

# PREFACE

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**The book** Whether you are an end user, a system administrator, or a little of both, this book explains with step-by-step examples how to get the most out of a Fedora or RHEL (Red Hat Enterprise Linux) system. In 29 chapters, this book takes you from installing a Fedora/RHEL system, through understanding its inner workings, to setting up secure servers that run on the system.

**The audience** This book is designed for a wide range of readers. It does not require you to have programming experience, although having some experience using a general-purpose computer, such as a Windows, Macintosh, UNIX, or another Linux system is certainly helpful. This book is appropriate for:

- **Students** who are taking a class in which they use Linux
- **Home users** who want to set up and/or run Linux
- **Professionals** who use Linux at work
- **System administrators** who need an understanding of Linux and the tools that are available to them, including the bash and Python scripting languages
- **Computer science students** who are studying the Linux operating system
- **Technical executives** who want to get a grounding in Linux

**Benefits** *A Practical Guide to Fedora™ and Red Hat® Enterprise Linux®, Seventh Edition*, gives you a broad understanding of many facets of Linux, from installing Fedora/RHEL through using and customizing it. No matter what your background, this book provides the knowledge you need to get on with your work. You will come away from this book understanding how to use Linux, and this book will remain a valuable reference for years to come.

Features in This edition covers many topics to help you get your work done using Fedora/RHEL.  
this edition

- Full coverage of LPI's Linux Essentials certification learning goals and extensive coverage of CompTIA's Linux+ exam objectives (Appendix E; page 1189)
- Updated chapters reflecting new features in Fedora 19 and RHEL 7 (beta)
- A new chapter that covers setting up VMs (virtual machines) and working in the cloud (Chapter 17; page 659)
- A new chapter on the Python programming language (Chapter 28; page 1081)
- A new chapter covering 32 Linux utilities (Chapter 7; page 215)
- A new chapter on the MariaDB/MySQL relational database (Chapter 29; page 1113)
- New coverage of the **firewalld** service (Chapter 25; page 898)
- Tutorials on the vim and nano editors (Chapter 7; pages 262 and 270)
- Nine chapters on system administration (Part III; page 325)
- A chapter on writing programs using bash (Chapter 27; page 981)
- Coverage of the XFS filesystem (Chapter 11; page 527)
- Coverage of LDAP (Chapter 21; page 786)
- A section on the Cacti network monitoring tool (Chapter 16; page 645)
- Coverage of IPv6 (Chapter 8; page 293)
- Four indexes, making it easier to quickly find what you are looking for. These indexes locate tables (page numbers followed by the letter **t**), provide definitions (italic page numbers), and differentiate between light and comprehensive coverage (light and standard fonts).
  - ◆ The JumpStart index (page 1283) lists all JumpStart sections in this book. These sections help you set up servers and clients as quickly as possible.
  - ◆ The File Tree index (page 1285) lists, in hierarchical fashion, most files mentioned in this book. These files are also listed in the Main index.
  - ◆ The Utility index (page 1289) supplies the location of all utilities mentioned in this book. A page number in a **light font** indicates a brief mention of the utility, whereas the regular font indicates more substantial coverage. The Utility index also appears on the inside of the front and back covers of the print book.
  - ◆ The revised Main index (page 1295) is designed for ease of use.

- Overlap** If you have read *A Practical Guide to Linux® Commands, Editors, and Shell Programming, Third Edition*, you will notice some overlap between that book and the one you are reading now. The first chapter, the chapters on the utilities and the filesystem, the appendix on regular expressions, and the Glossary are very similar in the two books, as are the three chapters on the Bourne Again Shell (bash) and the chapters on Python and MariaDB. Chapters that appear in this book but do not appear in *A Practical Guide to Linux® Commands, Editors, and Shell Programming, Third Edition*, include Chapters 2 and 3 (installation), Chapter 4 (Fedora/RHEL and the GUI), Chapter 8 (networking), all of the chapters in Part III (system administration) and Part IV (servers), and Appendix C (security).
- Differences** While this book explains how to use Linux from a graphical interface and from the command line (a textual interface), *A Practical Guide to Linux® Commands, Editors, and Shell Programming, Third Edition*, works exclusively with the command line and covers Mac OS X in addition to Linux. It includes full chapters on the vim and emacs editors, as well as chapters on the gawk pattern processing language, the sed stream editor, and the rsync secure copy utility. In addition, it has a command reference section that provides extensive examples of the use of 98 of the most important Linux and Mac OS X utilities. You can use these utilities to solve problems without resorting to programming in C.

