

Connection-oriented networks: SONET/SDH, ATM, MPLS and optical networks

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Finding your way in the complex and sometimes uncharted waters of networking is not like cruising, it is like sailing. It is no wonder, then, that the author, a keen sailor himself, successfully delivers to the reader the many aspects of connection-oriented networks.

The book is structured and enriched in such a way as to serve primarily as a textbook for both graduate and undergraduate courses on computer networks. It could also be used as a reference book by those in the field of computer networks, such as managers, academics, researchers, and system designers.

It provides a clear and complete overview of connection-oriented networks, covering both packet-switched and circuit-switched networks. A positive aspect is surely the broad range of topics addressed in this book, such as asynchronous transfer mode (ATM) and multiprotocol label switching (MPLS) networks; synchronous optical networks and synchronous digital hierarchy (SONET/SDH); and optical wavelength routing networks, the newly introduced optical burst switching networks, the asymmetric digital subscriber line (ADSL)-based and cable-based access networks, and solutions such as voice-over ATM and MPLS.

The book is comprised of 12 chapters, all of which are supported by self-review exercises and simulation-oriented projects. Extensive lists of references are included, along with a preface, a short biography of the author, and an index. A modern aspect to this book is its accompanying Web site, which includes a solutions manual and a set of PowerPoint presentations for instructors.

Chapter 1, "Introduction," starts almost from scratch, discussing the concept of connection and connection-oriented networks. The remainder of the chapter briefly describes each of the book's chapters and introduces the reader to national and international standardization bodies responsible for the standardization process of networking architectures and protocols.

Chapter 2, "SONET/SDH and the Generic Frame Procedure (GFP)," presents, in depth, the SONET/SDH transport technology. Starting from the very basic outline of T1 and E1, the author continues with a detailed description of the SONET/SDH hierarchy, and the SONET STS-1 and STS-3 frame structure. A discussion of SONET/SDH devices and rings follows. In particular, various architectures are depicted for the automatic recovery of SONET/SDH rings in case of a fiber link failure, otherwise known as self-

healing. Moreover, this chapter outlines the generic framing procedure, a simple adaptation scheme that extends the ability of SONET/SDH to carry different types of traffic. Finally, the data over SONET/SDH (DOS) architecture is presented, pointing to an efficient mechanism for the transport of integrated data services.

Chapter 3, "ATM Networks," is the first of three chapters on ATM. ATM is now a mature technology, used mainly in the backbone, able to deliver different types of traffic with different quality of service (QoS) requirements. In this chapter, the reader is primarily introduced to the main features of the ATM architecture, such as the header of the ATM cell, the ATM protocol stack, and the physical layer. Subsequently, the very common ATM shared memory switch architecture is outlined, and several scheduling algorithms are described. The depiction of the three ATM adaptation layers (AAL) follows, and the chapter concludes with the presentation of the transport of Internet protocol (IP) over ATM. Chapter 4, "Congestion Control in ATM Networks," discusses the procedure that allows the maximum traffic throughput without degradation of QoS. It begins by providing a thorough look into traffic characterization, QoS parameters, and the relevant ATM service categories offered. The remainder of this chapter discusses extensively both proactive and reactive congestion control mechanisms. Chapter 5, "Signaling in ATM Networks," concludes the ATM discussion. This chapter deals exclusively with the signaling protocol Q.2931 that runs between the user and the ingress switch.

Chapter 6, "The Multi-Protocol Label Switching (MPLS) Architecture," is one of two chapters devoted to MPLS. MPLS is shown to provide a connection-oriented structure to the otherwise connectionless IP networks, on top of offering QoS in the best-effort IP network. The ability of MPLS to run over different networking schemes is exhibited in the concluding section that presents MPLS over ATM. Chapter 7, "Label Distribution Protocols," focuses on signaling protocols for the reliable establishment of a label switched path (LSP) in MPLS. A wide range of diverse protocols is described by the author.

The next three chapters are devoted to optical networks. Chapter 8, "Optical Fibers and Components," somewhat differs from the other chapters since it discusses aspects of the physical layer of wavelength division multiplexing (WDM) optical networks, while the book in general considers layers higher than the physical one. Topics such as light transmission through an optical fiber, lasers, optical amplifiers, star couplers, and optical cross-connects (OXC) are discussed. Chapter 9, "Wavelength Routing Optical Networks," discusses the very popular deployment of OXCs interconnected with WDM fibers. The author introduces the concepts of lightpaths, optical circuit-switched connections for the transmission of data, and traffic grooming, the accommodation of multiple users on a single lightpath. Attention is given to the new ITU-T G.709 standard, otherwise known as the digital wrapper, that permits the transmission of IP packets, ethernet frames, ATM cells, and SONET/SDH data. The remainder of the chapter is devoted to the control

plane for wavelength routing networks. The author provides a detailed view of the generalized MPLS (GMPLS), an extension of the discussion on MPLS, that covers the basic features and extensions to signaling protocols necessary for the implementation of GMPLS. Chapter 10, "Optical Burst Switching [OBS]," covers this very new concept as a solution for the transmission of bursty traffic over optical networks. To draw the path to the latest developments, the earlier scheme of optical packet switching (OPS) is described, followed by a detailed presentation of OBS. The chapter ends with a discussion of the jumpstart signaling protocol, a proof-of-concept protocol developed to exhibit the viability of OBS.

Chapter 11, "Access Networks," describes the packet-switching networks that provide Internet connectivity and additional services, such as voice over Internet protocol (VoIP), voice over ATM, and video on demand (VoD). Primarily, the ADSL-based access networks are presented, supported by telephone operators using telephone lines to provide high-speed access to the Internet. In a similar manner, the author discusses cable-based access networks, supported by cable operators to provide Internet access, and the cost-effective ATM passive optical network (APON) as a third alternative to the access networks concept.

Chapter 12, "Voice over ATM and MPLS," is the book's final chapter, and discusses the ATM and MPLS technologies and their ability to deliver real-time QoS-aware traffic, such as voice. At the beginning, the reader is given the basic telephony terms and signaling protocols necessary to proceed in an informed manner to the voice over ATM and MPLS solutions. The chapter concludes with a detailed description of specifications for both voice over ATM and MPLS, as devised by the ATM Forum and the MPLS and Frame Relay Alliance, respectively.

This book clearly stands out in its presentation of the state-of-the-art of, and explanation of, connection-oriented networks. It will be a welcome companion not only for students and instructors of courses on computer networks, but also for professionals and researchers looking for a well-rounded reference book. The structure is excellent and well conceived, and the book is a joy to read and revisit.

Reviewer: Harry Skianis

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