Beginning the Linux Command Line

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CHAPTER 1

Starting Linux Command-Line Administration

To unleash the full power of Linux, as a Linux administrator you will spend most of your time typing commands on the Linux command line, the so-called shell prompt. For someone who is new to the command line, the things that advanced users do there may look like magic. In this chapter, you'll learn about the following topics:

- History of the Linux operating system
- What is open source?
- What are distributions?
- Logging in to Linux
- Command basics: working with commands, options, and arguments
- Using piping and redirection
- Getting help with `--help` and `man`
- Working with the shell

Linux Distributions

For someone new to Linux, the operating system may appear a little bit strange. For instance, exactly what Linux are we talking about? Due to its open source character, there are different versions (the so-called distributions) of Linux. After some Linux history, this chapter teaches you about the differences and similarities between these distributions.

Linux History

Linux started around 1991 all because the Finnish student Linus Torvalds wasn't too happy with Minix, the educational version of the UNIX operating system that he had to work with at the University of Helsinki. In particular, the ability of the kernel (which is the heart of the operating system) of this Minix distribution didn't please him much. He decided to create a better kernel and gave it the name Linux.

Possibly the smartest thing that Torvalds did when starting his initiative was decide not to do it alone. To find other people who wanted to work with him, he posted a message on

Usenet, a major platform in those days that could be used to exchange information with other people and get help from other people.

The initiative by Torvalds didn't stand on its own. Many other software developers had already started initiatives to create free software for the UNIX operating system. The only thing that really was missing at that moment was a kernel that was stable enough to go into production.

Open Source

Right from the start, Torvalds released his software as open source software—that is, software whose computer code is freely available to anyone. This open source initiative fitted well into many other open source programs that were a part of the GNU initiative. The acronym GNU stands for GNU is Not UNIX, which means that this is about software written for the UNIX platform but doesn't use UNIX licensing. This GNU initiative was a part of the Free Software Foundation (FSF), which wanted to create free software for a better operating system experience.

When it came to licensing, Torvalds released his software under the GPL. In those days, GPL stood for GNU Public License, but nowadays it means General Public License. The details of this license are quite complex, but in essence it means that software released under the GPL can be used and modified by anyone, as long as the person modifying this software makes sure that his or her modifications will be released under the GPL as well. In brief: once software has a GPL, it will always stay GPL software. This prevents companies from making small modifications and then taking the software out of GPL and selling it for a lot of money.

The First Distributions

Apart from the Linux kernel, lots of other programs were available under the GPL as well. In the early days, people who wanted to start using Linux had to go on the Internet and download these software programs themselves. Often, after downloading them, they even had to compile them for themselves. This compilation process was necessary to convert the program files, which were published as source code files only, to executable programs that users could execute on their computer.

Software compilation is not very easy to do, and for that reason, different people started to create collections that consisted of the Linux kernel and some other useful programs. One of the first persons to do so was Patrick Volkerding, who started his Slackware distribution in 1993. In those days, this distribution consisted of different software categories, all put together on no fewer than 43 diskettes. Volkerding was perhaps the first who made a successful Linux distribution that started to get used on servers all around the world.

Linux Turning Mainstream

The years between 1993 and 1998 marked the rise of the Linux operating system. One of the most important reasons for this is that it provided a very affordable alternative for the expensive UNIX operating system that was used on many mission-critical server systems. Due to this popularity, during this period the most important Linux distributions were created.

Whereas Slackware was just a collection of software programs with an installation program that made working with Linux easy, other Linux distributions soon started to add value to the open source software. Some did this by adding commercial support to their software collection, others by creating programs and adding that to their distribution, and some hired developers to optimize the open source programs. The result is that nowadays hundreds of Linux distributions are available for new Linux users. Of all these Linux distributions, only some really matter. In this book, I've focused on the three most important distributions: Red Hat, SUSE, and Ubuntu. By focusing on these three only, I am not making a statement about the quality of the other distributions; however, it makes sense to focus on these three as they make up more than 90% of the Linux market. Following are short descriptions of these three distributions.

Red Hat

North Carolina–based Linux distribution Red Hat had a major role in bringing Linux to the data center of many companies. The reason for the success of Red Hat was that this distributor added support for Linux. At one level, this is support of different hardware and software programs, which means that users of the supported hardware and software programs were guaranteed that they would work on Linux. Red Hat also added help for Linux users, available as a commercial added value to Linux.

Because Red Hat offered Linux with support, companies started putting aside their old flavors of UNIX and replacing them with the much cheaper Linux. This made Red Hat the most important Linux distributor for many years; only recently have SUSE and Ubuntu posed a threat to the commercial success of Red Hat in the enterprise environment.

Currently, there are three product lines related to Red Hat. The most important of these is Red Hat Enterprise Linux (RHEL), which consists of two server versions and a desktop version. RHEL is a commercial product, so it is not available as a free download. It is open source software, however, but the only reason you can't download it for free is because Red Hat has added the Red Hat logo to the RHEL software, and this is something that users have to pay for.

Red Hat also founded the Fedora open source project. Basically, you can see this as the development environment for RHEL. Most new software components are first used and tested in Fedora, and if they are successful there, they will make it into RHEL as well. Fedora Linux is available for free download at `www.redhat.com/fedora`.

Since the only thing that is not free in Red Hat Enterprise Linux is the Red Hat logo, the CentOS (Community ENTerprise Operating System) distribution offers Red Hat Enterprise Linux software from which the Red Hat logo has been removed. This sounds illegal, but it isn't, as Red Hat is completely open source software. So if you want the stability of Red Hat Enterprise Linux, but don't want to pay for it, CentOS provides a good alternative. You can download CentOS at `www.centos.org`.

SUSE

The SUSE Linux distribution was founded in Germany. It became popular quite fast because from the beginning SUSE Linux came with lots of software packages. SUSE was one of the first distributions that only sold their distribution and just delivered a demo system as freely available software, thus trying to make money out of it.

In 2004, Utah-based network software company Novell purchased SUSE and developed it into an enterprise-ready Linux distribution that could compete with Red Hat, which in that period still dominated the market.

Currently, there are two directions in SUSE Linux. SUSE Linux Enterprise is the commercial software that offers support, and it exists in three different flavors: SUSE Linux Enterprise

Server, SUSE Linux Enterprise Desktop, and SUSE Linux Enterprise Real Time, a tuned version that allows financial companies to process real-time transactions. With SUSE Linux Enterprise Desktop, Novell has some success in bringing Linux to the enterprise desktop, whereas Red Hat, for example, still focuses on server versions. Interestingly, the SUSE Linux Enterprise products (with the exception of SUSE Linux Enterprise Real Time) are freely downloadable at `www.novell.com/downloads`.

Apart from the SUSE Linux Enterprise products, there is OpenSUSE, which is a fully open source product. This version also offers a stable Linux distribution, but at the same time is used as a development platform for new software. You can download OpenSUSE at `www.opensuse.org`.

Ubuntu

Ubuntu is a relatively new Linux distribution. It has become quite successful because its founder, the South African millionaire Mark Shuttleworth, made it an extremely user-friendly distribution and even gives away CDs with the Ubuntu Desktop for free. Anyone can order as many CDs of this distribution he or she likes from `www.ubuntu.com`.

