Network Reading List:
TCP/IP, UNIX, and Ethernet

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Abstract

This annotated list of resources is intended for network managers, developers, and users at the University of Texas at Austin, or anywhere that TCP/IP, UNIX, and Ethernet are used to provide computer communications.* These three networking technologies share the same major attribute: they can be used to build interoperable network systems across a wide range of computer equipment. Because of their ability to provide the glue that holds networks together, TCP/IP, UNIX, and Ethernet are in wide use on campus and at many other sites.

*UNIX is a registered trademark of AT&T.

Introduction

This annotated list of resources was created to help you find information about TCP/IP, UNIX, and Ethernet. The list describes a number of items that cover the range from introductory to in-depth information.

This list is not comprehensive; instead it tries to describe those items that cover the territory well, and that deal with real-world problems found on growing networks. This list is not current, either; the amount of literature in this field is large and growing every day.

Why These Three Technologies?

The three technologies featured in this list are in wide use on campuses, at research centers and corporations, and at a rapidly growing number of sites worldwide. The popularity of TCP/IP, UNIX, and Ethernet is largely due to the vendor-neutral character of these technologies, which helps make interoperable networking possible.

All three technologies are ‘‘open’’ in that the software and specifications are readily available. The TCP/IP protocols were developed with public funding and are in the public domain. UNIX is provided by a wide range of vendors and has included support for TCP/IP protocols and Ethernet for many years. The specification for Ethernet was published by a multi-vendor consortium and has since become a world-wide standard. Any vendor can develop products based on these three widely available technologies, and many have. This openness is the key to the network interoperability that these technologies provide.

While there is no precise definition of network interoperability, it is often taken to mean a set of computers of widely varying types that are capable of working well together. In an interoperable network system you can get your work done across a range of computer systems linked by a common set of standard network protocols, network software, and network hardware.

In the network computing environment on campus today you will find equipment in use that comes from a wide variety of computer vendors. In such an environment interoperability isn’t just a desirable feature, it’s essential to the operation of the network system.

Another common feature of today’s networks is their growth and increasing complexity. TCP/IP, UNIX, and Ethernet have proven their ability to adapt as networks evolve and more and more users are added. These technologies make it possible to build large networks that are both reliable and fast, and that can support thousands of users.

Organization

The list was designed to be as self-contained as possible, and to make it easier for you to decide whether you want to follow up on a given resource.

ISBN book numbers are shown to make it easier to find and order the books listed here. Prices are included when available, quoted in US dollars. The prices should be treated only as a rough guide however, since they may have changed by the time you read this list.

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

Section 1

This is Section 1 of a four-section document entitled ‘‘Network Reading List: TCP/IP, UNIX, and Ethernet.’’ The four sections of this annotated list of resources were created to help you find information about TCP/IP, UNIX, and Ethernet. The complete list describes a wide range of items, including both introductory and in-depth information.

Section 1 covers TCP/IP resources, Section 2 covers UNIX, Section 3, Ethernet, and Section 4, miscellaneous items.

1. TCP/IP

A major advantage of the TCP/IP protocol suite is that it is widely implemented in many computer systems. This makes it possible for network managers to use TCP/IP protocols to link computers from many vendors.

The TCP/IP protocol suite was originally developed for the Advanced Research Projects Agency (ARPA), of the US Department of Defense. The original ARPANET was developed to explore the abilities of packet switching networks and it led, in turn, to the system of national and international networks known as the Internet.

In the US the Internet connects regional network systems, and the regional networks link university campuses, corporate sites, etc. This system of IP networks allows you to send electronic mail, transfer files, and otherwise interact with computers no matter where they are located, as long as they are attached to the Internet.

The formal network standards for the TCP/IP protocol suite are available as a set of documents known as Request for Comments (RFCs). The RFCs contain a wealth of material, and some RFCs are written specifically to provide tutorial information on the TCP/IP protocol suite.

However, most of the RFCs are technical specifications and do not contain introductory material to help the newcomer. Also, the details of managing a TCP/IP network are not covered in the formal network protocol specifications. To help fill in the gaps, this section begins with a look at some books that explain how things work. It also includes several guides to the worldwide network system that has grown up around the TCP/IP protocols.

1.1. Guides to the Internet

- **The Internet Companion**
  Tracy LaQuey with Jeanne C. Ryer
  1993, Addison-Wesley, 196 pps with index and bibliography
  ISBN 0-201-62224-6
  $10.95

An excellent beginner’s guide to the global Internet. Written for a general audience, this guide provides an overview of the Internet as well as a briefing on the major services provided on the Internet. An appendix provides a number of useful resources including a list of public access systems that provide individual accounts for access to the Internet. The text of this book is being made available on the Internet, two chapters a month. You can FTP them from **world.std.com** in the **pub/OBS/The.Internet.Companion** directory.

From the Preface:

‘‘We will tell you why you need to know about the Internet and show you how people are already using it in their everyday activities. We’ll explain how it vitalizes your home or office workstation beyond the usual capacities of word processing, games, and spreadsheet applications. And we’ll introduce you to basic Internet concepts and applications--showing how it’s possible to travel electronic highways and reach destinations such as Australia or Switzerland in mere seconds. If you’re not already connected to the Internet, we’ll show you how you can get access with only a computer and a modem.''

- **The Whole Internet User's Guide and Catalog**
  Ed Krol
  O'Reilly & Associates, Petaluma, CA, 1992.
  376 pps. with index and annotated resource guide.
  ISBN 1-56592-025-2
  $24.95

The best general guide to the territory of the Internet. Ed Krol's book functions both as a tutorial on the basic Internet services and as a travel guide to a wide range of resources that can be found on the networks. Krol also discusses several of the newer information finding services such as the Internet Gopher, the Wide Area Information Server (WAIS), and the World-Wide Web (WWW).

The book's audience is the general computer user, which means that you don't have to be a programmer or networking guru to benefit from the wide range of material in this book. Included is an excellent chapter that provides a step by step approach to dealing with network problems and figuring out why things may not be working correctly. Also included is the Whole Internet Catalog which provides an alphabetic list of Internet resources from Aeronautics and Astronautics to Zymurgy.

From Chapter One:

``In particular, here's what we will cover:
-o- How to log on to other computers on the Internet (telnet). (...)
-o- How to move files from one computer to another (ftp). (...)
-o- How to send electronic mail to other people who use the Internet. (...)
-o- How to read and participate in group discussions (USENET news). (...)
-o- How to find where various network resources, ranging from people to software to general databases, are located (``white pages,'' archie, gopher, WAIS, World-Wide Web). One of the Internet's problems is that it's too rich; there are so many resources available, it's hard to find what you want, or to remember where what you want is located. A few years ago, the network was like a library without a catalog. The ``cataloging'' tools are just now being put into place. We'll tell you how to use some new and exciting tools (and some older, less-exciting tools) to locate almost anything you might possible want, ranging from people and software to sociological abstracts and fruit-fly stocks.''

- **Cruise of the Internet**
  Merit Network, Inc.

Merit is a non-profit consortium of state-supported universities in Michigan. The Merit Network Information Center has produced a computer-based guided tour of the Internet that runs on both Mac and DOS computers.

You can use anonymous FTP to copy the files from host **ftp.merit.edu** in directory **internet/resources/cruise.mac** or **internet/resources/cruise.dos** Use the ''bin`` setting in FTP when copying the files to make sure that they remain in their original format. Instructions for using anonymous FTP can be found in the access to resources in Section 4. From the README file:

> Merit's ``Cruise of the Internet'' is a computer-based tutorial for new as well as experienced Internet ``navigators.'' The Cruise will introduce you to Internet resources as diverse as supercomputing, minorities, multimedia, and even cooking. It will also provide information about the tools needed to access those resources.
>
> The Cruise is designed to run on either Macintosh or DOS-compatible computers that meet the following specifications:

Mac - A Macintosh II, LC or Quadra series computer
- 8-bit color and any color monitor (12" minimum)
- System 6.05 or 7.x
- Approximately 3 MB of disk space
- 4 MB RAM is recommended"

DOS - An IBM-DOS or DOS-compatible computer
- XGA- or XGA-compatible adapter set to display 256 colors at 640x480
- Microsoft Windows(TM) version 3.1 running in enhanced mode
- Approximately 1.5 MB of disk space
- 2 MB RAM minimum

If you can't get the Cruise directly from the online archive, you have one other option. The Cruise is available on 1.44MB HD diskettes for both DOS and Mac for $10.00 per copy. Send your name and address, specify the operating system, and include a check or money order (payable to ‘‘University of Michigan’’) or your VISA/MasterCard number (including the expiration date and your signature) to:
Merit Network, Inc.
Information Services
2901 Hubbard, Pod G
Ann Arbor, MI 48105

- **Tour of the Internet**
  HyperCard Stack
  The NSF Network Service Center (NNSC)

This guide is based on HyperCard, a program that runs on Macintosh computers. The guide includes a large amount of information on both the structure and the content of the Internet. The set of cards in this HyperCard stack contain information on subjects ranging from the networks that make up the Internet, to how to find a variety of specific services available via the Internet. The HyperCard stack includes a section reserved for local information on your network. This allows you to customize the stack for use at your site.

From the README file:

‘‘The NSF Network Service Center (NNSC), a project of the Laboratories business unit of the Systems and Technologies Division, has developed a Tour of the Internet in HyperCard (TM) format for novice network users. The stack has basic information including history, sample email, ftp, and telnet sessions, and a glossary. The Tour is intended to be a fun and easy way to learn about the Internet.’’

‘‘We have included a ’Local Info’ section as part of the Tour. This section is a place where an organization can add information relevant to its own group of users, for example a listing of resources at that site, or other, specialized information.’’

‘‘In order to run this stack, you need to have HyperCard 2. HyperCard 2 requires Macintosh system 6.0.5 or higher.’’

Access Information for Internet Tour

The Internet Tour HyperCard stack is available via anonymous FTP from host **nnsc.nsf.net** in the **internet-tour** directory. The file **Internet-Tour-README** contains instructions on how to retrieve the HyperCard stack and convert it into a HyperCard file on your Macintosh. Instructions for using anonymous FTP can be found in the access to resources in Section 4.

