Network Manager's Reading List: TCP/IP, UNIX, and Ethernet

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Document Version 2.5
April, 1990

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Introduction

This is an annotated list of books and other resources of use to network managers who are using TCP/IP, UNIX, and Ethernet technologies.[1] These three technologies share the same major attribute: network managers can use them to build interoperable network systems across a wide range of vendor equipment. This list is intended for campus network managers at the University of Texas at Austin, or anywhere that TCP/IP, UNIX, and Ethernet are used to provide computer communications.

Each item in the list is annotated, and many items have introductory material quoted to help indicate their scope and organization. Access information is given for each item, and prices are included when available. The prices listed here are culled from a variety of sources and should be used only as a rough guide.

Comments, corrections, etc. are welcome and may be sent to **utnet@emx.utexas.edu.**

Section 1
TCP/IP

The TCP/IP protocol suite is widely implemented in a large range of computer systems. This means that it is possible for a network manager to use TCP/IP protocols to communicate among computers from many different vendors, running many different operating systems. This interoperability is the chief attribute that is driving the use of these protocols in network systems everywhere.

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[1]UNIX is a registered trademark of AT&T, Ethernet is a trademark of Xerox Inc.

The primary reference for the TCP/IP protocol suite is the set of standards maintained at the SRI Network Information Center, and called Request For Comments, or RFCs. Like all standards, however, the RFCs do not contain the tutorial material necessary to gain an understanding of how the protocol suite works, or how to manage a system running the TCP/IP protocols. The following items help fill in the context.

1. Introduction to TCP/IP

- **RFC 1118. The Hitchiker's Guide to the Internet**
  Ed Krol.
  See the Requests For Comments entry below for access information to the RFCs.

A quick introduction to the basic concepts and jargon of the TCP/IP Internet. Krol's primer contains instructions for finding more information from the DDN Network Information Center, and he includes a list of major RFCs that would be of interest to a network administrator. Updated as of September, 1989, and made available as RFC1118.

From the RFC:

''This RFC is being distributed to members of the Internet community in order to make available some ''hints'' which will allow new network participants to understand how the direction of the Internet is set, how to acquire online information and how to be a good Internet neighbor.''

''This document assumes that one is familiar with the workings of a non-connected simple IP network (e.g., a few 4.3 BSD systems on an Ethernet not connected to anywhere else). Appendix A contains remedial information to get one to this point. Its purpose is to get that person, familiar with a simple net, versed in the ''oral tradition'' of the Internet to the point that that net can be connected to the Internet with little danger to either. It is not a tutorial, it consists of pointers to other places, literature, and hints which are not normally documented.''

- **Internetworking With TCP/IP, Principles, Protocols, and Architecture**
  Douglas E. Comer.
  1988, Prentice Hall, Englewood Cliffs, New Jersey, 382 pps. with index and bibliography.
  ISBN 0-13-470154-2.
  $40.00.

An introduction to the TCP/IP protocol suite. The orientation of this book is useful for network managers who need to learn how the TCP/IP protocols fit into the greater scheme of things. For example, there is an appendix on ''4.3 BSD UNIX Interface to Internet Protocols'' that describes Berkeley sockets, and presents example client and server programs for a network whois service.

There's another appendix on ''Hints And Suggestions For Implementors'', that contains useful tips for network programmers. There's also an appendix called ''A Guide To RFCs'', which explains the Requests For Comments with due regard for the early folklore and development of the ARPANET. A guide to the first one thousand RFCs, extracted from RFC1000, is presented, as well as the electronic mail address and 800 phone number for getting your own copies of the RFCs.

From the Preface:

''For professionals, the book provides a comprehensive introduction to TCP/IP technology and the architecture of the Internet. Although it is not intended to replace protocol standards, the book is a good starting point for learning about internetworking because it gives a uniform overview that emphasizes principles. Moreover, it gives the reader

perspective that can be extremely difficult to obtain from individual protocol documents.''

''The book is organized into four main parts. Chapters 1 and 2 form an introduction that provides an overview and discusses existing technologies. In particular, Chapter 2 reviews physical network hardware. The intention is to provide basic intuition about what is possible, not to spend inordinate time on hardware details. Chapters 3-12 describe the TCP/IP Internet from the viewpoint of a single host, showing the basic services available and the protocols a host uses to access them. They cover the basics of Internet addressing and routing as well as the notion of protocol layering. Chapters 13-16 describe the architecture of the Internet when viewed globally. They explore the core gateway system and the protocols gateways use to exchange routing information. Finally, Chapters 17-19 discuss application level services available in the Internet. They present the client-server model of interaction and give several examples of how one can organize client and server software. The last section discusses electronic mail and the domain name system, two topics that are extremely popular.''

- **Volume 3. Handbook of Computer Communications Standards, Department of Defense (DOD) Protocol Standards**
  William Stallings, Paul Mockapetris, Sue McLeod, Tony Michel.
  Macmillan Publishing Co, New York, NY, 1988. 206 pps. with index.
  ISBN 0-02-948072-8.
  $34.95.

Part of a three volume set on computer communications protocols, this volume is a guide to the TCP/IP protocol suite. The chapters on IP and TCP were written by Stallings. The chapter on FTP is by Tony Michel, the SMTP chapter by Paul Mockapetris, and the Telnet chapter by Sue McLeod. The chapters are good descriptions of the various protocols and go into a fair amount of detail. While Douglas Comer's book is useful for showing how things hang together, this volume may be useful for a more in-depth view of the TCP/IP protocols than one gets in the Comer book. The RFCs described in Comer's book are, of course, the ultimate reference for the TCP/IP protocol suite.

