**Working Group 1 (WG1) Technical Issues -
Status Report**

Editors Note:

The following is the remit for the report to be used a guideline for the content and structure of the status report

Provide an overview of the current status of railway telecommunications in Europe, including fleet, infrastructure, IT, and telecom assets, based on a step-by-step approach. Goal is to create a mutual understanding about magnitude of FRMCS migration effort. This should encompass current retrofit and investment plans for infrastructure (IM plans) and onboard assets (RU and vehicle owner plans). The National Implementation Plans (NIPs) expected to be delivered by the Member States mid-2024 are considered key input for this action.

Based on point 1, which will be basis information for this point, estimate necessary capacities in industry, operators, NSA's/ERA, lessors, contractors, and network operators (both private and public). Create a 'placing into service' plan for operational implementation, also considering FRMCS suppliers and application suppliers. A roadmap should be delivered before full roll-out. Objective is to provide an estimate of the required European capacity on a yearly basis coming from information provided by infrastructure managers and, ideally, also from railway undertakings.

Disclaimer

This document is drafted by and belongs to EU Rail.

EU Rail encourages the distribution and re-use of this document, the technical specifications and the information it contains. EU Rail holds several intellectual property rights, such as copyright and trade mark rights, which need to be considered when this document is used.

EU Rail authorizes you to re-publish, re-use, copy and store this document without changing it, provided that you indicate its source and include the following mention [EU Rail trade mark, title of the document, year of publication, version of document, URL].

EU Rail makes no representation or warranty as to the accuracy or completeness of the information contained within these documents. EU Rail shall have no liability to any party as a result of the use of the information contained herein. EU Rail will have no liability whatsoever for any indirect or consequential loss or damage, and any such liability is expressly excluded.

You may study, research, implement, adapt, improve and otherwise use the information, the content and the models in the this document for your own purposes. If you decide to publish or disclose any adapted, modified or improved version of this document, any amended implementation or derivative work, then you must indicate that you have modified this document, with a reference to the document name and the terms of use of this document. You may not use EU Rail's trade marks or name in any way that may state or suggest, directly or indirectly, that EU Rail is the author of your adaptations.

EU Rail cannot be held responsible for your product, even if you have used this document and its content. It is your responsibility to verify the quality, completeness and the accuracy of the information you use, for your own purposes.

Contents

1. Current Status Railway Telecommunications in Europe

1.1 Overview

The key reference for the Status Report is the National Implementation Plans (NIP) as published in Q4 2024 https://transport.ec.europa.eu/transport-modes/rail/interoperability-safety/interoperability/national-implementation-plans-2024-under-control-command-and-signalling-tsi_en

The following chart provides a high level time plan for FRMCS deployment among Member States based on the NIP
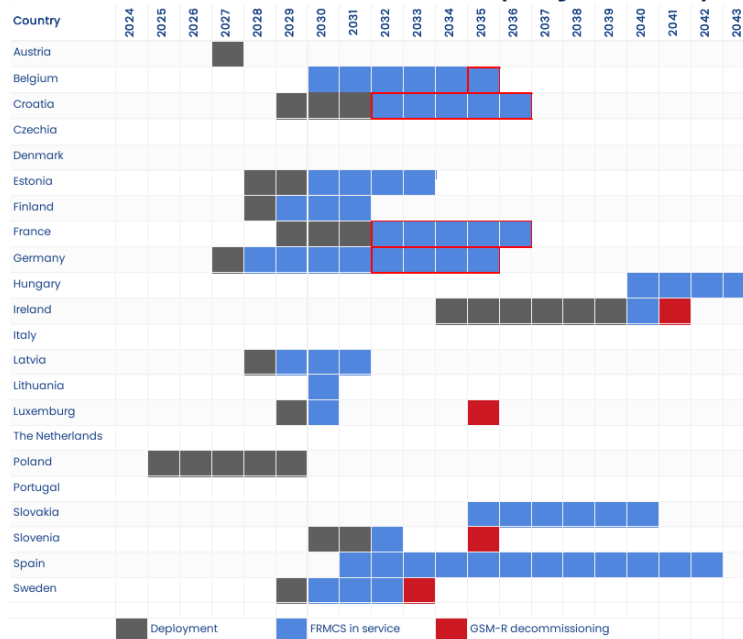
National FRMCS deployment plans in Member States (*)

(*) FRMCS plans for Spain and Sweden are not available in their NIPs. Other sources were considered

1.2 Germany

1.2.1   Infrastructure

1.2.1.1   *Current status of GSM-R trackside implementation*

- The Global System for Mobile Communication – Railway (GSM-R) has been rolled out across Germany.
- As of May 2025 30,485 km of the 33,297 km railway network is equipped with GSM-R.
- The system supports railway-specific communication and train control functions.
- Remaining gaps are being addressed as part of ongoing modernization efforts.

1.2.1.2   *Current status of ETCS implementation*

- By May 2025: 608 km of track in Germany has been equipped with ETCS (European Train Control System).
- 58 km equipped with ETCS Level 1.
- 550 km equipped with ETCS Level 2.
- ETCS deployment is part of the national strategy to replace legacy Class B systems and align with EU interoperability goals.
- A feasibility study completed in 2024 outlines further expansion and migration plans.

1.2.1.3   *Current status of ATO implementation*

- By the end of 2023, **24 km** of track in Germany had been equipped with **Automatic Train Operation (ATO) GoA2**.
- The **"Digital S-Bahn Hamburg"** project, launched in 2021, is the only operational ATO project in Germany.
- Plans exist for expanding ATO deployment alongside the Digital Rail Germany program.

-

1.2.1.4   *Technical Migration strategy of the radio part*

- GSM-R Decommissioning: GSM-R is planned for gradual phase-out with FRMCS (Future Railway Mobile Communication System) as its replacement.
- Migration Timeline:
  - 2027: First FRMCS pilot routes.
  - 2029: GSM-R decommissioning to begin.
  - 2035: Full transition to FRMCS expected.
- Challenges:
  - Ensuring compatibility between GSM-R and FRMCS during transition.
  - Upgrading onboard and trackside equipment.

1.2.1.5   *Strategy for the Introduction of FRMCS*

- FRMCS (5G-based railway communication) will replace GSM-R, enhancing data capacity and security.

- Planned Introduction:
  - Pilot projects in 2027.
  - Phased nationwide rollout by 2035.
- Funding & Regulation:
  - European Union funding and national investment are supporting FRMCS migration.
  - New technical specifications are being finalized to ensure interoperability.
-

1.2.1.6 *Strategy for the Introduction of ATO*

- Automatic Train Operation (ATO) GoA2 and Beyond:
  - Initial deployment in Hamburg as a proof-of-concept.
  - Further tracks equipped with ATO GoA2 technology are planned to go into operation within the "Digital Node Stuttgart" project:

    125 km of tracks by 2027, 300 km of tracks by 2030

  - Future expansions in key railway corridors with high traffic density.

- Integration with ETCS:
  - ETCS Level 2 and Level 3 are critical for ATO operations.
  - ATO deployment aligns with Digital Rail Germany (DSD) objectives.
- Challenges:
  - Ensuring smooth transition from conventional operations.
  - Funding and regulatory approvals.
  - Training personnel for ATO operations.
-

1.3 Fleet

1.3.1 Current status of GSM-R on-board implementation

- Vehicles
  - Around 13.800 vehicles in operation and equipped with GSM-R Cab Radios
  - Appr. 13% are equipped with two GSM-R Cab Radio installations

1.3.2 Current status of ETCS on-board implementation

- ☐ **Equipped Vehicles**:
- Around 1.100 **freight locomotives** and **passenger trains** are currently equipped with ETCS.
- The majority of existing rolling stock, approximately **12,700 vehicles**, still lacks ETCS and requires retrofitting.
- ☐ **ETCS System Versions in Use**:
- **Baseline 2 (SRS 2.3.0d)** is installed in older ETCS-fitted vehicles.
- **Baseline 3 (SRS 3.4.0 or later)** is the target version for future compatibility and deployment.
- Many newly manufactured trains are being delivered with **ETCS Baseline 3-compliant onboard units (OBUs)**.
-

1.3.3 Technical Migration Strategy of on-board CCS

- **Current Status**:
  - Germany's rolling stock primarily relies on **PZB and LZB** (Class B systems).
  - Only **around 700 locomotives** currently have **ETCS onboard units** (OBUs), while over **12,700 vehicles** still require retrofitting.
- **Migration Plan**:
  - **ETCS Baseline 3 (SRS 3.4.0) rollout** is prioritized to ensure long-term compatibility.
  - **2025-2030**: Increased ETCS OBU installations with a focus on interoperable corridors.
  - **2030-2050**: Full transition to **ETCS-only operation**, decommissioning Class B systems.
- **ATO Readiness and Integration with ETCS**
  - **Automatic Train Operation (ATO) GoA2** is currently being tested in Hamburg.
  - **ATO GoA3 and GoA4** require full integration with **ETCS Level 3** and FRMCS for autonomous operation.
  -

1.3.4 Number of current GSM-R end devices to be migrated to FRMCS

Country	Network	Handheld			Cab Radio			EDOR		
		Planned	Total Installed	SIM cards activated	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activate
Germany	DB			78276			25092			6946

1.4 Austria

1.4.1   Infrastructure

1.4.1.1   *Overview and Strategic Context*

Austria's National Implementation Plan (NIP) for ERTMS (2024) outlines the future replacement of GSM-R with the Future Railway Mobile Communication System (FRMCS), forming a central pillar of the nation's transition to next-generation railway communications. As mandated by the European Technical Specification for Interoperability (TSI CCS), FRMCS deployment is aligned with broader ERTMS rollout strategies, primarily led by ÖBB Infrastruktur AG.

GSM-R currently covers ~3,675 km of Austria's railway network, forming the Class A digital radio backbone for ETCS Level 2 operations. However, this 2G-based system is reaching obsolescence by the mid-2030s, necessitating a transition to the 5G-based FRMCS, which promises enhanced speed, security, and reliability. Initial plans aim to begin FRMCS pilot projects by 2027, with GSM-R decommissioning expected post-2035.

1.4.1.2   *Technical Foundations and Pilot Phases*

FRMCS is expected to replace all railway-specific radio technologies via its IP-based, 5G-compliant architecture. Key technological advancements include high scalability, low latency, enhanced encryption, and independent upgradeability for rail-specific applications and connectivity infrastructure.

FRMCS implementation requires full compatibility with ETCS Baseline 4, System Version 3.0. As of 2024, Austria's ETCS systems are primarily deployed using Baseline 2 (SRS 2.3.0d), with newer sections being installed using Baseline 3 (SRS 3.6.0). The nationwide switch to Baseline 4 is scheduled to begin from 2032, with major ETCS-only operations (and thus FRMCS readiness) being rolled out through 2036.

1.4.1.3   *Current status of ETCS implementation*
- In line with European legislation, it foresees the implementation of ETCS Level 2 on the TEN-T Core Network by 2030 and on other heavily used rail network by 2038.
- The deployment of ETCS had already gone through 2 phases, with ETCS Level 1 implemented on some existing lines (phase 1) and Level 2 on some new and retrofitted lines (phase 2). Based on these two phases, the ETCS Migration Plan of ÖBB Infrastruktur AG describes the roll-out of ETCS Level 2 on the heavily used rail network (appr. 3300 km) and is divided into three additional phases (phase 3.1, 3.2, 4 – see Table):
- As of 05/2024, 623 km of track in Austria has been equipped with ETCS.
- 155 km of track is equipped with ETCS Level 1.
- 468 km of track is equipped with ETCS Level 2.
- By 2030 around 2073 km of track will be equipped with ETCS.
- By 2038 around 3300 km of track will be equipped with ETCS.
- ETCS is currently being installed as an overlay on existing lines, while new lines are already being equipped exclusively with ETCS.
- The trackside ETCS rollout plan includes the geo-redundant construction of 20 Radio Block Centres (RBCs), whereby another can compensate for the failure of one RBC.

- Lines are currently equipped with the SRS Baseline 3 Release 2 with backward compatibility for the vehicle equipment in accordance with Baseline 2.3.0d in SV 1.1, the admissibility of which is given by the TSI CCS until 2032. Sections that were equipped with ETCS in the first phases are still partly based on BL2 SRS version 2.3.0.d (S.V. 1.1).

1.4.1.4 *Current status of GSM-R trackside implementation*

- A large part of the ÖBB-Infrastruktur AG rail network is already equipped with GSM-R train radio, which is the technical requirement for access to the network. It is also a prerequisite for ETCS Level 2 and the communication between on-board and trackside systems.
- GSM-R is deployed on appr. 3675 km of the Austrian railway network, which includes all TEN-T Core Network Corridors and the remaining main lines ("core network" of ÖBB Infrastruktur AG) as of 05/2024.
- By 2034, a further 724 km of railway lines will be equipped with a Class A radio system.

1.4.1.5 *Current status of deployment for ATO system*

- TSI CCS describes ATO (Automatic Train Operation) functionalities needed to operate train up to Grade of Automation 2 with ETCS providing the automatic train protection functionality to enable it. Therefore, ETCS Level 2 can be seen as an enabler for ATO, but ATO is not yet in operation on the Austrian rail network. ETCS baseline management has a major impact on the implementation of ATO, as ATO can be used from system version 2.3. The transition period between BL 2 and BL 3 or higher baselines will define the roll out process of ATO.

1.4.1.6 *Strategy for FRMCS deployment*

Pilot FRMCS projects are set to commence in 2027 following the finalisation of Version 3 of the FRMCS specifications (due by 2026). Initial parallel operations with GSM-R are anticipated to ensure uninterrupted communication.

- GSM-R is expected to be EOL in 2035
- ÖBB-Infrastruktur AG is currently planning to pilot FRMCS starting from 2027. The rollout of FRMCS and the phasing out of GSM-R must be coordinated. According to current planning, parallel operation will be necessary for a limited period of time.
- Delays in standardization (FRMCS V3) shorten the available rollout period for FRMCS, as suppliers are dependent on the finished standard in product development.
- Generally, it is planned to cover all ETCS lines with FRMCS, starting with the TEN-T corridors as the highest priority.

