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Report on Exploitation Y3

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Abstract

This deliverable has been created as part of the work in the project Work Package (WP) 6 “Promotion” and reports the activities performed for exploitation of project results toward vertical stakeholders. It presents the activities performed in terms of the planned organization of training workshops mainly targeting transport, public safety, and rural communities in this last year of the project.

Keywords

dissemination, exploitation, user groups, workshops, vertical markets

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Executive Summary

This deliverable corresponds to the third of a total of three deliverables, concerning the exploitation activities of the 5G-ALLSTAR project within the scope of WP6 focusing on promotion. In this second document, we report activities of each individual partner as well as the whole consortium performed during the third year, including those already reported in terms of progress in D6.10.

More specifically, it details the exploitable knowledge developed by each partner involved in the task, and the individual exploitation actions.

Contents

List of Tables

List of Abbreviations

3GPP	3rd Generation Partnership Project
4G	4th Generation mobile network
5G	5th Generation mobile network
B2B	Business-to-Business transaction type
B2C	Business-to-Consumer transaction type
CAN	Controller Area Network
IP	Intellectual Property
IPR	Intellectual Property (Rights)
KPI	Key Performance Indicator
mmWave	Millimeter wave
MN	Moving Network

MNO	Mobile Network Operators
PoC	Proof of Concept
R&D	Research & Development
RAN	Radio Access Network
RAT	Radio Access Technology
SA(n)	3GPP's Service and System Aspect meeting
TC	Traffic Control
SME	Small and Medium Enterprise
V2X	Vehicle to Everything
WAVE	Wireless Access in Vehicular Environments
WN	Wireless Communication and Network

1 Introduction

The results already obtained within the context of 5G-ALLSTAR and the expected results of the project suggest a viable exploitation of the results for commercial use.

In this document, we report project's results, based on the plan established in D6.9 for the exploitation toward vertical stakeholders in the transport, public safety markets, and rural communities.

Among these activities, we identified two main activities to foster project's innovations awareness, and future diffusion:

1. The development of potential user and key stakeholder groups in the identified verticals;

2. The organization of training workshops where the opportunity of satellite 5G and multi-connectivity are presented.

To assure a successful outcome, these activities are expected to be performed by project partners, both in Europe and Korea. In the following sections, we report them, their expected outcomes, the risks assessment and the mitigation plan.

1.1 Context of this document

The deliverable document corresponds to the third report of a series of three documents planning and then reporting the activities for fostering project's results exploitation for vertical markets.

This document is a deliverable within WP6, Task 6.3 "Business models and focus exploitation for vertical markets". The objectives of Task 6.3 can be summarized as follows:

1. Refine the business models/cases for the proposed 5G-ALLSTAR multiple access concept, initially developed within Task 2.4, and summarized in D2.4, along project's journey.

2. Set-up user groups from the targeted verticals in the area of transport (e.g. public safety sector, Railway Transportation sector which are actually both active in 3GPP), public safety and rural communities.

3. Organize of training workshops with representatives from the targeted verticals on the 5G-ALLSTAR defined solutions and developed technologies to collect feedback on the relevance of the business models and KPIs achieved.

The present deliverable document D6.11 reports the activities performed by project partners for the exploitation toward the targeted vertical markets.

2 Planned activities

In D6.9 of WP6, Task 6.3 “Business models and focus exploitation for vertical markets”, we report the knowledge for each partner involved in the task, and the individual exploitation plan. In the document, some partners had already detailed the exploitable knowledge they developed within the project, and the anticipated opportunities for exploitation.

With D6.10, we extend the previous report to account for the additional activities performed in the latest 6 months since the delivery of D6.9 the 31/12/2019.

This deliverable D6.11 presents updates from the third year of the project until its end the 31/10/2021.

2.1 Exploitable results

The following table reports the main exploitable 5G-ALLSTAR results along their descriptions and supposed mean of exploitation as previously identified.

