DAMIAN TOMMASINO

Cert Guide

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Hands-on Guide to the Red Hat[®] Exams: RHCSA[®] and RHCE[®] Cert Guide and Lab Manual



Hands-on Guide to the Red Hat[®] Exams

RHSCA[™] and RHCE[®] Cert Guide and Lab Manual

Damian Tommasino

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Hands-on Guide to the Red Hat® Exams

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About the Author

Damian Tommasino is currently a Linux system administrator at TradeCard and CEO of Modular Learning, Inc., an online IT training company. His current certifications include RHCE, RHCSA, MCSA, CCNA, CCENT, MCP, Security+, Network+, and A+. He has a popular blog called Security Nut (http://secnut.blogspot.com) that covers Red Hat, Linux, security, and more. Damian also spends time over at techexams.net helping out in the forums and conversing with friends.

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As the reader of this book, *you* are our most important critic and commentator. We value your opinion and want to know what we're doing right, what we could do better, what areas you'd like to see us publish in, and any other words of wisdom you're willing to pass our way.

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Preface

This book was written as a lab guide to help individuals pass the RHCSA (EX200) and RHCE (EX300) exams. It is meant for those with different amounts of experience, from novice to expert, and is structured to make it easy for any reader to find what he is looking for. The book contains 22 chapters and two full-length lab exams.

Book Features

Each chapter includes the following elements to aid your learning:

- **Opening topics list**—This list defines the topics to be covered in the chapter; it also lists the corresponding Red Hat objectives.
- Review Questions—Review questions help reinforce what you learned and help you identify what you may need to review.
- Answers to Review Questions—Answers are provided for each of the review questions.
- Labs—Chapters conclude with several lab-based exercises that provide handson training and also help you to see what questions on the actual exam might be like.

The labs also include scripts that can help you with troubleshooting. The scripts use the following syntax:

- v_script_name Used to verify a service or configuration
- t_script_name Used to cause trouble on your system

I have also included two full-length labs at the end of the book intended to give you an experience like that of the real exam as well as examples of what the real exam might cover.

I have also produced an additional set of scripts that you can download that will purposely cause trouble on your system. You can download them from

http://sourceforge.net/projects/rhcelabscripts/

Exam Registration and Costs

To register for the Red Hat exams, you must visit Red Hat's site at http://www.redhat.com/training and enroll online. The price for the new RHCSA exam is \$399, and it is 2 hours in length. With the addition of the RHCSA certification, the price of the RHCE exam has been reduced to \$399 (down from \$799).

The RHCE exam is also 2.5 hours in length. Each exam is performance based, meaning it is given in the form of labs. With the addition of the RHCSA certification, you are now required to obtain the RHCSA before you can become RHCE certified. You can still take the RHCE exam; however, you will not receive the certification until you have completed and passed both exams.

LPIC, RHCE, and Other Things You Should Know

The Red Hat exams are a big undertaking, particularly if you have never taken a performance-based exam before. There is the unknown element of what to expect on the exam plus the amount of material you need to be familiar with. Before sitting for either of the Red Hat exams, you might want to consider completing the LPIC-1 exam series. Why? The Red Hat exams test experience and skill, not just your ability to memorize content within a book. There is also a certain skill set that you need before you take the Red Hat exams. You are expected to know basic Linux commands, to be able to navigate around a system, and to be able to perform basic file operations. Being able to effectively use some form of text editor is a good thing, too.

The LPIC-1 certification is broken down into two exams: LPIC 101 and LPIC 102. The material covered in both of these exams is equivalent to the knowledge a junior system administrator should have, and it gives you a solid foundation for taking on the Red Hat exam material. Although many topics overlap between the LPIC-1 material and the Red Hat exams, this will only help to reinforce your understanding of particular topics. You should look through the exam objectives of the LPIC-1 exams to gain a better understanding of some of the prerequisite skills required. The objectives for the LPIC-1 exams are very detailed, so they will help you identify any weak areas you might have:

■ LPIC-101

http://www.lpi.org/eng/certification/the_lpic_program/lpic_1/ exam_101_detailed_objectives

■ LPIC-102

http://www.lpi.org/eng/certification/the_lpic_program/lpic_1/ exam_102_detailed_objectives

If you already have a solid set of Linux skills, you should have no problem starting out here. If you don't, you can still proceed with this book but will need to put in some extra effort in areas you don't fully understand. One question I see frequently is, "Should I take the LPIC exams if I'm an RHCSA/RHCE?" My answer is always yes! The reason behind this is that the Red Hat exams are vendor specific, whereas the LPIC-1 exams are vendor neutral. They focus more on implementing services and working with Linux from an unbiased perspective. Holding both certifications adds diversity to your resume, and the exams shouldn't be hard to pass with the amount of overlap in the material between the Red Hat exams and the LPIC-1 exams.

You should know the following topics (prerequisites) before you start studying for the Red Hat exams. This is by no means a complete list!

- How to use a text editor (vim, emacs, or nano)
- File system hierarchy structure
- Different types of media (/dev/sda versus /dev/hda)
- File operations:
 - pwd ~ find w
 - path cat locate who
 - ls more cp
 - echo less mv
 - cd tail ln
 - sort head wc
- How to search with grep
- Command piping
- The basics of sed and awk
- Compression:
 - ∎ tar
 - gunzip
 - bzip2
- Networking basics:
 - ping
 - netstat
 - ifconfig
- IP addresses, subnets, and gateways
- How to use a command line and a GUI-based email client

If you lack the experience, the introduction to this book covers a majority of these prerequisite commands. Although it shouldn't count as a replacement for learning all these commands individually, the introduction can get you up to speed quickly if you have little to no current Linux experience.

Self-Study and Experience

One of the biggest debates I see among those studying for the Red Hat exams is, "Should I self-study or take a course?" I am a self-study person and have yet to find a halfway decent course for a price that wouldn't give a person a heart attack. The problem that most people seem to encounter with taking a course is the cost. Simply put, they are not cheap! The average price for a Red Hat training course is around \$3,000, and such a course typically consists of four to five days of classroom training (which means footing the bill and taking time off work).

NOTE Red Hat offers an eLearning (or online version) of its training course for about half the price. I highly recommend that you DO NOT take this class because the learning experience is very different from that given in the classroom.

The benefits to taking a course, however, are that it is tailored specifically for the exams and the instructors can help you with questions. With the self-study option, you have to balance what you think important topics are (more likely to be tested on) versus less important topics (not likely to appear on the exam). This is really a strong point of the LPIC-1 exams: They list a "weight" for each topic, so you know how heavily it will count on the exam. If you spend the time researching the experience others have had on the Red Hat exams and read through the Red Hat Exam Prep Guide, you will start to get a feel for what topics are more likely to appear on the exam.

Experience plays another big factor in taking the Red Hat exams. After much research and talking to those who have taken the exams, I believe the amount of experience presented in Table P-1 would be required for each exam.

Exam	Years of Experience		
LPIC-101/102	0–1 year		
LPIC-201/202	2 years		
RHCSA	2 years		
RHCE	3 years		

Table P-1 Experience Recommended for the Red Hat Exams

Although these are only my recommendations, you will probably find, with a little research on the Web, they are pretty accurate. As you probably know too, everyone is different and learns at different rates. The biggest difference between the two exams is that the Red Hat exams are all hands-on (performance based), whereas the

LPIC-1 exams are multiple choice. Unless you truly know what you are doing and have experience in the technologies listed in the Red Hat Exam Prep Guide, you will not pass the Red Hat exams. Don't worry, though, because a little experience (either at home or on the job) and some lab work will fix that. I hope that you will have both, which makes the learning process slightly easier and more rewarding.

Materials from Red Hat

No exam would be complete without a listing of what you should know. In Red Hat's case, the company has created a prep guide that lists the topics you need to know for the exams. With the release of Red Hat Enterprise Linux 6 and the addition of the RHCSA, the exam prep guide has become more specific about what you are required to know for the Red Hat exams. This book covers every topic you need to know for both exams. Before you begin studying, review the prep guide for each exam. If you don't have one printed out or saved already, you can get it here:

- Red Hat RHCSA Exam Prep Guide https://www.redhat.com/certification/rhcsa/objectives/
- Red Hat RHCE Exam Prep Guide https://www.redhat.com/certification/rhce/objectives/

I have also included a copy of each in the next two sections of this preface. If you have taken an earlier version of the RHCE, you may notice that the required objectives have become more specific about what you need to know. This is good because they leave you with less guessing to do. One of the great benefits of the Red Hat exams is that they don't list any specific technology that you must know. For example, if the exam requires that you block access to a particular service, you can choose to use TCP Wrappers, iptables, or the security of the service itself. This approach is good because, just as in the real world, there is always more than one way to do something. Another example might be the exams requiring you to set up outgoing mail using SMTP. You could use the Sendmail service or Postfix. As long as the system is allowed to send out mail, the exams don't care how you accomplish it. The only exception, of course, is unless the exams specifically ask you to use a particular service. These requirements will be useful as you study and practice for the exams in case you already have experience with a particular service.

EXAM TIP

It is worth noting that although you have some freedom on the exam to implement different technologies, Red Hat may ask you do something in a particular way. Going back to the example of blocking something on the system, you may use any method you like, unless Red Hat says that you need to specifically use iptables. To aid you in setting up, configuring, and securing everything needed for the exams, Red Hat also provides documentation for its operating system. With the release of Red Hat Enterprise Linux 6, the documentation layout has also changed. The documentation guides are broken down into different sections instead of the two guides (installation guide and deployment guide) that were previously given. The following documentation is available from Red Hat:

- Installation Guide
 http://docs.redhat.com/docs/en-US/Red_Hat_Enterprise_Linux/6/
 html/Installation_Guide/index.html
- Managing Confined Services http://docs.redhat.com/docs/en-US/Red_Hat_Enterprise_Linux/6/html/ Managing_Confined_Services/index.html
- Migration Planning Guide
 http://docs.redhat.com/docs/en-US/Red_Hat_Enterprise_Linux/6/html/ Migration_Planning_Guide/index.html
- Security-Enhanced Linux http://docs.redhat.com/docs/en-US/Red_Hat_Enterprise_Linux/6/html/ Security-Enhanced_Linux/index.html
- Security Guide
 http://docs.redhat.com/docs/en-US/Red_Hat_Enterprise_Linux/6/html/ Security_Guide/index.html
- Storage Administration Guide http://docs.redhat.com/docs/en-US/Red_Hat_Enterprise_Linux/6/html/ Storage_Administration_Guide/index.html
- Virtual Server Administration http://docs.redhat.com/docs/en-US/Red_Hat_Enterprise_Linux/6/html/ Virtual_Server_Administration/index.html
- Virtualization Guide

http://docs.redhat.com/docs/en-US/Red_Hat_Enterprise_Linux/6/html/ Virtualization/index.html

You can find these guides available in HTML, EPUB, and PDF format. These guides are helpful tools when you're studying for the exams because they provide more command options than can be covered in any book. I recommend that you keep them close by as a reference.

