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

D8.4: Final Dissemination, Standardization, Exploitation and Joint Activities Report

Version 1.0

Work package	WP8
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Abstract

This deliverable describes the communication, dissemination, standardization, and exploitation activities, conducted in the second half of project (March 2022 – December 2023) to guarantee broad and effective visibility, promotion and continuity of the project's work and outcomes.

Keywords: Dissemination, Communication, Exploitation, Standardization, Press, Outreach, Liaisons, Events, KPIs

Document Revision History

Version	Date	Description of change	List of contributor(s)
v0.1	9/10/2023	Table of contents and first content editing	M.C. Campodonico, Galileo Disperati (Martel), Roy Boertien (MIW)
v0.2	12/12/2023	Partners' Contributions	Ahmad Reza Mir Mohammadi (HZ), Rudi Pauwels (Roosens), J. Marquez-Barja (imec), Nina Slamnik-Kriještorac (imec), TNO, Karel Kural (HAN), Bart Lannoo (BEM), Eric Kenis (MOW) M.C. Campodonico, Galileo Disperati (Martel), Roy Boertien (MIW)
v0.3	15/12/2023	Internal Review	Ahmad Reza Mir Mohammadi (HZ)
v1.0	22/12/2023	Final version ready for submission	J. Marquez-Barja (imec), W. Vandenberghe (MIW)

Disclaimer

Project co-funded by the European Commission under H2020-ICT-2018-20		
Nature of the deliverable:	R	
Dissemination Level		
PU	Public, fully open, e.g., web	√
CI	Classified, information as referred to in Commission Decision 2001/844/EC	
CO	Confidential to 5G-Blueprint project and Commission Services	

* R: Document, report (excluding the periodic and final reports)
DEM: Demonstrator, pilot, prototype, plan designs
DEC: Websites, patents filing, press & media actions, videos, etc.
OTHER: Software, technical diagram, etc

EXECUTIVE SUMMARY

The document at hand, developed in the context of WP8, follows and updates D8.3 (Intermediate Dissemination, Standardization, Exploitation and Joint Activities Report) carrying on building upon what outlined in D8.1 (5G-Blueprint Dissemination and Communication Plan); the document serves the main purpose of offering an in-depth report on the project's communication, dissemination, and community-building strategy that has been developed in the second half of the project. The strategy has been followed by all project partners to maximize the impact of 5G-Blueprint and ensure that the following communication-related project objectives are met:

- Ensure 5G-Blueprint's broad visibility by spreading knowledge about project activities and its results.
- Reach, stimulate, and engage a critical mass of relevant stakeholders to ensure that the project results are effectively showcased, leading to widespread validation, improvement, and further adoption of the developed technologies and concepts.
- Facilitate exploitation of project outcomes and promote the development of innovative solutions based on the 5G-Blueprint technologies and architecture.
- Foster an impactful contribution to relevant standardization bodies.
- Ensure close coordination with the 5G PPP community and establish liaisons with relevant initiatives, such as 5GAA, 5G IA, etc.

Beside describing the communication, dissemination, and community-building activities conducted by the 5G-Blueprint consortium during M19-M40 of the project, D8.4 presents actions taken to address recommendations offered during the previous project review, plans of activities after the project's end, and offers an overview on standardization and exploitation plans developed by project partners.

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ABBREVIATIONS

5G AA	5G Automotive Association
5G IA	5G Industrial Association
5G PPP	5G Infrastructure Public Private Partnership
5G SA	Standalone 5G
5G NSA	Non-Standalone 5G
AB	Advisory Board
AECC	Automotive Edge Computing Consortium
AI	Artificial Intelligence
BDVA	Big Data Value Association
CACC	Cooperative Adaptive Cruise Control
CAD	Connected and automated driving
CAM	Connected and Automated Mobility
CAPEX	Capital Expenditure
CAV	Connected and autonomous vehicles
CCAM	Cooperative, Connected and Automated Mobility
CNF	Containerized Network Functions
DMI	Dutch Mobility Innovation
DPO	Data Protection Officer
EC	European Commission
ECTS	European Credit Transfer System
ETA	Estimated Time of Arrival
GDPR	General Data Protection Regulation
GPU	Graphics Processing Unit
IoT	Internet of Things
iTLC	Intelligent Traffic Light Controllers
IP	Internet Protocol
iTLC	Instant Thin Layer Chromatography Medium
KPI	Key Performance Indicator
M	Month
MANO	Management and Orchestration
MEC	Multi-access Edge Computing
MIW	Ministry of Infrastructure and Water Management
MNO	Mobile Network Operator
MOOC	Massive Open Online Course
NFVI	Network Function Virtualization Infrastructure
NGI	Next Generation Internet
NGIoT	Next Generation Internet of Things
NIST	National Institute of Standards and Technology (USA)
NR	New Radio
OBU	On-board Units
OPEX	Operational Expenditures
ORD	Open Research Data
RAN	Radio Access Network
RAT	Radio Access Technology
RSU	Road Site Units
RTTI	Run-time Type Information
SAE	Society of Automotive Engineers
SEO	Search Engine Optimization
TC	Teleoperation Consortium
TCP	Transmission Control Protocol

TMC	Technical Management Committee
TO	Teleoperation
ToD	Teleoperated Driving
TOV-ratio	Teleoperated-to-vehicle ratio
TRL	Technological Readiness Level
V2V	Vehicle-to-vehicle
V2X	Vehicle-to-everything
VIM	Virtual Infrastructure Manager
VNF	Virtual Network Function
WG	Working Group
WP	Work Package

1 INTRODUCTION

1.1 Purpose of the document

The deliverable at hand has been prepared in the context of Work Package 8 (WP8) *Dissemination and external collaboration* to serve three main purposes:

- Updating D8.3 (Intermediate Dissemination, Standardization, Exploitation and Joint Activities Report), along the baseline established by D8.1 (5G-Blueprint Dissemination and Communication Plan, by covering activities for M19-M40.
- Summing up actions following reviewers' recommendations, lessons learned and post-project plans.
- Outlines exploitation plans developed jointly and individually by project partners.

1.2 Structure of the document

The sections of this deliverable are organized in the following manner: After the introductory **Section 1, Section 2** depicts communication and dissemination activities and tools used during the second half of the project (M19-M40) - including variations implemented - and presents the plan of activities after the end of project. **Section 3** describes standardization activities while **Section 4** focuses on the exploitation of project results. **Section 5** concludes the document.

2 COMMUNICATION AND DISSEMINATION

Communication and dissemination activities are central to the overall 5G-Blueprint effort. They are being closely monitored and coordinated to ensure an effective engagement of all targeted stakeholders, including those in the broader 5G and CAM ecosystems and related vertical domains. To raise awareness and maximize the impact of the project, a comprehensive communication and dissemination plan has been developed in Q1 of the project (see D8.1 for details). Its execution began at the early project stages and continued at steady pace throughout its whole duration. Building upon the activities conducted over the first half of the project – which are detailed in the previously submitted report (D8.3) - a set of dedicated online and offline activities, outlined below, has been pursued to support the achievement of project objectives and ensure a broad promotion and effective showcasing of developed concepts, technologies, use cases, and project results. These activities are conducted under MARTEL's leadership and guidance with active contributions from all 5G-Blueprint partners.

All data listed in this section and in the KPIs table in Section 2.3 have been collected until December 18, 2023.

2.1 Communication and dissemination activities M19-M40

2.1.1 Project website

The 5G-Blueprint website www.5gblueprint.eu (see Figure 1), has been developed to act as an information hub presenting the project's goals, activities, and achievements. The website was launched in August 2020 before the official start of the project and features the following:

- General information about the project, its vision, objectives, and anticipated impact.
- Information about project use cases and enabling functions.
- A brief introduction to all members of the consortium.
- News items and press releases.
- List of relevant events.
- A repository of resources, such as scientific publications, presentations/talks, promotional materials, videos, and public deliverables.
- Contact forms and information.
- An acknowledgment and reference to the European Union's Horizon 2020 Framework Program funding and the 5G PPP.

Figure 1: 5G-Blueprint website

The website is being periodically updated according to the evolution of the project. Notable amendments/implementations performed in the second half of the project – in alignment with inner re-organisation and with the recommendations provided through the previous review - include:

- Changes in the information concerning the use cases, and expansion of such information
- Addition of a “5G Angle” page, informing visitors on how the 5G contributions of the project fit multiple 5G relevant topics
- Conception and implementation on the homepage of an updated, brief and catchy animated video introduction to the key concept, ambition and use cases of the project.

In terms of reach/engagement, upon project closure, the website counts over 7,300 unique visitors, who generated:

- Over 23,500 page views
- Average visit duration of 1’

All information and e-mails collected are protected under the General Data Protection Regulation (GDPR). Contact is and will continue to only be made with people who have submitted inquiries. Similarly, the newsletters are and will continue to be sent out only to individuals who have explicitly requested to receive them. Any person who has subscribed can request for their e-mail address to be removed from the list. The website provides information on the data kept and how they are used in alignment with the GDPR under the Privacy policy link (footer of the webpage).

Last but not least, 5G-Blueprint opted for an environmentally responsible website hosting platform, which has been designed to be as energy efficient as possible to limit the unnecessary waste of resources. The web hosting provider, GreenGeeks, puts back three times the power consumed into the grid in the form of renewable energy.

2.1.2 Social media channels

5G-Blueprint established its presence on social media channels to regularly promote project activities and outputs while encouraging a wider discussion on topics related to 5G research and deployment as well as the teleoperation of vehicles and vessels. The project has built a fair follower base on several social media channels, namely X/Twitter, LinkedIn, and YouTube, which are all linked to the project's website.

2.1.2.1 X/Twitter

5G-Blueprint uses X/Twitter, as it is a very dynamic social network covering the news in real-time at a global level. To date, the 5G-Blueprint Twitter account (@5G_Blueprint) has attracted 324 followers. The project follows 102 accounts, mostly projects and initiatives in similar fields. The project Twitter account is used predominately to promote and disseminate project activities and developments but also to learn about and cross-share relevant and interesting events and initiatives, and to establish meaningful connections with relevant stakeholders, including policy makers, industry, and the general public.

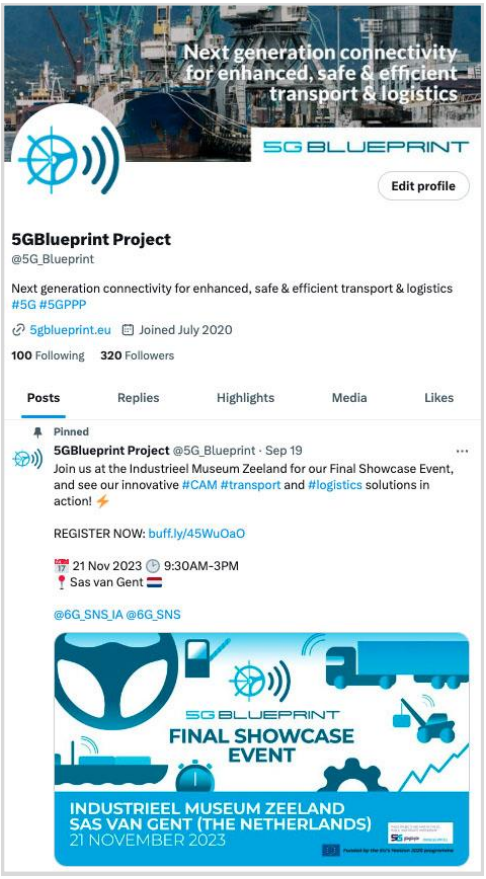


Figure 2: 5G-Blueprint X/Twitter profile

2.1.2.2 LinkedIn

LinkedIn, as one of the biggest business networks in the world (over 150 million users in more than 200 countries and territories), is a useful tool for 5G-Blueprint. It allows the project to network with individuals and organizations within the industry and beyond, share relevant information about project activities, and stay up to date on the latest developments in the field. To date, the 5G-Blueprint LinkedIn account (5gblueprint-project) has attracted 516 followers. Like in the case of X/Twitter, the LinkedIn account is used to promote project activities and learn about and cross-share relevant events and activities. Figure 5 presents the project's LinkedIn profile.

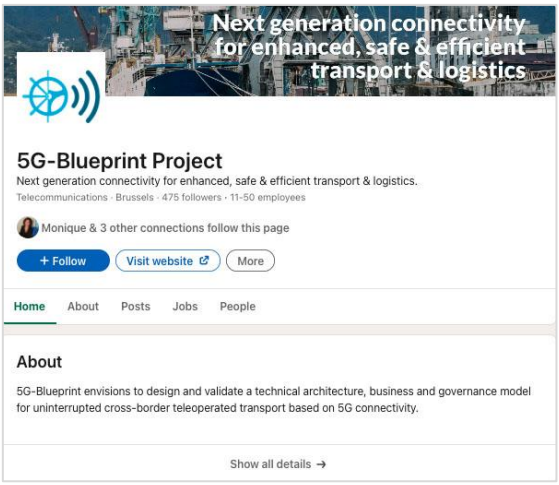


Figure 3: 5G-Blueprint LinkedIn profile

2.1.2.3 YouTube

5G-Blueprint has also created an account on YouTube, one of the leading video-sharing platforms. This channel has been opened at the early project stages to disseminate the first project video. Since then, the project has released a total of 25 videos, including the aforementioned new animated project introduction, interviews shot at events, and recordings of testing and demos conducted.

42 subscribers follow the 5G-Blueprint YouTube channel, which can be found at the following link: https://www.youtube.com/channel/UCv7n1u2SLeRH6DRJpfdGtrA

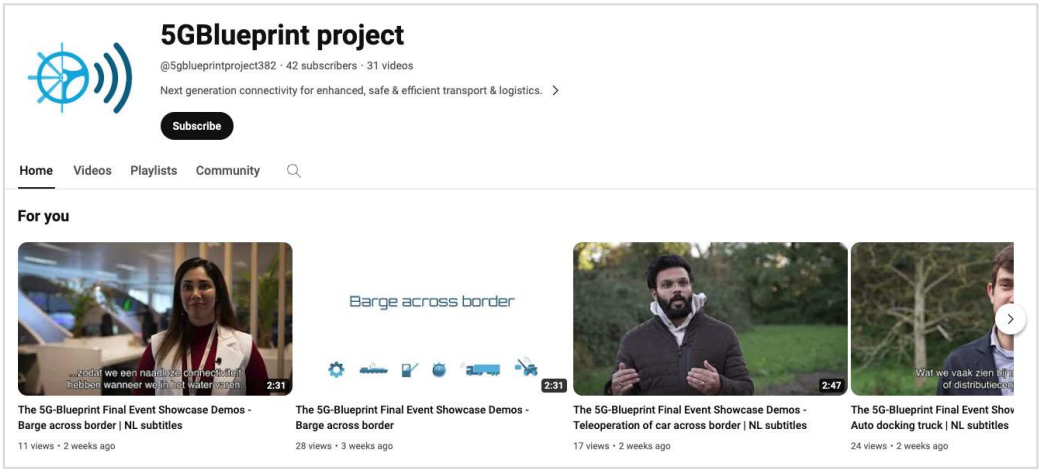


Figure 4: 5G-Blueprint YouTube channel

2.1.3 News items and press releases

The 5G-Blueprint consortium keeps the community and the general public informed about relevant activities, undertakings, and events by publishing news items and press releases. To date, 55 news items and 6 press releases have been published on the project website.

A special press release promoting the Final Showcase Event was released in two versions – English and Dutch (in close collaboration with coordinating partner MIW) to 202 and 66 selected contacts respectively in the specialised press. Additionally, project partner MOW also forwarded the Dutch version to over 350 contacts of their own. As a follow-up to this specific release, a recap of the event, and of the project results demonstrated, was forwarded post-event to the some of the aforementioned contacts.

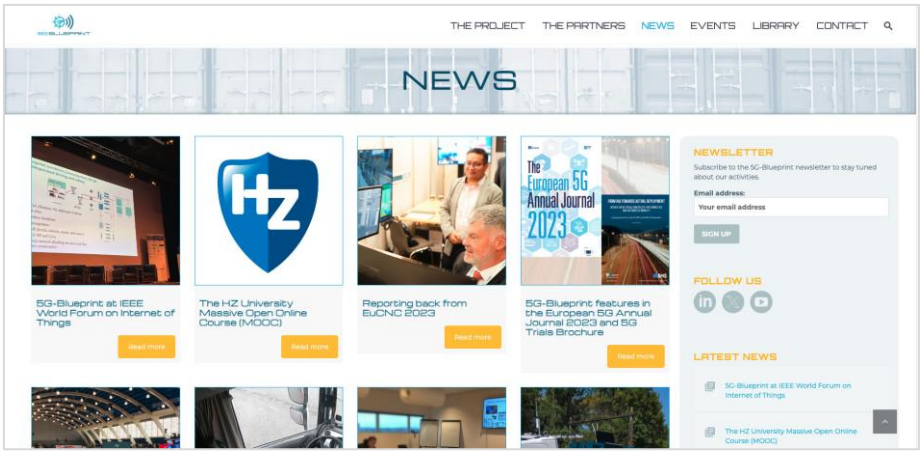


Figure 5: News items published on the 5G-Blueprint website

2.1.4 Newsletters and newsflashes

The 5G-Blueprint periodic newsletter is sent out twice a year, providing updates on the 5G and CAM ecosystems, as well as on the project activities, findings, and results. The project newsletters also contain information on the upcoming tasks, events, as well as any relevant news and announcements from individual project partners when relevant. A mailing list based on subscription has been created, giving the possibility to share the newsletter via mass mailing. A registration functionality allowing interested visitors to subscribe to the newsletter has been available on the project website since the beginning of the project. The design of each newsletter is aligned with the 5G-Blueprint brand identity. The newsletter is also fully responsive to ensure its readability on any device.

All issued newsletters are being uploaded on the website upon their distribution to subscribers. To date, 6 newsletters and a newsflash have been sent out (see Figure 7), the fourth edition in August 2022, the fifth edition in February 2023, and the final and sixth edition in October 2023 (which also served as a promotional tool for the MOOC course and the Final Showcase Event described in the following sections).

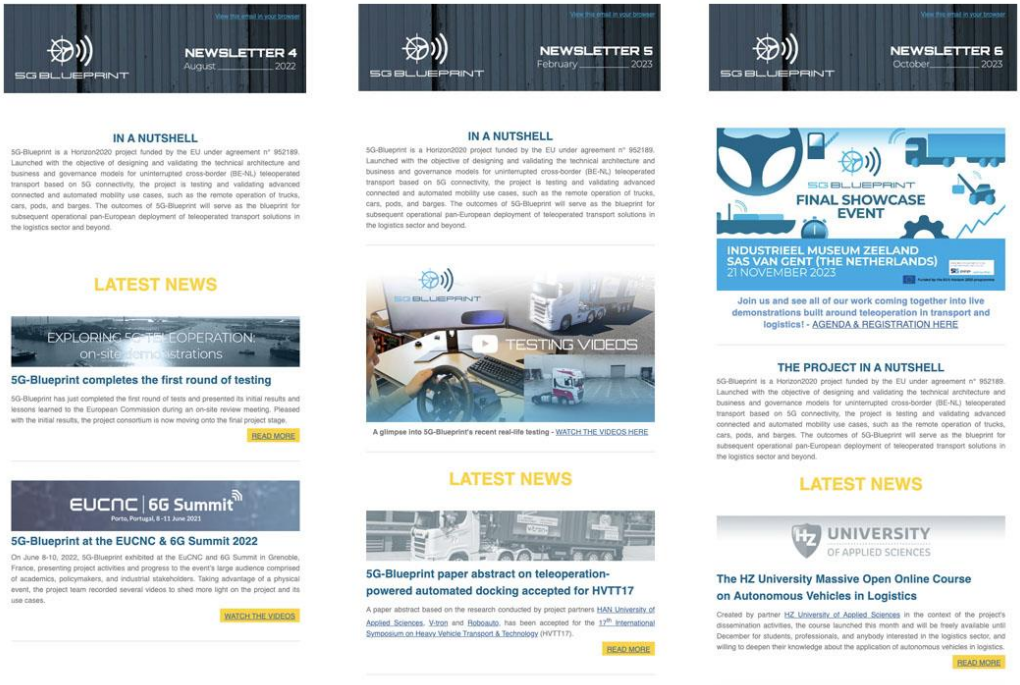


Figure 6: 5G-Blueprint newsletters

2.1.5 Publications

The 5G-Blueprint consortium is committed to bringing research results closer to the public and adheres to the Open Access guidelines set by the H2020 work programme. All project partners are strong supporters of Open Access as it enables all interested parties to use published research results irrespectively of their location or income, boosting the transfer of knowledge between science, the economy, and society at large. The project has been very active in that sphere since its early stages. For a complete list of the output for the reporting period, please see Annex A of the present document.

2.1.6 Project videos

The second half of the project's run saw an increase in the production of videos, thanks to the deployment of demos and the return to in-person events; in this section, some information on content, release and reach of each video item produced is offered. All videos listed are available on both the project website and the project YouTube channel.

Released in April 2022 and counting 23 views, the video **"Workshop on the role of 5G in autonomous driving and intelligent transport systems"** consists of a full recording of the talk given by Project Coordinator Wim Vandenberghe (MIW) in the context of the event on the role of 5G in autonomous driving and intelligent transport systems organised by partner KPN in Helmond (The Netherlands), the same month.

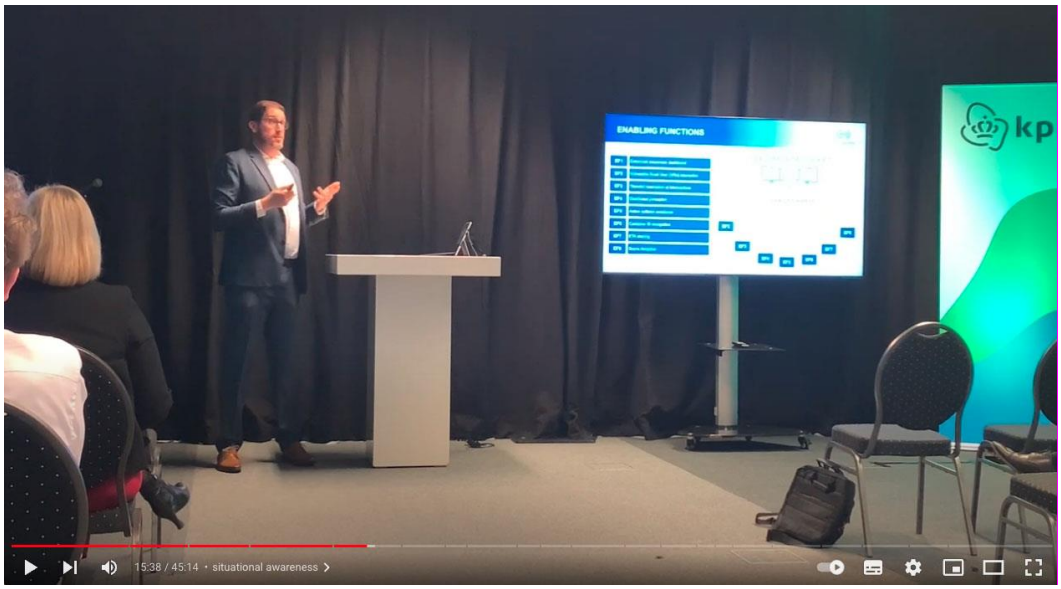


Figure 7: Screenshot of the video "Workshop on the role of 5G in autonomous driving and intelligent transport systems"

Released in June 2022 and counting 135 views, the video **"5G-Blueprint by Johann Marquez-Barja"** consists of a brief overview on the project, as delivered by Technical Coordinator Johann Marquez-Barja (imec), filmed at EuCNC 2022, in Grenoble, France, the same month.

Figure 8: Screenshot of the video "5G-Blueprint by Johann Marquez-Barja"

Also filmed at EuCNC 2022 and released in June 2022, the **video series "5G-Blueprint Use Cases"** comprises 4 videos in which project partner Nina Slamnik-Kriještorac (imec) walks the viewers through each use case; the series counts a total of 182 views.

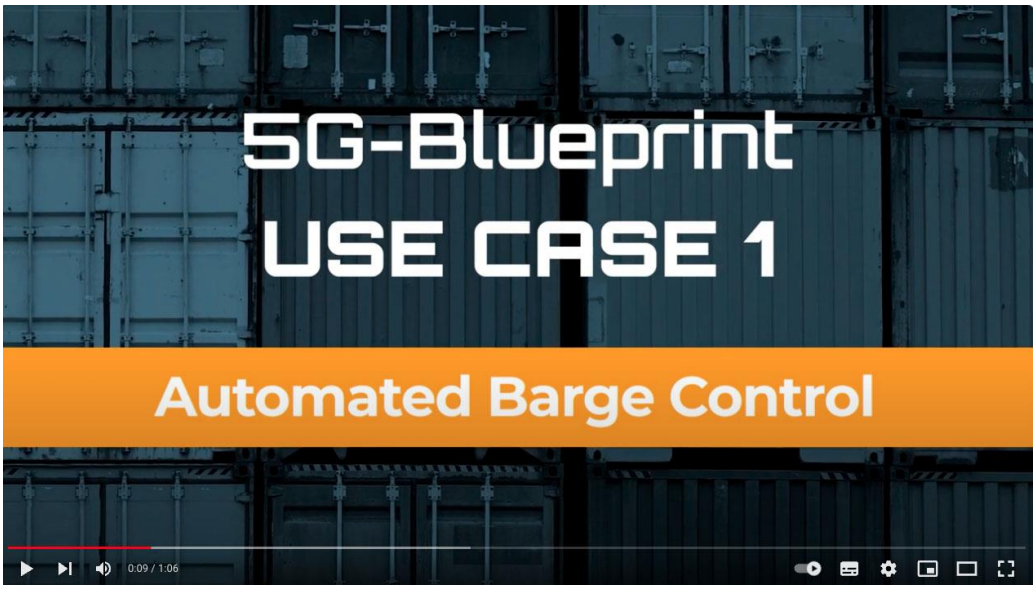


Figure 9: Screenshot of the first instalment of the video series "5G-Blueprint Use Cases"

Released in August 2022 and counting 439 views, the video **"5G & teleoperation: on-site demonstrations"** consists of a full recap – including brief interviews with project partners - of the demonstrations that took place during the 2-day on-site review meeting with EC representatives in July 2022, in which the consortium presented the initial project results and lessons learned.

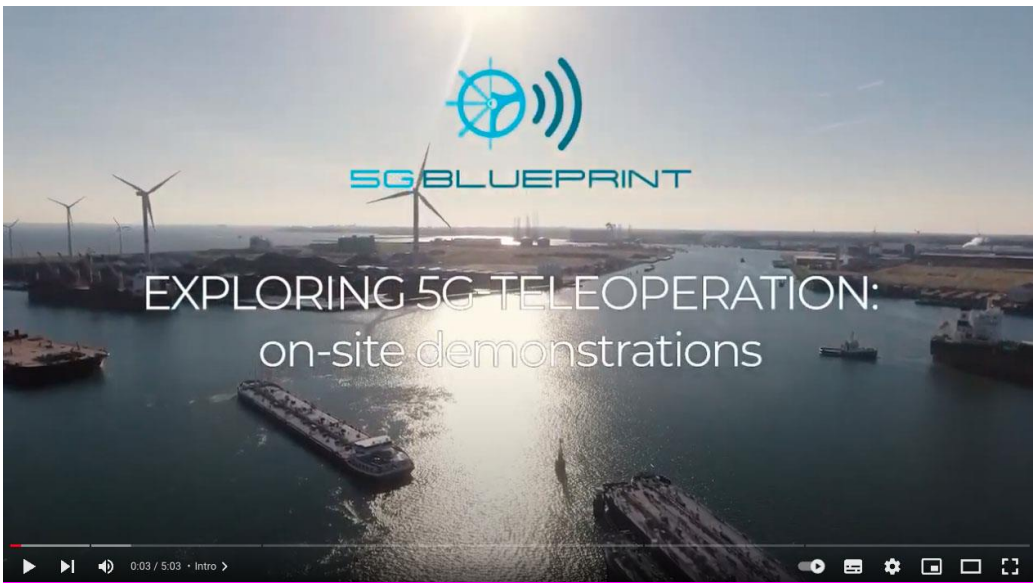


Figure 10: Screenshot of the video "5G & teleoperation: on-site demonstrations"

Released in January 2023 and counting 92 views, the video **"5G-Blueprint: Truck teleoperation testing"** offers a glimpse into partners HAN and V-tron's testing - with Roboauto providing the underlying teleoperation technology - on the full scale truck for the 5G-Blueprint project.

Figure 11: Screenshot of the video "5G-Blueprint: Truck teleoperation testing"

Released in January 2023 and counting 153 views, the video **"5G-Blueprint: Verbrugge site tests"** consists of an edit of recordings of testing conducted by partners HAN and V-tron at the Verbrugge site (Vlissingen, The Netherlands), showing both teleoperation and autodocking in action on the scaled truck; once again, partner Roboauto provided the underlying teleoperation technology used.

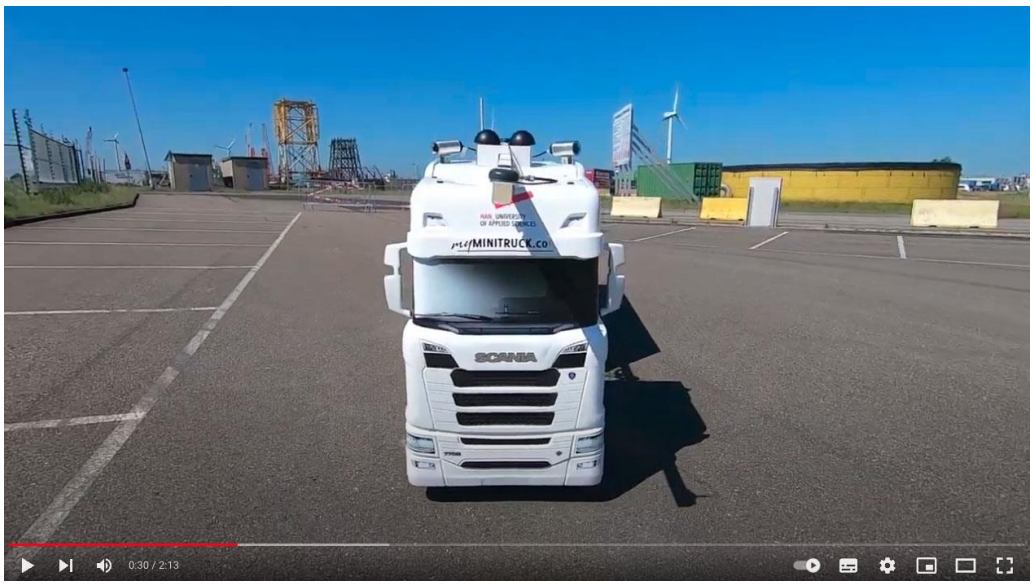


Figure 12: Screenshot of the video "5G-Blueprint: Verbrugge site tests"

Released in February 2023 and counting 333 views, the video **"5G-Blueprint: Full scale teleoperation & autodocking showcase"** shows how 5G-Blueprint brings the concept of autodocking into reality, depicting a full-scale autodocking system in action and showcasing the results of the work of partners V-tron, HAN and Roboauto.

Figure 13: Screenshot of the video "5G-Blueprint: Full scale teleoperation & autodocking showcase"

Released in March 2023 and counting 117 views, the video **"5G-Blueprint: Teleoperation showcase"** serves as a companion piece to the previous video released, by depicting the then recently completed final testing of teleoperation using 5G SA and NSA, as conducted in the Verbrugge International terminal site (The Netherlands). The video showcases two key benefits of the teleoperation solution within the logistical chain aimed at reducing the idle time of the drivers/operators: 1) the ability to have a multi-operator setup, and 2) having a higher work force mobility. The aim was to highlight how, through this method, a single operator can switch

between different vehicles with one remote station. The testing was once again tied to the joint work of V-tron, HAN and Roboauto.

Figure 14: Screenshot of the video "5G-Blueprint: Teleoperation showcase"

Released in April 2023 and counting 69 views, the video **"5G-Blueprint: Time Slot Reservation Demo"** showcases the Time Slot Reservation application developed by SWARCO in the context of the project to grant safe and seamless passage through traffic-controlled intersections for truck platoons. In collaboration with V-tron, Be-Mobile and North Sea Port, SWARCO demonstrated the Time Slot reservation application using the two North Sea Port iTLCs at the harbour location Vlissingen Oost.

