

# Red Hat® Linux® 6

David Pitts and Bill Ball et al.

## Expert Insight

The book presents authoritative explanations of the core features and complexities of Red Hat Linux 6, including

- Installing and configuring Red Hat Linux 6
- Detailed, timely advice on system administration, security, and network services
- Extensive coverage on the programming languages most often implemented by Linux professionals
- Comprehensive reference on important commands and shell operators

Includes  
Red Hat®  
Linux® 6

## Authoritative Advice

Linux gurus Bill Ball and David Pitts show you what you need to know in order to master Red Hat Linux 6. You know the basics—now move to the next level as Bill, David, and a host of other Linux experts share insights and tricks gained over many years of hands-on Linux experience.



Techmedia

SAMS

Authorised  
Edition For  
INDIAN  
Sub-Continent  
Only

# Unleashed

FROM KNOWLEDGE TO MASTERY

# Contents at a Glance

Introduction	1
<b>Part I Introduction and Installation of Red Hat Linux</b>	<b>7</b>
1 Introduction to Red Hat Linux and UNIX	9
2 Installation of Your Red Hat System	17
3 LILO	39
4 Configuring the X Window System, Version 11	49
5 Window Managers	99
<b>Part II Configuring Services</b>	<b>143</b>
6 System Startup and Shutdown	145
7 SMTP and Protocols	171
8 FTP	219
9 Apache Server	253
10 Internet News	297
11 The Domain Name Service	317
12 NIS: Network Information Service	361
13 NFS: Network File System	377
14 Samba	389
<b>Part III System Administration and Management</b>	<b>421</b>
15 Filesystems, Disks, and Other Devices	423
16 Printing with Linux	463
17 TCP/IP Network Management	489
18 Connecting to the Internet	543
19 Red Hat Graphical Administration Tools	569
20 Essential System Administration	609
21 Advanced System Administration	647
22 GNU Project Utilities	663
23 Backup and Restore	695
24 System Security	709
<b>Part IV Programming in Linux</b>	<b>725</b>
25 Shell Programming	727
26 gawk Programming	757

- 27 Automating Tasks 799
- 28 Configuring and Building Kernels 819
- 29 Network Programming 881
- 30 C and C++ Programming 907
- 31 Perl Programming 951
- 32 Motif Programming 973
- 33 tcl and tk Programming 995
- 34 Programming in Python 1027
- 35 Java Programming 1075

**Part V Appendixes 1113**

- A The Linux Documentation Project 1115
  - B Top Linux Commands and Utilities 1121
  - C The Linux Documentation Project Copyright License 1165
  - D Working with Other Systems 1169
- Index 1189**

005.43  
- C -

# Table of Contents

Introduction	1
<b>PART I Introduction and Installation of Red Hat Linux</b>	<b>7</b>
<b>1 Introduction to Red Hat Linux and UNIX</b>	<b>9</b>
Advantages of Linux	11
Copyright and Warranty	13
Where to Get Red Hat Linux	13
System Requirements	14
System Requirements—Intel	14
Summary	15
<b>2 Installation of Your Red Hat System</b>	<b>17</b>
Be Prepared, Be Very Prepared	18
Installing Red Hat Linux	19
Creating the Startup and Supplemental Disks	20
Installing Without Using a Startup Disk	20
Virtual Consoles	20
Dialog Boxes	21
Step-by-Step Installation	22
Starting the Installation	22
Kernel Parameter Options	24
The Installation Program	24
Selecting an Installation Method	25
CD-ROM Installation	26
Configuring Your Hardware	34
Choosing a Mouse	34
Configuring the X Window System	34
Configuring the Network	35
Setting the Time Zone	35
Selecting Services to Start Automatically	36
Configuring Your Printer	36
Root's Password	36
The Red Hat Package Manager	37
Installing and Removing Packages with RPM	38
Summary	38
<b>3 LILO</b>	<b>39</b>
Installing and Configuring LILO	41
Installing or Reconfiguring LILO	42
Configuring LILO	42
Using LOADLIN.EXE to Boot Linux	46
How to Uninstall LILO	47
Troubleshooting LILO	47
Summary	48

<b>4</b>	<b>Configuring the X Window System, Version 11</b>	<b>49</b>
	The X Window System.....	50
	Setting Up Your XFree86 System.....	51
	Configuring Your XFree86 System.....	53
	The XF86Config File .....	57
	Using Xconfigurator .....	58
	Examining the XF86Config File.....	64
	XF86Config Files Section .....	64
	XF86Config ServerFlags Section.....	66
	XF86Config Keyboard Section .....	67
	XF86Config Pointer Section .....	68
	XF86Config Monitor Section.....	69
	XF86Config Graphics Device Section.....	73
	XF86Config Screen Section.....	74
	Using xf86config .....	76
	Configuring with XF86Setup .....	87
	The .xinitrc File .....	91
	Using Red Hat's wmconfig Command.....	92
	The Personal X Resource File.....	94
	Using xdm .....	95
	Starting X Sessions .....	97
	Troubleshooting XFree86 .....	98
	Summary .....	98
<b>5</b>	<b>Window Managers</b>	<b>99</b>
	What Is a Window Manager? .....	100
	The GNOME X Environment .....	101
	What Is GNOME?.....	101
	GNOME Installation Components .....	102
	Configuring X11 to Use the GNOME or Other	
	Display Managers.....	103
	Using GNOME Clients and Tools.....	107
	Configuring Your Desktop with the GNOME Control Center .....	108
	GNOME Panel Configuration.....	110
	Features of the Enlightenment Window Manager.....	112
	Features of the K Desktop Environment.....	114
	KDE Installation Components .....	114
	Logging In with kdm .....	115
	Features of the KDE Desktop .....	116
	Performing Basic Desktop Actions .....	117
	Using Desktop Panel .....	117
	Editing the KDE Panel Menu .....	118
	Using the kfm File Manager .....	119
	Configuring KDE with the KDE Control Center .....	119
	Using Display Manager Options.....	120
	Changing Your Desktop's Wallpaper.....	121

