

Wiley Series on Parallel and Distributed Computing

Albert Y. Zomaya, Series Editor

Advanced Content Delivery, Streaming, and Cloud Services

Edited By

Mukaddim Pathan

Ramesh K. Sitaraman

Dom Robinson



WILEY

Table of Contents

[Cover](#)

[Series](#)

[Title Page](#)

[Copyright](#)

[Dedication](#)

[Preface](#)

[1.1 Overview and Scope of the Book](#)

[1.2 Organization of the Book](#)

[Acknowledgments](#)

[Contributors](#)

[Part I: CDN and Media Streaming Basics](#)

[Chapter 1: Cloud-Based Content Delivery and Streaming](#)

[1.1 Introduction](#)

[1.2 CDN Overview](#)

[1.3 Workings of a CDN](#)

[1.4 CDN Trends](#)

[1.5 Research Issues](#)

[1.6 Conclusion](#)

[References](#)

[Chapter 2: Live Streaming Ecosystems](#)

[2.1 Introduction](#)

[2.2 Live Streaming Pre-Evolution](#)

[2.3 Live, Linear, Nonlinear](#)

[2.4 Media Streaming](#)

[2.5 Related Network Models](#)

[2.6 Streaming Protocol Success](#)

[2.7 Platform Divergence and Codec Convergence](#)

[2.8 Adaptive Bitrate \(ABR\) Streaming](#)

[2.9 Internet Radio and HTTP](#)

[2.10 Conclusion](#)

[References](#)

[Chapter 3: Practical Systems for Live Streaming](#)

[3.1 Introduction](#)

[3.2 Common Concepts in Live Streaming](#)

[3.3 The Practicals](#)

[3.4 Conclusion](#)

[References](#)

[Chapter 4: Efficiency of Caching and Content Delivery in Broadband Access Networks](#)

[4.1 Introduction](#)

[4.2 Options and Properties for Web Caching](#)

[4.3 Zipf Laws for Requests to Popular Content](#)

[4.4 Efficiency and Performance Modeling for Caches](#)

[4.5 Effect of Replacement Strategies on Cache Hit Rates](#)

[4.6 Replacement Methods Based on Request Statistics](#)

[4.7 Global CDN And P2P Overlays for Content Delivery](#)

[4.8 Summary and Conclusion](#)

[Acknowledgments](#)

[References](#)

[Chapter 5: Anycast Request Routing for Content Delivery Networks](#)

[5.1 Introduction](#)

[5.2 CDN Request Routing: An Overview](#)

[5.3 A Practical Load-Aware IP Anycast CDN](#)

[5.4 Mapping Algorithms](#)

[5.5 Evaluation](#)

[5.6 IPv6 Anycast CDN](#)

[5.7 Discussion and Open Questions](#)

[5.8 Conclusion](#)

[References](#)

[Chapter 6: Cloud-Based Content Delivery to Home Ecosystems](#)

[6.1 Introduction](#)

[6.2 Bringing Cloud Services to Home: State of The Art](#)

[6.3 Virtualizing The Access Network Infrastructure](#)

[6.4 Virtualization for Cloud Service Delivery to Home](#)

[6.5 Future Trends](#)

[6.6 Summary and Conclusion](#)

[Acknowledgments](#)

[References](#)

[Chapter 7: Mobile Video Streaming](#)

[7.1 Introduction](#)

[7.2 Mobile Broadband Architecture](#)

[7.3 Video Streaming Protocols](#)

[7.4 Video Optimization Services](#)

[7.5 Operator-Hosted Cdn](#)

[7.6 Cloud-Based Video Streaming](#)

[7.7 Future Research Directions](#)

[Acknowledgments](#)

[References](#)

[Part II: CDN Performance Management and Optimization](#)

[Chapter 8: CDN Analytics: A Primer](#)

[8.1 Introduction](#)

[8.2 Why Measure?](#)

[8.3 What Do We Measure?](#)

[8.4 What About Business Intelligence?](#)

[8.5 Measuring Stateless Delivery](#)

[8.6 Billing Analytics](#)

[8.7 CDN Analytics Tools](#)

[8.8 Recent Trends in CDN Analytics](#)

[8.9 Conclusion](#)

[References](#)

[Chapter 9: CDN Modeling](#)

[9.1 Introduction](#)

[9.2 Basics on Mathematical Modeling and Optimization](#)

[9.3 Video-on-Demand Applications](#)