Table 2 1: Exploitable Results

Exploitable Result	Means of exploitation
Identification of potential use cases and related requirements and design of system architecture with required functionalities.	By **telco operators** to setup a heterogeneous 5G network comprising satellite and terrestrial wireless networks. By **service providers**, which can be provided with a key reference capable of creating new business models and facilitating the development of new applications. By standardization bodies to update relevant standards.
Analysis and simulation results and interference mitigation algorithms regarding spectrum sharing between satellite and cellular systems	By **telco operators** to optimize cell plan to minimize the interference with satellite links By **SNOs** to minimize interference and improve service quality By **standardization bodies** to develop specification that can avoid interference between cellular and satellite systems By **regulatory bodies** to harmonize and optimize spectrum resources
Open-source channel model (e.g., ray-tracing-based channel model) allowing a common framework for cellular and satellite	By **telco and SNOs operators** to use for the optimization of cell planning for both cellular and satellite systems by predicting and avoiding possible coverage holes. By the **research community** to model and assess 5G systems including cellular and satellite systems.
PoC testbeds and trial platforms	By **standardization bodies** to validate the benefits of some concepts. By both **SNOs** and **MNOs** (Mobile Network Operators) to identify some viable interoperability scenarios.

The expected exploitable results cover a broad spectrum of possible application and transversal addressable markets, namely telecommunication, satellite and mobile operators, and service

providers. Beyond these economic actors, standardization and regulatory bodies, and the overall research community may benefit from project results.

At the same time, within 5G-ALLSTAR we directly address vertical markets to foster adoption and facilitate knowledge transfer, eventually resulting in a faster business exploitation of the early results. Therefore, the partners of the project will coordinate their effort to address them directly and in accordance with their unique strategies.

2.2 Stakeholders Interests in the project

Table 2.1 below summarizes the objectives of exploitation of the partners in the consortium. Details are further presented in the Section 3.

Table 2 2: Identified objectives of exploitation

Partner (Role)	Exploitation interest	Exploitation Overview	Target Vertical Market
GEM (Business school)	Business models Business R&D	**Short term:** increasing the understanding of the reconfigurations of business models following the introduction of 5G networks and virtualized infrastructures. **Long term:** leverage the competences developed in the impacts of 5G on business models to study the condition that facilitates technology adoption and digital innovation diffusion.	No single target market, but prioritizing the study of those identified within the project: transport, public safety markets, and rural communities
HHI (Research Institute)	Integrated terrestrial / satellite channel model based on Quadriga	Further increase the user base of Quadriga by adding features that allow the satellite communications community as well as the vertical industry to get an understanding of the physical characteristics of the terrestrial radio access network and especially the impact of an overlay satellite constellation on top of that.	No single target market, but prioritizing satellite communities working on including direct access, backhaul and satellite IoT.
CRAT (Research consortium)	Traffic Flow controllers for Multi-Connectivity; Quality of Experience management systems	**Short term:** increasing the expertise of the company and general awareness regarding 5G by teaching activities and workshops in the masters held at the Universities constituting CRAT; dissemination of the scientific results of the project; development of a prototype for the demonstration of the proposed solutions starting from the PoC of the project. **Long term:** Contacts with SMEs and general technology transfer activities for the development of a market-ready solution that derives from the results of the project; Involvement in new and more advanced research projects.	No single target market, but prioritizing the study of those identified within the project: transport, public safety markets, and rural communities
ETRI (Research Institute)	Product, Standard and R&D (mmWave-	**Short term:** dissemination of the scientific results of the project; development of	No single target market, but prioritizing broadband Wi-Fi service on

