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Gary Kessler and Peter Southwick

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# ISDN

Concepts, Facilities  
and Services

Gary C. Kessler  
Peter V. Southwick

Signature Edition

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**This book is dedicated to my wife and friend, Carol,  
and to my children, Sarah and Joshua.**

**—Gary C. Kessler**

**This book is dedicated to my loving wife, Michele,  
and my daughters, Gabriella and Victoria.**

**—Peter V. Southwick**

## PREFACE

Much has happened in the evolution of ISDN since this book, and the subsequent editions, were published. Not only have "narrowband" ISDN standards, products, and services evolved and matured, but applications have grown. ISDN is finally beginning to realize its promise. Of even more significance, perhaps, is the emergence of Broadband ISDN (B-ISDN) technologies and services. B-ISDN received passing mention in the first edition of this book and at least one dedicated chapter plus prominent mention in other chapters in the second edition; this treatment was pretty much consistent with what details of B-ISDN were known at the time of the writing. In this edition, B-ISDN occupies a significant portion of the book.

Another, perhaps related, evolutionary step is that it has become harder to maintain expertise in all facets of ISDN. For that reason, the first author was joined by a second for the third edition. We two have been colleagues for many years, and hope that our complementary approach improves the book's usefulness to its readers.

The same issues that motivated me<sub>GCK</sub> to write the first edition prompted the second and the third. ISDN is an important technology and an important evolution for the telecommunications industry. It is also timely and rapidly moving. This fourth, signature edition adds more up-to-date information about ISDN products and services, and offers a new focus on B-ISDN services, the Internet, and alternative digital subscriber line technologies.

GARY C. KESSLER  
PETER V. SOUTHWICK

## **PREFACE TO THE FIRST EDITION**

This book is a first introduction to some of the many aspects of the integrated Services Digital Network (ISDN). It is intended for those who must learn about ISDN, but feel intimidated by all of the technical jargon commonly found in the current literature. This book will define ISDN terms and explain concepts, allowing the reader to better understand the standards and current literature, as well as vendor's implementation and application specifications.

This book will provide broad coverage to explain what ISDN is, define relevant terms and concepts, describe pertinent standards and protocols, and discuss some of the current ISDN issues, services, trials, and products. In that way, it will serve as a first step in the reader's process of learning about the many aspects of ISDN.

It can be argued that consumers are not interested in technology, but rather in solutions to their problems. In data and telecommunications today, these issues are becoming increasingly inseparable. To truly understand all of the available communications solutions and choose the correct strategy for a given environment and application, there must also be some understanding of the underlying technology. This book will help the reader to get started on that understanding of ISDN.

## ACKNOWLEDGMENTS

Over several editions, many people have helped to prepare this book. David W. Amidon, Peter J. Cavender, Dr. Bruce J. Chalmer, Robert L. Dayton, Walter J. Goralski, Hirsch Grunstein, Dr. Thomas M. Oser, N. Todd Pritsky, and Steven D. Shepard reviewed various drafts and portions of this and prior editions, and made many valuable comments, adding to its readability, usefulness, and technical correctness. E. Raymond Hapeman prepared much of the original material on ISDN signaling for the first edition. Brian King has again turned rough drawings into the artwork that is used in this book. We thank them and appreciate their time and skill. We also thank Jay Ranade and Steven Elliot for their continued encouragement, Dennis Gleason for his expert copyediting, and Ruth Mannino for keeping everything else on track.

Many organizations provided us with product, service, and other information. Special thanks are due to Adtran, the Alliance for Telecommunications Industry Solutions (ATIS), ascom Timeplex, AT&T Microelectronics, AT&T Network Systems, Bellcore, Cray Communications, Digi International, the European Telecommunications Standards Institute (ETSI), ISDN'tek, the North American ISDN Users' Forum, Nortel, Tekelec, Teleos, 3Com, U.S. Robotics, and Xircom.

We also thank our students and colleagues over the years who, through their questions and discussions, have challenged us both to better understand ISDN and B-ISDN, and have frequently taught us.

The Internet and the Internet community have also proven to be invaluable aids. Many readers of past editions have made comments that have been incorporated in this version of the book, mostly through electronic mail. Information servers on the Internet hold an incredible amount of information, and we particularly appreciate Dan Kegel's ISDN Home Page at Cal Tech, as well as other servers at the ADSL Forum, ANSI, ATM Forum, Bellcore, ETSI, Frame Relay Forum, ITU-T, Motorola, NIUE, the University of Indiana, and so many other locations.

Finally, we thank our families for their continued support, faith, and, most of all, patience.

