5GRAIL

AN IMPORTANT STEP FOR THE FRMCS INTRODUCTION

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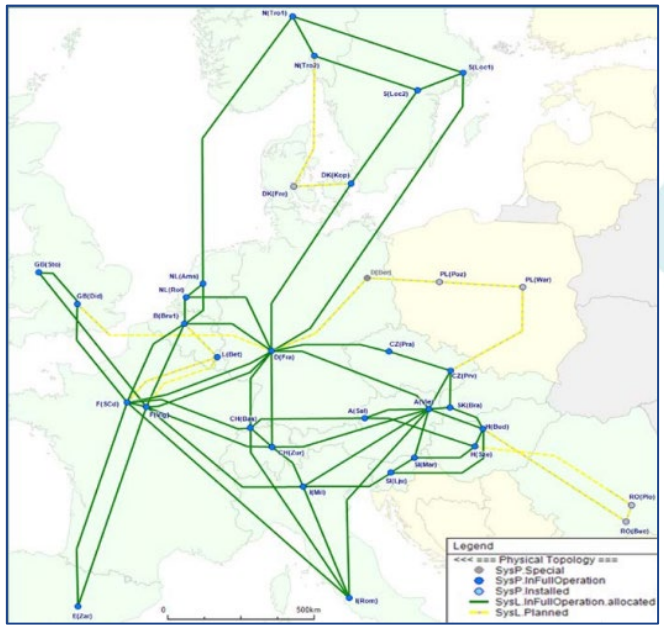
TODAY IS GSM-R...



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 signaller voice applications including the Railways Emergency Call and ETCS (European Train Control System), applications that requires specific functionalities and a very strong Quality of Service.

KEY FACTS

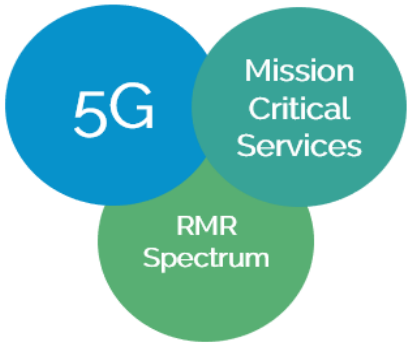
2G- BASED

+
NATION-WIDE
CONNECTIVITY
INTEROPERABLE
IMPROVE SAFETY
ENABLE: REC, ETCS

-
OBSOLESCENCE
APPROACHING

...TOMORROW WILL BE FRMCS

FRMCS
Future Railway Mobile Communication System



3GPP A GLOBAL INITIATIVE 5G

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

2Q'201 — 4Q'2022 — 4Q'2023 — 2025-2026 — 2026 — 2040

FRMCS V1 Specs

STARTING POINT

- URS 4.0
- Use Cases for 3GPP (60%)

PLAN

- ❑ FRS, SRS 1.0
- ➢ On-Board FRS, SRS 1.0
- ➢ FIS, FFFIS 1.0
- ➢ FRMCS Principle Architecture
- ➢ ETCS over FRMCS Principle Architecture
- ❑ Preparation for EC TSI inclusion (→ ERA)
- ➢ CEPT Reports on Railway Frequencies & ECC Decision
- ➢ Validation of Uses Cases V1 in 3GPP R16
- ➢ Use Cases V2 to 3GPP R17 (95%)
- Use Cases Gaps vs. 3GPP => ETSI TS
- ❑ Frequencies for Migration

FRMCS Demonstrator

STARTING POINT

- Stabilized FRMCS Specification
- R16 Products : MCX 5G (→ Industry)

PLAN

- ❑ FRMCS prototypes (→ H2020 5G CAM 5GRail)
- FRS, SRS 2.0
- On Board FRS, SRS 2.0
- FIS & FFFIS 2.0
- ➢ Validation of Use Cases V1 in 3GPP R17
- Use Cases V3 in 3GPP R18
- TSI inclusion 1 (→ ERA)
- Additional elements for TSI
- Technical Migration Scenarios
- ❑ European Interconnection Study
- Signalling Impacts

FRMCS European Trial ⇒ Readiness

STARTING POINT

- Operational FRMCS Specs
- R17 Products : FRMCS 5G (→ Industry)

