Chapter 1

Prepare for Red Hat Hands-on Certifications

CERTIFICATION OBJECTIVES

The Red Hat exams are an advanced challenge. This book covers the Red Hat Certified System Administrator (RHCSA) exam in Chapters 1 to 9, and it provides the foundation for those who want to earn the Red Hat Certified Engineer (RHCE) certification in the subsequent chapters. Red Hat offers several courses to help prepare for these exams, as described in the front matter and in this chapter.

The focus of this chapter is installation, to create a common version of Red Hat Enterprise Linux (RHEL) as a test bed for future chapters. It assumes and describes hardware required to implement Red Hat's default virtualization solution, the Kernel-based Virtual Machine (KVM). As rebuild distributions such as the Community Enterprise Operating System (CentOS) and Scientific Linux are essentially identical to RHEL, you should be able to use those solutions too. Just about the only differences between a rebuild and RHEL are the trademarks and the access to repositories, which will be described in Chapter 7.

Those of you familiar with earlier versions of the Red Hat requirements may remember the changes to the Red Hat exams during the past years. After the release of RHEL 6, Red Hat discontinued the RHCT exam and replaced it with the RHCSA. Although the RHCSA is, in many ways, similar to the RHCT, there are significant differences. Most RHCSA objectives were covered on the former RHCT exam. However, the RHCSA is not easier than the RHCT; it is just a prerequisite to the RHCE. The RHCSA also includes a number of requirements that were formerly part of the RHCE objectives.

Red Hat suggests that candidates for the RHCSA have one to three years of experience with the bash shell, user administration, system monitoring, basic networking, software updates, and more. Details are described in the introduction to this book.

If you're new to Linux or Unix, this book may not be enough for you. It's not possible to provide sufficient detail, at least in a way that can be understood by newcomers to Linux and other Unix-based operating systems. If after reading this book, you find gaps in your knowledge, please refer to one of the following guides:

- *Linux Administration: A Beginner's Guide,* Seventh Edition, by Wale Soyinka (McGraw-Hill, 2016), provides a detailed step-by-step guide to this operating system.
- *Security Strategies in Linux Platforms and Applications,* by Michael Jang (Jones & Bartlett, 2010), gives you a detailed look at how you can secure your Linux system and networks in every possible way.
- *LPIC-1 in Depth,* by Michael Jang (Course Technology PTR, 2009), covers the certification many Linux professionals qualify for prior to working on the RHCSA and RHCE.

Before installing Red Hat Enterprise Linux (RHEL), you need the right hardware. The installation of RHEL 7 is supported only on systems with 64-bit CPUs. This is not a problem if you have a server with the latest Intel or AMD processor model, but may be an issue if you want to install RHEL 7 on a machine running a 10-year-old Pentium CPU. Details are discussed in the chapter. As such, while the RHCSA and RHCE exams are, by and large, not hardware exams, some basic hardware knowledge is a fundamental requirement for any Linux administrator. As for the operating system itself, you can purchase a subscription to RHEL, or you can use one of the "rebuild" distributions where the distribution is built by third parties from source code publicly released by Red Hat.

If you're experienced with other Unix-type operating systems such as Solaris, AIX, and HP-UX, prepare to leave some defaults at the door. There are even significant differences between the Ubuntu and Red Hat distributions. When Red Hat developed its Linux distribution, the company made some choices that differed from other Unix implementations. When one of the authors of this *Study Guide* took Red Hat's RH300 course, some students with these backgrounds had difficulties with the course and the RHCE exam.

For the purpose of this book, we'll be running most commands as the Linux administrative user, root. Logging in as the root user is normally discouraged unless you're administering a computer. However, since the RHCSA and RHCE exams test your administrative skills, it's appropriate to run commands in this book as the root user. Of course, you will also need to know how to set up regular users with partial or full administrative privileges.

INSIDE THE EXAM

A Virtual Host

The RHCSA assumes that you know how to "configure a physical machine to host virtual guests." In other words, you need to be able to prepare a system to house VMs where other instances of RHEL (or even other operating systems such as Microsoft Windows) can be installed.

As this is RHEL, this is based on the Red Hat default VM system, KVM. Because appropriate rebuild distributions such as CentOS and Scientific Linux use the same source code, they also use KVM. In this chapter, not only will you install RHEL, but also you will install those packages that support KVM.

Default File Sharing Configuration Services

In the previous version of the RHCSA exam, candidates were expected to know how to "configure a system to run a default configuration HTTP server" and "configure a system to run a default configuration FTP server." Although those requirements have been removed from the RHCSA objectives on RHEL 7, we think that they are still valuable skills for your preparation, especially if you want to set up a remote HTTP or FTP software repository for a lab environment. Hence, in this chapter we have briefly illustrated the configuration of a simple HTTP and FTP server.

The default Red Hat solutions for these services are the Apache web server and the Very Secure FTP Daemon (vsftpd) server. Although these services can be complex, the steps required to set up these servers to share files are fairly simple. In fact, no changes are required to the default configuration files for these services. Some of the related steps described in this chapter depend on skills presented in future chapters.

(*Continued*)

The original release of the RHCSA objectives was worded slightly differently: "Deploy file sharing services with HTTP/FTP." We believe this provided a significant clue to Red Hat's original intent with these objectives. To that end, you'll examine how to set up these services as file servers, based on their default configurations.

Using Other Versions of Red Hat

For the purpose of this chapter, you can install RHEL 7 using a paid subscription or from a demonstration DVD. You can also use one of the rebuild distributions. However, whereas RHEL 7 is based in part on the work done by many open-source contributors, it's also based on both the Fedora 19 and 20 releases. Don't use Fedora to study for the Red Hat exams. If you use Fedora 19 or 20, some configuration settings may differ from RHEL 7. Later versions of Fedora are likely to have features not found in RHEL 7.

CERTIFICATION OBJECTIVE 1.01

The RHCSA and RHCE Exams

Red Hat first started giving certification exams in 1999. Since that time, its exams have evolved. The former RHCT was a complete subset of the RHCE. Today, the RHCSA covers topics separate from but closely related to the RHCE.

In addition, Red Hat has focused the exams more on hands-on configuration. Multiple choice questions were removed from the exam in 2003. More recently, in 2009, it simplified the exam by removing the requirement to install Linux on a "bare-metal" system. (However, the changes implemented in 2011 suggest that you need to know how to install Linux over a network on a VM.) In addition, there is no longer a separate troubleshooting portion of the exam. For more information, see http://www.redhat.com/certification/faq.

exam Watch

Red Hat provides "pre-assessment" tests for Red Hat RHCSA and RHCE Exam Prep courses. They correspond to the RH134 and RH254 courses, respectively. These tests are available through http://www.redhat.com/en/services/training/skills-assessment. Red Hat requires contact information before providing those pre-assessment tests.

The Exam Experience

Red Hat's certification tests are hands-on exams. As a result of this, they are respected throughout the industry as a sign of genuine practical knowledge. When you pass a Red Hat exam, you will stand head and shoulders above the candidate who has passed only a "standard" multiple choice certification exam.

When time starts, you'll be faced with a live system. You'll be given actual configuration problems associated with the items listed in the exam objectives for each certification, shown at http://www.redhat.com/en/services/certification/rhcsa and http://www.redhat.com/en/services/certification/rhce. Naturally, this book is dedicated to helping you gain the skills described on those web pages.

While you won't have Internet access during the exam, you will have access to online documentation such as man and info pages, as well as documentation in the /usr/share/doc/ directories, assuming appropriate packages are installed.

In addition, Red Hat provides the exam in electronic format. Although the basic instructions may be in a local language such as English, the RHCSA and RHCE exams are available in 12 different languages: English, Simplified Chinese, Traditional Chinese, Dutch, French, Italian, Japanese, Korean, Portuguese, Russian, Spanish, and Turkish. If one of these alternatives is desired, you should contact Red Hat training to be sure, at training@redhat.com or 1-866-626-2994.

Red Hat also has prep courses for both exams. The outlines for those courses are available from http://www.redhat.com. Although this book is not intended as a substitute for such courses, it is consistent with their outlines. This book covers the objectives associated with each of these exams.

exam Watch

This book's coverage of the items listed in the RHCSA and RHCE exam objectives can be found in the front matter for this book, in Table 2, page xlii.

The RHCSA Exam

The RHCSA exam allows you to demonstrate your ability to configure live physical and virtual systems for networking, security, custom filesystems, package updates, user management, and more. In essence, the RHCSA exam covers those skills required to configure and administer a Linux workstation in the enterprise.

The RHCSA exam lasts two and a half hours. When you sit down to take the exam, you'll have tasks to perform on a live RHEL system. Any changes that are made must survive a reboot. When you've completed the given tasks, the person grading the exam will see if the system is configured to meet the requirements. For example, if you're told to "create, delete,

and modify local user accounts," it doesn't matter if the associated configuration file has been modified with the **vi** editor or the graphical User Manager tool. As long as you don't cheat, it's the results that count.

The RHCE Exam

The RHCE exam tests your ability to configure live physical and virtual servers, running network services such as Apache, MariaDB, the Network File System (NFS), Samba, iSCSI targets, and more. It also tests your ability to handle complex configuration options associated with Security Enhanced Linux (SELinux), firewalls, networking, and more. In essence, if you pass the RHCE exam, hiring managers will know that you're qualified to help manage their enterprises of Linux systems.

The RHCE exam lasts three and a half hours. When you sit down to take the exam, you'll be given tasks to perform on a live RHEL system. As with the RHCSA, any changes that are made must survive a reboot. Usually, there are different ways to complete a task. For example, you can use BIND or Unbound to set up a caching name server. The choice is up to you; it's the result that matter, rather than how you actually got there.

The topics in the Red Hat preparation courses in a few areas go beyond those listed in the Red Hat Exam Prep guide. Although such topics are not currently part of the exam, they may be included in future versions of the Red Hat exams.

If You're Studying "Just" for the RHCSA Exam

Red Hat has been known to make minor changes to the requirements on occasion. Future changes may be based on topics covered in the Red Hat RHCSA Rapid Track course, RH199/RH200. So if you're not planning to take the RHCSA within the next few months, watch the outline for that course. It may, in effect, be a preview of where Red Hat wants to take the RHCSA exam in the future.

Evolving Requirements

Changes happen to the requirements for the Red Hat exams. You can see that in the differences between the old RHCT exam and the RHCSA. You can see that in the changes to the exam format, where bare-metal installations are no longer required. In fact, that change happened over two years into the life of RHEL 5. Changes happened in the first month after RHEL 6 was released. So when you're preparing for the RHCSA or RHCE exam, watch the associated exam objectives carefully.

CERTIFICATION OBJECTIVE 1.02

Basic Hardware Requirements

Now it's time to explore in detail the hardware that Red Hat Enterprise Linux can handle. Although some manufacturers now include their own Linux hardware drivers, most Linux hardware support comes from third parties, starting with the work of volunteers. Fortunately, there is a vast community of Linux users, many of whom produce drivers for Linux and distribute them freely on the Internet. If a certain piece of hardware is popular, you can be certain that Linux support for that piece of hardware will pop up somewhere on the Internet and will be incorporated into various Linux distributions, including Red Hat Enterprise Linux.

Hardware Compatibility

RHEL 7 can be installed only on 64-bit systems. Fortunately, most PCs and servers sold today are 64-bit systems. Even the lowly Intel i3 CPU can handle 64-bit operating systems. There are even 64-bit versions of the Intel Atom CPU common on netbook systems. Similar comparisons can be made for CPUs from Advanced Micro Devices.

Be careful when purchasing a new computer to use with Linux. Though Linux has come a long way the last few years, and you should have little problem installing it on most modern servers or PCs, you shouldn't assume Linux will install or run flawlessly on *any* computer, especially if the system in question is a state-of-the-art laptop computer. Laptops are often designed with proprietary configurations that work with Linux only after some reverse engineering. For example, when one of the authors of this book installed RHEL 7 on a brand-name laptop built in 2014, he had to do a bit of extra work to make the graphics card work with RHEL 7.

The architecture of a server or PC defines the components it uses as well as the way those components are connected. In other words, the architecture describes much more than just the CPU. It includes standards for other hardware such as memory, data paths such as computer buses, general system design, and more. All software is written for a specific computer architecture.

Even when a manufacturer creates a device for a CPU platform, it may not work with Linux. Therefore, it's important to know the basic architecture of a computer. But strictly speaking, if you want hardware compatible with and supported by Red Hat, consult the hardware compatibility list at https://hardware.redhat.com.

exam Watch

While it is important to know how Linux interacts with your hardware, the Red Hat exams are not hardware exams. However, to practice you do need to install RHEL 7 (or equivalent). And to configure a system for KVM, which requires hardware-assisted virtualization, you need a system with 64-bit CPUs and related hardware.

Architectures

Although RHEL 7 has been built for a variety of architectures, you can focus on the Intel/AMD 64-bit or x86_64 architecture for the RHCSA and RHCE exams. As of this writing, these exams are offered only on computers with such CPUs, so you need not worry about special architecture-specific issues such as specialty bootloaders or custom proprietary drivers. Nevertheless, customized Red Hat distributions are available for a variety of platforms.

