A Practical Guide to Fedora™ and Red Hat® Enterprise Linux®

COLLEGE EDITION

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PREFACE

The book

Whether you are an end user, a system administrator, or a little of each, this book explains with step-by-step examples how to get the most out of a Fedora or Red Hat Enterprise Linux (RHEL) system. In 28 chapters, this book takes you from installing a Fedora or Red Hat Enterprise Linux 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, but having some experience using a general-purpose computer is 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
- **Computer science students** who are studying the Linux operating system
- **Programmers** who need to understand the Linux programming environment
- **Technical executives** who want to get a grounding in Linux

Benefits

A Practical Guide to Fedora™ and Red Hat® Enterprise Linux®, College 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 gives you 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.

Overlap If you read *A Practical Guide to Linux® Commands, Editors, and Shell Programming*, you will notice some overlap between that book and the one you are reading now. The first chapter, and the chapters on the utilities, the filesystem, programming tools, and the appendix on regular expressions are very similar in the two books, as are the three chapters on the Bourne Again Shell (bash). Chapters that appear in this book but not in *A Practical Guide to Linux® Commands, Editors, and Shell Programming* 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).

This Book Includes Fedora 8 on a DVD

A Practical Guide to Fedora™ and Red Hat® Enterprise Linux®, College Edition, includes a DVD that you can use to install or upgrade to Fedora 8. Chapter 2 helps you get ready to install Fedora. Chapter 3 provides step-by-step instructions for installing Fedora from this DVD. This book guides you through learning about, using, and administrating Fedora or Red Hat Enterprise Linux.

What Is New in This Edition?

The college edition of *A Practical Guide to Fedora™ and Red Hat® Enterprise Linux®* covers Fedora 8 and Red Hat Enterprise Linux version 5. There is a new section on LDAP in Chapter 21. Chapters 2 and 3 cover booting into a live session and installing from live media. All the changes, large and small, that have been made to Fedora/RHEL since the previous edition of this book have been incorporated into the explanations and examples.

Features of This Book

This book is designed and organized so you can get the most out of it in the shortest amount of time. You do not have to read this book straight through in page order. 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 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 get additional information: Consider the Internet an extension of this book.

A Practical Guide to Fedora™ and Red Hat® Enterprise Linux®, College 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 that 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.
- **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 at www.sobell.com.
- This book provides resources for **finding software** on the Internet. It also explains how to **download** and **install** software using yum, BitTorrent, and, for Red Hat Enterprise Linux, Red Hat Network (RHN).
- The **glossary** defines more than 500 common terms.
- The book describes in detail many important **GNU tools**, including the gcc C compiler, the gdb debugger, the GNU Configure and Build System, make, and gzip.
- Pointers throughout the text provide help in obtaining **online documentation** from many sources, including the local system, the Red Hat Web site, the Fedora Project Web site, and other locations on the Internet.
- Many useful URLs (Internet addresses) point to sites where you can obtain software, security programs and information, and more.
- The comprehensive index helps you locate topics quickly and easily.

KEY TOPICS COVERED IN THIS BOOK

This book contains a lot of information. This section distills and summarizes its contents. You may want to review the table of contents for more detail. This book

Installation

- Describes how to download from the Internet and burn both Fedora Desktop Live Media CD/DVDs and Fedora Install Media DVDs.
- Helps you plan the layout of the system's hard disk and assists you in using Disk Druid or the GNOME graphical partition editor (gparted) to partition the hard disk.

- 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.
- Discusses booting into a live Fedora session and installing Fedora from that session.
- Describes in detail how to install Fedora/RHEL from a DVD, CD, a hard disk, or over a network using FTP, NFS, or HTTP.
- Covers boot command line parameters (*FEDORA*), responses to the **boot:** prompt (*RHEL*), and explains how to work with **Anaconda**, Fedora/RHEL's installation program.
- Covers the details of customizing the X.org version of the X Window System.

Working with Fedora/RHEL

- Introduces the graphical desktop (GUI) and explains how to use desktop tools, including the panel, Panel menu, Main menu, Window Operations menu, Desktop menu, Desktop switcher, and terminal emulator.
- Presents the KDE desktop and covers using Konqueror to manage files, start programs, and browse the Web.
- Covers the GNOME desktop and the Nautilus file manager.
- Explains how to customize your desktop to please your senses and help you work more efficiently.
- Covers the Bourne Again Shell (bash) in three chapters, including an entire chapter on shell programming that includes many sample shell scripts.
- Explains the command line interface (CLI) and introduces more than 30 command line utilities.
- Presents a tutorial on the vim (vi work-alike) textual editor.
- Covers types of networks, network protocols, 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.

System administration

- Explains how to use the Fedora/RHEL system-config-* tools to configure the display, DNS, Apache, a network interface, and more. You can also use these tools to add users and manage local and remote printers. (See page 429 for a list of these tools.)
- Describes how to use the following tools to download software and keep a system current:
  - yum—Downloads and installs software packages from the Internet, keeping a system up-to-date and resolving dependencies as it processes the packages. You can run yum manually or set it up to run automatically every night.

  - **BitTorrent**—Good for distributing large amounts of data such as the Fedora installation DVD and the live media CD/DVD. The more people who use BitTorrent to download a file, the faster it works.
  - up2date—The Red Hat Enterprise Linux tool for keeping system software current.
- Covers graphical system administration tools, including the Main menu, GNOME and KDE menu systems, KDE Control Center, and KDE Control panel.
- Explains system operation, including the boot process, init scripts, emergency mode, rescue mode, single-user and multiuser modes, and steps to take if the system crashes.
- Describes files, directories, and filesystems, including types of files and filesystems, **fstab** (the filesystem table), automatically mounted filesystems, filesystem integrity checks, filesystem utilities, and fine-tuning of filesystems.
- Covers backup utilities, including tar, cpio, dump, and restore.
- 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 (the **httpd** Web server), iptables (firewall), and more.
- Presents a complete section on SELinux (Security Enhanced Linux), including instructions for using system-config-selinux to configure SELinux.
- Covers using system-config-firewall to set up a basic firewall to protect the system.
- Provides instructions on using iptables to share an Internet connection over a LAN and to build advanced firewalls.
- Describes how to set up a chroot jail to protect a server system.
- Explains how to use TCP wrappers to control who can access a server.
- Covers controlling servers using the **xinetd** superserver.

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, NIS and LDAP, iptables (all of which are included with Fedora/RHEL).
- Describes how to set up a CUPS printer server.
- Describes how to set up and use a DHCP server.

Programming

- Covers programming tools, including the GNU gcc compiler, the gdb debugger, make, and CVS for managing source code.
- Explains how to debug a C program.

- Describes how to work with shared libraries.
- Provides a complete chapter on 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" (page 16) section details the typefaces and terminology this book uses.

Part I Part I, "Installing Fedora and Red Hat Enterprise Linux," discusses how to install both Fedora and RHEL. **Chapter 2** presents an overview of the process of installing Fedora and RHEL, 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 either Fedora or Red Hat Enterprise Linux and covers installing from a CD/DVD, a live session, a local hard disk, and installing over the network using FTP, NFS, or HTTP. It also shows how to set up the X Window System and customize your graphical user interface (GUI).

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 panel and the Main menu; explains how to use Konqueror to manage files, run programs, and browse the Web; and covers finding documentation, dealing with login problems, and using the window manager. **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 over or skip some or all of the chapters in Part II. All readers should take a look at "Conventions Used in This Book" (page 16), which explains the typographic and layout conventions that this book uses, and "Getting the Facts: Where to Find Documentation" (page 114), which points out both local and remote sources of Linux/Fedora/RHEL documentation.

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 and includes a section on how to run a graphical program on a remote system and have the display appear locally. The section on GNOME describes GNOME utilities and explains how to use the Nautilus file manager, including its spatial view, while the section on KDE explains more about Konqueror and KDE utilities. **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. 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 Superuser, SELinux (Security Enhanced Linux), system operation, 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 of using yum, BitTorrent, and RHEL's up2date utility. **Chapter 14** explains how to set up the CUPS printing system so you can print on the local system as well as on 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, and solving general problems. **Chapter 17** explains how to set up a local area network (LAN), including both hardware (including wireless) and software setup.

Part V

Part V goes into detail about setting up and running servers and connecting to them with clients. The chapters in this part of the book cover the following clients/servers:

- **OpenSSH**—Set up an OpenSSH server and use sh, 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.
- **Mail**—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 distribute information and authenticate users over a network.
- **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.
- **iptables**—Share a single Internet connection between systems on a LAN and set up a firewall to protect local systems.
- **Apache**—Set up an HTTP server that serves Web pages that browsers can display.

Part VI Part VI covers programming. **Chapter 27** discusses programming tools and environments available under Fedora/RHEL, including the C programming language and debugger, make, shared libraries, and source code management using CVS. **Chapter 28** goes into greater depth about shell programming using bash, with the discussion being enhanced by extensive examples.

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 and a comprehensive 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.

THANKS

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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 many interesting Linux pages.

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3

Step-by-Step Installation

In This Chapter

Chapter 2 covered planning the installation of Fedora/RHEL: determining the requirements; performing an upgrade versus a clean installation; planning the layout of the hard disk; obtaining the files you need for the installation, including how to download and burn CD/DVD ISO images; and collecting information about the system. This chapter focuses on installing Fedora/RHEL. Frequently the installation is quite simple, especially if you have done a good job of planning. Sometimes you may run into a problem or have a special circumstance; this chapter gives you tools to use in these cases. Read as much of this chapter as you need to; once you have installed Fedora/RHEL, continue with Chapter 4, which covers getting started using the Fedora/RHEL desktop. If you install a textual (command line) system, continue with Chapter 5.

Figure 3-1 Live session, automatic boot screen

RUNNING A FEDORA LIVE SESSION

As discussed in Chapter 2, a live session is a Linux session that you run on a computer without installing Linux on the computer. When you reboot after a live session, the computer is untouched. If you are running Windows, after a live session Windows boots the way it did before the live session. If you choose, you can install Fedora from a live session. Red Hat Enterprise Linux does yet not offer live sessions.

A live session gives you a chance to preview Fedora without installing it. Boot from the KDE Live CD to begin a live session and work with Fedora as explained in Chapter 4. When you are finished, remove the CD and reboot the system. The system will then boot as it did before the live session took place.

Because a live session does not write to the hard disk (other than using a swap partition if one is available), none of the work you save will be available once you reboot. You can use a USB flash drive, Webmail, or another method to transfer files you want to preserve to another system.

BOOTING THE SYSTEM

Before Fedora can display the desktop of a live session or install itself on a hard disk, the Linux operating system must be read into memory (booted). This

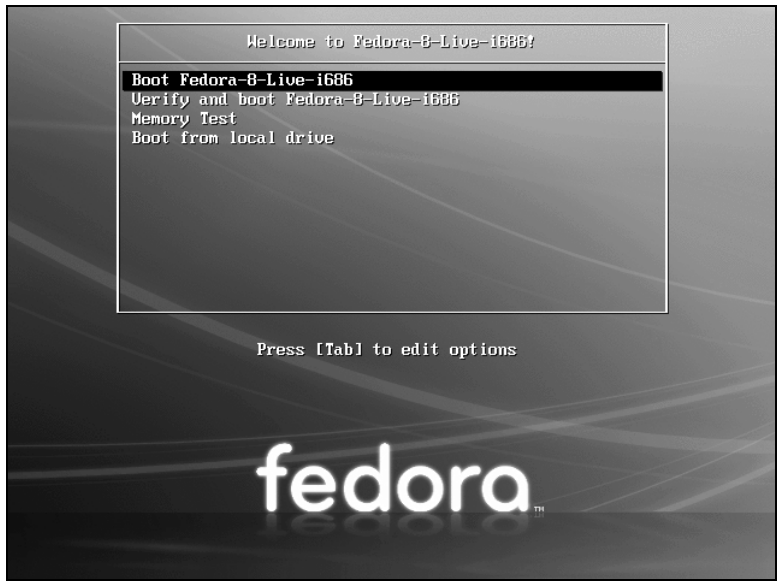

Figure 3-2 The Fedora Live Welcome menu

process can take a few minutes on older, slower systems or systems with minimal RAM (memory).

In most cases, you can boot Fedora to run a live session that displays a desktop without doing anything after you boot from a Live CD. To begin, insert the Live CD (either the standard GNOME **Fedora Desktop Live Media** or the **Fedora KDE Live Media**) into the CD drive and turn on or reset the system. Refer to "BIOS setup" on page 26 if the system does not boot from the CD. Refer to "Modifying Boot Parameters (Options)" on page 63 if Fedora does not boot or displays an error message.

A few moments after you start the system, Fedora displays a screen that says **Automatic boot in 10 seconds** and counts down from 10 to 1 (Figure 3-1). Text then scrolls by as the system boots. After a few moments, the system displays a graphical screen showing the word **Fedora**, the Fedora logo, and a progress bar.