PLAN

- FRMCS European Trials (→ EU Rail, H2020: 5GRAIL-2?)
- FRS & SRS 3.0
- On-board FRS 3.0
- FIS & FFFIS 3.0
- Validation of Use Cases V3 in 3GPP R18
- Use Cases V4 in 3GPP R19 (evolution)
- TSI inclusion 2 (→ ERA)
- Cross-borders
- Interconnection hubs development (→ EU-Rail, H2020 ?)
- Guidelines for Migration

National Deployments

STARTING POINT

- FRMCS 1st Edition
- R17-R18 Products

PLAN

- Corridors (→ CEF 2 ?)
- National Plans
- MNOs Synergies
- Tenders preparation: 2023 – 2024

(FRMCS evolutions:

2nd Edition,

…)

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,

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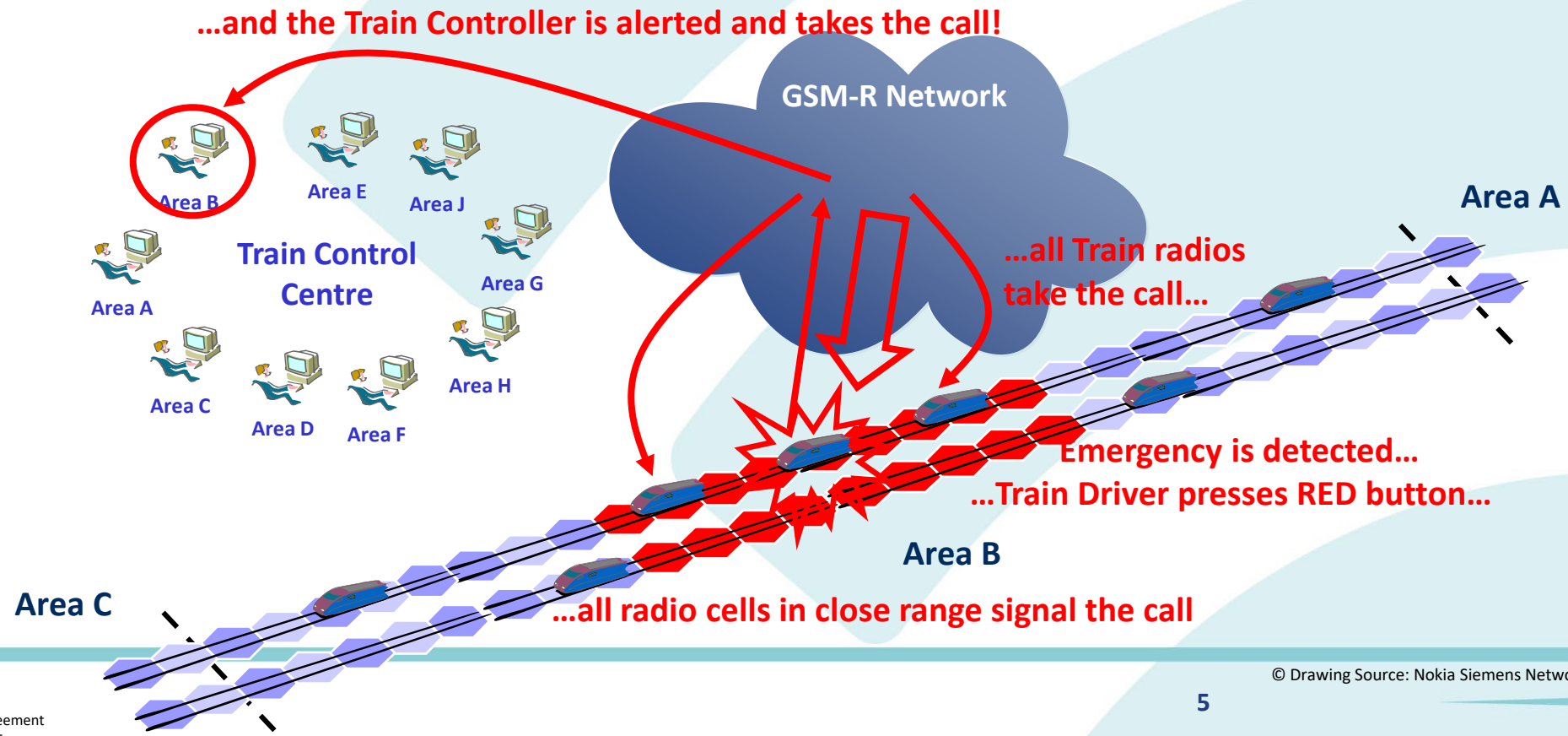
Railway Emergency Call – the killer application

- 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.