Apart from the Ubuntu Desktop, Ubuntu has a server edition as well, which due to the success of the desktop version has become quite popular (though not yet as popular as the Red Hat and SUSE server versions). Both versions of Ubuntu Linux are available for free; customers who are interested in getting support can purchase it from Canonical, a separate company that specializes in Ubuntu support.

Remarkable about Ubuntu Linux is the fact that there is a new software release every 6 months. By looking at the name of the distribution, you can see when it was released; for instance, Ubuntu 9.04 was released in April 2009. As enterprise users normally don't like upgrading their operating system every 6 months, there is also a Long Term Support (LTS) version that currently is released every 18 months. The special thing about this version is the extended period of support that is offered. For desktops this is 5 years, and for servers its 7 years.

■ **Note** This book focuses on Red Hat, SUSE, and Ubuntu Linux. You will notice, however, that 98% of the commands and configuration files covered in this book are available on other Linux distributions as well. This means that no matter what Linux distribution you use, the information in this book will be useful for you.

Logging In and Out

Before you can do anything on a Linux computer, you have to log in. In this section, you'll learn about usernames and different ways you can use to make yourself known to your Linux computer.

Different Login Interfaces

Before starting to work on your Linux computer, you need to tell it who you are. To help you with this, Linux offers you a login prompt. This can be either a graphical or a nongraphical prompt. If you are working on a Linux desktop, you are likely to see a graphical environment. If, however, it is a server you a working from, you'll just see a shell login prompt.

In Linux, there often is a choice between different solutions. This means there is not just one unified graphical login prompt, but many, depending on the distribution that you are using and on the graphical environment that you have installed. You will notice that the graphical login screen for that reason will be different between the distributions. In Figure 1-1, you can see what it looks like on SUSE Linux.

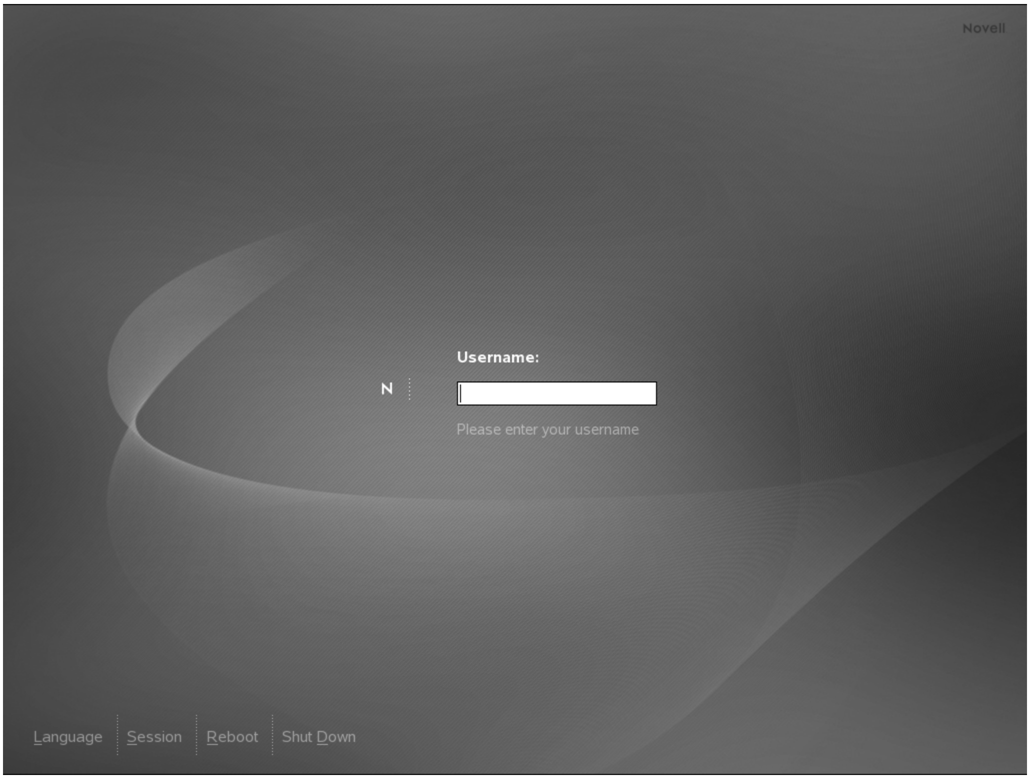
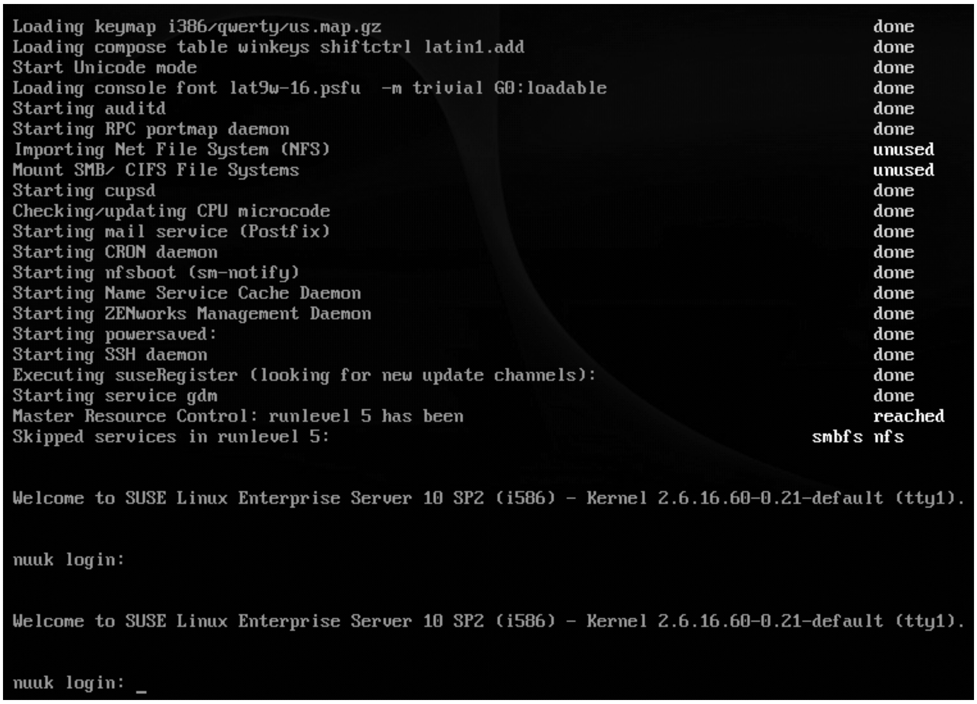


Figure 1-1. *The graphical login screen on SUSE*

When working with a graphical environment, it is the graphical environment that provides you with the login screen. More specifically, it is the `xdm` process that starts the graphical login screen. So what you see in Figure 1-1 is really the result of this `xdm` process.

