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SEAMLESS AND RELIABLE RAILWAY SYSTEMS: A CASE STUDY ON INTEGRATING SATELLITE COMMUNICATION AND COMPUTING FOR CONTINUOUS OPERATIONS

Abstract

The roll out of new satellite systems, the capacity expansion of existing satellite constellations, and new general-purpose services available on demand is paving the way for new business opportunities and beneficial technical solutions in many industrial use cases. Service providers seeking broad coverage or high redundancy for their systems are already preparing strategies for the integration of satellite communication, in their industrial systems such as future mobility and transportation systems (for both passengers and cargo transportation). However, technology updates, optimizations, or even replacements are complex and require careful impact assessment of new features and performance when operating over a satellite network. This work provides a reality check on a critical use case for railway systems, exploring distinct deployment considerations for the satellite network. This use case focus on a reliable control of trains and of the railway infrastructure as well as on a seamless interoperation of different subsystems to ensure proper operation of the system. In order to reduce the assessment complexity and its inherent costs, an emulation-based framework is used to analyze the corresponding applications over satellite on a system level. This emulation framework acts as digital twin for the system and sub-system simulation/emulation, allowing the estimation of satellite constellation, mobility, and communication parameters and the reproducibility and validation of results over a variety of scenarios, each differing in terms of topologies and/or configurations. In addition, this assessment also considers distinct offloading strategies of core application components to a satellite Edge as a further optimization that will be possible with the emergence of Satellite Computing capabilities. The insights of this work are expected to contribute to a better understanding of the impact of different satellite constellations, along with their capabilities, to fulfill the system requirements of the critical railway services as well as to extrapolate the requirements for future satellite constellations.