RHCSA Exam Prep Guide

Understand and Use Essential Tools

- Access a shell prompt and issue commands with the correct syntax.
- Use input-output redirection (>, >>, |, 2>, etc.).
- Use grep and regular expressions to analyze text.
- Access remote systems using SSH and VNC.
- Login and switch users in multi-user runlevels.
- Archive, compress, unpack, and uncompress files using tar, star, gzip, and bzip2.
- Create and edit text files.
- Create, delete, copy, and move files and directories.
- Create hard and soft links.
- List, set, and change standard ugo/rwx permissions.
- Locate, read, and use system documentation including man, info, and files in /usr/share/doc.

Operate Running Systems

- Boot, reboot, and shut down a system normally.
- Boot systems into different runlevels manually.
- Use single-user mode to gain access to a system.
- Identify CPU and memory-intensive processes, adjust process priority with renice, and kill processes.
- Locate and interpret system log files.
- Access a virtual machine's console.
- Start and stop virtual machines.
- Start, stop, and check the status of network services.

Configure Local Storage

- List, create, delete, and set partition types for primary, extended, and logical partitions.
- Create and remove physical volumes, assign physical volumes to volumes groups, and create and delete logical volumes.
- Create and configure LUKS-encrypted partitions and logical volumes to prompt for password and be available at system boot.

- Configure systems to mount file systems at boot by using Universally Unique ID (UUID) or labels.
- Add new partitions, logical volumes, and swap to a system non-destructively.

Create and Configure File Systems

- Create; mount; unmount; and use ext2, ext3, and ext4 file systems.
- Mount, unmount, and use LUKS-encrypted file systems.
- Mount and unmount CIFS and NFS network file systems.
- Configure systems to mount ext4, LUKS-encrypted, and network file systems automatically.
- Extend existing unencrypted ext4 formatted logical volumes.
- Create and configure set-GID directories for collaboration.
- Create and manage access control lists (ACLs).
- Diagnose and correct file permission problems.

Deploy, Configure, and Maintain Systems

- Configure network and hostname resolution statically or dynamically.
- Schedule tasks using cron.
- Configure systems to boot into a specific runlevel automatically.
- Install Red Hat Enterprise Linux automatically using kickstart.
- Configure a physical machine to host virtual guests.
- Install Red Hat Enterprise Linux systems as virtual guests.
- Configure systems to launch virtual machines at boot.
- Configure network services to start automatically at boot.
- Configure a system to run a default configuration HTTP server.
- Configure a system to run a default configuration FTP server.
- Install and update software packages from the Red Hat Network, a remote repository, or from the local file system.
- Update the kernel package appropriately to ensure a bootable system.
- Modify the system bootloader.

Manage Users and Groups

- Create, delete, and modify local user accounts.
- Change passwords and adjust password aging for local user accounts.
- Create, delete, and modify local groups and group memberships.
- Configure a system to use an existing LDAP directory service for user and group information.

Manage Security

- Configure firewall settings using system-config-firewall or iptables.
- Set enforcing and permissive modes for SELinux.
- List and identify SELinux and file process context.
- Restore default file contexts.
- Use Boolean settings to modify system SELinux settings.
- Diagnose and address routine SELinux policy violations.

RHCE Exam Prep Guide

System Configuration and Management

- Route IP traffic and create static routes.
- Use iptables to implement packet filtering and configure network address translation (NAT).
- Use /proc/sys and sysctl to modify and set kernel run-time parameters.
- Configure a system to authenticate using Kerberos.
- Build a simple RPM that packages a single file.
- Configure a system as an iSCSI initiator that persistently mounts an iSCSI target.
- Produce and deliver reports on system utilization (processor, memory, disk, and network).
- Use shell scripting to automate system maintenance tasks.
- Configure a system to log to a remote system.
- Configure a system to accept logging from a remote system.

HTTP/HTTPS

- Install the packages needed to provide the service.
- Configure SELinux to support the service.

- Configure the service to start when the system is booted.
- Configure the service for basic operation.
- Configure host-based and user-based security for the service.
- Configure a virtual host.
- Configure private directories.
- Deploy a basic CGI application.
- Configure group-managed content.

DNS

- Install the packages needed to provide the service.
- Configure SELinux to support the service.
- Configure the service to start when the system is booted.
- Configure the service for basic operation.
- Configure host-based and user-based security for the service.
- Configure a caching-only name server.
- Configure a caching-only name server to forward DNS queries (forwarding server).

FTP

- Install the packages needed to provide the service.
- Configure SELinux to support the service.
- Configure the service to start when the system is booted.
- Configure the service for basic operation.
- Configure host-based and user-based security for the service.
- Configure anonymous-only downloads.

NFS

- Install the packages needed to provide the service.
- Configure SELinux to support the service.
- Configure the service to start when the system is booted.
- Configure the service for basic operation.
- Configure host-based and user-based security for the service.
- Provide network shares to specific clients.
- Provide shares suitable for group collaboration.

Samba

- Install the packages needed to provide the service.
- Configure SELinux to support the service.
- Configure the service to start when the system is booted.
- Configure the service for basic operation.
- Configure host-based and user-based security for the service.
- Provide network shares to specific clients.
- Provide shares suitable for group collaboration.

SMTP

- Install the packages needed to provide the service.
- Configure SELinux to support the service.
- Configure the service to start when the system is booted.
- Configure the service for basic operation.
- Configure host-based and user-based security for the service.
- Configure a mail transfer agent (MTA) to accept inbound email from other systems.
- Configure an MTA to forward (relay) email through a smart host.

SSH

- Install the packages needed to provide the service.
- Configure SELinux to support the service.
- Configure the service to start when the system is booted.
- Configure the service for basic operation.
- Configure host-based and user-based security for the service.
- Configure key-based authentication.
- Configure additional options described in documentation.

NTP

- Install the packages needed to provide the service.
- Configure SELinux to support the service.
- Configure the service to start when the system is booted.
- Configure the service for basic operation.
- Configure host-based and user-based security for the service.
- Synchronize time using other NTP peers.

Setting Up the Lab

Throughout this book, I show you how to use different systems to set up services, perform configurations, and implement security. In many forums I often see people asking how to set up labs or practice for the Red Hat exams. The lab used throughout this book is built completely on top of VirtualBox. VirtualBox is like VMware in that it allows you to virtualize systems. If you don't have VirtualBox, you should grab a copy because it is free to use and very helpful when practicing labs.

VirtualBox

http://www.virtualbox.org/wiki/Downloads

Because you will be using many different machines in the lab environment, Chapter 1 describes how to set up Red Hat Enterprise Linux (RHEL). You can install RHEL on your own or follow along in Chapter 1 to completely set up the lab.

Table P-2 presents a layout of the lab used here. Each ID is a different virtual machine.

ID	Hostname	Red Hat Version	IP Address	Network
1	RHEL01	RHEL6	DHCP	Bridged
			172.168.1.1	Internal
2	RHEL02	RHEL6	172.168.1.2	Internal
3	Client01	RHEL5	172.168.1.10	Internal
4	Client02	RHEL6	172.168.1.20	Internal

Table P-2 Lab Layout

As you can see, four machines are used. The first is a dual-homed server that also serves as the gateway for all the internal clients. A majority of the configuration work takes place on this server, and you use the second server (RHEL02) as a backup. The two client machines are to simulate users on the network. The reason I set up the network like this for you is that all testing and configuration are done in a controlled environment (which is a good habit to get into). If something ever happens on the internal network, it doesn't affect the rest of the external (home) network. Some other details for the lab setup include those shown in Table P-3.

Table P-3	Lab Layout			
Host	Drive	Size	Layout	
RHEL01	Disk 1	20GB	Default	
	Disk 2	8GB		
	Disk 3	8GB		
	Disk 4	8GB		
RHEL02	Disk 1	10GB	Default	
RHEL02	Disk 1	10GB	Default	
Client01	Disk 1	10GB	Default	

All virtual machines use 384MB of RAM for memory. I also disabled the sound device for each virtual system because I never use it, but that is entirely up to you.

NOTE All drives in VirtualBox are considered IDE and use the /dev/hdx format.

In the first chapter, you set up each virtual machine for the lab. If you have experience working with VirtualBox, you can set up your lab with the outlined requirements beforehand; otherwise, you can follow along in the first chapter.

No network is complete without documentation and a diagram to finally tie it all together. The network is represented in Figure P-1.



Figure P-1 The network diagram.

NOTE In case you're thinking you don't have the hardware to host this number of machines or you don't know how you'll virtualize an entire lab, think again. These four virtual machines each use 384MB of RAM (1.5GB total). The host machine that I use is a laptop so that my lab is portable, and it has a dual-core processor with 3GB of RAM. I have also tested this lab setup on a Pentium 4 with 4GB of RAM. Both host machines were able to run the full virtual lab with no problems or delays. If you have some trouble with performance, you can also drop the amount of memory on RHEL02, Client01, or Client02 to 256MB of RAM. The primary host (RHEL01) is the only machine that really needs the extra memory.

CAUTION Don't create the three 4GB drives for host RHEL01 just yet! One of the limitations in VirtualBox is that you can have only four devices attached to a system at one time. To get the operating system installed, you need to have a CD-ROM device attached, and if you create the four drives listed here, you will have no room left for the CD-ROM. After you complete Chapter 1, you can remove the CD-ROM device and create the three extra 4GB drives that you will need later.

Who Should Read This Book?

The Red Hat exams are some of the most challenging exams in the Linux arena. This book is meant to be used as a hands-on lab guide to readers with all types of backgrounds. Whether you are just starting out or are a seasoned system administrator, this book helps you learn or fine-tune your skills to take the Red Hat exams. Although those just starting out need to put in more effort to learn some of the skills discussed in this book, it is possible to gain the required skills for the exams. While this book teaches you the necessary skills, the key to passing the Red Hat exams is practice, practice.

How This Book Is Organized

This book is laid out in a logical format that flows from cover to cover. Although you could jump around, each chapter builds on where the previous one left off, allowing you to build a system and understand how it works from the ground up. Although each chapter covers a different set of exam objectives, the first half of the book (Chapters 2 through 12) deals primarily with the RHCSA exam. The second half of the book (Chapters 13 through 21) covers the RHCE exam.

Chapter 1, "Installation," is an introductory chapter designed to help you install the Red Hat Enterprise Linux operating system and set up your virtual lab. The virtual lab that you set up will help you with the labs in each chapter, allowing you to build your hands-on skills for the real exams.

