Numerical Calculation of Loss Margins for Short Distance Communication over Rough Surfaces

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Unattended sea and ground sensors provide continuous monitoring of remote areas. Information gathered by them is frequently transferred to operator by means of a radio communication channel utilizing antenna mounted at the surface or at small elevation. The close proximity to the surface affects the maximal reliable communication distance and this is taken into account in the sensors design. Typical propagation models utilizing for the design account for flat surface propagation only. In this paper we present the results of computational study of communication margins due to rough surfaces.

For the calculations, commercially available software tools based on method of moments and finite element method are used. The use of two different computational methods helps to validate calculated results. Short range communication over distances a few tenths of meters in HF-VHF frequency ranges are considered. Sensors are supposed to be dipped into water and communicate by means of ideal Hertzian dipoles. Because of high electric conductivity, sea surface is modeled as a perfect electric conductor (PEC). For PEC surface there is no Norton surface wave, and thus the conventional two-ray propagation model can be used as a first approximation. When source and receiver are close to the surface, propagation loss follows $1/R^4$ power law, which corresponds to 12dB when distance is doubled. Calculations show that roughness introduces significant extra loss which needs to be taken into account. Since the loss depends on the parameters of rough surfaces, several sets of surfaces are considered.