Deliverable D7.3

Dissemination, communication and exploitation activity report

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5GRAIL

5G for future RAILway mobile communication system

D7.3 - Dissemination, communication and exploitation activity report

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Executive Summary

The aim of this document is to provide a report summarising the dissemination, communication and exploitation activities that took place during the lifetime of 5GRAIL (5G for future RAILway mobile communication system). The report provides detailed information on the materials and strategies that have been used to facilitate the widespread of information and knowledge of the results created by the project partners. The dissemination of 5GRAIL was essential throughout the duration of the project, and for this reason it needed to be carried out with the cooperation of all Work Packages.

In this respect, the details for communicating and disseminating 5GRAIL to the target audiences and the general public, as described in the communication, dissemination and exploitation plan for the project (D7.1 - CDEP), are presented in this report. Those include: the creation of a project identity; the creation of a public website; the creation of a project brochure; the production of two newsletters; the organisation of dissemination events; the participation to conferences and the publication of results in relevant journals/conferences.

The elements related to the exploitation of results from the 5GRAIL partners are also detailed in this report, together with an analysis of the standardisation and regulatory environment, showcasing the work that has been undertaken in collaboration with the relevant standardisation bodies.

An Advisory Board (AB) was also be created, in order to inform the relevant categories of stakeholders concerned, and to ensure their advice and support throughout the life of the project. A summary of the AB activities is also included in this report.

Abbreviations and Acronyms

Abbreviation	Description
3GPP	3rd Generation Partnership Project
AB	Advisory Board
ATO	Automatic Train Operation
CAM	Connected and Automated Mobility
CCRCC	Control Command and Railway Communication Conference
CCS	Control Command and Signalling
CDEP	Communication, dissemination and exploitation plan
ERA	European Union Agency for Railways
ETCS	European Train Control System
ETSI	European Telecommunications Standards Institute
EU	European Union
EU-RAIL	Europe's Rail Joint Undertaking
FRMCS	Future Railway Mobile Communication System
GA	Grant Agreement
H2020	Horizon 2020 framework programme
IEEE	Institute of Electrical and Electronics Engineers
IM	Infrastructure Manager
PPP	Public-Private Partnership
RU	Railway Undertaking
TCMS	Train Control and Monitoring System
TOBA	Telecom On-Board Architecture
TRA	Transport Research Arena
TSI	Technical Specification for Interoperability
UNISIG	Union Industry of Signalling
UNITEL	UNIFE Telecommunications Committee
WP	Work Package

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1 INTRODUCTION

The 5GRAIL communication and dissemination strategy has been designed to provide the most extensive coverage, meeting the limitation of the scale of the project and ensuring an efficient and coordinated take-up by the European Commission with their future R&D activities, notably through Europe's Rail Joint Undertaking (EU-Rail JU).

With the support of all the project partners, a wide dissemination of project results was ensured through several means, like the creation of the public website which was kept up to date with relevant content and information, along with the publication of the project brochure and project newsletters. Furthermore, the project was disseminated through the publication of papers or through articles in magazines/journals, as well as attendance and presentations in specific events (conferences, workshops etc.), but also promoted through social media.

All the above-mentioned elements, together with aspects related to exploitation and standardisation activities are described in more detail throughout this document. Section 2 gives an overview of all the communication and dissemination activities that took place from the start of the project in November 2020 until the end of the project in December 2023. Section 3 focuses on the exploitation activities and standardisation aspects of the project and Section 4 provides a summary of the activities related to the Advisory Board that was established specifically for the 5GRAIL project.

1.1 Background

The Future Railway Mobile Communication System (FRMCS) will be the 5G worldwide standard for railway operational communications, conforming to European regulation as well as responding to the needs and obligations of rail organisations outside of Europe.

The work on functional & technical requirements, functional and system specification, standardisation in 3GPP as well as regarding harmonised spectrum solutions is currently led by UIC, in cooperation with the whole railway sector. The main objective of 5GRAIL was to validate the first set of FRMCS specifications (also called FRMCS V1) by developing and testing prototypes of the FRMCS ecosystem, for both trackside infrastructure and on-board.

Regarding on-board, 5GRAIL aims to reduce specific equipment costs and installation engineering time by combining all train-to-ground communications by enabling a modular on-board setup based on standardised interfaces and including mainstream 5G components, called TOBA (Telecom On-Board Architecture), in alignment with the sector's technical vision.

The validation of the latest available railway-relevant 5G specification was achieved through emulation of cross border trials covering significant portions of railway operational communication requirements and including the core technological innovations for rail expected from 5G release 16 and pre-release 17.

The project first defined the functional tests and then worked towards prototypes development and evaluation, for both on-board and infrastructure, including the vital European Train Control System

(ETCS) and Automatic Train Operation (ATO), as well as the essential FRMCS voice specific services and Train Control and Monitoring System(TCMS) applications. Interfaces between TOBA and ETCS, ATO and TCMS were developed to contribute to the high-level targets detailed above.

Prototypes were then tested in simulated and real environments, with pilots in labs and in the field, rolled out in various European sites (France, Hungary and Germany), in order to ensure compliances and validation for specification, standards and performance, and consequently guarantee the time to market for FRMCS products.

5GRAIL outcomes are viewed by the railway sector as a key milestone in the global plan leading to FRMCS market readiness for railways in Europe.

1.2 Definitions

Throughout this document, the terms 'communication', 'dissemination' and 'exploitation' will be used frequently. The definitions used by the authors are shown below:

- *Communication*: The aim of taking strategic and targeted measures for promoting the action itself and its results to a multitude of audiences, including the media and the public, and possibly engaging in a two-way exchange. The aim is to reach out to society as a whole and in particular to some specific audiences while demonstrating how EU funding contributes to tackling societal challenges.
- *Dissemination*: The aim of dissemination is to spread the outputs of the project among interested parties, in a targeted way. This activity involves presentation of the project's results to the European railway community and the industrial and scientific community, while managing knowledge within the consortium. The means to achieve this are described in this document.
- *Exploitation*: The aim of exploitation is to favour the market uptake through the use of the results of the project, particularly by using them in further research activities (outside the action). This activity involves the use of the project's results and developed technologies by the suppliers and end users. It involves working closely with all work packages to ensure outputs are captured and partners are able to engage with potential customers and also that they are supported in the development of the project outputs in order to produce products and services that can be exploited.

Communication, dissemination and exploitation of results are crucial to the acceptance and implementation of technologies developed in the project by suppliers and end-users.

1.3 Scope and target groups

The consortium disseminated the results at different levels, with the main target audience listed below:

- Infrastructure Managers (IMs) and Railway Undertakings (RUs);
- Rail Supply Industry;
- 5G and ICT community;
- Associations, Regulatory and standardisation bodies;
- Pubic authorities;
- Research institutes;
- Shift2Rail (S2R) and its successor Europe's Rail Joint Undertaking (EU-Rail);
- Past and ongoing projects.

Table 1: Main Dissemination and Exploitation Tools aimed at the Project Target Groups

Tools	RUs & IMs	Rails Supply Industry	5G & ICT community	Associations, Regulatory and Standardisation Bodies	Public Authorities	Research Institutes and Associations	S2R & EU-Rail	Past and ongoing projects
Project Website	✓	✓	✓	✓	✓	✓	✓	✓
Social Media	✓	✓	✓			✓	✓	✓
Project Leaflet	✓	✓	✓	✓	✓	✓	✓	✓
Conferences / Events	✓	✓	✓	✓	✓	✓	✓	✓
Journals & Scientific Papers	✓	✓	✓	✓	✓	✓	✓	✓
Project Mid-term Conference	✓	✓	✓	✓	✓	✓	✓	✓
Project Final Conference	✓	✓	✓	✓	✓	✓	✓	✓

2 COMMUNICATION & DISSEMINATION

External communication was of key importance for maximising the impact of 5GRAIL and promoting the action itself and its results to the target audiences. Communication of the project research activities involved, reaching relevant transport stakeholders, the scientific community and creating awareness among the general public. This has been achieved through various means, starting with the creation of a project identity and a public website, followed by the participation in numerous events, like conferences and workshops, as well as publishing papers and articles. All this by leveraging the effect from social media.

2.1 Project Identity & Brochure

A project identity has been created at the beginning of the project including templates for presentations, reports, a project brochure and the 5GRAIL logo. The project identity considerably helped dissemination activities and ensured a consistent communication of the project concept, objectives and results. The brochure has been distributed at project workshops and conferences, where project partners have participated, and it was also possible to download it from the 5GRAIL public website.

