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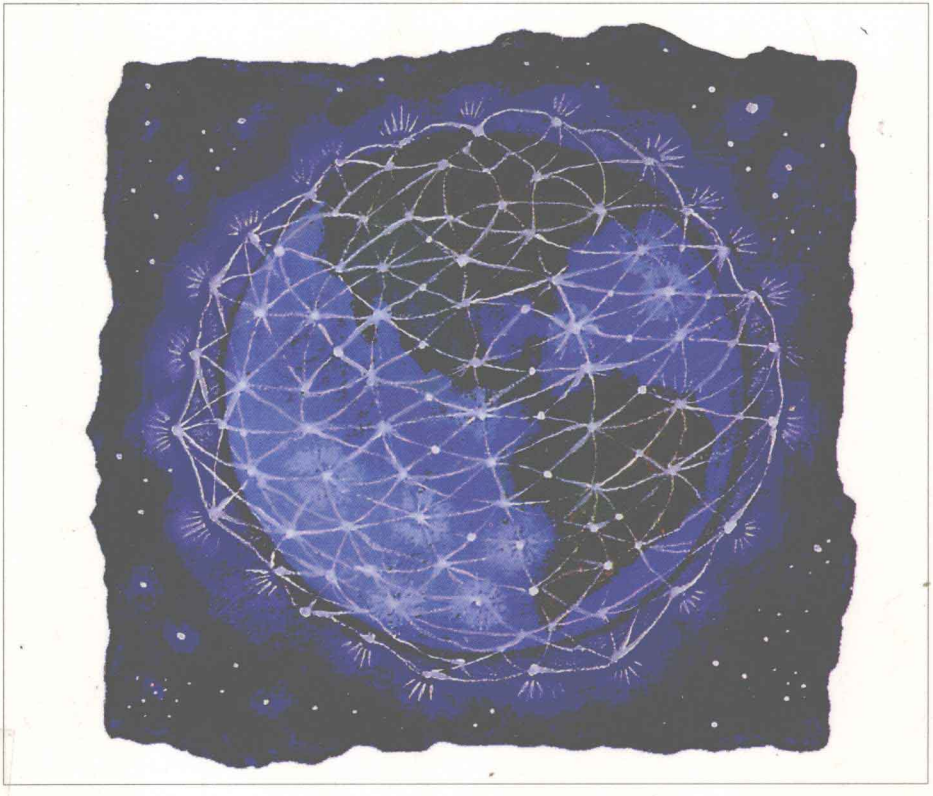
电子工程系列丛书（影印版）

NEXT GENERATION OPTICAL NETWORKS

The Convergence of IP Intelligence and Optical Technologies

下一代光网络

IP智能与光子技术的融合



Peter Tomsu • Christian Schmutzer

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出 版 前 言

电子工程是信息科学的基础。高等学校新的教学要求指出：计算机专业和电子学专业的学生应相互学习并渗透到彼此的专业领域，拓宽知识面，以适应信息技术飞速发展的时代。培养通晓相关专业领域知识的人才，已成为21世纪理工科教育的迫切要求。为此，我们挑选与信息科学、电子学有关的国外优秀著作，组成“电子工程系列丛书（影印版）”，奉献给国内读者。1999年我们曾推出了奥本海姆的《信号与系统第2版》、奥法尼德斯的《信号处理导论》和拉贝的《数字集成电路》。这三本影印版图书获得了读者的广泛支持。本世纪我们将继续进行这项工作。根据读者的意见，今后我们出版的影印版图书，其开本尺寸不再缩小，基本保持其原版开本尺寸。

我们希望，这套丛书能为国内高校师生、工程技术人员以及科研单位的工作人员提供新的知识和营养，也衷心期待着读者对我们一如既往的支持。

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About the Authors

PETER TOMSU, Ph.D., Senior Consulting Engineer at Cisco Systems, has worked with Cisco since 1996. He is involved in numerous network designs–from service provider backbones to large enterprise backbones–and is significantly driving new technologies during their definition, development, introduction, and final deployment phases. For many years, Tomsu has been a requested speaker at international conferences in the United States and worldwide. He received his Ph.D. from the Technical University of Vienna.

CHRISTIAN SCHMUTZER, M.S., Systems Engineer at Cisco Systems, has been with the company since 1998. He works primarily on the design and deployment of large service provider backbones and concentrates on optical networking as well as routing technologies. As a speaker for technical tutorials throughout Europe, he frequently shares his practical experience. He received his Masters from the Fachhochschule Technikum Wien in Vienna.

