

Covers  
Windows,  
NetWare,  
Solaris,  
SCO UNIX

# **DOS ↔ UNIX<sup>®</sup>**

---

## **NETWORKING AND INTERNETWORKING**

Michael J. Burgard and Kenneth D. Phillip

# DOS<—>UNIX Networking and Internetworking

---

Michael J. Burgard  
Kenneth D. Phillips



**John Wiley & Sons, Inc.**

New York \* Chichester \* Brisbane \* Toronto \* Singapore

Associate Publisher: Katherine Schowalter  
Editor: Diane Cerra  
Associate Managing Editor: Jackie Martin

This text is printed on acid-free paper.

Designations used by companies to distinguish their products are often claimed as trademarks. In all instances where John Wiley & Sons, Inc. is aware of a claim, the product names appear in Initial Capital or ALL CAPITAL Letters. Readers, however, should contact the appropriate companies for more complete information regarding trademarks and registration.

Copyright 1994 by John Wiley & Sons, Inc.

All rights reserved. Published simultaneously in Canada.

Reproduction or translation of any part of this work beyond that permitted by Section 107 or 108 of the 1976 United States Copyright Act without the permission of the copyright owner is unlawful. Requests for permission or further information should be address to the Permissions Department, John Wiley & Sons, Inc.

This publication is designed to provide accurate and authoritative information in regard to the subject matter covered. It is sold with the understanding that the publisher is not engaged in rendering legal, accounting, or other professional services. If legal advice or other expert assistance is required, the services of a competent professional person should be sought.  
FROM A DECLARATION OF PRINCIPLES JOINTLY ADOPTED BY A COMMITTEE OF THE AMERICAN BAR ASSOCIATION AND A COMMITTEE OF PUBLISHERS.

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

Dedicated  
to  
Our Wives  
Bonnie and Gini  
and to Our Children  
Jessica, Justin, Nicholas, and Natalie  
Rachel and Emily

# Preface

## Why We Wrote This Book

We believe there is a real need among small businesses, consultants, and large corporations alike to unite DOS and UNIX machines. PCs running DOS make up the single largest operating system base in the world, and UNIX represents the fastest growing segment of the computing marketplace. The voice of the business community rings loud and clear; they want these two operating systems working together. In *DOS—UNIX Networking and Internetworking* we attempt to meet this need head on.

We wanted to write a book that gets right down to the nuts and bolts of using DOS and UNIX together. After some investigation, we discovered most networking books either cover only DOS networking or only discuss UNIX networking. What the marketplace lacks is information on how to make UNIX and DOS work together on a practical level. That's what this book is all about.

With that in mind, we take a slightly unusual approach. We spend little time on the theoretical issues behind networks and operating systems, and do our best to avoid technological babble. Rather, we concentrate on specific solutions for specific problems. Though we provide some primer information in the first three chapters, you won't find discussions about the technical superiority of Ethernet over Token-Ring, or even an in-depth tutorial on how they work. We leave these discussions to those many good books already on the shelves.

This book is solution oriented. Business people do not solve problems with theories, concepts, or debates. They solve them by getting into the trenches—usually, with a product. The last half of the book is an in-depth evaluation of many products on the market. However, even in the how-to chapters, we are frequently product specific. Whenever appropriate, we provide detailed tables on products and their capabilities.

We provide cost and time-to-install information wherever we can. We, like you, are concerned about cost in the decision-making process. We respect its impact. We know businesses must often use the hardware and software on hand and cannot always afford an entirely new system or an expensive consultant.

While this is neither a UNIX networking book nor a PC LAN networking book, you will find information to help you with UNIX network setup, printer sharing, NetWare administration and other issues related to LANs. We also help you if you happen to have stand-alone machines on either side of the fence.

Finally, we consider this book a part and parcel of the client/server craze, although we choose to adopt the broad industry definition of client/server technology. In our context, a client is any machine/program requesting services or informa-

tion from another machine. In many respects, this describes much of what happens in DOS—UNIX networking and internetworking. We don't worry about whether it meets everyone's strict definition of client/server computing—our goal is to show you "how to do it."