## THIS BOOK INCLUDES A FEDORA 19 (SCHRÖDINGER'S CAT) DVD

The print book includes a DVD that holds an Install Image of Fedora 19 (Schrödinger's Cat). You can use this DVD to install Fedora 19. Chapter 2 helps you get ready to install Fedora/RHEL. Chapter 3 provides step-by-step instructions for installing Fedora from this DVD as well as installing RHEL. This book guides you through learning about, using, and administering a Fedora/RHEL system.

- DVD features** The DVD includes many of the software packages supported by Fedora. You can use it to perform a graphical or textual (command-line) installation of either a graphical or a textual Fedora system. If you do not have an Internet connection, you can use the DVD as a software repository: After you have installed Fedora, you can install supported software packages from the DVD.

### FOR READERS OF DIGITAL EDITIONS

If you are reading a digital edition of this book, see “Downloading an Installation Image File and Writing to/Burning the Installation Medium” on page 46 for instructions on how to download an Install Image and create a DVD or USB flash drive that holds an that image.

## FEATURES OF THIS BOOK

This book is designed and organized so you can get the most out of it in the least amount of time. You do not have to read this book straight through in page order. Instead, once you are comfortable using Linux, you can use this book as a reference: Look up a topic of interest in the table of contents or in an index and read about it. Or think of the book as a catalog of Linux topics: Flip through the pages until a topic catches your eye. The book includes many pointers to Web sites where you can obtain additional information: Consider the Internet to be an extension of this book.

*A Practical Guide to Fedora™ and Red Hat® Enterprise Linux®, Seventh Edition*, is structured with the following features

- In this book, the term “Fedora/RHEL” refers to both **Fedora** and **Red Hat Enterprise Linux**. Features that apply to only one of these operating systems are marked as such.
- **Optional sections** enable you to read the book at different levels, returning to more difficult material when you are ready to delve into it.
- **Caution boxes** highlight procedures that can easily go wrong, giving you guidance *before* you run into trouble.
- **Tip boxes** highlight ways you can save time by doing something differently or situations when it may be useful or just interesting to have additional information.
- **Security boxes** point out places where you can make a system more secure. The **security appendix** presents a quick background in system security issues and includes a tutorial on GPG.
- Concepts are illustrated by **practical examples** throughout the book.
- Each chapter starts with a list of **chapter objectives**—a list of important tasks you should be able to perform after reading the chapter.
- **Chapter summaries** review the important points covered in each chapter.
- **Review exercises** are included at the end of each chapter for readers who want to further hone their skills. Answers to even-numbered exercises are posted at [www.sobell.com](http://www.sobell.com).
- The **Glossary** defines more than 500 commonly encountered terms.
- The chapters covering servers include **JumpStart** sections that get you off to a quick start using clients and setting up servers. Once a server is up and running, you can test and modify its configuration, as is explained in the rest of each of these chapters.

- This book provides resources for **finding software** on the Internet. It also explains how to **download** and **install** software using yum, the Software window, and BitTorrent. It details controlling automatic updates using the Software Update Preferences window.
- This book describes in detail many important **GNU tools**, including the GNOME 3 desktop, the Nautilus File Browser, the parted and gnome-disks partition editors, the gzip compression utility, and many command-line utilities that come from the GNU Project.
- Pointers throughout the text provide help in obtaining **online documentation** from many sources, including the local system, the Fedora/RHEL Web sites, and other locations on the Internet.
- Multiple **comprehensive indexes** help you locate topics quickly and easily.