The first half of the book, Chapters 2 through 12, covers the following topics:

- Chapter 2, "System Initialization"—This chapter focuses on how to manage system services, system runlevels, and everything that occurs during the boot process. It also looks at how services work and are started and stopped.
- Chapter 3, "Disks and Partitioning"—This chapter addresses partitioning Red Hat systems. It discusses basic partitions, LVM, and RAID. Also covered are swap partitions and advanced use of LVM for in-depth storage management. This chapter prepares you to work with file systems in Chapter 4.
- Chapter 4, "File Systems and Such"—This chapter follows up where Chapter 3 left off. It describes file systems, how they work, and how to manage them. Also discussed are the new LUKS encryption options and file system security.
- Chapter 5, "Networking"—This chapter is all about networks. Nothing can
 happen unless you can communicate with other systems. This chapter describes
 how to set up and troubleshoot network connections and client-side DNS
 problems.
- Chapter 6, "Package Management"—This chapter examines how to install, search for, and remove software from Red Hat systems. It covers many different ways to work with packages, including building your own packages and package repositories.
- Chapter 7, "User Administration"—No system would be complete without users. This chapter covers user administration (creating, managing, and deleting). Also covered are switching between users and client-side authentication.
- Chapter 8, "Network Installs"—To make life easier, you can use automated installations. This chapter covers kickstart and how it can aid in the installation of Red Hat Enterprise Linux. Also covered is hands-free installation with DHCP and PXE boot clients.
- Chapter 9, "System Logging, Monitoring, and Automation"—This chapter dives into system logging and monitoring and how to interpret that data. It looks at different ways to find problems (or their answers). Also discussed is the automation of system monitoring.
- Chapter 10, "The Kernel"—This chapter discusses updating and tuning the kernel properly. Although the kernel is not a huge topic, it is important to address critical security issues with any system.
- Chapter 11, "SELinux"—This chapter covers one of the most complex topics in the book. It describes how to set up and work with SELinux without giving you a headache. Also covered is how to work with SELinux Boolean values to allow services to run properly.

• Chapter 12, "System Security"—This chapter talks all about system security, including TCP Wrappers, firewall rules, and security policies. Because firewall rules play a heavy role in all services, the second half of the book covers this topic in particular.

The second half of the book, Chapters 13 through 21, covers the following topics:

- Chapter 13, "Remote Access"—This chapter demonstrates how to remotely and securely manage your Red Hat systems. It covers SSH, the most popular remote management tool in Linux. Also covered is VNC for remote desktop management.
- Chapter 14, "Web Services"—This chapter discusses how to set up and manage Apache web servers. Because it is the most widely deployed web server in the world, this is a big topic in the Linux arena. This chapter also covers the Squid web proxy and how to use it in conjunction with Apache.
- Chapter 15, "NFS"—This chapter discusses network file systems. A great choice for centralized storage, NFS has many benefits over its SMB and FTP counterparts. Also covered in this chapter is connecting clients to NFS servers.
- Chapter 16, "Samba"—This chapter discusses Samba and how to set it up. As Samba progresses more and more, integration with Windows becomes easier for Linux systems. The chapter describes how to set up basic shares and printer services for Windows and Linux systems.
- Chapter 17, "FTP"—This chapter explains how to set up and use an FTP server. FTP is great for sharing files both securely and insecurely. The chapter describes the benefits of both, including how to troubleshoot FTP issues.
- Chapter 18, "DNS"—This chapter discusses how DNS works, server setup, and management of DNS servers. Although this is one of the most complex topics in the book, it is one of the easiest to work with after you understand it. This chapter also delves into different types of DNS servers.
- Chapter 19, "Network Services"—This chapter discusses setting up the core network services for your network. Topics include DHCP servers, NTP for time management, and more.
- Chapter 20, "Email Services"—This chapter explains how to properly set up different types of mail servers. Because email is one of the most critical business components, it is essential to understand how to work with this technology. The chapter also covers how to secure your mail servers so you don't get overrun by spammers.
- Chapter 21, "Troubleshooting"—This chapter discusses different troubleshooting steps for a variety of topics. Although this chapter doesn't cover all troubleshooting topics discussed throughout the book, it does cover the big topics that you should know for the exam.

The last chapter deals with Red Hat's newest addition, virtualization:

Chapter 22, "Virtualization with KVM"—This chapter discusses how to use virtualization with Red Hat Enterprise Linux 6. It talks about installation, setup, and configuration of virtual machines. Also discussed is how to monitor your virtual machines when they are in use.

Also included are two full exams that simulate what the real exams are like. The lab activities will help you prepare by asking you to accomplish various tasks, which is very similar to the real exam. There is one practice exam for each of the Red Hat exams this book covers. If you can comfortably make it through the full exams in the allotted time, then you should be in good shape for the real exam! In addition to the 22 chapters and 2 full labs, this book provides end of chapter questions and tasks to help you prepare for the exam. There are also additional troubleshooting scripts available for download at http://sourceforge.net/projects/rhcelabscripts.

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This introduction covers the following subjects:

- **File and Directory Management**—This section explains how to navigate, create, move, and explore files and directories on the system.
- **File Permission Basics**—This section explores file permissions and how the system uses them.
- Using a Text Editor This section covers using a text editor effectively from the command line.
- Regex This section covers regular expressions and how they are used for pattern matching.
- I/O Redirection This section covers how to pipe commands and redirect output.
- **Compression and Archiving**—This section explains how to compress and archive files and directories.

The following RHCSA exam objectives are covered:

- Access a shell prompt and issue commands with the correct syntax
- Use input-output redirection (>, >>, |, 2>, and so on)
- Use grep and regular expressions to analyze text
- Archive, compress, unpack, and uncompress files using tar, star, gzip, and bzip2
- Create and edit text files
- Create, delete, copy, and move files and directories
- Create hard and soft links
- List, set, and change standard ugo/rwx permissions
- Locate, read, and use system documentation including man, info, and files in /usr/share/doc

Introduction

Everyone has to start somewhere, and Linux administrators and engineers are no exception. If you have purchased this book, I imagine that your goal is to pass the Red Hat exams (RHCSA and RHCE) while acquiring or improving your current Linux skills. This introduction covers user-level commands that you will be required to know before you embark on your journey of becoming a system administrator or engineer. These skills and commands are all essential for knowing how to work with Linux, not just Red Hat. Although the current *Red Hat Exam Prep Guide* doesn't list (and can't) all the commands covered in this introduction, everything covered here is required for you to get through the rest of this book. This is in no way a complete list of every user-level command, but it is everything you need to get started. Many of the topics here are also covered later in the book. If you already have a decent set of Linux skills, most of this introduction will probably be a review for you.

File and Directory Management

For you to be able to work with different parts of the system, you need to know how to get around the system! In this section, we look at the following basic commands:

Displays the contents of a directory
Copies files or directories from one location to another
Moves or renames files and directories
Changes the current location
Deletes files or directories
Creates empty files
Creates a directory
Shows the present working directory
Displays the type of a file
Displays the beginning of a file
Displays the end of a file
This might seem like a lot of commands to start with; however, they are all quite simple to use, which makes explaining them easy. First, let's start by displaying a directory on the system using the 1s command.

Step 1. List the contents of the current directory:

1s Desktop Documents Downloads Music Pictures Public Templates Videos

Although you can't tell because this book is black and white, these directories are displayed in blue, alerting the user to the fact that they are indeed directories. Although it's great to have all these directories, how do you know where you are on the system? To view your current location, you can use the pwd command.

Step 2. Show the current location:

pwd
/home/user01

Presently, you are in user01's home directory, so the output of the 1s command was all directories that belong to user01. Let's move out of user01's home directory into one of the subdirectories. Using the cd command, you can move between different directories.

Step 3. Move down one level into the Documents directory:
 # cd Documents/

REAL-WORLD TIP

The trailing slash (/) is optional when you're using the cd command. It indicates that the name being specified is a directory.

Step 4. Now view the current location again:

pwd
/home/user01/Documents

What if you want to move up one level to the directory you just came from? If you use 1s, you don't see the user01 directory listed. You can, however, view two special directories.

Step 5. View all hidden	n directories with	the ls -a command:
-------------------------	--------------------	--------------------

ls -a . ..

Notice what seems like just a bunch of dots? They actually stand for two special types of directories. The first—the single .—stands for the current directory. The second—double ..—is the directory above where you currently are located.

- Step 6. To get back to the previous user01 directory, use the following:
 # cd ..
- **Step 7.** Verify with the pwd command:

pwd
/home/user01

Now you should be able to navigate around the system.

Let's move on to creating files and directories. First, let's look at directory creation.

Syntax: mkdir [option] DIRECTORY

Options:

- p	Creates a parent directory as needed
- V	Provides verbose output
Step 1.	Create a new directory called test: # mkdir test
Step 2.	Create a new set of directories within one another: # mkdir -p another/quick/test
	Because none of the directories you just chose exist, they are all created, including the subdirectories named quick and test.
Step 3.	Verify the directory creation with the 1s command:
	# 1s another quick

cd another
ls
Test

Step 4. Return to the home directory:

cd /home/user01
#pwd
/home/user01

As you will see throughout this book, there are a lot of quick tricks to navigating the system. Because the directories were all created successfully, let's move on to files. Using the touch command, you can create blank files.

Step 5. Create a file called test1:
 # touch test1

Step 6. Verify its existence:

ls test1

Sometimes files need to be created before you can use them, which is why the touch command is useful. You might also want to use a blank file as a placeholder for something later. If you are ever unsure what type of file something is, you can use the file command to find out.

Step 1. Check the file type of test1:

file test1
test1: empty

Step 2. Check the type of the password file on the system:

file /etc/passwd
passwd: ASCII text

Along with being able to create and determine file types, you need to be able to read them as well. There are many times, however, when you don't need to read the whole file (think log files), but instead can just view a few entries from that file. Using the tail and head commands, you can view either the beginning or the end of a file.