From the Preface:

''This book is one of a series of books that provides a comprehensive treatment of computer communications standards. The series systematically covers the major standards topics, providing the introductory and tutorial material not found in the actual standards documents. The books function as a primary reference for those who need an understanding of the technology, implementation, design, and application issues that relate to the standards.''

''This volume, Volume 3, covers the five military standard protocols that have been issued by the DOD. The book begins by introducing the four-layer communications architecture that is the framework within which these standards fit. Following the introduction of this architecture, a chapter is devoted to each of the standards.''

- **Introduction to the Internet Protocols**
  Charles L. Hedrick.
  1987, Rutgers, The State University of New Jersey, 27 pps.
  Available via anonymous ftp from host **cs.rutgers.edu** in the **runet** subdirectory. The file is called **tcp-ip-intro.doc** and a PostScript version is available as **tcp-ip-intro.ps.** Instructions for using anonymous ftp can be found in the section on Requests For Comments, below.

This is a tutorial written by Charles Hedrick in July 1987. It serves as a quick introduction to the concepts and components of the TCP/IP protocol suite.

From the Introduction:

‘‘This document is a brief introduction to TCP/IP, followed by advice on what to read for more information. This is not intended to be a complete description. It can give you a reasonable idea of the capabilities of the protocols. But if you need to know any details of the technology, you will want to read the standards yourself. Throughout the text, you will find references to the standards, in the form of ‘‘RFC’’ or ‘‘IEN’’ numbers. These are document numbers. The final section of this document tells you how to get copies of those standards.’’

1.1. TCP/IP Network Design and Administration

- **Introduction to Administration of an Internet-based Local Network**
  Charles L. Hedrick.
  1988, Rutgers, The State University of New Jersey. 46 pps. No index.
  Same anonymous ftp access as the Introduction to Internet Protocols item above. The file names for this document are **tcp-ip-admin.doc** for the text file, and **tcp-ip-admin.ps** for the PostScript version.

This is a tutorial written by Charles Hedrick in July 1988, and intended for network managers faced with the task of setting up a campus network system based on TCP/IP protocols. The illustrations are limited to ASCII graphics, and there is no index, but nonetheless the information in this brief guide can be very helpful when it comes to unraveling the issues involved in the complex tangle of network addressing, network routing, network topologies, and network hardware.

Of special interest is the discussion of network repeaters, bridges, and routers, in which Hedrick describes the main features of each, and contrasts their function and utility in the creation of large network systems.

From the Introduction:

‘‘This document is intended to help people who are planning to set up a new network based on the Internet protocols, or to administer an existing one. It assumes a basic familiarity with the TCP/IP protocols, particularly the structure of Internet addresses.’’

‘‘This document does not attempt to replace technical documentation for your specific TCP/IP implementation. Rather, it attempts to give overall background that is not specific to any particular implementation. It is directed specifically at networks of "medium" complexity. That is, it is probably appropriate for a network involving several dozen buildings. Those planning to manage larger networks will need more preparation than you can get by reading this document.’’

1.2. Guide to the TCP/IP Internet

- **The Matrix, Computer Networks and Conferencing Systems Worldwide**
  John S. Quarterman.
  Digital Press, 1990. 719 pps. with index.
  ISBN 1-55558-033-5.
  $49.95 Digital Press part number for ordering is EY-C176E-DP. Digital Press phone is 800-343-8321.

John Quarterman is the Baedeker of the worldwide computer networks. In *The Matrix,* he has created a guidebook that describes the worldwide networks in more detail than ever before. There’s a large amount of information in this book, all clearly organized, and heavily indexed.

The chapter on the TCP/IP Internet describes the many networks that make up the Internet system, the various mail addressing formats for these networks, and contains descriptions of each network with maps showing their topology. An indispensable tool for the network manager, and especially valuable for those who must deal with wide area connections.

From the Preface:

‘‘The first half of the book contains background material that introduces some important topics for readers who are not familiar with them. References are provided for those who want more complete treatments. Chapters 1 and 2 introduce basic terminology and services so that Chapter 3 can discuss networked communities and the effects of this technology and its applications on them and on the larger world. The basic underlying networking protocols are outlined in Chapter 4. Management protocols and issues such as naming, addressing, routing, and interconnection of networks are treated in Chapter 5. Chapter 6 considers building actual networks from the technology, including network names, numerical size and speeds, geographical extent, administration, and funding. Chapter 7 sketches the 20 year history of the Matrix, the intrinsic limitations that affect it, its user communities, and constructed and de facto standards for protocols; some speculations on the future are also included. Interoperability requires standards and committees to produce them; these are discussed in Chapter 8.’’

‘‘Descriptions of specific systems occupy the second half of the book. They are organized geographically to facilitate discussions of regional history and approaches, and each is characterized according to the background material developed in the first half of the book. Maps are included when available. Syntaxes and gateways are provided for sending mail from one system to others. Access information is given for those wishing to join or research a system, and the extensive references found at the end of each chapter will be useful for further investigation.’’

1.3. Electronic Mail and the Internet

- **!%@:: A Directory of Electronic Mail Addressing and Networks**
  Donnalyn Frey and Rick Adams.
  O’Reilly & Associates, Petaluma, CA, 1989. 284 pps. with three-way index.
  ISBN 0-937175-93-0.
  $26.95

The primary focus of this book is on electronic mail addressing in and among the various computer networks. The first section describes the format and peculiarities of electronic mail addressing. The next section, and the major portion of the book, is a description of many of the worldwide networks. Each network description includes an explanation of the electronic mail addressing they use, contact information, a description of the network architecture, and a map of the network. This book is complementary to *The Matrix* listed above. It covers fewer networks and in less depth, but focuses on revealing the electronic mail aspects of those networks. As a quick desk reference for those attempting to unravel tangled mail headers, there’s nothing better.