Changing Your Screensaver.....	122
Installing System Sounds .....	123
Changing Keyboard and Mouse Settings .....	124
Changing Window Buttons .....	126
Controlling Cursor Movement Through Desktops .....	128
Features of the fvwm2 AnotherLevel Configuration .....	129
Important Files .....	129
Configuring AnotherLevel .....	130
Keyboard Controls.....	131
Features of the AfterStep Window Manager.....	132
Important Files .....	133
Configuring AfterStep .....	133
Features of the GNU Window Maker Window Manager .....	133
Important Files .....	134
Configuring Window Maker .....	134
The fvwm2 Window Manager .....	135
The fvwm Window Manager .....	136
The twm Window Manager .....	137
Features of the Common Desktop Environment.....	139
Installing Red Hat's CDE and Library Fixes Using RPM .....	140
Summary .....	141
<b>PART II Configuring Services 143</b>	
<b>6 System Startup and Shutdown 145</b>	
The Boot Process.....	146
The Initialization Process and Startup Scripts .....	147
init and /etc/inittab .....	148
/etc/inittab and System States .....	151
linuxconf and Managing Your Services .....	156
Shutting Down the Linux System .....	160
shutdown .....	160
halt and reboot .....	162
When the System Crashes.....	163
Running as root .....	163
Creating a Boot Disk.....	164
Your File Toolbox .....	166
Red Hat to the Rescue! When the System Won't Boot .....	167
For More Information .....	168
Summary .....	170
<b>7 SMTP and Protocols 171</b>	
A Brief History of Internet Email Standards .....	172
Introduction to sendmail .....	172
The Post Office Protocol (POP) .....	173
The Internet Mail Access Protocol (IMAP) .....	173

SMTP and sendmail .....	174
Internet Mail Protocols .....	174
The Domain Name System and Email .....	176
sendmail's Jobs .....	180
sendmail's Auxiliary Files .....	181
The Aliases File .....	181
Setting Up sendmail .....	183
sendmail.cf: The Configuration File .....	187
Automatically Generating the sendmail.cf File .....	201
Testing sendmail and sendmail.cf .....	205
Common sendmail Configuration Mistakes .....	207
POP .....	208
Configuring a POP Server .....	208
The POP3 Protocol .....	211
IMAP .....	211
Configuring an IMAP Server .....	212
Mail Retrieval .....	213
Configuring Netscape for POP3 or IMAP Retrieval .....	213
fetchmail .....	215
Summary .....	216
<b>8 FTP 219</b>	
Getting and Installing the FTP Server .....	220
How the FTP Server Works .....	223
Configuring Your FTP Server .....	224
Controlling Access—The /etc/ftpaccess File .....	224
Converting Files On-the-Fly—The /etc/ftpconversions File .....	239
Configuring Host Access—The /etc/ftphosts File .....	241
The FTP Log File—/var/log/xferlog .....	242
FTP Administrative Tools .....	243
ftpshut .....	243
ftpwho .....	243
ftpcount .....	244
Using FTP Clients .....	244
autoexpect .....	246
ncftp .....	247
tftp .....	248
xtp .....	248
gftp .....	248
Summary .....	250
<b>9 Apache Server 253</b>	
Server Installation .....	255
Installing from the RPM .....	255
Building the Source Yourself .....	256

Runtime Server Configuration Settings .....	258
Editing httpd.conf .....	259
.htaccess Files and Access Restrictions .....	262
Virtual Hosting .....	264
Address-Based Virtual Hosts .....	265
Name-Based Virtual Hosts .....	265
Logging .....	267
CGI and SSI .....	268
CGI .....	269
SSI .....	269
Basic SSI Directives .....	270
Flow Control .....	273
Starting and Stopping the Server .....	274
Starting the Server Manually .....	274
The /etc/rc.d httpd Scripts .....	275
Configuration File Listings .....	278
Summary .....	296
<b>10 Internet News 297</b>	
Linux and Newsgroups .....	298
How a Newsfeed Works .....	299
Pushing and Pulling the News .....	300
Alternative Methods to Downloading Newsgroups .....	300
INN Hardware and Software Requirements .....	301
An Introduction to INN .....	302
Installing INN .....	302
The INN Startup Files .....	304
Configuring INN .....	308
Introduction to NNTPCache .....	310
How NNTPCache Works .....	310
Downloading and Configuring NNTPCache .....	311
Introduction to trn .....	314
Installing and Configuring trn .....	314
Summary .....	315
<b>11 The Domain Name Service 317</b>	
A Brief History of the Internet .....	318
The hosts.txt File .....	319
The /etc/hosts File .....	320
BIND 8 .....	321
A Word About This Chapter's Examples .....	322
Bringing Up a Trivial Caching DNS .....	323
The Real Solution .....	323
Testing Your Caching DNS .....	328
Caching Server Summary .....	330
Important DNS Facts and Concepts .....	331
The DNS Client and Server Are Distinct .....	331