You can install RHEL 7 on systems with a wide variety of CPUs. Red Hat supports three different basic 64-bit CPU architectures:

- Intel/AMD64 (x86_64)
- IBM POWER7
- IBM System z

To identify the architecture of a system, run the following command:

```
# uname -p
```

If you're planning to configure VMs on RHEL 7, be sure to choose a system that supports hardware-assisted virtualization, along with Basic Input/Output System (BIOS) or Universal Extensible Firmware Interface (UEFI) menu options that allow you to activate hardware-assisted virtualization. A configuration that supports hardware-assisted virtualization will have either the **vmx** (Intel) or **svm** (AMD) flags in the /proc/cpuinfo file.

on the Job

If you're not sure about a system, look at the processor specifications on the vendor's website, and check that the processor comes with extensions for hardware-assisted virtualization.

RAM Requirements

Although it's possible to run RHEL 7 on less, the RAM memory requirements are driven by the needs of the Red Hat installer. For basic Intel/AMD-based 64-bit architectures, Red

Hat officially requires 1GB of RAM. However, the graphical installer runs with a minimum of 512MB.

Of course, actual memory requirements depend on the load from every program that may be run simultaneously on a system. That can also include the memory requirements of any VMs that you might run on a physical RHEL 7 system. There is no practical maximum RAM because, theoretically, you could run 64TB of RAM on RHEL 7. But that's just theory. The maximum RAM supported on RHEL 7 for 64-bit Intel/AMD-based systems is 3TB, and since RHEL 7.1 the limit has been increased to 6TB.

If you're setting up Linux as a server, RAM requirements increase with the number of applications that may need to run simultaneously. The same may be true if you're running several different VMs on a single system. However, administrators typically "overcommit" RAM on VMs configured with different functionality. VMs can also transparently share memory pages to further improve efficiency.

Hard Drive Options

Before a computer can load Linux, the BIOS or UEFI has to recognize the active primary partition on the hard drive. This partition should include the Linux boot files. The BIOS or UEFI can then set up and initialize that hard drive, and then load Linux boot files from that active primary partition. You should know the following about hard drives and Linux:

- The number of drives that can be installed on modern computers has increased. On commodity hardware it's relatively easy to get 16 or 24 Serial Advanced Technology Attachment (SATA) or Serial Attached SCSI (SAS) internal drives on a system.
- You need both a UEFI firmware and a GPT-partitioned disk to boot from a drive larger than 2TB. UEFI is a firmware interface that is meant to replace the traditional BIOS, and today is available on many PCs on the market. The GUID Partition Table (GPT) is a partitioning format that supports drives larger than 2TB, but you also require a UEFI firmware (rather than a traditional BIOS firmware) to boot from such device.
- You can install RHEL 7 on a storage area network (SAN) volume. RHEL 7 supports more than 10,000 multipath devices.

Networking

As Linux was originally designed as a clone of Unix, it retains the advantages of Unix as a network operating system. However, not every network component works with Linux. A number of manufacturers of wireless network devices have not built Linux drivers. In most such cases, Linux developers have been working furiously to develop appropriate drivers and to get those drivers incorporated into the major distributions, including RHEL.

Virtual Machine Options

Virtualization makes it relatively easy to set up a large number of systems, so it can help you configure machines, each dedicated to a specific service. To that end, virtualization can be classified into different categories. Some solutions can belong to more than one category. As an example, VMware ESXi is a bare-metal, hypervisor-based virtualization solution that supports hardware-assisted virtualization and provides optional paravirtual drivers to be installed on the guest OS.

- **Application level vs. VM level** Systems such as Wine Is Not an Emulator (Wine) support the installation of a single application. In this case, Wine allows an application designed for Microsoft Windows to be installed on Linux. On the other end, VM-level virtualization emulates a number of complete computer systems for the installation of separate guest OSs.
- **Hosted vs. bare-metal hypervisor** Applications such as VMware Player and VirtualBox are hosted hypervisors because they run on a conventional operating system such as Microsoft Windows 8. Conversely, bare-metal virtualization systems, such as VMware ESXi and Citrix XenServer, include a minimal operating system dedicated to VM operations.
- **Paravirtualization vs. full virtualization** Full virtualization allows a guest OS to run unmodified on a hypervisor, whereas paravirtualization requires specialized drivers to be installed in the guest OS.

The KVM solution configured with RHEL 7 is known as a hypervisor—a VM monitor that supports the running of multiple operating systems concurrently on the same CPU. KVM replaces the previous default in RHEL 5, Xen.

KVM has replaced Xen in many open-source distributions. XenServer is owned by Citrix.

Another virtualization approach that is attracting a lot of interest is Linux containers, such as those provided by the Red Hat Enterprise Linux Atomic Host project. This solution is not hypervisor based but rather relies on the process and filesystem isolation techniques available in the Linux kernel (that is, cgroups and namespaces) to run multiple isolated Linux systems on the same physical host.

CERTIFICATION OBJECTIVE 1.03

Get Red Hat Enterprise Linux

The RHCSA and RHCE exams are based on your knowledge of RHEL. To get an official copy of RHEL, you'll need a subscription. In some cases, trial subscriptions are available. However, if you don't need the same "look and feel" of RHEL to prepare for an exam, third-party rebuilds are available. As such, "rebuilds" use the same source code as RHEL, and except for the trademarks and the connection to the Red Hat Customer Portal, they're essentially functionally identical to RHEL.

Once you either purchase a subscription or get approved for an evaluation copy, you'll be able to download RHEL 7 from the Red Hat Customer Portal at https://access.redhat.com/downloads. Downloads are available for the operating system in a format appropriate for a DVD. There's also a download available for a network boot CD. You'll even be able to download files with the source code for associated packages. These downloads are in ISO image format, with an **.iso** extension. Such files can be burned to appropriate media, using standard tools such as K3b, Brasero, and even corresponding tools on Microsoft systems. Alternatively, you can set up a VM where the virtual CD/DVD drive hardware points directly to the ISO file, as discussed in Chapter 2. Unless you purchase an actual boxed subscription, the burning or other use of these ISO files is your responsibility.

exam Watch

Although it is important to know how to get RHEL, that skill is not a part of the objectives for the RHCSA or RHCE exam.

Be aware, some of the installation options described in this part of the chapter have been subdivided into different sections. For example, the ways you can configure partitions are spread across multiple sections.

Purchase a Subscription

Different subscriptions are available for desktops, workstations, and servers. While the RHCSA is focused on workstations, it also does require the configuration of SSH and NTP services. Of course, the RHCE also requires the configuration of a variety of network services. Therefore, ideally most readers would need a server subscription.

A variety of server subscriptions are available, depending on the number of CPU sockets and virtual guests, and on the support level. A system associated with a standard RHEL subscription is limited to two CPU sockets and two virtual nodes. Each socket can have a multicore CPU. Significant discounts for academic users are available.

Red Hat also offers a "Red Hat Linux Development Suite" subscription, currently priced at $99 in the United States. This subscription provides download access to RHEL and several types of add-on software, but it is limited to development use only. According to the Red Hat legal agreement for Subscription Services, "development purposes" means that the software can also be used for testing.

Get an Evaluation Copy

Red Hat currently offers a 30-day unsupported evaluation option for RHEL. Red Hat requires some personal information from such users. Once approved by Red Hat, you'll get instructions on how to download the distribution. However, Red Hat provides evaluation subscriptions "for the sole purpose of evaluating the suitability of the Subscription Services for your future purchase, [...] and not for Production Purposes, Development Purposes or any other purpose."

Third-party Rebuilds

You don't have to pay for operating system support to prepare for Red Hat exams. To comply with the Linux General Public License (GPL), Red Hat releases the source code for just about every RHEL package. However, the GPL only requires that Red Hat makes the source code available to its customers. Red Hat does not have to make the binary packages compiled from that source code publicly available.

The description in this book of the GPL, trademark law, and Red Hat legal agreement for Subscription Services is not a legal opinion and is not intended as legal advice.

Under trademark law, Red Hat can prevent others from releasing software with its trademarks, such as the Red Hat logo. Nevertheless, the GPL gives anyone the right to compile that source code. If they make changes, all they need to do is release their changes under the same license. And several "third parties" have taken this opportunity to remove the trademarks from the released source code and have compiled that software into their own rebuilds, functionally equivalent to RHEL.

The RHEL source code, which used to be available at ftp://ftp.redhat.com for earlier releases, has now been moved to https://git.centos.org/project/rpms. However, the building of a distribution, even from source code, is a tricky process. But once complete, the rebuild has the same functionality as RHEL. Although it is true that rebuild distributions don't have a connection to and can't get updates from the Red Hat Customer Portal, this is not part of the Red Hat Exam Prep guide. And the developers behind rebuild distributions also use the

source code associated with new RHEL packages to keep their repositories up to date. Here are two options for rebuild distributions:

- **Community Enterprise Operating System (CentOS)** The rebuild known as CentOS includes a number of experienced developers who have been working with RHEL source code since the release of RHEL 3 back in 2002. In 2014, the CentOS project joined the Red Hat community. The current board of the project includes members from Red Hat as well as from the original CentOS core team. For more information, see http://www.centos.org.
- **Scientific Linux** This distribution is developed and supported by experts from the U.S. Government's Fermilab and the European Organization for Nuclear Research, known by its French acronym, CERN. The people associated with these organizations are among the smartest scientists around. For more information, see http://www.scientificlinux.org.

Check the Download

For downloads from the Red Hat Subscription Manager portal, Red Hat provides checksums based on the 256-bit Secure Hash Algorithm (SHA256). You can check these ISO files against the given checksum numbers with the **sha256sum** command. For example, the following command calculates the SHA256 checksum for the initial RHEL 7 DVD:

```
# sha256sum rhel-server-7.0-x86_64-dvd.iso
```

Although it's a good sign when a downloaded ISO image passes these tests, such a result is not a guarantee that the burned DVD will be free of errors.

CERTIFICATION OBJECTIVE 1.04

Installation Requirements

According to the Red Hat certification blog, Red Hat provides "pre-installed systems" for its exams. So you won't start from scratch, at least for the host physical system, but you'll still need to set up practice systems. The RHCSA objectives suggest that you need to do so with a network installation. On a pre-installed system, given the other requirements, that means that you need to know how to set up network installations on KVM-based VMs.

The installation requirements described in this section are suited to the creation of an environment for practice labs. That environment may also work as a baseline for other RHEL systems. On many real networks, new virtual systems are created or cloned from that baseline. Those new systems are then dedicated for a single service.

exam Watch

The Red Hat virtualization product is KVM. You can use VMware, VirtualBox, or any other third-party virtualization product to study for the Red Hat exams if you wish, but you do also need to practice with KVM.

When you create a physical host for test VMs, make sure to have enough room available for the host physical system and the guest VMs. This section suggests that you create three VMs for test purposes. For such purposes, 80GB of free space on a physical system would be sufficient. With some careful planning, you may be able to live with a smaller amount of free space and just two VMs. For more information on how to configure RHEL 7 on a VM, see Chapter 2.

You Won't Start from Scratch

Before installing RHEL 7, it may be helpful to review what is known about the latest RHCSA and RHCE exams. As described in the Red Hat blog announcement at http://redhatcertification.wordpress.com/, Red Hat now provides the following:

- Pre-installed systems
- Questions presented "electronically"

In other words, when seated for an exam, you'll see an installed copy of RHEL 7 on the test system, with questions in some electronic format. No public information is available on the format of the questions. This book will assume the most basic format for Red Hat exam questions—text files available in the root administrative user's home directory, /root.

The Advantages of Network Installation

Network installation means you don't have to use a full DVD on every system when installing RHEL 7. It means that every system is installed from the same set of installation packages, which are available on a remote software repository over the network. Network installations are usually faster than those from physical DVDs.

Network installations become especially powerful when combined with Kickstart files and the Pre-boot eXecution Environment (PXE). In that configuration, all you need to do to install RHEL 7 is boot a system, automatically download the appropriate Kickstart file, and—voila!—after a few minutes, you'll have a complete RHEL 7 installation.

on the Job

It is important to understand how you plan to configure VMs before setting up a physical host system. Although we describe basic information about the VMs in this chapter, you won't set up the actual KVM-based VMs until Chapter 2.

Red Hat and Virtual Machines

The objectives associated with the RHCSA suggest that you need to know how to "configure a physical machine to host virtual guests." It also suggests that you need to know how to perform a number of tasks with VMs as well as "install Red Hat Enterprise Linux automatically using Kickstart." That's consistent with the use of Kickstart files to set up RHEL 7 on a KVM-based VM.

One of the advantages of a VM is how it supports the use of an ISO file on a virtual CD/DVD drive. Files accessed from that virtual drive are not slowed by the mechanical speed of physical CD/DVD media. Therefore, virtual CD/DVD drives might be as fast as network access from a host system.

Virtual and Physical Systems

Virtual systems can't stand alone. They require some connection to a physical system. Even a "bare-metal" virtualization solution such as Citrix XenServer was built from or otherwise relies on a specialized version of the Linux kernel, which acts as the operating system on the physical host.

However, it's possible to install a substantial number of virtual systems on a single physical system. If those systems are dedicated to different services, they'll load the physical system at different times. Such loads make it possible to "overcommit" the RAM and other resources of the physical system.

