NEWSLETTER

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION`S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO: 951725

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01 Foreword

Jean-Michel Evanghelou, UIC (Project Coordinator)

Dear Reader,

In this first newsletter of the 5GRAIL (5G for future RAILway mobile communication system) project, you will learn about the project and the latest developments, now that the Project reached its halfway point.

The test plan is mature and reached its final form. The FRMCS on-board System (TOBA) prototype architecture has achieved a good maturity level. The current FRMCS specification have been considered everywhere it was possible, and the applications have also followed these principles, with 3GPP Mission Critical and FRMCS On Board applications interface (OBAPP) requirements also considered.

A first TOBA prototype was built and is already supporting lab testing. A second edition of this prototype version is being made available; it will also include a new FRMCS Modem prototype from Thales, supporting FRMCS 1900MHz band and positioning capabilities. The Labs of Nokia (WP3) and Kontron (WP4) are now fully operational, offering a complete 5G SA infrastructure and MCX services, also with other 5G bearers (and some others, for bearer flexible use cases) are available for testing of specific FRMCS applications. Applications provided by 5GRail partners are already integrated and installed or available remotely in both labs.

Voice applications testing has started in WP3 lab in parallel with some integration testing of data applications (ETCS, TCMS, CCTV, Video). WP4 lab, has achieved its 1st data FRMCS call, aligned with TSI 2022, with Alstom ATO and Kontron TOBA over an FRMCS 5G network of Kontron (including MCX server). ETCS and PIS applications testing is in progress. Cybersecurity demonstration in the scope of WP4 lab is currently under study.

WP5, responsible for field testing, started in January 2022. Functional tests to repeat in field, are already defined. Work on site readiness by 2023 is on-going.

The emulation of the road and rail coexistence scenario defined by WP6 is in progress.

To find out more about 5GRAIL, its objectives and the consortium partners, but also to access the public deliverables, please visit our website on http://www.5grail.eu

Enjoy the read!

02 Project Scope & Structure

Dan Mandoc, UIC (Technical Leader)

The Future Railway Mobile Communication System (FRMCS), that will be materially proven by 5GRAIL, is seen by the railway sector as the enabler of train digitalisation, and consequently as one, if not the one, of the major “Game Changers” of DG MOVE’s strategy for railway Command-Control System evolution.

The deployment of 5G FRMCS will open the possibility for railway operators to implement in addition to existing critical ones supported by GSM-R which are the Voice applications and the ETCS (European Train Control system), an extensive list of new applications permitting to optimise train operations and maintenance on one side, and to increase the quality of service to passengers (security, availability, punctuality and information) on the other side.

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. It will replace GSM-R, which represents around 130,000 km of coverage of tracks in Europe, announced obsolete by around 2030, due to its current 2G based technology. GSM-R is one of the components of the European Railway Traffic Management System (ERTMS), which is the European unified system for Control-Command and signalling, included in the European regulation.

The work on the FRMCS functional & system requirements specifications, including the on-board, interfaces, standardisation in 3GPP and ETSI, as well as regarding harmonised spectrum solutions is currently led by UIC, in cooperation with the whole railway sector.

A major challenge is the update by the European Railway Agency of the Technical Specification for Interoperability of Control Command and Signalling (CCS TSI) by the end of 2022 with version 1 of these FRMCS specifications with respect to functionalities for interoperability.

Therefore, the main objective of 5GRAIL, a DG Connect co-financed project, is to validate this 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. The test result will then support these specifications update in preparation for next step which is European Trials, based on upgraded 5G equipment around 2024.

Regarding on-board, 5GRAIL aims to reduce specific equipment costs and installation engineering time

FRMCS enables critical and train performance applications:

- Railway Emergency Call;
- ETCS and its enhancements;
- Automatic Train Operations;
- Remote monitoring and train surveillance systems;
- Remote control of engines;
- Video Capacity that will become available.

by combining all train-to-ground communications, with an 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.