## KEY TOPICS COVERED IN THIS BOOK

This section distills and summarizes the information covered by this book. In addition, “Details” (starting on page 1) describes what each chapter covers. Finally, the Table of Contents (starting on page xvii) provides more detail. This book:

- Installation
- Describes how to download Fedora installation images from the Internet and write/burn the Fedora Live or Install Image to a USB flash drive or DVD.
  - Helps you plan the layout of the system’s hard disk. It includes a discussion of partitions, partition tables, and mount points, and assists you in using Anaconda or the gnome-disks disk utility to examine and partition the hard disk.
  - Explains how to set up a dual-boot system so you can install Fedora/RHEL on a Windows system and boot either operating system.
  - Discusses booting into a live Fedora session and installing Fedora from that session.
  - Describes in detail how to use the new version of **Anaconda**, Fedora/RHEL’s installation program, to install Fedora/RHEL from an Install Image.
  - Covers testing installation media for defects, setting boot command-line parameters (boot options), and creating a RAID array.
  - Describes how to set up a VM (virtual machine) and install Fedora on the VM.
  - Explains how to use the Logical Volume Manager (LVM2) to set up, grow, and migrate logical volumes, which are similar in function to traditional disk partitions.

**xlvi** PREFACE

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Working with  
Fedora/RHEL

- Introduces the GNOME 3 Standard and Classic desktops (GUIs), and explains how to use desktop tools, including application and context menus, the Settings window, the Nautilus File Browser, and the GNOME terminal emulator.
- Covers the Bourne Again Shell (`bash`) in three chapters, including an entire chapter on shell programming, which includes many sample shell scripts. These chapters provide clear explanations and extensive examples of how `bash` works both from the command line in day-to-day work and as a programming language in which to write shell scripts.
- Explains the textual (command-line) interface and introduces more than 32 command-line utilities.
- Presents a tutorial on the `vim` and `nano` textual editors.
- Covers types of networks, network protocols (including IPv6), and network utilities.
- Explains hostnames, IP addresses, and subnets, and explores how to use `host` and `dig` to look up domain names and IP addresses on the Internet.
- Covers distributed computing and the client/server model.
- Explains how to use ACLs (Access Control Lists) to fine-tune user access permissions.

CentOS

- Describes CentOS by virtue of that operating system's compatibility with RHEL. CentOS ([www.centos.org](http://www.centos.org)) is a free Linux distribution that has more long-term stability than Fedora but, unlike RHEL, CentOS is unsupported.

System  
administration

- Explains how to use the Fedora/RHEL graphical and textual (command-line) tools to configure the display, DNS, NFS, Samba, Apache, a firewall, a network interface, and more. You can also use these tools to add users and manage local and remote printers.
- Describes how to use `su` to work with `root` privileges (become Superuser), and the advantages and dangers of working with escalated privileges.
- Goes into detail about using `sudo` to allow specific users to work with `root` privileges and customizing the way `sudo` works by editing the `sudoers` configuration file.
- Describes how to use the following tools to download and install software to keep a system up-to-date and to install new software:
  - ◆ Based on how you set up updates in the Software Update Preferences window, the **Software Update** window appears on the desktop to let you know when software updates are available. You can download and install updates from the Software Update window.
  - ◆ The **Software** window provides an easy way to select, download, and install a wide range of software packages.

- ◆ The yum utility downloads and installs software packages from repositories on the Internet, keeping a system up-to-date and resolving dependencies as it processes the packages.
- ◆ **BitTorrent** is a good choice for distributing large amounts of data such as the Fedora/RHEL Install Image. The more people who use BitTorrent to download a file, the faster it works.
- Covers graphical system administration tools, including the many tools available from the GNOME desktop.
- Explains system operation, including the boot process, rescue (single-user) and multiuser modes, and steps to take if the system crashes.
- Details the workings of the **systemd init daemon**, which replaces both the Upstart and System V **init** daemons.
- Explains how to set up and use the **Cacti** network monitoring tool to graph system and network information over time, including installing and setting up the **LAMP** (Linux, Apache, MariaDB/MySQL, and PHP) stack.
- Provides instructions on installing, setting up, and using a **MariaDB/MySQL** relational database.
- Discusses setting up and repairing an XFS filesystem.
- Describes files, directories, and filesystems, including types of files and filesystems, **fstab** (the filesystem table), and automatically mounted filesystems, and explains how to fine-tune and check the integrity of filesystems.
- Covers backup utilities, including **tar** and **cpio**.
- Describes compression/archive utilities, including **xz**, **gzip**, **bzip2**, **compress**, and **zip**.
- Explains how to customize and build a Linux kernel.
- Security
  - Helps you manage basic system security issues using **ssh** (secure shell), **vsftpd** (secure FTP server), Apache (Web server), **firewalld** and **iptables** (firewalls), and more.
  - Includes a tutorial on using **GPG** (GNU Privacy Guard) to provide identification, secrecy, and message integrity in email and file sharing.
  - Describes how to use the graphical **firewall-config** utility to protect the system.
  - Provides instructions on using **iptables** to share an Internet connection over a LAN and to build advanced firewalls.
  - Presents a complete section on **SELinux** (Security-Enhanced Linux), including instructions for using **system-config-selinux** to configure SELinux.
  - Describes how to set up a **chroot jail** to help protect a server system.