Syntax: head [options] FILE

Options:

- -n Specifies the number of files to print
- -v Provides verbose output

Syntax: tail [options] FILE

Options:

- -n Specifies the number of files to print
- -f Continuously displays the end of file (useful for logs)
- -v Provides verbose output
- **Step 1.** View the beginning of the messages log file:

head /var/log/messages Dec 5 03:13:06 RHEL01 dhclient: DHCPREQUEST on eth0 to 172.27.100.163 port 67 Dec 5 03:13:10 RHEL01 dhclient: DHCPREQUEST on eth0 to 255.255.255.255 port 67 Dec 5 03:13:20 RHEL01 dhclient: DHCPREQUEST on eth0 to 172.27.100.163 port 67 Dec 5 03:13:29 RHEL01 dhclient: DHCPREQUEST on eth0 to 255.255.255.255 port 67 Dec 5 03:13:30 RHEL01 dhclient: DHCPREQUEST on eth0 to 172.27.100.163 port 67 Dec 5 03:13:43 RHEL01 dhclient: DHCPREQUEST on eth0 to 255.255.255.255 port 67 Dec 5 03:13:44 RHEL01 dhclient: DHCPREQUEST on eth0 to 172.27.100.163 port 67 Dec 5 03:13:50 RHEL01 dhclient: DHCPREQUEST on eth0 to 255.255.255.255 port 67

Step 2. View the end of the messages log file:

tail /var/log/messages Dec 11 08:11:04 RHEL01 dhclient: DHCPDISCOVER on eth0 to 255.255.255.255 port 67 interval 13 Dec 11 08:11:04 RHEL01 dhclient: DHCPOFFER from 172.27.100.163 Dec 11 08:11:04 RHEL01 dhclient: DHCPREQUEST on eth0 to 255.255.255.255 port 67 Dec 11 08:11:04 RHEL01 dhclient: DHCPACK from 172.27.100.163 Dec 11 08:11:04 RHEL01 NET[26281]: /sbin/dhclient-script : updated /etc/resolv.conf Dec 11 08:11:04 RHEL01 dhclient: bound to 172.27.100.226 - renewal in 40864 seconds. Dec 11 08:18:00 RHEL01 abrt[26389]: saved core dump of pid 26388 (/usr/libexec/fprintd) to /var/spool/abrt/ccpp-1292073480-26388.new/coredump (757760 bytes) Dec 11 08:18:00 RHEL01 abrtd: Directory 'ccpp-1292073480-26388' creation detected Dec 11 08:18:00 RHEL01 abrtd: Crash is in database already (dup of /var/spool/abrt/ccpp-1291114420-26066)

You can see that being able to look at different sections of a file without actually opening it is really useful, particularly when it comes to looking at log files. Now that you know where one of the log files is, why don't you copy it to the /home/user01 directory? You can use the cp command for this.

Syntax: cp [options] SOURCE DEST

Options:	
- R	Copies recursively
- V	Provides verbose output
Step 1.	Copy the log file into the user01 home directory: # cp /var/log/messages /home/user01
Step 2.	You also could use the following: # cp /var/log/messages .
	Remember that the dot (.) represents the current location. After the messages log file is copied over, you should probably rename it for safe-keeping. You can use the mv command to accomplish this in addition to moving the file to a new location.
	Syntax: mv [options] SOURCE DEST
	Options:
	-v Provides verbose output
Step 3.	Rename the file by specifying the filename and the new name of the file: # mv messages messages.bak
Step 4.	With the file renamed, move it to the test directory for safekeeping: # mv messages.bak test/
	Because you specified a directory this time, the file was moved instead of renamed. You can also verify that the file was moved correctly.
Step 5.	List the contents of the test directory:
	# 1s test messages.bak
	What if you moved this file by mistake? In that case, you would need to delete it to make room for a new one. You can use the rm command to remove files or directories.
	Syntax: rm [options] FILE
	Options:
	-R Deletes recursively

- -f Forces deletion
- -v Provides verbose output

Step 1. Delete the messages.bak file:

```
# cd test
# rm messages.bak
rm: remove regular file `messages.bak'? y
```

Notice that you are prompted to delete the file? By using the -f option, you can skip the confirmation. While you're deleting things, also remove the test directory.

Step 2. Delete the test directory:

cd .. # rm -Rf test/

Because this example uses the -f option, there is no confirmation and the directory is just deleted. Here's one thing you need to make a note of: You must use the -R option to delete directories. If you don't use the -R option, you get a warning message about the directory not being empty.

By now, you should be able to get around the system, create and remote files and directories, and view files and their types. It may seem as though we moved fast through this section, but these are really basic commands and anyone with any Linux experience should know most of them.

File Permission Basics

Just like every operating system, Linux comes with a set of permissions that it uses to protect files, directories, and devices on the system. These permissions can be manipulated to allow (or disallow) access to files and directories on different parts of the system. Here are some of the commands you can use to work with permissions:

chmod	Changes the permissions of files or directories
chown	Changes the owner and group of files or directories
ls -l	Displays file permissions and ownership of files or directories
11	Same as 1s -1
umask	Defines or displays the default permissions for creation of files or directories

Before starting to use commands, let's look at how permissions work first. Linux permissions are implemented through the properties of files and defined by three separate categories. They are broken down into the following:

User	Person who owns the file
Group	Group that owns the file
Other	All other users on the system

Operation	Digit	Mnemonic	Description
Read	r	4	View file contents
Write	W	2	Write to or change
Execute	х	1	Run the file

Permissions in Linux can be assigned one of two ways. You can use the mnemonic or a single digit to represent the permissions level.

Let's start by looking at file permissions before changing them. You can view the home directory from one of the users I have set up. To view a file's or directory's permissions, you can use two different commands.

Step 1. View file permissions for user01's home directory:

```
# 11 /home/user01
total 32
drwxr-xr-x. 2 user01 user01 4096 Dec 11 07:43 Desktop
drwxr-xr-x. 2 user01 user01 4096 Dec 11 07:43 Documents
drwxr-xr-x. 2 user01 user01 4096 Dec 11 07:43 Downloads
-rw-rw-r-. 1 user01 user01 0 Dec 11 07:44 file1
-rw-rw-r-. 1 user01 user01 0 Dec 11 07:44 file2
drwxr-xr-x. 2 user01 user01 4096 Dec 11 07:43 Music
drwxr-xr-x. 2 user01 user01 4096 Dec 11 07:43 Pictures
drwxr-xr-x. 2 user01 user01 4096 Dec 11 07:43 Templates
drwxr-xr-x. 2 user01 user01 4096 Dec 11 07:43 Videos
```

Step 2. You could also use the following:

```
# 11 -s /home/user01
total 32
drwxr-xr-x. 2 user01 user01 4096 Dec 11 07:43 Desktop
drwxr-xr-x. 2 user01 user01 4096 Dec 11 07:43 Documents
drwxr-xr-x. 2 user01 user01 4096 Dec 11 07:43 Downloads
-rw-rw-r-. 1 user01 user01 0 Dec 11 07:44 file1
-rw-rw-r-. 1 user01 user01 0 Dec 11 07:44 file2
drwxr-xr-x. 2 user01 user01 4096 Dec 11 07:43 Music
drwxr-xr-x. 2 user01 user01 4096 Dec 11 07:43 Public
drwxr-xr-x. 2 user01 user01 4096 Dec 11 07:43 Templates
drwxr-xr-x. 2 user01 user01 4096 Dec 11 07:43 Videos
```

Here, you can see 10 different options that can be set on the file. The first field determines whether it is a directory. Desktop is a directory as denoted by the d in the first field. The next three fields each represent the owner, the group, and other. For example, file1 is not a directory, the owner of the file can read and write to this file, the group can read and write, and all others can only read the file. You can also see that file2

has the same permissions. The owner and group are listed after the permissions, and for all files in this directory, the owner is user01 and the group is user01. Users and groups are used to control who has access to files and directories.

Now that you know how to view the permissions of files and directories, let's look at how to modify them. Let's start with changing the owner and group of a file using the chown command. There is another user called user02 you can use.

Syntax: chown [option] [user] [: [group]]

Options:

-R Acts recursively

-v Provides verbose output

- Step 3. Change the owner of file1 from user01 to user02:
 # chown user02 file1
- Step 4. Change the group of file2 from user01 to user02:
 # chown :user02 file2
- **Step 5.** Now check the permissions again:

```
# 11
-rw-rw-r--. 1 user02 user01 0 Dec 11 07:44 file1
-rw-rw-r--. 1 user01 user02 0 Dec 11 07:44 file2
```

You can see that the user for file1 and group for file2 were changed appropriately. Currently, both files are set up to allow only other users to read them. What if you want to allow all users on your system to make changes to this file? In that case, you can use the chmod command to change permissions.

Syntax: chmod [options] FILE

Options:

- -R Acts recursively
- -v Provides verbose output
- **Step 6.** Change the permissions in the "other" section to allow write access to this file:

chmod 666 file1

Step 7. View the permissions change:

11 -rw-rw-rw-. 1 user02 user01 0 Dec 11 07:44 file1

Now user02, group user01, and everyone else on the system have read and write access to this file. You might be wondering where I got 666 for the permissions? When you assign permissions with numerical values, you add up the values of the permissions for each section. Because I wanted to keep the user and group permissions the same, I needed to make sure that they each had read (4) and write (2) permissions (4 + 2 = 6). Because I want the "other" group to be the same, I just continued with the same numerical value, which is where the 666 permissions come from. Being able to manipulate permissions isn't a difficult task but may take some practice to understand at first.

The last command that we look at is umask. You may be wondering where the permissions came from when we first created file1 and file2? They were given 664 as their default permissions upon creation, but where did that number come from? When users are created, they are assigned a umask value that defines all permissions for files and directories that users create. Let's look at how that works.

When files are created, they are given the default permissions 666 or rw-rw-rw- and directories are given the default permissions 777 or rwxrwxrwx. The umask command takes the default permissions and modifies them according to its mask value (through subtraction). Here is an example of how they are calculated:

File's default permissions	666 = 110 110 110 (in binary)
Subtract the umask	002 = 000 000 010 (in binary)
Value you get afterward	664 = 110 110 100 (in binary)

Now you have the default permissions 664 as shown previously. This calculation is the same with directories:

Directory's default permissions	777 = 111 111 111 (in binary)
Subtract the umask	002 = 000 000 010 (in binary)
Value you get afterward	775 = 111 111 101 (in binary)

Now you have the default permissions 775 as shown previously.

- **Step 8.** You can display the current value of the umask to find out what it is set to by calling the umask command:
 - # umask 0002

All files and directories have a leading 0, which is used for more advanced permissions. For now, just know that it is there but that you can leave it off when calculating directory permissions. You can also supply a value to umask to be able to change it, but this is not recommended.

If you don't understand the information covered here, that's all right because Chapter 7, "User Administration," deals with users, user creation, and advanced file permissions more closely. However, you should know how to set file permissions and understand how they are calculated before moving on.

Using a Text Editor

Being able to use a text editor is probably one of the most critical skills to have as a system administrator. You constantly need to edit config files, write scripts, or make changes to system files...all of which require you to use a text editor. The three most popular editors available today include

vi or vim	Text editor with great flexibility
emacs	Similar to vi, an advanced text editor with many features
nano	A basic text editor for quick editing

For the Red Hat exams, you need to know how to use the vim text editor. It is installed by default with Red Hat Enterprise Linux 6, although it isn't the only editor available. Vim is an enhanced version of vi with syntax highlighting for programming. You can install additional text editors if the packages for them are available during the exam. Personally, I use nano for most of my quick edits and vim for any config file building from scratch or programming.