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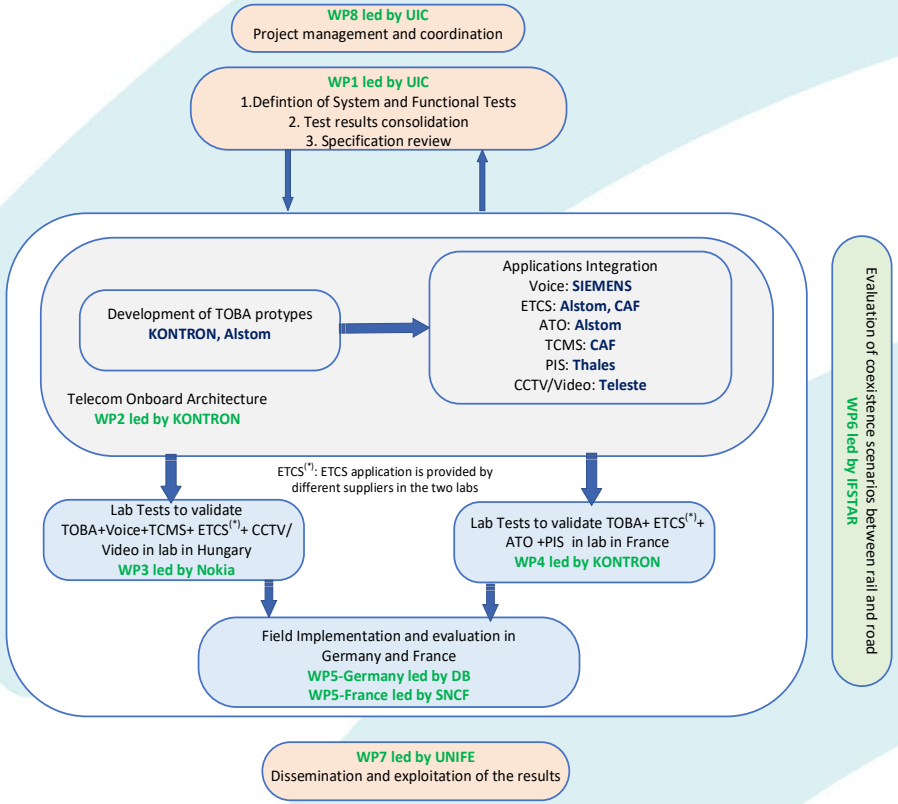
5GRAIL

5GRail: Scope, Structure and Consortium Partners

- 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.



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)

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WP1 - status

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

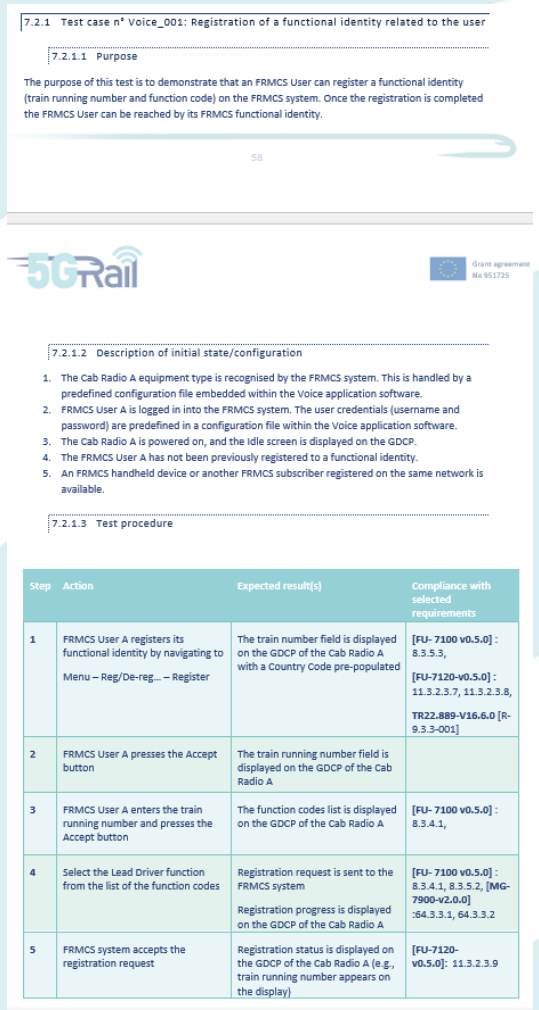
Achievements:

- ❑ 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



7.2.1 Test case n° Voice_001: Registration of a functional identity related to the user

7.2.1.1 Purpose

The purpose of this test is to demonstrate that an FRMCS User can register a functional identity (train running number and function code) on the FRMCS system. Once the registration is completed the FRMCS User can be reached by its FRMCS functional identity.

