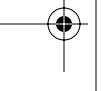
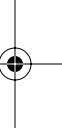
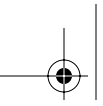


## Part 1

# Installing Fedora Core Linux

- ◆ **Chapter 1: Introducing Fedora Core Linux**
- ◆ **Chapter 2: Preparing Your Hardware**
- ◆ **Chapter 3: Installing Linux on a Stand-Alone System**
- ◆ **Chapter 4: Installing Linux over a Network**
- ◆ **Chapter 5: The First Boot Process**
- ◆ **Chapter 6: Kickstarting Linux**



## Chapter 1

# Introducing Fedora Core Linux

Linux is a better way to run your computers. It's reliable, secure, and flexible. It's surprisingly easy to install. It's easier to use than most people think. It's highly customizable. It's built for networking. It's on the cutting edge of technology. It's cost effective. Most important for the enterprise, it provides control; unlike the alternatives, enterprises can customize Linux to do exactly what's required.

For many people, Fedora Core and Red Hat are Linux. That isn't quite right. Linux is based on software developed by a worldwide community of volunteers. Much of the initial work was spearheaded by the Free Software Foundation ([www.fsf.org](http://www.fsf.org)). Originally it was developed as a clone of the Unix operating system. Today, it is so much more. It's evolving to meet the needs of a wide variety of people, such as aerospace engineers, moviemakers, theoretical physicists, and consumers. Even Wal-Mart is selling computers with Linux.

Strictly speaking, Linux is just the kernel, the part of the operating system that allows your software and hardware to communicate. But, oh, what a kernel! You can customize it in thousands of ways and update it for new features. Properly configured, it can optimize the effective speeds on your computer.

Fedora Core is the basic Linux operating system, designed for developers and hobbyists. As the testbed for Red Hat Enterprise Linux, it allows enterprise users to preview the latest features before they are released for the enterprise. It incorporates features as developed by the U.S. National Security Agency. It also includes a number of applications, such as several fully featured office suites, graphics programs, and multimedia applications that can satisfy even the most demanding users.

Linux is today the major alternative to Microsoft Windows. As a server, it includes all the tools you may need to configure and administer a wide variety of networks. It has the backing of many of the leaders in information technology, including Oracle, Dell, and Hewlett-Packard. IBM's support of Linux started in 2001 with investments of more than a billion dollars, and has accelerated from there. Hewlett-Packard received \$2.5 billion of Linux-related revenue in 2003. More and more companies are adopting Linux—as a server and as a desktop operating system.

**NOTE** For those who are dedicated to the Apple Macintosh, remember that the latest Mac OS X was developed from an operating system closely related to Linux, the Berkeley Standard Distribution (BSD).

Linux, and specifically a distribution developed by Red Hat, will become the operating system for the so-called "\$100 laptop" associated with the One Laptop Per Child (OLPC) initiative. For more information, see <http://laptop.media.mit.edu/>. I expect that the final version of OLPC will contain a "slimmed down" version of Fedora Core.

While no one company is behind Linux, you can still get world-class support. Red Hat offers support and updates for its Enterprise operating systems; Novell offers similar levels of support for SuSE Linux; other companies support Red Hat and other distributions. If you participate in the give

and take of the Linux community, thousands of developers will bend over backward to help you. This chapter covers the following topics:

- ◆ Introducing Fedora Core Linux
- ◆ Basic hardware requirements
- ◆ A short history of Unix and Linux
- ◆ Exploring the kernel
- ◆ Why choose Linux?
- ◆ The role of a Linux computer

## Introducing Fedora Core Linux

Fedora Core is more than just an operating system: It's a complete distribution. It includes a wide variety of commands, utilities, and applications. Installing additional software in packages from the CDs or DVD is easy. With the right downloads from the Internet, you can always keep your version of Fedora Core up-to-date.

If you're interested in the enterprise, you're in luck. Fedora Core 5 will be the testbed for Red Hat Enterprise Linux 5. Based on previous history, much of Red Hat Enterprise Linux 5 will be identical to Fedora Core 5.

Red Hat started the Fedora Core project in 2003 as its development platform for Red Hat Enterprise Linux. Developers are encouraged to create, test, and support new products within Fedora Core. As you can see in Appendix A, there are over 40 different mailing lists dedicated to different aspects of this operating system.

**NOTE** We use the term “Fedora Core” as there is also an earlier open source Fedora project ([www.fedora.info](http://www.fedora.info)), related to libraries. The Fedora Project was developed in cooperation between the University of Virginia and Cornell University. These universities are actually considering legal action on this topic (<http://fedora.info/redHat.shtml>). Therefore, the proper name of the operating system we cover in this book is Fedora Core Linux.

In my opinion, the Fedora Core project was a stroke of genius by Red Hat. It kept developers happy, it encouraged business to subscribe to Red Hat Enterprise Linux, and it allowed Red Hat to use the contributions of Linux developers everywhere to continuously support and improve its operating systems.

Officially, Fedora Core releases a new version of its distribution every four to eight months. Existing Fedora Core distributions are supported by the community, as of this writing, for approximately one year. Based on current policies, support for Fedora Core 5 will continue until the second “test” (what many of us think of as “beta”) release of Fedora Core 7. At that time, support for Fedora Core 5 will be transferred to the Fedora Legacy project ([www.fedoralegacy.org](http://www.fedoralegacy.org)).