1.4.1.7 *Timeline of Key Milestones*

- **2024**: GSM-R operates on 3,675 km including all TEN-T Core Network Corridors.
- **2026**: Finalisation of FRMCS technical specification (Version 3).
- **2027**: Launch of FRMCS pilot tenders and preparatory deployment.
- **2030**: Completion of ETCS Level 2 on TEN-T Core Network (required for FRMCS).
- **2032**: Introduction of ETCS Baseline 3.6.0 (MR2) as minimum on-board requirement.
- **2035**: Introduction of ETCS Baseline 4 SV 3.0 for full FRMCS compatibility.
- **2035-2038**: Gradual GSM-R decommissioning and switch to FRMCS-only corridors.
- **2038**: FRMCS expected to be operational on entire heavily used Austrian rail network.

1.4.1.8 *Cross-Border Operations and Coordination*

Cross-border integration is a central element of Austria's FRMCS rollout strategy. Border crossing sections already operational with ETCS and GSM-R include:

- **Austria-Czech Republic**: Bernhardsthal/Breclav
- **Austria-Hungary**: Nickelsdorf/Hegyeshalom
- **Austria-Slovenia**: Spielfeld-Sentilj (expected 2025)
- **Austria-Germany & Italy**: Kufstein-Brenner axis (ETCS since 2013)

FRMCS will be critical in enabling seamless cross-border interoperability as it provides unified communication architecture compatible with multi-country infrastructure. The border sections mentioned above are part of the TEN-T Core Network and will be among the first equipped with FRMCS during the early rollout phase.

Interoperability will be further facilitated through the alignment of Austria's implementation strategy with European norms and the harmonised specification frameworks led by UIC and ERA.

1.4.1.9 *Challenges and Implementation Considerations*

The primary challenges lie in the dependency on finalised FRMCS specifications, ensuring backward compatibility with legacy systems, and coordinating the transition across thousands of rolling stock vehicles.

Austria is addressing these through:

- Establishing an ETCS Vehicle Migration Working Group
- Early stakeholder engagement with railway undertakings
- Funding frameworks to support both infrastructure and vehicle retrofitting

The funding plan under ÖBB's "Rahmenplan 2024–2029" includes over EUR 352 million for ERTMS and FRMCS transition, supplemented by European CEF funding.

1.4.1.10 *Conclusion*

Austria's FRMCS strategy is deeply embedded within its ERTMS migration plan, focusing on technological modernization, interoperability, and long-term sustainability. With its structured timelines and cross-border coordination, Austria is positioning itself as a proactive leader in the adoption of future-ready railway communication systems.

1.4.2 Fleet

1.4.2.1 *Current status of ETCS on-board implementation*

The table below shows the current ETCS status of the rolling stock registered on the ÖBB-Infrastruktur AG network. It should be noted that the table also includes vehicles with owners from other countries. The numbers indicate that currently only around half of all registered vehicles are equipped with ETCS, a significant proportion of which with Baseline 2.

Vehicle type	Network Registrations	ETCS Baseline 2	ETCS Baseline 3
Locomotives	3890	2059	402
Railcar	1255	82	433
Control Car	334	60	0
Special Vehicle	280	18	0
Total	5759	2219	835
Status: 07.02.2024		38,5%	14,5%

As of March 2025, there are roughly

•   3400 Cab radios,

•   1350 EDORs, and

•   3600 GSM-R end devices (trackside handhelds) registered with ÖBB. This does not include the devices from other RUs operating on the Austrian rail network.

1.4.2.2   *Number of current GSM-R end devices to be migrated to FRMCS*

		Handheld			Cab Radio			EDOR		
Country	Network	Total								
		Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated
Austria	OBB	4300	3300	3581			3380		1347	2694

1.5 Belgium

1.5.1 Infrastructure

1.5.1.1 *Background and Strategic Objectives*

Belgium has been actively implementing ERTMS and modernizing its railway infrastructure since 1999, following serious accidents that highlighted the need for safer rail operations. The ETCS Master Plan developed by Infrabel (the Belgian infrastructure manager) aims to ensure full ETCS coverage on the national network by the end of 2025. As a long-term goal, Belgium is preparing to transition to a digital, radio-based railway communication system supported by the Future Railway Mobile Communication System (FRMCS), with deployment commencing after 2030.

The ETCS deployment uses a mix of ETCS Level 1 Full Supervision (FS), ETCS Level 2 FS, and ETCS Level 1 Limited Supervision (LS). This mix allows Belgium to manage the transition efficiently while retrofitting rolling stock independently. GSM-R is currently the operational radio system, with full nationwide coverage, and will be phased out by 2035.

1.5.1.2 *2. Technical Migration Plan for FRMCS*

FRMCS, the successor of GSM-R, is set to become the new railway communication backbone by 2035. Belgium has not yet implemented FRMCS but has defined a strategy that includes:

- **2030**: Start of FRMCS deployment alongside ATO (Automatic Train Operation)
- **2030–2035**: Dual operation of GSM-R and FRMCS (dual telecom)
- **Post-2035**: GSM-R decommissioning and full FRMCS operations

FRMCS deployment is conditional on the availability of market-ready products. It will be rolled out in parallel with the GSM-R network to ensure uninterrupted service. This dual system will exist both on infrastructure and trains until the migration is complete.

ATO functionalities will rely on FRMCS for safe and efficient ground-to-train communication. Migration to ETCS Radio-Based without lineside signals (leveraging FRMCS) is a key aspect of Belgium's digital signalling future.

1.5.1.3 *3. Timeline of Key Milestones*

- **2024**: GSM-R covers entire network with voice and data services; ETCS Level 2 on core routes
- **2025**: ETCS mandatory for all commercial operations on main lines
- **2028**: Start replacement of ETCS1 LS with ETCS2 (Radio-Based)
- **2030**: Planned launch of FRMCS and ATO deployment
- **2035**: GSM-R end-of-life deadline; start of full FRMCS deployment

- **2040**: Complete FRMCS-based signalling and communications on entire core network

1.5.1.4 *4. Border Crossings and International Coordination*

Belgium shares borders with France, Germany, Luxembourg, and the Netherlands. Seamless cross-border train operations are essential for European interoperability and freight corridors.

Key existing ETCS-compatible border crossings:

- **France**: L165/2, L130A, L94 – ETCS1 FS/TBL1+ and KVB in service
- **Germany**: L24, L37 – ETCS1 FS with PZB compatibility
- **Luxembourg**: L42, L162, L167 – ETCS1 FS on both sides
- **Netherlands**: L4, L12 – Full ETCS or mixed ETCS/ATB EG

Belgium initiated bilateral coordination with all neighboring infrastructure managers in 2024. These talks aim to ensure alignment in ETCS and future FRMCS rollouts, though challenges persist due to asynchronous planning processes. Belgium has requested stronger EU-level involvement to standardize cross-border coordination ahead of infrastructure contracts and funding agreements.

1.5.1.5 *5. Challenges and Transition Strategy*

Transitioning from GSM-R to FRMCS presents several challenges:

- Aligning rollout timelines with ETCS Baseline 3 and future Baseline 4 (required for FRMCS)
- Ensuring compatibility with diverse onboard equipment in freight and passenger fleets
- Managing cross-border handovers and fallback mechanisms

To mitigate these, Belgium maintains a flexible migration plan:

- Progressive deployment of ETCS2 FS to reduce reliance on lineside signalling
- Retrofitting rolling stock to support FRMCS (2030–2040)
- Maintaining GSM-R until full FRMCS coverage is achieved
- Dedicated funding through national investment programs and European CEF support

1.5.1.6 *Conclusion*

Belgium is on a clear path toward a fully digital and interoperable railway network, aligning with EU objectives. The FRMCS migration strategy, closely tied to the ETCS rollout and supported by robust bilateral and EU-wide coordination, will position Belgium to lead in next-generation railway communications. Cross-border integration and harmonized migration timelines remain key pillars for success.

1.5.2   Fleet

1.5.2.1   *Number of GSM-R end devices*

		Handheld			Cab Radio			EDOR		
		Total								
Country	Network	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated
Belgium	INFRABEL		261	261			3797			3293

1.6 Bulgaria

Pending publication of the Bulgaria National Implementation Plan

1.7 Croatia

1.7.1 Infrastructure

1.7.1.1 *Current Status of Railway Systems in Croatia*

The Croatian rail network, managed by HŽ Infrastruktura d.o.o., consists of 2617 km of track, including 2341 km of single-track and 276 km of double-track lines. It also includes 549 stations and stops, 1448 level crossings, 543 bridges, and 109 tunnels. While some sections of the network are equipped with ETCS Level 1, broader implementation of the European Railway Traffic Management System (ERTMS) is still in the early stages. Currently, GSM-R is not in use across the Croatian rail network, with Class B radio systems still being utilized.

1.7.1.2 *Transition from GSM-R to FRMCS*

Croatia plans to migrate from GSM-R to FRMCS to enhance railway communications. A tender for the design and construction of GSM-R and the migration to FRMCS was issued in March 2024, with an estimated project value of 450 million euros and a contract duration of 84 months. The project involves:

1. Development of technical documentation.
2. Construction of the GSM-R system.
3. Migration from GSM-R to FRMCS.

1.7.1.3 *Timelines for FRMCS Implementation*

The implementation of FRMCS will be phased, with priority given to different rail corridors:

- **Priority 1:** Mediterranean Corridor and Western Balkans - Eastern Mediterranean Corridor, plus the Oštarije-Knin-Split and Metković-Ploče lines. GSM-R deployment is planned to be completed by the end of 2029.
- **Priority 2:** GSM-R implementation to be completed by the end of 2031.
- **Priority 3:** GSM-R implementation to be completed by the end of 2033.

However, according to the implementation plan, GSM-R will not be implemented after 2029, and all projects will involve the installation of FRMCS. GSM-R systems will be gradually decommissioned as FRMCS is rolled out. The specific timelines for FRMCS deployment and GSM-R decommissioning are detailed in Table 13 of the implementation plan.

Table 13

Planning for FRMCS deployment and GSM-R decommissioning

ID	Railway line	FRMCS deployment planning			Planning of GSM-R decommissioning		Additional information				Note
		State of play	Realization	Date when FRMCS was put into service	Dates when GSM-R operation is no longer allowed	Date when GSM-R is decommissioned	Length	Baseline	Current GSM-R status	Types of measures	
M101	DG - S. Marof - Zagreb Gk	Not yet under construction	2029	2032	2032	2032	2x 26,733	Not defined	GSM-R will be in use before FRMCS	New	
M102	Zagreb Gk – Dugo Selo	Not yet under construction	2029	2032	2032	2032	2 x 21,198	Not defined	GSM-R will be in use before FRMCS	New	
M103	Dugo Selo - Novska	Not yet under construction	2031	2034	2034	2034	83,405	Not defined	GSM-R will be in use before FRMCS	New	

ID	Railway line	FRMCS deployment planning			Planning of GSM-R decommissioning		Additional information				Note
		State of play	Realization	Date when FRMCS was put into service	Dates when GSM-R operation is no longer allowed	Date when GSM-R is decommissioned	Length	Baseline	Current GSM-R status	Types of measures	
M301	DG - B. Monastery - Osijek	Not yet under construction	2031	2034	2034	2034	32,505	Not defined	GSM-R will be in use before FRMCS	New	
M302	Osijek - Strizivojna - Vrpolje	Not yet under construction	2031	2034	2034	2034	48,377	Not defined	GSM-R will be in use before FRMCS	New	
M303	S.-Vrpolje - S. Šamac - DG	Not yet under construction	2031	2034	2034	2034	23,298	Not defined	GSM-R will be in use before FRMCS	New	
M304	DG - Metković - Ploče	Not yet under construction	2029	2032	2032	2032	22,740	Not defined	GSM-R will be in use before FRMCS	New	
M401	Sesvete - Sava	Not yet under construction	2029	2032	2032	2032	2 x 11,090	Not defined	GSM-R will be in use before FRMCS	New	
M402	Sava - Zagreb Klara	Not yet under construction	2029	2032	2032	2032	2 x 6,677	Not defined	GSM-R will be in use before FRMCS	New	
M403	Zagreb RkPs - Z. Klara (K)	Not yet under construction	2029	2032	2032	2032	1,056	Not defined	GSM-R will be in use before FRMCS	New	
M404	Zagreb Klara - Delta	Not yet under construction	2029	2032	2032	2032	3,575	Not defined	GSM-R will be in use before FRMCS	New	
M405	Zagreb Zk - Trešnjevka	Not yet under construction	2029	2032	2032	2032	1,317	Not defined	GSM-R will be in use before FRMCS	New	
M406	Zagreb Bor. – Zagreb Resnik	Not yet under construction	2029	2032	2032	2032	2,007	Not defined	GSM-R will be in use before FRMCS	New	
M104	Novska – Tovarnik - DG	Not yet under construction	2029	2032	2032	2032	2 x 185,405	Not defined	GSM-R will be in use before FRMCS	New	
M201	DG – Botovo – Dugo Selo	Not yet under construction	2029	2032	2032	2032	1x58,761 + 2x20,948	Not defined	GSM-R will be in use before FRMCS	New	
M202	Zagreb Gk - Rijeka	Not yet under construction	2029	2032	2032	2032	227,871	Not defined	GSM-R will be in use before FRMCS	New	
M203	Rijeka – Šapjane – DG	Not yet under construction					30,896	Not defined	GSM-R will be in use before FRMCS	New	

| ID	Railway line	FRMCS deployment planning			Planning of GSM-R decommissioning		Additional information				Note
		State of play	Realization	Date when FRMCS was put into service	Dates when GSM-R operation is no longer allowed	Date when GSM-R is decommissioned	Length	Baseline	Current GSM-R status	Types of measures	
M407	Sava – Velika Gorica	Not yet under construction	2029	2032	2032	2032	6,295	Not defined	GSM-R will be in use before FRMCS	New	
M408	Zagreb RkOs – Mićevac	Not yet under construction	2029	2032	2032	2032	1,316	Not defined	GSM-R will be in use before FRMCS	New	
M409	Z. Klara - Zagreb RkPs (S)	Not yet under construction	2029	2032	2032	2032	1,071	Not defined	GSM-R will be in use before FRMCS	New	
M410	Zagreb RkOs - Zagreb RkPs	Not yet under construction	2029	2032	2032	2032	2,719	Not defined	GSM-R will be in use before FRMCS	New	
M501	DG - Čakovec - Kotoriba -DG	Not yet under construction	2031	2034	2034	2034	42,388	Not defined	GSM-R will be in use before FRMCS	New	
M502-1	Zagreb Gk – Velika Gorica	Not yet under construction	2029	2032	2032	2032	14,048	Not defined	GSM-R will be in use before FRMCS	New	
M502-2	V. Gorica – Sisak – Novska	Not yet under construction	2029	2032	2032	2032	102,743	Not defined	GSM-R will be in use before FRMCS	New	
M601	Vinkovci - Vukovar	Not yet under construction	2029	2032	2032	2032	18,712	Not defined	GSM-R will be in use before FRMCS	New	
M602	Škrljevo - Bakar	Not yet under construction	2029	2032	2032	2032	12.586	Not defined	GSM-R will be in use before FRMCS	New	
M603	Sušak - Rijeka Brajdica	Not yet under construction	2029	2032	2032	2032	3,802	Not defined	GSM-R will be in use before FRMCS	New	