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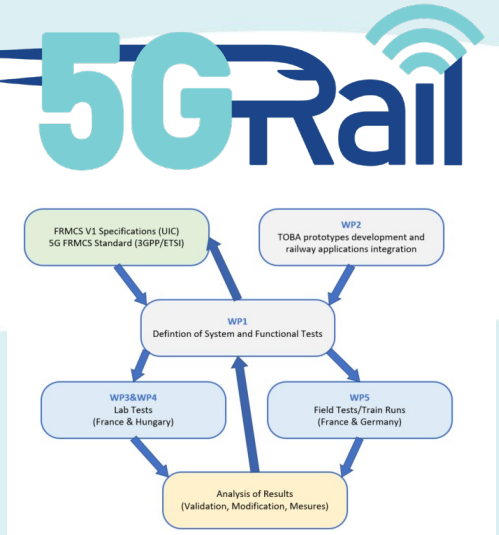
7.2.1.2 Description of initial state/configuration

1. The Cab Radio A equipment type is recognised by the FRMCS system. This is handled by a predefined configuration file embedded within the Voice application software.
2. FRMCS User A is logged in into the FRMCS system. The user credentials (username and password) are predefined in a configuration file within the Voice application software.
3. The Cab Radio A is powered on, and the Idle screen is displayed on the GDCP.
4. The FRMCS User A has not been previously registered to a functional identity.
5. An FRMCS handheld device or another FRMCS subscriber registered on the same network is available.

7.2.1.3 Test procedure

Step	Action	Expected result(s)	Compliance with selected requirements
1	FRMCS User A registers its functional identity by navigating to Menu – Reg/De-reg… – Register	The train number field is displayed on the GDCP of the Cab Radio A with a Country Code pre-populated	**[FU- 7100 v0.5.0]** : 8.3.5.3, **[FU-7120-v0.5.0]** : 11.3.2.3.7, 11.3.2.3.8, **TR22.889-V16.6.0** [R-9.3.3-001]
2	FRMCS User A presses the Accept button	The train running number field is displayed on the GDCP of the Cab Radio A	
3	FRMCS User A enters the train running number and presses the Accept button	The function codes list is displayed on the GDCP of the Cab Radio A	**[FU- 7100 v0.5.0]** : 8.3.4.1,
4	Select the Lead Driver function from the list of the function codes	Registration request is sent to the FRMCS system Registration progress is displayed on the GDCP of the Cab Radio A	**[FU- 7100 v0.5.0]** : 8.3.4.1, 8.3.5.2, **[MG-7900-v2.0.0]** :64.3.3.1, 64.3.3.2
5	FRMCS system accepts the registration request	Registration status is displayed on the GDCP of the Cab Radio A (e.g., train running number appears on the display)	**[FU-7120-v0.5.0]**: 11.3.2.3.9



Deliverable D1.1

Test Plan

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WP2 status

WP2 - TOBA prototypes development

Deliverables:

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

Achievements

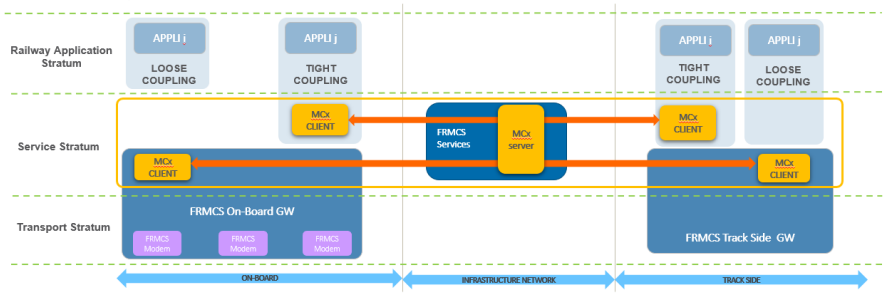
- ❑ The TOBA prototypes phase 1 have been delivered and integrated in the labs with the track side equipment and the applications prototypes.
- ❑ The Project have obtained n39 (FRMCS 1900 MHz) chipsets
- ❑ The applications have been worked out to include MCX architecture (see below).

