAR project”
<https://www.globenewswire.com/news-release/2017/06/07/1009182/0/en/Ericsson-leads-European-5GCAR-project.html>

<http://inpublic.globenewswire.com/2017/06/07/Ericsson+leads+European+5GCAR+project+HUG2111074.html>



D Individual Exploitation Plans

The exploitation strategy will depend on the participant's category, i.e., telecom infrastructure providers, mobile network operators, industrial equipment vendors, car manufacturers, small to medium sized enterprises, and academia. The partners will have the results of the 5GCAR project at their disposal for further research.

D.1 Telecom infrastructure providers

Telecom infrastructure providers involved in the 5GCAR project acknowledge the importance of 5G wireless communications in the future automotive industry and business landscape in Europe V2X communication and collaboration. In this context, the manufacturers need to have an influence on early harmonization and system specifications, in order to create the corresponding markets and address them with competitive products at the appropriate time.

D.1.1 Ericsson

For ERICSSON, the 5G V2X communication platform is one central component for realizing its networked society vision. The 5GCAR project is crucial to create the required alignment among the involved industries from car manufacturers and their tier 1 suppliers over device and telecom infrastructure vendors to mobile network operators to form a common consensus regarding requirements and solutions.

ERICSSON will exploit the technical solutions that is being developed in the project in various ways. Results and insights will be presented to the business units and will thereby have an impact on future product decisions that target the V2X use cases. Promising solutions will be contributed to relevant standardization bodies like 3GPP or ETSI-ITS and will be used in the context of pre-standardization fora like the 5G Automotive Association (5GAA), where ERICSSON is a founding member. The 5GCAR results will also help in regulatory discussions and decisions in order to ensure the availability of spectrum to operate critical V2X related services. The project will also generate innovations that will be protected with IPR in order to protect their competitive advantage. Overall, we expect that the joined effort of the 5GCAR project partners helps to speed up the market introduction of V2X services

D.1.2 Huawei

HWDU is leading the European innovation activities of HUAWEI, the globally leading telecommunication vendor. HWDU is working to push innovation in 5G in Europe and to foster a quick market penetration of V2V, V2I and V2N applications. 5GCAR will facilitate to bring the different value-chain stakeholders to the same table and help them better explore this new market. We first benefit from an envelope of requirements and interworking that is new for the telecommunication industry. This will help us to enhance our existing product portfolio and even to create new products for different types of V2X communications. To this end, we aim at driving the required standardization activities in 3GPP and ETSI-ITS, as well as to pre-standardization



bodies such as the 5G Automotive Association (5GAA), where HUAWEI is one of the founding members. Early acceptance of new technology trends by the customers will be achieved by promoting these through Huawei's Customer Innovations Centers located in Germany, UK, France, Spain and Sweden. Our ultimate benefit from 5GCAR is to eventually deliver the essential communication modules and tools for device manufacturers, car industry and mobile network operators so that 5G V2X solutions becomes a reality in Europe first and then exported to the world.

D.1.3 Nokia

NOKIA intends to use the results from the 5GCAR project to influence and make recommendations to existing standardization organizations as well as global cross-industry pre-standardization associations, including at least 3GPP and 5GAA (5G Automotive Association). We will contribute the developed solutions to different groups in 3GPP. Moreover, NOKIA is a founding member of 5GAA and we plan to contribute and collaborate within the association on technical, business and regulatory aspects towards the development and accelerated deployment of solutions for the automotive use cases. Such collaboration will also include the validation of the technical solutions through demonstrations, pilots and testbeds that will help provide guidance to NOKIA Business Units for the development and evolution of future products and services.

D.2 Telecom operator

Mobile network operator involved in 5GCAR recognize the potentials the automotive sector offers to expand their total service offering, thereby increasing their market size and growth rate. The need to enhance existing infrastructure or functions has also been identified in order to achieve V2X Services' QoS metrics.

D.2.1 Orange

ORANGE is willing to assess future 5G deployment scenarios and infrastructure investments and to build the rolling plan according to related business. ORANGE will first use 5G-PPP Phase 2 research and innovation projects to design jointly relevant applications with vertical industries, to build European ecosystems around these applications and to demonstrate that a shared infrastructure can support several vertical applications in parallel. 5GCAR will be the place to benchmark and select technologies and architectures for future standards and infrastructure enablers. The 5GCAR project will also help ORANGE ensure that future network services will offer the best experience to our customers and will be sustainable (in terms of energy, costs and social issues) and operationally manageable. Orange is contributing to the WP6, being task leader for T6.2, for the dissemination of information relative to the standardization in ETSI TC ITS in 5GCAR project and potentially animate the liaison created between 5GCAR and ETSI TC ITS.



