



**A critical step for introduction of FRMCS, as the GSM-R successor and enabler of Railways Digitalization**

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# TODAY IS GSM-R...

The European railways currently use the GSM-R system for operational communication, 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 has introduced a national wide connectivity and the digital communication advantages; it is supporting the train driver to signaller Voice applications including the Railways Emergency Call (considered to be the best method to avoid a train accident when all the other system has failed), as well as the ETCS (European Train Control System).

Although the limited data capability, GSM-R is also supporting some other railway applications, e.g. track side phones, passenger information screens on platform, etc.



2G+  
+  
NATION-WIDE  
CONNECTIVITY  
INTEROPERABLE  
IMPROVE SAFETY  
ENABLE RAILWAY  
EMERGENCY CALL AND  
ETCS  
-  
OBSCURITY  
APPROACHING



# ...TOMORROW WILL BE FRMCS

The Future Radio Mobile Communication System (FRMCS) is the Railways response for two elements of strategic importance for the future of the railways.

Firstly, GSM-R is a 2G system, where the manufacturers have announced that GSM-R equipment is due to reach the end of its life and will be supported until around 2035.

Secondly, whilst replacing GSM-R is a complex issue, due the specific railways requirements in term of Functionality (Railway Emergency Call), Quality of Service, Life Cycle, Cross-Border Interoperability and European Migration Timeline, it is also a significant opportunity, which is to enable and support the Railways Digitalization, and therefore the need to transmit, receive and use increasing volumes of data, which is at the very heart of sustainable transport.

Improving the telecom service quality, the potential offered by the Internet of Things, smart maintenance, replacing copper or fiber cables with wireless, driverless trains... railways need a suitable radio system to enable these ever-increasing communication flows in an efficient way.



- 5G
- ENHANCE SAFETY
- IMPROVED RAILWAY EMERGENCY CALL
- ETCS
- ATO GOA 2
- ENHANCE RAIL TRAFFIC & PERFORMANCE
- DIGITALISATION



# The Global Project Planning of the FRMCS Introduction



## FRMCS High Level Plan

2Q'2019	4Q'2021	3Q'2023	2Q'2025
FRMCS V1 Specification	FRMCS Demonstrator ⇒ V2 Spec	FRMCS European Trial ⇒ Readiness	
<div>STARTING POINT</div> <ul style="list-style-type: none"> <li>• URS 4.0</li> <li>• Use Cases V1 to 3GPP R16 (60%)</li> </ul>	<div>STARTING POINT</div> <ul style="list-style-type: none"> <li>• <u>Stabilized</u> FRMCS Specification</li> <li>• R16 Products : MCX 4G/5G (→ <b>Industry</b>)</li> </ul>	<div>STARTING POINT</div> <ul style="list-style-type: none"> <li>• <u>Operational</u> FRMCS Specification</li> <li>• R17 Products : FRMCS 5G (→ <b>Industry</b>)</li> </ul>	
<div>PLAN</div> <ul style="list-style-type: none"> <li>• FRS, SRS 1.0</li> <li>• On-Board FRS, SRS 1.0</li> <li>• Principle Architecture, FIS, FFFIS 1.0</li> <li>• ETCS over FRMCS Principles</li> <li>• Interim specifications for TSI inclusion (→ <b>ERA</b>)</li> <li>• Validation of Uses Cases V1 in 3GPP R16</li> <li>• Use Cases V2 to 3GPP R17 (95%)</li> <li>• Use Cases Gaps vs. 3GPP =&gt; ETSI TS</li> <li>• CEPT Reports with Railway Frequencies &amp; Coexistence Criteria, ECC Decision</li> <li>• Migration Scenarios</li> </ul>	<div>PLAN</div> <ul style="list-style-type: none"> <li>• FRMCS demonstrator based on FRMCS V1 (→ <b>H2020 - 5GRail, S2R</b>)</li> <li>• FRS, SRS 2.0</li> <li>• On Board FRS 2.0</li> <li>• Validation of Use Cases V1 in 3GPP R17</li> <li>• Use Cases V3 in 3GPP R18</li> <li>• TSI inclusion 1 (→ <b>ERA</b>)</li> <li>• Additional elements for TSI</li> <li>• Frequency Plans for Migrations</li> <li>• Deployment &amp; ENIR Migration assessments</li> <li>• Signalling Continuity assessments</li> </ul>	<div>PLAN</div> <ul style="list-style-type: none"> <li>• FRMCS European Trials based on FRMCS V2 (→ <b>CEF 2, S2R</b>)</li> <li>• FRS &amp; SRS 3.0</li> <li>• On-board FRS 3.0</li> <li>• FIS &amp; FFFIS 3.0</li> <li>• Validation of Use Cases V3 in 3GPP R18</li> <li>• Use Cases V4 in 3GPP R19</li> <li>• TSI inclusion 2 (→ <b>ERA</b>)</li> <li>• Cross-borders procedures</li> <li>• Interconnection hubs development (ENIR) (→ <b>Industry, → S2R</b>)</li> <li>• Guidelines for Operational Migrations</li> </ul>	