Checking the disk

The first time you use a CD, it is a good idea to check it for defects. To do so, interrupt the automatic boot by pressing a key such as the SPACE BAR while Fedora is counting down. Fedora displays the Welcome menu (Figure 3-2). Use the DOWN ARROW key to highlight the line that starts with **Verify and boot Fedora...** and press RETURN (the mouse will not work yet). Fedora verifies the contents of the CD, keeping you apprised as it does so. If the CD is good, the system continues to boot.

GNOME

If you are installing from Fedora Desktop Live Media, you are installing the GNOME desktop manager. When you boot from this disk, Fedora displays a login screen for 60 seconds, automatically logs in as the user named **fedora**, and displays

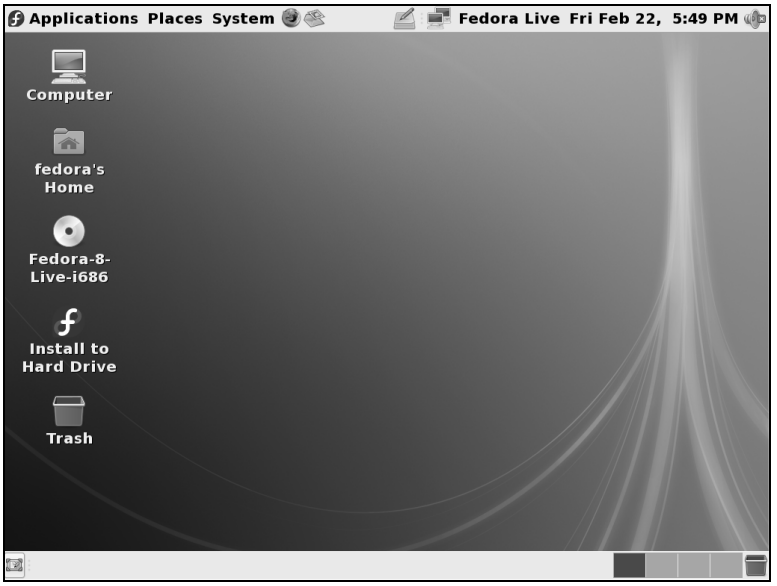

Figure 3-3 A GNOME Live desktop

the GNOME desktop (Figure 3-3). To speed up this process, you can log in as **fedora** (no password) when Fedora displays the login screen.

KDE If you are installing from Fedora KDE Live Media, you are installing the KDE desktop manager. When you boot from this disk, Fedora next displays a KDE startup screen and then the KDE desktop—there is no need to log in. If the system can connect to the Internet, KDE displays the message **Connection Established**.

optional SEEING WHAT IS GOING ON

If you are curious and want to see what Fedora is doing as it boots, remove **quiet** from the boot parameters (Figure 3-16 on page 64; the list of parameters will be different from those shown in the figure). With the Fedora Live Welcome menu displayed (Figure 3-2), press TAB to display the boot command line parameters. Use the BACK ARROW key to back up over—but not remove—the words to the right of **quiet**. Press BACKSPACE or DEL to back up over and erase **quiet** from the boot command line. Press RETURN. As Fedora boots, it displays information about what it is doing. Text scrolls on the screen, although sometimes too rapidly to read.

INSTALLING FEDORA/RHEL LINUX

You can install Fedora/RHEL from a live session (preceding section, *FEDORA* only) or from the Install DVD (*RHEL+FEDORA*). Installing from a live session is simpler, but does not give you the flexibility that installing from the Install DVD does. For example,

you cannot select the language the installer uses nor can you choose which software packages you want to install when you install from a live session.

Check to see what is on the hard disk before installing Fedora/RHEL

caution Unless you are certain the hard disk you are installing Fedora/RHEL on has nothing on it (it is a new disk) or you are sure the disk holds no information of value, it is a good idea to examine the contents of the disk before you start the installation. You can use gparted (page 69) for this purpose.

The Install DVD holds many of the software packages that Fedora/RHEL supports. You can install whichever packages you like from this disk without connecting to the Internet. However, without an Internet connection, you will not be able to update the software on the system.

The Live CD holds a limited set of software packages. Once you install from this CD, you must connect to the Internet to update the software on the system and download and install additional packages.

To begin most installations, insert the Live CD or the Install DVD into the CD/DVD drive and turn on or reset the system. For hard disk and network-based installations, you can use the rescue CD (page 42) or a USB flash drive instead.

Installing from a Live Session

Bring up a live GNOME or KDE session as explained on page 48. Double-click (left-click) the object labeled **Install to Hard Drive** (Figure 3-3) to begin installing Linux. Continue reading at "The Anaconda Installer" on page 53.

Installing/Upgrading from the Install DVD

FEDORA To install Fedora from the Install DVD, insert the Install DVD into the DVD drive and turn on or reset the system. After a few moments, Fedora displays the Install DVD Welcome menu (Figure 3-4, next page) and a message that says **Automatic boot in 60 seconds**.

Press a key, such as the SPACE BAR, within 60 seconds to stop the countdown and display the message **Press [TAB] to edit options** as shown in Figure 3-4. If you do not press a key, after 60 seconds Fedora begins a graphical install/upgrade. Refer to "BIOS setup" on page 26 if the system does not boot from the DVD. Refer to "Modifying Boot Parameters (Options)" on page 63 if Fedora/RHEL does not boot or displays an error message.

The Welcome menu has the following selections:

Install or upgrade a system — Installs a graphical Fedora/RHEL system using the graphical installer.

Install or upgrade a system (text mode) — Installs a graphical Fedora/RHEL system using the textual installer.

Rescue installed system — Brings up Fedora/RHEL but does not install it. After detecting the system's disks and partitions, the system enters rescue mode and allows you to mount an existing Linux filesystem. For more information refer to "Rescue Mode" on page 411.

Figure 3-4 The Install DVD Welcome menu

Boot from local drive — Boots the system from the hard disk. This selection frequently has the same effect as booting the system without the CD/DVD (depending on how the BIOS [page 26] is set up).

Memory test — Runs memtest86+, a GPL-licensed, stand-alone memory test utility for x86-based computers. Press **C** to configure the test; press ESCAPE to exit and reboot. See www.memtest.org for more information.

RHEL — The process of installing Red Hat Enterprise Linux is similar to that of installing Fedora. The biggest difference is in the initial screen the two systems display. While *FEDORA* displays a menu, *RHEL* displays a **boot:** prompt. Follow the instructions on the screen for installing *RHEL* in graphical or textual mode. To bring the system up in Rescue mode (page 411), enter **linux rescue** and press RETURN. Most parameters you enter at the **boot:** prompt begin with the word **linux**. You can use all of the parameters discussed in "Modifying Boot Parameters (Options)" on page 63, but they must be preceded by the word **linux**. Press the function keys listed at the bottom of the screen for more information.

THE DISC FOUND SCREEN

The first screen that the Install DVD installation process displays is the pseudo-graphical Disc Found screen. Because it is not a true graphical screen, the mouse does not work. Instead, you must use the TAB or ARROW keys to highlight different choices and press RETURN to select the highlighted choice. This screen allows you to test as many installation CD/DVDs as you like. Choose **OK** to test the media or **Skip** to bypass the test. See the caution box on the next page.

A DVD may fail the media test if the software that was used to burn the disk did not include padding. If a DVD fails the media test, try booting with the **nodma** parameter. See page 63 for information on adding parameters to the boot command line.

Test Install DVDs

caution Many people download ISO images from the Web and burn disks using these images. It is possible for data to become corrupted while fetching an ISO image; it is also possible for a transient error to occur while writing an image to recordable media. When you boot Fedora/RHEL from an Install DVD, Anaconda displays the CD Found screen before starting the installation. From this screen, you can verify that the installation DVD does not contain any errors. Testing the DVD takes a few minutes and can save you hours of aggravation if the installation fails due to bad media.

If the DVD passes the media test when you boot the system with the **nodma** parameter, the DVD is good; reboot the system without this parameter before installing Fedora/RHEL. If you install Linux after having booted with this parameter, the kernel will be set up to always use this parameter. As a consequence, the installation and operation of the system may be very slow.

THE ANACONDA INSTALLER

Anaconda, which is written in Python and C, identifies the hardware, builds the filesystems, and installs or upgrades the Fedora/RHEL operating system. Anaconda can run in textual or graphical (default) interactive mode or in batch mode (see "Using the Kickstart Configurator" on page 78).

Exactly which screens Anaconda displays depends on whether you are installing Fedora from a live session or from the Install DVD, or whether you are installing Red Hat Enterprise Linux, and which parameters you specified on the boot command line. With some exceptions—most notably if you are running a textual installation—Anaconda probes the video card and monitor, and starts a native X server with a log in **/tmp/X.log**. (This log is not preserved unless you complete the installation.)

While it is running, Anaconda opens the virtual consoles (page 125) shown in Table 3-1. You can display a virtual console by pressing CONTROL-ALT-F*x*, where *x* is the virtual console number and F*x* is the function key that corresponds to the virtual console number.

Table 3-1 Virtual console assignments during installation

	Information displayed during installation	
Virtual console	**Install DVD**	**Live CD**
1	Installation dialog	Login prompt (log in as **fedora**)
2	Shell	Login prompt (log in as **fedora**)
3	Installation log	Installation log
4	System messages	Login prompt (log in as **fedora**)
5	Nothing	Login prompt (log in as **fedora**)
6	GUI interactive installation screen[a]	Login prompt (log in as **fedora**)
7	GUI interactive installation screen[a]	GUI interactive installation

a. The GUI appears on virtual console 6 or 7.

Figure 3-5 The Logo screen

At any time during the installation, you can switch to virtual console 2 (CONTROL-ALT-F2) and give commands to see what is going on. Do not give any commands that change any part of the installation process. To switch back to the graphical installation screen, press CONTROL-ALT-F6 or CONTROL-ALT-F7.

USING ANACONDA

Anaconda provides a button labeled **Next** at the lower-right corner of each installation screen and a button labeled **Back** next to it on most screens. When you have completed the entries on an installation screen, click **Next** or F12; from a textual installation, press the TAB key until the **Next** button is highlighted and then press RETURN. Select **Back** to return to the previous screen. Click **Release Notes** at the lower-left corner of the screen to display the release notes for the version of Fedora/RHEL you are installing.

ANACONDA SCREENS

Anaconda displays different screens depending on which commands you give and which choices you make. During a graphical installation, Anaconda starts, loads drivers, and probes for the devices it will use during installation. After probing, it starts the X server. This section describes the screens that Anaconda displays during a default installation and explains the choices you can make on each of them.

Logo — Anaconda displays the Logo screen (Figure 3-5) after it obtains enough information to start the X Window System. There is nothing for you to do on this screen except display the release notes. Click **Next**.

Language — Select the language you want to use for the installation. This language is not necessarily the same language that the installed system will display.

Keyboard — Select the type of keyboard attached to the system.

Initialize warning — Anaconda displays this warning if the hard disk has not been used before. The dialog box says that the partition table on the device was unreadable and asks if you want to initialize the drive. When you initialize a drive, all data on the drive is lost.

Figure 3-6 The Install or Upgrade screen

Click **Yes** if it is a new drive or if you do not need the data on the drive. Anaconda initializes the hard disk immediately.

Install or Upgrade

Anaconda displays the Install or Upgrade screen (Figure 3-6) only if it detects a version of Fedora/RHEL on the hard disk that it can upgrade. Anaconda gives you the choice of upgrading the existing installation or overwriting the existing installation with a new one. Refer to "Upgrading an Existing Fedora/RHEL System Versus Installing a Fresh Copy" on page 28 for help in making this selection.

Disk Partitioning

The Disk Partitioning screen (Figure 3-7) allows you to specify partition information and to select which drives you want to install Fedora/RHEL on (assuming the system has more than one drive). Specify which drives you want to install Linux on in the frame labeled **Select the drive(s) to use for this installation**. Anaconda presents the following options in the drop-down list near the top of the screen; click the box and then click the choice you want:

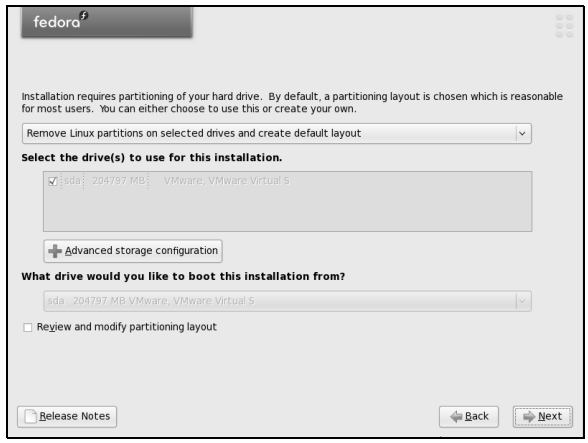

Figure 3-7 The Disk Partitioning screen

- **Remove all partitions on selected drives and create default layout**—Deletes all data on the hard disk and creates a default layout on the entire hard disk, as though you were working with a new hard disk.
- **Remove Linux partitions on selected drives and create default layout**—Removes all Linux partitions, deleting the data on those partitions and creating a default layout in place of one or more of the removed partitions. If there is only a Linux system on the hard disk, this choice is the same as the previous one.
- **Use free space on selected drives and create default layout**—Installs Fedora/RHEL in the *free space* (page 29) on the disk. This choice does not work if there is not enough free space.
- **Create custom layout**—Does not alter hard disk partitions. This choice causes Anaconda to run Disk Druid (page 66) so you can preserve the partitions you want to keep and overwrite other partitions. It is a good choice for installing Fedora/RHEL over an existing system where you want to keep **/home**, for example, but want a clean install and not an upgrade.