An alternative method of access is to use the CSNET INFO-SERVER as described in the following excerpt from the README file:

(1) Send a message to 'INFO-SERVER@sh.cs.net'. You do not need a subject field. The text of your message must be in a special format (this is very important), but it does not matter whether the letters are uppercase or lowercase.
REQUEST: nsfnet
topic: INTERNET-TOUR
TOPIC: HELP
request: end

''Request: nsfnet'' tells the Info-Server to look for the topics in the NSFNET section of the Info-Server. ''Topic:internet-tour'' orders BOTH of the files about the tour, ''Internet-Tour-readme'' and ''Internet-Tour.sit.hqx''. ''Topic: help'' orders a file with information about other NSFNET files in the CSNET Info-Server.

(2) If you want to order ONLY the file ''Internet-Tour.sit.hqx'', put the following request in the text of your message:
request: NSFNET
topic: internet-tour.sit.hqx
REQUEST: end

1.2. Electronic Mail and the Internet

- **!%@:: A Directory of Electronic Mail Addressing and Networks**
  Third edition due June 1993
  Donnalyn Frey and Rick Adams.
  O'Reilly & Associates, Petaluma, CA, 1989. 420 pps. with three-way index.
  ISBN 1-56592-031-7
  $27.95

This directory describes how to use electronic mail. The first section of the book contains a general description of the format and peculiarities of electronic mail addressing. The next section, the major portion of the book, contains brief descriptions of many of the worldwide networks. Each network description includes an explanation of the electronic mail addressing in use, contact information, and a map of the network. As a quick desk reference for the harried network manager who is trying to unravel tangled electronic mail messages, there's nothing better.

From the preface:

''If you routinely send electronic mail, this book will provide you with up-to-date, concise information on the major electronic mail networks around the world. If you are an administrator or network manager, your users can use this book to find information on networks themselves, without asking you.''

''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.''

1.3. TCP/IP Network Administration

- **TCP/IP Network Administration**
  Craig Hunt
  1992, O'Reilly & Associates, Petaluma, CA
  ISBN 0-937175-82-X

$29.95

A guide to TCP/IP administration that collects all the bits and pieces of network administration in one place. The topics in the book range from the basics of TCP/IP protocols and how to set up a TCP/IP address on your machine, to configuration of name service, mail service, and routing. The target machine is a UNIX system running System V or SunOS.

From the Preface:
‘‘This book is intended for everyone who has a UNIX computer connected to a TCP/IP network. This obviously includes the network managers and the system administrators who are responsible for setting up and running computers and networks, but the audience also includes any user who wants to understand how his or her computer communicates with other systems. The distinction between a ‘‘system administrator’’ and an ‘‘end-user’’ is growing increasingly fuzzy. You may think of yourself as an end-user, but if you have a UNIX workstation on your desk, you’re probably also involved in system administration tasks.’’

Contents include:
- overview of TCP/IP
- delivering the data
- name service concepts
- getting started
- basic configuration
- configuring the interface
- configuring routing
- configuring DNS name service
- network applications
- sendmail
- troubleshooting TCP/IP
- network security
- other sources of information
- appendixes include: network contacts, forms, a gated reference, named reference

- **Introduction to Administration of an Internet-based Local Network**
  Charles L. Hedrick.
  1988, Rutgers, The State University of New Jersey. 46 pps. No index.
  Available via anonymous FTP from host **cs.rutgers.edu** in the **runet** subdirectory. The file is called **tcp-ip-admin.doc** and a PostScript version is available as **tcp-ip-admin.ps** Instructions for using anonymous FTP can be found in the access to resources in Section 4.

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.’’

- **The Simple Book**
  An Introduction to Management of TCP/IP-based Internets
  Marshall T. Rose
  1991, Prentice Hall, Englewood Cliffs, New Jersey, 384pps with index and bibliography.
  ISBN 0-13-812611-9
  $54.00

As the TCP/IP Internet has grown, the problem of how to manage the network system has grown as well. The approach to network management that has evolved for TCP/IP is based on the Simple Network Management Protocol (SNMP), described in this, *The Simple Book.* Marshall Rose is an expert in the field and has been involved in the standards process that led to the adoption of SNMP. The *Simple Book* explains how the SNMP protocols work, and how they are organized. Marshall Rose candidly discusses the politics of standards development, and includes some pithy observations on this subject between the ‘‘soapbox’’ icons in the book’s margins.

From the Preface:

‘‘This book is intended to serve both as a graduate-level text and also as a professional reference. It is expected that the reader has a modest background in networking.’’

‘‘The first part of the book, Chapters 1 and 2, presents a brief history of networking and the need for network management. Following this, the Internet suite of protocols is examined. Since this is a book about managing TCP/IP-based internets, many of the management details can make sense only in the presence of a discussion of the protocols and systems being managed. The text tries to present a ‘‘detailed introduction.’’ That is, the level of information must be deep enough so that management issues can be explored later on, but not too detailed so as to dwell on the nuances of each protocol.’’

‘‘The second part of the book, Chapters 3 through 5, details the Internet-standard Network Management Framework. In particular, the Structure of Management Information (SMI) and the Management Information Base (MIB) are thoroughly explored, followed by the mechanism used to manage internets, the Simple Network Management Protocol (SNMP).’’

‘‘The third part of the book, Chapter 6, briefly introduces the policies used to manage internets. The actual policies (as opposed to mechanical aspects) of network management are currently poorly understood, so only a basic coverage can be presented at this time.’’

‘‘The fourth part of the book, Chapter 7, gives an overview of an actual implementation, the 4BSD/ISODE SNMP package. Both an agent and manager implementation will be examined, along with a common Applications Programmer’s Interface (API).’’

‘‘Finally, as the book concludes, future trends are identified in Chapter 8. In the appendices, the book contains a chapter on Internet management ‘‘lore’’ (commonly asked questions and answers), various lists of object assignments and definitions, and so on. In addition, ordering information for ISODE is given.’’

1.4. The Request for Comments (RFCs)

A major advantage of the TCP/IP protocol suite is that the formal protocol standards are readily available. The standards documents that describe the protocols are freely available over the Internet, or they can be purchased in hard copy form.

These standards are known as Request for Comments, or RFCs. The origin of the name is described in RFC 1000. RFC 1000 describes the evolution of the RFCs, beginning with the original protocol developers who, being graduate students and faced with the need for publishing the evolving technical specifications, chose to call the documents Request for Comments so as not to offend anyone who might be in charge of the newly chartered ARPANET. Most of the RFCs are still available, and the entire set of RFCs provides a rare look at the evolution of a major protocol suite.

The Internet is still evolving, and RFCs are still being written to guide, codify, and explain this evolution. Some of the RFCs are purely informative in nature, aimed at the newcomer to TCP/IP networking, or intended to help programmers implement the standards correctly. When looking for an RFC be sure to check the RFC index for the latest version, since RFCs are updated when changes are needed.

The RFCs are available electronically by way of the File Transfer Program (FTP), as well as by electronic mail. Both of these methods are described below. Hard copies of the RFCs are also available from SRI International as described below.

1.4.1 Some Useful RFCs

The books by Douglas Comer and Marshall Rose contain guides to the RFCs, listed by category, and these guides can provide a handy navigational aid through the sea of specifications. As of this writing there are over 1,450 RFCs listed in the RFC index, and it's impossible to describe even the most important ones here. Instead, listed next are some examples of RFCs written as purely informative documents as well as some RFCs describing essential numbers used in the TCP/IP protocols.

- **RFC1462, FYI on ''What is the Internet?''**

''This FYI RFC answers the question, ''What is the Internet?'' and is produced by the User Services Working Group of the Internet Engineering Task Force (IETF). Containing a modified chapter from Ed Krol's 1992 book, "The Whole Internet User's Guide and Catalog," the paper covers the Internet's definition, history, administration, protocols, financing, and current issues such as growth, commercialization, and privatization.''

- **RFC1359, Connecting to the Internet: What connecting institutions should anticipate.**

''This FYI RFC outlines the major issues an institution should consider in the decision and implementation of a campus connection to the Internet.

In order to provide clarity to the reader, some specific information has been detailed. In doing so, the document has been directed toward U.S. academic institutions that have not yet connected to the Internet.

However, the issues for which specific information has been provided can be generalized for any organization that wishes to participate in the world-wide Internet community. It will be necessary for those organizations to obtain the correct and detailed information from their local or national IP service providers. In addition, this document may be used as an evaluation checklist for organizations that are currently connected. Readers are expected to have general familiarity with networking concepts and terminology.''

- **RFC1244, Site Security Handbook**

A comprehensive list of the issues to be considered when developing computer and network security policy at your site. Includes a brief description of each issue, as well as a guide to security-oriented mailing lists and software. Also includes an annotated bibliography of other resources for information on security issues.

- **RFC1208, A Glossary of Networking Terms**

A relatively short glossary produced to help a newcomer to networking find their way around the special jargon and acronyms used in the networking industry.

- **RFC1207, Answers to Commonly Asked ‘Experienced Internet User’ Questions**

This is one of two RFCs called ‘‘Questions and Answers,’’ produced by the User Services Working Group of the Internet Engineering Task Force. This set of Questions and Answers focuses on the sort of questions that might be asked by someone with experience using the Internet.

- **RFC1325, Answers to Commonly Asked ‘New Internet User’ Questions**

The companion RFC to RFC1207. This set of Questions and Answers focuses on the sort of questions that might be asked by someone new to the Internet.

- **RFC1175, Where to Start: A Bibliography of Internetworking Information.**

This 42-page RFC contains an extensive bibliography on TCP/IP and the Internet, including several of the resources listed here. Also included is a list of conferences and workshops of interest to those in the field, as well as a set of newsletters on the subjects of TCP/IP and the regional network systems.

- **RFC1173, Responsibilities of Host and Network Managers: A Summary of the ‘‘Oral Tradition’’ of the Internet**

This short (5 page) RFC attempts to fill in some gaps by providing operational guidelines for network managers and host system managers. As noted in the title, the guidelines presented here are of the sort that ‘‘everybody knows’’ but that are rarely documented.

- **RFC1178, Choosing a Name for Your Computer**

This short RFC provides some guidelines that can help ease the task of choosing a reasonable network name for your computer.

- **RFC1118, Hitchikers Guide to the Internet**

This 24 page RFC is an informal guide to the basic concepts and the jargon of the TCP/IP Internet, intended for newcomers to TCP/IP.

- **RFC1402, There’s Gold in them thar Networks! or Searching for Treasure in all the Wrong Places.**

An RFC written to help network users navigate among the many sources of information in the Internet. From the RFC: ‘‘This document was presented at the 1991 ACM SIGUCCS User Services Conference. It appears here in its updated form.