ID	Railway line	FRMCS deployment planning			Planning of GSM-R decommissioning		Additional information				Note
		State of play	Realization	Date when FRMCS was put into service	Dates when GSM-R operation is no longer allowed	Date when GSM-R is decommissioned	Length	Baseline	Current GSM-R status	Types of measures	
M604	Oštarije - Knin - Split	Not yet under construction	2029	2032	2032	2032	1 x 318.483 + 2 x 3.616	Not defined	GSM-R will be in use before FRMCS	New	
M605	Ogulin – Tick	Not yet under construction	2029	2032	2032	2032	6,153	Not defined	GSM-R will be in use before FRMCS	New	
M606	Knin – Zadar	Not yet under construction	2031	2034	2034	2034	95,364	Not defined	GSM-R will be in use before FRMCS	New	
M607	Perković – Šibenik	Not yet under construction	2031	2034	2034	2034	22.503	Not defined	GSM-R will be in use before FRMCS	New	
R101	DG - Buzet - Pula	Not yet under construction	2031	2034	2034	2034	91,140	Not defined	GSM-R will be in use before FRMCS	New	
R102	Sunja - Volinja - DG	Not yet under construction	2029	2032	2032	2032	21,575	Not defined	GSM-R will be in use before FRMCS	New	
R103	DG - L.D. Field - Knin	Not yet under					59,068	Not defined			The railroad is not in traffic.
R104	Vukovar-B.n. - Erdut - DG	Not yet under construction	2031	2034	2034	2034	26,046	Not defined	GSM-R will be in use before FRMCS	New	
R105	Vinkovci - Drenovci - DG	Not yet under construction	2031	2034	2034	2034	50,939	Not defined	GSM-R will be in use before FRMCS	New	
R106	Zabok – Đurmanec - DG	Not yet under construction	2031	2034	2034	2034	27,198	Not defined	GSM-R will be in use before FRMCS	New	
R201	Zaprešić – Čakovec	Not yet under construction	2031	2034	2034	2034	100,714	Not defined	GSM-R will be in use before FRMCS	New	

ID	Railway line	FRMCS deployment planning			Planning of GSM-R decommissioning		Additional information				Note
		State of play	Realization	Date when FRMCS was put into service	Dates when GSM-R operation is no longer allowed	Date when GSM-R is decommissioned	Length	Baseline	Current GSM-R status	Types of measures	
R202	Varaždin - Dalj	Not yet under construction	2031	2034	2034	2034	249,847	Not defined	GSM-R will be in use before FRMCS	New	
L101	Čakovec – M. Centre - DG	Not yet under construction	2033	2036	2036	2036	17,942	Not defined	GSM-R will be in use before FRMCS	New	
L102	S. Marof - Kumrovec - DG	Not yet under construction	2033	2036	2036	2036	38,522	Not defined	GSM-R will be in use before FRMCS	New	
L103	Karlovac - Kamanje - DG	Not yet under construction	2033	2036	2036	2036	28,799	Not defined	GSM-R will be in use before FRMCS	New	
L201	Varaždin - Golubovec	Not yet under construction	2033	2036	2036	2036	34,596	Not defined	GSM-R will be in use before FRMCS	New	
L202	Hum-Lug - Gornja Stubica	Not yet under construction	2033	2036	2036	2036	10,820	Not defined	GSM-R will be in use before FRMCS	New	
L203	Križevci – Bjelovar – Kloštar	Not yet under construction	2033	2036	2036	2036	62,047	Not defined	GSM-R will be in use before FRMCS	New	
L204	Banova Jaruga - Bee	Not yet under construction	2033	2036	2036	2036	95,752	Not defined	GSM-R will be in use before FRMCS	New	
L205	Nova Kapela - Našice	Not yet under construction	2033	2036	2036	2036	60,493	Not defined	GSM-R will be in use before FRMCS	New	
L206	Pleternica - Large	Not yet under construction	2033	2036	2036	2036	24,955	Not defined	GSM-R will be in use before FRMCS	New	

ID	Railway line	FRMCS deployment planning			Planning of GSM-R decommissioning		Additional information				Note
		State of play	Realization	Date when FRMCS was put into service	Dates when GSM-R operation is no longer allowed	Date when GSM-R is decommissioned	Length	Baseline	Current GSM-R status	Types of measures	
L207	Bizovac - Belišće	Not yet under construction	2033	2036	2036	2036	12,940	Not defined	GSM-R will be in use before FRMCS	New	
L208	Vinkovci - Osijek	Not yet under construction	2031	2034	2034	2034	33,770	Not defined	GSM-R will be in use before FRMCS	New	
L209	Vinkovci - Županja	Not yet under construction	2033	2036	2036	2036	28,073	Not defined	GSM-R will be in use before FRMCS	New	
L210	Sisak Caprag – Petrinja	Not yet under construction	2033	2036	2036	2036	11,018	Not defined	GSM-R will be in use before FRMCS	New	
L211	Ražine - Šibenik Luka	Not yet under construction	2031	2034	2034	2034	3,714	Not defined	GSM-R will be in use before FRMCS	New	
L212	Rijeka Brajdica - Rijeka	Not yet under					2,037	Not defined			Not planned for upgrade
L213	Lupoglav - Raša	Not yet under construction	2031	2034	2034	2034	52,996	Not defined	GSM-R will be in use before FRMCS	New	
L214	Gradec – Sv. I. Frog	Not yet under construction	2033	2036	2036	2036	12.520	Not defined	GSM-R will be in use before FRMCS	New	

Figure below shows the timelines of FRMCS introduction based on railway routes:
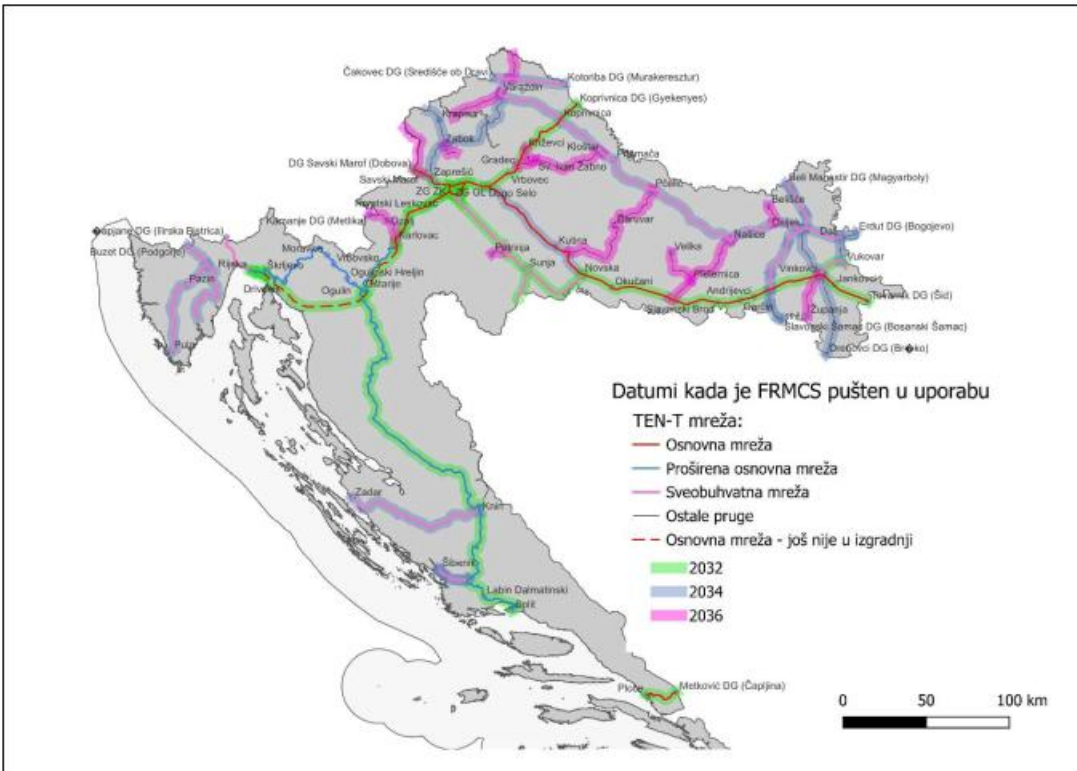
1.7.1.4   *Border Crossings*

The implementation plan also addresses interoperability at border crossings. It acknowledges the importance of coordinating with neighboring countries to ensure seamless rail operations. Border stations and their corresponding railway lines and neighboring countries are listed in the document, highlighting the existing infrastructure and the responsible infrastructure managers in those countries. The plan emphasizes the need for alignment with EU regulations and coordination with other member states to achieve interoperability.

1.8 Czech Republic

1.8.1 Infrastructure

1.8.1.1 *Current state of implementation of Class A train protection system*

Currently, almost 1,200 km of lines are equipped with ETCS, with ETCS L2 (1,098 km) and ETCS STOP (98 km) application levels. However, the length of lines on which ETCS is currently being implemented or is under development far exceeds these figures.

1.8.1.2 *Current state of ATO deployment*

The trackside part of the automation system for vehicle control fully compliant with the Commission Implementing Regulation (EU) 2023/1695 of 10 August 2023 on the technical specification for interoperability relating to the control-command and signalling subsystems of the rail system in the European Union (hereinafter referred to as "CCS TSI") has not yet been deployed in the Czech Republic. On selected lines of the Czech railway network and on selected vehicles, the automatic train operation system AVV is used, which allows optimising the train's movement based on knowledge of the line, vehicle and timetable parameters, guiding the train to a specified speed, target braking to a predetermined location and minimising energy consumption during the train's movement.

1.8.1.3 *Current state of Class A radio system deployment*

In the Czech Republic, GSM-R is continuously being deployed on the main transit lines within the deadlines set by European regulations, on other lines undergoing upgrading and according to the needs of radio system development. At present, GSM-R is deployed on almost 2 700 km of lines, mainly TEN-T network lines.

1.8.1.4 *FRMCS implementation strategy*

Planning specific dates for the deployment of the FRMCS radio system, which at the moment has no TSI-defined technical specifications and no solution available on the market, cannot be done responsibly at this time.
It is expected that the pilot project will be carried out in cooperation between infrastructure manager Správa železnic, s.o. and DB InfraGO AG on the line Chomutov - Vejprty - German border (- Annaberg-Buchholz).
Responsible planning of the implementation of the FRMCS system can only be done after the EU has defined the technical specifications and clarified the financial, technical and design requirements of the project.
In general terms, it can be assumed that it will not be possible to implement FRMCS until two years after the approval of the FRMCS technical specifications, as the availability of commercial products for trackside and on-board equipment cannot be assumed at an earlier date.

1.8.1.5 *GSM-R decommissioning strategy*

As mentioned above, neither the technical specifications of FRMCS, as a generational successor to GSM-R, nor their interaction and coexistence within trackside and on-board systems are known at this time. In view of this fact, the Czech Republic cannot at this time responsibly

define a strategy for the decommissioning of GSM-R. This strategy will be determined following the approval of the final specifications of the FRMCS by the EU.
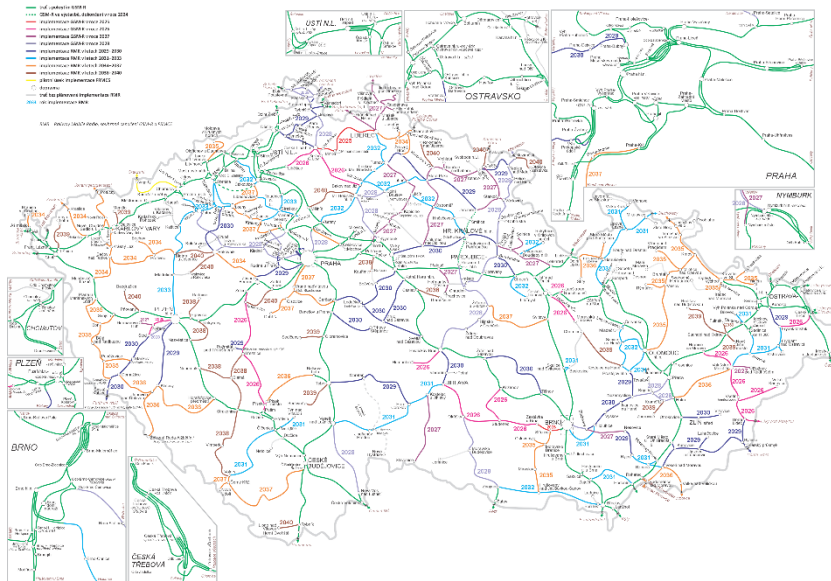
1.8.1.6 *Timeline of FRMCS deployment on the network Správa železnic, s.o., Czech Republic*

2020-2026: Preliminary studies and standards (Infrastructure: GSM-R, Vehicles: GSM-R, RBC: ISDN)
- Adaptation of ETSI and 3GPP telecommunication standards
- Preparation of specifications (FRMCS v1, v2, v3)
- Preliminary studies
- Strategic planning
- Cost estimates
- Technology assessment
- Together with UNMZ to approve and modify ETSI
- Správa železnic, s.o. has two FRMCS studies. One study on cooperation witch Slovakia.

