A TEXTBOOK ON

WIRELESS COMMUNICATIONS AND NETWORKS

K. Srinivasa Reddy

A TEXTBOOK ON WIRELESS COMMUNICATIONS AND NETWORKS

A TEXTBOOK ON WIRELESS COMMUNICATIONS AND NETWORKS

(II-Semester of B.Tech. ECE and M. Tech. for Embedded Systems)
As per JNTU Syllabus

By

K. SRINIVASA REDDY
M. Tech., IAENG,
Associate Professor and Head Department of
Electronics and Communication Engineering,
Chilkur Balaji Institute of Technology
Hyderabad, Andhra Pradesh

UNIVERSITY SCIENCE PRESS
(An Imprint of Laxmi Publications Pvt. Ltd.)
An ISO 9001:2008 Company
BENGALURU • CHENNAI • COCHIN • GUWAHATI • HYDERABAD
JALANDHAR • KOLKATA • LUCKNOW • MUMBAI • RANCHI • NEW DELHI
INDIA • USA • GHANA • KENYA

A TEXTBOOK ON WIRELESS COMMUNICATIONS AND NETWORKS

Copyright © by Laxmi Publications Pvt. Ltd.
All rights reserved including those of translation into other languages. In accordance with the Copyright (Amendment) Act, 2012, 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. Any such act or scanning, uploading, and or electronic sharing of any part of this book without the permission of the publisher constitutes unlawful piracy and theft of the copyright holder's intellectual property. If you would like to use material from the book (other than for review purposes), prior written permission must be obtained from the publishers.

Printed and bound in India
Typeset at : Monu Printographics, Delhi
First Edition : 2011, *Reprint* : 2015
ISBN : 978-93-80856-58-2

Limits of Liability/Disclaimer of Warranty: The publisher and the author make no representation or warranties with respect to the accuracy or completeness of the contents of this work and specifically disclaim all warranties. The advice, strategies, and activities contained herein may not be suitable for every situation. In performing activities adult supervision must be sought. Likewise, common sense and care are essential to the conduct of any and all activities, whether described in this book or otherwise. Neither the publisher nor the author shall be liable or assumes any responsibility for any injuries or damages arising herefrom. The fact that an organization or Website if referred to in this work as a citation and/or a potential source of further information does not mean that the author or the publisher endorses the information the organization or Website may provide or recommendations it may make. Further, readers must be aware that the Internet Websites listed in this work may have changed or disappeared between when this work was written and when it is read.

All trademarks, logos or any other mark such as Vibgyor, USP, Amanda, Golden Bells, Firewall Media, Mercury, Trinity, Laxmi appearing in this work are trademarks and intellectual property owned by or licensed to Laxmi Publications, its subsidiaries or affiliates. Notwithstanding this disclaimer, all other names and marks mentioned in this work are the trade names, trademarks or service marks of their respective owners.

Branches

✆ **Bengaluru**	080-26 75 69 30
✆ **Chennai**	044-24 34 47 26
✆ **Cochin**	0484-237 70 04, 405 13 03
✆ **Guwahati**	0361-254 36 69, 251 38 81
✆ **Hyderabad**	040-27 55 53 83, 27 55 53 93
✆ **Jalandhar**	0181-222 12 72
✆ **Kolkata**	033-22 27 43 84
✆ **Lucknow**	0522-220 99 16
✆ **Mumbai**	022-24 91 54 15, 24 92 78 69
✆ **Ranchi**	0651-220 44 64

PUBLISHED IN INDIA BY

UNIVERSITY SCIENCE PRESS
(An Imprint of Laxmi Publications Pvt. Ltd.)
An ISO 9001:2008 Company
113, GOLDEN HOUSE, DARYAGANJ, NEW DELHI-110002, INDIA
Telephone : 91-11-4353 2500, 4353 2501
Fax : 91-11-2325 2572, 4353 2528
www.laxmipublications.com info@laxmipublications.com

C—9536/014/11
Printed at : Ajit Printers, Delhi.