## Basic Hardware Requirements

Table 1.1 provides a general guide to the minimum hardware requirements associated with Fedora Core. These requirements are not absolute; for example, I've run Fedora Core at the command-line interface with as little as 96MB of RAM. Chapter 2, “Preparing Your Hardware,” describes other hardware requirements.

## EXPLORING FEDORA CORE AND RED HAT PRODUCTS

While Red Hat officially sponsors Fedora Core, it does not itself produce freely available versions of the Red Hat operating system. It now supports the Linux community through the Fedora Core project. As you can tell from the web address, `fedora.redhat.com`, it's still closely associated with Red Hat.

According to plan, Red Hat Enterprise Linux 5 will be based on Fedora Core 5. If you're using Fedora Core 5 as a preview, you're probably interested in the variety of products associated with Red Hat Enterprise Linux. Each version includes additional features, such as CDs and support, for a price. The features I cite in this sidebar are available at `www.redhat.com/software/rhel/purchase/index.html`. Alternatively, you can also get freely available "rebUILds" (we'll describe this in more detail shortly) of Red Hat *Enterprise* Linux from third parties without support.

You can also download 30-day evaluation subscriptions of the following versions Red Hat Enterprise Linux. These subscriptions allow update and security downloads through the Red Hat Network for the noted period.

### RED HAT ENTERPRISE LINUX ES (ENTRY-LEVEL SERVER)

Red Hat Enterprise Linux ES supports basic servers, and is optimized for entry- and department-level server applications. It's the ideal solution for more basic file, print, web, and mail services. It is designed to run on computers with one or two Intel-compatible 32-bit CPUs; unfortunately, it does not support computers with other CPUs as of this writing. It's configured for computers with up to 8GB of RAM. The Basic Edition includes one year of access to the Red Hat Update Agent, downloadable ISOs, and quarterly ISO updates. The Standard Edition adds physical installation CDs, printed documentation, and web- and telephone-based support for one year.

### RED HAT ENTERPRISE LINUX AS (ADVANCED SERVER)

Red Hat Enterprise Linux AS is designed and optimized for larger organizations as well as the data-center. It's certified for use with an extensive array of enterprise-level applications. You can install this operating system on computers with up to 16 CPUs. It supports basic servers and is optimized for entry- and department-level server applications. It's designed to run on computers with seven different architectures (prices vary by architecture and support level): Intel 32-bit, Intel Itanium, AMD64, IBM zSeries, IBM iSeries, IBM pSeries, and IBM S/390. It's configured for computers with up to 64GB of RAM. The Standard Edition includes one year of access to the Red Hat Update Agent, downloadable ISOs, quarterly ISO updates, physical installation CDs, printed documentation, and web- and telephone-based support for one year. The Advanced Edition includes a premium level of web- and telephone-based support 24/7/365, with a one-hour response time.

### RED HAT ENTERPRISE LINUX WS (WORKSTATION)

Red Hat Enterprise Linux Workstation includes all but about 20 server RPMs included with Red Hat Enterprise Linux ES. It's designed to run on computers with one or two Intel-compatible 32-bit CPUs; a version is also available for 64-bit Itanium and AMD CPUs. In either case, it's configured for computers with up to 4GB of RAM. The Basic Edition includes one year of access to the Red Hat Update Agent, downloadable ISOs, and quarterly ISO updates. Also, associated web- and telephone-based support is available for 30 days. The Standard Edition adds physical installation CDs, printed documentation, and web- and telephone-based support for one year.

**RED HAT PROFESSIONAL WORKSTATION**

Red Hat Professional Workstation (RHPW) includes all the software associated with Red Hat Enterprise Linux WS; however, it only supports (up to 2) Intel-compatible 32-bit CPUs. As of this writing, new RHPW subscriptions are no longer supported. If you're renewing this subscription, Red Hat offers a reduced cost upgrade to Red Hat Enterprise Linux WS.

**RED HAT DESKTOP**

Red Hat offers an enterprise-level distribution for desktop computers, known as Red Hat Desktop. It is offered as subscriptions for 10 or 50 systems. Administrators have the option of using the Red Hat Network Proxy or Satellite Servers to keep Red Hat Desktop systems up to date.

**OTHER RED HAT PRODUCTS**

Red Hat has other specialty operating systems. These include the Cluster Suite, Content Management System, Developer Suite, Proxy Server, Satellite Server, Portal Server, and more.

**THIRD-PARTY REBUILDS OF RED HAT ENTERPRISE LINUX**

As of this writing, several groups have built and organized the 1,000+ freely available *source* RPMs associated with Red Hat Enterprise Linux 3 and 4. As Red Hat uses open source software, it is required under related licenses to release the source code. These groups have used this source code to build their own versions of Red Hat Enterprise Linux. They are known as “rebUILds” as Red Hat is first building its packages from source code. But as it's the same source code, it's the same software associated with Red Hat Enterprise Linux. Naturally, it doesn't include support or updates from Red Hat. Those available at the time of this writing include the following:

- ◆ cAos—Community Linux: [www.caosity.org](http://www.caosity.org)
- ◆ White Box Enterprise Linux: [www.whiteboxlinux.org](http://www.whiteboxlinux.org)
- ◆ Lineox: [www.lineox.net](http://www.lineox.net)
- ◆ Tao Linux: [www.taolinux.org](http://www.taolinux.org)

A more complete list of rebuild distributions is available from <http://linuxmafia.com/faq/RedHat/rhel-forks.html>. Some actually include their own versions of paid support and updates, using tools such as yum and apt. As yum is also the standard Fedora Core update tool, you will find out more about it in Chapter 11, “Managing and Updating Packages.” For example, Lineox provides preferred updates to subscribers.

