

**CHARACTERISATION OF SHORT-RANGE
TROPOSCATTER COMMUNICATION
CHANNELS**

A THESIS SUBMITTED
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DOCTOR OF PHILOSOPHY

BY
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CERTIFICATE

This is to certify that the thesis, entitled, "Characterisation of Short-Range Troposcatter Communication Channels" being submitted by Surya Prakash Uttam for the award of Doctor of Philosophy to the Indian Institute of Technology, Delhi, is a record of his bonafide research work. The results obtained in this thesis have not been submitted to any other University or Institute for the award of any degree or diploma.

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ABSTRACT

Short-range troposcatter communication links at microwave frequencies are increasingly being used today. For design of communication systems for these links, accurate estimates of frequency correlation bandwidth (which is the frequency separation between two signals for which correlation coefficients drop to a predetermined value, generally 0.4) and the aperture-to-medium coupling loss are required. Various models for prediction of these parameters have been attempted in the past. However, these models fail to predict the frequency correlation bandwidth for short-range links. Further, the coupling loss predicted by these models does not explain the experimental observations. In view of this, the investigation of these parameters assumed significance. The results of investigations on these two parameters for short-range troposcatter communication channels at microwave frequencies are reported in this thesis.

Bello's single integral model has been used as the starting point. The model has been rederived to include the effect of partial water vapour pressure in the common volume. Further, a more appropriate expression for altitude has been used. By considering the scatter angle exponent, m , as a variable, the rederived expression has been used to obtain values of m for different judiciously chosen short-range links by matching the predicted values and field data. Using the least square curve fit, an expression for the exponent m as a function of antenna beamwidths, path length and

sum of take-off angles has been obtained. The effect of various parameters on m has been studied. Using this value of m , the model has been shown to predict correlation bandwidth for both short- and medium range links accurately. This model is based on two-dimensional approximations.

An expression for delay power spectrum has been derived using three-dimensional analysis also. It has been shown by calculations that the two-dimensional approximation is sufficiently accurate as far as calculation of delay power spectrum and therefore, frequency correlation function is concerned.

Antenna beamwidth has been shown as the main factor controlling the variation of m . Therefore, the effect of the exponent m has been studied for antenna patterns and the expressions for modified pattern and the beamshift have been derived. It has been shown by calculation that the antenna beam gets focussed and shifted upwards and becomes unsymmetrical. This suggests the existence of lens-like structures in the lower troposphere. This supports an earlier suggestion in the literature for existence of lens-like structures though it was made on an altogether different basis.

Utilising this modified geometry, an expression for aperture-to-medium coupling loss has been derived. The calculated coupling loss for a short-range paths has been shown. The results support the experimental observation on coupling loss for short-range tropo links.

CONTENTS

	Page
ABSTRACT	i
LIST OF FIGURES	iii
LIST OF TABLES	iv
LIST OF SYMBOLS	v
CHAPTER 1 INTRODUCTION	1
1.1 Modes of propagation	2
1.2 Some characteristics of tropo channels	5
1.2.1 Correlation bandwidth	5
1.2.2 Aperture-to-medium coupling loss	8
1.3 Problem of the thesis	11
1.4 Structure of the thesis	14
CHAPTER 2 TURBULENT SCATTERING THEORY	16
2.1 Refractive index variation and their characterisation	17
2.1.1 The wave number spectrum of the refractive index fluctuations	21
2.1.2 Refractive index structure constant	22
2.2 Scattering cross section	23
CHAPTER 3 DETERMINATION OF CORRELATION BANDWIDTH	30
3.1 The Gaussian WSSUS model	32
3.2 Expression for the delay power spectrum $Q(\xi)$	35

		Page	
	3.3	Empirical formulation	39
	3.4	Determination of scatter angle exponent	40
	3.5	Discussion	50
CHAPTER	4	MODIFICATION OF ANTENNA PATTERN	56
	4.1	Effect of scatter angle exponent on antenna patterns	57
	4.1.1	Basic formulations	57
	4.1.2	Numerical evaluation	59
	4.2	Determination of correlation bandwidth	65
	4.3	Discussion	68
CHAPTER	5	THREE-DIMENSIONAL MODEL FOR FREQUENCY CORRELATION FUNCTION	71
	5.1	The three-dimensional $Q(\xi)$	73
	5.2	Discussion	76
CHAPTER	6	APERTURE-TO-MEDIUM COUPLING LOSS	78
	6.1	Determination of coupling loss	79
	6.2	Observations	82
CHAPTER	7	CONCLUSIONS	84
APPENDIX	A	DETERMINATION OF DELAY POWER SPECTRUM	89
	A.1	Two-dimensional case	93
	A.2	Three-dimensional case	98
APPENDIX	B	LINK DETAILS	108
REFERENCES			130