For our purposes, there is no real difference whether the installation is performed on a physical or a virtual system. The software functions in the same way. As long as IP forwarding is enabled on the physical host system, networking on the virtual system works in the same way as well.

A Pre-installed Environment for Practice Labs

The baseline RHEL 7 system configured in this chapter is relatively simple. It starts with a 16GB virtual disk. Part of that disk will be organized as shown in Table 1-1. Some of the space will be configured as regular partitions. The remaining space on the hard drive will be left empty for potential configuration during the lab exercises as logical volumes.

Two additional virtual disks of 1GB each are included to facilitate the post-installation configuration of a logical volume. The 16GB hard disk and 10GB root partition are arbitrary sizes that provide plenty of room for RHEL 7 software. If space is limited on your system, you might go as low as 8GB for a virtual disk or skip full disk allocation, as long as swap space is also appropriately limited. Swap space in Linux is used as an extension of local RAM, especially when that resource runs short.

The baseline minimum installation of RHEL 7 does not include a GUI. Although it is fairly easy to install the package groups associated with the GUI after installation is

TABLE 1-1

Filesystem Mount Points

Location	Size
/boot	500MB
/	10GB
/home	1024MB
Swap	1024MB

complete, that process requires the installation of several hundred megabytes' worth of packages. And that takes time. Since Red Hat provides a pre-installed system to reduce the time required for the exam, it is reasonable to suggest that the system provided by Red Hat includes the GUI. And the default GUI for Red Hat systems is the GNOME Desktop Environment.

GNOME was initially an acronym within an acronym. It stood for the GNU Network Object Model Environment. GNU is itself a recursive acronym because it stands for GNU's Not Unix. Linux is filled with similar recursive acronyms, such as PHP: Hypertext Preprocessor (PHP).

The amount of RAM to allocate is more complex, especially on a VM. For the purpose of this book, we've configured VMs with 1GB of RAM to comfortably enable GUI-based illustrations of the RHEL installation process. If text-mode installations are acceptable, you can run RHEL 7 in 512MB of RAM, or possibly even less. Since different VMs rarely use all the RAM simultaneously, it's possible to "overcommit" RAM; for example, it may be possible to set up three VMs, with 1GB of RAM each, on a physical host system with less than 3GB of physical RAM. Some RAM on the VMs will remain unused, available to the physical host system.

System Roles

Ideally, you can set up several systems, each dedicated to different roles. A network with a dedicated DNS (Domain Name Service) server, a dedicated DHCP (Dynamic Host Configuration Protocol) server, a dedicated Samba file sharing server, and so on is more secure. In that situation, a security breach in one system does not affect any other services.

However, that's not practical, especially during the Red Hat exams. Table 1-2 lists the roles appropriate for each of the three systems described in Lab 1.

TABLE 1-2

Roles for Test Systems

System	Roles
server1	Main server to practice with the labs in this book, configured as server1.example.com on the 192.168.122.0/24 network. This book assumes a fixed IP address of 192.168.122.50.
tester1	Secure shell server that supports remote access, configured as tester1.example.com on the 192.168.122.0/24 network. May include servers for client testing, such as the Domain Name Service (DNS). This book assumes a fixed IP address of 192.168.122.150.
outsider1	Workstation on a third IP address, configured as outsider1.example.org. Some services should not be accessible from that workstation. This book assumes a fixed IP address of 192.168.100.100.

There's also another implicit fourth system in this network—the physical host for the virtual machines. We will configure some services used by the other nodes (such as the files required to install the other VMs) on this machine later in this chapter. When multiple networks are configured, that host will have virtual network adapters that connect to each network. For this book, we've set up a system named maui.example.com. The following excerpts from the **ip address show** command display the virbr0 and virbr1 adapters, with connections to both networks:

```
4: virbr0 <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue↵
state UP
    link/ether 9e:56:d5:f3:75:51 brd ff:ff:ff:ff:ff:ff
    inet 192.168.122.1/24 brd 192.168.122.255 scope global vibr0
       valid_lft forever preferred_lft forever
5: virbr1 <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue↵
state UP
    link/ether 86:23:b8:b8:04:70 brd ff:ff:ff:ff:ff:ff
    inet 192.168.100.1/24 brd 192.168.100.255 scope global vibr1
       valid_lft forever preferred_lft forever
```

Of course, you can change the names and IP addresses associated with each of these systems. They are just the defaults to be used in this book. The server1.example.com system is the designated exam system, which will be used for exercises that address actual Red Hat exam requirements. For convenience, we have also set up some RHCE services on the physical host system.

The tester1 system can be used to verify the configuration on the server1 system. For example, if you've configured two virtual websites with different names, you should be able to access both websites from the tester1 system. The Red Hat exams assume that you may

connect a system as a client to servers such as Samba and LDAP. They also assume that a DNS server is configured with appropriate hostnames and IP addresses. Although the configuration of some services such as Kerberos is beyond the scope of the RHCSA/RHCE exams, they can be used during the exams by the other systems as clients.

Finally, the outsider1 system is essentially a random system from an external network such as the Internet. Appropriate security settings mean that some services on the server1 machine won't be accessible to outsider1. Before following these recommendations, read Chapter 2. This chapter is focused on the configuration of a physical host system.

CERTIFICATION OBJECTIVE 1.05

Installation Options

Even most beginner Linux users can install RHEL 7 from a CD/DVD. Although this section addresses some of the options associated with installation, it is focused on the creation of that baseline system that can be used to set up other custom RHEL 7 systems.

In addition, the installation process is an opportunity to learn more about RHEL 7, not only boot media, but the logical volumes that can be configured after installation is complete. However, because pre-installed physical systems are now the norm for Red Hat exams, detailed discussions of logical volumes have been consolidated in Chapter 6.

The steps described in this section assume that you're installing directly from the RHEL 7 Binary DVD, or from a USB drive that contains the RHEL 7 Binary DVD image, as explained in the next section.

Boot Media

When you are installing RHEL 7, the simplest option is to boot it from the RHEL 7 DVD. But that's not the only available installation option. In essence, five methods are available to start the RHEL 7 installation process:

- Boot from a RHEL 7 Binary DVD.
- Boot from a USB drive containing the RHEL 7 Binary DVD image.
- Boot from a minimal RHEL Boot CD.
- Boot from a USB key containing a minimal RHEL Boot CD image.
- Boot from a Kickstart server using a PXE network boot card.

The last three options generally assume that you're going to install RHEL over a network. The installation and boot media are available from the Red Hat Customer Portal for users with a subscription. They are also be available from servers associated with rebuild distributions.

Nevertheless, if you need to create a boot USB drive containing the full RHEL 7 DVD image or a flash key with the minimal boot CD, download the appropriate ISO file from the Red Hat Customer Portal. Then, you can write that image to the USB device. If that USB device is located on /dev/sdc, you'd write the image with the following command:

```
# dd if=name-of-image.iso of=/dev/sdc bs=512k
```

Be careful—if /dev/sdc is a drive with data, these commands will overwrite all data on that drive.

Know how to create the right boot disk for your system. If you have a problem, the installation boot CD or USB drive can also serve as a rescue disk. At the boot prompt, a Troubleshooting option will eventually bring you to a Rescue a Red Hat Enterprise Linux System menu, which can start a rescue mode to mount appropriate volumes and recover specific files or directories.

CD/DVD or Boot USB Starts Installation

Now you can boot a target system from the installation DVD or a USB drive. After a few files are opened and decompressed, a RHEL installation screen should appear with at least the following three options:

- Install Red Hat Enterprise Linux 7.0
- Test this media & install Red Hat Enterprise Linux 7.0
- Troubleshooting

The first option should work for most users. If you want to check the integrity of the installation media before starting the installation process, select the second option.

Two modes are associated with the Red Hat installation program (also known as "Anaconda"): text mode and graphical mode. Although the graphical mode is the recommended method, you would be automatically redirected to text mode if the installation program does not properly detect your video card.

You can also force installation in text mode if you wish. To do so, highlight the Install Red Hat Enterprise Linux 7.0 option and press the TAB key. When you do, the following options are revealed on that screen, on one line:

```
> vmlinuz initrd=initrd.img inst.stage2=hd:LABEL=RHEL-7.0\x20Server.x86_64↵
quiet
```

To force installation in text mode, add **inst.text** to the end of this line.

Basic Installation Steps

The basic RHEL installation is straightforward and should already be well understood by any Red Hat certification candidate. Most of the steps are described here for reference; it's useful to remember this process as you work on advanced configuration situations such as the Kickstart files described in Chapter 2.

The order of these steps vary depending on whether they're run directly from the CD/DVD or over a network. Variations occur depending on whether there's a previous version of Linux and Linux-formatted partitions on the local system. For this section, the following assumptions are made:

- Installation based on the RHEL 7 Binary DVD, or from a USB drive that contains the RHEL 7 Binary DVD image
- At least 512MB of RAM
- RHEL 7 as the only operating system on the local computer

However, dual-boot situations are acceptable. In fact, one of the authors of this book usually works on an Intel Core i7 laptop system in a triple-boot configuration where RHEL 7 coexists with Windows 7 and Ubuntu 14.04. If you're installing the system on a dedicated physical computer or a VM, the basic steps are the same. As a physical host is required for VMs, we assume you'll be first installing RHEL 7 on a physical system.

The most efficient way—and therefore (in our opinion) the most likely way—to install Red Hat Enterprise Linux is via a text or graphical installation from a remote server. For that purpose, Lab 2 configures an FTP server with the RHEL 7 installation files. Alternatively, it's possible to set up those installation files on an HTTP server such as the Apache web server, as discussed later in this chapter.

The sequence of steps for the installation process varies, depending on whether you're installing from the DVD or the network installation CD, as well as whether you're installing in text or graphical mode. It also may vary if you're using a rebuild distribution of RHEL 7. So be flexible when reading the following instructions:

1. Boot your computer from the RHEL DVD, or a boot USB drive that contains a copy of the DVD ISO image. Three options are normally shown:
   - Install Red Hat Enterprise Linux 7.0
   - Test this media & install Red Hat Enterprise Linux 7.0
   - Troubleshooting
2. Figure 1-1 illustrates the options from the Scientific Linux 7.0 DVD. Select the first option and press ENTER.
3. Select a language to use during the installation process, as shown in Figure 1-2. English is the default; over 50 options are available.

FIGURE 1-1

The installation boot screen

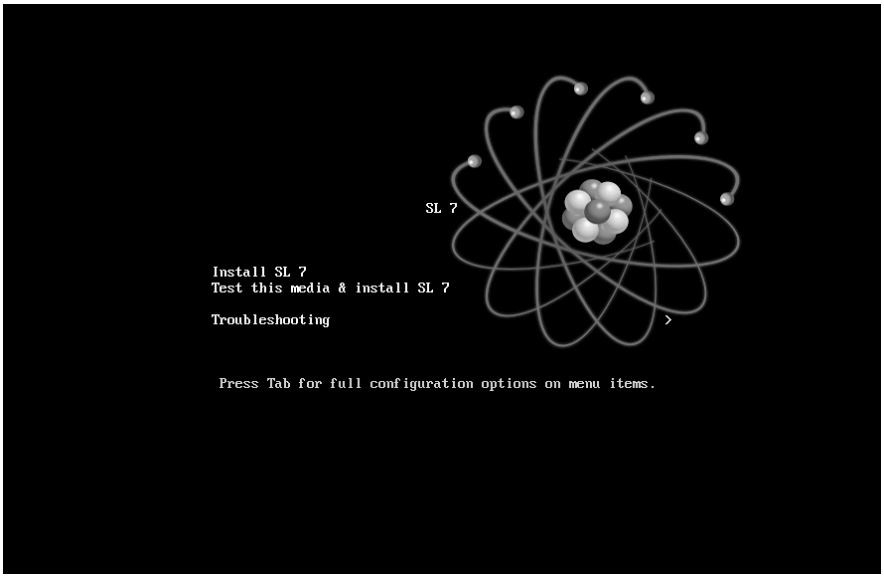
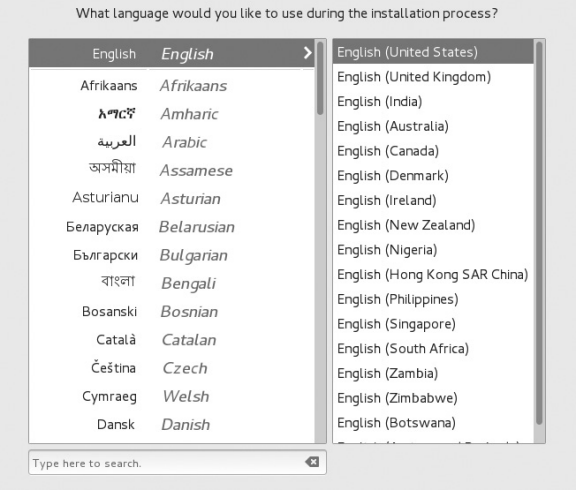