	band vehicular communication systems)	a prototype system for the demonstration of the proposed solutions. **Long term:** continuous participation in relevant standardization activities to secure IPRs from research results; technology transfer to Korean SMEs through technology licensing, allowing them to reduce their R&D costs and strengthen their competitiveness; Involvement in new and more advanced research projects.	public transportations (e.g., trains, city/express busses) and other V2X applications
KT SAT (Service Operator)	Service	**Short term:** dissemination of the scientific results of the project; development of a prototype system for the demonstration of the proposed solution by aspect of satellite-based **Long term:** exploration how to this project outcome enable to develop global satellite business market and technologies to global customers	No single target market, but prioritizing the study of those identified within the project: transport, public safety markets, and rural communities
SKT (Service Operator)	Service	**Short term:** dissemination of the scientific results of the project; development of a prototype system for the demonstration of the proposed solution **Long term:** exploration how to this project outcome enable to develop next cellular network technologies	No single target market
KATECH (Research Institute)	Standard, R&D (mmWave band vehicular communication systems for connected and automated vehicle application)	**Short term:** dissemination of the scientific or technical results of the project **Long term:** (Standard) following standardization activities in ITS standardization in terms of hybrid V2X service for connected automated driving system. (R&D) deploying developed technology to extend operational domain design of cooperative, connected automated mobility in terms of communication coverage.	No single target market, but prioritizing the study of those identified within the project: transport, public safety markets, and rural communities
SnetICT (Enterprise)	Service, R&D (mobile core network solution for automated vehicle application using multi-connectivity)	**Short term:** development of a prototype system for the demonstration of the proposed solutions. **Long term:** announcement and publication of research results; Discover business models and analyze technology economics related to market	No single target market, but prioritizing the study of those identified within the project: transport, public safety markets, and rural communities

3 Exploitable Knowledge and Individual plans

3.1 Grenoble Ecole de Management (GEM)

GEM is a leading European business school which mission is to accompany corporate performance by providing the knowledge, skills and talent to meet the economic challenges firms face today and prepare them for those that still lay in the future. As both a teaching and re-search institution, GEM's objective in the project concerns the development of expertise and the identification of the emerging business opportunities of 5G multi-connectivity.

3.1.1 Exploitable Knowledge

The following table identifies the exploitable knowledge developed by GEM in the context of the project.

Table 3 1: GEM's exploitable knowledge

ID	Exploitable Knowledge	Target Vertical Market	Timeframe	Possible IP protection or exploitation
1.GEM	Business models of satellite 5G	No single target market, but prioritizing the study of those identified within the project: transport, public safety markets, and rural communities	3 years	Know-how
2.GEM	Capabilities of multi-connectivity 5G	No single target market, but prioritizing the study of those identified within the project: transport, public safety markets, and rural communities	3 years	Know-how

3.1.2 Progress and outcomes

GEM activities focused on the accumulation of the knowledge necessary to frame the overall opportunity of multi-connectivity and 5G. Specifically, we focused on the analysis and understanding of the expected impacts and opportunities as reported in D2.4, where we analyzed the opportunity for 5G based satellite businesses.

As we already reported, the COVID pandemic has affected GEM's along this third year, partially impacting our research projects overall. We proceeded with our activities and worked toward the diffusion and involvement of industry stakeholders and public raising their awareness of the opportunity of 5G satellite multi-connectivity. The activities mainly involved a specific action toward media, with our appearance on national media (both radio and television), a new set of new interviews with key informants, and the organization of two workshops targeting vertical stakeholders. In particular, we involved communities in the Alpine area for which the 5G opportunity represent an important opportunity for improving the base service offering. The first workshop was held online in May this year gathering more than 80 participants. The workshop gathered both researchers contributing to the development of 5G technologies, and business actors focused in understanding the economic and industrial benefits of 5G networks in vertical markets. The second workshop is planned for the end of 2021 and mainly targets an international and broader audience. We plan to invite multiple stakeholders, beyond those currently directly involved with the project.

3.2 Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute (HHI)

The core competence of HHI is in the areas of mobile broadband systems, photonic networks, and electronic imaging technology for multimedia. The Wireless Communication and Networks (WN) department develops solutions within the broad area of wireless communication systems and networks ranging from information theory via channel measurement, algorithm and protocol design, system and network simulation right through to the implementation of algorithms in demonstrators and tests in the field.

