On the Plausibility of using Existing Cellular Networks as Bearers of Train Signalling

Johan Garcia[1,2], Claes Beckman[1,3], Rikard Reinhagen[1] and Anna Brunström[2]
[1] Icomera AB, Göteborg, Sweden. rikard.reinhagen@icomera.com
[2] Karlstad University, Karlstad, Sweden. johan.garcia@kau.se, anna.brunstrom@kau.se
[3] KTH Royal Institute of Technology, Stockholm, Sweden. claesb@kth.se

There are today over 20 different national signalling and speed control systems in the European rail system, which creates an obstacle to the free flow of rail traffic across Europe. Hence, the main purpose of ERTMS/FRMCS is to replace these old and mutually incompatible legacy train protection and safety systems with one pan-European system (CER 2020). However, the full cost of deploying ERTMS/FRMCS along the tracks throughout the complete European railway network is estimated at between 73 and 177 billion Euros (European Court of Auditors 2017).

In parallel to the evolution of critical rail control, there has been a rapid development of techniques and systems to provide reliable and high-capacity internet access to passengers onboard the train. Such onboard internet access systems often use external train-mounted cellular antennas connected to an onboard router that aggregates several concurrent cellular connections on multiple operator networks (Alasali 2014). These router-based solutions with multi-operator connectivity by necessity provides additional capacity, greater coverage and higher reliability compared to what any single-operator cellular wireless infrastructure would be able to provide (cellular or dedicated radio network) and might serve as a cost-effective alternative also for control and signalling traffic.

In our recent study (Garcia 2022) we provide 1) a reliability model of the essential characteristics of a cellular train communications system, 2) a large-scale empirical characterization of communications reliability, and 3) a quantification of connectivity failure correlation and the impact on reliability. The empirical evaluation showed that the chosen timeout-based connection reliability metric goes from a value of 99.953% for the best single link, to 99.994% when aggregation over four links is used.

In conclusion we find that link aggregation of existing commercial mobile network infrastructure could plausibly be used to provide part of the underlying connectivity or redundancy for train signalling. This would reduce the need of dedicated infrastructure hardware and lower the investment cost for taxpayers.

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Railway Signal Digitalization with ERTMS and PTC, Industry 4.0 Expectations and Reality

Steven Harrod[1]
[1] Department of Engineering Technology and Didactics
Technical University of Denmark, Ballerup, Denmark 2750
Email: stehar@dtu.dk

Introduction

Positive Train Control (PTC) and ERTMS are digital railway signal systems in North America and Europe, respectively. They are frequently described as interchangeable, but they are not. This paper explains the history and motivations for each continent, and the general technical and capability differences between the two signal systems.

Analysis

The United States has completed a major safety upgrade of its major traffic lines with PTC, while the European Union has only made minor progress towards fragmented installation of ERTMS on selected lines. As of 2020, the US had nearly ten times as many kilometers of PTC installed as the EU had of ERTMS (Figure 1).

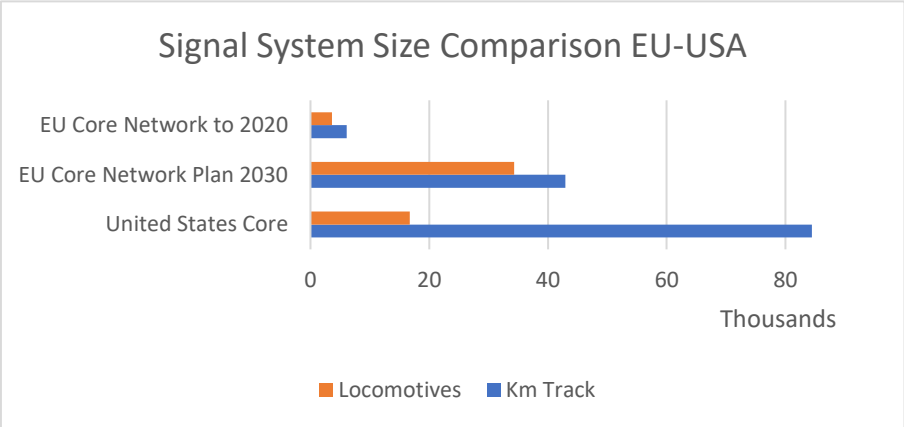

Figure 1: Relative scale of signal installations in EU and USA.

Conclusions

ERTMS is significantly more expensive than PTC, and the cost has been justified with expectations of greater capacity. Multiple studies find no basis for large capacity increases after implementation of ERTMS. In addition, the added cost of ERTMS threatens an already weak rail freight market in Europe.