From the preface:

‘‘Assume you need to know how to contact someone in Iceland who you met at a conference. You can use this book by turning to the three-way index and looking up Iceland to find ISNET, the network in Iceland. Next you turn to the section of the book on ISNET and read who participates in the network and how to address mail. Then you can look up an individual university or company in the alphabetical index of second-level domain addresses to help you create a working electronic mail address for your correspondent.

You can also send electronic mail to the contact person for ISNET, listed under Contact, and ask how you might find an address for your colleague in Iceland.''

1.4. Network Management Tools

- **A Network Management Tool Catalog: Tools for Monitoring and Debugging TCP/IP Internets and Interconnected Devices**
  NOCTools Working Group

  An RFC that is also an FYI. The number is RFC1147, or FYI2. FYIs are a new category of document available from the SRI NIC.

  Following is access info extracted from the SRI NIC announcement for this document:

  ''This FYI can be obtained via FTP from NIC.DDN.MIL. Using FTP, login with the FTP username ANONYMOUS and password GUEST. Use the pathname FYI:FYI2.PS, or RFC:RFC1147.PS (for the secondary version use FYI:FYI2.TXT, or RFC:RFC1147.TXT).''

  ''Note: This is a PostScript FYI RFC, a secondary version is available in ASCII. The secondary ASCII version may lack figures and the information encoded in typographic variation (italics, boldface, etc.). Since this information often provides esssential context, the ASCII version is at best incomplete and at worst misleading. Anyone expecting to understand this document is strongly encouraged to obtain the PostScript version.''

The NOCTools RFC/FYI is a collection of network management tools known to the Internet Engineering Task Force members who collaborated to produce the RFC. The RFC lists software and hardware based tools available from both commercial and non-commercial sources. The RFC also includes a brief tutorial on network management. This RFC provides a useful guide to the territory of network management, and includes good general introduction to the specific topic of TCP/IP network management.

From the Introduction and Purpose sections:

''This catalog contains descriptions of several tools available to network managers in debugging and maintaining TCP/IP internets and interconnected communications resources. Entries in the catalog tell what a tool does, how it works, and how it can be obtained.''

''The practice of re-inventing the wheel seems endemic to the field of data communications. The primary goal of this document is to fight that tendency in a small but useful way. By listing the capabilities of some of the available network management tools, we hope to pool and share hard-won knowledge and experience.''

1.5. Requests For Comments

The official specifications for the Internet Protocol family of network protocols are called Requests For Comments (RFCs). These RFCs are available in hard copy and electronically. The central depository for the RFCs is SRI Inc., in Menlo Park California.

The address of the DDN Network Information Center at SRI is:

DDN Network Information Center
SRI International
333 Ravenswood Avenue
Menlo Park, CA 94025
800-235-3155 or 415-859-3695

Electronic mail address: NIC@NIC.DDN.MIL

1.5.1. Electronic Mail Server

The RFCs are available via electronic mail from a mail server maintained by SRI's DDN Network Information Center. The following message is the help file from SRI's electronic mail server, which provides a quick description of how the mail-based server operates:

NIC Mail Services November 1989

This is an automated service provided by the DDN Network Information Center. It allows access to NIC documents and information via ordinary electronic mail. This is especially useful for people who do not have access to the NIC via a direct Internet link, such as BITNET, CSNET and UUCP sites.

To use the mail service, send a mail message to SERVICE@NIC.DDN.MIL. In the SUBJECT field, request the type of service you wish followed by any needed arguments. The message body is normally ignored. Large files will be broken into smaller separate messages. The information you request will be sent back to you as soon as possible.

The following services are currently available:

HELP This message; a list of current services.
HOST xxx Returns information about host xxx. WHOIS xxx can also be used to get more details about a host.
IDEA xxx xxx is a file name or the word INDEX for INTERNET-DRAFTS.
IEN nnn nnn is the IEN number or the word INDEX.
NETINFO xxx xxx is a file name or the word INDEX.
RFC nnn nnn is the RFC number or the word INDEX.
RFC nnn.PS to retrieve an available Postscript RFC. Check RFC INDEX for form of RFC.
SEND xxx xxx is a fully specified file name.
WHOIS xxx Returns information about xxx from the WHOIS service. Use "WHOIS HELP" for information on how to use WHOIS.

Example SUBJECT lines:

HELP
RFC 822
RFC INDEX
RFC 1119.PS
NETINFO DOMAIN-TEMPLATE.TXT
SEND RFC:ASSIGNED-NUMBERS.TXT
HOST NIC.DDN.MIL
WHOIS NEOU, VIVIAN

Send comments or suggestions to SUGGESTIONS@NIC.DDN.MIL. Send questions and bug reports to BUG-SERVICE@NIC.DDN.MIL.

1.5.2. Anonymous FTP

The RFCs are also available via an anonymous login for the file transfer program. If you have the file transfer program known as FTP, and access to the nationwide Internet, you may ftp files from the SRI NIC by typing:

ftp nic.ddn.mil

When prompted for a name, type

anonymous

When prompted for a password, type your username and host. At this point you can use the file retrieval commands supported by the ftp program to retrieve the RFC you desire. If you would like to retrieve the index to all RFCs, which is a good place to start for example, the following command in the Sun UNIX ftp program:

get RFC:RFC-INDEX.TXT rfc-index.txt

would retrieve a copy of the file ‘‘RFC-INDEX.TXT’’ from the RFC: directory on the SRI computer and write it to a file called ‘‘rfc-index.txt’’ on the Sun computer used in our example.

