

Series editor: S. Merrill Weiss
FOCAL PRESS MEDIA TECHNOLOGY PROFESSIONAL



Second Edition

Implementing Mobile TV

ATSC Mobile DTV, MediaFLO, DVB-H/SH, DMB,
WiMAX, 3G Systems, and Rich Media Applications

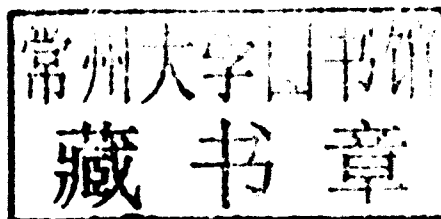
Amitabh Kumar



Implementing Mobile TV

*ATSC Mobile DTV, MediaFLO, DVB-H/SH, DMB,
WiMAX, 3G Systems, and Rich Media Applications*

Amitabh Kumar



ELSEVIER

AMSTERDAM • BOSTON • HEIDELBERG • LONDON
NEW YORK • OXFORD • PARIS • SAN DIEGO
SAN FRANCISCO • SINGAPORE • SYDNEY • TOKYO

Focal Press is an imprint of Elsevier



Focal Press is an imprint of Elsevier
30 Corporate Drive, Suite 400, Burlington, MA 01803, USA
The Boulevard, Langford Lane, Kidlington, Oxford, OX5 1GB, UK

© 2010 Elsevier Inc. All rights reserved.

No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without permission in writing from the publisher. Details on how to seek permission, further information about the Publisher's permissions policies and our arrangements with organizations such as the Copyright Clearance Center and the Copyright Licensing Agency, can be found at our website: www.elsevier.com/permissions.

This book and the individual contributions contained in it are protected under copyright by the Publisher (other than as may be noted herein).

All information presented in this book is based on the best efforts by the author and is believed to be accurate at the time of writing. It should be recognized that Mobile TV is still an emerging technology and many facets of the technology including standards, regulatory treatment, spectrum and applications may undergo changes. The author or the publisher make no warranty of any kind, expressed or implied with regard to the accuracy or completeness of the information contained, documentation or intended uses of any product or service described herein. The author or publisher shall not be liable in any event for incidental or consequential damages in connection with, or arising out of, the furnishing or use of this information in any manner whatsoever.

Notices

Knowledge and best practice in this field are constantly changing. As new research and experience broaden our understanding, changes in research methods, professional practices, or medical treatment may become necessary.

Practitioners and researchers must always rely on their own experience and knowledge in evaluating and using any information, methods, compounds, or experiments described herein. In using such information or methods they should be mindful of their own safety and the safety of others, including parties for whom they have a professional responsibility.

To the fullest extent of the law, neither the Publisher nor the authors, contributors, or editors, assume any liability for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions, or ideas contained in the material herein.

Library of Congress Cataloging-in-Publication Data

Application submitted

British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library.

ISBN: 978-0-240-81287-8

For information on all Focal Press publications
visit our website at www.elsevierdirect.com

10 11 12 13 5 4 3 2 1

Printed in the United States of America

Working together to grow
libraries in developing countries

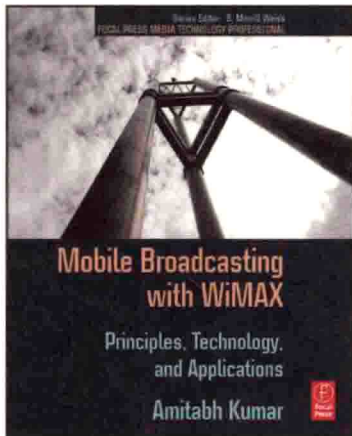
www.elsevier.com | www.bookaid.org | www.sabre.org

