Time Frequency Processing Dedicated to Electromagnetic Compatibility Issues in the Railway Domain

Mohamed R. Kousri [1], Virginie Deniau[2], Sylvie Baranowski[3], Marc Heddebaut[2] and Jean Rioult[2]
(1) Institute of Technological Research "Railenium"
(2) Univ. Lille Nord de France, IFSTTAR, Villeneuve d'Ascq, France.
(3) Université Lille 1 Sciences et technologies, IEMN, Villeneuve d'Ascq, France.

The railway environment is characterized by various electromagnetic interferences (EMI) due to the large number of EMIs sources. In parallel, due to the variety of vulnerable systems (location, signalization, communication...) embedded or in the train vicinity, different techniques are required to study EMC issues. This work is focused on time-frequency tool adapted to the analysis of different EMI, whereas their significant differences in terms of frequency, power and time characteristics. Such tools could be integrated in real time spectrum analyzers in order to optimize measurements for railway EMC issues.

The frequency band to consider in railways goes from DC components to the GHz to protect the railway communications. The EMIs to study can be permanent (EM field radiated by the catenary), periodic as the supply current harmonics or transient produced by railway sub-stations, or perfectly unpredictable like transients associated to sparks between catenary and pantograph. Time-frequency representation allows seeing over time frequency variations of a signal, to observe any EMI and to determine its bandwidth, duration and power range. Nevertheless, the use of time-frequency characterization can be difficult if the time and frequency resolutions are not adapted to the characteristics of the potential victim systems.

The analyzing tool has to offer flexibility, in terms of time and frequency resolutions, allowing the study of EMIs and their impact for railway systems. The FFT is incompatible with this flexibility because the window width has to correspond with a *n* power of 2, and the resolutions are limited by this width. The developed tool transposes the signal from the time to the frequency domain, where the frequency can go from DC to the maximum analysis frequency with a 1Hz-step. Convolution with a rectangular window is then performed, which width is defined according to the studied frequency band and the wanted time and frequency resolutions. The rectangular window is justified by the possibilities in terms of optimization. Indeed, the convolution with a rectangular window shifted by one sample consists of deleting the first sample and adding a new one. This property permits us to optimize significantly the computation time. However, the rectangular window introduces significant lateral lobes, which are corrected by applying the convolution with the rectangular window several times.

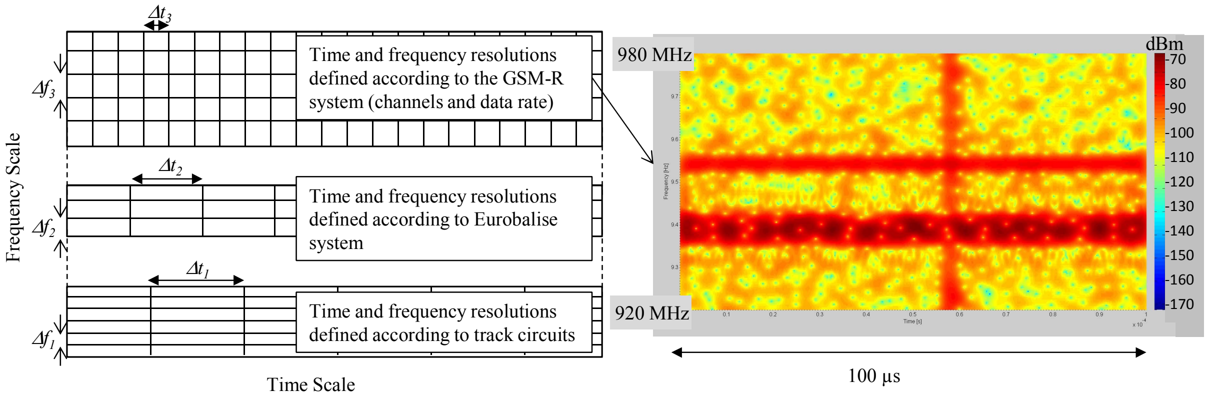

Fig. 1: Setting principle of the analysis tool and results for the GSM-R frequency band