This unique approach has minor drawbacks. First, because we are working with more than 100 different products, we recognize the impossibility of being in sync with the latest release of every product. We worked hard to get the most recent version of each product before the book went into production.

In addition, some specifics may be outdated within one or two years. New products or methodologies inevitably replace older ones. For example, the shift from TSR-based TCP/IP programs to the Windows Socket API (WinSock) was just gaining momentum while we were writing the book.

The benefits of our approach outweigh any drawbacks. For many of you, working with what you have already installed is a necessity. Small businesses cannot afford to upgrade to the newest version. In many cases, earlier versions still perform the job adequately. Good business management means upgrading as needed—not necessarily all in one shot.

## How to Use This Book

This book can be used in a variety of ways. A newcomer to the dual environment of DOS and UNIX can choose it as an overall primer on the subject. Software purchasers will find the product evaluations useful in their own selection process. Implementors can profit from the network setup hints woven throughout the book.

The first three chapters are primers. If you need some background in either DOS or UNIX as an operating system, read Chapter 1. Those with only a vague understanding of networks will benefit from the simple approach to networking theory in Chapter 2. Chapter 3 outlines an entire decision process—the many choices you face when incorporating DOS or UNIX into your network. This chapter should be read by everyone.

Chapters 4-12 cover the mechanics of DOS—UNIX networking and internetworking. We talk about hardware and software—but avoid discussions of vaporware. These chapters deal with the practical aspects of installation, setup, usage, and maintenance of DOS and UNIX working together. We think it is easier to learn how to do something by really doing it, so many of our examples revolve around real installations, real hardware, and real software products.

Chapters 13-18 contain the evaluations of key product groups. This is where you turn to find out about the latest products on the market and how easily you can use them. In almost every case, we loaded the software, or installed the hardware, and tested it for its intended use. We attempted to be fair, noting both when we liked and did not like a product, and why. Not every product on the market is good and we want to help you sort the wheat from the chaff. Tables at the end of these chapters



compare the features of the products, simplifying your selection process. We made every attempt to contact vendors right up until production time. However, because products change continuously, always double check with the vendor if you need a specific feature we did not mention.

Appendix A contains a small gold mine of UNIX and DOS operating system information. Turn there if you need to get a quick background in commands and procedures, or use it for occasional reference. Finally, we provide several pages of vendor addresses in Appendix B to assist you in your quest for more information.

We try to give the book a readable flavor. Throughout the book, we provide simple diagrams describing complicated concepts. We explain the concepts from a bottom-line point of view. When we talk about hardware, we provide a picture of a sample product whenever possible. When we discuss software, we give you a screen shot. In the product chapters particularly, we use screen shots to help you get a feel for the various user interfaces. Throughout the book, we supply a variety of hot tip boxes and warning boxes to alert you to items of special interest.

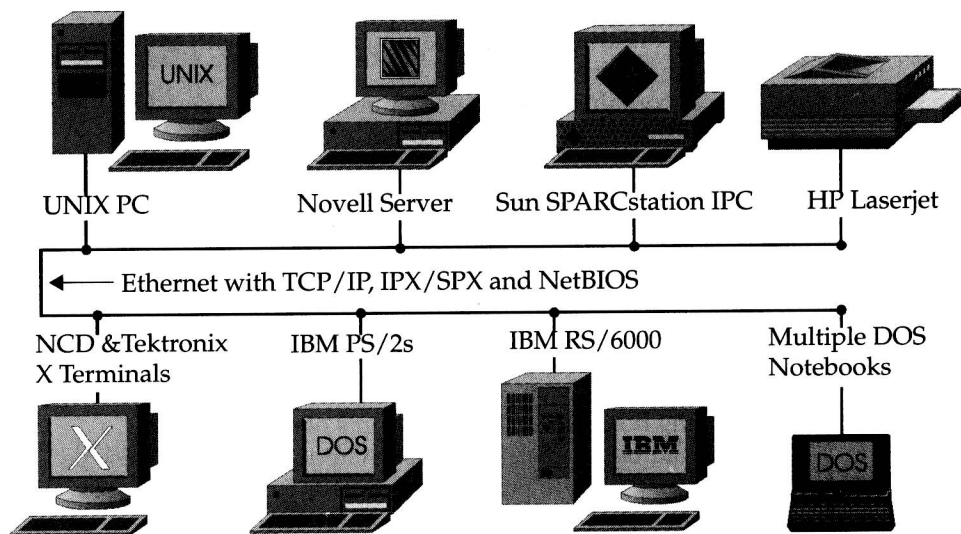
We try to avoid being grim-faced about networking. Business people need a little humor, since they have to pay real money for computer networks. Implementors need to know that we have been where they are. We wish to act as guides, not instructors. For these reasons, we have tried to write as comfortably as possible, using "you" and "we," ... and we confess that we are not above poking fun occasionally. Nevertheless, we take our research seriously. We know it means time, money, and productivity to our readers.

