

# Next-Generation Connectivity in A Heterogenous Railway World

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The authors discuss several network models and enhancements including satellite communications, Software-Defined Networking integration and antenna systems that support multiple bearers in one.

## ABSTRACT

Global System for Mobile communication – Railway (GSM-R) is widely used for operational communications between train and signaller. However, there is a need to define a successor that addresses: obsolescence, radio spectrum demand and the enabling of a range of emerging digital applications such as radio-based signaling and Automatic Train Control (ATC). Therefore, the International Union of Railways (UIC) started the initiative to develop the Future Railway Mobile Communication System (FRMCS). This article describes an Adaptable Communication System (ACS) that is being developed jointly by industry and railway operators as a possible successor covering all types of railways and all aspects of the FRMCS. A pragmatic approach is suggested that considers diverse railway settings and makes use of various radio access technologies. Countries, geographical regions and infrastructure managers differ concerning available radio technologies, but use of a suitable ACS could pave the way towards innovation in the railway sector. For this adaptive concept we discuss several network models and enhancements including satellite communications (SatCom), Software-Defined Networking (SDN) integration and antenna systems that support multiple bearers in one. For SatCom a software defined radio (SDR) prototype using random access is presented that is able to fulfill the requirements of ETCS. We found that SDN can be used for dynamically changing the access technology for critical and non-critical railway use cases. Furthermore, we present an antenna prototype that can be used for 5G, GSM, WLAN and LTE in parallel which saves limited mounting surface on the train.

## INTRODUCTION

GSM-R is the long-standing de-facto operational railway communication standard used to provide voice communication and the European Train Control System (ETCS) services for digital signaling to trains. However, the emergence of new use-cases and advanced applications such as Automatic Train Control (ATC), moving block, virtual coupling and train integrity that are developed by railways to improve the performance

will require broadband connectivity among many devices and additional features (resource management, IP connectivity, security, etc.) which cannot be supplied by GSM-R. Additionally and most importantly, vendors announced GSM-R obsolescence by 2030. These have stimulated a need to develop a successor led by the International Union of Railways (UIC) under the Future Railway Mobile Communication System (FRMCS) initiative. The FRMCS User Requirements Specification (URS) [1] was published in 2020 describing a wide range of functional requirements and service characteristics of the communication system. The services have been categorized into critical, performance, and business-related services. It is currently used as the basis for standardization work in the Rail Telecommunications Technical Committee of the European Telecommunications Standard Institute (ETSI TC-RT) and the 3rd Generation Partnership Project (3GPP) working group SA1 (system architecture – functional). As part of this initiative, a dedicated frequency band has been assigned, i.e., in the ECC Decision (20)02 for migration to FRMCS:

- 974.4–880 and 919.4–925 MHz
- 1900–1910 MHz (TDD)

European rail infrastructure managers (IMs) published a position paper for strategic deployment of 5G connectivity and spectrum for rail together with railway operators and rail industry [2].

An Adaptable Communication System (ACS) for train to ground communication is answering these needs and matching the requirements of FRMCS URS as it is developed as one of the technology demonstrators within the Innovation Program 2 (IP2) of the European Horizon 2020 research and innovation initiative Shift2Rail and it is being delivered under the X2Rail suite of projects. Off-networks solution have been investigated in the same context in [3]. The ACS developments will directly compliment the FRMCS project and ETSI standardization as collaborations are established. It is aligned with the position paper and its targets as well as FRMCS, whilst exploring different business models considering dedicated and public networks.

Roll-out of new telecoms infrastructure e.g., across the whole of Europe, means equipping sev-

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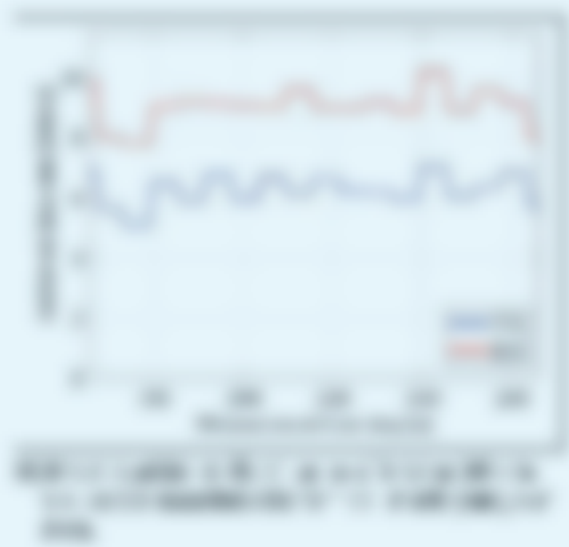
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