There is a wealth of information on the network. In fact, so much information that you could spend your entire life browsing. This paper will present some of the "gold nuggets" of information and file repositories on the network that could be of use to end users.

The ultimate goal is to make the route to these sources of information invisible to the user. At present, this is not easy to do. I will explain some of the techniques that can be used to make these nuggets easier to pick up so that we can all be richer.’’

- **RFC1360, Official Protocol Standards**

This RFC is the most recent version of the Official Protocol Standards. This frequently updated RFC describes the TCP/IP standards creation process, as well as listing the RFCs that are the officially recognized TCP/IP standards.

- **RFC1340, Assigned Numbers**

The most recent version of the Assigned Numbers RFC as of this writing. The Assigned Numbers RFC contains a description of the IP addressing fields as well as lists of all the essential numbers used in various parts of the protocol suite. This RFC also contains a list of Ethernet numbers of interest to anyone managing Ethernets. When looking for a copy of the Assigned Numbers RFC make sure to get the most recent version, as this RFC is periodically updated.

- **RFC1180, A TCP/IP Tutorial**

A brief description of the basic structure of the TCP/IP protocol suite and how it works. Includes a description of sending TCP/IP datagrams over Ethernet networks, and how the ARP protocol is used to build links between IP and Ethernet addresses.

- **RFC1147, FYI on a Network Management Tool Catalog: Tools for Monitoring and Debugging TCP/IP Internets and Interconnected Devices**

This RFC is a large collection of tools for network management, including sources for public domain software for network testing and troubleshooting. The RFC includes a network management tutorial that describes some of the basic concepts of networking monitoring and management. A handy guide to a rapidly growing area.

- **RFC1122, Requirements for Internet Hosts - Communication Layers**
  RFC1123, Requirements for Internet Hosts - Application and Support

These two ‘‘Host Requirements’’ RFCs provide the latest guidelines and interpretations for the TCP/IP protocols. Together they represent the latest understanding of how the protocol suite functions, as well as providing corrections and expanded information for many of the prior RFCs. These two documents are essential companions to the RFCs that are listed as standards for the TCP/IP protocol suite.

- **RFC 1000, The Request For Comments Reference Guide**

This 149 page RFC contains an annotated guide to the first 1000 RFCs, along with a brief history of the origins of the RFCs.

1.4.2 Electronic Mail and FTP Access to the RFCs

The RFCs and several other documents in this guide may be retrieved using the TCP/IP-based File Transfer Program (FTP). If your computer supports the FTP program, and you have direct access to the Internet, you may retrieve such documents via the ‘‘anonymous FTP’’ process as described in the access to resources in Section 4.

The RFCs listed above, and many more, are also available via e-mail for those without a direct Internet connection. One source of information for both FTP and electronic mail access to the RFCs is a mail server located at **isi.edu**. To get information on using the ISI mail server send a message to **mail-server@isi.edu** with the world ‘‘help’’ in the message body. Do not use quotation marks in the message you send, just the word ‘‘help’’ by itself.

To find a location for retrieving copies of the RFCs send a message to **mail-server@isi.edu** with the command ‘‘help: ways_to_get_rfcs’’ in the message body. Once again, do not include the quotation marks. In reply you will be sent a file that lists a large number of sites that provide on-line access to the RFCs and many other documents. Here are some excerpts from that document:

> **Where and how to get new RFCs**
>
> RFCs may be obtained via EMAIL or FTP from many RFC Repositories. The Primary Repositories will have the RFC available when it is first announced, as will many Secondary Repositories. Some Secondary Repositories may take a few days to make available the most recent RFCs.
>
> **Primary Repositories:**
>
> RFCs can be obtained via FTP from DS.INTERNIC.NET, NIC.DDN.MIL, FTP.NISC.SRI.COM, NIS.NSF.NET, NISC.JVNC.NET, VENERA.ISI.EDU, WUARCHIVE.WUSTL.EDU, SRC.DOC.IC.AC.UK, or FTP.CONCERT.NET.
>
> **1. DS.INTERNIC.NET - InterNIC Directory and Database Services**

RFC’s may be obtained from DS.INTERNIC.NET via FTP, WAIS, and electronic mail. Through FTP, RFC’s are stored as rfc/rfcnnnn.txt or rfc/rfcnnnn.ps where ’nnnn’ is the RFC number. Login as "anonymous" and provide your e-mail address as the password. Through WAIS, you may use either your local WAIS client or telnet to DS.INTERNIC.NET and login as "wais" (no password required) to access a WAIS client. Help information and a tutorial for using WAIS are available online. The WAIS database to search is "rfcs".

2. NIC.DDN.MIL (aka DIIS.DDN.MIL)

RFCs can be obtained via FTP from NIC.DDN.MIL, with the pathname rfc/rfcnnnn.txt (where "nnnn" refers to the number of the RFC). Login with FTP username "anonymous" and password "guest".

3. FTP.NISC.SRI.COM

RFCs can be obtained via FTP from FTP.NISC.SRI.COM, with the pathname rfc/rfcnnnn.txt or rfc/rfcnnnn.ps (where "nnnn" refers to the number of the RFC). Login with FTP username "anonymous" and password "guest". To obtain the RFC Index, use the pathname rfc/rfc-index.txt.

SRI also provides an automatic mail service for those sites which cannot use FTP. Address the request to MAIL-SERVER@NISC.SRI.COM and in the body of the message indicate the RFC to be sent: "send rfcNNNN" or "send rfcNNNN.ps" where NNNN is the RFC number. Multiple requests may be included in the same message by listing the "send" commands on separate lines. To request the RFC Index, the command should read: send rfc-index.

4. NIS.NSF.NET

To obtain RFCs from NIS.NSF.NET via FTP, login with username "anonymous" and password "guest"; then connect to the directory of RFCs with cd /internet/documents/rfc. The file name is of the form rfcnnnn.txt (where "nnnn" refers to the RFC number).

For sites without FTP capability, electronic mail query is available from NIS.NSF.NET. Address the request to NIS-INFO@NIS.NSF.NET and leave the subject field of the message blank. The first text line of the message must be "send rfcnnnn.txt" with nnnn the RFC number.

5. NISC.JVNC.NET

RFCs can also be obtained via FTP from NISC.JVNC.NET, with the pathname rfc/RFCnnnn.TXT.v (where "nnnn" refers to the number of the RFC and "v" refers to the version number of the RFC).

JvNCnet also provides a mail service for those sites which cannot use FTP. Address the request to SENDRFC@JVNC.NET and in the subject field of the message indicate the RFC number, as in "Subject: RFCnnnn" where nnnn is the RFC number. Please note that RFCs whose number are less than 1000 need not place a "0". (For example, RFC932 is fine.) No text in the body of the message is needed.

6. VENERA.ISI.EDU

RFCs can be obtained via FTP from VENERA.ISI.EDU, with the pathname in-notes/rfcnnnn.txt (where "nnnn" refers to the number of the RFC). Login with FTP username "anonymous" and password "guest".

7. WUARCHIVE.WUSTL.EDU

RFCs can also be obtained via FTP from WUARCHIVE.WUSTL.EDU, with the pathname info/rfc/rfcnnnn.txt.Z (where "nnnn" refers to the number of the RFC and "Z" indicates that the document is in compressed form).

At WUARCHIVE.WUSTL.EDU the RFCs are in an "archive" file system and various archives can be mounted as part of an NFS file system. Please contact Chris Myers (chris@wugate.wustl.edu) if you want to mount this file system in your NFS.

8. SRC.DOC.IC.AC.UK

RFCs can be obtained via FTP from SRC.DOC.IC.AC.UK with the pathname rfc/rfcnnnn.txt.Z or rfc/rfcnnnn.ps.Z (where "nnnn" refers to the number of the RFC). Login with FTP username "anonymous" and password "your-email-address". To obtain the RFC Index, use the pathname rfc/rfc-index.txt.Z. (The trailing .Z indicates that the document is in compressed form.)

9. FTP.CONCERT.NET

To obtain RFCs from FTP.CONCERT.NET via FTP, login with username "anonymous" and your internet e-mail address as password. The RFCs can be found in the directory /rfc, with file names of the form: rfcNNNN.txt or rfcNNNN.ps where NNNN refers to the RFC number. This repository is also accessible via WAIS and the Internet Gopher.

1.4.3 Hard Copies of the RFCs

Paper copies of the RFCs may be acquired from SRI International.

- **SRI International**
  Network Information Systems Center - EJ291
  333 Ravenswood Avenue
  Menlo Park, CA 94025
  (415) 859-6387
  FAX (415) 859-6028

Hard copies of the RFCs, an RFC subscription service, and other products and services may be acquired from the Network Information Systems Center at SRI.

1.5. Internet Registration Service

The Internet registration service provides IP network numbers and other registration services to sites wishing to connect to the Internet. In times past the registration of Internet addresses has been performed by the Network Information Systems Center at SRI International and then by the US Dept. of Defense Network organization (DDN NIC). As of April 1993, the registration service for non-DDN sites on the Internet is part of a new organization called the InterNIC. The InterNIC is a three part organization which includes network registration services, directory services and information services.

The operation of the Internet registration service is described in **RFC1400.** You may also FTP to **rs.internic.net** to retrieve copies of the registration templates, policy documents, etc.

The new Internet registration service provides a root name server zone file and a root name service for the Domain Name Service on the Internet. Information about the Internet Domain Name Service is provided in the books *TCP/IP Network Administration* and *DNS and BIND.* The primary root name server is: **ns.internic.net** at IP address **198.41.0.4**

You can FTP the root zone file from:

rs.internic.net in the **/domain** directory.

Telephone support for the Internet Registration service may be reached at:
1-800-444-4345
or
1-703-742-4777

The electronic mail address for more information is:
hostmaster@internic.net

For more information you may also telnet to host: **rs.internic.net**

The U.S. Postal Address is:
Network Solutions, Inc.
Attn: InterNIC Registration Service
505 Huntmar Park Drive
Herndon, VA 22070 USA

1.6. Other InterNIC Services

There are three organizations that make up the InterNIC, and registration services is one of them. The other two services are Information Services and Directory Services.

- **Information Services**

The information services portion of the InterNIC provides introductory information for Internet users and support for network information centers at other Internet sites. There are a number of ways to access the information at the Information Services center, including anonymous FTP, Telnet, and Gopher.

