

# CONTENTS

---

LIST OF JUMPSTARTS xxxix

PREFACE xli

## CHAPTER 1: WELCOME TO LINUX 1

The History of UNIX and GNU-Linux 2

    The Heritage of Linux: UNIX 2

    Fade to 1983 3

    Next Scene, 1991 4

    The Code Is Free 5

    Have Fun! 6

What Is so Good About Linux? 6

    Why Linux Is Popular with Hardware Companies and Developers 9

    Linux Is Portable 10

    The C Programming Language 10

Overview of Linux 11

    Linux Has a Kernel Programming Interface 11

    Linux Can Support Many Users 12

    Linux Can Run Many Tasks 12

    Linux Provides a Secure Hierarchical Filesystem 12

    The Shell: Command Interpreter and Programming Language 14

    A Large Collection of Useful Utilities 15

    Interprocess Communication 16

    System Administration 16

Additional Features of Linux	16
GUIs: Graphical User Interfaces	16
(Inter)Networking Utilities	17
Software Development	17
Conventions Used in This Book	18
Chapter Summary	20
Exercises	20

## PART I INSTALLING FEDORA/RHEL LINUX 23

### CHAPTER 2: INSTALLATION OVERVIEW 25

The Desktop Live CD and the Install DVD	26
More Information	27
Planning the Installation	28
Considerations	28
Requirements	28
Processor Architecture	30
Interfaces: Installer and Installed System	31
Which Are You Installing: Fedora or Red Hat Enterprise Linux?	32
Fedora/RHEL Releases	33
Fedora Standard Versions	33
Fedora Spins	33
Installing a Fresh Copy or Upgrading an Existing Fedora/RHEL System?	34
Setting Up the Hard Disk	34
RAID	41
LVM: Logical Volume Manager	42
The Installation Process	43
Downloading and Burning a CD/DVD	44
The Easy Way to Download a CD/DVD ISO Image File	44
Other Ways to Download a CD/DVD ISO Image File	45
Verifying an ISO Image File	47
Burning the CD/DVD	48
Gathering Information About the System	48
Chapter Summary	49
Exercises	50
Advanced Exercises	50

### CHAPTER 3: STEP-BY-STEP INSTALLATION 51

Running a Fedora Live Session	52
Booting the System	53
Installing Fedora/RHEL	54
Installing from a Live Session (Fedora)	55
Installing/Upgrading from the Install DVD	56

The Anaconda Installer	58
Firstboot: When You Reboot	65
Initializing Databases and Updating the System	67
Installation Tasks	67
Modifying Boot Parameters (Options)	67
Using Disk Druid to Partition the Disk	71
palimpsest: The GNOME Disk Utility	77
Using the Kickstart Configurator	81
Setting Up a Dual-Boot System	82
gnome-control-center/Displays: Configures the Display	85
Chapter Summary	85
Exercises	86
Advanced Exercises	86

## PART II GETTING STARTED WITH FEDORA/RHEL 87

### CHAPTER 4: INTRODUCTION TO FEDORA AND RED HAT ENTERPRISE LINUX 89

Curbing Your Power (Superuser/ <b>root</b> Privileges)	90
A Tour of the Fedora/RHEL Desktop	90
Logging In on the System	91
Configuring Fallback Mode (Fedora)	92
Installing and Using gnome-tweak-tool (Fedora)	94
Introduction to the Desktop	95
Launching Programs from the Desktop	96
Switching Workspaces	98
Setting Personal Preferences	99
Mouse Preferences	101
Working with Windows	102
Using Nautilus to Work with Files	102
Updating Software	109
Session Management	110
Getting Help	111
Feel Free to Experiment	111
Logging Out	111
Getting the Most Out of the Desktop	112
GNOME Desktop Terminology	112
Opening Files	113
Panels	113
The Main Menu	114
Windows	115
The Object Context Menu	119