Default layout

The default layout that the first three choices create includes two logical volumes (swap and root [**/**]) and one standard partition (**/boot**). With this setup, most of the space on the disk is assigned to the root partition. For information on the Logical Volume Manager, see page 35.

The disk is not partitioned until later

tip

Anaconda does not write to the hard disk when you specify partitions. Instead, it creates a table that specifies how you want the hard disk to be partitioned. The disk is actually partitioned and formatted when you click **Next** from the Begin Installation screen (Figure 3-13, page 61). However, if Anaconda displays the Initialize Warning dialog box (page 54), when you click **Yes**, it writes to the disk immediately.

Disk Druid

Anaconda runs Disk Druid only if you put a check mark in the box labeled **Review and modify partitioning layout** or if you select **Create custom layout** from the drop-down list as described earlier. You can use Disk Druid to verify and modify the layout before it is written to the hard disk. For more information refer to "Using Disk Druid to Partition the Disk" on page 66.

Warning

Anaconda displays a warning if you are removing or formatting partitions. Click **Yes** or **Format** to proceed.

Boot Loader Configuration

Anaconda displays the Boot Loader Configuration screen (Figure 3-8) only when you put a check mark in the box labeled **Review and modify partitioning layout** or select **Create custom layout** from the drop-down list in the Partition the Disk screen. By default, Anaconda installs the grub boot loader (page 545). If you do not want to install a boot loader, click the radio button next to **No boot loader will be installed**. When you install Fedora/RHEL on a machine that already runs another operating system, Anaconda frequently recognizes the other operating system and sets up grub so you can boot from either operating system. Refer to "Setting Up a

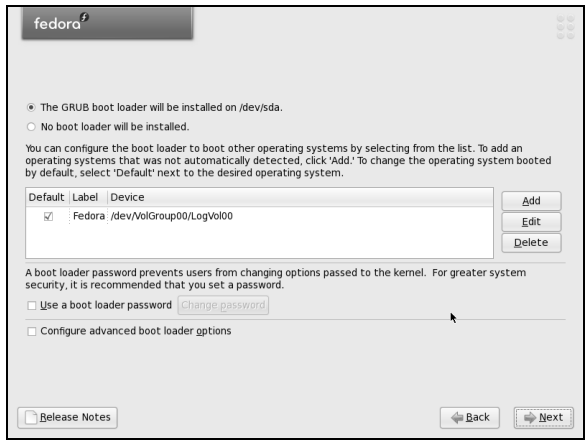

Figure 3-8 The Boot Loader Configuration screen

Dual-Boot System" on page 79. To manually add other operating systems to grub's list of bootable systems, click **Add** and specify a label and device to boot from. For a more secure system, specify a boot loader password.

Network Configuration

The Network Configuration screen, which allows you to specify network configuration information, has three parts: Network Devices, Hostname, and Miscellaneous Settings (Figure 3-9). If you are using DHCP to set up the network interface, you do not need to change anything on this screen.

The Network Devices frame lists the network devices that the installer finds. Normally you want network devices to become active when the system boots. Remove the check mark from the box at the left of a device if you do *not* want that device to become active when the system boots.

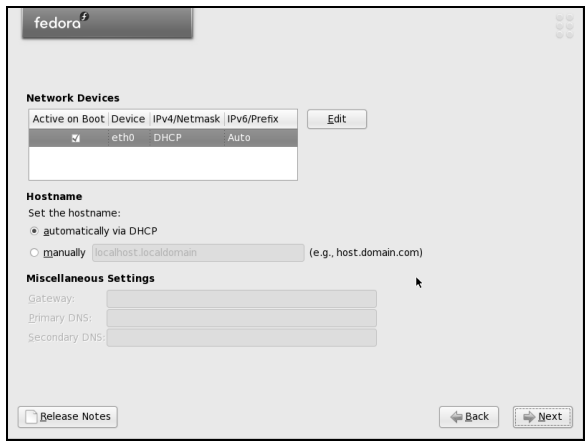

Figure 3-9 The Network Configuration screen

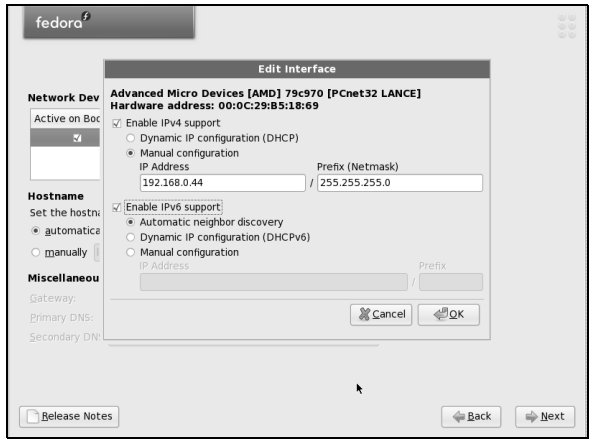

Figure 3-10 Network Configuration: Edit Interface window

To configure a network device manually (not using DHCP), highlight the device and click **Edit** to the right of the list of devices. Anaconda displays the Edit Interface window (Figure 3-10). To set up IPv4 networking manually, click the radio button labeled **Manual configuration** under **Enable IPv4 support** and enter the IP address and netmask of the system in the appropriate boxes. You can also set up or disable IPv6 networking on this screen. Click **OK**.

If you are not using DHCP, click the radio button labeled **manually** under **Set the hostname** in the network configuration screen and enter the name of the system. When you turn off DHCP configuration in Network Devices, Anaconda allows you to specify a gateway address and one or more DNS (nameserver) addresses. You do not have to specify more than one DNS address, although it can be useful to have two in case the first nameserver stops working. Click **Next**.

Root Password

Specify the **root** password twice to make sure you did not make a mistake typing it.

Install KDE to follow the examples in Chapter 4

tip Chapter 4 uses examples from KDE to introduce the graphical desktop. Install KDE if you want to follow these examples. You can remove KDE later if you like. To install KDE, click the radio button next to **Customize now** on the Software Selection screen and follow the instructions in the text. You can install both KDE and GNOME or just one of them.

Software selection

As the Software Selection screen explains, by default Anaconda installs a basic Fedora system, including software that allows you to use the Internet. See Figure 3-11. Near the top of the screen are three boxes that you can put check marks in to select categories of software to install: **Office and Productivity** (selected by default), **Software Development**, and **Web server**.

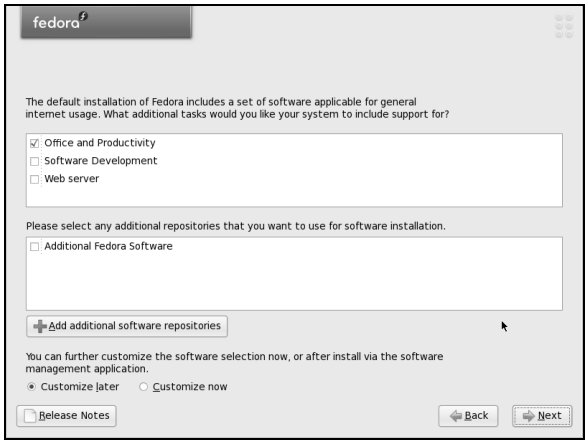

Figure 3-11 The Software Selection screen

Fedora/RHEL software is kept in repositories (see Chapter 13). In the middle of the screen is a box you can put a check mark in to select a repository that holds **Additional Fedora Software** (*FEDORA*). Below that box is a button labeled **Add additional software repositories**. See Chapter 13 for more information on software repositories.

Toward the bottom of the screen are two radio buttons:

- **Customize later**—Installs the default packages plus those required to perform the tasks selected from the list at the top of this screen.
- **Customize now**—Calls pirut (next section) after you click **Next** on this screen so you can select specific categories of software and package groups you want to install. If you want to set up servers as described in Part V of this book, select **Customize now** and install them in the next step.

In most cases it is a good idea to customize the software selection before installation. The examples in Chapter 4 are based on KDE. If you want to follow these examples, click the radio button labeled **Customize now** and follow the instructions in the next step.

Regardless of which software groups and packages you select now, you can use pirut to change which software groups and packages are installed on a system any time after the system is up and running (as long as the system can connect to the Internet).

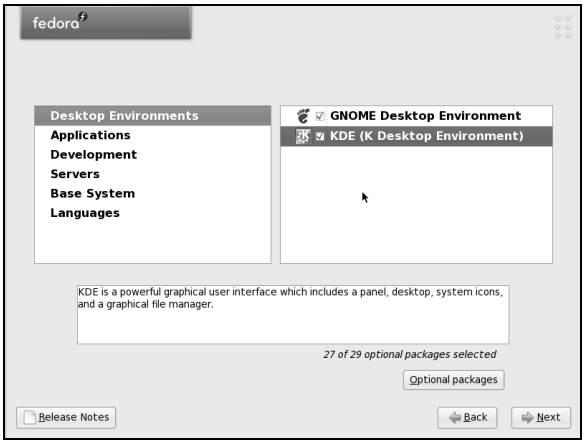

Figure 3-12 The pirut package selection utility with KDE selected

pirut utility

The pirut utility (page 497) displays two adjacent frames toward the top of the screen (Figure 3-12). Select a software category from the frame on the left and package groups from the frame on the right.

For example, to install KDE, which is not installed by default, click **Desktop Environments** on the left. The pirut utility highlights your selection and displays a list of desktop environments you can install on the right. Click the box next to **KDE (K Desktop Environment)** so there is a check mark in it; pirut highlights KDE, displays information about KDE in the text frame toward the bottom of the window, displays the number of optional packages that are selected, and activates the **Optional packages** button. To get started, accept the default optional packages. See page 498 for information about installing other optional packages. If you will be running servers on the system, click **Servers** on the left and select the servers you want to install from the list on the right. Select other package categories in the same manner. When you are done, click **Next**.

Begin Installation

Clicking **Next** on the Begin Installation screen (Figure 3-13) begins the process of writing to the hard disk. First Anaconda partitions and formats the disk as necessary; next it installs Fedora/RHEL based on what you have specified in the preceding screens, placing a log of the installation in **/root/install.log** and a Kickstart file (page 78) in **/root/anaconda-ks.cfg**. Clicking **Back** allows you to step back through the installation screens and make changes. To completely change the way you set up Fedora/RHEL, you can press CONTROL-ALT-DEL to reboot the system and start over. If you reboot the system, you will lose all the work you did up to this point. Click **Next** to install Fedora/RHEL.

This is when Anaconda writes to the hard disk

caution You can abort the installation by pressing CONTROL-ALT-DEL at any point up to and including the Begin Installation screen (Figure 3-13) without making any changes to the system. Once you click **Next** in this screen, Anaconda writes to the hard disk. As mentioned earlier, if Anaconda displayed the Initialize Warning dialog box (page 54), it wrote to the hard disk when you clicked **Yes**.

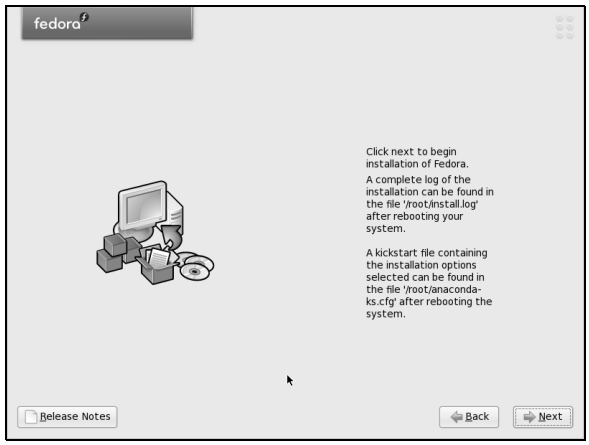

Figure 3-13 The Begin Installation screen

Installing Fedora/RHEL can take a while. The amount of time depends on the hardware you are installing the operating system on and the number of software packages you are installing.

Installation Complete

When Anaconda is finished, it tells you that the installation is complete. Remove the CD/DVD (if that is the medium you installed from) and click **Reboot**.

FIRSTBOOT: WHEN YOU REBOOT

When the system reboots, it is running Fedora/RHEL. The first time it boots, Fedora/RHEL runs Firstboot, which asks a few questions before allowing you to log in.

Welcome

There is nothing for you to do on the Welcome screen (Figure 3-14). Click **Forward**.

License Information

After the Welcome screen, Firstboot displays the License Information screen. If you understand the license information, click **Forward**.

Figure 3-14 The Welcome screen

Figure 3-15 The Firewall screen

Firewall Next you are given the opportunity to set up a very basic *firewall* (page 1058). First select **Enabled** or **Disabled** from the drop-down list labeled **Firewall** (Figure 3-15). If you enable the firewall, select which services the firewall will to pass through to the system. These services are the ones that the system is providing by means of servers you set up. For example, you do not need to enable WWW to browse the Web using Firefox; you need to enable WWW only if you want to set up an Apache (HTTP) Web server. Select **Secure WWW (HTTPS)**, which is used for secure browser connections, to allow secure HTTP to pass through the firewall. Click the triangle to the left of **Other ports** to open a frame in which you can add and remove additional protocols and ports that the firewall will pass. Use the buttons labeled **Add** and **Remove** to manipulate this list.