DNS Terminology .....	331
DNS Maps Names to IP Numbers, and Vice Versa .....	332
The Forward and Reverse Zones Must Be Kept in Sync .....	332
The HUP Signal Versus Restart .....	333
The IN-ADDR.ARPA Domain .....	333
Host Naming Schemes .....	333
Configuring the DNS Client: <code>/etc/resolv.conf</code> .....	333
The Software of DNS .....	334
DNS Server Configuration Files .....	337
The DNS Boot File: <code>/etc/named.conf</code> .....	337
DNS Zone Data Files .....	340
Configuring DNS Server Master Zones .....	345
Adding Local Domain Resolution .....	345
Adding Virtual Domain Resolution.....	348
Delegating Authority .....	349
Add Authority for <code>subdomain.domain.cxm</code> on <code>sylvia</code> .....	350
Test the <code>subdomain.domain.cxm</code> Local Resolution.....	351
Delegate from <code>numark</code> to <code>sylvia</code> for the Subdomain .....	351
Test the <code>subdomain.domain.cxm</code> Delegation.....	352
Adding a Slave DNS Server .....	352
Changes to <code>mtx</code> .....	354
Changes to <code>numark</code> .....	355
Troubleshooting and Debugging DNS .....	356
Using Scripting to Stress-Test Your DNS Setup .....	356
Debugging with Dumps and Logs .....	357
Other DNS Documentation .....	358
<code>/usr/doc/HOWTO/DNS-HOWTO</code> .....	358
<code>/usr/doc/LDP/nag/index.html</code> .....	358
<code>/usr/doc/bind-8.2.6/</code> .....	358
<code>http://www.math.uio.no/~jan1/DNS/</code> .....	358
<code>http://www.dns.net/dnsrd/</code> .....	358
<code>http://www.isc.org/bind.html</code> .....	358
Summary .....	359
<b>12 NIS: Network Information Service 361</b>	
Understanding NIS .....	362
NIS Domains .....	362
The Different Servers .....	363
Installing the Software .....	363
Configuring a Master NIS Server .....	364
Starting the Daemons on Boot .....	368
Configuring an NIS Client .....	368
Testing the Client .....	370
Configuring an NIS Secondary Server .....	371
Using NISisms in Your <code>/etc/passwd</code> File .....	372

Using Netgroups .....	373
Some Troubleshooting Tips.....	374
Summary .....	375
<b>13 NFS: Network Filesystem 377</b>	
Installing NFS .....	379
Starting and Stopping the NFS Daemons .....	380
Status of NFS .....	380
Configuring NFS Servers and Clients .....	380
Setting Up the /etc/exports File .....	381
Using mount to Mount an Exported Filesystem.....	382
Unmounting a Filesystem .....	384
Configuring the /etc/fstab File to Mount Filesystems	
Automatically .....	385
Complete Sample Configuration Files .....	387
Summary .....	388
<b>14 Samba 389</b>	
Installing Samba .....	391
Getting a Simple Samba Setup Running .....	391
Testing with a Linux Client.....	392
Testing with a Windows Client .....	393
Configuring Samba .....	396
The [global] Section .....	396
The [homes] Section .....	398
The [printers] Section .....	399
Sharing Files and Print Services .....	403
Optimizing Samba Performance .....	404
Testing Your Configuration .....	405
Testing with smbstatus .....	406
Running the Samba Server .....	407
Accessing Shares.....	407
Using smbclient on a Linux Client .....	407
Mounting Shares on a Linux Client .....	409
Mounting Shares on a Windows Client.....	410
Common smb.conf Configuration Options.....	410
Special Conventions .....	410
read Only= Versus writeable= Versus writable= Versus	
write ok= (S).....	411
valid users= (S) .....	411
invalid users= (S) .....	411
read list= (S) .....	412
write list= (S) .....	412
path= (S) .....	412
create mask= and create mode= (S) .....	413
browseable= (S) .....	413

printable= (S).....	414
hosts allow=, hosts deny=, allow hosts=, and deny hosts= (S) .....	414
public= and guest ok= (S) .....	414
comment= (S) and server string= (G) .....	415
domain logons= (G) .....	415
encrypt passwords= and smb passwd file= (G) .....	415
hosts equiv= (G).....	415
interfaces= (G).....	415
load printers= (G).....	415
null passwords= (G).....	415
password level and username level (G) .....	415
security= (G) .....	416
workgroup= (G) .....	416
config file= (G).....	416
Samba Documentation Sources.....	416
Samba Applications Documentation Sources .....	417
Configuration Option Documentation.....	418
Other Documentation .....	418
Using SWAT for Web-Based Samba Configuration .....	418
Activating SWAT on Your Server .....	419
Configuring smb.conf from Your Browser Using SWAT .....	419
Summary .....	420
<b>PART III System Administration and Management 421</b>	
<b>15 Filesystems, Disks, and Other Devices 423</b>	
Character Devices .....	424
Block Devices .....	425
Filesystems .....	426
The mount Command .....	426
Potential Problems with mount.....	427
Mounting with the User Mount Tool .....	431
Setting Up Filesystems .....	431
Editing /etc/fstab Manually.....	431
Creating New Filesystems.....	433
Creating and Editing Filesystems Graphically with fsconf .....	436
Access Local Drive .....	436
Repairing Filesystems .....	439
Various Kinds of Hardware.....	442
Hard Disks.....	442
Floppy Disks .....	444
CD-ROM Drives .....	445
Loopback Devices .....	446
Other Block Devices .....	449
Character Devices .....	451

