5GRAIL

AN IMPORTANT STEP FOR THE FRMCS INTRODUCTION

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Railways are currently using the GSM-R system for operational communication, as a key component of the European Railway Traffic Management System ERTMS.

Designed 20+ years ago and completely border-crossing interoperable, GSM-R is deployed on more than 130,000 kilometers of track in Europe and 210,000 kilometers worldwide.

GSM-R is supporting the train driver to signaler voice applications including the Railways Emergency Call and ETCS (European Train Control System), applications that require specific functionalities and a very strong Quality of Service.
The Future Railways Mobile Communication System (FRMCS) is the railways response for two elements of strategic importance for the future of the railways:

**GSM-R Obsolescence**
GSM-R is a 2G system. Manufacturers have announced that GSM-R equipment is due to reach the end of its life (around 2030) and will be supported until around 2035. Without a suitable and timely replacement, this will heavily impact the train system in Europe.

**Digitalisation**
FRMCS is also a significant opportunity - enable the Railways Digitalization - the need to transmit, receive and use increasing volumes of data, which is at the very heart of sustainable transport.

The FRMCS 1st Edition, planned to be available for implementations end of 2025, is a 5G system, including the Mission Critical (MCX) work frame, based on 3GPP R17 and R18.

**FRMCS Key Facts**
- 5G based
- Improved REC
- ETCS and ATO
- Enhanced Railway traffic & performance
- Enable digitalisation
5GRAIL is an essential part of the FRMCS introduction plan

Our goal is to make available together with partner Industry and Authorities a FRMCS 1st Edition, end 2025, to be able to start the national trials, and the migration.

To reach that the embedded three steps plan is followed.

A very important step of this plan is building and testing the FRMCS Demonstrator, especially On-Board.

This will be performed through the EU co-funded H2020 ICT-053 5GRAIL project.

FRMCS will continuous improve, with enhancements introduced in R19 and beyond,
The Railway Emergency Call (REC) is very different to 112. The Train is a guided vehicle; it cannot steer right or left, and it weights more than 800 tons. The brake distance of a train with 15 coaches from 120 kmph is 875 metres.

In case of danger, the Train Driver presses the REC button on his radio. A pre-engineered Group Call Area is instantly created, and all trains in it are notified within two seconds, and will start braking the trains. PTT speech is granted for the call initiator first after which the Train Controller, who will also be alerted, starts organising the response and the traffic restart.
Elaborate FRMCS prototypes based on the FRMCS V1 specifications, including the new on-board equipment (TOBA), the critical applications Voice, ETCS, ATO, and the performance applications TCMS, CCTV/Video;

Define the relevant functional end-to-end tests required to verify the prototypes;

Execute these tests in lab environment firstly, and then in railway environment with train runs

Prepare a performance measurements methodology, based on field activities, to apply on further 5G FRMCS deployment;

Define and emulate coexistence scenarios between railway and roads;

Analyze the outcomes of these tests to loop back on FRMCS V1 specification, to amend or modify those, and then obtain a finalized version of FRMCS V2 specification for sector regulation.

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**Project acronym** 5GRAIL

**Project title** 5G for future RAILway mobile communication system

**Starting date** 01/11/2020

**Duration in months** 30

**Call (part) identifier** H2020-ICT-2019-3

**Topic** ICT-53-2020 5G PPP – 5G for Connected and Automated Mobility (CAM)
WP1 - status

WP1 - FRMCS tests definition, tests results consolidation and specification review

Achievements:

- D1.1 v2 Test plan (phased approach) submitted:
  - 114 Test Cases for lab testing phase (WP3 and WP4)
  - Includes the Integration test cases, QoS negotiation, Expected results, Mapping of the test case description to the network and radio set-up configuration

- Selection of field test cases

Next steps:

- Description of Field Test Cases
- Determine end-to-end performance KPIs
- Descriptions degraded conditions set-up in the relevant test cases
- Cybersecurity - to be tested with ATO and ETCS applications

- Prepare next deliverables with observations from labs and fields tests

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WP2 status

WP2 - TOBA prototypes development

Deliverables:
- D2.1 TOBA architecture report v2 submitted.
- D2.2 Integration Report submitted

Achievements
- The TOBA prototypes phase 1 have been delivered and integrated in the labs with the track side equipment and the applications prototypes.
- The Project have obtained n39 (FRMCS 1900 MHz) chipsets
- The applications have been worked out to include MCX architecture (see below).