Figure 15: Screenshot of the video "5G-Blueprint: Time Slot Reservation Demo"

Released in April 2023 and counting 164 views, the video **"5G-Blueprint in a nutshell"** is a fast-paced and playful animated explainer video offering a revised overview of the project's vision and objectives, which has been since primarily featured on the project website homepage and at events. As mentioned in Section 2.1.1, the video was created in alignment with the

communication and dissemination adjustments tied to the inner re-organisation based on the recommendations provided through the first review.

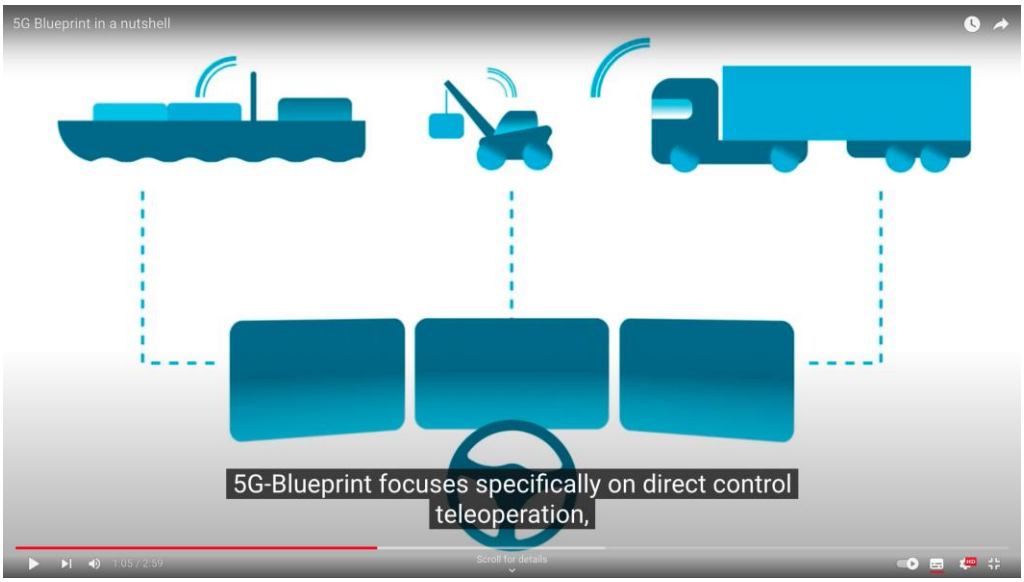


Figure 16: Screenshot of the video "5G-Blueprint in a nutshell"

Released in June 2023 and counting 31 views, the video **"5G-Blueprint at EuCNC 2023"** sees once again the project's Technical Coordinator Johann Marquez-Barja (imec) in front of the camera - delivering a brief message on 5G-Blueprint's key achievements - from the project's showcase at EuCNC 2023 (which featured the remote teleoperation simulator depicted).

Figure 17: Screenshot of the video "5G-Blueprint at EuCNC 2023"

Released in December 2023 and counting 110 views, the video **"Teleoperated logistics | KPN"**, created by partner KPN, showcases the teleoperated logistics features developed in the context of 5G-Blueprint in action at the Vlissingen test site. The testing footage is intercut with interviews to representatives of the project partners directly involved, which include Verbrugge International BV, V-tron, Roboauto and HAN University of Applied Sciences.

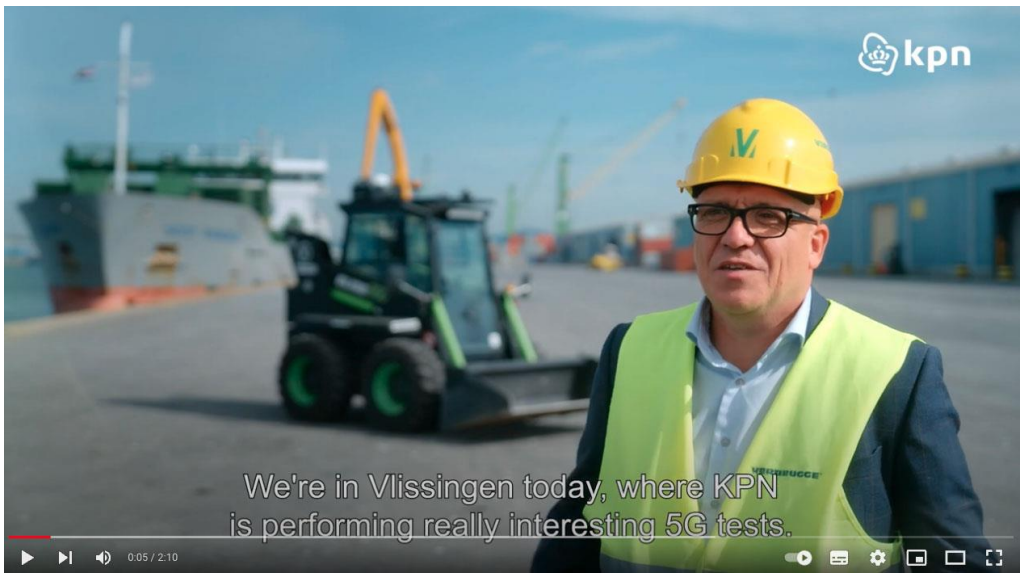


Figure 18: Screenshot of the video "Teleoperated logistics | KPN"

In addition, **a set of 5 videos were produced in November 2023 to serve as a record/recap of the demos presented live during 5G-Blueprint's Final Showcase Event** to an audience of over 140 participants (autodocking truck, barge across border, car crossing border, container recognition and skidsteer operation); the 5 videos have also been subsequently made available to the project's YouTube channel and website. At the time of writing, the English and Dutch versions of the videos count over 300 views in total.

Figure 19: Screenshots from the 5-video set for the demos of the 5G-Blueprint Final Showcase Event

2.1.7 MOOC 'Automated Vehicles in Logistics'

Within the framework of the project, partner HZ University of Applied Sciences developed an educational program in the form of a Massive Open Online Course (MOOC) – which opened in October 2023, running until December 2023 - designed to be freely available for students, professionals, and anybody interested in the logistics sector, and willing to deepen their knowledge about the application of autonomous vehicles in logistics. In order to support the reach and boost engagement, WP8 coordinated with HZ to promote MOOC online through 5G-Blueprint's social media channels, with posts linked to a landing page on the project website, detailing aim, scope and structure of the course (serving as a centralised hub for useful information and adjusted according to any necessary update). The dedicated social media posts were also released in specific LinkedIn groups connected to the ecosystems targeted by the

project (including 6G SNS's group), and information/social media posts on the kick-off of the course were shared with fellow projects not only towards the ICT-53 projects' Dissemination and Communication' counterparts but also under DG MOVE namely the FOR FREIGHT project consortium knowing that their interest in the topic could effectively increase its impact.

More details on the course itself can be found in the dedicated standalone deliverable, D8.6.

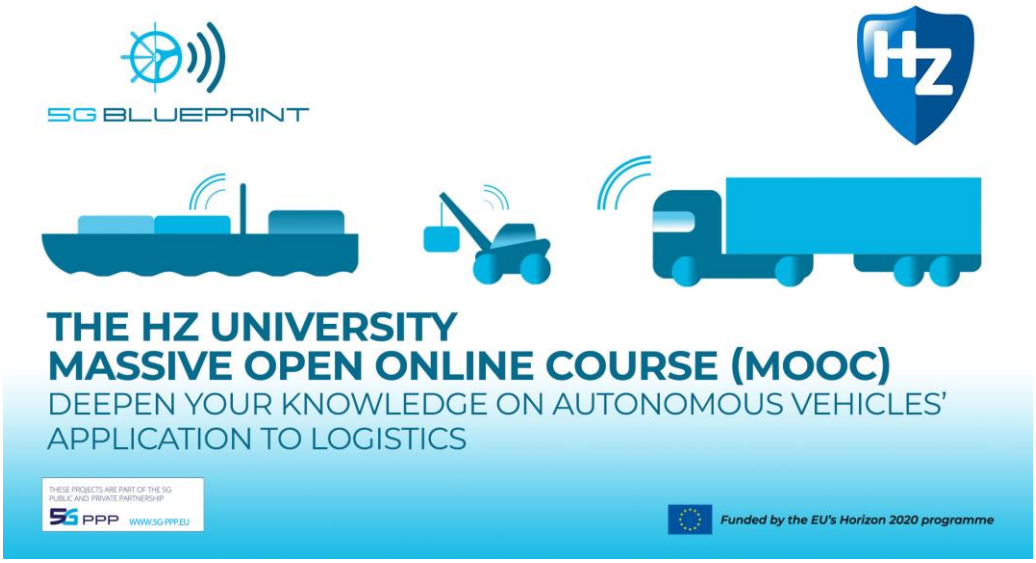


Figure 20: Promotional social media card for the MOOC course

2.1.8 Digital and printed promotional material

An **update of the project overview 4-page brochure** providing an overview of the project was created in late May 2023, for distribution at EuCNC 2023 (see Figure 10) to match the aforementioned updates to the website (concerning use cases, in particular) the changes in the composition of the project consortium. It of course still maintains a clear indication of the project's affiliation to 5G PPP and the acknowledgment of the EU funding. The flyer was furtherly updated and re-printed in support of the project's Final Showcase Event, in October 2023.

The flyer's digital version (in its latest iteration) is available on the project website. Its printed version has been made available to partners for distribution at external attended events too.

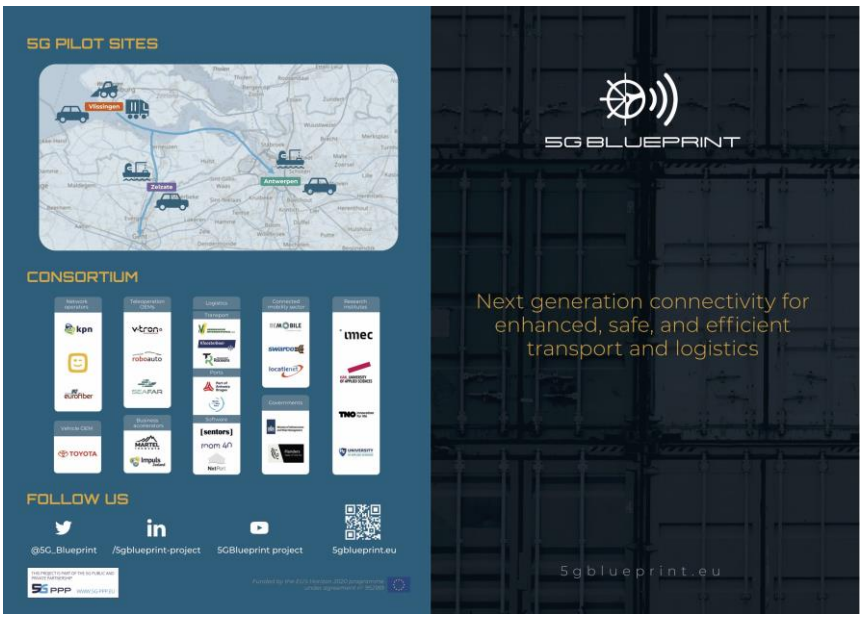


Figure 21: Cover sides of the updated 5G-Blueprint overview leaflet

The previously created poster, presenting the consortium partners was also revised to match the changes in its composition. The promotional item is available to partners for printing in A2 format and is available on the project website in digital format.

Figure 22: 5G-Blueprint partners poster

In line with the changes on the website and overview brochure's content changes, the previously designed **"Use Cases" roll-up** was also updated and re-printed for display at the shared ICT-53 showcase during the participation at ITS European Conference 2023 in Lisbon, Portugal (May 2023).

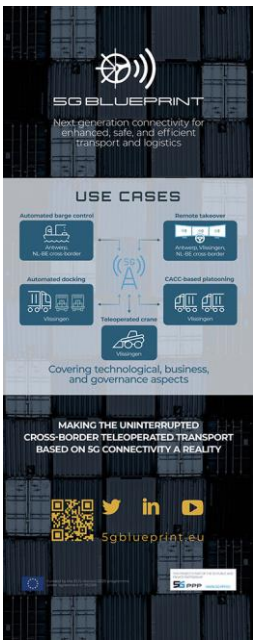


Figure 23: Updated 5G-Blueprint "Use Cases" roll-up

An **additional custom poster** was designed in coordination with partner TNO, for EuCNC 2023's Poster Sessions (June 2023), presenting their research work as a summarised extract of the paper "5G Standalone Seamless Roaming for Cross-Border Automotive Use Cases". This Item is also available in digital form on the website.

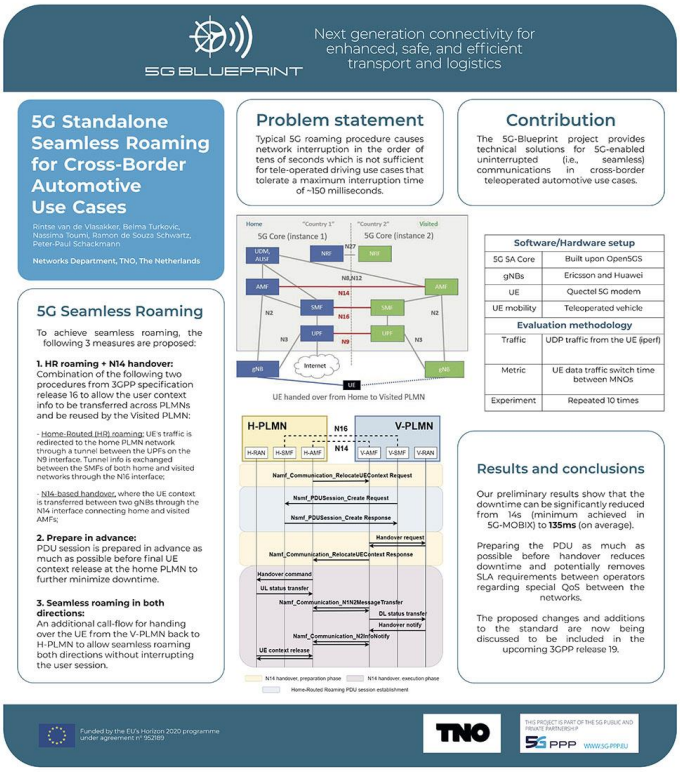


Figure 24: "5G Standalone Seamless Roaming for Cross-Border Automotive Use Cases" poster

In addition to such print materials, WP8 also coordinated the creation **of assets to promote events participation and organization conducted with fellow ICT-53 projects, under the joint banner and branding "Pathways to Future CAM"** (more details on these actions will follow, in section 2.1.9.1). This included a series of social media cards which, while adapting

to specific situations, maintained a recognizable and representative image throughout deployment.

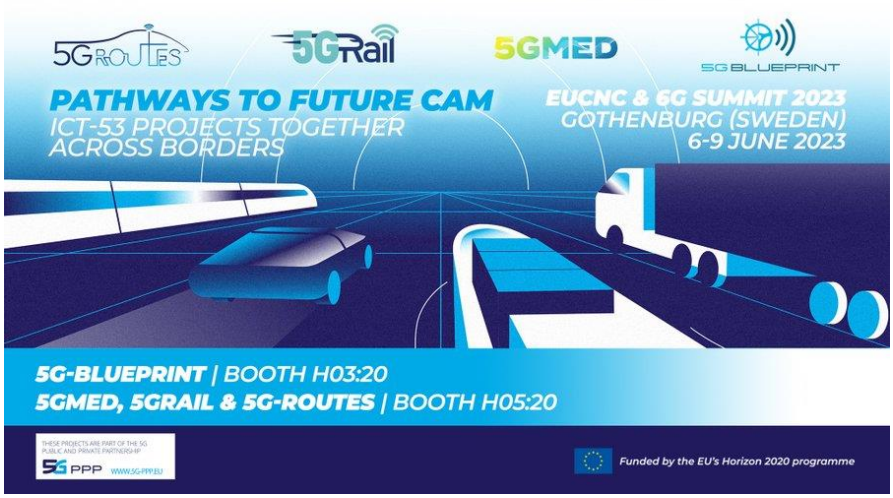


Figure 25: "Pathways to Future CAM" branding – Card promoting joint activities at EuCNC 2023

Finally, in support of the project's Final Showcase Event (November 2023), several digital and printed materials were created: from social media visuals to promote the event to **a series of leaflets and a brochure** for distribution at the various specific showcases set up at the event:

- "5G architecture for enabling seamless cross-border teleoperation" 4-page leaflet (covering WP5's activities)

- A set of 3 4-page leaflets covering WP3's aims and work, each with a specific focus:
  - Business
  - Techno-economic assessment
  - Road Map

- A 16-page brochure detailing all Enabling Functions (EFs) and the partners involved in WP6's activities

Figure 26: Final Event Showcase leaflets and Enabling Functions brochure

Each specific showcase also featured a newly designed roll-up, and two additional items were created as part of the promotional set distributed to participants upon registration: a **postcard** with a QR code leading to the digital versions of the leaflets and brochure described above, and a **tote bag** to easily gather all materials together.

Figure 27: Final Event Showcase tote bag and postcard

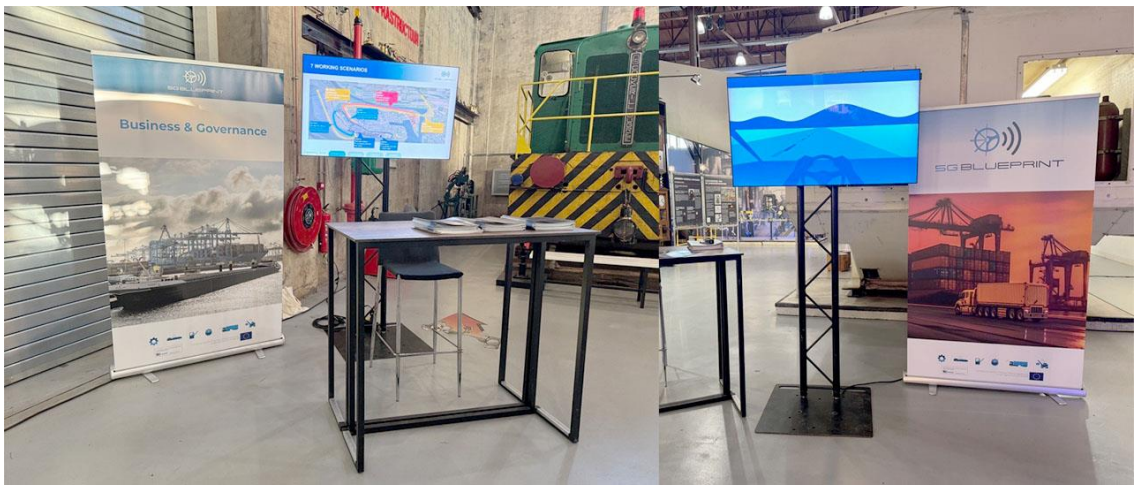


Figure 28: Some of the Final Event Showcase roll-ups

2.1.9 Events

Event organization and attendance are an important aspect of the 5G-Blueprint communication and dissemination's strategy. After this type of activity was significantly hindered in the first half of the project due to the ongoing COVID-19 pandemic, 5G-Blueprint's project partners took great advantage of the return to in-person events – as soon as deemed safely feasible - to promote the project and increase its visibility. Table 2 provides further details on attended events for the reporting period.

Event name	Location and date	Event website	Type of contribution	Partners involved
The role of 5G in autonomous driving and intelligent transport systems - Workshop	Helmond, The Netherlands	https://www.5gblueprint.eu/workshop-on-the-role-of-5g-in-autonomous-driving-and-intelligent-transport-systems/	Workshop, project presentation, Keynote speaker	KPN, MIW
HAN Automotive Research Knowledge Festival	Arnhem, The Netherlands May 20, 2022	https://blog3.han.nl/energizer-international/first-knowledge-festival-han-automotive-research-big-success/	Project presentation, workshop	HAN
ITS European Congress 2022	Toulouse, France May 30-June 1, 2022	https://itseuropeancongress.com/	Presentation in Special Interest Session	BEM
2022 EuCNC & 6G Summit	Grenoble, France	https://www.eucnc.eu/	Paper presentations, booth	MAR, imec

	June 7-10, 2022			
ACM International Conference on Information Technology for Social Good (GoodIT 2022)	Limassol, Cyprus September 7-9, 2022	https://www.math.unipd.it/~cpalazzi/NAMO2022/	Project and paper presentation	imec
AVEC Symposium	Kanagawa, Japan September 12-16, 2022	https://avec2022.org/	Paper presentation	HAN
5G-LOGINNOV-ALICE: Collaborative Innovation Day	Online October 2, 2022	https://www.etp-logistics.eu/5g-loginnov-alice-collaborative-innovation-day/	Presentation	V-TRON
2022 IEEE Future Networks World Forum	Montreal, Canada October 12-14, 2022	https://fnwf.ieee.org/	Paper presentation	imec
PortComms 2022	London, UK October 9-10, 2022	http://www.wireless-networks-in-ports.com/	Paper presentation	imec
HIVE LIVE	Groningen, The Netherlands November 17, 2022	https://www.hivemobility.nl/event/hive-live-connect-the-future/	Keynote speaker	KPN
Automotive Week 2023	Helmond, The Netherlands April 16-19, 2023	https://www.automotiveweek2023.com/	Demo	V-TRON, HAN
EUCAD 2023	Brussels, Belgium May 3, 2023	https://www.connectedautomateddriving.eu/blog/event/4th-european-conference-on-connected-and-automated-driving-eucad-2023/	Booth, speaker at breakout session	MIW, BEM
Havendagen 2023	Ghent, Belgium May 7, 2023	https://www.northseaport.com/havendagen	Showcase	NSP

ITS European Congress 2023	Lisbon, Portugal May 22-24, 2023	https://2023.itseuropeancongress.com/	Presentations, panels, booth	MAR, imec, MOW, BEM
2023 EuCNC & 6G Summit	Gothenburg, Sweden June 6-9, 2023	https://www.eucnc.eu/	Booth, presentations, panels, poster session	MAR, imec, TNO
Move East	Enschede, The Netherlands June 16-17, 2023	https://oostnl.nl/nl/move-east	Demo	V-TRON, HAN
IEEE 9th World Forum on Internet of Things	Aveiro, Portugal October 12-27, 2023	https://wfiot2023.iot.ieee.org/	Project presentation in Industry Forum 5G for CAM	imec, SF
Smart cities: 5G and its impact	San Pedro Garza García, Mexico September 29, 2023	https://www.udem.edu.mx/en	Presentation on project results	imec
HVTT17+ICWIM9	Brisbane, Australia November 6-10, 2023	https://hvttforum.org/hvtt17-icwim9/	Paper presentation	V-TRON, HAN, ROBOAUTO
Connectivity beyond limits in mobility cross-border scenarios with 5G	Online November 8, 2023	https://events.teams.microsoft.com/event/4dc9f8fa-f393-4b31-bdb2-bdc063d0cf52@e28f7919-adf0-4feb-85b5-997a9b4e4907	Project presentation	imec
IEEE Future Networks World Forum	Baltimore, MD, USA November 13-15, 2023	https://fnwf2023.ieee.org/	Paper presentation	TNO
POLIS Conference	Leuven, Belgium November 29-30, 2023	https://polisconference2023.eu/	Project presentation	MOW
"Key outputs from the ICT-53 projects in deploying 5G in cross-	Online December 14, 2023	https://www.linkedin.com/events/outputsfromtheict-53projectsind7135656935663562752/about/	Project results presentation, roundtable discussion	MOW

border corridors scenarios" - A 5GMED Webinar				

Table 1: Events attended in the second half of the project

2.1.9.1 Events organized

5G-Blueprint organized several showcases and events in the reporting period, also thanks to the return to in-person events, which allowed co-location within renowned international venues. The presentation slides mentioned are available in the dedicated section of the project website.

On May 22-24, 2023, at the 15th **ITS European Congress** (Lisbon, Portugal), under the mutually developed banner “Pathways to Future CAM” (which enticed a joint communication campaign and related design assets) the project shared a booth with fellow Connected and Automated Mobility 5G-PPP ICT-53 projects 5GMED, 5GRAIL and 5G-ROUTES, which resulted not only in a mutual reach boost, but also offered a great chance to catch-up on how the respective activities proceeded and to plan follow-up joint activities.

Figure 29: 5G-RAIL, 5GMED and 5G-Blueprint representatives at the shared ITS booth

The 5G-Blueprint and “Pathways to Future CAM” ITS joint effort also extended beyond the exhibition floor, stretching to the double session entitled **“Driving towards realizing seamless automated cross-border mobility”**, moderated by Jorge Pereira (European Commission – DG CONNECT). The session was the result of the merger of different sessions proposals submitted to the congress, conducted with the aim to create cohesion on the already connected focus areas and themes, while emphasizing the work conducted on the so-called “5G Corridors” (and related projects), which represent the most strategic deployment areas for accelerating private investments in 5G infrastructure for Connected and Automated Mobility solutions. Representing 5G-Blueprint was partner Nina Slamnik-Kriještorac (imec), who walked an audience of around 40 participants through the project’s approach to seamless cross-border mobility)

Figure 30: Nina Slamnik-Kriještorac (imec) presenting 5G-Blueprint at the "Driving towards realizing seamless automated cross-border mobility" ITS session

Under the lead of 5G-Blueprint, the collaboration with the aforementioned ICT-53 projects also resulted in the organization of the collective **special session "5G for CAM in cross-border scenarios: challenges and lessons learnt"** on June 7, 2023, held within **EuCNC & 6G Summit 2023**. The session - also promoted online under the "Pathways to Future CAM" shared branding - reunited under the same roof the ICT-53 projects group and their predecessors, ICT-18 projects 5G-Mobix, 5GCroCo and 5GCARMEN, to sum up what has been collectively achieved in terms of cross-border sustainability of connectivity, and how we can bring it to the next level. Markus Dillinger – Head of 5G R&D for verticals at Huawei, Executive Committee member of 5G Automotive Association (5GAA) and co-initiator WG CAM vice chairman – served as a moderator, also offering an overview of the projects' paths and work, with the support of the facts and figures presented in the then recently released 5G-PPP and SNS JU Ecosystem's updated brochure on "Trials and Pilots for Connected and Automated Mobility"; offering the EC perspective on the projects was Jorge Pereira (DG CONNECT), who spoke of his first-hand experience overseeing the work conducted within them and how they fit in today's and future Europe. Representing 5G-Blueprint among the speakers/panelists coming from the projects, Technical Coordinator Johann Marquez-Barja (imec).

Figure 31: Johann Marquez-Barja (imec) on the stage of the "5G for CAM in cross-border scenarios: challenges and lessons learnt" session

At EuCNC 2023, 5G-Blueprint also organized a **standalone showcase**, which not only featured updated communication material (namely, our updated brochure) but also a remote driving simulator, which allowed visitor to put themselves in the (virtual) shoes of a teleoperator and experience first-hand the benefits of the innovative 5G solutions that we're fostering for future transport and logistics. The simulator was the highlight of our showcase, attracting a steady flow of visitors, including European Commission's Director of Future Networks Pearse O'Donohue

and Jesus Alonso-Zarate (Director Research and Innovation Policy and Strategy in Europe at i2CAT), trying their hands at the wheel.

Figure 32: Pearse O'Donohue (EC) and Jesus Alonzo-Zarate (i2CAT) trying the remote driving simulator at the 5G-BLUEPRINT showcase

As briefly mentioned in Section 2.1.6 and 2.1.8 - while covering the connected communication materials - as a wrap-up to the project's run, the consortium finally organized a **Final Event Showcase** on November 21, 2023, held at the Industrial Museum Zeeland, in Sas van Gent, The Netherlands. The in-person event revolved mainly around live demonstrations created around the project's use cases (as detailed in Section 2.1.6, which describes the videos created out of the demos). The event counted over 140 participants, gathering representatives from the industry and research communities, and from the Dutch Ministry of Infrastructure and Water Management and the Flemish Ministry of Mobility and Public Works, which provided introductory speeches highlighting the importance of the research conducted.

The event also featured a panel debate between representatives of the consortium partners, a series of booths corresponding to different specific aspects of the project or project partners (supported by the related leaflets and brochure described in Section 2.1.8, plus video screens), and a networking lunch and informal closing reception to allow further discussion among the participants.

Here below, a breakdown of the agenda (which took place over a half-day; 10:30 – 16:15):

- Keynote speech | Kees van der Burg (Director-General for Mobility and Transport, Dutch Ministry of Infrastructure and Water Management)
- Keynote speech | Jan Noelmans (Counselor logistics, regional airports and rail Cabinet of the Flemish Minister for Mobility and Public Works)
- Project highlights | Johann Marquez-Barja (Technical project coordinator 5G-Blueprint, Professor at imec)
- Panel session with project partners | Jan Cools (CEO – Be-Mobile), Muriel Desaeger (General Manager R&D Technology Strategy Planning & Incubation – Toyota Motor Europe), Jakub Juza (CEO – Roboauto), Geerd Kakes (Director Fieldlabs – KPN), Peter Van Parys (COO – North Sea Port)
- Teleoperation of a car seamlessly crossing the border | Rakshith Kusumakar (V-tron)
- Teleoperation and auto docking of a truck | Bas Hetjes (Researcher - Hogeschool van Arnhem en Nijmegen (HAN))
- Lunch, information market at the museum
- Demonstration carousel (Teleoperation of a skid steer in both indoor and outdoor environments; teleoperation of a barge seamlessly crossing the border; enabling functions)

- Informal closure (drinks and snacks)

Figure 33: Snapshots from the 5G-Blueprint Final Showcase event

2.2 Collaboration and liaisons with other projects and relevant initiatives

2.2.1 Liaisons within the 5G-PPP landscape

5G-Blueprint continued its relationship with some of the 5G-PPP projects previously identified as having aligned focus and objectives, and actively interacted with. Once again, depending on the project, different actions have been carried out, such as engaging in an active dialogue, exchanges/collaborations on publications and other releases, or planning of potential joint activities. Here below, a breakdown of all such projects 5G-Blueprint liaised with during the second half of the project.

- **5GCroCO** and 5G-Blueprint continued an active and dynamic collaboration for the remaining duration of 5GCroCo's run within the reporting period. To facilitate the process of exchanging know-how and ideas, the two projects previously established a collaboration framework spanning several types of activities: Wim Vandenberghe, the 5G-Blueprint project coordinator, continued to be part of the 5GCroCo advisory board until the end of 5GCroCo's run and the two projects have connected during several events, including EuCNC 2022 and 2023 (notably, for the latter, the project was part of the panelists for the special session organized by 5G-Blueprint, as described above). 5GCroCo and 5G-Blueprint also supported each other in their respective communication and dissemination efforts. The communication teams informed each other of relevant events and papers and cross-shared each other's articles and social media posts to reach an even larger audience and raise awareness about the work performed within both projects.
- **5G-MOBIX** and 5G-Blueprint have three common consortium members, namely imec, TNO and KPN. These organizations are responsible for interchanging knowledge and experience between both projects, which happens mainly within the context of WP5, and hence with an emphasis on connectivity aspects. In the same context, KPN made use of the 5G-MOBIX test site in Helmond to facilitate 5G-Blueprint integration testing, allowing 5G-Blueprint to perform the system integration before its pilot sites go live in

Vlissingen, Zelzate, and Antwerp. In terms of joint event participation, the project was also part of the panelists for the special session organized by 5G-Blueprint at EuCNC 2023; as a general baseline, the communication and dissemination teams of 5G-Blueprint and 5G-MOBIX actively collaborated similarly to what described above in the case of the relationship with 5GCroCo.

- **5GCARMEN** As part of the ICT-18 projects tracing the direct path to our focus and objectives, representatives of 5GCARMEN were invited alongside 5G-MOBIX and 5GCroCO to take the stage of the special session organized by 5G-Blueprint at EuCNC 2023, which 5GCARMEN also promoted on their own channels.
- **5GMED, 5G-ROUTES, 5GRAIL**: aside from the previously established active dialogue with 5GMED – which enticed sharing relevant news or information related to events - all three projects now actively collaborated with 5G-Blueprint as part of the ICT-53 projects' communication and dissemination task force, resulting in the organization and coordinated promotion of the series of shared activities described in Sections 2.1.9.1 and, 2.2.1.1.

In addition, 5G-Blueprint's representatives participated in several 5G-PPP-connected events and provided contributions to 5G-PPP releases such as June 2023's "From R&I towards actual deployment update on 5G trials and pilots for connected and automated mobility: A perspective from the 5G-PPP and SNS JU Ecosystem", which offers a cohesive and detailed overview on the status of related activities across Europe and across projects.