Let's look at some of the options for vim.

Syntax: vim [arguments] [file]

Arguments:

- R	Opens a file in read-only mode
- b	Specifies binary mode
+	Starts at the end of the file
+ <num></num>	Starts at line <num></num>

Vim functions in three different modes: command mode, insert mode, and last line mode. When you first start working with a file, you are in command mode. Here, you can issue commands that allow you to move around your file without actually inserting text into the file. When you're ready to insert text into the file, you can use i or a to move into insert mode, enabling you to insert text at the cursor location. To move out of insert mode back into command mode, just press the Esc key. The last mode you can enter is last line mode, which you enter by typing a colon (:). In this mode, you can issue additional commands to save, quit, and do even more.

There are some additional options you should know for command mode.

Commands for command mode:

	е	Moves to the end of a word	
	b	Moves to the beginning of a word	
	\$	Moves to the end of a line	
	Н	Moves to the first line onscreen	
	L	Moves to the last line onscreen	
	i	Enters insert mode	
	а	Appends after the cursor	
	0	Opens a new line below and inserts	
	0	Opens a new line above and inserts	
	R	Enters insert mode but replaces characters instead of inserting	
	dd	Deletes the current line	
	х	Deletes text under the cursor	
	уу	Yanks (copies) the current line	
	р	Pastes the yanked line	
	u	Undoes the last action	
(Commands for last line mode:		
	:n	Jumps to line n	

- :w Writes the file to disk
- :q Quits vim
- :q! Quits without saving changes

Using vim is rather confusing at first if you have not used it before. I suggest you create and work with some sample files before continuing so that you become more familiar with it. You can also practice with nano and emacs to see the difference in how the editors work. Although nano is quicker to pick up and easier to use, it is not as flexible or powerful as vim or emacs. There is a huge war between system administrators over which text editor is better—vim or emacs. I won't choose sides, but I will say you should try both and see which you are more comfortable with.

Regex

From time to time, you need to hunt down something specific on your system, whether it's a file itself, something within a file, or through a script. In Linux, you can use regular expressions (also known as *regex*) that enable you to find specific information. Regex uses special expressions in combination with any of the following:

Literal	Any character used in a search or matching expression
Metacharacter	One or more special characters with special meaning
Escape sequence	Use of metacharacters as a literal

Regex is one of those topics that either you pick up or it causes tons of frustration and headaches. Just like anything else though, the more you practice and look at examples, the more you should begin to pick up on how it works and how to use it more efficiently.

In this section, we look at only a single command called grep, which can be used with regex. To start, let's look at the options that can be used with it.

Syntax: grep [options] PATTERN [file]

Options:

- W	Forces PATTERN to match whole words only
- X	Forces PATTERN to match whole lines only
- E	Makes PATTERN an extended regular expression
- f	Obtains PATTERN from a file
- V	Inverts the match (prints nonmatching lines)
-m [NUM]	Stops after NUM matches
- R	Acts recursively when searching through directories
-color=[WHEN]	Displays output in color; WHEN is always, auto, or never

The hardest thing to understand when you're starting with regex is how to build a pattern to find what you're looking for. You not only need to know which option to use when calling the grep command, but also need to understand pattern options. Let's go through what some of these options include.

Metacharacters:

- [] Matches anything inside the brackets, either individually or as a whole, including letters or numbers. Be aware that lower- and uppercase letters are different.
- Creates a range; for example, one through nine would be 1-9. This dash can also be used to search for a range of letters such as a-z or A-Z. There are no spaces between characters when using a range.
- ^ Negates a search when used inside brackets. The caret is used outside brackets to find only lines that begin with a given string.
- Similar to a caret outside brackets, finds lines based on their ending character or string.
- . Finds any character in its position.
- * Matches any character zero or more times.
- () Combines multiple patterns.
- Finds left or right values, which is very useful in combination with ().

These characters should be enough to get you started. The following text is used in the file_example file for all regex examples.

Step 1. Copy the following into a file called file_example:

My original text Another line with the number 3 Search for the word "me" I contain 5and6 Skip me and me 0 + 1 = 1 Above this line is a math equation...duh!

Step 2. For the bracket example, look for S[ek] as a pattern:

grep S[ek] file_example
Search for the word "me"
Skip me

You can see that two lines were returned from the file. The first line was returned because it contained the word *Search*, which has *Se* in it. The second line contains the word *Skip*, which matches the *Sk*.

Step 3. Try another match with c[or] as the pattern:

```
# grep c[on] file_example
I contain 5and6
```

Here, both letters are matched in the word *contain*. Now let's check out how range works in a pattern.

Step 4. Search for any line that contains a number using [0-9] as the pattern:

```
# grep [0-9] file_example
Another line with the number 3
I contain 5and6
0 + 1 = 1
```

You can see all lines with any number between zero and nine were returned. Can you think of another way you could have returned only lines that contained numbers and no words?

Step 5. Search for all letters (both lower- and uppercase) with [A-Za-z] as your pattern and then invert your selection:

```
# grep -v [A-Za-z] file_example
0 + 1 = 1
```

Let's run through a few more examples to finish this section.

Step 6. Search for all lines beginning with the letter *S*:

```
# grep ^S file_example
Search for the word "me"
Skip me
```

Step 7. Find any line that ends in the word *me*:

```
# grep me$ file_example
Skip me
and me
```

Step 8. Find all lines that begin with uppercase *A* or lowercase *a* and have any number of characters after it:

```
# grep ^[Aa]. file_example
Another line with the number 3
and me
Above this line is a math equation...duh!
```

As you are probably starting to realize, there is an infinite number of combinations you can use to hunt down lines or words in a file. Using regular expressions is a huge topic, and there are many great books dedicated to it. For the purposes of this book, we have covered enough for you to find what you're looking for in files. Make sure that you keep practicing with the sample and even system config files trying to find different combinations. If you're having trouble with the results of matches, I highly recommend using the -color=always options with your grep command. This highlights on your terminal what is actually being matched by your pattern, allowing you to get some better insight into what the pattern is actually looking for.

I/O Redirection

Sometimes you need to use the output from a command more than once. To accomplish this, you can redirect the output of commands using some neat command-line tricks. Let's look at the following commands:

sort	Sorts the output of a command or file
WC	Provides a word or line count
cat	Displays the contents of a file
uniq	Lists all the unique lines in a file or command output
echo	Outputs or displays a string
cut	Divides a string or output

There are also a few characters you can use to direct or redirect output of commands. These characters are

- > Directs output to a file or device (overwrites if the file exists)
- < Directs input from the file or device
- >> Appends output or text to a file (creates if the file doesn't exist)
- Pipes the output of one command to another
- && Combines commands

This might be a lot of commands to take in at once if you've never worked with them before. After we go through a few examples, most of these commands and characters will make more sense.

Step 1. Use the echo command to output some text to a file: # echo "This is some sample text" > file_example

Normally, the echo command just displays the text you have given it back to the screen, but because you are using the output direction character, the output is pushed to the file specified instead. **Step 2.** Verify that the text was output correctly by viewing the contents of the file:

cat file_example This is some sample text

Having this line in a file provides a good chance to look at the cut command.

```
Syntax: cut OPTION [FILE]
Options:
-d Specifies a delimiter
-f Displays a particular field
```

Because you know what is in the text file you just created, why not pick it apart using the cut command?

Step 3. Display the third field of the text using the space as a delimiter:

cut -d " " -f3 file_example
some

You can see that with this kind of command you can select which piece of a string or text file you'd like. Now that you know how to put some text in a file and pick it apart, see whether you can put these commands together. Using the pipe character (¦), you can combine the two previous commands to make one command pipe into another.

Step 4. Combine the two commands into a single line:

cat file_example ¦ cut -d " " -f3 file_example
some

Here, the cat command normally outputs the contents of the file named file_example. However, instead, the output is sent to the cut command for further processing. Instead of piping the commands together, you can also use && to have one command execute after another.

Step 5. Execute one command and then another:

echo "This is some more text" > file_example && cut -d " " -f3
file_example
some

So far, you've seen some creative ways to output text to files and manipulate the text in the file. What if you output text to a file and then run the same command a second time?

Step 1. View the current contents of the sample file:

cat file_example
This is some more text

- Step 2. Output some more text to this file: # echo "Different text" > file_example
- **Step 3.** Verify the contents of the file again:

cat file_example
Different text

What happened to the original text? When you use the >, the output is sent to a file or device. However, it always overwrites what is in the current file or device. If you want to append text, you can use the same character twice.

Step 4. Append text to the file instead of overwriting it:

```
# echo "My original text" >> file_example
```

Step 5. Verify the contents of the file:

cat file_example
Different text
My original text

Step 6. Run the same exact command again and view the contents of the file:

echo "My original text" >> file_example && cat file_example
Different text
My original text
My original text

Notice there are now two lines with the same text. What if this was a config file for a service with duplicate data? In that case, you can use the uniq command to pull only unique lines from a file, making sure that there are no duplicates.

Step 7. View only unique lines in the sample file, create a new file based on the output, and view the contents of this new file:

uniq file_example > uniq_file && cat uniq_file
Different text
My original text

Now that you've been through a few commands and characters, you're ready to start working with the rest of the commands and some real files. Suppose you are looking through the /etc/passwd file for a particular user. When you view the contents of this file, you notice that they are not in order.

