Media Networks

Architectures, Applications, and Standards

Edited by
Hassnaa Moustafa and Sherali Zeadally

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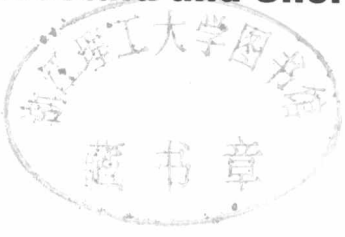

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Preface

Recent advances in networking technologies, personal, entertainment and home equipment, and multimedia services have dramatically changed users' consumption models for multimedia and audiovisual services creating a new category of users known as prosumers (producers–consumers). Consequently, media networks is an emerging subject that currently attracts the attention of research and industrial communities due to the expected large number of services and applications in the short-term accompanied by a strong change in users' consumption model and style.

Media Networks: Architectures, Applications, and Standards studies media networks with special attention devoted to video and audiovisual services and aims to be a comprehensive and essential reference on media networks and audiovisual domain, to fill a gap in the market on media networks, and to serve as a useful reference for researchers, engineers, students, and educators. Industrial audiences are also expected to be up-to-date with the current standardization activities in this domain, the deployment architectures, network technologies, technical challenges, users' experience, and killer applications.

This book helps in learning the media network, which is an emerging type of network, and in acquiring a deep knowledge of this network and its technical and deployment challenges through covering media networks basics and principles, a broad range of architectures, protocols, standards, advanced audiovisual and multimedia services, and future directions.

The book is divided into three parts: Part I focuses on digital TV in Chapters 1 through 6; Part II covers media content delivery and quality of experience (QoE) in Chapters 7 through 14; and Part III gives special attention to user-centricity and immersive technologies that take into account advanced services personalization, immersive technologies architectures and applications, e-health, and societal challenges in Chapters 15 through 23.

This book has the following salient features:

- Provides a comprehensive wide-scale reference on media networks and audiovisual domain

- Covers basics, techniques, advanced topics, standard specifications, and future directions
- Contains illustrative figures enabling easy reading

We owe our deepest gratitude to all the chapter authors for their valuable contribution to this book and their great efforts. All of them were extremely professional and cooperative. We express our thanks to Auerbach Publications (Taylor & Francis Group) and especially Richard O'Hanley for soliciting the ideas in this book and working with us for its publication, and Jennifer Ahringer for her huge efforts in the production process. Last but not least, a special thank you to our families and friends for their constant encouragement, patience, and understanding throughout this project.

The book serves as a comprehensive and essential reference on media networks and is intended as a textbook to teach this emerging type of network, or to help readers acquire a deep knowledge of these networks and the technical and deployment challenges that must be overcome to enable us to carry out and continue research in this area.

We welcome and appreciate your feedback and hope you enjoy reading the book.

Hassnaa Moustafa
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Editors

Hassnaa Moustafa has been a senior research engineer at France Telecom R&D (Orange Labs), Issy Les Moulineaux (France) since January 2005. She obtained her tenure in computer science (HDR) in June 2010 from the University of Paris XI, her PhD in computer and networks from Telecom ParisTech in December 2004 and her master's in distributed systems in September 2001 from the University of Paris XI. Her research interests include mobile networks, basically *ad hoc* networks and vehicular networks. Routing, security, authentication and access control are the main areas of her research interests in these types of networks. Moreover, she is interested in NGN, IPTV, services' convergence and personalization.

Dr. Moustafa is a regular member of the IETF and a member of the IEEE and IEEE ComSoc. She manages a number of research projects at France Telecom and has many publications in a number of international conferences including *ICC*, *Globecom*, *PIMRC*, *VTC*, *Mobicom*, among others, and in a wide number of international journals. Dr. Moustafa edited books and coauthored a wide range of book chapters with CRC Press. She has also served as chairperson and co-chairperson at several international conferences and workshops and has coedited several journal special issues. In addition, she served as a TPC member for a wide number of international conferences and workshops including *IEEE ICC*, *IEEE Globecom*, and several *ACM* conferences, and served as a peer reviewer for several international journals including *IEEE Transactions on Wireless Communications*, *IEEE Transactions on Parallel and Distributed Systems*, *IEEE Transactions on Mobile Computing*, *IEEE Transactions on Broadcasting*, *Wiley Wireless Communications and Mobile Computing Journal*, *Springer Telecommunication Systems Journal*, *Springer Annals of Telecommunications*, *Elsevier Computer Networks*, and *IEEE ComSoc.*

Sherali Zeadally received a bachelor's degree in computer science from the University of Cambridge, England, and a doctorate in computer science from the University of Buckingham, England, in 1996. He is currently an associate professor in the Department of Computer Science and Information Technology at the University of the District of Columbia, Washington, DC, and serves on the editorial boards of over 18 peer-reviewed international journals. He has served as a guest

editor for over 20 special issues of various peer-reviewed scholarly journals, and as a technical program committee member for more than 180 refereed conferences/symposia/workshops. He is a fellow of the British Computer Society and a fellow of the Institution of Engineering Technology, UK.