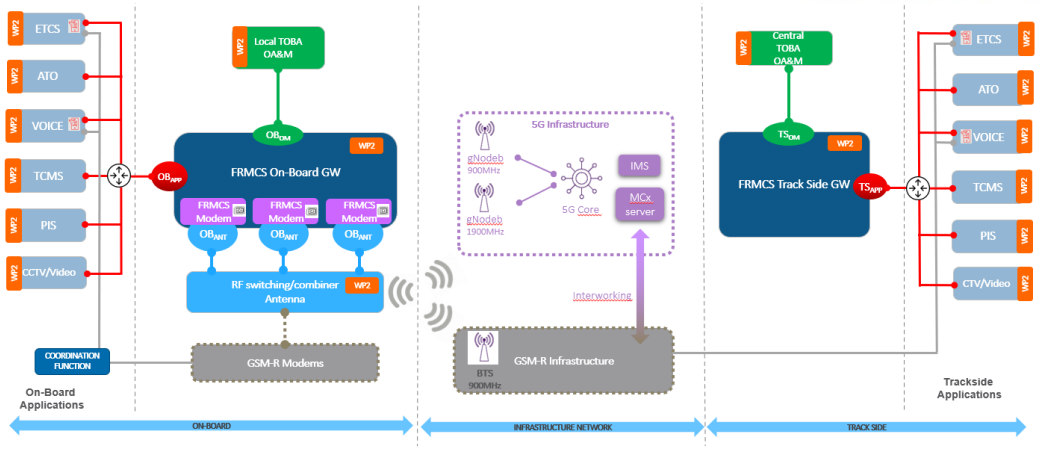
Next steps:

