## Optical Switching Networks

*Optical Switching Networks* describes all the major switching paradigms developed for modern optical networks, discussing their operation, advantages, disadvantages, and implementation. Following a review of the evolution of optical wavelength division multiplexing (WDM) networks, an overview of the future of optical networks is set out. The latest developments of techniques applied in optical access, local, metropolitan, and wide area networks are covered, including detailed technical descriptions of generalized multiprotocol label switching, waveband switching, photonic slot routing, optical flow, burst, and packet switching. The convergence of optical and wireless access networks is also discussed, as are the IEEE 802.17 Resilient Packet Ring and IEEE 802.3ah Ethernet passive optical network standards and their WDM upgraded derivatives. The feasibility, challenges, and potential of next-generation optical networks are described in a survey of state-of-the-art optical networking testbeds. Animations showing how the key optical switching techniques work are available via the Web, as are lecture slides.

This authoritative account of the major application areas of optical networks is ideal for graduate students and researchers in electrical engineering and computer science as well as practitioners involved in the optical networking industry.

Additional resources for this title are available from www.cambridge.org/9780521868006.

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CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo, Delhi

Cambridge University Press
32 Avenue of the Americas, New York, NY 10013-2473, USA

www.cambridge.org
Information on this title: www.cambridge.org/9780521868006



First published 2008

Printed in the United States of America

*A catalog record for this publication is available from the British Library.*

*Library of Congress Cataloging in Publication Data*

Maier, Martin.
Optical switching networks / Martin Maier.
p. cm.
Includes bibliographical references and index.
ISBN 978-0-521-86800-6 (hardback)
1. Optical communications. 2. Telecommunication systems. 3. Computer networks.
I. Title
TK5103.59.M36 2008
621.382′7—dc22

2007052216

ISBN 978-0-521-86800-6 hardback

**In love and gratitude to my wonderful wife**
**and our two little Canadians**

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# Preface

Optical fiber is commonly recognized as an excellent transmission medium owing to its advantageous properties, such as low attenuation, huge bandwidth, and immunity against electromagnetic interference. Because of their unique properties, optical fibers have been widely deployed to realize high-speed links that may carry either a single wavelength channel or multiple wavelength channels by means of wavelength division multiplexing (WDM). The advent of Erbium doped fiber amplifiers was key to the commercial adoption of WDM links in today's network infrastructure. WDM links offer unprecedented amounts of capacity in a cost-effective manner and are clearly one of the major success stories of optical fiber communications.

Since their initial deployment as high-capacity links, optical WDM fiber links turned out to offer additional benefits apart from high-speed transmission. Most notably, the simple yet very effective concept of optical bypassing enabled network designers to let in-transit traffic remain in the optical domain without undergoing optical-electrical-optical conversion at intermediate network nodes. As a result, intermediate nodes can be optically bypassed and costly optical-electrical-optical conversions can be avoided, which typically represent one of the largest expenditures in optical fiber networks in terms of power consumption, footprint, port count, and processing overhead. More important, optical bypassing gave rise to so-called all-optical networks in which optical signals stay in the optical domain all the way from source node to destination node.

All-optical networks were quickly embraced by both academia and industry, and the research and development of novel architectures, techniques, mechanisms, algorithms, and protocols in the arena of all-optical network design took off immediately worldwide. The outcome of these global research and development efforts is the deployment of optical network technologies at all hierarchical levels of today's network infrastructure covering wide, metropolitan, access, and local areas.

The goals of this book are manifold. First, we set the stage by providing a brief historical overview of the beginnings of optical networks and the major achievements over the past few decades, thereby highlighting key enabling technologies and techniques that paved the way to current state-of-the-art optical networks. Next, we elaborate on the big picture of future optical networks and identify the major steps toward next-generation optical networks. The major contribution of this book is an up-to-date overview of the latest and most important developments in the area of optical wide, metropolitan, access, and local area networks. We pay particular attention to recently standardized and emerging high-performance switching paradigms designed for the cost-effective and

bandwidth-efficient support of a variety of both legacy and new applications and services at all optical network hierarchy levels. In addition, we explain recently standardized Ethernet-based optical metro, access, and local area networks in great detail and report ongoing research on their performance enhancements. After describing the concepts and underlying techniques of the various optical switching paradigms at length, we take a comprehensive look at current testbed activities carried out around the world to better understand the implementation complexity associated with each of the described optical switching techniques, as well as to get an idea of what future optical switching networks are expected to look like. Finally, we include a chapter on the important topic of converging optical (wired) networks with their wireless counterparts.

This book was written to be used for teaching graduate students as well as to provide communications networks researchers, engineers, and professionals with a thorough overview and an in-depth understanding of state-of-the-art optical switching networks and how they support new and emerging applications and services.

# Acknowledgments

I am grateful to Dr. Andreas Gladisch of Deutsche Telekom for introducing me to the exciting research area of optical networks many years ago. I also would like to thank my former advisor Prof. Adam Wolisz of the Technical University of Berlin for his guidance of my initial academic steps. In particular, I am grateful to my mentor Prof. Martin Reisslein from Arizona State University and his former PhD students Chun Fan, Hyo-Sik Yang, Michael P. McGarry, and Patrick Seeling for their immensely fruitful collaboration. I am deeply grateful to Dr. Martin Herzog for his significant contributions over the past few years and his review of parts of this book. Furthermore, I would like to acknowledge the outstanding support of Prof. Michael Scheutzow and his group members (former or current) Stefan Adams, Frank Aurzada, Matthias an der Heiden, Michel Sortais, and Henryk Zähle of the Technical University of Berlin. In addition, I am grateful to Prof. Chadi M. Assi and Ahmad Dhaini of Concordia University and Prof. Abdallah Shami of the University of Western Ontario for their excellent collaboration on performance-enhanced Ethernet PONs. I also would like to thank Prof. Eytan Modiano of the Massachusetts Institute of Technology and Prof. Leonid G. Kazovsky of Stanford University for being my hosts during my research visits and for their fruitful discussions and insightful comments.

At Cambridge University Press, I would like to thank Dr. Phil Meyler for offering me the opportunity to write this book and Anna Littlewood for making the publication process such a smooth and enjoyable experience.

Finally and most importantly, I am deeply grateful to my wife Alexie who supported and encouraged me with all her love, strength, and inspiration throughout the past year and a half while I wrote this book. This book is dedicated to my wife and our two children; it not only carries all the technical details but also the countless personal memories of our first two years in Canada.