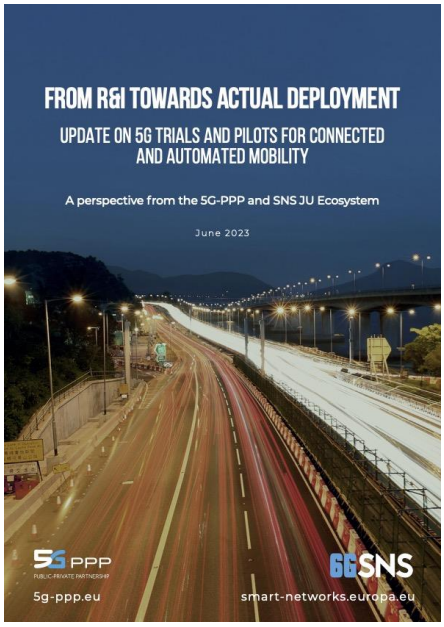


Figure 34: The 5GPPP release "From R&I towards actual deployment update on 5G trials and pilots for connected and automated mobility: A perspective from the 5G-PPP and SNS JU Ecosystem"

2.2.1.1 H2020 ICT-53 projects' communication and dissemination task force

Since the first half of its run, 5G-Blueprint has been active part in the H2020 ICT-53 projects' communication and dissemination task force initiated by the 5GMED project. In the reporting period, the project stuck to its commitment to the previously mutually agreed objectives to be carried by the group:

- Maximization of the impact of the ICT-53 projects by identifying joint communication and dissemination activities.
- Sharing best practices and communication and dissemination strategies in the context of CCAM, 5G, and cross-border handovers.

- Organization of joint events and webinars to increase the visibility of H2020 ICT-53 projects and uptake of their results.

Following up from such objectives, the task force held regular meetings and not only renewed its joint effort to present a workshop proposal for EuCNC 2023 – which was accepted and materialized as the "5G for CAM in cross-border scenarios: challenges and lessons learnt" session held within the event (as described in Section 2.2.9.1) – but also devised the set of common communications items described in Section 2.1.8, to be used as a shared branding for both joint and separate participations to events. Also previously described in the Events Section (2.1.9) of the present document, another major joint effort is represented by the task force's shared showcase at ITS Conference 2023, where the projects' representatives also took turns on the stage during the double session entitled "Driving towards realizing seamless automated cross-border mobility". 5G-Blueprint also make sure to share with the task force information on any other initiative or event that could be relevant for the other members, such as the MOOC course opening or the project's Final Showcase Event.
As indicated in the events participation table, 5G-Blueprint was also integral part of 2 different webinars organized by 5GMED – and attended by the other ICT-53 task force projects 5GRAIL and 5G-ROUTES – in winter 2023: "Connectivity beyond limits in mobility cross-border scenarios with 5G" (November 8, 2023), presenting the results obtained during the last months to the 5G community (where we were represented by imec), and "Key outputs from the ICT-53 projects in deploying 5G in cross-border corridors scenarios" (December 14, 2023), which consisted of two roundtable sessions to discuss achievements, outputs, strategic plans, challenges, recommendations, and lessons learned from the projects in deploying 5G technologies in cross-border scenarios.
Moreover, the Dissemination Task Force has enabled to gather a Technical Task Force, where the Technical leads/coordinators of each ICT-53 project exchanged technical approaches and information not only via mailing lists but also by joint meetings. The project plans to present the outcome of the project at the upcoming event of EuCNC 2024.

2.2.2 Liaisons with other relevant initiatives

Next to liaisons with the 5G PPP-related initiatives described above, the following collaborations with other relevant initiatives have been initiated:

- **5G IA**: imec represents 5G-Blueprint in the 5G CAM WG, and the Smart Networks WG, where several European projects gather to share experiences and to push collaboratively further the state of the art of 5G technologies and related verticals. Within 5G CAM WG, 5G-Blueprint contributes weekly to the progress of several inter-project initiatives, and representing the ICT-53 wave perspective.
- **6G IA**: Our Technical Coordinator Johann Marquez-Barja (imec) presented the lessons learnt within 5G-Blueprint, from the technological and business perspective, at the 5G4CAM Working Group of the 6G IA on December 18, 2023.
- **5GAA**: The 5G Automotive Association is a global, cross-industry organization of companies from the automotive, technology, and telecommunication industries, working together to develop end-to-end solutions for future mobility and transportation services. Created in September 2016, the 5GAA counts more than 130 members. MIW is not a full member of the 5GAA but it has signed a Memorandum of Understanding (MoU), effectively establishing a mutually beneficial cooperative relationship in areas of common interest. This MoU arranges confidentiality, facilitating the information exchange between both parties, and the participation of MIW in 5GAA meetings. As part of this cooperation, MIW has actively participated in the 5GAA's Teleoperation Work Item to transfer 5G-Blueprint learnings to 5GAA, and vice versa. This work however was

part of the first reporting period, and is hence detailed further in D8.3. In the second reporting period covered in this D8.4 document, MIW remained in collaboration with 5GAA, still covered by the original MoW, but in a less intense and more informal manner since the 5GAA Teleoperation Work Item was formally closed. MIW did invite the management team of that discontinued 5GAA Work Item to the final showcase even of the project on November 21st 2023, leading to the participation of the 5GAA CTO Maxime Flament in the event. Furthermore partner Eric Kenis (MOW) participated in the dedicated 5GAA session held at the 2023 European ITS Congress (Lisbon, 22-24 May) discussing the challenges and roles of public (road) authorities regarding (facilitation of) the rollout of automated mobility, the (5G) connectivity, and the co-operation with the automotive industry.

- **AECC:** the Automotive Edge Computing Consortium works with leaders across industries to drive the evolution of edge network architectures and computing infrastructures to support high volume data services in a smarter and more efficient connected-vehicle future. It is chaired by the Toyota Motor Corporation (TME). As a representative of 5G-Blueprint, TME actively exchanges information about mobile edge computing between 5G-Blueprint and their Asian colleagues who participate in the AECC.
- **Teleoperation Consortium (TC)** is a non-profit business league established to facilitate interactions and advance interests of the entities involved in the teleoperation ecosystem. The Teleoperation Consortium enables the collaboration of companies, organizations, and governmental bodies engaged in developing bidirectional vehicle communications. Membership is open to any corporation, public entities, standards and specification organizations and academic institutions. The 5G-Blueprint team liaises directly with the TC CEO regarding relevant events and similar activities. As such, the TC helped to organize the 5G-Blueprint Forum on Teleoperation.
- **CCAM Association** is the international not-for-profit organisation representing the private side of the CCAM Partnership, regrouping more than 180 innovation stakeholders involved in the connected, cooperative and automated mobility field. Imec, MIW and MOW are members. CCAM supported the promotion of 5G-Blueprint event. Within this association imec, representing 5G-Blueprint aims to bridge the automotive and communications perspective of CCAM association.
- **FOR-FREIGHT** Is a fellow EU-funded project that aims to maximise the utilisation of multimodal freight transport capacity, achieve competitive sustainability with higher levels of efficiency, and reduce the average cost of freight transport through the development of novel solutions and their integration with legacy logistics systems. FOR-FREIGHT started during the reporting period and directly sought out to collaborate with 5G-Blueprint (given the common focus on logistics), ultimately coordinating with us for a joint paper and the eponymous EuCNC session entitled “Enabling innovation in Transport and Logistics operations: a 5G approach”, which also involved other 5G logistics-focused projects and initiatives such as 5G-LOGINNOV, VITAL-5G, and FENIX. The general scope of the session was to bring forward a multi-perspective impact of 5G connectivity on improving the operations and whole end-to-end processing in T&L. Since first contact, similarly to what described for the projects in the 5G PPP orbit, there was also a mutual exchange of information and a cross-posting routine was established.

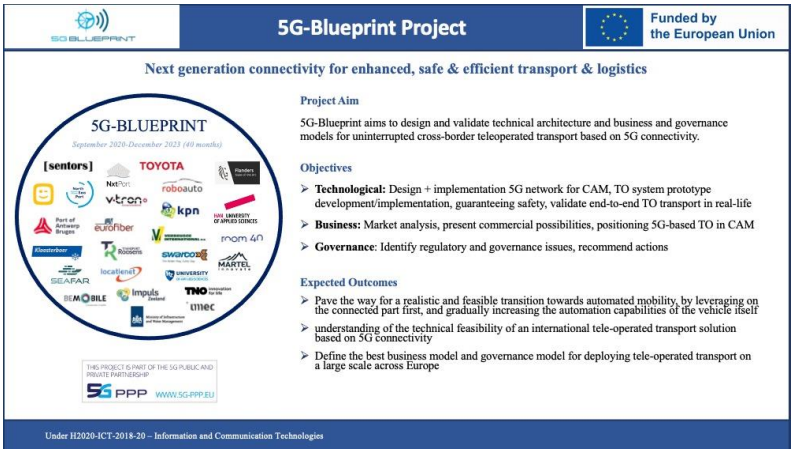


Figure 35: Screenshot from the "Enabling innovation in Transport and Logistics operations: a 5G approach" session

- **5G-LOGINNOV** Is another fellow EU-funded project in the field of logistics-connected CAM which aims, through the creation, testing and deployment of services, to ensure port areas and city-ports' handling of upcoming and future capacity, whilst coping with traffic congestion and environmental challenges. After establishing a first contact in October 2022, which saw 5G-Blueprint invited to participate with a speaker to the online event "5G-LOGINNOV-ALICE: Collaborative Innovation Day" – and kicked-off a mutually beneficial continuous exchange of information and cross-posting – 5G-Blueprint coordinated with 5G-LOGINNOV on the occasion of both major events held in Spring/Summer 2023: beside taking the stage along us in the previously described EuCNC collective paper and session, the two projects also sat side by side at the ITS Congress session "5G based logistics: business challenges and new opportunities" held on May 23, 2023. Eric Kenis (MOW) represented 5G-Blueprint at the session, which was organised as a panel, attracted around 30 people and revolved around the potential of 5G-based communications for facilitating data sharing, discussing enablers for the effective uptake of innovative solutions. Bringing their experience to the table were also fellow EU funded projects and initiatives, VITAL-5G, FENIX (and its follow-up FENIX2.0), KEYSTONE and ALICE. The presentation slides mentioned are available in the dedicated section of the project website.

Figure 36: Eric Kenis (MOW) representing 5G-Blueprint at the "'data sharing and 5G-enabled solutions in logistics" ITS session

2.3 Impact assessment

The project has defined a comprehensive set of communication and dissemination KPIs (see Table 3) to monitor the progress achieved across online and offline outreach and impact creation channels.

Measure	**Indicators**	**Target** (M40)	**Status at M40**
Project website	Total visits	2.500 *(per year)*	>7,300
Social Media	Twitter followers	> 250 *(by the end of the project)*	324
	LinkedIn followers	>100 *(by the end of the project)*	516
e-Newsletters	Number of newsletters developed	2 *(per year)*	7
	Number of contacts receiving the newsletter	200 *(per edition)*	160 (avg.)
Events Participation	Number of scientific events participated in	10+	11
	Number of non-scientific events participated in	10+	12
Events Organization	Number of events organized	3	5
	Number of participants	100+	>500
Videos	Number of videos developed	3	26
Brochures/leaflets	Number of brochures printed and distributed	500	450 leaflets 50 EF brochures 150 postcards
Scientific publications	Number published	20+	32
MOOC	No of MOOC organized	1	1

Table 2: Communication and dissemination KPIs

No.	**Milestone Name**	**Lead**	**Due**	**Status**
MS18	5G-Blueprint website ready	MAR	M1	Achieved
MS19	Inception Workshop completed	MAR	M16	Achieved
MS20	Engagement Workshops completed	MAR	M33	Achieved
MS21	Final showcase completed	MAR	M40	Achieved

Table 3: Communication and dissemination-related milestones

No.	Deliverable Name	Lead	Type	Diss level	Due	Status
D8.1	Dissemination, and communication and plan	MAR	R	PU	M3	Submitted
D8.2	5G-Blueprint visual identity and promo toolkit	MAR	OTH	PU	M2	Submitted
D8.3	Intermediate Dissemination, Standardization, Exploitation and Joint Activities Report	MAR	R	PU	M18	Submitted
D8.4	Final Dissemination, Standardization, Exploitation and Joint Activities Report	MAR	R	PU	M40	Current document
D8.5	Minor-course Automated Vehicles in Logistics	HZ	R	PU	M09	Submitted
D8.6	Automated Vehicles in Logistics	HZ	R	PU	M40	Submitted

Table 4: WP8 deliverables

2.4 Addressing reviewers' recommendations

Following the previous project reviews, the consortium has discussed each suggestion brought forward and acted to address those related to dissemination and communication activities as detailed here below. In Italics the Reviewers comments followed by the consortium reply.

"The consortium should not artificially increase its publication KPIs including publications that are not part of the 5G Blueprint work.

The project website and D8.3 have been updated according to the reviewers' requests. *"Also, the consortium should plan well ahead (and with a European focus) its last two events to ensure their maximum possible impact. Planning for the organization of planned events for showcasing project activities should improve."*

The updated plan has been included in the resubmitted version of D8.3.

"The project has to review its website that focuses basically on the CAM aspects of the project and not the 5G ones".

The 5G-Blueprint website now features a section dedicated to the 5G angle of the project.

"The consortium must make stronger efforts towards disseminating the contributions of 5G-Blueprint in a broader scope, and considering a broader set of stakeholders. It is recognized that a significant Advisory Board (AB) has been established, but it has been remarked that it is mainly involving local stakeholders."

The large and diverse array of events-related activities reported in section 2.1.9 reflects a definite effort in terms of broader-scope dissemination. It must be mentioned that the AB doesn't feature only local members, in fact (Ford Otosoan, International Container Barge Operators ICBO, HERE).

"To increase the impact bringing it to a European dimension, a more extended involvement of additional non-local stakeholders would be highly recommended."

- Collaboration with other ICT projects is ongoing.
- Dissemination activities to wider community (e.g. particpation to ITS congress)

"Although the project was planning for standardization impact, no specific measures, actions or contributions have yet been identified. The consortium should consider more standardization and industry 5G impacts, e.g. in the area of experimentally validating 5G slices and proposal for modifications to such slices to better address the needs of CAM services (e.g. when considering URLLC capabilities) as well as 5G SA roaming."

KPN further tried to make this an official topic in GSMA. Multiple informal discussions held, work on draft vision paper started, but all activities were stopped when the lead from GSMA left. KPN will continue trying, but chances are low that will succeed here.

TNO and KPN brought 3 contributions (Change Requests) to 3GPP in the SA2 Working Group in the August 2023 meeting for Release 16, 17 and 18 respectively. The CRs comprised additions to the standards related to experience from the 5G SA seamless roaming implementation and trials. After discussions with delegates from different companies and modifications, one CR for Release 18 has been agreed, which introduced a reference to the procedure for I-SMF insertion/modification/removal in the N2 handover clause to support inter-PLMN handover scenarios.

"Remove from the website and related dissemination reports and deliverables all publications that are not specifically related to 5G-Blueprint activities."

The website and F&T portal underwent updates, following the request.

"Include on the website information related to 5G networks and deployments in 5G-Blueprint as well as 5G technologies and solutions that are going to be trialled for improving service continuity across borders and MNOs."

The consortium has updated the website accordingly.

"The consortium must plan well in advance the events planned until the end of the project to maximize their impact."

The updated plan has been included in the resubmitted version of D8.3; the consortium lead the organisation of workshops and panels in the context of major events such as ITS and at EuCNC, to maximise reach, and dedicated great effort to the organisation and success of the final showcase event, as detailed in section 2.1.9.1.

"WP8: fair outreach with website and social media; good scientific publication, but with extra papers not resulting from5G-Blueprint"

Those extra papers were removed from the website and from the dedicated list in D8.3.

"the project needs to better assess standardization and exploitation"

These aspects were addressed in D8.3's revised version.

"The advisory board is local, which may not work on the spread of the project to lead the European TO industry"

The AB also features members coming from outside the EU.

"Several demos have been presented in the review meeting. The demos on tele-operation have used the NSA 5G deployment in Vlissingen. There is also much work on applications, some applications without a connection to 5G (detection of containers) or cross-border (UAV for situation awareness of the trucks arriving in the port)."

The WP8 angle was made more clear for every UC and EF in our internal documents.

"The focus needs to be on 5G now, and these UCs and EFs do not need to be further developed."

We confirm that development work on UCs and EFs has been completed at M24.

"Moreover, and to be able to evolve on the 5G teleoperation in cross-borders, it is key to bring TNO and the research core."

TNO is indeed a new beneficiary, and completed its tasks, at the time of writing.

"Apart from the impact on the consortium SMEs, no specific action has been designed for increasing the impact on external SMEs. The outcome of WP3 could have a positive impact on SMEs across Europe if it helps regulate and design effective policies for developing teleoperation. To do so, the project has to develop the necessary measures to ensure it will impact Europe as a whole, and this is currently not the case since actions and engagement seem to be too local."

It has to be noted that innovations developed within the project have since been singled out by the EC's Innovation Radar in terms of impact.

"The project has disseminated and communicated relatively well project activities and results through the website and social media. The information online is mostly focused on the project, use cases and enabling functions. There is no information on 5G, the networks being deployed, 5G service continuity, etc. The website should be revisited to include information on the 5G-Blueprint network deployments, and most importantly on the 5G solutions to be trialled for improving service continuity".

As mentioned in the previous sections, dedicated changes have since been implemented to the project website.

"The consortium organized an inception workshop/forum on teleoperation but the information on the event, and most importantly on the conclusions reached from the workshop are not available online and have not been well disseminated."

The website now features extensive information (including full video recordings) relating to the teleoperation forum.

"This should be corrected, and presentations/videos should be published online (could not be found at the time of writing this report)."

The full video recordings of the teleoperation forum's sessions are now available on the website (and on the project's YouTube channel), and the reporting connected to the event has been revised. *"The consortium plans for educational activities which are interesting and innovative. The objectives of the minor course are well defined and are all very relevant."*

HZ contributed to educational activities within the 5G-Blueprint project, by developing both a minor course and a Massive Open Online Course (MOOC). The minor course offers a 30 ECTS educational program for bachelor students, facilitating exploration and application of technical aspects and characteristics of autonomous systems. Students delve into potential applications and assess their societal impact, particularly on mobility. The MOOC extends this knowledge globally, targeting a broad audience including students, professionals, and logistics enthusiasts, aiming to deepen their understanding of autonomous vehicle applications in logistics. The course comprehensively covers relevant features, technological aspects, and characteristics of autonomous vehicles, providing valuable insights into their potential logistics applications. It equips participants with tools to tackle challenges associated with autonomous vehicle implementation, contributing to advancements in the logistics sector and beyond.

"There is no information about standardization."

KPN further tried to make this an official topic in GSMA. Multiple informal discussions held, work on draft vision paper started, but all activities were stopped when the lead from GSMA left. KPN will continue trying, but chances are low that will succeed here.

TNO and KPN brought 3 contributions (Change Requests) to 3GPP in the SA2 Working Group in the August 2023 meeting for Release 16, 17 and 18 respectively. The CRs comprised additions to the standards related to experience from the 5G SA seamless roaming implementation and trials. After discussions with delegates from different companies and modifications, one CR for Release 18 has been agreed, which introduced a reference to the procedure for I-SMF insertion/modification/removal in the N2 handover clause to support inter-PLMN handover scenarios.

2.5 Plan of activities after the end of the project

The 5G-Blueprint project's communication and dissemination activities will not stop at M40. In fact, as mentioned before, 5G-Blueprint partners will:

- The 5G-Blueprint web domain https://www.5gblueprint.eu/ will remain active for two years after the project end so that 5G-Blueprint's results can be available to other research initiatives and or industry, SMEs, etc. so that parties interested in the technology can benefit from the results achieved. Martel will be available to update the website when needed and keep the social media channels active accordingly.

- Being still active after the project's end, 5G-Blueprint's online outlets will remain the prime jump-off point to inform stakeholders on any development building upon what achieved through the project.

- The consortium, under the lead of imec, is planning to submit a series of additional scientific publications based on the project's key outcomes to EuCNC 2024. The preparation of such publications is still ongoing at the time of writing. Upon approval, these materials will be uploaded to the project website's library.

3 STANDARDIZATION

3.1 Objectives of Task 8.3 Standardization

The objective of this task is to identify relevant technologies to be standardized to guarantee the universal adoption of the developed technologies into the market, and to try to positively impact the corresponding standardization activities. For this, the 5G-Blueprint consortium actively follows the activities of a number of standardization bodies and tries to contribute where relevant.

3.2 Standardization plan

The following standardization bodies have been identified as relevant for 5G-Blueprint, and are hence actively monitored in search of contribution opportunities:

- CEN/TC 278 Intelligent Transport Systems
- ISO /TC 204 Intelligent Transport Systems
- ETSI Technical Committee (TC) Intelligent Transport Systems
- 5GAA Work Item Teleoperated Driving (ToD)
- 3GPP SA2 Working Group
- CROW Change Advisory Board on iVRI (aka iTLC or Intelligent Traffic Light Controller)
- TISA Guideline Estimated Travel Time (ETT) Metrics and Tests

However, this monitoring has revealed two challenges when it comes to impacting their standardization activities.

Challenge 1: The complexity of organising new work items within a standardization body. This typically involves an intensive process of defining the scope of the new work item, defining the different roles that need to be involved (leads, secretariat, experts, etc.), finding parties willing to take up these roles, (sometimes) acquiring financial resources to perform this activity, and finally, getting the board's approval for the launch of a new work item. Given the limited resources available for standardization activities in the project, it was hence decided that setting up new work items in the selected standardization bodies was not a feasible approach. Instead, project partners agreed that the monitoring should focus on identifying already active work items to which 5G-Blueprint could positively contribute.

Challenge 2: When you define a standard, you have to be certain that the specifications that you are defining will also be suitable in practice. Since 5G-Blueprint is an Innovation Action, this certainty only exists after the successful validation of the developed solutions at the pilot sites. An activity that is only finalized by the end of the project. This means that standardization contributions focusing on the definition of detailed technical specifications can only be made in the last phase of the project.

Based on the above, for the moment, the following standardization contributions have been defined (see Tables below).

3GPP (SA2 Working Group)	
Topic	Inter-PLMN N2 handover
State of the art	The 3GPP SA2 Working Group focuses on defining the architecture and procedures for enabling 5G systems and their functionalities. In particular, the Home-routing roaming architecture and procedures, and N2 handover procedures are defined.
Contribution(s)	Submitted and discussed contributions for Releases 16, 17 and 18 related to enabling inter-PLMN N2 handover in Home-Routed roaming for 5G based on experience from the project trials. These contributions have been pushed to 3GPP in the meeting held on 21 - 25 August, 2023, Goteborg, Sweden. This has been recorded in the official 3GPP agenda of that meeting[1]. The corresponding part where TNO contributed the 5G-Blueprint results looks as follows: 6.2 S2-2309277 CR Approval 23.502 CR4426 (Rel-16, 'F'): Clarifications for N2 inter-PLMN handover KPN N.V., TNO 6.2 S2-2309278 CR Approval 23.502 CR4427 (Rel-17, 'A'): Clarifications for N2 inter-PLMN handover KPN N.V., TNO 6.2 S2-2309280 CR Approval 23.502 CR4428 (Rel-18, 'A'): Clarifications for N2 inter-PLMN handover KPN N.V., TNO 6.2 S2-2309652 CR Approval 23.502 CR4428R1 (Rel-18, 'A'): Clarifications for N2 inter-PLMN handover KPN N.V., TNO 6.2 S2-2309955 CR Approval 23.502 CR4428R2 (Rel-18, 'F'): Clarifications for N2 inter-PLMN handover KPN N.V., TNO More details can also be found by looking up the CR numbers of the list above in the status report of the meeting[2] : S2-2309277, S2-2309278, S2-2309280, S2-2309652, S2-2309955.
Participant(s)	KPN, TNO

Table 5: 5G-Blueprint contribution towards 3GPP

5GAA	
Topic	Teleoperation using 5G
State of the art	As an organization where many representatives of the automotive and telecom sectors come together, it became clear that teleoperation using 5G is an interesting concept, but that many unclarities have to be discussed before it can be considered a feasible option. Therefore, it initiated a Work Item called Teleoperated Driving (ToD)

[1] https://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_158_Goteborg_2023-08/TdocsByAgenda.htm
[2] https://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_158_Goteborg_2023-08/Report/S2-158_Draft_Report_v006.zip

Contribution(s)	Review of report on use case[3] Active contribution to network requirements and system architecture definitions[4] Lead of the study regarding business considerations[5] Active contribution to the white paper bringing all results together[6]
Participant(s)	MIW

Table 6: 5G-Blueprint contribution towards 5GAA

CROW	
Topic	Intelligent Traffic Light Controllers
State of the art	In the Netherlands, a new generation of traffic light controllers (iTLC, or in Dutch iVRI) has been created during the Talking Traffic Innovation Partnership. At the moment roughly 1 000 of these new generation traffic light controllers have been deployed throughout the project, and Flanders has started to do the same as part of the Mobilidata programme (currently roughly 100 deployed). To guarantee the technical stability of the ecosystem, all iTLC related specifications are managed by a Dutch organization called CROW, in which a Change Advisory Board on these specifications has been created.
Contribution(s)	Active contribution to updated specifications regarding priority requests (important for the further deployment of Enabling Function 3 Time slot reservation at intersection)
Participant(s)	MIW, MOW, Swarco

Table 7: 5G-Blueprint contribution towards CROW

TISA	
Topic	Estimated Travel Time (ETT)
State of the art	The Traveller Information Services Association (TISA) provides advisory information to all concerned with Traffic and Travel Information services and products. In this perspective, a TISA guideline was created that recommends a framework and quality

[3] https://5gaa.org/news/tele-operated-driving-tod-use-cases-and-technical-requirements/
[4] https://5gaa.org/news/tele-operated-driving-tod-system-requirements-analysis-and-architecture/
[5] https://5gaa.org/news/tele-operated-driving-tod-business-considerations/
[6] https://5gaa.org/news/tele-operated-driving-use-cases-system-architecture-and-business-considerations/

TISA	
	metrics allowing to evaluate the quality of Estimated Travel Time (ETT) in a navigation context.
Contribution(s)	Contributing to the provision of metrics and framework to measure Estimated Travel Time (ETT) to evaluate traffic data, incorporating real-time traffic, historic traffic and predictive traffic. This includes the specification of a framework based on the usage of real driven trips as ground truth and identification of the appropriate metrics to use to estimate the quality of estimated travel times (important for the further deployment of Enabling Function 7 ETA sharing).
Participant(s)	BEM

Table 8: 5G-Blueprint contribution towards TISA

It should also be noted that it was also investigated if the control messages to create CACC based platoons as part of UC 4.3 could be brought to an appropriate standardization activity. However, further state of the art analysis on this topic made clear that this was already done sufficiently by the Ensemble project, in its deliverable D2.8[7]. Therefore, it was decided to abandon the pursuit of this specific standardization possibility.

3.3 Data management and ownership

Data management and ownership are now covered in detail in a dedicated deliverable D2.4 (Data Management Plan – Final version).

[7] https://platooningensemble.eu/storage/uploads/documents/2021/03/24/ENSEMBLE_D2.8_V2X-communication_Final.pdf

4 EXPLOITATION

4.1 The exploitation plan in 5G-Blueprint

The 5G-Blueprint project consortium drafted a final plan for the exploitation of innovative project outcomes, classified them based on potential impacts and market values, and identified the potential consumers of these outcomes at the end of the project (M40). The plan makes use of research done in work package 3 'CAM Governance and Business Models' and gathered information in previously presented exploitation plans of the project. The term exploitation is already defined in deliverable 8.3 as *''The use of results for commercial purposes or in public policy-making''* in line with the definition of the EU (n.d.). Within the project a distinction is made between a project-wide exploitation plan and individual exploitation plans of the public, private and academic consortium partners. The project consortium agreed upon knowledge transfer with external projects and initiatives. An additional feature was that the 5G-blueprint pilot environment and deployed infrastructure could be set open for access under experimental and predefined conditions. However, the planning schemes in combination with an external illegally transmitting source of interference ('jammer') forced the consortium to not validate the use of infrastructure by parties external to the project. The set of activities above contribute to the overall goals of the project and specifically work package 8:

- To align efforts to come to relevant standards and open-source initiatives, fostering contribution to them as appropriate and relevant to exploitation plans and project's outcomes.
- To facilitate exploitation of the project's outcome and actively promote the further development of innovative solutions based on the 5G-Blueprint outcome.

This chapter presents the final exploitation plan of the 5G-Blueprint project. It first touches upon the policy and research background behind the project and interactions with fellow projects and initiatives in this regard; secondly, the achieved results are detailed; thirdly, both project-wide and individual partners' exploitation plans are described, then naturally flowing into planned activities and joint/individual exploitable results. A last subsection on the takeaways at the end of the project wraps up the chapter.

4.2 Achieved results and project-wide exploitation

The position of the 5G-Blueprint in the wider spectrum of policy ambitions, incentives and trends is essential for further consideration of the exploitation of the outcomes and upcoming activities of the consortium partners similar to the consortium as a whole (see Annex B). In fact, the described policy and research activities in the previous paragraph sharpen the understanding that the goal of formulating a blueprint for 5G-based (logistic) teleoperation is indeed meant to be a catalyst starting from the pilot environment and squeezing into several policy domains and actions. This section will explain on the other hand that enablers and roadblocks still need further research besides underlining the fact that innovative achievements have been made.

4.2.1 5G-Blueprint roadmap-based exploitation opportunities

The final project-wide exploitation plan is an overall result fed by developed governance and business models in WP3 and input on exploitable assets and project outcomes from project partners. The defined deployment scenarios described in detail in D3.5 are summarised here as the framework with the aim to streamline and narrow down realistic project-wide and individual exploitable assets. The development of the Innovation Radar Questionnaire assists in this respect and pinpoints practical directions which can relate to the joint exploitation

strategy. A 5G-Blueprint presented the following innovative aspects developed within the project to the attention of the EC initiative:

1. Teleoperation solutions for trucks and skid steers using 5G.
2. Teleoperation solutions for barges using 5G.
3. Auto-docking services for teleoperated trucks using 5G.
4. Container ID recognition using 5G.
5. Scene analytics using 5G.

Grounded in the original characteristics of the 5G-Blueprint project and complemented with new insights about different deployment scenarios, four deployment scopes are defined to contain sufficient potential for facilitating the upscaling of project-wide outcomes.

Scope 1: Teleoperation is limited to private premises. Within this scope, we can make a further distinction between teleoperated transport with a limited range and teleoperated transport with free range within the private premises. Similar to the deployment areas in 5G-Blueprint, port environments (see for instance 5G-LOGINNOV in Annex B) prove to be one of the areas where the solutions of teleoperated OEMs are able to put foot on the ground on the short term and support ports and logistic service providers. Bosch and APCOA show that in case of valet parking possibilities exist also beyond the port environment. Therefore, the following list of private areas becomes relevant:

- Airports
- Valet parking
- Marshalling yards
- Military sites
- Mining grounds
- Agricultural lands
- Forest and nature
- Warehouses
- Hospitals
- Campuses
- Industrial sites
- Construction sites
- Event sites

Scope 2: Teleoperation is limited to a specific local area that includes a mix of private and (semi) public roads (e.g. a port terminal and surrounding area) or local waterways. Typically, for these shuttle run transports the number of origins and destinations will be limited. As a result of constraining rules and regulations it will not be possible to perform activities of shuttle run on the short trajectories. Therefore, it is smart to frame this stage in the perspective of up-scaling teleoperation to a second local phase. Although benefits can occur in solely focusing on scope 1 deployment areas, the next step will be to analyze the local environment surrounding the mentioned private areas (as in for example 5GCroco). The combination of local private and public infrastructure encourages to look at the increased potential further on in a transport network and making local connections between areas. In the project a typical example is presented of transportation between a port terminal (North Sea Port) and warehouse (MSP Unions) using teleoperation.