Anonymous FTP access is provided at host **is.internic.net.** Gopher access is provided at the **internic.net** address. To access this gopher, start up a gopher application pointed to **internic.net.** If you do not have a gopher application running on your computer you can access the gopher via Telnet. Telnet to **is.internic.net** and login as ‘‘gopher’’ to access the gopher information. This gopher provides access to information for all three portions of the InterNIC.

The information services portion of the InterNIC may also be reached at:

InterNIC Information Services
General Atomics
P.O. Box 85608
San Diego, California
Telephone: (800) 444-4345 or (619) 455-4600
FAX: (619) 455-3990
E-mail: info@internic.net

- **Directory Services**

The directory services portion of the InterNIC provides a top-level directory of directories, as well as lists of various types of information servers available on the Internet.

You can get access to the Directory Services information via anonymous FTP, Telnet, etc. For more information see the gopher described above, or telnet to **ds.internic.net** login as ‘‘guest,’’ and follow the instructions.

The directory services portion of the InterNIC may also be reached at:

Phone: (908) 668-6587
Fax: (908) 668-3763
Mail: admin@ds.internic.net

1.7. TCP/IP Protocols

This section of the reading list describes two resources that provide tutorial information about the TCP/IP protocol suite.

- **Internetworking With TCP/IP,**
  Volume I: Principles, Protocols, and Architecture

Douglas E. Comer.
1991, Second Edition, Prentice Hall, Englewood Cliffs, New Jersey, 547 pps. with index and bibliography.
ISBN 0-13-468505-9.
$48.00.

Comer's writing style is clear and the book is well organized, making this a good starting point for anyone who wants to understand how the TCP/IP protocol suite works. The book provides an introduction and guide to the entire TCP/IP protocol suite. The basic concepts behind internetworking are described, as well as LAN technologies such as Ethernet and ProNET. With the basics covered, Comer goes on to explain how the essential elements of the TCP/IP protocols function, including examples of network applications based on the protocols.

Comer has two other volumes available in this series from Prentice Hall, one providing a complete example implementation of the TCP/IP protocols with source code made available, and the other describing client-server computing using TCP/IP protocols. The titles are *Internetworking with TCP/IP, Volume II: Design, Implementation, and Internals* and *Internetworking with TCP/IP, Volume III: Client-Server Programming*

From the Preface of Internetworking with TCP/IP, Volume I:

''Most textbooks and network courses concentrate on the first two stages of network research, presenting the well-known theories of data communications and queueing analysis. Although such information is important to engineers who design network technologies and hardware products, most network architects purchase commercially available network hardware. Instead of detailed knowledge about how bits or packets flow across communication media, they need to know how to interconnect such hardware and how to use the resulting system.''

''This text concentrates on the third stage of networking. It examines the architecture of interconnected networks and explains the principles and protocols that make such interconnected architectures function as a single unified communication system. More important, it shows how an interconnected architecture can be used for distributed computation.''

''Designed as both a college text and as a professional reference, the book is written at an advanced undergraduate or graduate level. For professionals, the book provides a comprehensive introduction to the 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 provides a uniform overview that emphasizes principles. Moreover, it gives the reader perspective that can be extremely difficult to obtain from individual protocol documents.''

- **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.**

This tutorial was written by Charles Hedrick in July 1987. It serves as a short introduction to some of the basic concepts of the TCP/IP protocol suite. For another approach to the subject see RFC 1180, ''A TCP/IP Tutorial'' in the section on RFCs.

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.''

Section 2

This is Section 2 of a four-section document entitled ‘‘Network Reading List: TCP/IP, UNIX, and Ethernet.’’ The four sections of this annotated list of resources were created to help you find information about TCP/IP, UNIX, and Ethernet. The complete list describes a wide range of items, including both introductory and in-depth information.

Section 1 covers TCP/IP resources, Section 2 covers UNIX, Section 3, Ethernet, and Section 4, miscellaneous items.

2. UNIX

It may seem odd to include an operating system in a list of network resources. However the UNIX system has been the platform for many networking innovations over the last decade. This section of the reading list is designed to help you find information on how UNIX networking functions, and how UNIX fits into the networking equation.

The development of UNIX has been closely tied to both TCP/IP and Ethernet. In the early 1980’s ARPA chose to fund the development of a Berkeley UNIX implementation of the TCP/IP protocols. This led to the inclusion of the TCP/IP protocols in Berkeley UNIX release 4.2.

At the time, Berkeley had begun using the newly standardized Ethernet LAN technology to link their campus computers together, and the model of UNIX systems running TCP/IP and linked with Ethernet was exported to many other sites with the release of 4.2BSD UNIX. The availability of UNIX, TCP/IP, and Ethernet also helped spur growth of the scientific workstation market. The combination of UNIX workstations with TCP/IP networking software and Ethernet hardware is quite common at many sites today.

2.1. 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 some background and context on UNIX in general, and UNIX network administration in particular.

- **Life With UNIX**
  Don Libes, Sandy Ressler
  1989, Prentice Hall, Englewood Cliffs, NJ., 346 pps. with index.
  ISBN 0-13-536657-7.
  $34.95

UNIX documentation can be exceedingly cryptic and difficult to decipher. While the efforts of the many UNIX vendors have frequently improved the UNIX documentation of their systems (it would be hard to make it worse), it’s still the case that a newcomer can find themselves drowning in details and wishing for some UNIX expert to come by and supply the big picture.

Life With UNIX is that expert. While it could do with an update, nonetheless this is still the best single source for much undocumented folklore about how UNIX grew, and why things are the way they are.

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.
  1989, Prentice Hall, Englewood Cliffs, NJ, 593 pps. with index and bibliography.
  ISBN 0-13-933441-6.
  $42.00

While somewhat dated, the UNIX System Administration Handbook still provides an exceptionally comprehensive guide to the nitty gritty details of UNIX system administration. It's also well written, with solid ''hands-on'' information. Of special interest is the large section on UNIX network administration.

Included in this section is a brief description of how Ethernet works, featuring a list of typical Ethernet components. There's a short description of TCP/IP protocols and how to set up the various UNIX files that make TCP/IP software run. There's also a description of some LAN design issues, followed by the Sun Network File System protocols and operation. The section concludes with a few pages on how to debug and monitor your network. The book *TCP/IP Network Administration* listed in Section I contains much more network-specific information for UNIX systems; however, the *UNIX System Administration Handbook* is useful for the complete range of subjects it covers.

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.''

- **DNS and BIND**
  Paul Albitz and Cricket Liu
  O'Reilly & Associates, Petaluma, CA, 1993
  381 pps. with index
  ISBN 1-56592-010-4
  $29.95

If you are managing a UNIX system that is attached to the Internet, then sooner or later you will need to deal with the Internet domain name system. This book provides an in-depth treatment of the Internet domain name system and the most widely used implementation of the name system software. Basic configuration information for the Internet domain name system software on a UNIX host may be found in the book *TCP/IP Network Administration*, which is listed in Section I.

From the O'Reilly catalog:

''Here's a complete guide to the Internet's Domain Name System (DNS) and the Berkeley Internet Name Domain (BIND) software, which is the UNIX implementation of DNS. DNS is the system that translates hostnames into Internet addresses. Until BIND was developed, name translation was based on a ‘‘host table’’--if you were on the Internet, you got a table that listed all the systems connected to the network, and their addresses. As the Internet grew, host tables became unworkable. DNS is a distributed database that solves the same problem effectively, allowing the network to grow without constraints. Rather than having a central table that gets distributed to every system on the net, it allows local administrators to assign their own hostnames and addresses, and install these names in a local database. This database is automatically distributed to other systems, as names are needed.’’

‘‘In addition to covering the basic motivation behind DNS and how to set up the BIND software, this book covers many more advanced topics: how to become a ‘‘parent’’ (i.e., ‘‘delegate’’ the ability to assign names to someone else); how to use DNS to set up mail forwarding correctly; debugging and trouble-shooting; and programming. Assumes a basic knowledge of system administration and network management.’’

2.2. UNIX Security

The next few items discuss UNIX security. Once you have attached a computer directly to the worldwide Internet your computer system is available to any of the millions of people who have access to the Internet. Even though your computer may be attached to a ‘‘local’’ network, if that network is directly linked to the Internet then your machine is accessible by anyone on the planetary network system.

Given that, making sure that the files on your machine are secure from malicious attacks is a very important task. You should not take anything for granted when it comes to system security. Vendors frequently ship system software with minimal or no security enabled, and with well known holes in the system. It’s up to you to make sure that your computer system is secure.

Computer systems are complex and ensuring the security of those systems can be equally complex. **RFC1244,** the *Site Security Handbook* provides an introduction to the territory and a survey of the major issues. The following resources provide more information on this subject.

- **Practical UNIX Security**
  Simon Garfinkel and Gene Spafford
  O’Reilly & Associates, Petaluma, CA, 1991
  483 pps. with index
  $29.95

From the review of *Practical UNIX Security* in **RFC1244:**

‘‘This is one of the most useful books available on Unix security. The first part of the book covers standard Unix and Unix security basics, with particular emphasis on passwords. The second section covers enforcing security on the system. Of particular interest to the Internet user are the sections on network security, which address many of the common security problems that afflict Internet Unix users. Four chapters deal with handling security incidents, and the book concludes with discussions of encryption, physical security, and useful checklists and lists of resources. The book lives up to its name; it is filled with specific references to possible security holes, files to check, and things to do to improve security.’’

- **Improving the Security of Your UNIX System**
  David Curry
  SRI International Report ITSTD-721-FR-90-21, April 1990.

This paper describes a number of security issues that should be checked on UNIX systems. The paper is oriented to SunOS 4.x systems and other Berkeley UNIX systems.

Available from a number of sites on the Internet, including CERT, the Computer Emergency Response Team site. You can retrieve this document via anonymous FTP from **cert.sei.cmu.edu** in the **/pub/info** directory as **security-doc.txt** an ASCII text file and **security-doc.tar.Z** a compressed UNIX tar file containing the troff source for the document and a PostScript output file of the document.

2.3. UNIX Networking In Detail

The next few items cover UNIX networking in vast technical detail. These items are for those who want to understand UNIX networking right down to the details of the kernel implementation. This material assumes that you have a programming background, or at least a reading knowledge of C programming. As it says on old maps of uncharted and dangerous territories, ‘‘Here there be dragons.’’

- **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
  $46.00

This book provides an in-depth look at the design and implementation of the entire 4.3BSD (Berkeley Software Distribution) UNIX system. Of special interest is Part 4 which describes UNIX Interprocess Communication. This section includes Chapter 10, which describes the kernel data structures and socket mechanisms used for networking, 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 the engineers who had a hand in making the decisions.