[9.4 Optimization Problems in Content Delivery and VoD Services](#)

[9.5 Visionary Thoughts for Practitioners](#)

[9.6 Future Research Directions](#)

[9.7 Conclusions](#)

[Acknowledgments](#)

[References](#)

[Chapter 10: Analyzing Content Delivery Networks](#)

[10.1 Introduction](#)

[10.2 Previous Work](#)

[10.3 Basic CDN Model](#)

[10.4 Enhancing The Model](#)

[10.5 Performance Evaluation](#)

[10.6 Conclusions](#)

[References](#)

[Chapter 11: Multisource Stream Aggregation in the Cloud](#)

[11.1 Introduction](#)

[11.2 Terminologies](#)

[11.3 Background and Related Work](#)

[11.4 The Substream Method in the Cloud](#)

[11.5 Stream Aggregation in the Cloud](#)

[11.6 Models](#)

[11.7 Analysis](#)

[11.8 Visionary Thoughts for Practitioners](#)

[11.9 Future Research Directions](#)

[11.10 Conclusion](#)

[References](#)

[Chapter 12: Beyond CDN: Content Processing at the Edge of the Cloud](#)

[12.1 Introduction](#)

[12.2 Existing Content Delivery Platforms](#)

[12.3 Comparison of Existing Content Delivery Platforms](#)

[12.4 An Edge Cloud-Based Model](#)

[12.5 Results and Insights](#)

[12.6 Future Research Directions](#)

[12.7 Conclusion](#)

[References](#)

[Chapter 13: Dynamic Reconfiguration for Adaptive Streaming](#)

[13.1 Introduction](#)

[13.2 Background and Related Work](#)

[13.3 Dynamic Server Deployment](#)

[13.4 From Content Delivery to Streaming](#)

[13.5 Future Research Directions](#)

[13.6 Conclusion](#)

[Acknowledgments](#)

[References](#)

[Chapter 14: Mining Distributed Data Streams on Content Delivery Networks](#)

[14.1 Introduction](#)

[14.2 Background and Related Work](#)

[14.3 A Hybrid Multidomain Architecture](#)

[14.4 A Prototype for Stream Mining in a CDN](#)

[14.5 Visionary Thoughts for Practitioners](#)

[14.6 Future Research Directions](#)

[14.7 Conclusion](#)

[References](#)

[Chapter 15: CDN Capacity Planning](#)

[15.1 Introduction](#)

[15.2 Capacity Planning Process](#)

[15.3 Undertaking the Capacity Planning Process](#)

[15.4 CDN Capacity Planning Case Study](#)

[15.5 Recent Developments and Challenges](#)

[15.6 Summary and Conclusion](#)

References

Part III: Case Studies and Next Generation CDNs

Chapter 16: Overlay Networks: An Akamai Perspective

16.1 Introduction

16.2 Background

16.3 Caching Overlays

16.4 Routing Overlays

16.5 Security Overlays

16.6 Conclusion

References

Chapter 17: Next-Generation CDNs: A CB Perspective

17.1 Introduction

17.2 Carrier CDNs

17.3 Managed CDNs

17.4 Federated CDNs

17.5 Licensed CDNs

17.6 Case Study: CoBlitz

17.7 CoBlitz Commercialization

17.8 Implications of HTTP Adaptive Streaming

17.9 CoBlitz Commercialization Lessons

17.10 CDN Industry Directions

Acknowledgments

References

Chapter 18: Content Delivery in China: A ChinaCache Perspective

18.1 Introduction

18.2 Content-Aware Network Services in China

[18.3 Directions for Future CDN Research and Trends in China](#)

[18.4 Conclusion](#)

[References](#)

[Chapter 19: PlatonTV: A Scientific High Definition Content Delivery Platform](#)

[19.1 Introduction](#)

[19.2 Background and Related Work](#)

[19.3 PlatonTV Architecture](#)

[19.4 Content Ingest](#)

[19.5 Content Distribution and Management](#)

[19.6 Content Delivery](#)

[19.7 Availability and Reliability](#)

[19.8 Visionary Thoughts for Practitioners](#)

[19.9 Future Research Directions](#)

[19.10 Conclusion](#)

[Acknowledgments](#)

[References](#)

[Chapter 20: CacheCast: A Single-Source Multiple-Destination Caching Mechanism](#)

[20.1 Introduction](#)

[20.2 Related Work](#)

[20.3 CacheCast Overview](#)

