

FRMCS

SYSTRA

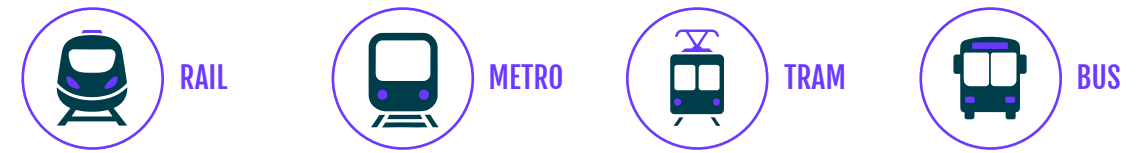
Preparing Mass Transit and Rail for the end
of GSM-R and TETRA from 2035.



NOT A FUTURE ISSUE, A FULL SYSTEM TRANSFORMATION THAT MUST BE PREPARED NOW!

Initiated by the International Union of Railways (UIC), FRMCS is becoming the new backbone for railway voice & data mission-critical communications. It is being driven by a combination of technological obsolescence, digital transformation, regulatory evolution and rising operational expectations. The opportunity is considerable, but so is the challenge. Industry trends and technology evolution cycles indicate that legacy railway radio systems will no longer be sustainable post 2035.

For infrastructure managers, train and freight operators, as well as public decision makers, the transition to FRMCS by 2035 requires early decisions, strong coordination and a structured migration strategy. The replacement of GSM-R and TETRA is complex as it will affect onboard systems, trackside assets, rolling stock, signalling, cybersecurity, technical rooms and control centres alike. It will reshape the communications architecture of the railway.



The Future Railway Mobile Communication System, or FRMCS, is the next-generation mobile communications standard for rail.

Developed at international level and progressively embedded into the European railway standardisation framework, FRMCS is intended to replace legacy railway radio systems built around GSM-R and the specification includes the Mission Critical applications that is the natural successor of TETRA systems. One of the biggest risks today is to see FRMCS as a simple radio renewal project. It is not.

The replacement of GSM-R and TETRA entails the addition and modernisation of a wide range of existing assets, from onboard cab radios and rooftop antennas, trackside radio towers, antennas and base station equipment, telecoms transmission networks, control-centre dispatching systems, technical rooms as well as direct interfaces with signalling and operational systems. In many cases, associated power supply and monitoring arrangements must also be upgraded.



THE KEY ISSUES STAKEHOLDERS MUST ADDRESS

01

CONTINUITY OF OPERATIONS

The current systems cannot simply be switched off and replaced overnight. Migration will necessarily be progressive, with a long coexistence period between legacy and new technologies.

Continuity of service during this coexistence period will be one of the hardest parts of the transition. Stakeholders will need to ensure that trains can continue running safely, that staff retain reliable operational communications, and that transitional architectures do not introduce unacceptable vulnerabilities.

02

RAILWAY SAFETY

Rail telecoms are not just support systems. They are part of the operational and, in many contexts, safety chain.

FRMCS must therefore deliver the performance, resilience and prioritisation required for critical services, while being validated against operational and safety expectations. This includes robustness, availability, fallback arrangements, secure interfaces and confidence in degraded modes of operation.

03

INTEROPERABILITY

FRMCS cannot become a patchwork of disconnected national or local interpretations. Interoperability is central to railway efficiency and market viability.

Railways, especially in Europe, need harmonised approaches across networks, countries, suppliers and operators. Without this, costs will rise, industrialisation will slow down and cross-border operations will be weakened.

04

SPECTRUM

Spectrum is not a secondary topic; it is a strategic enabler. Access to suitable, protected and sustainable frequencies will directly affect coverage design, deployment models, coexistence strategy and long-term performance.

This issue is technical, regulatory and political at the same time. It requires alignment between rail stakeholders, telecom regulators and public authorities.

05

CYBERSECURITY

The move toward more open, software-driven and IP-based architectures creates major opportunities, but also increases cyber exposure.

Information security management and cybersecurity in FRMCS is not an add-on. It must be designed in from the outset, with appropriate mechanisms for authentication, segmentation, supervision, resilience, patching and secure lifecycle management.

This is essential because any compromise of critical communications can directly affect operations, service availability and trust in the system.

UNDERSTANDING THE CHALLENGES OF FRMCS MIGRATION

The real challenge will be to manage this transition in a way that preserves continuity, coherence and long-term interoperability across the network.

Rather than a standalone technology upgrade, FRMCS migration should be seen as a progressive system transformation. Its complexity arises from a combination of factors. Success will depend not only on deployment itself, but on the sector's ability to manage this transition while preserving overall network coherence.



