

PREFACE

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 28 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 Perl 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®, Sixth 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 This edition covers many topics to help you get your work done using Fedora/RHEL.

- A chapter on the Perl programming language (Chapter 28; page 1057)
- Seven chapters on system administration (Section IV; page 405)
- A chapter on writing programs using bash (Chapter 27; page 1057)
- Coverage of LDAP in Chapter 21 (page 776)
- Coverage of the MySQL relational database in Chapter 16 (page 635).
- A section on the Cacti network monitoring tool in Chapter 17 (page 657).
- New coverage of IPv6 in Chapter 10 (page 373).
- Updated chapters reflecting new features in Fedora 15 and RHEL 6
- 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 1199) 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 1201) lists, in hierarchical fashion, most files mentioned in this book. These files are also listed in the Main index.
 - ◆ The Utility index (page 1205) supplies the location of all utilities mentioned in this book. A page number in a **light font** indicates a brief mention of the utility, while 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 1211) is designed for ease of use.

Overlap If you have read *A Practical Guide to Linux® Commands, Editors, and Shell Programming, Second 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 chapter on Perl. Chapters that appear in this book but do not appear in *A Practical Guide to Linux® Commands, Editors, and Shell Programming, Second Edition*, include Chapters 2 and 3 (installation), Chapters 4 and 8 (Fedora/RHEL and the GUI), Chapter 10 (networking), all of the chapters in Part IV (system administration) and Part V (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, Second 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 100 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 15 (LOVELOCK) DVD

The print book includes an install DVD that holds Fedora 15 (Lovelock). You can use this DVD to install or upgrade to Fedora 15. 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 administrating 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.

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®, Sixth 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 operating system or the other are marked as such using these indicators: (Fedora) or (RHEL).
- **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.
- 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.
- 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 Add/Remove Software window, BitTorrent, and, for RHEL, Red Hat Network (RHN). It details controlling automatic updates using the Software Update Preferences window.
- This book describes in detail many important **GNU tools**, including the GNOME desktop, the Nautilus File Browser, the parted, palimpsest, and gparted 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.
- The 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 xlvii) describes what each chapter covers. Finally, the Table of Contents (starting on page xv) provides more detail. This book:

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| Installation | <ul style="list-style-type: none">• Describes how to download Fedora ISO images from the Internet and burn the Fedora live CD or the Fedora install 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 Disk Druid, the GNOME palimpsest disk utility, or the gparted graphical partition editor 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 Anaconda, Fedora/RHEL's installation program, to install Fedora/RHEL from an install DVD.• Covers testing a Fedora/RHEL CD/DVD for defects, setting boot command-line parameters (boot options), and creating a RAID array.• 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. |
| Working with Fedora/RHEL | <ul style="list-style-type: none">• Introduces the GNOME desktop (GUI) and explains how to use desktop tools, including the panels, panel objects, the Main menu, object context menus, the Workspace Switcher, 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 30 command-line utilities.• Presents a tutorial on the vim textual editor.• 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 | <ul style="list-style-type: none">• Describes CentOS by virtue of that operating system's compatibility with RHEL. CentOS (www.centos.org) is a free Linux distribution that has more long-term stability than Fedora but has less support than RHEL. |

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:
 - ◆ If you do not have an Internet connection, you can use the **Software Update Preferences** window to set up the DVD included with this book as a software repository. You can then install from this repository software packages that Fedora/RHEL supports.
 - ◆ 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 **Add/Remove 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 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 installation DVD and CDs. 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 Main menu.
- Explains system operation, including the boot process, `init` scripts, rescue (single-user) and multiuser modes, and steps to take if the system crashes.
- Details the workings of the new **systemd init daemon**, which replaces both the Upstart and System V **init** daemons (Fedora).
- Describes how to use and program the new **Upstart init daemon**, which replaces the System V **init** daemon (RHEL).
- 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, MySQL, and PHP) stack.
- Provides instructions on installing and setting up a **MySQL** relational database.

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- Describes files, directories, and filesystems, including types of files and file-systems, **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 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), iptables (firewalls), and more.
 - Describes how to use the graphical system-config-firewall 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.
- Clients and servers
- Explains how to use TCP wrappers to control who can access a server.
 - Explains how to set up and use the most popular Linux servers, providing a chapter on each: Apache, Samba, OpenSSH, **sendmail**, DNS, NFS, FTP, system-config-firewall and iptables, and NIS/LDAP.
 - Describes how to set up a CUPS printer server.
 - Explains how to set up and use a MySQL relational database.
 - Describes how to set up and use a DHCP server.
- Programming
- Provides a chapter on the Perl 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. The “Conventions Used in This Book” section on page 18 details the typefaces and terminology used in this book.
- 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 a CD or DVD, and planning the layout of the hard disk. **Chapter 3** is a step-by-step guide to installing Fedora and RHEL; it covers installing from a CD/DVD and from a live session (Fedora).

- Part II Part II, “Getting Started with 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, including the panels and the Main menu; 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. **Chapter 5** introduces the shell command-line interface, describes more than 30 useful utilities, and presents a tutorial on the vim text editor. **Chapter 6** discusses the Linux hierarchical filesystem, covering files, filenames, pathnames, working with directories, access permissions, and hard and symbolic links. **Chapter 7** 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.

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. Two sections that should *not* be skipped are: “Conventions Used in This Book” (page 18), which explains the typographic and layout conventions used in this book, and “Where to Find Documentation” (page 125), which points out both local and remote sources of Linux and Fedora/RHEL documentation.
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- Part III Part III, “Digging into Fedora and Red Hat Enterprise Linux,” goes into more detail about working with the system. **Chapter 8** discusses the GUI (desktop) and includes a section about running a graphical program on a remote system and having the display appear locally. The section on GNOME describes several GNOME utilities and goes into more depth about the Nautilus File Browser. **Chapter 9** extends the bash coverage from Chapter 7, 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** explains networks, network security, and the Internet, and discusses types of networks, subnets, protocols, addresses, hostnames, and various network utilities. A new 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 V.)
- Part IV Part IV covers system administration. **Chapter 11** 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 Upstart (RHEL) and systemd (Fedora) **init** daemons; chroot jails; TCP wrappers; general information about how to set up a server; DHCP; and PAM. **Chapter 12** 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; and the use of tune2fs to change filesystem parameters. **Chapter 13** 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 14** explains how to set up the CUPS printing system so you can print on both local and remote systems. **Chapter 15** details customizing and building a Linux kernel. **Chapter 16** covers additional administration tasks, including setting up user accounts, backing up files, scheduling automated tasks, tracking disk usage, solving general problems, and setting up a MySQL relational database. **Chapter 17** 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.

Part V Part V 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 V 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.
- **system-config-firewall 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 VI Part VI covers two 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 popular, feature-rich Perl programming language, including coverage of regular expressions and file handling.

Part VII Part VII includes appendixes on regular expressions, helpful Web sites, system security, and free software. This part also includes an extensive Glossary with more than 500 entries plus the JumpStart index, the File Tree index, the Utility index, and a comprehensive Main index.

SUPPLEMENTS

The author's home page (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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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) and I will fix it in the next printing. My home page (www.sobell.com) contains a list of errors and credits those who found them. 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.

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