For more information on setting up a firewall, refer to "JumpStart: Building a Firewall Using system-config-firewall" on page 794. Chapter 25 on iptables has information on how to build a more complete and functional firewall. Click **Forward**.

SELinux SELinux (Security Enhanced Linux) enforces security policies that limit what a user or program can do. On this screen you can choose one of two policies, **Enforcing** or **Permissive**, or you can disable SELinux. If you enable SELinux, you can modify its policy. The policy defaults to Enforcing, which prevents any user or program from doing anything that is not permitted by the policy. If you will never want to use SELinux, disable it. If you do not want to use it now but may want to do so in the future, establish a Permissive policy—it issues warnings but does not enforce the policy. It can take a lot of time to turn on SELinux on a system where it has been disabled. For more information refer to "SELinux" on page 414. Click **Forward**.

Date and Time The next screen allows you to set the system date and time. Running the Network Time Protocol (NTP) causes the system clock to reset itself periodically from a clock on the Internet. If the system is connected to the Internet, you may want to enable NTP by clicking the Network Time Protocol tab and putting a check mark in the box next to **Enable Network Time Protocol**. Click **Forward**.

Hardware Profile When you select the radio button labeled **Send Profile**, the smolt hardware profiler sends a monthly update of the system's hardware profile to smolts.org. Select the radio button labeled **Do not send profile** if you do not want smolt to send the system's profile to the Fedora Project. Click **Forward**.

Create User The next screen allows you to set up a user account. You can set up a user account now or after the system is fully operational. For more information refer to "Configuring User and Group Accounts" on page 550.

When the Create User screen closes, you are done with the installation. You can now use the system and set it up as you desire. You may want to customize the desktop as explained in Chapters 4 and 8 or set up servers as discussed in Part V of this book.

INITIALIZING DATABASES AND UPDATING THE SYSTEM

Update the **whatis** database so that whatis (page 158) and apropos (page 157) work properly. Next update the **locate** database so that locate works properly. (The locate utility indexes and allows you to search for files on the system quickly and securely.) Instead of updating these databases when you install the system, you can wait for cron (page 559) to run them overnight, but be aware that whatis, apropos, and locate will not work until the next day. The best way to update these databases is via the cron scripts that run daily. Working as **root**, give the following commands:

```
# /etc/cron.daily/makewhatis.cron
# /etc/cron.daily/mlocate.cron
```

These utilities run for several minutes and may complain about not being able to find a file or two. When the system displays a prompt, the **whatis** and **locate** databases are up-to-date.

INSTALLATION TASKS

This section details some common tasks you may need to perform during or after installation. It covers modifying the boot parameters, using Disk Druid to partition the disk during installation, using gparted to modify partitions, using logical volumes (LVs) to facilitate disk partitioning, using Kickstart to automate installation, and setting up a system that will boot either Windows or Linux (a dual-boot system).

MODIFYING BOOT PARAMETERS (OPTIONS)

FEDORA To modify boot parameters, you must interrupt the automatic boot process by pressing a key such as the SPACE BAR while Fedora is counting down when you first boot from a the Live CD (page 48) or Install DVD (page 51). When you press a key, Fedora displays the Welcome menu (Figure 3-2 on page 49 or Figure 3-4 on page 52). Use the ARROW keys to highlight the selection you want *before* proceeding (page 51). With the desired selection highlighted, press the TAB key to display the boot command line parameters (Figure 3-16, next page).

RHEL *RHEL* presents a **boot:** prompt in place of the boot parameters line that *FEDORA* displays when you press TAB. You can enter any of the parameters described in this section in

Figure 3-16 The Welcome screen displaying boot parameters (options)

response to the **boot:** prompt; however, you must precede these parameters with the word **linux**. (See the examples in the next paragraphs.)

RHEL+FEDORA Type a SPACE before you enter any parameters. You can specify multiple parameters separated by SPACEs. Press RETURN to boot the system. For more information on boot parameters, refer to www.kernel.org/doc/Documentation/kernel-parameters.txt and www.kernel.org/pub/linux/kernel/people/gregkh/lkn/lkn_pdf/ch09.pdf.

What to do if the installation does not work

tip On some hardware, the installation may pause for up to ten minutes. Before experimenting with other fixes, try waiting for a while. If the installation hangs, try booting with one or more of the boot parameters described in this section. Try running the installer in pseudographical (textual) mode. If these techniques fail, force the bootloader (syslinux) to run in textual mode by holding down the SHIFT key while the system boots from the DVD. (Do not depress the SHIFT key until after the BIOS finishes displaying information about the system.) Doing so does not affect the rest of the installation.

Following are some of the parameters you can add to the boot command line. If you encounter problems with the display during installation, supply the **nofb** parameter, which turns off video memory. If you are installing from a medium other than a DVD—that is, if you are installing from files on the local hard disk or from files on another system using FTP, NFS, or HTTP—supply the **askmethod** or **method** parameter.

Many of these parameters can be combined. For example, to install Linux in text mode using a terminal running at 115,200 baud, no parity, 8 bits, connected to the first serial device, supply the following parameters (the **,115200n8** is optional). The first line shows the parameters you enter while booting *FEDORA*. The second line shows the parameters, including **linux**, you enter in response to the **boot:** prompt while booting *RHEL*.

```
text console=ttyS0,115200n8 FEDORA
boot: linux text console=ttyS0,115200n8 RHEL
```

The next set of parameters installs Fedora/RHEL on a monitor with a resolution of 1024 × 768, without probing for any devices. The installation program asks you to specify the source of the installation data (CD, DVD, FTP site, or other) and requests a video driver.

```
resolution=1024x768 noprobe askmethod FEDORA
boot: linux resolution=1024x768 noprobe askmethod RHEL
```

noacpi Disables ACPI (Advanced Configuration and Power Interface). Useful for systems that do not support ACPI or that have problems with their ACPI implementation. The default is to enable ACPI. Also **acpi=off**.

noapic Disables APIC (Advanced Programmable Interrupt Controller). The default is to enable APIC.

noapm Disables APM (Advanced Power Management). The default is to enable APM. Also **apm=off**.

askmethod Presents a choice of installation sources: local CD/DVD or hard disk, or over a network using NFS, FTP, or HTTP. (Install DVD only.)

- **Local CDROM**—Displays the CD Found screen, which allows you to test the installation media (the same as if you had not entered any boot parameters).
- **Hard drive**—Prompts for the partition and directory that contains the installation tree or the ISO image of the Install DVD. Do not include the name of the mount point when you specify the name of the directory. For example, if the ISO images are in the **/home/sam/FC8** directory and **/dev/hda6** holds the partition that is normally mounted on **/home**, you would specify the partition as **/dev/hda6** and the directory as **sam/FC8** (no leading slash).
- **NFS**, **FTP**, or **HTTP**—Displays the Configure TCP/IP screen from which you can select DHCP or enter the system's IP address and netmask, and the IP addresses of the default gateway and primary nameserver.

  When using NFS, the remote (server) system must export (page 709) the directory hierarchy that holds the installation tree or the ISO image of the Install DVD. The NFS Setup screen requires you to enter the NFS server name and name of the Fedora/RHEL directory. Enter the server's IP address and the *name* of the exported directory, not its device name.

nodma Turns off direct memory access (DMA) for all disk controllers, which may make buggy controllers (or controllers with buggy drivers) more reliable, but also causes them to perform very slowly because the connected devices have to run in PIO mode instead of DMA mode. This parameter may facilitate testing CD/DVDs that were not written correctly. For more information refer to "The Disc Found Screen" on page 52.

nofb **no framebuffer** Turns off the framebuffer (video memory). This option is useful when problems arise when the graphical phase of the installation starts. It is particularly useful for systems with LCD displays.

irqpoll Changes the way the kernel handles interrupts.

ks=*URI* Specifies the location of a Kickstart (page 78) file to use to control installation. The *URI* is the pathname or network location of the Kickstart file.

nolapic Disables local APIC. The default is to enable local APIC.

lowres Runs the installation program at a resolution of 640 × 480 pixels. See also **resolution**.

mem=*xxx*M Overrides the detected memory size. Replace *xxx* with the number of megabytes of RAM in the computer.

method=*URI* Specifies an installation method and location without prompting as **askmethod** does. For example, you can use the following parameter to start installing from the specified server:

```
method=ftp://download.fedora.redhat.com/pub/fedora/linux/releases/8/Fedora/x86_64/os
```

noprobe Disables hardware probing for all devices, including network interface cards (NICs), graphics cards, and the monitor. This option forces you to select devices from a list. You must know exactly which cards or chips the system uses when you use this parameter. Use **noprobe** when probing causes the installation to hang or otherwise fail. This parameter allows you to supply arguments for each device driver you specify.

rescue Puts the system in rescue mode; see page 411 for details.

resolution=*WxH* Specifies the resolution of the monitor you are using for a graphical installation. For example, **resolution=1024x768** specifies a monitor with a resolution of 1024 × 768 pixels.

text Installs Linux in pseudographical (page 26) mode. Although the images on the screen appear to be graphical, they are composed entirely of text characters.

vnc Installs over a VNC (virtual network computing) remote desktop session. After providing an IP address, you can control the installation remotely using a VNC client from a remote computer. You can download the VNC client, which runs on several platforms, from www.realvnc.com. Use yum (page 492) to install the **vnc** software package to run a VNC client on a Fedora/RHEL system.

PARTITIONING THE DISK

See page 29 for a discussion of partitions and set up of the hard disk.

USING DISK DRUID TO PARTITION THE DISK

Disk Druid, a graphical disk-partitioning program that can add, delete, and modify partitions on a hard disk, is part of the Fedora/RHEL installation system. You can use Disk Druid only while you are installing a system; it cannot be run on its own. You can use gparted (page 69), parted (page 72), or fdisk to manipulate partitions and system-config-lvm to work with LVs after you install Fedora/RHEL. As explained earlier, if you want a basic set of partitions, you can allow Anaconda to partition the hard disk automatically.

Anaconda runs Disk Druid when you put a check mark in the box labeled **Review and modify partitioning layout** or when you select **Create custom layout** in the Disk Partitioning screen (Figure 3-7, page 55).

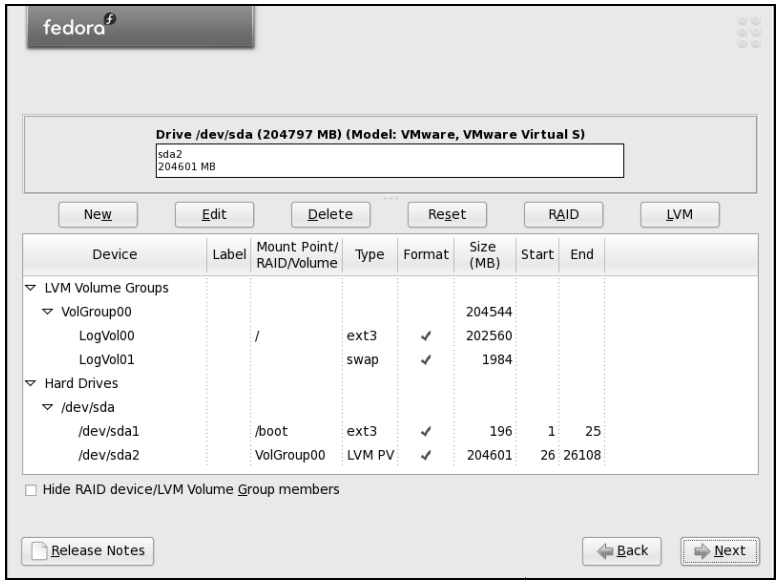

Figure 3-17 Disk Druid: main screen, default layout

Clone and RAID

Disk Druid includes Clone, a tool that copies the partitioning scheme from a single drive to other drives. Clone is useful for making multiple copies of a RAID partition/drive when you are creating a large RAID array of identical partitions or identically partitioned drives. Click the **RAID** button to access the Clone tool, which is active only when at least one unallocated RAID partition exists. For more information on RAID, see page 33.

Default layout

Figure 3-17 shows the Disk Druid main screen as it appears when you have chosen the default layout for the hard disk (see "Disk Partitioning" on page 55). This screen has three sections (going from top to bottom): a graphical representation of the disk drives showing how each is partitioned, a row of buttons, and a table listing one partition or LV per line.