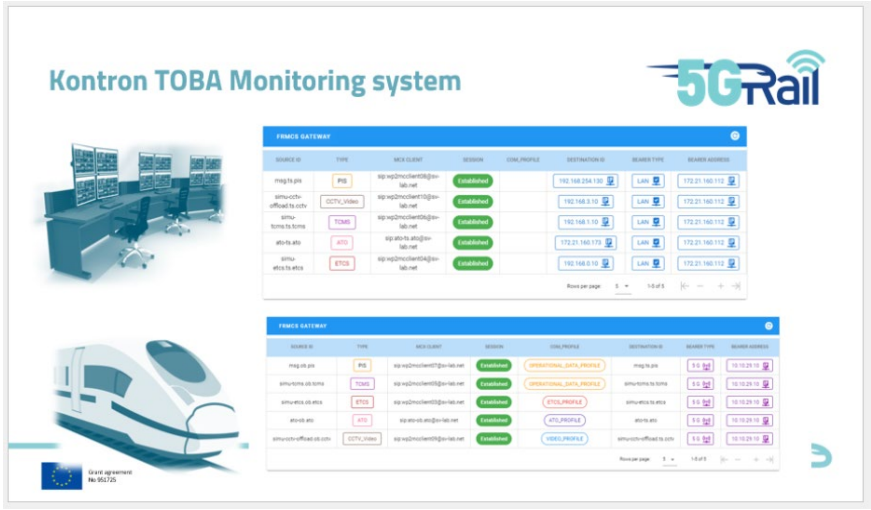
Include

- ❑ Multi-connectivity
- ❑ Localization
- ❑ Include n39 / 31 dB Modem

- ❑ Preparation of next deliverables







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WP3 status

Global hardware view of WP3 Nokia's lab with partners equipment

NOKIA

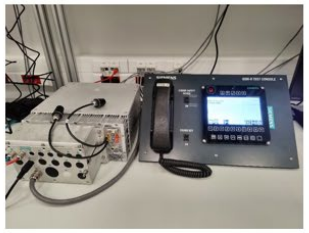
Radio, Core , Terminals

kontron S&T Group

Gateways

TELESTE

Video Camera and Servers



SIEMENS

Cab Radio

CAF

Onboard and Trackside

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

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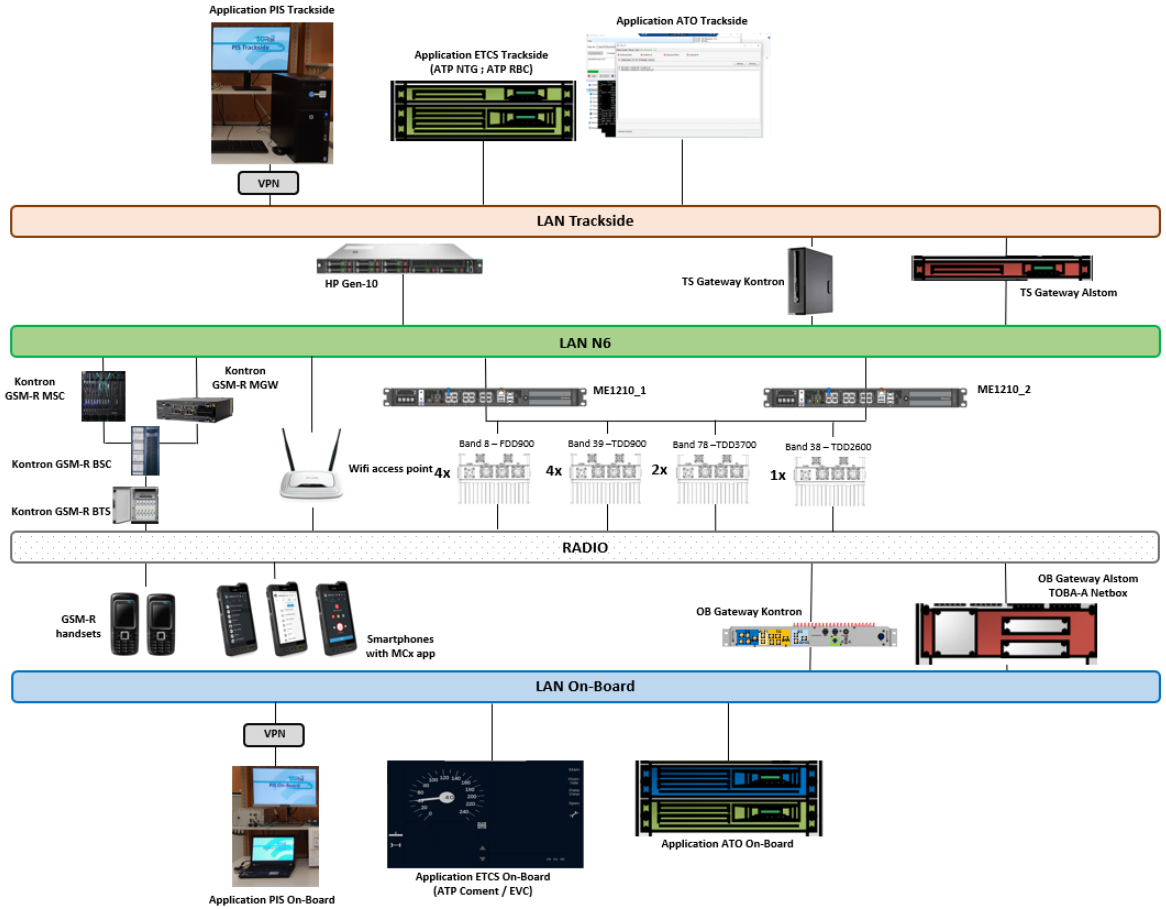
WP4 status

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

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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)**

❑ Test Site in FR

❑ Test Site in DE

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WP6 status

WP6 - Rail and Road communication systems coexistence

Achievements:

- Deliverables
  - ❑ D6.1 Scenarios for Rail and road communication system coexistence delivered

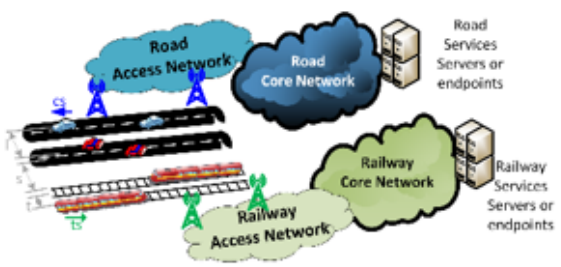
- Implementation of the scenarios in the simulators
  - ❑ Selection of coexistence scenarios done

