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FEASIBILITY AND DEMONSTRATION OF SATELLITE-BASED FUNCTIONS FOR THE  
EUROPEAN RAIL TRAFFIC MANAGEMENT SYSTEMS – USER NEEDS, RESULTS, AND  
LESSONS LEARNED

**Abstract**

The European Rail Traffic Management System(ERTMS) is an initiative backed by the EU,with the objective of improving safety and increasing interoperability of rail transport in Europe through a Europe-wide standard for train control and command systems,replacing existing national systems.ERTMS consists of two parts:the European Train Control System(ETCS),an automatic train protection system (ATP) providing in-cab train control;and GSM-R,a radio system based on GSM for providing voice and data communications between the track and the train with specific functions for railway(e.g.functional addressing,voice group call services including emergency calls,voice broadcast service,multi-level precedence and pre-emption service, etc.).The European Space Agency,through its Integrated Applications Promotion (IAP) program,supported two projects:3InSat and SBS-RailS, which were focused on the exploitation of space-based assets to improve performances and reduce capital expenditure, operations and maintenance costs associated with the deployment of ERTMS infrastructure.Two concepts were considered in these projects: the use of Global Navigation Satellite Systems(GNSS) for detection of virtual balises, reducing the number of physical balises installed along the track; and use of multi-bearer communications including satellite communications for track to train communications. The 3InSat project developed a satellite-based train control system based on the ERTMS standard,integrating new functions that made use of Satellite Navigation and Satellite Telecommunications.The project was initiated by Ansaldo STS (Italy),with the participation of the Italian and German railway undertakings,RFI (Rete Ferroviaria Italiana) and DB Netze (Deutsche Bahn Netze), which contributed to the definition of user requirements.RFI organized a test train to validate the system on 50 kilometres of railway line in Sardinia (Italy).The SBS-RailS study investigated how GNSS and SATCOM technologies can be used within the ERTMS and its foreseen evolution.Regarding the GNSS technologies, the study focused on the virtual balise concept using GNSS for detection of virtual balises.This concept had previously been identified by the signalling supplier industry as an option for minimising the impact of the introduction of satellite-based functionalities on the existing European Train Control system(ETCS) architecture.The study investigated suitable SATCOM solutions in the context of future bearer independent telecommunication solutions as an evolution to GSM-R.As with virtual balise detection using GNSS, the impact of introducing SATCOM technologies in ERTMS shall be minimised, guaranteeing interoperability with the existing specification and reducing complexity of operational scenarios and commissioning.This paper provides an overview of the two projects including a description of the user needs, the selected technical solution,innovative elements,achieved performances and results.The paper concludes with a discussion on lessons learned and future directions.