[20.4 Background on Multidestination Traffic](#)

[20.5 CacheCast Design](#)

[20.6 CacheCast Efficiency](#)

[20.7 CacheCast Applications](#)

[20.8 Visionary Thoughts for Practitioners](#)

[20.9 Future Research Directions](#)

[20.10 Conclusion](#)

[Acknowledgments](#)

[References](#)

[Chapter 21: Content Replication and Delivery in Information-Centric Networks](#)

[21.1 Introduction](#)

[21.2 Related Work](#)

[21.3 Framework for Information Replication in ICN](#)

[21.4 Performance Evaluation](#)

[21.5 Future Research Directions](#)

[21.6 Conclusion](#)

[Acknowledgments](#)

[References](#)

[Chapter 22: Robust Content Broadcasting in Vehicular Networks](#)

[22.1 Introduction](#)

[22.2 Vehicular Networks](#)

[22.3 Forward Error Correction Techniques](#)

[22.4 A Robust Broadcast-Based Content Delivery System](#)

[22.5 CDS Simulation in NS-3](#)

[22.6 Performance Evaluation](#)

[22.7 Future Research Trends](#)

[22.8 Summary and Conclusion](#)

[Acknowledgments](#)

[References](#)

[Chapter 23: On the Impact of Online Social Networks in Content Delivery](#)

[23.1 Introduction](#)

[23.2 Online Social Networks Background](#)

[23.3 Characterization of Social Cascades](#)

[23.4 Online Social Network Measurements](#)

[23.5 Systems](#)

[23.6 Future Research Directions](#)

[23.7 Conclusion](#)

[Acknowledgments](#)

[References](#)

[Index](#)

[Series](#)

[End User License Agreement](#)

List of Illustrations

[Figure 1.1](#)

[Figure 1.2](#)

[Figure 1.3](#)

[Figure 1.4](#)

[Figure 1.5](#)

[Figure 1.6](#)

[Figure 1.7](#)

[Figure 1.8](#)

[Figure 2.1](#)

[Figure 2.2](#)

[Figure 3.1](#)

[Figure 3.2](#)

[Figure 3.3](#)

[Figure 3.4](#)

[Figure 3.5](#)

[Figure 3.6](#)

[Figure 3.7](#)

[Figure 3.8](#)

[Figure 3.9](#)

[Figure 3.10](#)

[Figure 3.11](#)

[Figure 3.12](#)

[Figure 3.13](#)

[Figure 3.14](#)

[Figure 3.15](#)

[Figure 3.16](#)

[Figure 4.1](#)

[Figure 4.2](#)

[Figure 4.3](#)

[Figure 5.1](#)

[Figure 5.2](#)

[Figure 5.3](#)

[Figure 5.4](#)

[Figure 5.5](#)

[Figure 5.6](#)

[Figure 5.7](#)

[Figure 5.8](#)

[Figure 6.1](#)

[Figure 6.2](#)

[Figure 6.3](#)

[Figure 6.5](#)

[Figure 6.4](#)

[Figure 6.6](#)

[Figure 6.7](#)

[Figure 6.8](#)

[Figure 6.9](#)

[Figure 6.10](#)

[Figure 6.11](#)

[Figure 6.12](#)

[Figure 7.1](#)

[Figure 7.2](#)

[Figure 7.3](#)

[Figure 7.4](#)

[Figure 7.5](#)

[Figure 8.1](#)

[Figure 9.1](#)

[Figure 9.2](#)

[Figure 9.3](#)

[Figure 10.1](#)

[Figure 10.2](#)

[Figure 10.3](#)

[Figure 10.4](#)

[Figure 10.5](#)

[Figure 11.1](#)

[Figure 11.2](#)

[Figure 11.3](#)

[Figure 11.4](#)

[Figure 11.5](#)

[Figure 11.6](#)

[Figure 11.7](#)

[Figure 11.8](#)

[Figure 11.9](#)

[Figure 11.10](#)

[Figure 11.11](#)

[Figure 12.1](#)

[Figure 12.2](#)

[Figure 12.3](#)

[Figure 12.4](#)

[Figure 12.5](#)

[Figure 12.6](#)

[Figure 13.1](#)

[Figure 13.2](#)

[Figure 13.3](#)

[Figure 13.4](#)

[Figure 13.5](#)

[Figure 13.6](#)

[Figure 14.1](#)

[Figure 14.2](#)

[Figure 14.3](#)

[Figure 14.4](#)

