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MINISTERSTVO PRŮMYSLU A OBCHODU

FRMCS applications used in

STUDY 17 · FRMCS & RADIO COMMUNICATIONS

Use of FRMCS in rail transport, including dedicated channels in the 900 MHz and 1900 MHz bands -coverage, capacity, migration scenarios and their costs.

Prepared for the Ministry of Industry and Trade of the Czech Republic · November 2024

AT A GLANCE

STUDY 17 FRMCS & RADIO COMMUNICATIONS

- **Scope & method** — implementation conditions for FRMCS in Czechia: applications (UIC FRMCS URS), coverage in the 900 & 1900 MHz rail bands, MNO and satellite options, capacity, migration scenarios and costs, legislation — built on CEPT/UIC/ERA/3GPP sources, ETSI TR 103 554-2 simulations, corridor pre-planning and a sector survey.
- **A by-product with EU reach** — an expert Czech translation of the FRMCS URS application definitions, submitted to the EC Translation Service as the reference for Czech versions of EU railway legislation.
- **Bottom line** — no single dedicated band carries the full critical set. Plan FRMCS as a 900 + 1900 MHz overlap and/or offload to public operators — and get that multipath capability into FRMCS V3.

Between GSM-R's fading horizon — vendor support ends after 2035 — and FRMCS specifications still in motion, every European infrastructure manager faces the same questions: what to build, where, and when. This study answers them for the Czech network, with a working group spanning carriers (ŽESNAD, SVOD Bohemia), Správa železnic, both ministries and Czech delegates to ERJU and UNIFE.

WHAT RAILWAYS ACTUALLY NEED

The study maps the applications of the UIC FRMCS URS — 30 critical plus some twenty performance ones — against GSM-R support, FRMCS version planning and a survey of Czech carriers and the IM. Consensus is clear where railways already operate the services: voice, emergency calls, train protection (ETCS) and voice/data recording score at the top; views split sharply elsewhere between carriers and the IM.

Video is the paradox: the largest expected consumer of capacity, unrealistic in bands below 2 GHz, yet drawing the lowest interest — four HD cab cameras stream ~4 MB/s (20–40 GB/day per vehicle), of which incidents actually need 0.4–0.7 %. The survey's one surprise: broad appetite for **real-time speech translation** in cross-border operation.

TWO DEDICATED RAIL BANDS — AND WHAT THEY DEMAND

900 MHz (n100) · FDD — shared with GSM-R during migration

UL 874.4–880.0 (uplink) · DL 919.4–925.0 (downlink)

2 × 5.6 MHz — widened by 2 × 1.6 MHz vs. the original GSM-R band

Two coexistence options with GSM-R:

- band split — FRMCS ≤ 3.2 MHz, needs new 5G NR Rel-18 3 MHz channel
- whitespace overlay — full 5 MHz, Rel-17 suffices; per-gNB configuration

1900 MHz (n101) · TDD — rail-only band harmonised in 2021

1900–1920 MHz · TDD · 20 MHz

Not yet assigned for rail in CZ — the infrastructure manager can request assignment from 2025. TDD means flexible UL/DL split, but strict inter-network synchronisation and denser sites.

Source: study ch. 2.1–2.2 (CEPT band plans; corridor pre-planning study [25]). Dots illustrative, counts exact.

THE Ddensification BILL

Pre-planning of the 133 km Brno – Břeclav – Kúty – Bratislava 5G/FRMCS corridor (GSM-R: CZ side in operation, SK partly planned)

GSM-R on the corridor · 23 base stations · avg spacing 6.0 km

+ FRMCS in 1900 MHz · +21 new gNB · spacing 3.2 km

= +91 % sites — or +56 % if existing MNO towers along the corridor are shared

8 of the 21 new sites lie at or near existing MNO 1800 MHz towers — a concrete case for passive infrastructure sharing.

CAN TWO RAIL BANDS CARRY IT?

The migration-start package — today's GSM-R scope without critical video — needs ~0.2 Mb/s per train, and every simulated variant delivers it in either band. First critical-video packages (~3.5 Mb/s) already hit cell-edge limits; the full critical set (7.4 Mb/s up / 4.4 Mb/s down) exceeds any single RMR band. The study's answer: multipath routing over an **overlap of both bands** and/or MNO networks, with 1900 MHz densification that will still not reach the commonly assumed 100 %.