Here’s an example of the actual commands sent and received during an anonymous ftp request for the index to all RFCs from SRI.

```
% ftp nic.ddn.mil
Connected to nic.ddn.mil.
220 NIC.DDN.MIL FTP Server Process 5Z(47)-6 at Mon 12-Mar-90 07:38-PST
Name (nic.ddn.mil:myname): anonymous
331 ANONYMOUS user ok, send real ident as password.
Password: (typed my name and host address here - no echo from ftp server)
230 User ANONYMOUS logged in at Mon 12-Mar-90 07:39-PST, job 37.
ftp> get rfc:rfc-index.txt rfc-index.txt
200 Port 11.47 at host 128.83.134.2 accepted.
150 ASCII retrieve of TS:<RFC>RFC-INDEX.TXT.1146 (55 pages) started.
226 Transfer completed. 139615 (8) bytes transferred.
local: rfc-index.txt remote: rfc:rfc-index.txt
139615 bytes received in 60 seconds (2.3 Kbytes/s)
ftp> quit
221 QUIT command received. Goodbye.
```

Section 2
UNIX

The UNIX operating system is a major reason for the growth in the use of TCP/IP network protocols carried between computers over Ethernet LANs. Workstations running UNIX, and equipped with TCP/IP software and Ethernet hardware, have become common at many sites. The following items can help the network manager understand how UNIX fits into the networking equation.

2. UNIX In General

UNIX and how it networks can be a daunting subject to the newcomer. To help try to cut things down to size, the next two items provide both background and context on UNIX in general, and UNIX network administration in particular.

- **Life With UNIX**
  Don Libes, Sandy Ressler.
  Prentice Hall, NJ., 1989, 346 pps. with index.
  $29.95.
  ISBN 0-13-536657-7.

Everything you always wanted to know about the UNIX operating system, but couldn't find out from anyplace else. This book includes much undocumented folklore about how UNIX grew, and why things are the way they are. A useful companion to the standard UNIX documents. Reading this book is like having a UNIX expert at your elbow when it comes to figuring out how things fit together in the UNIX world.

From the Preface:

''No matter what people have told you, you can't learn UNIX from the manuals, or even the sources. UNIX is so much more than that. To understand UNIX is to understand its users and its applications, as well as its failures and flaws. This is just some of what this book hopes to cover.''

''Make sure you realize what this book isn't. It isn't a textbook on C or UNIX programming. (There are already plenty of good ones.) You won't learn how to write shell scripts or what is in the kernel. Well, maybe a little. But you will learn plenty of useful things. Things that will fill in gaps between other useful and useless things you already know about UNIX.''

- **UNIX System Administration Handbook**
  Evi Nemeth, Garth Snyder, and Scott Seebass.
  Prentice Hall, Englewood Cliffs, NJ. 1989. 593 pps. with index and bibliography.
  ISBN 0-13-933441-6.
  $32.00

An exceptionally comprehensive and useful guide to UNIX administration. Among the many issues discussed in this book are how to go about acquiring an IP address for your host, registering a domain name, and how to set up printing to remote hosts over the network. Of special interest is a long (83 pps.) section on ''Networking under BSD.'' This section covers Berkeley UNIX networking using Ethernet hardware and TCP/IP network protocols.

Included is a short section on how Ethernet works, featuring a list of typical Ethernet components and prices. Following is a section on TCP/IP and how to set up the various UNIX files to make the networking software run. There's also a description of some network design issues, followed by a section that describes the Sun Network File System protocols and operation. There are even a few pages on how to debug and monitor the network. This is much needed information for the UNIX administrator faced with the task of attaching their host to the network.

From the preface:

'' Without guidance, it's easy for a new administrator to lose sight of ultimate goals in a sea of documentation or to inadvertently skip over one or more critical areas through failure to realize that they are important. That is where this book fits in. While we can't claim that *everything* you need to know is included, we can guarantee that after reading it you will know pretty much what UNIX administration involves and how to go about it.''

‘‘The first six chapters of this book are presented in a sequence you should find useful if you are bringing up a system straight from the packing crate. In this section are contained the bare essentials, things you need to know just to get the system up and running. Chapters 7-14 introduce the various kinds of hardware that are typically used with UNIX and discuss how to install, configure, and operate this equipment. Chapters 15-19 discuss five important UNIX software subsystems: electronic mail, telephone communication, network news, backups, and accounting. The rest of the chapters represent a grab-bag of UNIX topics, some of which may not concern you.’’

2.1. UNIX Networking In Detail

The next several items look at UNIX networking in more technical detail.

- **UNIX Network Programming**
  W. Richard Stevens
  1990, Prentice Hall, Inc., 772 pps. with index and annotated bibliography.
  ISBN 0-13-949876-1.
  $41.00.

This is a wide-ranging treatment of the networking software found in modern UNIX implementations. The book contains scores of program examples, and is indispensable reading for the network software developer. A useful reference for anyone who wants an in-depth understanding of the internals of UNIX networking software.

From the Preface:

‘‘This book provides both the required basics that are needed to develop networking software along with numerous case studies of existing network applications. The intent of this book, however, is to concentrate on the development of *software* to use a computer network.’’

‘‘This text is divided into four parts.