Parallel Ports .....	451
Tape Drives .....	452
Serial Communications .....	456
Generic SCSI Devices .....	457
CD-ROM Recorders .....	457
Testing CD Images .....	458
Other Character Devices .....	458
Summary .....	462
<b>6 Printing with Linux 463</b>	
Printer Devices .....	464
What Printer Should I Use with Linux? .....	465
Ghostscript Printing Support.....	466
How Do I Print? .....	468
New Parallel-Port Drivers .....	468
The RHS Linux Print System Manager .....	470
Remote Linux Printers .....	470
Local Printers .....	474
Customizing RHS Printer Filters .....	475
Linux Printing Commands .....	476
Simple Formatting.....	477
Other Helpful Printer Programs and Filters .....	478
APsfilter .....	478
BubbleTools.....	479
magicfilter .....	479
LPRMagic .....	479
HPTools .....	479
PostScript Printers.....	479
Enhanced Printer Spooler .....	480
System Accounting .....	480
Infrared Printer Support .....	480
Some Program Tips .....	481
emacs .....	481
Appixware for Linux .....	481
WordPerfect 8 for Linux .....	483
Other Helpful Programs .....	485
pbm Utilities.....	485
gv .....	485
Troubleshooting and More Information .....	486
Summary .....	487
<b>17 TCP/IP Network Management 489</b>	
TCP/IP Basics .....	490
IP Addresses .....	490
Dividing the Network .....	491
The TCP/IP Protocol Suite .....	496

Ports.....	497
Sockets.....	498
Configuring the Network .....	499
Configuration Files .....	499
Configuration Programs .....	506
Network Daemons.....	513
Standalone TCP/IP Daemons .....	514
The Internet Super-Server: <code>inetd</code> .....	514
Configuring a PPP Server .....	516
Basic Configuration.....	517
Setting Up PPP Access via the Shell .....	519
Setting Up Direct PPP Access Without Shell Access .....	519
TCP/IP Troubleshooting Tools .....	520
ping.....	520
tracert.....	522
tcpdump .....	524
Network Security Tools.....	527
Firewalls .....	527
Secure Remote Access—SSH, the Secure SHell .....	537
Summary .....	542
<b>18 Connecting to the Internet 543</b>	
Setting Up the Dummy Interface .....	544
Setting Up PPP .....	547
Installing PPP .....	548
Setting Up a PPP User Account .....	548
Setting Up chat .....	549
Configuring pppd .....	550
Combining chat and pppd .....	551
Setting Up PPP Using the PPP Scripts .....	552
Setting Up PPP with the <code>netcfg</code> Client.....	553
Setting Up PPP with the <code>kppp</code> Client .....	556
Setting Up SLIP .....	563
Configuring SLIP .....	563
Setting Up a Dial-In PPP Server.....	565
Summary .....	567
<b>19 Red Hat Graphical Administration Tools 569</b>	
Organization of the Red Hat Filesystem.....	570
Essentials of <code>/bin</code> and <code>/sbin</code> .....	570
Configuration Files in <code>/etc</code> .....	571
<code>/home</code> .....	573
<code>/mnt</code> .....	573
<code>/tmp</code> and <code>/var</code> .....	574
<code>/usr</code> .....	575
The Red Hat Package Manager (RPM) .....	576
Major Modes and Common Options.....	577

Installing Packages .....	579
Upgrading Packages .....	581
Uninstalling Packages .....	581
Querying Packages .....	583
Verifying Packages .....	585
Introduction to gnorpm .....	586
Red Hat Tools .....	589
Using the control-panel Client .....	590
Configuring Apache with the Comanche Tool .....	591
Configuring Fetchmail with the fetchmailconf Tool .....	592
Configuring Linux Runlevels with the tksysv Tool .....	592
Setting the Time and Date with the timetool Command .....	594
Configuring Your Printers with the Printtool Client .....	595
Configuring Network Devices with the netcfg Tool .....	595
Getting Help with the helptool Client .....	596
Configuring Your Linux Kernel with the kernelcfg Tool .....	597
Creating /dev/modem with the modemtool Client .....	598
Using Red Hat's setup Command .....	599
Configuring Your Keyboard with the kbdconfig Command .....	600
Configuring Your Mouse with the mouseconfig Command .....	600
Configuring Your Sound Card with the sndconfig Command .....	601
Configuring System Services with the ntsysv Command .....	603
Setting the System Time Zone with the timeconfig Command .....	603
Using the linuxconf Command .....	604
Summary .....	608
<b>20 Essential System Administration 609</b>	
Handling the All-Powerful root Account .....	610
Maintaining the System—Implementing Changes .....	612
Planning Processes .....	612
Creating a Back-Out Plan .....	613
Making Changes in Small Increments .....	613
Developing a Test Plan .....	613
Communicating Effectively and in a Timely Manner .....	613
Getting Help .....	620
Man Pages .....	620
Email .....	624
Red Hat Mailing Lists and Newsgroups .....	624
Other Newsgroups .....	626
Problem Solving—Logs .....	628
Other Files That Deny or Allow Users or Hosts .....	629
syslog.conf .....	629
Adding Users .....	630
Editing etc/passwd .....	631