## HOW TO USE THIS BOOK

This book has been planned so that it may be useful to the telecommunications professional needing to learn more about various aspects of ISDN or by a professor/student in a telecommunications curriculum. The paragraphs below give the general flow of the book's chapters.

The first few chapters are generic background for both ISDN and B-ISDN. Chapter 1 provides an overview of some basic data and telecommunications topics. The concepts described in this chapter are essential for a good understanding of ISDN and B-ISDN technology. Chapter 2 defines terms and concepts necessary for the description and understanding of ISDN/B-ISDN standards, services, and products, as well as an overview of some of the standards organizations that are impacting ISDN and B-ISDN. Chapter 3 describes the categories of ISDN services, per the current standards. The topics in these three chapters provide a foundation for the rest of the book.

The next several chapters focus primarily of aspects of "narrowband" ISDN. Chapter 4 is an overview of the ISDN protocol architecture. Chapters 5 and 6 describe the Physical Layer and Data Link Layer protocols, respectively. Although these chapters do not go into intimate detail on the procedures associated with the protocols, they do contain technical information that may be oriented more toward implementors and product developers than to casual end-users. These chapters may be skimmed by those readers wanting only general information about these protocols without losing comprehension of the later chapters. Chapter 7 describes the interface between the user and the network. This chapter describes the basic procedures in which voice and data calls are established and terminated, and the use of supplementary services. This chapter is aimed at developers and users alike. Chapter 8 describes packet-mode (X.25) and frame-mode services, and serves as an introduction to how these data services can be offered in an ISDN. Chapters 4 through 8 can also be used as the basis for a much more rigorous treatment about the ISDN protocols.

Chapter 9 discusses National ISDN, a process to ensure compatible products and service offerings in the United States. Chapter 10 is devoted to Signaling System No. 7 (SS7), the common channel signaling network associated with ISDN. This chapter describes common channel signaling



network concepts, SS7 protocols, and SS7 services; the middle of the chapter may be skipped by those readers who are not interested in the SS7 protocol layers without losing comprehension about SS7 services.

The next several chapters finish off the general discussion about ISDN. Chapter 11 deals with ISDN applications, while Chapters 12 and 13 describe ISDN implementations, services, and products.

The next eight chapters discuss B-ISDN and fast packet switching technologies. Chapter 14 provides a general overview and definition of B-ISDN and fast packet, defining terms, concepts, and motivations for these technologies. This chapter is essential for an understanding of the chapters that follow.

Chapters 15 through 17 focus on frame relay. Chapter 15 describes frame relay technology and protocols in detail, followed by a chapter on frame relay call control signaling. Chapter 17 describes frame relay applications, products, and service offerings.

Similarly, Chapters 18 through 20 focus on Asynchronous Transfer Mode (ATM). Chapter 18 describes ATM technology and protocols in detail, followed by a chapter on ATM call control signaling. Chapter 20 describes ATM applications, products, and service offerings. In a related discussion, Chapter 21 describes Switched Multimegabit Data Service (SMDS).

The relationship between ISDN, B-ISDN, and the Internet is discussed in Chapter 22. This chapter stands alone, in many ways. The chapter begins with a discussion of the Internet, access to Internet services, and the protocols used on the Internet. The remainder of the chapter describes the relationship between ISDN/B-ISDN and Internet protocols, and how ISDN/B-ISDN may be used to access Internet services.

Finally, ISDN sparked a new set of local loop services based on Digital Subscriber Line (xDSL) technologies, which are described in Chapter 23. This chapter, too, stands alone in many ways but assumes a familiarity with ISDN DSL terms. The chapter begins with a discussion of the motivation for xDSL technologies with an emphasis on Asymmetric Digital Subscriber Line (ADSL) service, compares and contrasts xDSL and ISDN, then lists some current xDSL products and services.

This book has several appendices. Appendix A provides a list of the important abbreviations and acronyms that are used in the book (and in ISDN/B-ISDN literature). Appendix B lists significant ISDN, B-ISDN, and SS7 recommendations from the ITU-T, as well as specifications from the ADSL Forum, ANSI, the ATM Forum, Bellcore, ETSI, the Frame Relay Forum, IETF, NIUF, and the SMDS Interest Group. Appendix C lists the messages and information elements used for signaling across the ISDN

and B-ISDN user-network interface. Appendix D gives the addresses of the standards organizations mentioned in this book and addresses of Internet sites with additional information related to the issues described in this book. Finally, there is a glossary of ISDN-related terms, a reference list, and detailed index.

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