If you are working on a server, the graphical environment doesn't matter and is normally not started by default. That is because the graphical environment consumes resources, and these resources on server systems are better reserved for other purposes. Therefore, servers normally offer a text-based login prompt only. In Figure 1-2, you can see what this sort of login prompt looks like.

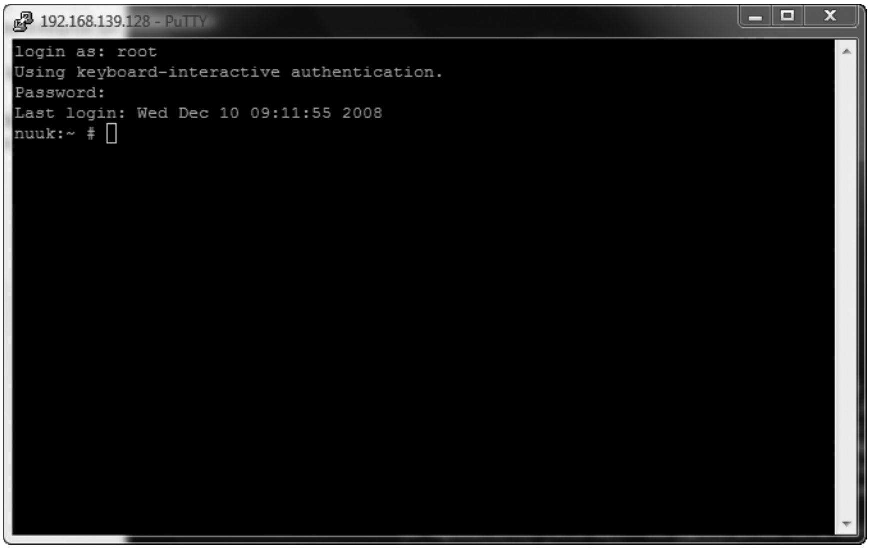


```
Loading keymap i386/qwerty/us.map.gz                                                   done
Loading compose table winkeys shiftctrl latin1.add                                     done
Start Unicode mode                                                                     done
Loading console font lat9w-16.psfu  -m trivial G0:loadable                             done
Starting auditd                                                                        done
Starting RPC portmap daemon                                                            done
Importing Net File System (NFS)                                                        unused
Mount SMB/ CIFS File Systems                                                           unused
Starting cupsd                                                                         done
Checking/updating CPU microcode                                                        done
Starting mail service (Postfix)                                                        done
Starting CRON daemon                                                                   done
Starting nfsboot (sm-notify)                                                           done
Starting Name Service Cache Daemon                                                     done
Starting ZENworks Management Daemon                                                    done
Starting powersaved:                                                                   done
Starting SSH daemon                                                                    done
Executing suseRegister (looking for new update channels):                              done
Starting service gdm                                                                   done
Master Resource Control: runlevel 5 has been                                           reached
Skipped services in runlevel 5:                                                  smbfs nfs


Welcome to SUSE Linux Enterprise Server 10 SP2 (i586) - Kernel 2.6.16.60-0.21-default (tty1).


nuuk login:


Welcome to SUSE Linux Enterprise Server 10 SP2 (i586) - Kernel 2.6.16.60-0.21-default (tty1).


nuuk login: _
```

Figure 1-2. *The text-based login prompt*

There are other ways of connecting to a Linux machine as well. If you are a server administrator, your server will probably be installed in an air-conditioned cold server room that you enter only if really necessary. Therefore, as a server administrator, you may use a remote access tool like PuTTY to get shell access to the server. In Figure 1-3, you can see what the PuTTY login screen looks like.

■**Note** PuTTY is the de facto standard for accessing Linux machines from a Windows desktop. You can download PuTTY for free from `www.putty.org`. To use it, you need SSH on your Linux computer as well. SSH is covered in detail in Chapter 11.



```
login as: root
Using keyboard-interactive authentication.
Password:
Last login: Wed Dec 10 09:11:55 2008
nuuk:~ # 
```

Figure 1-3. *PuTTY is the de facto standard for accessing a Linux console remotely from a Windows workstation.*

As you can see, there are many ways to connect to a Linux machine. In all cases, you do need to provide user credentials. The next section gives more information about that.

Working with a User Account

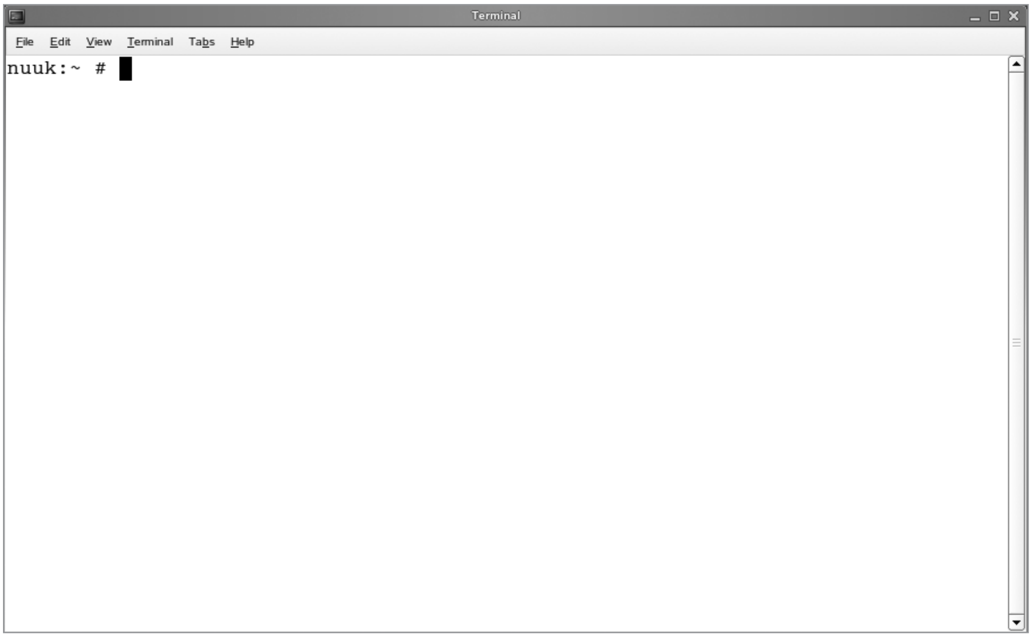
To log in to a Linux machine, you need a user account name and a password. You should already know what username to use if you installed the machine yourself. If someone else installed the machine for you, ask him or her what username you should use. This username will also have a password. At the login prompt, you need to provide the username and password to make yourself known to the machine. This procedure is also known as *authentication*.

Note There are alternatives to passwords for authentication. For instance, you may use a smart card to authenticate on your machine. However, this is not very common, and for this reason, in this book I will focus on password authentication.

When authenticating for the first time, you have to decide what user account to use. You can authenticate as a normal user, but you can authenticate with the account of the system administrator as well. The username for this account is root. On every Linux computer, there is a user with the name root, and this user account has no restrictions. The user root really is almighty. If you are a system administrator, it makes sense to authenticate as root; after all, you need to do system administration, and for that purpose you need all the permissions there are. If, however, you are a normal user, you shouldn't make a habit of logging in as root by default. Just log in with your normal user account, and use `su` or `sudo` to become root when needed. In Chapter 2, you'll learn how to do this. At this time, just make sure that you are authenticated.