## I PREFACE

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- Explains how to use TCP wrappers to control who can access a server.
- Clients and servers
  - Explains how to set up and use the most popular Linux servers, providing a chapter on each: Apache; Samba; OpenSSH; **sendmail**; DNS; NFS; FTP; firewall-config, **firewalld**, and iptables; and NIS/LDAP.
  - Describes how to set up a CUPS printer server.
  - Explains how to set up and use a MariaDB/MySQL relational database.
  - Describes how to set up and use a DHCP server.
- Programming
  - Provides a chapter on the Python programming language and a full chapter covering shell programming using bash, including many examples.

## DETAILS

- Chapter 1 **Chapter 1** presents a brief history of Linux and explains some of the features that make it a cutting-edge operating system.
- Part I Part I, “Installing Fedora and Red Hat Enterprise Linux,” discusses how to install Fedora/RHEL Linux. **Chapter 2** presents an overview of the process of installing Fedora/RHEL Linux, including hardware requirements, downloading and burning or writing the installation medium, and planning the layout of the hard disk. The “Conventions Used in This Book” section on page 26 details the typefaces and terminology used in this book. **Chapter 3** is a step-by-step guide to installing Fedora and RHEL; it covers installing from an Install Image and from a live session (Fedora).
- Part II Part II, “Using Fedora and Red Hat Enterprise Linux,” familiarizes you with Fedora/RHEL, covering logging in, the GUI, utilities, the filesystem, and the shell. **Chapter 4** introduces desktop features; describes configuring the system using the Settings window; explains how to use the Nautilus File Browser to manage files, run programs, and connect to FTP and HTTP servers; covers finding documentation, dealing with login problems, and using the window manager; and presents some suggestions on where to find documentation, including manuals, tutorials, software notes, and HOWTOs. The introduction to the command line includes information on terminal emulators, virtual consoles, correcting mistakes on the command line, a few basic utilities, and how to write and execute a simple shell script. **Chapter 5** introduces the Bourne Again Shell (bash) and discusses command-line arguments and options, redirecting input to and output from commands, running programs in the background, and using the shell to generate and expand filenames. **Chapter 6** discusses the Linux hierarchical filesystem, covering files, filenames, pathnames, working with directories, access permissions, and hard and symbolic links. **Chapter 7** provides in-depth coverage of 32 useful utilities, and presents tutorials on the vim and nano text editors. **Chapter 8** explains networks, network security, and the Internet, and discusses types of networks, subnets, protocols, addresses, hostnames, and various network utilities. A section covers the all-important IPv6 protocol. The section on distributed computing describes the client/server model and some of the servers you can use on a network. (Details of setting up and using clients and servers are reserved until Part IV.)



## Experienced users may want to skim Part II

**tip** If you have used a UNIX or Linux system before, you may want to skim or skip some or all of the chapters in Part II. Do *not* skip “Conventions Used in This Book” (page 26), which explains the typographic and layout conventions used in this book. Both “Getting Help” (page 113), which explains how to get help using a GUI, and “Getting Help from the Command Line” (page 128), point out both local and remote sources of Linux and Fedora/RHEL documentation.