Step 1. Display the contents of /etc/passwd:

```
# cat /etc/passwd
root:x:0:0:root:/root:/bin/bash
bin:x:1:1:bin:/bin:/sbin/nologin
daemon:x:2:2:daemon:/sbin:/sbin/nologin
adm:x:3:4:adm:/var/adm:/sbin/nologin
lp:x:4:7:lp:/var/spool/lpd:/sbin/nologin
sync:x:5:0:sync:/sbin:/bin/sync
shutdown:x:6:0:shutdown:/sbin:/sbin/shutdown
halt:x:7:0:halt:/sbin:/sbin/halt
mail:x:8:12:mail:/var/spool/mail:/sbin/nologin
uucp:x:10:14:uucp:/var/spool/uucp:/sbin/nologin
operator:x:11:0:operator:/root:/sbin/nologin
games:x:12:100:games:/usr/games:/sbin/nologin
gopher:x:13:30:gopher:/var/gopher:/sbin/nologin
nobody:x:99:99:Nobody:/:/sbin/nologin
dbus:x:81:81:System message bus:/:/sbin/nologin
usbmuxd:x:113:113:usbmuxd user:/:/sbin/nologin
avahi-autoipd:x:170:170:Avahi IPv4LL Stack:/var/lib/avahi-
autoipd:/sbin/nologin
vcsa:x:69:69:virtual console memory owner:/dev:/sbin/nologin
rpc:x:32:32:Rpcbind Daemon:/var/cache/rpcbind:/sbin/nologin
rtkit:x:499:499:RealtimeKit:/proc:/sbin/nologin
abrt:x:498:498::/etc/abrt:/sbin/nologin
nscd:x:28:28:NSCD Daemon:/:/sbin/nologin
haldaemon:x:68:68:HAL daemon:/:/sbin/nologin
nslcd:x:65:55:LDAP Client User:/:/sbin/nologin
saslauth:x:497:495:"Saslauthd user":/var/empty/saslauth:/sbin/nolo-
gin
avahi:x:70:70:Avahi mDNS/DNS-SD Stack:/var/run/avahi-
daemon:/sbin/nologin
ntp:x:38:38::/etc/ntp:/sbin/nologin
rpcuser:x:29:29:RPC Service User:/var/lib/nfs:/sbin/nologin
pulse:x:496:494:PulseAudio System Daemon:/var/run/pulse:/sbin/nolo-
qin
sshd:x:74:74:Privilege-separated SSH:/var/empty/sshd:/sbin/nologin
tcpdump:x:72:72::/:/sbin/nologin
```

How are you supposed to find anything in this mess? You could do some searching with regex to find a specific user, but what if you just need a little organization in your life? If that's the case, you can use the sort command to make heads or tails of this mess.

Syntax: sort [options] [FILE]

Options:

- -b Ignores leading blanks
- -f Ignores case
- -n Compares according to numerical string value
- -r Sorts in reverse order

Step 2. Display the /etc/passwd file again, this time in a sorted format:

sort /etc/passwd abrt:x:498:498::/etc/abrt:/sbin/nologin adm:x:3:4:adm:/var/adm:/sbin/nologin apache:x:48:48:Apache:/var/www:/sbin/nologin avahi-autoipd:x:170:170:Avahi IPv4LL Stack:/var/lib/avahiautoipd:/sbin/nologin avahi:x:70:70:Avahi mDNS/DNS-SD Stack:/var/run/avahidaemon:/sbin/nologin bin:x:1:1:bin:/bin:/sbin/nologin daemon:x:2:2:daemon:/sbin:/sbin/nologin dbus:x:81:81:System message bus:/:/sbin/nologin games:x:12:100:games:/usr/games:/sbin/nologin gdm:x:42:42::/var/lib/gdm:/sbin/nologin gopher:x:13:30:gopher:/var/gopher:/sbin/nologin haldaemon:x:68:68:HAL daemon:/:/sbin/nologin halt:x:7:0:halt:/sbin:/sbin/halt lp:x:4:7:lp:/var/spool/lpd:/sbin/nologin mail:x:8:12:mail:/var/spool/mail:/sbin/nologin nfsnobody:x:65534:65534:Anonymous NFS User:/var/lib/nfs:/sbin/nologin nobody:x:99:99:Nobody:/:/sbin/nologin nscd:x:28:28:NSCD Daemon:/:/sbin/nologin nslcd:x:65:55:LDAP Client User:/:/sbin/nologin ntp:x:38:38::/etc/ntp:/sbin/nologin operator:x:11:0:operator:/root:/sbin/nologin postfix:x:89:89::/var/spool/postfix:/sbin/nologin pulse:x:496:494:PulseAudio System Daemon:/var/run/pulse:/sbin/nologin root:x:0:0:root:/root:/bin/bash rpcuser:x:29:29:RPC Service User:/var/lib/nfs:/sbin/nologin rpc:x:32:32:Rpcbind Daemon:/var/cache/rpcbind:/sbin/nologin rtkit:x:499:499:RealtimeKit:/proc:/sbin/nologin saslauth:x:497:495:"Saslauthd user":/var/empty/saslauth:/sbin/nologin shutdown:x:6:0:shutdown:/sbin:/sbin/shutdown sshd:x:74:74:Privilege-separated SSH:/var/empty/sshd:/sbin/nologin sync:x:5:0:sync:/sbin:/bin/sync tcpdump:x:72:72::/:/sbin/nologin usbmuxd:x:113:113:usbmuxd user:/:/sbin/nologin uucp:x:10:14:uucp:/var/spool/uucp:/sbin/nologin vcsa:x:69:69:virtual console memory owner:/dev:/sbin/nologin

This sorted output is much better and makes it easier to read. Why stop here, though? What if you want to know how many users are listed in this file? You could count the lines in this file, or you could use the wc command to do it for you.

Syntax: wc [option] [FILE]

Options:

- C	Prints the byte count
- m	Prints the character count
-1	Prints the number of lines
- W	Prints the word count

Step 3. Determine how many lines are in the /etc/passwd file:

```
# wc -l /etc/passwd
35 /etc/passwd
```

At this point, we have covered a bunch of commands for piping and redirection. We saw not only some simple examples, but also some practical uses. Make sure you are comfortable piping, redirecting, or combining commands for efficiency. Being able to pass the Red Hat exams requires that you have good time management skills, which you can accomplish by being able to use fewer commands more efficiently.

Compression and Archiving

One of the great things about Linux is that many things don't have a standard. This allows for various implementations and customizations among many different software programs and practices. This also can be a downfall. As you will learn when you become a system administrator, backups are the number one priority. If something should crash or become corrupt and you can't restore it because you aren't keeping up with your backups or you just don't keep any, you may be looking for a new job. Although we don't address backup programs here, this is a good lead into archiving and compression. For that task, we look at a single command in this section:

tar Used for compressing and archiving files and directories

The tar utility has a monstrous number of options, so it would be impossible to cover them all here. Instead, let's focus on some common options used in this book.

```
Syntax: tar [options] [FILE]
```

Options:

- C	Creates a new archive
- d	Finds differences between the archive and file system
- f	Specifies the archive file to use
- p	Preserves files and directory permissions
-t	Lists the files in an archive
- V	Produces verbose output

Right away, you should be able to see that this little utility would be perfect to create an archive of files and directories that you could keep as a backup. Although using this tool solely as a backup strategy isn't recommended, it is useful for transferring a group of files and directories quickly. Let's look at some examples showing how to use the tar command.

- Step 1. Create some random blank files:
 # touch file1 file2 file3 another_file
- Step 2. With the files in place, create a simple archive containing these files:

tar cvf sample.tar file1 file2 file3 another_file
file1
file2
file3
another_file

Step 3. Of course, you know that you can also use some of the other tricks you learned already to make this task easier:

```
# tar cvf sample.tar <file>
another_file
file1
file2
file3
```

When an archive is created, you can also apply compression to reduce the amount of space the archive file takes up. Although multiple types of compression are supported with the use of tar, we look only at gunzip (.gz) and bzip2 (bz2) here.

Step 4. Let's re-create the archive using the gunzip compression:

```
# tar cvf sample.tar.gz <file>
another_file
file1
file2
file3
```

Step 5. View the current directory to see the two current archive files:

ls
sample.tar
sample.tar.gz

If these archives contained actual files instead of the blank ones, you'd notice that the .tar.gz file is smaller than the normal .tar file. Suppose now that you are working for a software company and the developers just sent over a build called Dec2010_MyApp.tar.gz. You need to deploy it to all your application servers, but you first need to uncompress and then extract it from the remaining .tar file. Before you deploy this build file (Dec2010_MyApp.tar.gz) to the application servers, a developer asks you to check for a file called file5.jsp within the build file. How can you tell whether this file is in the build without uncompressing and untarring the build?

Step 6. Use the -t option to list all the contents within the build file:

```
# tar tf Dec2010_MyApp.tar.gz
MyApp/
MyApp/build.xml
MyApp/app.config
MyApp/config/file3.sql
MyApp/config/file1.jcml
MyApp/config/file2.xml
MyApp/source/
MyApp/source/file4.jar
MyApp/source/file3.jar
MyApp/source/file5.jsp
```

As you can see, the file is indeed in the build. If this build were much larger, however (which they usually are), you could also use the grep command to filter out just the file you were looking for.

Step 7. Query only for the file you want within the build file:

```
# tar tf Dec2010_MyApp.tar.gz ¦ grep file5.jsp
MyApp/source/file5.jsp
```

Step 8. Query again for the same thing, but with this command, use -v for additional information:

Step 9. Now extract this build file verbosely:

```
# tar xvf Dec2010_MyApp.tar.gz
MyApp/
MyApp/build.xml
MyApp/app.config
```

```
MyApp/config/
MyApp/config/file3.sql
MyApp/config/file1.jcml
MyApp/config/file2.xml
MyApp/source/
MyApp/source/file4.jar
MyApp/source/file3.jar
MyApp/source/file5.jsp
```

Again, you know that this build file is small, so there is no harm in allowing the extra output to see what files you're getting. You can leave out the verbose option when extracting large archives, and you get a new command prompt after the extraction is finished. You can see how the tar command is quite useful for many purposes and plays a large role in the real world. Make sure you're comfortable creating, extracting, and looking through archives, both compressed and uncompressed.

Summary

Think we've covered a lot? Unfortunately, this is only the tip of the iceberg when it comes to Linux. As mentioned at the beginning of this introduction, all the tools discussed here are user-level commands that you need to know to continue in this book. If you haven't seen many of the things described here, don't panic! Everyone learns at different speeds, and with some practice and repetition, you will quickly pick up everything. Remember, this book is a lab manual; hands-on is the number-one way to learn how to work with Red Hat and any other Linux operating system. Now let's move on to Chapter 1 on how to install Red Hat Enterprise Linux 6.

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This chapter covers the following subjects:

- Starting the Installation This section covers the installation and setup of the Red Hat Enterprise Linux operating system.
- Verifying the Installation After you complete the installation, this section shows you how to verify that the installation was successful.



This chapter covers the following subjects:

- Working with Syslog This section covers logging, both local and centralized.
- Monitoring System Performance This section looks at how to monitor system performance.
- Automation with cron and at—This section covers system automation via scheduled and single-instance jobs.

The following RHCSA exam objectives are covered:

- Identify CPU and memory-intensive processes, adjust process priority with renice, and kill processes
- Locate and interpret system log files
- Schedule tasks using cron

The following RHCE exam objectives are covered:

- Produce and deliver reports on system utilization (processor, memory, disk, and network)
- Use shell scripting to automate system maintenance tasks
- Configure a system to log to a remote system
- Configure a system to accept logging from a remote system

System Logging, Monitoring, and Automation

How do you know when something goes wrong on your system? You look at the logs, of course! In all seriousness, understanding system logging is important so that you can troubleshoot when something goes wrong. Logs are kept for almost everything that you can think of, including the kernel, boot process, and different services that are running. Aside from logs, there are also utilities you can use to monitor and check the status of your system. This chapter looks at how you can use these tools and logging to troubleshoot anything that is thrown your way. The chapter also touches on how to automate some of these tasks.