Command-Line Basics

The command line is important, because a system administrator can do anything from it. Linux has many, many commands, more than you will ever know, and new commands are added on a regular basis. All of these commands, though, share a common way of working. In this section, you'll learn about common elements that you will encounter in any Linux command. First, you'll learn about the common structure that every Linux command has. Next, we'll talk about characters that you can and can't use in Linux commands. Figure 1-4 shows what a command line looks like, when started as a terminal from a graphical environment.



```
nuuk:~ #
```

Figure 1-4. *The command line as seen from a terminal window*

The command line offers you a prompt that consists of different parts. The first part of the prompt, as you can see in Figure 1-4, is the name of the computer you are working on. In this case, the computer name is `nuuk`. Next, the prompt refers to the current directory in the file system where the user is at right now. In Figure 1-4, you can see a ~ sign instead of the name of a directory. This sign refers to the home directory, which is the folder in the file system where the user can store his or her personal files. Last, the # sign in this prompt indicates that the current user is *root*, the mighty system administrator. If you see anything other than #, the current user is not root, but a normal user with normal privileges. Be aware that if this is the case, some commands have limited use. For instance, on Linux a normal user cannot format hard disks.

■**Note** Since in open source there are no rules, a developer can do as he or she likes. Therefore, words like "always" and "every" are not applicable in Linux, as there are often exceptions to the rules that are used in Linux. To keep this book readable, I will, however, use these words anyway. Just keep in mind that when you see the terms "every" and "always," it should read "almost every" and "almost always."

The Command Interpreter

When working on the command line, as an administrator you will be dealing with the shell. The shell is the command interpreter: it is responsible for making something out of the things that you type on the command line. How you work with commands is largely defined by the abilities of the shell. The shell itself is a program that your server starts automatically after you log in on your server, no matter if you've done so directly on the server console or via a remote session that you've started from PuTTY on your Windows workstation. Two shells are used quite often: Bash and Dash. Bash is the default shell on the current SUSE and Red Hat versions, and Dash is the default shell on Ubuntu. The good news is that as a beginning command-line administrator, you don't really care which shell is used—both work in the same way. In the section "Working with the Shell" later in this chapter, you'll learn about some of its most important and most useful features.

Commands, Options, and Arguments

A Linux command normally consists of three parts: the command itself, the command options, and its arguments. For instance, the following example shows what a Linux command looks like:

```
useradd -m -G sales linda
```

This example consists of three parts, `useradd`, which is the command; `-m` and `-G` sales, which are both options; and `linda`, which is a generic argument. Further on in this section, I'll explain these components in more detail.

The command itself is the character string you type to activate a certain task. For instance, the command `ls` (see Listing 1-1) lists files. In Listing 1-1, you see the result of this command when used in the home directory of the user root (the Linux system administrator). Certain functionality is defined for this command. Linux has many commands, as mentioned previously; later in this chapter, in the section "Using `man` to Get Help," you'll learn how to get detailed usage information about them by using the `man` command.

Listing 1-1. *Using the `ls` Command Without Options Shows Files in the Current Directory*

```
nuuk:~ # ls
.ICEauthority  .exrc    .gnome2_            private         .metacity
.Xauthority    .fvwm    .gnupg              .nautilus       .wapi
.bash_history  .gconf   .gstreamer-0.10     .qt             .xsession-errors
.config        .gconfd  .gtkrc              .recently-used  Desktop
.dmrc          .gnome   .gtkrc-1.2-gnome2   .skel           Documents
.esd_auth      .gnome2  .kbd                .suse_          register.log  bin
```

Options

Most commands have options as their second part. By using these options, you modify the behavior of the commands. For instance, the `ls` command just shows the names of files in the current directory, as you can see in Listing 1-1. If you want to see details, such as the file size, the permissions that are set for it, and information about the creation date, you can add the option `-l`. In Listing 1-2, you can see how this option modifies the behavior of the `ls` command.

Listing 1-2. *By Adding an Option to a Command, You Modify Its Behavior*

```
nuuk:~ # ls -l
total 120
-rw-------  1  root  root  777   Dec  5  10:43  .ICEauthority
-rw-------  1  root  root  115   Dec  5  10:43  .Xauthority
-rw-------  1  root  root  2558  Nov 24  13:39  .bash_history
drwx------  3  root  root  4096  Nov  7  11:04  .config
-rw-------  1  root  root  24    Nov  7  11:03  .dmrc
-rw-------  1  root  root  16    Nov  7  11:03  .esd_auth
-rw-r--r--  1  root  root  1332  Nov 23  2005   .exrc
drwxr-xr-x  2  root  root  4096  Nov  7  10:47  .fvwm
drwx------  5  root  root  4096  Dec  5  10:43  .gconf
drwx------  2  root  root  4096  Dec  5  11:03  .gconfd
drwxr-xr-x  3  root  root  4096  Nov  7  11:04  .gnome
drwx------  6  root  root  4096  Nov  7  11:04  .gnome2
drwx------  2  root  root  4096  Nov  7  11:03  .gnome2_private
drwx------  3  root  root  4096  Nov  7  11:03  .gnupg
drwxr-xr-x  2  root  root  4096  Dec  5  10:43  .gstreamer-0.10
-rw-r--r--  1  root  root  123   Nov  7  11:03  .gtkrc
-rw-r--r--  1  root  root  134   Nov  7  11:03  .gtkrc-1.2-gnome2
drwxr-xr-x  2  root  root  4096  Nov  7  10:47  .kbd
drwx------  3  root  root  4096  Nov  7  11:03  .metacity
drwxr-xr-x  3  root  root  4096  Nov  7  11:04  .nautilus
drwxr-xr-x  2  root  root  4096  Nov 19  15:03  .qt
-rw-------  1  root  root  325   Dec  5  10:43  .recently-used
drwxr-xr-x  2  root  root  4096  Nov  7  11:03  .skel
```

```
-rw-r--r--  1  root  root  795   Dec  5  10:44  .suse_register.log
drwx------  3  root  root  4096  Nov  7  11:04  .thumbnails
drwxr-xr-x  2  root  root  4096  Dec  1  05:27  .wapi
-rw-r--r--  1  root  root  1238  Dec  5  10:43  .xsession-errors
drwxr-xr-x  2  root  root  4096  Nov  7  11:04  Desktop
drwx------  2  root  root  4096  Nov  7  11:04  Documents
drwxr-xr-x  2  root  root  4096  May  3  2007   bin
```

Options provide you a method that is defined within the command code to modify the behavior of the command. This means that as a user or an administrator, you cannot add options yourself. The only way of doing this is to change the source code of the command. Options are very specific to the command you use. Some commands don't have any options, and other commands can have more than 50. The `man` command normally gives you a complete list of all options that are available.