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



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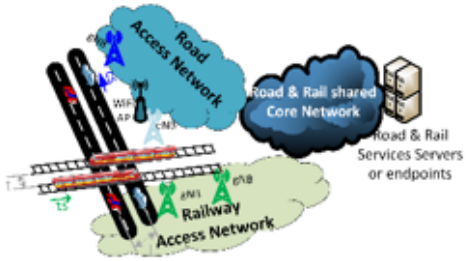

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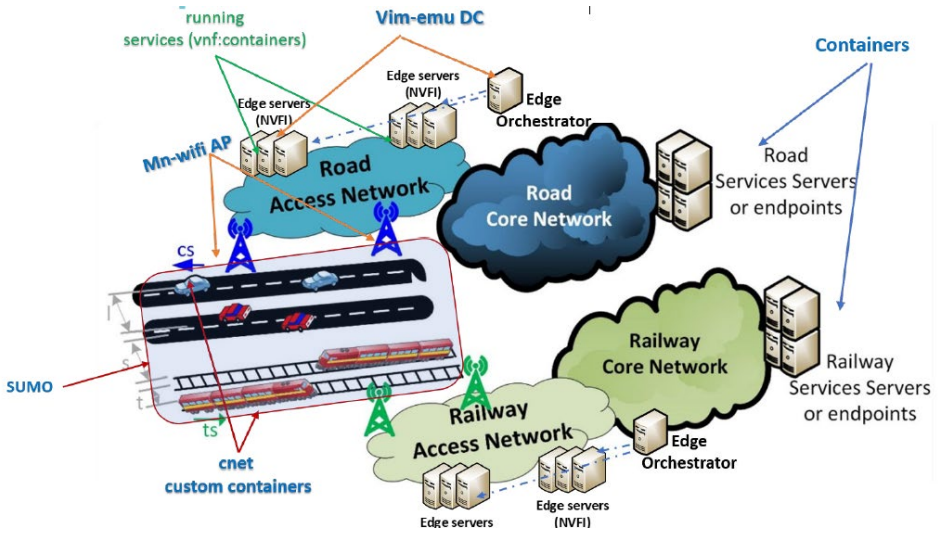

Reference experimentation Testbed

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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.

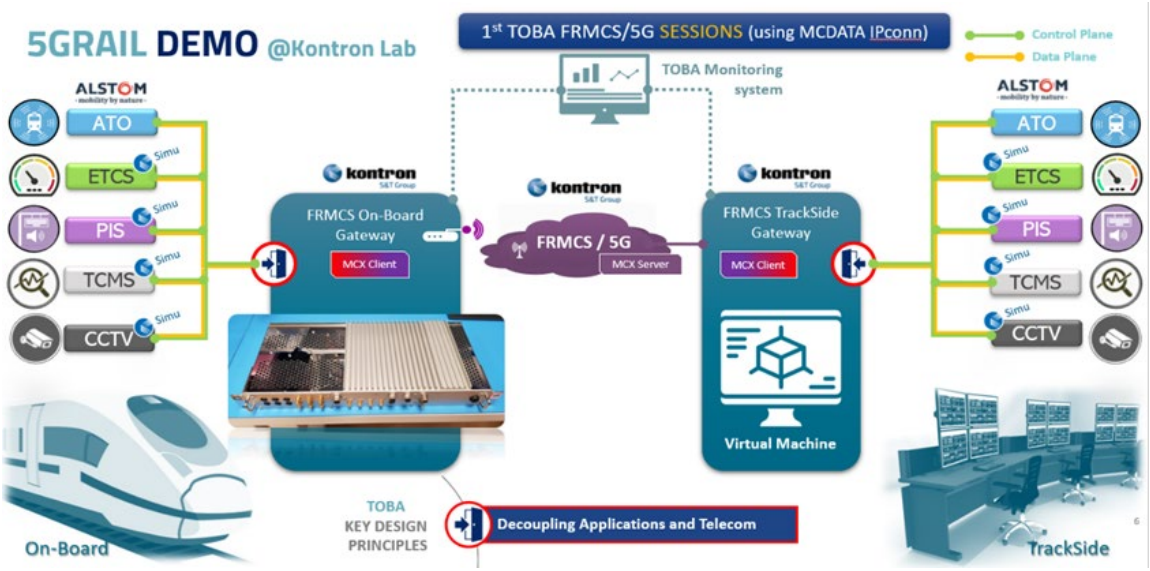
Lab test phase have started, with first data call successfully performed, and the first voice call will be made very soon.