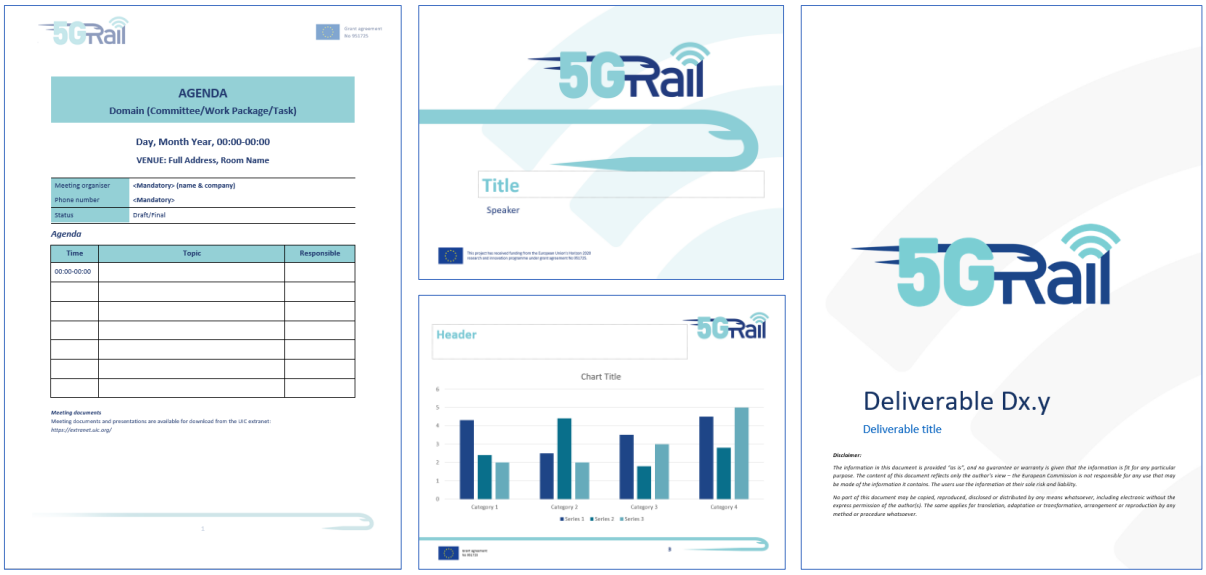


Figure 1: Sample of 5GRAIL templates

Figure 2: Snapshots of the 5GRAIL brochure

2.2 Public website

A dedicated website was created at the beginning of the project and has been updated throughout the life of 5GRAIL. The website (https://5grail.eu/) is publicly accessible, with a section where visitors can contact the coordinator to express their interest.

The project website displays the key project information, partners, results, news/events and links to the partners' websites. All the public deliverables are published on the website and are available for download, as well as any available publications or other dissemination material such as the project brochure or newsletters. The website will remain online at least 5 years after the end of the project.

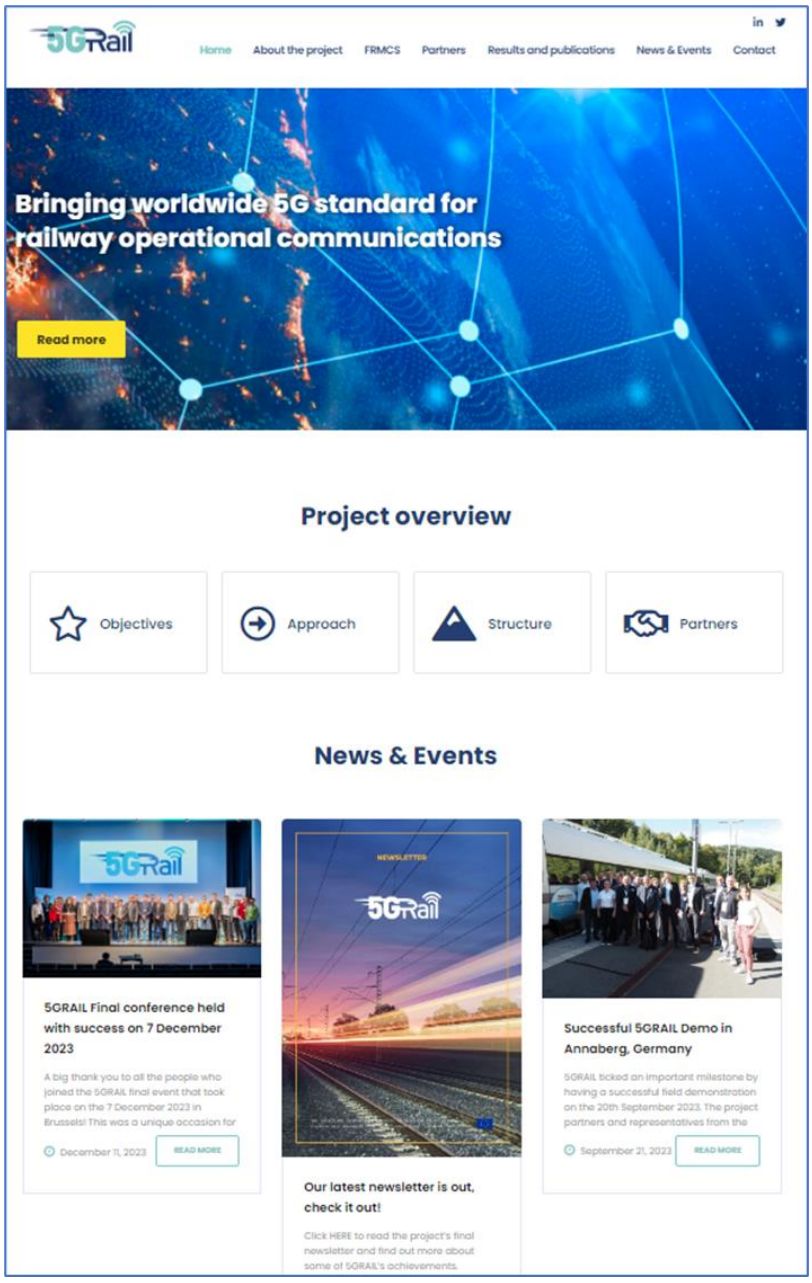
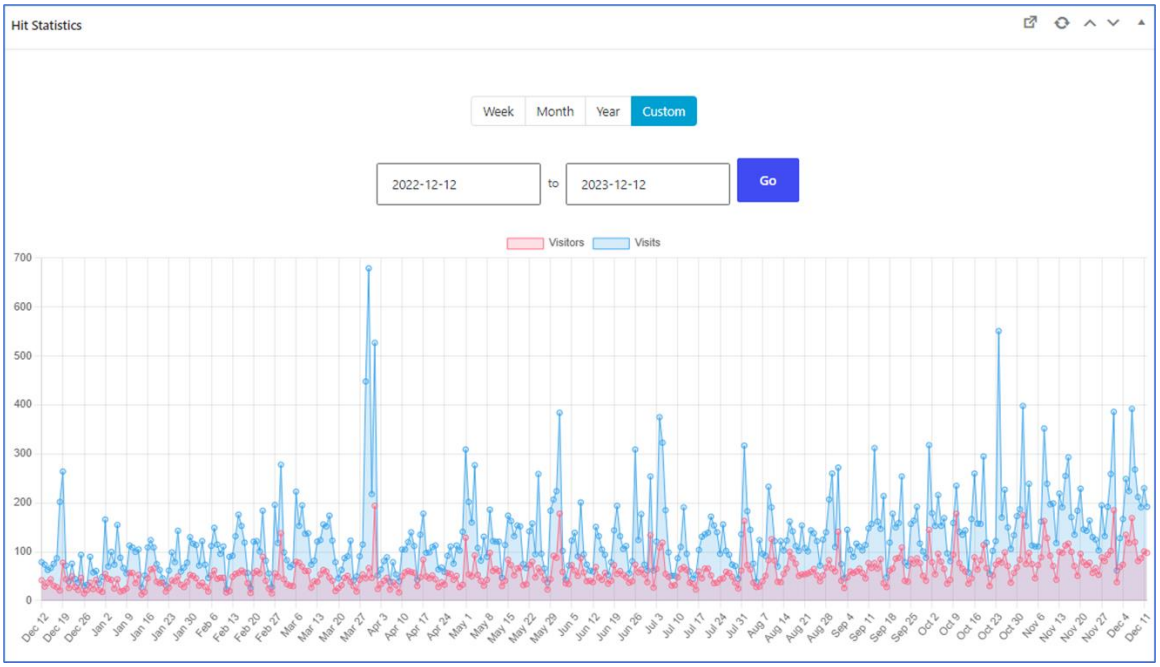


Figure 3: Homepage of the 5GRAIL public website

The analytics of the 5GRAIL website can be seen in the figures below, displaying the number of visitors during the last year of the project, the top 10 visited pages, as well as the total number of visitors (new and returning).



Top 10 Pages

ID	Title	Link	Visits
1	Home Page	/	23,634
2	Contact	/contact-2/	5,529
3	About the project	/about-the-project/	4,365
4	FRMCS	/frmcs/	3,343
5	Results and publications	/results-and-publications/	2,657
6	Partners	/partners/	1,701
7	News & Events	/news/	1,477
8	About the project	/about-the-project	834
9	Register now for the 5GRAIL Final Conference on 7 Dec. 2023!	/2023/10/03/experimental-trials-for-the-future-railway-mobile-communication-system-in-5grail-project-registrations-open-for-5grail-final-conference-on-07-12-2023/	795
10	PRESENTATIONS AVAILABLE | 5GRAIL Mid-Term Conference	/2021/12/14/registrations-now-open-for-the-5grail-mid-term-conference/	749

Summary

Online Users: 0

	Visitors	Visits
Today:	69	144
Yesterday:	62	127
Last 7 Days (Week):	727	1,554
Last 30 Days (Month):	2,794	5,970
Last 365 Days (Year):	21,866	49,841
Total:	30,574	71,107

Figure 4: Analytics of the 5GRAIL Public Website

2.3 Newsletters

The project has produced two newsletters, one towards the middle of the project and another one in the end of the project, providing up-to-date information on the status and achievements of the project at these particular times.

The first newsletter was released in May 2022 and the second one in December 2023. Both of the newsletters have been distributed during public events where the project was disseminated and have also been made available for download on the 5GRAIL public website.

Figure 5: Snapshots from the 5GRAIL Newsletters

2.4 Social media

The 5GRAIL project was also disseminated through social media, which are very efficient for targeting a large audience or more specific communities. The X network (formerly Twitter) together with LinkedIn have been chosen as the main communication channels for social media[1]. Dedicated accounts have been created for the 5GRAIL project, but the objective was also to use the project partners' existing social media accounts in order to leverage their already established audience

[1] LinkedIn: https://www.linkedin.com/company/74016686/admin/ Twitter: https://twitter.com/5Grail

when posting news about the project, such as articles, information about 5GRAIL events, relevant conferences, major findings, etc.