The following buttons appear near the top of the screen:

- **New**—Adds a new partition to the disk (page 68)
- **Edit**—Edits the highlighted partition or LV (both on page 75)
- **Delete**—Deletes the highlighted partition or LV
- **Reset**—Cancels the changes you have made and causes the Disk Druid table to revert so it matches the layout of the disk
- **RAID**—Enables you to create software RAID partitions and to join two or more RAID partitions into a RAID device (page 33)
- **LVM**—Enables you to create physical volumes (PVs), which you can then use to create LVs (page 35)

The Disk Druid table contains the following columns:

- **Device**—The name of the device in the **/dev** directory (for example, **/dev/sda1** or the name of the LV).
- **Label**—The device label.
- **Mount Point/RAID/Volume**—Specifies where the partition will be mounted when the system is brought up (for example, **/usr**). It is also used to specify the RAID device or LVM volume the partition is part of.
- **Type**—The type of partition, such as **ext3**, **swap**, or LVM PV.
- **Format**—A check mark in this column indicates the partition will be formatted as part of the installation procedure. All data on the partition will be lost.
- **Size (MB)**—The size of the partition or LV in megabytes.
- **Start**—The number of the block the partition starts on.
- **End**—The number of the block the partition ends on.

At the bottom of the screen is a box that allows you to hide RAID device and LVM volume group members. Do not put a check mark in this box if you want to see all information about the disk drives.

Add a new partition

To add a new partition to a hard disk, the hard disk must have enough free space to accommodate the partition. Click the **New** button to add a partition; Disk Druid displays the Add Partition window (Figure 3-18). Specify the mount point (the name of the directory that the partition will be mounted over; page 30) and the filesystem type; use the arrow buttons at the right ends of these boxes to display drop-down lists.

If there is more than one drive, put a check mark in the box next to the drive you want the partition to be created on in the Allowable Drives frame. Specify the size of the partition and, in the Additional Size Options frame, mark **Fixed size** to create the partition close to the size you specify. Because of block-size constraints, partitions are not usually exactly the size you specify. Mark **Fill all space up to (MB)** and fill in the maximum size you want the partition to be to create a partition that takes up the existing free space, up to the maximum size you specify. In other words, Disk Druid will not complain if it cannot create the partition as large as you would like. Mark the third choice, **Fill to maximum allowable size**, to cause the partition to occupy all the remaining free space on the disk, regardless of size. (If you create another partition after creating a **Fill to maximum allowable size** partition, the new partition will pull blocks from the existing maximum size partition.)

Put a check mark in the box labeled **Force to be a primary partition** to create a primary partition (page 30). Click **OK**, and Disk Druid adds the partition to its table (but does not write to the hard disk).

Edit an existing partition

To modify an existing partition, highlight the partition in the Disk Druid table or the graphical representation of the hard disk and click the **Edit** button; Disk Druid

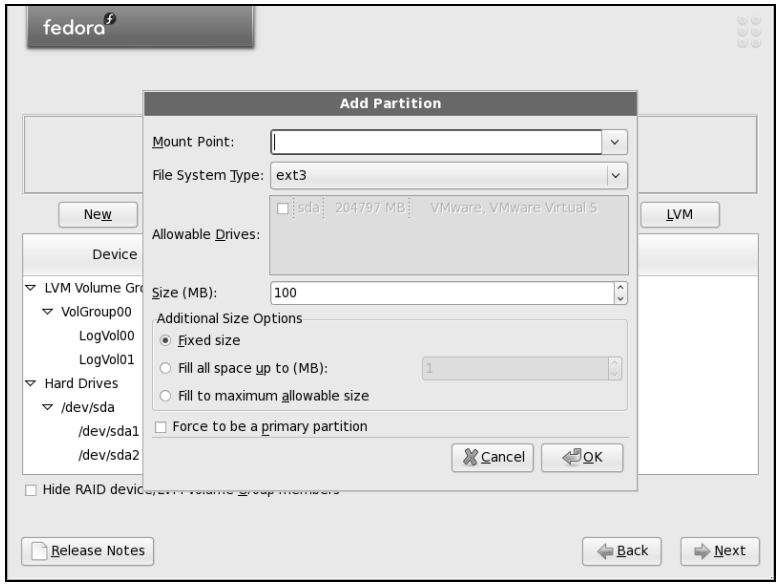

Figure 3-18 Disk Druid: Add Partition window, **ext3** filesystem

displays the Edit Partition window. From this window, you can change the mount point of a partition or format the partition as another type (**ext3**, **vfat**, **swap**, and so on). You cannot change the size of a partition from this window. To do so you must delete the partition and create a new partition of the desired size.

gparted: THE GNOME PARTITION EDITOR

Unless you are certain the hard disk you are installing Fedora/RHEL on has nothing on it (it is a new disk) or you are sure the disk holds no information of value, it is a good idea to examine the contents of the disk before you start the installation. The GNOME Partition Editor (gparted), which is available from a live session, is a good tool for this job. (You can also examine the partition by mounting it from a live session using Konqueror [page 106] or Nautilus [page 255].)

Open the Partition Editor window under GNOME by selecting **Applications: System Tools⇨GParted** as shown in Figure 3-19 on the next page. Under KDE, use **Main menu: System⇨GParted** (open the Main menu by clicking the **K** at the lower-left corner of the screen).

The Partition Editor displays the layout of a hard disk and can resize partitions, such as when you are setting up a dual-boot system by adding Fedora/RHEL to a Windows system (page 79). Although you can create partitions using the Partition Editor, you cannot specify the mount point (page 30) for a partition—this step must wait until you are installing Fedora/RHEL and using the Disk Druid partitioner. You can save time if you use the Partition Manager to examine a hard disk and Disk Druid to set up the partitions you install Fedora/RHEL on.

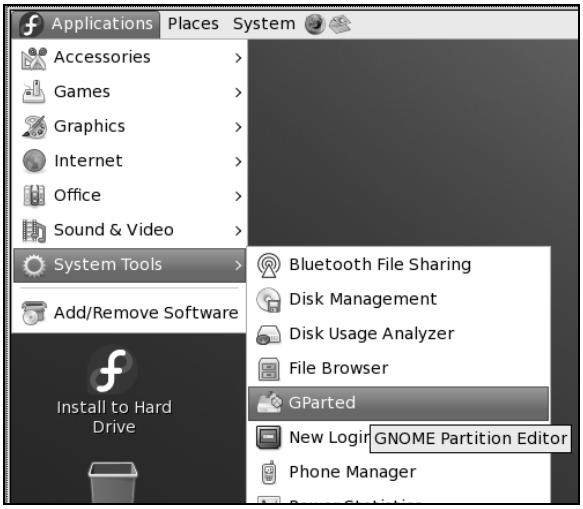

Figure 3-19 Selecting the GNOME Partition Editor from the Main menu

AN EMPTY HARD DISK

The Partition Editor shows one large unallocated space for a new hard disk (empty, with no partition table). If you have more than one hard disk, use the list box in the upper-right corner of the screen to select the disk for which the Partition Editor displays information. Figure 3-20 shows an empty 200-gigabyte hard disk on the device named **/dev/sda**.

DELETING A PARTITION

Before deleting a partition, make sure it does not contain any data you need. To use the Partition Editor to delete a partition, highlight the partition you want to delete, click **Delete**, and then click **Apply** on the toolbar.

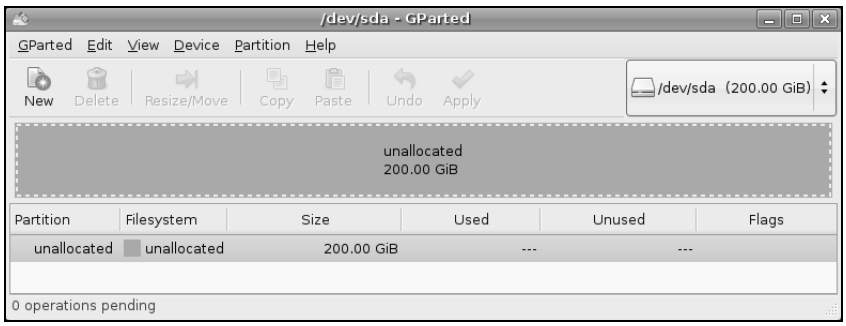

Figure 3-20 The GNOME Partition Editor displaying an empty disk drive

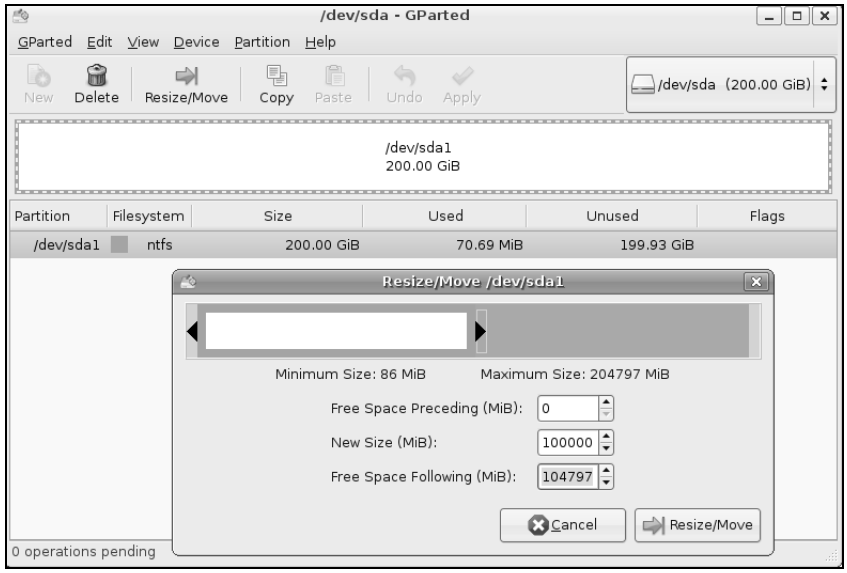

Figure 3-21 The Partition Editor displaying a disk drive holding a Windows system

RESIZING A PARTITION

Figure 3-21 shows the Partition Editor displaying information about a hard disk with a single partition that occupies the entire disk. It shows a single 200-gigabyte NTFS filesystem. The process of resizing a partition is the same regardless of the type of partition: You can use the following technique to resize Windows, Linux, or other types of partitions.

Always back up the data on a hard disk

caution If you are installing Fedora/RHEL on a disk that holds data that is important to you, always back up the data before you start the installation. Things can and do go wrong. The power might go out in the middle of an installation, corrupting the data on the hard disk. A bug in the partitioning software might destroy a filesystem. Although it is unlikely, you might make a mistake and format a partition holding data you want to keep.

To install Fedora/RHEL on this system, you must resize (shrink) the partition to make room for Fedora/RHEL. Before you resize a Windows partition, you must boot Windows and defragment the partition using the Windows defragmenter; see the tip on page 80. To resize the partition, right-click to highlight the line that describes the partition and select **Resize/Move** on the toolbar. The Partition Editor opens a small Resize/Move window, as shown in Figure 3-21.

At the top of the Resize/Move window is a graphical representation of the partition. Initially the partition occupies the whole disk. The spin box labeled **New Size (MiB)**

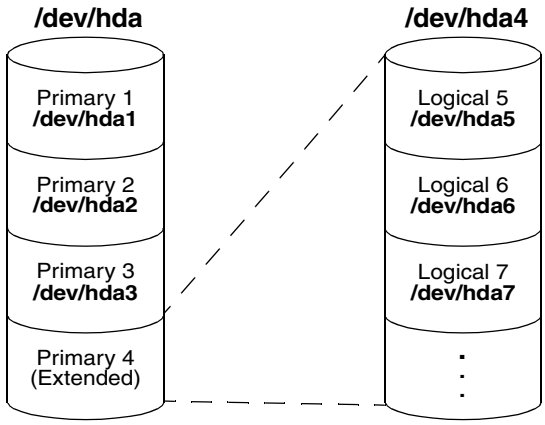

Figure 3-22 The primary and extended partitions from the example

shows the number of megabytes occupied by the partition—in this case the whole disk. The two spin boxes labeled **Free Space** show no free space.

Back up the partition before you begin resizing. You can specify how you want to resize the partition by (right-clicking and) dragging one of the triangles at the ends of the graphical representation of the partition or by entering the number of megabytes you want to shrink the Windows partition to in the spin box labeled **New Size**. In response, the value in one of the spin boxes labeled **Free Space** increases. Click **Resize/Move** to add the resize operation to the list of pending operations at the bottom of the window. Click **Apply** on the toolbar to resize the partition.

