Perspective View of Wireless Communication

(A Theoretical Study)

Mr.Udavakumar Allimuthu., B.E. M.E. (PhD)., (Research Scholar). **Department of ICE, Anna University Center for** Research. Anna University-Chennai. Dr. K. Mahalakshmi., B.E, MBA, M.Tech, PhD. (Professor, Department of IT), Karpagam College of Engineering(Autonomous), Coimbatore - 641032, India. Mrs. T. Ponsindhu., B.Com, MBA, M.Phil, (PhD)., (Research Scholar), **Bharathiar University Coimbatore**, (Assistant Professor), Department of Commerce at KG College of Arts and Science, Coimbatore - 641035, India *---*--*--*--*--*

Perspective	View	of	Wireless	Communication	:	Α
Theoretical Study						

Copyright ©	: Mr. Uadaykumar Allimuthu
Publishing Rights 🖻	: VSRD Academic Publishing
	A Division of Visual Soft India Pvt. Ltd.

ISBN-13: 978-93-87610-06-4 FIRST EDITION, MAY 2018, INDIA

Printed & Published by: VSRD Academic Publishing (A Division of Visual Soft India Pvt. Ltd.)

Disclaimer: The author(s) are solely responsible for the contents compiled in this book. The publishers or its staff do not take any responsibility for the same in any manner. Errors, if any, are purely unintentional and readers are requested to communicate such errors to the Authors or Publishers to avoid discrepancies in future.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the Publishers & Author.

Printed & Bound in India

VSRD ACADEMIC PUBLISHING

A Division of Visual Soft India Pvt. Ltd.

REGISTERED OFFICE

154, Tezabmill Campus, Anwarganj, KANPUR – 208003 (UP) (IN) Mb: 9899936803, Web: www.vsrdpublishing.com, Email: vsrdpublishing@gmail.com

MARKETING OFFICE

340, FF, Adarsh Nagar, Oshiwara, Andheri(W), MUMBAI–400053 (MH)(IN) Mb: 99561 27040, Web: www.vsrdpublishing.com, Email: vsrdpublishing@gmail.com

PREFACE

This book was motivated by the desire we and others have had to further the evolution of the core course in communication systems. This book developed from notes from online citation. The goal is to give beginning communication systems majors a solid foundation for further study in wireless communication. However, wireless networks are becoming increasingly important in a much wider range of scientific and engineering disciplines. Therefore, a goal is to give those students who will not take advanced courses in concepts of wireless communication the conceptual tools that the field provides. Finally, a more pervasive goal is to expose all students not only to practical concepts but also to the intellectually rich foundations of the field.

We have tried to integrate effectively the mathematical foundations with the wireless channel propagation models, diversity techniques, wireless standards, multiple access in wireless networks and 3G and 4G models. We thus hope to provide a better feel for the soul of wireless communication than might be found in a theoretical course subspecialty. We believe that, as time goes on, all scientists and engineers will take a foundational course similar to the one offered at Stanford upon which this book is based. Such a study in communication systems should become as standard..

✓ Udayakumar Allimuthu
✓ Dr. K. Mahalakshmi
✓ T. Ponsindhu

ACKNOWLEDGEMENT

First and foremost, I would like to thank my Appa Mr.M.Veerasamy for standing beside me throughout my career and writing this book. He has been my inspiration and motivation for continuing to improve my knowledge and move my career forward. He is my rock, and I dedicate this book to him. I thank my better-half Ponsindhu for always making me energy and for understanding on those weekend mornings and evening when I was writing this book instead of disturbing. I also thank my wonderful childrens: Pozhil Oviya Priya, Pozhil Yagavi Priva and Pozhil Yazhini Priva. for always making me smile and for understanding on those weekend mornings when I was writing this book instead of crying. I hope that one day they can read this book and understand why I spent so much time in front of my computer. I'd like thank to mv parents Mrs.A.Devaki Allimuthu, and Mrs.T.Sumathi Thilagar, for allowing me to follow my ambitions throughout my childhood. My families, including my in-laws, have supported me throughout my career alwavs and authoring this book and I really appreciate it. I owe a my Brothers Mr.A.Javakumar, huge thanks to Mr.A.Manikandan and MehthaKaviThamizharasu for providing excellent support and help. I look forward to discussing this book with my family at future gatherings as I'm sure they will all read it soon. My co-workers, especially my MD, Mr.Jaganathvelan, and Mrs.Bala Subashini, who showed me the ropes in it. Without that knowledge I wouldn't have ventured into learning about Communication network, which ultimately led to this! I'd really like to thank Dr.K.Mahalakshmi for providing me with the opportunity to become the lead author for this book. I appreciate that she believed in me to provide

the leadership and knowledge to make this book a reality. Dr.K.Mahalakshmi is a great person and a research guide; without her, this book may not have been written. Dr.K.Mahalakshmi and Mrs.T.Ponsindhu collaborated to find the other great authors that helped us write this book. In the end, I believe that the team of authors that was chosen provides the perfect blend of knowledge and skills that went into authoring this book. I thank each of the authors for devoting their time and effort towards this book; I'd like to especially thank Mr.Balanand & Mrs.Prema for trusting me to support and develop the applications for our department: I think that it will be a great asset to the community! Thanks for everything; I look forward to writing the second edition soon!. I also wish to thank all of our technical supporters Mrs.B.Privalakshmi and Mrs.S.Murugaveni. All of their efforts helped to make this book complete and we couldn't have done it without you. Last, but definitely not least, I'd like to thank the Mrs.Sivagami Veerasamv and Mrs.T.Prema Javakumar, to provide Strength us with this great work. Thanks to the MSIT-Coimbatore and MSIT-Tirunelveli employees for providing great ideas and support via the mailing; without this help I could not provide the book.