[Figure 14.5](#)

[Figure 14.6](#)

[Figure 15.1](#)

[Figure 15.2](#)

[Figure 15.3](#)

[Figure 15.4](#)

[Figure 15.5](#)

[Figure 15.6](#)

[Figure 16.1](#)

[Figure 16.2](#)

[Figure 16.3](#)

[Figure 16.4](#)

[Figure 16.5](#)

[Figure 16.6](#)

[Figure 16.7](#)

[Figure 16.8](#)

[Figure 16.9](#)

[Figure 17.1](#)

[Figure 17.2](#)

[Figure 17.3](#)

[Figure 18.1](#)

[Figure 18.2](#)

[Figure 18.3](#)

[Figure 18.4](#)

[Figure 18.5](#)

[Figure 18.6](#)

[Figure 19.1](#)

[Figure 19.2](#)

[Figure 19.3](#)

[Figure 19.4](#)

[Figure 20.1](#)

[Figure 20.2](#)

[Figure 20.3](#)

[Figure 20.4](#)

[Figure 20.5](#)

[Figure 20.6](#)

[Figure 20.7](#)

[Figure 20.8](#)

[Figure 20.9](#)

[Figure 20.10](#)

[Figure 20.11](#)

[Figure 20.12](#)

[Figure 20.13](#)

[Figure 20.14](#)

[Figure 21.1](#)

[Figure 21.2](#)

[Figure 21.3](#)

[Figure 21.4](#)

[Figure 22.1](#)

[Figure 22.2](#)

[Figure 22.3](#)

[Figure 22.4](#)

[Figure 22.5](#)

[Figure 22.6](#)

[Figure 22.7](#)

[Figure 22.8](#)

[Figure 22.9](#)

[Figure 22.10](#)

[Figure 22.11](#)

[Figure 22.12](#)

[Figure 22.13](#)

[Figure 22.14](#)

[Figure 22.15](#)

[Figure 23.3](#)

[Figure 23.1](#)

[Figure 23.2](#)

[Figure 23.4](#)

List of Tables

[Table 1.1](#)

[Table 1.2](#)

[Table 1.3](#)

[Table 1.4](#)

[Table 1.5](#)

[Table 1.6](#)

[Table 8.1](#)

[Table 8.2](#)

[Table 8.3](#)

[Table 12.1](#)

[Table 12.2](#)

[Table 15.1](#)

[Table 19.1](#)

[Table 19.2](#)

[Table 20.1](#)

[Table 20.2](#)

[Table 20.3](#)

**WILEY SERIES ON PARALLEL
AND DISTRIBUTED COMPUTING**

Series Editor: Albert Y. Zomaya

A complete list of titles in this series appears at the end of this volume.

Advanced Content Delivery, Streaming, and Cloud Services

Edited by

Mukaddim Pathan

Telstra Corporation Ltd., Australia

Ramesh K. Sitaraman

University of Massachusetts, Amherst and Akamai
Technologies, USA

Dom Robinson

id3as-company Ltd., UK

IEEE
computer
society

WILEY

Cover Image: iStockphoto © nadla

Cover Design: Wiley

Copyright © 2014 by John Wiley & Sons, Inc. All rights reserved.

Published by John Wiley & Sons, Inc., Hoboken, New Jersey.

Published simultaneously in Canada.

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, scanning, or otherwise, except as permitted under Section 107 or 108 of the 1976 United States Copyright Act, without either the prior written permission of the Publisher, or authorization through payment of the appropriate per-copy fee to the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923, (978) 750-8400, fax (978) 750-4470, or on the web at www.copyright.com. Requests to the Publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, (201) 748-6011, fax (201) 748-6008, or online at <http://www.wiley.com/go/permission>.

Limit of Liability/Disclaimer of Warranty: While the publisher and author have used their best efforts in preparing this book, they make no representations or warranties with respect to the accuracy or completeness of the contents of this book and specifically disclaim any implied warranties of merchantability or fitness for a particular purpose. No warranty may be created or extended by sales representatives or written sales materials. The advice and strategies contained herein may not be suitable for your situation. You should consult with a professional where appropriate. Neither the publisher nor author shall be liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or other damages.

For general information on our other products and services or for technical support, please contact our Customer Care Department within the United States at (800) 762-2974, outside the United States at (317) 572-3993 or fax (317) 572-4002.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic formats. For more information about Wiley products, visit our web site at www.wiley.com.