One of the key advantages of using social media is that they enable the dissemination of short pieces of information which will contribute to driving back the traffic towards the project website. Another benefit is the multimedia support offered, which allows partners to post short videos, text and pictures. The partners have used at least the specific hashtag created for the project: #5GRAIL in order to maximise the impact of the outreach.

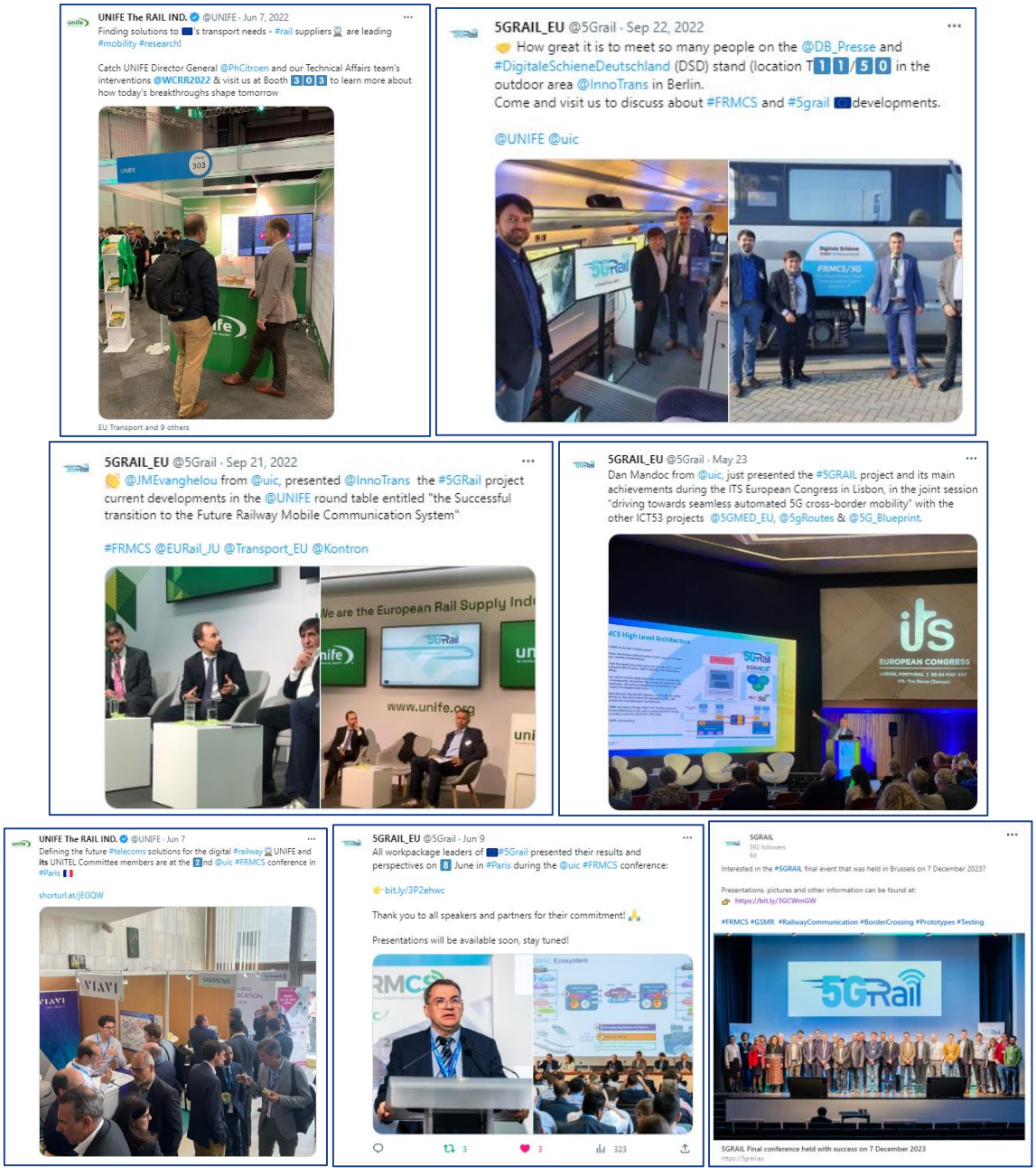


Figure 6: Examples of social media posts done during the duration of 5GRAIL

2.5 Events

2.5.1 Organisation of events

The 5GRAIL consortium has organised two main project events during the life of the project, a mid-term conference on the 12th April 2022 and a final conference on the 7th December 2023.

- The 5GRAIL mid-term conference was held at the Pullman Centre Midi Hotel in Brussels and was attended by around 100 participants from the international railway community and telecoms sector. During the conference, project partners showcased the progress 5GRAIL had made from the beginning of the project and introduced how the final objectives of the project are going to help the delivery of a demonstrator for FRMCS. During the mid-term conference, the floor was given to the 5GRAIL work package leaders, who presented the project status and plans. A first insight of the two labs was also shown, in connection to the tests that had begun. The mid-term conference closed with a roundtable discussion on the way forward, with speakers representing the suppliers, railways and standardisation bodies.

Figure 7: Picture from the 5GRAIL mid-term conference

- The final conference of 5GRAIL took place in the SPARKS conference centre in Brussels, with the participation of around 150 people. the 5GRAIL consortium gave an overview of the work done during the life of the project. The presentations and discussions covered the prototypes that were developed, the labs that were set up in Hungary and France (highlighting the tests that were performed), in parallel to the field tests undertaken in Germany and France. Furthermore, the application prototypes and overall experience were

showcased. Important elements such as border crossing were given special attention, concluding the day with a roundtable discussion, addressing topics such as the needs and expectations for FRMCS, the overall 5GRAIL experience and the 5G benefits expected for the railways.

The presentations shown during both of these 5GRAIL events are available on the 5GRAIL website. Both events were largely promoted through social media and on the project website.

Figure 8: Picture from the 5GRAIL final conference

Another event which was organised by 5GRAIL partners was related to the IEEE VTC2023-Spring, which was held between the 20-23 June 2023 in Florence. A dedicated workshop was organised on the 20 June by 5GRAIL partners with the theme “5G for Railways – Challenges and Opportunities for Operational and Passenger Connectivity”. The workshop has been co-chaired by Marion Berbineau (Université Gustave Eiffel), Friederike Maier (DB Netz) and Nazih Salhab (SNCF-Réseau) and featured the following three keynote speeches:

- 5G-RACOM: Major milestones towards the FRMCS, Shirish Kendre, Deutsch Bahn
- 5G for CAM – addressing Rail, Jorge Pereira, DG Connect
- Railway cyber-security in the era of interconnected systems, Simone Soderi, IMT Lucca

And the following papers (including 4 papers from 5GRAIL):

- J. Nasreddine et al., "5GMED Seamless Connectivity for Digital Trains," 2023 IEEE 97th Vehicular Technology Conference (VTC2023-Spring), Florence, Italy, 2023, pp. 1-6, doi: 10.1109/VTC2023-Spring57618.2023.10199954.

- S. Tardif et al., "Experimental Trials for the Future Railway Mobile Communication System in 5GRail Project," 2023 IEEE 97th Vehicular Technology Conference (VTC2023-Spring), Florence, Italy, 2023, pp. 1-5, doi: 10.1109/VTC2023-Spring57618.2023.10199568.
- F. Maier et al., "Field Evaluation of MCX Implementations for the Future Railway Mobile Communication System," 2023 IEEE 97th Vehicular Technology Conference (VTC2023-Spring), Florence, Italy, 2023, pp. 1-6, doi: 10.1109/VTC2023-Spring57618.2023.10199238.Train Antennas Requirements, Design and Integration for 5GRail Project
- N. Salhab, A. Haidar, J. J. Muñoz and C. Reboul, "Train Antenna Requirements, Design and Integration for 5GRAIL Project," 2023 IEEE 97th Vehicular Technology Conference (VTC2023-Spring), Florence, Italy, 2023, pp. 1-5, doi: 10.1109/VTC2023-Spring57618.2023.10199389.
- V. Corlay and J. . -C. Sibel, "An MDP approach for radio resource allocation in urban Future Railway Mobile Communication System (FRMCS) scenarios," 2023 IEEE 97th Vehicular Technology Conference (VTC2023-Spring), Florence, Italy, 2023, pp. 1-6, doi: 10.1109/VTC2023-Spring57618.2023.10200339.
- T. Sylla, L. Mendiboure, M. Berbineau, R. Singh, J. Soler and L. Dittmann, "Implementing Edge Computing Architectures for Railway Applications: An example Using the Emu5GNet Platform," 2023 IEEE 97th Vehicular Technology Conference (VTC2023-Spring), Florence, Italy, 2023, pp. 1-5, doi: 10.1109/VTC2023-Spring57618.2023.10200145.
- W. Chérif, C. Vitry and L. Durieux, "Adaptable Communications System for train remote driving," 2023 IEEE 97th Vehicular Technology Conference (VTC2023-Spring), Florence, Italy, 2023, pp. 1-5, doi: 10.1109/VTC2023-Spring57618.2023.10200708.
- A. Habib, A. E. Falou, C. Langlais and M. Berbineau, "Reconfigurable Intelligent Surface Assisted Railway Communications: A survey," 2023 IEEE 97th Vehicular Technology Conference (VTC2023-Spring), Florence, Italy, 2023, pp. 1-5, doi: 10.1109/VTC2023-Spring57618.2023.10200574.
- Y. Cao, Z. Qiu and H. Long, "A Sequence Spread Modulation Scheme Based on Orthogonal Time Frequency Space," 2023 IEEE 97th Vehicular Technology Conference (VTC2023-Spring), Florence, Italy, 2023, pp. 1-5, doi: 10.1109/VTC2023-Spring57618.2023.10199725.