Updating, Installing, and Removing Software Packages	122
Updates	123
Add/Remove Software	124
Where to Find Documentation	125
GNOME Desktop Help Window	125
man: Displays the System Manual	126
apropos: Searches for a Keyword	127
info: Displays Information About Utilities	128
The <b>--help</b> Option	131
HOWTOs: Finding Out How Things Work	131
Getting Help	132
More About Logging In	134
The Login Screen	134
What to Do if You Cannot Log In	135
Logging In Remotely: Terminal Emulators, ssh, and Dial-Up Connections	135
Logging In from a Terminal (Emulator)	136
Changing Your Password	137
Using Virtual Consoles	138
Working from the Command Line	139
Correcting Mistakes	139
Repeating/Editing Command Lines	141
Chapter Summary	142
Exercises	143
Advanced Exercises	144

## CHAPTER 5: THE LINUX UTILITIES 145

Special Characters	146
Basic Utilities	147
ls: Lists the Names of Files	148
cat: Displays a Text File	148
rm: Deletes a File	148
less Is more: Display a Text File One Screen at a Time	149
hostname: Displays the System Name	149
Working with Files	149
cp: Copies a File	149
mv: Changes the Name of a File	150
lpr: Prints a File	151
grep: Searches for a String	152
head: Displays the Beginning of a File	152
tail: Displays the End of a File	153
sort: Displays a File in Order	154
uniq: Removes Duplicate Lines from a File	154
diff: Compares Two Files	154
file: Identifies the Contents of a File	156

(Pipe): Communicates Between Processes	156
Four More Utilities	157
echo: Displays Text	157
date: Displays the Time and Date	158
script: Records a Shell Session	158
unix2dos: Converts Linux and Macintosh Files to Windows Format	159
Compressing and Archiving Files	159
bzip2: Compresses a File	160
bzcat and bunzip2: Decompress a File	161
gzip: Compresses a File	161
tar: Packs and Unpacks Archives	162
Locating Utilities	164
which and whereis: Locate a Utility	164
locate: Searches for a File	166
Displaying User and System Information	166
who: Lists Users on the System	166
finger: Lists Users on the System	167
w: Lists Users on the System	168
Communicating with Other Users	170
write: Sends a Message	170
mesg: Denies or Accepts Messages	170
Email	171
Tutorial: Using vim to Create and Edit a File	172
Starting vim	172
Command and Input Modes	174
Entering Text	175
Getting Help	176
Ending the Editing Session	179
The <b>compatible</b> Parameter	179
Chapter Summary	179
Exercises	182
Advanced Exercises	183

## CHAPTER 6: THE LINUX FILESYSTEM 185

The Hierarchical Filesystem	186
Directory Files and Ordinary Files	187
Filenames	188
The Working Directory	190
Your Home Directory	191
Pathnames	191
Absolute Pathnames	192
Relative Pathnames	193

Working with Directories	194
mkdir: Creates a Directory	194
cd: Changes to Another Working Directory	196
rmdir: Deletes a Directory	197
Using Pathnames	198
mv, cp: Move or Copy Files	198
mv: Moves a Directory	199
Important Standard Directories and Files	199
Access Permissions	202
ls -l: Displays Permissions	202
chmod: Changes Access Permissions	203
Setuid and Setgid Permissions	205
Directory Access Permissions	207
ACLs: Access Control Lists	208
Enabling ACLs	209
Working with Access Rules	209
Setting Default Rules for a Directory	212
Links	213
Hard Links	214
Symbolic Links	216
rm: Removes a Link	218
Chapter Summary	219
Exercises	221
Advanced Exercises	222

## CHAPTER 7: THE SHELL 225

The Command Line	226
Syntax	226
Processing the Command Line	229
Executing a Command	231
Editing the Command Line	231
Standard Input and Standard Output	232
The Screen as a File	232
The Keyboard and Screen as Standard Input and Standard Output	233
Redirection	234
Pipes	239
Running a Command in the Background	242
Filename Generation/Pathname Expansion	244
The ? Special Character	245
The * Special Character	246
The [ ] Special Characters	247
Builtins	249
Chapter Summary	250
Utilities and Builtins Introduced in This Chapter	250
Exercises	251
Advanced Exercises	252