From the Preface:

‘‘This book is about the internal structure of 4.3BSD and about the concepts, data structures, and algorithms used in implementing 4.3BSDXs system facilities. Its level of detail is similar to that of Bach’s book about System V UNIX however, this text focuses on the facilities, data structures, and algorithms used in the Berkeley variant of the UNIX operating system. 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.’’

- **UNIX Network Programming**
  W. Richard Stevens
  1990, Prentice Hall, Inc., 784 pps. with index and annotated bibliography.
  ISBN 0-13-949876-1.
  $51.00.

Richard Stevens’s book features both a comprehensive treatment of UNIX networking concepts and a vast assortment of real world examples. The book contains scores of program examples, and is indispensable reading for the network software developer, or for anyone who wants to see what real networking software looks like in a UNIX system.. The book is an extremely useful resource for anyone who needs an in-depth understanding of the internals of UNIX networking software.

The book contains about 15,000 lines of C source code (including comments), some of which is taken directly from the Berkeley UNIX networking software and modified by the author, and some of which was created by the author for the task at hand. Another major advantage of this text is that all 15,000 lines of source code are available on-line as described below.

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.’’

2.3.1. Access to Source Code In UNIX Network Programming

The complete source code for the Richard Stevens book is available in the UNIX source archives kept by UUNET Technologies in Falls Church, Virginia. For those readers with a connection to the Internet, the source code from the Richard Stevens book may be retrieved using the anonymous FTP service. By opening a connection to host **ftp.uu.net** and logging in as username ‘‘anonymous,’’ you can gain access to the source archives stored at UUNET.

Once logged into UUNET, the source code is located in the **published** directory as filename **stevens.netprog.tar.Z**. The capital Z suffix means that the file has been compressed using the UNIX compress program, which turns the file from a text format to a binary format. This, in turn, means that you will have to type ‘‘bin’’ to the FTP program, to set the file retrieval to binary mode. The compressed version of the file occupies almost 192 Kilobytes.

Once retrieved, the file will need to be uncompressed, which will leave you with a tape archive or ‘‘tar’’ file. Unpacking this file with the UNIX tar program will reveal the 15,000 lines of source code.

Section 3

This is Section 3 of a four-section document entitled ‘‘Network Reading List: TCP/IP, UNIX, and Ethernet.’’ The four sections of this annotated list of resources were created to help you find information about TCP/IP, UNIX, and Ethernet. The complete list describes a wide range of items, including both introductory and in-depth information.

Section 1 covers TCP/IP resources, Section 2 covers UNIX, Section 3, Ethernet, and Section 4, miscellaneous items.

3. Ethernet

Ethernet is a popular local area network (LAN) technology in wide use at sites around the world. Ethernet moves data between computers at a rate of 10 megabits per second over a wide variety of physical media including twisted-pair wire, coaxial cable, and fiber optic cable. A major reason for its popularity is that Ethernet is a very flexible and low cost network system. Ethernet’s popularity also provides a high level of network interoperability. Since Ethernet is so widely implemented you can link systems built by many different vendors using the same Ethernet LAN. Like TCP/IP and Unix, Ethernet is a technology that provides a common basis for supporting heterogeneous networks.

The 10 megabit Ethernet network standard has been in existence for over a decade, and is an international LAN standard. As a result, a large number of vendors sell Ethernet equipment and this helps keep the cost of the technology low. The large market for Ethernet equipment also leads to a steady stream of innovations, such as the use of thin coaxial and twisted-pair cabling, that makes it easier to build a reliable LAN in a wide variety of sites using standard Ethernet.

3.1. Introduction To LAN Concepts

- **Local Area Networks**
  An introduction to the technology
  John E. McNamara.
  Prentice Hall Agency, 1985, 165 pps. with index and glossary.
  $29.00
  ISBN 0-13-539669-7

This book provides a clear introduction to the essential ideas and basic technologies of LANs. McNamara keeps it simple, while managing to cover many different technologies. The author avoids covering specific products in favor of describing the general territory of LANs and their topologies. The special problems of extending LANs and supporting multiple protocol campus area networks are also discussed.

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.’’

‘‘The book begins with a general introduction, discussing the development of local area networks and emphasizing their possible uses. This is followed by more detailed treatment of physical factors: topology, media, and installation requirements. Next, the hardware that permits programs to access the local area network and transfer data is discussed. Then, software is covered, starting with an introduction to communications protocols. Finally, the combined base of hardware and software knowledge from the previous parts of the book are used in discussions of network services, network expansion, and the problems associated with creating large networks. The need for standards is implied throughout the book, and a brief final chapter discusses the creation of standards and their current status.''

3.2. Introduction to Three Ethernet Varieties

This short introduction to the three Ethernet technologies most widely used in office connections is provided to help you understand the references to these technologies in the resources that follow. After the IEEE published the basic thick coaxial Ethernet specifications in 1985 it went on to specify new varieties of Ethernet media, including thin coaxial Ethernet and twisted-pair Ethernet. There are currently three media systems designed to provide Ethernet service to an office. They include:

(1) **Thick Ethernet**
The original Ethernet system based on coaxial cable which uses a thick (0.4 inch) yellow cable. Computers are attached to the coaxial cable with an outboard Ethernet transceiver (also called a MAU) that is clamped to the cable. The transceiver, in turn, is connected to an Ethernet interface in the host computer by way of a transceiver cable (also called an AUI cable). This system is the one developed at Xerox, and could be called ``Ethernet Classic.'' The IEEE has assigned shorthand identifiers for each media variety of Ethernet. The identifier for thick Ethernet is 10BASE5, which stands for 10 megabit per second speed, baseband signaling, and 500 meter maximum segment length.

(2) **Thin Ethernet**
A coaxial-based Ethernet system that uses a thinner, more flexible coaxial cable than the original thick Ethernet system, and is known as thin Ethernet or ``Cheapernet.'' In the thin Ethernet system the transceiver is located inside the computer along with the Ethernet interface. This makes it possible to attach the thin Ethernet coax directly to the back of the host computer, reducing the number of devices and cables needed, and making the network connection more affordable. The IEEE identifier for thin Ethernet is 10BASE2, which stands for 10 megabit per second speed, baseband signalling, and, despite the ``2'' used in the shorthand identifier, 185 meters maximum segment length.

(3) **Twisted-Pair Ethernet**
The twisted-pair variety of Ethernet is based on the same low cost twisted-pair wiring used in telephone systems. The IEEE identifier for twisted-pair Ethernet is 10BASE-T, which stands for 10 megabits per second, baseband signalling, and twisted-pair media. The transceiver is located inside the computer in the twisted-pair system, which helps lower the cost of connecting to the segment. In the 10BASE-T system individual computers are attached to twisted-pair segments, which, in turn, are attached to a multiple-connection box called a multiport repeater or hub. A typical standalone hub supports 8 or 12 10BASE-T connections. Ethernet hubs can also be designed as modular systems called chassis hubs. Chassis hubs can support several media varieties of Ethernet, and not just twisted-pair. With its reliance on proven telephone system technology the twisted-pair variety of Ethernet provides a reliable, yet simple and low-cost method for attaching computers to an Ethernet system.

- **Ethernet Frequently Asked Questions (FAQ)**

Another handy guide to general Ethernet information can be found in the latest edition of the Ethernet FAQ. A FAQ is a list of frequently asked questions with their answers. The Ethernet FAQ was created for distribution over the Usenet group dedicated to the subject of Ethernet LANs. For more information about Usenet groups and the Ethernet group in particular see Section IV of this list.

For those without access to the Usenet, a copy of the Ethernet FAQ may also be acquire via anonymous FTP from **dorm.rutgers.edu** in **pub/novell/DOCS.**

3.3. Vendor Guides

Some very useful tutorial information on Ethernet may be found in a variety of publications available from vendors. Be warned that vendor guides are not very formal publications and may go out of print at any time. You also have to allow for the vendor-specific orientation, and understand that there may be other ways to do things. Nonetheless, despite the emphasis on a single vendor's products you can find good tutorial information in these guides. Listed next in no particular order are several guides that have proven useful.

Hewlett-Packard Manuals

- **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 Ordering at (800) 227-8164

This slightly out-of-date manual from HP is still one of the better sources of tutorial information on how to deal with the thick and thin Ethernet varieties. The manual does not mention the twisted-pair Ethernet system. Despite the specific product orientation, the Ethernet configuration information is useful, and the guidelines for designing networks are clear and well written. Thin Ethernet is covered, using HP's ThinLAN name for the technology. In addition, the manual shows how to tap a thick Ethernet cable for installation of the typical transceiver connection.

One nit to pick is that the advice on running cable between buildings is based on older coax technology and does not take into account the newer IEEE Fiber Optic Inter-Repeater Link (FOIRL) standard. The FOIRL standard makes it possible to link Ethernets between buildings while preserving complete electrical isolation between the LANs. Such isolation is important when it comes to preserving the safety of the LAN system and preventing damage to the system components.

This manual really shines when it comes to descriptions of thick cable and thin cable tooling and details of cable 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 the N connectors and BNC connectors used with the thick and thin coaxial cables. The manual finishes with a short section on verifying the cables you've built, and a section on how to use a time domain reflectometer to test network cables.

Another useful feature of the manual are the safety warnings that explain the hazards of the crimping tools, and the various electrical dangers that may be present when working on network cable systems. While on the subject of safety warnings, it should be mentioned that the crimping tools shown in this manual use a mechanism that prevents them from opening until they have closed all the way. It 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.

- **HP SiteWire Twisted-pair Cabling Installation Guide**
  January 1988, Hewlett-Packard Company, Roseville Networks Division, 8000 Foothills Boulevard, Roseville, California 95678.
  Approximately 100 pps, with 11 sections, 2 Appendixes, and an Index.
  $40.00.
  HP Manual Part Number 5959-2208.
  Order From HP Direct Ordering at (800) 227-8164

Like the HP guide on coaxial cabling, this document is oriented to HP product offerings. Covering twisted-pair wiring for data communications, and including the Ethernet 10BASE-T variety, this guide provides instructions on how to test and install twisted-pair wiring for networks. While limited to HP offerings, it still provides a useful introduction and primer for for twisted-pair Ethernet installations.