Although you can use the Partition Editor to create partitions to install Fedora/RHEL on, it may be easier to create partitions using Disk Druid while you are installing Fedora/RHEL. Disk Druid allows you to specify mount points for the partitions; the Partition Editor does not.

parted: REPORTS ON AND PARTITIONS A HARD DISK

The parted (partition editor) utility reports on and manipulates hard disk partitions. The following example shows how to use parted from the command line (see "Running Commands from the Terminal Emulator/Shell" on page 105). It uses the **print** command to display information about the partitions on the **/dev/hda** drive:

```
# parted /dev/hda print
Disk geometry for /dev/hda: 0kB - 165GB
Disk label type: msdos
Number  Start   End     Size    Type      File system  Flags
1       32kB    1045MB  1045MB  primary   ext3         boot
2       1045MB  12GB    10GB    primary   ext3
3       12GB    22GB    10GB    primary   ext3
4       22GB    165GB   143GB   extended
5       22GB    23GB    1045MB  logical   linux-swap
6       23GB    41GB    18GB    logical   ext3
7       41GB    82GB    41GB    logical   ext3
Information: Don't forget to update /etc/fstab, if necessary.
```

Figure 3-22 graphically depicts the partitions shown in this example. The first line that parted displays specifies the device being reported on (**/dev/hda**) and its size (165 gigabytes). The **print** command displays the following columns:

- **Number**—The minor device number (page 477) of the device holding the partition. This number is the same as the last number in the device name. In the example, **5** corresponds to **/dev/hda5**.
- **Start**—The location on the disk where the partition starts. The parted utility specifies a location on the disk as the distance (in bytes) from the beginning of the disk. Thus partition 3 starts 12 gigabytes from the beginning of the disk.
- **End**—The location on the disk where the partition stops. Although partition 2 ends 12 gigabytes from the beginning of the disk and partition 3 starts at the same location, parted takes care that the partitions do not overlap at this single byte.
- **Size**—The size of the partition in kilobytes (kB), megabytes (MB), or gigabytes (GB).
- **Type**—The partition type: primary, extended, or logical. See Figure 3-22 and page 30 for information on partition types.
- **File system**—The filesystem type: **ext2**, **ext3**, **fat32**, **linux-swap**, and so on. See Table 12-1 on page 478 for a list of filesystem types.
- **Flags**—The flags that are turned on for the partition, including **boot**, **raid**, and **lvm**. In the example, partition 1 is bootable.

In the preceding example, partition 4 defines an extended partition that includes 143 gigabytes of the 165-gigabyte disk (Figure 3-22). You cannot make changes to an extended partition without affecting all logical partitions within it.

In addition to reporting on the layout and size of a hard disk, you can use parted interactively to modify the disk layout. Be *extremely* careful when using parted in this manner, and always back up the system before you work with this utility. Changing the partition information (the *partition table*) on a disk can destroy the information on the disk. Read the parted info page before you attempt to modify a partition table.

parted can destroy everything

caution Be as careful with parted as you would be with a utility that formats a hard disk. Changes you make with parted can easily result in the loss of large amounts of data. If you are using parted and have any question about what you are doing, quit with a **q** command before making any changes. Once you give parted a command, it immediately makes the change you requested.

To partition a disk, give the command **parted** followed by the name of the device you want to work with. In the following example, after starting parted, the user gives a **help** (or just **h**) command, which displays a list of parted commands:

```
# parted /dev/hdb
GNU Parted 1.8.6
Using /dev/hdb
Welcome to GNU Parted! Type 'help' to view a list of commands.
(parted) help
  check NUMBER                   do a simple check on the file system
  cp [FROM-DEVICE] FROM-NUMBER TO-NUMBER   copy file system to another partition
  help [COMMAND]                 prints general help, or help on COMMAND
  mklabel LABEL-TYPE             create a new disklabel (partition table)
  mkfs NUMBER FS-TYPE            make a FS-TYPE file system on partititon NUMBER
  mkpart PART-TYPE [FS-TYPE] START END     make a partition
  mkpartfs PART-TYPE FS-TYPE START END     make a partition with a file system
  move NUMBER START END          move partition NUMBER
  name NUMBER NAME               name partition NUMBER as NAME
  print [NUMBER]                 display the partition table, or a partition
  quit                           exit program
  rescue START END               rescue a lost partition near START and END
  resize NUMBER START END        resize partition NUMBER and its file system
  rm NUMBER                      delete partition NUMBER
  select DEVICE                  choose the device to edit
  set NUMBER FLAG STATE          change a flag on partition NUMBER
  toggle [NUMBER [FLAG]]         toggle the state of FLAG on partition NUMBER
  unit UNIT                      set the default unit to UNIT
  version                        displays the version of GNU Parted and copyright info
(parted)
```

In response to the (**parted**) prompt, you can give the command **help** followed by the name of the command you want more information about. When you give a **print** (or just **p**) command, parted displays current partition information, just as a **print** command on the command line does.

The parted utility will not allow you to set up overlapping partitions (except for logical partitions that overlap the extended partition that contains them). Similarly it will not allow you to create a partition that starts at the very beginning of the disk (cylinder 0). Both of these situations can cause loss of data.

Following are guidelines to remember when defining a partition table for a disk. For more information refer to "Partitioning a Disk" on page 31.

- Do not delete or modify the partition that defines the extended partition unless you are willing to lose all data on all logical partitions within the extended partition.
- If you put **/boot** on a separate partition, it is a good idea to put it at the beginning of the drive (partition 1) so there is no issue of Linux having to boot from a partition located too far into the drive. When you can afford the disk space, it is desirable to put each major filesystem on a separate partition. Many people choose to combine **/** (root), **/var**, and **/usr** into a single partition, which generally results in less wasted space but can, on rare occasions, cause problems.

- Although parted can create some types of filesystems, it is typically easiest to use this utility to create partitions and then use mkfs and mkswap to create filesystems on the partitions.

The following sequence of commands defines a 300-megabyte, bootable, Linux partition as partition 1 on a clean disk:

```
# parted /dev/hdb
...
Using /dev/hdb
(parted) mkpart                                  (create new partition)
Partition type?  primary/extended? primary       (select primary partition)
File system type?  [ext2]?                       (default to an ext2 filesystem)
Start? 1                                         (start at the beginning of the disk)
End? 300m                                        (specify a 300-megabyte partition)
(parted) help set                                (use help to check the syntax of the set command)
  set NUMBER FLAG STATE         change a flag on partition NUMBER

        NUMBER is the partition number used by Linux.  On msdos disk labels, the primary
        partitions number from 1 to 4, logical partitions from 5 onwards.
        FLAG is one of: boot, root, swap, hidden, raid, lvm, lba, hp-service, palo,
        prep, msftres
        STATE is one of: on, off
(parted) set 1 boot on                           (turn on the boot flag on partition 1)
(parted) print                                   (verify that the partition is correct)
Disk geometry for /dev/hdb: 0kB - 250GB
Disk label type: msdos
Number  Start   End     Size    Type      File system  Flags
1       1kB     300MB   300MB   primary   ext2         boot
(parted) quit
Information: Don't forget to update /etc/fstab, if necessary.
```

When you specify a size within parted, you can use a suffix of **k** (kilobytes), **m** (megabytes), or **g** (gigabytes). After creating a partition, give a **print** command to see where the partition ends. Perform this task before you define the next contiguous partition to make sure you do not waste space. After setting up all the partitions, exit from parted with a **quit** command.

Next make a filesystem (mkfs; page 432) on each partition that is to hold a filesystem (not swap). Make all partitions, except swap and **/boot**, of type **ext3**, unless you have a reason to do otherwise. Make the **/boot** partition of type **ext2**. Use mkswap (page 472) to set up a swap area on a partition. You can use e2label (page 432) to label partitions.

LVs: LOGICAL VOLUMES

When you ask Anaconda to partition the hard disk with a default layout (see "Disk Partitioning" on page 55), it uses LVM (page 35) to set up most of the hard disk, creating LVs instead of partitions. It places **/boot** on the first partition on the drive, not under the control of LVM. LVM creates a volume group (VG) named **VolGroup00**. Within this VG it creates two LVs: root (**/**, **LogVol00**) and swap (**LogVol01**). The swap LV occupies up to a few gigabytes; the root LV takes up the rest of the drive. This section explains how to make the root LV smaller so you can add additional LVs to **VolGroup00**.

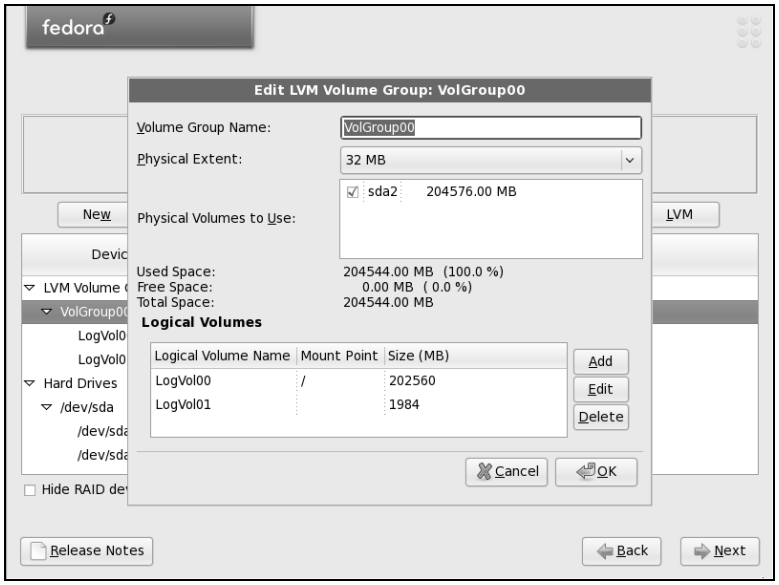

Figure 3-23 Disk Druid: Edit LVM Volume Group window

If you click the Disk Druid **LVM** button with the default setup (with the root LV occupying all of the disk that is not occupied by the swap LV and the **/boot** partition), Disk Druid displays a dialog box that advises you that there are not enough physical volumes and suggests that you create a new partition. Because the existing partitions occupy the whole disk, you cannot create a new partition.

To make the root LV smaller and make room for additional partitions, first highlight the root partition (**LogVol00**) and then click **Edit**. Disk Druid displays the Edit LVM Volume Group window (Figure 3-23). The figure shows that **VolGroup00** has no free space (see the line in the middle of the window). It shows two LVs: swap, which does not have a mount point, and root, with a mount point of **/**.

Highlight root (**LogVol00**) in the frame labeled **Logical Volumes** and click **Edit**. Disk Druid displays the Edit Logical Volume window (Figure 3-24), which allows you to change the size of the root LV. Replace the numbers in the text box labeled **Size (MB)** with the number of megabytes you want to assign to the root LV. Figure 3-24 shows the size of the root partition being changed to 100 gigabytes (100,000 megabytes). Click **OK**.

Once you decrease the size of the root partition, the Edit LVM Volume Group window shows that the VG has free space. You can now add another LV to the VG. Click **Add** in the Edit LVM Volume Group window to display the Make Logical Volume window (Figure 3-25). Select a mount point, filesystem type, and size for the LV. You can change the LV name if you like, although Disk Druid assigns logical, sequential names that are easy to use. Figure 3-25 shows a **/home** LV being created with a size of 80 gigabytes. Click **OK** when the LV is set up the way you want.

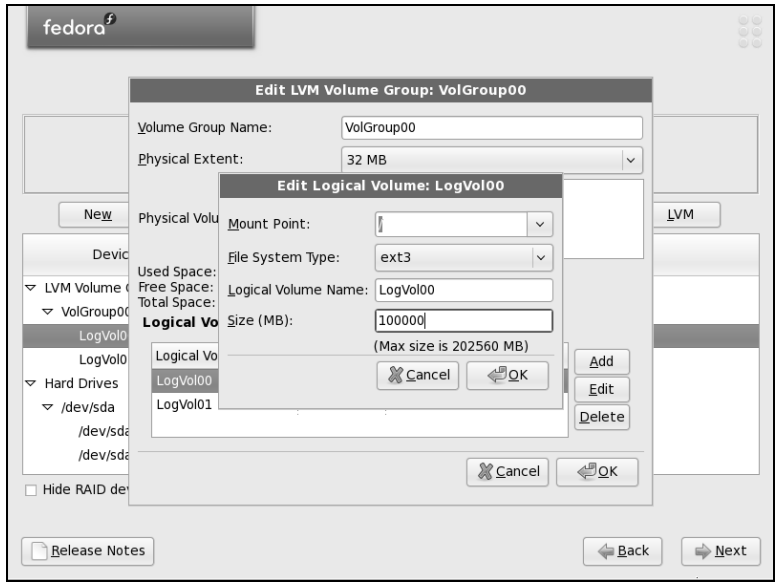

Figure 3-24 Disk Druid: Edit Logical Volume window

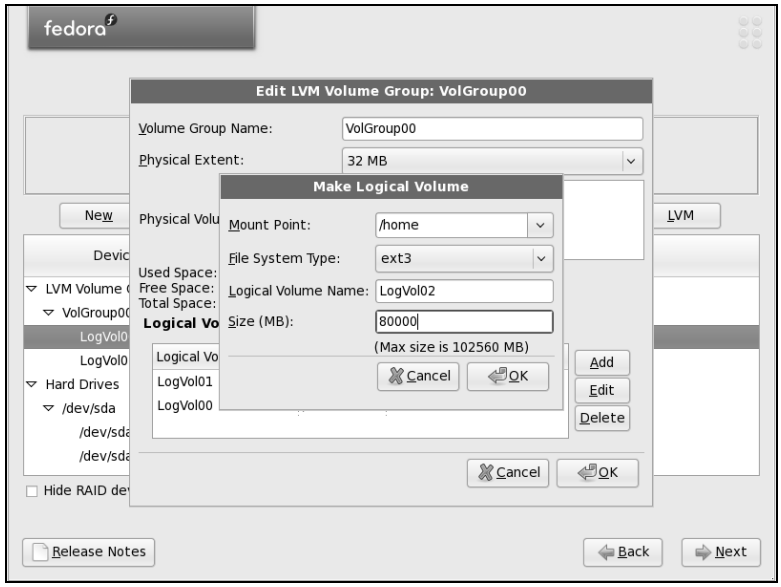

Figure 3-25 Disk Druid: Make Logical Volume window

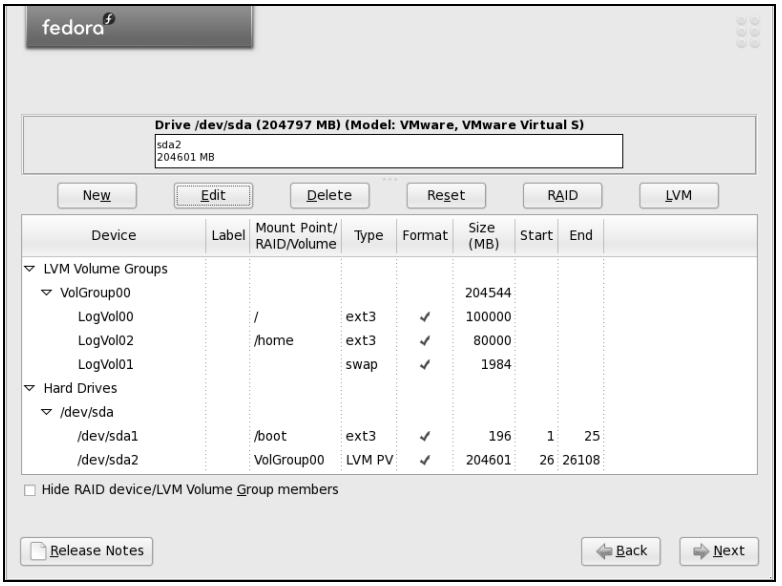

Figure 3-26 Disk Druid: main screen with the new **/home** LV

Figure 3-26 shows the modified Disk Druid main screen with the new **/home** LV.