FIGURE 1-2

Select a language for installation

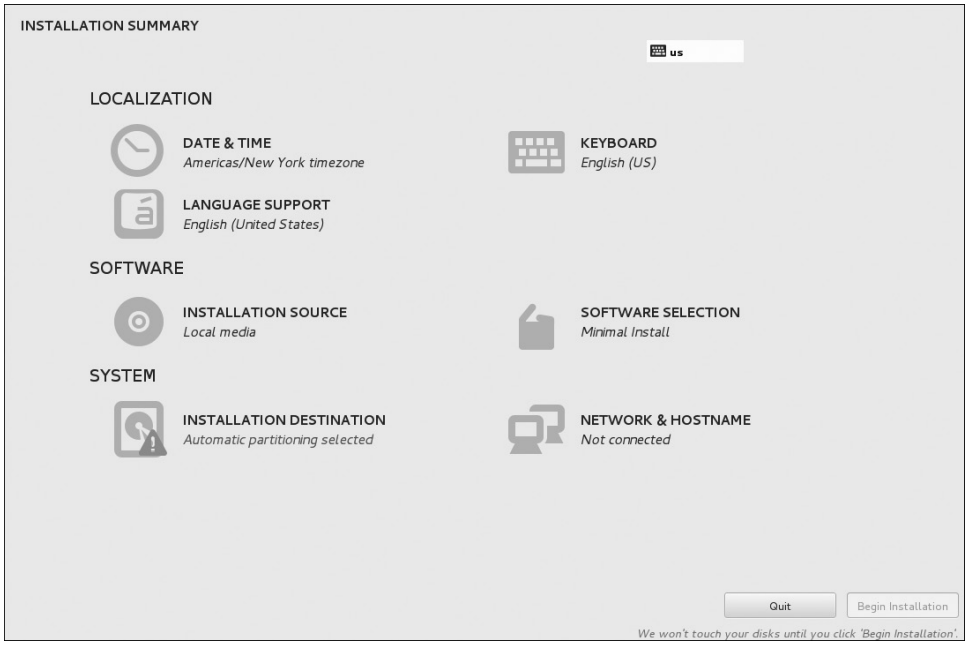


on the Job

If you encounter problems, examine the messages in the first, third, fourth, and fifth consoles; to do so, press CTRL-ALT-F1, CTRL-ALT-F3, CTRL-ALT-F4, or CTRL-ALT-F5. A command line is available by pressing CTRL-ALT-F2. To return to the GUI screen, press CTRL-ALT-F6. If in text-mode installation, you can return to that screen by pressing ALT-F1.

4. The next screen is the Installation Summary screen, shown in Figure 1-3. From this interface you can review and edit all installation settings. As you can see in Figure 1-3, one item in the Installation Summary screen is marked with a "warning" symbol. This indicates that you must configure the corresponding section before being able to proceed with the installation.
5. From the Installation Summary screen, review the date and time zone of the local system, and make appropriate changes if necessary.
6. Similarly, you can review the keyboard configuration and the language settings if needed.

FIGURE 1-3 The Installation Summary screen



7. The next option in the Installation Summary screen relates to the installation media. Because you are installing from a local DVD or USB drive, leave this setting as "Local media." For network installations, you would need to specify the location of an installation source. For example, to point to the FTP server that you will configure in Lab 2, select the "On the network" installation option, specify the ftp:// URL locator from the drop-down menu, and type the IP address and path of the installation source, such as 192.168.122.1/pub/inst.
8. Review the Network & Hostname settings in the Installation Summary screen, as shown in Figure 1-4. The left panel lists the network interfaces detected by the installation program. Select the interface you want to activate, and move the switch at the top-right corner to the ON position.
9. Click the Configure button to choose how you want IP addressing to be configured. You will see the window shown in Figure 1-5. Your options are to enable support as a DHCP client for IPv4 and/or IPv6 addresses, or to manually enter a static IP address. (If the network DHCP server, such as a home router, does not support IPv6, select Ignore in the drop-down menu under IPv6 Settings.) For a physical system on a home network, Automatic (DHCP) should work if your home router provides DHCP services. For the three systems listed in Table 1-2, fixed IPv4 addresses should be set up. If you are not sure what to do, this is an excellent time to plan a network as described in Lab 1.

FIGURE 1-4 The Network & Hostname configuration screen

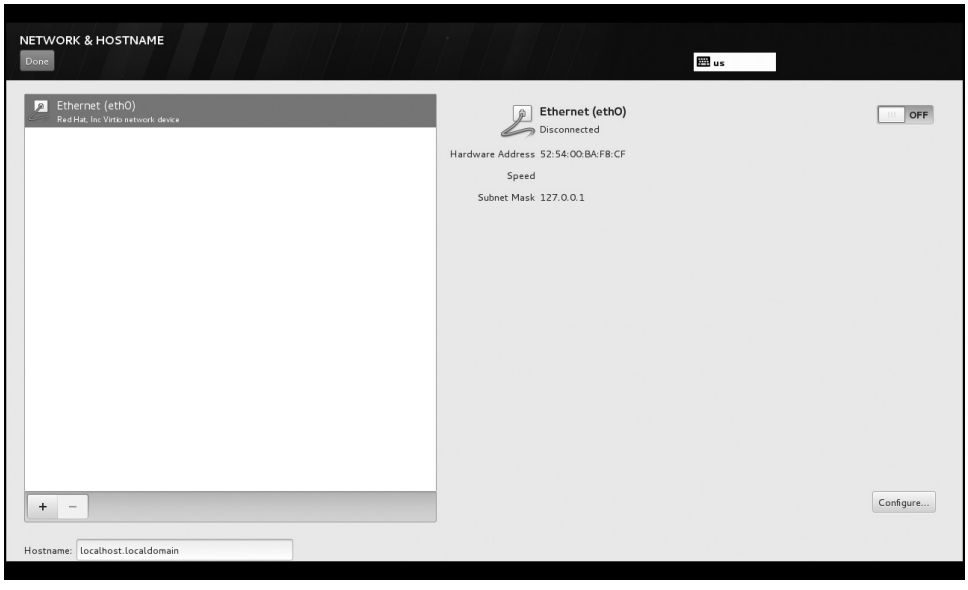
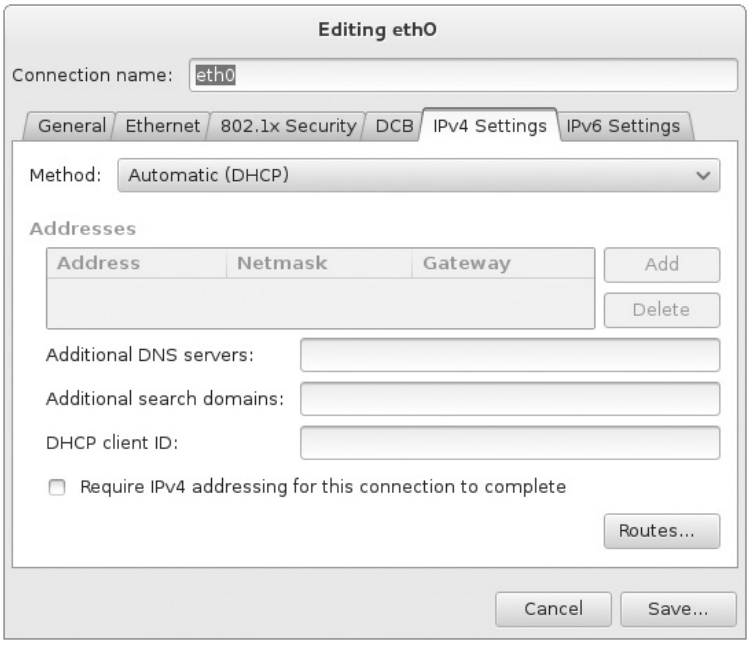


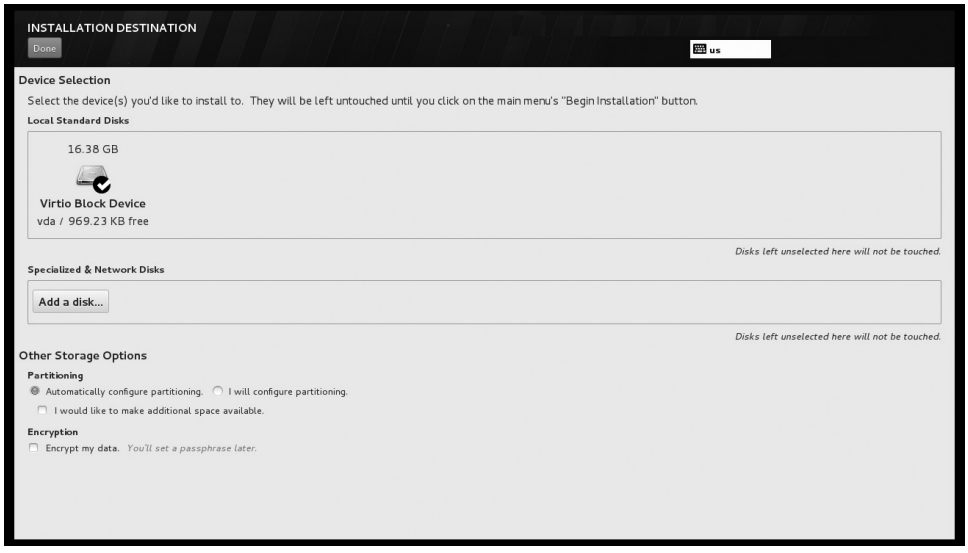
FIGURE 1-5

IPv4 network settings



10. In the input field shown at the bottom left in Figure 1-4, set a hostname for the local system. If you are installing one of the virtual systems listed in Table 1-2, the hostname is indicated in the table (for example, server1.example.com). Once you have completed your configuration changes, click the Done button.
11. Click the Installation Destination item from the Installation Summary screen, and you will see the screen shown in Figure 1-6. From this interface, select one or more local standard disks (SATA, SAS, or a virtual block device on a KVM system) where you want to install RHEL 7. From the Specialized & Network Disks section, you can also select a SAN volume as an installation destination, such as a volume on an iSCSI or an FC storage array. However, this is outside of the scope of the RHCSA exam.
12. From the Other Storage Options section of the Installation Destination screen, you can determine how space on configured disk drives, local and remote, is used. Here, you can choose between automatically and manually configured partitioning. For automatic partitioning, you can select the checkbox "I would like to make additional space available" if you want to reconfigure space from other existing partitions. Optionally, you can select "Encrypt my data." For the purpose of this installation, select "I will configure partitioning" and click Done to continue.

FIGURE 1-6 The Installation Destination screen



The Installation Perspective on Partitions

Once a partition is created, you can configure Linux to mount a partition on that directory. Alternatively, that partition can be designated as a RAID device or as part of a logical volume.

To define a partition, you may need some background on naming conventions, the configuration of different filesystems, uses of swap space, logical volumes, and RAID arrays. This is just an overview. Detailed information is available in Chapter 6, including tasks that may be required during the Red Hat exams and on real systems.

Naming Conventions

Linux has a simple naming standard for disk partitions: three letters followed by a number. The first letter identifies the type of drive (*s* is for SATA or SAS, and *v* is for virtual disks on KVM-based VMs). The second letter is *d* for disk, and the third letter represents the relative position of that disk, starting with *a*. For example, the first SATA drive is sda, followed by sdb, sdc, and sdd.

The number that follows is based on the relative position of the partition. Two partitioning schemes are available on modern PCs: the traditional Master Boot Record (MBR) and the newer GUID Partition Table (GPT) scheme.

In the MBR scheme, partitions can be one of three types: primary, extended, or logical. Primary partitions can contain the boot files for an operating system. Hard drives can also be configured with one extended partition, which can then contain a number of logical partitions.

Hard disks are limited to four primary partitions. When four partitions are not enough, an extended partition can be substituted for the last primary partition. That extended partition can then be subdivided into logical partitions. So when planning a partition layout, make sure that extended partition is big enough. Although it's possible to create more, you should not create more than 12 logical partitions on any individual SATA, SAS, or virtual hard drive.

The GPT partitioning scheme does not have such limitations and by default can support up to 128 partitions.

Each partition is associated with a Linux device file. At least that is straightforward; for example, the device filename associated with the third partition on the first SATA drive is /dev/sda3.

A volume is a generic name for a formatted segment of space that can be used to contain data. Volumes can be partitions, RAID arrays, or those logical volumes associated with Logical Volume Management (LVM). A filesystem exists inside a volume and provides the ability to store files. Filesystems handle the conversion of blocks on the volumes to files. For example, Red Hat uses the XFS filesystem as the default format for its volumes. The standard way to access data in Linux is to first mount that filesystem onto a directory. For example, when the /dev/sda1 partition is formatted to the XFS filesystem, it can then be mounted on a directory such as /boot. It is common to say something like, "The /dev/sda1 filesystem is mounted on the /boot mount point." For more information, see Chapter 6.

Separate Filesystem Volumes

Normally, you should create several volumes for RHEL 7. Even in the default configuration, RHEL is configured with at least three volumes—a top-level root directory (/), a /boot directory, and Linux swap space. Additional volumes may be suitable for directories such as /home, /opt, /tmp, and /var. They're also suitable for any custom directories such as for websites, dedicated groups of users, and more.

Although it's important to configure the /boot directory on a regular partition, other directories can readily be configured on logical volumes or RAID arrays.

Dividing the space from available hard drives in this manner keeps system, application, and user files isolated from each other. This helps protect the disk space used by system services and various applications. Files cannot grow across volumes. For example, an application such as a web server that uses huge amounts of disk space can't crowd out space needed by another service. Another advantage is that if a bad spot develops on the hard drive, the risk to your data is reduced, as is recovery time. Stability is improved.

