CEIT's Multi-connectivity Platform Development

Andy Rodríguez Lorenzo, Nerea Fernández-Berrueta,
Carlos Pupiales, Alfredo Artiles Vallecillo, Jaizki Mendizabal

6th SmartRaCon San Sebastian, Spain
October 23rd, 2024

Context

Train-Trackside Communications

- Current state and in which direction it is moving
- Different solutions
- Ceit's approach

An interoperable system around Europe

European Rail Traffic Management System

ERTMS $\longrightarrow$ ETCS + GSM-R

GSM-R is nearing obsolescence

- The telecoms industry's life cycles are by nature much shorter than the rail industry's
- Service providers have committed to maintaining GSM-R until 2030

What should a comm. system for the railway industry takes into account?

- Communications needs depend on operational conditions that can vary according to the route
- The communications system should constrain the integration of new applications as little as possible
- Expansion of machine-to-machine communications for operational and maintenance purposes
- Cost-effectiveness

Network models trade-off

GSM-R is a dedicated private network

We can find five candidate network models:

1. Dedicated Mobile Network
2. Dedicated Network with Supplementary Public Network
3. Dedicated Network RAN Sharing with Public Network
4. Public Network, IM as Mobile Virtual Network Operator (MVNO)
5. Public Network

[†]B. Allen *et al.* Next-Generation Connectivity in A Heterogenous Railway World, 2023

Network models trade-off

GSM-R is a dedicated private network

We can find five candidate network models:

1. Dedicated Mobile Network
2. Dedicated Network with Supplementary Public Network
3. Dedicated Network RAN Sharing with Public Network
4. Public Network, IM as Mobile Virtual Network Operator (MVNO)
5. Public Network

Dedicated networks offer maximum flexibility to an IM, but it is expensive[†]

[†]B. Allen *et al.* Next-Generation Connectivity in A Heterogenous Railway World, 2023

Future Railway Mobile Communication System (FRMCS)

The International Union of Railways (UIC) is working on the definition of the FRMCS in cooperation with the different stakeholders from the rail sector[†]

FRMCS responds to two fundamental issues:

- to be the successor of GSM-R → become the standard
- to facilitate the digitization of railways exchanging increasing volumes of information

FRMCS ecosystem relies on 5G Core and Access Networks, next generation of 5G modems and Mission Critical Services[‡]

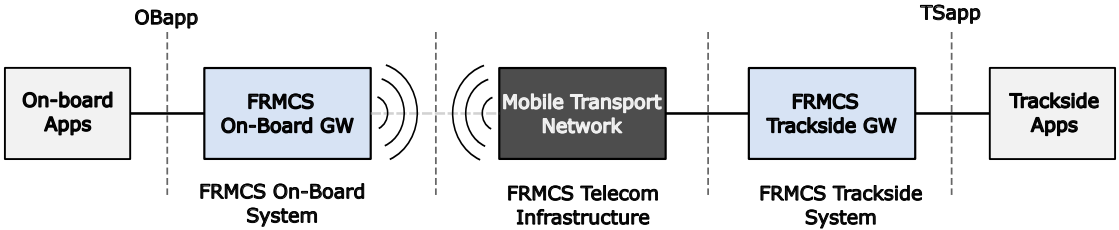
[†] `https://uic.org/rail-system/telecoms-signalling/frmcs`

[‡] V. Nikolopoulou & D. Mandoc *et al.*, 5GRAIL paves the way to the Future Railway Mobile Communication System Introduction, 2022

FRMCS Gateway

There are two main ways to access to the FRMCS services[†]:

- Direct access mode
- Gateway access mode



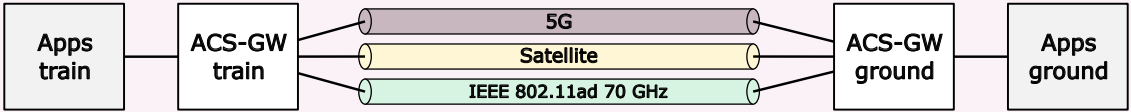
5GRail Project: validation of FRMCS V1

- Development of the initial OB-GW and FRMCS compliant 5G network equipment
- Interfacing of various solutions
- Test and feedback

[†]Future Railway Mobile Communication System Functional Interface Specification, FIS-7970, 2023

Other proposals

5GMED Project: Multi-bearer approach



- ACS-GW perform transparent per-application independent forwarding of IP packets[†]

X2Rail-5 Project | Adaptable Communication System (ACS)

- Multi-bearer approach
- ACS is bearer agnostic and application independent
- QoS control block
- Demonstrators for different lines[‡]

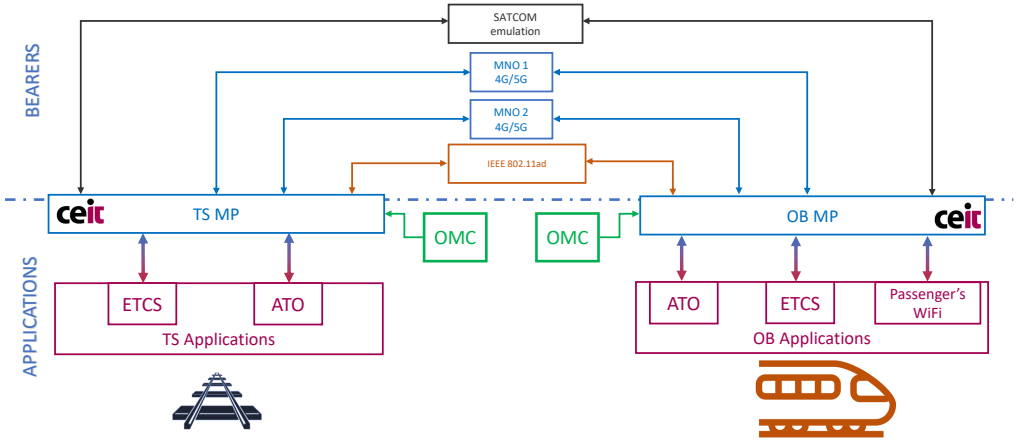
[†] D3.2: 5GMED ICT architecture and initial design, 2022

[‡] X2Rail-5, Deliverable D3.1, 2023

Multi-connectivity platform CEIT

Within the scope of Europe's Rail Europe's FP2-R2DATO

Architecture design, specification, prototyping, and testing of both gateways



Multi-connectivity platform CEIT (II)

- Multiple bearers:
  - IEEE 802.11ad 70 GHz (at the front and rear of the train)
  - 5G from two different operators
  - SATCOM
- Bearer selection:
  - Localization
  - Network monitoring
- Operation Maintenance and Configuration Interface
- Application registration
- TS MP reachable from OB MP after VPN establishment
- One TS MP should be able to deal with more than one OB MP

Conclusions

Current status: Replacement of GSM-R for Train-Trackside communications

- More transmission capacity $\rightarrow$ new applications
- Railways Digitalization

UIC Solution: FRMCS

- In the standardization process
- Deployment and operation costs

CEIT's Solution: MP Platform

- Multi-bearer. Network transparent to the apps
- Alternative to the deployment of a dedicated network infrastructure. Cost-effective

CEIT's Multi-connectivity Platform Development

Andy Rodríguez Lorenzo, Nerea Fernández-Berrueta,
Carlos Pupiales, Alfredo Artiles Vallecillo, Jaizki Mendizabal

6th SmartRaCon San Sebastian, Spain
October 23rd, 2024