USING THE KICKSTART CONFIGURATOR

Kickstart is a Fedora/RHEL program that completely or partially automates the same installation and postinstallation configuration on one or more machines. To use Kickstart, you create a single file that answers all the questions that are normally asked during an installation. Anaconda then refers to this file instead of asking you questions during installation. See the **ks** boot parameter on page 66. Using Kickstart, you can automate language selection, network configuration, keyboard selection, boot loader installation, disk partitioning, X Window System configuration, and more.

The system-config-kickstart utility (part of the **system-config-kickstart** package that you can install using yum; page 492) displays the Kickstart Configurator window (Figure 3-27), which creates a Kickstart installation script.

Figure 3-27 shows the first window the Kickstart Configurator displays. To generate a Kickstart file (**ks.cfg** by default), go through each section of this window (the items along the left side) and fill in the answers and put check marks in the appropriate boxes. It may be helpful to start with the Kickstart installation script that Anaconda generated when you installed the system (**/root/anaconda.cfg**). Click **Help** on the menubar for instructions on completing these tasks. When you are finished, click **File⇨Save**. The Kickstart Configurator gives you a chance to review the generated script before it saves the file.

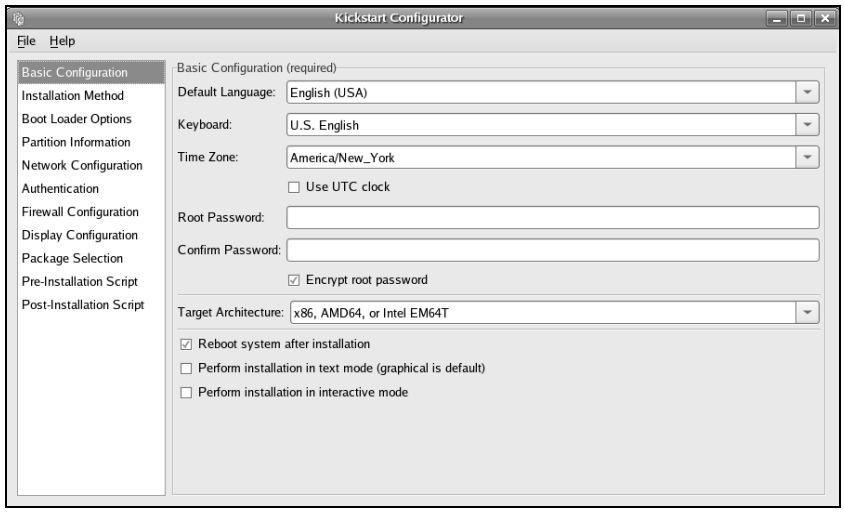

Figure 3-27 Kickstart Configurator window

SETTING UP A DUAL-BOOT SYSTEM

A *dual-boot* system is one that can boot one of two (or more) operating systems. This section describes how to add Fedora/RHEL to a system that can boot Windows, thereby creating a system that can boot Windows or Linux. You can use the same technique for adding Fedora/RHEL to a system that runs a different version or distribution of Linux.

One issue that arises when you are setting up a dual-boot system is the need to find disk space for the new Fedora/RHEL system. The next section discusses several ways to create the needed space.

CREATING FREE SPACE ON A WINDOWS SYSTEM

Typically you install Fedora/RHEL in free space on a hard disk. To add Fedora/RHEL to a Windows system, you must have enough free space on a hard disk that already holds Windows. There are several ways to provide or create this free space. The following paragraphs discuss these options in order from easiest to most difficult.

Add a new hard disk

Add another hard disk to the system and install Linux on the new disk, which contains only free space. This technique is very easy and clean but requires a new hard disk.

Use existing free space

If there is sufficient free space on the Windows disk, you can install Linux there. This technique is the optimal choice, but there is rarely enough free space on an installed hard disk.

Resize Windows partitions

Windows partitions often occupy the entire disk, making resizing a Windows partition the most commonly used technique to free up space. Windows systems typically use NTFS, FAT32, and/or FAT16 filesystems. You can use the GNOME Partition Editor to examine and resize an existing Windows partition to open up free space in which to install Linux (page 71).

Always defragment before resizing

caution You must boot Windows and defragment a Windows partition before you resize it. Sometimes you may need to run the Windows defragmenter several times to consolidate most file fragments. Not only will defragmenting give you more space for a Linux partition, but it may also keep the process of setting up a dual-boot system from failing.

Remove a Windows partition

If you can delete a big enough Windows partition, you can install Linux in its place. To delete a Windows partition, you must have multiple partitions under Windows and be willing to lose the data in the partition you delete. In many cases, you can save this data by moving it from the partition you will delete to another Windows partition.

Once you are sure a partition contains no useful information, you can use the GNOME Partition Editor to delete it (page 70). After deleting the partition, you can install Fedora/RHEL in the free space formerly occupied by the partition you removed.

INSTALLING FEDORA/RHEL AS THE SECOND OPERATING SYSTEM

After you have created enough free space on a Windows system (see the previous section), you can begin installing Fedora/RHEL. When you get to the Disk Partitioning screen (Figure 3-7, page 55), choose **Use free space on selected drives and create default layout** to have Anaconda partition the free space on the hard disk automatically. If you need to delete a Windows partition, you must choose **Create custom layout**; this selection calls Disk Druid (page 66) so you can delete the appropriate Windows partition and create Linux partitions in the free space. When you boot the system, you will be able to choose which operating system you want to run.

THE X WINDOW SYSTEM

If you specified a graphical desktop environment such as GNOME or KDE, you installed the X.org (x.org) implementation of the X Window System when you installed Linux. The X Window System release X11R7.2 comprises almost 50 software packages. The X configuration files are kept in **/etc/X11**; the configuration file that guides the initial setup is **/etc/X11/xorg.conf**.

Make a copy of xorg.conf

tip Make a copy of the **/etc/X11/xorg.conf** file when you install or upgrade a system and each time the file is modified, such as when you install a new monitor or graphics card. The copy makes it a simple job to restore a system with a nonfunctional **xorg.conf** file.

system-config-display: CONFIGURES THE DISPLAY

The system-config-display utility displays the Display settings window (Figure 3-28), which allows you to configure X.org, including the monitor type and video card. Most users never need to run this utility: In almost all cases, Fedora/RHEL autoconfiguration sets up X.org to work properly. To run this utility, enter **system-config-display** on

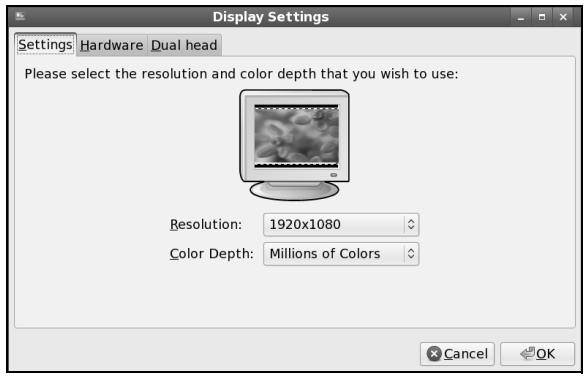

Figure 3-28 The Display Settings window, Settings tab

a command line. From KDE, select **Main menu: System⇨Display**; from GNOME, select **System: Administration⇨Display**.

Figure 3-28 shows the Settings tab of the Display settings window, which allows you to specify the resolution and color depth for the monitor. Normally the system probes the monitor and fills in these values. If these values are missing, check the specifications for the monitor and select the appropriate values from the drop-down lists. No harm is done if you specify a lower resolution than the monitor is capable of displaying, but you can damage an older monitor by specifying a resolution that is higher than the monitor is capable of displaying. A color depth of 8 bits equates to 256 colors, 16 bits to thousands of colors, and 24 or 32 bits to millions of colors.

Next click the **Hardware** tab. The system normally probes for the monitor type and brand as well as the model of video card; these values appear next to the words **Monitor Type** and **Video Card**. You can manually select a monitor or video card. Figure 3-29 shows the Monitor window on top of the Hardware tab of the Display settings window.

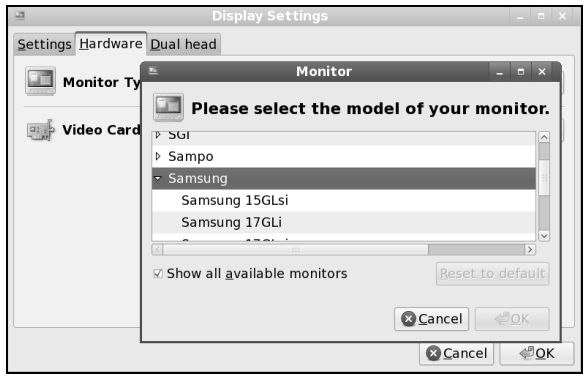

Figure 3-29 The Display Settings window, Hardware tab, Monitor window

Specifying a monitor

To specify a monitor, click **Configure** across from the words **Monitor Type**; system-config-display displays the Monitor window. If necessary, put a mark in the check box labeled **Show all available monitors**. Scroll down until you see the name of the manufacturer of the monitor you are using and click the triangle to the left of that name; system-config-display opens a list of models made by that manufacturer. Scroll through the list of models. Click to highlight the model you are using and then click **OK**. If an appropriate model is not listed, scroll to the top of the list and click the triangle next to **Generic CRT Display** or **Generic LCD Display**, depending on the type of monitor you are setting up. From one of these lists, select the maximum resolution the monitor is capable of displaying. Click **OK**.

Specifying a video card

To specify a video card, click **Configure** adjacent to the words **Video Card**; system-config-display displays the Video Card window. Scroll down and click to highlight the manufacturer and model of the video card in the system. Click **OK**.

Specifying two monitors

The Dual head tab allows you to specify a second video card that can drive a second monitor. On this tab, specify the monitor type, video card, resolution, and color depth as you did earlier. You can choose to have each monitor display a desktop or to have the two monitors display a single desktop (spanning desktops). Click **OK** to close the Display Settings window.

The system-config-display utility generates an **xorg.conf** file (discussed in the next section) with the information you entered.

THE xorg.conf FILE

If you choose to edit **/etc/X11/xorg.conf** manually, read the notes at the top of the file. You may also want to refer to the **xorg.conf** man page. The **xorg.conf** file comprises sections that can appear in any order. Each section is formatted as follows:

```
Section "name"
   entry
   ...
EndSection
```

where ***name*** is the name of the section. A typical ***entry*** occupies multiple physical lines but is a single logical line, consisting of a keyword followed by zero or more integer, real, or string arguments. Keywords in these files are not case sensitive; underscores (_) within keywords are ignored. Most strings are not case sensitive, and SPACEs and underscores in most strings are ignored. All strings must appear within double quotation marks.

The Option keyword provides free-form data to server components and is followed by the name of the option and optionally by a value. All Option values must be enclosed within double quotation marks.

Boolean Options take a value of **TRUE** (**1**, **on**, **true**, **yes**) or **FALSE** (**0**, **off**, **false**, **no**); no value is the same as **TRUE**. You can prepend **No** to the name of a Boolean Option to reverse the sense of the Option.

