

New methods for the prediction of rain attenuation in terrestrial links

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Abstract

Rain attenuation is the main cause of unavailability in radio links operating at frequencies above 10 GHz. Attenuation due to rainfall along a path may be calculated by integrating the specific attenuation over the path length if the rainfall rate variation along the path is known. Rainfall rate, however, is inhomogeneous in both space and time posing a major difficulty in predicting rain attenuation for link design.

Most practical methods make use of cumulative distributions of rainfall rate measured at a point. The statistical rain profile is simply characterized by an effective rainfall rate derived from measurements. An alternative procedure is to apply the reduction coefficient to the actual path length, which yields an equivalent path length over which the rain intensity may be assumed to be constant. This type of procedure is currently adopted in the methodology of Recommendation ITU-R P.530.

One limitation in the current ITU-R method is that the attenuation is predicted using only the measured rainfall rate exceed at 0.01% of the time. For other percentages of time, the attenuation is obtained using extrapolation functions. More importantly, the method is based on fitting of the path reduction factor using limited experimental data, without an actual physical basis.

This paper will discuss possible new approaches to develop a prediction method relying on a stronger physical basis. One possibility is to include in the method parameters such as the wind speed and direction during rainy conditions, which should affect the attenuation along the links in addition to the cumulative distribution of rainfall rate and link geometry already considered in the current method. A tentative method will be presented, derived based on measurements of signal attenuation in converging links with different path lengths, spatial orientations and operation frequencies, as well as information on wind speed and direction during rainy periods.

Another approach is the use of rain attenuation synthesizers to predict not only attenuation statistics but also its dynamic behaviour. Recently there has been extensive work being carried out in time series synthesizers using the synthetic storm technique to provide attenuation time series. The main challenge here is to obtain the synthesizer parameters for different link characteristics and radiometeorological regions. This kind of modelling is still in its early stages but some available results will be reviewed.