Preface

Lo, soul! seest thou not God's purpose from the first?
The earth to be spann'd, connected by net-work
From *Passage to India!*
Walt Whitman, "Leaves of Grass", 1900.

The Internet is growing at a tremendous rate today. New services, such as telephony and multimedia, are being added to the pure data-delivery framework of yesterday. Such high demands on capacity could lead to a "bandwidth-crunch" at the core wide-area network resulting in degradation of service quality. Fortunately, technological innovations have emerged which can provide relief to the end-user to overcome the Internet's well-known delay and bandwidth limitations. At the physical layer, a major overhaul of existing networks has been envisaged from electronic media (such as twisted-pair and cable) to optical fibers – in the wide area, in the metropolitan area, and even in the local area settings. In order to exploit the immense bandwidth potential of the optical fiber, interesting multiplexing techniques have been developed over the years.

Wavelength division multiplexing (WDM) is such a promising technique in which multiple channels are operated along a single fiber simultaneously, each on a different wavelength. These channels can be independently modulated to accommodate dissimilar bit rates and data formats, if so desired. Thus, WDM carves up the huge bandwidth of an optical fiber into channels whose bandwidths (1-10 Gbps) are compatible with peak electronic processing speed. Optical fibers employing the technique of WDM can support around 1000 times the capacity of their electronic counterparts. WDM is already being deployed in commercial point-to-point fiber links including undersea installations. WDM-based

optical networks have been tested in the U.S. (e.g. MONET, NTONC projects), Europe (e.g. RACE, ACTS projects) and other countries. Several vendors have demonstrated WDM-based optical switching systems in the recent past.

Computer communication networks have evolved to make full use of the optical fiber technology. Paul E. Green, Jr. in his book "Fiber Optic Networks" (Prentice Hall, NJ, 1993) refers to three generations in the evolution of high-speed networks (see Fig. 1.1). In a first-generation network, the nodes were interconnected with copper links which had limited bandwidth capabilities. In a second-generation network, optical fiber was used as a replacement for copper as the transmission medium, in view of its huge bandwidth capability. However, data sent over this network along multiple links undergoes optical-to-electronic conversion and vice versa, at each intermediate node before reaching its destination. Hence, the network does not provide protocol-transparency – the capability to accommodate data comprising many different bit rates and formats at the same time. Data processing at each intermediate node also results in additional overhead. A third-generation network provides a continuous optical connection between all nodes. Data can be sent from one node to another entirely in the optical domain, providing complete transparency.

One may well argue that both the second-generation and the third--generation networks mentioned above can be referred to as "optical" networks since they use the optical fiber as the medium for transmission. Note that the WDM technique can improve the bandwidth availability in both configurations (providing WDM transmission in the one and additionally, WDM switching in the other). However, of late, the term optical communication networks has been increasingly used to refer to fiber-based networks which support high-bandwidth transmission supported by high-speed switching (either all-optically or through electro-optical and opto-electronic conversions) and usually involving multiple wavelengths. Furthermore, recent advances in device technology have brought us closer than ever to realizing a full-fledged all-optical network over a large geographical domain. In this book, we will focus solely on the design of such third-generation networks for local, metropolitan and wide-area environments. Indeed, such optical WDM networks are widely considered to be promising candidates for the architecture of the next-generation Internet!

This book is targeted towards researchers and practitioners in the field of optical networks and WDM, but will also be of interest, we hope, to all students of networking and telecommunications.

We are pleased to present in this book a sampling of problems and proposed solutions associated with the design of wavelength division multiplexing based optical networks. This book focuses exclusively on the design aspects whereas earlier books cover a broader range of topics in this field. We hope this book will contribute to the understanding of this exciting field of optical networks.

We hope you will enjoy reading this book.

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