CONTENTS

Preface (*vii*)

Acknowledgement (*viii*)

Syllabus (*ix*)

Unit 1. Wireless Communications and System Fundamentals **1–10**

1.1 Introduction 1

1.2 Examples of Wireless Communication Systems 1

1.3 Comparison of Common Wireless Communication Systems 3

1.4 Trends in Cellular Radio and Personal Communications 4

1.5 General Cellular Concepts 9

Unit 2. Multiple Access Techniques for Wireless Communication **11–25**

2.1 Introduction 11

2.2 Packet Radio Media Access Protocols 21

2.3 Reservation Protocol 22

2.4 Cellular System Capacity 23

Unit 3. Wireless Networking **26–35**

3.1 Introduction 26

3.2 Differences in Wireless and Fixed Telephone Networks 26

3.3 Fixed Wireless Access Technologies and Standards 28

3.4 List of Acronyms 30

3.5 Packet Switching 31

3.6 Switch Functionality 32

3.7 Introduction to X.25 33

Unit 4. Wireless Data Services **36–54**

4.1 Introduction 36

4.2 Cellular Digital Packet Data (CDPD) 36

4.3 Advanced Radio Data Information Services (ARDIS) 37

4.4 RAM Mobile Data 40

4.5 Common Channel Signaling 41

4.6 ISDN (Integrated Service Digital Network) 41

4.7 ATM: Asynchronous Transfer Mode Protocol 45

4.8 Signaling System #7 (SS7) 47

Unit 5. Mobile IP and Wireless Application Protocol **55–79**
5.1 Introduction Mobile IP 55
5.2 Applications 56
5.3 Wireless Application Protocol 59
5.4 The Types of Wireless Application Protocol 60
5.5 Optimal WAP Bearer 63
5.6 Wireless Datagram Protocol 67
5.7 Wireless Transaction Protocol 69
5.8 Wireless Session Protocol 71
Unit 6. Wireless LAN Technology **80–95**
6.1 Introduction 80
6.2 Types of Wireless LAN 81
6.3 IEEE 802 Protocol Architecture 85
6.4 IEEE 802.11 Architecture 89
Unit 7. Bluetooth **96–114**
7.1 Introduction to Bluetooth 96
7.2 Bluetooth Architecture 97
7.3 The Bluetooth Protocol Stack 98
7.4 Bluetooth Formats 102
7.5 Applications of Bluetooth 103
7.6 Bluetooth IEEE 802.15.1 vs. Wi-Fi IEEE 802.11 in Networking 103
7.7 Computer Requirements 105
7.8 Mobile Phone Requirements 105
7.9 Specifications and Features 106
7.10 Extra Information of Bluetooth 108
7.11 Wireless Local Loops (WLL) 112
Unit 8. Mobile Data Networks **115–130**
8.1 Introduction 115
8.2 CDPD (Cellular Digital Packet Data) 117
8.3 GPRS (General Packet Radio Service) 123
8.4 SMS as Part of GSM 127
8.5 Mobile Application Protocol 129
Index **131–133**

PREFACE

Wireless Communications plays a major role in our lives. Wireless networking products are rapidly emerging and promise to become a major part of the telecommunications infrastructure within the next decade. Developments in Wireless Communication Technology have increased its applications in allied fields of electronics, security, military and defence.

Every care has been taken to eliminate misprints, omissions and errors but it is too much to expect that no inaccuracy/misprint/error has crept in and the author would be grateful to the readers for bringing to his notice any such errors/misprints/omissions they may come across while going through the book.

The author will like to thank the readers (both teachers and students) who sent their valuable suggestions that became the basis for the revision of the book.

The author shall feel satisfied if the book meets the needs of the students for whom it is meant. Suggestions and criticism for improvement of the book are always welcomed.

The author hopes that book will fulfill the need of interested readers and welcome any suggestions towards the improvement of the book.

—Author

ACKNOWLEDGEMENT

I would like to thank *Prof.M.Moorthy Muthukrishnan* for his valuable Supervision and support during the preparation of this book. The author extends his thanks to all my *M.Tech* classmants for their valuable suggestions.

I must express my deep appreciation to my wife *Mrs. Geetha Reddy* and my family for their patience, co-operation and understanding which made the tedious task of writing this book much easy to endure.

Special thanks to Dr. Sudhakar Rao P (Dean R and D, ECE, VITS-HYD), Mr. M. Jagadesh Chandra Prasad (professor, BVRIT), Mr. David Soloman Raju.Y (Associate Professor, ECE, HIET-HYD) for constant encouragement.

Great care has been taken to produce this book free from errors, but some may remain.

I will therefore accept the pleasure any information, which will draw the attention to such mistakes and errors.

Criticism about the book shall always be appreciated.

—Author

WIRELESS COMMUNICATIONS AND NETWORKS

UNIT I

WIRELESS COMMUNICATIONS & SYSTEM FUNDAMENTALS: Introduction to wireless communications systems, examples, comparisons & trends. Cellular concepts-frequency reuse, strategies, interference & system capacity, trucking & grade of service, improving coverage &capacity in cellular systems.