🗷 Udayakumar Allimuthu

This book is dedicated to our beloved kids, Elakkiya Sudar. J.P.Pozhil Oviya Priya, U.P.Pozhil Yagavi Priya U.P.Pozhil Yazhini Priya, And Sai's Gift ... Sai Vandhana

CONTENTS

1. WIRELESS CHANNEL PROPAGATION AND MODEL

1	Wireless Channel Propagation
	And Model Overview1
1.1.	Wireless Propagation3
1.2	Propagation Modeling7
1.3	Reflection10
1.4	Refraction12
1.5	Diffraction and Scattering13
1.6	Importance For Propagation14
1.7	Small Scale Fading15
1.8	Factors Influencing Small Scale Fading16
1.8.1	Fast Fading16
1.8.2	Slow Fading18
1.9	Channel Classification19
1.10	Digital Channel Models20
1.11	Analog Channel Models21
1.11.1	Types of Digital Channel Models23
1.12	Cost-231-Hata Model23

1.13	The Longley–Rice Model (LR)25	5
1.14	Multipath Fading Models: Rayleigh Fading2	8
1.15.	Multipath Fading Models: Rician Fading2	9
1.16	Shadowing and Link Budgets	9
1.16.1	Large-Scale Shadowing3	0
1.16.2	Log-Normal Shadowing30)
1.17	Summary	0

2. **DIVERSITY**

2.1	Fading Channels
2.1.1	Frequency Non Selective Channel Vs Frequency Selective Channel
2.2	Channel Capacity34
2.3	Realization of independent fading paths
2.4	Diversity Overview37
2.4.1	Receiver Diversity
2.5	Diversity Techniques40
2.5.1	Diversity Reception40
2.5.2	Methods for obtaining multiple replicas41

2.6	Selection Methods44
2.6.1	Capacity of Frequency Selective Fading Channels44
2.7	Transmitter Diversity47
2.7.1	Transmitter Diversity: Channel known at Transmitter48

3. MIMO COMMUNICATIONS

3	MIMO Communications Overview	49
3.1	Functions of MIMO	51
3.2	Types of MIMO	54
3.2.1	Multi-antenna types	54
3.2.2	Multi-user types	59
3.3	Coping With Signal Attenuation	62
3.4	Parallel decomposition of the MIMO channel	65
3.5	MIMO channel capacity	67
3.6	MIMO Diversity Gain: Beam forming	70
3.6.1	Eigen-Beamforming	75
3.7	Diversity-Multiplexing Tradeoffs	78
3.8	Space time Modulation and coding	80

3.9	Spatial Multiplexing and BLAST Architectures82
	4. MULTI USER SYSTEMS
4	Multiple accesses85
4.1	Multi User Systems Overview86
4.2	Narrowband Systems Vs Wideband Systems89
4.3	Frequency Division Multiple Access (FDMA)91
4.3.1	Advantages of FDMA95
4.3.2	Disadvantages of FDMA96
4.3.3	Examples of systems using FDMA96
4.4	Time division multiple access (TDMA)97
4.5	Code Division Multiple Access (CDMA)100
4.5.1	Orthogonal frequency division multiplexing (OFDM)103
4.6	Spatial division multiple access (SDMA)104
4.7	ALOHA108
4.8	Slotted ALOHA (SALOHA)111
4.8.1	The ALOHA Protocol112
4.8.2	ALOHA Facts113
4.9	Carrier Sense Multiple Access (CSMA)114
4.9.1	CSMA Access Modes117

4.9.2	Protocol Modifications120
4.9.3	CSMA-CD121
4.9.4	Carrier Sense Multiple Access Collision Avoidance (CSMA/CA) 122
4.9.5	Application122
4.10	Scheduling123
4.10.1	Key concepts in scheduling124
4.11	Uplink anddownlink124

5. WIRELESS NETWORKS

5.1	Wireless Networks Overview	126
5.2	Configuring a wireless LAN	127
5.2.1	The network name or service set identifier	
	(SSID)	128
5.2.2	Identifying a Wireless Network	129
5.3	Basic Security in Wireless Networks	131
5.3.1	Wireless network Vs Wired Network	137
5.4	Wireless links	138
5.5	Types of Wireless Networks	140
5.6	3G Overview	145
5.6.1	3G Cellular Systems	149

5.7	Universal Mobile Telecommunications System15	4
5.8	UMTS Standardization154	4
5.8.1.	UMTS Radio Interface15	6
5.9	4G features and challenges15	9
5.9.1.	Key features of 4G wireless networks16	0
5.10	The benefits of 4G16	60