These minimums assume a stand-alone Linux computer with just a few services. If you want to install additional software, configure a graphical user interface (GUI), or set up a server, the requirements go up accordingly. They vary by architecture. For the information best suited to your system, see the Fedora Core release notes, available from the `RELEASE-NOTES` file on the first installation CD or DVD.

**New Features**

Fedora Core is constantly incorporating new features and updating software. Most important are updates to the latest kernel and services. The following list includes some of the major improvements incorporated into Fedora Core:

- ◆ GCC compiler version 4.1, with improved security and performance features.



- ◆ New models for PC Cards, associated with the latest Linux kernel, which improves associated hotplug support.
- ◆ Security Enhanced Linux (SELinux) is much easier to use.
- ◆ Xen virtualization software is incorporated into the Fedora Core Anaconda installer.
- ◆ Remote logging is easier to configure.
- ◆ The Xorg X11R7 server is now included, which improves modularity, speeding bug fixes.
- ◆ The OpenOffice.org 2.0 suite is now included.
- ◆ Update and package management systems are improved with the Pup and Pirut interfaces.

Fedora Core also configures several tools not found in other Linux distributions. You can start these tools from a command-line interface inside a GUI such as GNOME (GNU Network Object Model Environment) or KDE (K Desktop Environment), using a `system-config-*` command. For example, `system-config-samba` lets you configure Samba, the service that allows Linux to work on a Microsoft Windows network. Samba is discussed in detail in Chapter 26, “Making Samba Work for You.”

**TABLE 1.1:** Basic Hardware Requirements

TYPE	MINIMUM
CPU	Pentium-class Intel-compatible 32-bit, 200MHz or better (400 MHz or better for GUI mode)  Intel EMT64 or AMD64  PowerPC G3 or Power4 PPC
RAM	Minimum RAM for Intel 32-bit compatible architecture: 64MB for text mode, 256MB recommended for GUI mode
Hard disk	The release notes suggest that Fedora Core can be installed on a system with just over 100MB of free space. A more practical minimum, in this author's opinion, is 1GB (not including swap space or other files); more for other types of installations, as described in Chapter 3, “Installing Linux Locally”

## Basic Components

Linux can be broken down into a number of modules. The modular nature of Linux allows developers to work independently and more efficiently. They can reuse and reconfigure these modules to achieve different results. At least six categories of modules are associated with Linux: kernel, network, `init`, daemons, shells and utilities, and the X Window.

### KERNEL

The kernel is the most important part of any operating system. It allows Linux and any software you install to communicate with computer hardware. The kernel communicates with your hardware through dedicated device drivers. For example, when you mount a floppy drive, a specific kernel driver sends and receives messages to and from the floppy drive.

If you install new hardware and it isn't detected when you start Linux, you can add a driver module to your kernel, as described in Chapter 13, "Upgrading and Recompiling Kernels."

Other parts of the kernel manage the Linux filesystem as well as any data stored in such areas as your disk cache. The kernel is loaded into protected-mode memory when you start Linux. You can learn how to configure and compile the kernel in Chapter 13.

As Fedora Core is the testbed for Red Hat Enterprise Linux, Fedora Core encourages the use of the latest working releases of many components. For example, Fedora Core 5 includes the test releases for GNOME desktop version 2.14, which wasn't itself released until approximately the same date as Fedora Core 5.

### NETWORK

Linux computers are most commonly organized in a client/server network. Some computers act as workstations, or clients, for users; others are servers, which control resources shared by multiple users on different workstations. In this type of network, clients ask servers for items they need, such as files or applications. In a Linux network, clients can even ask for X Window information. In other words, you can set up terminals on Linux clients that access their GUI data from a Linux server.

The network modules of the Linux operating system attempt to keep client/server communication running as smoothly as possible. Ideally, the connection between client and server is seamless. If your network is fast enough, your users won't be able to tell the difference between local and network services.

Because network modules are loaded in the same area as the kernel, their failure may mean that you have to reboot Linux. We cover the basics of Linux networking in Chapters 16–18.

### INIT

In general, the only way to start a Linux program is with another Linux program. For example, you log into the Linux terminal program, known as `minetty`. But something has to start the terminal program. When you boot Linux on your computer, the kernel loads and starts `init`. The `init` program then mounts your drives and starts your terminal programs. When you log in, the terminal program starts your command-line interface shell.

After Linux boots on your computer, `init` watches for anything that might shut down your computer, such as a power failure signal from an uninterruptible power supply (UPS) or a reboot command. Details of `init` and the governing `/etc/inittab` file are discussed in Chapter 12, "Configuring and Troubleshooting the Boot Process."

### DAEMONS

Linux includes a series of services. These are programs that can run in the background and start as needed. Many Linux services are known as *daemons*. In Linux, several dozen daemons can run simultaneously, standing ready to start your network, serve web pages, print your files, or connect you to other Linux or Windows computers. Typical daemons include the following:

- ◆ Apache, the most popular web server on the Internet, also known as `httpd`. Apache is covered in Chapter 27, "Web Services."
- ◆ Samba (also known as `smbd`), the network service that allows Linux to talk to Microsoft Windows computers. Samba is covered in Chapter 26.
- ◆ A printer daemon that manages communication with your printers. The CUPS daemon is `cupsd`; it's covered in more detail in Chapter 21, "Printing with CUPS."



