MOFINT - Propagation Models for Interference and Frequency Coordination Analysis (ESA Contract No. 4000105298/12/NL/CLP)

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Introduction

Within the European Space Agency’s ARTES 5.1 programme, a consortium led by the Czech Technical University in Prague developed and experimentally validated propagation models and relevant input data for the statistical prediction of radio interference on ground terminals of satellite systems.

- Budget: 253 k€
- Prime contractor: Faculty of Electrical Engineering, Czech Technical University in Prague
- Sub-contractor: Czech Metrology Institute
- Total duration: 22 months (April 2012 – February 2014)
- 12 Work Packages including CCN extension

The project was driven by the recent development in both the terrestrial and satellite systems which resulted in sharing a number of frequency bands. As a consequence, interference analysis becomes very critical especially for the case of ground stations for deep space research. Currently, two ITU-R Recommendations are available for interference analysis: P.452-14 [1] and P.620-6 [2]. In order to address all the areas of interest, the objectives of the activity were as follows:

- develop and experimentally validate propagation models and relevant input data for the statistical prediction of radio interference on ground terminals of satellite systems,
- implement the models into a software tool.

The main important effects considered are the atmospheric refraction, causing signal enhancement due to ducts and elevated layers, and diffraction, in fact also strongly predetermined by the refraction through the k-factor defining the propagation path geometry. Modeling of these two effects utilizing dedicated measurements was the main focus of the project while available models were utilized for the case of the other effects.

Long-Term Experiment

Experimental microwave terrestrial links at the frequencies of 11 GHz and 38 GHz were utilized to assess the models of diffraction, multipath propagation and ducting. Both the radio and meteorological measurements were taken between July 1, 2012 and July 31, 2013, i.e. within a period of 13 months. The path length of the experiment was 49.82 km with Tx located on the TV Tower in Prague and Rx located at a radio mast in Podebrady.

New Radiometeorological Maps

New maps with a 1° spatial resolution were derived by using ERA Interim datasets (ECMWF) for the years 1979 – 2011. The reason is that current ITU-R Recommendations are based on an insufficient set of data while global maps based on a longer time period are needed for critical scenarios. The new maps were submitted to ITU-R SG3.

- Derived parameters:
  - Surface refractivity, \( n_s \) (N-unit)
  - Soiling height, \( h_s \) (km)
  - Sea level refractivity, \( n_0 \) (N-unit)
  - Vertical gradient of refractivity, \( \beta \) (N-unit/km)
  - Surface height (from surface geopotential), \( h \) (km)
  - Water vapor density, \( WVD \) (g/m³)
  - Land-sea mask of ERA Interim, for sea, 1-land


Software Tool


Short-Term Terrain Diffraction Measurements

To address the performance of the selected terrain diffraction models, corresponding short-term measurements were carried out during August and September 2012 to obtain a large relevant set of experimental data for various frequencies, Tx and Rx heights and terrain profiles. Characteristics of the measurements are as follows:

- 7 scenarios in the Czech Republic (7 km up to 50 km, single/multiple obstacles)
- Narrowband measurements at 2.0, 3.5, 5.5, 5.5, 11.2 and 38.0 GHz, linear (H or V) and circular polarizations
- Truck-mounted access platforms utilized to achieve different combinations of Tx/Rx heights
- A total of 1237 valid measurements performed


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