Similar to land-based scenarios, the water-based scenario can start small in port environments by making shuttle runs between different docks (inspiration based on 5G-VITAL). Instead of transporting goods on the road or rail between terminals, the waterways can be used more efficiently and without crew on-board. The support of one or multiple ‘hub’ dock(s) enrich(es) the opportunity to increase the amount of good supply because the logistic flows do not depend on waiting times and over-supply on docks. The same TO service provider can during the in-

between times assist the seaport by dredging its waterways and perhaps even helping in flora and fauna research. A more human-centric approach is to focus on the transport of travelers who want to cross waterways. Water taxis or water ponds can ship people from one side to the other in geographical areas such as delta's, rivers, inland seas and lakes.

From a policy perspective it will be interesting to find out how teleoperation can support local first-mile or last-mile distribution areas to make a teleoperated modal shift from water-based transport to land-based transport and vice versa. The integration between water and land infrastructure offers a third promising concept where the upscaling above private areas can be sought. The 5G-Blueprint project offered the example of how this could be enabled.

Scope 3: Teleoperation takes place over an extended geographic area with unlimited amounts of origins and destinations. The differentiator for this scope is the upscaling of teleoperation between the local-regional level to the national level across local, regional and national level. Especially for this scope the functional segmentation of the trip in Level4 and Level5 parts is important (see Annex B). During the 5G-Blueprint project the highways are considered to become the enabling infrastructure for Level5 deployment in the shortest term. The difficulty is that the complexity of road infrastructure is increasing when local and regional roads become involved in the trajectory because of their more unpredictable nature in terms of road structures, users and user behavior. The challenge will be to align and time manage the implementation of L5 automated mobility with local/regional teleoperation solutions which can take-over the more complex parts of the road. Again, this strengthens the idea that stakeholders should do a network analysis based on where local/regional areas with teleoperation solutions are (closely) intertwined with commercial, policy-based or safety operations. The primary example of exploiting scope 3 is teleoperation for the transport of logistics between distribution centers along highways. A national part of The Trans European Transport Network (TEN-T) provides a geographical framework for commercializing the current teleoperation solutions (see for example 5G-CARMEN in Annex B or the company Einride). In the short term this may be performed during the night for meeting safety requirements and, consequently, granting permission.

Another example is the adoption of teleoperation in shared mobility services and public transport. Current practices show that employees of shared mobility and public transport providers have to travel around and re-park vehicles with the incentive to facilitate the demands of customers and to take care of the fuel and maintenance. Teleoperation can solve this issue by driving vehicles to desired locations or to shared mobility hubs (with a mechanic). In the same sphere is a more socially-driven opportunity to provide a shared mobility pick-up service for children, adults and elderly when they live in places with no or neglectable options for transportation to education, work or health care. Companies in Europe such as Elmo, Vay, Ush and Amber are already working on this type of cases.

Scope 4: Teleoperation takes place over an extended geographic area with (in theory) unlimited amounts of origins and destinations, including origins and destinations that are in different countries. Typical application for land – Cross-border: The transport of containers between two warehouses via a major international transport axis is (at least partially) teleoperated. Typical application for water:bulk goods are transported over (inland) waterways via teleoperated barges, potentially cross-border. Specifically, the role of the skipper is transferred from the vessel to a control center.

In both the land-based and water-based scenario it is the cross-border element where the challenge can be found. The project contributed within its scope to the harmonization and standardization of at least teleoperation solutions being able to travel from one country to another. The bottleneck is the presence of a 5G-network in both countries while the take-over time is not critically hampered and sufficient services can be operational on the network to make investments commercially attractive. In wider context can be learned from road and rail transportation (see 5G-MED, 5G-Routes, 5G-MOBIX in Annex B), since it can be assumed that

the rollout of teleoperation on rail moves on faster than on road and water because of the ODD, users and user behavior. In terms of teleoperation service providers it can be insightful to review the station-based approach of Eurocontrol for deploying control centers.

4.2.2 5G-Blueprint business tool

5G-Blueprint business models and performances against KPIs is described in detail in D3.4, where multiple KPIs have been addressed and the developed business tool offer the opportunity to be validated by logistics companies. The business tool allows comparisons (FTE, investment and operational costs) between the situation with teleoperation and the situation without the use of teleoperation. Both are based on 5G-telecommunication.

4.2.3 5G-Blueprint ecosystem

The 5G-Blueprint ecosystem is well balanced consortium of public, private and knowledge parties, which have joined forces to create a blueprint for 5G teleoperation for logistic services. The unique selling point of the 5G-Blueprint ecosystem is that involved partners knowing exactly what parties should be contacted and can contribute to examining and realising deployments. Parties outside the ecosystem can learn from this. In a practical sense the outcome of the ecosystem-based approach of 5G-Blueprint will result in clusters of organisations that are able to find each other and work together on implementations according to the phases of the roadmap. The value network of described in D3.1. assists in defining roles and responsibilities.

4.2.4 5G-Blueprint risk and liability scheme

D3.5 'Road map & Governance presents the identified main challenges for further upscaling of teleoperated transport. The main challenges are linked and pinpointed to the different phases as presented in the roadmap. The focus is put on operational roadblocks, the tasks of the operator and product liability process, legal issues and 5G.

4.3 Exploitation plans of consortium partners

4.3.1 National governments (ministries and road operators)

Ministry of Infrastructure and Water Management *(including the national road operator Rijkswaterstaat, and with support of the Dutch Telecom Agency)*
The Dutch Ministry of Infrastructure and Water Management (MIW) is the main national responsible public authority for affairs on infrastructure, mobility and water. The three core strategic policy drivers of MIW are accessibility, sustainability and safety with the goal to improve the life of Dutch citizens and temporary workers or visitors. MIW coördinated the 5G-Blueprint project based on these drivers and still present needs. For example, decrease in accessibility in rural areas, reduced efficiency in logistic processes with the result of increased CO2-emissions and with digital instruments resolvable unsafe traffic situations. Therefore, MIW is going to stimulate the adoption of the most promising results of this project in the broadest sense possible because 5G-Blueprint connects to multiple policy domains which can together provide a fertile soil for exploiting teleoperation. The plan is to divide the exploitation into three policy actions that are proportional to the responsibilities of MIW: Adoption strategy of teleoperation concepts in Dutch national policies and rules and legislation. (this exploitable asset relates to the exploitable asset of MOW), knowledge support for smart-scale deployments of teleoperation and experience and knowledge in a public-private ecosystem for state-of-the-art teleoperation solutions.

Exploitable Asset	
Name	Adoption strategy of teleoperation concepts in Dutch national policies and rules and legislation. (this exploitable asset relates to the exploitable asset of MOW).
Short description	The project-wide exploitation plan illustrates that the potential deployment areas for teleoperation can increase similar to teleoperation use cases. Specifically MIW will stimulate the adoption of project outcomes in programmes and projects related to 5G, Connected Automated Mobility, logistics and spatial planning. In addition, MIW contributes to aligning and implementing teleoperation concepts into European and national rules and legislation.
Type of exploitable asset	Policy-making and rules and legislation.
High-level goal (commercial, research, policy-making)	Policy-making.
Related UCs	All.
Related EFs	All.
Related WPs	WP8.
Ownership	MIW.
Constraints to Intellectual Property Rights (IPR)	N/A.
Customer Target Group	Public authorities.
Customer Target Problem	Absence of or insufficient knowledge about implementation possibilities of teleoperation and added societal value.
Customer Key Benefits	Deliberate, smart and faster policy- and decision-making process when teleoperation offers potential societal added value.
Customer target geographical scale	National and cross-border (GE-NL, BE-NL).
Competitors	Commercial parties creating vendor lock-in or assumption-based steering unknowledgeable public authorities.
Differentiation of exploitable asset	National scale adoption.
Marketing, communication and promotion	Social media of MIW and MIW-supported initiatives.

Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	Project outcomes will be used for the Dutch human capital agenda on automated mobility, programme on smart introduction of automated vehicles, national policy on 5G, national logistic policies on urban logistics and TEN-T and the DMI-ecosystem.
Notes / Additional information	MIW foresees a role of the EU to promote, communicate and exploit policy-related project outcomes on the European scale level.

Exploitable Asset	
Name	Knowledge support for smart-scale deployments of teleoperation.
Short description	The roadmap of the project shows that private areas become the first deployment areas for teleoperation (with 5G). The policy and legal responsibility of MIW is not to finance or act on private areas. As such, MIW will bring knowledge support in.
Type of exploitable asset	Knowledge.
High-level goal (commercial, research, policy-making)	Commercial, research and policy-making
Related UCs	All UCs.
Related EFs	It can include EFs.
Related WPs	WP4, WP8.
Ownership	MIW.
Constraints to Intellectual Property Rights (IPR)	N/A.
Customer Target Group	Industry and SMEs, associations and networks of organisations, automotive sector related organisations, logistics operators, telecom operators, academia and research institutes, policy makers, port authorities, road and motorway manager, public authorities.
Customer Target Problem	Lack of state-of-the-art knowledge about implementation of teleoperation.

Customer Key Benefits	More advanced understanding of necessary conditions related to the deployment area.
Customer target geographical scale	Local.
Competitors	Industry and SMEs, research institutes.
Differentiation of exploitable asset	The legal and policy perspective on deployment requirements.
Marketing, communication and promotion	Communication channels related to programmes and projects where MIW is involved focusing on Connected Automated Mobility.
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	Dutch public authorities are asked to think about proposals for the deployment of connected automated mobility. MIW is working 5G Field Labs for Automated Train Operations.
Notes / Additional information	N.A.

Exploitable Asset	
Name	Experience and knowledge in a public-private ecosystem for state-of-the-art teleoperation solutions.
Short description	The collaboration of multiple parties working on innovative solutions for specifically teleoperation has been critical for the success of the project. Therefore, the approaches taken during the project are of important value for MIW also in the broader sense of working in public-private ecosystems.
Type of exploitable asset	Knowledge
High-level goal (commercial, research, policy-making)	Policy-making
Related UCs	N/A.
Related EFs	N/A.
Related WPs	WP2, WP8.
Ownership	MIW.

Constraints to Intellectual Property Rights (IPR)	N/A.
Customer Target Group	Industry and SMEs, associations and networks of organisations, automotive sector related organisations, logistics operators, telecom operators, academia and research institutes, policy makers, port authorities, road and motorway manager, public authorities.
Customer Target Problem	Lack of knowledge about working in public-private ecosystems.
Customer Key Benefits	Efficiency in collaboration
Customer target geographical scale	Local, regional, national, European.
Competitors	N/A.
Differentiation of exploitable asset	The inclusion of legal and policy requirements.
Marketing, communication and promotion	Ex-ante and ex-durante steering of needed actions and requirements.
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	The outcomes of this project are brought into the public-private ecosystem Dutch Metropolitan Innovations.
Notes / Additional information	N.A.

Flander's Department Mobiliteit en Openbare Werken

The Department of Mobility and Public Works is responsible for the planning, execution and evaluation (of impacts) of hard and soft infrastructure and measures regarding the transport infrastructure and mobility-management. Their goal is to ensure seamless hinterland connections, and to set-up or foster an advanced and intelligent multi-modal transport system ensuring safe travelling for passengers and goods while ensuring affordable access for all and a minimal environmental impact

The motivation for joining the 5G-Blueprint project lies in the aim of fostering economic growth, using existing (infrastructure-related) capacities at best while also ensuring safe operations and facilitating sound working conditions - in light of combining economic development and prosperity, and overall well-being.

The department believes automation in transport can contribute to these objectives on condition its introduction is well framed and guided; tele-operation is being seen as a driver for the introduction of automated driving/ sailing systems whereas it also provides (required) fall-back solutions - at least during the initial phase of wider introduction; the department has been happy to support testing and validation while guiding the exploitation of business and governance models.

Project approaches and overall outcome are presented and discussed – in particular with regard to speeding up the introduction of automated driving/ sailing on Flemish roads/ waterways and facilitating both a better use of available (infrastructure) capacities and a speedy roll-out of 5G networks by making us of the MOW-proprietary fibre network along major roads and waterways.

As a matter of fact, building on the outcome of the project and taking into consideration the business and governance recommendations produced, Flanders has set up a public-private 'Task Force on automated mobility (including tele-operation)' and equally plans a 'real world' follow-up pilot in early 2024 - combining and assessing the interaction of teleoperated and automated driving (L4) on both a closed road circuit and a segment of the public road network (budget reserved: 500k€).

Exploitable Asset	
Name	5G-Blueprint Road map (D3.5).
Short description	Road map for the deployment of tele-operated driving & sailing - including Governace
Type of exploitable asset	Policy-making and rules and legislation.
High-level goal (commercial, research, policy-making)	Policy-making, validation of considerations & best practices; impact analysis; recommendations on governance
Related UCs	All.
Related EFs	All.
Related WPs	WP3 & 8
Ownership	MOW; D3.5 = project / public
Constraints to Intellectual Property Rights (IPR)	N/A.
Customer Target Group	Public authorities/ industry & wider public (acceptance).
Customer Target Problem	Insufficient insight/ knowledge on operational value and impacts, societal added-value.
Customer Key Benefits	Societal added value; economic relevance.
Customer target geographical scale	National & cross border (NL, GE).
Competitors	None.
Differentiation of exploitable asset	No existing roadmaps nor a clear view on Business Models & Governance required
Marketing, communication and promotion	N/A.
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.

Planned activities for exploitation	set-up of a 'Flemish task force on automated mobility' (also covering tele-operation) with thematic working domains - led by the minister of Mobility and Public Works and leading officials from policy domains MOW, Economy & Innovation, the Road Directorate and the Public Transport company (De Lijn) plus delegates from industry and research, supported by a large sounding board. Kick-off realized on 27/09/2023
Notes / Additional information	N/A.

Exploitable Asset	
Name	Validated TO Use cases & potential Business models
Short description	Validated results from TO Use cases (WP4) and Business Models (D3.4); guidance on 5G infrastructure required
Type of exploitable asset	Reports providing understanding & insight;
High-level goal (commercial, research, policy-making)	Raising insight; provision of best practices and recommendations; impact analysis
Related UCs	All.
Related EFs	All.
Related WPs	WP3, WP4, WP5
Ownership	Deliverables are public
Constraints to Intellectual Property Rights (IPR)	N/A.
Customer Target Group	industry & wider public; local authorities
Customer Target Problem	Insufficient insight/ knowledge on operational value, commercial and societal added-value.
Customer Key Benefits	economic & societal relevance
Customer target geographical scale	National & cross border (NL, GE).
Competitors	None.
Differentiation of exploitable asset	limited information & guidance on TO available

Marketing, communication and promotion	Communication channels targeting logistics companies and actors involved in Connected Automated Mobility.
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	2024: real life demo/ exploitation and validation of TO in combination of L4 automation (budget secured: 500k€).
Notes / Additional information	N/A.

4.3.2 Universities and research institutes

imec

imec will advance regarding experimental validation of innovative 5G-based V2X communication technologies, which is relevant for imec's research activities as well as for its industrial partners. The knowledge and expertise gained from 5G-Blueprint will be very relevant to extend imec's Smart Highway testbed capabilities with 5G technology. imec's Smart Highway testbed – being deployed in the area of Antwerp – is an important asset for both the research community and industrial partners including telco operators, network equipment vendors, car manufacturers, and application developers. In this case, 5G-Blueprint will be an enabler to position imec as an important hub in research and validation of 5G and CAM and it will help imec to set up future projects with industry, especially for validation and feasibility testing, rapid prototyping and commercialization. It could also be exploited by establishing spin-off companies through imec's Incubation & Entrepreneurship programs.

Exploitable Asset	
Name	5G network evaluation software tools.
Short description	A set of tools for 5G end-to-end network evaluation consisting of (1) python scripts to retrieve, log and process in real-time 5G modem statistics and network performance metrics, (2) database to store measurements, (3) visualisation Dashboard (Grafana) to fetch, analyse and represent the data.
Type of exploitable asset	Software.
High-level goal (commercial, research, policy-making)	Research.
Related UCs	All.
Related EFs	All.
Related WPs	WP4, WP5, WP6 and WP7.
Ownership	Single.

Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Research organisations and universities, OEM and Telco Operators.
Customer Target Problem	Lack of technology and knowledge. Network evaluation tools are not specifically designed for custom 5G field testing and do not have the flexibility to be customised for the specific network testing needs in a cross border context using the latest 5G modules.
Customer Key Benefits	Perform tailored real-time 5G network evaluation according to the specific needs of latest release 5G networks (including network slicing) with support for cross border settings.
Customer target geographical scale	Global.
Competitors	Other research institutes, commercial 5G measurement solution vendors.
Differentiation of exploitable asset	Customizable and flexible, Support for cross-border testing.
Marketing, communication and promotion	Website, videos, papers, social media.
Initial Technological Readiness (TRL)	4.
Final Technological Readiness (TRL)	7.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

Exploitable Asset	
Name	5G network evaluation hardware (portable box).
Short description	A portable hard case consisting of several hardware components (processing units, 5G modules, 4G router, switch, power extension cable) to allow easy and flexible on the field realtime 5G testing (drive-tests).
Type of exploitable asset	Hardware.
High-level goal (commercial, research, policy-making)	Research.
Related UCs	All.

Related EFs	All.
Related WPs	WP4, WP5, WP6 and WP7.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Research organisations and universities, OEM, Telco Operators.
Customer Target Problem	Lack of technology, technology and appropriate equipment to perform in-depth 5G network evaluation.
Customer Key Benefits	Utilise appropriate hardware equipment to perform tailored real-time 5G network evaluation according to the specific needs of latest release 5G networks (including network slicing) with support for cross border settings.
Customer target geographical scale	Global.
Competitors	Other research institutes, commercial 5G measurement solution vendors.
Differentiation of exploitable asset	Customizable and flexible, support for cross-border testing.
Marketing, communication and promotion	Website, videos, papers and social media.
Initial Technological Readiness (TRL)	4.
Final Technological Readiness (TRL)	7.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

Exploitable Asset	
Name	Hybrid V2X research testbed with intelligent V2X communication solution.
Short description	A lab testbed consisting of processing units, commercial C-V2X PC5, ITS-G5 and 5G UE hardware allowing research on intelligent hybrid V2X communication.
Type of exploitable asset	Hardware and software.

High-level goal (commercial, research, policy-making)	Research.
Related UCs	N/A.
Related EFs	N/A.
Related WPs	WP5.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Research organisations and universities, OEM and Telco Operators.
Customer Target Problem	Not much open road testing track which supports multiple V2X technologies on Highway.
Customer Key Benefits	Users can test different use cases related to the highway scenario in real life settings. The connectivity aspects of the experiment conforms to the current 3GPP and ITS standards.
Customer target geographical scale	Global.
Competitors	Other research institutes.
Differentiation of exploitable asset	The testbed supports multiple Radio Access Technologies, multi-access edge computing, and can provide precise positioning with higher computational power.
Marketing, communication and promotion	Website, videos, papers and social media.
Initial Technological Readiness (TRL)	6.
Final Technological Readiness (TRL)	8.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

Exploitable Asset	
Name	Smart Highway: imec's V2X Testbed Vehicle-to-everything (V2X) road side units (RSUs) and onboard units (OBUs).

Short description	The Antwerp Smart Highway test site is being built on the InterCor Belgium/Flanders (CEF Action 2015-EU-TM-0159-S) 'C-ITS test site' on the E313 highway These RSUs and OBUs are fully designed and developed by imec. They are the central engine of imec's Smart Highway testbed and enable a flexible integration of the newest V2X solutions in order to (1) compare the performance of competing V2X technologies like ITS-G5 (based on 802.11p standard) and C-V2X (LTE sidelink based on Release 12 and 14) and (2) test and propose new features and enhancements for V2X technologies. Both commercial off-the-shelf (COTS) and software defined radio (SDR) communication modules are included.
Type of exploitable asset	Hardware.
High-level goal (commercial, research, policy-making)	Research.
Related UCs	N/A.
Related EFs	N/A.
Related WPs	WP5 and WP7.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Research organisations and universities, OEM and Telco Operators.
Customer Target Problem	Not much open road testing track which supports multiple V2X technologies on Highway.
Customer Key Benefits	Users can test different use cases related to the highway scenario in real life settings. The connectivity aspects of the experiment conforms to the current 3GPP and ITS standards.
Customer target geographical scale	Global.
Competitors	Other research institutes.
Differentiation of exploitable asset	The testbed supports multiple Radio Access Technologies, multi-access edge computing, and can provide precise positioning with higher computational power.

Marketing, communication and promotion	Website, videos, papers, social media.
Initial Technological Readiness (TRL)	6.
Final Technological Readiness (TRL)	8.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

Exploitable Asset	
Name	OpenRAN-compatible 5G testbed.
Short description	Multi-purpose 5G testbed offering indoor and outdoor 5G connectivity based on two gNodeBs and a 5G Core Stand Alone deployment where different combinations of Open RAN combinations can be tested. imec has obtained a BIPT test licence, which is valid for the 3800-4200MHz frequency range (N77 upper), and stretches on the road covered by the above mentioned Smart Highway testbed. The testbed components are being exploited for setting up an OpenRAN system for highly mobile scenarios in combination with the Smart Highway testbed. This example shows the opportunities for exploiting softwarized network components from the testbed.
Type of exploitable asset	Hardware/software.
High-level goal (commercial, research, policy-making)	Research.
Related UCs	N/A.
Related EFs	N/A.
Related WPs	WP5 and WP7.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Research organisations and universities, OEM and Telco Operators.
Customer Target Problem	Lack of OpenRAN-compatible 5G testbeds for indoor and outdoor environments, with

	programmable network functions, since typical telco-oriented solutions are either proprietary or limited in terms of programmability and flexibility for various research purposes.
Customer Key Benefits	Users can test 5G Standalone performance using open-source software and programmable and open interfaces between network functions.
Customer target geographical scale	Global.
Competitors	Other research institutes.
Differentiation of exploitable asset	The testbed supports 5G Standalone capabilities, including multi-access edge computing.
Marketing, communication and promotion	Website, videos, papers, social media.
Initial Technological Readiness (TRL)	2.
Final Technological Readiness (TRL)	4.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

Exploitable Asset	
Name	Distributed perception for platooning of vehicles.
Short description	Distributed perception is the idea that multiple vehicles share information to collectively perceive and understand their environment. In distributed perception, these vehicles collaborate by sharing data, insights, or observations, thereby improving the accuracy, reliability, and overall situational awareness of the system.
Type of exploitable asset	Hardware and software.
High-level goal (commercial, research, policy-making)	Research.
Related UCs	UC4.3.
Related EFs	EF4.
Related WPs	WP4, WP6 and WP7.

Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Research organisations and universities, OEM and Telco Operators.
Customer Target Problem	Lack of technology and knowledge. The technology requires expensive efficient onboard processing units equipped with GPUs. Additionally, the distributed perception scheme relies heavily on the stability and bandwidth of the network which adds more challenges to the distributed perception technology.
Customer Key Benefits	The developed technology would enable target groups to fuse visual (LiDAR) data retrieved from vehicles located within the same area but at different spatial positions, to achieve shared situational awareness.
Customer target geographical scale	Global.
Competitors	Other research institutes.
Differentiation of exploitable asset	The developed technology utilises visual data fusion using graph networks which increases the reliability and efficiency of the aggregation process.
Marketing, communication and promotion	Website, videos, papers, social media.
Initial Technological Readiness (TRL)	2.
Final Technological Readiness (TRL)	5.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

Exploitable Asset	
Name	A techno-economic analysis framework.
Short description	The developed techno-economic analysis framework consists of a set of models implemented as java code. These models are developed to evaluate the techno-economic feasibility of deploying 5G networks to support teleoperation.
Type of exploitable asset	Software.

High-level goal (commercial, research, policy-making)	Research.
Related UCs	All.
Related EFs	All.
Related WPs	WP3.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Research organisations and universities, OEM and Telco Operators.
Customer Target Problem	Lack of knowledge and data.
Customer Key Benefits	The exploitable asset enables the customer target group to judge the economic feasibility of the 5G deployment to support teleoperation or other similar services.
Customer target geographical scale	Global.
Competitors	Other research institutes.
Differentiation of exploitable asset	The developed framework considers new service requirements (UL capacity) yet existing models only make the analysis using DL capacity. In addition, the developed framework compares several 5G connectivity options to generate more insights and guidelines into the cost-effective deployment option given certain circumstances.
Marketing, communication and promotion	Website, videos, papers, social media.
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

HAN University of Applied Sciences

HAN will try to use the learning outcomes of the projects within the curriculum of its bachelor and master program of intelligent mobility to keep the students up to date on the technological reforms and the benefits of 5G technology. Some of the research within this project was performed alongside the students thereby providing a good exposure to the students of the upcoming technology. The learning outcomes from this project will be used as a base for current and upcoming projects HAN will participate in.

Exploitable Asset	
Name	Educational material in the module of Intelligent Mobility.
Short description	Transformation of project learnings and results into a number of lectures/workshops/student projects which will be integrated into the module of Intelligent Mobility.
Type of exploitable asset	Education material (Knowledge, Presentations, Videos).
High-level goal (commercial, research, policy-making)	Education.
Related UCs	UC4.2.
Related EFs	EF1, EF2, EF4 and EF7.
Related WPs	WP4.
Ownership	HAN
Constraints to Intellectual Property Rights (IPR)	Will be used internally.
Customer Target Group	Students of the University.
Customer Target Problem	Lack of educational content on the topic of teleoperation and 5G connectivity technology.
Customer Key Benefits	Valuable lecture material which prepares the student to the up to date needs of the industry.
Customer target geographical scale	Global (students from all over the world).
Competitors	Other universities and online courses.
Differentiation of exploitable asset	Exclusive Content based on field results.
Marketing, communication and promotion	Will be used for internal lectures and curriculum.
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	Lectures, Student projects and open courses in the future via the automotive research division at the HAN.
Notes / Additional information	N/A.

HZ University of Applied Sciences

HZ University of Applied Sciences, located in the South-West of the Netherlands, is a middle-sized university with around 4,800 students. It consistently ranks in the top three Dutch multidisciplinary universities of applied sciences since 2011. HZ focuses on practice-based education and research, collaborates closely with the business world and research centers, and maintains a global network of partner universities.

HZ has joined the 5G-BP project in order to contribute to the project results, to be used as - an input for the Logistics Engineering bachelor curriculum, - in applied research and - deployment projects at request of logistics service providers in the region of Zeeland. In order to adopt these technologies, logistics companies might need to change their business models, their logistics operations and their human capital capabilities.

HZ will support logistics service providers, especially SMEs in the process of identification of the opportunities and required changes by means of student projects (internships and graduation projects of bachelor students) and working groups in which knowledge is shared between logistics service operators that are preparing for adoption of these technologies. In the Zeeland region, approximately 50 transport companies based in the region will be supported over the next 10 years.

Exploitable Asset	
Name	Minor course.
Short description	A minor course about automated and teleoperated driving in logistics, created within the project, which can be continued in the future.
Type of exploitable asset	Educational material.
High-level goal (commercial, research, policy-making)	Education and research.
Related UCs	All are input
Related EFs	All are input
Related WPs	WP8
Ownership	Single (but information can be shared upon request).
Constraints to Intellectual Property Rights (IPR)	No licence.
Customer Target Group	Students from technical studies interested in applying autonomous systems
Customer Target Problem	Lack of educational materials and courses on these topics.
Customer Key Benefits	Knowledge and lectures about the topic.
Customer target geographical scale	Europe.
Competitors	Other universities and online courses.

Differentiation of exploitable asset	Newest, latest innovative insights are included in minor
Marketing, communication and promotion	Advertised on HZ-intranet, externally on Dutch national website www.kiesopmaat.nl
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	Contents included in MOOC
Notes / Additional information	N/A.

Exploitable Asset	
Name	MOOC on minor course.
Short description	Online course about automated and teleoperated driving in logistics (online version of the minor course).
Type of exploitable asset	Educational material.
High-level goal (commercial, research, policy-making)	Education and research.
Related UCs	All are input
Related EFs	All are input
Related WPs	WP8
Ownership	Single (but information can be shared upon request).
Constraints to Intellectual Property Rights (IPR)	No licence.
Customer Target Group	Students, professionals, and anybody interested in the logistics sector
Customer Target Problem	Lack of educational materials and courses on these topics
Customer Key Benefits	Knowledge and lectures about the topic
Customer target geographical scale	Europe.
Competitors	Other universities.
Differentiation of exploitable asset	Newest, latest innovative insights are included in minor
Marketing, communication and promotion	- 5G-Blueprint's social media channels (posts linked to landing page on project website) - dedicated social media posts in

	specific LinkedIn groups connected to the ecosystems targeted by the project - information/social media posts on the kick-off of the course were shared with fellow projects
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	MOOC will remain open and kept up-to-date with future HZ research project outcomes
Notes / Additional information	N/A.

Exploitable Asset	
Name	Simulation model.
Short description	Simulation model developed to estimate teleoperator-to-vehicle ratios in different scenarios.
Type of exploitable asset	Methodology and model.
High-level goal (commercial, research, policy-making)	Education and research.
Related UCs	All are input
Related EFs	
Related WPs	WP3.
Ownership	Single (but information can be shared upon request).
Constraints to Intellectual Property Rights (IPR)	No constraint.
Customer Target Group	Teleoperated service operators, independent advisors, interested students
Customer Target Problem	Explore and justify improvement potential (awareness and consultancy), lack of educational materials and courses on these topics.
Customer Key Benefits	Optimal teleoperator-to-vehicle ratios, cost reduction, flexible resource planning personnel
Customer target geographical scale	Europe.
Competitors	Not relevant.

Differentiation of exploitable asset	First tool/study/model applied on logistical data
Marketing, communication and promotion	Academic paper.
Initial Technological Readiness (TRL)	Supporting tool for deployment, not technology itself
Final Technological Readiness (TRL)	Supporting tool for deployment, not technology itself
Planned activities for exploitation	No concrete plans at the moment, but will be applied and further improved when relevant in upcoming projects
Notes / Additional information	N/A.

TNO

TNO joined the project 2 years after the start after being asked by I&W and KPN to do so, based on a successful collaboration in the 5G-MOBIX project. In this project TNO developed and enhanced a 5G core network able to do slicing and LBO roaming. As the 5G-Blueprint project required even more advanced 5G Core functionality, which the project partners and its suppliers could not provide, KPN and I&W wondered whether TNO would be capable to bring in its 5G Core and further extend its functionality to meet the cross-border seamless-roaming requirements of the 5G-Blueprint project. After a couple of talks with KPN, I&W, imecTelenet TNO decided to join, as this would be a great opportunity to both help the project and its project members and enhance its 5G-Core with important functionality and to implement this in an actual cross-border site.

Exploitable Asset	
Name	5G SA core, able to provide seamless roaming
Short description	TNO upgraded its 5G SA core implementation with functionality (interfaces, messages) to provide seamless roaming. This has been built on top of advanced 5G Core functionality such as slicing, LBO, developed in a previous HE project
Type of exploitable asset	Software.
High-level goal (commercial, research, policy-making)	Research.
Related UCs	UC4 (teleoperated vehicle and teleoperated barge, driving or sailing cross-border with seamless hand-over between netwroks)
Related EFs	N/A.
Related WPs	WP5 and WP7.

Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Using commercial licence for Open 5G S, for research purposes, and extended the software suite with additional modules.
Customer Target Group	Telecom operators and Telecom industry.
Customer Target Problem	Lack of knowledge, technology, available commercial software with required functionality.
Customer Key Benefits	Ability to provide seamless 5G roaming to its customers.
Customer target geographical scale	EU.
Competitors	None. TNO is not intending to commercially exploit the software. The knowledge and expertise gained in the project is fed into standardisation (a.o.), allowing the telecom industry to build implementation accordingly.
Differentiation of exploitable asset	Existing solutions do not have the required functionality.
Marketing, communication and promotion	Different publications and press releases have been released (3GPP, EU-CNC, Tweakers, AG-Connect).
Initial Technological Readiness (TRL)	TRL 3
Final Technological Readiness (TRL)	TRL 6
Planned activities for exploitation	TNO will implement and further enhance its 5G core.in future collaboration project such as the project ENVELOPE (SNS project) and FNS (Dutch Growth Fund project)
Notes / Additional information	N/A.

4.3.3 Ports

North Sea Port

North Sea Port is a binational port that extends over more than 60 kilometers, 9,100 hectares over two countries: Belgium and the Netherlands. Thanks to its location on the North Sea, the port is directly accessible to maritime shipping, benefiting global trade and household innovative companies.

