PREFACE

For more than 2500 years, light has been used in communications. In those days, light towers were used to send quickly a brief encoded message from point A to point B and across the land, such as "the enemy is approaching" or "festivities will start next month."

Communicating with light in open space, although a seemingly simple operation, had its own problems. For example, when a robust code was used so that the enemy could not easily decode the message, many factors had to be considered. The light should be intense enough so that it could be seen from a distant tower. The tower should be strategically positioned and be tall enough so that trees and low hills could not obstruct the line of sight. The atmosphere should be clear so that heavy rain or fog could not absorb the optical signal. The towers should be adequately equipped and staffed. A synchronization mechanism should exist so that the receiving tower would know when a message was about to be transmitted. A protocol should be followed so that when the received message was not understood, a request to retransmit could be made. And, of course, there were many maintenance functions that are not too difficult to imagine. As problematic as it was, this method of optical communication lasted until a couple of centuries ago.

Throughout history many scientists made significant contributions in the optical domain. The reflectivity and refractivity of light were studied, and in ancient times the paraboloid reflector was studied and invented. Although in antiquity glass was not as clear as it is today, it generated a lucrative industry primarily in the making of jewelry and of perfume vessels and in other more "exotic" applications of refracting light to perhaps form the first lens systems. Thus, glass evolved and in modern times it is a ubiquitous material. It would be very difficult today to envision life without glass. Only in the far future might we envision ourselves without it, when high-technology transparent plastics, better and more cost-efficient than glass, might replace it.

Today, glass is used in a myriad of ways, including optical communication lines. Glass-based fiber is wrapped around the globe like a ball of yarn connecting all continents and transmitting enormous amounts of data at the speed of light. Currently, a single fiber can transmit the contents of hundreds of thousands of volumes of data within a second.

Since glass and optical components provide key functionality in communications, there are visions of an all-optical network able to carry unprecedented amounts of information over many hundreds of thousands of kilometers without converting the optical signal into electronic and back to optical. The only electrical-to-optical conversion, and vice versa, will be at the end terminals, at the source and at the sink of the signal, respectively.

ABOUT THIS BOOK

My interest in the field of optical communication has culminated in two books, *Introduction to DWDM Technology: Data in a Rainbow* (IEEE Press, 2000) and *Understanding SONET/SDH and ATM: Communications Networks for the Next Millenium* (IEEE Press, 1999). Recently, I have been working on the evaluation of faults and degradations of optical components in multiwavelength systems and networks, on fault detectability and localization, and also on the necessary remedial actions. Degradations and faults of optical components is an integral part of system and network design that cannot be overlooked. For example, degradations and faults affect the quality of the optical signal and thus the optical signal-to-noise ratio, the optical bit error rate, and the fiber span without amplification. In addition, they affect the selection of the forward error correction (FEC) code, the receiver design, fail-safe mechanisms, monitoring strategies and remedial actions, and in general fault management, as well as the system and network robustness. At the ultrahigh bit rates and aggregate bandwidth used today, such degradations and faults should be identified as soon as they happen and remedied.

My personal notes and several documents that I have published provided the source material for this book. In many respects, this book is the continuation of *Introduction to DWDM Technology: Data in a Rainbow,* which describes the properties of light, its interaction with matter, and how optical components work in optical communications, such as filters, multiplexers, optical switches, and many others. This book provides only a brief overview of key principles and optical components and focuses on the understanding of optical fault and degradation mechanisms (detection, localization, and remedial action) that affect the optical signal and the operation of the DWDM system and perhaps of the network. The understanding of optical faults and degradations is important in the architectural design of optical systems and networks, in the design of complex optical components, in fault management of dense wavelength division multiplexing (DWDM) systems and networks, and in the development of standards. DWDM technology is still evolving, and as such, the reader interested in the details of DWDM is strongly recommended to consult the most current updated standards. I wish you happy and easy reading.

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