The main objective of the in railways community, in agreement with supplier industry, is to make available for first deployments a FRMCS First Edition, based on 5G 3GPP R17, as a replacement for GSM-R, and designed to function in full coexistence with GSM-R, around Q2 2025.

The success of the introduction of FRMCS in 2025 is a European Level issue. It is important to say that this is also followed with great interest by railways worldwide.

This will be achieved in three main steps (see embedded figure).

A crucial step of this plan is building and testing the FRMCS Demonstrator, especially On-Board, allowing to validate the UIC FRMCS specifications, which will enable a strong confidence for step three, which is the European cross-border Trials.

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

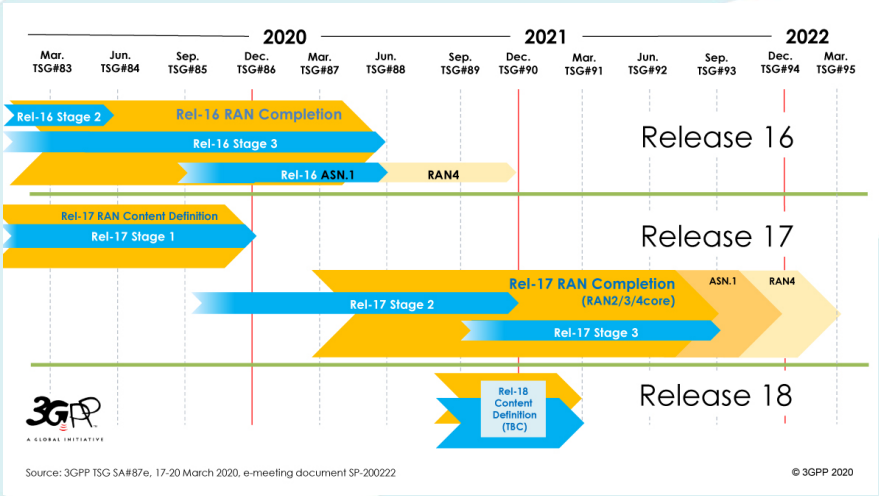
# FRMCS will be based on 3GPP 5G



The FRMCS 1st Edition, planned to be available for implementors second half of 2025, will be a 5G 3GPP R17 system.

The embedded timeline, source 3GPP web site, is subject to evolve due to COVID-19 situation, in the sense of possible delay (3 supplementary months possible).

The FRMCS system will continue to evolve with more services with R18 and beyond.



URS Ref.	Application	Use	Type	applications to be considered for the migration phase
5.1	On-train outgoing voice communication from the train driver towards the controller(s) of the train	Critical	Comms	Y
5.2	On-train incoming voice communication from the controller towards a train driver	Critical	Comms	Y
5.3	Multi-Train voice communication for drivers including ground user(s)	Critical	Comms	Y
5.4	Banking voice communication	Critical	Comms	Y
5.5	Trackside Maintenance Voice communication	Critical	Comms	Y
5.7	Public emergency call	Critical	Comms	Y
5.8	Ground to ground voice communication	Critical	Comms	Y
5.9	Automatic Train Protection communication	Critical	Comms	Y
5.10	Automatic Train Operation communication	Critical	Comms	Y
5.11	Data communication for Possession Management	Critical	Comms	Y
5.12	Trackside Maintenance Warning System communication	Critical	Comms	Y
5.13	Remote control of Engines	Critical	Comms	Y
5.14	Monitoring and control of critical infrastructure	Critical	Comms	Y
5.15	Railway Emergency Communication	Critical	Comms	Y
5.16	On-train safety device to ground communication	Critical	Comms	Y
5.19	Voice recording and access	Critical	Comms	Y
5.20	Data recording and Access	Critical	Comms	Y