Part III “System Administration,” goes into more detail about administrating the system. **Chapter 9** extends the `bash` coverage from Chapter 5, explaining how to redirect error output, avoid overwriting files, and work with job control, processes, startup files, important shell builtin commands, parameters, shell variables, and aliases. **Chapter 10** discusses core concepts, such as the use of `su` and `sudo`; working with `root` privileges; SELinux (Security-Enhanced Linux); system operation, including a discussion of the systemd `init` daemon; `chroot` jails; TCP wrappers; general information about how to set up a server; DHCP; and PAM. **Chapter 11** explains the Linux filesystem, going into detail about types of files, including special and device files; the use of `fsck` to verify the integrity of and repair filesystems; the use of `tune2fs` to change filesystem parameters; and the XFS filesystem and related utilities. **Chapter 12** explains how to keep a system up-to-date by downloading software from the Internet and installing it, including examples that use `yum` to perform these tasks. It also covers the RPM software packaging system and the use of the `rpm` utility. Finally, it explains how to use BitTorrent from the command line to download files. **Chapter 13** explains how to set up the CUPS printing system so you can print on both local and remote systems. **Chapter 14** details customizing and building a Linux kernel and includes information on GRUB 2. **Chapter 15** covers additional administration tasks, including setting up user accounts, backing up files, scheduling automated tasks, tracking disk usage, and solving general problems. **Chapter 16** explains how to set up a local area network (LAN), including both hardware (including wireless) and software configuration, and how to set up Cacti to monitor the network. **Chapter 17** describes VMs (virtual machines), how to set up and work with VMs, and how to work with VMs in the cloud.

Part IV goes into detail about setting up and running servers and connecting to them using clients. Where appropriate, these chapters include JumpStart sections, which get you off to a quick start in using clients and setting up servers. The chapters in Part IV cover the following clients/servers:

- **OpenSSH**—Set up an OpenSSH server and use `ssh`, `scp`, and `sftp` to communicate securely over the Internet.
- **FTP**—Set up a `vsftpd` secure FTP server and use any of several FTP clients to exchange files with the server.
- **Email**—Configure `sendmail` and use Webmail, POP3, or IMAP to retrieve email; use SpamAssassin to combat spam.
- **NIS and LDAP**—Set up NIS to facilitate system administration of a LAN and LDAP to maintain databases.

- **NFS**—Share filesystems between systems on a network.
- **Samba**—Share filesystems and printers between Windows and Linux systems.
- **DNS/BIND**—Set up a domain nameserver to let other systems on the Internet know the names and IP addresses of local systems they may need to contact.
- **firewalld**, **firewall-config**, and **iptables**—Set up a firewall to protect local systems and share a single Internet connection between systems on a LAN.
- **Apache**—Set up an HTTP server that serves Web pages, which browsers can then display. This chapter includes many suggestions for increasing Apache security.

Part V Part V covers three important programming tools that are used extensively in Fedora/RHEL system administration and general-purpose programming. **Chapter 27** continues where Chapter 9 left off, going into greater depth about shell programming using `bash`, with the discussion enhanced by extensive examples. **Chapter 28** introduces the flexible and friendly Python programming language, including coverage of lists and dictionaries, using libraries, defining functions, regular expressions, and list comprehensions. **Chapter 29** covers the widely used MariaDB/MySQL RDBMS (relational database management system), including installation, creating a database, adding a user, creating and modifying tables, joins, and adding data to the database.

Part VI Part VI includes appendixes on regular expressions, helpful Web sites, system security including GPG, updating software using `apt-get`, and a map that indexes LPI's Linux Essentials certification learning goals and CompTIA's Linux+ exam objectives to the pages in this book that cover each topic. This part also includes an extensive Glossary with more than 500 entries plus the JumpStart index, the File Tree index, the Utility index, and the comprehensive Main index.

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## SUPPLEMENTS

The author's home page ([www.sobell.com](http://www.sobell.com)) contains downloadable listings of the longer programs from this book, as well as pointers to many interesting and useful Linux sites on the World Wide Web, a list of corrections to the book, answers to even-numbered exercises, and a solicitation for corrections, comments, and suggestions.

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## THANKS

First and foremost, I want to thank Mark L. Taub, Editor-in-Chief, Prentice Hall, who provided encouragement and support through the hard parts of this project. Mark is unique in my 30+ years of book writing experience: an editor who works with the tools I write about. Because Mark runs Linux on his home computer, we

shared experiences as I wrote this book. Mark, your comments and direction are invaluable; this book would not exist without your help. Thank you, Mark T.