Library of Congress Cataloging-in-Publication Data:

Advanced content delivery, streaming, and cloud services / editors, Mukaddim Pathan, Ramesh K. Sitaraman, Dom Robinson.

pages cm

Includes index.

ISBN 978-1-118-57521-5 (hardback)

1. Cloud computing. 2. Computer networks. I. Pathan, Mukaddim. II. Sitaraman, Ramesh Kumar, 1964- III. Robinson, Dom.

QA76.585.A377 2014

004.67'82-dc23

2014005235

To my wife Ziyuan for her inspiration, love, and support. This book would not have been completed, if she did not single-handedly take care of everything, while I was too busy in writing and compilation!—Mukaddim

To my wife Vidya and our active children Anu and Siddu for whom the Internet can never be fast enough!—Ramesh

To my wife Mariana and our wonderful kids Sofia and Zac— I am sure you will enjoy this book as a bedtime reading. And to my parents (that funny “computer thing” you bought me as a kid came in handy!)—Dom

Preface

The ever-evolving nature of the Internet brings new challenges in managing and delivering content to end-users. Content Delivery Networks (CDNs) improve Web access and streaming performance, in terms of response time and system throughput, while delivering content to Internet end-users through multiple, geographically distributed edge servers. The CDN industry, that is, content delivery, consumption, and monetization, has been undergoing rapid changes. The multidimensional surge in content delivery from end-users has led to an explosion of new content, formats, and an exponential increase in the size and complexity of the digital content supply chain. These changes have been accelerated by economic downturn in that the content providers are under increasing pressure to reduce costs while increasing revenue.

The main value proposition for CDN services has shifted over time. Initially, the focus was on improving end-user-perceived experience by decreasing response time, especially when the customer website experiences unexpected traffic surges. Nowadays, CDN services are treated by content providers as a way to use a shared infrastructure to handle their peak capacity requirements, thus allowing reduced investment cost in their own hosting infrastructure. Moreover, recent trends in CDNs indicate a large paradigm shift toward a utility computing model, which allows customers to exploit advanced content delivery services, hosted on commodity hardware, without having to build a dedicated infrastructure.

From a market perspective, historically buyers based the bulk of demand and spending on “core” CDN products that

facilitate the delivery of Web-based content services. Over the last few years, offering from video streaming and value-added services (VASs) peaked as the most demandable CDN products. They formed the basis of most of the present-day CDNs' offering, while strong demand for the basic CDN services still continues. Market research shows that on average, buyers reported 43% of total CDN spending on core products, such as caching and content delivery, while 57% spending on VAS-based products.

While satisfying the market demands, CDN providers are more and more focusing on higher margin, VAS offering in order to gain (or stabilize) overall profit margins. These VASs include mobile data acceleration, content protection, content management, application acceleration, mobile data delivery, and cloud-based storage. While these products currently have a reasonable market penetration, they represent even more substantial near-term growth opportunities.

In addition to the emergence of innovative CDN models, such as managed CDNs, licensed CDNs, and federated CDNs, Telco/operator CDNs are evolving into major market share holders. Telcos/operators around the world have started building CDN platform, technology, and support to aid content consumption, delivery, and rich media experience by end-users. The geographic expansion of Web-based content continues to grow and drive global CDN business requirements. Many CDN players have started with a regional focus and then expanded to offer services in new regions. It is expected that these trends in the CDN industry will continue, as the definition and scope of a CDN gets broader.

1.1 Overview and Scope of the Book

The book entitled *Advanced Content Delivery, Streaming, and Cloud Services* presents fundamental and trendy CDN technologies, with a comprehensive coverage of evolution, current landscape, and future roadmap. The book builds on academic and industrial research and developments, and case studies that are being carried out at different organizations around the world. In addition, the book identifies potential research directions and technologies that will drive future innovations. This book is aimed at a large audience including systems architects, practitioners, product developers, and researchers. It can be used as a reference/textbook for graduate students and a roadmap for academicians, who are starting to research in the field of content delivery. We expect the readers to have at least the basic knowledge about Web technologies and the Internet. In particular, readers should be knowledgeable about Web caching, replication, Internet-based services and applications, and basic networking.

Upon reading this, book readers will perceive the following benefits:

1. Learn the state of the art in research and development on content management, delivery, and streaming technologies.
2. Obtain a future roadmap by learning open research issues.
3. Gather the background knowledge to tackle key problems, whose solutions will enhance the evolution of next-generation content networks.
4. Use the book as a valuable reference and/or textbook.