1. The framework of a Unix process (Chapter 2), and IPC between processes on a single system (Chapter 3).
2. An overview of networking (Chapter 4), and a description of some networking protocols currently in use (Chapter 5): TCP/IP, Xerox NX (XNS), IBM’s SNA, NetBIOS, the OSI protocols, and UUCP. These two chapters provide the networking background for the remainder of the text.
3. Transport layer interfaces: Berkeley sockets and System V TLI (Chapters 6 and 7). These are the interfaces that an application uses to communicate across a network.

4 Networking examples (Chapters 8 through 18). The specific examples covered are: security, time and date servers, file transfer, line printer spoolers, remote command execution, remote login, remote tape drive access, and remote procedure calls.’’

- **Operating System Design - Volume II, Internetworking with Xinu**
  Douglas Comer.
  1987, Prentice Hall, Englewood Cliffs, NJ., 567 pps. with index and bibliography.
  ISBN 0-13-637414-X.
  $48.00.

This book is based on the Xinu operating system software whose availability from Purdue University is described in the book. Xinu was written to give students the experience of studying a UNIX-like operating system whose source code was available for modification. Lots of software examples in every chapter make this an especially useful text for aspiring network programmers. It’s also good resource for those just curious as to what

network software looks like, and how it fits together.

From the Preface:

‘‘Chapters 1-11 comprise a self-contained unit that covers the basics of internet communication. Each of the eleven chapters explores one component of internet protocol software, motivating and explaining how that component fits into the overall system design. The unit starts with a detailed examination of one network technology, the Ethernet, and moves on to consider the internet concept, address resolution, internet datagrams, routing, control messages, user datagrams, and datagram demultiplexing. Later chapters build on the basic communication system, examining client-server interaction, and remote file access, as well as a user interface and commands that manipulate both local and remote files.’’

‘‘Written as a continuation of ’Operating System Design - The XINU Approach’ (Comer [1984]), this text starts where the earlier one ends. The two volumes were written to support a two-semester course in systems design that encompasses operating systems and networks... .’’

- **UNIX Networking**
  Stephen G. Kochan and Patrick H. Wood, Consulting Editors.
  1989, Hayden Books, Indianapolis, Indiana. 400 pps. with index.
  ISBN 0-672-48440-4.
  Price $29.95.

An introduction to the various networking protocols and services that one is likely to find in UNIX systems. There are ten chapters, written by various authors, on such subjects as UUCP, TCP/IP, NFS and RPC, Streams, and so on. The chapter on TCP/IP describes the BSD 4.3 library routines and system calls used in application programs based on TCP/IP.

From the Introduction:

‘‘This book provides both a historical and technical look at UNIX networks. The book is organized with the earliest UNIX networks appearing first, and each chapter has an overview of the history of the development of that networking system.’’

- **The Design and Implementation of the 4.3BSD UNIX Operating System**
  Samuel J. Leffler, Marshall Kirk McKusick, Michael J. Karels, John S. Quarterman.
  1989, Addison-Wesley Publishing Co., Reading, Mass. 471 pps. with index and glossary.
  ISBN 0-201-06196-1

An in-depth look at the design and implementation of 4.3BSD UNIX. Section 4 describes UNIX Interprocess Communication. This section includes Chapter 10, which describes the socket mechanisms, and Chapters 11 and 12, which cover Network Communication and Network Protocols, respectively. These chapters provide an in-depth look into the details of the BSD networking implementation, written by engineers who had a hand in making the decisions.

From the Preface:

‘‘The book covers 4.3BSD from the system-call level down -- from the interface to the kernel to the hardware itself. The kernel includes system facilities, such as process management, memory management, the I/O system, the file system, the *socket* IPC mechanism, and network-protocol implementations. Material above the system-call level—such as libraries, shells, commands, programming languages, and other user interfaces—is excluded, except for some material related to terminal interface and to system startup. Like Organick’s book about Multics, it is an in-depth study of a contemporary operating system.’’

‘‘Readers who will benefit from this book include operating-system implementors, system programmers, UNIX application developers, administrators, and curious users. The book may be read as a companion to the source code of the system, falling as it does between the manual and the code in detail of treatment. But the book is specifically neither a UNIX programming manual nor a user tutorial. Familiarity with the use of some version of the UNIX system and with the C programming language, would be extremely useful.’’

Section 3
Ethernet

Ethernet is the de facto LAN technology on most campuses and many other sites. The major advantage that Ethernet brings to the network manager is the same advantage shared by all three technologies listed here: interoperability. Ethernet is in common use because it has been widely implemented in many different computer systems. This allows the network manager to link systems built by many different vendors using the same Ethernet LAN.

Since Ethernet is also an international LAN standard, there’s a huge number of vendors selling Ethernet equipment. That helps keep the costs down, and has led to a steady stream of innovations which have made it easier to build departmental LANs using standard Ethernet.

3. Introduction to LANs

These books introduce the general field of local area networks. The book by John McNamara covers the basic concepts of LANs. The second book, by Thomas Madron, contains a more detailed introduction, with a survey of IEEE Project 802 LAN standards that includes IEEE 802.3/Ethernet.

- **Local Area Networks**
  John E. McNamara.
  Published by Digital Press, 1985, 165 pps. with index and glossary.
  $29.00 (quoted from DEC Direct).
  ISBN 0-932376-79-7.
  Digital Press part number for ordering is EY-00051-DP. Digital Press phone is 800-343-8321.

This is a general introduction to the concepts and basic technologies of LANs. McNamara keeps it simple, while still managing to cover a lot of different technologies. The special problems of extending local area networks and supporting campus area networks are discussed as well.

From the Preface:

‘‘This book is intended for students, computer system managers, telecommunications managers, and others who want to become more familiar with local area networks. Since product offerings in this area are constantly changing, a deliberate attempt has been made to emphasize the general principles, operating characteristics, and problem areas of local area network hardware, rather than cite specific product examples.’’

