Multi-band prediction of millimeter-wave propagation effects for dynamic and fixed scenarios in rugged time-varying environments

The constantly growing demand for high-speed mobile communication leads to increased interest in the millimeter wave band in the 30-300 GHz range. As before, also nowadays in the development of the fifth generation (5G) and beyond mobile networks, propagation research and channel modeling plays an important role, which allows to increase the efficiency, coverage, and capacity of these networks, increase transmission throughput and provide new telecommunications services. Threfore, radio wave propagation deals with the description of physical phenomena accompanying the transmission of radio waves that occur in the real environment and the study of the these phenomena effects on the form of the received information signal. In wireless communication systems, this information signal is transmitted from the transmitter to the receiver, i.e., for example from a base station to a mobile terminal (i.e., user equipment) of a cellular network. The analyzed propagation phenomena may cause various effects that degrade the quality of the received signal and the provided services. Therefore, it can be said that a proper understanding of these phenomena offers the opportunity to improve future telecommunications systems. At the stage of research and design of new radio networks, various types of channel models are used in the simulation studies, which allow to reflect physical phenomena occurring in the real world.

The project aims to assess the specific properties of radio wave propagation in the millimeter range. Research will be conducted for a variety of mobile and fixed scenarios in rugged urban and suburban areas. The planned measurements will be carried out in various millimeter-wave bands, i.e., 28, 38, 60 and 80 GHz, by two research teams from the Brno University of Technology (Czech Republic) and the Military University of Technology (Poland). Additionally, the National Institute of Technology in Durgapur (India) will provide support for the analysis of measurement data. The time-varying characteristics of the radio channel will be explored both from a short-term perspective, focused on very rapid changes in the channel, and from the perspective of long-term changes over several hours or days.

The result of the project will be models of statistical and geometry-based channels created based on real measurement data. New results are expected, especially in the area of channel analysis taking into account the influence of weather (e.g., rain or snow) and the study of long-term channel statistics. The aim of the project is to extend the current channel analysis to higher frequencies, compare the obtained results for different millimeter-wave bands and new scenarios using unconventional measurement methods, such as real-time spatial scanning of multi-path components or innovative data pre-processing techniques, including machine learning.

The reason for undertaking the described research is the noticed lack of discussing these topics in the literature. This provides the basis for the implementation of original and innovative research, the results of which may be of interest to a wide group of specialists in the field of wireless communications.

During the project, devices (so-called channel sounder) for sounding the radio channel will be developed, which will allow to study the influence of propagation phenomena on the form of the received signal. The results of the recorded measurement signals will base for further analysis and evaluation of the propagation properties of millimeter-waves. At the stage of analyzing the measurement results, it is planned to use machine learning methods, which will introduce the element of the so-called artificial intelligence technology in the field of radio wave propagation and channel modeling. The final result of the project will be useful statistical and geometry-based channel models, which will be verified based on the performed measurements. The obtained results will be presented in articles published in international scientific journals and at international conferences.