All the papers are accessible in IEEE-Xplore. The event was promoted through the 5GRAIL website and through social media.

2.5.2 Participation in conferences

The 5GRAIL partners participated to some major transportation and/or telecommunication events, where the project was presented and communicated to a wide audience. The 5GRAIL consortium aimed at attending (through the submission of abstracts and/or papers when relevant) some high-level European and International conferences and public events, listed below in chronological order, with the aim of promoting the project and its findings, as well as increasing the visibility on FRMCS developments and collecting valuable feedback whenever possible.

Table 2: Main Dissemination events attended by 5GRAIL consortium

Nr	Event name, date and location	Description	Responsible partner(s)
1	IEEE 5G Virtual Summit for CAM Summit 2021 (11-12/05/2021), online	Paper submission and presentation	UIC
2	Nets4Workshop2021 (16-17/11/2021), Madrid (Hybrid event)	Presentation	DB
3	ERA ERTMS 2022 Conference (26-28/04/2022), Valenciennes	Participation, providing feedback from 5GRAIL perspective during roundtable discussion on FRMCS and in several workshops during the conference	NOKIA
4	WCRR 2022 - World Congress on Railway Research (6-10/06/2022), Birmingham	Two abstracts and two papers submitted, followed by poster and oral presentations. Dissemination material distributed through UNIFE stand	UNIFE, UIC, SNCF
5	EuCNC & 6G Summit (7-10/06/2022), Grenoble	Abstract and paper submitted and presentation	UIC, DTU
6	UNIFE General Assembly 2022 (15-17/06/2022), Paris	5GRAIL dissemination material distributed	UNIFE
7	Global IoT Summit2022 (21/06/2022), Dublin	Paper Submitted and Presentations	UIC
8	UIC High Speed 2022 (28/06-01/07/2022), Beijing	5GRAIL dissemination material distributed	UIC
9	InnoTrans 2022 (20-23/09/2022), Berlin	Project promotion through dedicated panel discussion at the UNIFE stand on "Successful transition to the Future Railway Mobile Communication System (FRMCS)". Promotion of project in DB train and dissemination material distributed through UNIFE and KONTRON stands.	UNIFE, UIC, KONTRON, DB
10	WIMOB2022 – Wireless and Mobile Computing, Networking and Communications (10-12/10/2022), Thessaloniki	Paper submission and presentation	UGE, DTU
11	FNWF2022 - IEEE Future Networks World Forum (12-14/10/2022), Montreal	Paper submission for track/workshop "S10: Symposium on 5G for Connected and Automated Mobility", followed by	UIC, KONTRON, NOKIA, DB, SNCF, UGE,

	(Hybrid event)	presentation	UNIFE
12	TRA2022 - Transport Research Arena (14-17/11/2022), Lisbon	Two abstracts and two papers submitted, followed by poster presentation	UNIFE, UIC, UGE, DTU
13	ITS European Congress 2023 (22-24/05/2023), Lisbon	Dissemination material distributed through common stand with other ICT-53 projects. Presentation during workshop "Driving towards seamless automated 5G cross-border mobility"	UNIFE, UIC
14	EuCNC & 6G Summit 2023 (6-9/06/2023), Gothenburg	Special session on "5G for CAM in cross-border scenarios: challenges and lessons learnt"	UGE
15	UIC FRMCS conference (7-8/06/2023), Paris	5GRAIL WP leaders presented their results and perspectives during the 2-day conference. Dedicated space for stands was also available for further discussions with project partners on the proposed solutions	UIC, KONTRON, DB, SNCF, NOKIA, UNIFE, UGE, DTU
16	IEEE VTC Conference (20/06/2023), Florence	Paper and Presentation	Kontron, SNCF, UGE
17	WIMOB2023 (21-23/06/2023), Montreal	Paper submission.	UGE, DTU
18	IEEE 9th World Forum on Internet of Things, 12-27/10 2023, Aveiro, Portugal	5GRAIL, 1st FRMCS Demonstrator, Presentation of the objectives and achievements of 5GRAIL, as part of the FRMCS 1st edition program.	UIC
19	IEEE Future Networks / S07 CAM Symposium Baltimore, 13-15/11 2023	5GRAIL contributes to the FRMCS, as GSM-R successor, Remote presentation of the 5GRAIL end-to-end architecture, prototypes, achievements in lab and field testing and pre-standard implementations	UIC

2.5.3 Railways Working Groups and ERA stakeholder meetings

The awareness level of the 5GRAIL project has been very high amongst the various Railways Forums and notably within the following ones:

- UIC ERIG – A forum of European Heads of Railways Telecoms, meeting three times / year, where 5GRAIL status, technical developments of choices have been presented and discussed during all of the project lifetime.

- ERA Radio Coordination Group – A regular meeting organised by ERA, three times /year, where 5GRAIL has been presented.
- UIC Working Groups – The UIC Working Groups developing FRMCS Specifications have been regularly updated and discussed, along with the 5GRAIL status and technical developments.
- ETSI TC-RT – The ETSI Technical Committee for Railways Telecoms, where the 5GRAIL status and the project's technical choices have been presented and discussed.

2.5.4 Cooperation with other ICT-53 projects

5GRAIL kept a close contact with the other H2020 ICT-53: 5G for CAM projects, namely 5G-Blueprint, 5GMED, 5GRoutes, to identify potential opportunities for joint dissemination activities. Such collaboration occurred during the following occasions:

- ITS European Congress 2023 (22-24/05/2023), Lisbon;
- EuCNC & 6G Summit 2023 (6-9/06/2023), Gothenburg;
- Webinar (08/11/2023), with the theme: "Connectivity beyond limits in mobility cross border scenarios with 5G";
- Webinar (14/12/2023), with theme: "Key outputs from the ICT-53 projects in deploying 5G in cross-border corridors scenarios".

From the collaboration with the other H2020 ICT-53 projects, it was possible to share best practices and strategies and identify joint communication and dissemination opportunities and to increase the visibility of the projects and their results, focusing on common aspects like CCAM, 5G and cross-border handovers. Regular exchanges and conference calls were organised between the representatives of each ICT-53 project to identify such collaboration opportunities and to prepare for the expected contributions. Such collaboration came in the form of common booths in fairs and/or special sessions and webinars being organised on dedicated topics.

Figure 9: Pictures showing collaboration with other ICT-53 projects (left: common booth during ITS European Congress 2023, right: special session during EuCNC & 6G Summit 2023

2.5.5 Publications & Papers/journals

Project results have been published during several specialised national and international conferences, through papers and presentations. The 5GRAIL partners have actively looked-out for high profile academic and industrial events or fairs that are within the domain of interest of the project. Throughout the life of the project, 5GRAIL has been presented/published in the following events and press:

Table 3: Main publications done by the 5GRAIL consortium

Nr	Source	Type of publication	Date of issue	Responsible partner(s)
1	UIC+UNIFE, reproduced amongst others by Global Railway Review, Industrial News, Bahnaktuell	Press Release	November 2020	UIC, UNIFE
2	International Railway Journal	Article	December 2020	UIC, UNIFE
3	DB's Digital Rail program (Digitale Schiene Deutschland), see: FRMCS/5G-Datenkommunikation | Digitale Schiene Deutschland (digitale-schiene-deutschland.de)	Newsfeed	March 2021	DB
4	The future of rail critical communications (globalrailwayreview.com)	Article	May 2021	Kontron
5	DB's Digital Rail program (Digitale Schiene Deutschland), see: https://digitale-schiene-deutschland.de/Kollaboration_DSD_Nokia	Newsfeed	January 2022	DB, Nokia
6	Railway Gazette International	Article	February 2022	NOKIA, UIC, UGE
7	S+D article "5G for the digital rail system of the future – the prospects for FRMCS" (in German: "5G für das digitalisierte Bahnsystem der Zukunft – ein Ausblick auf FRMCS")	Article	March 2022	DB
8	Global Railway Review	Article	June 2022	UNIFE
9	Paper published for MDPIs Network Journal "Coexistence of Railway and Road Services by Sharing Telecommunication Infrastructure Using SDN-Based Slicing: A Tutorial"	Paper	December 2022	TUD, UGE
10	5GRAIL paves the way to the Future Railway Mobile Communication System	Paper	WCRR 2022	UIC, UNIFE

	(FRMCS)			
11	SNCF paving the way towards FRMCS adoption: a new era for railway communications	Paper	WCRR 2022	SNCF
12	5GRAIL paves the way to the Future Railway Mobile Communication System Introduction	Paper	TRA 2022	UIC, UNIFE
13	Emulator for Railway and Road communication coexistence scenarios in FRMCS validation	Paper	TRA2022	DTU, UGE
14	Train Antenna Requirements, Design and Integration for 5GRAIL project	Paper	IEEE VTC Spring2023	SNCF
15	Experimental Trials for the Future Railway Mobile Communication System in 5GRail Project	Paper	IEEE VTC Spring2023	DB, KONTRON, NOKIA, SNCF, UIC, UGE, UNIFE
16	Field Evaluation of MCX Implementations for the Future Railway Mobile Communication System	paper	IEEE VTC Spring2023	DB
17	Implementing Edge Computing Architectures for Railway Applications: An example Using the Emu5GNet Platform	paper	IEEE VTC Spring2023	UGE, DTU
18	European 5G Annual Journal / 2023	Article	June 2023	DB, KONTRON, NOKIA, SNCF, UIC, UGE, UNIFE
19	SoD-MQTT: A SDN-Based Real-Time Distributed MQTT Broker	paper	WIMOB2023	UGE, DTU
20	International Railway Journal “FRMCS moves from concept to reality”	Article	August 2023	UIC, UNIFE
21	Main Line Communications: Preparing for FRMCS see: marketing.gts.urbanandmainlines.com/White_Paper_FRMCS	White Paper	September 2023	Thales GTS

2.6 Dissemination KPIs

At the beginning of the project, some target KPIs were set with respect to the dissemination aspects of the project. The table below depicts the achieved activities compared to the target metric that was set.