URS Ref.	Application	Use	Type	applications to be considered for the migration phase
10.1	Billing information	Business	Support	Y
5.24	On-train outgoing voice communication from train staff towards a ground user	Critical	Comms	Y
5.25	On-train incoming voice communication from a ground user towards train staff	Critical	Comms	Y
5.27	Critical real time video	Critical	Comms	Y
5.27	Critical real time video in case of ATO GoA3/GoA4 operation	Critical	Comms	Y
8.1	Assured voice communication	Critical	Support	Y
8.2	Multi user talker control	Critical	Support	Y
8.3	Role management and presence	Critical	Support	Y
8.4	Location services	Critical	Support	Y
8.5	Authorisation of communication	Critical	Support	Y
8.7	Authorisation of application	Critical	Support	Y
8.8	QoS class negotiation	Critical	Support	Y
8.9	Safety application key management communication	Critical	Support	Y
8.10	Assured data communication	Critical	Support	Y
8.11	Inviting-a-user messaging	Critical	Comms	Y
8.12	Arbitration	Critical	Comms	Y



# 5G RAIL - General Information

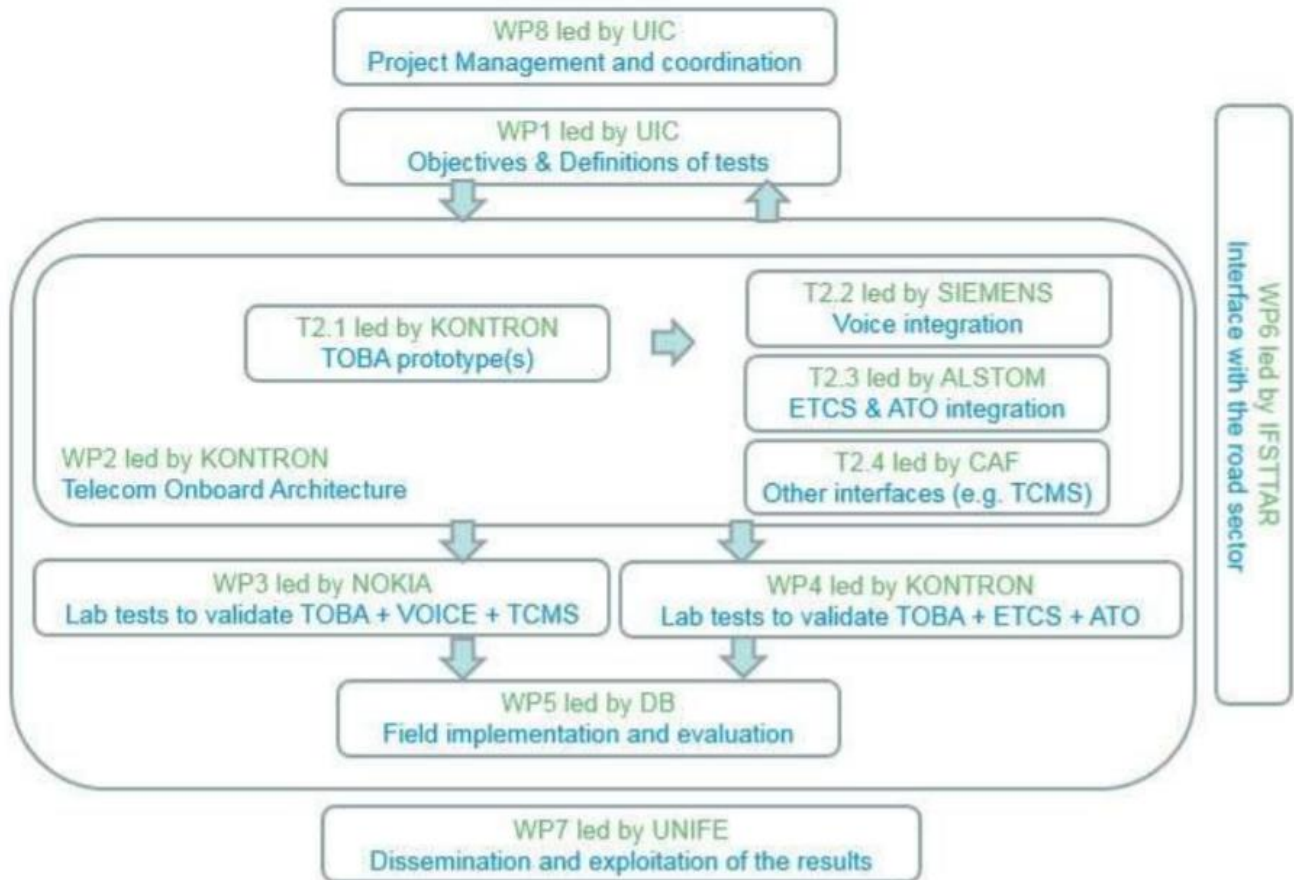


<b>Project acronym</b>	<b>5G RAIL</b>
<b>Project title</b>	<b>5G for future RAILway mobile communication system</b>
<b>Starting date</b>	<b>01/11/2020</b>
<b>Duration in months</b>	<b>30</b>
<b>Call (part) identifier</b>	<b>H2020-ICT-2019-3</b>
<b>Topic</b>	<b>ICT-53-2020 5G PPP – 5G for Connected and Automated Mobility (CAM)</b>