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Introduction

Recent advances in networking technologies, personal, entertainment, home equipments, and multimedia services have dramatically changed users' consumption models for multimedia and audiovisual services creating a new category of users known as prosumers (producers–consumers). Users are now empowered with low-cost technologies that enable them to create and contribute a whole range of different media types and applications and making them available through various ways such as UGC (User Generated Contents) on YouTube or Dailymotion. On the other hand, the users' consumption model for video and audiovisual services has changed; consumption of video services during mobility and through different kinds of portable devices (such as tablet devices) is a drastic increase. 3D content is also of great interest, and users' content sharing is becoming increasingly popular. Entertainment and social services are experiencing an unprecedented growth while interactivity and personalization of services are also achieving a great success. All these dramatic changes in technologies, user behaviors, and expectations are making network operators, equipment manufacturers and service and content providers work hard to cope with this evolutional trend in the media domain and to change their traditional business models to adapt to this evolution and handle the emergence of multiple actors. In addition, over-the-top (OTT) players are continuously introducing new actors who provide new multimedia and audiovisual services through numerous innovative applications that are accessible through the Internet (including peer-to-peer applications).

Consequently, media networks are an emerging area that is currently attracting the attention of research and industrial communities because of the expected rapid growth of a large number of services and applications accompanied by strong changes in users' consumption model, habits, and lifestyle.

This book, *Media Networks: Architectures, Applications, and Standards*, explores media networks focusing on video and audiovisual services. Our goal is to present a comprehensive and essential reference on media networks and the audiovisual domain, to fill a gap in the market on media networks, and to serve as a useful reference for researchers, engineers, students, and educators. Industrial audiences are also expected to be up-to-date with the current standardization activities on this

domain, the deployment architectures, network technologies, technical challenges, users' experience, and killer applications.

The book will help newcomers to the area of media networks, which are an emerging type of network, to acquire a deep knowledge of these networks and their technical and deployment challenges. The book covers a range of topics related to media networks including fundamental definitions, basics and principles, a broad range of architectures, protocols, standards, advanced audiovisual and multimedia services, and future directions.

The book is broadly divided into three parts: Part I focuses on Digital TV in Chapters 1 through 6. Then, Part II covers media content delivery and Quality of Experience (QoE) in Chapters 7 through 14. Finally, Part III gives special attention to User-Centricity and Immersive Technologies that take into account Advanced Services Personalization, Immersive Technologies Architectures and Applications, E-Health, and societal challenges in Chapters 15 through 23.

In Part I of the book, Chapter 1 presents Digital TV technologies along with their deployment architectures as well as the role of the major contributors (such as network operators, service providers, content providers, and manufacturers) and the future trends. Chapter 2 gives an overview on Open IPTV general concept, services, architectures, content delivery, market aspects, and business models. Chapter 3 presents an overview of Mobile TV along with recent Mobile TV standards that have been recently deployed, identifying some of the technological and deployment challenges that need to be addressed to achieve cost-effective service distribution together with business models for Mobile TV. Chapter 4 is about connected TV. It presents an overview of connected TV technology, various past efforts made in the past in the connected devices area and gives an overview on some of the related standardization efforts. Chapter 5 presents an overview on 3D video. This chapter identifies some of the requirements that must be met to enable 3DTV services over an end-to-end delivery chain. It describes related standardization efforts and identifies subsequent challenges to introduce new 3D video services with enhanced 3D quality of experience. Chapter 6 describes standardization activities on digital TV including IPTV, Mobile TV, and Content Delivery Networks (CDNs).

In Part II of the book, Chapter 7 introduces the Future Internet discussing Future Internet Media applications, demonstrating the new vision of collaboration between Internet services and underlying networks. Chapters 8 and 9 cover Information-Centric Networks (ICN) focusing on ICN solution approaches highlighting the major challenges that need to be considered to enable ICN-related applications (such as Web, VoIP), technical aspects (such as Naming and Addressing, Routing, Security, Resources Management, and Content Caching) and related standardization efforts. Chapters 10 and 11 focus on CDN introducing the recent changes in the Internet eco-systems that have led to an increased interest in CDNs. They present CDNs architectures that are being deployed while considering the different technical challenges and standardization efforts related to CDN issues, and also present an overview on CDN actors and market

trends in this area. User satisfaction and experience are becoming increasingly important factors for many consumer-related businesses and media networks and services are no exception. To evaluate customer satisfaction and user experience, QoE is being used as a metric. Chapters 12 through 14 focus on QoE in Future Media Networks. These chapters describe QoE-related topics which include different transport protocols, compression technologies, users' consumption trends, QoE evaluation methods, QoE introduction in CDN architectures, and QoE considerations in 3D media delivery systems.

In Part III of the book, Chapter 15 focuses on perceived QoE in user-centric multimedia applications. Chapter 16 identifies the deficiencies in current delivery mechanisms for immersive 3D media and presents solutions based on content-aware processing, coding, and adaptation techniques. Chapters 17 and 18 focus on services personalization presenting an overview on IPTV services personalization and the context-awareness principle used in services personalization. Chapters 19 and 20 consider metadata exploitation and semantically linked media for user-centric services in Future Media networks, respectively. Chapter 21 gives an overview on Telepresence systems. This chapter presents features differentiating them from conventional videoconferencing systems and describes technical constraints and requirements of Telepresence systems in addition to providing a review of ongoing standardization efforts. Chapter 22 discusses the current trends in Media Networks aimed at improving the effectiveness of healthcare particularly the technological aspects that aim to encourage and engage users in their own rehabilitation in community and home settings. Finally, Chapter 23 concludes the book by describing some of the societal challenges for Networked Media.

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