UNIT II

MULTIPLE ACCESS TECHNIQUES FOR WIRELESS COMMUNICATION: FDMA, TDMA, SSMA (FHMA/CDMA/Hybrid techniques), SDMA technique (AS applicable to wireless communications). Packet radio access-protocols, CSMA protocols, reservation protocols, capture effect in packet radio, capacity of cellular systems.

UNIT III

WIRELESS NETWORKING: Introduction, differences in wireless & fixed telephone networks, traffic routing in wireless networks–circuit switching, packet switching X.25 protocol.

UNIT IV

Wireless data services—cellular digital packet data (CDPD),advanced radio data information systems, RAM mobile data (RMD). Common channel signaling (CCS), ISDN-Broad band ISDN & ATM-Signaling System no. 7(SS7)-protocols, network services part, user part, signaling traffic, services & performance.

UNIT V

MOBILE IP AND WIRELESS APPLICATION PROTOCOL: Mobile IP Operation of mobile IP, Co-located address, Registration, Tunneling, WAP Architecture, overview, WML scripts, WAP service, WAP session protocol, wireless transaction, Wireless datagram protocol.

UNIT VI

WIRELESS LAN TECHNOLOGY: Infrared LANs, Spread spectrum LANs, Narrow bank microwave LANs, IEEE 802 protocol Architecture, IEEE802 architecture and services, 802.11 medium access control, 802.11 physical layer.

UNIT VII

BLUE TOOTH: Overview, Radio specification, Base band specification, Links manager specification, Logical link control and adaptation protocol. Introduction to WLL Technology.

UNIT VIII

MOBILE DATA NETWORKS: Introduction, Data oriented CDPD Network, GPRS and higher data rates, Short messaging service in GSM, Mobile application protocol.

TEXTBOOKS

1. Wireless Communication and Networking—William Stallings, PHI, 2003.
2. Wireless Communications, Principles, Practice—Theodore, S. Rappaport, PHI, 2nd Edn., 2002.
3. Principles of Wireless Networks—Kaveh Pah Laven and P. Krishna Murthy, Pearson Education, 2002.

REFERENCE

1. Wireless Digital Communications—Kamilo Feher, PHI, 1999.

UNIT 1 WIRELESS COMMUNICATIONS AND SYSTEM FUNDAMENTALS

1.1 INTRODUCTION

The rapid evolution of cellular technology and the more user demand for advanced mobile services leads the industry to develop more efficient network structures. The increasing number of cellular subscribers and the demand for cellular networks communication (3rd and 4th generation) drives to the research of the new methodologies for the design of cellular networks and services.

1.2 EXAMPLES OF WIRELESS COMMUNICATION SYSTEMS

Most people are familiar with a number of mobile radio communication systems used in everyday life. Garage door openers, remote controllers for home entertainment equipment, cordless telephones,hand-held walkie-talkies, pagers (also called paging receivers or "beepers"), and cellular telephones are all examples of mobile radio communication systems. However, the cost, complexity,performance, and types of services offered by each of these mobile systems are vastly different.The term *mobile* has historically been used to classify *any* radio terminal that could be moved during operation. More recently, the term *mobile* is used to describe a radio terminal that is attached to a high speed mobile platform (*e.g.,* a cellular telephone in a fast moving vehicle) whereas the term *portable* describes a radio terminal that can be hand-held and used by someone at walking speed (*e.g.,* a walkie-talkie or cordless telephone inside a home). The term *subscriber* is often used to describe a mobile or portable user because in most mobile communication systems,each user pays a subscription fee to use the system, and each user's communication device is called a *subscriber unit.* In general, the collective group of users in a wireless system are called *users* or *mobiles,* even though many of the users may actually use portable terminals. The mobiles communicate to fixed *base stations* which are connected to a commercial power source and a fixed *backbone network.* Mobile radio transmission systems may be classified as *simplex, half-duplex* or *full-duplex.* In simplex systems, communication is possible in only one direction. Paging systems, in which messages are received but not acknowledged, are simplex systems. Half-duplex radio systems allow two-way communication, but use the same radio channel for both transmission and reception. This means that at any given time, a user can only transmit or receive information. Constraints like "push-to-talk" and "release-to-listen" are fundamental features of half-duplex systems. Full duplex systems, on the other hand, allow simultaneous radio transmission and reception between a subscriber and a base station, by providing two simultaneous but separate channels (Frequency Division Duplex, or FDD)

or adjacent time slots on a single radio channel (Time Division Duplex, or TDD) for communication to and from the user.