Conducting workshops to introduce stakeholders to the software and demonstrating its applicability in the design process for new solutions in the field of mobile communications play an essential part of our exploitation strategy.

3.2.1 Progress and outcomes

An updated version of our Quadriga channel model software enhanced to simulate satellite scenarios has been made available to the public in form of open-source under a proprietary license that allows anything but commercial use and prevents patent infringement as opposed to L-GPL for example (https://quadriga-channel-model.de/). Exemplary code for the generation of channels to be used in system-level simulations has been included to make it easier for new users to get started. The software has been already applied to successfully perform calibration exercises in 3GPP standardization groups RAN1 and RAN4. Many new users contact us with questions on the usage as well as ideas to further improve the model.

3.3 Consortium for the Research in Automation and Telecommunication (CRAT)

CRAT expects to reinforce and develop its collaboration with the consortium's members, in particular with end users and other research centers. The collaboration with the end users will enable CRAT to acquire familiarity with realistic and high-end testbeds, allowing the development of new researches in the scope of 5G, compliant with the latest standards and state of the art demonstrators.

3.3.1 Exploitable Knowledge

The following table identifies the exploitable knowledge developed by CRAT in the context of the project.

Table 3 2: CRAT's exploitable knowledge

ID	Exploitable Knowledge	Target Vertical Market	Timeframe	Possible IP protection or exploitation
1.CRAT	Traffic Flow Control algorithms and solutions	Every utility network (power, gas, water, transport…) control system may benefit from some of the results developed in WP4, even if the main target market is, by design, Telco operators.	3 years	Know-how
2.CRAT	QoE-aware traffic steering	Quality of Experience-based control systems are an emerging solution for 5G service provision. No particular vertical has been identi-	3 years	Know-how

		fied among the ones identified by the project as the most impactful for 5G.		
3.CRAT	Adaptive video streaming tailored to satellite 5G	Entertainment and media delivery systems	3 years	Know-how

3.3.2 Progress and outcomes

CRAT completed the development and integration activities related to the multi-connectivity algorithms of WP4. The integrated tool that was developed for the project PoC has been extensively tested and represents for CRAT a potential target for technology transfer opportunities. The acquired know-how on the methodologies behind the multi-connectivity algorithms allowed the universities that constitute CRAT to update the material of their courses (in particular the graduate courses of Control of Communication and Energy Networks and Control of Multi-Agent Systems held at the university of Rome “La Sapienza”) and to held several seminars for the general public and the engineering students.

3.4 Electronics and Telecommunications Research Institute (ETRI)

As a government funded research institute and a key technology innovator in Korea, ETRI is carrying out numerous research projects on developing 5G and future mobile communication systems. As an extension of ETRI’s previous and current research, 5G-ALLSTAR project provides a great opportunity to exploit our accumulated technical expertise and outcomes of previous research to facilitate technological evolutions of this project, primarily focusing on cellular and satellite multi-connectivity technology and its applicability to mmWave-band vehicular communication systems through a close collaboration between European and Korean partners.

3.4.1 Exploitable Knowledge

The following table identifies the exploitable knowledge developed by ETRI in the context of the project.

Table 3 3: ETRI’s exploitable knowledge

ID	Exploitable Knowledge	Target Vertical Market	Timeframe	Possible IP protection or exploitation
1.ETRI	IPRs related to the specification design and the developed key enabling technologies for mmWave-band vehicular communication system	No single target market, but prioritizing broadband Wi-Fi service on public transportations (e.g., trains, city/express busses) and other V2X applications	3 years	Know-how
2.ETRI	Software/hardware design (e.g., source codes and associated technical documents) of mmWave-band vehicular communication system with beam switching and cellular-satellite	No single target market, but prioritizing broadband Wi-Fi service on public transportations (e.g., trains, city/express busses) and other V2X applications	3 years	Know-how

	multi-connectivity techniques			

3.4.2 Progress and outcomes

During the first year of the project, ETRI implemented the first version of a trial platform for a mmWave-band vehicular communication system called Moving Network (MN) system. A preliminary test was conducted in the center of Daejeon city, which successfully validated that the MN system with the developed beam switching technique can achieve a peak physical layer data rate of up to 2.5 Gbps, and a satisfactory performance was observed even when the vehicle changes lanes or overtakes.