While there are many advantages to creating more volumes, it isn't always the best solution. When hard drive space is limited, the number of partitions should be kept to a minimum. For example, if you have a 10GB hard drive and want to install 5GB of packages, having dedicated /var and /home volumes could lead to a situation where disk space runs out far too quickly.

Linux Swap Space

Linux swap space is normally configured either on a dedicated partition or a logical volume. Such space is used to extend the amount of effective RAM on a system as virtual memory for currently running programs. But normally you should not just buy extra RAM and eliminate swap space. Linux moves infrequently used programs and data to swap space even if you have gigabytes of free RAM.

The way Red Hat recommends to assign swap space is based on the amount of RAM on a system. For systems of up to 2GB, the recommended swap space size is twice the amount of installed RAM. Between 2GB and 8GB, it's equal to the amount of RAM. Above 8GB, it's half the amount of RAM. But those are not "hard and fast" rules. Workstations with several gigabytes of RAM frequently use very little swap space. However, certain application workloads may need a big swap partition, such as applications that use large tmpfs filesystems (tmpfs is a temporary filesystem stored in RAM that relies on swap space as a backing store if the server is under memory pressure). In any case, the default installation configures swap space not in a dedicated partition, but as a logical volume.

Basic Information on Logical Volumes

The creation of a logical volume from a partition requires the following steps. Details on these concepts as well as the actual commands required to execute these steps are described in Chapter 6. Some of these steps are run automatically if you create a logical volume during the installation process.

- The partition should be labeled as a Linux LVM volume.
- The labeled partition can then be initialized as a physical volume.
- One or more physical volumes can be combined as a volume group.
- A volume group can be subdivided into logical volumes.
- A logical volume can then be formatted to a Linux filesystem or as swap space.
- The formatted logical volume can be mounted on a directory or as swap space.

Basic Information on RAID Arrays

RAID was an explicit requirement on the RHCT/RHCE exams up to the release of RHEL 6. Because it is no longer found in either the RHCSA/RHCE objectives or the outlines of the

prep courses for these certifications, you can relax a bit on that topic. In any case, the RAID configured on RHEL 7 is software RAID. The acronym, Redundant Array of Independent Disks, is somewhat misleading because software RAID is usually based on independent partitions. Redundancy comes from the use of partitions from different physical hard drives.

Partition Creation Exercise

Now we return to the installation process. If you followed the steps described so far in this chapter and the system has sufficient RAM, you should see the Manual Partitioning screen shown in Figure 1-7.

At this screen, the drop-down menu gives you the opportunity to configure filesystems on standard partitions, on LVM volumes, on thin-provisioned LVM volumes, and on BTRFS volumes. The /boot mount point will be always configured on a standard partition, regardless of the partition scheme settings you have selected in this screen.

1. Select Standard Partition from the partitioning scheme drop-down menu. LVM will be discussed in Chapter 6. BTRFS is also an available option, but it's outside of the scope of the RHCSA exam.

FIGURE 1-7 Partition configuration from the Manual Partitioning screen

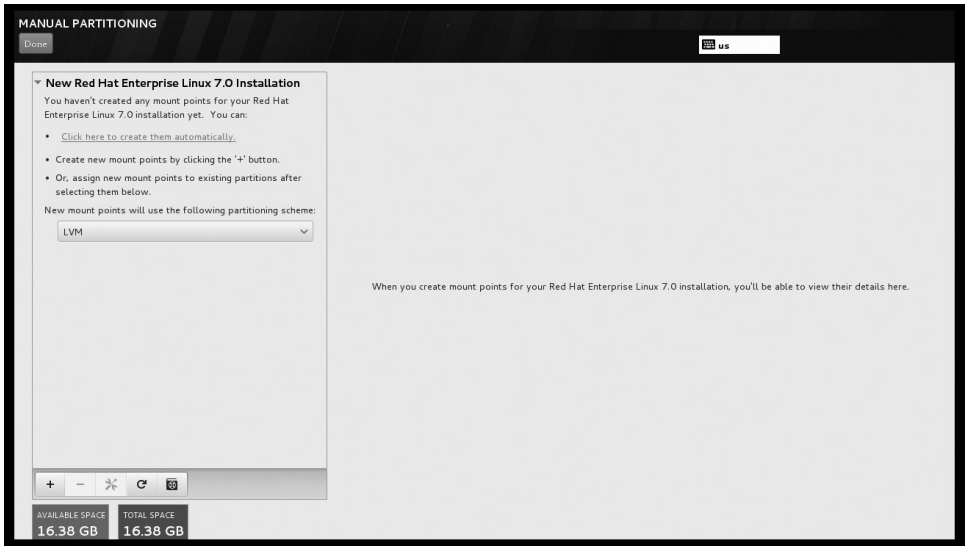
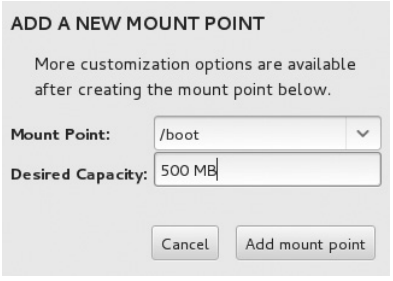


FIGURE 1-8

Adding a mount point



2. Configure standard mount points as described earlier in Table 1-1. Larger partitions are acceptable if you have the space. They would be necessary if you're creating the physical host system that will contain the VMs. At the bottom left of the screen, the + button supports the creation of a new mount point, as shown in Figure 1-8.
3. Back in the Manual Partitioning screen, you should now see the settings shown in Figure 1-9. This window supports a number of choices:
   - **Mount Point** This is the directory (such as /boot) whose files will be stored on the partition.
   - **Label** You can provide an optional label.
   - **Desired Capacity** Indicate the desired capacity of the partition in MB; in this case, the partitions to be configured for this baseline system are defined in Table 1-1.

FIGURE 1-9 Configuration for the /boot partition

- **Device Type** This is the device type, which you previously set to Standard Partition from the partitioning scheme menu.
- **File System** Select the filesystem type; in this case, the default xfs filesystem is sufficient.

Now it's time for an exercise. First, we examine how to create and configure partitions during the installation process. We'll also look at how to allocate a filesystem to a partition or a logical volume.

EXERCISE 1-1

Partitioning During Installation

This exercise is based on changes that you would make to an installation of RHEL 7, in progress, so be sure to take care. However, it is easy to recover from mistakes because you can click the Reload Storage Configuration button to discard any configuration changes. This exercise starts with the Manual Partitioning screen shown in Figure 1-7 and continues with the screens shown in Figures 1-8 and 1-9. In addition, it assumes sufficient RAM (512MB) to work with the graphical installation.

1. Click the Reload Storage Configuration button (second-to-last button at the bottom left in Figure 1-7) to discard all the configuration changes you have made. If you're starting with one or more blank hard disks, no partitions will be configured.
2. If no space is available, delete the configured partitions using the – button at the bottom left of the screen.
3. Create a custom layout.
4. Select the LVM partitioning scheme from the drop-down menu on the left.
5. At the bottom left of the screen, click the + button to add a new mount point.
6. Set up an appropriate mount point, such as /boot, set the capacity to 500MB, and click the button labeled "Add mount point."
7. Note that despite you having selected the LVM partitioning scheme, the /boot mount point has been created on a standard partition.
8. Click the File System drop-down menu and review the available options.
9. Create an additional volume for the swap space. Under Mount Point, select "swap" and set the size to 1GB.
10. Leave the swap space on a standard partition. Ensure that the swap partition is selected and change the Device Type setting from LVM to Standard Partition. Then click Update Settings.
11. Create an additional mount point for the root filesystem, using the steps just described. Select / in the Mount Point input box and set the size to 10GB. If you are

installing RHEL on a physical system, you may want to adjust this setting based on the total disk space available.

12. Ensure that the / mount point is selected. What is the free space available on the volume group?
13. You will now extend the volume group to take all the space available on the disk. Click the Modify button next to the Volume Group menu and review the settings. Set the Size policy to "As large as possible" and click Save.
14. Click Update Settings again. What is the free space available on the volume group?
15. Repeat the preceding step to create a mount point for the /home filesystem and set the size to 1GB. If you are installing RHEL on a physical system, you may want to adjust the size of the partition based on the total disk space available. If you wish to use all the remaining disk space for this mount point, leave the Desired Capacity setting blank and click Update Settings.

Now that the exercise is complete, the partition configuration should reflect at least the minimums shown in Table 1-1. One version is shown in Figure 1-10. If a mistake is made, highlight a partition and edit its configuration settings. Do not be concerned with small errors; modest variations in size are not relevant in practice—and the Red Hat exams reflect what happens in practice.

FIGURE 1-10

Sample partition configuration

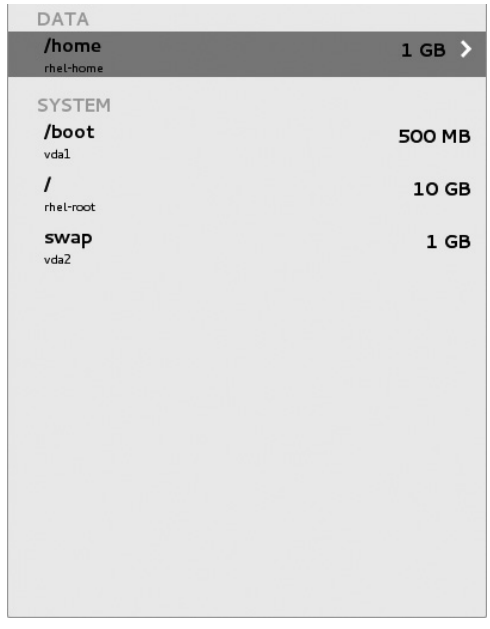
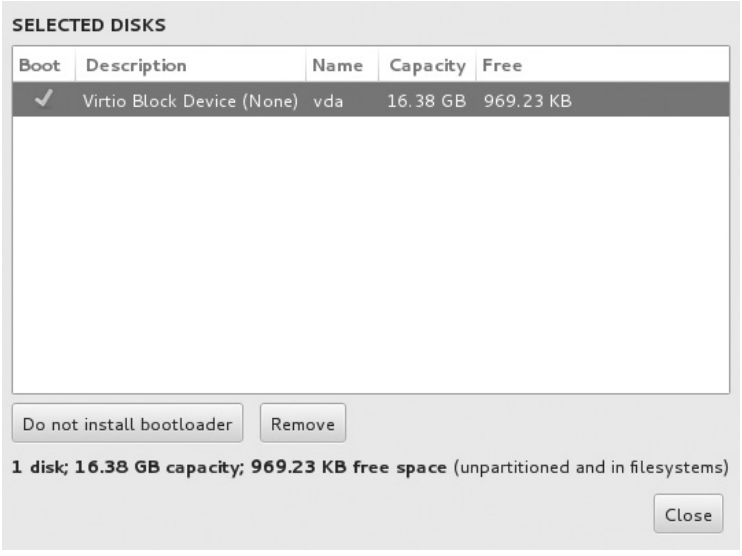


FIGURE 1-11

Configure the bootloader



To complete this part of the process, click Done. You will see a Summary of Changes screen. This is your last chance to cancel before proceeding. Assuming you're satisfied, click Accept Changes to continue.

Return to the Installation Destination screen, and at the bottom click the "Full disk summary and bootloader" link. The standard Linux bootloader is GRUB 2, the GRand Unified Bootloader version 2. The settings shown in Figure 1-11 are reasonable defaults. In most cases, no changes are required.

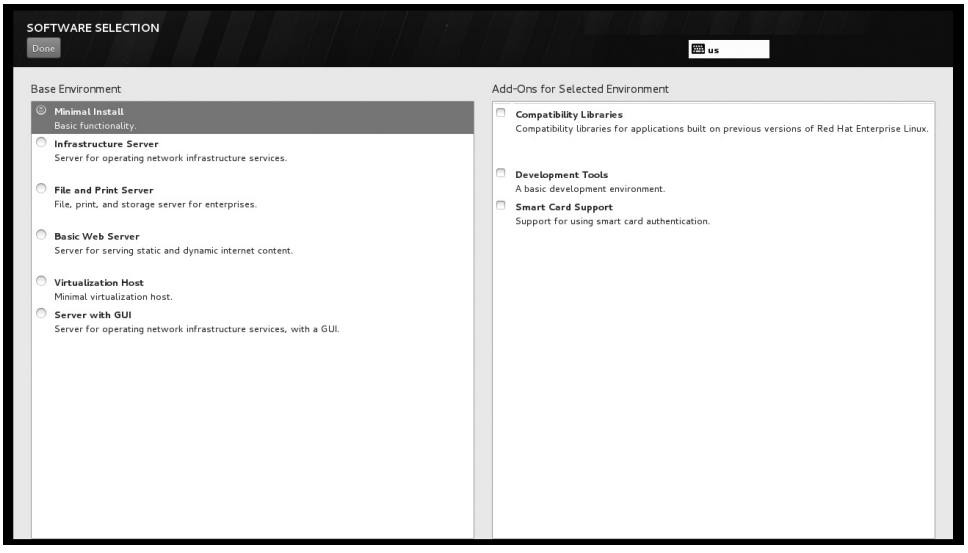
on the job

The terms "boot loader" and "bootloader" are interchangeable. Both are frequently found in Red Hat documentation.