ELSEVIER

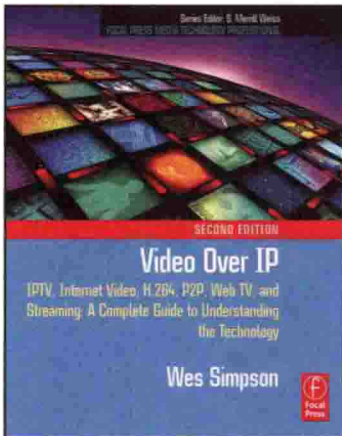
BOOK AID
International

Sabre Foundation

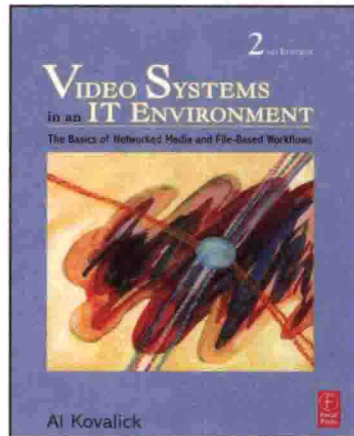
**Recent Focal Press Titles available at
bookstores and www.focalpress.com**



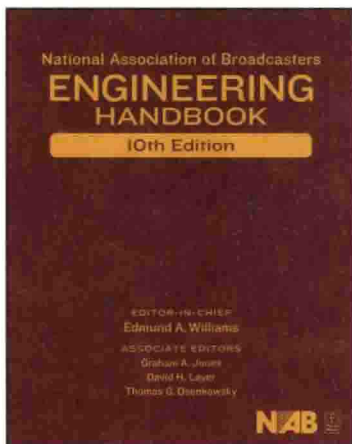
ISBN: 9780240810409



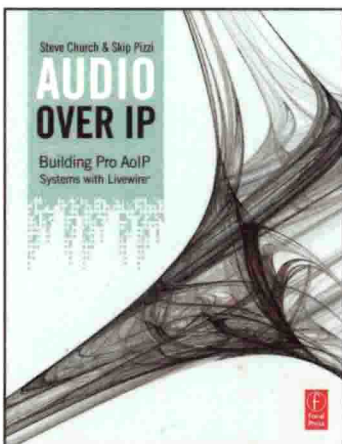
ISBN: 9780240810843



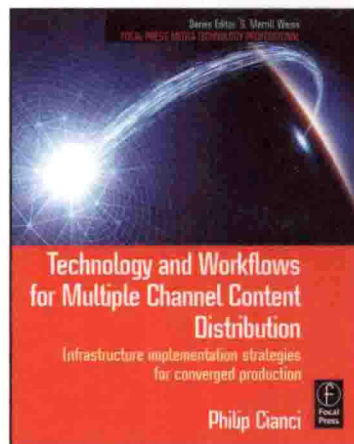
ISBN: 9780240810423



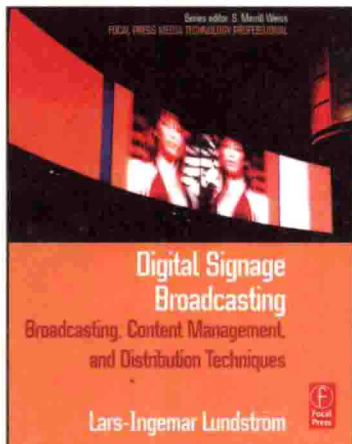
ISBN: 9780240807515



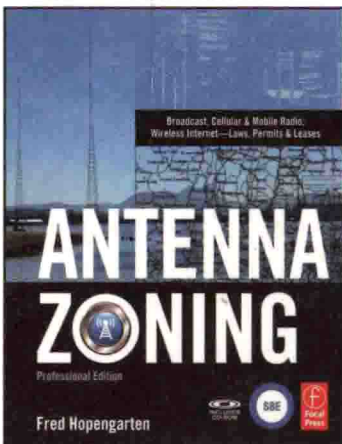
ISBN: 9780240812441



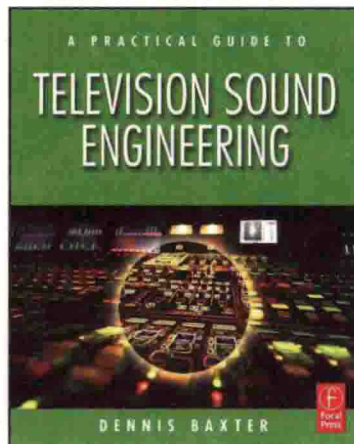
ISBN: 9780240811727



ISBN: 9780240809762



ISBN: 9780240811123



ISBN: 9780240807232

Implementing Mobile TV

This book is dedicated to my father.