D.3 Car manufacturers

Car manufacturers in the 5GCAR consortium are interested in embedding both intelligence and communication components in vehicles. Vehicles that are smoothly collaborating with other vehicles or devices will enhance awareness and problem-solving functions for safety, automation and traffic efficiency, under very strict time/space performance requirements

D.3.1 PSA

PSA Group has been a pioneer in communicating cars. Since 2003, the Group has been renowned for its best-selling emergency call and automated assistance systems, which automatically call for help in case of an accident. To date, more than 1.8 million Peugeot, Citroën and DS vehicles have been equipped with this system. The PSA Group has a connectivity roadmap which consists of three key stages, namely: “Save Time” (2016), “Easy Life” (2016-2018), and “Enjoy Life” (2018-2020). Based on this roadmap, the Group will gradually introduce a series of technological solutions, such as remote services and Car-to-Car and Car-to-Infrastructure communications technology. In this set of solutions, the V2X communications are an enabler for the 5G are a crucial tool to get drive and emergency context awareness.

Continuous and integrated connectivity will pave the way for automated driving, a huge opportunity to improve road safety (nearly 90% of road accidents are caused by human error). PSA has defined three stages for its advanced driver assistance systems (ADAS) where the last “Eyes-Off”, is planned for 2020-2025. It includes remote parking capabilities and the advent of a fully automated, driverless vehicle (“Mind Off”).

PSA projections see the European mobility market growing to more than €13.6 billion in 2020, from €7.7 billion in 2014, an explosion of over 56%. 1.7 million vehicles would be required to serve this market in 2020 (compared to 1.27 million in 2014) in G10 Europe, including 500,000 in the area of car-sharing alone (B2B business car-sharing and B2C urban car-pooling). For this the new business model which will be enabled by 5G will be studied in the project

D.3.2 Volvo Car Corporation

Volvo Car Corporation (VCC) has been involved in various wireless research projects related to V2X communication and the 5GCAR project is an important step towards enabling cooperative awareness. Investigating new business cases using 5G could improve customer experience and enable new business opportunities for our customers. The 5GCAR project and the research in a high accuracy radio-based positioning system could be one key contribution to improve the positioning on vehicles and assist with identification of VRUs.

VCC engineers are contributing in various work packages and feed in experience from previous wireless research projects and learn more on how to integrate the 5G technology with potential antenna designs into the vehicles, enable faster time to market.



D.4 Industrial equipment vendor

Industrial equipment vendor that participate in 5GCAR and provide V2X solutions recognize that the collaboration between the industrial equipment vendors, OEMs and telecom industry is crucial. The generation and ownership of intellectual property is essential to ensure profitability of the manufacturer's business, and at the same time, to provide incentives for competition through open platforms or cross-license agreements on fair and reasonable terms

D.4.1 Bosch

BOSCH is planning to disseminate the results of the project within different business units focusing on connected and automated mobility. The findings from the project will be used directly to make future product decisions and will speed up the adoption of the 5G technology for the automotive domain and strengthen the position of BOSCH as a world leading solution provider for automated and connected mobility. During the project, we also expect the generation of IPR to strengthen our competitive position, by bringing domain-specific know-how and 5G communication technology together. Moreover, speed and informed technical decisions are important for our business as tier 1 in the automotive business. For a profound product development phase, we need the cooperation with network operators, service providers and tier 2 equipment vendors, and research organizations. The results achieved in the project with respect to cooperative systems and the supporting communication technologies will be used to provide valuable contributions for the standardization of 5G mobile networks and the work of the Car-to-Car Communication Consortium as well as the newly formed European Automotive–Telecom Alliance. Finally, the results from 5GCAR with regard to communication technologies and systems will serve as a starting point for further research activities to support our product development of in-vehicle Connectivity Control Units and Connected Driver Assistance Systems/ Highly Automated Driving Systems

D.5 Academics

Academic partners, i.e., universities and research institutions, that participate in the 5GCAR consortium are interested in building on and further developing existing research strength in V2X systems. The gained expertise will permeate into the daily university life and will be disseminated within academic education as preparation of future European ITS and 5G experts.

D.5.1 Centre Tecnològic de Telecomunicacions de Catalunya

The exploitation plan of Centre Tecnològic de Telecomunicacions de Catalunya (CTTC) is threefold since the participation in 5GCAR will i) generate knowledge in the area of wireless technologies for V2X within 5G, strengthening the international reputation of CTTC as a key reference institution within the field of V2X communications for 5G and, in particular, for the automotive vertical sector, ii) strengthen the visibility of CTTC as a key player in the specification of V2X communications for 5G, thus facilitating further collaboration in future research programs involving Machine-Type Communications and Software Defined Networking, and iii) strengthen the collaboration with leading European and National industry players, thus



maximizing the technology transfer generated by CTTC. One of the main objectives of CTTC is to build bridges between academia and industry, promoting a new economy based on knowledge and technology. The participation of CTTC in 5GCAR will facilitate the involvement of SMEs and academia in 5G-related activities, and establish connections with big industrial players in Europe, both within the automotive sector and also in other sectors with similar communication requirements to those of automotive use cases, e.g., Industry 4.0. Therefore, the expertise, knowledge and visibility gained in 5GCAR will put CTTC in an ideal position to interconnect all players (universities, research centres, and industry) in the 5G ecosystem.