---

## PART III DIGGING INTO FEDORA/RHEL 255

### CHAPTER 8: LINUX GUIs: X AND GNOME 257

X Window System	258
Using X	260
Desktop Environments/Managers	265
The Nautilus File Browser Window	266
The View Pane	267
The Sidebar	267
Control Bars	269
Menubar	269
The Nautilus Spatial View (RHEL)	272
GNOME Utilities	273
Pick a Font Window	273
Pick a Color Window	274
Run Application Window	274
Searching for Files	274
GNOME Terminal Emulator/Shell	276
Chapter Summary	277
Exercises	277
Advanced Exercises	278

### CHAPTER 9: THE BOURNE AGAIN SHELL 279

Background	280
Shell Basics	281
Startup Files	282
Commands That Are Symbols	285
Redirecting Standard Error	285
Writing a Simple Shell Script	288
Separating and Grouping Commands	292
Job Control	296
Manipulating the Directory Stack	298
Parameters and Variables	301
User-Created Variables	302
Variable Attributes	305
Keyword Variables	307
Special Characters	315
Processes	316
Process Structure	316
Process Identification	317
Executing a Command	318
History	319
Variables That Control History	319
Re-executing and Editing Commands	320
The Readline Library	328

Aliases	334
Single Versus Double Quotation Marks in Aliases	335
Examples of Aliases	336
Functions	338
Controlling bash: Features and Options	340
Command-Line Options	340
Shell Features	341
Processing the Command Line	344
History Expansion	345
Alias Substitution	345
Parsing and Scanning the Command Line	345
Command-Line Expansion	345
Chapter Summary	354
Exercises	356
Advanced Exercises	357

## CHAPTER 10: NETWORKING AND THE INTERNET 359

Introduction to Networking	360
Types of Networks and How They Work	362
Broadcast Networks	362
Point-to-Point Networks	363
Switched Networks	363
LAN: Local Area Network	364
WAN: Wide Area Network	367
Internetworking Through Gateways and Routers	367
Network Protocols	370
IPv4	372
IPv6	373
Host Address	376
CIDR: Classless Inter-Domain Routing	380
Hostnames	380
Communicate Over a Network	381
finger: Displays Information About Remote Users	381
Mailing List Servers	382
Network Utilities	382
Trusted Hosts	382
OpenSSH Tools	383
telnet: Logs In on a Remote System	383
ftp: Transfers Files Over a Network	385
ping: Tests a Network Connection	386
traceroute: Traces a Route Over the Internet	387
host and dig: Query Internet Nameservers	388
whois: Looks Up Information About an Internet Site	388

Distributed Computing	390
The Client/Server Model	390
DNS: Domain Name Service	391
Ports	393
NIS: Network Information Service	394
NFS: Network Filesystem	394
Network Services	394
Common Daemons	395
Proxy Servers	398
RPC Network Services	398
WWW: World Wide Web	400
Browsers	401
Search Engines	401
URL: Uniform Resource Locator	401
Chapter Summary	402
Exercises	403
Advanced Exercises	404

## PART IV SYSTEM ADMINISTRATION 405

CHAPTER 11: SYSTEM ADMINISTRATION: CORE CONCEPTS	407
Running Commands with <b>root</b> Privileges	409
The Special Powers of a Privileged User	410
Gaining <b>root</b> Privileges	410
Using su to Gain <b>root</b> Privileges	413
Using sudo to Gain <b>root</b> Privileges	415
<b>sudoers</b> : Configuring sudo	419
Locking the <b>root</b> Account (Removing the <b>root</b> Password)	425
consolehelper: Allows an Ordinary User to Run a Privileged Command	425
The <b>init</b> Daemon	426
The <b>systemd init</b> Daemon (Fedora)	426
The Upstart <b>init</b> Daemon (RHEL)	436
SysVinit ( <b>rc</b> ) Scripts: Start and Stop System Services (Fedora/RHEL)	442
System Operation	448
Runlevels	448
Booting the System	449
Single-User Mode	449
Going to Graphical Multiuser Mode	451
Logging In	451
Logging Out	453
Bringing the System Down	453
Crash	455

