

Preface

Modeling and optimization of computer and communication networks has always been a significant topic to both researchers and practitioners. The interest in developing efficient optimization models and methods is motivated by the deployment of new network services and the growing numbers of users. Armed with a good set of algorithms, it is possible to design the network across various protocols, technologies, topologies, and traffic patterns in an efficient way to provide solutions that meet the expected cost and performance limits.

In the past few decades, a great deal of research has been accomplished on modeling and optimization of computer and communication networks. However, in the last few years, networks have undergone an important change driven by the emergence and rapid expansion of new services. The concepts of cloud computing and content-oriented networking are some of the most significant and disruptive technologies that have recently gained wide interest. Cloud computing together with content-oriented networking have revolutionized the way various network services are delivered to end users, bringing new research challenges. More specifically, the key issue is to model and optimize networks with new traffic patterns to allow cost-effective implementation of recent networking services with Quality of Service guarantees and high scalability. The need to develop appropriate and powerful optimization methods for these new services is enhanced by intense competition among telecoms and network service providers observed in the global market.

The fact that cloud computing and content-oriented services have proliferated has triggered a change in the network traffic patterns. In particular, in place of traditional unicast flows, anycast and multicast transmissions have been gaining wide acceptance. This trend mostly follows from the nature of cloud computing and content-oriented services; that is, highly specialized data centers distributed throughout the network are used as repository for computing and storage. In addition, the most popular and voluminous content offered in contemporary networks is video that can be efficiently delivered to end customers via multicast streaming. As a consequence, the main aim of this book is to cover various aspects

of modeling and optimization that are relevant in the context of cloud computing and content-oriented services, including issues related to anycast and multicast flows. The emphasis is on formulating the considered problems as mathematical optimization models in the form of mixed-integer programming (MIP) or integer programming (IP), and on different optimization methods including branch-and-cut algorithms, Lagrangian relaxation, and various heuristic and metaheuristic algorithms. Moreover, several numerical experiments are described in order to show the performance of the optimization methods proposed and to present the know-how on experimental evaluation of networking problems.

Contemporary networks offer much flexibility in terms of new service deployment. In fact, different network layers can be utilized to implement services based on many factors including technical and economic aspects, starting from the physical layer typically implementing optical technologies, through the network layer employing connection-oriented protocols like MPLS, and ending with the application layer solutions realized by overlay networks. To this end, this book focuses on modeling and optimization of cloud-ready and content-oriented networks in the context of different layers and accounts for specific constraints following from protocols and technologies used in a particular layer. A wide range of additional constraints important in contemporary networks is addressed in this book, including various types of network flows, survivability issues, multi-layer networking, and resource location.

The contents of this book are organized as follows. Chapter 1 briefly presents information on cloud computing and content-oriented services, and introduces basic notions and concepts of network modeling and optimization. Chapter 2 covers various optimization problems that arise in the context of connection-oriented networks. Chapter 3 focuses on modeling and optimization of Elastic Optical Networks. Chapter 4 is devoted to overlay networks. The book concludes with Chap. 5, summarizing the book and presenting recent research trends in the field of network optimization. The material of each chapter is mostly self-contained.

The book presents the author's research results gained during the past eight years. Some of these results have been published in prestigious international journals and conference proceedings. As well as including additional new results, the existing results are finalized, extended, and presented in a comprehensive and cohesive way.

I would like to thank Prof. Janusz Kacprzyk for including my book in the prestigious Springer series "Studies in Systems, Decision and Control," and Springer's staff members for their kind cooperation and support during the publishing process.

The book would not have been written without the continuing support and help from a number of colleagues and students from the Department of Systems and Computer Networks, Faculty of Electronics, Wrocław University of Technology. I am especially grateful to Prof. Michał Woźniak, my former and current Ph.D. students: Michał Aibin, Damian Bulira, Grzegorz Chmaj, Jakub Gładysz, Róża Goścień, Wojciech Kmiecik, Michał Kucharzak, Adam Smutnicki, Maciej Szostak, and my M.Sc. students: Wojciech Charewicz, Maciej Donajski, Tomasz Kacprzak,

Michał Kosowski, Marek Miziołek, Krzysztof Pajak, Juliusz Skowron, Bartosz Rabiega, Michał Tarnawski and Michał Wiśniewski for their insightful comments, fruitful discussions, and help in computer experiments.

Also, I extend my warmest thanks to Prof. Andrzej Kasprzak, who first showed me the beauty of networks and always supported my academic career.

Moreover, I am indebted to my former and current collaborators: Prof. Mirosław Klinkowski, Dr. Michał Przewoźniczek, Dr. Jacek Rak, Prof. Arun Sen, and Prof. Massimo Tornatore for valuable and clarifying discussions on network optimization topics during the past few years.

My family perhaps suffered the most during my work on this book. I would like to express my gratitude to my wife Monika and my kids Zuzia and Maciek for their support, love, and understanding during the preparation of this book.

Wrocław
November 2015

Krzysztof Walkowiak

Modeling and Optimization of Cloud-Ready and
Content-Oriented Networks

Walkowiak, K.

2016, XVIII, 279 p. 50 illus., 7 illus. in color., Hardcover

ISBN: 978-3-319-30308-6