On Microwaves Radio Networks Performance Parameters

Tudor Palade[1]

Abstract - **Microwave links have to be designed such that propagation effects do not reduce the quality of the transmitted signals. Measurements and the derived propagation parameters are analysed and discussed, for Cluj-Napoca County, in order to improve future planning of the radio links.**

Keywords **– Radio channel, multipath activity, geoclimatic factor, received field prediction**

I. INTRODUCTION

The line-of-sight radio links network has to be designed to meet the very high quality objectives. The planning involves careful consideration of the actual path and the propagation effects [1]. A precise prediction of the expected multipath fading is therefore important. There is no previous radio measurements on multipath activity in the hilly region of Cluj-Napoca County so, less information is available. The our days development of the public and private radio networks requires more data on propagation effects in the microwave range.

II. MULTIPATH MEASUREMENTS

The Radio-communications Laboratory of TUC-N carried out multipath fading measurements on four analogue radio relay links over the year 1995. The links pass mostly over hilly areas and they are designed to meet the standard recommendations of ITU-R that means there is enough clearance. Some characteristics about the links are given in Table I.

The strength of the received field was measured on using a multichannel acquisition board. A special Test Point three modules software package has been written to control the acquisition action, to process the collected data and finally to produce the predicted values of the output parameters. The main features of these modules have been included in Table II

TABLE I: RADIO LINKS CHARACTERISTICS

	Feleac TV1 F2	Deag	Feleac TF F1	Deag	Feleac TF F1	Zalau	Feleac TV	Zalau
Transmitter or Receiver	R	T	R	T	R	T	R	T
Path length (km)	54.6		54.6		64		64	
Frequency (GHz)	6.88		6.96		6.80		6.96	
Bandwidth (MHz)	30		30		30		30	
Ground height above sea (m)	748	428.7	748	428.7	748	717	748	717
Antenna height (m)	41	39	41	39	9.5	15	9.5	15
Antenna diameter (m)	4	4	4	4	4	3	4	3
Measurements periods in 1995	January-March + June-December				January-March + June-December			

TABLE II: STRUCTURE OF THE MULTIPATH ANALYSES SOFTWARE PACKAGE

	Acquisition module	Statistical data processing module	Computing module
Input data	- radio link characteristics - sampling period - received signal	- database produced by the acquisition module	- geoclimatic factor - radio links features - path profile - fade depth A (dB)
Output data	Database files including - level of the received signal for each channel (mV) - tested channel number - date (dd-mm-yy) - time (hh-mm-ss)	- received power vs time per channel - histogram per channel and month - fading probability distribution - mean value and standard deviation - average worst month - geoclimatic factor value from data	- channel profile graphic - percentage of time that fade depth A is exceeded using for computation Method I and Method II.

[1] Tudor Palade is with the Faculty of Electronics and Telecommunications, Technical University of Cluj-Napoca, 15 C. Daicoviciu, 3400 Cluj-Napoca, Romania, E-mail: palade@com.utcluj.ro

The acquisition equipment takes a sample of the AGC signal level each second for each tested radio link receiver. A threshold was established for the AGC received signal level and a correlation between the magnitude of this signal and the received field in antenna was considered. Only the level of a new sample, which exceeds the previous one with more than 3%, is recorded. Following this procedure a database was obtained with files for each radio link over the whole period of measurements. Using such records the monthly distribution of the signal fading was computed and plotted resulting the worth month distribution for the individual link Fig.1 and Fig.2.[2]