D.5.2 Centro Tecnológico de Automoción de Galicia

Having gathered a strong background in development and deployment of C-ITS services based on ETSI ITS G5 technology during last years, CTAG (Centro Tecnológico de Automoción de Galicia) is now working to include into this V2X solution to also support 4G and 5G communication modes. Participation in the 5GCAR project will allow CTAG not only to go on exploiting C-ITS services potential by increasing its offer in terms of availability and capability but also to analyse and compare the different technology approaches depicted for C-ITS systems. The extension and enhancement of CTAG competences that the 5GCAR project will bring should pave the way to keep CTAG updated and in good position at European level as C-ITS service provider. Support to different stakeholders (e.g., OEMs, Road Authorities) not only to deploy in a coherent manner C-ITS services then leading large scale deployment in urban and interurban environments, but also to test and validate them being technological agnostic (hybrid approach) is the aspiration. Finally, results from 5GCAR will act as trigger for further research initiatives where experience gathered will support development of other systems and services.

D.5.3 Chalmers University of Technology

CHALMERS will use the 5GCAR project to build on and further develop our existing research strengths in the targeted fields of the project. The involved senior researchers will increase their knowledge, which will permeate into the daily university life and will be disseminated within the academic research and education. For the involved post docs, this means a chance to qualify for further academic positions. For the Ph.D. and M.Sc. students in the project, the research and knowledge gained during the project will help them achieve their Ph.D. and M.Sc. titles, respectively. By actively contributing to this project, when graduated, the students will be highly attractive for further career in industry and academia. Patent application might be considered for selected innovations.

CHALMERS will disseminate project results to the scientific community via international peer-reviewed conferences and journals with high impact factor in the fields of signal processing, information theory, communications theory, and wireless networks. CHALMERS will also actively contribute to project dissemination at international workshops, such as the International Workshop on Emerging Technologies for 5G and Beyond Wireless and Mobile Networks (ET5GB) in conjunction with IEEE Globecom that we have been co-organizing the last years and the European Conference on Networks and Communications (EuCNC) and at technical and



management meetings of the COST Action CA15104 (IRACON). CHALMERS will also seek to organize special issues in journals such as JSAC, IEEE networks, as well as organizing tutorials on selected topics in conjunction with the top international conferences. The results will also be included in M.Sc. and Ph.D. theses.

D.5.4 King's College London

King's College London (KCL) will exploit the technical solutions developed within the 5GCAR project to speed up the introduction of up-to-date education and training materials on 5G MTC, and 5G V2X via the followings:

- Massive online courses (MooC): KCL has already an established MooC on the IoT and is aiming to expand this course based on the knowledge gained from 5GCAR.
- Postgrad and undergrad projects: KCL delivers more than 20 undergrad and postgrad programmes on telecommunications, electronic engineering, robotic engineering and big data. The 5GCAR knowledge will be exploited by means of student projects, relevant to the state of EU industry in KCL.

Furthermore, KCL will exploit the results to build on their existing efforts in the city of London in introducing 5G to various services in the city including public transportations.

D.6 Small to medium sized enterprises

Small and Medium-sized Enterprises (SMEs) engaged in 5GCAR will create strong R&D links with both academia and leading industrial entities which positions them within a very strong value chain. The SMEs at the same time provide an innovative character with necessary edge competence, services and products.

D.6.1 MARBEN

MARBEN V2X software product is today a complete and proven solution supporting both EU and US standards for, respectively, ITS-G5 and DSRC (over 802.11p). It includes both a protocol stack and V2V/V2I/I2V applications, for vehicles, road-stations and vulnerable users (e.g. pedestrians). MARBEN V2X roadmap includes supporting the protocol stack (above the MAC layer) and applications over 5G interfaces, as well as new applications taking advantage of 5G unique network capabilities. The 5GCAR project will greatly help Marben Products achieving this roadmap, and validating its solutions, quickly acquiring knowledge about 5G architecture and technologies, thanks to the expertise of 5GCAR partners and 5GCAR project outcomes.

D.6.2 SEQUANS

SEQUANS is developing chipset for 4G terminals. The 5GCAR project is important for SEQUANS to open new possible markets related to connecting the car, one of the particular objects to be connected with 4G evolution and 5G. Moreover, the presence of the main V2X actors in the project will allow SEQUANS to identify and adopt the mainstream solution for V2X and thus provides to the company a possible time to market advantage. The project outcomes



will help SEQUANS to define next generation products features, in particular those related to V2X communications.

D.6.3 VISCODA

The technology of VISCODA is already applied in various pre- and series developments in the European automotive industry, e.g., for real time 3D-reconstruction and semantic interpretation of the car surrounding by the use of cost efficient monocular cameras for driver assistance systems. It is planned to utilize the results of the 5GCAR project to acquire new pre- and series developments and to access new markets in the context of V2X. The technical achievements and the network among the participants within the 5GCAR project will give VISCODA a market advantage.