Working with Syslog

Whenever something goes wrong—and sometimes when things go right—on the system, a message is generated by the syslog service. These messages are used to keep track of how the system is performing, what actions are taking place, and if there is a problem with something. Red Hat comes with a syslog service built in and already set to start at boot. In RHEL6, the rsyslog package is installed by default and is the primary logging service used.

MIGRATION TIP

In RHEL5, the default logging service was split between two daemons: syslogd and klogd. Syslogd was used for system messages and klogd for kernel messages. In RHEL6, these have both been replaced with the rsyslogd daemon, which handles both types of messages. If you are still on RHEL5, you can install the syslog service via the sysklogd package.

The rsyslog service has a main config file, /etc/rsyslog.conf, that controls where messages are sent when they are generated. Because logging is a critical piece of the operating system, it is installed by default as part of the core packages.

Step 1. Just out of good habit, you should verify that the package is installed:

rpm -qa | grep syslog
rsyslog-4.6.2-2.el6.x86_64

Because you can see that it is installed, you should also check on two other issues.

Step 2. First, make sure that the service is set to start when the system boots:

chkconfig rsyslog --list
rsyslog 0:off 1:off 2:on 3:on 4:on 5:on
6:off

Step 3. Second, make sure that the service is currently running:

service rsyslog status
rsyslogd (pid 1279) is running...

For RHEL05:

Step 1. Verify the installation of the package:

rpm -qa | grep klog
sysklogd-1.4.1-44.el5

Step 2. Check that the service will start on boot:

chkconfig syslog --list
syslog 0:off 1:off 2:on 3:on 4:on 5:on
6:off

Aside from the name difference, as we have already discussed, there are two daemons that run instead of one. They do, however, both run under a single service name.

Step 3. Verify that the service is running:

service syslog status
syslogd (pid 2214) is running...
klogd (pid 2217) is running...

As you can see here, there are some slight differences between logging on RHEL5 and RHEL6 (such as the naming and single versus double daemons). The rsyslog service provides better logging features, so it is recommended to upgrade if possible.

All the messages sent to the rsyslog service are stored in the /var/log directory, and each message section has its own file or subdirectory. You can also define your own log files or directories. The biggest problem that arises from using any logging service is the files can become uncontrollable if left unchecked. Being able to log different alerts and to obtain information from logs, in my opinion, is an art all unto itself. There are so many ways to customize logs, and each network setup is different. You should know that there are nine different alerts that the syslog service uses. These alerts can be produced by different network devices and Red Hat systems.

The nine severity levels of syslog include the following:

- emerg
- alert
- crit
- err
- warning
- notice
- info
- debug
- none

The Config File

The /etc/rsyslog.conf file is broken down into the following parts:

Modules	Indicate whether they can be loaded or unloaded (rsyslog is modular)
Global directives	Specify config options that apply to the daemon (all start with a \$)
Rules	Indicate cooperation of a selector and an action
Selector	Is based on <facility>.<priority></priority></facility>
Action	Defines what to do with messages after they're sorted by the selector

Let's look at the default config file to see some examples:

cat /etc/rsyslog.conf #rsyslog v3 config file

if you experience problems, check

http://www.rsyslog.com/troubleshoot for assistance

MODULES #### \$ModLoad imuxsock.so # provides support for local system logging (e.g. via logger command) \$ModLoad imklog.so # provides kernel logging support (previously done by rklogd) #\$ModLoad immark.so # provides --MARK-- message capability # Provides UDP syslog reception #\$ModLoad imudp.so #\$UDPServerRun 514 # Provides TCP syslog reception #\$ModLoad imtcp.so #\$InputTCPServerRun 514 #### GLOBAL DIRECTIVES #### # Use default timestamp format \$ActionFileDefaultTemplate RSYSLOG_TraditionalFileFormat # File syncing capability is disabled by default. This feature is usually not required, # not useful and an extreme performance hit #\$ActionFileEnableSync on #### RULES #### # Log all kernel messages to the console. # Logging much else clutters up the screen. #kern.* /dev/console # Log anything (except mail) of level info or higher. # Don't log private authentication messages! *.info;mail.none;authpriv.none;cron.none /var/log/messages # The authpriv file has restricted access. authpriv.* /var/log/secure # Log all the mail messages in one place. mail.* -/var/log/maillog

```
# Log cron stuff
cron.*
                                                            /var/log/cron
# Everybody gets emergency messages
*.emerg
# Save news errors of level crit and higher in a special file.
uucp,news.crit
                                                             /var/log/spooler
# Save boot messages also to boot.log
local7.*
                                                             /var/log/boot.log
# ### begin forwarding rule ###
# The statement between the begin ... end define a SINGLE forwarding
# rule. They belong together, do NOT split them. If you create multiple
# forwarding rules, duplicate the whole block!
# Remote Logging (we use TCP for reliable delivery)
#
# An on-disk queue is created for this action. If the remote host is
# down, messages are spooled to disk and sent when it is up again.
#$WorkDirectory /var/spppl/rsyslog # where to place spool files
#$ActionQueueFileName fwdRule1 # unique name prefix for spool files
#$ActionQueueMaxDiskSpace 1g  # 1gb space limit (use as much as possible)
#$ActionQueueSaveOnShutdown on # save messages to disk on shutdown
#$ActionQueueType LinkedList  # run asynchronously
#$ActionResumeRetryCount -1 # infinite retries if host is down
# remote host is: name/ip:port, e.g. 192.168.0.1:514, port optional
#*.* @@remote-host:514
# ### end of the forwarding rule ###
```

You can see from the output where some of the files are stored. Also shown is a sample rule.

Log Rotation

If left alone, logs can grow to enormous size. Luckily for you, the logrotate command allows you to rotate logs before they become too big. By default, the logrotate command is called daily to cycle the log files into a new file. The parameters of the command are defined in its config file, /etc/logrotate.conf, and the /etc/logrotate.d directory. However, the command itself is called from /etc/cron.daily/logrotate, a cron job that is run daily (as already mentioned). You can always call the logrotate command yourself if you'd like to rotate your logs, but don't do this too frequently because you'll end up with tons of rotated logs and you'll be right back to square one with a mess of unorganized log files.

Syntax: logrotate [options] configfile

Options:

- -d Debugs; doesn't do anything but test
- -f Forces file rotation
- v Provides verbose output

The following example rotates the current logs as defined in the config file:

```
# logrotate /etc/logrotate.conf
```

Centralized Logging

If you'd like to set up a centralized syslog server, you need to choose which server you'd like to store all your logs on. For this example, you can use the RHEL01 system as the centralized server and configure it to receive logs from the other systems on the network.

Step 1. Look at a section of the /etc/rsyslog.conf file again:

MODULES

\$ModLoad imuxsock.so # provides support for local system logging (e.g. via logger command) \$ModLoad imklog.so # provides kernel logging support (previously done by rklogd) #\$ModLoad immark.so # provides --MARK-- message capability # Provides UDP syslog reception #\$ModLoad imudp.so #\$UDPServerRun 514 # Provides TCP syslog reception #\$ModLoad imtcp.so #\$InputTCPServerRun 514

In the modules section, you can see two areas that will provide the capability to receive logs from other systems. The standard is to use the UDP protocol on port 514. By uncommenting the section related to UDP reception, you essentially can provide a way for the syslog server to become the centralized server for the network.

Step 2. Uncomment the following two lines:

\$ModLoad imudp.so
\$UDPServerRun 514

Step 3. When you're finished, you need to save the file, exit, and restart the syslog service:

```
# service rsyslog restart
Shutting down system logger: [ OK ]
Starting system logger: [ OK ]
```

As with any service that you'd like to make available to your network, you need to create a firewall allowing UDP 514 to be opened up.

- **Step 5.** Save the firewall rule you just created:

```
# service iptables save
Saving firewall rules to /etc/sysconfig/iptables: [ OK ]
```

Step 6. Then restart the iptables service:

service iptables restart iptables: Flushing firewall rules: 0K 1 ſ iptables: Setting chains to policy ACCEPT: filter 0K 1 ſ iptables: Unloading modules: OK 1 ſ iptables: Applying firewall rules: 0K 1 ſ

The firewall rules might not make sense at the moment because we haven't covered iptables or firewall rules yet. After you read Chapter 12, "System Security," return here to make sure you understand what is happening in the creation of firewall rules.

MIGRATION TIP

Unfortunately, due to the revamp of the syslog service, centralized logging for RHEL5 is quite different. On RHEL5, the syslog config file doesn't contain a modules section to enable remote management. Instead, you need to edit the daemon config file. We cover centralized logging for RHEL5 in the next section.

Now that the security requirements have been addressed and the centralized server is configured, you can shift your attention to the client systems. Let's look at RHEL02 for the client system. You can config RHEL02 to send some or all of its log files to the centralized syslog server (RHEL01).

You can use the following syntax when configuring log files to be sent to the centralized server:

<log file> @<hostname or IP of system (local or remote)>

You can edit the RHEL02 system to point all security logs to the central server:

nano /etc/rsyslog.conf
authpriv.* @172.168.1.1

Save the file and restart the syslog service on RHEL02:

# service rsyslog restart			
Shutting down system logger:	[0K]
Starting system logger:	[0K]

If you log out and log back in on RHEL02, it generates a security event. You can then jump over to the RHEL01 host and check the logs to see the event generated by the client system RHEL02.

REAL-WORLD TIP

When you're pointing logs to a centralized server, either local or remote, there are a few special options you can use:

```
# Send messages using the TCP protocol instead of UDP
Authpriv.* @@172.168.1.1
# Displays messages on the console instead of sending them remotely
Authpriv.* @system
# Discard all messages generated for this log file
Authpriv.* ~
# Send alert to all log files ** use with caution **
Authpriv.* *
```

These options can be used in conjunction with forwarding your logs to keep a local copy on your server.

Centralized Logging (The RHEL5 Way)

To set up centralized logging for RHEL5, do the following:

Step 1. Edit the /etc/sysconfig/syslog file to include the -r option:

```
# nano /etc/sysconfig/syslog
# Options to syslogd
# -m 0 disables 'MARK' messages.
# -r enables logging from remote machines
# -x disables DNS lookups on messages received with -r
# See syslogd(8) for more details
SYSLOGD_OPTIONS="-m 0 -r"
```

Step 2. Save the file, exit, and restart the syslog service:

# service syslog restart			
Shutting down kernel logger:	[0K]
Shutting down system logger:	[0K]
Starting system logger:	[0K]
Starting kernel logger:	[0K]

With the syslog service now accepting remote logs, you need to create a firewall rule. This process is the same as on RHEL6. One last

modification that needs to be made on RHEL5 is the adjustment of some SELinux protections.