Rescue Installed System	457
Securing a System	458
Avoiding a Trojan Horse	458
SELinux	459
PAM	463
System Administration Tools	469
Textual Administration Utilities	469
Graphical Configuration Tools	475
Setting Up a Server	477
Standard Rules in Configuration Files	478
<b>rpcinfo</b> : Displays Information About <b>rpcbind</b>	480
The <b>xinetd</b> Superserver	481
Securing a Server	484
DHCP: Configures Network Interfaces	489
More Information	490
How DHCP Works	490
DHCP Client	491
DHCP Server	491
<b>nsswitch.conf</b> : Which Service to Look at First	494
Information	494
Methods	495
Search Order	495
Action Items	495
<b>compat</b> Method: ± in <b>passwd</b> , <b>group</b> , and <b>shadow</b> Files	496
Getting Help	497
Chapter Summary	497
Exercises	498
Advanced Exercises	499

## CHAPTER 12: FILES, DIRECTORIES, AND FILESYSTEMS 501

Important Files and Directories	502
File Types	514
Ordinary Files, Directories, Links, and Inodes	515
Device Special Files	515
Filesystems	519
<b>mount</b> : Mounts a Filesystem	520
<b>umount</b> : Unmounts a Filesystem	523
<b>fstab</b> : Keeps Track of Filesystems	524
<b>fsck</b> : Checks Filesystem Integrity	525
<b>tune2fs</b> : Changes Filesystem Parameters	526
Chapter Summary	528
Exercises	528
Advanced Exercises	528

---

## CHAPTER 13: FINDING, DOWNLOADING, AND INSTALLING SOFTWARE 531

Introduction	532
JumpStart: Installing and Removing Packages Using yum	534
Finding the Package That Holds an Application or File You Need	537
yum: Keeps the System Up-to-Date	538
Updating Packages	539
yum Commands	540
yum Groups	540
Downloading RPM Package Files with yumdownloader	541
<b>yum.conf</b> : Configures yum	542
yum Repositories	543
BitTorrent	545
RPM: The RPM Package Manager	547
Querying Packages and Files	548
Installing, Upgrading, and Removing Packages	550
Installing a Linux Kernel Binary	551
Installing Non-rpm Software	551
The <b>/opt</b> and <b>/usr/local</b> Directories	551
GNU Configure and Build System	552
Keeping Software Up-to-Date	553
Bugs	553
Errata	554
Red Hat Network (RHEL)	554
wget: Downloads Files Noninteractively	555
Chapter Summary	556
Exercises	557
Advanced Exercises	557

## CHAPTER 14: PRINTING WITH CUPS 559

Introduction	560
Prerequisites	561
More Information	561
Notes	561
Fedora/RHEL Configures a Local Printer Automatically	562
JumpStart I: Configuring a Printer Using system-config-printer	562
Configuration Selections	563
JumpStart II: Setting Up a Local or Remote Printer	565
Working with the CUPS Web Interface	568
Configuring Printers	570
Modifying a Printer	570
The CUPS Web Interface	571
CUPS on the Command Line	572
Sharing CUPS Printers	576