2023-2027: Tests and projects (infrastructure: GSM-R, vehicles: GSM-R, RBC: ISDN and dual operation ISDN/IP)
- Tests and trials
- Prototyping
- Project preparation for pilot sites
- Tests and tests in laboratories
- Tests and trials on the test circuit
- Decision on how to select a supplier

2027-2029: Pilot deployment (infrastructure: GSM-R/FRMCS migration time, vehicles: GSM-R/FRMCS migration time, RBC: dual ISDN/IP operation)
- Purchases of new technologies
- First pilot deployment
- Optimisation of radio coverage
- Approval and authorisation in the Czech railway environment

- Cooperation with operators
- Development and adaptation of current technologies for FRMCS

2030-2031: Start of FRMCS (infrastructure: GSM-R/FRMCS migration time, vehicles: GSM-R/FRMCS migration time, RBC: dual ISDN/IP operation)
- Commissioning of FRMCS in the SŽ environment
- Continuation of the design of other buildings
- Implementation and consolidation of the robustness of the whole FRMCS system
- Completion of GSM-R preparation and construction
- Start of possible cooperation with operators

2031-2040: National deployment of FRMCS (infrastructure: GSM-R/FRMCS migration time, vehicles: GSM-R/FRMCS migration time, RBC: dual ISDN/IP operation)
- Deployment of FRMCS in the RU environment
- Gradual preparation for the end of GSM-R

2040 ->: End of GSM-R (infrastructure: FRMCS, vehicles: FRMCS, RBC: IP)
- End of GSM-R operation
- GSM-R support from suppliers is at least until 2035
- As part of the FRMCS implementation, the deadline may be postponed

The individual steps must of course build on each other.
This plan is also dependent on funding.

1.8.2   Fleet

1.8.2.1   *Number of GSM-R end devices*

Country	Network	Handheld Total			Cab Radio			EDOR		
		Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated
Czechia	SŽ	1000	563	563	5000	4523	4523	5000	2480	2480

1.9 Denmark

1.9.1 Infrastructure

Investigations are ongoing to enable a decision on the implementation of FRMCS when the specifications are provided through the TSI CCS (expected in 2027).

1.9.1.1 *Decommissioning of GSM-R*

Investigations are ongoing to enable a decision on the implementation of FRMCS when the

specifications are provided through the TSI CCS (expected in 2027). GSM-R is expected to remain in service until end of the migration to FRMCS.

1.9.1.2 *. Information on cross-border lines*

As the specifications of FRMCS are not available until 2027, there are currently no specific plans for cross-border FRMCS implementation.

1.9.1.3 *. Information on nodes*

As the specifications of FRMCS are not available until 2027, there are currently no specific plans for FRMCS implementation in nodes.

1.9.2 Fleet

1.9.2.1 *Number of GSM-R end devices*

Country	Network	Handheld			Cab Radio			EDOR		
		Planned	Total Installed	SIM cards activated	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated
Denmark	BDK	1500		0	1500		180			

1.10 Estonia

1.10.1 Infrastructure

As of 2040, Estonia will start transferring 1520/1524 mm railway network and railway undertakings' rolling stock to Class A protection systems. The migration of the rail network involves the design, construction and phased deployment of the systems.

In addition to the above, the Rail Baltica 1,435 mm rail network will be built with Class A protection system ERTMS level 2. Rail Baltica FRMCS has an in-service date planned in 2030. Rail Baltic has 213 km planned in Estonia

All intersections are at different levels. International passenger terminals in Tallinn and Pärnu and 12 local stops will be built in Estonia. The design speed is 249 km/h for passenger trains, 120 km/h for freight trains. Rail Baltica can operate passenger trains up to 400 m and freight trains up to 1 050 m.

1.11 Finland

1.11.1 Infrastructure

The Finnish railway sector is preparing for the transition from the existing GSM-R system to the Future Railway Mobile Communication System (FRMCS) as part of the broader ERTMS (European Rail Traffic Management System) modernization efforts. This shift is driven by the need for a more resilient, future-proof, and high-capacity communication network to support the increasing demands of digital railway operations. The deployment of FRMCS aligns with European regulatory requirements and is aimed at enhancing operational safety, efficiency, and interoperability with other European rail networks.

The implementation strategy for FRMCS in Finland follows a phased approach, ensuring a smooth transition while maintaining uninterrupted railway operations. The plan includes a pilot phase, expected to test key functionalities such as voice communication, data transmission, and cybersecurity measures. Once validated, a gradual rollout will replace GSM-R in key railway corridors. The transition is expected to take place over several years, ensuring compatibility with existing systems before a full migration.

One of the key challenges in the deployment is infrastructure readiness, including the need for new radio towers, spectrum allocation, and upgrading onboard equipment. The Finnish Transport Infrastructure Agency (FTIA) is coordinating with railway operators, technology providers, and regulatory bodies to ensure seamless implementation. Special attention is being given to ensuring network resilience in harsh weather conditions, a critical factor for Finland's railway system.

The deployment of FRMCS is expected to bring significant operational and financial benefits. The system will provide faster and more reliable communications, enabling real-time monitoring, predictive maintenance, and automated train control. These improvements will lead to enhanced safety, lower operational costs, and better capacity management, making railway transport more competitive with other modes of transportation.

Looking ahead, the full transition to FRMCS is projected to be completed by the early 2030s, aligning with the broader European timetable for phasing out GSM-R. The Finnish railway sector is taking a proactive approach to ensure that the transition is cost-effective and future-ready, while also prioritizing cybersecurity, regulatory compliance, and system reliability. The success of this

deployment will play a crucial role in the digital transformation of Finland's railway network, ensuring its long-term sustainability and competitiveness.

1.11.1.1 *Timeline for FRMCS Deployment*

The Finnish railway sector has structured the **FRMCS deployment** in a phased approach to ensure a smooth transition from GSM-R. The key milestones include:

- **2024-2025: Planning and Preparation Phase**
  - Regulatory and technical framework finalization.
  - Initial frequency spectrum allocation discussions.
  - Coordination with European stakeholders for interoperability.
- **2026-2028: Pilot and Testing Phase**
  - **Pilot tests** in selected railway corridors.
  - Evaluation of **voice and data communication capabilities**.
  - **Cybersecurity testing** and system integration with existing railway operations.
  - Ensuring compatibility with legacy systems (GSM-R) to prevent disruptions.
- **2029-2032: Gradual Deployment and Migration**
  - **Progressive replacement of GSM-R infrastructure** with FRMCS-compliant systems.
  - Deployment of **new radio towers and base stations**.
  - **Onboard equipment upgrades** for train communication systems.
  - Training programs for railway operators and personnel.
- **2033 Onward: Full FRMCS Adoption**
  - Complete phase-out of GSM-R in Finland.
  - Full operational integration with ERTMS Level 2/3 systems.
  - Optimization and enhancement of the network for **future autonomous train operations**.

1.11.1.2 *Key Technical Challenges in FRMCS Deployment*

1. **Infrastructure Readiness**
   - Upgrading thousands of kilometers of railway network to support **5G-based FRMCS**.
   - Need for **new base stations, antennas, and fiber-optic connections**.
   - Ensuring **nationwide coverage, including tunnels and remote areas**.
2. **Interoperability with GSM-R and ERTMS**
   - FRMCS must **coexist with GSM-R** during the transition period to prevent disruptions.
   - Integration with **ERTMS Level 2 and Level 3 signaling systems**.
3. **Spectrum Allocation and Frequency Management**
   - FRMCS requires a **dedicated frequency band**, which must be coordinated at the European level.
   - Risk of interference with other communication networks.
4. **Cybersecurity and Data Protection**

- o Higher reliance on **IP-based networks** increases exposure to **cyber threats**.
- o Need for **strong encryption, intrusion detection, and secure authentication**.
5. **Cost and Investment Requirements**
   - o High costs associated with **infrastructure modernization, onboard system upgrades, and staff training**.
   - o Coordination with government and private stakeholders to **secure funding and subsidies**.

1.11.2 Fleet

1.11.2.1 Number *of GSM-R end devices*

		Handheld			Cab Radio			EDOR		
Country	Network	Planned	Total Installed	SIM cards activated	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated
Finland	FTIA	0		0	2000		740			

1.12 France

1.12.1 Infrastructure

The FRMCS deployment schedule is conditional on meeting the schedule for the functional and technical specifications of this technology. FRMCS will therefore be deployed gradually across the entire French rail network between 2032 and 2035.

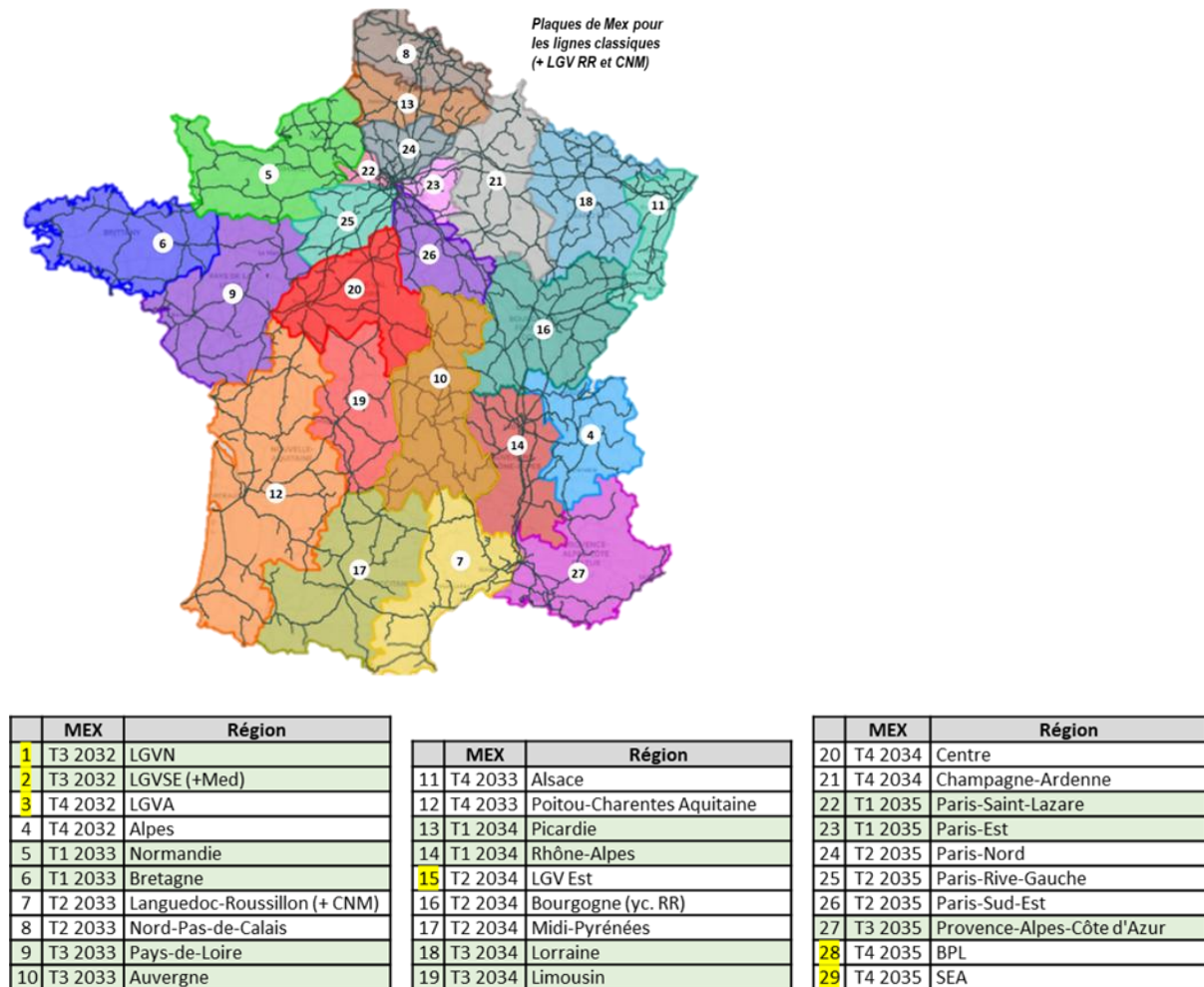The projected deployment timelines are detailed in Figure 0.1, appended to the deployment plan.

MEX		Région
1	T3 2032	LGVN
2	T3 2032	LGVSE (+Med)
3	T4 2032	LGVA
4	T4 2032	Alpes
5	T1 2033	Normandie
6	T1 2033	Bretagne
7	T2 2033	Languedoc-Roussillon (+ CNM)
8	T2 2033	Nord-Pas-de-Calais
9	T3 2033	Pays-de-Loire
10	T3 2033	Auvergne

MEX		Région
11	T4 2033	Alsace
12	T4 2033	Poitou-Charentes Aquitaine
13	T1 2034	Picardie
14	T1 2034	Rhône-Alpes
15	T2 2034	LGV Est
16	T2 2034	Bourgogne (yc. RR)
17	T2 2034	Midi-Pyrénées
18	T3 2034	Lorraine
19	T3 2034	Limousin

MEX		Région
20	T4 2034	Centre
21	T4 2034	Champagne-Ardenne
22	T1 2035	Paris-Saint-Lazare
23	T1 2035	Paris-Est
24	T2 2035	Paris-Nord
25	T2 2035	Paris-Rive-Gauche
26	T2 2035	Paris-Sud-Est
27	T3 2035	Provence-Alpes-Côte d'Azur
28	T4 2035	BPL
29	T4 2035	SEA

Figure 0.1

1.12.2 Fleet

1.12.2.1 *Number of GSM-R end devices*

		Handheld			Cab Radio			EDOR		
Country	Network	Planned	Total Installed	SIM cards activated	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated
France	SNCF Réseau	0		3402			16155			6967

1.13 Greece

1.13.1 Infrastructure

Pending publication of National Implementation Plan

1.13.2 Fleet

1.13.2.1 *Number of GSM-R end devices*

		Handheld			Cab Radio			EDOR		
Country	Network	Total								
		Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated
Greece	OSE	1920		90	670		120			

1.14 Hungary

1.14.1 Infrastructure

1.14.1.1 *Summary of FRMCS Implementation Plans in Hungary*

The "Hungary's National Implementation Plan for the Interoperability Technical Specifications of the Control-Command and Signaling Subsystem of the European Union Railway System (CCS TSI NIP) 2024-2050" outlines Hungary's strategy for upgrading its railway signaling and communication systems. This includes a transition to the Future Railway Mobile Communication System (FRMCS).

