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Experimental characterisation of the radio propagation channel in the millimetre frequency bands for railway communications - Preliminary results

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A new 5G based system called FRMCS (Future Railway Mobile Communication Systems) is under development at European level to replace GSM-R that will be obsolete in 2030. This new system will be deployed in very narrow frequency bands allocated for railway critical applications: 4 MHz in the actual GSM-R band and 10 MHz in the 1900 MHz band. To overcome frequency scarcity, millimeter frequency bands are explored. Radio channel characterization and modelling in the millimeter frequency bands is a very active field of research for 5G and beyond system developements [1]. Only some works deal with the railway case. Static measurements at 60 GHz for in train propagation are presented in [2]. Some measurements at 60 GHz with moving trains are reported in [3] using a modified RUSK channel sounder.

The objective of our work is to develop millimeter wave radio channel models for dynamic railway scenarios (moving transmitters, receivers and scatterers) for specific use cases such as virtual coupling of trains, platooning, remote driving of trains and specific areas (train stations, shunting yards, high-speed lines, secondary lines). To this aim, the IMT Atlantique / Lab-STICC research laboratory has developped a Single Input Single Output millimetre-band chirp channel sounder based on Software Defined Radio boards (SDR). In order to perform the baseband conversion to 60 GHz, a development board from Analog Device is used. This digitally controllable board allows to obtain a millimetre band transmission and reception chain with variable gains, separated in two different modules synchronised by the GPS. A 25 dB amplifier on transmitter side is used for longer measurement distances. The excitation signal is a chirp. We measure the complex transfer function of the channel to obtain the complex impulse response. A classical "back to back" calibration stage allows to take into account the antenna gains as well as the transfer functions of the transmitting and receiving chains. The bandwidth used is 160 MHz (SDR available band).

Figure 1. Environnement of the first measurements campaign

A first measurements campaign in a railway trial site (Figure 1.) was performed in SISO mode to validate the global operating mode of the channel sounder. Dynamic measurements at low speed were done. In the final paper, we will present and comment the evolution of the Power Density Profile (PDP) along the distance, the Doppler for the main path and a statistical analysis of the results. The work is performed in the framework of the French ANR (Agence Nationale de la Recherche) project mmW4Rail (Wireless mmW communications for Railway).

References

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