Many commands offer two different methods of working with options: the short option and the long option. For example, you can use the command `ls -lh`, which makes the `ls` command present its output in a human-readable way by showing kilobytes, megabytes, and gigabytes instead of just bytes. You can also use the short option `-h` in a long way, written as `--human-readable`. In Listing 1-3, you can see this option at work, combined with the option `-l`, which makes sure that the output of `ls` is given as a long listing. (Unfortunately, there is no long alternative for the short option `-l`.)

Listing 1-3. *Most Linux Commands Work with Short As Well As Long Options*

```
nuuk:/somedir # ls -l -h
total 4.0M
-rwxr-xr-x  1  root  root  1.5M  Dec  5  11:32  vmlinux-2.6.16.60-0.21-default.gz
-rw-r--r--  1  root  root  1.3M  Dec  5  11:32  vmlinuz
-rw-r--r--  1  root  root  1.3M  Dec  5  11:32  vmlinuz-2.6.16.60-0.21-default
nuuk:/somedir # ls -l --human-readable
total 4.0M
-rwxr-xr-x  1  root  root  1.5M  Dec  5  11:32  vmlinux-2.6.16.60-0.21-default.gz
-rw-r--r--  1  root  root  1.3M  Dec  5  11:32  vmlinuz
-rw-r--r--  1  root  root  1.3M  Dec  5  11:32  vmlinuz-2.6.16.60-0.21-default
```

Short options are preceded by a - sign, and you can add more than one short option after the - sign. For instance, you can combine the options `-l` and `-h` from the example in Listing 1-4 as `ls -lh`. Long options are preceded by the -- sign. For instance, `ls --human-readable` executes the `ls` command with just one option, which is `--human-readable`. If by mistake you put just one - in front of a long option, the long option is not interpreted as a long option, but as a collection of short options. This means that `ls --human-readable` would be interpreted as `ls -h -u -m -a -n -- -r -e -a -d -a -b -l -e`.

Arguments

Apart from options, many Linux commands have arguments. These are additional specifications that you can add to the command to tell it more precisely what to do, but the argument is typically not defined in the command code itself. For example, consider the command `ls -l /etc/hosts`:

```
nuuk:/somedir # ls -l /etc/hosts
-rw-r--r-- 1 root root 683 Nov  7 10:53 /etc/hosts
```

In this example, `/etc/hosts` is the argument. As you can imagine, you can use any other file name instead of `/etc/hosts`, and this is typical for arguments. They are not fixed, and you can use any argument you like as long as it is relevant in the context of the command. In this book, I'll make a very clear distinction between options and arguments.

You should be aware that not only commands have arguments, but also options have arguments as well. For example, consider the following command:

```
mail -s hello root
```

This command consists of four different parts:

- `mail`: The command itself
- `-s`: The option that tells the `mail` command what subject it should use
- `hello`: The argument of the option `-s`, which specifies what exactly you want to do with the option `-s`
- `root`: The argument of the command, which in this case makes clear to whom to send the mail message

As a rule of thumb, arguments at the end of the command are normally command arguments, and arguments for options are placed right next to the options. You may wonder now how to find out the differences between command arguments and arguments for options, but later in this chapter in the section "Getting Help," you'll see that it is fairly simple to differentiate the two argument types.

Piping and Redirection

To unleash the full power of Linux's many commands, you can use piping and redirection. By piping, you can send the result of a command to another command, and by using redirection, you can determine where the command should send its results.

Piping

Piping offers you great benefits in a Linux environment. By using piping, you can combine the abilities of two or more commands to create a kind of super command that offers even more capabilities. By creating the right pipes, you can really do amazing stuff. For an advanced Linux administrator, a command such as the following is pretty common (after reading all the chapters in this book, you should be able to understand what this command is doing):

```
kill `ps aux | grep y2 | grep -v grep | awk '{ print $2 }'`
```

As a Linux administrator, you absolutely need to know about piping, so let's start with an easy example. If you try a command like `ls -R /`, you will see that it gives a lot of output that scrolls over your screen without stopping. On Linux, there is a very useful command, named `less`, that you can use as a viewer for text files. For example, try `less /etc/hosts` (see Listing 1-4); this will open the `/etc/hosts` file in `less` to show the contents of the file (use `q` to quit `less`).

Note The `/etc/hosts` file contains a list of IP addresses and the matching host name. In a small network, you can use it as an alternative to using DNS for resolving host names.

Listing 1-4. *You Can Use* `less` *As a Viewer to Read Text Files*

```
nuuk:/ # less /etc/hosts
#
# hosts         This file describes a number of hostname-to-address
#               mappings for the TCP/IP subsystem.  It is mostly
#               used at boot time, when no name servers are running.
#               On small systems, this file can be used instead of a
#               "named" name server.
# Syntax:
#
# IP-Address  Full-Qualified-Hostname  Short-Hostname
#

127.0.0.1       localhost

# special IPv6 addresses
::1             localhost ipv6-localhost ipv6-loopback

fe00::0         ipv6-localnet

ff00::0         ipv6-mcastprefix
ff02::1         ipv6-allnodes
ff02::2         ipv6-allrouters
ff02::3         ipv6-allhosts
127.0.0.2       nuuk.sander.gl nuuk
/etc/hosts lines 1-23/23 (END)
```

The `less` command can be very useful in a pipe as well. By using piping, you'll send the result of the first command to the second command. So if you use `ls -R / | less`, the `ls -R /` command executes and sends its result to the `less` command. `less` will function as a pager in this situation and show you the output of the first command screen by screen (see Listing 1-5). It will also show you the current position that you are at; this is indicated by `lines 1-23`, which you see at the end of the example file. Press the spacebar to proceed to the next screen of output.

Listing 1-5. *By Piping to `less`, You Can Display the Results of a Command That Gives a Large Amount of Output Screen by Screen*

```
nuuk:/ # ls -R / | less
/:
.rnd
bin
boot
dev
etc
home
lib
lost+found
media
mnt
opt
proc
root
sbin
somedir
srv
sys
tmp
usr
var

/bin:
lines 1-23
```

Redirection

Another operator that is very useful in the Linux command shell is the redirection operator, `>`. By default, a command will show its result on your computer monitor. In Linux slang, you can also say that the shell will send the result of a command to standard output, abbreviated to STDOUT, which is usually your computer monitor. Using redirection, you can send it somewhere else.

■ **Tip** If possible, try all commands described in this section immediately after reading about them. Without trying them yourself, it may be quite hard to understand what they are doing.

Let's use the command `ls -l` once more as an example. If you just type the command, you will see its result on STDOUT. However, if you type `ls -l > somewhere`, you'll tell the command to send its output somewhere else, in this case to a file that has the name `somewhere`. This file will be created in the current directory if it doesn't exist. If a file with this name already exists, you will overwrite it by using this command. In case you want to add to an existing file instead of overwriting it, use `ls -l >> somewhere`. The double redirector tells the command to append to the contents of the file instead of overwriting it. If the file doesn't already exist, the command will create it. So if you want to be sure never to overwrite an existing file by accident when using redirection, use `>>` at all times instead of `>`.

