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**„Metoda wymiany informacji w relacji tor-pojazd z wykorzystaniem
sygnałów szerokopasmowych”**

**“The method of information exchange in the track-vehicle relation with the use of
broadband signals”**

This doctoral dissertation presents the original method of signal transmission in the track – vehicle relationship with the use of LTE technology in the presence of phenomena limiting transmission at higher train speeds and in the aspect of delayed transmission of the signal.

In the first chapter an assessment of the state of knowledge in the use of the LTE system on the railway has been made and deficiencies appearing in foreign and domestic literature in this field have been pointed out. Presented is the genesis of the problem and research problems, which motivated the author to put forward the thesis of scientific work, with appropriately selected assumptions, as well as to define the purpose and scope of the work.

The second chapter analyzes the propagation models of electromagnetic waves used to draw up the power balance of the telecommunications link, taking into account the attenuation of free space and the character of the wave propagation area. This balance is an important aspect when designing the fourth generation LTE architecture. This chapter also analyzes the impact of the Doppler effect on the change of signal frequency and handover in cellular networks.

The third chapter describes the services of the GSM-R system, handover in the GSM-R system and limitations existing in this system, as well as characterization of the LTE system in terms of its use in railway aspects, especially for transmission in the track-vehicle relation. The fourth chapter analyzes the impact of MIMO technology on the parameters of transmission in the radio channel, forming the signal beam and increasing the bandwidth of the link. Delay time algorithms for the tested multi-antenna system model were determined. The effect of MIMO technology on the bit rate error of broadband signal transmission in the track-vehicle relation was analyzed.

The fifth chapter analyzes the radio transmission model in the track-vehicle relationship. The analysis of the LTE signal system shaping in the aspect of high-speed railway resulting from the transfer of the handover connection was made. The results of field

studies related to handover and modeling of the transmission system in the track-vehicle relation are presented. The methodology of the telegram, its coding and transmission from the Local Control Center to the vehicle using the open LTE system using the proprietary application is presented. Next, the distribution of the probability density function of transmission delays was determined when transmitting messages of various sizes. It has been proven that the resulting distribution of density functions is a combination of three distributions and is different from normal distribution.

The summary presents the conclusions of this dissertation, the statements regarding the thesis of the scientific work and the further directions of development of the subject taken in the doctoral dissertation.