The production people at Prentice Hall are wonderful to work with: Julie Nahil, Full-Service Production Manager, worked with me day by day during production of this book providing help and keeping everything on track, while John Fuller, Managing Editor, kept the large view in focus. Thanks to Stephanie Geels, Copyeditor, and Andrea Fox, Proofreader, who made each page sparkle and found the mistakes the author left behind.

Thanks also to the folks at Prentice Hall who helped bring this book to life, especially Kim Boedigheimer, Editorial Assistant, who attended to the many details involved in publishing this book; Heather Fox, Publicist; Stephane Nakib, Marketing Manager; Dan Scherf, Media Developer; Sandra Schroeder, Design Manager; Chuti Prasertsith, Cover Designer; and everyone else who worked behind the scenes to make this book come into being.

I am also indebted to Denis Howe, Editor of *The Free On-Line Dictionary of Computing* (FOLDOC). Denis has graciously permitted me to use entries from his compilation. Be sure to visit [www.foldoc.org](http://www.foldoc.org) to look at this dictionary.

A big “thank you” to the folks who read through the drafts of the book and made comments that caused me to refocus parts of the book where things were not clear or were left out altogether:

Nicklos See, Instructor, Bismarck State College; Eugene Murray, Chair, School of Information Technology, ITT Technical Institute; Doug Hughes, D. E. Shaw Research, LLC.; Carl Draper; Max Sobell; Rahul Sundaram, Fedora contributor; Tony Godfrey, TT Technical Institute, Strongsville, Ohio; Susan Lauber, Lauber System Solutions, Inc.; Sam Sobell, Student, UCLA; Ankur Sinha, Fedora project volunteer; Professor Maria Ripoll; David A. Lane, long-time Linux user and systems architect; Pete Travis, Fedora Documentation Project; Rickard Körkkö, Orc Group; Jennifer Davis, Senior Production Engineer at Yahoo; Matthew Miller, Fedora Project at Red Hat, Inc.; Jiri Popelka, Red Hat, Inc.; Thomas Woerner, Red Hat, Inc.; Ben Whaley, Co-author of the *UNIX and Linux System Administration Handbook*.

Thanks also to the following people who helped with my previous Linux books, which provided a foundation for this book:

Richard Woodbury, Site Reliability Engineer, Google, whose knowledge of IPv6 proved invaluable; Lennart Poettering, Red Hat, Inc.; George Vish II, Senior Education Consultant, Hewlett-Packard; Garth Snyder; Nathan Handler; Dick Seabrook, Professor Emeritus, Anne Arundel Community College; Chris Karr, Audacious Software; Scott McCrea, Instructor, ITT Technical Schools; John Dong, Ubuntu Developer, Forums Council Member; Andy Lester, author of *Land the Tech Job You Love: Why Skill and Luck Are Not Enough*; Scott James Remnant, Ubuntu Development Manager and Desktop Team Leader; David Chisnall, Swansea University; Scott Mann, Aztek Networks; Thomas Achtemichuk, Mansueto Ventures; Daniel R. Arfsten, Pro/Engineer

Drafter/Designer; Chris Cooper, Senior Education Consultant, Hewlett-Packard Education Services; Sameer Verma, Associate Professor of Information Systems, San Francisco State University; Valerie Chau, Palomar College and Programmers Guild; James Kratzer; Sean McAllister; Nathan Eckenrode, New York Ubuntu Local Community Team; Christer Edwards; Nicolas Merline; Michael Price; Mike Basinger, Ubuntu Community and Forums Council Member; Joe Barker, Ubuntu Forums Staff Member; James Stockford, Systemateka, Inc.; Stephanie Troeth, Book Oven; Doug Sheppard; Bryan Helvey, IT Director, OpenGeoSolutions; and Vann Scott, Baker College of Flint.

Also, thanks to Jesse Keating, Fedora Project; Carsten Pfeiffer, Software Engineer and KDE Developer; Aaron Weber, Ximian; Cristof Falk, Software Developer at CriterDesign; Steve Elgersma, Computer Science Department, Princeton University; Scott Dier, University of Minnesota; Robert Haskins, Computer Net Works; Lars Kellogg-Stedman, Harvard University; Jim A. Lola, Principal Systems Consultant, Privateer Systems; Eric S. Raymond, Cofounder, Open Source Initiative; Scott Mann; Randall Lechlitner, Independent Computer Consultant; Jason Wertz, Computer Science Instructor, Montgomery County Community College; Justin Howell, Solano Community College; Ed Sawicki, The Accelerated Learning Center; David Mercer; Jeffrey Bianchine, Advocate, Author, Journalist; John Kennedy; and Jim Dennis, Starshine Technical Services.