PUBLIC NETWORKS AS THE THIRD LEG

Critical use of MNO bands demands rail-grade coverage, QoS, security and SLAs commercial networks rarely meet today. The study weighs **national roaming** vs. **MOCN RAN sharing** (FirstNet, Finland's Erillisverkot) and sees the nearest synergy in **passive infrastructure sharing** along corridors.

SATELLITES — REAL, BUT NOT YET

LEO links promise 10+ Mb/s, comparable to the RMR bands; **GEO** fits backhaul only (SATis5 tests: >200 ms, too slow for voice and signalling). The EU's **IRIS²** serves government users first. In CZ only band **n256** is set aside — and it cannot share a vehicle roof with terrestrial n1.

THE STANDARDS CLOCK

TSI CCS 2023 legalised **FRMCS V1** for experiments; V2+V3 feed **TSI CCS 2027 — "FRMCS Baseline 1"**, the first complete enough to produce, buy and install. A third of applications wait for V4+; the mandated ETCS **SV 3.0** is not expected commercially before 2032.

WHY THE SECTOR HESITATES

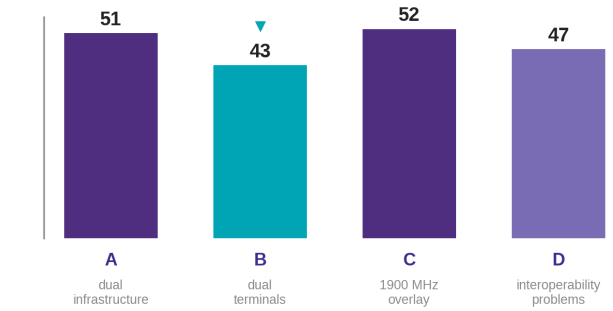
The only motivation rated high by **all** surveyed subjects is **EU regulation**. Carriers remember forced ETCS retrofits — exclusive-operation mandates, support shares cut from 80 % towards 50 %, monopoly suppliers. Without stabilised rules and funding, motivation stays minimal.

MIGRATION: TWO PATHS, ONE BOTTLENECK

Two strategies frame the choice: **dual infrastructure** (both networks on the ground; vehicles switch once) and **dual terminals** (both radios on vehicles). DB InfraGO, SNCF Réseau and Norway build on dual vehicle equipment — but in CZ that path collides with vehicle-approval timelines and component availability, while dual infrastructure stands or falls with 900 MHz coexistence.

WHAT MIGRATION WOULD COST — MODEL NPV 2025–2050 (IM + CARRIERS)

CZK bn, total NPV



READ THE MODEL RIGHT

- B (dual terminals) is cheapest on paper and most robust to neighbours' choices — but the study calls it likely impassable: no time reserve to pilot & approve on-board kit.
- The decisive cost item in every scenario is carriers' investment in induced ETCS upgrades (CZK 2.5–3.9 bn/yr for 9–11 yrs) — not FRMCS itself. Stable, interoperable specs are key.

Milestones: GSM-R vendor support ends after 2035 · modelled migration window 2030–2050 · GSM-R shutdown must be notified in RINF ≥ 5 years ahead

Source: study ch. 3.4, Table 10 — economic model adapted from ERA (2016) to Czech 2020s conditions; orientation values, full CBA still required.

WHAT THE STUDY PROPOSES

— stabilise technical regulation, vehicle certification and public funding, so the ETCS experience does not repeat:

1. **Lighter legislation** — stop hard-wiring technical duties into TSI annexes; reference harmonised standards instead (in line with ERJU's plan on the status of TSIs).
2. **Decoupled ERTMS components** — separate HW and SW specs (DB & SNCF proposal): compatible hardware fitted early, final FRMCS as a software upgrade.
3. **Backward compatibility & component-level approval** — accept the "FRMCS adapter" to existing ETCS BL3 or the "light" variant keeping ETCS at SV 2.1; approve components, not whole vehicles, with transferable assessments.
4. **National funding rules** covering also SW renewal forced by regulatory change, with sustainability periods that may close when specifications shift substantially.

KEY TAKEAWAY

FRMCS in Czechia will stand on three legs: a widened 900 MHz band shared with GSM-R, a densified — and so far unassigned — 1900 MHz layer, and, where needed, offload to commercial networks. Dual terminals are cheapest on paper (NPV CZK 43 bn vs. 51 bn) but likely impassable for lack of time reserves; the workable dual-infrastructure path hinges on 900 MHz coexistence and stable specifications. In every scenario the bill is driven by **induced ETCS upgrades**, not FRMCS itself.