

QUESTION ITU-R 204-4/3

Propagation data and prediction methods required for terrestrial line-of-sight systems

(1990-1993-1995-1997-2000-2009)

The ITU Radiocommunication Assembly,

considering

a) that a better knowledge of the characteristics of propagation contributes greatly to the design of economic line-of-sight systems and to the improvement of system performance and in particular:

- that the design of digital systems is largely controlled by the performance and the availability required (as related to propagation) and that periods of adverse propagation are significant to the design of digital systems;
- that amplitude and group-delay distortions across a microwave radio channel have a profound effect on the bit error ratio of digital systems,

decides that the following Questions should be studied

1 What is the distribution of the value of transmission loss additional to free space resulting from multipath propagation, diffraction, precipitation and absorption, etc., for frequency bands above about 300 MHz for each month of the year, including its diurnal variation averaged over each month?

2 What propagation data may be used for station site selection and for determining the height of antennas and their radiation characteristics, including the distribution of refractive-index gradient or *k*-factor during subrefractive conditions averaged over a specified path length?

3 What data may be obtained on clear-air propagation effects (both fading and enhancements), in particular:

- the number of atmospheric and ground reflected rays during multipath propagation, and the statistical distribution of their relative amplitudes and delays;
- statistics of single-frequency fading, flat fading, selective fading (including minimum and non-minimum phase fading, in-band power differences (IBPD), in-band amplitude dispersions (IBAD) and notch depths) and composite fading (flat plus selective), and diffraction fading;
- conditional probabilities of flat fading, selective fading, delays and notch depth to determine the inter-dependence of the principal multipath parameters;

- the dependence of all the items above on:
 - path and terrain characteristics, frequency, antenna patterns and geoclimatic factors;
 - diversity (angle, space and in-band and cross-band frequency);
- degree of correlation of multipath fading on different channels on the same path and different paths in a multi-hop link?

4 What models of the tropospheric channel transfer function can be used for the computation of system performance?

5 What data may be obtained on precipitation effects, in particular:

- concurrent long-term statistical distributions of rainfall attenuation and rainfall intensity, especially in tropical regions;
- the influence of sleet and wet snow;
- long-term number of precipitation attenuation events of duration shorter than 10 s and 10 s or longer for various attenuation levels, and the mean duration of precipitation events of duration 10 s or longer in combination with long-term statistical distributions of precipitation attenuation exceedances;
- the degree of correlation of precipitation effects on different paths of the same link?

6 What precipitation parameters, in addition to rainfall intensity, can be applied to precipitation-related prediction methods to take account of different climates?

7 What refractivity parameters, in addition to, or instead of, refractivity gradient statistics in the first 100 m of the atmosphere, can be applied to clear-air prediction methods to take account of different climates?

8 What is the variation, due to clear-air propagation effects, precipitation or any other cause, of the isolation between two orthogonal polarizations, including systems using diversity?

9 What is the set of conditions that must be met to identify the period of non-faded propagation?

10 What is the frequency of occurrence and duration of fades exceeding specified values and the rate of change of received signal in these fades, noting that the time resolution of measurements to obtain these statistics must be adequate to describe the rate of variation of the propagation effects. The duration statistics should also be apportioned between events shorter than 10 s and those 10 s or longer?

11 What is the improvement to be gained using diversity systems in the presence of rain or multipath?

12 What are the cumulative effects of all propagation factors, on the overall system performance of multi-hop links (including one or more satellite hops), and the dependence of these factors on hop characteristics?

13 How can the contributions from the various propagation effects be apportioned to performance and availability?