I hope that posterity will judge me kindly, not only as to the things which I have explained, but also as to those which I have intentionally omitted so as to leave to others the pleasure of discovery.

René Descartes, La Geometrie (1637)

Mobile TV-A Prologue

The economists are generally right in their predictions, but generally a good deal out in their dates.

Sidney Webb, The Observer, Sayings of the Week, February 25, 1924

When mobile TV was first launched in 2005, it was perceived as one of the most important happenings that would shape the mobile industry in the coming years. But events were to prove otherwise to the disappointment, and to an extent, the surprise of a very large industry. In fact the situation in 2008 was such that many virtually wrote off mobile TV. It was only in 2009 that a dramatic turnaround in fortunes began, with mobile TV in 2010 set to reach a critical mass for a very large ecosystem of viewers, operators, handset and chip manufacturers and software developers.

The reasons in hindsight are not difficult to understand, and it is also not that the industry did not valiantly struggle to overcome these. The problem is that there were too many issues. First was the issue of mobile operators and broadcasters going different ways in leveraging their own networks to provide mobile TV. This led to the use of 3G unicast streaming by mobile operators and terrestrial transmission by the broadcasters based on replication of TV programs with little or no interactivity and a handful of receivers available that could actually receive them. Second was the use and multiple standards that split networks even within the same country, as was the case in Germany with DVB-H and DMB networks, both of which eventually closed down. In addition, the regulators were not helpful with spectrum issues, which held up launches in large parts of Europe and Asia. Third, the operators did not seem to get the model right. They attempted to offer the service as pay TV, which restricted the market and the handsets available. This is evident from the success of free to air DMB-T services in Korea and ISDB-T in Japan. Korea had over 20 million users of its free ISDB-T service, while Japan had over 60 million phones sold that had tuners for its 1-Seg ISDB-T services, which are aired free. A majority of multimedia handsets in these markets now come with the mobile TV tuners and decoders built in. In contrast, the users of pay mobile TV in any market did not reach even a fraction of this number. The only exception was the 3G-based services such as MobiTV (over 6 million customers), which do not need special handsets. However, even these networks did not make a breakthrough, as operators in most markets levied high data usage charges for a bandwidth, which was at a premium.

The 3G quality was also restricted for various reasons, such as low encoding resolution, usage environment and limitations of unicast streaming.

It was not a surprise that the initial years left bruised operators and foreclosed networks even while the major product vendors touted successful trials in each country. In the United States, for the broadcast systems based on ATSC DTV, there was no mobile extension until as late as 2009. The initial launches of DVB-H by Modeo and Hi-Wire were closed down, as it was impractical to build entirely new infrastructure. MediaFLO, which operated on its own spectrum and provided services through AT&T and Verizon Wireless, also garnered less than half a million users in the first year of its launch due to the requirement of a separate FLO-enabled handset and the availability of the service in limited markets only. The situation changed only in 2009 when additional spectrum became available after the digital transition. The success story of AT&T was being written with the iPhone, a device that did not support mobile TV. Mobile TV was not a priority with the major operators: AT&T, Verizon Wireless, or T-Mobile.

In Europe, the European Union (EU) took the bold step of declaring DVB-H as the standard to be followed across Europe. Despite this apparent advantage, mobile TV continued to face heavy challenges. DVB-H met the same fate in Germany as in the United States, where Operator '3' returned the DVB-H license to the regulator. In the United Kingdom, no spectrum was made available for DVB-H, while in France and Spain, commercial launches were delayed. With the exception of Italy, the pioneer of mobile TV in Europe, no country could get even a million users, with their pay mobile TV offerings requiring special handsets and conditional access systems. The users could opt for either a substandard phone that offered mobile TV or one that burnt a hole in their pockets. Phones in use by large segments of the customers stayed out of the domain, which was addressed by the mobile operators. The model of set-top boxes as applied to mobile TV was not working.