Thanks also to Dustin Puryear, Puryear Information Technology; Gabor Liptak, Independent Consultant; Bart Schaefer, Chief Technical Officer, iPost; Michael J. Jordan, Web Developer, Linux Online; Steven Gibson, Owner, SuperAnt.com; John Viega, Founder and Chief Scientist, Secure Software; K. Rachael Treu, Internet Security Analyst, Global Crossing; Kara Pritchard, K & S Pritchard Enterprises; Glen Wiley, Capital One Finances; Karel Baloun, Senior Software Engineer, Looksmart; Matthew Whitworth; Dameon D. Welch-Abernathy, Nokia Systems; Josh Simon, Consultant; Stan Isaacs; and Dr. Eric H. Herrin II, Vice President, Herrin Software Development.

More thanks go to consultants Lorraine Callahan and Steve Wampler; Ronald Hiller, Graburn Technology; Charles A. Plater, Wayne State University; Bob Palowoda; Tom Bialaski, Sun Microsystems; Roger Hartmuller, TIS Labs at Network Associates; Kaowen Liu; Andy Spitzer; Rik Schneider; Jesse St. Laurent; Steve Bellenot; Ray W. Hiltbrand; Jennifer Witham; Gert-Jan Hagenaars; and Casper Dik.

*A Practical Guide to Fedora™ and Red Hat® Enterprise Linux®, Seventh Edition*, is based in part on two of my previous UNIX books: *UNIX System V: A Practical Guide* and *A Practical Guide to the UNIX System*. Many people helped me with those books, and thanks here go to Pat Parseghian; Dr. Kathleen Hemenway; Brian LaRose; Byron A. Jeff, Clark Atlanta University; Charles Stross; Jeff Gitlin, Lucent Technologies; Kurt Hockenbury; Maury Bach, Intel Israel; Peter H. Salus; Rahul Dave, University of Pennsylvania; Sean Walton, Intelligent Algorithmic Solutions; Tim Segall, Computer Sciences Corporation; Behrouz Forouzan, DeAnza College; Mike Keenan, Virginia Polytechnic Institute and State University; Mike Johnson, Oregon State University; Jandelyn Plane, University of Maryland; Arnold Robbins

and Sathis Menon, Georgia Institute of Technology; Cliff Shaffer, Virginia Polytechnic Institute and State University; and Steven Stepanek, California State University, Northridge, for reviewing the book.

I continue to be grateful to the many people who helped with the early editions of my UNIX books. Special thanks are due to Roger Sippl, Laura King, and Roy Harrington for introducing me to the UNIX system. My mother, Dr. Helen Sobell, provided invaluable comments on the original manuscript at several junctures. Also, thanks go to Isaac Rabinovitch, Professor Raphael Finkel, Professor Randolph Bentson, Bob Greenberg, Professor Udo Pooch, Judy Ross, Dr. Robert Veroff, Dr. Mike Denny, Joe DiMartino, Dr. John Mashey, Diane Schulz, Robert Jung, Charles Whitaker, Don Cragun, Brian Dougherty, Dr. Robert Fish, Guy Harris, Ping Liao, Gary Lindgren, Dr. Jarrett Rosenberg, Dr. Peter Smith, Bill Weber, Mike Bianchi, Scooter Morris, Clarke Echols, Oliver Grillmeyer, Dr. David Korn, Dr. Scott Weikart, and Dr. Richard Curtis.

I take responsibility for any errors and omissions in this book. If you find one or just have a comment, let me know ([mgs@sobell.com](mailto:mgs@sobell.com)) and I will fix it in the next printing. My home page ([www.sobell.com](http://www.sobell.com)) contains a list of errors. It also offers copies of the longer scripts from the book and pointers to interesting Linux pages on the Internet. You can follow me at [twitter.com/marksobell](https://twitter.com/marksobell).

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