Table 4: 5GRAIL Dissemination Key Performance Indicators

Dissemination Activity	Target Metric	Achieved
Design of project logo, visual material (PPTs and documents template)	1 each	1 each
Total visits to Project´s website	2000	71100
Production of brochure	1	1
Project Newsletters	2	2
Conferences / Events	3/year	18 in total
Mid Term Conference	Number of registered participants: 150	Number of registered participants: 124
Project Final Conference	Number of registered participants: 150	Number of registered participants: 157
Publications in traditional media and scientific papers	3/year	18 in total
Social Media	Followers + posts: 500	592 followers on LinkedIn 189 followers on X (former Twitter)

3 EXPLOITATION

3.1 Objectives

FRMCS is the system that will replace GSM-R. It is very important to highlight that it will also improve the safety through improved Railway Emergency Call and enable the evolution of ETCS and ATO, and also enable the Railway digitalisation. 5GRAIL delivered FRMCS prototypes, especially on-board. This is an essential step towards the FRMCS 2025 industrialised products expected for second half of 2025.

In this context, the exploitation of 5GRAIL results have a broader timeframe, as it started during the project implementation and will continue also after the conclusion of the project (for example through the contributions of 5GRAIL in the area of Standards and Regulation). Moreover, exploitation aims at developing interactions with stakeholders outside of the consortium to enhance the acceptance and recognition of 5GRAIL results after the end of the project (for example through the members of the Advisory Board).

The objectives of the exploitation of results are the following:

- Inputs to **Infrastructure Managers** and **Railway Undertakings** by establishing a good communication frame with the IMs and RUs that participated in the project Advisory Board. This setting supported a good and transparent discussion about the 5GRAIL project, and made available the results of the project, especially linked with the On-Board architecture and solutions. This was extremely important in the context of migration to FRMCS. Further communication channels were established through email, social media and also through the participation to important conferences, for example the UIC Passenger Forum meetings. Moreover, IMs and RUs organisations were invited to the 5GRAIL mid-term and final conferences. A direct link with most of the aforementioned stakeholders was also established through the 5GRAIL Advisory Board;

- Contribution to **Specifications, Standards and Regulation**. 5GRAIL assessed the impacts of the WPs on the FRMCS specifications and further-on on the European standardisation activities. Interface with the FRMCS UIC Working Groups (Functional, Architecture & Technology, Telecom ON Board and Frequency Affairs), as well as with the ETSI TC-RT and 3GPP were put in place for a two-way communication between 5GRAIL and the WGs interface experts. 5GRAIL benefited from the current specification and standardisation work to prepare the adequate test cases and a compliant TOBA Gateway, with a gap as controlled and as reduced as possible;

- As per one of main declared objectives for 5GRAIL, the outputs allowed a verification and update of the UIC FRMCS Specification V1, that was the basis of the prototyping activities. The resulting specifications, FRMCS V2, form the basis for the FRMCS introduction into the next step, which is the preparation of the FRMCS European trials (2024 – Q2-3 2025). To be noted that V1 specifications have been included in the TSI 2022 revision;

- Furthermore, UNIFE is a member of the Rail Sector Forum, which is an advisory group of CEN-CENELEC. Therefore, UNIFE is involved in the review of the CEN-CENELEC standardisation programme. This is an opportunity to present regularly the potential impacts of the project to CEN-CENELEC and define a working progress in case the project could impact existing standards or be at the origin of new ones.

- Inputs to the **EU Rail Supply Industry** through the UNIFE-UNITEL committee, bringing together EU rail telecommunication stakeholders, is another channel where the first outputs of the project were presented, getting the feedback from industrial members on the project development;

- Targeted liaison with **Shift2Rail and its successor Europe's Rail** to ensure proper integration of the 5GRAIL developments into their planned activities. More specifically the Shift2Rail Innovation Programmes 1 and 2 dealing with rolling stock and signalling systems and the successive Flagship Area 2 of Europe's Rail. With the help of the WP leaders, relevant exchange of information/outputs between 5GRAIL and the relevant Shift2Rail/Europe's Rail channels. Regular interactions were envisaged either in the form of bilateral meetings or dedicated conference calls depending on the needs of the projects, but also in terms of aligning with respect to the FRMCS roadmap;

- Exploitation of project results **in other R&D activities** and market uptake: The results of 5GRAIL are also relevant as input for future R&D activities and be marketable in the near future, as partners are going to follow their individual exploitation strategies.

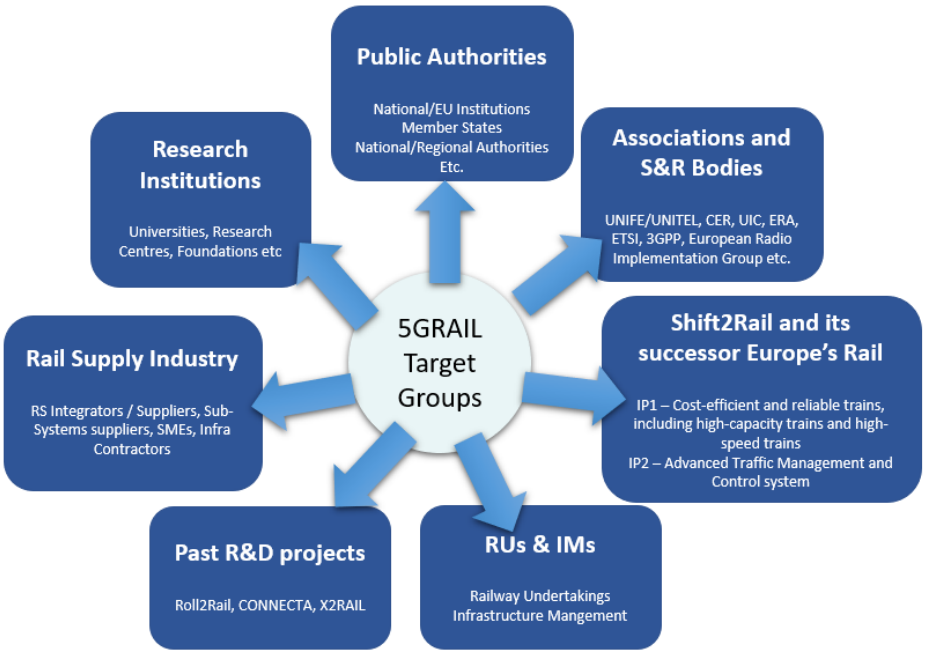


Figure 10: 5GRAIL Target Groups

3.2 Exploitations Measures

The following steps have been taken in order to ensure that the objectives of the exploitation plan are met:

- Developed Collaboration Agreements with 5G PPP projects listed in Article 2 of the Grant Agreement (action completed early 2021) and established close links with Shift2Rail or Europe's Rail projects and relevant channels linked to the 5GRAIL scope;
- Established the 5GRAIL Advisory Board;
- Ensured that standardisation bodies were aware of the project developments on a regular basis;
- Through interactions with other relevant research projects, organised and/or attended technical workshops on specific subjects identified, whenever needed.

All this exchange of information enabled the 5GRAIL project to provide feedback to the relevant stakeholders, and also to collect suggestions that were relevant for the on-going activities of the project.

The dissemination and exploitation measures of the project addressed the full range of potential users and uses. This includes Railway Infrastructure Managers, Railway Undertaking and Freight Operators, Associations/Federations/Regulatory Bodies (ERA, CEN/CENELEC, 3GPP and ETSI), Research centres, stakeholders in the railway supply industry, Regional/National and European Institutions.

It also includes existing working groups for developing the necessary specification and standards for the next generation of 5G radio telecommunication. Due to the nature and the duration of the project, this constituted a sound basis for the evolutions of these standards to be set with the appropriate stakeholders, through the organisation of meetings with relevant bodies during the whole duration of the project.

The table below describes in more detail the exploitation activities performed and/or envisaged by each partner of the 5GRAIL consortium.

Table 5: 5GRAIL Consortium members' Exploitation Strategies

Nr.	Partner name	Planned exploitation activities
1	UIC	5GRAIL outcome has been used to confirm or amend FRMCS V1 Specifications, following the conclusion of the tests and measurements in lab and field conditions, as well as to and raise some implementation constraints, that are currently under consideration for the FRMCS V2 specifications. 5GRAIL experience contributed to a validated set of FRMCS V1 specifications, already introduced in the European CCS TSI 2023 (Control-Command System Technical Specifications for Interoperability) for railway regulation. The lessons learnt of the 5GRAIL testing experience are also a valuable input for the preparation of MORANE 2 project. 5GRAIL test cases constitute an input for future test specifications. Although, performance measurements were not