Some commands give you error messages apart from output. The good thing is that you can redirect these error messages also. To do this, use `2>` instead of `>`. So if `ls -l` gives you a lot of error messages as well (which isn't very likely, but you never know), you can send all of them to the file `errors`, which will be created in the current directory if you use `ls -l 2> errors`. And it is even possible to redirect the standard output of a command in one direction, while sending the error output somewhere else. For instance, the command `ls -l > output 2> errors` will create two files, the file `output` for the regular output and the file `errors` for the error output.

Instead of sending the results of a command to a file, you can redirect to some of the Linux special devices as well. Every piece of hardware in Linux can be addressed by using a device file. For instance, there is the device file `/dev/null`, which can be used as a digital waste bin. Everything that you send to `/dev/null` will immediately disappear into thin air. So if you just don't want to see any error messages at all, instead of saving them somewhere on your system, you can redirect the error messages to the `/dev/null` device. The following example shows how to do so:

```
ls -l 2> /dev/null
```

In this example, the regular output is still written to your current terminal, but you just won't see error messages anymore.

Apart from output, you can also use redirection on input for a command. This is used not as often, but can be useful for commands that open an interactive prompt where you are expected to provide input for the command. An example of this is the Linux `mail` command that you can use on the command line.

■ **Tip** You can use the `mail` command for some simple mail handling from a terminal screen, but if your server is configured properly, you can even use it to send mail to other users on the Internet. The only thing you need to do is set up DNS on your server.

Consider the command `mail -s hello root`. This command opens a command prompt that will allow you to compose a mail message to the user root (whose name is provided as the argument to the command). The option `-s hello` specifies the subject, in this case `hello`. In Listing 1-6, you can see the result of this command.

Listing 1-6. *Composing a Mail Message with `mail`*

```
nuuk:/ # mail -s hello root
Hi root, how are you.
.
EOT
```

Now the problem with the mail command is that when used in this way, it opens an interactive prompt where you type the message body. When finished typing the message body, you have to provide a dot on a separate line and press Enter. By using input redirection, you can feed the dot immediately to the command, which allows you to run the command without any interruption from the command line.

```
mail -s hello root < .
```

The difference between Listing 1-6, where mail opens a command prompt, and the preceding example, where input redirection is used, is that in the example with input redirection, you cannot enter a message in the body of the mail. To send the mail, there is just one line to use, and that's all.

Getting Help

Linux offers many ways to get help. Let's start with a short overview:

- The man command offers documentation for most commands that are available on your system.
- Almost all commands accept the --help option. Using it will display a short overview of available options that can be used with the command.
- As with every shell, the Bash shell also has internal commands. These commands can't be found as a program file on disk, but they are built in the Bash shell and available in memory as soon as the Bash shell is loaded. For these Bash internal commands, you can use the help command to find out more about them. For example, use help for to get more information about the Bash internal command for.

■ **Note** Want to find out whether a command is an internal command or not? Use type. For example, try type cd; the result will show you what kind of command cd is, in this case a Bash internal command.

Using man to Get Help

The most important source of information about commands on your Linux system is man, which is short for the System Programmers Manual. The basic structure for using man is to type man followed by the command you want information about. For example, type man passwd to get more information about the passwd item. You'll then see a page displayed by the less pager, as shown in Listing 1-7.

Listing 1-7. *Example of a* `man` *Page*

```
PASSWD(1)                  User Commands                  PASSWD(1)

NAME
       passwd - change user password

SYNOPSIS
       passwd [options] [LOGIN]

DESCRIPTION
       passwd changes passwords for user accounts. A normal user
       may only change the password for his/her own account, while
       the super user may change the password for any account.
       passwd also changes account information, such as the full
       name of the user, the user's login shell, or his/her
       password expiry date and interval.

   Password Changes
 Manual page passwd(1) line 1
```

Each `man` page consists of the following elements.

- *Name*: This is the name of the command. It briefly describes the purpose of the command.
- *Synopsis*: Here you can find short usage information about the command. It will show all available options and indicate whether an option is optional (shown between square brackets) or mandatory (not between brackets).
- *Description*: This describes what the command is doing. Read it to get a clear and complete picture of the purpose of the command.
- *Options*: This is a complete list of all options that are available, and it documents the use of all of them.
- *Files*: If it exists, this section provides a brief list of files that are related to the command you want more information about.
- *See also*: This is a list of related commands.
- *Author*: This indicates the author and also provides the mail address of the person who wrote the `man` page.

`man` Sections

In the early days, nine different `man` volumes documented every aspect of the UNIX operating system. This structure of separate books (nowadays called sections) is still present in the `man` command. Table 1-1 lists the available sections and the type of help you can find in them.

Table 1-1. *`man` Sections and What They Cover*

Section	Topic	Description
0	Header files	These are files that are typically in `/usr/include` and contain generic code that can be used by your programs.
1	Executable programs or shell commands	For the user, this is the most important section because it normally documents all commands that can be used.
2	System calls	As an administrator, you will not use this section on a frequent basis. The system calls are functions that are provided by the kernel. It's all very interesting if you are a kernel debugger, but normal administrators won't need this information.
3	Library calls	A library is a piece of shared code that can be used by several different programs. Typically, `man` pages that are documented in section 3 are relevant for programmers, not so much for Linux users and system administrators.
4	Special files	In here, the device files in the directory `/dev` are documented. These files are needed to access devices in a computer. This section can be useful for learning more about the workings of specific devices and how to address them using device files.
5	Configuration files	Here you'll find the proper format you can use for most configuration files on your server. If, for example, you want to know more about the way `/etc/passwd` is organized, use the entry for `passwd` in this section by issuing the command `man 5 passwd`.
6	Games	On a modern Linux system, this section contains hardly any information.
7	Miscellaneous	This section contains some information on macro packages used on your server.
8	System administration commands	This section does contain important information about the commands you will use on a frequent basis to change settings on your Linux machine.
9	Kernel routines	This is documentation that isn't even included as part of the standard install and optionally contains information about kernel routines.

So the information that matters to you as a system administrator is in sections 1, 5, and 8. Mostly you don't need to know anything about the other sections, but sometimes an entry can be found in more than one section. For example, information on an item called `passwd` is found in section 1 as well as in section 5. If you just type `man passwd`, you'll see the content of the first entry that `man` finds. If you want to make sure that all the information you need is displayed, use `man -a <yourcommand>`. This makes sure that `man` browses all sections to see whether it can find anything about `<yourcommand>`. If you know what section to look in, specify the section number as well, as in `man 5 passwd`, which will open the `passwd` item from section 5 directly.

Now `man` is a very useful tool for getting more information on how to use a given command. On its own, however, it is useful only if you know the name of the command you want to read about. If you don't have that information and need to locate the proper command, you will like `man -k`. The `-k` option allows you to locate the command you need by looking at keywords.

Note `man -k` is very useful. Instead of using `man -k`, you may also use the `apropos` command, which does exactly the same thing.

`man -k` often produces a very long list of commands from all sections of the `man` pages, and in most cases you don't need to see all that information; the commands that are relevant for the system administrator are in sections 1 and 8. Sometimes, when you are looking for a configuration file, section 5 should be browsed as well. Therefore, it's good to pipe the output of `man -k` through the `grep` utility, which can be used for filtering. For example, use `man -k time | grep 1` to show only lines from `man` section 1 that have the word "time" in the description.