Formatting issues are minor, but you should be aware of those we use. We differentiate from DOS and UNIX commands by making all DOS commands capitalized since DOS is not CAPS sensitive. We bold all commands. When we list a short script or set of commands separately, we place them in a smaller program font to set them off from the text. Italics are occasionally used for emphasis.

## Our Network Layout

Within the confines of our laboratory, we matched real business situations as closely as possible. We always maintained a Novell NetWare 3.11 network with 1 to 4 NetWare clients, a SunSelect PC-NFS TCP/IP network with 2 to 4 PC clients, a Sun SPARCstation IPC, and an IBM RS/6000 on the network as shown in the accompanying figure.

In addition, at various times we used a Microsoft LAN Manager network, a Microsoft Windows for Workgroups network, a Windows NT network, and a LANtastic network, running over our same set of cables. Different UNIX hosts included SCO OPEN DESKTOP 2.0 and 3.0; UnixWare Application Server and Personal Edition; and a DECstation 3100. We also installed an IBM OS/2 PC, X terminals from NCD and Tektronix, and character-based terminals from Wyse Technology. At any given time, we had 10 to 13 different hardware platforms running 3 to 5 different



**FIGURE P.1** Our Test Lab—Multiple Machines and OSs on the Same Cable

operating systems during our testing. We spent hours on the phone getting technical support. Many products did not always work as they should. Reliable delivery, we discovered, didn't necessarily mean that *we* knew where our information ended up; it went somewhere, we're certain, but where, only our software seemed to know. Networks right out of the box may be just around the corner, but don't throw away those working gloves just yet.

## Acknowledgments

We have many people to thank for the content and production of this book, *DOS—UNIX Networking and Internetworking*. Certainly when we set out to examine over 100 products, we needed to have support from the vendors, and we got it without exception. We are especially grateful to Rose Kearsley at Novell, Beth Beyers at Sun-Select, Barbara LoFranco at SCO, and Melanie King at Univel/Novell for their support on the software side.

We also need to thank a number of hardware vendors who loaned us equipment at various times to enable us to complete our testing. We want to thank IBM Corp. for loaning a number of PS/2s and an RS/6000 Model 320; NCD Corp. for an NCD 17c X terminal; Tektronix Inc. for an XP337 X terminal; Sun Microsystems Inc. for a Sun SPARCstation IPC; Digital Equipment Corp. for a DECstation 3100; Best Power Systems for three Fortress UPS systems; Zenith Data Systems for a Z-note 386 notebook; Keydata for a Keynote notebook; Xircom for portable LAN adapters and print



servers; U.S. Robotics for modems; Standard Microsystems Corp. for numerous Ethernet adapters; Eagle Technology for more Ethernet adapters; Pacific Data for a multiprotocol print accelerator; and Hewlett-Packard Company for LaserJet boards and a font cartridge.

We are also grateful to Frame Technology Corp. and Corel Systems Corp. for supplying software for the production of our manuscript. We used CorelDraw 3.0 for Windows; CorelDraw 2.1 for UNIX; Framemaker for OpenLook; and Framemaker for Microsoft Windows. Fiona Rochester at Corel Systems and Yolana Leinson at Frame Technology were especially helpful and courteous.