We discuss various Linux daemons in detail throughout this book.

**TIP** Case matters in Linux. For example, the acronym for the Common Unix Print System is CUPS; the associated daemon is `cupsd`.

### SHELLS AND UTILITIES

Any Linux program or utility that talks to the kernel is a user-mode program, which consists of shells and utilities. User-mode programs don't communicate directly with your hardware (that's a job for the kernel). In other words, these programs can crash without affecting the basic operation of the Linux operating system. The three basic types of user-mode programs are as follows:

- ◆ *Login* programs associate a user ID with a user's shell and other personalized settings, such as with the X Window and web browsers.
- ◆ *Shell* programs act as Linux command interpreters. The most common Linux shell is known as *bash*, short for the Bourne Again Shell.
- ◆ *Utilities* are small-scale commands used inside a shell.

The basics of the `bash` shell and associated commands are covered in Chapters 7–9.

### X WINDOW

Linux builds the GUI from different program modules. GUI window managers, such as GNOME and KDE, as well as all GUI applications are built on the foundation of the X Window. The basics of the X Window and associated applications are covered in Chapters 30–33.

## A Short History of Unix and Linux

Linux was developed as a clone of Unix. In other words, the developers of Linux built their system without using the programming instructions, also known as the *source code*, used to build Unix. Because Linux is a Unix clone, you can use most of the same command-line commands on either operating system.

Although it would've been easier to adapt Unix for the personal computer, important historical reasons lie behind the development of Linux. And the way Linux was developed drives the way Linux developers, companies, and users work today.

### Unix and the Coming Internet

Computers were once quite expensive. They were the domain of universities and larger corporations. There was a lot of demand for these early computers; to support this demand, a number of computer scientists developed the concept of *time-sharing*, where multiple users are connected to the same computer simultaneously.

Even though computers have become more powerful and less expensive, we've returned to this notion of time-sharing. Today, administrators are quite familiar with the concept of the time-sharing system, now known as the *multiuser server*. One network often includes multiple servers; your username may be the same across all these servers. In fact, it's fair to say that we're all time-sharing users on the biggest network of all—the Internet.

The following sections chronicle some of the developments that occurred along the road to Linux.

## MULTICS

One of the early time-sharing projects was Multics (Multiplexed Information and Computing Service), a joint project between MIT, AT&T's Bell Labs (now Lucent Technologies), and General Electric. Although Bell Labs withdrew from the project in 1969, two of their developers, Ken Thompson and Dennis Ritchie, still had an itch for what would become the multiuser operating systems we know today.

## UNIX

Thompson and Ritchie continued their pioneering work through the early 1970s. Perhaps the key to their success was their development of the C programming language for writing the kernel and a number of basic commands, including those in the Bourne Again Shell, also known as bash.

When Unix was developed in 1969, AT&T was a regulated monopoly in the United States. Various court and regulatory rulings and agreements kept AT&T out of the computer business.

In 1974, AT&T distributed Unix to the University of California for the cost of the manuals and tapes. It quickly became popular at a number of universities. Nevertheless, AT&T wasn't allowed to make a profit from it.

## A COOPERATIVE ENVIRONMENT

Bell Labs has a history of groundbreaking research. The company had some of the best minds in the world working on fundamental problems. Bell Labs wanted the goodwill of the academic community. Since AT&T wasn't allowed to make money from software, it kept the license for Unix and distributed the operating system with source code to universities for a nominal fee. In exchange, AT&T's lawyers insisted that the license explicitly state that Unix came with no warranty. This release technique became known as *open source*.

The timing was good. Various universities adapted the Unix source code to work with three different kinds of computers available at the time: mainframes, minicomputers, and microcomputers.

At about the same time, the U.S. Department of Defense's Advanced Research Project Agency (ARPA) wanted to set up a nationwide communications network that could survive a nuclear war. Most universities on this ARPA network used Unix. TCP/IP was built on Unix and eventually became the communication protocol for the ARPANET, which eventually became the foundation for the Internet you know today. Unix and derivative clones, such as Linux, are critical parts of the Internet.

## THE AT&T CONSENT DECREE

AT&T retained the license to Unix through the 1980s. When the U.S. government settled the AT&T antitrust suit in 1982, one of the provisions allowed AT&T to go into the computer business. This became known as the AT&T *consent decree*. At that point, AT&T was able to sell the Unix operating system and source code with all the protections associated with a copyright.

The programmers who used Unix wanted to keep the advantages of an open source operating system. Unix programmers wanted the ability to customize the software. As academics, they wanted to share the results. The Unix users of the time had the high level of knowledge that made open source software worthwhile.

Ironically, AT&T was never very successful at selling Unix and eventually sold the rights to the operating system. For a while, the rights were owned by Novell, which now owns SuSE Linux. The direct successor is now owned by the SCO Group, which also owns the rival SCO (formerly Caldera) Linux distribution. However, there are many who believe that Novell never gave up its rights to the Unix source code.

**NOTE** In 2003, the SCO Group filed suit against IBM over Unix. This is controversial in part because it has attacked the General Public License (GPL), under which so much Linux software has been released. While I think SCO's claims are worthless, the case is still pending as of this writing. The markets seem to agree; the price of SCO stock is way down relative to its initial highs after it first filed the suit. Nevertheless, the details are complex; there are multiple countersuits, and several other companies and organizations are deeply involved. A good source for the latest information is [www.groklaw.net](http://www.groklaw.net).