1.14.1.1.1 Current Status of Railway Systems in Hungary

Hungary has implemented the European Train Control System (ETCS) on 917.8 km of its TEN-T railway network, predominantly at Level 2. The primary suppliers for the ETCS deployment are Siemens and GTS (formerly Alcatel, Thales). The Hungarian railway network primarily uses Class B train control systems, specifically EVM-120 and Indusi/PZB, which have speed limitations. Many vehicles are equipped with Class B systems. Some locomotives are equipped with GSM-R.

1.14.1.2 *Transition to FRMCS*

Hungary is planning a transition from GSM-R to FRMCS. The document details plans for GSM-R deployment as a stepping stone towards the later adoption of FRMCS.

1.14.1.3 *Timelines*

The plan outlines the following timelines:

- **GSM-R Deployment:** GSM-R deployment is underway on several TEN-T lines, with completion dates varying by section, mostly in 2024.

- **FRMCS Deployment:** The document indicates that GSM-R will be transitioned to FRMCS. However, the precise timeline for FRMCS deployment is not detailed in this document.

- **GSM-R Decommissioning:** The document includes network maps showing the decommissioning schedule for GSM-R.

- **Class B System Decommissioning:** There is a plan to phase out Class B systems, but the document does not provide a detailed schedule.

1.14.1.4 *Border Crossings*

Hungary has established GSM-R roaming agreements with Austria (from 2016), Slovakia and Slovenia (from 2017), and the Czech Republic, Germany, and Romania (from 2019). ETCS has been implemented at the following border crossings, primarily at Level 1:

- Austria: Hegyeshalom-Nickelsdorf

- Romania: Lökösháza-Curtici

- Slovenia: Bajánsenye-Hodos

ETCS deployment is in progress towards Serbia at the Kelebia-Kelebija border crossing.

1.14.1.5 *Challenges*

The document identifies several challenges related to the implementation of new signaling and communication systems:

- **Vehicle Equipment:** Many vehicles are equipped with Class B systems, and upgrading or retrofitting them for ETCS and FRMCS can be technically complex and costly. The need for dual systems (Class B and ETCS/FRMCS) during the transition period adds to the complexity.

- **Financial Considerations:** The document mentions the financial burden on operators, especially for upgrading older vehicles.

- **Coordination:** Effective coordination is needed.

- **National Regulations:** Existing national regulations may pose challenges to the smooth implementation of the new systems.

1.14.1.6 *Implementation Strategy*

The implementation strategy involves:

- Gradual deployment of ETCS and GSM-R on priority lines.

- Phased transition from Class B systems.

- Upgrading vehicle fleets.

- Coordination with neighboring countries.

1.14.1.7 *Conclusion*

Hungary is committed to modernizing its railway network by implementing ERTMS and transitioning to FRMCS. While the document provides a good overview of the plans and objectives, the specific timelines for FRMCS deployment require further clarification. The document also highlights the challenges related to vehicle upgrades and the importance of cross-border interoperability.

1.14.2 Fleet

1.14.2.1 *Number of GSM-R end devices*

		Handheld			Cab Radio			EDOR		
Country	Network	Total								
		Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated
Hungary	MAV	1280		150	3000		1700	510		620

1.15 Ireland

1.15.1 Infrastructure

1.15.1.1 *Summary of FRMCS Implementation Plans in Ireland*

The "NATIONAL IMPLEMENTATION PLAN Ireland" outlines the strategy for upgrading Ireland's railway signaling and communication systems. This includes plans for the Future Railway Mobile Communication System (FRMCS). Iarnród Éireann-Infrastructure Manager is the primary entity responsible for these upgrades.

1.15.1.2 *Current Status of Railway Systems in Ireland*

Currently, Ireland is deploying ETCS Level 1. The implementation of GSM-R is also underway. The existing system relies on legacy Class B systems.

1.15.1.3 *Transition to FRMCS*

Ireland plans to transition to FRMCS, although the specific details and timelines for FRMCS implementation are not extensively detailed in the provided document. The strategy involves deploying GSM-R as a preliminary step. The document indicates that a commercially available FRMCS solution is expected in the early 2030s, following which Iarnród Éireann-IM will develop an implementation strategy for FRMCS deployment before 2040.

1.15.1.4 *Timelines*

- **ETCS Level 1 Deployment:** ETCS Level 1 is currently being deployed on several lines, including:
    - Dublin Connolly to Belfast Line (to the border with Northern Ireland)
    - Dublin Central Area (Dublin Connolly to Dublin Pearse)
    - Dublin Pearse to Rosslare Europort Line (Dublin Pearse to Greystones)
- **GSM-R Deployment:** GSM-R is being implemented in phases:
    - Phase 1: DART area & EMU fleet (Commissioned in June 2016, EMU fleet in service by March 2020)
    - Phase 2: Northern, Rosslare and Sligo lines & 29000 DMU fleet (Infrastructure works complete)
    - Phase 3a: Tralee, Cork/Cobh/Middleton, Dublin/Cork, Limerick Junction/Limerick, Limerick/Athenry/Galway lines (Infrastructure works complete, certifications in progress)
    - Phase 3b: Cherryville Junction/Waterford, Portarlington/Athenry, and Athlone/Westport/Ballina lines (Infrastructure works planned to be completed by October 2024)
- **FRMCS Deployment:** The document specifies that Iarnród Éireann-IM will develop an FRMCS implementation strategy once a commercial solution is available in the early 2030s, with a target deployment before 2040.
- **GSM-R Decommissioning:** The document indicates that GSM-R will be operational until 2040. There is no specific timeline for GSM-R decommissioning in the document.

- **Class B System Decommissioning:** The plan is to replace the legacy Class B system with ETCS Level 1, with a target completion by the end of 2040.

1.15.1.5 *Border Crossings*

The document provides the following information regarding cross-border lines:

- **Dublin Connolly to Belfast Line:** This line runs from Dublin Connolly to the border with Northern Ireland.

The document emphasizes the importance of cross-border interoperability, particularly concerning the line connecting Dublin and Belfast.

1.15.1.6 *Challenges*

The key challenges identified in the plan include:

- **Funding:** The timeline for ETCS implementation is dependent on available funding.
- **System Upgrades:** Upgrading the train protection system across the network is a significant undertaking.
- **Technological Transition:** The transition from the existing Class B systems to ETCS Level 1 and the subsequent transition to FRMCS require careful planning and execution.

1.15.1.7 *Key Objectives and Benefits*

The primary objectives of these upgrades are:

- Replacing obsolete Class B systems.
- Enhancing safety through the implementation of ETCS Level 1, which provides train stop and speed supervision.
- Aligning with EU targets as much as possible.
- Supporting continued GSM-R deployment until 2040.
- Deploying FRMCS before 2040.

1.15.1.8 *Technology*

- **ETCS:** Ireland is deploying ETCS Level 1.
- **GSM-R:** GSM-R deployment is ongoing.
- **FRMCS:** Ireland plans to deploy FRMCS.
- **Class B Systems:** Ireland currently uses Class B systems, which are being replaced.
- **TSI Compliant Train Detection:** TSI compliant train detection is in service on approximately 1,100 km of track.

1.15.2 Implementation Strategy

The implementation strategy involves:

- Replacing Class B systems with ETCS Level 1.
- Phased deployment of GSM-R.
- Developing an FRMCS implementation strategy in the early 2030s.
- Aiming to have FRMCS deployed and operational before 2040.

1.15.2.1 *Conclusion*

Ireland is focused on modernizing its railway infrastructure by deploying ETCS Level 1 and planning for the introduction of FRMCS. While the plan outlines the ETCS and GSM-R deployment in detail, more specific information on the FRMCS deployment timeline and strategy will be developed in the early 2030s. The plan acknowledges the challenges related to funding and the need for a smooth transition to new technologies.

1.16 Italy

1.16.1 Infrastructure

1.16.1.1 *Summary of FRMCS Implementation Plans in Italy*

The "Piano Nazionale di Attuazione ERTMS" (National Implementation Plan for ERTMS - 2024) outlines Italy's strategy for upgrading its railway signaling and communication systems, thus including the transition to the Future Railway Mobile Communication System (FRMCS). However, the actual plan for the deployment of FRMCS will be developed in the coming years, when the FRMCS standardization activities will be consolidated. Indeed, the standardization activities for FRMCS are not yet completed and the commissioning plan and subsequent FRMCS installation activities can only begin following these standardization activities. The most accredited strategy for the introduction of the FRMCS on the RFI network envisages first upgrading or equipping circulating trains with on-board subsystems capable of inter-operating on both GSM-R and FRMCS networks, and subsequently, the activation, on a line-by-line basis, of the FRMCS system and the simultaneous decommissioning of the GSM-R system.

1.16.1.2 *Current Status of Railway Systems in Italy*

Italy has been actively investing in upgrading its railway infrastructure, including the installation of the national train control system (SCMT), the deployment of GSM-R, and the modernization of stations with computerized central traffic control systems (ACC/ACCM). These efforts are aimed at migrating towards the European Rail Traffic Management System (ERTMS).

- **ETCS:** RFI has been using the ERTMS system on its High-Speed/High-Capacity (AV/AC) network lines since 2005. Today, out of a total of 16.800 km, about 1.000 km of High-Speed lines and 270 km of conventional lines on the Core Corridors are already equipped with ERTMS. The current plan foresees the installation of ETCS on both High Speed/High Capacity (HS/HC) and conventional lines.
- **GSM-R:** RFI has implemented a GSM-R network infrastructure on approximately 11.700 km of railway lines. The plan includes the extension of GSM-R to lines where it is currently absent.
- **Class B Systems:** The entire Italian railway network is equipped with Class B train protection systems, primarily SCMT (Sistema di Controllo Marcia Treno) and SSC (Sistema di Supporto alla Condotta). The Plan provides for the progressive decommissioning of these systems with the introduction of ERTMS.
- **Fleets upgrade:** The NIP outlines a "dual on-board" approach for the on-board systems to facilitate the transition from legacy Class B systems to ERTMS. RFI has taken a leading role by contracting the development of ETCS Baseline 3 Release 2 (B3R2) Generic Applications with integrated SCMT/SSC (Class B). The upgrade to ERTMS of all national Vehicle Types has begun. The upgrade of the fleets must be done in line with the trackside ERTMS deployment plan. It is expected that approximately 5.000 on-board units will be equipped with ERTMS in coordination with the trackside ERTMS deployment plan (this implies approximately 10,000 Mobile Terminals and 5,800 GSM-R Cab radios).

1.16.1.3 *Transition to FRMCS*

The Italian plan for the transition to FRMCS will be elaborated in the next few years, when the FRMCS standardisation activities will be consolidated and will make it possible to assess the impacts related to the coexistence, on the same line, of the two systems (GSM-R and FRMCS) and the possible migration strategies. The most accredited hypothesis at the moment for the introduction of FRMCS envisages firstly the upgrade of the trains with on-board subsystems capable of inter-working on both the GSM-R and FRMCS networks, and subsequently the activation, on a line-by-line basis, of the FRMCS system and the simultaneous switch-off of the GSM-R system.

1.16.1.4 *Timelines*

- **ETCS Deployment:** ETCS deployment is ongoing, with varying completion dates for different lines. The plan aims to complete ERTMS implementation on the core network by 2033 and on the entire RFI network (TEN-T and Off-TEN) by 2041.
- **GSM-R Deployment:** GSM-R deployment is in progress.
- **FRMCS Deployment:** The document indicates a transition from GSM-R to FRMCS, but specific timelines for FRMCS are not yet detailed. The commissioning plan and subsequent FRMCS installation activities can only start after the FRMCS standardisation activities have been completed.
- **Class B System Decommissioning:** SCMT and SCC decommissioning will occur concurrently with ERTMS L2 stand-alone activation. The decommissioning of Class B systems will begin in 2025, in coordination with the relevant railway companies, and in line with the deployment of ERTMS.

1.16.1.5 *Border Crossings*

The NIP provides information on ETCS implementation at the following border crossings:

- Italy – France:
    - Ventimiglia (e) – State border – Mentone (e)
    - Bardonecchia (i) – State border - Modane (e)
    - Limone – State border
    - Olivetta S. Michele – State border
- Italy – Switzerland
    - Domodossola - State border – Iselle
    - Domodossola/Domodossola II
    - Luino - Pino Tronzano – State border – Ranzo
    - PM Bevera – State border – Stabio
- Italy – Austria
    - Brennero – State border – Steinach
    - San Candido – State border – Sillian
    - Tarvisio – State border – Villach
- Italy – Slovenia
    - Villa Opicina - State border - Sezana

The document emphasizes the importance of cross-border interoperability.

1.16.1.6 *Challenges*

The document identifies several challenges:

- **Technological and Financial Challenges:** The transition to ERTMS, including the deployment of both trackside and on-board systems, involves significant technological and financial investments.
- **Vehicle Equipment:** Upgrading or retrofitting vehicles with ETCS (and later FRMCS) equipment, especially for older fleets, is a significant challenge.

1.16.1.7 *Implementation Strategy*

The implementation strategy involves:

- Progressive deployment of ERTMS on the entire RFI network, starting with core network lines.
- Gradual phasing out of Class B systems synchronized with the ERTMS commissioning.
- Coordination with neighboring countries for cross-border interoperability.
- For what concerns FRMCS, the deployment is contingent on the completion of FRMCS standardization, with detailed plans to be developed subsequently.

1.16.1.8 *Conclusion*

Italy is committed to upgrading its railway infrastructure by deploying ERTMS and transitioning towards FRMCS. The plan acknowledges the challenges involved in this transition, including technological complexity, financial costs, and the need for coordination. The transition from GSM-R to FRMCS is planned but contingent on the completion of FRMCS standardization, with detailed plans to be developed subsequently.

1.16.2 Fleet

1.16.2.1 *Number of GSM-R end devices*

		Handheld			Cab Radio			EDOR		
Country	Network	Total Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated
Italy	RFI	2500		59300	3450		3963			7926

1.17 Latvia

1.17.1 Infrastructure

1.17.1.1 *FRMCS Introduction in Latvia*

Latvia is undertaking a significant modernization of its railway communications as part of the European CCS TSI framework, with a focus on implementing the Future Railway Mobile Communication System (FRMCS) across its rail network.