In FDD, a pair of simplex channels with a fixed and known frequency separation is used to define a specific radio channel in the system. The channel used to convey traffic to the mobile user from a base station is called the *forward channel,* while the channel used to carry traffic from the mobile user to a base station is called the *reverse channel.* In the U.S. AMPS standard, the reverse channel has a frequency which is exactly 45 MHz lower than that of the forward channel. Full duplex mobile radio systems provide many of the capabilities of the standard telephone, with the added convenience of mobility. Full duplex and half-duplex systems use *transceivers* for radio communication.

In Time Division Duplexing (TDD) uses the fact that it is possible to share a single radio channel in time, so that a portion of the time is used to transmit from the base station to the mobile, and the remaining time is used to transmit from the mobile to the base station. If the data transmission rate in the channel is much greater than the end-user's data rate, it is possible to store information bursts and provide the appearance of full duplex operation to a user, even though there are *not* two simultaneous radio transmissions at any instant. TDD is only possible with digital transmission formats and digital modulation, and is very sensitive to timing. It is for this reason that TDD has only recently been used, and only for indoor or small area wireless applications where the physical coverage distances (and thus the radio propagation time delay) are much smaller than the many kilometers used in conventional cellular telephone systems.

Basic Definitions in Cellular System

Base Station	A fixed station in a mobile radio system used for radio communication with mobile stations. Base stations are located at the center or on the edge of a coverage region and consist of radio channels and transmitter and receiver antennas mounted on a tower.
Control Channel	Radio channel used for transmission of call setup, call request, call initiation, and other beacon or control purposes.
Forward Channel	Radio channel used for transmission of information from the base station to the mobile.
Full Duplex System	Communication systems which allow simultaneous two-way communication. Transmission and reception is typically on two different channels (FDD) although new cordless/PCS systems are using TDD.
Half Duplex Systems	Communication systems which allow two-way communication by using the same radio channel for both transmission and reception. At any given time, the user can only either transmit or receive information.
Handoff	The process of transferring a mobile station from one channel or base station to another.
Mobile Station	A station in the cellular radio service intended for use while in motion at unspecified locations. Mobile stations may be hand-held personal units (portables) or installed in vehicles (mobiles).

Mobile switching Center	Switching center which coordinates the routing of calls in a large service area. In a cellular radio system, the MSC connects the cellular base stations and the mobiles to the PSTN. An MSC is also called a Mobile Telephone Switching Office (MTSO).
Page	A brief message which is broadcast over the entire service area, usually in a simulcast fashion by many base stations at the same time.
Reverse Channel	Radio channel used for transmission of information from the mobile to base station.
Roamer	A mobile station which operates in a service area (market) other than that from which service has been subscribed.
Simplex Systems	Communication systems which provide only one-way communication.
Subscriber	A user who pays subscription charges for using a mobile communications system.
Transceiver	A device capable of simultaneously transmitting and receiving radio signals.

1.3 COMPARISON OF COMMON WIRELESS COMMUNICATION SYSTEMS

Comparison of Mobile Communication Systems—Mobile Station

Service	*Coverage Range*	*Required Infra-Structure*	*Complexity*	*Hardware Cost*	*Carrier Frequency*	*Functionality*
TV Remote Control	Low	Low	Low	Low	Infrared	Transmitter
Garage Door Opener	Low	Low	Low	Low	< 100 MHz	Transmitter
Paging System	High	High	Low	Low	< 1 GHz	Receiver
Cordless Phone	Low	Low	Moderate	Low	< 1 GHz	Transceiver
Cellular Phone	High	High	High	Moderate	< 2 GHz	Transceiver

Comparison of Mobile Communication Systems—Base Station

Service	*Coverage Range*	*Required Infra-Structure*	*Complexity*	*Hardware Cost*	*Carrier Frequency*	*Functionality*
TV Remote Control	Low	Low	Low	Low	Infrared	Receiver
Garage Door Opener	Low	Low	Low	Low	< 100 MHz	Receiver
Paging System	High	High	High	High	< 1 GHz	Transmitter
Cordless Phone	Low	Low	Low	Moderate	< 1 GHz	Transceiver
Cellular Phone	High	High	High	High	< 2 GHz	Transceiver

1.4 TRENDS IN CELLULAR RADIO AND PERSONAL COMMUNICATIONS

Since 1989, there has been enormous activity throughout the world to develop personal wireless systems that combine the network intelligence of today's PSTN with modern digital signal processing and RF technology. The concept, called Personal Communications Services (PCS), originated in the United Kingdom when three companies were given spectrum in the 1800 MHz range to develop Personal Communication Networks (PCN) throughout Great Britain.

