Digital Transmission Systems and Networks

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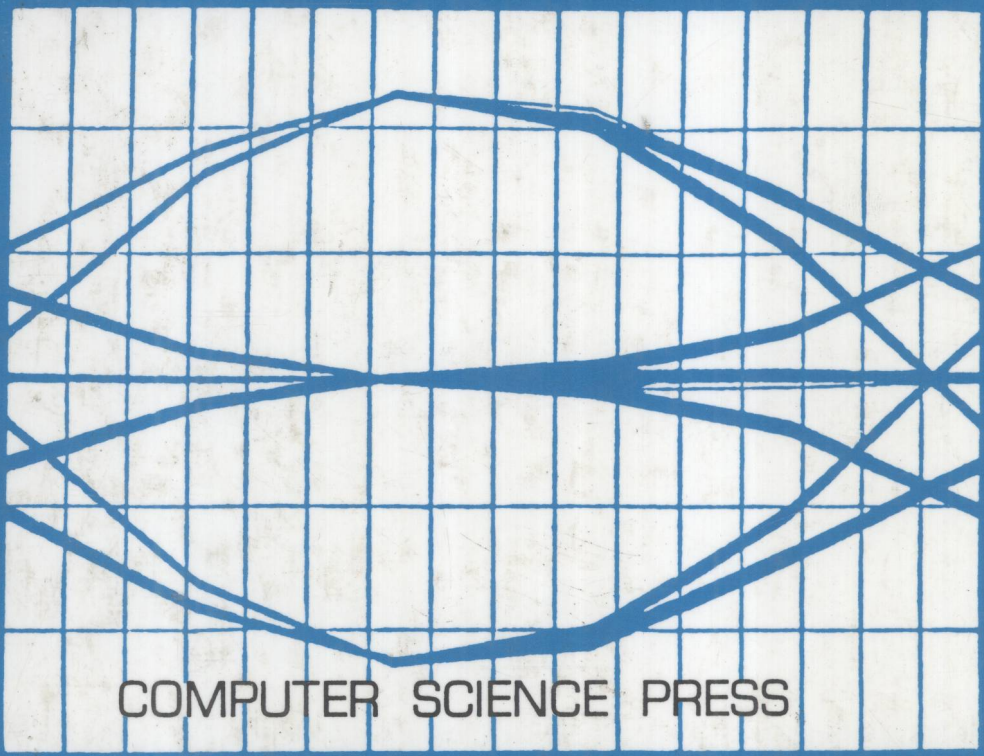

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Dedicated to
Edith, Kristina, David, Karen
and
Ameera, Sonya, Nisha

PREFACE

With the rapid growth of digital techniques in telecommunications networks, there is a need for a revised approach to the study of the principles and the applications of digital transmission systems and networks. The purpose of this two-volume text is to provide an introductory treatment of principles involved in digital communications (Volume I) and to integrate these principles into the applications environment (Volume II). The engineering aspects of integrated communications systems for telephony, television, data, and other network services are discussed in the second volume.

These texts should be useful for senior undergraduate students in the communication sciences, graduate students, and practicing engineers. They should also prove valuable to computer science students and software designers who wish to understand networks and their control. Network control and the design of special purpose software, associated with the management of networks under normal and abnormal conditions needs a firm grasp of the principles discussed in Volume I and their applications discussed in Volume II.

The two volumes are intended for a sequence of two semester courses in digital transmission systems and networks. Some familiarity with the principles of analogue communication systems will give the reader an appreciation of the digital techniques discussed in the two volumes. Prior exposure to basic probability theory related to random processes would be helpful.

Volume I, in particular, is concerned with the evolution of the digital networks, the different types of signals encountered in baseband digital transmission, intersymbol interference and pulse shaping, signal regeneration, measurement techniques, and digital encoding of speech. Considerable effort has been made to make the material useful to senior undergraduate students and to practicing engineers in the telecommunications industry. Emphasis is therefore given to a careful presentation of the essential concepts and typical engineering solutions with computer programs and without becoming unnecessarily concerned with too many theoretical proofs. The rapidly changing VLSI environment preempts our detailed presentation of the hardware realizations of the basic building blocks of these baseband systems.

Volume II is concerned with implementation of the principles (discussed in Volume I) in the physical networks for the transmission of data. In particular, digital radio, telephone, and computer networks are presented together with the implementation of error control in such networks. Integrated Services Digital

Networks (ISDN) and Digital Subscriber Systems (DSS) are also presented in considerable detail in the light of their capabilities, design, optimization, trade-offs, and the potential impact on the telephone networks around the world. We have delineated the steps and the optimizations undertaken in the early designs and progress of the 144 kbit/s facility and the 56 kbit/s circuit switched digital capability introduced by AT&T in the early eighties as a precursor to the ISDN-like network services now being offered by certain telephone operating companies in the United States. This volume is directed towards graduate students in telecommunications and practicing network and design engineers. It also provides an insight into the devices necessary to realize the network terminal functions. System programmers and software designers will find these discussions attractive in implementing the network control strategies.

The emphasis in these texts is on a pedagogic approach to understanding essential engineering concepts. Often this is achieved by examining a number of specific cases which illustrate an idea rather than by attempting to develop proofs for the general case. For many practicing engineers several years out of graduation, some basic tools of mathematical analysis have lain dormant and need to be revitalized. For a professional engineer working in a rapidly developing field such as telecommunications, an analytical appreciation of new ideas is essential. The purely descriptive approach is too limiting. The use of many problems with worked solutions in the text is intended to foster the reader's understanding and development of these analytical skills.

We anticipate that these texts should fill a gap in the current literature on the subject particularly with its emphasis on evolving digital networks. It can provide the basis of courses for senior students and for professional development courses for practicing engineers.

We are particularly grateful to Telecom Australia for supporting the initial preparation of this material. The result reflects the benefits of practical experience gained by each of us as employees of Telecom Australia and Bell Telephone Laboratories Inc., respectively. It is almost certain that this work would never have been commenced were it not for John Grivell, a senior engineer in Telecom Australia, who attended one of our lecture courses and recorded and annotated lecture notes which were much more clear and comprehensive than the original source material. We also wish to sincerely thank Dr. Teresa Buczkowska of the New South Wales Institute of Technology for contributing the chapter on computer networks and Professor Shu Lin of Texas A&M University for his influence on the section on error control. Thanks also go to Elaine Milsom, Judy Duval, and Isobel Keegan for their assistance with typing.

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Bell Communications Research at Morristown, New Jersey, where the original research work from AT&T Bell Laboratories was considerably extended. The opportunity to carry on the basic ISDN and CSDC work was initiated under the direction of Eric E. Sumner of the AT&T Bell Laboratories and by Frederick T. Andrews, now of Bell Communications Research. Dr. Ralph W. Wyndrum, Dr. Barry Bosik, Dr. Harold Seidel, and Dr. Peter Bohn of AT&T Bell Laboratories have also influenced the direction and findings we present in the last two chapters of the second volume. Dr. N. S. Jayant, William L. Shafer, and Albert J. Schepis of the AT&T Bell Telephone Laboratories, Joseph F. Urich, Rein R. Laane, Dr. Richard A. McDonald, Wilhelm H. von Aulock of Bell Communications Research have provided constructive comments based upon the manuscript we had presented to them.

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