The production of the book is due to many helping hands. Nearly all the drawings and diagrams were done by Bruce Pierson, our technical assistant and artist-in-residence. He did a fantastic job, and without him our pages would have been bland, to say the least. We are also grateful to Gini Phillips for her work in formatting, editing, and organizing the production of the book. We would not have a book without the contributions of these two.

Those at John Wiley who helped us in the process include our patient and thoughtful editor, Diane Cerra; her assistant, Tammy Boyd, who helped keep us on track, and Jackie Martin, the managing editor who made sure our camera-ready disks were just right. Thanks as well to Rik Farrow, UNIXWorld's Technical Editor for his review of some critical UNIX system administration issues.

Finally, our family and friends in Bozeman, MT deserve our applause and gratitude. We thank our wives, Bonnie and Gini, for their support and patience during those long, extra hours of product testing. Jessica, Justin, Nicholas, Natalie, Rachel, and Emily were great for helping us to remember the important and satisfying things in life. In many ways this book has been a family endeavor.

Michael J. Burgard

Kenneth D. Phillips

Comments can be directed to the authors via e-mail:

mjburgard@mcimail.com (Mike)

602-2316@mcimail.com (Ken)

or, by mail to:

3017 Secor Avenue

Bozeman, MT 59715

# Contents

<b>1</b>	<b>DOS and UNIX Primer</b>	<b>1</b>
	Introduction	1
	The UNIX Operating System	2
	Basic Components of UNIX	3
	X Windows System	7
	The UNIX OS Shuffle	10
	The MS-DOS Operating System	12
	Microsoft Windows and Windows NT	16
	The OS/2 Operating System	18
	Hardware Platforms	19
<b>2</b>	<b>Network Primer</b>	<b>22</b>
	Introduction	22
	LAN Basics	22
	The OSI Model	23
	The MBKP Practical Decision Model	26
	What Is a Physical Topology?	27
	What Is Physical Media?	30
	What Is a Logical Topology?	33
	What Are LAN Adapter Drivers?	37
	What Are Communications Protocols?	40
	What Is a Network Operating System?	43
<b>3</b>	<b>A Decision Primer</b>	<b>45</b>
	Introduction	45
	What Do You Want to Do?	46
	What Is It Going to Cost You?	54
	What Can You Do with What You Have?	57
	How Much Work Do You Want to Do?	60
	Recommendations	62

<b>4</b>	<b>Assembling Ethernet Hardware</b>	<b>63</b>
	Introduction	63
	Ethernet Components	63
	Installing Ethernet Cable	65
	Useful Cable Adapters	70
	Concentrating on UTP	71
	Attaching PCs to Ethernet	72
	Attaching UNIX Workstations to Ethernet	78
	Getting More Distance with Repeaters	79
	Assembling Your Network	79
	Directing Network Traffic	80
	Troubleshooting	84
<b>5</b>	<b>Setting Up a TCP/IP Network</b>	<b>88</b>
	Introduction	88
	What You Gain from TCP/IP Networking	88
	Selecting a TCP/IP Networking Product	94
	Preparing for Installation	96
	TCP/IP Configuration Parameters	96
	Installing TCP/IP on a DOS/Windows PC	99
	Readying the UNIX Server	117
	Establishing Communications Between DOS and UNIX	123
	Troubleshooting	125
<b>6</b>	<b>Installing NFS Products</b>	<b>131</b>
	Introduction	131
	Why NFS Makes Sense for DOS PCs	132
	How NFS Works	133
	Varieties of NFS Products for the PC	134
	NFS Server Daemons	134
	Exporting Filesystems	138
	Steps for Configuring an NFS Server	139