1.17.1.2 *Rail Network Overview*

- Existing 1,520 mm gauge (interoperable with Lithuania and Estonia)
- New 1,435 mm Rail Baltica corridor under construction

1.17.1.3 *FRMCS Deployment Timeline for Rail Baltica corridor*

2024–2025: Technical and financial offers

2025–2027: Resource mobilization (EU and national funds)

2028–2031: Construction phase

By December 31, 2031: Planned entry into service

DMR will continue as backup during transition on 1,520 mm gauge network

1.17.1.4 *Technical Scope and Coverage (based on FRMCS in 900 MHz)*

- ~1,800 km coverage
- ~260 base stations
- ~155 fixed terminals
- ~850 portable radios
- ~80 fixed terminals for wagon maintenance
- ~400 traction vehicles (~680 radios total)

Based on 900 MHz band operation; supports train radio, shunting, maintenance, safety-critical functions

1.17.1.5 *Key cross-border lines:*

- Riga–Jelgava–Meitene (Lithuania)
- Riga–Lugaži (Estonia)

Coordination with Lithuania and Estonia to synchronize deployment and ensure seamless operation

1.17.1.6 *Integration with Rail Baltica*

Rail Baltica to use ETCS Level 2, FRMCS Baseline 1, ATO Baseline 1

Compliant with future TSI CCS updates; focus on digital, signal-less operations

ETCS Level 1 as intermediate step before full FRMCS-ETCS Level 2 rollout

1.18 Lithuania

1.18.1 Infrastructure

1.18.1.1 *Summary of FRMCS Introduction in Lithuania*

Lithuania is advancing its railway modernization under the European CCS TSI framework, focusing on implementing FRMCS on the 1,435 mm Rail Baltica corridor while maintaining GSM-R on the 1,520 mm legacy network.

1.18.1.2 *Network Overview*

- Total railway length: ~1,924 km

    o 1,520 mm gauge: ~1,796 km (legacy network)

    o 1,435 mm gauge: ~128 km (Rail Baltica, under construction)

- Current train protection and radio systems:

    o GSM-R deployed on 1,520 mm network since 2010, covering ~1,563 km.

    o B-class ALSN train protection in place on most legacy lines.

    o No ETCS currently deployed.

1.18.1.3 *FRMCS Rollout Plan*

- **Scope:** FRMCS will be introduced only on the 1,435 mm Rail Baltica line, not on the 1,520 mm network.

- **Timeline:**

    o 2024–2029: Construction and system integration.

    o By end of 2030: FRMCS operational.

- **Lines included:**

    o Kaunas–Ramygala (~76 km)

    o Ramygala–Latvia border (~92 km)

    o Kaunas–Vilnius (~88 km)

    o Jiesia–Poland border (~78 km)

- **Technical targets:** FRMCS Baseline 1, fully digital rail operations, no prior GSM-R.

1.18.1.4 *GSM-R Decommissioning Plan*

- **1,520 mm network:**

    o GSM-R will **remain operational** beyond 2030; no decommissioning currently planned.

    o GSM-R transformation to FRMCS will follow a separate, later roadmap once the European standard is finalized.

- **1,435 mm network:**

    o No GSM-R installation; FRMCS will be the first and only radio system.

- GSM-R infrastructure on legacy network includes:

    o ~136 base stations, ~200 dispatcher terminals, ~600 vehicle radios.

    o Fully deployed on main national and border lines since 2010.

1.18.1.5 *Border Crossing Strategy*

- Key cross-border FRMCS deployment on Rail Baltica:

    o **Latvia border:** Vaškai–Bauskė section.

    o **Poland border:** Mockava–Trakiškės section.

- Joint projects with Latvia and Estonia under the RB Rail consortium:

    o ETCS Level 2 + FRMCS Baseline 1 + ATO Baseline 1.

    o Full interoperability across Baltic states.

- On the 1,520 mm legacy network:

    o GSM-R in place on border crossings to Latvia, Belarus, and Russia (Kaliningrad).

    o Continued use of GSM-R for international traffic until migration plan is developed.

1.18.1.6 *Transition and Migration*

- Legacy B-class ALSN train protection to remain on 1,520 mm lines; no short-term ETCS or FRMCS upgrade planned.

- Rail Baltica will introduce full ERTMS (ETCS + FRMCS) from the start, setting a model for future upgrades on the legacy network.

- Future migration of the 1,520 mm network will depend on European regulatory developments and national funding.

1.19 Luxembourg

1.19.1 Infrastructure

Luxembourg is preparing to modernize its railway communications with FRMCS, building on its fully ETCS Level 1-equipped network and GSM-R system. The small but strategically located national network (~275 km) plays an important role in European cross-border traffic, especially toward Belgium, France, and Germany.

1.19.1.1 *Current Network and Communication Systems*

- **ETCS status:**

  o Entire network operates under ETCS Level 1 Full Supervision since 2018.

  o No Class B train protection systems are in use.

- **GSM-R status:**

  o Deployed across the entire network (~275 km) since December 2018.

  o Used as the only communication system for train operations.

  o Class B radios (legacy Telecar 10/460) remain only for shunting; decommissioning planned by 2027 after MCX deployment.

1.19.1.2 *FRMCS Deployment Plan*

- **Deployment timeline:**

  o Start of construction and rollout: ~2029

  o Full FRMCS operation: **2030**

  o Parallel operation with GSM-R until ~2035

  o Final GSM-R switch-off: **end of 2035**

- **Deployment approach:**

    o Initial rollout in **n101 band (1900 MHz TDD)** to avoid conflicts with GSM-R in n100 band (900 MHz FDD).

    o After GSM-R decommissioning, FRMCS will also use n100 band.

    o Forecast baseline: **FRMCS v3**

- **Scope:**

    o Entire national network, including cross-border lines.

1.19.1.3 *GSM-R Decommissioning Strategy*

- **Transition period:**

    o Five-year parallel operation between GSM-R and FRMCS (2030–2035).

    o Gradual migration of all operational functions from GSM-R to FRMCS.

- **Class B radio (shunting) decommissioning:**

    o To be phased out with full MCX deployment by **2027**.

    o CFL has secured spare parts to ensure operational readiness until decommissioning.

1.19.1.4 *Border Crossing Considerations*

Luxembourg's network is critical for international connectivity:

- **Belgium:** Troisvierges – Gouvy

- **France:** Bettembourg – Thionville, Rodange – Longwy

- **Germany:** Wasserbillig – Trier

Plans include:

- Coordinated cross-border FRMCS implementation with neighboring countries.

- Ensuring seamless international interoperability, especially on:

    o **Bettembourg – Thionville (France)**

    o **Rodange – Athus (Belgium)**

    o **Wasserbillig – Trier (Germany)**

This requires close cooperation under the EU's Rail Freight Corridors and agreements on synchronized GSM-R phase-out.

1.19.1.5 *Broader Migration and ATO Integration*

- **ATO plans:**

  - Pilot GoA2 ATO project underway on the Walferdange–Ettelbruck line, aiming for deployment assessment by 2028.

  - Future integration of ATO with FRMCS.

- **Train detection systems:**

  - Being progressively upgraded to TSI-compliant solutions as part of interlocking renewals.

1.19.2 Fleet

1.19.2.1 *Number of GSM-R end devices*

-

		Handheld			Cab Radio			EDOR		
Country	Network	Planned	Total Installed	SIM cards activated	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activa
Luxemburg	CFL	400		70	203		188	0	0	0

1.20 Netherlands

1.20.1 Infrastructure

1.20.1.1 *Summary of FRMCS Introduction in the Netherlands*

The Netherlands is embarking on a substantial modernization of its railway communication and control systems through the rollout of FRMCS (Future Railway Mobile Communication System) as part of its broader ERTMS (European Rail Traffic Management System) program. This initiative, led by ProRail in cooperation with Dutch railway undertakings and aligned with European standards, aims to replace the aging GSM-R system and enhance cross-border operations.

1.20.1.2 *Current Status and Migration Path*

The Dutch rail network is already comprehensively equipped with GSM-R (Global System for Mobile Communications – Railway), which provides voice and data communication services. All lines have GSM-R coverage, and Class B radio systems are no longer in use, eliminating the need for their decommissioning. However, the migration towards FRMCS is still in the preparation phase, with no precise start dates yet announced.

The migration strategy involves:

- Upgrading rolling stock to ETCS (European Train Control System) version 2.0 or 2.1, followed by infrastructure upgrades to version 2.1.

- Preparing for the TSI CCS 2023 introduction, which brings FRMCS, and functionalities associated with ETCS version 3.0.

- Announcing rolling stock conversion requirements at least five years in advance.

A dedicated workgroup under the ERTMS Program is defining critical migration aspects:

- Milestones for phasing out GSM-R.

- Assessment of retrofitting vehicles with ETCS 2.0/2.1 for FRMCS compatibility.

- Infrastructure systems and interfaces.

- Migration scenarios, associated choices, risks, and governance.

- Cost-benefit analysis and governance recommendations.

The preparatory phase is expected to conclude by Q3 2024.

1.20.1.3 *GSM-R Decommissioning Plan*

The detailed decommissioning timeline for GSM-R will be outlined in the revised ERTMS program. While all lines currently use GSM-R, the transition to FRMCS will happen progressively, considering technical, operational, and economic aspects. ProRail is also participating in the EU-wide Morane 2 initiative to verify and validate European FRMCS specifications and will launch a CEF II pilot study with NS in September 2024 to explore technological opportunities and challenges.

Key points:

- GSM-R will remain operational during early FRMCS deployments.

- GSM-R decommissioning dates are yet to be determined and will be included in the upcoming revised program.

- There is no existing Class B radio system, simplifying the transition.

1.20.1.4 *Cross-Border Considerations*

The Netherlands has numerous critical cross-border rail connections with Germany and Belgium, which are integral to the Comprehensive TEN-T Network. The country is actively coordinating with neighboring infrastructure managers to align ERTMS and future FRMCS deployment.

Key cross-border sections include:

- **Germany:** Nieuweschans–Weener, Oldenzaal–Bad Bentheim, Enschede–Gronau, Zevenaar–Emmerich (ETCS L2), Venlo–Kaldenkirchen, Haanrade–Herzogenrath.

- **Belgium:** Sas van Gent–Zelzate, Roosendaal–Essen (ETCS L2/TBL1+), Breda–Noorder Kempen (ETCS L2/L1), Budel–Hamont, Eijsden–Visé.

These lines currently operate a mix of train protection systems (ATB EG, ATB NG, PZB, ETCS L2, Crocodile, TBL1+). GSM-R provides voice radio coverage on all these cross-border routes, and ERTMS applications are supported where ETCS Level 2 is installed. The future FRMCS deployment will ensure seamless radio communication across borders, enhancing interoperability and safety.

1.20.1.5 *Looking Forward*

The Dutch strategy emphasizes:

- A phased, learning-based rollout of FRMCS.

- Initial trials on simpler regional lines.

- Close coordination with neighboring countries.

- Minimization of operational disruptions.

- Robust stakeholder engagement, including freight operators, historic fleet owners, and infrastructure managers.

A final government decision on the updated rollout strategy is expected by mid-2025, with the first tranche of deployment details announced in late 2024.

1.20.2 Fleet

1.20.2.1 *Number of GSM-R end devices*

		Handheld			Cab Radio			EDOR		
Country	Network	Planned	Installed	Total SIM cards activated	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activa
Netherlands	ProRail	0		600	3000	3000	3000		200	140

1.21 Poland

1.21.1 Infrastructure

1.21.1.1 *FRMCS Introduction in Poland*

Poland, through its national rail infrastructure manager PKP Polskie Linie Kolejowe S.A. (PLK S.A.), is undertaking a major modernization of its railway communication systems. This includes the rollout of the Future Railway Mobile Communication System (FRMCS), which will eventually replace the legacy GSM-R network. The FRMCS deployment is a vital part of the broader European ERTMS (European Rail Traffic Management System) migration, improving interoperability, safety, and digitalization across the rail network.

1.21.1.2 *FRMCS Deployment Timeline*

- **Implementation Study:** Poland plans to first conduct an in-depth FRMCS implementation study, including cost-benefit analysis, to assess financial, material, and technical needs.

- **Testing:** Experimental deployments and tests are underway at the Żmigród test track, covering electromagnetic compatibility, cybersecurity risks, and practical migration scenarios.

- **Specifications and Availability:** FRMCS deployment will only proceed once final technical specifications are published (expected Q4 2026) and mature, non-prototype equipment is available (expected 2027).

- **Full Rollout:** The target is network-wide FRMCS deployment by **2035**, conditional on funding and market readiness. A formal migration strategy and funding mechanisms will be included in updated national plans.

1.21.1.3 *GSM-R Decommissioning Strategy*

- **Current Status:** GSM-R is being rolled out nationwide, with completion targeted by **2029**. GSM-R is currently available on ~1,585 km and will cover ~17,600 km when fully deployed.

- **Decommissioning Plan:** The 150 MHz legacy system will be switched off within three years after GSM-R activation on a given line. GSM-R will remain operational until at least **2035**, aligned with vendor support timelines.

- **Transition to FRMCS:** GSM-R decommissioning will depend on FRMCS progress. The migration will be coordinated to ensure no gaps in critical communication and to avoid stranded investments in GSM-R infrastructure.

1.21.1.4 *Use of Public Infrastructure*

To speed up FRMCS deployment, Poland plans to collaborate with public mobile network operators to share existing towers and transmission systems. This approach aims to minimize the need for new builds, reducing both cost and bureaucratic delays.

1.21.1.5 *Border Crossing and Interoperability*

- **ETCS and Cross-Border Sections:** Poland is prioritizing interoperable ETCS (European Train Control System) deployment on border sections with **Germany, the Czech Republic, and Lithuania**. Agreements are being developed with neighboring infrastructure managers to coordinate technical and operational aspects.

- **FRMCS on Borders:** While no detailed cross-border FRMCS plans are published yet, Poland aims to synchronize FRMCS implementation with its neighbors to ensure smooth, uninterrupted rail operations across borders.

1.21.1.6 *R&D and National Coordination*

- **Żmigród Test Track:** Key experimental site for FRMCS, covering full-scale tests of rolling stock, trackside equipment, and digital services (e.g., passenger information, energy monitoring).

- **Future Training Grounds:** A research ground is planned at PKM S.A. in collaboration with Warsaw University of Technology, focusing on layered FRMCS architecture, service development, and practical validation between 2025–2029.

- **Cybersecurity Focus:** Tests include assessing radio interference, electromagnetic resistance, and cyber risks—critical for ensuring FRMCS resilience.