### Unix Alternatives

At the time, with their limited budgets, universities didn't have the money to purchase the now proprietary Unix, and they didn't want to have their academic freedoms limited by copyrights. Generally, academics are most comfortable when they can share all of their data. To this end, Douglas Comer developed Xinu (Unix, spelled backward) in 1983 to illustrate operating system structures in a classroom setting. In 1986, Andrew Tannenbaum developed Minix as a Unix clone and free alternative. Like Linux, Minix doesn't use Unix's source code, and therefore it doesn't infringe on any of AT&T's Unix copyrights.

Even before the consent decree, Bill Joy of the University of California worked on Unix. He also started work on the Berkeley Standard Distribution (BSD), which, like Unix, was released under an open source style license. A number of BSD utilities were incorporated into later versions of Unix. In 1982, Joy became a cofounder of Sun Microsystems, which later released a related operating system known as Solaris.

Several other operating systems are closely related to Unix, as shown in Table 1.2.

One telling trend is that a number of these companies are moving toward using Linux on many of their servers. While Fedora Core is packaged only for the Intel 32-bit, AMD 64-bit, and PowerPC systems, Fedora Core kernels are available for the Intel Itanium, PowerPC 64, and IBM S/390 platforms.

**TABLE 1.2:** Unix-Style Operating Systems

OPERATING SYSTEM	DESCRIPTION
AIX	The Advanced Interactive eXecutive operating system, developed by IBM; used with high-end CPUs such as Power4 and RS64 IV (64-bit PowerPC chips).
BSD	The Berkeley Standard Distribution, an open source alternative to Linux.
HP-UX	Developed by Hewlett-Packard; version 11i is developed for 64-bit RISC and Itanium CPUs.
IRIX	Developed by Silicon Graphics for 64-bit CPUs.
Linux	The free operating system clone of Unix.
Solaris	Developed by Sun Microsystems for its UltraSPARC CPUs; also available for other architectures, including Intel x86 systems.
Tru64	Formerly known as Digital Unix; optimized for 64-bit CPUs.
UnixWare	The successor to AT&T's version of Unix; now owned by the SCO Group.

## The Free Software Foundation

Some of the work of the academic community on cloned Unix software eventually developed into a serious rebellion. In its early stages, it was led by Richard Stallman and his Free Software Foundation (FSF). (For more information, see their website at [www.fsf.org](http://www.fsf.org).)

Stallman started work on the GNU's Not Unix (GNU) project in 1984. He summarized the focus of the FSF in his introductory Usenet message: "I consider that the golden rule requires that if I like a program I must share it with other people who like it." Stallman's purpose was to set up a group where the free sharing of software would be strongly encouraged. To realize his dream, Stallman needed an operating system, free of the code that was then copyrighted by AT&T.

The FSF developed the General Public License (GPL) to build a body of free software protected from those who would use it to create proprietary closed-source systems. This same license still protects Linux today; you can read it in the back of the book.

By 1991, the FSF had cloned all of the major components of a Unix-style operating system except the kernel.

### THE GENERAL PUBLIC LICENSE

Stallman developed the GPL to bring the advantages previously available with Unix to the general software community. He wanted to develop a license that would protect software from anyone who would hide its source code. GNU software is licensed under the GPL. While you can read the GPL in the back of the book (and its proposed successor in Appendix C), you can also learn three of the basic principles behind the GPL (disclaimer: I am not a lawyer):

- ◆ All GPL software must be distributed with a complete copy of the source code. The source code must include clear documentation.
- ◆ Any software added to GPL software must also be clearly documented. If the new software interacts with the GPL software, the package as a whole must be distributed as GPL software.
- ◆ Any GPL software comes without a warranty.

## Linus Develops a Kernel

In 1991, Linus Torvalds was a graduate student in Finland. He wasn't happy with the operating systems available for his new computer with a 386 CPU. So he put together a kernel to allow some operating system components to communicate with computer hardware. By 1995, several companies assembled Linus's kernel with the GNU software of the FSF to produce the first Linux distributions.

**NOTE** Richard Stallman and the people of the FSF believe that the Linux operating system is more properly known as GNU/Linux because it combines a large number of GNU-licensed programs, commands, and utilities with one Linux kernel.

## Exploring the Kernel

Life in any operating system begins and ends with the kernel. When properly configured, any operating system can work like a wonderful ballet where hardware is ready just when you need it. When problems crop up, the kernel can slow or stop your computer.

With the Linux kernel, you can configure hardware, filesystems, networking support, and more. Hardware drivers can be configured within the kernel or as separate modules.

## Configuring the Kernel

If you ever need to reconfigure your kernel, you'll become familiar with a Linux Kernel Configuration similar to that shown in Figure 1.1. As you can see, there are a number of different hardware components, such as ACPI and PCI devices, that you can configure through the kernel. Each of the buttons shown in the menu opens individual submenus.

You can also see some kernel options not directly associated with hardware, such as Networking and Code Maturity Level Options. For example, in the Networking Options menu, you can set up Linux to work with different network protocols. You'll find detailed information on reconfiguring the kernel in Chapter 13.