Prototypes will be 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 the FRMCS version 1 specifications, and consequently significantly support the the time to market for FRMCS products, planned for the end of 2025 as per the European timeline.

5GRAIL will span a period of 30 months and is divided into 8 Work Packages (WPs), six of which will focus on research and development, test, field implementation and evaluation and two on coordination and dissemination:

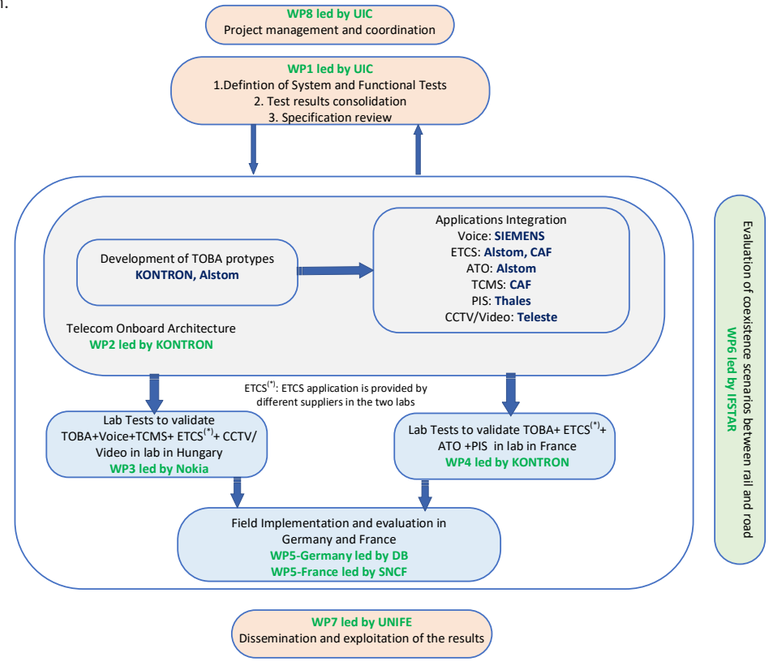

Figure 1: 5GRAIL project structure

03 WP1

FRMCS tests definition, tests results & specification review

Vassiliki Nikolopoulou (WP1 Leader)

5GRAIL WP1 is in charge of the definition of functional end-to-end tests to validate a selected subset of features of FRMCS V1 Specifications, analysis and conclusions on observations and outcomes during lab activities of WP3 (Nokia–Hungary) and WP4 (Kontron-France) and field activities WP5 (DB-Germany, SNCF-France), contributing to the preparation of a performance measurements methodology, based on WP5 field activities, to apply on further 5G FRMCS operational deployment, identifying technical constraints related to implementation issues to potentially amend or modify FRMCS V1 Specifications. WP1 has a core position in the 5GRAIL project, since it has an interaction with almost all WPs and all partners are involved in this WP in different ways, as summarized on the figure below.

The main achievements during this 1st period aligned with the timeline of the WP, is the elaboration of the Test plan (Deliverable 1.1) with more than 114 test cases for labs of WP3 and WP4, validating the FRMCS interfaces (OBapp/TSapp) compatibility for MCX ''loose coupled'' data applications (ATP (ETCS), ATO, TCMS, PIS) and tight coupled (voice), providing test cases descriptions for a preliminary R17 Railway Emergency Call, cross-border scenarios for TCMS, ATP (ETCS), bearer flexible feature validation using CCTV, ATP (ETCS) and ATO applications. Moreover, application KPIs and QoS negotiation elements are introduced in the test plan's descriptions to compare performances between perfect and degraded conditions.

The foreseen next steps will be further deliverables analysing observations made during the lab and field tests.