Tip It may happen that `man -k` provides only a message stating that nothing is appropriate. If this is the case, run the `mandb` command. This will create the database that is necessary to search the `man` indexes.

Using the `--help` Option

The `--help` option is pretty straightforward. Most commands accept this option, although not all commands recognize it. But the nice thing is that if your command doesn't recognize the option, it will give you a short summary on how to use the command anyway because it doesn't understand what you want it to do. Although the purpose of the command is to provide a short overview of the way it should be used, you should be aware that the information is often still too long to fit on one screen. If this is the case, pipe it through `less` to view the information page by page. In Listing 1-8, you see what happens when you do that.

Listing 1-8. *Displaying Information Screen by Screen by Piping Through `less`*

```
nuuk:/ # ls --help | less
Usage: /bin/ls [OPTION]... [FILE]...
List information about the FILEs (the current directory by default).
Sort entries alphabetically if none of -cftuSUX nor --sort.

Mandatory arguments to long options are mandatory for short options too.
  -a,  --all              do not ignore entries starting with .
  -A,  --almost-all       do not list implied . and ..
       --author           with -l, print the author of each file
  -b,  --escape           print octal escapes for nongraphic characters
       --block-size=SIZE  use SIZE-byte blocks
  -B,  --ignore-backups   do not list implied entries ending with ~
  -c                       with -lt: sort by, and show, ctime (time of
                           modification of file status information)
                           with -l: show ctime and sort by name
                           otherwise: sort by ctime
  -C                       list entries by columns
       --color[=WHEN]      control whether color is used to distinguish file
                           types.  WHEN may be `never', `always', or
                           `auto'
  -d,  --directory         list directory entries instead of contents,
                           and do not dereference symbolic links
  -D,  --dired             generate output designed for Emacs' dired mode
  -f                       do not sort, enable -aU, disable -lst
  -F,  --classify          append indicator (one of */=>@|) to entries
lines 1-23
```

Getting Information on Installed Packages

Another nice source for information that is often overlooked is the documentation you can install for software packages in the directory `/usr/share/doc/`. This information is not installed by default on all distributions; you'll probably need to install the `Documentation` software package yourself to get it. (More on management of software appears in Chapter 8.) Beneath this directory, you'll find a long list of subdirectories that all contain some usage information. In some cases, the information is really short and not very good, but in other cases, thorough and helpful information is available. Often this information is available in ASCII text format and can be viewed with `less` or any other utility that is capable of handling clear text.

In many cases, the information in `/usr/share/doc` is stored in a compressed format. You can recognize this format by the extension `.gz`. To read files in this format, you can use `zcat` and pipe the output of that to `less`, which allows you to browse through it page by page. For example, if you see a file with the name `changelog.gz`, use `zcat changelog.gz | less` to read it.

In other cases, you will find the documentation in HTML format, which can only be displayed properly with a browser. If this is the case, it is good to know that you don't necessarily need to start a graphical environment to see the contents of the HTML file because Linux comes with the `w3m` browser, which is designed to run from a nongraphical environment. In `w3m` you can use the arrow keys to browse between hyperlinks. To quit the `w3m` utility, use the `q` command.

Working with the Shell

Linux uses the kernel to address and control the machine's hardware. The kernel can be considered the heart of the Linux operating system. On top of this kernel, as shown in Figure 1-5, Linux gives users the shell interface to tell this kernel and the services running on top of it what they should do. This interface interprets the commands that users enter and translates them to machine code.

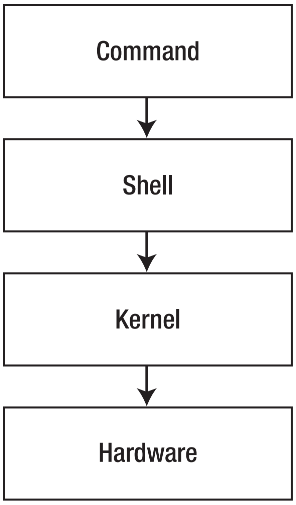


Figure 1-5. *Overview of the relation between kernel and shell*

Several shells are available. The very first shell that was ever created for UNIX, back in the 1970s, was the Bourne shell. It is still available in Linux as the program file `/bin/sh`. Another popular shell is Bash (short for the Bourne Again Shell). The Bash shell is completely compatible with the original Bourne shell, but it has many enhancements. Bash is used as the default shell for all users on most Linux distributions. Whereas SUSE and Red Hat use Bash, Ubuntu uses another shell, named Dash. For regular server administration tasks, there are no important differences between Bash and Dash. You should be aware that other shells are available as well. Some people prefer using these other shells, three of which I'll merely mention here:

- *tcsh*: A shell with a scripting language that works like the C programming language (and thus is fairly popular with C programmers).
- *zsh*: A shell that is compatible with Bash, but offers even more features.
- *sash*: The stand-alone shell. This is a very minimal shell that runs in almost all environments. It is thus well suited for troubleshooting systems.

Using the Shell to Best Effect

Basically, in the shell environment, an administrator is working with commands to execute the tasks he or she wants to perform. An example of such a command is `ls`, which can be used to display a list of files in a directory. Bash has some useful features to make working with these line commands as easy as possible.

Some shells offer the option to complete a command automatically. Bash has this feature, but it does more than just complete commands. Bash can complete almost *everything*: not just commands, but also file names and shell variables.

Working with Files and Directories

You'll find that when working in the shell, you'll often be manipulating files and directories. A directory is the folder in which files are stored that are related to one another; for instance, in the directory `/bin`, you will find binary files. Some directories are created by default, but you can also create directories yourself. To do this, use `mkdir`. For instance, the following command would create a directory with the name `groups` in the root of the file system:

```
mkdir /groups
```

In a directory, you'll find files. These can be text configuration files, program files, and documents; all that is stored on a Linux machine is stored in a file in some directory. In some cases, it can be useful to create a dummy text file that allows you to test functionality. To do this, use the `touch` command. The following command shows how to use `touch` to create an empty text file in the current directory:

```
touch somefile
```

This was just a very short introduction to working with files and directories. Chapter 2 of this book gives many more details on this subject.

Using Automatic Command Completion

Using this feature is as simple as pressing the Tab key. For example, the `cat` line command is used to display the contents of an ASCII text file. The name of this file, which is in the current directory, is `thisisafile`. So, to open this file, the user can type **cat thi** and then press the Tab key. If the directory has only one file that starts with the letters "thi," Bash automatically completes the name of the file. If the directory has other files that start with the same letters, Bash will complete the name of the file as far as possible. For example, let's say that there is a file in the current directory with the name `thisisatextfile` and another with the name `thisAlsoIsAFile`. Because both files start with the text `this`, Bash will complete only up to `this` and no further. To display a list of possibilities, you then press the Tab key again. This allows you to manually enter more information. Of course, you can then press the Tab key again to use the completion feature once more.

■ **Tip** Working with the Tab key really makes the command-line interface much easier. Imagine that you need to manage logical volumes on your server, and you remember only that the command for that starts with `lv`. In this case, you can type **lv** and press the Tab key twice. The result will be a nice list of all commands that start with `lv`, from which you'll probably recognize the command that you need.