The guide begins with a general introduction to twisted-pair connections. The system shown is not based on the widely used AT&T Premises Distribution System (PDS); instead the HP approach to wiring both telephones and data service for an office space is described. PDS equipment may be used with the HP approach however, and the guide notes that for large installations you may want to base your design entirely on the PDS system.

The guide explains the basics of how to build twisted-pair cables, test them for continuity, and install them in an office. The use of 66-type and 100-type punch-down tools and punch-down blocks is explained, along with the basics of making a host connection to a twisted-pair Ethernet.

The rest of the document describes how to install 10BASE-T hubs. The guide also shows the HP 10BASE-T interface boards for PCs that contain two modular jacks; one for connection to the building wiring system, and one for connection to a telephone. This allows you to support both telephone and data on the same twisted-pair cable, and you are shown how to install wiring for such a system.

DEC Manuals

- **Telecommunications and Networks Buyer's Guide**
  Published twice a year by Digital Press.
  Free.
  No part number. Ask for it by title from a DEC sales office. Call (800) 332-4636 if you don't have a local DEC sales contact.

This guide lists all communication hardware, communication software products, and network services that DEC provides. Of special interest are the configuration guidelines for DEC's 802.3/Ethernet products. Here you will find all manner of information about 802.3/Ethernet in general and the DEC product line in particular. Included is a description of DEC's building wiring standard, Open DECconnect.

You will also find media and topology information for fiber optic Ethernet connections, unshielded twisted pair, thin Ethernet and thick Ethernet. The guide includes illustrations and descriptions of many Ethernet components including barrels and terminators for thick Ethernet, DECconnect wiring equipment, and repeaters and bridges.

The guide is completely DEC-centric, of course, but the price is right and the information can be quite useful. The guide lists many other products, including DEC's offerings for the 100 Mbit/sec LAN standard known as FDDI.

- **OPEN DECconnect Building Wiring Components and Applications Catalog**
  1990, Digital Equipment Corporation.
  Free.
  No part number. Ask for it by title from DEC sales office. Or call the DEC pre-sales support group at (800) 344-4825

The components and applications catalog lists individual parts of the DECconnect wiring system including a description and order number. Line drawings for each part are shown. The second half of the catalog shows some typical wiring applications and how they are configured to use the DECconnect system.

MOD-TAP

- **MOD-TAP Applications Manual 1993**
- **MOD-TAP Components Catalog**
  MOD-TAP, 285 Ayer Road, PO Box 706, Harvard, MA 01451-0706, (508) 772-5630.
  Applications Manual $5.00, Components Catalog Free.

MOD-TAP supplies communications cabling products for computer users. Their applications manual covers a wide range of communications cabling applications for several different network standards. Of interest here is their support for 10BASE-T Ethernet. The applications manual describes some basic concepts for building cabling design, and also goes into detail on the wide variety of twisted pair wiring schemes in use today.

A major benefit of this manual is the information on the various twisted pair wiring schemes currently in use and how they can be used to support 10BASE-T twisted pair Ethernet. The manual also describes some basic wiring installation techniques, including how to develop a cable numbering scheme to help keep it all straight.

The components catalog describes the entire line of MOD-TAP products. Included are a set of charts that show the twisted pair wiring schemes used in the USOC, AT&T 258A, AT&T 356A, ROLM, DEC, EIA, and 10BASE-T standards. The building you may be trying to wire for 10BASE-T Ethernet may include twisted-pair wires installed according to any one (or more) of these standards. The information shown here can be invaluable for figuring out how to get the signals from the 10BASE-T hub in the wiring closet to show up on the user's desk.

3.4. Ethernet Hardware and Vendors

Ethernet hardware comes in several forms. At the physical media level there are basic pieces of hardware: coaxial cable, twisted-pair cable, and connectors. The next level up features components such as transceivers, transceiver cables, and Ethernet interfaces. At the higher levels of network concatenation are devices such as multiport transceivers, Ethernet repeaters, chassis hubs, and bridges.

Just to keep things interesting, the different media varieties of Ethernet require different components. For instance, thick Ethernet media systems use different low-level hardware and components than twisted-pair media. Moreover, every vendor seems to have its own special design for equipment such as Ethernet hubs. It's a large market, and impossible to cover in any short list of resources such as this one. Lists of vendors and products may be found in buyer's guides published by some of the LAN magazines shown in the next section.

Shown next are a few representative examples of equipment and hardware catalogs from equipment distributors.

- **Anixter Wiring Systems Product Catalog**
  Anixter Bros., Inc.
  4711 Golf Road
  Skokie, IL 60076
  Phone (312) 677-2600

The Anixter Wiring Systems Product Catalog is a vast compendium that lists many different vendors, supplying all manner of communications equipment. The catalog describes the full range of products supplied by Anixter, but does not include pricing.

The catalog has separate sections for both Ethernet and DEC's special Ethernet wiring system (called DECconnect). The catalog also features a glossary of communications industry terms, and an index. All in all, this catalog is a useful resource for the LAN manager. Catalogs are available from your local Anixter distributor, or call the main office in Skokie.

- **Anixter Networking Products Guide**
  4711 Golf Road
  Skokie, IL 60076
  Phone (800) 622-6415 (orders) (800) 622-6417 (technical assistance)

This 166 page catalog is also called ‘‘One Network Place’’ and features a selection of networking equipment including Ethernet products. The catalog lists components used in twisted-pair wiring systems, basic networking devices like transceivers, Ethernet interfaces, and hubs, and network devices such as Ethernet bridges. Prices are included for all items.

- **AT&T Systimax PDS Components Catalog**
  For access see a local AT&T representative or call:
  (800) 344-0223 ext 1102 (USA)
  32-2-676-3623 (Europe)
  (416) 756-5118 (Canada)

This catalog describes the wiring components used in the AT&T Premises Distribution System (PDS). AT&T’s PDS is a widely adopted scheme for installing twisted-pair wire in commercial buildings. The design of the Ethernet twisted-pair standard allows it to operate over PDS wire systems. There are no prices in this catalog and no tutorial information. Instead it provides you with a description of the wiring components used in one of the most widely adopted twisted-pair wiring systems for buildings.

- **Hubbel Premise Wiring Inc.**
  Full Line Catalog #1100R
  14 Lord’s Hill Road
  PO Box 901
  Stonington, CT 06378-0901
  (203) 535-3809 or (800) 626-0005

Another catalog listing a complete line of premise wiring for twisted-pair systems. Includes some information on the EIA/TIA Commercial Building Wiring Standard. A useful catalog for anyone implementing a twisted-pair Ethernet system.

- **Network Electronics LAN Catalog**
  4801 N. Ravenswood Ave.
  Chicago, IL. 60640-4496
  (312) 784-5100

Newark has branch offices all over the US. This catalog provides access to the network products that Newark carries, including coaxial and twisted-pair Ethernet. Also included are a wide range of network cabling components. Prices are included for all items listed.

3.5. Network and LAN Troubleshooting Guides

- **Network Troubleshooting Guide**
  August 1990, Digital Equipment Corporation
  Approx. 278 pps. with index and glossary.
  $95.00
  Digital part number is EK-339AB-GD-002.
  Digital Direct phone is (800) 344-4825.

While the price is steep, this is a useful guide to a variety of techniques for testing and troubleshooting networks that support both DECnet and TCP/IP protocols. The guide begins with a brief description of how both DECnet and TCP/IP function, including details of addressing in both protocol suites.

Chapter 2 describes how to develop a basic network troubleshooting methodology for your site. Following this is a chapter on network management and troubleshooting tools, listed alphabetically, and including both VMS and ULTRIX-based tools. The emphasis is on Digital applications, but more general applications such as ‘‘ping’’ and ‘‘traceroute’’ are also shown.

Chapter 4 describes resources for troubleshooting. These include various ULTRIX and VMS log files that contain information on problems that may have occurred with software running the DECnet and TCP/IP protocols.

Chapter 5 is the largest chapter of the guide. It describes network troubleshooting procedures for a wide variety of common network problems in both DECnet and TCP/IP. The problems are categorized as ULTRIX host problems, VMS host problems, LAN problems, WAN problems, and cross-category problems that include two or more of the preceding problems.

This chapter explains how to interpret common error messages seen, and how to go about troubleshooting the source of the error. Each problem is described and troubleshooting procedures explained. An example for TCP/IP includes the the error message ‘‘connection timed out.’’ A variety of errors that could cause this message are explained, and a troubleshooting strategy is listed. You are shown how to use ‘‘ping’’ to check for connectivity, ‘‘netstat’’ to check for errors on the host interface, etc.

While the guide focuses on DEC equipment running VMS and ULTRIX operating systems, there is still much useful information provided for debugging complex network problems in a mixed vendor environment. For example, many of the utilities described for ULTRIX are commonly available on other Unix systems. Although the guide assumes you have a DEC LAN Traffic Monitor (LTM) available, this is not a severe limitation. You can replicate much of the information you can get from the LTM by running commonly available applications such as ‘‘etherfind’’ or ‘‘tcpdump’’ on your system.

This guide has two major advantages; the structured approach to troubleshooting and the unusual mix of both DECnet and TCP/IP troubleshooting procedures in the same manual. While the troubleshooting information appears to list more DECnet-based errors than TCP/IP ones, the guide manages to present quite a lot of technical information about both protocol suites and their possible failure modes in a clear and well organized format.

- **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

A wide-ranging guide to troubleshooting information for several LAN technologies including Ethernet. The author manages to fit a surprising amount of technical information about three LAN technologies, Ethernet, token ring, and ARCNET, into one volume. Though there isn’t any tutorial information about Ethernet, 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 IEEE 10BASE-T unshielded twisted-pair system is also briefly described. This book provides quick access to some essential troubleshooting information for the three main varieties of Ethernet.

From the Preface:

‘‘This book has a very fundamental thesis: how to keep your local area network alive. There are three parts to that goal. First, you must understand how the LAN should operate if you are to properly define when it is not operating. Secondly, you must have the proper hardware and software tools readily available to troubleshoot problems. Third, you must take preventative measures to keep those failures from recurring in the future.''

''To accomplish this goal, the book is divided into ''network generic'' and ''network specific'' chapters. 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.''

3.6. The Ethernet Standards

Ethernet became the first non-proprietary LAN technology with the publication of the original multi-vendor Ethernet specification in 1980.

There are two basic Ethernet standards: one issued by the multi-vendor consortium in 1980, and one developed by the Institute of Electrical and Electronics Engineers (IEEE). The multi-vendor standard is known as the DIX standard, so called due to the initials of the three participants: Digital Equipment Corp, Intel, and Xerox. The DIX standard includes versions 1.0 and 2.0.