During the second year, ETRI mainly focused on the enhancement of the trial platform implemented in the first year, including the stabilization of each protocol layer (L1 and L2/L3) and the interworking testing between the protocol layers. During an indoor functional test for the integration of L1 and L2/L3 modules, key functionalities of the MN system (e.g., fast handover and link adaptation) were validated, and the test result showed that the developed L2/L3 modules are capable of providing a 4K video streaming service on YouTube.

During the third year, to further validate the feasibility and effectiveness of the MN system, ETRI carried out its final test on a highway test track located between Yeoju junction and Gamgok interchange in Korea. The test results showed that the system with the developed technologies is capable of providing a broadband onboard Wi-Fi service through broadband wireless connectivity between the vehicle UE and gNB. However, during the test, it was observed that performance degradation occurs at some locations due to signal blockage (especially when the vehicle is located near a bridge). Since our system targets not only highway scenarios but also urban road scenarios where a lot of obstacles could cause more serious degradation in system performance. Hence, during the third year, on top of the field test on the test track, multi-connectivity between cellular and satellite networks for service continuity has been implemented, and its validation has been conducted at ETRI premises. During the test, it was observed that when Traffic Controller (TC) detected signal blockage of the cellular link, the TC switched over to the satellite link, enabling the system to maintain the video streaming even without cellular connectivity. In addition, with close collaboration with the Korean and European partners, the final demo has been conducted in October. During the demo, a variety of services enabled by the technologies developed in the project have been successfully showcased. The demonstrated services include a non-real-time 4K/8K video streaming service via an intercontinental network between the Korean and European testbeds, and a real-time 360-degree video streaming service and a VR game via the public Internet.

During the project, ETRI has produced several scientific publications including both journal and conference papers. For standardization, one contribution & Recommendation Y.3324 at ITU-T SG13 Q.21 meeting has been agreed, and three proposals at 3GPP SA5 meetings to define a use case for multi-RAT load balancing associated with a satellite RAN and a terrestrial RAN have been approved.

3.5 Korea Telecom Satellite (KT SAT)

As a wholly owned by KT Corps, the largest telecom/media service provider in Korea, KT SAT is the only one satellite service provider in Korea. As a part of customer service, KT Sat provides satellite-based mobile communication backhaul for LTE coverage over remote area using LTE Femtocell and satellite links.

3.5.1 Opportunities for Exploitation

Currently, global satellite industry including KT SAT, is under conduct researching with a lot of interest in interworking technologies between satellite and 5G, such as 5G-ALLSTAR project. KT SAT expects to be able to acquire technologies and expertise to provide multi-connectivity

services to customer on moving vehicle (such as cars, vessels, etc.) by successfully executed 5G-ALLSTAR project.

3.5.2 Progress and outcomes

KT SAT will strive to develop this service continuity use-case on moving vehicle or applying other use-cases to provide service to our (potential) customer through 5GSAT multi-connectivity technique mainly in terms of service continuity, which will be based on the technique performed our jointly test.

In addition, KT SAT will promote our jointly test results to (potential) customers and will contribute to various space-scientific journals with related organization.

3.6 SK Telecom (SKT)

SK Telecom is the largest mobile operator in Korea with nearly 50 percent of the market share. The company successfully commercialized 5G network on December 1st, 2018 and launched the world's first 5G B2B service for smart factory. Then the company commercialized the world's first 5G smartphone for 5G B2C service, Samsung Galaxy S10 5G, for purchase in Korea starting April 3, 2019. The number of 5G subscribers of SK Telecom is steadily increasing and reached 8M in Aug. 2021.