Nr.	Partner name	Planned exploitation activities
		the priority in 5GRAIL testing campaigns, due to the prototyping conditions of equipment and applications, some KPIs and measurement methods have been proposed and assessed during 5GRAIL. These will be considered in order to decide the measurement methodology for FRMCS 1st edition validation during the pilot trials. 5GRAIL has confirmed that the FRMCS principles that were specified in v1 specifications are correct.
2	NOKIA (NOKIA-DE NOKIA-IT NOKIA-HU)	Nokia will and has used the results of 5GRAIL for the discussions with Infrastructure Managers on FRMCS capabilities, timelines, migration aspects and potential further joined test activities with main railway Infrastructure Managers in Europe and outside Europe to promote FRMCS worldwide. This will be done e.g. using Nokia Railway User groups or in bilateral workshops. Nokia especially involves customer and projects outside Europe (like Australia) to explain the benefits of following FRMCS standards and explaining the 5GRAIL results. Experiences from 5GRAIL will further guide the feature and roadmap planning of Nokia for the FRMCS portfolio to be offered in future to customer.
3	KONTRON	Kontron will feed its findings towards the UIC FRMCS specifications , ETSI TC RT and 3GPP via appropriate contributions. Kontron will as well use the 5GRAIL results within its future R&D activities link to the FRMCS roadmap. Kontron will leverage its findings to enhance its prototype within the course of 5GRAIL and other European projects such as 5G RACOM and EU-Rail.
4	ALSTOM	Alstom will use the outputs of the 5GRAIL activities to properly implement the various versions of the FRMCS specifications and will feed back any update requirements for the next specifications versions to the organizations in charge of the Specifications and Technical Standards. Alstom will use the implementations of the product's deliverables to enrich its solution portfolio dealing with FRMCS over 5G with the ultimate objective to provide a compliant solution for the CCS TSI future versions.
5	DBN	DBN will demonstrate relevant use cases as a result of the test campaigns, focusing on functional and performance tests as well as cross-border simulations in the German field. For dissemination and exploitation of results, the following approach is planned: DBN will publish the findings at European conferences, in specialized magazines or through presentations in front of subject matter experts. 5GRAIL findings will be fed back into FRMCS standardization groups, into railway infrastructure manager coordination rounds as well as into industry fora within the railway signalling and communication sector. In that way DBN will help to further impact the FRMCS ecosystem and product roadmap.

Nr.	Partner name	Planned exploitation activities
		DBN will use the project results to define and refine the system principles for the migration from GSM-R to FRMCS and to get an understanding of several implementation challenges in the own network. In the mid-term, 5GRAIL outcomes will be input for early FRMCS PoC and pilot deployments of DBN and in the long-term they will influence the roll-out plans of the live network in later years. Besides, DBN will identify key aspects from 5GRAIL which can be transferred to other research projects, e.g. within EU-Rail as well as the Franco-German innovation project 5G-RACOM.
6	SNCF-R	SNCF-Reseau will organise and execute some use cases pertaining to functional and performance testing as well as cross-border simulation in the French field. In this context, several exploitation strategies are envisioned as follows. On first hand, the learning-by-doing will enrich the competence and skills of the implicated technical team and smooth their learning-curves. On the second hand, 5GRAIL outcomes will allow to understand the challenges to anticipate when transiting to FRMCS. Accordingly, SNCF-Reseau technical teams would be able to imagine live ecosystem performance issues, through experience, allowing to imagine what to expect when it comes to deploying the FRMCS. Moreover, the lessons learnt would provide solid inputs for accurately planning the progressive migration to FRMCS on the live network, later on. Finally, throughout the lifecycle of the project, SNCF-Reseau experts would be conducting thorough analyses of the gathered results out of the field tests to identify which findings and outcomes could be further valorised or even patented when applicable.
7	THALES	Thales will exploit 5GRAIL's outcomes, findings and results as an input to support ongoing activities aiming at shaping operational FRMCS rollouts and migration. Through internal and external working groups, Thales will build on the project's outcomes to feed into UIC FRMCS specifications V2, develop internal capabilities to support future FRMCS deployments, drive the maturity of the industrial ecosystem and help customers plan their migration to FRMCS.
8	SBB	SBB have studied the results and findings and taken into account the maturity of products and specifications to replan its own FRMCS rollout and migration project, in particular with respect to first end-to-end test tracks for which FRMCS radio coverage is currently being planned. The participation in 5GRAIL

Nr.	Partner name	Planned exploitation activities
		also helped to strengthen the coordination with ongoing standardisation work in particular in the TOBA working group. In addition to reviewing and studying the internal 5GRAIL deliverables for its own purposes, SBB has presented the public results in its December 2023 GSM-R/FRMCS management board that unites several IMs and RUs in Switzerland affected by FRMCS as well as the Office of Transport of the federal government to prepare Switzerland's rail sector for the introduction of FRMCS.
9	UNIFE	UNIFE will exploit the results of 5GRAIL through its internal Working Groups, by raising awareness of the relevance of the outcomes of the projects among its members and promoting the continuation of the work done in 5GRAIL in future R&D activities.
10	CAF	CAF will exploit the results of the project internally in its Signalling and TCMS business units. Additionally, the outcomes from the project will serve as baseline for future R&D activities tackling FRMCS. Last but not least, CAF will also share its experience in the integration of FRMCS in TCMS within the IEC TC09 WG43.
11	OEBB	The findings of 5GRAIL are taken into account for FRMCS migration projects and rollout planning by internal Working Groups at ÖBB, as an Infrastructure Manager in Austria.
12	SIEMENS	As an established leader in railway solutions (including primary supplier in rail telecom and GSM-R solutions), Siemens will continue to communicate our participation & contributions in the 5GRAIL Project with the relevant stakeholders (such as customers and partners) in all discussions regarding 5G FRMCS related topics. Siemens is committed to its future development and is investing in 5G technology with the belief that it will form a pivotal role in our product roadmap. As a major contributor and part of the various industry groups & forums, Siemens will continue to contribute the developments of 5GRAIL into the relevant consortiums & ventures, including standardisation forums and upcoming new European projects. Furthermore, our existing relationship with consortium members to date has formed a solid and productive collaboration which Siemens will be looking to build upon for the purposes of 5G FRMCS to be a key enabler for digitalisation within the rail industry.
13	IP	IP, as the Portuguese Rail and Road Infrastructure Manager, is mainly focused on the 5GRAIL outcomes and their subsequent exploitation among several

Nr.	Partner name	Planned exploitation activities
		areas within the company. Besides, IP intends to continue working alongside UIC, across the various groups concerning the development/application of FRMCS specifications/standards, to evaluate the overall results of this project. Furthermore, IP aims to monitor closely the progress of the work developed in FRMCS/5GRAIL (through scientific publications, workshops, summits/conferences, fairs, among others). Last but not least, IP aims at fostering the development of R&I projects on C-ITS/CAM, in which potential synergies and coexistence of rail and road 5G-V2X communication systems could be more exploited.
14	UNI. EIFFEL	The results of the project will have direct impact in the activities of UNI. EIFFEL. Firstly, the different results will be exploited for new developments and also for publications in conferences and journal. Secondly, the results will be exploited directly to contribute to the education of young researchers (PhD candidates or post-doctorate). Results will be also incorporated to existing teaching activities. Ultimately, the resulting developments will be used as a basis for further collaboration of proposals at national (France) and international level (EU-other).
15	TELESTE	TELESTE utilizes 5GRAIL project results in different internal and external marketing activities, such as exhibitions, trainings, presentations, workshops, conferences, blogs, LinkedIn posts and press releases. Results will be also utilized in TELESTE's solutions and product portfolio and roadmaps. TELESTE will also utilize results when negotiating and defining solutions for the end customers.
16	DTU	The results of the project will have direct impact in the activities of DTU. Firstly, active development of prototypes and related activities will contribute to the education of young researchers (PhD candidates). Results will be as well incorporated to existing educational activities such as DTU's course on Signaling Systems and Technology for Railway (34345) and associated student-projects offer. Ultimately, the resulting developments will be used as playground for further collaboration proposals at national (Dk) and international level (EU-other).

3.3 Standardisation Plan

FRMCS is based on 3GPP, ETSI and UIC Specifications. Figure 11 is showing the hierarchy in which these specifications are considered.

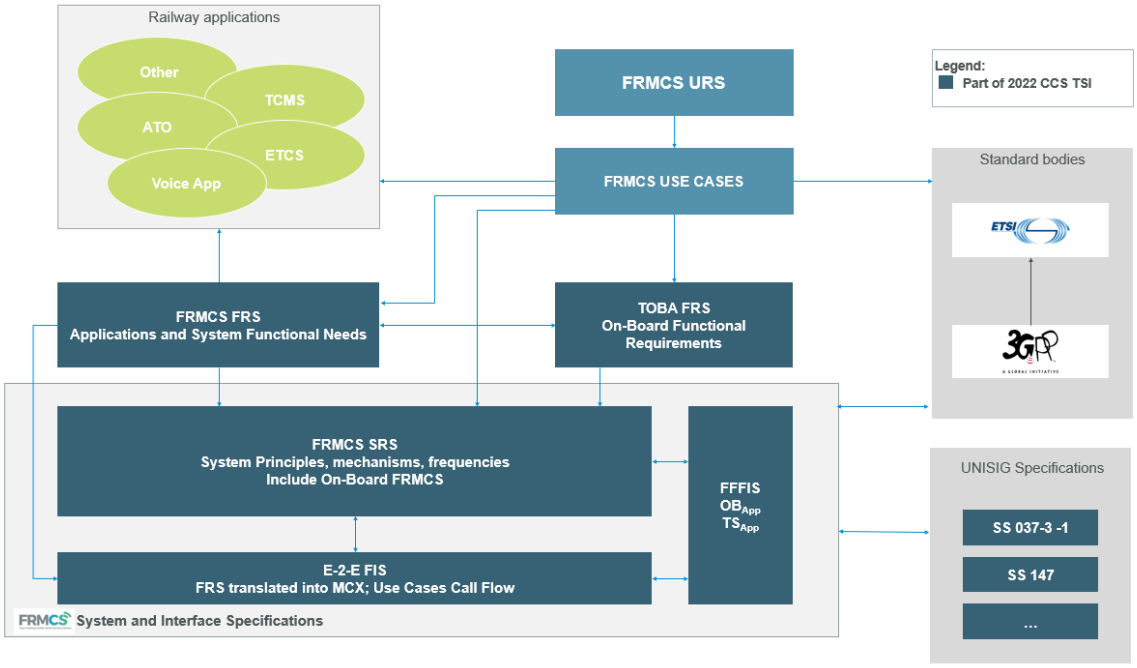


Figure 11: FRMCS V1 specifications interdependencies between themselves and with other specifications

5GRAIL considered the existing 3GPP and UIC FRMCS specifications and assessed the existing technology to build the relevant prototypes.