Asia, China, and India were delayed in their regulatory processes, which would have enabled the provision of mobile TV to large communities. Smaller countries did launch mobile TV, but these were prodded by the vendors and looked more like "me-too" efforts rather than a successful mobile TV offering. China came out of the time warp only in 2009, with the SARFT driving terrestrial mobile TV with CM-MB standard.

In order to address the split markets, new operators ventured forth with satellite-based mobile TV. In 2008, it appeared to be a panacea for all the ills of mobile TV. China, going into the 2008 Olympics, had signed a deal with CMBsat, a subsidiary of EchoStar for a high powered S-band satellite providing services over China. However, its regulators failed to give the necessary permissions for the satellite to be placed in orbit. On April 18, 2008, the ICO G1 satellite was launched and all set to provide mobile TV services for the U.S. market. In January 2009, the W2A satellite was launched for providing high-powered DVB-SH mobile TV services for Europe by Solaris after it won the license. However, all was to go

wrong with this industry as early as 2009. The CBMsat satellite was delayed, while the W2A mobile broadcasting payload failed after its launch in early 2009. By May 2009, ICO North America had filed for bankruptcy under Chapter 11, despite having an operational satellite in orbit and an operational network on the ground. The successes of Japan and Korea again appeared to be not working elsewhere.

The quest for business models was unending. Any single model, such as subscription, advertising, or sponsored content did not seem to work, as there were too few handsets except in Korea and Japan. Mobile networks did embrace multimedia, but in ways that were not predicted by analysts and research reporters. Mobile devices came with such large memories (upwards of 16 GB) that a connection to online music services was unnecessary. On-device storage of videos and music became the norm. Where video was concerned, it was YouTube and Google Video that emerged as the winners, apart from social networking sites.

But in an industry with more than 4 billion mobile users, the initial fallacies in embarking on mobile TV were quickly understood. ATSC has now come out with its mobile handheld standard, ATSC Mobile DTV (formerly ATSC M/H), which can enable thousand of transmitters across the United States at a relatively low cost to also broadcast simultaneously to mobile phones. Despite apparently different mobile TV standards, the underlying technologies have converged to a set of uniform standards, such as IP-Datacasting (IPDC), the Open Mobile Alliance's Electronic Service Guide (ESG), smartcard profiles (SCP) for content protection, and multistandard universal chipsets that can tune in to any type of transmission.

After a dawn-to-dusk cycle, the sun is again rising on the horizon for mobile TV—and with a renewed intensity. The use of video content on mobile phones is entering a new phase, with customers increasingly wanting video access on their mobile phones. The number of 3G users has ballooned, as have the smartphones needed for multimedia. Equipment vendors now make multistandard transmission equipment as well as receivers, making the diverse standards not such a major issue at the end of the day. Spectrum has begun to be available after WRC 07 and the digital transition in which was completed in 2009. The launch of CMMB in China has led to a massive uptake of mobile TV. According to an In-Stat report on China¹ released in 2006, the number of mobile TV users in China was predicted to grow at a compound annual growth rate of over 315% in the next five years. It is now estimated that by 2012, more than 20% of users will be using mobile TV. The scales will be tilted by the increasing use of free-to-air broadcast networks, including ATSC Mobile DTV in the United States, and the spread of mobile TV to user communities in China and India.

There are likely to be four major streams for the growth of mobile TV. The first will continue to be the mobile operators, where improved quality will be offered through the upgrades to

¹ **Mobile TV in China**, Anty Zheng – Research Director, **In-Stat China** (<http://www.instat.com.cn/index.php/archives/672>)

3GPP standards and the use of MBMS. These operators will also embrace LTE by 2012. The second stream remains that of broadcasters, which are scaling up the operations as spectrum and standards issues get resolved. The third stream is that of wireless broadband (including mobile WiMAX, a technology that has weathered many a storm and is now here to stay, with more than 500,000 users being added per quarter) and broadband for all plans on the horizon in the United States. The fourth category of providers is that of satellite-based mobile TV providers with a terrestrial component.

This book is a second journey into the exciting world of mobile TV and multimedia, with new operators, technologies, and business models.

Introduction to the Second Edition

The trouble with doing something right the first time is that nobody appreciates how difficult it was.