Wow, Look at All That Software!

Over 4300 packages are available just from the RHEL 7 installation DVD. That number does not include a number of packages available only through other subscription channels on the Red Hat Customer Portal. With so many packages, it's important to organize them into groups. After configuring the GRUB 2 bootloader, click Software Selection from the Installation Summary screen. You'll see the options shown in Figure 1-12, which allow you to configure the local system to a desired functionality. The selection depends on your objective. If you're installing on a production physical system to set up KVM-based

FIGURE 1-12 Functional installation options



virtualization, select Virtualization Host. If you're setting up virtual guests (or other dedicated physical servers), select Server with GUI. During a Red Hat exam, you'll be installing most additional software after basic operating system installation is complete. Other options are listed in Table 1-3. Depending on the rebuild distribution, the options may vary significantly.

TABLE 1-3 Installation Software Categories

Category	Description
Minimal Install	Includes a minimal list of packages for the operating system
Infrastructure Server	Installs basic packages for Red Hat as a server
File and Print Server	Configures a system with Samba, NFS, and CUPS
Basic Web Server	Sets up a system with the Apache web server
Virtualization Host	Configures a system for running virtual machines using the KVM hypervisor
Server with GUI	Same as the Infrastructure Server, plus a GUI

For a truly secure baseline in a production environment, consider the minimal installation. Fewer packages means fewer vulnerabilities. You can then add just the packages needed for the desired functionality. Any software that isn't installed can't be exploited by a "black hat" hacker.

on the Job

In the security world, the term "white hat" hackers refers to good people who break systems for nonmalicious reasons, such as for a security penetration test. The term "black hat" hackers refers to people who want to break into other systems with evil intent.

Baseline Packages

In this section, you'll get a basic overview of what's available during the RHEL 7 installation process. During the exams, you may refer to one of these package groups with the Red Hat Add/Remove Software tool. You can also find a list of available package groups with the **yum group list** command. More information is available in Chapter 7.

Red Hat package groups are organized logically. It's important to choose only the package groups you need. Fewer installed packages means more room for personal files, as well as the log files needed to monitor systems.

Package Groups

This section includes the briefest possible overview of each of the package groups available during the RHEL installation process. As you can see from Figure 1-12, there are high-level groups in the left panel ("environments"), such as Infrastructure Server, and package groups in the right panel ("add-ons"), such as Development Tools. Some add-ons in the right panel are separated by a horizontal line. The add-ons below the line are common to all environment groups, whereas the add-ons above the line are available only to the environment group you have selected.

The details of the RPMs associated with each package group are stored in an XML file. To review that file, go to the RHEL installation DVD and read the *-comps-Server-x86_64.xml file in the /repodata directory.

For an example of the details within a package group, open the file *-comps-Server-x86_64.xml file with an editor of your choice, and look for the line containing the string "Server with GUI." After scrolling down a few lines, you will find the content listed in Figure 1-13.

As you can see from Figure 1-13, the Server with GUI group is a collection of other groups. In RHEL there is a distinction between regular groups, which include standard software packages, and environment groups (such as Server with GUI), which are collections of regular groups.

Whereas the groups listed in the **<grouplist>** section are all mandatory, those listed under **<optionlist>** are optional, and correspond to the add-ons listed on the right panel in the Software Selection screen.

FIGURE 1-13

Package group details for "Server with GUI"

```
<grouplist>
  <groupid>base</groupid>
  <groupid>core</groupid>
  <groupid>desktop-debugging</groupid>
  <groupid>dial-up</groupid>
  <groupid>fonts</groupid>
  <groupid>gnome-desktop</groupid>
  <groupid>guest-agents</groupid>
  <groupid>guest-desktop-agents</groupid>
  <groupid>input-methods</groupid>
  <groupid>internet-browser</groupid>
  <groupid>multimedia</groupid>
  <groupid>print-client</groupid>
  <groupid>x11</groupid>
</grouplist>
<optionlist>
  <groupid>backup-server</groupid>
  <groupid>directory-server</groupid>
  <groupid>dns-server</groupid>
  <groupid>file-server</groupid>
  <groupid>ftp-server</groupid>
  <groupid>ha</groupid>
  <groupid>hardware-monitoring</groupid>
:
```

Take some time studying this screen. Examine the packages within each package group. You'll learn about the kinds of packages that are installed by default. If you don't add them during the installation process, it isn't the end of the world. You can still add them with the **rpm** and **yum** commands or the GNOME Software tool described in Chapter 7.

If the XML file is too confusing, just make a note of the name of a package group. From that name, you can find a list of associated packages after installation is complete. For example, the following command identifies mandatory, default, and optional packages for the **base** package group:

```
$ yum group info base
```

For the purpose of this installation, select Server with GUI from the Software Selection screen shown in Figure 1-12. In addition, for the physical host system configured for KVM-based VMs, make sure that the Virtualization add-ons are selected.

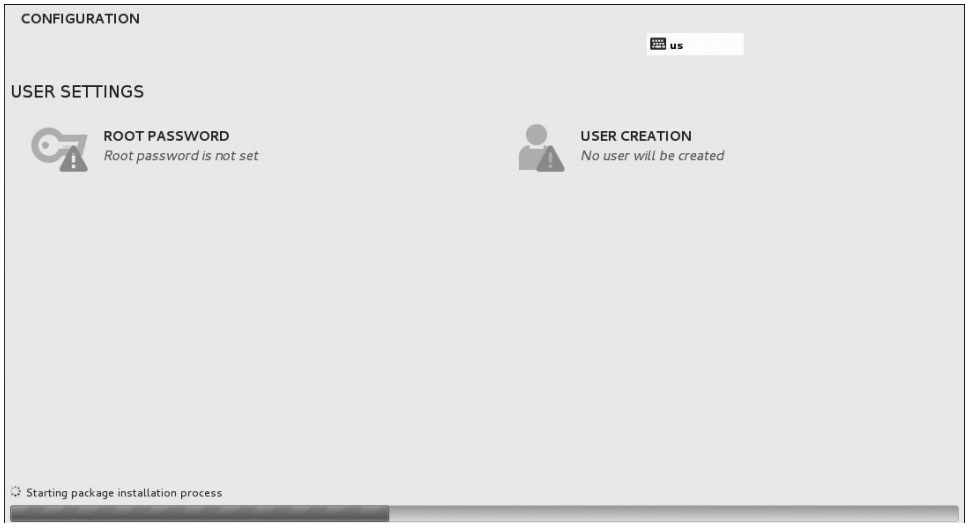
Once the add-ons for the desired packages are selected, click Done and then click Begin Installation. Anaconda then proceeds to the installation process.

During the Installation

After the installation of the software packages is initiated, you will see the screen shown in Figure 1-14. From this interface, you can set a password for the root user and optionally create a user account.

Click the Root Password option and enter a password for the root administrative user twice. Although not required at this stage, you can create a regular user for the system.

FIGURE 1-14 Installing the RPM packages



If you click User Creation, a window opens that can help you customize user details, as discussed in Chapter 8. Set up a local user and then click Done to continue.

When the installation is complete, you'll see a final message to that effect, with an option to reboot the system. If you've installed RHEL 7 on a physical system, don't forget to eject or remove the boot disk and/or the installation DVD. In most installations, RHEL 7 will start the Firstboot application discussed later in this chapter.

CERTIFICATION OBJECTIVE 1.06

System Setup Options

Baseline configurations are important. Once a baseline is configured, you can clone it to set up as many systems as needed. On a real network, a good baseline can be used to create systems dedicated to specific services. To enable remote access, it will have a Secure Shell (SSH) server, configured with a regular user.

For the boot process, RHEL 7 includes systemd, which replaces the SysVinit-based Upstart system available on RHEL 6. It determines the consoles, services, and displays, as well as the target units that are activated when a system is booted. Some systems use remote authentication, configured to connect to remote servers for username and password verification. Although these systems are covered in other chapters, enough information is provided in this section to set up a baseline system.

Initial Setup and Firstboot

In most cases, the first time RHEL 7 boots, two applications start: the Initial Setup screen, followed by Firstboot. The following steps assume a GUI-based RHEL 7 installation:

1. At the initial setup screen, accept a license agreement. The agreement varies depending on whether this is RHEL 7 or a rebuild distribution.
2. If you did not create a regular user account during the installation process, you can do so from the Initial Setup screen.
3. Click Finish Configuration.
4. The next screen allows you to enable and customize the configuration of Kdump, a service that collects data associated with kernel crashes. This is not covered in the RHCSA requirements, so leave the default settings and click Forward.
5. On a RHEL 7 system, you're prompted to connect the system to Red Hat Subscription Management (RHSM). To register, you'll need an RHSM account, with an available subscription. Complete this step and click Forward to continue.
6. On the next screen, review your language and keyboard settings, along with the date and time for the local system. Make desired changes and click Next to continue.

Default Security Settings

When RHEL 7 is installed, there are default settings associated with SELinux and the zone-based firewall. For more information on SELinux security options, see Chapters 4, 10, and others.

First, SELinux is enabled in enforcing mode by default. You can confirm the setting with the **sestatus** command, which should lead to the following output:

```
SELinux status:                 enabled
SELinuxfs mount:                /sys/fs/selinux
SELinux root directory:         /etc/selinux
Loaded policy name:             targeted
Current mode:                   enforcing
Mode from config file:          enforcing
Policy MLS status:              enabled
Policy deny_unknown status:     allowed
Max kernel policy version:      28
```

You'll learn more about SELinux and the RHCSA exam in Chapter 4. If you go for the RHCE, you'll also learn to configure SELinux from Chapter 10 onward to support a wide variety of services.

If you want detailed information about the current firewall configuration for the default zone, run the following command:

```
firewall-cmd --list-all
```

This command lists the network interfaces in the default firewall zone, along with the allowed inbound services.

In the list of allowed services you should see at least the Secure Shell (SSH) service, which supports remote administration of the local system. If there's a good network connection, you'll be able to connect remotely to this system. If the local IP address is 192.168.122.50, you can connect remotely to Michael's user account with the following command:

```
# ssh michael@192.168.122.50
```

The SSH server can be configured to enhance security even further. For more information, see Chapter 11.

Special Setup Options for Virtual Machines

On a physical host running the KVM hypervisor, you may notice additional firewall rules. For example, if you run **iptables -L** to list firewall rules, you should see the following additional rules, which accept traffic over the default subnet attached to the virtual machines:

```
Chain FORWARD (policy ACCEPT)
target     prot opt source               destination
ACCEPT     all  --  anywhere             192.168.122.0/24     ↵
cstate RELATED,ESTABLISHED
ACCEPT     all  --  192.168.122.0/24     anywhere
```

These rules work for IPv4 networking with the help of IP forwarding, as shown in the /proc/sys/net/ipv4/ip_forward virtual file. If the content of this file is set to 1, IPv4 forwarding is active. When IP forwarding is active, the host acts as a router, forwarding traffic from one interface to another.

On stand-alone hosts, IPv4 forwarding is disabled by default. However, on physical hosts running the KVM hypervisor, IP forwarding is enabled to allow routing between VM network segments and the external network.

If you have installed the Virtualization Hypervisor add-on, this setting should be enabled. To be sure, check the content of /proc/sys/net/ipv4/ip_forward. You could set it to 1, but that is not enough because it won't persist a system reboot. To permanently activate IP forwarding, open the /etc/sysctl.conf file and add the following line:

```
net.ipv4.ip_forward=1
```

To implement the changes immediately on the local system, run the following command:

```
# sysctl -p
```

For more information on the related /proc filesystem, see the RHCE section on Kernel run-time parameters in Chapter 12.

CERTIFICATION OBJECTIVE 1.07

Configure Default File Sharing Services

The RHEL 6 version of the RHCSA objectives included two additional objectives:

- Configure a system to run a default configuration HTTP server
- Configure a system to run a default configuration FTP server

Even though you won't be tested on these objectives, we believe the related skills can help you set up a lab to prepare for the certification exam.

The default HTTP server is the Apache web server. The corresponding default FTP server is vsFTP. These systems include basic functionality in their default installations.

You'll confirm the operation of the default installation. Next, you'll take this process one step further to set up these services to share files, specifically the files copied from the installation DVD.

It is fairly simple to configure these services for file sharing. You do not need to change the main configuration files. Assuming SELinux is enabled (as it should be during the exams), the basic steps are as follows:

- Mount and copy the contents of the RHEL 7 installation DVD to the appropriate directory.
- Make sure the contents of the noted directory are configured with the right SELinux contexts.
- Configure the noted service to point to the specified directory and to start when the system is booted.

Naturally, the steps vary by service. The details described in this chapter are rudimentary and may not be sufficient if the related commands and services are new to you. For more information on the **mount** command, see Chapter 6. For more information on SELinux, see Chapter 4. For more information on the Apache web server, see Chapter 14.