The following sections can appear in an **xorg.conf** file:

ServerFlags	Global Options (optional)
ServerLayout	Binds Screen(s) and InputDevice(s)
Files	Locations of configuration files
Module	Modules to be loaded (optional)
InputDevice	Keyboard(s) and pointer(s)
Monitor	Monitor (optional)
Device	Video card(s)
Screen	Binds device(s) and monitor(s)
VideoAdaptor	Configures the Xv extension (optional)
Modes	Video modes (optional)
DRI	Direct Rendering Infrastructure (optional)
Vendor	Vendor-specific information (optional)

This chapter covers the sections you are most likely to need to work with: ServerLayout, InputDevice, Monitor, Device, and Screen.

ServerLayout SECTION

The ServerLayout section appears first in some **xorg.conf** files because it summarizes the other sections that are used to specify the server. The following ServerLayout section names the server **single head configuration** and specifies that the server comprises the sections named Screen0, Mouse0, Keyboard0, and DevInputMice.

The term *core* in this file means *primary;* there must be exactly one CoreKeyboard and one CorePointer. The AlwaysCore argument indicates that the device reports core events and is used here to allow a non-USB mouse and a USB mouse to work at the same time. The result is that you can use either type of mouse interchangeably without modifying the **xorg.conf** file:

```
Section "ServerLayout"
        Identifier  "single head configuration"
        Screen   0  "Screen0" 0 0
        InputDevice "Mouse0" "CorePointer"
        InputDevice "Keyboard0" "CoreKeyboard"
        InputDevice "DevInputMice" "AlwaysCore"
EndSection
```

Refer to the following sections for explanations of the sections specified in ServerLayout.

InputDevice SECTION

There must be at least two InputDevice sections: one specifying the keyboard and one specifying the pointer (usually a mouse). An InputDevice section has the following format:

Section "InputDevice"
* Identifier "**id_name**"*
* Driver "**drv_name**"*
* **options***
* ...*
EndSection

where ***id_name*** is a unique name for the device and ***drv_name*** is the driver to use for the device, typically **keyboard** or **mouse**. The system-config-display utility typically creates three InputDevice sections.

The following section defines a keyboard device named Keyboard0 that uses the **keyboard** driver. The keyboard model is a 105-key PC keyboard. You can change **pc105** to **microsoft** if you are using a U.S. Microsoft Natural keyboard, although the differences are minimal. The **us+inet** layout works similarly to the **us** layout and enables many multimedia keys on laptops and fancy keyboards.

```
Section "InputDevice"
        Identifier  "Keyboard0"
        Driver      "keyboard"
        Option      "XkbModel" "pc105"
        Option      "XkbLayout" "us+inet"
EndSection
```

To change the language the keyboard supports, change the argument to the XkbLayout Option to, for example, **fr** for French.

The next InputDevice section defines a mouse named Mouse0 that uses the **mouse** driver. The Device Option specifies a PS2 device. The ZAxisMapping Option maps the Z axis (the mouse wheel) to virtual mouse buttons 4 and 5, which are used to scroll a window. For more information refer to "Remapping Mouse Buttons" on page 252. When set to **YES**, the Emulate3Buttons Option enables the user of a two-button mouse to emulate a three-button mouse by pressing the two buttons simultaneously.

```
Section "InputDevice"
        Identifier  "Mouse0"
        Driver      "mouse"
        Option      "Protocol" "IMPS/2"
        Option      "Device" "/dev/psaux"
        Option      "ZAxisMapping" "4 5"
        Option      "Emulate3Buttons" "no"
EndSection
```

The next InputDevice section is similar to the previous one except that the Device Option specifies a USB mouse. See "ServerLayout Section" on page 83 for a discussion of this option.

```
Section "InputDevice"
# If the normal CorePointer mouse is not a USB mouse then
# this input device can be used in AlwaysCore mode to let you
# also use USB mice at the same time.
        Identifier  "DevInputMice"
        Driver      "mouse"
        Option      "Protocol" "IMPS/2"
        Option      "Device" "/dev/input/mice"
        Option      "ZAxisMapping" "4 5"
        Option      "Emulate3Buttons" "no"
EndSection
```

Monitor SECTION

The **xorg.conf** file frequently does not include a Monitor section because this section is required only for older and nonstandard displays. Typically Fedora/RHEL determines the characteristics of a monitor using the DDC (Display Data Channel) and EDID (Extended Display Identification Data).

The easiest way to set up this section is to use the system-config-display utility, which either determines the type of monitor automatically by probing or allows you to select from a list of monitors.

Do not guess at values for HorizSync or VertRefresh

caution If you configure the Monitor section manually, do not guess at the scan rates (HorizSync and VertRefresh); on older monitors, you can destroy the hardware by choosing scan rates that are too high.

The following section defines a monitor named Monitor0. The VendorName and ModelName are for reference only and do not affect the way the system works. The optional DisplaySize specifies the height and width of the screen in millimeters, allowing X to calculate the DPI of the monitor. HorizSync and VertRefresh specify ranges of horizontal sync frequencies and vertical refresh frequencies for the monitor; these values are available from the manufacturer. The dpms Option specifies that the monitor complies with *DPMS* (i.e., has energy-saving features; page 1056).

```
Section "Monitor"
        Identifier   "Monitor0"
        VendorName   "Monitor Vendor"
        ModelName    "Dell D1028L"
        DisplaySize  360 290
        HorizSync    31.0 - 70.0
        VertRefresh  50.0 - 120.0
        Option       "dpms"
EndSection
```

A Monitor section may mention DDC; a monitor can use DDC to inform a video card about its properties. If you omit or comment out the HorizSync and VertRefresh lines, X uses DDC probing to determine the proper values.

Device SECTION

The **xorg.conf** file must have at least one Device section to specify the type of video card in the system. The VendorName and BoardName are for reference only and do not affect the way the system works. The easiest way to set up this section is to use the system-config-display utility, which usually determines the type of video card by probing.

The following Device section specifies that Videocard0 uses the **nv** driver and locates it on the PCI bus (it may be either a PCI or AGP card):

```
Section "Device"
        Identifier  "Videocard0"
        Driver      "nv"
        VendorName  "Videocard vendor"
        BoardName   "NVIDIA GeForce4 (generic)"
        BusID       "PCI:3:0:0"
EndSection
```

Screen SECTION

The **xorg.conf** file must contain at least one Screen section. This section binds a video card specified in the Device section to a display specified in the Monitor section.

The following Screen section specifies that Screen0 comprises Videocard0 and Monitor0, both defined elsewhere in the file. The DefaultDepth entry specifies the default *color depth* (page 1051), which the Display subsection can override.

Each Screen section must have at least one Display subsection. The subsection in the following example specifies a color Depth and three Modes. The Modes specify the screen resolutions in units of dots per inch (dpi). The first Mode is the default; you can switch between Modes while X is running by pressing CONTROL-ALT-KEYPAD+ or CONTROL-ALT-KEYPAD–. You must use the plus or minus on the numeric keypad when giving these commands. X ignores invalid Modes.

```
Section "Screen"
        Identifier  "Screen0"
        Device      "Videocard0"
        Monitor     "Monitor0"
        DefaultDepth     24
        SubSection  "Display"
         Depth       24
         Modes       "1024x768" "800x600" "640x480"
        EndSubSection
EndSection
```

If you omit or comment out the Depth and Modes lines, X uses DDC probing to determine the optimal values.

MULTIPLE MONITORS

X has supported multiple screens for a long time. X.org supports multimonitor configurations using either two graphics cards or a dual-head card. Both setups are usually configured the same way because the drivers for dual-head cards provide a secondary virtual device.

Traditionally each screen in X is treated as a single entity. That is, each window must be on one screen or another. More recently the Xinerama extension allows windows to be split across two or more monitors. This extension is supported by

X.org and works with most video drivers. When using Xinerama, you must set all screens to the same color depth.

For each screen, you must define Device, Monitor, and Screen sections in the **xorg.conf** file. These sections are exactly the same as for a single-screen configuration, but each screen must have a unique identifier. If you are using a dual-head card, the Device section for the second head is likely to require a BusID value to enable the driver to determine that you are not referring to the primary display.

The following section identifies the two heads on an ATI Radeon 8500 card. For other dual-head cards, consult the documentation provided with the driver (for example, give the command **man mga** to display information on the **mga** driver):

```
Section "Device"
        Identifier  "Videocard0"
        Driver      "radeon"
        VendorName  "ATI"
        BoardName   "Radeon 8500"
EndSection
Section "Device"
        Identifier  "Videocard1"
        Driver      "radeon"
        VendorName  "ATI"
        BoardName   "Radeon 8500"
        BusID       "PCI:1:5:0"
EndSection
```

Once you have defined the screens, use the ServerLayout section to tell X where they are in relation to each other. Each screen is defined in the following form:

*Screen [**ScreenNumber**] "**Identifier**" **Position***

The ***ScreenNumber*** is optional. If it is omitted, X numbers screens in the order they are specified, starting with 0. The ***Identifier*** is the same Identifier used in the Screen sections. The ***Position*** can be either absolute or relative. The easiest way to define screen positions is to give one screen an absolute position, usually with the coordinates of the origin, and then to use the **LeftOf**, **RightOf**, **Above**, and **Below** keywords to indicate the positions of the other screens.

```
Section "ServerLayout"
        Identifier     "Multihead layout"
        Screen      0  "Screen0" LeftOf "Screen1"
        Screen      1  "Screen1" 0 0
        InputDevice    "Mouse0" "CorePointer"
        InputDevice    "Keyboard0" "CoreKeyboard"
        InputDevice    "DevInputMice" "AlwaysCore"
        Option         "Xinerama" "on"
        Option         "Clone" "off"
EndSection
```

By default, Xinerama causes multiple screens to act as though they were a single screen. Clone causes each of the screens to display the same image.

gdm: DISPLAYS A GRAPHICAL LOGIN

Traditionally users logged in on a textual terminal and then started the X server. Today most systems provide a graphical login. Fedora/RHEL uses the GNOME display manager (gdm) to provide this functionality, even if you are bringing up a KDE desktop.

CONFIGURING gdm

The gdmsetup utility configures the login presented by gdm by editing the heavily commented **/etc/gdm/custom.conf** file. By default, **root** can log in both locally and remotely. It is a good idea to disable remote **root** logins because, when a user logs in remotely using gdm, the password is sent in cleartext across the network. From GNOME, you can select **System: Administration⇨Login Window** to configure gdm.

USING kdm

The kdm utility is the KDE equivalent of gdm. There is no benefit in using kdm in place of gdm: Both perform the same function. Using gdm does not force you to use GNOME.

The configuration file for kdm, **/etc/kde3/kdm/kdmrc**, is heavily commented. You can edit the kdm configuration using the KDE control panel, but doing so removes the comments from the file.

MORE INFORMATION

Web X.org: X.org, freedesktop.org
X.org documentation: ftp.x.org/pub

CHAPTER SUMMARY

Most installations of Fedora/RHEL begin by booting from the Live CD or the Install DVD. When the system boots from the CD/DVD, it displays a message saying when it will boot automatically. During the time it displays this message, you can give various commands and then have the system continue booting.

The program that installs Fedora/RHEL is named Anaconda. Anaconda identifies the hardware, builds the filesystems, and installs or upgrades the Fedora/RHEL operating system. It can run in textual or graphical (default) interactive mode or in batch mode using Kickstart. Anaconda does not write to the hard disk until it displays the Begin Installation screen. Until it displays this screen, you can press CONTROL-ALT-DEL to abort the installation without making any changes to the hard disk.

The Disk Druid graphical disk-partitioning program can add and delete partitions and logical volumes (LVs) on a hard disk during installation. The gparted and parted utilities report on and manipulate hard disk partitions before or after installation. The system-config-lvm utility works with logical volumes after installation.

A dual-boot system can boot one of two operating systems, frequently Windows and Linux. The biggest task in setting up a dual-boot system, assuming you want to add Linux to a Windows system, is finding enough disk space to hold Linux.

Fedora/RHEL uses the X.org X Window System version X11R7.2. The file named **/etc/X11/xorg.conf** configures the X server, setting up the monitor, mouse, and graphics card. The system-config-display utility is a graphical editor for this file.

Fedora/RHEL uses the GNOME display manager (gdm) to provide a graphical login, even if you are using a KDE desktop. The gdmsetup utility configures the login presented by gdm by editing the **/etc/gdm/custom.conf** file.

EXERCISES

1. What is the difference between Xinerama and traditional multimonitor X11?
2. Which boot parameter would you use to begin an FTP installation?
3. Describe the Anaconda installer.
4. Where on the disk should you put your **/boot** partition or the root (**/**) partition if you do not use a **/boot** partition?
5. If the graphical installer does not work, what three things should you try?
6. When should you specify an **ext2** filesystem instead of **ext3**?
7. Describe Disk Druid.

ADVANCED EXERCISES

8. When does a Fedora/RHEL system start X by default?
9. If you do not install grub on the master boot record of the hard disk, how can you boot Linux?
10. Why would you place **/var** at the beginning of the disk?
11. Assume you have configured four screens, **screen0** through **screen3**. How would you instruct X.org that your screen layout was a T shape, with the first screen at the bottom and the other three screens in a row above it?

INDEX

Note: Only variables that must always appear with a leading dollar sign are indexed with a leading dollar sign. Other variables are indexed without a leading dollar sign.

SYMBOLS

NUMERICS

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Y

Z