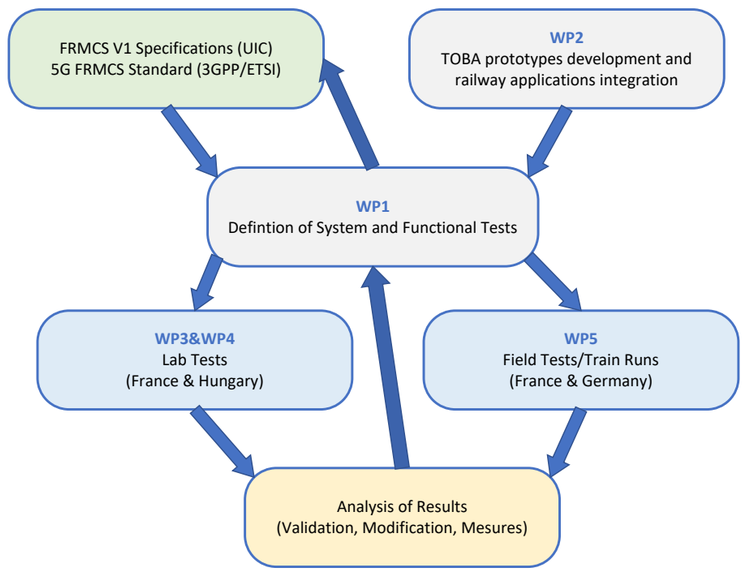

Figure 2: Interdependencies between WP1 and the other WPs

04 WP2

TOBA prototypes development

Farid Bazizi, Kontron (WP2 Leader)

TOBA (Telecom on-board Architecture) is the FRMCS entry point for the On-Board and Track-Side applications. As shown in Figure 3, TOBA is based on 3 key design paradigms:

- **Decoupling** of Applications and Communication Services/Transport;
- **Bearer Flexibility** (i.e. variety of bearers or Radio Access Technologies simultaneously);
- **Resource Sharing** (e.g. providing transport services for multiple applications of any category using the same FRMCS on-board system considering the individual QoS requirements of the application and possibly priorities among applications).

To enable the lab and field trials, there are two types of prototypes to be developed :

· The Applications, already rolled out in GSM-R which need to be ported over the new FRMCS systems. Main evolution is the compliancy with the new FRMCS standardized reference points OBapp for the on-board part and TSapp for the trackside part.

· The TOBA system that is declined into the two FRMCS gateways for on-board and trackside. These prototypes are developed from scratch being a new node of FRMCS.

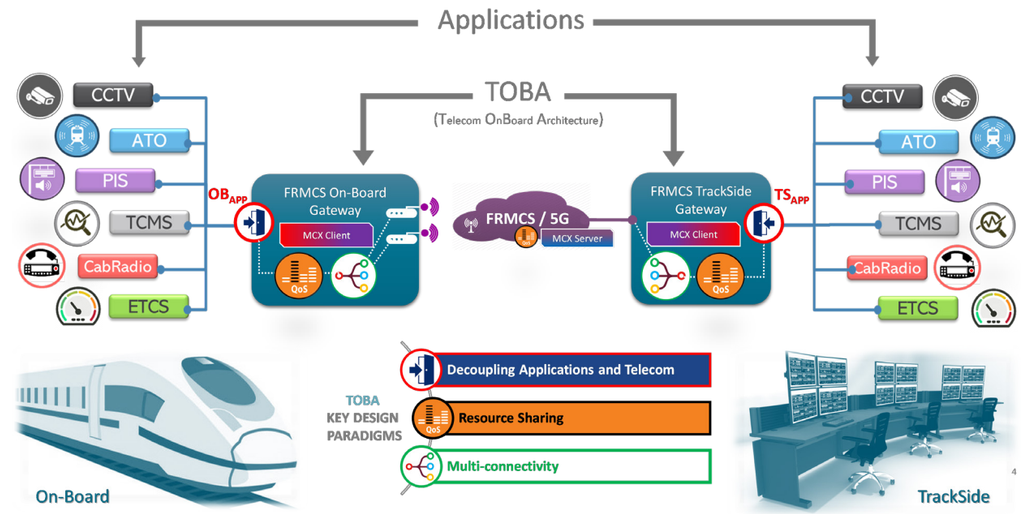

Figure 3: TOBA prototypes and design paradigms

After almost 18-month project execution, find below the main achievements :