Working with Variables

A variable is simply a common value that is used often enough by the shell that it is stored with a name. Many system variables are available from the moment your system boots, but you can set variables yourself as well. For instance, when you use the command `SWEET=good` on the command line, you have temporarily defined a variable that you can use later. Setting variables yourself is mainly interesting when writing shell scripts; you'll read much more about this subject in Chapter 12.

Apart from the variables that you would define yourself, there are system variables as well. These system variables are stored in the user's environment and help make it easier to work from the shell. An example of such a variable is `PATH`, which stores a list of directories that should be searched when a user enters a command. To refer to the contents of a variable, prefix a `$` sign before the name of the variable. For example, the command `echo $PATH` displays the content of the current search path that Bash is using.

On any Linux system, you'll get quite a few variables automatically when logging in. For an overview of all of them, you can use the `env` (short for *environment*) command. Listing 1-9 shows the result of this command.

Listing 1-9. *The `env` Command Shows All Variables That Are Defined in Your Shell Environment*

```
root@RNA:~# env
TERM=xterm
SHELL=/bin/bash
SSH_CLIENT=192.168.1.71 1625 22
SSH_TTY=/dev/pts/1
USER=root
MAIL=/var/mail/root
PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games
PWD=/root
LANG=en_US.UTF-8
SHLVL=1
HOME=/root
LOGNAME=root
VISUAL=vi
```

When working from the command line, in some cases you'll need to change some variables. Several of the most relevant variables are listed here:

- `MANPATH`: A lists of directories where your system will look for `man` pages.
- `PATH`: A list of directories that your system will search for executable files.
- `HOSTNAME`: The name of your computer. When booting, your computer reads this variable from the file `/etc/HOSTNAME`.
- `PS1`: The current prompt layout that your computer uses.
- `SHELL`: The name of the shell the current user is using.
- `TERM`: The terminal type that is used. This is an important variable, because it defines how text on your console is displayed.
- `USER`: The name of the current user.
- `LANG`: The current language settings and what language is used to display items like `man` pages. This variable is important for international users. `POSIX` is the setting for US English. If, for example, you want to use the French language, change this setting to `fr_FR.UTF-8`.

Normally, as a user, you'll get your variables automatically when logging in to the system. The most important source of new variables is the /etc/profile file, a script that is processed for every user who logs in to the system. Want to add a new variable for all users on your system? Add it to the bottom of the /etc/profile file to make sure it is available for all users. You must, however, log in as the system administrator root if you want to do this, if you have some code you want to apply to /etc/profile. Also be aware that changes you make to /etc/profile only become active after you log out and back in to the system.

If you want to make sure that your variable experiments don't cause harm to all users on your system, use the command cd ~ to change to your home directory, and in the directory, create a file with the name .profile. All users can have such a file in their home directories, and it will be treated as an addition to /etc/profile. So if you put a new variable in this file, it will be executed only for the user in whose home directory you inserted this file.

Working with Bash History

Another useful feature of the Bash shell is the history feature, which lets you reuse commands you have recently used. Many distributions will remember the last 1,000 commands that a user has used; in fact the number of commands the shell remembers is defined in a variable itself. The name of this variable is HISTSIZE. The history feature is useful for sessions beyond even the current one. A file, named .bash_history, is created in the home directory of every user, and this file records the last 1,000 commands that the user has entered. You can see an overview of these commands by entering history at the Bash prompt. Listing 1-10 is an example of this list.

■ **Note** In addition to the history command, you can also use the up/down arrow keys, page up/down keys, and Ctrl+P/Ctrl+N to browse the history.

Listing 1-10. *The history Command Shows a List of All Commands That You Recently Used*

```
sander@RNA:~$ history
....
  182  ls -l -h
  183  ls -l --human-readable
  184  clear
  185  ls -l /etc/hosts
  186  ls -R / | less
  187  ls -R
  188  ls -R /
  189  clear
  190  ls -R /
```

```
191  clear
192  cd /
193  clear
194  less /etc/hosts
195  clear
196  ls -R / | less
197  clear
198  mail -s hello root
199  type ls
200  type cd
201  man ls
202  clear
203  ls --help | less
204  history
```

The history feature is especially useful because you can reissue any command from this list without typing it all over again. If you want to run any of the listed (and numbered) commands again, simply type its number preceded by an exclamation mark. In this example, typing **!198** would run `mail -s hello root` again.

A user can also erase his or her history by using the `history` command. The most important option offered by this Bash internal command is `-c`, which clears the history list for that user. This is especially useful because everything that a user types at the command line—such as passwords—is recorded. So use `history -c` to make sure your history is cleared if you'd rather not have others knowing what you've been up to. Once you use this option, however, you can't use the up arrow key to access previous commands, because those are all erased.

Because everything you enter from the command line is saved in the file `.bash_history` in your home directory, I recommend never entering a plain-text password in the first place, even if you regularly erase the history. Never forget that the history file is also a default keylogger on your Linux system!

Managing Bash with Key Sequences

Sometimes, you'll enter a command from the Bash command line, and either nothing happens at all or something totally unexpected happens. In such an event, it's good to know that some key sequences are available to perform basic Bash management tasks. Here are some of the most useful key sequences:

- *Ctrl+C*: Use this key sequence to quit a command that is not responding (or simply takes too long to complete). This key sequence works in most scenarios where the command is operational and producing output to the screen. In general, Ctrl+C is also a good choice if you absolutely don't have a clue as to what's happening, and you just want to terminate the command that's running in your shell. If used in the shell itself, it will close the shell as well.
- *Ctrl+D*: This key sequence is used to send the "end of file" (EOF) signal to a command. Use this when the command is waiting for more input, which is indicated by the secondary prompt (>). You can also use this key sequence to close a shell session.

- *Ctrl+R*: This is the reversed search feature. It will open the "reversed I-search" prompt, which helps you locate commands that you used previously. The Ctrl+R key sequence searches the Bash history, and the feature is especially useful when working with longer commands. As before, type the first characters of the command, and you will see the last command you've used that started with the same characters.
- *Ctrl+Z*: Some people use Ctrl+Z to stop a command that is running interactively on the console (in the foreground). Although it does stop the command, it does not *terminate* it. A command that is stopped with Ctrl+Z is merely paused, so that you can easily start it in the background using the `bg` command or in the foreground again with the `fg` command. To start the command again, you need to refer to the job number that the program is using. You can see a list of these job numbers using the `jobs` command. You will learn more on running commands in the background in Chapter 7. For the moment, just remember *never* to use this key sequence if you want to stop a command!

Summary

In this chapter, you have learned about the essentials you'll need to know to work with Linux. The following topics were covered:

- History of the Linux operating system
- What is open source?
- Differences between distributions
- Logging in to Linux
- Structure of a command, including options and arguments
- Piping and redirection
- Getting help with `man` and `--help`
- Working with the shell

Based on the information in this chapter, you now have the basic skills that are required to start using some commands. In the next chapter, you'll learn about some useful commands and the way they work.