For the identified gaps, the 5GRAIL experts have considered a set of assumptions, that have been decided in line with the specifications development or equipment or features availability expectation.

A strong link was established between 5GRAIL and the UIC working groups - Telecom On-Board Architecture (TOBA) WG, Architecture & Technology (AT) WG and Frequencies WG (UGFA), for a duplex link, in the sense of delivering the FRMCS technical requirements towards 5GRAIL, especially WP2 and WP1, and also in the other sense by considering 5GRAIL findings, that are assumed to support some FRMCS discussions.

With the finalisation of the project, the delta between 5GRAIL and FRMCS V1, 3GPP Specifications has been recorded in the whole D1.2 and in particular in chapter §6 Testing Outcomes Impacting Specifications (FRMCSv1 as well as 3GPP R18 and beyond) and in D2.4. chapter §4 Learnings.

This delta is summarized in the table below.

Table 6: Contribution of 5GRAIL to the specification

Nr	Domain	Description of delta (or open topics in FRMCS V1 specifications)	Mapping to the Specifications roadmap
1	OBapp/TSapp API improvements	• Improvement of registration procedure • SIP core/MCX server support multiple registrations in a short time • SESSION_END processing: review the order of responses • Definition of maximum time to answer to an API request to avoid getting stacked due to unavailability of the network • OB_GTW supporting session_start request under a non-coverage area, where the MCX clients is not registered yet	FRMCS V2
2	Registration/authentication	Call flow (SIP REGISTER/SIP PUBLISH)	FIS V1
3	Local binding	• Assessment between WebSocket and HTTP 2. • HTTP 2 was chosen in FFFIS V1	FIS V1
4	TSapp architecture	• For 5GRAIL implementation, OBapp interface was considered identical to TSapp, at least for loose coupled applications. • For tight coupled applications, direct connection to the MC Server was implemented. • Different scenarios are discussed in the UIC specifications WGs based also on the 5GRAIL outcomes to decide the relevant architecture in FFFIS v2.	FRMCS V2

5	Multipath	• Alstom's implementation: at service layer (several MCdata-IPconn sessions established on the different links), need one MC data user per link et per application • Kontron's implementation: The Kontron's multipath solution, in the scope of 5GRail project, is based on the MPTCP protocol. Due to the MCx server limitations of not being able to manage two sessions for the same pair of MCx clients, duplication of MC client was implemented. • Multipath Function under discussion in the FRMCS specifications WGs for V2.	FRMCS V2
6	IP Addressing and end-to-end IP routing	Virtual IP addresses configured at TOBA level are used, which are NATed.	FRMCS V2
7	MCX credentials	Provisioning and storage of MCX credentials	FRMCS V2
8	OB and TS interoperability	Session establishment interoperability (e.g., client-server from different providers)	FRMCS V2
9	Functional alias	Call restriction based on subparts/elements of functional alias	3GPP Rel.18 CRs in TS22.280
10	Location information and clarification of location terms	Additional parameters for Location Information and clarification of Location terms	3GPP Rel.18 CRs in TS22.280
11	REC (Railway Emergency Call)	• REC server based, instead of client-based using location criterion • Implemented with Ad hoc Group communication service	3GPP Rel.18&19 CRs in TS22.280
12	FRMCS-GSMR interworking	Group calls and REC calls involving MC users from the two coexisting systems during the migration period	ETSI TR 103 768
13	Border crossing	• Usage of 2UEs for service continuity with ETCS and ATO application, that will be used in a first phase for Border Crossing until MCX Interconection & Migration mechanisms and interfaces will be	FRMCS V2

		made available • Network transition between FRMCS and GSM-R system with REC voice where proven to be possissble • 5G InterPLMN Handover have been proved possible at Transport level (5G) by 5GRail, and parallel projects e.g. 5G Med and 5G Blueprint; we consider that once MCX Interconnection & Migration will be available, and suitable as transition delays, to be applied for a set of Railways applications and to replace 2UEs.	

3.3.1 Background for different stages of FRMCS specification process

3.3.1.1 Mapping of FRMCS requirements into 3GPP Specifications

International Union of Railways (UIC) working groups have investigated and summarised their requirements for the next generation railway communication system in the Future Railway Mobile Communication User Requirements Specification. These requirements have been sent to 3GPP by ETSI TC-RT. Besides general requirements, this document identifies use cases for the FRMCS based by giving descriptions, rationale etc. and identifying requirements. These requirements needed to be assessed regarding their relevance for 3GPP and if necessary, adapted to 3GPP terminology.

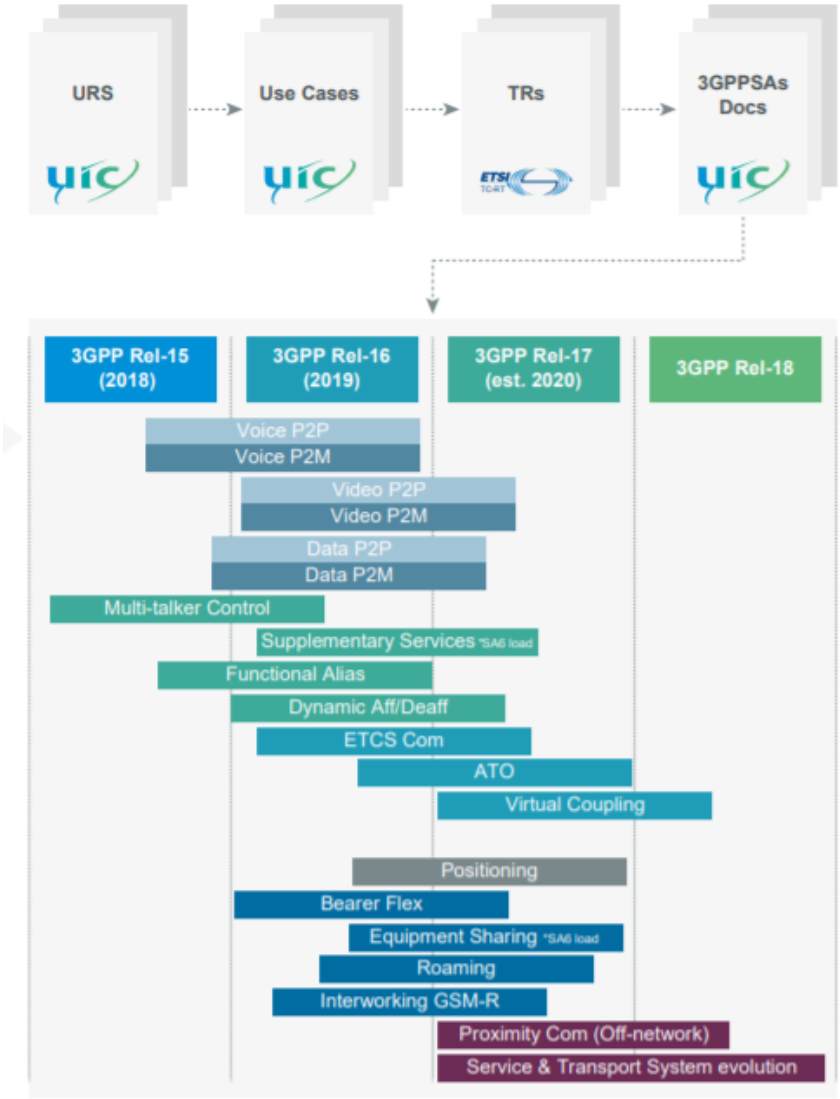


Figure 12: FRMCS 3GPP Standardisation mechanism and main FRMCS 3GPP/5GRAIL building blocks

A gap analysis was started in 3GPP Release-15 with stage 1 study item FS_FRMCS, and continued in Release-16, Release-17, Release-18 and Release-19.

The following figure shows current FRMCS 3GPP standardisation and 5GRAIL roadmaps.

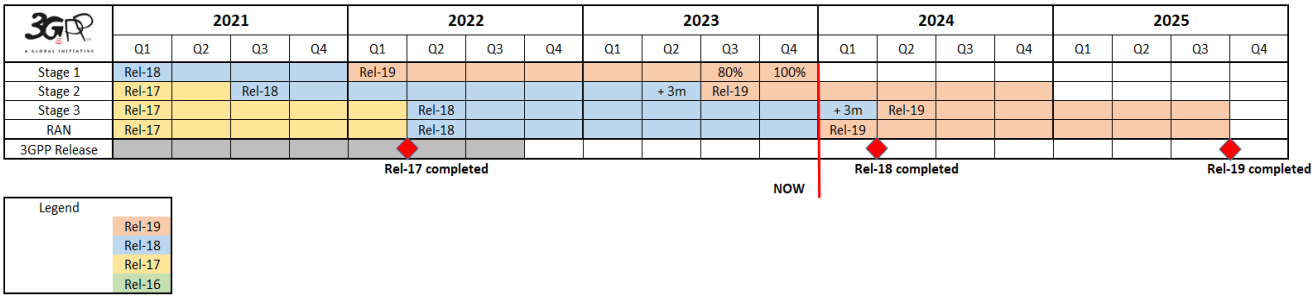


Figure 13: FRMCS 3GPP/5GRAIL Standardisation roadmaps

3.3.1.2 FRMCS Specification Map

UIC has mapped all relevant specifications existing (or to be developed) which are needed to completely define FRMCS and allow its introduction into operation.