Field-proven and interoperable FRMCS solutions will not be available at scale overnight. Stakeholders must avoid assuming that publication of specifications automatically means immediate availability of mature, interoperable and field-proven solutions at scale.



Migration affects many interdependent systems. Telecoms, signalling, rolling stock, operations, cybersecurity and regulation must all **move in a coordinated way**. A delay or inconsistency in one area can affect the whole programme.



Timing is tight. The 2035 horizon may appear distant, but railway transformation cycles are long. Studies, spectrum allocation decisions, licences, land acquisition/construction permit, procurement, network roll-out, testing and pilot projects all take time and must all begin well in advance.



It will not happen everywhere at the same time. Deployment will progress line by line and fleet by fleet, creating a prolonged period of partial implementation across the network. During this transition, legacy systems such as GSM-R or TETRA will often need to remain in operation until trains are equipped with FRMCS, requiring parallel radio environments with significant operational and financial implications.



The sector will **need strong collaboration** to maintain interoperability, continuity and effective migration planning across all stakeholders as on open rail networks used by different operators and cross-border traffic, trackside deployment and onboard retrofit will not always move in step: some lines may be ready before trains are equipped, while some trains may be ready before the infrastructure is in place. As a result, the sector will need strong coordination to maintain interoperability, continuity and effective migration planning across all stakeholders.

4 QUESTIONS FOR...



As FRMCS deployment moves forward across Europe, its migration phase is emerging as one of the most complex challenges for the rail sector, and we asked Tom Warner, FRMCS champion at SYSTRA, to help us understand that complexity.

Why should FRMCS migration be seen as more than a technical upgrade?

 **Tom Warner:** FRMCS migration should be seen as more than a technical upgrade because it is not a simple one-time replacement of one radio system by another. The transition will unfold progressively across lines, fleets and operating contexts, at different speeds depending on where and by whom deployment takes place. This makes FRMCS a broader transformation of the rail system, affecting not only technology choices but also operations, planning and the way the network is managed over time

What does a phased migration mean for the rail system as a whole?

 **T.W.:** A phased migration means that the rail system will have to operate in a hybrid environment for a prolonged period. Infrastructure and rolling stock will not all be ready at the same time, so legacy systems such as GSM-R or TETRA will often need to remain in service alongside FRMCS. For the rail system as a whole, this implies added complexity in infrastructure management, operational continuity, safety assurance and cost control. More broadly, it means the sector must manage a long transition rather than expect a clean switchover.

What will be the critical success factors for a coordinated transition to FRMCS?

 **T.W.:** The critical success factors will be alignment, interoperability and strong coordination across the rail ecosystem. Many rail corridors are used by different operators, rolling stock owners and even cross-border services, which means onboard retrofit and trackside deployment will not always progress in sync. A successful transition will therefore depend on clear coordination between infrastructure managers, train operators, neighbouring networks, suppliers and regulators. It will also require practical arrangements to manage mixed fleets, maintain service continuity and avoid gaps between infrastructure readiness and fleet readiness. More broadly, migration must be organised in a way that enables systems to be changed or upgraded while preserving existing implementations wherever possible, together with their associated certifications and homologations.

Why is SYSTRA well positioned to support FRMCS migration?

 **T.W.:** FRMCS migration goes beyond technology replacement. It calls for an integrated view of telecoms, operations, safety, interoperability and deployment planning. Drawing on experience from complex telecom migration programmes, contributions to international FRMCS specification work, and studies delivered for the European Union Agency for Railways, SYSTRA combines strategic perspective with practical understanding of the technical and operational issues that will shape the transition over time. This capability is further strengthened by SYSTRA's expertise across the wider railway system, including operations, infrastructure, rolling stock, signalling and systems integration, enabling a more complete view of the transformation required and helping ensure that FRMCS migration is addressed as a railway system change rather than as a telecom project alone.

WHY FRMCS HAS BECOME NECESSARY?

Obsolescence is not a future risk, it is already shaping railway communication strategies. It's a strategic issue, not only a maintenance concern.



GSM-R, derived from 2G technology, and many legacy TETRA systems are approaching the limits of their technical, industrial and operational sustainability. Maintaining these systems over time will become increasingly difficult due to ageing assets, reduced supportability, growing cybersecurity constraints and misalignment with the needs of a more digital railway.

The case for FRMCS starts with obsolescence, but it does not end there. It was designed for a railway environment where critical voice and limited data were sufficient for operational needs. That model is no longer enough.

Railways are becoming increasingly digital, data-intensive and integrated. They now require richer

communications for operations, safety, signalling, maintenance, supervision, passenger information and security monitoring.

