Principles of Broadband Switching and Networking

Tony T. Lee and Soung C. Liew

A JOHN WILEY & SONS, INC., PUBLICATION

Principles of Broadband Switching and Networking

WILEY SERIES IN TELECOMMUNICATIONS AND SIGNAL PROCESSING

John G. Proakis, Editor
Northeastern University

A complete list of the titles in this series appears at the end of this volume.

Principles of Broadband Switching and Networking

Tony T. Lee and Soung C. Liew

A JOHN WILEY & SONS, INC., PUBLICATION

Published by John Wiley & Sons, Inc., Hoboken, New Jersey
Published simultaneously in Canada

ISBN: 978-0-471-13901-0

Library of Congress Cataloging-in-Publication Data is available.

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

Dedicated to Professor Charles K. Kao for his guidance,
and to our wives, Alice and So Kuen, for their unwavering support.

CONTENTS

PREFACE

The past few decades have seen the merging of many computer and communication applications. Enabled by the advancement of optical fiber, wireless communication, and very-large-scale integration (VLSI) technologies, modern telecommunication networks can be regarded as one of the most important inventions of the past century.

Before the emergence of Broadband Integrated Services Digital Network (B-ISDN), several separate communication networks already existed. They include the telephone network for voice communication, the computer network for data communication, and the television network for TV program broadcasting. These networks are designed with a specific application in mind and are typically not well suited for other applications. For example, the conventional telephone network cannot carry high-speed multimedia services, which require diverse quality-of-service (QoS) guarantees to support multirate and multicast connections. In addition, these heterogeneous networks often require expensive gateways equipped with different access interfaces running different protocols.

Meanwhile, the appeal of interactive video communication is on the rise in a society that is increasingly information-oriented. Images and facial expressions are more vivid and informative than text and audio for many types of human interactions. For example, video conferencing has made distant learning, medicine, and surgery possible, while 3D Internet games give rise to real-time interactions between remote players. All these applications are based on high-resolution video with large bandwidth demands. These developments led to the emergence of B-ISDN—the concept of an integrated network to support communication services of all kinds to achieve the most cost-effective sharing of resources was conceived in the late 1980s.

This book focuses on the design and analysis of switch architectures that are suitable for broadband integrated networks. In particular, the emphasis is on packet-switched interconnection networks with distributed routing algorithms. The focus is on the mathematical properties of these networks rather than specific implementation technologies. As such, although the pedagogical explanations in this book are in the context of switches, many of the fundamental principles are relevant to other communication networks with regular topologies. For example, the terminals in a multi-hop ad hoc wireless network could conceivably be interconnected together to form a logical topology that is regular. This could be enabled by the use of directional