PCN was seen by the U.K. as a means of improving its international competitiveness in the wireless field while developing new wireless systems and services for citizens. Presently, field trials are being conducted throughout the world to determine the suitability of various modulation,multiple-access, and networking techniques for future 3G PCN and PCS systems.The terms PCN and PCS are often used interchangeably. PCN refers to a wireless networking concept where any user can make or receive calls, no matter where they are, using a light-weight, personalized communicator. PCS refers to new wireless systems that incorporate more network features and are more personalized than existing cellular radio systems, but which do not embody all of the concepts of an ideal PCN.

Indoor wireless networking products are rapidly emerging and promise to become a major part of the telecommunications infrastructure within the next decade. The European Telecommunications Standard Institute (ETSI) is also developing the 20 Mbps HIPERLAN standard for indoor wireless networks. Breakthrough products such as Motorola's 18 GHz Altair WIN (wireless information network) modem, that was not commercialized, and Avaya's (formerly NCR and Lucent) /ORiNOCO waveLAN computer modem have been available as wireless ethernet connections

since 1990 and are beginning to penetrate the business world. As we enter the 21st century, products are emerging that allow users to link their phone with their computer within an office environment, as well as in a public setting, such as an airport or train station. A worldwide standard, the Future Public Land Mobile Telephone System (FPLMTS)- renamed International Mobile Telecommunication 2000 (IMT-2000) in mid-1995—has been formulated by the International Telecommunications Union (ITU) which is the standards body for the United Nations, with headquarters in Geneva, Switzerland. The technical group TG 8/1 standards task group is within the ITU's Radiocommunications Sector (ITU-R). ITU-R was formerly known as the "Consultative Committee for International Radiocommunications (CCIR)". TG 8/1 is considering how worldwide wireless networks should evolve and how worldwide frequency coordination might be implemented to allow subscriber units to work anywhere in the world. FPLMTS (now IMT-2000) is a third generation universal, multi-function, globally compatible digital mobile radio system that will integrate paging, cordless, and cellular systems, as well as Low Earth Orbit (LEO) satellites, into one universal mobile system. A total of 230 MHz in frequency bands 1885 to 2025 MHz and 2110 to 2200 MHz was targeted by the ITU's 1992 World Administrative Radio Conference (WARC). In March 1999, ITU-R agreed to additional spectrum allocations that include the frequency bands 806 to 960 MHz, 1710 to 2200 MHz, and 2520 to 2670 MHz. This additional spectrum allocation was approved in May 2000 at the ITU World Radio Conference (WRC-2000). The types of modulation, speech coding, and multiple access schemes to be used in IMT-2000 were also locked down by the ITU Radio General Assembly in mid-2000. The selected radio interfaces for terrestrial wireless service include expansions of today's GSM and IS-95 CDMA, as well as a new timecode CDMA standard proposed by China.Worldwide standards are also required for Low Earth Orbit (LEO) satellite communication systems that were developed in the 1990s but which failed commercially at the turn of the century. Due to the very large areas on earth which are illuminated by satellite transmitters, satellitebased cellular systems will never approach the capacities provided by land-based microcellular systems. However, satellite mobile systems were touted as offering tremendous promise for paging, data collection, and emergency communications, as well as for global roaming. In early 1990, the aerospace industry demonstrated the first successful launch of a small satellite on a rocket from a jet aircraft. This launch technique was pioneered by Orbital Sciences Corp. and was more than an order of magnitude less expensive than conventional ground-based launches and allowed rapid deployment, suggesting that a network of LEOs could be rapidly launched for wireless communications around the globe. While several companies, such as Motorola's Iridium, proposed systems and service concepts for worldwide paging, cellular telephone, and emergency navigation and notification in the early 1990s [IEE91], the capital markets have not supported mobile satellite systems in general. In emerging nations, where existing telephone service is almost nonexistent, fixed cellular telephone systems are being installed at a rapid rate. This is due to the fact that developing nations are finding it is quicker and more affordable to install cellular telephone systems for fixed home use, rather than install wires in neighbourhoods which have not yet received telephone connections to the PSTN.