-
  Set up FRMCS on Żmigród Test Track – 2026
- Signing frame agreements for passive infrastructure sharing with mobile operators – 2025/2026
- Set up and run 5G Core – 2028
- FRMCS deployment on 1st rail line – 2030
- Prerequisite for setting up priorities for FRMCS lines is to continue GSM-R project. Depends on the scope and progress of its priorities will be determined".

"

.

1.21.1.7 *Summary of Key Milestones*

	Target Date
Final FRMCS specifications	Q4 2026
Set up FRMCS on Żmigród Test Track – 2026 • Signing frame agreements for passive infrastructure sharing with mobile operators – 2025/2026 • Set up and run 5G Core – 2028	2027
Market-available, non-prototype FRMCS equipment	
National FRMCS rollout completion	2035
GSM-R deployment completion	End of 2029
GSM-R decommissioning start	Post-2035

1.21.2 Fleet

1.21.2.1 *Number of GSM-R end devices*

Country	Network	Handheld			Cab Radio			EDOR		
		Planned	Total Installed	SIM cards activated	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated
Poland	PKP	6500		0	5455		230	330		

Conclusion

Poland's FRMCS plan is ambitious but carefully staged, balancing innovation with pragmatic risk management. By integrating public infrastructure, coordinating with neighboring countries, and focusing on robust testing, Poland is positioning itself as a leader in next-generation railway communications in Europe.

1.22 Portugal

1.22.1 Infrastructure

1.22.1.1 Current Network and Communication Systems

Portugal's railway network is undergoing a gradual upgrade under the European ERTMS framework, combining ETCS Level 2, GSM-R, and future FRMCS deployment. The current network includes:

- **GSM-R status:** Installed on selected lines including Linha de Cascais, Linha do Algarve, Linha do Alentejo, Linha de Évora, and Linha da Beira Baixa.

- **Class B radio systems:** TTT CP-N, still operational on non-GSM-R lines but beyond its economic lifespan.

- **Class B train protection systems:** EBICAB 700 and INDUSI I60, with long-term phase-out planned.

- **ETCS Level 2 deployment:** Ongoing on key corridors, with full completion targeted by 2030.

1.22.1.2 FRMCS Deployment Plans.

- **Planned timeline:** FRMCS introduction is predicted for **2030–2035**, aligned with the anticipated end of GSM-R support from vendors.

- **Migration strategy:** Parallel operation of GSM-R and FRMCS during a transition period, similar to the earlier migration from Class B radio systems to GSM-R.

- **Dependencies:** The rollout depends on finalization of FRMCS specifications at the European level and market availability of mature technology.

1.22.1.3 GSM-R Decommissioning Strategy

- GSM-R will remain the backbone communication system until **at least 2035**.

- Dual-mode onboard radios (supporting both GSM-R and Class B) are currently being installed on rolling stock to support the transitional period.

- The decommissioning of Class B radio systems will occur only after full GSM-R coverage is achieved.

- A similar dual-mode strategy is envisioned for the future transition from GSM-R to FRMCS.

1.22.1.4 *Cross-Border Coordination*

- Portugal's cross-border railway connections with Spain (ADIF) are still under development or construction.

- **Current state:** No Class A (ETCS) or FRMCS systems are yet installed on cross-border lines.

- **Coordination status:** Technical meetings between Portugal's infrastructure manager IP and ADIF are ongoing, but no formal agreements or GSM-R roaming arrangements have been finalized.

1.22.1.5 *Major Technical Programs*

- **ETCS deployment:**

  - Linha da Beira Alta (Pampilhosa–Vilar Formoso), Linha de Évora, Linha de Cascais—under contracts or construction.

  - Full network completion targeted by 2030–2035.

- **GSM-R deployment:**

  - Ongoing and expanding, including upgrades and new installations on major freight and passenger corridors.

- **Train detection systems:**

  - TSI-compliant systems are being progressively deployed, with full renewal planned by 2030.

- **Rolling stock upgrades:**

  - ETCS and GSM-R retrofitting underway across multiple operators (CP, Takargo, Medway, Fertagus).

1.22.1.6 *Class B System Phase-Out*

- **INDUSI I60:** To be decommissioned on the Cascais Line by 2025–2035.

- **EBICAB 700:** National phase-out planned for 2040–2050.

- **TTT CP-N (Class B radio):** To be retired after GSM-R rollout completion.

1.22.1.7 *Financing and Future Readiness*

- Funding from national sources and European programs (Recovery and Resilience Plan, Sustainable 2030).

- Applications to the Connecting Europe Facility (CEF) for fleet upgrades (e.g., CP A4000 units).

1.22.1.8 *Summary of Key Milestones*

Component   **Timeline**

GSM-R completion	By ~2029–2030
FRMCS deployment	Starts ~2030–2035
Class B radio removal	After GSM-R full rollout
ETCS network coverage	By ~2030–2035
Cross-border FRMCS	No timeline yet; under discussion

1.22.2 Fleet

1.22.2.1 *Number of GSM-R end devices*

		Handheld			Cab Radio			EDOR		
Country	Network	Total Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated	Planned	Installed	SIM act
Portugal	REFER	500		44	550	290	290	0	0	0

1.23 Romania

1.23.1 Infrastructure

NIP is not yet available

1.23.2 Fleet

1.23.2.1 *Number of GSM-R end devices*

		Handheld			Cab Radio			EDOR		
Country	Network	Planned	Total Installed	SIM cards activated	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated
Romania	CFR	200		0	9	9	500	16	16	

1.24 Slovakia

1.24.1 Infrastructure

1.24.1.1 *Current Network and Communication Systems*

Slovakia is implementing the European Control-Command and Signalling (CCS) standards to modernize its railway network, including the deployment of ERTMS, ETCS, GSM-R, and eventually FRMCS. The national infrastructure manager, Železnice Slovenskej republiky (ŽSR), oversees ~3,600 km of lines, including:

- ~3,500 km of 1,435 mm gauge

- ~88 km of 1,520 mm gauge

1.24.1.2 *FRMCS Deployment Plan*

- **Current status:** No FRMCS deployed yet; focused on ETCS and GSM-R rollout.

- **Planned approach:**

  o Synchronize FRMCS with the ETCS Level 2 upgrade.

  o Transition from GSM-R to FRMCS on both national and international corridors.

- **Timeline:**

  o Pilot and preparation phase (2025–2030).

  o Gradual national rollout (2030–2040).

  o Target completion by ~2045–2050, aligned with TEN-T deadlines.

1.24.1.3 *GSM-R Deployment and Decommissioning*

- **Current GSM-R status:**

  o ~400 km in operation or installed.

  o Additional ~400 km under construction (2025–2027 target completion).

- **Use cases:** Voice and data services on TEN-T core and comprehensive networks.

- **Decommissioning plan:**

- o   GSM-R will stay operational until FRMCS is fully implemented.

- o   Class B legacy systems (e.g., LS, MIREL) are being phased out.

- o   Final GSM-R switch-off depends on European FRMCS specification maturity (~2035–2045 window).

1.24.1.4 *Cross-Border Coordination*

Slovakia's rail network has critical cross-border connections with:

- **Czech Republic** (e.g., Čadca–Mosty u Jablunkova, Kúty–Lanžhot)

- **Hungary** (e.g., Rusovce–Rajka, Čierna nad Tisou–Chop)

- **Austria** (e.g., Devínska Nová Ves–Marchegg, Bratislava-Petržalka–Kittsee)

- **Poland** and **Ukraine**

Plans include:

- Harmonized FRMCS introduction across borders.

- Coordination with neighboring infrastructure managers to ensure seamless roaming and service continuity.

- Synchronization with ETCS Level 2 upgrades on international corridors.

1.24.1.5 *ETCS and ERTMS Strategy*

- ~212 km of ETCS currently in operation.

- ~275 km under construction (2025–2030 target commissioning).

- Strategy prioritizes ETCS Level 2 deployment.

- Plans to migrate from ETCS Level 1 to Level 2 on key freight and passenger routes.

- National deadlines aligned with TEN-T targets:

  - o   Core network by 2030.

  - o   Extended core by 2040.

  - o   Comprehensive network by 2050.

1.24.1.6 *Summary of Key Milestones*

Milestone	Target Date
GSM-R rollout completion	~2027
FRMCS rollout start	~2030
FRMCS network-wide completion	~2045–2050
Class B system decommissioning	By ~2040 (core), ~2045 (extended), ~2050 (comprehensive)
Cross-border synchronization	Coordinated with Czech Republic, Austria, Hungary, Poland, Ukraine

- o

1.24.2 Fleet

1.24.2.1 *Number of GSM-R end devices*

Over 70 locomotives and trainsets equipped with ETCS; ongoing upgrades.

- Average retrofit costs:

    - o ETCS: ~€566,000 per vehicle.

    - o GSM-R: ~€47,000 per vehicle.

- Dual-mode onboard equipment planned for the transition to FRMCS.

1.25 Slovenia

1.25.1 Infrastructure

1.25.1.1 *Strategic Migration Context*

Slovenia's railway network is undergoing a comprehensive transition aligned with the EU's CCS TSI and TEN-T regulations. The focus is on replacing legacy Class B systems (Indusi I60R) and GSM-R infrastructure with ETCS and FRMCS, ensuring interoperability across the trans-European transport network.

1.25.1.2 *GSM-R Deployment and Decommissioning*

- GSM-R (Class A) has been fully deployed across Slovenia since 2017, covering all lines except line 43 (d.m.–Lendava).

- The system provides full voice communication, text messaging, and data capability (EIRENE SRS 15.4.0 and FRS 7.4.0).

- GSM-R is planned to remain in service until **2035**.

- FRMCS integration is set to begin in **2032**, with both systems operating in parallel until GSM-R shutdown.

1.25.1.3 *FRMCS Migration Plan*

- Preparatory work includes technical specifications, standardization, prototype testing, and national migration studies.

- A national 5G network will be developed to support FRMCS.

- Interconnection hubs will be upgraded to FRMCS for seamless cross-border interoperability.

1.25.1.4 *Cross-Border Considerations*

Slovenia borders Austria, Italy, Hungary, and Croatia. Current border infrastructure:

- **ETCS and GSM-R**: Deployed up to the borders with Austria, Hungary, and parts of Croatia.

- **Class B (Indusi I60R)**: Still active on all border lines except select connections to Croatia and Italy.

- FRMCS interconnection is not yet in place, requiring coordination with neighboring countries during rollout.

1.25.1.5 *Additional Considerations*

- Slovenia is not deploying ATO (automated train operation).

- TSI-compliant train detection (Frauscher RSR180 axle counters) is widely deployed.

- The Class B radio system (RDZ) was decommissioned in 2021.

1.25.1.6 *Conclusion*

- Slovenia is methodically aligning with EU targets for full ETCS and FRMCS deployment. The current GSM-R system provides robust coverage and will coexist with FRMCS during the migration window (2032–2035). Interoperability with neighboring countries is a key consideration, as is the gradual retrofit of rolling stock and signal systems. The next few years are critical for finalizing FRMCS specifications, infrastructure readiness, and operator coordination.

1.25.2 . Fleet

1.25.2.1 *Rolling Stock Upgrades*

- All operational vehicles in Slovenia are equipped with **GSM-R**.

- Only a **limited fleet** is equipped with ETCS onboard units (e.g., some Vectron and Siemens units).

- Rolling stock modernization includes gradual equipping of locomotives with ETCS and later FRMCS modules.

1.25.2.2 *Vehicle Equipment Snapshot (sample):*

- E193 Vectron: ETCS + GSM-R

- 1216/541 Taurus: GSM-R only

- 310/316: Dual GSM-R (2 units)

- Majority of passenger DMUs and EMUs: GSM-R only

1.25.2.3 *ETCS Deployment Overview*

- ETCS Level 1 Baseline 2 and 3 systems installed along all core lines.

- Some segments temporarily decommissioned due to infrastructure works, with reactivation planned.

- Full deployment across the core network due by **2030**; extended core network by **2040**.

1.25.2.4 *Class B Systems Phase-Out*

- Class B (Indusi I60R) remains in active service across all major lines.

- Decommissioning schedule:

    o Core network: by **2040**

    o Extended core: by **2045**

    o Comprehensive network: by **2050**

1.25.2.5 *Number of GSM-R end devices*

	Handheld	Cab Radio	EDOR

Country	Network	Total								
		Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated
Slovenia	SŽ	1953		1472	236	206	206	0	0	0

1.26 Spain

1.26.1 Infrastructure

1.26.1.1 *Overview of Actual Situation and UIC Planning*

The Spanish rail sector is actively preparing for the migration to FRMCS (Future Railway Mobile Communication System) as part of a coordinated European strategy. A significant milestone is the validation of FRMCS version 2 specifications, under the MORANE 2 project. This project spans 30 months and brings together a large consortium: UIC, Siemens, Alstom, CAF, Funkwerk, Kontron, Ericsson, Nokia, Hitachi, Teltronic, Frequentis, TrioRail, Eviden, Viavi, TRV, Prorail, DB, and ADIF, under the leadership of UIC and ERJU, with a budget of €13.5 million.

1.26.1.2 *FRMCS Status and Timeline*

- **First Edition of FRMCS:** ETI CMS expected June 2027

- **Commercial Product Readiness:** Estimated for 2028

- **GSM-R End of Life:** Targeted for 2035, prompting an urgent need for transition planning

1.26.1.3 *Spain's Current Rail Communications Landscape*

Spain's rail network features a mix of technologies across different line types:

- Large portions of conventional lines still operate with analog systems.

- Diverse topology includes Analog, GSM-R SH, GSM-R CL, commuter lines, and narrow gauge.

- All high-speed lines are equipped with GSM-R, largely due to ERTMS and CTC deployments.

- There are numerous ongoing GSM-R projects and deployments across the country.

1.26.1.4 *Spanish FRMCS Strategy and Migration Plan*

Spain's national migration plan is under construction, with completion expected during 2025. Key points include:

- No deployment until a stable version of FRMCS specifications is available.

- Long-term maintenance agreements will continue with the GSM-R industry.

- FRMCS site designs will largely mirror GSM-R site solutions.

- Existing infrastructure (sites, towers, energy systems, fiber optics) will be reused where possible.

- Preferred deployment frequency is 900 MHz, except where GSM-R is still in service or where higher bandwidth is needed (1900 MHz).