# 5G RAIL scope and overall framework



Elaborate FRMCS prototypes based on the FRMCS V1 specifications, including telecom 5G infrastructure compliant with FRMCS 3GPP specific standardization elements, and the new on-board equipment (FRMCS On-Board Gateway and additionally prototypes of adapted ETCS and ATO elements);

Define all the relevant technical and functional tests to be achieved to verify the compliance of the prototypes with the FRMCS V1 specification, maximizing the scope of applications to be tested or simulated (particularly operational voice services, ETCS, ATO, TCMS, video and interaction with automotive) and including some measurements of performance;

Execute these tests in lab environment firstly, and then in railway environment with train runs, considering cross-borders conditions, define 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 V1 specification for sector regulation.

# Work Packages and Consortium members



WP Number	WP Title	Lead
WP1	FRMCS tests definition, tests results consolidation and specification review	UIC
WP2	TOBA prototypes development	KONTRON
WP3	Validation of ETCS, Voice, TCMS and CCTV/Video within TOBA – Laboratory tests	NOKIA
WP4	Validation of Data, ETCS, ATO and Cybersecurity within TOBA – Laboratory tests	KONTRON
WP5	Field Implementation and Evaluation	DB Netz
WP6	Rail and Road communication systems coexistence	UNI.EIFFEL
WP7	Dissemination, Communication and Exploitation	UNIFE
WP8	Project Management & Coordination	UIC

5GRAIL started on 1<sup>st</sup> of November 2020, for a 30 months duration.

The project is advancing well, with a very good experts engagement, and with the On-Board Gateway Architecture report being delivered, and the Test Plan and the first prototypes available end October 2021.

1	UIC	France
2	Nokia-DE	Germany
3	KONTRON	Austria
4	Alstom	France
5	DB Netz	Germany
6	SNCF Reseau	France
7	THALES	France
8	SBB	Switzerland
9	UNIFE	Belgium
10	CAF	Spain
11	OBB	Austria
12	SIEMENS	UK
13	IP	Portugal
14	UNIVERSITE GUSTAVE EIFFEL	France
15	TELESTE	Finland
16	DTU	Denmark
17	NOKIA-IT	Italy
18	NOKIA-HU	Hungary