Editing /etc/group .....	634
Creating a Home Directory and Copying Files to the New Home .....	636
Changing Ownerships and Permissions .....	637
Setting the Password .....	637
Changing User Properties .....	637
Temporarily Disabling a User .....	637
Adding a User with a Configuration Tool .....	638
Adding a User with Gnome's linuxconf .....	640
The User's Password .....	641
Deleting a User .....	641
Groups .....	642
The Login and How to Become a Specific User .....	643
The su Command .....	644
Searching for User's Information .....	644
who .....	644
finger .....	645
Summary .....	645
<b>21 Advanced System Administration 647</b>	
Basic Performance Analysis .....	648
Determining CPU Usage with vmstat .....	648
top .....	650
Graphical Monitoring Tools .....	653
Xosview .....	653
How Much Swap Is Enough? .....	655
Momma Always Said to Be Nice! .....	656
Summary .....	661
<b>22 GNU Project Utilities 663</b>	
The GNU Project Software Distributions .....	664
File Utilities .....	667
Listing Directory Contents .....	668
File Operations .....	671
Changing File Attributes .....	672
Disk Usage .....	675
Find Utilities .....	676
locate .....	676
find .....	678
xargs .....	680
Shell Utilities .....	682
Who's Who in GNU .....	683
The id Commands .....	684
Checking What System You're Running .....	685
Environment Variables and Shell Functions .....	685
Text Utilities .....	686
The head and tail Commands .....	687

The split Command .....	689
Counting Words .....	690
Summary .....	693
<b>23 Backup and Restore 695</b>	
Successful Backup Considerations .....	696
The Difference Between Backup and Archive .....	696
Qualities of a Good Backup .....	697
Selecting a Backup Medium .....	697
Selecting a Backup Tool .....	698
Backup Strategies and Operations .....	700
Performing Backups with tar and cpio .....	701
Performing Backups with the taper Script .....	702
Performing Backups with BRU-2000 .....	704
Restoring Files .....	707
What Is on the Tape? .....	707
Summary .....	708
<b>24 System Security 709</b>	
Thinking About Security—An Audit .....	710
A Security Plan .....	710
Security Tools .....	711
Knowledge Gathering .....	713
Danger, Will Robinson, Danger! .....	714
Preparing for the Worst .....	715
suid and sgid .....	715
File and Directory Permissions .....	717
Files .....	717
Directories .....	718
How suid and sgid Fit into This Picture .....	721
The Default Mode for a File or Directory .....	722
Passwords—A Second Look .....	722
Related WWW Sites .....	723
Summary .....	724
<b>PART IV Programming in Linux 725</b>	
<b>25 Shell Programming 727</b>	
Creating and Executing a Shell Program .....	729
Variables .....	732
Assigning a Value to a Variable .....	732
Accessing Variable Values .....	733
Positional Parameters .....	733
Built-In Variables .....	734
Special Characters .....	735
Double Quotes .....	736



Single Quotes .....	737
Backslash.....	737
Backtick.....	738
Comparison of Expressions.....	738
pdksh and bash .....	738
tcsh.....	743
Iteration Statements.....	746
The for Statement .....	746
The while Statement .....	747
The until Statement .....	748
The repeat Statement (tcsh) .....	749
The select Statement (pdksh) .....	749
The shift Statement .....	750
Conditional Statements .....	750
The if Statement .....	751
The case Statement .....	752
Miscellaneous Statements .....	754
The break Statement .....	755
The exit Statement .....	755
Functions .....	755
Summary .....	756
<b>26 gawk Programming 757</b>	
Applications of awk.....	758
Features of the awk Language.....	759
awk Fundamentals .....	759
Using awk from the Command Line .....	760
Patterns and Actions .....	762
Handling Input.....	766
Coding Your Program .....	767
Actions.....	768
Variables .....	768
Strings .....	772
Arrays .....	776
Built-In Numeric Functions .....	779
Arithmetic Operators.....	780
Conditional Flow .....	780
Looping .....	782
Advanced Input and Output .....	785
Input.....	785
Output .....	787
Functions .....	790
Function Definition .....	790
Function Parameters .....	792
The return Statement (Explicit Return) .....	793
Writing Reports .....	794

Complex Reports .....	794
Extracting Data .....	794
Commands On-the-Fly .....	795
One Last Built-In Function: <code>system</code> .....	797
Summary .....	798
<b>27 Automating Tasks 799</b>	
First Example—Automating Data Entry .....	800
Problem and Solution .....	800
Analysis of the Implementation .....	801
Tips for Improving Automation Technique .....	803
Continuing Education .....	804
Good Engineering .....	805
Shell Scripts .....	805
Changing Strings in Files with <code>chstr</code> .....	805
WWW Retrieval .....	807
Conclusions on Shell Programming .....	808
Scheduling Tasks with <code>cron</code> and <code>at</code> Jobs .....	809
<code>cron</code> and <code>find</code> —Exploring Disk Usage .....	810
<code>at</code> : Scheduling Future Events .....	811
Other Mechanisms: Expect, Perl, and More .....	811
Expect .....	812
Perl .....	813
Other Tools .....	814
Internal Scripts .....	817
Concluding Challenge for an Automater—Explaining Value .....	817
Summary .....	818
<b>28 Configuring and Building Kernels 819</b>	
An Introduction to the Linux Kernel .....	822
Microkernels Versus Monoliths .....	822
Kernel Modules .....	823
Kernel Version Numbers .....	825
Obtaining the Kernel Sources .....	826
Patching the Source Tree .....	829
About Modules .....	831
New Features in 2.2 .....	832
Configuring Linux Kernel .....	833
Configuration Options .....	835
Code Maturity Level .....	836
Processor Type and Features .....	837
Loadable Module Support .....	838
General Setup .....	839
Networking Support .....	839
BSD Accounting .....	839
SysV IPC (DOSEMU) .....	839
<code>sysctl</code> Support .....	840