Mount and Copy the Installation DVD

The **mount** command is used to connect a device such as a partition or a DVD drive on a specified directory. For example, the following command mounts the standard DVD drive onto the /media directory:

```
# mount /dev/cdrom /media
```

If the DVD is properly configured, it should automatically find the appropriate filesystem format from the /etc/filesystems file. In this case, the DVD media is formatted to the iso9660 standard. If there's a problem, you'd see the following error message:

```
mount: you must specify the filesystem type
```

Alternatively, you can mount an ISO file on a directory, without wasting a physical DVD. For example, you could mount the RHEL 7 DVD ISO file with the following command:

```
# mount -o loop rhel-server-7.0-x86_64-dvd.iso /media
```

Next, copy the contents of the DVD to a directory configured on the file server of your choice (FTP or HTTP). For example, the following command copies all files in archive (**-a**) mode recursively. When you include the dot at the end of the /media directory, you're including all hidden files in the copy command.

```
# cp -a /media/. /path/to/dir
```

Set Up a Default Configuration Apache Server

The Apache web server uses the /var/www/html directory as the repository for its default website. You can configure subdirectories for file sharing. Do make sure port 80 is open in any existing firewall.

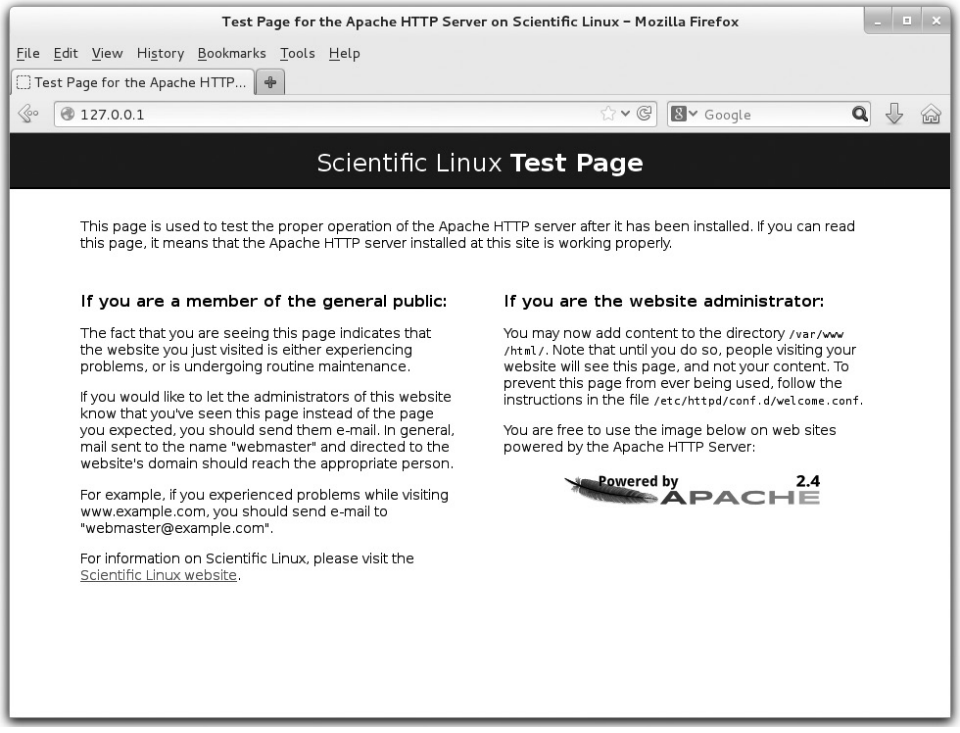
The steps required to configure Apache as a RHEL installation server are similar to those required to configure vsFTP. In Exercise 1-2, you'll take the steps required to configure Apache as an installation server. But first, you need to make sure Apache is installed with the following command:

```
# yum -y install httpd
```

If the command is successful, you will find the main Apache configuration file, httpd.conf, in the /etc/httpd/conf/ directory. To make sure the default installation works, first start the Apache service with the following command:

```
# systemctl start httpd
```

FIGURE 1-15 Proof of a working default Apache server



Next, use a browser on the system where Apache is installed and navigate to the localhost IP address with the following URL: http://127.0.0.1/. An example is shown in Figure 1-15.

If port 80 is open in an existing local firewall, this page should be accessible from remote systems as well. In addition, you'll need to make sure Apache starts automatically the next time RHEL 7 is booted. One way to do so is with the following command:

```
# systemctl enable httpd
```

For more information on how services such as Apache are controlled during the boot process, see Chapter 11. Although that is an RHCE chapter, the **systemctl** command shown here is simple.

EXERCISE 1-2

Configure Apache as an Installation Server

In this exercise, you'll install and configure the Apache web server as a file server, suited for RHEL 7 installations. You'll need either a copy of the RHEL 7 DVD or the associated file in ISO format. In this exercise, you'll take the steps needed to create an appropriate directory, copy the installation files, set an appropriate SELinux context, open port 80 in any existing firewall, and restart the Apache service. Here are the basic steps (detailed Apache configuration is discussed in Chapter 14):

1. Mount the RHEL 7 DVD on an empty directory. You might use one of the following two commands. Whereas the first mounts an actual physical CD or DVD, the second mounts the ISO file:

```
# mount /dev/cdrom /media
# mount -o loop rhel-server-7.0-x86_64-dvd.iso /media
```

2. Create an appropriate directory for the installation files. Since the standard directory for Apache web server files is /var/www/html, it's simplest to create a subdirectory there with the following command:

```
# mkdir /var/www/html/inst
```

3. Copy the files from the mounted DVD to the new directory:

```
# cp -a /media/. /var/www/html/inst/
```

4. Make sure the files have the right SELinux context with the **chcon** command. The **-R** switch applies the changes recursively through the copied installation files. The **--reference=/var/www/html** switch applies the default SELinux context from that directory.

```
# chcon -R --reference=/var/www/html /var/www/html/inst
```

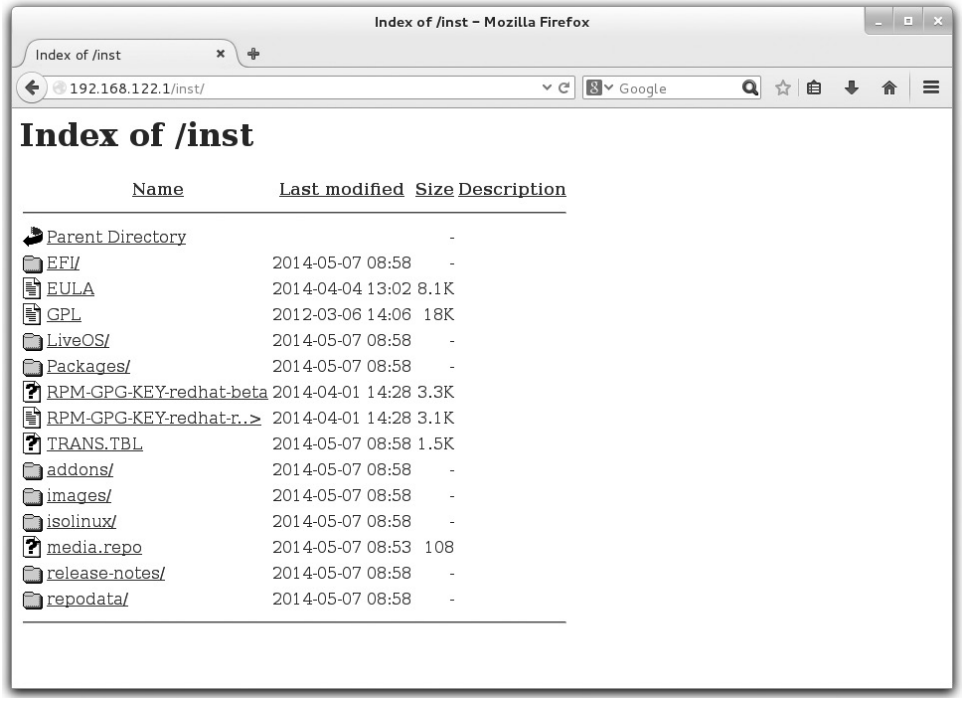
5. Open port 80, the default associated with the Apache web server. To do so from the command line, just run the following commands. You'll learn to configure firewalls in more detail in Chapters 4 and 10.

```
# firewall-cmd --permanent --add-service=http
# firewall-cmd --reload
```

6. Make sure the Apache web server is running and is enabled to start at boot with the following commands:

```
# systemctl restart httpd
# systemctl enable httpd
```

FIGURE 1-16 Browsing the files from the RHEL 7 DVD



The Apache web server should now be ready for use as a file server, sharing the installation files from the RHEL 7 DVD. To confirm, point your browser to the IP address for the server and to the inst/ subdirectory. If that IP address is 192.168.122.1, you'd navigate to

```
http://192.168.122.1/inst
```

If successful, you'll see a page of clickable and downloadable files, as shown in Figure 1-16.

Share Copied Files via FTP Server

The Red Hat implementation of the vsFTP server includes the /var/ftp/pub directory for published files. For the purpose of the installation files, you can create the /var/ftp/pub/inst directory. To make the system compatible with SELinux, you'll then change the security contexts of each of those files with one command. When you then start or restart the vsFTP server, it will be ready for use as an installation server. The process is documented in Lab 2.

Assuming an appropriate connection to remote repositories using RHSM or from a rebuild distribution, you can make sure the latest version of the vsFTP server is installed with the following command:

```
# yum install vsftpd
```

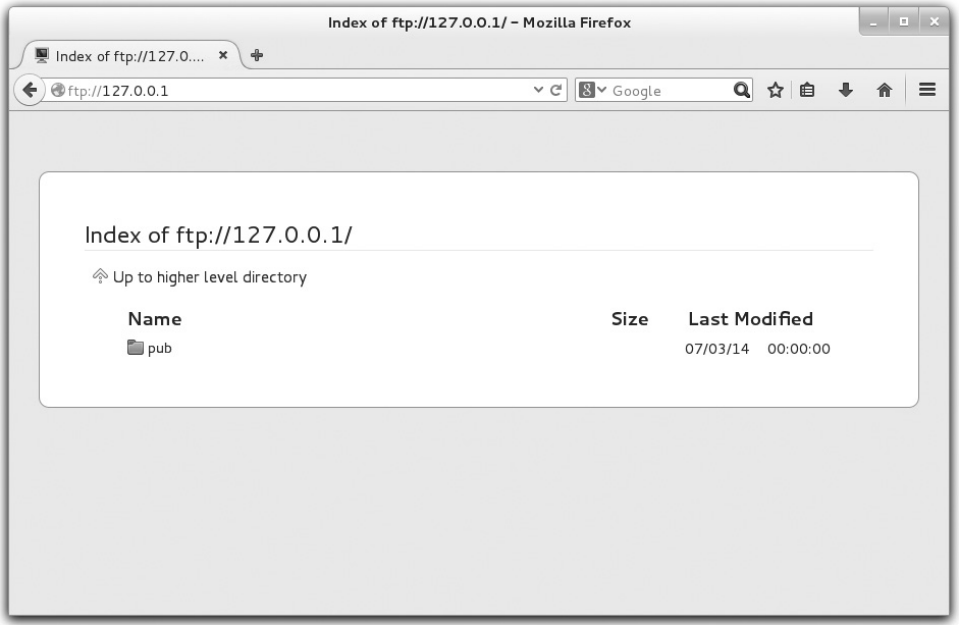
If successful, you can find the main vsFTP configuration file, vsftpd.conf, in the /etc/vsftpd directory, as well as the main data directory in /var/ftp/pub. Make sure to start the vsFTP service with the following command:

```
# systemctl start vsftpd
```

As web browsers can access FTP servers, you can confirm the default FTP server configuration on the local system by navigating to ftp://127.0.0.1/. The default result in the Firefox web browser is shown in Figure 1-17. The pub/ directory shown is actually the /var/ftp/pub directory.

Note the security associated with the vsFTP server. Click the Up To Higher Level Directory hyperlink. The current directory does not change. Users who connect to this FTP server are unable to see, much less download, files from anything above the /var/ftp directory.

FIGURE 1-17 Access to the default FTP server



To grant access to the FTP service from remote systems, run the following commands:

```
# firewall-cmd --permanent --add-service=ftp
# firewall-cmd --reload
```

In addition, you'll need to make sure the vsFTP server starts automatically the next time RHEL 7 is booted. One way to do so is with the following command:

```
# systemctl enable vsftpd
```

The *d* at the end of vsFTP refers to its daemon. For more information on how services such as vsFTP are controlled during the boot process, see Chapter 11. Although that is an RHCE chapter, it should not be hard to remember this one **systemctl** command.

CERTIFICATION SUMMARY

The RHCSA and RHCE exams are not for beginners. This chapter helps you install a basic RHEL system, with the packages and settings suitable for the remainder of this book. Both exams are practical, hands-on exams. When you sit for either exam, you'll be faced with a live RHEL system with a series of problems to solve and systems to configure. The RHCSA covers core system administration skills.

RHEL 7 supports only the use of a 64-bit system. Also, you're required to configure RHEL 7 as a virtual host for the RHCSA.

With a subscription to the RHSM, you can download RHEL installation ISO files from the associated account. Since RHEL software is released under open-source licenses, third parties such as CentOS and Scientific Linux have used that source code without Red Hat trademarks. You can also use such rebuild distributions to study for the RHCSA and RHCE exams.