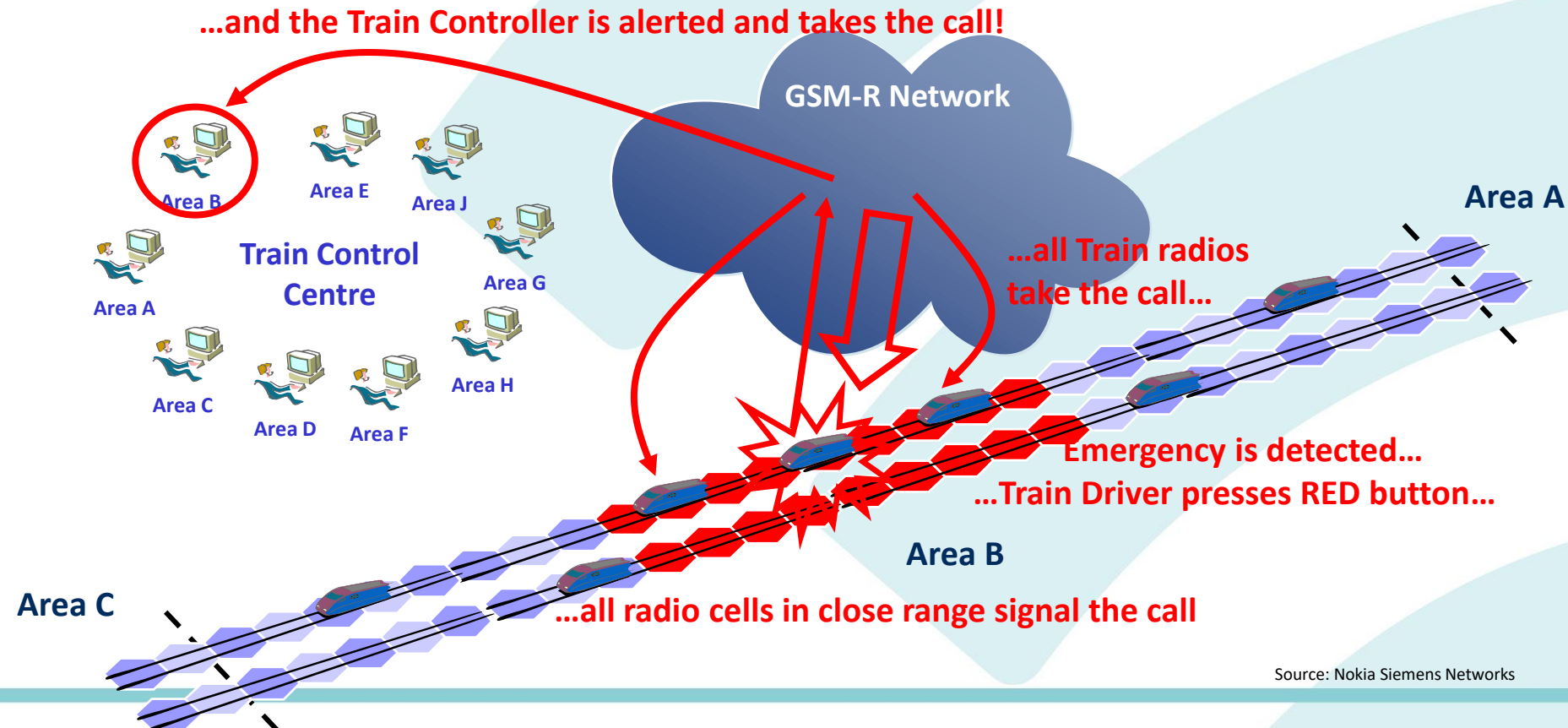


# Use Case: The Railway Emergency Call



In Emergency situations a Train Driver must be able to warn all other trains at close range! The Train Controller for the Area must also be informed!

**GSM-R REC:** The Train Driver simply presses the red Railway Emergency button on his radio! All Train Driver radios at a pre-engineered range (e.g. 15 km) are notified and will automatically take the call! The Train Controller for the Area will also be alerted!

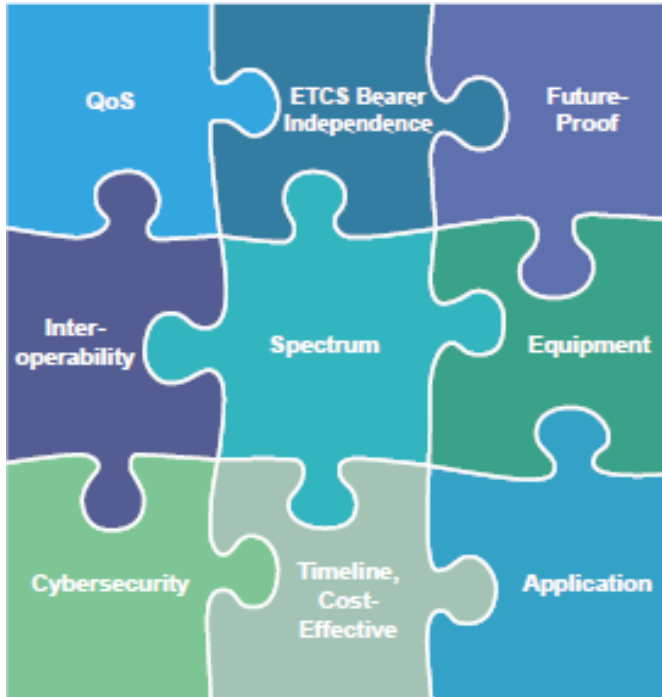


Source: Nokia Siemens Networks



Grant agreement  
No 951725

# FRMCS CHALLENGES – considered within 5GRail



FRMCS main challenges are listed in the embedded picture. They are considered within 5GRail:

- Interworking with GSM-R
- Railway Emergency Call
- ETCS and ATO demonstrators
- Cross Border scenarios
- Some Quality of Service Scenarios
  - the Quality of Service to ensure the connectivity for the train-to-ground voice and signalling applications must be without errors and at any moment
- Radio modules in the FRMCS range
  - as per the ECC draft decision (20)02
- Cyber Security assessment

5GRail is on its scheduled path. It is a crucial step for the FRMCS introduction. It is a project followed with great interest by the Railway community, which have started already planning the migration to FRMCS.



**Thank you for your attention!**