Support for Misc Binaries .....	841
Parallel Ports (parport) .....	844
Advanced Power Management (APM) Support .....	845
Watchdog Support .....	846
Plug-and-Play Support .....	846
Block Devices .....	846
Networking Options .....	850
Kernel Netlink Socket .....	851
Network Firewall .....	851
Optimize as Router .....	852
IP Tunnelling .....	852
Webmasters and IP Aliasing .....	853
IPX and Appletalk Support .....	854
Enterprise Networks and X.25 Support .....	855
Forwarding on High-Speed Interfaces and Slow CPUs .....	855
QoS and/or Fair Queuing .....	856
SCSI Support .....	856
Network Device Support .....	856
Dummy Network Device .....	856
EQL .....	857
PLIP, PPP, and SLIP Dial-Up Networking Support .....	857
Amateur Radio and Wireless Support .....	857
IrDA Subsystem and Infrared Port Device Drivers .....	858
ISDN Subsystem .....	858
Old CD-ROM Drivers (Not SCSI or IDE) .....	858
Character Devices .....	859
Terminals and Consoles .....	859
Serial Ports .....	859
Unix98 PTY .....	859
Parallel Printer .....	859
Mice .....	860
Watchdog, NVRAM, and RTC Devices .....	860
DoubleTalk Speech Synthesizer .....	860
Video4Linux .....	861
Joystick Support .....	861
Ftape, the Floppy Tape Device Driver .....	861
Filesystems .....	861
MS-DOS and VFAT (Windows) Filesystems .....	862
ISO 9660, UDF, and DVD Support .....	862
Network Filesystems .....	862
CODA Distributed Filesystem .....	863
NFS .....	863
SMB (Windows Shares) and NPC .....	864
Partition Types .....	864
Native Language Support .....	864

Console Drivers .....	864
Frame Buffer Support .....	865
Sound .....	865
Additional Low-Level Drivers .....	867
Kernel Hacking .....	867
Load/Save Configuration .....	868
Saving Your Configuration .....	868
Building and Installing the Kernel .....	869
Building the Kernel .....	869
Manually Installing a New Kernel .....	871
Troubleshooting the New Kernel .....	872
System Information Files .....	872
Setting Kernel Parameters and Options .....	874
Troubleshooting and Recovery .....	874
Repeated Rebooting .....	875
Partial LILO Prompt .....	875
Kernel Halts While Loading .....	876
Kernel Panic .....	876
Kernel Oops and Bug Reporting .....	877
Linux and Y2K .....	878
References and Resources .....	878
Summary .....	879
<b>29 Network Programming 881</b>	
Networking Concepts .....	882
Building Network Addresses .....	884
Network Services .....	886
Sockets and Portability .....	887
Protocols and Socket Types .....	887
Making a Connection .....	890
A TCP Client Example .....	890
A TCP Server Example .....	891
A UDP Example .....	894
Blocking Versus Nonblocking Descriptors .....	896
I/O Multiplexing with UDP .....	898
I/O Multiplexing with TCP .....	901
Advanced Topics in Network Programming .....	903
Summary .....	904
<b>30 C and C++ Programming 907</b>	
Background on the C Language .....	908
Programming in C: Basic Concepts .....	909
Functions in C Programs .....	909
Data in C Programs .....	911
Creating, Compiling, and Executing Your First Program .....	911
Elements of the C Language .....	913

Elementary C Syntax.....	913
Expressions .....	916
Statement Controls .....	919
Functions .....	921
Creating a Simple Program .....	923
Building Large Applications .....	926
Project Management Tools .....	927
Building Programs with make .....	927
Managing Software Projects with RCS and CVS.....	929
Debugging Tools .....	931
Elements of the C++ Language.....	933
Programming in C++: Basic Concepts .....	933
File Naming.....	934
Differences Between C and C++ .....	935
Scope of Reference in C and C++ .....	935
Overloading Functions and Operators in C++ .....	938
Functions within C++ Data Structures .....	940
Classes in C++.....	942
Declaring a Class in C++ .....	942
Inheritance and Polymorphism .....	944
GNU C/C++ Compiler Command-Line Switches .....	945
New Features of the GNU egcs Compiler System .....	946
egcs Considerations for Red Hat 5.2 .....	947
Additional Resources .....	949
Summary .....	949
<b>31 Perl Programming 951</b>	
A Simple Perl Program .....	952
Perl Variables and Data Structures .....	953
Perl Variable Types .....	954
Special Variables .....	955
Conditional Statements: if/else and unless .....	955
if.....	955
unless .....	957
Looping .....	957
for.....	957
foreach .....	958
while .....	958
until .....	959
Regular Expressions .....	959
Access to the Shell .....	960
Switches.....	961
Modules and CPAN.....	965
Code Examples .....	966
Sending Mail.....	966
Purging Logs .....	967

	Posting to Usenet.....	968
	One-Liners.....	968
	Command-Line Processing.....	970
	For More Information.....	970
	Books.....	970
	Usenet.....	970
	WWW.....	971
	Other.....	971
	Summary.....	972
<b>32</b>	<b>Motif Programming 973</b>	
	What Is Motif?.....	974
	Where Do I Get Motif?.....	975
	What Version of Motif Should I Use?.....	975
	Red Hat Motif Installation.....	977
	Motif 2.1 Development rpms.....	978
	Motif 2.1 rpms.....	978
	Motif 2.1 Mwm rpms.....	978
	Motif Demonstration Source rpms.....	978
	Motif Demos rpms.....	979
	A Simple Example of Motif Programming Concepts.....	979
	Widgets and Event-Driven Programming.....	980
	The Simple Motif Program.....	981
	How the Program Works.....	985
	Sample Program Resources.....	986
	The UIL Compiler.....	987
	Tutorials and Examples.....	988
	Using imake and xmkmf.....	988
	LessTif—An Alternative Motif Clone.....	989
	Building, Installing, and Testing LessTif.....	990
	For More Information.....	992
	Summary.....	993
<b>33</b>	<b>tcl and tk Programming 995</b>	
	tcl Basics.....	996
	Interactive Use of tcl.....	997
	Noninteractive Use of tcl.....	997
	The tcl Language.....	998
	Command Structure.....	998
	Comments.....	999
	Datatypes.....	999
	Variables.....	1000
	Manipulating String Values.....	1003
	Manipulating Numeric Values.....	1005
	Quoting and Substitution.....	1007
	Flow Control—if and switch.....	1009
	Loops.....	1011