- **LANs, Applications of IEEE/ANSI 802 Standards**
  Thomas W. Madron.
  John Wiley & Sons, New York, NY., 1989, 308 pps. with index and glossary.

$34.95.
ISBN 0-471-62049-1.

An introduction to LANs from the point of view of the evolving network standards. This book is useful for the outlook it presents on the world of network standards, and how they interrelate. The various standards agencies are described, the OSI model is explained, and then the IEEE 802 series of standards for LANs, including 802.3/Ethernet, are introduced in detail. Finally, the basics of TCP/IP operation and the function of LANs in the delivery of TCP/IP services are described.

From the Preface:

‘‘The object of this book is to provide a reasonably detailed overview of contemporary LAN standards, especially those developed through the auspices of the Institute of Electrical and Electronics Engineers (IEEE). To be meaningful, however, the discussion of the IEEE standards is placed in the context of the development of standards generally, then in the framework of the Open System Interconnection (OSI) Reference Model of the International Organization for Standardization (ISO). After describing the IEEE standards (from 802.1 through 802.6), the way in which the standards can be applied in ’real’ networks is illustrated through a discussion of the Manufacturing Automation Protocol (MAP) and the Transmission Control Protocol/Internet Protocol (TCP/IP), in Chapters 9 and 10 respectively.’’

3.1. Ethernet Installation Guide

This slightly out-of-date manual from HP is still one of the better sources for tutorial information on how to construct Ethernet coaxial cables. There are similar manuals available from DEC, but the DEC manuals tend to focus exclusively on the DEC building wiring plan for Ethernet. The DEC system is called DECconnect, and is based on 10BASE2 thin Ethernet.

- **LAN Cable and Accessories Installation Manual**
  Published by Hewlett-Packard Co, January 1986. Approx. 204 pps. with index.
  $43.00.
  HP Part No. 5955-7680. Order from HP Direct at 800-538-8787.

This manual is old, and therefore does not mention the twisted-pair Ethernet system. On the other hand, the thick Ethernet configuration information is useful and the guidelines for routing cables are informative. Thin Ethernet is also covered, using HP’s ThinLAN name for the technology.

Another nit to pick is that HP’s cable grounding guidelines allow metallic coax cable to be connected between buildings if HP’s surge arrestors are installed, and strict guidelines as to cable type and length are observed. Given the ease of using fiber optic cable and fiber optic repeaters, and the dangers inherent in metallic network cables that travel between building frames, one would prefer that these guidelines be modified to encourage the use of industry standard fiber optic cables. No doubt this is another example of the age of this manual, since the fiber optic inter repeater link is a relatively recent IEEE standard.

The manual really shines when it comes to descriptions of thick cable and thin cable tooling and construction. The wire strippers and connector crimpers required for each cable type are described, although only HP part numbers are cited for these tools. There are also diagrams showing how to prepare each kind of cable for connectors, and how to crimp on N connectors and BNC connectors. There are useful safety warnings throughout the manual that explain the hazards of the tools, and the dangers that may be present when working on cable systems. The manual also shows how to tap a thick

Ethernet cable for installation of the typical non-intrusive vampire tap transceiver.

There's a short section on verifying the cables you've built, and a longer section on how to use a time domain reflectometer to test networks. As it happens, the crimp tools for Ethernet connectors shown in this manual use a mechanism that prevents them from opening until they have closed all the way. That can be painful if a finger, rather than a connector, gets into the works. The HP manual thoughtfully includes an appendix on how to get your finger out of a crimp tool, should the need arise.

3.2. Ethernet Troubleshooting Guide

- **LAN Troubleshooting Handbook**
  Mark A. Miller.
  1989, M&T Publishing Co., Redwood City, CA., 309 pps. with index.
  $29.95.
  ISBN 1-55851-054-0

An wide-ranging guide to troubleshooting information for several LAN technologies, including Ethernet. The author manages to fit a large amount of technical information about three LAN technologies, Ethernet, token ring, and ARCNET, into one volume. The troubleshooting information is clear, and the book is well illustrated. The material on Ethernet covers two sections; one on coaxial cable based Ethernets (both thick and thin), and one on twisted pair Ethernet technology, including Synoptics LattisNet and AT&T StarLAN products. The evolving IEEE 10BASE-T unshielded twisted pair system is described as well.

From the Preface:

''Chapters 1, 2, 3, and 4 address the generic issues of LAN standards, Documentation, Test Equipment, and Cabling. Chapters 5, 6, 7, and 8 address specific issues associated with popular LAN architectures: ARCNET, Token Ring, Ethernet, and StarLAN, respectively. Also included in the network-specific chapters are examples of protocol analysis of Novell's NetWare, IBM's NetBIOS, DEC's DECnet, and TCP/IP. Chapter 9 concludes with a dose of preventative medicine.''

3.3. The Ethernet Standards

The next several items list the formal Ethernet standards in use today. Be warned that these items contain no tutorial or background material at all. They are the technical standards for Ethernet/802.3 LANs, and they can be heavy going for non-engineers.

3.3.1. Version 2.0, DEC-Intel-Xerox (DIX) Ethernet Standard

- **Ethernet Local Area Network Specification Version 2.0. November, 1982**
  Digital Equipment Corporation, Intel Corporation, Xerox Corporation, 103 pps.
  $32.00.
  DEC Part Number: AA-K759B-TK. Available from DEC-Direct by calling 800-344-4825.