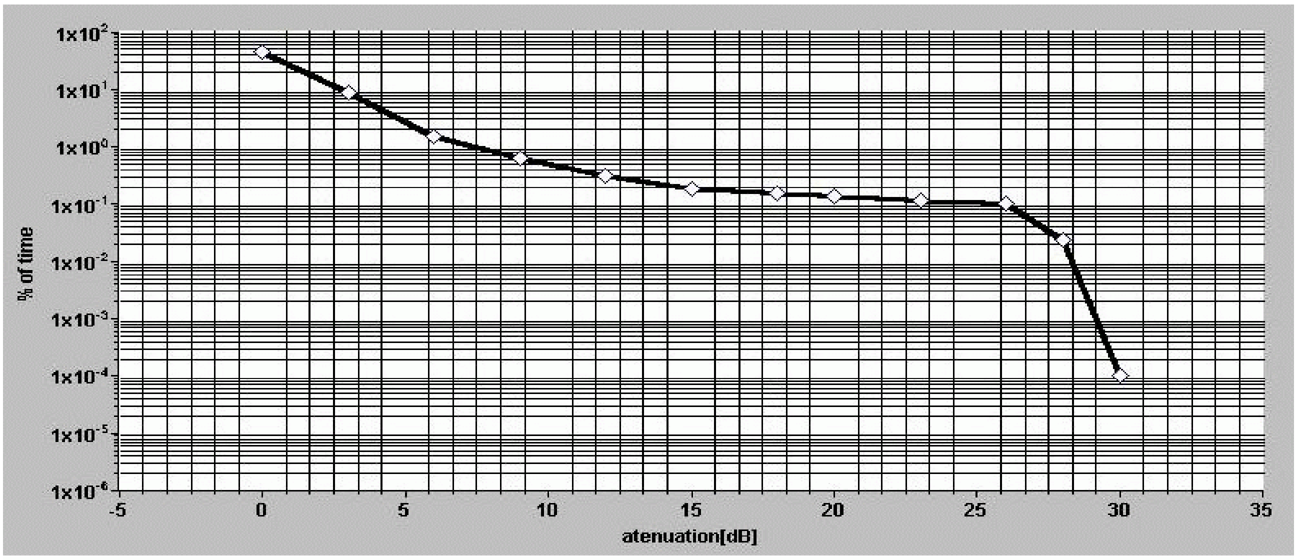

Fig. 1. The worst month cumulative distribution for path 3.

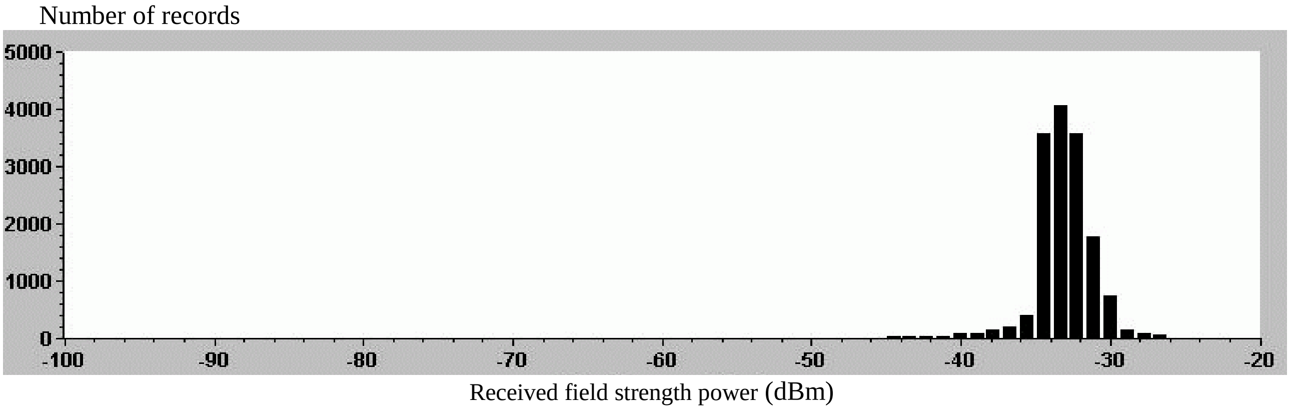

Fig. 2. The histogram of the received power levels for path 3.

From the above mentioned graphs the fade depth A_i beyond which the distribution is approximately linear was noted and P_i, the corresponding point for percentage was considered. With these pairs of co-ordinates for the "first tail point" the K_i individual geoclimatic factor has been computed according the CCIR Report 338-6, Annex III specifications.

Averaging the values of log K_i an average geoclimatic factor has been derived for our specific geoclimatic conditions: K_{av} = 5.947E-7.

The values of K_i for each tested radio link and the co-ordinates of each "first tail point" taken from the distribution curves (A_i ,P_i), are given in Table III.

Taken into account the resulted average value for K, the P_L parameter was estimated using the Olsen and Terje method [3] and the following value has been obtained: P_L = 0.28. With the obtained value for K and P_L the C parameter (which takes into account the terrain features) was estimated using the ITU-R formula:

$$K = 10^{-C} \cdot P_L^{1.5} \quad (1)$$

The calculated value C = 7.27 is specific for our region and is with 10% greater in comparison with the value estimated by ITU-R for general hilly areas.

TABLE III. THE CO-ORDINATES FOR THE TAIL POINT AND THE VALUE OF K FOR EACH RADIO LINK.

Path number	Name of the radio link	K_i	A_i (dB)	P_i (%)
1	Rx TV1 F2 Cluj-Deag	2. 5824E-6	15	27
2	Rx TF F1 Cluj-Deag	1.4825E-6	15	21
3	Rx TF F1 Cluj-Zalau	1.2381E-6	15	13
4	Rx TV Cluj-Zalau	2.6354E-8	15	13

III. CONCLUSIONS

A more accurate estimation of the K and P_L values needs further measurements on the same radio links to obtain a multiannual multipath fading distribution and the average worth month for each path.

REFERENCES

[1] M.P.M. Hall, *Effects of the troposphere on radio communications*, Peter Peregrinus, 1997.
[2] ***, *COST 255 Final Report* - ESA 2000.
[3] R.L.Olsen and T.Terje, “Modelling of the multipath distributions”, Proceedings of URSI Workshop, Oslo 1996.