It will be helpful to create multiple installations of RHEL 7 to practice the skills you'll learn in later chapters. To that end, we recommend the configuration of three systems. Although many users don't have three spare physical computers to dedicate to their studies, VMs make it possible to set up these systems on a single physical computer.

Because the installation of RHEL 7 is relatively easy even for newer Linux users, not every detail is covered in this chapter. After installation comes the Initial Setup and Firstboot applications. However, this varies depending on whether you've installed a GUI.

TWO-MINUTE DRILL

Here are some of the key points from the certification objectives in Chapter 1.

The RHCSA and RHCE Exams

- ❑ The RHCSA is a separate exam from the RHCE.
- ❑ Red Hat exams are all "hands-on"; there are no multiple choice questions.
- ❑ If you're studying for the RHCSA, focus on Chapters 1–9. If you're studying for the RHCE, although you're responsible for the information in the entire book, focus on Chapters 1–2 and 10–17.

Basic Hardware Requirements

- ❑ Although RHEL 7 can be installed on a variety of platforms, you'll need hardware with 64-bit CPUs and hardware-assisted virtualization for the Red Hat exams.
- ❑ Red Hat supports RHEL 7 installations on systems with at least 1GB of RAM. Less is possible, especially on systems without a GUI. You need, at a minimum, 512MB of RAM to start the GUI installation program.
- ❑ RHEL 7 can be installed on local or a variety of storage network devices.

Get Red Hat Enterprise Linux

- ❑ The Red Hat exams use Red Hat Enterprise Linux.
- ❑ Production and development subscriptions of RHEL 7 are available.
- ❑ Since Red Hat releases the source code for RHEL 7, third parties are free to "rebuild" the distribution from the Red Hat source code (except for the trademarks).
- ❑ Third-party rebuilds of RHEL 7 are functionally identical, except for access to Red Hat Subscription Management.
- ❑ Reputable third-party rebuilds are available from CentOS and Scientific Linux.

Installation Requirements

- ❑ Red Hat has stated that exams are presented on "pre-installed systems" with questions presented "electronically."
- ❑ The RHCSA requires the configuration of a physical machine as a virtual host.
- ❑ The native RHEL 7 VM solution is KVM.
- ❑ It's useful to set up multiple VMs to simulate network communications.

Installation Options

- ❑ You can start the installation process from a variety of boot media.
- ❑ RHEL 7 can be installed from DVD, from a local drive, from an NFS directory, from an Apache web server, or from an FTP server.
- ❑ RHEL 7 should be configured on separate volumes for at least the top-level root directory (/), the /boot directory, and Linux swap space.
- ❑ RHEL 7 includes installation package groups in a number of categories.

System Setup Options

- ❑ The first post-installation steps involve the Initial Setup and Firstboot applications.
- ❑ SELinux and zone-based firewalls are enabled by default.

Configure Default File Sharing Services

- ❑ Although not strictly required by the RHCSA exam objectives, it is convenient to deploy HTTP and FTP servers to practice with RHEL installations over the network.
- ❑ The default services associated with the HTTP/FTP protocols are the Apache web server and the vsFTP server.
- ❑ One way to deploy a default HTTP or FTP server is to configure it with the installation files from the RHEL DVD.

SELF TEST

The following questions will help you measure your understanding of the material presented in this chapter. Because there are no multiple choice questions on the Red Hat exams, there are no multiple choice questions in this book. These questions exclusively test your understanding of the chapter. It is okay if you have another way of performing a task. Getting results, not memorizing trivia, is what counts on the Red Hat exams.

The RHCSA and RHCE Exams

1. How many multiple choice questions are there on the RHCE exam? And on the RHCSA exam?

   _____

Basic Hardware Requirements

2. Assuming Intel-based PC hardware, what's the default virtualization technology for RHEL 7?

   _____

3. Which Intel/AMD CPU architectures can be used on RHEL 7?

   _____

Get Red Hat Enterprise Linux

4. Name one third-party distribution based on RHEL 7 source code.

   _____

Installation Requirements

5. How much time is allocated for installation during the RHCSA and RHCE exams?

   _____

Installation Options

6. Name two different options for installation media that will boot the RHEL 7 installation program.

   _____

   _____

7. Name three types of volumes that can be configured and formatted during the RHEL 7 installation process to store data.

   _____

   _____

   _____

8. Say you've mounted the RHEL 7 DVD on the /media directory. There's an XML file on that DVD with a database of packages and package groups. In what directory can you find that XML file?

   _____

System Setup Options

9. What application is started after the Initial Setup screen?

   _____

10. What service is allowed through the default firewall?

    _____

Configure Default File Sharing Services

11. What is the standard directory for file sharing for the RHEL 7 implementation of the vsFTP server?

    _____

12. What is the standard directory for HTML files on the Apache web server?

    _____

LAB QUESTIONS

The first lab is fairly elementary, designed to get you thinking in terms of networks and networking. The second lab should help you configure an installation server. The third lab suggests that you look at the requirements associated with the Linux Professional Institute for a different perspective on system administration.

Lab 1

In this lab, you'll plan the network configuration for the systems required to complete the practice labs in the rest of the book. You have three computers configured with RHEL 7. Two of these computers are to be configured on one domain, example.com. These computers will have short hostnames: server1 and tester1. The third computer is to be configured on a second domain, example.org, with a short hostname of outsider1.

If these systems are configured as guests on a KVM virtual host, IP forwarding will make it possible for these systems to communicate, even though they're set up on different networks. Alternatively, one of the computers in the example.com domain, server1, may be configured with two network cards. The focus will be on IPv4 addressing.

- Systems on the example.com domain will be configured on the 192.168.122.0/24 network.
- Systems on the example.org domain will be configured on the 192.168.100.0/24 network.

Ideally, you should set up the server1.example.com system as a server with GUI. The basic instructions described in this chapter should suffice because it will be up to you to install and configure required services after installation is complete. It will be the primary system you use for practice. You'll install RHEL 7 on this system in Chapter 2, and you'll clone it for different chapters as well as the sample exams at the end of this book.

The tester1.example.com system will be a system that allows remote access only from the SSH service. In some cases, services not necessarily required for certification may be configured on the physical host or on the outsider1.example.org network. That will allow you to test clients that are required for certification.

Lab 2

This lab assumes you've downloaded the DVD-based ISO for RHEL 7 or a rebuild such as CentOS or Scientific Linux. The DVD-based ISO is important because it will serve two purposes. It will be the installation repository used earlier in this chapter as well as the package repository to be configured in Chapter 7. This lab simply includes those commands required to configure the noted files on the vsFTP server.

Although the Red Hat exams are given on a pre-installed system, the associated requirements do suggest that you need to know how to install systems over a network as well as configure Kickstart installations. Also, because you don't have Internet access during the exam, you won't have access to Red Hat Subscription Management or any other Internet repository.

1. Create a directory for your installation files. With the following command, create the /var/ftp/pub/inst directory. (If you get an error message, vsFTP may not be properly installed.)

   ```
   # mkdir /var/ftp/pub/inst
   ```

2. Insert the RHEL 7 installation DVD into its drive. If not automatically mounted, do so with a command such as **mount /dev/cdrom /media**. (If all you have are the ISO files, say in the Downloads/ subdirectory, substitute **mount -ro loop Downloads/*rhel**.iso /media**.)
3. Copy the required files from the RHEL 7 installation DVD. Use the **cp -a /*source*/. /var/ftp/pub/inst** command, where *source* is the mount directory (such as /media/).
4. Make sure there's nothing blocking access to your vsFTP server. Use a tool such as the **firewall-cmd** configuration tool to open up ports for the FTP services on the local system, as illustrated in the following commands. For more information on firewalls and SELinux, see Chapter 4.

```
# firewall-cmd --permanent --add-service=ftp
# firewall-cmd --reload
```

5. If SELinux is enabled on the local system, run the following command to apply appropriate SELinux contexts to the files on the new directory:

```
# chcon -R -t public_content_t /var/ftp/
```

6. Now activate the FTP server with the following command:

```
# systemctl restart vsftpd
# systemctl enable vsftpd
```

7. Test the result. On a remote system, you should be able to use the Firefox web browser to connect to the local FTP server, using its IP address. Once connected, you'll be able to find the installation files in the pub/inst/ subdirectory.

Lab 3

The Red Hat exams are an advanced challenge. In this lab, you'll examine the Red Hat exam prerequisites from a slightly different perspective. If you're uncertain about your readiness for this exam, the Linux Professional Institute has Level 1 exams that test basic skills in more detail. In addition, they cover a number of related commands that we believe are implied prerequisites for the Red Hat certifications.

To that end, examine the detailed objectives associated with the noted exams 101 and 102. Links to those objectives are available from www.lpi.org. If you're comfortable with most of the files, terms, and utilities listed in the objectives for those exams, you're ready to start your studies for the Red Hat exams.

A SELF TEST ANSWERS

The RHCSA and RHCE Exams

1. There are no multiple choice questions on any Red Hat exams. It has been more than a decade since the Red Hat exams had a multiple choice component. The Red Hat exams are entirely "hands-on" experiences.

Basic Hardware Requirements

2. The default virtualization technology for RHEL 7 is KVM. Although there are many excellent virtualization technologies available, KVM is the default option supported by Red Hat on RHEL 7.
3. To install RHEL 7, you need a system with one or more 64-bit CPUs.

Get Red Hat Enterprise Linux

4. There are several different distributions available built on RHEL 7 source code. The most common options are CentOS, Oracle Linux, and Scientific Linux. There may be additional correct answers.

Installation Requirements

5. There is no correct answer to this question. Although the Red Hat exams are now presented on pre-installed systems, it's possible that you'll have to install RHEL 7 on a VM within an existing RHEL 7 installation.

Installation Options

6. Options for installation boot media for RHEL 7 include a CD, a DVD, and a USB drive.
7. You can configure and format regular partitions, RAID arrays, and logical volumes during the installation process to store data.
8. You can find the specified XML file under the noted conditions in the /media/repodata directory.

System Setup Options

9. Firstboot is started after the Initial Setup screen.
10. The default RHEL 7 firewall allows access to the Secure Shell service (SSH for short).

Configure Default File Sharing Services

11. The standard directory for file sharing for the RHEL 7 implementation of the vsFTP server is /var/ftp/pub.
12. The standard directory for HTML files for the RHEL 7 implementation of the Apache web server is /var/www/html.

LAB ANSWERS

Lab 1

When configuring a network connected to the Internet, you'll want to allow access to some systems and deny it to others. To that end, this lab provides a framework for the systems you'll want to set up to study for the RHCSA/RHCE exams.

As the RHCSA is in many ways an exercise in configuring a workstation, it may seem less important to set up a network to study for that exam. However, there are server elements to that exam, such as the configuration of NFS clients, so networks can't be neglected for the RHCSA.

With the development of VMs, the cost of hardware should be less of a handicap even for home users who are studying for the Red Hat exams. RHCSA specifically requires the configuration of VMs, so this should be practiced even if physical hardware is available.

Although dynamic IPv4 addresses are used for most workstations, static IPv4 addresses are more appropriate in many cases, including services such as DNS, FTP, Web, and e-mail.

Three systems is a suggested minimum because the rules associated with firewalls are typically not applied to a local system and you will need to be able to test services from a client that is both permitted and denied; the second system is a remote client that should have access to local server services, and the third should not.

Of course, "real-life" networks are much more complex—and you are welcome to set up a network with more systems.

In Chapter 2, when you install RHEL 7 systems on KVM-based virtual machines, you will want to clone one system to support configuration from a baseline. And, in fact, that's what happens in many enterprises. VMs make it practical to dedicate one or more RHEL 7 systems to a specific service, such as the Apache web server.

Lab 2

During the Red Hat exams, you won't have access to the Internet. However, many installations and updates require Internet access to download software packages.

When you configure the files from the RHEL 7 installation DVD on a remote system, you're configuring an effective substitute for the purpose of installation of additional packages. In addition, those files support network installation, which is still an RHCSA requirement.

The steps described are associated with the configuration of the vsFTP server, protected by SELinux. Do not fear SELinux. As suggested by the steps in this lab, the configuration of the vsFTP server is fairly simple. Although the use of SELinux may seem intimidating to the RHCSA candidate, it is a requirement. The commands described in this lab show how you can live with SELinux on a vsFTP server. Chapter 4 will explain how you can make life with SELinux work for you in a number of other situations.

Lab 3

This lab may seem odd given that it references the requirements for a different Linux certification. However, many Linux administrators take the exams of the Linux Professional Institute (LPI) seriously. LPI creates excellent certifications. Many Linux administrators study for and pass the LPIC Level 1 exams. Passing the LPIC 101 and 102 exams provides an excellent foundation for the RHCSA and RHCE exams.

If you feel the need to get more of a grounding in Linux, refer to some of the books described at the beginning of this chapter.

The Red Hat exams are an advanced challenge. Some of the requirements for the RHCSA and RHCE exams may seem intimidating. It's okay if some of them seem beyond your capabilities at the moment, because that is the reason you are reading this book. However, if you're uncomfortable with basic command-line tools such as **ls**, **cd**, and **cp**, you might need more of a grounding in Linux first. Many candidates are successfully able to fill in the gaps in their knowledge with some self-study and practice.