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A very special thanks to our employer, Cisco Systems, for providing great help over the past two years, especially Jane Butler and Rob Lloyd, who supported this book from the very beginning. We also received great support from Gerhard Wieser, David Tsiang, George Suwala, and all others who helped us to finalize this book and are not listed here.

Many of the figures were adapted from Cisco Systems presentations, as well as ITU, IETF, ATM Forum, and other standardization bodies documents.

Preface

Why This Book

We had the idea to write this book two years ago, when service providers started commonly thinking about optical technologies such as Wavelength Division Multiplexing (WDM) to increase the capacity of optical transmission systems. The need for higher bandwidth came, of course, from the growing demand generated by the Internet and all of its applications and services.

Historically, there has not been much consensus between service providers and telecommunications camps (on the one side) and Internet service providers (ISPs) and Internet users (on the other side). Obviously, the most important reason for that is that, in the past, telephony companies built Time Division Multiplexing (TDM) networks and delivered voice services to their customers. As the Internet became more popular and generated increasing amounts of traffic, new ISPs started building router networks running IP. These delivered e-mail and World Wide Web (WWW) access and, later, more advanced IP services to their customers. Also at this time, traditional telephone providers started building router networks delivering IP services like their counterparts, the ISPs. From an organizational point of view, this represents two completely separated groups of people, two completely separated business functions, two completely separated areas of responsibility, two completely separated budgets, and—last but not least—two different human generations.

However, time changed quickly and while market deregulation was introduced, a broad range of alternate service providers started to compete in a very

fast-growing market with the incumbent providers. This very competitive situation now forces every single service provider to optimize its network architecture and to streamline its internal organizational structure in order to minimize its operational expenses (OPEX), one of the most important keys to success.

Suddenly, people talking about IP are also talking about WDM and the other way around. Although this is fine and a major step forward, there is still the problem that most people who have worked in the transmission space for years are experts on TDM, WDM, and all other optical transmission technologies. On the other hand, people who have worked for years in the Internet arena are experts in data networking, IP, and IP routing protocols. Both are experts but only in their tightly focused area of technology.

This is where our book is intended to enter the arena—to build a bridge between the two historically separated technology areas. It first outlines the most important technologies of optical transmission space, then focuses on important IP networking technologies. Finally, it concentrates on the convergence of both optical and IP to conclude. We are sure that the reader will obtain a deep understanding of what is really behind the "IP + optical" topic, a topic already of significant interest today and one that will gain even more momentum during the next few years.

Targeted Audience

The target audience for this book includes all people interested and working in the networking arena, service providers, and enterprises that are planning, designing, or deploying advanced optical IP-based infrastructures. The book is structured and written in a way that should be easily understandable for newcomers. It supplies many helpful references to standards and other literature and in-depth explanations, including information for advanced readers who want to get a complete picture of the state of the art of optical networking and the according control and provisioning mechanisms for these networks.

Structure of This Book

Chapter 1 of this book gives an overview about existing and possible future carrier network architectures. The architectural elements of traditional multilayer networks are described, and essential information about applied technologies

such as Synchronous Optical Network/Synchronous Digital Hierarchy (SONET/SDH), Asynchronous Transfer Mode (ATM), or Multiprotocol Label Switching (MPLS), is included.

Chapter 2 focuses on standardization activities in the optical networking arena. A snapshot of what already has been specified by such standardization bodies as International Telecommunications Union (ITU), Institute of Electrical and Electronics Engineering (IEEE), Optical Internetworking Forum (OIF), or Internet Engineering Task Force (IETF) and what kind of proposals are to be finalized soon is provided.

Chapter 3 represents a technology backgrounder delivering in-depth knowledge about optical transmission technologies, data transmission technologies, and network survivability concepts required for understanding how next-generation networks are designed and deployed.

Chapter 4 concentrates on the overall network architecture of advanced optical IP-based infrastructures and describes the three major steps in the evolution, from static IP over optical networks to dynamic and integrated IP + optical networks.

Chapter 5 finally outlines optical end-to-end networking design trends seen in the industry. Three case examples are described to put the theory about the convergence of IP and optical technologies covered in Chapters 1 and 4 into a practical perspective.

Further Information Online

All readers are welcome to consult the Web site www.nextgenzone.net for ongoing updated information related to this book and the authors, as well as for reading about the hot topics in the networking industry. A lot of up-to-date background information, including links to useful Web sites, industry articles, and much more online material can be found.

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