## **Contents**

vii

Installing DOS Software on a Workstation File Server	143
Troubleshooting	144
<b>7 Linking UNIX with PC LANs</b>	<b>146</b>
Introduction	146
Why Link Networks?	146
Purchasing Considerations	147
Linking UNIX with the Novell NetWare Environment	150
Linking UNIX with the Microsoft Windows Environment	161
Installing UNIX Software (for the UNIX Novice)	166
Troubleshooting	166
<b>8 Using X Servers on PCs</b>	<b>170</b>
Introduction	170
X Windows System	170
Why Choose a PC X Server?	172
Basic PC Requirements	173
The Costs	174
Installing Your Windows X Server	176
Window Managers	181
Xterm	183
X Clients	186
Autostarting X Applications	187
X Display Manager	188
Cutting and Pasting	194
Keyboards	195
Fonts	197
Colors in X	200
Troubleshooting	200
<b>9 Making Serial Connections</b>	<b>202</b>
Introduction	202
Choosing Serial Connections	202

Installing and Configuring Software	205
Cabling Basics	207
Preparing the PC	209
Preparing the UNIX Host	211
Modems—Buying and Installing	218
File Transfer Protocols	222
Serial TCP/IP Protocols	223
Rolling Your Own Serial Connection	224
Cabling and Connections	227
Troubleshooting Serial Communications	233
<b>10 Emulating DOS</b>	<b>235</b>
Introduction	235
DOS Emulation Described	235
Workstation Requirements	238
Preparing for Installation	240
Installing DOS Emulation Hardware	242
Installing DOS Emulation Software	243
Running DOS Emulation	246
WABI and Friends	249
<b>11 Connecting Printers</b>	<b>251</b>
Introduction	251
Product Types	253
Selecting a Hardware Interface	254
Networking a Printer Under UNIX	256
Networking a Printer Under DOS	273
Novell NetWare Print Servers and Queues	276
How to Print PostScript Files on Non-PostScript Printers	278
How to Install a PostScript/PCL Print Accelerator	281
How to Install an Internal Network Adapter	283

## **Contents**

ix

<b>How to Install a Print Server</b>	<b>284</b>
<b>How to Install a Network-Ready, Multiprotocol Printer</b>	<b>287</b>
<b>12 E-Mail, Terminals, and More</b>	<b>289</b>
Introduction	289
E-Mail Options	289
Sneakernet	294
Internetwork Management Tools	295
Macintosh Connectivity	300
Character-Based Terminals	301
Multiport Boards	303
Terminal Servers	304
X-Terminals	305
AlphaWindows Terminals	307
Uninterruptible Power Systems	308
<b>13 TCP/IP Networking Products</b>	<b>312</b>
Introduction	312
Evaluation Criteria	312
Product Evaluations	313
Recommendations	348
<b>14 PC LAN—UNIX Products</b>	<b>357</b>
Introduction	357
Evaluation Criteria	357
Product Evaluations	358
Recommendations	397
<b>15 X Servers</b>	<b>401</b>
Introduction	401
Evaluation Criteria	401
Product Evaluations	402
Recommendations	420



<b>16</b>	<b>Terminal Emulators</b>	<b>423</b>
	Introduction	423
	Evaluation Criteria	423
	Product Evaluations	424
	Recommendations	452
<b>17</b>	<b>DOS Emulators</b>	<b>456</b>
	Introduction	456
	Evaluation Criteria	456
	Product Evaluations	456
	Recommendations	465
<b>18</b>	<b>E-Mail Options</b>	<b>467</b>
	Introduction	467
	Evaluation Criteria	467
	Product Evaluations	468
	Recommendations	487
<b>Appendix A</b>	<b>Survival Kit</b>	<b>489</b>
	Common DOS/UNIX Commands and Keys	489
	Other Important Commands and Keys	491
	Search Paths for Executable Programs	492
	Editing Text Files Under DOS and UNIX	493
	Boot Processes	495
	Shutdown Processes	497
	Getting Help	498
	What to Do with Core Files	498
	Copying Files Between DOS and UNIX Computers	499
<b>Appendix B</b>	<b>Books and Vendors</b>	<b>500</b>
	<b>Index</b>	<b>512</b>

# 1

## DOS and UNIX Primer

---

### Introduction

Whenever you cross into the realm of internetworking, you encounter a whole new set of issues—not the least of which is the learning curve. The very concept of internetworking implies more than one operating system and more than one type of hardware box. You may have a large number of IBM PS/2s connected to a single Sun Microsystems server, or you may have a network of DECstations and need to add some low-cost PC clones for a particular task.