File I/O and File Info .....	1012
Procedures .....	1014
The tk Toolkit .....	1016
Introduction to Widgets .....	1016
Creating Widgets .....	1017
Widget Options .....	1018
A tcl/tk Widget Programming Example .....	1019
A tcl/tk Interface to xsetroot .....	1021
Summary .....	1026
<b>34 Programming in Python 1027</b>	
Getting Ready to Run Python .....	1028
Installing Python .....	1029
Setting Python Environment Variables .....	1031
Python Command-Line Interpreter .....	1032
Python Programs .....	1034
Command-Line Arguments and Environment Variables .....	1035
Control Statements .....	1037
The if Statement .....	1037
The while Loop .....	1040
The for Loop .....	1041
Lists and the range() Function .....	1042
Using Tuples .....	1046
Dictionaries .....	1047
Console I/O .....	1049
File I/O .....	1050
File Output .....	1050
File Input .....	1052
File I/O Example .....	1054
Functions and Modules .....	1055
Functions .....	1055
Modules .....	1056
Strings and Regular Expressions .....	1057
Strings .....	1057
Regular Expressions .....	1061
Strings and Regular Expressions Example .....	1065
Classes .....	1067
Class Definition and Instantiation .....	1067
Encapsulation and Private Identifiers .....	1068
Inheritance .....	1071
Additional Python Capabilities .....	1073
Summary .....	1074
<b>35 Java Programming 1075</b>	
What Is Java? .....	1076
Uses of Java .....	1076
The Java Virtual Machine .....	1077

Applications Versus Applets .....	1078
Cross-Platform Development Versus Proprietary Development.....	1079
Java Support in Red Hat Linux .....	1079
Software Development Kits (Java Development Kits) .....	1080
Interpreters.....	1081
An Overview of the Java Language .....	1081
Objects, Classes, and Object-Oriented Programming.....	1083
Datatypes .....	1084
Expressions .....	1087
Control Statements: if-else, while, for .....	1089
Writing Your Own Methods .....	1090
Java Compared to C and C++ .....	1091
Exception Handling.....	1092
Java Object Packages .....	1093
Writing Java Programs .....	1099
Creating the Code .....	1099
Required Sections (Methods) .....	1100
Compiling Java Source Code .....	1101
Creating and Running an Application.....	1101
Creating and Running an Applet.....	1102
Java and the Internet .....	1104
JDBC .....	1104
RMI .....	1105
java.net: Networking Techniques .....	1107
Servlets .....	1109
Other References .....	1111
Books.....	1111
Web Sites .....	1111
Summary .....	1112
<b>PART V Appendixes 1113</b>	
<b>A The Linux Documentation Project 1115</b>	
Overview of the Linux Documentation Project .....	1116
Getting Involved .....	1116
Current Projects.....	1116
FTP Sites for LDP Works .....	1117
Documentation Conventions .....	1117
Copyright and License .....	1117
Publishing LDP Manuals .....	1118
<b>B Top Linux Commands and Utilities 1121</b>	
General Guidelines .....	1122
The List .....	1122
. .....	1123
& .....	1123



! .....1123  
| .....1123  
> .....1124  
< .....1124  
>> .....1124  
<< .....1124  
adduser .....1124  
alias .....1124  
apropos <parameter>.....1125  
ash.....1125  
at.....1125  
atq.....1125  
atrm.....1125  
banner .....1125  
bash.....1126  
batch .....1126  
bc.....1126  
bg.....1127  
bind.....1127  
cat.....1127  
cd.....1128  
chfn.....1128  
chgrp .....1128  
chmod .....1128  
chown .....1130  
chroot .....1130  
chsh.....1130  
control-panel .....1130  
cp.....1130  
cpio.....1131  
crond .....1131  
crontab .....1131  
cu.....1131  
cut.....1131  
dc.....1131  
dd.....1132  
df.....1132  
dir.....1132  
display .....1132  
dmesg .....1132  
du.....1132  
dump.....1132  
echo.....1133  
ed.....1133  
edquota .....1133  
efax.....1133  
efix.....1133

elm.....	1133
emacs .....	1133
emacs-nox .....	1133
env.....	1134
ex.....	1134
fax.....	1134
faxq.....	1134
faxrm .....	1134
faxrunq .....	1135
faxspool .....	1135
fc.....	1135
fdformat .....	1135
fetchmail .....	1135
fg.....	1135
file.....	1136
find.....	1136
finger .....	1136
fmt.....	1136
free.....	1136
ftp.....	1137
glint .....	1137
gnuplot .....	1137
grep.....	1137
groff .....	1138
gs.....	1138
gunzip .....	1138
gv.....	1138
gvim.....	1138
gzip.....	1138
halt.....	1139
head.....	1139
hostname .....	1139
ical.....	1139
ifconfig .....	1139
irc.....	1139
ispell .....	1139
jed.....	1140
jmacs .....	1140
joe.....	1140
jpico .....	1140
jstar .....	1140
kill.....	1140
less.....	1141
ln.....	1141
locate .....	1141
login .....	1141