In 1985 the IEEE 802.3 CSMA/CD standard for Ethernet technology was released. Based on the DIX Ethernet standard, the IEEE version brought the thick Ethernet system into the world of international standards. While they may appear quite different at first, the DIX version and the IEEE version of the standard are functionally similar. Many vendors rate their Ethernet hardware for use in both IEEE 802.3 and DIX version 2.0 systems. Of course, the prudent networker makes sure that all of the hardware used to attach a computer to the Ethernet is based on a single version of the standard.

Most of the changes that the IEEE version of the standard made were at the level of the Ethernet frame, which is the set of bits that carry the data between computers. However, both IEEE and DIX Ethernet frames can coexist on the same Ethernet LAN without problems.

The next several items list an introduction to IEEE standards and describe the formal Ethernet standards in use today. The formal standards are the technical documents for Ethernet/802.3 LANs, and they can be heavy going for non-engineers. There is no tutorial information in the standards, and the technical jargon they use makes them difficult to read. The newer IEEE standards use a special language developed for open systems standards that can bewilder the unprepared. The book listed next provides a guide to the newcomer to IEEE standards.

- **LANs**
  Applications of IEEE/ANSI 802 Standards
  Thomas W. Madron.
  1989, John Wiley & Sons, New York, NY, 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 presents the world of network standards and how they're organized. The various standards agencies are described and the Open System Interconnection (OSI) model is explained. Following this, the IEEE 802 standards are described, and the way that the IEEE standards fit within the OSI organization is explained.

The bulk of the book describes the individual IEEE LAN standards. The book closes with a explanation of the basics of TCP/IP operation, including the function of LANs in the delivery of TCP/IP services.

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.''

3.6.1. The DIX Standard

- **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.
  $31.00.
  DEC Part Number: AA-K759B-TK.
  Available from DEC-Direct by calling (800) 344-4825.

This is Version 2.0 of the original 10 Mbit/sec thick 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 the DIX specification.

This specification is organized according to the OSI model, but uses somewhat less technical jargon than newer standards. That makes it a document that is more approachable by the non-expert than the IEEE standard tends to be. The DIX specification is still a technical standard, however, and contains no tutorial information on the design and operation of Ethernets. Just the facts.

3.6.2. The IEEE 802.3 Standard (ISO 8802.3)

The IEEE 802.3 standard is the current standard for thick Ethernet as well as for all newer varieties. However, nothing stands still very long in the standards world, and the IEEE standard is no exception. Starting as a multi-vendor standard (DIX), the Ethernet system then became a national standard (IEEE/ANSI), and the IEEE specs are now incorporated in an international (ISO/IEC) standard. This explains why the IEEE organization now sells the ISO volume of specifications, instead of the older IEEE 802.3 volume. The name of the latest international ''Ethernet-like'' standard is (take a deep breath):

- **(ISO/IEC) (ANSI/IEEE Std 802.3, 1992)**
  Information Processing Systems - Local and Metropolitan Area Networks -
  Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD)
  Access Method and Physical Layer Specifications (ANSI)
  ISBN 1-55937-049-1
  IEEE product number: SH13482
  $75.00 (from IEEE publications catalog)
  Available from:
  IEEE Customer Service
  445 Hoes Lane
  PO Box 1331
  Piscataway, New Jersey 08854-1331
  or by calling (800) 678-4333 (IEEE).
  Outside US and Canada call, (908) 981-1393.
  The FAX number is (908) 981-9667

These are the current specifications for an Ethernet-like CSMA/CD LAN. Despite the major reworking of the original DIX standard by the IEEE, and despite changes made in the way some things work, the IEEE and DIX specs have a strong functional similarity at the hardware level.

Old and new hardware can interoperate well on Ethernet/802.3 LANs, despite the differences in the specifications. Many network protocol implementations (TCP/IP among them) continue to use the original DIX Ethernet frame, for example. Campus Ethernets used to interconnect computers equipped with hardware built according to both the DIX and 802.3 specs can interoperate on the same Ethernet LAN. The standards were written so that mixing things together like this on the same Ethernet system still works.

3.6.3. Twisted-Pair Ethernet Specifications

Since the creation of the twisted-pair Ethernet standard in 1990 the twisted-pair Ethernet market has seen extraordinary growth. The twisted-pair system makes it possible to install Ethernet in an office using standard twisted-pair wiring. This has led to the twisted-pair Ethernet system becoming the system of choice at many sites. The twisted-pair specification is described in a supplement from the IEEE. Eventually the twisted-pair standard will be incorporated in the ISO 8802.3 standard document. Until that happens you need to acquire this document to get the formal twisted-pair specifications. This supplement also contains some newly written guidelines for building large, multi-segment Ethernets using a mix of Ethernet varieties. The title is (take an even deeper breath):

- **802.3i-1990 IEEE Supplement to Carrier Sense Multiple Access with Collision Detection CSMA/CD Access Method and Physical Layer Specifications: System Considerations for Multisegment 10 Mb/s Baseband Networks (Section 13) and Twisted-Pair Medium Attachment Unit (MAU) and Baseband Medium, Type 10BASE-T (Section 14)**
  ISBN 1-55937-070-X
  IEEE Product Number SH13763
  Price $26.00, from IEEE catalog. Same access for IEEE as above.

3.7. Ethernet Numbers

This section describes two sets of numbers used in the Ethernet system. Both sets are useful in network troubleshooting. The standards agencies that oversee the administration of these numbers are also listed.

3.7.1. Ethernet Type Numbers and Addresses

The Ethernet frame specified by the DIX standard contains a Type field. The DIX Ethernet Type field contains a type number that describes the type of high-level network protocol (such as TCP/IP) being carried by the Ethernet frame. This information can be quite handy when you're troubleshooting a LAN problem and trying to figure out which high-level protocol may be involved.

In the new IEEE 802.3 frame specification, the type field was replaced by a more general, but more complex, set of frame specifiers. Nevertheless, many network software implementations still use the DIX frame specification with its accompanying Ethernet type field.

The addresses used in Ethernet frames are also useful to the network troubleshooter. The 48-bit Ethernet address is called an ''Organizationally Unique Identifier'' (OUI) and is divided into two 24-bit portions. The first portion is assigned to a specific manufacturer by the IEEE and the second portion is used by that manufacturer to create a unique address for each Ethernet interface. The total result is a 48-bit address for each Ethernet interface consisting of a 24-bit pattern that is assigned by the IEEE and another 24 bits assigned by the manufacturer to each interface.

If you know the manufacturer's number, you can frequently identify which computer may be causing network problems. This is not a foolproof mechanism, since some vendors may buy their boards from other manufacturers. Nonetheless, in many cases knowing the Ethernet addresses assigned to a manufacturer can help track down a malfunctioning device.

3.7.2. IEEE OUI List

The IEEE used to treat all OUI assignments as confidential information. The latest policy is that the address assignment will be made publicly available unless the vendor requests privacy. Vendors may regard the number of OUIs they request as confidential information, so the public list of OUIs assigned by the IEEE must be assumed to be incomplete.

The IEEE list can be retrieved via anonymous FTP from host **ieee.org** in the **info/stds** directory as filename **info.stds.oui**. You may also retrieve a copy of the IEEE list by sending an e-mail message to **info.stds.oui@ieee.org** and a copy of the list will be sent to you in return.

3.7.3. MIT Numbers List

The IEEE does not supply a list of DIX Ethernet Type fields, since the IEEE does not assign Type fields. Also, the IEEE list of OUIs is necessarily incomplete. To help overcome these problems a publicly available list of type fields and vendors' addresses has been compiled by network administrators who have observed and analyzed Ethernet traffic on their networks. This list too is necessarily incomplete, but nonetheless provides a wealth of useful information.

The list of OUIs and Type fields may be found via anonymous FTP on host **ftp.lcs.mit.edu** in directory **pub/map** as filename **EtherNet-codes**. If you have discovered a new vendor's address or other Ethernet number that you would like to add to this list, you can send your entry to **map@lcs.mit.edu.**

3.7.4. Assigned Numbers RFC

A list of Ethernet numbers for troubleshooting, including both the type field numbers and the Ethernet address numbers, can also be found in the Assigned Numbers RFC. The Assigned Numbers RFC is an RFC for the TCP/IP protocol suite that also contains a list of some of the Ethernet numbers. This RFC may be retrieved as described in the section on TCP/IP and the RFCs.

3.7.5. Administration of Ethernet Numbers

Type Field

Since the type field is part of the older DIX specification, Xerox manages the administration of Ethernet type fields. The Ethernet patents are owned by Xerox as well, and licenses to build Ethernet equipment using these patents can be obtained from the same source. Anyone wishing to apply for a new type field should contact Xerox at the following address:

Xerox Corporation
Xerox Systems Institute
3400 Hillview Ave.
P.O. Box 10034
Palo Alto, CA 94303
(415) 813-7164

As stated in Xerox literature: ''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.''

IEEE 802.3 Addresses

All new Ethernet addresses (OUIs) are assigned by the IEEE, although older ones assigned by Xerox are still valid. Anyone attaching a computer to an Ethernet system need not concern themselves with addresses, since a unique Ethernet address is assigned to each Ethernet interface at the factory. On the other hand, for the curious, 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

3.8. Ethernet Performance Analysis

Ethernet has been around for a while and provides network communications at many sites, so you'd think that the performance characteristics would be well established. Nonetheless there have been surprising claims made about Ethernet's ability to transmit data. Some of the claims have been based on papers written about the Ethernet system over the last several years, and a number of these papers have based their performance analysis on simulations and simplifications of the Ethernet protocols. This has inadvertently helped to establish a mythology about Ethernet performance limits. Fortunately there has been some empirical analysis that demonstrates the actual performance of Ethernet.

- **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.

This technical report from Digital's Western Research Lab presents empirical evidence showing that the 10 Mbit/sec Ethernet system is capable of transmitting at the full 10 megabit data rate. Also useful is the analysis of what makes a good Ethernet implementation. The report includes a brief set of network design guidelines for network managers who want to optimize their Ethernet system.

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 available over the Internet via electronic mail from the DEC Western Research archive server. Send a message to the automatic mail server with the word ''help'' in the Subject line of the message for detailed instructions. The address of the DEC technical reports mail server 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

Section 4

This is Section 4 of a four-section document entitled ‘‘Network Reading List: TCP/IP, UNIX, and Ethernet.’’ The four sections of this annotated list of resources were created to help you find information about TCP/IP, UNIX, and Ethernet. The complete list describes a wide range of items, including both introductory and in-depth information.

