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Modeling of a GSM-R receiving chain exposed to transient IEMIs

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Abstract—With the deployment of the European Rail Traffic Management System (ERTMS), most of the existing ground-based signaling equipment operated along railway tracks will gradually disappear. The signaling information and command/control signals will be exchanged over Global System for Mobile communications-Railways (GSM-R). Consequently, railway signaling resilience should be re-evaluated against Intentional ElectroMagnetic Interference (IEMI) threats.

In this paper we investigate GSM-R vulnerability to IEMI. These IEMIs consist in known interferers and their corresponding interference characteristics [1]. The paper starts by describing the GSM-R communication model. Then, the interference characteristics are analyzed and progressively modified in order to study the corresponding impact on the communication. Results are presented according to these interferer characteristics and associated communication bit error rate (BER).

Keywords- Transient (IEMI); GSM-R; vulnerability; BER.

I. INTRODUCTION

GSM-R is a European railway communication standard. Voice transmission and signaling information are continuously exchanged with train drivers, enabling high safe traffic density. GSM-R uses the 876-915 MHz band for the uplink and the 921-960 MHz band for the downlink. On board moving trains, the received GSM-R power generally varies between -20 dBm and -90 dBm [2]. Considering this dynamics, IEMI can alter more or less seriously the ground to train communication.

Therefore, the impact of different types of interference on the communication effectiveness is studied. The main objective is to detect if such intentional interference can cause a significant degradation of service for the railway network.

II. MODELING OF GSM-R COMMUNICATION CHAIN

A. Model and Transient IEMI

In order to simulate a railway transmission, a GSM-R communication is generated. A GSM-R burst (Fig. 2(a)) is modulated and transmitted through a Gaussian channel. A scenario of intentional EM disturbances is applied (Fig. 1).

The tested intentional disturbances are transient EM signals and various wave forms were generated and applied (ultra-wide band signal, damped sine wave, narrowband signals,

subsequent arcing...), to assigns error according to the characteristics (power, duration, time occurrence...) of the attack.

B. Results

For illustration, a Gaussian wide band attack signal (Fig. 2(b)) is used. By varying the bandwidth and intensity of the signal, we analyze the bit errors (Fig. 1(c)) on the railway communication.

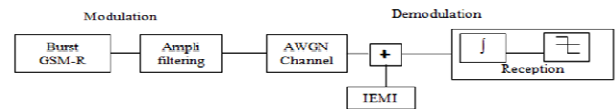


Figure 1. Block diagram of the communication chain.

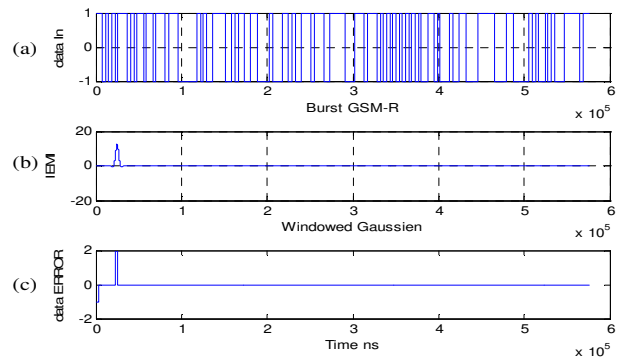


Figure 2. Perturbation Burst Data by windowed Gaussian.

In the final paper, we will detail the model of the communication chain. Several scenarios of attacks (waveforms, time occurrence, repetition rate, power...) will be presented in order to analyze their impact on the BER of the GSM-R communications.

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