Walt West

This book is exclusively dedicated to mobile TV, which is the killer application of the twenty-first century, riding on the success of 3G mobile networks, transition to digital TV, and wireless broadband. A lot has changed since mobile TV initially appeared in 2005. 3G networks have achieved a critical mass of over 500 million users. There have been breakthroughs in terrestrial broadcasting of mobile TV across countries, addressing potentially a billion additional users in 2010 alone. It today presents an opportunity that is unparalleled in history. This is an opportunity for service providers, content producers, application developers, handset vendors, and users alike to target high revenue generating applications. This revised edition is about the new opportunity. It provides a comprehensive overview of the entire landscape, answers all your questions, and provides all the tools you need to be a meaningful player in the new markets.

About This Book

Even though mobile TV is slated to grow exponentially in the very near future, concise information on the subject continues to remain scattered. It is true that many of the technologies have recently emerged from the trials, but the basic bedrock of the structure on which such services will be based is now firmly in place. No single week passes by today when a new commercial launch of mobile TV somewhere in the world is not announced. The standards for the services have the status of recommendations of ATSC, DVB, ETSI, ITU, and 3G Partnership projects. The implementation is swift and multifronted—in the form of technology itself as well as every other form: handsets, applications, chipsets, software, operating systems, spectrum, transmission technologies, and even content writing for mobile TV.

The book provides a comprehensive introduction to the technological framework in which such services are being provided, with extensive clarity on how one type of service, for example, a mobile TV service based on 3G (MobiTV™, AT&T®) differs from DMB service in Korea or CMMB in China or ISDB-T in Japan. Will it be possible to use one handset for

all these services? What types of services can be expected on mobile networks? What are the techniques used for digital rights management on these networks? What spectrum will they use? What limitations do they have? What quality of viewing can they offer? What type of content will make such networks work and how will it make money?

Mobile multimedia has brought about a profound change in the industry. The handsets are now designed to deliver multimedia rather than voice. They support large, 3-inch WVGA screens, stereo speakers, A2DP Bluetooth, media players, and 16 GB flash memories. Their software is empowered to deliver content tailored for cellphones or mobiles with rich animations. It is a different world, carrying with it smaller screens, and requiring lower data rates to carry the information, but in a much more challenging delivery environment. It deals with media formats that are unique to the mobile domain. It deals with players that are for mobiles and with browsers that are unique to the mobile world. It also deals with technologies that not only deliver content but also provide mechanisms for its payment and user interactivity.

The growth of mobile TV brings challenges for everyone. The users now have a very powerful device in their hands that can do much more than connect calls or play music. Are they ready to use such services? The operators are aggressively launching services. Are the content providers ready for them? Is the content secure? What type of advertising will work on such networks? What are the technology options for operators and service providers and customers? Are the regulatory authorities ready to enable the environment for mobile TV? What spectrum will be available for such services? What are the limitations for services based on each individual technology? The book addresses all these questions.

About the Second Edition

The technology and markets for mobile TV have changed dramatically in the very recent past. In July 2009, the ATSC Mobile DTV transmitters went on the air, signifying a new era in the United States, where most local stations will have a mobile simulcast based on the newly recognized ATSC Mobile DTV standards. CMMB, a mobile TV standard for China, has spread to about 200 cities by end of 2009, and 3G is now enabled in China and India. MediFLO technology has had a new lease on life with additional spectrum having been released in the United States with DTV transition and its recognition as an approved technology for mobile TV in Japan, the largest mobile TV market in the world, and a bastion of ISDB technologies. This revised second edition is a completely rewritten volume that updates technologies, services and media formats and presents all information in a practical framework. Four new chapters have been added on ATSC Mobile DTV, MediaFLO technologies, WiMAX, and DVB-SH, while information on others such as CMMB has also been added in detail.

The book is divided into four parts:

Part I: Overview of Technologies

Part II: Technologies for Mobile TV and Multimedia Broadcasting

Part III: Multimedia Handsets and Related Technologies

Part IV: Content and Services on Mobile TV and Multimedia Networks

Part I begins by laying down the fundamentals that go into the mobile multimedia networks, such as those that deliver mobile TV. Though digital multimedia is discussed in brief, the key focus is on mobile multimedia. Part I also gives an overview of Mobile Networks worldwide as well as an overview of technologies for mobile TV.