The shift from 2G-based railway communications to 5G-type architectures changes the model fundamentally. Next-generation mobile networks bring higher data capacity, lower latency, better prioritisation of critical flows, improved quality-of-service management and support for much broader service families. FRMCS is designed to answer these needs. It is not only intended to replace current critical voice and ETCS communication bearers, but also to enable higher-bandwidth applications such as advanced supervision, real-time remote monitoring, maintenance data exchange, video-related services and future digital railway functions.

Another key reason why FRMCS has become necessary is that it is bearer-agnostic: it can already support several communication bearers, including satellite, while providing a flexible framework that facilitates future evolution towards next-generation technologies such as 6G and 7G.

In that sense, FRMCS is not only a replacement programme ; it is the future backbone of the digital railway.



AI-ENABLED SUPPORT FOR COMPLEX FRMCS PROGRAMMES

FRMCS migration creates complex requirements and interface challenges across infrastructure, rolling stock, operations and systems integration. Our AI-enabled tools help manage this complexity and support requirements analysis, interface management and traceability. Combined with SYSTRA's engineering expertise, it helps strengthen consistency, identify interdependencies and improve control across complex migration programmes companies.

CONTINUITY, RESILIENCE, AVAILABILITY: THE CONDITIONS FOR SUCCESS



IMPACTS FOR TRAIN AND FREIGHT OPERATORS

Operators will need to adapt onboard systems, operational rules and staff capabilities. The migration will require retrofitting rolling stock, coordinating industrial programmes, carrying out testing and approval processes, and managing hybrid periods where old and new systems coexist.

It will also create opportunities. FRMCS can support richer real-time information flows, more connected maintenance, stronger links between onboard and control-centre systems, and more advanced operating models. But capturing these benefits will require changes in procedures, competencies and internal coordination.

YOUR PRIORITIES

- » Defining business cases and transition cost assumptions
- » Planning fleet migration and onboard retrofit programmes
- » Managing onboard systems and operational interfaces
- » Preparing testing, approvals and operational readiness
- » Ensuring continuity during legacy and FRMCS coexistence



IMPACTS FOR INFRASTRUCTURE MANAGERS

Infrastructure managers must modernise radio sites, transmission, core networks, interfaces with control centres and integration with signalling and other operational systems.

FRMCS transition will require a broader redesign of telecom architecture, technical facilities and operating models. Infrastructure managers will also need to choose between different implementation options, including dedicated networks, shared infrastructure, partial use of public mobile operators, hybrid models and virtualised network functions.

They will have to manage a long coexistence between current and new technologies while maintaining day-to-day railway operations. This is both a technical and governance challenge, and it will further require staff training and, where appropriate, the adaptation of operating procedures.

YOUR PRIORITIES

- » Building the business case for transition
- » Defining target network architecture and deployment models
- » Planning radio coverage, rollout sequencing and site strategy
- » Establishing functional and technical requirements
- » Preparing procurement and tendering strategies
- » Managing systems integration across operational environments
- » Ensuring RAMS, safety assurance and technical validation



IMPACTS FOR MOBILITY AUTHORITIES AND PUBLIC DECISION-MAKERS

Authorities have a critical role in spectrum, funding, governance, procurement strategy and alignment between stakeholders. The transition cannot succeed if it is approached only as a technical matter. It is also a regulatory, industrial, organisational and financial transformation.

Public authorities and sponsoring bodies therefore need to act early, define strategic frameworks, support coordination and prepare investment decisions well ahead of the final switch-off of legacy systems.

YOUR PRIORITIES

- » Identifying stakeholders and structuring cross-sector coordination
- » Defining migration strategy, governance and implementation models
- » Shaping funding, investment and cost assumptions
- » Building business cases to inform strategic decision-making
- » Structuring procurement and market engagement approaches

Lovan Pushparatnam
lpushparatnam@systra.com

Tom Warner
twarner@systra.com

SYSTRA

SYSTRA Australia
Level 13, 65 Berry St,
North Sydney, NSW 2060
AUSTRALIA

SYSTRA Canada
1100 René-Lévesque Blvd. W.
10th Floor, Montreal,
Quebec H3B 4N4
CANADA

SYSTRA Denmark
Kay Fiskers Plads 10,
2300 Copenhagen S,
DENMARK

SYSTRA France
72 rue Henry Farman,
75015 Paris
FRANCE

SYSTRA Iberica
Calle Vallehermoso 18, Bajo
28015 Madrid
SPAIN

SYSTRA India
Vatika Mindscapes,
Mathura Road, Faridabad
INDIA

SYSTRA Singapore
1 Coleman Street
#07-01 The Adelphi
SINGAPORE - 179803

SYSTRA Sweden
Folkungagatan 20,
411 02 Gothenburg
SWEDEN

SYSTRA UK & Ireland
3rd Floor, 1 Carey Lane,
London, EC2V 8AE
UNITED KINGDOM



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