## The /proc Filesystem

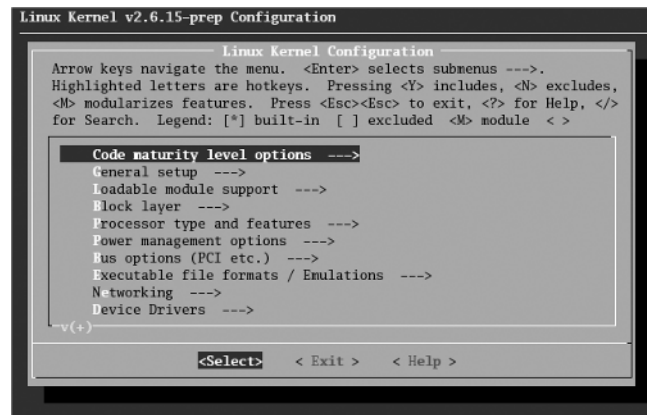
The /proc directory is a virtual filesystem stored in your RAM. It documents the way the Linux kernel interacts with your computer. A number of these files document how the Linux kernel reads your hardware. When you read the right file, you can find hardware settings for different components. You can find more information on /proc in Chapter 12.

## Modular or Monolithic

You can set up every hardware driver within the main part of the Linux kernel. This would be a *monolithic* kernel. But for most configurations, there are many hundreds of hardware drivers. If you put them together into one kernel file, the sheer size of the hardware drivers can overload your system.

It's usually more efficient to configure a *modular* kernel. Various kernel modules, normally associated with various hardware components, are loaded after Linux starts on your computer. Figure 1.2 shows an example from my Fedora Core system.

**FIGURE 1.1**  
Linux kernel  
configuration



**FIGURE 1.2**  
Linux modules

Module	Size	Used by
ip_conntrack_ftp	7729	0
ip_conntrack_netbios_ns	3009	0
ipt_REJECT	5441	1
ipt_state	1985	11
ip_conntrack	49773	3 ip_conntrack_ftp,ip_conntrack_netbios_ns,ipt_state
nfnetlink	6488	1 ip_conntrack
iptable_filter	3009	1
ip_tables	18753	3 ipt_REJECT,ipt_state,iptable_filter
nls_utf8	2241	1
ppdev	8645	0
autofs4	19269	2
rfcomm	35541	0
l2cap	23745	5 rfcomm
bluetooth	44325	2 rfcomm,l2cap
sunrpc	136957	1
raid1	19649	1
video	15941	0
button	6737	0
battery	9413	0
ac	4933	0
ipv6	228513	12
lp	12297	0
parport_pc	26245	1
More--		

As you can see, there are hardware modules, such as `battery`, to support Laptop batteries. There are also software modules, such as `autofs4`, to support the Automounter described in Chapter 9, “Making the Shell Work for You.” For more information on managing kernel modules, see Chapter 12. If you want to make sure that your kernel is modular, see Chapter 13.

## Why Choose Linux?

Linux is most frequently compared to Microsoft Windows. Linux is also replacing other Unix-style operating systems described earlier in Table 1.2. Four factors make Linux a better choice for many users and organizations: control, cost, reliability, and support.

### Control

Linux provides a great deal of control of your computers. The Red Hat Package Management (RPM) system makes it easy to add the software you need. For more information on RPM packages and the `rpm` command, see Chapter 11. The `pi` `rut` and `pup` tools, also described in Chapter 11, make this process of software management even easier.

You can optimize the Linux kernel using the techniques discussed in Chapter 13. An optimized kernel makes everything faster in Linux, from the boot process to networking. With the right techniques, you should always have an easily accessible working kernel; in contrast, small errors when changing the Microsoft Windows Registry can be disastrous.

Linux is easily upgradeable. You can keep an older version of Linux up-to-date with the latest in kernels, applications, and other software. The `rpm` and `yum` tools described in Chapter 11 help you with this process.

### Cost

Fedora Core is freely available for download. And Red Hat Enterprise Linux doesn't have to cost you anything. The price charged by Red Hat defrays its cost of support and updates. You can download free “rebuilt” of this operating system from one of the third-party providers described earlier in the “Exploring Fedora Core and Red Hat Products” sidebar.

The price Red Hat has set for Red Hat Enterprise Linux includes support. There is no licensing fee as this is still almost all GPL software. This cost difference can still be significant when compared to



the thousands of dollars required just to license many other Unix-style operating systems—as well as Microsoft operating systems.

The price of the operating system isn't the only cost. Other costs include the time required for installation, configuration, and internal support.

If you're planning to upgrade to Red Hat Enterprise Linux 5, and that distribution has not been released yet, Fedora Core is an excellent place to start. Red Hat is using Fedora Core 5 as the testbed for Red Hat Enterprise Linux 5.

### INSTALLATION

As you install Linux over the next few chapters, you'll learn that the process isn't difficult. If you're installing Fedora Core on a group of computers, you can use the Kickstart techniques described in Chapter 6, "Kickstarting Linux," to automate the installation process.

Since Fedora Core can be installed on most computers without a problem, the discussion of hardware in Chapter 2 may seem extreme. However, if you're an administrator responsible for installing Linux on several high-priced servers, mistakes can quickly get expensive.

### CONFIGURATION

To make any operating system useful, you need to install and configure it. Whether you're configuring a server for your department, corporate network, or global website, the basic configuration process remains the same. Linux has always had the command-line tools with the flexibility to satisfy most Linux gurus.

With the `system-config-*` tools described throughout the book, Fedora Core also offers the graphical tools that can help administrators of more graphical operating systems make the transition.

### Reliability

Linux is reliable. It's common to see reports of Linux servers that run for several months at a time without reboots. Imagine never having to reboot your computer after installing new software. Imagine being able to stop a runaway program without rebooting your computer. That's the power of Linux.