This is Version 2.0 of the original ten-megabit Ethernet specification. The newer IEEE 802.3 standard supersedes the DIX spec listed here, but many network protocol implementations still use the Ethernet frame from this DIX specification.

This specification is organized according to the OSI model, but unlike more recent standards, it uses language that is still fairly close to English. That makes it a document much more approachable by the non-expert than the IEEE standards tend to be. The DIX spec is still a technical standard, however, and contains no tutorial information on the

design and operation of Ethernets. Just the facts.

3.3.2. IEEE 802.3 Standard (ISO 8802.3)

The IEEE 802.3 standard has been superseded by the International Organization for Standardization (ISO) 8802-3 : 1989 (E) standard. What this means is that Ethernet is now an international LAN standard, based on the US LAN technology that was invented by Xerox, and standardized first by the DIX group, and then by the IEEE.

This, in turn, means that the IEEE sells the new ISO 8802-3 book now, instead of the older IEEE 802.3 book.

- **International Standard ISO 8802-3, ANSI/IEEE Std 802.3, Information Processing Systems - Local Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications**
  First edition 1989-02-24.
  ISBN 1-55937-005-X.
  $65.00 (from IEEE publications catalog). IEEE members get 50% off on their first copy of a standards publication.
  Available from, IEEE Service Center, 445 Hoes Lane, Piscataway, New Jersey 08854-1331, or by calling 1-800-678-IEEE.

The latest specifications for an Ethernet-like CSMA/CD LAN. Despite the major reworking of the original DIX spec by IEEE, and despite several changes made in the way things work, the IEEE and DIX specs are functionally more alike than they are different. The changes that have caused problems are the ones that affect the signals and wiring on the transceiver (AUI) cable, primarily used in older thick Ethernet installations.

Old and new equipment can interoperate well on Ethernet LANs, despite the differences in the DIX and IEEE/ISO specifications. For example, many network protocol implementations (TCP/IP among them) continue to use the original DIX Ethernet frame. At the same time, campus Ethernets used to interconnect the computers running these implementations, also contain Ethernet equipment built according to both the DIX and 802.3 specs. The standards were written so that mixing things together like this still works.

The ISO/IEEE standard contains much more jargon than the DIX standard and can be much less understandable at first. An explanatory guide to the OSI world, like Madron's book listed above, is a necessity to help the newcomer to OSI-based specs make any sense of it all.

- **Supplements to Carrier Sense Multiple Access with Collision Detection,ANSI/IEEE Std 802.3b, c, d, and e-1989**
  $49.50 (from IEEE publications catalog).
  ISBN 0-471-61153-0 Same access as above.

The companion document to ISO 8802-3 above. This supplement contains a set of additions to the standard, including the Fiber Optic Inter Repeater Link. Also included is the broadband standard (Type 10BROAD36) and a revision of section 9 of the 1985 standard on repeaters.

3.4. Ethernet Hardware and Vendors

Ethernet hardware comes in several forms. At the lowest level, there's the basic parts consisting of cable and connectors. Next level up, there are built components like transceivers, transceiver cables, Ethernet interfaces, and repeaters. At the higher levels of network concatenations are devices such as Ethernet bridges and routers.

Just to keep things interesting, there are also different parts for the different types of Ethernet such as thick coax, thin coax, unshielded twisted pair, and broadband. Every vendor also seems to have a special variation of something like Ethernet hubs, or special Ethernet transceiver cable stretchers, or what have you. It's a large market, and impossible to cover in any short list of resources such as this one.

The next several items list representative examples of various Ethernet vendors. Larger lists of vendors may be found in vendor guides published by the various LAN magazines.

3.4.1. Ethernet Parts - Coaxial Cable.

There are many wire vendors selling Ethernet coaxial cables and transceiver cables. Belden Wire and Cable is one major wire vendor that has been making Ethernet coaxial cables from the very beginning of the Ethernet standards. They have a line of coaxial cables for both thick and thin Ethernet. Belden also sells transceiver cables.

Note that Belden offers a special 10BASE2 thin Ethernet cable that is not exactly the same outside diameter as the general RG 58 A/U or C/U cables used as acceptable media examples in the thin Ethernet specifications (10BASE2). Belden also offers the standard RG58 cables. If you order crimp-on connectors for the Belden 10BASE2 cable, you need to make sure that the BNC connectors you use will crimp onto the Belden cable properly. Check with the connector vendor, and tell them what cables you intend to use their connectors on.

Belden has regional distributors across the US. Call their 800 number for more information.

Belden Wire and Cable
P.O. Box 1980,
Richmond, IN 47375

Phone 1-800-BELDEN-1

3.4.2. More Ethernet Parts: Connectors and Other Components

At the cable level you need things like cable connectors, tooling to install the connectors, cable terminators and other such essential small components. Once again, there's a large number of vendors selling such equipment. One distributor's catalog that lists many different vendors is the Anixter catalog.

The Anixter Wiring Systems Product Catalog is a vast compendium of all manner of communications equipment. It has separate sections for both Ethernet and DEC's special Ethernet wiring system called DECconnect. The catalog also features a 65 page glossary of communication industry terms, and a 45 page index. All in all a quite useful resource for the LAN manager. Many different vendors are represented in the catalog. Catalogs are available from your local Anixter distributor, or try:

Anixter Bros., Inc.
4711 Golf Road
Skokie, IL 60076
Phone 312-677-2600

3.4.3. Ethernet Components and Other Equipment

There are also hundreds of high quality vendors when it comes to Ethernet equipment like transceivers, repeaters, etc. A few are listed in the Anixter catalog, above. One vendor not listed in the Anixter catalog, but used at the University of Texas at Austin, is Cabletron Inc. It's also true that equipment from many other vendors is in use at the

University of Texas at Austin. The Cabletron listing shown here is simply as a representative example.