1.2 Organization of the Book

This book is organized into three parts, namely, Part I: CDN and Media Streaming Basics; Part II: CDN Performance Management and Optimization; and Part III: Case Studies and Next-Generation CDNs. Specifically, the topics of the book are the following:

- *CDN*—Infrastructure, architecture, and technology for web content delivery, content management services, and media streaming.
- *Adaptive Bitrate Streaming (ABR)*. Techniques for multimedia streaming over computer networks using the HTTP protocol.
- *Cloud-Based Content Delivery*. Integration of cloud computing with traditional CDN model for content and Web application delivery.
- *Wide Area Network (WAN) Optimization*. Optimization algorithms to increase data transfer efficiency in an end-to-end delivery path across WANs.
- *Mobile Acceleration Service*. Optimizing content and video streams to mobile devices to meet dynamic and personalized content needs of mobile users.
- *Transparent Caching*. Carriers network caching technology to control over what content to cache, when to cache, and how fast to accelerate the content delivery.
- *Request-Routing Techniques*. Known and advanced algorithms for redirecting end-user requests, such as DNS-based routing, anycasting, and content-based routing.
- *CDN Performance, Availability, and Reliability*. SSL processing, network-based personal video recorder (PVR), and measurement techniques.

- *Next-Generation CDNs*. Overview of managed/licensed CDN, Telco/carrier CDNs, P2P CDN, and federated CDNs.
- *CDN Case Studies*. Overview of operational infrastructure and services from the major CDNs.
- *CDN Business Intelligence*. Coverage of the CDN market trends, ongoing planning, and management.

Part I of the book focuses on the basic ideas, techniques, and current practices related to content delivery and media streaming. Chapter 1 by Pathan presents an overview of CDNs, operational models, and use cases. It covers recent market and technology trends, as well as identifies a few research issues in the CDN domain. Robinson, in Chapters 2 and 3, provides a comprehensive description of the live media streaming ecosystem and demonstrates the practical configuration of live streaming using a few tools. In Chapter 4, Haßlinger identifies key properties of caching and content delivery in broadband access network, and describes how efficiency can be achieved by configuration and performance tuning. Alzoubi et al. in Chapter 5 present mechanisms and algorithms to effectively redirect end-user requests in a CDN platform. This chapter demonstrates the applicability of IP anycasting for request redirection. Basics of content delivery to cloud-based home ecosystem is covered in Chapter 6 by Cruz et al., highlighting key challenges, industry practices, and recent trends. In Chapter 7, Narayanan et al. describe the challenges in delivering video in mobile networks and present various adaptation techniques for mobile video streaming.

Part II of the book provides a coverage of CDN performance measurement techniques, tools, reporting, and analytics. In Chapter 8, Siglin covers CDN analytics tools and explores a variety of analytic practices and their

implications in practical context, including new methods for analyzing adaptive bitrate (ABR) streaming technology. Mathematical modeling to optimize CDN services, such as video on demand (VoD) content delivery, is covered in Chapter 9 by Bektaş and Ercetin. It makes the reader aware of fundamental optimization problems arising in content delivery and the ways of effectively solving these problems. Molina et al. in Chapter 10 present a basic analytical model to analyze the basic and advanced properties of a CDN. Zhanikeev in Chapter 11 describes a method for cloud-based multisource streaming and compares its performance over traditional methods. In Chapter 12, Islam and Grégoire discuss on the intersection of CDN and cloud computing by exposing a number of trade-offs on the deployment of multimedia processing functions inside the cloud and identify relevant performance factors. In Chapter 13, Yoshida describes the performance of a dynamic streaming CDN, comprising techniques for dynamic network reorganization, and load distribution and balancing to realize dynamicity, as well as techniques for stream segmentation and reconstruction, and QoS assurance. Cesario et al. in Chapter 14 present the analysis of mining streaming data in a CDN, improving efficiency and effectiveness of a CDN architecture. A hybrid multidomain architecture is described that solves the problem of computing frequent items and frequent itemsets from distributed data streams. In Chapter 15, Davies and Pathan cover the capacity planning process that is instrumental for the ongoing operation of a deployed CDN infrastructure. It includes a practical application and workflow of the CDN capacity planning process.

Part III, the final part of the book, consists of a handful of representative case studies on present- and next-generation CDNs. In Chapter 16, Sitaraman et al. discuss different network overlays that are crucial for meeting the