Section 1 covers TCP/IP resources, Section 2 covers UNIX, Section 3, Ethernet, and Section 4, miscellaneous items.

4. Interest Groups, Periodicals, and Conferences

This section briefly lists some electronic mail interest groups, networking periodicals, networking conferences, and other miscellaneous items.

4.1. Interest Groups

There is a large and ever-increasing set of interest groups that communicate via redistributed e-mail and the Usenet (User’s Network). Details on how electronic mail functions may be found in sources listed in previous sections.

One form of electronic mail redistribution consists of mailing lists to which you add your e-mail address. Mail sent to the list is redistributed to all members of the list. Some of the lists have moderators who filter the incoming mail before sending it out to the members. Other lists are unmoderated, and all mail sent to the main address of the list is automatically resent to every member of the list.

The Usenet system is a method of distributing electronic mail that has been organized as a set of articles stored as a newsgroup. In practice, each group consists of a disk file that holds a given number of messages sent to the group address. The number of files saved in each group at any given moment is a local administration issue, and depends on the disk space available, etc. As the space is filled up, old messages disappear when new messages arrive. There are many groups being distributed by the Usenet system, with an uncounted but huge audience worldwide. Usenet is often simply called ‘‘netnews,’’ or even just ‘‘news.’’

4.1.1. BITNET

The BITNET networks support a wide range of interest lists and archives. The best way to find out about these resources is to send a message to the LISTSERV utility maintained at host BITNIC. You can request a help file describing the LISTSERV utility. You can also request a copy of the BITNET list of lists which is called the LISTSERV GROUPS file.

Access to BITNET Lists

To get a copy of the LISTSERV lists file send a mail message to **LISTSERV@BITNIC.BITNET** and include the command:
SENDME LISTSERV GROUPS
The command should be in the body of the message and there should be no other text in the message. To get a copy of a description of the LISTSERV utility send a request to the same address with the command:
SENDME LISTSERV MEMO

4.1.2. Usenet Groups

There are a large number of interest groups available via the Usenet. Here are just a few examples:

- **comp.protocols.tcp-ip**
  This stands for ‘‘computers, protocols, TCP/IP.’’ This list discusses any and all TCP/IP issues.
- **comp.unix.misc**
  One of many UNIX Usenet groups, this one assigned to discussions of miscellaneous issues.
- **comp.dcom.lans**
  General LAN questions and answers, including some Ethernet information.
- **comp.dcom.lans.ethernet**
  Dedicated to Ethernet questions and information.

There are many, many more lists of this sort available via the Usenet. The group **news.announce.newusers** periodically publishes articles that contain lists of groups available on Usenet, as well as mailing lists available on other network systems. The monthly postings in this group also include introductory articles for newcomers to the Usenet system. Consult your local system administrator for information about access to the Usenet system.

The group **news.answers** contains postings of the various lists of Frequently Asked Questions (FAQs) for each Usenet list that has generated a FAQ. You can also get FAQs by anonymous FTP from host **pit-manager.mit.edu** in the **pub/usenet/news.answers** directory. These files can be retrieved via e-mail as well. You can retrieve an introduction to FAQs by sending the command **send usenet/news.answers/news-answers/introduction** in an e-mail message sent to **mail-server@pit-manager.mit.edu**

4.2. Periodicals

You’ll find networking topics described in many different periodicals and journals. The book ‘‘Life With UNIX’’ lists a number of UNIX periodicals that include articles on networking.

There are also many periodicals and journals that specialize in networking issues or have a heavy emphasis on covering networking stories. Several network periodicals are listed here to provide an idea of what’s available.

Each periodical has a different format, mix of articles, and writing style. It’s up to you to try them out and decide which ones provide the information you need. For more examples consult an engineering library or technical bookstore.

- **Network World**
  The Newsweekly of User Networking Strategies
  Weekly tabloid
  Available free to qualified subscribers
  Network World
  161 Worchester Road
  Framingham, Mass. 01701
  (508) 875-6400

Wide coverage of the network market including frequent product guides focused on specific equipment such as bridges or routers. A good place to find the latest news on what the major vendors are up to, as well as the latest network technology offerings.

- **Communications Week**
  The Newspaper For Network Decision Makers
  Weekly tabloid
  Available free to qualified subscribers
  Communications Week
  P.O. Box 2070

Manhasset, NY 11030

A networking weekly that also tracks the networking market as well as the activities of major vendors. Publishes product guides.

- **Data Communications**
  McGraw-Hill's Networking Technology Magazine
  Monthly magazine
  Available free to qualified subscribers
  Data Communications
  McGraw-Hill Inc.
  McGraw-Hill Building
  1221 Avenue of the Americas
  New York, N.Y. 10020
  (212) 512-2000

Features large network systems along with LAN coverage. Includes articles on wide area networks, T1 and other serial line technologies, equipment tests, the latest networking developments, etc.

- **Connexions**
  The Interoperability Report
  U.S./Canada subscriptions $150 for 12 issues/year
  No advertising
  Connexions
  480 San Antonio Road
  Mountain View, CA 94040-1219
  (415) 941-3399
  E-mail: connexions@interop.com

A publication associated with the Interop conference, Connexions concentrates on technical articles from protocol developers and others working on the latest issues in network interoperability. Status reports on the latest research in various network issues are also featured.

- **Computer Communication Review**
  The SIGCOMM Quarterly Publication
  $37 includes copy of Annual SIGCOMM conference proceedings
  Association for Computing Machinery
  P.O. Box 12115
  Church Street Station
  New York, N.Y. 10249
  (212) 869-7440

The Computer Communication Review is a quarterly report on SIGCOMM, the ACM special interest group on data communication. It includes reports on networking, telephony, and protocol verification. The topics covered include network architecture and design for LANs and large networks, recent network standards activities, etc. You can find news here about the latest thinking in network standards, as well as reports on work to increase the speed of networks and protocols. A subscription also gets you a copy of the annual SIGCOMM conference proceedings.

- **InfoWorld**
  Infoworld Publishing Co.
  155 Bovet Road Suite 800
  San Mateo, CA 94402
  (415) 572-7341 or (800) 227-8365

Focusses on personal computing and networks. Includes ‘‘From the Ether’’ column by publisher Bob Metcalfe, chief inventor of the Ethernet system.

- **LAN**
  The Local Area Network Magazine
  $19.97 for 12 issues /year
  For subscriptions:
  LAN
  Miller Freeman Publications
  P.O. Box 41904
  Nashville, TN 37204
  (800) 933-3321 or (615) 377-3322

Covers personal computer LANs, and includes interviews with various networking experts. Also features regular product guides, equipment tests and reviews, and articles on new network technologies.

- **Network Computing**
  Available free to qualified subscribers:
  Network Computing
  600 Community Drive
  Manhasset NY 11030-9789
  (516) 562-5071

Emphasizes network operating systems and software. Personal computer issues and the latest in PC network hardware and software are topics.

4.3. Conferences

Just about every computer conference includes networking issues these days. There are also several conferences that focus on networking, each with their own particular slant such as PC networks, mainframe networks, etc.

INTEROP

The Interop conferences focus on networks and network interoperability and are loaded with information on the three main topics of this reading list. They are held on the east and west coasts in the Spring and the Fall, although future conferences will be held in Las Vegas.

A feature of Interop is that the vendor booths are all attached to a large show network in a practical demonstration of network interoperability. The conference features tutorials by TCP/IP experts, and several days of technical sessions on all manner of TCP/IP subjects, UNIX networking, and Ethernet issues, as well as on evolving OSI protocols, etc. For more information contact:

- **Interop Inc.**
  480 San Antonio Road
  Mountain View, CA 94040
  (415) 941-3399
  (800) 776-6676
  FAX (415) 949-1779

USENIX

One UNIX-oriented meeting that is likely to be of use to networkers is the USENIX conference, run by the USENIX Association. USENIX conferences are aimed at the technical UNIX developer and feature technical sessions based on refereed papers. You can stay fairly current with the latest in UNIX networking and other developments by reading the conference proceedings for the twice a year USENIX conferences.

The USENIX Association also publishes a newsletter, ‘‘;login:,’’ which publishes book reviews, reports on UNIX standardization meetings, and the like. For more information, contact:

- **USENIX Association**
  2560 Ninth Street, Suite 215
  Berkeley, CA 94710
  (415) 528-8649
  Internet Address: office@usenix.org

4.4. Access to the Internet

The UT Austin campus network is connected to the national and worldwide Internet via THEnet, the statewide Texas Higher Education network. Like UT, many universities are connected to the Internet by way of various regional networks. Many companies have gained access to the Internet in the same fashion. If you are looking for an Internet connection, the first thing to do is check with your local network administrator.

You can also find lists of service providers in the books *The Internet Companion* and *The Whole Internet User's Guide and Catalog.*

4.5. Access to Resources

Many of the resources listed here are books, and can be found in technical bookstores and engineering libraries. If you are having trouble finding a book listed here, the following bookstore can probably help.

- **Computer Literacy Bookshop**
  2590 North First St.
  San Jose, CA 95131
  Phone (408) 435-0744
  FAX (408) 435-1823
  E-mail: info@clbooks.com

Computer Literacy is an excellent source for computer and electronics books of all kinds. They also carry some of the IEEE and ISO network standards, and can probably supply most of the books listed in this guide.

Anonymous FTP

Anonymous FTP simply means that the remote site makes files available by way of the TCP/IP-base File Transfer Program to anyone who wishes to acquire them. After making a connection to the site with the FTP program, you log in using ‘‘anonymous’’ as a username. At the password prompt it is often the case that you are asked to provide your electronic mail address, or you may use the word ‘‘guest.’’

FTP by E-mail

For sites that have only e-mail access to the Internet it is still possible to retrieve files via FTP. For Internet sites send e-mail to **ftpmail@decwrl.dec.com** with the word ‘‘help’’ in the body of the message. You will receive a help file in response, explaining the commands that you can send in an e-mail message that will cause the FTPmail service to retrieve a file for you. UUCP sites with an Internet connection can use the address **your_link!decwrl!ftpmail** to contact the FTPmail service.

BITNET sites may retrieve instructions on the use of a BITNET FTPmail service by sending the word ‘‘help’’ in an e-mail message sent to **bitftp@pucc.princeton.edu**

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