Traditional UNIX Printing 577

Print from Windows 579

    Print Using CUPS 579

    Print Using Samba 580

Printing to Windows 581

Chapter Summary 581

Exercises 582

Advanced Exercises 582

## CHAPTER 15: BUILDING A LINUX KERNEL 583

Downloading, Installing, and Prepping the Kernel Source Code 585

    Prerequisites 585

    More Information 585

    Downloading the Source Code 585

    Installing the Source Code 587

    Prepping the Source Code 587

Configuring and Compiling the Linux Kernel 588

    Labeling the Kernel 588

**.config**: Configures the Kernel 589

    Customizing a Kernel 590

    Cleaning the Source Tree 592

    Copying the Configuration File 593

    Compiling a Kernel Image File and Loadable Modules 593

    Using Loadable Kernel Modules 593

Installing the Kernel, Modules, and Associated Files 594

GRUB: The Linux Boot Loader 595

    Configuring GRUB 596

    grub-install: Installs the MBR and GRUB Files 597

dmesg: Displays Kernel Messages 597

Chapter Summary 598

Exercises 598

Advanced Exercises 599

## CHAPTER 16: ADMINISTRATION TASKS 601

Configuring User and Group Accounts 602

**system-config-users**: Manages User Accounts 602

    Managing User Accounts from the Command Line 604

Backing Up Files 605

    Choosing a Backup Medium 606

    Backup Utilities 607

    Performing a Simple Backup 610

Scheduling Tasks 611

**cron** and **anacron**: Schedule Routine Tasks 611

**at**: Runs Occasional Tasks 615

System Reports	615
<b>vmstat</b> : Reports Virtual Memory Statistics	615
<b>top</b> : Lists Processes Using the Most Resources	616
Maintaining the System	617
<b>parted</b> : Reports on and Partitions a Hard Disk	617
<b>logrotate</b> : Manages Log Files	621
<b>rsyslogd</b> : Logs System Messages	623
Keeping Users Informed	625
Creating Problems	626
Solving Problems	627
MySQL	635
More Information	635
Terminology	635
Syntax and Conventions	636
Prerequisites	636
Notes	636
JumpStart: Setting Up MySQL	636
Options	637
The <b>.my.cnf</b> Configuration File	638
Working with MySQL	638
Chapter Summary	643
Exercises	643
Advanced Exercises	644
 <b>CHAPTER 17: CONFIGURING AND MONITORING A LAN</b> 645	
Setting Up the Hardware	646
Connecting the Computers	646
Routers	647
NIC: Network Interface Card	647
Tools	648
Configuring the Systems	650
<b>NetworkManager</b> : Configures Network Connections	651
The NetworkManager Applet Right-Click Menu	651
Setting Up Servers	656
Introduction to Cacti	657
Configuring SNMP	658
Setting Up LAMP	658
Enabling the Cacti Poller	661
Configuring Cacti	661
Basic Cacti Administration	663
Setting Up a Remote Data Source	664
More Information	668
Chapter Summary	668
Exercises	669
Advanced Exercises	669

## PART V USING CLIENTS AND SETTING UP SERVERS 671

### CHAPTER 18: OPENSSH: SECURE NETWORK COMMUNICATION 673

Introduction to OpenSSH	674
How OpenSSH Works	675
Files	675
More Information	677
Running the ssh, scp, and sftp OpenSSH Clients	677
Prerequisites	677
JumpStart: Using ssh and scp to Connect to an OpenSSH Server	677
Configuring OpenSSH Clients	678
ssh: Logs in or Executes Commands on a Remote System	681
scp: Copies Files to and from a Remote System	683
sftp: A Secure FTP Client	685
<code>~/.ssh/config</code> and <code>/etc/ssh/ssh_config</code> Configuration Files	686
Setting Up an OpenSSH Server ( <code>sshd</code> )	688
Prerequisites	688
Notes	688
JumpStart: Starting an OpenSSH Server	688
Authorized Keys: Automatic Login	689
ssh-agent: Holds Your Private Keys	691
Command-Line Options	692
<code>/etc/ssh/sshd_config</code> Configuration File	692
Troubleshooting	695
Tunneling/Port Forwarding	696
Forwarding X11	696
Port Forwarding	697
Chapter Summary	698
Exercises	699
Advanced Exercises	699