Linux isn't perfect. Mistakes happen. I describe troubleshooting techniques throughout this book. If you ever have a problem booting Linux, you can rescue most systems with your Fedora Core installation CD or DVD (without reinstalling Linux).

### Support

There are a number of ways to get excellent support for your Linux system. But first, because Linux is open source, administrators can often fix many problems. If you're working with a closed-source system, you can't even "look under the hood."

Since Linux is developed by a community, there are many in that community who are anxious to make their name by solving new problems. Their insights are available online. It's quite possible that the answer to your problem is already available in the Internet newsgroup database, accessible through `groups.google.com`.

There are a number of dedicated Fedora Core mailing lists and even Internet Relay Chat (IRC) channels where support may be available. These groups are summarized at <http://fedora.redhat.com/participate/communicate/> and are described in more detail in Appendix A.

The support associated with Red Hat Enterprise Linux answers the concerns of many administrators and IT managers, who want a single source of corporate support. If you purchase Red Hat Enterprise Linux, you can get some of the support you need directly from Red Hat. You can purchase additional support from third-party vendors such as Linuxcare ([www.linuxcare.com](http://www.linuxcare.com)). Some of the large companies behind Linux, such as IBM and HP, also provide support for Red Hat Enterprise Linux as installed on their systems.

## The Role of a Linux Computer

You can configure Fedora Core as a server or as a workstation. Linux is flexible; you can install it on many older computers that you may otherwise have to scrap.

Fedora Core includes a number of additional programs and applications that enhance what Linux can do as a commodity server, in the enterprise, and even on the desktop.

### Linux as a Server

Linux is built for networking. You can set it up as a server to manage many different kinds of resources for your network. Table 1.3 lists just a few of the Linux services you can configure. Many of these services have their own individual daemons. Others are associated with the Extended Internet Services Daemon (`xinetd`) described in Chapter 18, “Securing Your Linux Network.”

**TABLE 1.3:** Linux Server Services

SERVICE	DESCRIPTION	CHAPTER
<code>crond</code>	Runs scripts on a schedule	14
<code>cups</code>	Manages the Common Unix Print System (CUPS)	21
<code>httpd</code>	The Apache web server	27
<code>named</code>	The Domain Name System service	20
<code>nfs</code>	A Network File System server	24
<code>sendmail</code>	A common e-mail transport agent	22
<code>slapd</code>	A Lightweight Directory Access Protocol service.	25
<code>smb</code>	Samba, which makes Linux computers members of Microsoft Windows networks	26
<code>squid</code>	A web caching proxy service	27
<code>sshd</code>	Secure Shell	19
<code>vsftpd</code>	The Very Secure FTP Daemon	24
<code>xinetd</code>	The Extended Internet Services Daemon	19
<code>ypserv</code>	A Network Information Service server	25

It's common to install Linux on older computers. You can set up a Linux computer as a server with limited functionality. In many cases, this doesn't require a great deal of RAM or hard disk space. For example, you could set up a Linux computer as a modern print server or a firewall. You wouldn't have to purchase dedicated hardware for these purposes.

## Linux on the Desktop

Linux is a serious alternative on the desktop. As you'll see in Chapters 31–33, Linux provides essentially the same basic GUI applications and configuration tools that you can find in any version of Microsoft Windows.

In addition, three major office suites are available that you can use in place of Microsoft Office. Firefox and Konqueror are fully featured web browsers; alternatively, you can still install Netscape or Opera on Linux. Evolution provides an alternative to Microsoft Outlook.

People are taking a serious look at Linux on the desktop. As of this writing, Wal-Mart is selling several different computers with Linspire (formerly Lindows) ([www.linspire.com](http://www.linspire.com)), and Xandros (formerly Corel Linux) ([www.xandros.com](http://www.xandros.com)) a version of Linux that's customized to run a number of Microsoft Windows applications. Linux is getting a serious look as a desktop alternative outside the United States.

Game manufacturers are creating ways to play on Linux. Tux Games is an online store ([www.tuxgames.com](http://www.tuxgames.com)) with a warehouse of interesting games. There's even a version of The Sims for Linux, courtesy of TransGaming Technologies ([www.transgaming.com](http://www.transgaming.com)).

Applications available for Linux may not meet everyone's needs. However, in the personal finance area, GNUcash, is quickly catching up with features associated with the latest versions of Quicken. Other Linux personal finance programs are listed at [www.linuxlinks.com/Software/Financial/Personal\\_Finance/](http://www.linuxlinks.com/Software/Financial/Personal_Finance/). One other excellent Linux compatible personal finance option is Moneydance ([www.moneydance.com](http://www.moneydance.com)).

If you need a few Microsoft Windows programs, multiple solutions are available. Code-Weavers' CrossOver Office ([www.codeweavers.com](http://www.codeweavers.com)) allows you to run Microsoft Office 97/2000/XP, Quicken, Lotus Notes, and more. You can set up Microsoft Windows inside a virtual computer inside Linux, courtesy of VMware ([www.vmware.com](http://www.vmware.com)), NeTraverse's Win4Lin ([www.netraverse.com](http://www.netraverse.com)), Bochs (<http://bochs.sourceforge.net>), or Qemu (<http://fabrice.bellard.free.fr/qemu/>).