Next steps:
Include
- Multi-connectivity
- Localization
- Include n39 / 31 dB Modem

- Preparation of next deliverables
WP3 status

WP3: Validation of ETCS, Voice, TCMS and CCTV/Video within TOBA – Laboratory tests

Achievements:
- Deliverables
  - D3.1 First Lab Integration and Architecture Description submitted
  - D3.2 First Lab Test Setup Report in final review for publication

Achievements
- Prototypes are integrated and in testing
- Voice Cab Radio (integrated directly to MCX at application-level)
- Successful voice call from Nokia smartphone to the Cab Radio
- Interworking with GSM-R testing started (voice)

Next steps:
- Cab radio integration and testing (application level):
- ETCS/TCMS integration and testing
- Video/train to track-side server integration and testing
- Border Crossing (TCMS and Voice use case)
- D3.3 Test report to be published end of April 2023
WP4 status

Global hardware view of WP4 Kontron’s lab with partners equipment

WP4: Validation of Data, ETCS, ATO and Cybersecurity within TOBA – Laboratory tests

Achievements:
- Deliverables
  - D4.1 Second Lab Integration and Architecture Description submitted
- Achievements
  - Prototypes are integrated and in testing
  - 1st call with ATO
  - Integration of n39 23 dB modem

Next steps:
- Integration tasks
  - 31 dB n39 modems
  - FRMCS ATO/ETCS
  - Cybersecurity to be tested with ATO and ETCS applications
  - D4.2 Second Lab Test Setup Report, to be published end of August
WP5 status

WP5 – Field Implementation and Evaluation

- Activities Kicked Off
- Field test cases selection agreed
- Testbeds architecture in progress

- Track Location:
  - France (SNCF) - Commercial line in Vigneux sur Seine, Ile de France (Trunk Villeneuve St. Georges – Juvisy), approx. 7 km length
  - Germany (DB NETZ) Line for experimental trials within Digitales Testfeld Bahn (Erzgebirge), allows 50-80 km/h

- 5GRail Spectrum:
  - France: Future FRMCS Spectrum 1.9 GHz (currently 5G band n39)
  - Germany: Industrial Private Network Spectrum 3.7-3.8 GHz (5G band n78)
WP6 status

WP6 - Rail and Road communication systems coexistence

Achievements:
- Deliverables
  - D6.1 Scenarios for Rail and road communication system coexistence delivered
- Implementation of the scenarios in the simulators
  - Selection of coexistence scenarios done

Next steps:
- Selection and Validation of Tools for the emulation/simulation platform based on:
  - Handover
  - Data Traffic Generation
  - Data Traffic Differentiation with VLANS
- Execute emulations/simulations based on the created demonstrators in laboratory (hardware and software) (e.g., changing host capabilities, assuming different service requirements, modifying 5G radio access parameters to evaluate impact on KPIs, etc.)

Examples of coexistence scenarios

Reference experimentation Testbed
Conclusion and way forward

5GRail is an important step for the introduction of the 5G FRMCS radio system for European Railways.

TOBA prototypes – that include radio modules compatible with FRMCS 1900 MHz conditions are available.

Most of the application prototypes are available. It is important to say that they have been worked out to reach compatibility with Mission Critical architecture.

The test plan, that covers the lab functional and performance tests is available.

Lab test phase have started, with first data call successfully performed, and the first voice call will be made very soon.

Emulation of selected Road and Rail coexistence scenarios is well progressing.

The Field Tests work package have been kicked off, and the test cases have been selected.

The project is already delivering on the sense of interaction with V1 specifications, and the first achieved calls.

We will continue the activities as planned and convinced that the purposes of this project will be reached!
Thank you for your attention

www.5GRail.eu
The Railway Emergency Call (REC) is very different to 112. The Train is a guided vehicle; it cannot steer right or left, and it weighs more than 800 tons. The brake distance of a train with 15 coaches from 120 kmph is some 900 metres. At higher speeds, this will be longer.

In case of danger, the Train Driver presses the REC button on his radio. A pre-engineered Group Call Area is instantly created, and all trains in this area are notified within two seconds, and the train drivers will start braking the trains. Speech is granted for the call initiator (PTT); after which the Train Controller, who will also be alerted, starts organising the response and the traffic restart.

REC has to work “100 %”

...and the Train Controller is alerted and takes the call!