### CHAPTER 19 FTP: TRANSFERRING FILES ACROSS A NETWORK 701

Introduction to FTP	702
Security	702
FTP Connections	703
FTP Clients	703

---

More Information	703
Notes	704
Running the <code>ftp</code> and <code>sftp</code> FTP Clients	704
Prerequisites	704
JumpStart I: Downloading Files Using <code>ftp</code>	704
Anonymous FTP	707
Automatic Login	708
Binary Versus ASCII Transfer Mode	708
<code>ftp</code> Specifics	709
Setting Up an FTP Server ( <code>vsftpd</code> )	712
Prerequisites	712
Notes	713
JumpStart II: Starting a <code>vsftpd</code> FTP Server	713
Trouble Shooting	713
Configuring a <code>vsftpd</code> Server	715
Chapter Summary	726
Exercises	726
Advanced Exercises	726

## CHAPTER 20: **sendmail**: SETTING UP MAIL SERVERS, CLIENTS, AND MORE 729

Introduction to <b>sendmail</b>	730
Outbound Email	731
Inbound Email	731
Alternatives to <b>sendmail</b>	731
More Information	732
Setting Up a <b>sendmail</b> Mail Server	732
Prerequisites	733
Notes	733
JumpStart I: Configuring <b>sendmail</b> on a Client	733
JumpStart II: Configuring <b>sendmail</b> on a Server	734
Working with <b>sendmail</b> Messages	735
Mail Logs	736
Aliases and Forwarding	736
Related Programs	738
Configuring <b>sendmail</b>	739
The <code>sendmail.mc</code> and <code>sendmail.cf</code> Files	739
Other Files in <code>/etc/mail</code>	741
SpamAssassin	744
How SpamAssassin Works	744
Prerequisites	745
Testing SpamAssassin	745
Configuring SpamAssassin	746

Additional Email Tools	749
Webmail	749
Mailing Lists	752
Setting Up an IMAP or POP3 Mail Server	754
Authenticated Relaying	754
Chapter Summary	756
Exercises	757
Advanced Exercises	757

## CHAPTER 21: NIS AND LDAP 759

Introduction to NIS	760
How NIS Works	760
More Information	763
Running an NIS Client	763
Prerequisites	763
Notes	764
Configuring an NIS Client	764
Troubleshooting the Client	766
<code>yppasswd</code> : Changes NIS Passwords	767
Setting Up an NIS Server	769
Prerequisites	769
Notes	770
Configuring the Server	770
Troubleshooting the Server	775
<code>yppasswdd</code> : The NIS Password Update Daemon	775
LDAP	776
More Information	778
Setting Up an LDAP Server	779
Prerequisites	779
Note	779
Step-by-Step Setup	779
Tools for Working with LDAP	784
Evolution Mail	785
Chapter Summary	788
Exercises	789
Advanced Exercises	789

## CHAPTER 22: NFS: SHARING DIRECTORY HIERARCHIES 791

Introduction to NFS	793
More Information	795

Running an NFS Client	795
Prerequisites	796
JumpStart I: Mounting a Remote Directory Hierarchy	796
mount: Mounts a Directory Hierarchy	797
Improving Performance	800
/etc/fstab: Mounts Directory Hierarchies Automatically	801
Setting Up an NFS Server	801
Prerequisites	801
Notes	802
JumpStart II: Configuring an NFS Server Using system-config-nfs (Fedora)	802
Manually Exporting a Directory Hierarchy	804
Where the System Keeps NFS Mount Information	808
exportfs: Maintains the List of Exported Directory Hierarchies	809
Troubleshooting	810
automount: Mounts Directory Hierarchies on Demand	811
Chapter Summary	814
Exercises	815
Advanced Exercises	815