3.6.1 Exploitable Knowledge

The following table identifies the exploitable knowledge developed by SKT in the context of the project.

Table 3 4: SKT's exploitable knowledge

ID	Exploitable Knowledge	Target Vertical Market	Timeframe	Possible IP protection or exploitation
1.SKT	Service feasibility for mmWave solutions, architecture design know-how for inter-operable systems between cellular and satellite systems	No single target market, but prioritizing mmWave service for 5G	3 years	Know-how

3.6.2 Progress and outcomes

SKT attended in 3GPP standardization activities relevant to mmWave systems and cellular and satellite multi-connectivity technologies. And the company exploited lessons learned of the research results of 5G-ALLSTAR project including IPRs (e.g., patents) and outcomes of software/hardware design (e.g., source codes and associated technical documents) to evolve SKT's 5G network. The company provided the outcomes of mmWave services with the partners of 5G-ALLSTAR project.

3.7 SNET Information and Communication Technology (SnetICT)

The core capability of SnetICT is to develop core network solutions that provide 5G heterogeneous access through multi-connectivity research.

3.7.1 Progress and outcomes

SnetICT has implemented the first trial version of 5G core network system based 3GPP standard specifications for vehicular communication system called Moving Network (MN). Through the verification of MN service, we tested fundamental functions of control plane and data plane.

3.8 Korea Automotive Technology Institute (KATECH)

KATECH in Korea is the Korea's only R&D institute specializing in automotive parts providing comprehensive and systematic technical support and playing a leading role in technology development. KATECH has been established with government and private fund to support systematic R&D for auto part industry in Korea based on "Industrial Technology Innovation & Promotion Law". With rich experience and knowledge of automotive communication system such as CAN, WAVE, Wi-Fi, etc., KATECH will develop traffic aggregation technology among 5G network, satellite modem, and Wi-Fi network. KATECH will also provide urban type smart vehicle testbed supporting various communication system such as WAVE, Wi-Fi and 5G for 5G-ALLSTAR Korean trial.

Table 3 5: KATECH's exploitable knowledge

ID	Exploitable Knowledge	Target Vertical Market	Timeframe	Possible IP protection or exploitation
1.KATECH	Traffic Flow Control algorithms and its solutions enabled by mix of mmWAVE and satellite communication	Cooperative, Connected Automated Mobility (CCAM) market in terms of extension of Operational Design Domain (ODD).	3 years	Know-how

Progress and outcomes

During the first year of the project, KATECH designed the data aggregation system supporting multi-connectivity, a so-called Traffic Controller (TC), for acquiring data from both a mmWave-band vehicular communication system and a satellite communication system.

During the second year, KATECH is mainly working on the developing data aggregation test platform to test and to evaluate the data aggregation algorithm for supporting multi-connectivity access between mmWave-band vehicular communication system and a satellite communication system. The basic functional test of the data aggregation system was almost completed.

4 Conclusions

This deliverable document D6.11 “Report on Exploitation Y3 defines the proposed activities for 5G-ALLSTAR project results exploitation.

In this document, we first summarize expected exploitable knowledge of the main stakeholder and their progress demonstrating how the contributions interest a broader target than the identified verticals in the area of transport (e.g. public safety sector, Railway Transportation), public safety and rural communities. Progress was realized toward different addressable markets depending on partners’ individual strategies (e.g., SMEs, B2B, B2C). The report describes the progress in the exploitation of the identified exploitable knowledge on a by-partner basis and addresses the current progress and outcomes up to this stage of the 5G-ALLSTAR project.

Overall, the timeframe for 5G-ALLSTAR project results exploitation corresponds to 3 years project’s span until the 31/10/2021. The COVID-19 pandemic affected both the second and the third years of the project our capacity to diffuse the developed knowledge and our capacity to involve vertical stakeholders effectively, but several actions have been put into place and performed that allowed us to achieve the stated objectives.