Because companies in North Sea Port are active in the further automation and connectivity of terminal processes port, tech companies involved within the 5G-Blueprint project are interested in setting up their business (technology) here as well. The port acts as a director, bringing together interested and mutually complementary parties and facilitating cooperation between them. The first step will be focused on optimisation of road and barge transport (with this call). Important is that 5G and the call will provide the possibility to widen up the proven technology,

business models and governance to the other multimodal transport solution (, rail). And a wider spread of use cases (asset management: inspection of quays or depth inspections.

Exploitable Asset	
Name	Data & knowledge for policy adaption wireless connection within a port area (maybe further 5G-private network).
Short description	What can and will (big)data bring towards the port community. What can we do with it, what are the major threats.
Type of exploitable asset	Data.
High-level goal (commercial, research, policy-making)	Realising a port community system in which the sharing of data between public and private parties in the port community is envisioned. Besides sharing data, the North Sea Portal will also make various digital services/applications available, tailored to the community needs. This should result in an optimization of port logistics processes for the entire port community.
Related UCs	UC3. UC1 (Zelzate cross-border) ; UC4 as road operator (permission to pilot – providing safe environment)
Related EFs	EF3.
Related WPs	WP3 and WP8.
Ownership	N/A.
Constraints to Intellectual Property Rights (IPR)	N/A.
Customer Target Group	Port authority and its community.
Customer Target Problem	Insufficient knowledge of possibilities big data can bring to a safe and secure, but also very conservative part of the supply chain.
Customer Key Benefits	Gain knowledge to enable innovation in a community. DO we want/need a digital twin. What is actually required for autonomous ops?
Customer target geographical scale	Port area and stakeholders.
Competitors	N/A.
Differentiation of exploitable asset	N/A.

Marketing, communication and promotion	Publication of project findings and having the wider public known with 5G driver logistic use cases « North Sea Port Port Days may'23).
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	Embed a strategic program around connectivity in the port. Moreover, think about the comparison with capacities on the electricity grid and or water demand that needs to be managed. Because of dependencies having a proper wireless and well covered connectivity , facing differences in national laws and regulations. We do see an opportunity to start up the discussion with the mobile network providers (MNO's) So that we can build together on unhindered cross-border connectivity and the learnings from the 5G-blueprints after the completion of the project.
Notes / Additional information	N/A.

Port of Antwerp-Bruges

Port of Antwerp-Bruges is the second largest port of Europe and wants to be a frontrunner in digitisation and automatisation of port activities. The knowledge gained in this project will be exploited internally and externally. Internally by integrating it in the future employment of technology and externally in our different discussions with stakeholders and for future projects. Amaris, which takes up the role of PoAB's IT department, will also further exploit the 5G (technical) knowledge gained in this project.

Exploitable Asset	
Name	Educational material / courses.
Short description	Take project learnings of 5G/Automated and teleoperated driving into courses/workshops for port authorities/port companies and knowledge about the topic in your own company in view of possible business cases or hurdles.
Type of exploitable asset	Educational material.
High-level goal (commercial, research, policy-making)	Detect infrastructural and economical needs and hurdles.
Related UCs	UC3

Related EFs	EF3
Related WPs	WP3, WP7, WP5 and WP8.
Ownership	Single but can be shared with project partners.
Constraints to Intellectual Property Rights (IPR)	N/A.
Customer Target Group	Industry and SMEs, associations and networks of organisations, automotive sector related organisations, logistics operators, policy makers, port authorities, road and motorway manager, public authorities.
Customer Target Problem	Lack of content about the project's topic + impact on safety.
Customer Key Benefits	Knowledge and pushing companies towards teleoperated driving.
Customer target geographical scale	Local, port area of Antwerp and Bruges
Competitors	Other ports
Differentiation of exploitable asset	Unique insights & data
Marketing, communication and promotion	Services to customers.
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	We see the large advantages ths technology brings to operators like Seafar that are already active in our port. As well as the initiation of tele-operated trucks and the first use-cases that appear (docking at Group Joosen).
Notes / Additional information	N/A.

4.3.4 Mobile network operators

KPN

KPN will use the outcomes of this project in any ways possible, but especially for all sites near the borders. KPN will try to translate the 5G-Blueprint technical and governance guidelines on how to design, deploy and configure the different network components in such a way that KPN can reuse the outcomes on its entire network.

Exploitable Asset	
Name	Product Suite Campus.

Short description	Part of this product suite is enabling our business customers with private 5G. This in different propositions: 1. Offering a completely private system 2. Offering a local breakout as part of our mobile network With these services we are able to offer 5G services at logistical spaces and harbours where all data stays local and we are able to enable specific quality of service features.
Type of exploitable asset	Mobile network
High-level goal (commercial, research, policy-making)	Commercial.
Related UCs	UC4.
Related EFs	EF6.
Related WPs	WP5.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Propriety.
Customer Target Group	Business market.
Customer Target Problem	Indoor/Outdoor, large area coverage, handover, exploitation costs.
Customer Key Benefits	Outdoor large area coverage, security, low latency, local breakout.
Customer target geographical scale	Local.
Competitors	Telcos, 5G service providers.
Differentiation of exploitable asset	Currently plant/area coverage is done without 5G. Frequencies were not available for private companies yet.
Marketing, communication and promotion	Publications, advertisements and KPN sales channel will promote this.
Initial Technological Readiness (TRL)	4.
Final Technological Readiness (TRL)	7.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

Telenet

Telenet will use the results to build new technology strategy and ecosystem agreements. Utilising its sales, integration and field force will provide new services to the market. Starting with existing logistic and IoT customers to all IT empowered verticals. Telenet will also build other R&D activities with universities/institutions based on the work of this project.

Exploitable Asset	
Name	5G SA network.
Short description	5G mobile network: 5G SA core (lab environment) and 5G production antenna's.
Type of exploitable asset	Mobile network.
High-level goal (commercial, research, policy-making)	Research.
Related UCs	N/A.
Related EFs	N/A.
Related WPs	WP5.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	N/A.
Customer Target Group	Industry and SMEs.
Customer Target Problem	Due to lack of 5G SA network deployment in Belgium, some industries might be interested in making use of Telenet's 5G SA test network, by doing some tests and capturing learnings.
Customer Key Benefits	Users can test 5G SA network features that are not available on 4G (low latency, slicing).
Customer target geographical scale	Local.
Competitors	N/A.
Differentiation of exploitable asset	N/A.
Marketing, communication and promotion	N/A.
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

4.3.5 Infrastructure operators

Eurofiber

Eurofiber is always working towards the successful roll-out of new network technology and its primary goal is to help maintain the unique position of the Netherlands in the Digital Society, bringing about fundamental changes to our society, shaping our future. The research- and development results of this project will be used to further the design and roll-out of new, suitable backhaul- and connectivity propositions that will be at the heart of the Dutch and Belgian 5G-fiber-core infrastructure of tomorrow. Eurofiber will try to use the project collaboration and the 5G-Blueprint results to initiate and deploy new joint MNO and Government strategies, leveraging an efficient and cost-effective way to build the vital foundation on which the national and international 5G networks are built. Eurofiber will initiate the definition of governance- and business models and, as a neutral host, investigate possible joint ventures, further enabling the use of existing and new network solutions accommodating the digital transition.

Exploitable Asset	
Name	Knowhow backhaul and connectivity.
Short description	Design and roll-out of new, suitable backhaul- and connectivity propositions.
Type of exploitable asset	Knowledge and methodology
High-level goal (commercial, research, policy-making)	Commercial.
Related UCs	N/A.
Related EFs	N/A.
Related WPs	WP7.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Business to business connectivity markets in Industry, Government, Telco industry, MNO's, carriers and network operators.
Customer Target Problem	New functional low latency and bandwidth requirements in backhaul network connectivity.
Customer Key Benefits	Affordability.
Customer target geographical scale	NE, BE, FR and GER.
Competitors	N/A.
Differentiation of exploitable asset	N/A.
Marketing, communication and promotion	Website, newslekkers, direct outreach
Initial Technological Readiness (TRL)	N/A.

Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

Exploitable Asset	
Name	Knowhow Joint MNO and Gov Strategy.
Short description	Initiate and deploy new joint MNO and Government strategies.
Type of exploitable asset	Knowledge and methodology.
High-level goal (commercial, research, policy-making)	Commercial.
Related UCs	N/A.
Related EFs	N/A.
Related WPs	WP3 and WP8.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Business to business connectivity markets in Industry, Government, Telco industry, MNO's, carriers and network operators.
Customer Target Problem	New functional low latency and bandwidth requirements in backhaul network connectivity.
Customer Key Benefits	Valuecase design for effective use of public infrastructure.
Customer target geographical scale	NE, BE, FR and GER.
Competitors	N/A.
Differentiation of exploitable asset	N/A.
Marketing, communication and promotion	Website, newsletters and direct outreach.
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.

Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

Exploitable Asset	
Name	Knowhow Neutral Host Joint Ventures.
Short description	As a neutral host, investigate possible joint ventures.
Type of exploitable asset	Knowledge and methodology.
High-level goal (commercial, research, policy-making)	Commercial.
Related UCs	N/A.
Related EFs	N/A.
Related WPs	WP9.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Business to business connectivity markets in Industry, Government, Telco industry, MNO's, carriers and network operators.
Customer Target Problem	New functional low latency and bandwidth requirements in backhaul network connectivity.
Customer Key Benefits	Strong partnership options leading to quality improvement and backhaul SLA improvement.
Customer target geographical scale	NE, BE, FR and GER.
Competitors	N/A.
Differentiation of exploitable asset	N/A.
Marketing, communication and promotion	Website, newsletters and direct outreach.
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.

Notes / Additional information	N/A.

4.3.6 Automotive OEMs

TME

TME will exploit the knowledge and experience gained through the project internally to enhance its research and development activities in the field of autonomous vehicle and vehicle communication technologies i.e. vehicle-to-x, to realise even better vehicles keeping safety and quality in mind.

Exploitable Asset	
Name	Vehicle design influence.
Short description	Key observations regarding 5G modems, communication protocols, and teleoperation vehicle hardware were recorded, and may be used in the setting of specification in a future Toyota model.
Type of exploitable asset	Vehicle and technology knowledge.
High-level goal (commercial, research, policy-making)	Input relevant specifications to future vehicle platforms.
Related UCs	UC3, UC4.
Related EFs	N/A.
Related WPs	WP5.
Ownership	Joint.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	OEM research centres.
Customer Target Problem	Lack of experience with teleoperation and 5G connectivity technology.
Customer Key Benefits	Knowledge and presentations about the topic.
Customer target geographical scale	EU.
Competitors	Not relevant.
Differentiation of exploitable asset	Internal availability, target directly internal divisions, up to date & accurate information.
Marketing, communication and promotion	Invitation to final demo event of several attendees from EU and Japan to final demo event. Internal presentations.

Initial Technological Readiness (TRL)	1.
Final Technological Readiness (TRL)	3.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

Exploitable Asset	
Name	Use Cases knowledge.
Short description	Two Use Cases emerged as potentially viable technological investments: (1) Logistics optimization for movement of vehicles in parking/assembly line and trucks for distributing parts, and (2) New mobility as a support system for Automated vehicles, and teleoperated car-for-hire.
Type of exploitable asset	Relevant teleoperation Use Case knowledge.
High-level goal (commercial, research, policy-making)	Create awareness within TME of benefits in specific Use Cases.
Related UCs	UC3 and TNO .
Related EFs	N/A.
Related WPs	WP3 and WP5.
Ownership	Joint.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	OEM research centres.
Customer Target Problem	Lack of educational content on the topic of teleoperation and 5G connectivity technology.
Customer Key Benefits	Knowledge and presentations about the topic.
Customer target geographical scale	EU.
Competitors	Not relevant.
Differentiation of exploitable asset	Internal availability, target directly internal divisions, up to date & accurate information.

Marketing, communication and promotion	Invitation to final demo event of several attendees from EU and Japan to final demo event. Internal presentations.
Initial Technological Readiness (TRL)	1.
Final Technological Readiness (TRL)	3.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

Exploitable Asset	
Name	New contact channels.
Short description	Close contacts were formed between Toyota and project stakeholders, leading to wide-spread Teleoperation awareness and understanding of potential value: Authorities (testing & deployment), Regulators (new regulation by country), Technology companies (opportunities to optimise), Logistics providers, MNOs (for partnerships), and AECC working group input.
Type of exploitable asset	Contact channels for consultation.
High-level goal (commercial, research, policy-making)	Leverage new contact channels to best navigate research into Teleoperation.
Related UCs	UC3 and UC4.
Related EFs	N/A.
Related WPs	WP3 and WP5.
Ownership	Joint.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	OEM research centres.
Customer Target Problem	OEMs need to become familiar with teleoperation and 5G connectivity ecosystem stakeholders.
Customer Key Benefits	Useful contacts in various other spheres of technology.
Customer target geographical scale	EU.

Competitors	Not relevant.
Differentiation of exploitable asset	Internal availability, target directly internal divisions, up to date & accurate information.
Marketing, communication and promotion	Invitation to final demo event of several attendees from EU and Japan to final demo event. Internal presentations.
Initial Technological Readiness (TRL)	1.
Final Technological Readiness (TRL)	3.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

4.3.7 Teleoperation OEMs (both on road and on water)

V-tron

V-tron is an innovative organisation working in the field of smart mobility projects with the interest in developing sustainable solutions for enhanced mobility and the transportation industry. We collaborate with various partners from automotive industry, government entities and research institutes, and work across different sectors including smart mobility, intelligent transport systems, connected vehicles, driver safety to provide efficient solutions. Within the 5G blueprint, V-tron looked into venturing in the realm of teleoperated driving, for this a multitude of solutions were researched and developed and V-tron will use this to build new ventures with the partners from the project and the industry.

Exploitable Asset	
Name	TO interface - car.
Short description	Interface use to integrate the teloperation hardware for cars.
Type of exploitable asset	Hardware and software platform package.
High-level goal (commercial, research, policy-making)	Commercial research.
Related UCs	UC4.
Related EFs	EF1, EF2 and EF5.
Related WPs	WP4.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	OEMs and TO service providers.

Customer Target Problem	For OEMs as a tier 1 supplier to enhance teloperation functionality for their vehicles as a single point of disclosure for internal vehicle architecture. For Service providers the lack of automotive knowledge can be bridged via this platform.
Customer Key Benefits	Direct integration, the platform provider in this case V-Tron will make sure the OEM does not have to invest anything additional in TO research and for TO service providers can build their system independent of the vehicle make and model.
Customer target geographical scale	European Tier1s.
Competitors	Other Tier1s.
Differentiation of exploitable asset	Modularity and platform independence
Marketing, communication and promotion	Through websites, social media and social events.
Initial Technological Readiness (TRL)	3
Final Technological Readiness (TRL)	7.
Planned activities for exploitation	Marketing newsletter, Events and contacts in the industry such as OEMs, TIER1s etc.
Notes / Additional information	N/A.

Exploitable Asset	
Name	CACC-TO platform.
Short description	Automation layer for TO vehicles.
Type of exploitable asset	Hardware+software platform package.
High-level goal (commercial, research, policy-making)	Commercial research.
Related UCs	UC3.
Related EFs	EF5.
Related WPs	WP4.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	OEMs, TO service providers.

Customer Target Problem	For OEMs as a tier 1 supplier to enhance teloperation functionality for their vehicles as a single point of disclosure for internal vehicle architecture. For Service providers the business for TO can be made more interesting by including automation.
Customer Key Benefits	Direct integration, the platform provider in this case V-Tron will make sure the OEM does not have to invest anything additional in TO research and for TO service providers can build their system independent of the vehicle make and model.
Customer target geographical scale	European Tier1s.
Competitors	Other Tier1s.
Differentiation of exploitable asset	Modularity and platform independence.
Marketing, communication and promotion	Through websites, social media and social events.
Initial Technological Readiness (TRL)	4
Final Technological Readiness (TRL)	6.
Planned activities for exploitation	Marketing newsletter, Events and contacts in the industry such as OEMs, TIER1s etc.
Notes / Additional information	N/A.

Exploitable Asset	
Name	TO interface - truck.
Short description	Interface used to integrate the teloperation hardware for trucks.
Type of exploitable asset	Hardware+software platform package.
High-level goal (commercial, research, policy-making)	Commercial research.
Related UCs	UC4.
Related EFs	EF1, EF2, EF5 and EF6.
Related WPs	WP4.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.

Customer Target Group	OEMs, TO service providers.
Customer Target Problem	For OEMs as a tier 1 supplier to enhance teloperation functionality for their vehicles as a single point of disclosure for internal vehicle architecture. For Service providers the lack of automotive knowledge can be bridged via this platform.
Customer Key Benefits	Direct integration, the platform provider in this case V-Tron will make sure the OEM does not have to invest anything additional in TO research and for TO service providers can build their system independent of the vehicle make and model.
Customer target geographical scale	European market - Logistics and transportation industries.
Competitors	Other Tier1s.
Differentiation of exploitable asset	Modularity and platform independence.
Marketing, communication and promotion	Through websites, social media and social events.
Initial Technological Readiness (TRL)	3
Final Technological Readiness (TRL)	6.
Planned activities for exploitation	Marketing newsletter, Events and contacts in the industry such as OEMs, TIER1s etc.
Notes / Additional information	N/A.

Exploitable Asset	
Name	Scaled platform with sensor suite and V2V.
Short description	Development platform with sensor suite and communication unit for research and development.
Type of exploitable asset	Hardware+software platform package.
High-level goal (commercial, research, policy-making)	Commercial research.
Related UCs	UC3 and UC4.
Related EFs	N/A.
Related WPs	WP4.
Ownership	Single.

Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Research organisations and universities.
Customer Target Problem	Organisations and universities looking to develop and test automated vehicle systems can use this platform to validate and optimise their algorithms.
Customer Key Benefits	The system will offer physical validation of the system without having to invest additional resources and time ino hardware development.
Customer target geographical scale	European research organisations and universities.
Competitors	Scaled platform developers.
Differentiation of exploitable asset	Modularity and close to full scale vehicle network architecture and protocols.
Marketing, communication and promotion	Through websites, social media and social events.
Initial Technological Readiness (TRL)	3
Final Technological Readiness (TRL)	5.
Planned activities for exploitation	Marketing newsletter, Events and contacts in the universities and research organisation etc.
Notes / Additional information	N/A.

Exploitable Asset	
Name	OBU - V2X.
Short description	On board unit for V2X communication with C-ITS stack for multiple applications.
Type of exploitable asset	Hardware+software platform package.
High-level goal (commercial, research, policy-making)	Commercial research & policy making.
Related UCs	UC3.
Related EFs	N/A.
Related WPs	WP4.
Ownership	Single.

Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	OEMs, Tier1 and research institutes.
Customer Target Problem	Customers looking to develop C-ITS use cases based on V2X communication can use this platform.
Customer Key Benefits	The system will offer a modular platform for C-ITS development without having to invest additional resources and time into hardware and backend development.
Customer target geographical scale	European OEMs and Tier1s.
Competitors	Other CITS product developers.
Differentiation of exploitable asset	Single source for hardware and software platform.
Marketing, communication and promotion	Through websites, social media and social events.
Initial Technological Readiness (TRL)	4
Final Technological Readiness (TRL)	6.
Planned activities for exploitation	Marketing newsletter, Events and contacts in the industry such as OEMs, TIER1s etc.
Notes / Additional information	N/A.

Exploitable Asset	
Name	Testing platform for future scenarios.
Short description	Testing platform for new use case with TO and automation with the vehicles prepared for 5G BP.
Type of exploitable asset	Service.
High-level goal (commercial, research, policy-making)	Commercial research.
Related UCs	UC3 and UC4.
Related EFs	N/A.
Related WPs	WP4.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.

Customer Target Group	OEMs, Tier1 and research institutes.
Customer Target Problem	Developers who are willing to develop new use case and new TO systems can use the platform as a service to test future scenarios.
Customer Key Benefits	The system will offer physical validation of the system without having to invest additional resources and time in hardware development.
Customer target geographical scale	European Tier1s, Research organisations, Universities, National and local governments and roadside operators.
Competitors	Other Tier1s.
Differentiation of exploitable asset	Modularity and platform independence.
Marketing, communication and promotion	Through websites, social media and social events.
Initial Technological Readiness (TRL)	3
Final Technological Readiness (TRL)	7.
Planned activities for exploitation	Marketing newsletter, Events and contacts in the industry such as OEMs, TIER1s etc.
Notes / Additional information	N/A.

Exploitable Asset	
Name	Advisory and consultancy services.
Short description	Consultancy service to developers building TO and automation systems based on 5G-BP experiences.
Type of exploitable asset	Service.
High-level goal (commercial, research, policy-making)	Commercial research and policy making.
Related UCs	UC3 and UC4.
Related EFs	N/A.
Related WPs	WP4.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.

Customer Target Group	OEMs, Tier1 and research institutes.
Customer Target Problem	Developers who are willing to develop new use case and new TO systems can use the platform as a service to test future scenarios.
Customer Key Benefits	Advise on technical developments based on the knowledge gained during the 5G BP development and experimentation.
Customer target geographical scale	European Tier1s, Research organisations, Universities, National and local governments and roadside operators.
Competitors	Other Tier1s.
Differentiation of exploitable asset	On field experience in development and testing of TO and automated systems.
Marketing, communication and promotion	Through websites, social media and social events.
Initial Technological Readiness (TRL)	5.
Final Technological Readiness (TRL)	7.
Planned activities for exploitation	Marketing newsletter, Events and contacts in the industry such as OEMs, TIER1s etc..
Notes / Additional information	N/A.

Roboauto

The main goal of Roboauto is to contribute to the development of a safer and more socially friendly form of transporting people and goods. Tele-operation is a solution for more efficient transport and optimization of a load of individual drivers in the transfer nodes. Tele-operation is an interesting alternative to normal driving, especially for the next generation. Roboauto plans to use the knowledge from this project to deploy tele-operation in public transport such as trains and trams. Furthermore, based on the results of this project, we will build the first tele-operation centre to provide remote drivers for logistics operations in ports.

Exploitable Asset	
Name	Universal Teleoperation System
Short description	The system for remote control for different types of vehicles
Type of exploitable asset	Hardware+software platform package.
High-level goal (commercial, research, policy-making)	Commercial
Related UCs	2, 3, 4
Related EFs	All

Related WPs	WP4, WP5, WP3
Ownership	Single
Constraints to Intellectual Property Rights (IPR)	Proprietary
Customer Target Group	OEMs, Tier 1 suppliers
Customer Target Problem	Legislation, ROI
Customer Key Benefits	More efficient transport and optimization of a load of individual drivers in the transfer nodes.
Customer target geographical scale	Global
Competitors	Ottopia, Phantom auto, Vay
Differentiation of exploitable asset	low latency, modularity
Marketing, communication and promotion	Through websites, social media and social events.
Initial Technological Readiness (TRL)	4
Final Technological Readiness (TRL)	7
Planned activities for exploitation	Marketing newsletter, Events and contacts in the industry such as OEMs, TIER1s etc.
Notes / Additional information	N/A.

Seafar

If successful, the 5G solutions will provide a base for cross border operations with remotely operated vessels and so open the routes between Belgium and The Netherlands for unmanned vessels. The 5G solutions will be the base for the expansion of operations for unmanned waterway transport and provide an answer to the lack of coverage and latency that remote controlled vessels are facing today. Seafar will use the result gained through the project to enhance its R&D activities in the field of autonomous ships communication technologies for V2I and V2V. this will ensure the safety of the ship and the environment it operates. In addition to safety, efficiency of the communication will be assessed.

Exploitable Asset	
Name	Know-how / knowledge.
Short description	Methodology to use Peplink devices for 5G, firmware, communication with hardware developers.
Type of exploitable asset	Knowledge.
High-level goal (commercial, research, policy-making)	Commercial.
Related UCs	UC 4.1.

Related EFs	N/A
Related WPs	WP4
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Propriety
Customer Target Group	Industry and SMEs, logistics operators, telecom operators.
Customer Target Problem	Knowledge, technology.
Customer Key Benefits	Utilise 5G-enabled network equipment.
Customer target geographical scale	Global.
Competitors	All companies in remote operation.
Differentiation of exploitable asset	The methodology is tested in a real remote operation of a commercial and operational vessel.
Marketing, communication and promotion	Visits and social media.
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

Exploitable Asset	
Name	MOOC Material.
Short description	Short material for education purposes on remote operation of a vessel.
Type of exploitable asset	Educational material.
High-level goal (commercial, research, policy-making)	Research.
Related UCs	4.1.
Related EFs	N/A.
Related WPs	WP8
Ownership	Joint.

Constraints to Intellectual Property Rights (IPR)	Open document.
Customer Target Group	Academia and research institutes.
Customer Target Problem	Knowledge and technology.
Customer Key Benefits	Understand about remote operation of barges.
Customer target geographical scale	Global.
Competitors	Companies in remote operation of barges.
Differentiation of exploitable asset	It is made based on knowledge gathered in several years in the pioneering field of autonomous barges.
Marketing, communication and promotion	Videos, participating in events.
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

Exploitable Asset	
Name	5G Data.
Short description	The dataset was collected while the vessel was sailing in a real-world scenario.
Type of exploitable asset	Data.
High-level goal (commercial, research, policy-making)	Research, policy-making.
Related UCs	4.1.
Related EFs	N/A.
Related WPs	WP4
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Open data.
Customer Target Group	Telecom operators, academia and research institutions.

Customer Target Problem	Knowledge.
Customer Key Benefits	Utilise data analysis to learn about 5G signals behaviour.
Customer target geographical scale	Global.
Competitors	Telecom companies.
Differentiation of exploitable asset	Data is collected in a real-world scenario of barge remote operation.
Marketing, communication and promotion	Academic papers.
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

Exploitable Asset	
Name	ROC Connectivity Crossborder.
Short description	Knowledge and methodology of dealing with challenges for connectivity and hand over in cross border scenarios.
Type of exploitable asset	Methodology.
High-level goal (commercial, research, policy-making)	Commercial,research, policy-making.
Related UCs	4.1.
Related EFs	N/A.
Related WPs	WP4.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Telecom operators.
Customer Target Problem	Knowledge, safety, rules and legislations.
Customer Key Benefits	Learn about challenges in cross border applications.
Customer target geographical scale	Europe.

Competitors	Telecom companies, companies active in remote operation.
Differentiation of exploitable asset	The knowledge is gathered in a real remote operation of a vessel.
Marketing, communication and promotion	Academic papers, newsletters, websites and social media.
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

4.3.8 Application provider for vulnerable road users

Locatienet

Locatienet is a developer of end-user mobility services, such as web sites and smartphone apps. It has successfully developed apps for both Vulnerable Road Users (VRUs) and motorised road users, building on its Tripzoom app toolkit and platform. Over 1 million unique users in Europe use Locatienet's services on a monthly basis.

Locatienet has a significant installed base of users of in-car and bicycle apps. It is uniquely positioned to market a solution that makes tele-operators aware of other road users, in particular VRUs. In the 5G Blueprint project, Locatienet developed such a solution (working title "VectorDrive").

The solution will be made available as a white-label product to app developers, bicycle manufacturers, last mile service providers and OEMs.

Exploitable Asset	
Name	LN V2X exchange service.
Short description	V2X exchange service.
Type of exploitable asset	Software.
High-level goal (commercial, research, policy-making)	Commercial.
Related UCs	UC2.2, UC2.3.
Related EFs	EF1, EF2, EF4 and EF5.
Related WPs	WP6 and WP7.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.

Customer Target Group	Road Authorities, TLC providers, telecom providers, service aggregators.
Customer Target Problem	No solution available to efficiently exchange V2X messages between road users and infrastructure assets with ultra low latency using 5G.
Customer Key Benefits	Exchange of V2X messages between road users and infrastructure objects. Can be deployed as cloud service or on the 5G edge.
Customer target geographical scale	EU, EEA.
Competitors	Monotch, Yunex.
Differentiation of exploitable asset	Low-cost, low-latency, can be deployed in the cloud and in 5G edge.
Marketing, communication and promotion	Direct sales.
Initial Technological Readiness (TRL)	4/5
Final Technological Readiness (TRL)	6/7.
Planned activities for exploitation	Liaise with potential customers through trade fairs, direct contact with existing customers.
Notes / Additional information	N/A.

Exploitable Asset	
Name	LN Collision detector.
Short description	Collision detector.
Type of exploitable asset	Smartphone software.
High-level goal (commercial, research, policy-making)	Commercial.
Related UCs	UC2.2, UC2.3.
Related EFs	EF1, EF2, EF4 and EF5.
Related WPs	WP6, WP7.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	App developers and OEMs.
Customer Target Problem	No solution available to determine collision risks based on V2X messages.

Customer Key Benefits	Receive warning for potential collision site/time of road user.
Customer target geographical scale	EU, EEA.
Competitors	Unknown.
Differentiation of exploitable asset	Low-cost, low-latency, can be deployed in clients.
Marketing, communication and promotion	Direct sales.
Initial Technological Readiness (TRL)	4/5
Final Technological Readiness (TRL)	6/7.
Planned activities for exploitation	Liaise with potential customers through trade fairs, direct contact with leading (smart) bicycle manufacturers.
Notes / Additional information	N/A.

4.3.9 Application and service providers for logistics

Sentors

Sentors delivers flexible solutions to recognize shipping containers using cameras, also called OCR (optical character recognition). Customers are inland terminals, container depots, and other logistical service providers where containers are an important part of the logistic process.

The reason to join the project is to gain real-life experience with 5G and investigate whether 5G has the ability to disrupt the way systems are deployed, and if new services could be offered. In particular, the combination of 5G radio (because of upload capacity) and Mobile Edge Computing could offer interesting features. The first benefit is that fewer local PC's/servers (connected to the camera) could be needed, which is especially interesting when they can be omitted in harsh environments such as container handling (where the hardware needs to sustain dozens of G-power). A second benefit is that software maintenance becomes easier, since a single software installation could handle multiple deployments. Thirdly, a benefit of a new service would be if the same software could be deployed on tablets and smartphones from the drivers and planners, that currently don't have the processing power to handle real-time video recognition.

In this project, Sentors has used a common security camera in combination with a 5G modem, without a local PC, where the software was running on an edge node of telecom operator KPN. This way only electricity was needed locally, and the test system could be moved around in a "plug and play" fashion to different locations, as long as there was electricity and 5G signal. A similar set-up could be deployed on any barge terminal (at gates, cranes, and reach stackers), empty depots, warehouses and other premises that handle containers. The concept itself is widely applicable also beyond container recognition, and would be valid for any solution where cameras and image recognition are used.

Exploitable Asset	
Name	Sentors.

Short description	The concept of deploying automatic container and rail wagon recognition, where only a camera and 5G modem are required at the premises, where the software runs on an edge node in the telecom network.
Type of exploitable asset	Software.
High-level goal (commercial, research, policy-making)	Commercial.
Related UCs	None.
Related EFs	EF6.
Related WPs	WP6 and WP7.
Ownership	Joint: Sentors (service provider) and network operators such as KPN (5G network and edge computing).
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Companies where containers are an important aspect in their business processes. In particular: container terminals, empty depots, manufacturing plants, logistic service providers, and public road operators.
Customer Target Problem	Lack of personnel (time) to properly register all handled containers together with their relevant handling data (date/time, stack location, and video/photos for damage disputes). Putting up many outdoor computers in the infrastructure is typically expensive and not always possible in heavy-duty machines such as reach stackers and cranes. And the desire to have similar features on tablets and smartphones (“board computers”) that are already carried by the drivers and planners.
Customer Key Benefits	First, automatic registration to save time (manually typing over CMR's and searching for containers in the stack). Second, to prevent errors to prevent the wrong container is leaving the premises. Finally, video recording to have proof when damage disputes occur.
Customer target geographical scale	Europe.
Competitors	Existing container scanning solutions, currently mainly used at large deep sea ports.
Differentiation of exploitable asset	Very limited local hardware required (i.e. less purchasing costs, and less maintenance), and dividing costs across multiple sites.
Marketing, communication and promotion	Mainly via social media (LinkedIn) and 5G Blueprint channels.
Initial Technological Readiness (TRL)	4/5.

Final Technological Readiness (TRL)	7/8
Planned activities for exploitation	Sentors is currently exploring with KPN the real-life deployment of this solution. In this case, it would not use 3.5GHz but the available frequencies, but the Mobile Edge Computing component will be available from one of the data centres.
Notes / Additional information	N/A.

Room40

It is the intention of Room40 together with its platform partner Nokia to demonstrate the need of real-time streaming solutions for mobility, security and public safety. The 5G technology enabling these streaming solutions will be used as key differentiators internationally. Deploying solutions in real time and only when they are relevant for the user can only be achieved by using the 5G technologies. Therefore, Room40 will support activities disseminating this, and deploy the use of 5G technologies underneath its own solutions.