## CHAPTER 23: SAMBA: LINUX AND WINDOWS FILE AND PRINTER SHARING 817

Introduction to Samba	818
More Information	819
Notes	819
Samba Users, User Maps, and Passwords	820
smbpasswd and pdedit: Work with Samba Users and Passwords	821
Running Samba Clients	822
Prerequisites	822
Working with Shares from Linux	823
Working with Shares from Windows	825
Setting Up a Samba Server	826
Prerequisites	826
JumpStart: Configuring a Samba Server Using system-config-samba (Fedora)	827
swat: Configures a Samba Server	830
smb.conf: Manually Configuring a Samba Server	834
Troubleshooting	840
Chapter Summary	843
Exercises	844
Advanced Exercises	844

## CHAPTER 24: DNS/BIND: TRACKING DOMAIN NAMES AND ADDRESSES 845

Introduction to DNS 846	
Nodes, Domains, and Subdomains 847	
Zones 849	
Queries 850	
Servers 850	
Resource Records 851	
DNS Queries and Responses 855	
Reverse Name Resolution 856	
How DNS Works 857	
More Information 858	
Setting Up a DNS Server 858	
Prerequisites 858	
Notes 859	
JumpStart I: Setting Up a DNS Cache 860	
JumpStart II: Setting Up a Domain Using system-config-bind (Fedora) 861	
Configuring a DNS Server 866	
<b>named.conf</b> : The <b>named</b> Configuration File 866	
Zone Files 868	
Setting Up a DNS Cache 869	
DNS Glue Records 874	
TSIGs: Transaction Signatures 875	
Running BIND in a chroot Jail 877	
Troubleshooting 878	
Setting Up Different Types of DNS Servers 879	
A Full-Functioned Nameserver 880	
A Slave Server 884	
A Split Horizon Server 884	
Chapter Summary 889	
Exercises 890	
Advanced Exercises 890	

## CHAPTER 25: system-config-firewall AND iptables: SETTING UP A FIREWALL 891

JumpStart: Building a Firewall Using system-config-firewall 893	
Introduction to iptables 895	
More Information 898	
Prerequisites 898	
Notes 899	
Anatomy of an iptables Command 900	

---

Building a Set of Rules Using <code>iptables</code>	902
Commands	902
Packet Match Criteria	903
Display Criteria	904
Match Extensions	904
Targets	906
Copying Rules to and from the Kernel	908
<code>system-config-firewall</code> : Generates a Set of Rules	909
Sharing an Internet Connection Using NAT	910
Connecting Several Clients to a Single Internet Connection	911
Connecting Several Servers to a Single Internet Connection	913
Chapter Summary	914
Exercises	914
Advanced Exercises	915

## CHAPTER 26: APACHE (`httpd`): SETTING UP A WEB SERVER 917

Introduction	918
More Information	919
Notes	919
Running an Apache Web Server	920
Prerequisites	921
JumpStart I: Getting Apache Up and Running	921
Filesystem Layout	923
Configuration Directives	925
Directives I: Directives You Might Want to Modify as You Get Started	925
Contexts and Containers	930
Directives II: Advanced Directives	935
The Fedora/RHEL <code>httpd.conf</code> File	947
Section 1: Global Environment	948
Section 2: Main Server Configuration	949
Section 3: Virtual Hosts	950
Advanced Configuration	950
Redirects	950
Content Negotiation	951
Server-Generated Directory Listings (Indexing)	952
Virtual Hosts	953
Troubleshooting	956
Modules	957
<code>mod_cgi</code> and CGI Scripts	958
<code>mod_ssl</code>	958
Authentication Modules and <code>.htaccess</code> Files	961
Scripting Modules	962
Multiprocessing Modules (MPMs)	962

webalizer: Analyzes Web Traffic	963
MRTG: Monitors Traffic Loads	964
Error Codes	964
Chapter Summary	965
Exercises	965
Advanced Exercises	966