The need to carry mobile TV and rich media applications has led to 3G networks evolving rapidly in order to add higher data carrying capabilities with HSDPA, EV-DO, and LTE. This book seeks to piece together the technologies of video, audio, data, and networks that make mobile TV possible and presents an integrated view of the interfaces, services, and applications that will frontline the developments of mobile TV in the coming years. These are discussed in two chapters on “Overview of mobile networks”(Chapter 4) and “Overview of technologies for mobile TV”(Chapter 5).

In Part II, the book discusses each of the mobile TV technologies, including those based on 3G, ATSC Mobile DTV, MediaFLO, DMB and CMMB, DVB-H, and WiMAX in detail, with one chapter devoted to each service. The technology-specific chapters dwell on all aspects of the services ranging from standards, protocols, transmission, ESG, broadcast characteristics, and examples of networks where these are implemented. The rollout of mobile TV is also closely linked to the availability of spectrum as a resource. One chapter (Chapter 13) is devoted to spectrum for mobile TV services and the manner of rollout in various countries. This chapter presents the information in a holistic manner, including the impacts of digital dividend post-digital transition and WRC 07 harmonized allocations.

Interoperability issues between networks and roaming have proved to be very important in the past, and will be more so in the future. Interoperability for mobile TV and multimedia networks is discussed in a separate chapter (Chapter 17).

Mobile TV has spawned many new industries and fast-paced developments are happening in operating systems for mobile devices, application software, chipsets, and the handsets themselves. The industry is aware that the past growth has been possible due to increasing volumes and continuously lowering prices. The revenues that can be derived from the networks will depend on understanding the optimum multimedia formats and delivery modes, smartphones, feature phones available in the market, and how they can be addressed. The new handsets and user devices present in all cases frontline developments in each area of technology ranging from satellite or terrestrial tuners to multimode devices such as portable navigation devices or personal media players. Part III of the book is exclusively dedicated to presenting the new devices and what drives them. We discuss the chipsets, operating systems, and handsets for multimedia in Chapters 14, 15, and 16.

Finally, Part IV of the book, devoted to content, presents a series of interlinked chapters on content types that can be delivered along with their preparation tools, user interactivity, and content security. Although mobile TV will undoubtedly have its share of live TV channels, a host of new content best suited for viewing on the small screens is already appearing and will be the key to the usage and growth of mobile TV services. Mobile environment needs content specifically designed that can be compelling to watch. The content for mobile TV, already a specialized business, will be more so in the coming years. Along with the content, the delivery platforms for such content are equally important. This book discusses the emerging trends and prerequisites in this regard. Mobile networks have emerged as important vehicles for delivery of content. However, such delivery of content needs to be secure and the license holders need to be able to exercise rights on how the content is used. Content security technologies common across the industry such as OMA BCAS and smartcard profiles are discussed.

Intended Audience

The book is primarily intended to give a coherent view of the world of mobile TV and multimedia applications on mobile networks. It offers an insight into the maze of technologies, processes, and dimensions involved in providing the mobile TV services. The book—while technical—does not contain any formulae or mathematical calculations that go into the design of networks. It has been planned in a manner to benefit all those in the mobile industry, such as professionals, engineers, and managers, as well as students and the academic community. The mobile industry directly or indirectly comes into contact with every individual, and extensive work is being done to further the capabilities of the networks. The book is intended to help all those who are in any manner connected with mobile networks and multimedia, as they need to get a complete picture on what is happening in the field and how they can be a part of the momentum. It helps users, content providers, and operators, as well as those who are planning such services understand the dimensions of the new medium, which is the best possible integration of communication, broadcasting, and multimedia technologies. The understanding of the basic technologies and all related developments in the field prepare the ground for an easy introduction to the complex world of mobile TV, which will be essential for success in the coming years.