These specifications are divided in seven categories:

- User & Functional Requirements (UIC)
- 3GPP Specifications
- ETSI Specifications
- System Requirements (UIC)
- Test cases
- Applications Requirements (UIC)
- Frequency Reports and Decisions

The current status of the ''Specification Map'' is listed below:

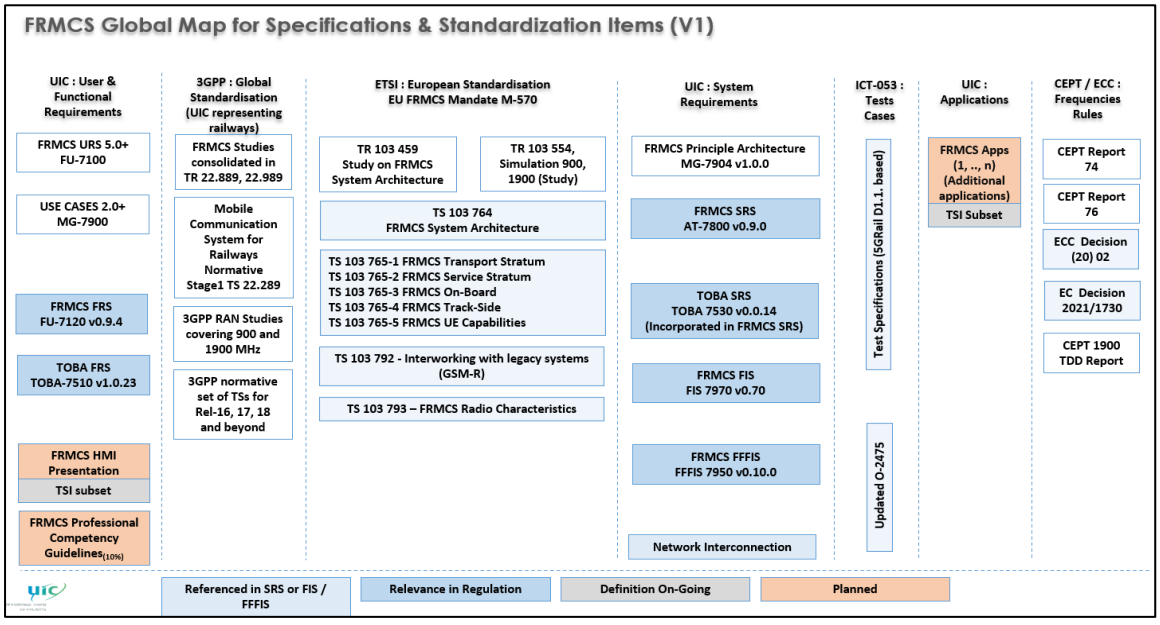


Figure 14: FRMCS Global Standadization Landscape

3.3.1.3 FRMCS Implementation Status

Work on FRMCS started some years ago. 2018 / 2019, UIC have proposed to all stakeholders an FRMCS Implementation plan. This Plan has remained unchanged since then, except adaptations depending on findings during this activity.

The current version of this plan is presented below:

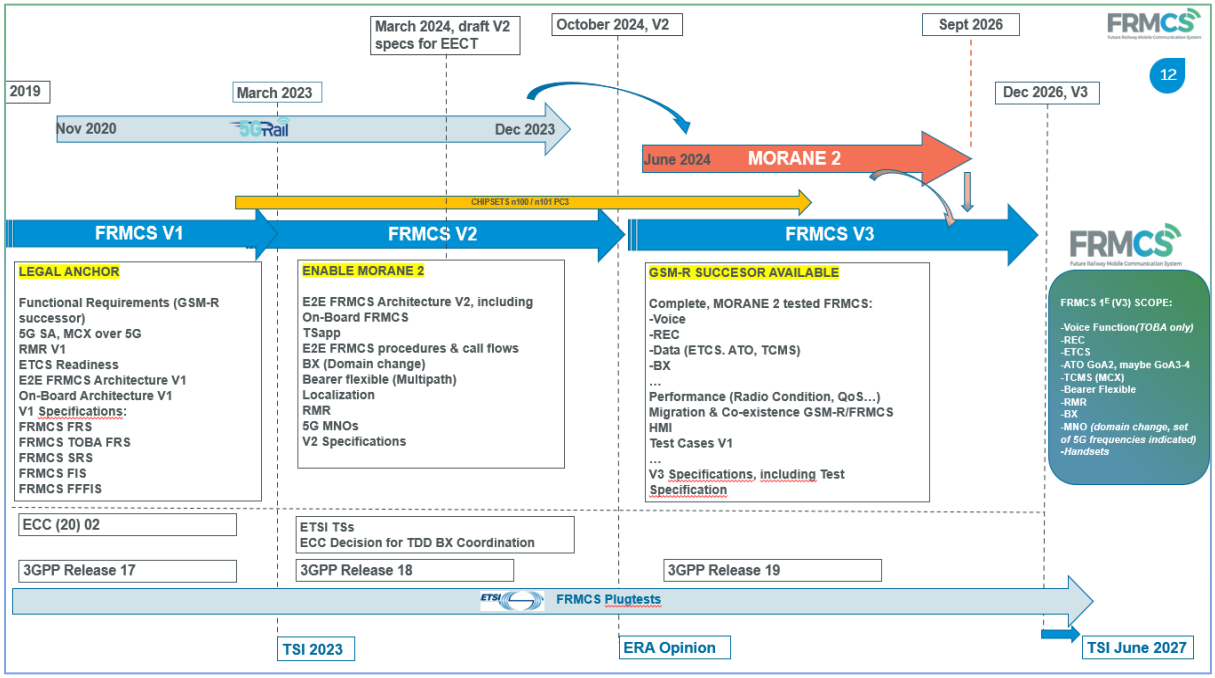


Figure 15: FRMCS implementation plan

It is important to say that this plan is now agreed between UIC and ER JU, DG Move, ERA and UNITEL. The FRMCS Presentation has been planned since the beginning on three steps:

Step 1 – FRMCS V1

This Step is successfully closed. Within this step, FRMCS V1 specifications have been built. Currently, FRMCS has been introduced in the 2023 CCS TSI, together with the FRMCS V1 specifications, see below links where all these documents are freely available for download:

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2023.222.01.0380.01.ENG&toc=OJ%3AL%3A2023%3A222%3ATOC

https://uic.org/rail-system/telecoms-signalling/frmcs

Step 2 – FRMCS V2 – Enabling MORANE-2

We are currently in full activity to prepare and deliver FRMCS V2 specifications. These will enable the execution of MORANE 2 Trial, the FRMCS European Trial. This Trial is planned to be co-financed by ER JU. MORANE-2 is planned to start in June 2024, and last 27 Months.

The role of 5GRAIL was very important, as it allowed the confirmation of the FRMCS V1 principles, in some cases helping on solutions choices. 5GRAIL will also help for the planning of MORANE-2.

Step 3 – FRMCS V3 – FRMCS -the GSM-R successor availability.

With the successful execution of MORANE-2, it will be possible to finalise the FRMCS V3 specifications, that are planned to be delivered to ERA and DG Move in December 2026. With this, DG Move plans to introduce FRMCS v3 in the next CCS TSI, planned around June 2027.

4 ADVISORY BOARD

In 5GRAIL, the research and technology uptakes were developed in parallel to standardisation activities. The 5GRAIL partners therefore supported this task by checking the viability and accuracy of the 5GRAIL results with the developments in Regulation and Standardisation bodies in order to safeguard the project services and conformance to actual standards and regulations.

For this main reason, an Advisory Board was established within 5GRAIL, with members from UNISIG, UNITEL, EU-Rail, ERA and ETSI, as the main beneficiaries of the outcomes of 5GRAIL.

Moreover, other relevant interested European rail stakeholders such as Railway Undertakings, Infrastructure Managers, railway operators and industrial companies, as well as Rail Baltica also participated to discuss 5GRAIL achievements and upcoming actions, so that 5GRAIL can benefit from the feedback and can discuss where possible various related issues.

The participation to the Advisory Board was based on written demand, and following the CA rules.

The main tasks of the Advisory Board were notably:

- To get feedbacks/comments from the members of the Advisory Board;
- To establish cooperation and link activities (mutual cooperation);
- To report regularly on the progress of the project to facilitate the transfer of the results to the sector;
- To establish direct contacts with regulatory and standardisation bodies.

Three meetings of the Advisory Board were held as follows:

- 1st AB meeting on 10/06/2021 (virtual meeting)
- 2nd AB meeting on 15/12/2021 (virtual meeting)
- 3rd AB meeting on 04/10/2022, Paris (hybrid meeting)

The members of the AB were also invited to attend the 5GRAIL final conference on the 7th December 2023 in Brussels.

5 CONCLUSIONS

This report has provided an exhaustive list of all dissemination/communication activities carried out during the 38 months of project implementation.

A large audience has been reached by 5GRAIL messages, ensuring a proper dissemination of the project developments:

- 5GRAIL consortium members have reached some 19 conferences and delivered some 21 papers and articles;
- Good collaboration has been achieved with sister H2020 ICT-53 5G for CAM projects (5G-Blueprint, 5GMED, 5GRoutes).
- 5GRAIL technical details and choices have been discussed with railways communities numerous times.
- The main FRMCS Client, the European Railways Heads of Telecoms have permanently been in contact with 5GRAIL, as well as the EU Agency for Railways (ERA).
- 5GRAIL supported the FRMCS specification developments and helped the decisions for many items.
- Lastly, 5GRAIL has helped smoothen the planning for the execution of the FRMCS European Trial (MORANE-2).

The 5GRAIL partners have shown their engagement towards the market uptake of the results and have ensured through their exploitation activities the smooth and effective transfer of results, especially in terms of the opportunities for future research to be carried out through EU-Rail.

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