Preface

Introduction

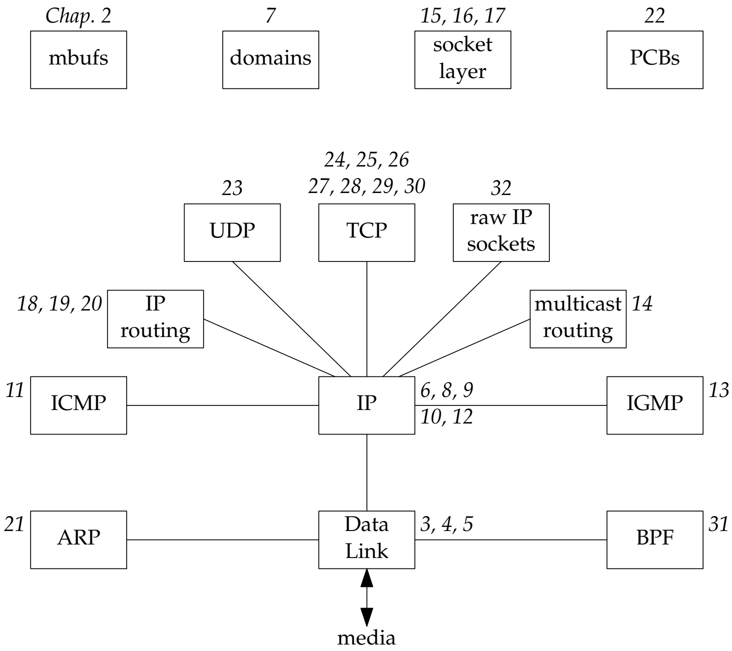
This book describes and presents the source code for the common reference implementation of TCP/IP: the implementation from the Computer Systems Research Group (CSRG) at the University of California at Berkeley. Historically this has been distributed with the 4.x BSD system (Berkeley Software Distribution). This implementation was first released in 1982 and has survived many significant changes, much fine tuning, and numerous ports to other Unix and non-Unix systems. This is not a toy implementation, but the foundation for TCP/IP implementations that are run daily on hundreds of thousands of systems worldwide. This implementation also provides router functionality, letting us show the differences between a host implementation of TCP/IP and a router.

We describe the implementation and present the entire source code for the kernel implementation of TCP/IP, approximately 15,000 lines of C code. The version of the Berkeley code described in this text is the 4.4BSD-Lite release. This code was made publicly available in April 1994, and it contains numerous networking enhancements that were added to the 4.3BSD Tahoe release in 1988, the 4.3BSD Reno release in 1990, and the 4.4BSD release in 1993. (Appendix B describes how to obtain this source code.) The 4.4BSD release provides the latest TCP/IP features, such as multicasting and long fat pipe support (for high-bandwidth, long-delay paths). Figure 1.1 (p. 4) provides additional details of the various releases of the Berkeley networking code.

This book is intended for anyone wishing to understand how the TCP/IP protocols are implemented: programmers writing network applications, system administrators responsible for maintaining computer systems and networks utilizing TCP/IP, and any programmer interested in understanding how a large body of nontrivial code fits into a real operating system.

Organization of the Book

The following figure shows the various protocols and subsystems that are covered. The italic numbers by each box indicate the chapters in which that topic is described.



We take a bottom-up approach to the TCP/IP protocol suite, starting at the data-link layer, then the network layer (IP, ICMP, IGMP, IP routing, and multicast routing), followed by the socket layer, and finishing with the transport layer (UDP, TCP, and raw IP).

Intended Audience

This book assumes a basic understanding of how the TCP/IP protocols work. Readers unfamiliar with TCP/IP should consult the first volume in this series, [Stevens 1994], for a thorough description of the TCP/IP protocol suite. This earlier volume is referred to throughout the current text as *Volume 1*. The current text also assumes a basic understanding of operating system principles.

We describe the implementation of the protocols using a data-structures approach. That is, in addition to the source code presentation, each chapter contains pictures and descriptions of the data structures used and maintained by the source code. We show how these data structures fit into the other data structures used by TCP/IP and the kernel. Heavy use is made of diagrams throughout the text—there are over 250 diagrams.

This data-structures approach allows readers to use the book in various ways. Those interested in all the implementation details can read the entire text from start to finish, following through all the source code. Others might want to understand how the protocols are implemented by understanding all the data structures and reading all the text, but not following through all the source code.

We anticipate that many readers are interested in specific portions of the book and will want to go directly to those chapters. Therefore many forward and backward references are provided throughout the text, along with a thorough index, to allow individual chapters to be studied by themselves. The inside back covers contain an alphabetical cross-reference of all the functions and macros described in the book and the starting page number of the description. Exercises are provided at the end of the chapters; most solutions are in Appendix A to maximize the usefulness of the text as a self-study reference.

Source Code Copyright

All of the source code presented in this book, other than Figures 1.2 and 8.27, is from the 4.4BSD-Lite distribution. This software is publicly available through many sources (Appendix B).

All of this source code contains the following copyright notice.

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Camera-ready copy of the book was produced by the authors. It is only fitting that a book describing an industrial-strength software system be produced with an industrial-strength text processing system. Therefore one of the authors chose to use the Groff package written by James Clark, and the other author agreed begrudgingly.

We welcome electronic mail from any readers with comments, suggestions, or bug fixes: `tcpipiv2-book@aw.com`. Each author will gladly blame the other for any remaining errors.

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