- **TOBA Architecture has been elaborated**: TOBA key design paradigm and complete definition of the OBapp and TSapp interface has been documented in D2.1 TOBA Architecture Report document.
- **Prototype development has been started**:
  - **Almost all applications have completed the OBapp and TSapp interface implementation** and are now ready for starting the integration with the FRMCS Gateways
  - **TOBA prototypes have been developed** and can support the 1st design paradigm: meaning decoupling application and transport with OBapp and TSapp interface.
  - **OBapp and TSapp simulators** for Applications has been developed to derisk their integration with real TOBA systems. This workstream has been capitalized in **D2.2 TOBA Integration Report**.
  - **The 1st data FRMCS call**, aligned with TSI 2022, was achieved in Kontron Lab with Alstom ATO and Kontron TOBA gateways (using MCX IPConn) over Kontron 5G networks (including MCX Server), using full OBapp and TSapp interface – refer to Figure 4.

Next steps are to finalize the OBapp/TSapp integration for all applications and to start prototyping the 2 other TOBA design paradigms : Ressource sharing with QoS management and Multiconnectivity with usage of different radio bearers.

Particularely using FRMCS 5G bearer based on new FRMCS Modem prototype from Thales that will support FRMCS 1900MHz band. This modem is under development and will be integrated in the onboard FRMCS gateway by mid 2022.

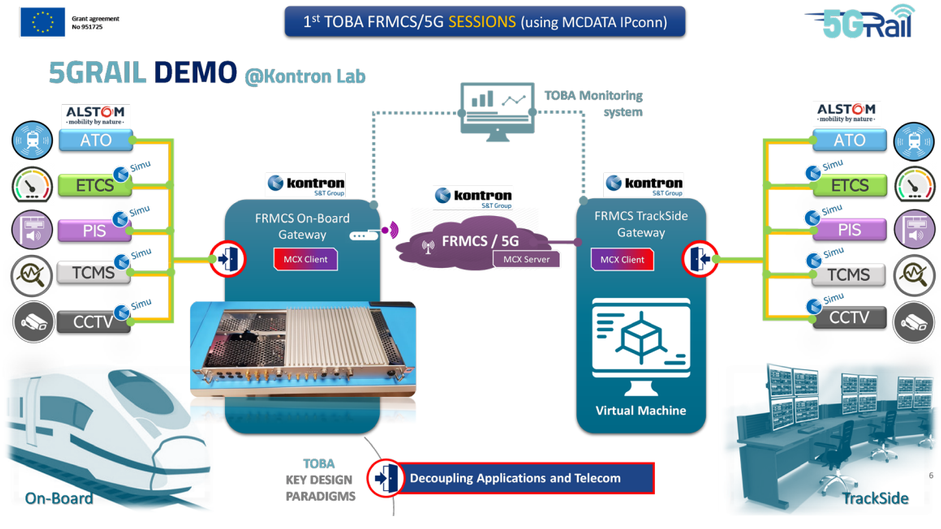

Figure 4: 1st FRMCS E2E data call in Kontron lab in France

05 WP3

Validation of ETCS, Voice, TCMS and CCTV/Video within TOBA – Laboratory tests

Michael Klöcker, Nokia (WP3 Leader)

WP3 provides the first 5G reference lab environment situated at Nokia premises in Hungary/Budapest. The activities of this lab are focused on voice applications, ETCS, TCMS, CCTV and Video.

The focus of the lab test is to combine FRMCS 5G infrastructure and On-board GW prototypes with the related application prototypes in a unique environment for testing.

GSM-R infrastructure is available to cover 5G-GSM-R interworking scenarios as defined in WP1. The lab configuration will be used to de-risk field tests in the scope of WP5, led by DBN in Germany and connect 5G core, MCX server and GSM-R infrastructure remotely for field test execution.

The achieved integration of the various elements provided by Nokia and partners has been achieved and the test execution has just started. Additionally, to cope with the COVID 19 impacts, remote connection for maintenance activities or even remote tests were setup for every partner allowing to access their installed products.