logout .....	1141
look.....	1141
lpc.....	1141
lpd.....	1141
lpq.....	1142
lpr.....	1142
lprm.....	1142
ls.....	1142
lynx.....	1143
mail.....	1143
make.....	1143
makewhatis .....	1143
man.....	1143
mcopy .....	1144
mdel.....	1144
mdir.....	1144
mesg.....	1144
mformat .....	1144
mgetty .....	1144
minicom .....	1144
mkdir .....	1145
mke2fs .....	1145
mkfs.....	1145
mkswap .....	1145
mlabel .....	1145
more.....	1145
mount .....	1146
mpage .....	1146
mt.....	1146
mv.....	1146
netcfg .....	1146
netstat .....	1146
newgrp .....	1147
nxterm .....	1147
passwd .....	1147
pdksh .....	1148
pico.....	1148
pine.....	1148
ping.....	1148
pppd.....	1148
pppstats .....	1148
pr.....	1149
printtool .....	1149
procmail .....	1149
ps.....	1149
pwd.....	1149

quota .....	1149
quotacheck .....	1150
quotaoff .....	1150
quotaon .....	1150
rclock .....	1150
red.....	1150
repquota .....	1150
restore .....	1150
rjoe.....	1150
rm.....	1151
rmdir .....	1151
route .....	1151
rxvt.....	1151
sed.....	1151
sendfax .....	1151
set.....	1152
setfdprm .....	1152
setserial .....	1152
seyon .....	1152
shutdown .....	1152
slrn.....	1152
sort.....	1153
stat.....	1153
statserial .....	1153
strings .....	1153
su.....	1153
swapoff .....	1153
swapon .....	1154
tail.....	1154
talk.....	1154
taper .....	1154
tar.....	1154
tcsh.....	1154
telnet .....	1155
tin.....	1155
top.....	1155
touch .....	1155
tput.....	1155
tr.....	1155
tree.....	1155
twm.....	1156
ulimit .....	1156
umount .....	1156
unalias .....	1156
unzip .....	1156
updatedb .....	1156

uptime .....	1156
uugetty .....	1157
vdir.....	1157
vi.....	1157
view.....	1157
vim.....	1157
vimx.....	1157
vmstat .....	1157
w .....	1157
wall.....	1158
wc.....	1158
whatis .....	1158
whereis .....	1158
who.....	1158
whoami .....	1159
xclock .....	1159
xcutsel .....	1159
xdaliclock .....	1159
xdm.....	1159
xfig.....	1159
xhost + .....	1160
xjed.....	1160
xload .....	1160
xloadimage .....	1160
xlock .....	1160
xlsfonts .....	1160
xmessage .....	1160
xminicom .....	1161
xmkmf .....	1161
xmodmap .....	1161
xscreensaver .....	1161
xscreensaver-command.....	1161
xset.....	1161
xsetroot .....	1161
xtop.....	1162
xv.....	1162
xwd.....	1162
xwininfo .....	1162
xwud.....	1162
zip.....	1162
zsh.....	1162
Summary .....	1163

<b>C The Linux Documentation Project Copyright License</b>	<b>1165</b>
Copyright License .....	1166
Publishing LDP Manuals .....	1167
<b>D Working with Other Systems</b>	<b>1169</b>
Emulators.....	1170
Emulating DOS with DOSEMU.....	1170
Running Windows Clients with Wine.....	1172
VMware for Linux and Windows .....	1174
The mtools Package .....	1179
Windowing Clients .....	1182
Building and Installing the vnc Software .....	1183
Enabling Virtual Network Service .....	1184
Summary .....	1187

## About the Contributing Authors

Richard M. Stallone is a software engineer at IBM. He has been contributing to the Linux kernel since 1991. He is also the author of the book "Linux in a Nutshell".

Linus Torvalds is the creator of the Linux kernel. He is currently working at the Linux Foundation. He is also the author of the book "Linux in a Nutshell".

David S. Miller is a software engineer at IBM. He has been contributing to the Linux kernel since 1991. He is also the author of the book "Linux in a Nutshell".

Andreas Koenig is a software engineer at IBM. He has been contributing to the Linux kernel since 1991. He is also the author of the book "Linux in a Nutshell".

Greg Kroah-Hartman is a software engineer at IBM. He has been contributing to the Linux kernel since 1991. He is also the author of the book "Linux in a Nutshell".

Alan Cox is a software engineer at IBM. He has been contributing to the Linux kernel since 1991. He is also the author of the book "Linux in a Nutshell".

Ben Collins is a software engineer at IBM. He has been contributing to the Linux kernel since 1991. He is also the author of the book "Linux in a Nutshell".

David Woodhouse is a software engineer at IBM. He has been contributing to the Linux kernel since 1991. He is also the author of the book "Linux in a Nutshell".

Greg Kroah-Hartman is a software engineer at IBM. He has been contributing to the Linux kernel since 1991. He is also the author of the book "Linux in a Nutshell".

Alan Cox is a software engineer at IBM. He has been contributing to the Linux kernel since 1991. He is also the author of the book "Linux in a Nutshell".

Ben Collins is a software engineer at IBM. He has been contributing to the Linux kernel since 1991. He is also the author of the book "Linux in a Nutshell".

David Woodhouse is a software engineer at IBM. He has been contributing to the Linux kernel since 1991. He is also the author of the book "Linux in a Nutshell".