## PART VI PROGRAMMING TOOLS 967

### CHAPTER 27: PROGRAMMING THE BOURNE AGAIN SHELL 969

Control Structures	971
<b>if...then</b>	971
<b>if...then...else</b>	974
<b>if...then...elif</b>	976
<b>for...in</b>	983
<b>for</b>	984
<b>while</b>	986
<b>until</b>	990
<b>break</b> and <b>continue</b>	992
<b>case</b>	992
<b>select</b>	999
Here Document	1001
File Descriptors	1003
Parameters and Variables	1006
Array Variables	1006
Locality of Variables	1008
Special Parameters	1010
Positional Parameters	1012
Expanding Null and Unset Variables	1017
Builtin Commands	1018
<b>type</b> : Displays Information About a Command	1019
<b>read</b> : Accepts User Input	1019
<b>exec</b> : Executes a Command or Redirects File Descriptors	1022
<b>trap</b> : Catches a Signal	1025
<b>kill</b> : Aborts a Process	1028
<b>getopts</b> : Parses Options	1028
A Partial List of Builtins	1031
Expressions	1032
Arithmetic Evaluation	1032
Logical Evaluation (Conditional Expressions)	1033

String Pattern Matching	1034
Operators	1035
Shell Programs	1040
A Recursive Shell Script	1041
The <b>quiz</b> Shell Script	1044
Chapter Summary	1050
Exercises	1052
Advanced Exercises	1053

## CHAPTER 28: THE PERL SCRIPTING LANGUAGE 1057

Introduction to Perl	1058
More Information	1059
Help	1059
perldoc	1059
Terminology	1061
Running a Perl Program	1062
Syntax	1064
Variables	1066
Scalar Variables	1068
Array Variables	1069
Hash Variables	1072
Control Structures	1073
<b>if/unless</b>	1074
<b>if...else</b>	1076
<b>if...elsif...else</b>	1077
<b>foreach/for</b>	1077
<b>last</b> and <b>next</b>	1079
<b>while/until</b>	1080
Working with Files	1082
Sort	1086
Subroutines	1087
Regular Expressions	1090
Syntax and the <code>=~</code> Operator	1090
CPAN Modules	1095
Examples	1098
Chapter Summary	1101
Exercises	1102
Advanced Exercises	1102

## PART VII APPENDICES 1103

### APPENDIX A: REGULAR EXPRESSIONS 1105

Characters	1106
Delimiters	1106
Simple Strings	1106
Special Characters	1106
Periods	1107
Brackets	1107
Asterisks	1108
Caret and Dollar Signs	1108
Quoting Special Characters	1109
Rules	1109
Longest Match Possible	1109
Empty Regular Expressions	1110
Bracketing Expressions	1110
The Replacement String	1110
Ampersand	1111
Quoted Digit	1111
Extended Regular Expressions	1111
Appendix Summary	1113

### APPENDIX B: HELP 1115

Solving a Problem	1116
Finding Linux-Related Information	1117
Documentation	1117
Useful Linux Sites	1118
Linux Newsgroups	1119
Mailing Lists	1119
Words	1120
Software	1120
Office Suites and Word Processors	1122
Specifying a Terminal	1122

### APPENDIX C: SECURITY 1125

Encryption	1126
Public Key (Asymmetric) Encryption	1127
Symmetric Key Encryption	1129
Encryption Implementation	1130
GnuPG/PGP	1130
File Security	1131

Email Security	1131
MTAs (Mail Transfer Agents)	1132
MUAs (Mail User Agents)	1132
Network Security	1132
Network Security Solutions	1133
Network Security Guidelines	1133
Host Security	1135
Login Security	1136
Remote Access Security	1137
Viruses and Worms	1138
Physical Security	1139
Security Resources	1140
Appendix Summary	1143
APPENDIX D: THE FREE SOFTWARE DEFINITION	
1145	
GLOSSARY	1149
JUMPSTART INDEX	1199
FILE TREE INDEX	1201
UTILITY INDEX	1205
MAIN INDEX	1211