How to Read This Book

Any of the four parts of the book can be read independently, with the other parts being used for a reference to the technologies or networks in use. However, as mobile TV and multimedia networks are characterized by their own file formats, encoding technologies, and content delivery mechanisms, it is useful to read through the book in sequence if time permits. Readers will find some repetition in the content in some chapters, which was

necessary to present the matter in a self-contained format without excessive referrals to other sections or chapters.

Acknowledgments

The information in a book of this nature is based on the work of numerous standards bodies, industry organizations, and operators who have deployed the technology in their networks. These include the OMA, DVB, ATSC, ETSI, ITU, 3GPP, CDG, GSMA, and many others.

I would like to thank Paul Temme, Senior Acquisitions Editor at Focal Press, who not only encouraged me to write this extensively revised edition but also provided valuable suggestions. I would also like to thank Anais Wheeler, who managed the production of the book in the most friendly and efficient manner.

Finally, I would also like to thank the many readers who provided valuable input after the first edition, which makes the second much more practical and aligned to readers as well as the industry.

Amitabh Kumar

kumar.amitabh@gmail.com

Contents

The most merciful thing in the world, I think, is the inability of the human mind to correlate all its contents.

H. P. Lovecraft, The Call of Cthulu (1926)

Mobile TV-A Prologue.....	xv
Introduction to the Second Edition	xix
Part I Overview of Technologies	1
Chapter 1: About Mobile TV	1
1.1 The Beginning	2
1.2 Mobile TV: A New Reality	3
1.3 What Else is Different in Mobile TV?.....	4
1.4 Standards for Mobile TV	5
1.5 New Growth Areas with Mobile TV	7
1.6 What Type of Opportunity Does Mobile TV Present?	7
1.7 What Handset Types Does Mobile TV Work On?	8
1.8 Is Mobile TV Really Important?.....	8
Chapter 2: Introduction to Digital Multimedia	9
2.1 Introduction	9
2.2 Picture	10
2.3 Image Compression	16
2.4 Video.....	18
2.5 Analog TV Signal Formats	21
2.6 Digital TV Formats.....	23
2.7 Video Bit Rate Reduction	25
2.8 Compression Standards	31
2.9 The AVS – M Video Coding Standard (China)	39
2.10 Video Files	40

2.11 File Containers and Wrappers	44
2.12 Audio Coding	46
2.13 Audio Compression	48
2.14 Streaming.....	54
2.15 Streaming Players and Servers	57
2.16 Summary and File Formats.....	60
Chapter 3: Introduction to Streaming and Mobile Multimedia.....	63
3.1 What is Mobile Multimedia?.....	63
3.2 How Do Mobile Devices Access Multimedia?.....	67
3.3 File Formats for Mobile Multimedia	68
3.4 3GPP Mobile Media Formats	72
3.5 Internet Video	81
3.6 Flash Lite™	83
3.7 DivX Mobile.....	84
3.8 Rich Media–Synchronized Multimedia Integration Language (SMIL)	87
3.9 Delivering Multimedia Content.....	90
3.10 Graphics and Animations in the Mobile Environment	96
3.11 Mobile Multimedia Applications.....	98
3.12 Summary of File Formats Used in Mobile Multimedia.....	103
Chapter 4: Overview of Cellular Mobile Networks.....	105
4.1 Introduction	105
4.2 Cellular Mobile Services: A Brief History	106
4.3 CDMA Technologies	109
4.4 3G Networks.....	111
4.5 3G Technologies: CDMA and GSM.....	114
4.6 4G Technologies	118
4.7 Data and Multimedia Over Mobile Networks	119
4.8 Multimedia and Data Over 3G Networks	122
4.9 Mobile Networks: A Few Country-Specific Examples	128
Chapter 5: Overview of Technologies for Mobile TV	137
5.1 Why New Technologies for Mobile TV?	137
5.2 What Does a Mobile TV Service Require?	139
5.3 Mobile TV Using 3G Technologies.....	148
5.4 Terrestrial TV Technology Overview	154
5.5 Mobile TV Using Terrestrial Broadcasting Networks.....	163
5.6 Comparison of Mobile TV Services.....	175
5.7 Outlook for Mobile TV Services	178