Your site may have different requirements for network equipment, and an independent evaluation should be conducted to find the best equipment for your needs. Lists of Ethernet equipment vendors may be found in the various LAN magazines and network trade journals.

Cabletron equipment has features that have proved useful in building and operating departmental LANs. The use of multiple diagnostic LEDs on most of the Cabletron equipment has proven to be a major benefit when troubleshooting LAN problems. Other thoughtful design features, such as including a brace for securing transceiver cables on the multiport transceiver box, have been handy as well.

Cabletron sells directly from the factory, and from local distributors.

Cabletron Systems, Inc.
Cabletron Industrial Park.
E. Rochester, NH 03867
Phone 603-332-9400

3.5. Ethernet Numbers

In this section some essential Ethernet numbers are covered in a couple of different ways. The first item consists of a collection of Ethernet numbers that are useful in network debugging. The second item lists the standards agencies that oversee the type field and the Ethernet/802.3 address assignments.

3.5.1. Ethernet Troubleshooting Numbers

The DIX specification includes an Ethernet type field in the frame. This field is used to specify which type of high level network protocol is being carried by the Ethernet frame. The type field was dropped in the 802.3 frame specification, in favor of a more general, and more complex, set of frame specifiers. Nevertheless, most vendors still use the DIX frame specification, and its Ethernet type field. The list of Ethernet troubleshooting numbers below, contains descriptions of which type number corresponds to which protocol family. This information is useful in network debugging.

Ethernet addresses contain another set of useful numbers. The Ethernet address is divided into two blocks of 24 bits each. The first block is used for the number identifying a specific manufacturer. If you know this manufacturer number, you can frequently identify the kind of host that is causing network problems.

A list of useful Ethernet numbers for troubleshooting can be found in the latest Assigned Numbers RFC. The Assigned Numbers RFC that contains the Ethernet numbers is RFC1046. This RFC may be retrieved as described in the section on RFCs earlier in this document. This is a useful RFC to have on hand, since it also lists special numbers for the TCP/IP protocol suite and the TCP/IP implementation in UNIX, among other things.

3.5.2. Ethernet Type Field

The Ethernet type field is part of the DIX specification, and was dropped in the 802.3 spec. Nonetheless, many vendors still use the DIX frame, and most TCP/IP implementations are based on the DIX frame. Xerox Corp. manages the list of Ethernet type fields. The Ethernet patents are owned by Xerox as well, and licenses to build Ethernet equipment using these patents can be arranged from the following source.

Xerox Corporation
Xerox Systems Institute
475 Oakmead Parkway
Sunnyvale, CA 94086
408-737-4652

As stated in a recent Xerox literature catalog:

''Per Appendix B of the Ethernet Specification, a Ethernet type field will be assigned on written request to each licensee of Ethernet patents. The licensing fee is $1000.00. Others wishing to obtain type field assignments may do so by including a $300.00 administrative fee with their written request.''

3.5.3. IEEE 802.3 Addresses

The 48-bit Ethernet address is now known as a unique Host Identification number. Old addresses assigned by Xerox remain valid, but all new Ethernet addresses are assigned by the IEEE. A block of addresses costs $1000.00. The address for inquiries is:

IEEE Standards Office
820 Second Avenue, 7th Floor
New York, NY 10017-4504
(201) 981-0060

3.6. Ethernet Technical Report

There have been many papers written about the Ethernet system over the years. A number of them have been based on simulations and simplifications of the Ethernet protocols. As a result, a persistent mythology about Ethernet performance has been established. Some people will tell you, based on these simulations and simplifications, that Ethernet systems saturate at relatively low packet rates. Fortunately, the analyses didn't stop there.

The following technical report from the Digital Equipment Corporation's Western Research Lab documents empirical evidence showing that the 10 megabit Ethernet system is capable of transmitting large amounts of data in a reliable fashion. The report is also useful for its analysis of what makes a good Ethernet implementation. Included is a brief set of guidelines for the network manager who wants their Ethernet system to run as well as possible.

- **Measured Capacity of an Ethernet: Myths and Reality**
  David R. Boggs, Jeffrey C. Mogul, Christopher A. Kent.
  Proceedings of the SIGCOMM '88 Symposium on Communications Architectures and Protocols, ACM SIGCOMM, Stanford, CA., August 1988, 31 pps.

From the Abstract:

''Ethernet, a 10 Mbit/sec CSMA/CD network, is one of the most successful LAN technologies. Considerable confusion exists as to the actual capacity of an Ethernet, especially since some of the theoretical studies have examined operating regimes that are not characteristic of actual networks. Based on measurements of an actual implementation, we show that for a wide class of applications, Ethernet is capable of carrying its nominal bandwidth of useful traffic, and allocates the bandwidth fairly.''

This paper is also available over the Internet via electronic mail from the DEC Western Research archive server. Send a message to the following address with the word ''help'' in the Subject line of the message for detailed instructions. The address is WRL-

Techreports@decwrl.dec.com.

You may also request a copy of the report through the U.S. postal system by writing to:

Technical Report Distribution
DEC Western Research Laboratory, UCO-4
100 Hamilton Avenue
Palo Alto, California 94301

Access

Aside from access information listed above, the following book store can be of service:

Computer Literacy Bookshop
2590 North First St.
San Jose, CA 95131
Phone 408-435-1118 for mail orders.

A good source for computer and electronics books of all kinds. They carry the IEEE network standards, and can probably supply most of the books listed above.