WP3 focuses on the following test cases with below partners within a Lab that has the following architecture:

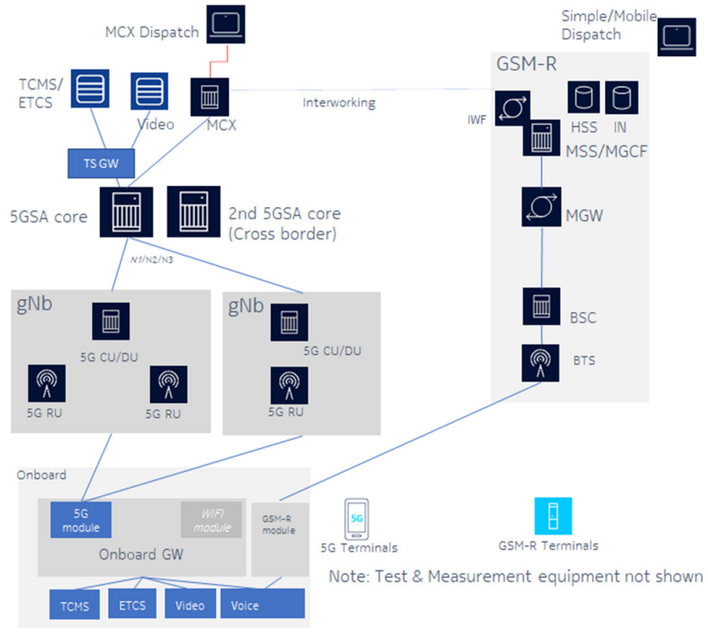

Figure 5: WP3 Lab Configuration

Application	Partner
Voice / CAB Radio	Siemens
TCMS/ETCS	CAF
Video	Teleste
OB/TS GW	Kontron
Infrastructure	
5G Core, Radio, MCX Server, Dispatcher, GSM-R	Nokia

Railway Emergency incl. GSM-R Interworking	Train to/from Dispatcher
ETCS	TCMS: Remote Control / Telemetry/Cross Border
CCTV – Transfer of files / Bearer Flexibility	Real Time Video Streaming

Figure 6: WP3 test cases

06 WP4

Validation of Data, ETCS, ATO & Cybersecurity within TOBA – Laboratory tests

Sebastien Tardif, Kontron (WP4 Leader)

WP4 is responsible for building a second test lab in order to test some railways data applications, such as ETCS, ATO and PIS, in an FRMCS setup and with some cybersecurity aspects. This WP is driven by Kontron Transport which provides main 5G SA infrastructure in its Montigny's premises near Paris, France. Other WP members include Thalès, which provides an access via VPN to its Passenger Information System solution, and Alstom, which not only brings its ETCS/ATO expertise with installing related components in the lab but also contributes, like Kontron, in FRMCS On-Board and Trackside Gateways development and testings. SNCF and IP also participate in WP4, SNFC having in perspective the preparation of WP5 french field tests that will occur in 2023.

First part of WP4 project consisted in building the lab, now fully operationnal as shown on the figure below:

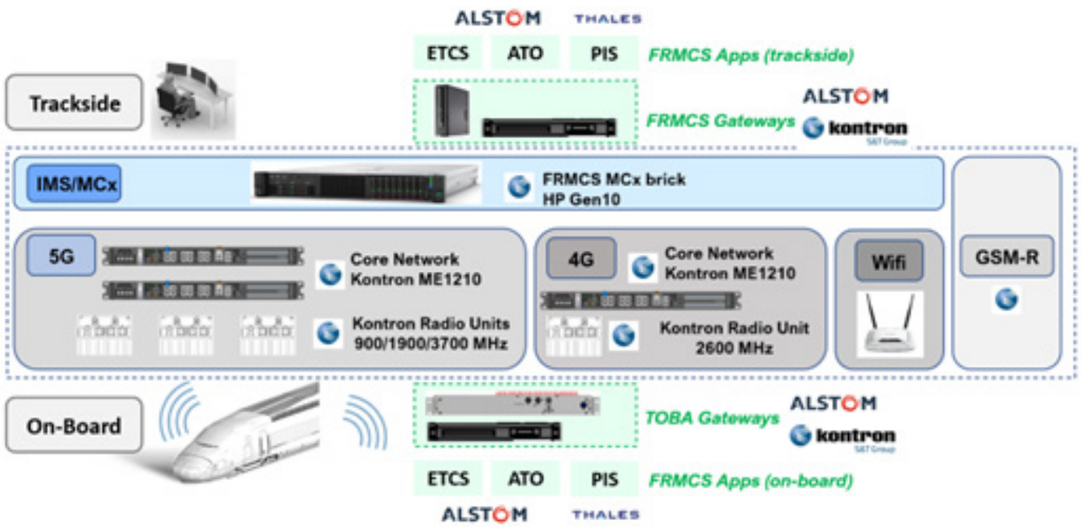

Figure 7: WP4 lab components

07 WP5

Field implementation and Evaluation

Guillaume Jornod, DB & Nazih Salhab, SNCF (WP5 Leader and co-leader)

The field implementation and evaluation work package aims at providing a 5G railway field test environment in order to evaluate the technical solutions and the prototypes that have been developed in the project. The field test will demonstrate the usability of 5G as a solution to the needs of railway applications.

The tests will be performed in parallel in two sites, one in France and one in Germany, with each different characteristics in terms of architecture and test cases. Complementary cross-border use cases will be performed to compare the results in different conditions.

The WP has been kicked-off in January 2022. The planning phase has started for both test sites, regularly synchronising with the different partners involved in the test beds, especially for the network installation and the applications. In the meantime, an assumptions list has been compiled for the test beds, and the test cases list has been reviewed from the field implementation point of view.

Figure 8: Test site in Germany

Figure 9: Test site in France

08 WP6

Rail and Road communication systems coexistence

Marion Berbineau, Universite Gustave Eiffel France (WP6 leader)
Jose Soler, Technical University of Denmark (WP6 co-leader)

The main objective of this WP is the evaluation of Rail and Road communication systems. The topics addressed are:

- **Identification of various scenarios** (including level crossing but not only) for rail/road systems interaction in present operation, when future autonomous trains and cars are implied, and where a level of autonomy is used by automotive and another by railway;
- **Development of a simulation/emulation platform** to implement a set of specific scenarios;
- **Simulations/emulations and conclusions** based on simulation results.

Figure 10: Examples of coexistence scenarios

The methodology developed to identify the coexistence scenarios from a communication point of view has consisted in identifying:

• the number of Radio Access Technologies (RATs) and associated Radio Access Networks (RANs);

• whether these identified RANs are public or private;

• the amount of core networks and whether these networks are public or private.

The simulation/emulation platform is under construction based on well known open source tools such as SUMO for mobility, Mininet-Wifi and Open Air Interface 5G for network communications. Conections with well known simulators are also being analysed and some preliminary scenarios will be implemented and evaluated in the next steps.

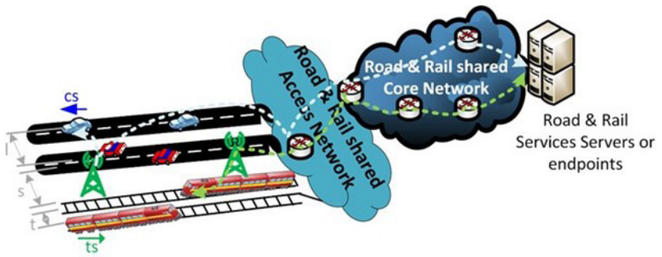

Figure 11: Example of coexistence scenario with shared RAN and shared core network

5G Rail

STARTING DATE
01/11/2020

BUDGET
13.3 M€

CALL IDENTIFIER
H2020-ICT-2019-3

DURATION
30 MONTHS

TOPIC
ICT-53-2020, 5G PPP
5G FOR CAM

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