## Fedora Core as a Workstation

Fedora Core is not focused on the desktop. This book is focused on using Fedora Core as a server. However, Fedora Core provides a powerful desktop alternative, suitable for higher-end "desktop" environments such as computer-aided Design (CAD) stations and databases.

To this end, Fedora Core has configured GNOME and KDE with a similar look and feel. These changes are documented in an "overlay" to these desktop environments, known as Bluecurve. I describe these desktop environments and associated applications briefly in Chapters 31–33.

Workstation users may be pleased with the wide array of applications that come with Fedora Core. They include the following:

- ◆ OpenOffice.org, a fully featured office software suite.
- ◆ Firefox and Konqueror, web browsers as fully featured as Microsoft Internet Explorer. In many ways, Firefox is clearly superior to Internet Explorer.

- ◆ Internet utilities such as an Instant Messenger, news clients, remote desktops, and more. (In fact, I use the GNOME Instant Messenger application to connect to the Microsoft Messenger network.)
- ◆ Multimedia applications that allow you to write CDs and even DVDs at full speed.

While the Fedora Core desktop graphics utilities don't yet have the CMYK (cyan, magenta, yellow, and black) graphics software such as Paint Shop Pro, a number of movie studios do create animation and special effects on Linux computers.

**NOTE** CMYK is a color model more popular in high-end graphics applications than the original RGB (red-green-black) standard.

### Fedora Core for Small Businesses

Fedora Core can be a fantastic option for a small businesses or organization. You can install it on servers and workstations. It provides the scalability and control needed by a small growing business. Like anyone else, small businesses can download and install Fedora Core for free. Fedora Core computers are fairly easy to configure in a network, even if you need to connect them to Microsoft Windows computers. You can even configure Fedora Core as a PDC in a Microsoft Windows-style network. Once Samba is properly configured (see Chapter 26), other Microsoft computers won't be able to tell the difference.

If you administer a small business network, and need a supported distribution such as Red Hat Enterprise Linux, don't discount Fedora Core. In fact, Fedora Core 5 serves as the testbed for Red Hat Enterprise Linux 5. Alternatively, you can try the freely available "rebuilt" of Red Hat Enterprise Linux described earlier in this chapter.

With the right configuration, you can easily connect your network to the Internet. You can also protect your network from many of the ravages of the Internet with appropriate settings on your firewall and other network tools.

### Fedora Core for Bigger Business

Many corporations, governments, and educational institutions have already installed Red Hat Enterprise Linux to power their high-demand servers. With the certified options available for this distribution, you'll get a powerful enterprise tool for everything, from Oracle databases to high-capacity secure web servers.

Amazon.com has saved millions by converting to Red Hat. Google runs its search engine databases on a cluster of more than 8,000 servers running Red Hat. This operating system is becoming more popular for other large organizations as well, such as BP, Kenwood, and MIT. In a Red Hat case study, Toyota actually found slightly *lower* support costs after converting its computers to Red Hat.

If you administer an enterprise network, and need a supported distribution such as Red Hat Enterprise Linux, don't discount Fedora Core 5, as it serves as the testbed for Red Hat Enterprise Linux 5. Alternatively, you can try the freely available "rebuilt" of Red Hat Enterprise Linux described earlier in this chapter.

## Summary

Linux was developed as a clone of Unix. The Free Software Foundation reverse-engineered most of the key components of Linux. Critical was Linus Torvalds's creation of the Linux kernel. Most of it is protected through the General Public License.

As Fedora Core is being released, businesses and governments want control over their operating systems. Because Linux is modular and highly configurable, it provides the support that organizations need to keep their costs to a minimum.

Fedora Core includes the same basic components as all other Linux distributions: the kernel, `init`, daemons, user-mode shells and utilities, network, and the X Window. It incorporates the latest changes to the Linux kernel, as well as improvements in printing, web services, and more. The `system-config-*` graphical tools make it easier for administrators of other operating systems to make the transition.

When looking at Linux, you should consider four factors: control, reliability, cost, and support. I believe that Linux has advantages in all four areas when compared to other operating systems.

Fedora Core can play many roles in computing. Traditionally, it's used as a server, and functions well even on many older computers. Fedora Core is adding tools that make it suitable as a high-powered workstation. Such flexibility makes Fedora Core a viable alternative for small businesses.

In the next chapter, we'll start looking at getting your computers ready for Fedora Core.

### REPORTING PROBLEMS

Linux is a work in progress. Developers are constantly adding and revising features for new software and hardware. It's possible that in your journey with Linux, you'll run into a problem or two. There are at least three ways to look for a solution:

**Newsgroups** As described earlier, many users bring up problems they have in different newsgroups. Google collected recent newsgroup messages into a searchable database at `groups.google.com`. If you want to post on a newsgroup, it's best to use a newsgroup reader such as those described in Chapters 31–33. Alternatively, you can post messages using Google's interface at `groups.google.com` (registration is required).

**Mailing lists** Red Hat maintains a series of mailing lists on different topics and versions for Fedora Core; you can sign up at `www.redhat.com/mailling-lists/`. The developers of a number of different applications maintain their own mailing lists, which you can find on their websites.

**Bugzilla** Red Hat's bugzilla database can also help you identify and report problems associated with Fedora Core. Navigate to `http://bugzilla.redhat.com/bugzilla`, and click Login or New Account. Create an account if you don't already have one. You can then search through the Bugzilla database to see if someone has already raised the issue with Red Hat. If not, and if you've exhausted the other resources, submit a bug report through the Red Hat Bugzilla system.