- FRMCS deployment is planned to begin in 2031 and finish by 2042, covering all radio systems (timeline is preliminary and subject to confirmation).

1.26.1.5 *Challenges and Considerations*

- Managing coexistence of analog, GSM-R, and future FRMCS systems during the transition.

- Aligning Spain's deployment timeline with European specifications and readiness.

- Ensuring that maintenance support agreements with GSM-R vendors are robust enough to cover the extended overlap period.

- Identifying lines that require higher bandwidth to potentially use the 1900 MHz band.

1.26.1.6 *Technical and Operational Aspects*

- Spain's approach leverages lessons learned from GSM-R to design FRMCS sites.

- Migration will depend heavily on the reuse of existing assets to control costs and minimize service disruptions.

- Spain is working closely with the UIC-led consortium to align technical standards and validation outcomes.

1.26.1.7 *Future Outlook*

The successful rollout of FRMCS in Spain hinges on:

- Finalization of a national migration plan by 2025.

- Availability of mature, validated FRMCS specifications (v2) by 2027.

- Market readiness of commercial FRMCS products by 2028.

- Coordinated deployments starting in 2031 and completed by 2042, aligning with the planned retirement of GSM-R by 2035.

1.26.1.8 *Conclusion*

Spain's approach to FRMCS deployment reflects a cautious, carefully staged strategy aimed at minimizing risk, leveraging existing assets, and aligning with European standards. The involvement in the UIC-led consortium ensures Spain remains at the forefront of this critical transformation in rail communications. The next milestones—completion of the national migration plan and availability of stable FRMCS specs—will be decisive for the country's success in this ambitious initiative.

1.26.2 Fleet

1.26.2.1 *Number of GSM-R end devices*

		Handheld			Cab Radio			EDOR	
		Total							
Country	Network	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated	Planned	SIM cards activated
Spain	ADIF	0		2550			3290		1766

1.27 Sweden

1.27.1   Infrastructure

1.27.1.1 *Overview of the Swedish Railway Network*

- 14,100 km of operational railway lines, mostly single track and electrified (12,300 km).

- 9,800 km covered by ATC (Automatic Train Control, Class B system).

- Managed largely by Trafikverket, with ~60 private passenger and freight operators.

- Cross-border connections: 1 to Denmark (Öresund Bridge), 4 to Norway, 1 to Finland.

1.27.1.2 *FRMCS Plan*

Sweden plans a long-term modernization combining ETCS and future FRMCS, replacing its aging Class B system and GSM-R.

- FRMCS will follow GSM-R decommissioning, with national migration plans to be detailed in future transport plans (2026–2037 and beyond).

- FRMCS will leverage the planned 5G digital backbone.

- Sweden's FRMCS Program has connections and dependencies on the following programs:

  - Opto 2.0

  - CEF-Digital 5G4RailScand

The following charts summarizes Sweden's FRMCS time plan
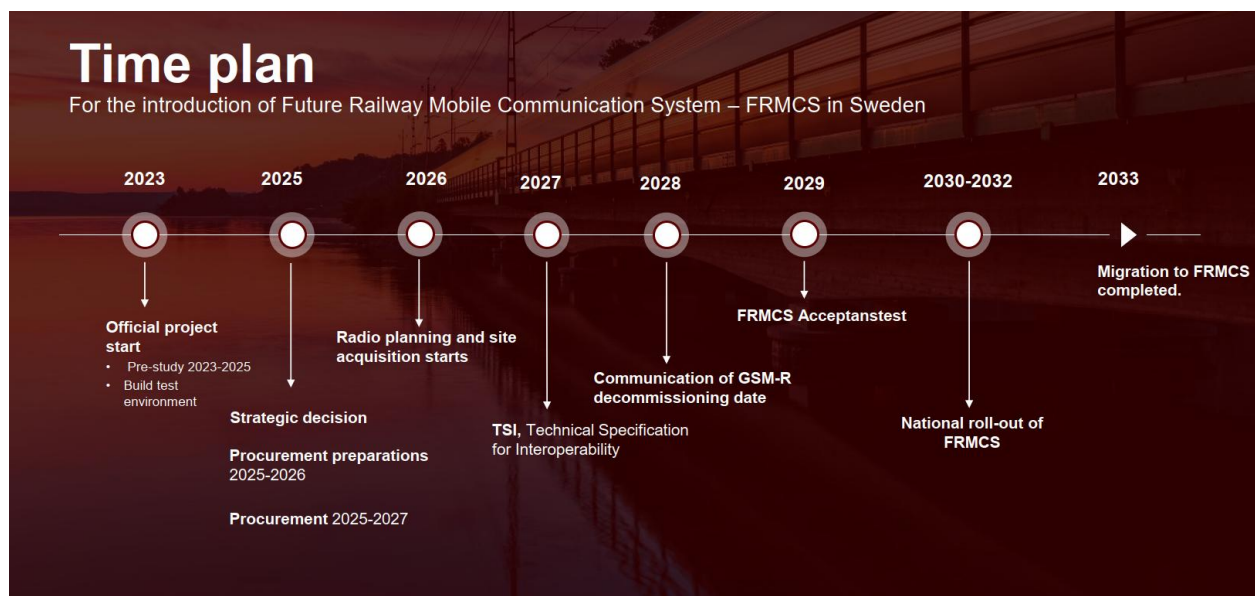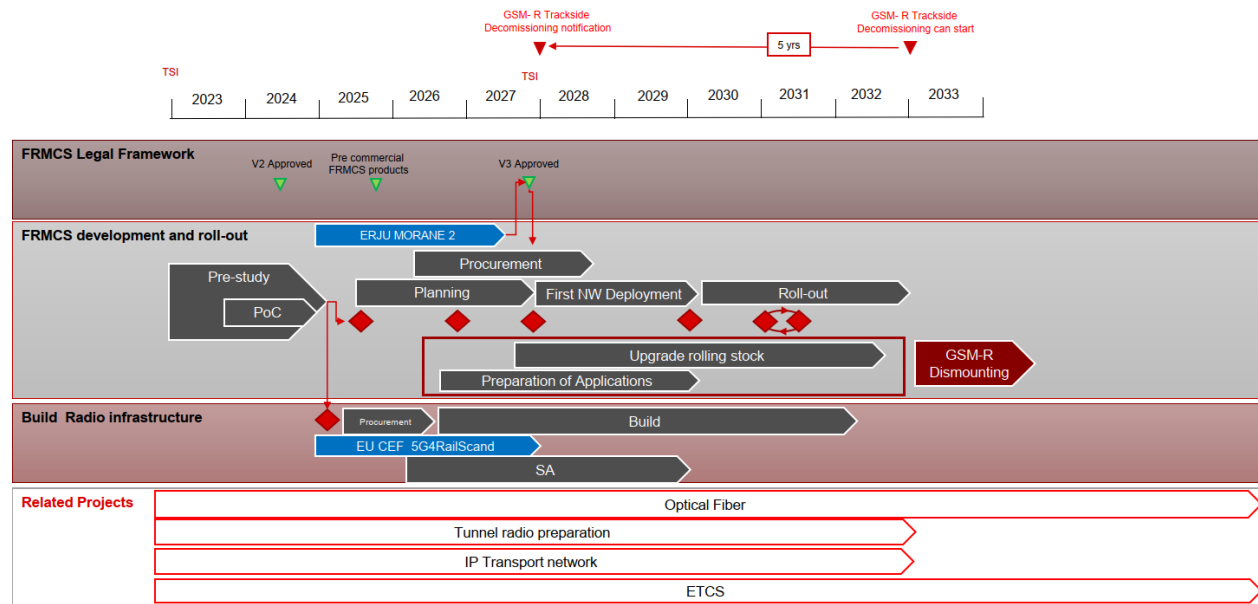
FRMCS deployment is phased according to the following Transport Flows

Flow 1 – Stockholm/Hallsberg-Malmo//Copenham

Flow 2 – Trelleborg-Malmo-Oslo

Flow 3 – Hallsberg-Luleá

Flow 4 – Gotenburg-KilBorlânge-Gāvle

Flow 5 – Stockholm-Gotherung

Flow 6 – Stockholm-Oslo

Flow 7 – Stockholm-Vàsterās-Oͤebro

Flow 8 – Stockholm-Umeå

1.27.1.3 Trafikverket FRMCS test track
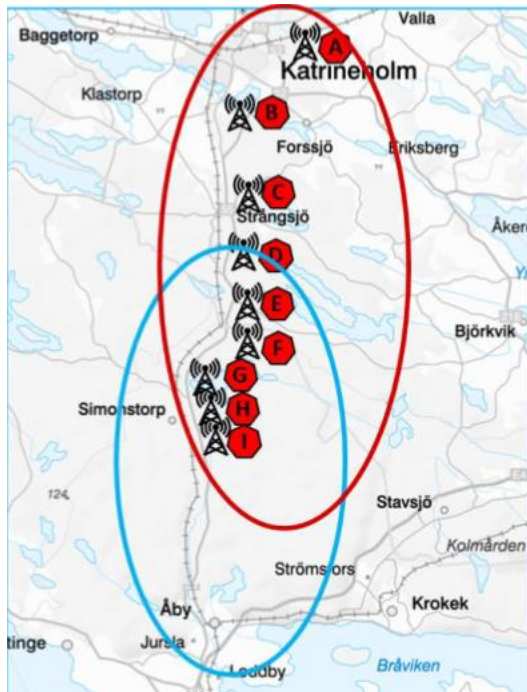
- Test track length is 40 km
- Double track
- 1 measurement train
- Speeds up to 200 kph
- Mast heights 4-54m
- 1900 MHz RMR band
- 700 MHz Telia band in MOCN configuration

Noralla Tunnel Test Track

- Near Söderhamn in northern Sweden, on the Ostkustbanan line
- Uses leaky cables
- 3 macro radio sites
- Tests coexistence of GSM-R, public safety, 1900 MHz and MNO bands in tunnel
- Tunnel length 3.8 km
- Speed up to 200 kph

1.27.1.4 GSM-R and ATC Decommissioning

- GSM-R currently provides national rail communications but will be phased out after FRMCS is established.

- GSM-R Trackside Decommissioning formal notification is scheduled for Q1 2028

- ATC decommissioning targets:

    o Core control areas prioritized from 2036.

    o GSM-R replacement timeline aligned with FRMCS rollout, precise phase-out dates pending final national plans.

1.27.1.5 ETCS Deployment Timeline (2024–2044)

- 2027: Malmbanan (Riksgränsen–Harrträsk).

- 2029: Ådalsbanan, Mittbanan, Öresundsförbindelsen (Sweden–Denmark), Tjust- and Stångådalsbanan, Kontinentalbanan.

- 2033: Malmbanan (Harrträsk–Luleå), Skellefteåbanan, Norrbotniabanan, Umeå, Ostkustbanan, Ostlänken, Västkustbanan, Skånebanan, Södra stambanan.

- 2044: Norrbotniabanan (Luleå–Piteå), Norra stambanan, Godstråket, Mälarbanan, Södra Stambanan, Ostlänken, Göteborg–Borås, Västkustbanan, Hässleholm–Lund, Kontinentalbanan, Ystabanan.

1.27.1.6 Rolling Stock Upgrades

- Majority of vehicles to be ETCS-equipped by 2030, enabling FRMCS-readiness.

- Costs included in onboard upgrades (installation only, not extra vehicle owner costs).

- Legacy vehicles: ATC + GSM-R; modern fleet (e.g., Vectron) equipped with ETCS + GSM-R.

- Resource mobilization and sector readiness are part of the national plan.

1.27.1.7 Border Crossing Considerations

- Denmark: Öresund Bridge, part of early ETCS phases (2029).

- Norway and Finland: coordinated cross-border signaling and communication upgrades planned alongside national rollouts.

- Leasing and interoperability benefits expected from FRMCS and ETCS, improving cross-border traffic flexibility.

1.27.1.8 *5G4RailScand Project*

Along the 800 km Copenhagen Gothenburg–Oslo section of the TEN-T Scan-Med Corridor, the project will contribute to prepare the railway infrastructure, for implementing Future Rail Mobile Communication System (FRMCS).

Objective

- To make preparatory cross border studies for the implementation of FRMCS in the railway corridor.
- To map for each country radio cell sites placement and configuration, optical fibre infrastructure and frequencies to be used.
- To install the needed passive infrastructure in the railway corridor.

- To prepare for active infrastructure deployment in the corridor.

- To establish cooperation between Sweden, Norway and Denmark for ensuring interoperable FRMCS systems in Scandinavia.

Project has received 18 M€ in total funding from the CEF (Connecting Europe Facility) fund to build a passive telecom infrastructure along the TEN-T Scandinavian-Mediterranean transport corridor in the section Copenhagen-Sweden-Oslo preparing for the introduction of new 5G system for railway, FRMCS (Future Railway Mobile Communication System).

Behind the project is a consortium consisting of Trafikverket, Bane NOR and Øresundsbro Konsortiet, with Banedanmark as associated partner.

1.27.1.9 *Cost and Investment Framework*
- Total cost for signaling upgrades (2022–2070): ~SEK 50 billion.

- Short-term costs to 2044: ~SEK 22 billion for legacy network, ~SEK 3 billion for new lines.

- Benefits: standardization, predictive maintenance, cost-effective operation, interoperability.

1.27.1.10 *Expected Benefits*
- Modern digital interlockings (from 780 to ~160 standardized units).

- Improved maintenance efficiency and reliability.

- Enhanced traffic management and capacity expansion potential.

- Socio-economic benefits, although not fully quantified.

1.27.1.11 *Challenges and Risks*
- Slow deployment leads to a heterogeneous system, increasing maintenance costs.

- Dependency on vehicle conversions and industry readiness.

- Annual progress reports and cost optimization measures mandated by government.

Conclusion Sweden's FRMCS deployment is closely linked to its ETCS rollout and the decommissioning of ATC and GSM-R systems. Major investments and rolling stock upgrades will prepare the network for digitalization, improved safety, and cross-border interoperability, with full system modernization targeted by 2070.

1.27.2 Fleet

1.27.2.1 *Number of GSM-R end devices*

		Handheld			Cab Radio			EDOR	
			Total						
Country	Network	Planned	Installed	SIM cards activated	Planned	Installed	SIM cards activated	Planned	SIM cards activated
Sweden	TV	0		1147			3550		673