Unfortunately, most of us have a rather well-defined job, and it usually revolves around a specific set of hardware and software. When we venture outside this arena, we find ourselves unable to speak the language and groping for the information needed to solve a specific problem. In Chapters 1 and 2, our intention is to provide information which you may need before you delve into the world of internetworking.

Chapter 1 outlines basic information on UNIX and DOS, as well as some other related hardware and software issues. If you are a UNIX guru but short on DOS knowledge, you might skip the sections on UNIX and just read the MS-DOS and Windows sections. Similarly, if you run a large DOS network but have no idea what UNIX does, you can concentrate on the UNIX portion. The DOS and UNIX sections cross reference similarities where they exist in order to help the new user understand foreign-sounding terms. There is also a DOS to UNIX command cross-reference and other information in Appendix A.

In any case, we make no attempt to replicate the volumes of information about these operating systems. There are excellent books available on UNIX, MS-DOS, Windows, and each of the network operating systems from a variety of sources. These include *Modern UNIX* by Alan Southerton (John Wiley & Sons, Inc. books), *Running MS-DOS* by Van Wolverton (Microsoft Press), and *Running Windows* by Craig Stinson (Microsoft Press). These books and others are listed in Appendix B.

Instead, we cover the operating systems basics and discuss some of their similarities and differences. If your project is small, the knowledge you gain from these chapters and the hands-on information provided in later chapters should allow you to get up and running. Bigger projects may require you to invest in some general background references. Our goal in this chapter is to get you started.

## The UNIX Operating System

The widespread popularity of the UNIX operating system is relatively recent. This popularity stems from many different factors, but includes UNIX acceptance by the education community, its ability to run on a variety of platforms, its openness, the stability of the operating system kernel, and a dozen other items. Following is a brief overview of what UNIX is and what it has to offer. See Appendix B for a list of books to give you an in-depth treatment of UNIX.

### Origin and History

UNIX is an operating system developed by researchers at AT&T's Bell Labs in 1969. For many years, UNIX was a trademark of AT&T, though later it came under the auspices of UNIX Software Laboratories, or USL, which was purchased by Novell, Inc. in 1993. While originally created for a PDP-7 (a mini-computer manufactured by Digital Equipment Corporation) in PDP assembler language, UNIX quickly spread beyond this proprietary hardware, once it was ported to the C language.

There were a number of reasons for UNIX to grow beyond its dependence upon a single hardware system. UNIX quickly evolved into a portable and scalable operating system. That is, you could "port" it to any kind of processor, whether from Motorola or Intel or SPARC or MIPS, and it would run on a machine constructed with that processor. One of its inventors, Dennis Ritchie, once said that "it was easier to port UNIX to a new hardware machine than an application to a new operating system." It is also scalable, which means it runs on small machines like laptops as well as big machines like supercomputers. In these days of linking big networks together, administrators prefer worrying about as few operating systems as possible.

For the first 10 years of UNIX's existence, its position in the commercial marketplace was insignificant. No one attempted to resell UNIX until Interactive Systems did so in 1977, eight years after its genesis—a lifetime in operating systems longevity. Even the formation of The Santa Cruz Operation, Inc. in 1981 and Sun Microsystems in 1982, did not quickly change the landscape. Instead UNIX grew slowly during the go-go days of the PC in the mid-1980s, taking a position of importance in scientific and engineering situations, but not making a large impact on the general business computing environment. As Table 1.1 shows, the UNIX market has grown steadily yet substantially since those early days.

UNIX experienced a splitting of the ranks so to speak when in the early 1980s, the University of California, Berkeley, created a version of UNIX based on AT&T source code. This new version of UNIX became known as Berkeley UNIX and, because universities could get the source code for a low price, it became a popular variant. Sun Microsystems adopted Berkeley UNIX for its line of workstations and lengthened its life considerably. When it is important, we point out differences between Berkeley UNIX and AT&T System V UNIX (known just as System V).