Measurement and modeling of diffraction in the 40 GHz band

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Diffraction is an important way of propagation mechanism for mobile and wireless communications systems. We have studied this propagation phenomenon for the millimetric wave band, especially in the region known as "shadow region". This knowledge is useful to evaluate the use of electromagnetic field site shielding technique.

Diffraction is frequently estimated using Fresnel knife edge approximation, but that model ignores important parameters as polarization, conductivity, permitivity, and surface roughness of the diffracting edge. Heuristic formulations, not formally based on Maxwell equations, have been introduced to approximate the solution to the diffraction problem in lossy and rough surfaces, giving results close to Maliuzhinet's formulas in shadow and reflection boundaries.

For the purpose of this work, we have considered the formulation given for the heuristic diffraction coefficient of Luebbers and the improved version of this coefficient given by Holm, for non-perfectly conducting wedges. This last one approximates the diffracted field with good accuracy in the vicinity of shadow boundaries and also in the deep shadow and lit regions. The form given by Holm is in good agreement with the more rigorous formulation in the shadow region, such as Maliuzhinet's solution.

From diffraction measurements, we conclude the presence of diffraction in the shadow region. We can observe that results for incidence angles lower than 40º, carried out with horizontal polarization, present a level 10dB higher than results achieved for the other incidence angles, carried out with vertical polarization.

The measured values of diffraction losses are compared with the theoretical diffraction coefficients given by Luebbers and Holms. Divergences between theoretical and experimental results are observed for the direct, reflection and shadow zones.

Luebbers coefficient shows a larger overestimation in the diffraction losses than the shown by Holm coefficient for incidence angles in the range [10º, 30º]. In the rest of angles, [40º, 60º] the difference between both coefficients is negligible.

In general, we conclude that an overestimation of diffracted levels is present with independence of the incidence angle considered. This fact leads us to extract a model to fit better the level reached in the shadow zone.

Diffraction losses in the shadow region seem to be a linear function of the diffraction angle (θ_d), which is measured from the ISB boundary to the *n*-face. A model for incidence angles lower than 40º can be enunciated, and another different must be considered for angles from 40º to 60º. This model consists in a linear approximation of decreasing level of signal received in the shadow region. Equations of approximations can be extracted and given.