Exploitable Asset	
Name	Scene Analytics platform.
Short description	A real-time multimedia feed analytics and anomaly detection platform.
Type of exploitable asset	Software.
High-level goal (commercial, research, policy-making)	Commercial.
Related UCs	UC4.
Related EFs	EF8.
Related WPs	WP6 and WP7.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Mixed, proprietary with open-source elements.
Customer Target Group	Industry.
Customer Target Problem	Safety, personnel, budget.
Customer Key Benefits	Maintaining safety standards with lower personal and financial needs.
Customer target geographical scale	Global.
Competitors	Existing Video Management system offerings.
Differentiation of exploitable asset	The solution focuses on detecting anomalies (in trends or objects) while competition focuses on detections alone.

Marketing, communication and promotion	Promotion video, leaflets, etc.
Initial Technological Readiness (TRL)	4.
Final Technological Readiness (TRL)	6.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

Exploitable Asset	
Name	5G-hub.
Short description	Physical hosting for processing hardware and 5G equipment.
Type of exploitable asset	Hardware platform.
High-level goal (commercial, research, policy-making)	Commercial.
Related UCs	UC4.
Related EFs	EF8.
Related WPs	WP6 and WP7.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Industry.
Customer Target Problem	Safety, personnel and budget.
Customer Key Benefits	Increasing on-site safety and connectivity.
Customer target geographical scale	Global.
Competitors	N/A.
Differentiation of exploitable asset	The 5G Hub is a.unique hardware & software combination able to act as a neutral host for a variety of third-party solutions.
Marketing, communication and promotion	Promotion video, leaflets, etc.
Initial Technological Readiness (TRL)	6.
Final Technological Readiness (TRL)	8.

Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

4.3.10 ITS service providers

Be-Mobile

Be-Mobile is a smart mobility service provider, developing high-tech solutions in the areas of traffic information, analytics and management, connected vehicle technologies (C-ITS), fleet management, mobile parking payment and toll collection to pave the way to smoother daily mobility. By participating in 5G-Blueprint, Be-Mobile could extend its C-ITS portfolio in a 5G context, with a specific focus on providing reliable safety functionalities in combination with real-time, dynamic traffic information. This includes priority requests at iTLC, real-time speed advice and turn-to-turn navigation, and also the support of safety-related alerts (e.g., towards VRUs). Tele-operated trucks were an ideal use case to test the feasibility of our technology, but for Be-Mobile the extended C-ITS functionalities are applicable in a broader area, and will be especially of interest towards seamless autonomous vehicles. These functionalities will be integrated in our existing C-ITS offering, available for our external and internal customers, and can also lead to a new product offering focused on supporting functionalities for autonomous vehicles.

Exploitable Asset	
Name	Truck route planner, turn-by-turn navigation and ETA.
Short description	The advancements developed and piloted in 5G Blueprint with respect to route planning, specifically for truck transport, and determination of an appropriate ETA in real-time, taking into account various other sources, will be used to improve Be-Mobile's own route planner.
Type of exploitable asset	Software, methodology.
High-level goal (commercial, research, policy-making)	Commercial.
Related UCs	UC4.2, UC4.3 and UC4.4.
Related EFs	EF7 (+ EF1, EF2, EF3).
Related WPs	WP6.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Logistic planners, providers of navigation software / applications for heavy goods transport.

Customer Target Problem	Need for reliable real-time route planners which take into account constraints imposed by truck transport and measures by road operators/local authorities.
Customer Key Benefits	Improved route planner and ETA which explicitly accounts for constraints imposed by truck transport.
Customer target geographical scale	Benelux (starting point) + Europe (target).
Competitors	Other providers of truck route planning software.
Differentiation of exploitable asset	Fine-grained real-time ETA, which takes into account detected obstacles on route (not just real-time travel times, but also whether priority was granted at an intersection).
Marketing, communication and promotion	In supply of products / services to customers, website, newsletters, social media, participating in events.
Initial Technological Readiness (TRL)	4/5.
Final Technological Readiness (TRL)	8/9.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	N/A.

Exploitable Asset	
Name	Long-distance and route-based priority requests at iTLC.
Short description	Following advancements made during the project, we will be able to request priority over longer distances than before, and this based on a route provided by the transport for which priority is requested.
Type of exploitable asset	Software, standards, methodology.
High-level goal (commercial, research, policy-making)	Commercial.
Related UCs	UC4.2.
Related EFs	EF3, EF7 (+ EF1).
Related WPs	WP6.

Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Emergency vehicles, heavy-goods transport, public transport, active road users.
Customer Target Problem	Priority at an intersection is being asked too short in advance such that priority is sometimes not possible.
Customer Key Benefits	Priority can be requested a longer time in advance (e.g. 2 minutes before). This can allow iTLCs to adjust light phases in time to guarantee fast crossing of the intersection for the vehicle that requested priority.
Customer target geographical scale	Benelux (starting point) + Europe (target)
Competitors	Other providers of cloud- or radio-based priority services.
Differentiation of exploitable asset	Long-distance and route-based makes for more reliable priority granting.
Marketing, communication and promotion	In supply of products / services to customers, website, newsletters, social media, participating in events.
Initial Technological Readiness (TRL)	4/5
Final Technological Readiness (TRL)	6/7.
Planned activities for exploitation	Integration in our C-ITS platform, so that it can be offered as additional service in future C-ITS projects. Be-Mobile is exploring the C-ITS market in Europe, to extend our C-ITS project portfolio beyond the Benelux.
Notes / Additional information	N/A.

Exploitable Asset	
Name	Speed advice.
Short description	The advancements made during the project will allow us to provide more reliable speed advice to end-users; in first place focussing on providing speed advice that allows vehicles to arrive at intersections during a green light phase.
Type of exploitable asset	Algorithms.

High-level goal (commercial, research, policy-making)	Commercial.
Related UCs	UC4.2.
Related EFs	EF7 (+ EF1, EF3).
Related WPs	WP6.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Users of navigation applications, Consumers of priority services.
Customer Target Problem	Road users have to stop in front of a red light even though by adjusting their speed they could have had a green light without stopping.
Customer Key Benefits	Road users receive speed advice which would increase the probability that they have a green light at the next intersection. This would reduce emissions and increase road safety.
Customer target geographical scale	Benelux (starting point) + Europe (target).
Competitors	Other providers of navigation applications.
Differentiation of exploitable asset	Speed advice to the next intersection is something that has not been done before.
Marketing, communication and promotion	In supply of products / services to customers, website, newsletters, social media, participating in events.
Initial Technological Readiness (TRL)	3.
Final Technological Readiness (TRL)	6/7.
Planned activities for exploitation	Integration in our C-ITS platform, so that it can be offered as additional service in future C-ITS projects. Be-Mobile is exploring the C-ITS market in Europe, to extend our C-ITS project portfolio beyond the Benelux.
Notes / Additional information	N/A.

SWARCO

By doing experiences in 5G-Blueprint SWARCO will learn more about the integration between 5G and C-ITS applications and by that SWARCO will be able to explore this in all the countries where SWARCO is active.

Exploitable Asset

Name	SWARCO Cloud RIS.
Short description	iTLC concept with ITS Traffic Engineering Application as a cloud service for Road Authorities.
Type of exploitable asset	Software and cloud service.
High-level goal (commercial, research, policy-making)	Commercial.
Related UCs	ETA for trucks on a route to an intersection.
Related EFs	EF3.
Related WPs	WP6.
Ownership	Road Authority.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Road Authorities.
Customer Target Problem	Network concept of trajectories for coordination of traffic flow.
Customer Key Benefits	Running traffic engineering applications as a cloud service in bigger geographical areas for road networks will be much easier to achieve.
Customer target geographical scale	Mainly on bigger cities to improve mobility also within the green deal for reducing emission by 45% in 2023.
Competitors	RHDHV, Yunex.
Differentiation of exploitable asset	N/A.
Marketing, communication and promotion	Big launch is foreseen on Intertraffic Amsterdam April 2024.
Initial Technological Readiness (TRL)	Technology is operational and meanwhile already on air.
Final Technological Readiness (TRL)	Product is already available and up and running.
Planned activities for exploitation	Liaise with the customer partners to propose and kickstart the usage of the lessons learned from the project.
Notes / Additional information	SWARCO is trying to use this concept in many European countries as part of ITS.

4.3.11 End-users of the logistics sector (shipping or transportation)

Kloosterboer

Kloosterboer is building a better cold chain to help feed the world. As a leading and innovative provider of temperature-controlled warehousing and logistics solutions, our customers have access to a global network with hundreds of strategically located facilities and billions of cubic feet in capacity across North America, Europe and Asia-Pacific.

Add our temperature-controlled industrial infrastructure to our industry-leading expertise in end-to-end logistical solutions and innovative technology, and you get a partner that can help you increase distribution efficiency, advance sustainability and minimise supply chain waste.

Most important, as a Visionary Partner of Feeding America, Kloosterboer is committed to helping feed the world while eliminating waste. With our partners and customers, we make a real difference to millions of people all over the world. That's why we're working to reimagine the global supply chain. Let's do more good together.

At Kloosterboer Vlissingen we are not only operating temperature-controlled warehouses, but also operating a fully automated electrically driven container terminal. The rubber tired gantry cranes (RTGs) are semi-automated, only small parts need to be operated remote from Remote Operation Stations located in the office.

Containers that are getting discharged from the vessels are now transported from the quay to the container terminal. From the container terminal, about 80% of the containers need to get transported to our warehouses across our premises.

Also other way around, containers brought to our container terminal by third parties need to be transported to the quay side in order to load them on the vessels.

All these movements across our terrain are done manually by terminal tractors of trucks.

The goal of Kloosterboer in this time where (forklift-, tugmaster) drivers are harder to find is to find solutions for this increasing problem. Hence durable deployment is our key driver. We improve the working environment and work for the drivers through automating the steering that is enormously boring and a constant repetition during the day. Through this we optimise the internal traffic, make the work that needs to be done more interesting and improve the working life of the employed drivers. Automating the transport between quay, container terminal and warehouses would be a logical and valuable next step in automation of our daily operation. Kloosterboer will facilitate the deployment and exploitation of the delivered 5G-Blueprint results as much as possible on our terminal and in our vehicles. This will be made possible through various projects and pilots.

Exploitable Asset	
Name	Port environment.
Short description	Learn how 5G/Automated and teleoperated driving can be used in a port environment, integrated within daily operations (i.e. Automated Terminal Tractors working together with RTGs, Reach stackers, Mobile Harbour Cranes etc.).
Type of exploitable asset	Knowledge of port logistics.
High-level goal (commercial, research, policy-making)	Education and research.
Related UCs	UC2 Automated driver in loop docking UC4 Remote take over

Related EFs	EF6 Container ID recognition EF7 ETA sharing
Related WPs	WP 3 + 4
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary
Customer Target Group	Port industries and Logistics providers.
Customer Target Problem	Rules and legislation / safety.
Customer Key Benefits	Next step in automation of our container terminal, autonomous or teleoperated driving.
Customer target geographical scale	Local/regional
Competitors	Other container terminals.
Differentiation of exploitable asset	The Kloosterboer Container Terminal is focussed on reefer containers, we have 1,200 reefer plugs available, and is located next to our warehouses. We can directly store the goods in our warehouses or stuff containers from our warehouses. Furthermore, an empty depot is also located directly near the container terminal with PTI, repair and cleaning services in place.
Marketing, communication and promotion	Website and presentations
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	The autonomous / tele-operated (internal) transport will definitely remain on the agenda, but needs to be further developed in order to use this in our daily operations. We keep connected to Autonomous Transport Zeeland (Impuls Zeeland / Zeeland Connect) and are willing to facilitate for testing purposes.
Notes / Additional information	N/A.

Verbrugge

Verbrugge International is a logistics service provider with a total package of logistics services for various industries operating in the ports of Terneuzen and Vlissingen. The ideal "gateway to Europe", thanks to our strategic locations, customer focus, operational quality and high safety standards.

Driven by our family values, integrity and sustainable entrepreneurship we have grown into a trusted, innovative, and strong partner for maritime transhipment and storage, transport, distribution, chartering, forwarding, port agency and customs and tax services.

Verbrugge joined the project, because we see opportunities in digitalisation and automation on our terminals. An increase in efficiency by using semi-autonomous terminal tractors, tele-operated cranes and wheel loaders will help us in reaching our targets. We use the learning outcomes of the project within the following sectors: Safer work environment; Business process improvement; Service enhancements; Expansion of project results; Industry assistance on implementation.

At our Verbrugge Scaldia Terminals, we function as a pilot site where we facilitate and support the project partners in deploying their technologies and test the tele-operated skid steer in a work environment.

Exploitable Asset	
Name	Port Environment.
Short description	Finding out whether tele-operated /autonomous transport can add value to the daily operations on the terminal in order to smoothen the operations.
Type of exploitable asset	Learning how we can take advantage of 5G technology by tele-operating equipment. Resulting in a more efficient daily operation.
High-level goal (commercial, research, policy-making)	Increase efficiency/productivity and create a more safe working environment by moving labour from a possible risky environment to a tele-operation control room.
Related UCs	3.2 Business Models 3.4 Deployment scenarios 4.4 Remote takeover
Related EFs	EF6
Related WPs	WP3, WP4, 3.2+3.4
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary
Customer Target Group	Logistics Operators / Terminals.
Customer Target Problem	Return on Investment, rules and legislation, specialised personnel, reliability of the network, safety in mixed traffic environment).
Customer Key Benefits	More efficient usage of employees. Multiple vehicles can be controlled by one operator. No restrictions on time in a dangerous environment).

Customer target geographical scale	Local
Competitors	Break-/bulk Terminals
Differentiation of exploitable asset	More operational efficiency. Create the best working environment.
Marketing, communication and promotion	Show our innovative mindset to the world.
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	Awaiting further developments and once upscaling will start, we will investigate more in detail how we can integrate this in our terminal operations. The blueprint is created, we will keep following the developments in order to adapt early
Notes / Additional information	N/A.

Roosens

Roosens sees a major advantage in the project, for example by using unmanned vehicles for the dock tracking (e.g., overnight). With this type of transport, a lot of time is lost due to waiting times: one driver could simultaneously operate several vehicles e.g., reach stacker and truck(s). An additional advantage could be that from the head office, the 2 other locations (Left Bank and Right Bank) the 3 reach stackers could also be controlled by 1 operator.

Exploitable Asset	
Name	Knowledge Roosens.
Short description	In-house knowledge for transport and logistics.
Type of exploitable asset	Picking up and dropping off containers by multiple stackers, due by 1 person remotely from the office. When delivering containers on trailers, the driver spends a lot of time queuing up for loading or unloading at customers' terminals, and his rest times are compromised. By using a remote control system from the moment the driver registers at the gate of a terminal, the truck could be controlled remotely, and by using a shuttle service the driver can continue his work on another truck.
High-level goal (commercial, research, policy-making)	Improving the bottleneck profession of truck driver. The risk of personal accidents because the driver is no longer present during the manipulations of the containers

	is completely eliminated, and physical contact with the handling equipment is no longer possible.
Related UCs	UC2, UC3 and UC4.
Related EFs	EF6.
Related WPs	WP4, WP6, WP8.
Ownership	Roosens.
Constraints to Intellectual Property Rights (IPR)	N/A.
Customer Target Group	Transport.
Customer Target Problem	Safety & work hours.
Customer Key Benefits	Safety & economic & personnel.
Customer target geographical scale	Ports - Clients.
Competitors	Other transport companies.
Differentiation of exploitable asset	Through the 5G Blueprint project, Roosens has discovered the possibilities of 5G, connected automated mobility, safety opportunities and logistics management.
Marketing, communication and promotion	Promotion and communication with the Belgian federation of the transport sector they are certainly interested in solutions that make the profession of truck driver attractive and safer
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	Roosens wants to remain involved in the development and expansion of the possibilities of the 5G Blueprint project. The follow-up will mainly focus on the employability and safety of the truck drivers. The economic and safety aspects must be linked.
Notes / Additional information	N.A.

4.3.12 Specialised support offices

Martel

Martel is a dynamic Swiss-based digital innovation agency with more than 25 years' experience empowering organisations across Europe and worldwide, throughout their journey from novel

ideas to technological implementation, media and market strategy. After more than one hundred cutting edge projects. Building on its foundation in European Commission funded project management consulting, Martel has grown from its origins as a small consulting agency into a thriving organisation whose business has diversified to include research and development activities in several advanced domains, but also a broad palette of communication, marketing, media and training services. With a skilled and passionate team, Martel helps its customers and partners achieve ambitious innovation goals in an impactful and sustainable way. Martel offers support and guidance spanning from securing funds and providing expertise in selected ICT domains, to brand building and strategic communication and marketing. Martel also offers dedicated training on Horizon Europe mechanisms, on media and communication for science and technology, and on advanced topics in Cloud Computing, Edge Computing, Internet of Things, Artificial Intelligence and open-source Software Engineering. By participating to the 5G-Blueprint, Martel consolidated its experience and position in the research and innovation context, which was exploited and will be exploited in several ways. The acquisition of new expertise and knowledge through serving as project lead of dissemination, communication and stakeholder engagement activities via WP8, allowed Martel to offer new innovation management, consulting and media services in the European and international R&D&I context. The exposure gained through the planned stakeholders' engagement, dissemination and communication activities allowed Martel to become a key player in facilitating the take-up of project results by interested industries, SMEs and external actors. Moreover, the acquisition of new expertise and knowledge via close coordination of all project's tasks and lead of several CC-programme strategic coordination activities, allowed Martel to strengthen and enrich the spectrum of services offered to its customers and partners, spanning from innovative media and communications, research and innovation management methodologies and tools, training and events.

Exploitable Asset	
Name	Consultancy and media services.
Short description	Enrich the services offered in innovative media and communications, R&I management methodologies and tools, training and events.
Type of exploitable asset	Service.
High-level goal (commercial, research, policy-making)	The know-how acquired over the project's run will serve as a baseline for further commercial opportunities in the related ecosystem.
Related UCs	N/A.
Related EFs	N/A.
Related WPs	WP8 and WP2.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	N/A.
Customer Target Group	Academia, industry and SMEs.
Customer Target Problem	Lack of knowledge in the EU funded project management.

Customer Key Benefits	Turn scientific concepts into practice, through projects - and receive funding for the execution of such projects.
Customer target geographical scale	Europe and beyond.
Competitors	Other consulting companies.
Differentiation of exploitable asset	In-depth knowledge of the R&I ecosystem and funding programmes.
Marketing, communication and promotion	Support and promotion action of related concepts and applications in the ecosystem/sector.
Initial Technological Readiness (TRL)	N/A.
Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	Martel will be able to extend its offer in innovation management, consulting and media services in the European and international R&D&I context.
Notes / Additional information	N/A.

Impuls

Impuls Zeeland is the economic development agency for the province of Zeeland. Impuls helps entrepreneurs convert ideas into future-proof innovations. We do this by developing programs and projects and finding financing. We also support Zeeland companies with international ambitions and assist companies in establishing and expanding in Zeeland. With the aim: making the Zeeland economy more sustainable and strengthening. Logistics is important for Zeeland: The strategic location of Zeeland with well-connected ports plays a vital role in international trade, supporting local industries, facilitating efficient supply chains, and contributing to the region's economic development and sustainability. From this perspective, Impuls is highly interested in accelerating the development, deployment and validation of innovative services, as those intended to be developed by the 5G-Blueprint also in concert with the “Autonomous Transport Zeeland” project that aims to explore the possibility of autonomous road transport within the logistics sector of Zeeland and create awareness about 5G based tele-operated logistics.

Exploitable Asset	
Name	Consultancy and general support.
Short description	As an organisation Impuls and Zeeland Connect is in the middle of the logistics companies in Zeeland. Being a bridge between business and government, Impuls helps stakeholders in this project to connect and develop.
Type of exploitable asset	Impuls provides access to the business and government network and plays a role in the valorisation of concepts and technology.

High-level goal (commercial, research, policy-making)	Commercial and operational benefit for the logistic sector, lobby for relevant government support (i.e. policy).
Related UCs	All use cases are relevant for the Zeeland logistic community as they directly intervene with the operational and business benefits for the companies.
Related EFs	Impuls has not directly been involved in the development of the enabling functions.
Related WPs	WP3 and WP4.
Ownership	Single.
Constraints to Intellectual Property Rights (IPR)	Proprietary.
Customer Target Group	Logistic community in Zeeland, both shippers and logistic service providers. In addition to this, governments (provinces and municipalities), schools and universities.
Customer Target Problem	Logistics sector is dealing with a shortage of personnel (for instance truck drivers), and low efficiency. Tele-operated transport can help the sector with both aspects. However, there is a lack of interest and knowledge due to strong operational focus within logistical companies in Zeeland.
Customer Key Benefits	Making sure Logistic companies in Zeeland are informed about possibilities of 5G and teleoperated driving. Facilitating any testing in the region from a practical perspective. Merging knowledge of the 5G project with that of living lab autonomous transport.
Customer target geographical scale	Province of Zeeland.
Competitors	No, as there is only one non-profit regional economical development agency for the province
Differentiation of exploitable asset	Due to the unique components of the 5G Blueprint, Impuls has obtained a unique knowledge in the combination of 5G, connected automated mobility and logistic supply chain management.
Marketing, communication and promotion	Yes, through the communication channels of Impuls Zeeland (news letter, Linkedin, direct contacts), the Zeeland Connect community, Province of Zeeland, etc.
Initial Technological Readiness (TRL)	N/A.

Final Technological Readiness (TRL)	N/A.
Planned activities for exploitation	Impuls will keep in close contact with the consortium partners and learn about commercially available solutions as well as continue to actively create awareness about the possibilities of tele-operated logistics based on 5G.
Notes / Additional information	N/A.

4.4 Planned activities

In the interplay between the project-wide exploitation plan and individual exploitation plans new activities will be planned. The current planned activities have already been described in the previous paragraphs. Based on an overarching point of view, the consortium is adressing the follow key activities to be planned:

- The outcomes of the project are used to generate and start **follow-ups** at least in the Netherlands, Belgium and Germany.
- The consortium produces a **white paper** to dissiminate the key outcomes of the project to global and European telecommunication, mobility and logistic communities.
- Relevant **business and policy agenda's** can be **connected, shaped and enforced** with the help of the project.
- On the basis of the **Innovation Radar** developed technologies are further examined and deployed.
- **Collaboration with standardisation bodies** is foreseen.

5 CONCLUSIONS AND LESSONS LEARNED

The document at hand reported on communication, dissemination, standardisation, and exploitation activities conducted in the second half of the 5G-Blueprint project, including progress against the set KPIs, in addition to presenting the grounds for any future exploitation of what was built and validated throughout the project.

Having successfully worked to address the previous review's recommendations and having met - or successfully re-routed to effective impact - all related KPIs, despite still carrying over from the previous reporting period the disadvantage caused by various pandemic-related restrictions, the project consortium is satisfied with the results achieved by WP8.

The various types of promotional activities described in this document offer a comprehensive picture of the project's run, while consisting in a solid starting point to further promote the work performed by the project consortium and uptake of its results, benefiting project stakeholders and the extended 5G-Blueprint community.

Based on what gathered from interaction with fellow projects in the field, stakeholders, and upon review, in terms of communication and dissemination, we further strived to connect with other initiatives to strengthen the ecosystem and create an "echo chamber" to transmit the results and the finding of 5G-Blueprint project. Key was also the suggestion of adding more explicit detail on the connection to the 5G market in all promotional material, to further ground the objectives and achievements of the project. Culminating in the Final Showcase Events demos and presentations, the project has proven that through 5G it becomes possible to teleoperate cars, trucks, barges and skid steers, given that the need to support stringent requirements is considered: teleoperation requires low latency, high uplink throughput, and high reliability. The project has validated in real-life environments that 5G technology supports this challenging set of requirements. Furthermore, it also created and validated novel solutions that allow a 5G connection to keep performing in this manner when crossing a country border. Where in a typical 4G network an end user gets disconnected for a minute or longer when crossing the border, the 5G-Blueprint project managed to reduce this disconnection time to less than 150 milliseconds. This opens the path for international teleoperation of vessels and vehicles throughout Europe.

And since business and governance related analysis performed in the project has identified that teleoperation can be a valuable or even essential companion technology for autonomous driving solutions, these project achievements also contribute to bringing the combination of autonomous and remote driving solutions one step closer to EU-wide deployments. In summary, the following lessons-learned are formulated:

UC-dependent

Which 5G deployment approach is best depends on the scope of TO deployment.

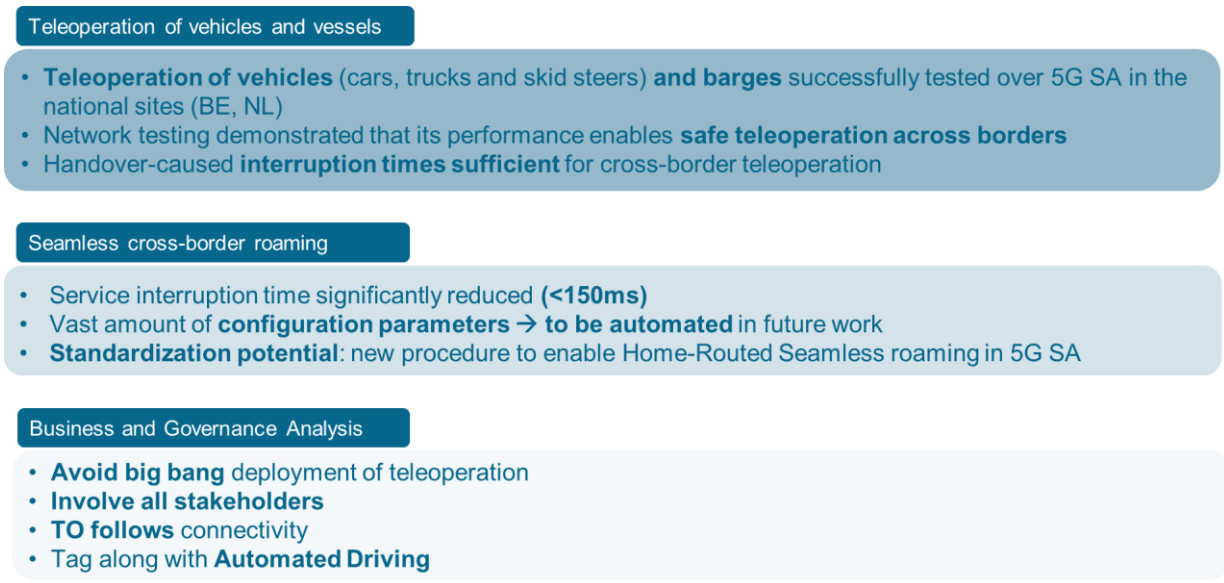
Anticipate scaling up

Assess and approach potential customers and network operators; seek investment kickstarters.

OPEX matters

OPEX is the key cost element to target for reducing total cost of ownership.

Anticipate labour market shift



Realizing objectives set after the first review, through a re-framing of communication addressing the 5G and cross-border aspects of the project (highlighting the potential uptake of teleoperation solutions in the context of the transport and logistics sector), WP8 successfully backed up the significance and appeal of the 5G-Blueprint within the European ecosystem and beyond.

For what concerns standardization, the most significant contribution of the project is the contribution of the Inter-PLMN solutions developed in the project (realizing seamless cross border roaming in less than 150 ms) in the 3GPP SA2 Working Group. This was done as contributions for both Releases 16, 17 and 18, and was pushed to 3GPP in the meeting held on 21 - 25 August, 2023, Goteborg, Sweden. Furthermore, intense collaboration with 5GAA on the topic of Teleoperated Driving in the first reporting period was important in aligning insights with a broad telecom and automotive industry representation. And also standardization activities were executed to facilitate the further deployment of some of the Enabling Functions of the project (EF3 at the Dutch standardization body CROW, and EF7 at the international standardization body TISA).

In terms of Exploitation, the project-wide exploitation plan sets the high-level scope for upscaling the specific outcomes of the project based on core principles underlying research and policy mechanisms in Europe of the past and the future. The individual exploitable assets can be seen as the seeds able to grow on the fertile soil the project consortium created. It can be stated that the soil would have never been there without the contribution of the European Union and efforts of the consortium partners together. In fact, the developed governance and business models can take of it now. A Zenodo community is and was open to make the project findings and results openly available to any party interested in the uptake of the blueprint developed in the framework of the project.

The project stuck to its declared intention of distributing the gained knowledge of the project as much as possible by means of the planned activities described in chapter 2.

ANNEX A – SCIENTIFIC PUBLICATIONS LIST (PERIOD 2)

Title	Authors	Venue/Published in
Encouraging the Sustainable Adoption of Autonomous Vehicles for Public Transport in Belgium: Citizen Acceptance, Business Models, and Policy Aspects	Pol Camps-Aragó, Laura Temmerman, Wim Vanobberghen, Simon Delaere	MDPI
Experimental V2X Evaluation for C-V2X and ITS-G5 Technologies in a Real-Life Highway Environment	V. Maglogiannis, D. Naudts, S. Hadiwardoyo, D. van den Akker, J. Marquez-Barja and I. Moerman	IEEE
Network Service and Resource Orchestration: A Feature and Performance Analysis within the MEC-Enhanced Vehicular Network Context	Slamnik-Kriještorac, N.; de Britto e Silva, E.; Municio, E.; Carvalho de Resende, H.C.; Hadiwardoyo, S.A.; Marquez-Barja, J.M.	MDPI
Realistic Experimentation Environments for Intelligent and Distributed Management and Orchestration (MANO) in 5G and beyond	N. Slamnik-Kriještorac, P. Soto-Arenas, M. Camelo Botero, L. Cominardi, S. Latré and J. M. Marquez-Barja	IEEE 19th Annual Consumer Communications & Networking Conference (CCNC)
Latency-aware C-ITS application for improving the road safety with CAM messages on the Smart Highway testbed	V. Charpentier, N. Slamnik-Kriještorac, J. M. Marquez-Barja	IEEE INFOCOM
Assessing the impact of CAM messages in vehicular communications in real highway environments	V. Charpentier, N. Slamnik-Kriještorac, J. M. Marquez-Barja	IEEE INFOCOM
Meerwaarde en impact van teleoperatie in het wegvervoer (Added value and impact of tele-operation in road transport)	Lauren Deckers, Bahman Madadi, Thierry Verduijn	Logistiek +, tijdschrift voor toegepaste logistiek (Logistics Plus, Journal for Applied Research in Logistics)
Model Predictive Control based Driver Support for Docking of Articulated Vehicles at Logistics Areas	Abram Dekker, Jason van Kolfschoten, Karel Kural, Laura Ferranti, Jan Benders	AVEC 2022

Wireless Technology Recognition and Characterization to Enable Spectrum Sharing in ITS Band	Merkebu Girmay, Vasilis Maglogiannis, Dries Naudts, Muhammad Aslam, Adnan Shahid and Ingrid Moerman	Elsevier Journal on Vehicular Communications.
Enabling Cross-Technology Communication to Protect Vulnerable Road Users	Xhulio Limani, Henrique Cesar Carvalho De Resende, Vincent Charpentier, Johann Marquez-Barja, and Roberto Riggio	IEEE Conference on Network Function Virtualization and Software Defined Networks
Assessing the Benefits of Teleoperation of Trucks by Logistics Service Providers	Bahman Madadi and Thierry Verduijn	Logistiek+
Real-Time QoE Estimation for DASH Video Using Active Network Probing	G. Miranda, Jr, E. Municio, J. M. Marquez-Barja, D. Fernandes Macedo	25th IEEE/ACM Conference on Innovation in Clouds, Internet and Networks (ICIN)
Performance Validation Strategies for 5G-enhanced Transport & Logistics: The 5G-Blueprint Approach	Nina Slamnik-Krijestorac, Wim Vandenberghe, Rakshith Kusumakar, Karel Kural, Matthijs Klepper, Geerd Kakes, Linde Vande Velde, Johann M. Marquez-Barja	IEEE Future Networks World Forum (FNWF)
A proposal on a Connected Automated Mobility (CAM) communication system for (U)Avs	Vincent Charpentier, Nina Slamnik-Krijestorac, Cristina Costa, Johann Marquez-Barja	ACM International Conference on Information Technology for Social Good (GoodIT 2022)
Data Management Platform For Smart Orchestration of Decentralized and Heterogeneous Vehicular Edge Networks	Berk Ayaz, Nina Slamnik-Krijestorac, Johann M Marquez-Barja	ACM International Conference on Information Technology for Social Good (GoodIT 2022)
The testing framework for Vehicular Edge Computing and Communications on the Smart Highway	Thomas Verschoor, Vincent Charpentier, Nina Slamnik-Kriještorac, Johann M. Marquez-Barja	IEEE 20th Annual Consumer Communications & Networking Conference (CCNC)
Leveraging 5G to Enable Automated Barge Control: 5G-Blueprint Perspectives and Insights	Nina Slamnik-Krijestorac, Wim Vandenberghe, Najmeh Masoudi-Dione, Stijn Van Staeyen, Lian Xiangyu, Rakshith Kusumakar, Johann M. Marquez-Barja	IEEE 20th Annual Consumer Communications & Networking Conference (CCNC)
An ML-driven framework for edge orchestration in a vehicular NFV MANO environment	Nina Slamnik-Krijestorac, Miguel Camelo, Luca Cominardi, Steven Latre, Johann M. Marquez-Barja	IEEE 20th Annual Consumer Communications & Networking Conference (CCNC)

Automated docking of tractor semitrailer with driver in the loop via 5G teleoperation	K. Kural, N. Muthakana, D. Devasia, G. van Stekelenburg, B. Hetjes, R. Kusumakar	17th International Symposium on Heavy Vehicle Transport & Technology (HVTT17)
On Assessing the Potential of 5G and Beyond for Enhancing Automated Barge Control	Nina Slamnik-Krijestorac, Wim Vandenberghe, Najmeh Masoudi-Dione, Stijn Van Staeyen, Lian Xiangyu, Rakshith Kusumakar, Johann M. Marquez-Barja	EuCNC 2023

ANNEX B – FURTHER READING ON EXPLOITATION

The 5G-Blueprint project is part of Horizon2020 Research and Innovation programme formulated, inter alia, in subsequence of the Digital Agenda for Europe. Part of the programme and agenda is the programme 'Industrial Leadership – Leadership in enabling and industrial technologies – Information and Communication Technologies (ICT)' with the specific goal to activate Europe in continuing help, evolvement and exploitation of ICT-opportunities and -benefits for its citizens, businesses and researchers. One of the research calls within this programme has been the ICT-53-2020: 5G-PPP – 5G for Connected and Automated Mobility (CAM). The objectives of the research call are:

- Validation of the latest version of 5G technologies and architecture in a CAM context, including validation of innovative business models and applicable standards.
- Validated cost/benefit analysis of cross-border 5G deployment enabling CAM along 5G corridors potentially including several business domains.
- Characterisation of 5G Release 16 or beyond for the most advanced CAM use cases (see through, sensor sharing, high density platooning, etc.) including innovative spectrum use.
- Validation of sustainable models combining 5G and AI features to support most advanced CAM use cases.
- Technological validation of 5G introduction for train/railways use cases including FRMCS aspects, migration, spectrum, and co-existence issues with the automotive case.
- Development of a sustainable model for a pan-European cloud infrastructure supporting CAM services at European scale.
- Support for sustainable deployment models paving the way towards deployment actions.