1.4.1 Paging Systems

Paging systems are communication systems that send brief messages to a subscriber. Depending on the type of service, the message may be either a numeric message, an alphanumeric message, or a voice message. Paging systems are typically used to notify a subscriber of the need to call a particular telephone number or travel to a known location to receive further instructions. In modern paging systems, news headlines, stock quotations, and faxes may be sent. A message is sent to a paging subscriber via the paging system access number (usually a toll-free telephone number) with a telephone keypad or modem. The issued message is called a *page*. The paging system then transmits the page throughout the service area using base stations which broadcast the page on a radio carrier.Paging systems vary widely in their complexity and coverage area. While simple paging systems may cover a limited range of 2 to 5 km, or may even be confined to within individual buildings,wide area paging systems can provide worldwide coverage. Though paging receivers are simple and inexpensive, the transmission system required is quite sophisticated. Wide area paging systems consist of a network of telephone lines, many base station transmitters, and large radio towers that simultaneously broadcast a page from each base station (this is called *simulcasting*). Simulcast transmitters may be located within the same service area or in different cities or countries. Paging systems are designed to provide reliable communication to subscribers wherever they are; whether inside a building, driving on a highway, or flying in an airplane. This necessitates large transmitter powers (on the order of kilowatts) and low data rates (a couple of thousand bits per second) for maximum coverage from each base station. Figure 1.1 shows a diagram of a wide area paging system.

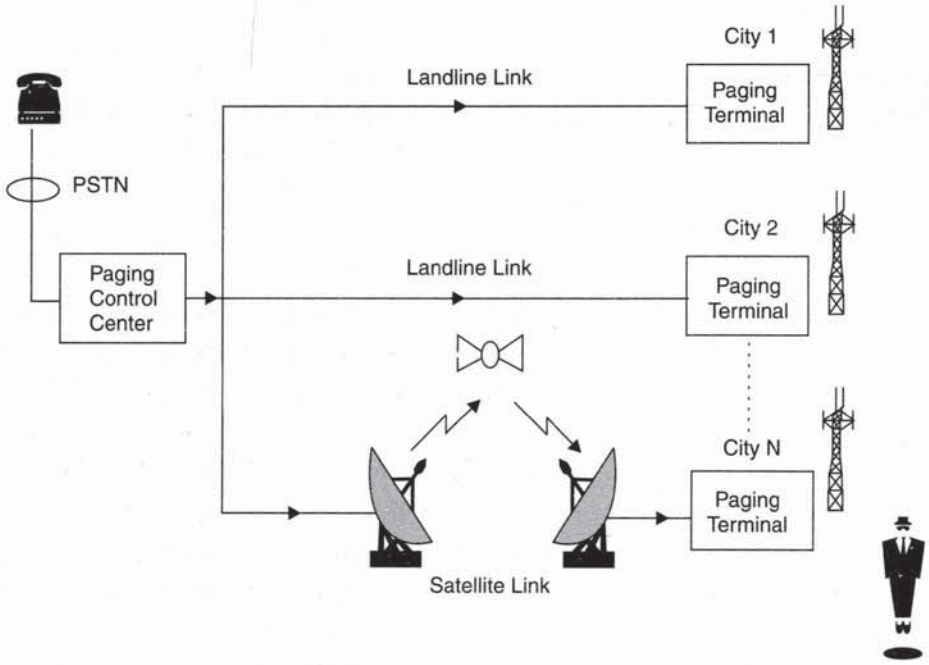
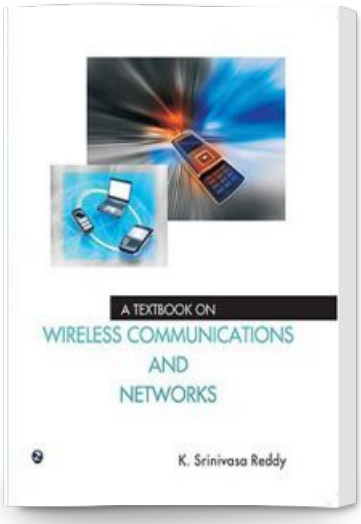


Fig. 1.1. A wide area paging system. The paging control center dispatches pages received from the PSTN throughout several cities at the same time

Wireless Communication



Publisher : Laxmi Publications ISBN : 9789380856582 Author : K. Srinivasa Reddy

Type the URL :https://www.kopykitab.com/product/5944

Get this eBook