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!



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Thank you for your attention

www.5GRail.eu

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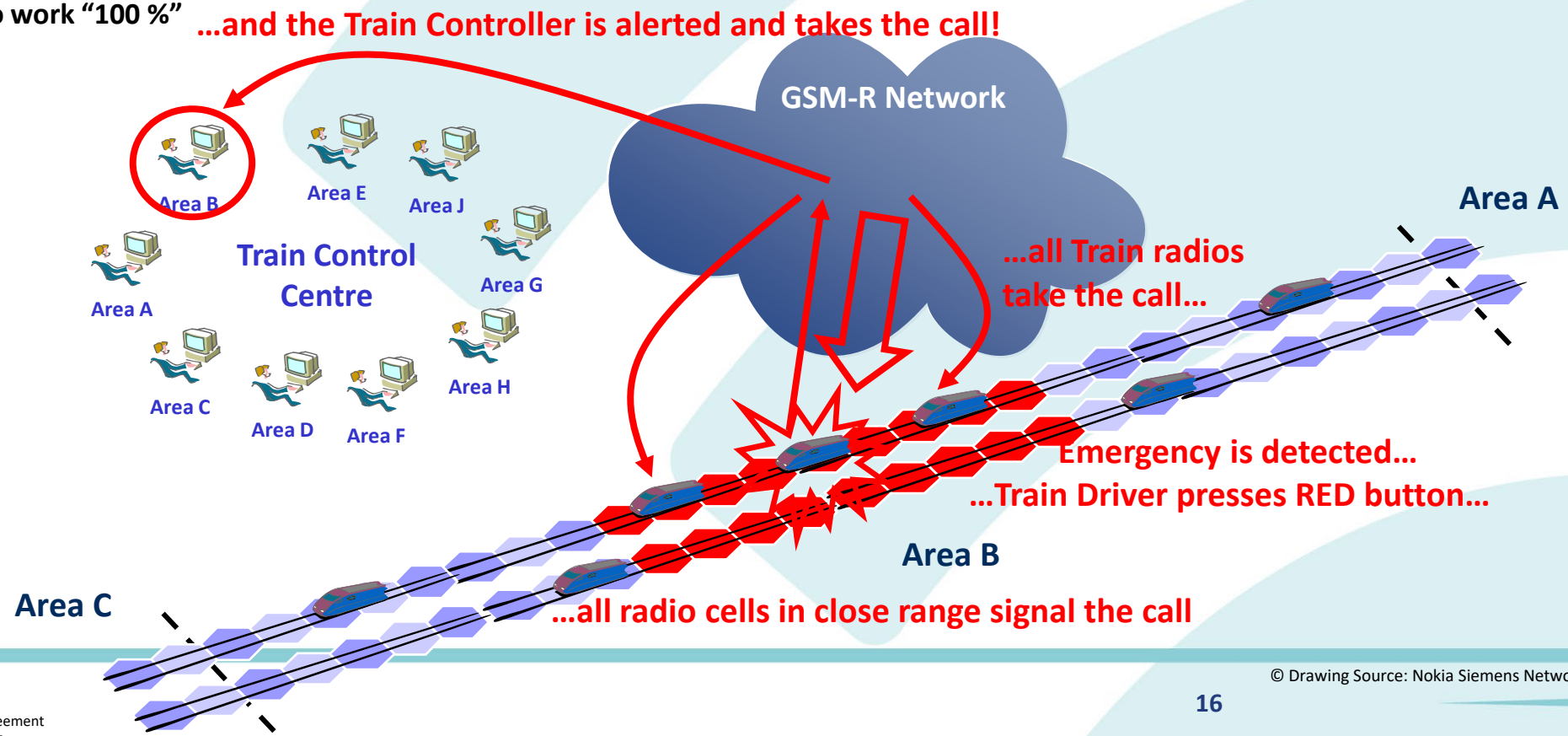
- In case of danger, the Train Driver presses the REC button on his radio. A pre-engineered Group Call Area is instantly created, and all trains in this area are notified within two seconds, and the train drivers will start braking the trains. Speech is granted for the call initiator (PTT); after which the Train Controller, who will also be alerted, starts organising the response and the traffic restart.
- REC has to work "100 %"



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