Table 1. Scope of the ICT-53-2020 research and innovation call.

The validation of the latest available 5G specification in the context of innovative CAM applications under realistic conditions and seamlessly functioning across borders. This is realised through cross-border trials along 5G corridors covering significant portions of roads or railways and including the core technological innovation expected from 5G release 16 including positioning services, or beyond. Relevant work takes a broad innovation perspective covering use cases in the vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-pedestrian (V2P), and vehicle-to-network (V2N) domains including the supporting service infrastructure. The work covers the key 5G innovation in support of innovative CAM ecosystems, notably at radio, RAN and core network levels. It also includes supporting innovations in the area of Artificial Intelligence (AI) to enable advanced CAM use cases managing a broad range of relevant data sets based on connectivity and sensors. It is based on a multi-tenant business architecture that optimises the return on investments and the efficiency of the deployed connectivity and service infrastructure, while considering the opportunity of a European cloud supporting Europe-wide roaming of CAM services. Beyond technological validation, the proposed pilots will allow better understanding of the roles, relations and responsibilities of market players and public authorities within the CAM ecosystem.

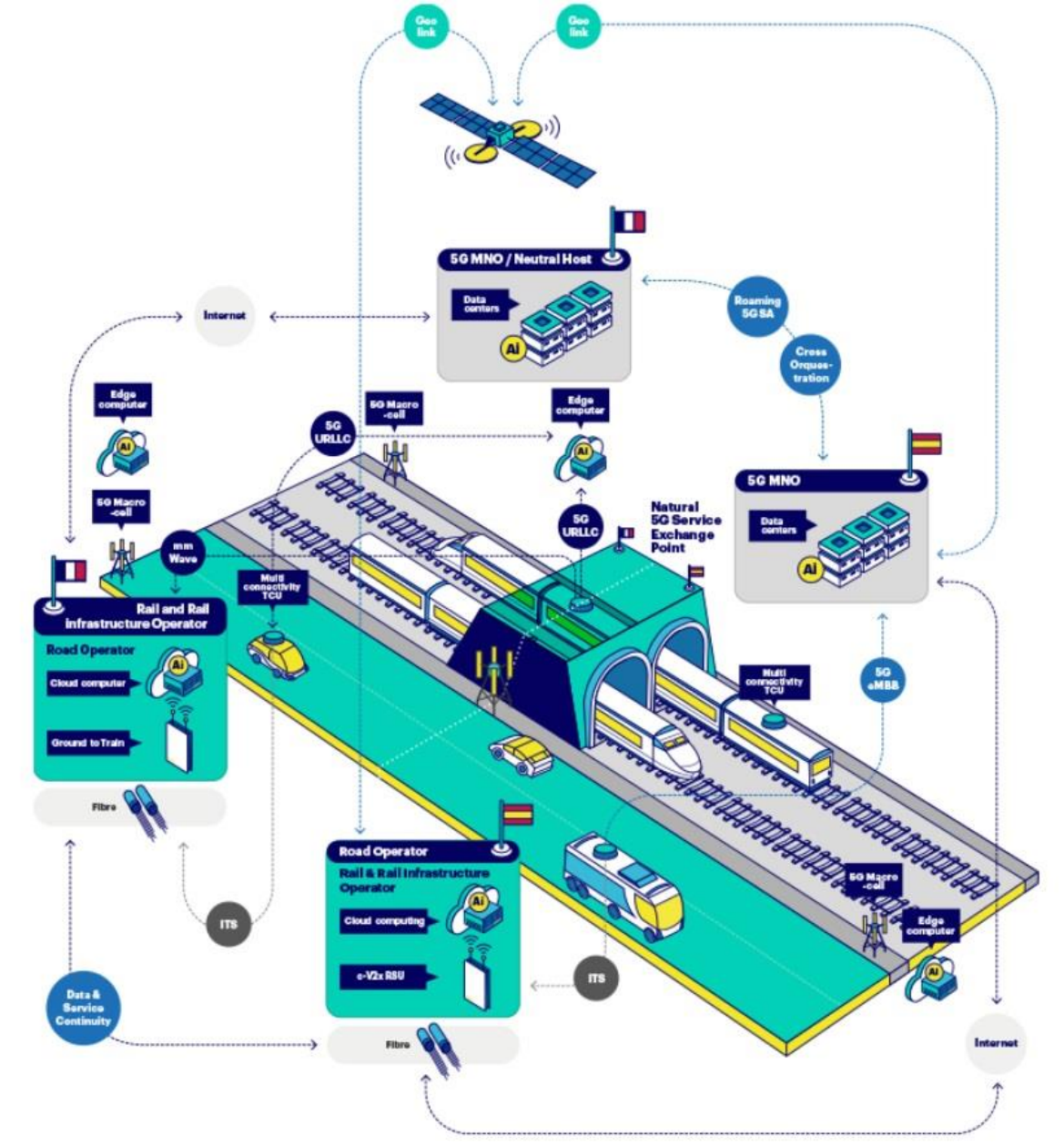
5G-Blueprint is one of the projects that is part of the ICT-53 call and contributes to the formulated objectives in line with the scope of the call. In addition, the combination of elements such as blueprint, cross-border operations, cross-sectoral operations and field trials align with stated objectives of the wider European 5G Action Plan in which 5G is positioned as a strategic opportunity with the ambition to provide wireless broadband services at gigabits speed. The challenge is to create uniformity and standardisation across European Member States. As part of the 5G-PPP community, the 5G-Blueprint project specifically experiments with the development of 5G-based logistic teleoperated services within the European Union. The project was envisioned to design and validate a technical architecture and a business and governance model for uninterrupted cross-border teleoperated transport based on 5G connectivity. The four use cases of 5G-Blueprint (automated barge control, automated driver-in-loop docking functionality, Cooperative Collision Avoidance System based platooning, remote take-over operations) in cooperation with enabling technological functions formed the entry points of research in which the benefits and challenges are explored during the project. The narrative of the 5G-Blueprint mainly focuses on determining a blueprint for cross-border (logistic) teleoperation/remote driving based on 5G-telecommunication. The wider use and potential of the blueprint across European Member States is what can be considered the key asset and learning of the project.

ICT-53 projects

Similar to the 5G-Blueprint project, other ‘sister’-projects participate in the ICT-53 Innovation Act and did start using innovative outcomes and collaborative sessions of the project:

Project: 5G-MED – Sustainable 5G-deployment model for future mobility in the Mediterranean Cross-Border Corridor.

The EU is gearing up to integrate European road and rail transport with 5G technologies that will function seamlessly across borders, enabling connected and automated mobility (CAM). The EU-funded 5GMED project is addressing this goal along the Mediterranean core network corridor, specifically the cross-border connection between Barcelona, Spain and Perpignan, France. Scientists plan to test new technologies to deliver both cooperative connected and automated mobility (CCAM) and future railway mobile communication system (FRMCS) services. The CCAM demonstration will include remote and autonomous driving enabled by extensive sensor deployment along the roads for AI-powered traffic management. FRMCS services will include real-time analysis of high-speed trains via camera data as well as high-speed internet service to passengers. Both will integrate media services for passengers to ensure the seamless migration of functionality across borders.



Key take-aways for exploitation of project outcomes:

1. Commercial equipment not fully compliant with 3GPP Release features :
   - Most smartphones do not support testing (non-commercial) PLMN IDs.
   - Limited numbers of UEs support slicing. Those supporting it can only be active with 1 slice.
   - 5G RAN slicing is still not supported by some RAN vendors (e.g., Sunwave).
   - Handover between gNodeBs of different RAN vendors fails due to incompatibility issues.
2. Roaming mechanisms/optimizations not implemented in most 5G Cores (commercial, open-source).
   - Need to align project timeline and 5G Core manufacturers roadmap (N14 interface, LBO roaming).
3. Deployment of orchestrated (dynamic) network slicing on the RAN side is still far from being realistic.
   - Commercial RAN Equipment allows communication with an orchestrator through OSS, but it is expensive, or it is not possible due to cybersecurity issues.
   - Most O-RAN equipment that allows direct communication with orchestrators is still unstable.
4. Irregular orography in corridors requires a complex transport network (multi-hop microwave links).

Collaboration 5G-MED – 5G-Blueprint

- See section 2.2.1.1.

Project: 5G-Routes – 5th Generation connected and automated mobility cross-border EU trials.

Across Europe, 5G for the large-scale deployment of connected and automated mobility (CAM) provides the opportunity to make our mobility system safer, cleaner, more efficient and more user-friendly. The EU-funded 5G-ROUTES project will validate the latest 5G features and 3GPP specifications of CAM under real conditions. The project will perform advanced large-scale field tests of most representative CAM applications, to prove coherent performance across an important 5G cross-border corridor (Via Baltica) that will traverse Latvia, Estonia and Finland. 5G-ROUTES results will increase confidence in 5G-based CAM services and will accelerate their deployment in Europe. The project will also validate 5G as a real facilitator of advanced CAM services that current technology cannot realise.

Key take-aways for exploitation of project outcomes

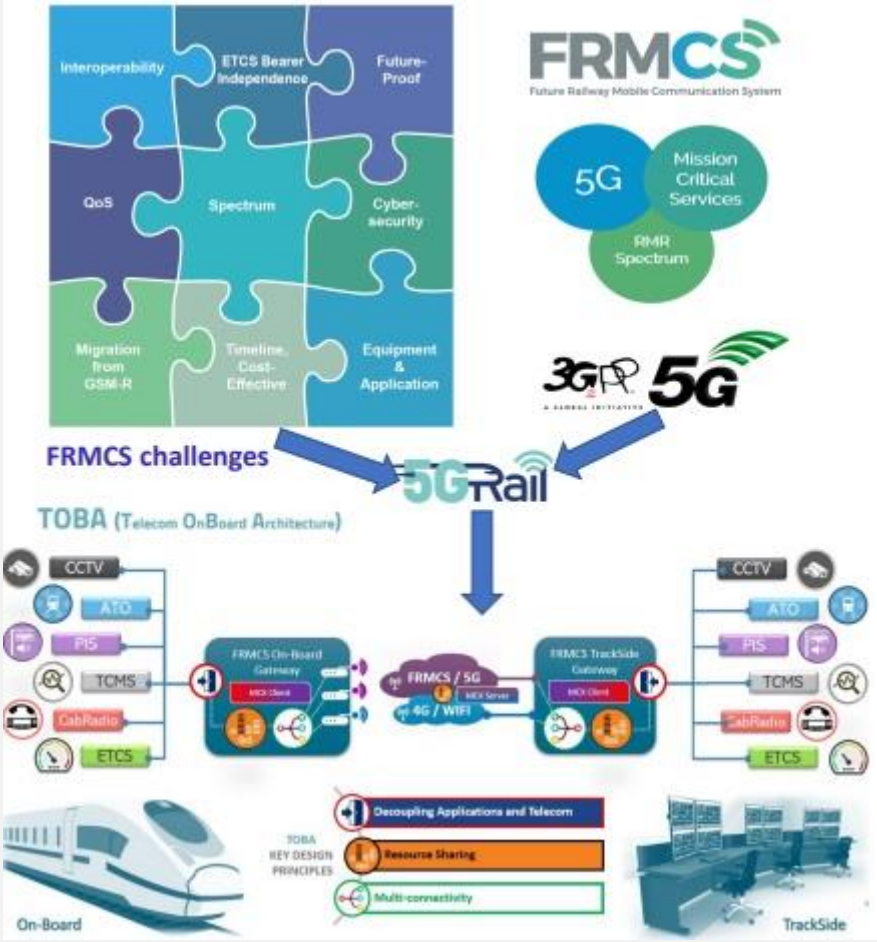
- See project website.

Collaboration 5G-Routes – 5G-Blueprint

- See section 2.2.1.1.

Project: 5GRAIL – 5G for future RAILway mobile communication system.

The 5G worldwide standard for railway operational communications will be the Future Railway Mobile Communication System (FRMCS). Within this context, the European Railway Agency should have updated the technical specifications for interoperability of control command and signalling by the end of 2022. To address this challenge, the EU-funded 5GRAIL project aims to develop and test prototypes of the FRMCS ecosystem. The project will verify the first set of FRMCS specifications and standards, and will potentially update FRMCS V1 specifications and identify technical constraints related to implementation issues.



Key take-aways for exploitation of project outcomes

- Railway Emergency Calls (in FRMCS, GSM-R, coexistence FRMCS and GSM-R and transition from FRMCS to GSM-R modes).
- Uplink Video Streaming and multiple applications over the same TOBA – Video and Voice Call simultaneously.
- This was performed via the 5GRail FRMCS network (3GPP 5G Stand Alone, Mission Critical).

Collaboration 5G-RAIL – 5G-Blueprint

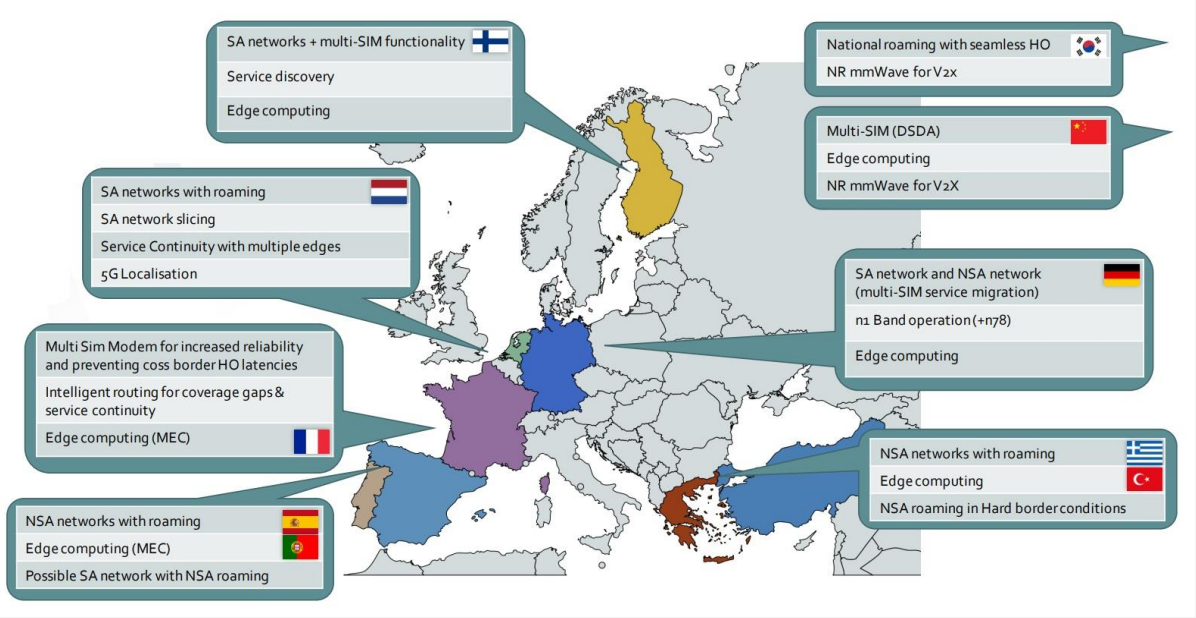
- See section 2.2.1.1.

Other collaborative projects

Next to the ICT-53 projects, in total 101 5G-projects have been launched within the ICT research and innovation AI funding scheme according to the Cordis-website. During the lifespan of the 5G-Blueprint project the consortium interacted with the following relevant projects, although some already concluded their run, [1] beside the identified ‘sister’-projects:

Project: 5G-MOBIX – 5G for cooperative and connected automated Mobility on X-border corridors.

High-speed, widely available 5G networks will be needed to support the data deluge that will arise from connected vehicles all communicating in real time. The scope of the EU-funded 5G-MOBIX project is to measure the added value of 5G connectivity for connected and automated mobility services and functionalities in cross-border conditions. The project aims to ensure that seamless connectivity is retained in cases when an autonomous vehicle crosses the border of a country and ceases to be served by its home 5G network. Trials will be conducted to assess the benefits of 5G for applications such as cooperative overtake, highway lane merging, truck platooning, remote driving and vehicle quality-of-service support.



Key take-aways for exploitation of project outcomes (combined with the key take-aways for exploitation of project outcomes 5GCroCo and 5G-CARMEN):

1. Cross-border service continuity.

Project: corridor area	Network reselection (baseline today)	RwR (no S10)	RwR (S10)	Inter-PLMN HO
5G-MOBIX: ES-PT	Highly dependent on end-device configuration, but typically resulting in tens of seconds and even a few minutes of interruption time	-	-	245 ms
5G-MOBIX: GR-TR		-	-	194 ms
5G-CARMEN: DE-AT-IT		1950 ms	-	-
5GCroCo: FR-DE-LU		6246 ms	727 ms	121 ms

2. 5G performance and improvement compared to 4G.

- Downlink spectral efficiency is more than doubled from 4.4 bit/s/Hz in 4G to 9.2 bit/s/Hz in 5G.
- The increase of uplink spectral efficiency is 45 % from 2.2 bit/s/Hz in 4G to 3.2 bit/s/Hz in 5G.

Project: corridor area	Throughput (UL+DL)	Delay (UL+DL) / RTT	Reliability (UL+DL) / Total
5G-MOBIX: ES-PT	(75 + 399) Mbps	20 ms	98-100 %
5G-MOBIX: GR-TR	(N/A + 525) Mbps	16.3 ms	99.9%
5G-CARMEN: DE-AT-IT	(57 + 349) Mbps	32 ms	98 %
5GCroCo: FR-DE-LU	(30 + 900) Mbps	8.7 ms	97-100 %

3. MEC in cross-border
4. Deployment

- The most suitable 5G network deployment to provide CAM services along corridors sections would be to start with low-band spectrum (e.g., 700 MHz band) for quickly achieving wide-area coverage, by leveraging primarily existing tower and roof-top sites. These sites can be upgraded to include a capacity layer based on the mid-band spectrum such as, e.g., the 3.x GHz band or other legacy bands. Extrapolating for areas around the corridors, a significant number of new sites will be required to deploy such a capacity layer – as 5G for CAM and non-related eMBB traffic will grow.
- While 5G communication infrastructures are the first and foremost foundation of enabling 5G for CAM, the low-latency computing element must not be neglected, especially for more advanced 5G for CAM services. Here, the deployment of regional MEC data centres in reasonable (no more than a few hundred kilometres, same country) proximity to the 5G RAN “network edge” will become pivotal for completing the enabler infrastructure elements required for 5G for CAM services. As a start, regional MEC deployments like one per region within the respective corridor sections of the involved countries have been suggested. These can scale by deploying more computing power per MEC site or by deploying more distributed MEC infrastructures in subregions – and the combination of both.
- Key cost drivers were concluded to depend on geographic location and topology, the existing RAN infrastructure and planned 5G roll-out of the mobile operators along the corridors.

5. Roadmap

- 5G can support, already today, about 80 % of connected/automated driving services (including all day-1 services) as their requirements are in line with commercially available performance.
- If there is at least a 5G-NSA deployment, deployment projects should implement inter-PLMN handovers. If this is not possible, a minimum Release with Redirect

using the S10 interface should be implemented. These features are available within 5G-NSA deployments.

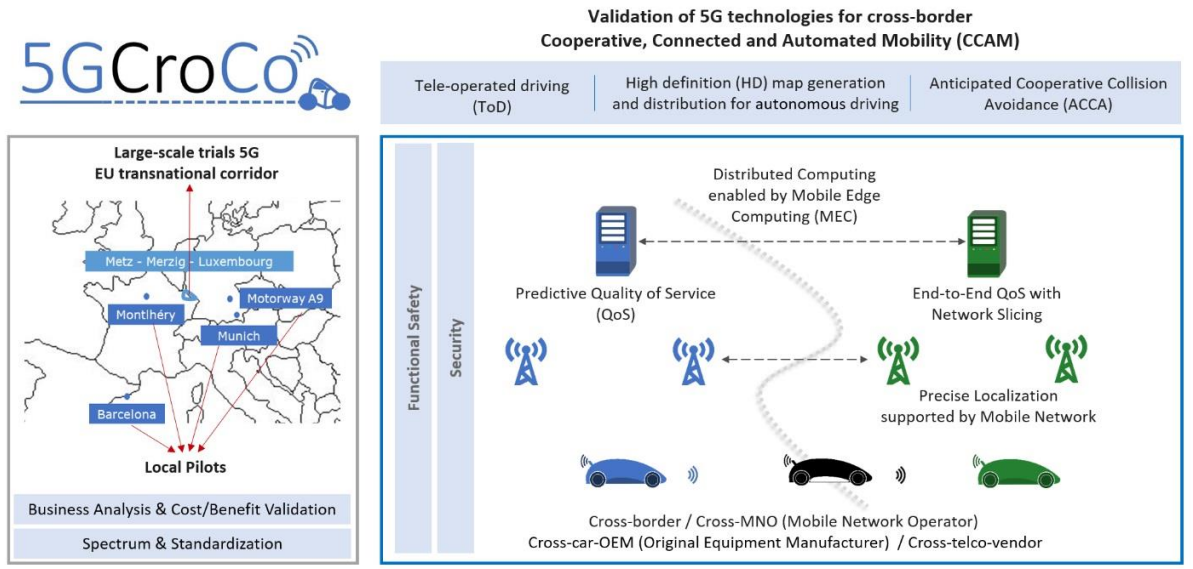
- If coverage is key for a specific corridor, the focus should be on creating seamless connectivity.
- If capacity is key for a specific corridor, the focus should be on QoS mechanisms for service differentiation.
- For ‘local’ cross-border use-cases and very specific deployment scenarios, targeted deployments together with the MNOs should have the focus.
- Link aggregation and/or multi-sim/multi-modem solutions provide both the needed use-case specific QoS and seamless cross-border service handover needed earlier than through waiting for full deployment, to expedite service deployment. Trials in 5G-MOBIX demonstrated the clear advantage of link aggregation solutions, over link selection ones, in the presence of dual connectivity i.e., dual-modem. On the other hand, NTN solutions proved unable to support CAM use case specific QoS in limited trials conducted in 5G-MOBIX.
- In addition to the immediate benefits that 5G will bring, the potential for 5G to further evolve is also a significant lesson learned from the work carried out in the three ICT-18 projects, with 5G SA being the relevant basis upon which performance will be built upon.
- Furthermore, 5G SA supports Session and Service Continuity (SSC) mode 3, which enables seamless Local Breakout Routed Roaming necessary for re-anchoring: once a seamless Inter-PLMN handover has been executed, all traffic is efficiently routed through the visited network.
- Finally, 5G SA adds Network Slicing as another option to achieve QoS service differentiation.

Collaboration 5G-MOBIX – 5G-Blueprint

- See section 2.2.1.1.

Project: 5GCroCo – Fifth Generation Cross-Border Control.

The possibility of providing connected, cooperative and autonomous mobility (CCAM) services along different countries when vehicles traverse various national borders has a huge innovative business potential. However, the seamless provision of connectivity and the uninterrupted delivery of services along borders also poses interesting technical challenges. The situation is particularly challenging given the multi-country, multi-operator, multi-telco-vendor, and multi-vehicle-OEM scenario of any cross-border layout. Motivated by this, 5GCroCo brings together a strong consortium from both European automotive and mobile communications industries, with the explicit support of road traffic authorities and the respective national governments (through letters of support), to develop innovation at the intersection of these two industrial sectors. The aim is to define a successful path towards the provision of CCAM services along cross-border scenarios and reduce the uncertainties of a real 5G cross-border deployment. 5GCroCo aims at trialling 5G technologies in the cross-border corridor connecting the cities of Metz-Merzig-Luxembourg, traversing the borders between France, Germany and Luxembourg. The objective is to validate advanced 5G features, such as New Radio, MEC-enabled distributed computing, Predictive QoS, Network Slicing, and improved positioning systems, all combined together, to enable innovative use cases for CCAM. 5GCroCo aims at defining new business models that can be built on top of this unprecedented connectivity and service provisioning capacity, also ensuring that relevant standardisation bodies from the two involved industries are impacted. 5GCroCo validation will focus on three use cases: 1) tele-operated driving, 2) high definition maps for autonomous vehicles, and 3) Anticipated Cooperative Collision Avoidance (ACCA) and will also provide general recommendations for any other use cases.



Collaboration 5GCroCo – 5G-Blueprint

- See section 2.2.1.1.

Project: 5G-CARMEN – 5G for Connected and Automated Road Mobility in the European UnioN.

Road vehicles are destined to become more connected and automated thanks to technological advances in the field of transportation. But keeping motorists safe remains the top priority. This means successful vehicle manoeuvre negotiations are needed on several automation levels. In this context, the EU-funded 5G-CARMEN project provides a cooperative, connected and automated mobility (CCAM) platform leveraging the most recent 5G advances and enabling vehicles to exchange speed, position, intended trajectories and manoeuvres by exploring distributed and centralised approaches for cooperative lane merging. Extensive cross-border trials will be undertaken across the corridor from Bologna to Munich, connecting the European regions of Bavaria, Tirol and Trentino/South-Tyrol. 5G-CARMEN will maximise commercial, societal and environmental impact by delivering safer, greener and intelligent transportation.

Collaboration 5G-CARMEN – 5G-Blueprint

- See section 2.2.1.1.
- Leveraging the outcome of 5G-CARMEN served as a jumping-off basis for the work on 5G-Blueprint.

Project: 5G-LOGINNOV – 5G creating opportunities for LOGistics supply chain INNOVation.

The emergence of 5G technology has increased efficiency in many sectors including city ports, resulting in business innovation, economic development and environmental benefits. The EU-funded 5G-LOGINNOV project will design an innovative scheme to integrate and validate CAD/CAM technologies related to the industry 4.0 and port domains, by creating new opportunities for logistics value chain innovation. The innovation is supported by 5G technological blocks, including a new generation of 5G terminals, new types of Internet of Things 5G instruments, data analytics, next-generation traffic management and emerging 5G networks allowing ports to manage upcoming and future capacity, traffic, efficiency and environmental challenges. The advanced capabilities of 5G in wireless connectivity and Core network agility will allow city ports to significantly optimise operations and reduce environmental impact on the city.

Key take-aways for exploitation of project outcomes

At the level of Hamburg Living Lab, the results identified as relevant are mainly linked to the foreseen use cases implementations during the project, which imply a joint effort by several actors in terms of development.

- 5G enabled Floating Truck Emission Data (FTED).
- 5G enabled GLOSA.
- 5G enabled Collision Warning.
- 5G enabled Carbon Emission Trading.

In the case of Koper, the common result of all contributing partners is know-how gain on putting building technological blocks together to bring up an added value service for the port. In terms of technological results, it has been agreed to address their exploitation strategy at the individual partners' level, due to the fact that their development is clearly linked to a specific partner.

- Supporting security and logistics processes in port environments based on 5G, IoT and related technologies.
- Establishing local partnerships in logistics domains.

In Athens, key exploitable results correspond mainly to expertise (know-how) gain in 5G, IoT and relevant ecosystem technologies; development of services tailored to port operations; and collaborations and network of partnerships built for further collaborations and opportunities (which have also been discussed to define partners' individual plans).

- 5G IoT Platform in Port Operations.
- Logistics Service: Container Seal Detection.
- Security/Safety Service: Human Presence Detection.
- 5G Truck Fleet Management Platform.

Collaboration 5G-LOGINNOV – 5G-Blueprint

- See section 2.2.2.

Project: 5G-VITAL

The VITAL-5G project has the vision to advance the offered transport & logistics (T&L) services by engaging significant logistics stakeholders (Sea and River port authorities, road logistics operators, warehouse/hub logistic operators, etc.) as well as innovative SMEs and offering them an open and secure virtualized 5G environment to test, validate and verify their T&L related cutting-edge Network Applications (NetApps). The combination of advanced 5G testbeds (offered through participating MNOs / vendors) with vertical specialised facilities and infrastructure (offered by participating key logistics stakeholders) through an open service validation platform (repurposed and created by the project) will create a unique opportunity for third parties such as SMEs to validate their T&L related solutions and services utilising real-life resources and facilities, otherwise unavailable to them. The platform will provide to 3rd party experimenters, the necessary testing and validation tools, offering them a trusted and secure service execution environment under realistic conditions that supports multi-tenancy. Such an elaborate validation mechanism will allow for the further refinement and fine-tuning of the provided services fostering the creation of new services and the evolution of existing ones, while boosting the SME presence in the emerging 5G-driven logistics ecosystem.

The VITAL-5G project plans to showcase the added-value of 5G connectivity for the European T&L sector by adopting a multi-modal approach containing major logistics hubs for freight and passengers (sea ports, river ports, warehouse / logistics hubs, highways, etc.) as well as the respective stakeholders (road operators, port authorities, 3rd party logistics (3PL) operators), thus creating an end-to-end chain of connected T&L services accommodating the entire continent.

Collaboration 5G-VITAL – 5G-Blueprint

- See section 2.2.2

Project: FOR-FREIGHT
As anticipated in Section 2.2.2, 5G-Blueprint - and other CAM EU-funded initiatives relating to logistics and transport – teamed up with FOR-FREIGHT project for the joint paper “Enabling innovation in Transport and Logistics operations: a 5G approach”, submitted to EuCNC 2023. FOR-FREIGHT led such action, which also resulted in a matching session at the event, which featured a roundtable on the subjects covered by the publication. The content concerning 5G-Blueprint was authored by imec, and it tackled main achievements from testing campaigns in WP7, reflecting on the main results and lessons learned obtained during the Minimum Viable Platform (MVP) phase. The paper is readily available for download in the dedicated section of the project website.
Collaboration FOR-FREIGHT – 5G-Blueprint • See section 2.2.2

In accordance with the innovative, blueprint and investigative nature of the project, a more generic, broad perspective on the European exploitation of project outcomes is desired to reduce double costs on inventing the wheel in numerous places and learn from the current state-of-the-art technologies for reaching societal and commercial benefits. It is at the utmost importance that governments, private companies and knowledge institutions working on 5G, teleoperation and/or logistics should directly be guided towards the examined necessities for instance in terms of network requirements, deployment scenarios and rules and legislation. The preferable situation would be that the developed knowledge will not become lost or obscured. Therefore, it is crucial to pinpoint the project outcomes in a series of relevant transitions where the results form an ingredient in relation to other objectives that are interlinked and can stimulate the adoption of (parts of) the blueprint.

The telecommunication landscape with 5G

From the start was the promise of telecommunication through 5G that, compared to 4G and predecessors, ultra-low-latency communication, stable connectivity and wireless broadband services provided at gigabits speed can be achieved including the goal to secure network drop-off within milliseconds without users knowing that a network drop-off has taken place and enabling innovative cross-sectoral connections between devices and objects. The project specifically contributes to the understanding of what technical capabilities are necessary for this new situation as a result of the experimentation with logistic use cases and enabling functions for efficiency and safety purposes based on teleoperation via 5G in a cross-border setting. One of the key learnings has been that the practical configuration of 5G technology contains a lot of extra work. Moreover, the higher 3.5GHz frequency bandwidths are vulnerable for signal distribution from physical objects such as buildings and ships. Further rollout of 5G on these bandwidths requires therefore probably a further expansion of radio-infrastructure which, in turn, contributes to additional upfront costs. In line with this learning, another interesting insight has been that telcos jointly have decided to use a specific 5G configuration which only allows that 20% of the total capacity can be used for uplink from the vehicle to the internet. In teleoperation 4 to 6 full HD cameras are used for teleoperation which makes the previous sentence an unlucky choice. On the basis of these insights the general expectation is that the further rollout of the necessary 5G-capacity for large teleoperation deployments will become a gradual and time-intensive process.

The broader perspective is that the combination of innovation and research in the 5G-landscape adds up to the EU policy goal of a coordinated approach on 5G-network rollout throughout European Member States instead of solitary national approaches. The recent issue in for instance the Netherlands has been that the postponed auction for the 3GHz-broadband stagnates the upscaling of 5G-services for various services and organisations. While not in the scope of the project, concerns have been raised In Belgium and the Netherlands about potential health care issues because of electromagnetic fields. Respectively, the Department Leefmilieu of the Flemish Ministry and the Dutch Ministry of Economic Affairs are taking this into consideration.

One of the key elements of the 5G Action Plan was to promote pan-European multi-stakeholder trials as catalysts to turn technological innovation into full business solutions. In fact, the 5G-blueprint project is filling in the action of the European promotion of preliminary trials and key technological experiments, under the 5G-PPP arrangement, to take place from 2017 onwards, and pre-commercial trials with a clear EU cross-border dimension from 2018. Next to this action point, other activities focus on adopting 5G policy plans in all European Member States, spectrum bands, global standardisation, industry-led funding and early deployments. Special attention is put into encouraging Member States to consider using the future 5G infrastructure to improve the performance of communications services used for public safety and security, including shared approaches in view of the future procurement of advanced broadband public protection and disaster relief systems. Member States are encouraged to include this consideration in their national 5G roadmaps.

On the road to Connected Automated Mobility

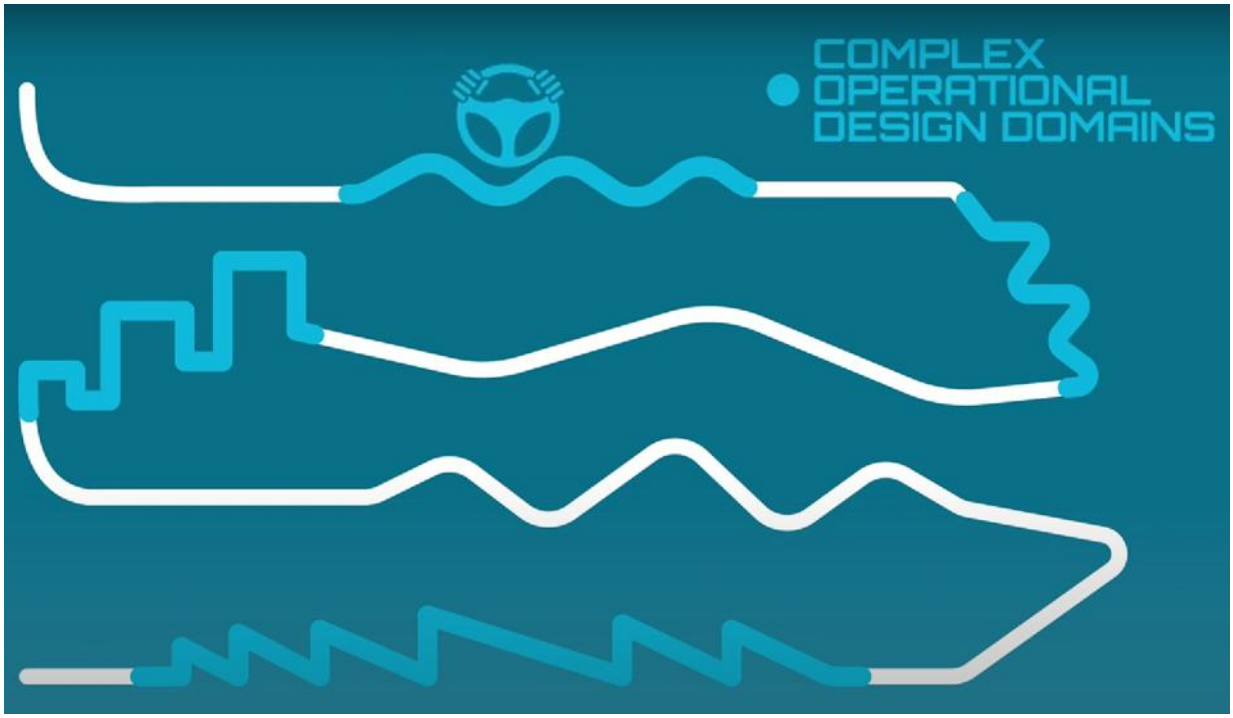
In the summer of 1995, Dean Pomerleau and Todd Jochem of Carnegie Mellon University's Robotics Institute took a 2850 miles journey across the United States in a minivan. The minivan drove autonomously for 98,2% of the trip. Since then, the entire autonomous mobility sector has been at work to cover the remaining ~2%. The main challenge is guaranteeing safety in traffic situations where one or more unusual operating circumstances may take place. And, those proved to be hard and expensive to identify, test and optimise.

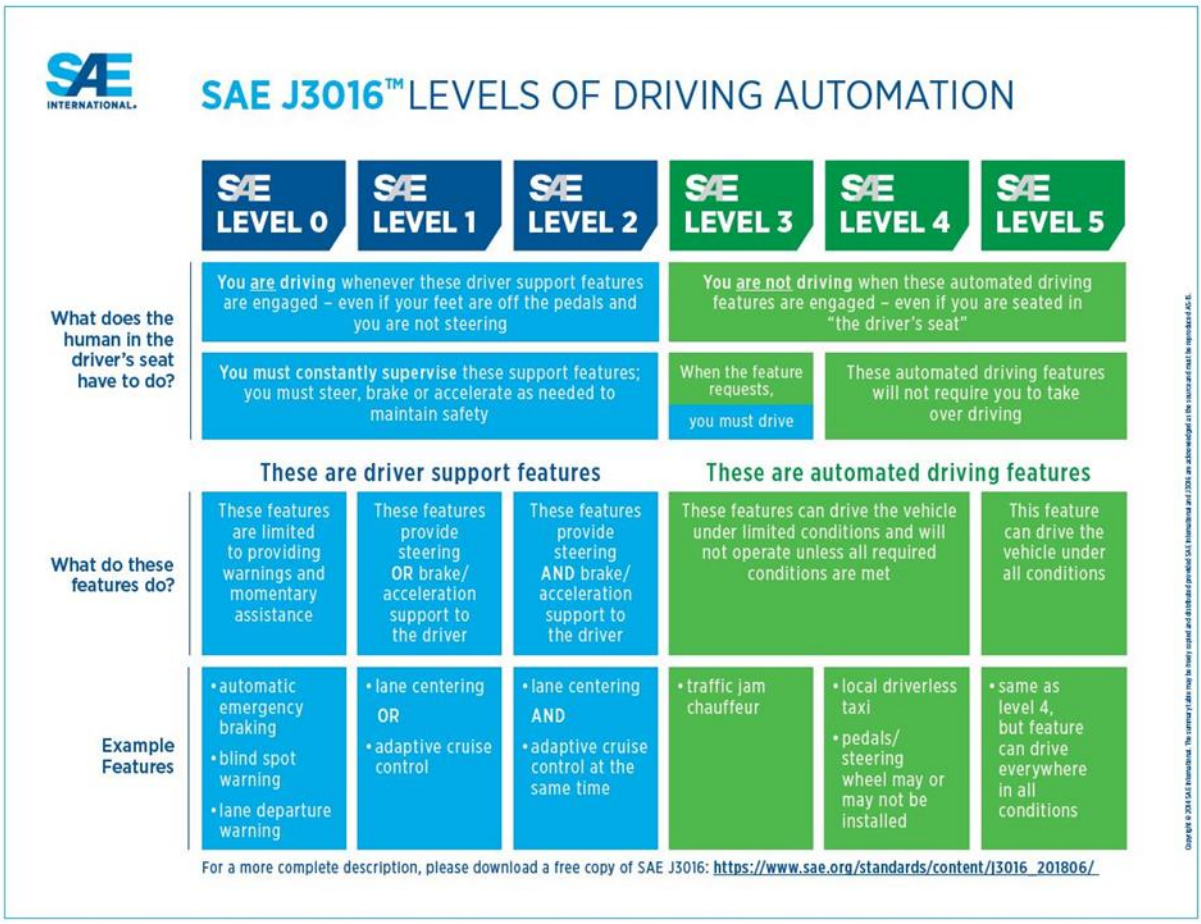
The global and European industry continued to develop modalities with more advanced functionalities. One of the central considerations has been that a vehicle on its own cannot be the only source of information that creates awareness of the surrounding static and dynamic environment so the vehicle is able and allowed to move. The connection between vehicles and with the surrounding environment is of similar importance. In places where multiple smart technologies are interconnected it can be that an advanced vehicle is able to move for example more autonomously because it is more aware of its environment. The opposite is also true that an environment with less complex traffic situations and users can be more easily fixed for using smarter vehicles. This is where the 5G-blueprint project comes in and provides valuable insights to solve this problem in the mobility transition towards Connected Automated Mobility. By adopting teleoperation: part of all tasks in the act of driving a vehicle or sailing a vessel are performed by a remote operator, usually over wireless communications. 5G-Blueprint is focussing specifically on direct control teleoperation, where humans perform the actual dynamic driving tasks. Direct control teleoperation, not being a subset of driving automation, has been overlooked, so far, in the quest to bring autonomous vehicles to roads and waterways. In this project it was considered as the missing piece of the puzzle for real-life deployment with direct control teleoperation and automation complementing each other (figure x). As the following paraphrases will outline, the main outcomes are:

- On the short-term small-scale commercial deployment of teleoperation scenario's is possible in a legal system of road authorities accepting examptions.
- In the long-term will type-approval be necessary for realising large scale deployment of teleoperation.

- Simultaneously, a permit system for providers of teleoperated services is seen a necessary to ascertain potential liability issues.

Direct control teleoperation can allow splitting up L4 (figure X and X) vehicle trajectories in different segments with different operational domains and assign each of them to either automated driving or remote driving depending on how difficult they are to automate. The idea is in line with what Pomerleau and Jochem did in 1995: rely on human drivers to navigate that challenging 2% of the route. But, by using 5G, those drivers don't need to be physically present in the vehicle anymore and could remotely jump in and out of different vehicles to take-over when needed, which also reduces personnel costs. As such, TO can help 'getting to' the areas where Automated Driving (already) is realistic and feasible without having the driver inside the vehicle - which implies both a reduction of costs (and better allocation of existing - scarce- resources) and a better work/ life balance for the driver, still needed for reaching the ODD where the driver isn't needed anymore during the 'automated drive/ navigation' and could 'abstain' from the driving task.





The above positioning of the 5G-Blueprint project can be difficult to understand, but the ambition and results show that the project is effectively proposing a solution bridging the gap between SAE level 4 and SAE level 5. Complementary to the SAE taxonomy are the 5GAA drafted definitions of different types of teleoperation below. As mentioned before, the full focus of the project has been to carry out research for the purpose of scrutinising direct control Teleoperated Driving. On the basis of these results the defined roadmap of 5GAA can be foreseen with more deepened information including expected timelines.

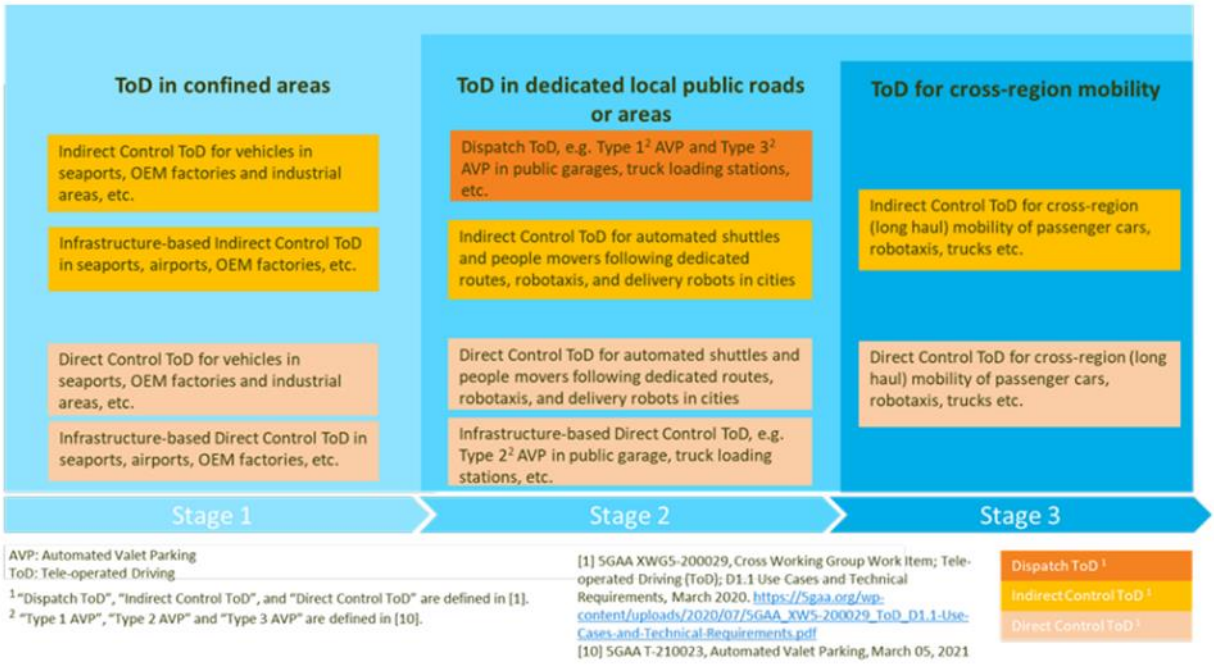
- Non-ToD: The ToD operator is not engaged in the act of driving, i.e. taking no role in the act of driving. All three of the above levels of driving operations are performed by an in-vehicle user or system.

- Dispatch ToD: The ToD operator takes the role of the Dispatcher, which only performs the Strategic-level Operations of driving, while the Tactical and Real-time DDT are performed by the in-vehicle user or system. For driving automation systems, this type of ToD corresponds to the Dispatch Function in driverless operation.

- Indirect Control ToD: The ToD operator takes the role of the Indirect Controller (Remote Assistant) to perform the Tactical-level Operations, which corresponds to the Remote Assistance function for driving automation systems. If needed, the Indirect Controller may also perform Strategic-level Operations. In Indirect Control ToD, the Real-time Dynamic Driving Tasks are performed by an in-vehicle user or system.

- Direct Control ToD: The ToD operator takes the role of the Direct Controller (Remote Driver), to perform all or part of the Real-Time DDT. If needed, the Direct Controller may also perform the Tactical and Strategic-level Operations of driving.

ToD Type (Role of ToD operator[5])	Act of Driving		
	Strategic Functions (Travel planning, route and itinerary selection)	Tactical Functions (Pathway planning in difficult situations[6])	Real-time Operational and Real-Time Tactical Functions (Real-Time Dynamic Driving Task)
Non-ToD (No Role)	In-vehicle user or system	In-vehicle user or system	In-vehicle user or system
Dispatch ToD (Dispatcher)	ToD operator	In-vehicle user or system	In-vehicle user or system
Indirect Control ToD (Indirect Controller or Remote Assistant)	ToD operator (if needed[2])	ToD operator	In-vehicle user or system
Direct Control ToD (Direct Controller or Remote Driver)	ToD operator (if needed[4])	ToD operator (if needed[4])	ToD operator (all or part of DDT[3])



From a policy point of view, the current European vision of smart and sustainable mobility is offering promising perspectives for dealing with chicken-egg problems in kickstarting investments and adopting rules and legislation. The Digital Agenda for Europe encouraged the development and upscaling of new digital products and services. By signing the 'Declaration of Amsterdam' in 2016 the Member States of the EU proactively stated to strive for European harmonisation on goals and actions within the field of connected and automated mobility via an European integral approach on this topic. A complex puzzle of differing rules and legislation next to non-compatibility in digital mobility services across EU Member States should then be prevented. In line with these goals the presented taxonomies on categorising levels of automated systems for mobility and teleoperated driving are developed.

During the early stages of the 5G-Blueprint project, the EU published its 'Sustainable and Smart Mobility Strategy – Putting European Transport on track for the future' in addition to the European Green Deal ambitions and earlier policy agendas on mobility, digitalisation and economics. The visions consists of nine guiding principles:

1. Mobility and transport matters to us all.
2. Mobility brings many benefits for its users, it is not without costs for our society.
3. The most serious challenge facing the transport sector is to significantly reduce its emissions and become more sustainable.
4. A coordinated European approach to connectivity and transport activity are essential to overcome any crisis.
5. Ensuring that our transport system is truly resilient against future crises must also be a key objective of the EU's transport policy.
6. Greening mobility must be the new licence for the transport sector to grow.
7. Digitalisation will become an indispensable driver for the modernisation of the entire system.
8. It is crucial that mobility is available and affordable for all, that rural and remote regions are better connected, accessible for persons with reduced mobility and persons with disabilities, and that the sector offers good social conditions, reskilling opportunities, and provides attractive jobs.
9. Overall, we must shift the existing paradigm of incremental change to fundamental transformation.

In the hindsight of principle 9 the combination of technological, commercial and legal outcomes of the project reveal transformation for connected automated mobility is more likely to be one of incremental change rather than fundamental. On the other hand, one key outcome is that on the road to autonomous vehicles a mobility system occurs where conventional, teleoperated and automated vehicles are all together part of the rural-urban mobility system whilst stimulating external spatial developments such as hub exploitation for a teleoperation service provider or features for shared mobility providers. Figure X adds to this notion that confined areas (seaports, airports, OEM factories) are seen as the first deployment scenarios towards deployment on public infrastructure. 5GAA foresees:

- Automated shuttles, buses, and other vehicles primarily for transporting people and for last-mile mobility services whose operation follow predetermined routes on public roads.
- Infrastructure-based automated valet parking services for automated passenger vehicles in public garages or for logistic trucks in automated truck loading stations.
- Robotaxis and delivery robots operating in dedicated districts of a city.

In an exaggerated and far-fetched breath this may imply that cities and regions will change the way in how they design and distribute infrastructure and (shared) mobility systems in the long-term based on foreseeable technological enablers and policy thinking as a result of the 5G-Blueprint project. Currently the Dutch Ministry of Infrastructure and Water Management is working in a ADS Taskforce with the RDW, RWS, CBR, Ministry of Justice and Safety and police with the goal to guide the anticipated major system changes and implications. Nevertheless, the cornerstone of this project has been to set the blueprint for upscaling 5G teleoperated logistic services. One of the key guiding principles of the vision with relevance for 5G-Blueprint is the positioning of digitalisation as an indispensable driver for the modernisation of the entire mobility system so levels of safety, security, liability and comfort become enhanced, the EU remains leader in transport equipment manufacturing and services and the EU's global competitiveness will be improved as result of efficient and resilient logistics chains. The set goal is to deploy automated mobility at large scale by 2030. The mobility strategy contains two agenda's, so-called flagships, with actions that directly adhere to the realisation of the goal by 2030. In terms of clarification and illustration of the meaning of a flagship, two flagships and relevant connected actions are mentioned below:

Flagship 6 'Making connected and automated multimodal mobility a reality'

- **The EU needs to take full advantage of smart digital solutions and intelligent transport systems (ITS).**
- Europe must seize the opportunities presented by **connected, cooperative, and automated mobility (CCAM).**
- The Commission will explore options **to further support safe, smart and sustainable road transport operations** under an existing agency or another body. This body could support the deployment and management of ITS and sustainable connected and automated mobility across Europe.
- **Planning and purchasing tickets for multimodal journeys** is cumbersome, as a conducive framework for EU-wide, integrated, multimodal information, ticketing and payment services is lacking.

Flagship 7 'Innovation, data and Artificial Intelligence for Smart Mobility

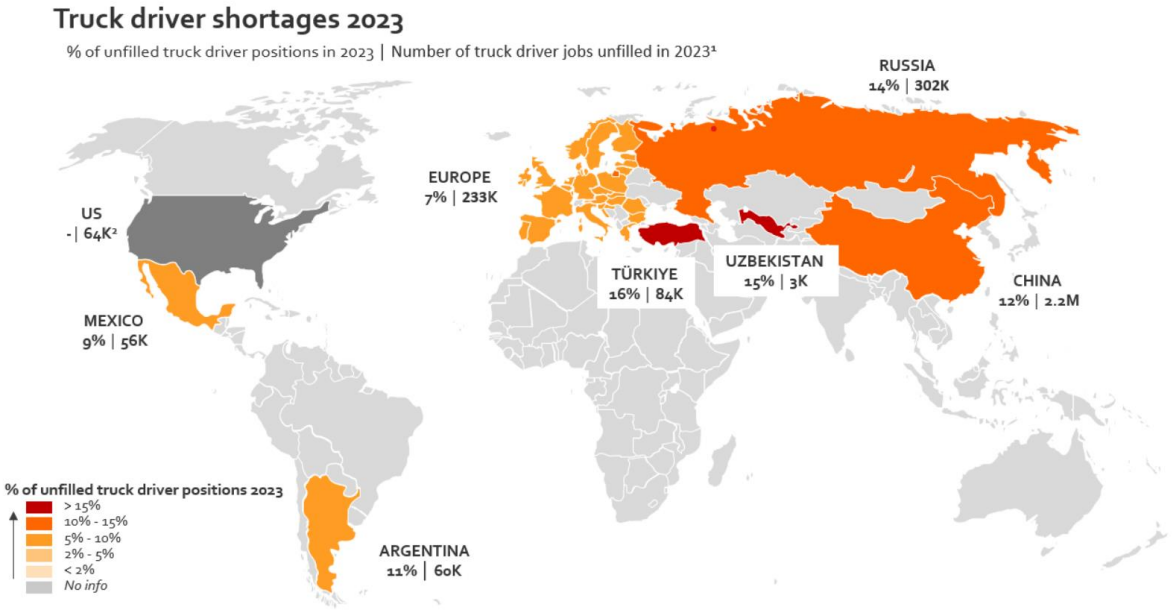
- **Proactively shaping our future mobility by developing and validating new technologies and services is key to staying ahead of the curve**.
- The Commission will **drive the research and deployment of innovative and sustainable technologies in transport**. Investment in disruptive solutions will pave the way for important breakthroughs and environmental gains in the years and decades to come. Today's EU research programmes will be crucial for tomorrow's deployment, through instruments like the Connecting Europe Facility (CEF), the Cohesion Fund, the European Regional Development Fund or InvestEU.
- Furthermore, in order to make the digital transformation of the transport sector a reality, **the EU needs to ensure that the key digital enablers are in place**, including electronic components for mobility, network infrastructure, cloud-to-edge resources, data technologies and governance as well as Artificial Intelligence. The EU should further strengthen its industrial capacities related to the digital supply chain. This includes the design and production of components, software platforms and the Internet of Things technology for a further electrification and automation in transport and mobility.
- The EU also needs to ensure the **highest level and performance of digital infrastructure**, notably through **5G**, which offers a wide range of services and helps to reach higher levels of automation across different mobility applications. In addition, further efforts are needed to achieve the objective of uninterrupted coverage across the major transport corridors across Europe with 5G connectivity infrastructure, as set out in the 2016 5G Action Plan. Having a digital single market that functions well is key.

In total, 111 actions have been formulated to realise the policy goals of the Sustainable & Smart Mobility Strategy. The two out of ten flagships above are the ones that are closely related to the research done in the 5G-Blueprint project. Not only has the project contributed to the practical implementation of policy ambitions and actions, it provides new information for a better understanding of what achievements need to be made in order to reach a goal.

Sustainable Logistic Supply Chains

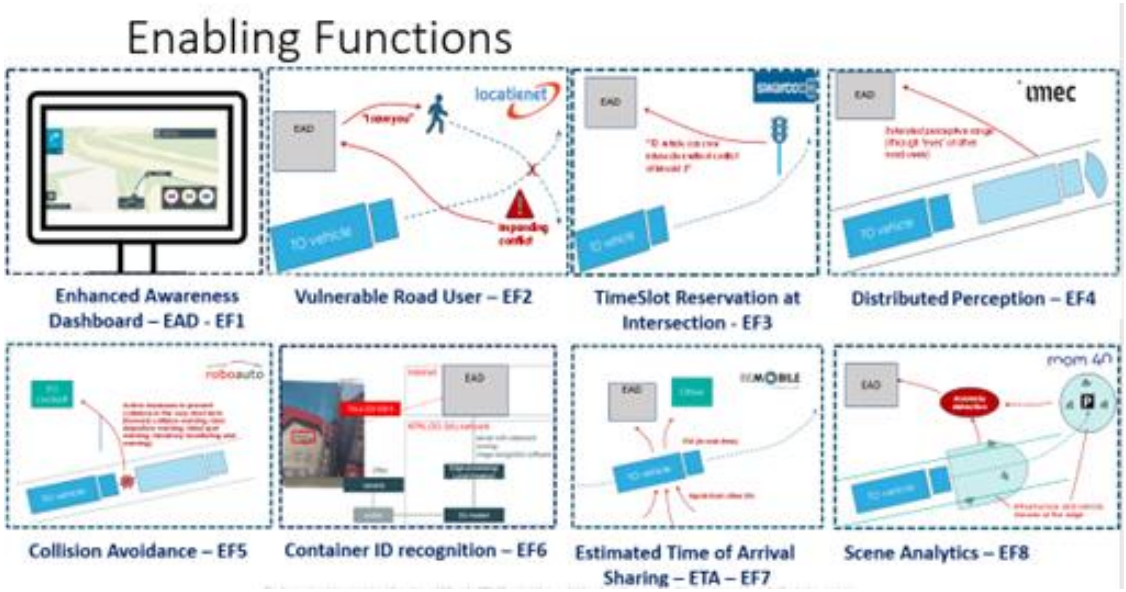
From a logistical perspective multiple overall goals of the Sustainable and Smart Mobility Strategy are directly affecting (parts) of the logistical supply chain. By 2030 100 European Cities will be Climate-Neutral, high-speed rail traffic will double, zero-emission vessels will become ready for market. By 2050 nearly all nearly all cars, vans, buses as well as new heavy-duty vehicles will be zero-emission, rail freight traffic will double, high-speed rail traffic will triple and the multimodal Trans-European Transport Network (TEN-T) equipped for sustainable and smart transport with high speed connectivity will be operational. On a European scale, the policy goal is to make the (former) 328 TEN-T ports sustainable, attractive and competitive for long-term prosperity including better living standards for European Citizens. The focus of activities is put on (1) establishing a clear European legislative environment to guarantee equal conditions for competition and legal certainty, (2) promoting an effective social dialogue between the employers and employees of the port communities, in particular dockworkers and (3) making full use of the new TEN-T Guidelines and the Connecting Europe Facility to attract investors, connect ports to the rail, inland waterways and road network and to enhance their role as an integral logistic element within the corridors.

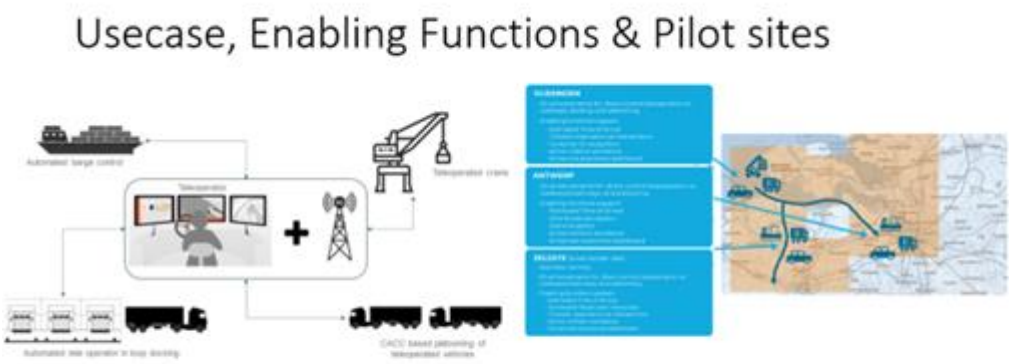
According to the European Port Policy of 2013, this directly affects the operations related to the present 74% of goods that are imported and exported and 37% of goods exchanges within the EU through seaports. For some trades in traditional ports, costs of ports and terminal operations may exceed 30% of the total door-to-door logistic costs. In terms of internal reparation of costs, port infrastructure charges represent between 5-10%, technical nautical services between 10-15%, cargo-handling between 45-60% and other charges and ancillary services between 10-30% of the costs. Additionally, the 233.000 truck driver shortage (figure x) and shortage of freight handlers (Eurostat, 2023) are forcing logistic service providers to examine new and innovative solutions to cope with the supplies and demands of, respectively, sellers and buyers (figure x). Those parties are in fact obliged to smarten their present-day operations if they are able and willing to comply with policy objectives and keep on running and improving their day-to-day operations. In other words, the logistic sector can be helped with instruments towards becoming more sustainable in an ecological, social and economic way. Research from the Organisation for Economic Co-operation and Development shows that the implementation of new technologies, such as teleoperation, can even attract new employees.



In an effort to match the ambitions with possibilities and practicalities, the 5G-Blueprint project has taken an ecosystem-based approach with relevant partners working in different parts of the logistic supply chain. Otherwise, it has not been possible to do deliberated research on the potential of 5G teleoperated logistics in the wider spectrum of connected automated mobility and labour market potential on the European and global scale-level. A long-term perspective is that logistics service providers are able to transport goods more efficiently during the night with the help of teleoperation since roads can be utilised more effectively. At the start, it is likely that the transport of containers and full-load trucks do not cause severe (liability) issues for employees. More specifically is the project's feature of practical testing and validating use cases and enabling functions providing insights in potential added value and challenges for economics, governance, technology and rules and legislation. Figure X shows the researched use cases that assist in smartening port environments and transport corridors. Each of the use cases contain an element of optimisation and efficiency of current workflows.

In addition to performing logistical tasks, safety requirements are important for the safety of people during operations and the insurance and tracking of goods in port environments and on transport corridors. In consideration of this more soft part of enabling logistic operations to run more safely and sustainable, eight enabling functions are examined during this product with the question how 5G can support them. The figure above shows on which locations the specific functions have been tested.





Together do the use cases and enabling functions in line with the other trends in telecommunication and connected automated mobility reveal the need for symbiosis between sectors and parties to work together. Minor adjustments in logistic operations can illustrate and convince the pathway to major results regarding reducing CO2-emissions, the well-being of workers and saved expenses. When done in a harmonised manner on a European level, the lessons-learned from the 5G-Blueprint project can contribute to more prosperity across Europe.