Step 3. Query the required Boolean values:

getsebool -a | grep logd
klogd_disable_trans --> off
syslogd_disable_trans --> off

Step 5. Verify the preceding Booleans have been changed:

getsebool -a | grep logd
klogd_disable_trans --> on
syslogd_disable_trans --> on

Although we haven't covered SELinux yet (it is covered in Chapter 11, "SELinux"), the Boolean values are required here if you are still using RHEL5. After you read through Chapter 11, you can refer back here to make sure you understand the changes being made.

User Login Events

Aside from the normal logs generated and used by the syslog service, there are two special commands that deal with system logins. These two commands have special logs that can be read only through the use of these commands:

lastlog	Lists login records
faillog	Lists failed login attempts

You can use these two commands for viewing login events. These two commands are useful for hunting down attacks where users are trying to force themselves into other users' accounts (called *a brute-force attack*).

Syntax: lastlog [options]

Options:

- b	DAYS	Displays	results	older	than	DAYS
-----	------	----------	---------	-------	------	------

- u LOGIN Displays results for the user LOGIN

Show the last time the user01 account logged in:

<pre># lastlog -u</pre>	user01			
Username	Port	From	Latest	
user01	tty		Fri Sep 10 05:16:42 -0400	2010

You can also view more details using the faillog command.

```
Syntax: faillog [options]
```

Options:

- a	Displays all events
-1 SEC	Locks the account for SEC seconds after a failed login
-u LOGIN	Prints records for user LOGIN

Show more information about the user01 account login events:

```
# faillog -u user01
Login Failures Maximum Latest On
user01 0 0
```

The ability to work with syslog is important to being able to help troubleshoot any issue on Linux, not just Red Hat. When you're trying to find an issue or resolve one, the log files should always be your first stop.

Monitoring System Performance

Every time a program or command is run, a process is created for it. These processes are all unique and identified by the process identification (PID) that becomes allocated to it. System processes are critical to keeping the system up and running or providing services to clients. Management of processes can help keep the system stable or help when the system becomes unstable. Here are some of the process management commands you can use:

ps	Displays information about running processes
kill	Terminates a process
pgrep	Finds a process based on its PID
pidof	Displays all processes related to a service or command
top	Monitors system resources (similar to Task Manager in Windows)
renice	Adjusts the priority of a particular process
First, let's look at the processes the root user currently owns by using the ps command:

ps PID TTY TIME CMD 4474 pts/3 00:00:00 bash 4506 pts/3 00:00:00 ps

The ps command includes a number of options for producing different types of output, including viewing all processes currently running on the system.

To view processes with more detailed information, you can use the following command:

# ps	u										
USER	PID	%CPU	%MEM	VSZ	RSS	TTY	STAT	START	TIME	COMMAND	
root	2387	0.0	0.1	1660	424	tty1	Ss+	07:30	0:00	/sbin/mingetty	tty1
root	2388	0.0	0.1	1660	420	tty2	Ss+	07:30	0:00	/sbin/mingetty	tty2
root	2389	0.0	0.1	1660	420	tty3	Ss+	07:30	0:00	/sbin/mingetty	tty3
root	2390	0.0	0.1	1660	420	tty4	Ss+	07:30	0:00	/sbin/mingetty	tty4
root	2391	0.0	0.1	1660	448	tty5	Ss+	07:30	0:00	/sbin/mingetty	tty5
root	2392	0.0	0.1	1660	420	tty6	Ss+	07:30	0:00	/sbin/mingetty	tty6

Here, you see not only the PID, but also the CPU and memory utilization. A common set of options that I use when working with the ps command is aux combined with the grep command to weed out anything I'm not interested in. This way, I can get detailed information about a particular process. Say you'd like to see what information is available about any process pertaining to the SSH service:

# ps aux	grep	ssh									
root	4286	0.0	0.1	62616	1216	? Ss	Sep23	0:00	/usr/sb:	in/sshd	
root	15872	0.0	0.3	90116	3248	? Ss	10:06	0:00	sshd: u	ser01 [p	oriv]
user01	15874	0.0	0.1	90116	1740	? S	10:06	0:00	sshd: us	ser01@pt	s/0
user01	15921	0.0	0.0	61176	728	pts/0	R+ 10:1	4 0:	00 grep	ssh	

You also could use

ps aux

With this command, however, you would receive 59 lines of output that you would have had to go through to view those 4 lines that you actually need. You can see how narrowing down your output can be really helpful.

Let's also look at some of the other options the ps command offers:

```
$ ps - help
******** simple selection ******** selection by list ********
-A all processes -C by command name
```

```
-N negate selection
                                -G by real group ID (supports names)
-a all w/ tty except session leaders -U by real user ID (supports names)
-d all except session leaders
                              -g by session OR by effective group name
-e all processes
                               -p by process ID
T all processes on this terminal
                               -s processes in the sessions given
a all w/ tty, including other users -t by tty
                        -u by effective user ID (supports names)
g OBSOLETE - DO NOT USE
r only running processes
                               U processes for specified users
x processes w/o controlling ttys t by tty
-o,o user-defined -f full
                               --Group --User --pid --cols --ppid
-j,j job control s signal --group --user --sid --rows --info
-0,0 preloaded -o v virtual memory --cumulative --format --deselect
-1,1 long u user-oriented --sort --tty --forest --version
-F extra full X registers --heading --no-heading --context
                 ********* misc options ********
-V,V show version L list format codes f ASCII art forest
-m,m,-L,-T,H threads S children in sum -y change -l format
-M,Z security data c true command name -c scheduling class
-w,w wide output n numeric WCHAN,UID -H process hierarchy
```

You can see here that there are numerous output formats and sort features. Knowing how to manipulate the output of the ps command and find what you're looking for really helps when troubleshooting on the exams, but it also plays a huge role in troubleshooting in the real world.

What happens if one of the processes running on your system becomes out of control? In that case, you can use the kill command to terminate the process, even if it isn't responding (also called a *runaway process*). To use the kill command, however, you need to know the PID of the process that you want to kill (are you starting to see why the ps command is so helpful?).

Syntax: kill PID

If you want to stop the SSH service because it isn't responding, you just have to look for the PID associated with the SSH daemon. If you look back at the output, you can see this is PID 4286. To kill the process forcefully and effectively stop the SSH service, you can do the following:

kill 4286

Sometimes if the kill command doesn't work the way you intended it to, you can also call it with the -9 option to give it priority on the system:

kill -9 4286

What happens if you don't know the PID of the process you want to terminate? How could you look that up if you weren't sure what to query from the output of the ps command? There are actually two other commands you can use to determine the PID(s) of a service or command: pidof and pgrep.

First, let's look at pidof, to which you can pass just the name of the service or daemon. To find the PID(s) belonging to the SSH service, use the following:

```
# pidof sshd
15874 15872 4286
```

To achieve the same information in an easier-to-read format, you can use the pgrep command:

```
# pgrep sshd
4286
15872
15874
```

It's good to know that you can hunt down and kill processes or even just find out how many are running, but what if you need more information? Suppose you need to know how much of the CPU a particular process is taking up? Let's look at the final command: top. This command gives you an overview of processes on the system, including memory usage, CPU utilization, and more.

To check out the system overall, issue the following command and you get results similar to those shown in Figure 9-1:

#top

top -	13:30	0:26 up	6:01	. 4	users,	. load	avera	age: 0	.08. 0.02	. 0.01
Tasks	: 124	total,	2 1	unnin	g, 122	sleep	ing,	0 st	opped, (0 zombie
Cpu(s)): 0.	.0%us,	0.7%s	y, 0	. 0%ni,	98.7%	id, (). 3%wa	, 0.3%hi	. 0.0%si, 0.0%st
Mem:	38	5300k to	stal,	343	412k i	ised.	418	88k fr	ee, 26	564k buffers
swap:	78	6424k to	stal,		Ok L	used,	7864	24k fr	ee, 187	160k cached
PID	USER	PR	NI S	VIRT	RES	SHR S	%CPU	SMEM	TIME+	COMMAND
2099	root	18	3 0	1972	668	584 S	0.3	0.2	0:10.53	hald-addon-stor
4640	root	15	5 0	2332	1036	800 R	0.3	0.3	0:00.03	top
1	root	15	5 O	2068	616	528 S	0.0	0.2	0:01.50	init
2	root	RT	-5	0	0	0 5	0.0	0.0	0:00.00	migration/0
3	root	- 34	19	0	0	0 5	0.0	0.0	0:00.07	ksoftirgd/0
4	root	RT	r − 5	0	0	05	0.0	0.0	0:00.00	watchdog/0
5	root	10) -5	0	0	05	0.0	0.0	0:00.08	events/0
6	root	10) -5	0	0	0 5	0.0	0.0	0:00.14	khe Iper
7	1001	18	3 -5	0	0	0 5	0.0	0.0	0:00.04	kthread
10	root	10) -5	0	0	05	0.0	0.0	0:00.60	kblockd/0
11	root	20) -5	0	0	05	0.0	0.0	0:00.00	kacpid
51	root	20) -5	0	0	0 5	0.0	0.0	0:00.00	cqueue/0
54	root	10) -5	0	0	0 5	0.0	0.0	0:00.00	khubd
56	root	10) -5	0	0	05	0.0	0.0	0:00.01	kseriod
118	root	23	3 0	0	0	05	0.0	0.0	0:00.00	pdflush
119	root	15	0	0	0	05	0.0	0.0	0:00.33	pdflush
120	root	10) -5	0	0	0 5	0.0	0.0	0:00.08	kswapd0
121	1001	18	3 -5	0	0	0 5	0.0	0.0	0:00.00	aio/0
274	root	11	-5	0	0	0 5	0.0	0.0	0:00.00	kpsmoused
298	root	16	5 -5	0	0	05	0.0	0.0	0:00.00	ata/0
299	root	16	5 -5	0	0	0 5	0.0	0.0	0:00.00	ata_aux
304	root	18	3 -5	0	0	0 5	0.0	0.0	0:00.00	kstriped
313	root	20) -5	0	0	0 5	0.0	0.0	0:00.00	ksnapd
324	root	10) -5	0	0	0 5	0.0	0.0	0:00.37	kjournald
355	root	10) -5	0	0	0 5	0.0	0.0	0:00.01	kauditd
200	and the second s	4 6		2073	1 600	103 6	0.0	~ *	0.00 67	

Figure 9-1 Results of running top.

The output in Figure 9-1 shows real-time information about the system resources. You can use the q to quit from the top command.

When you're comfortable working with processes, you can then make some more advanced adjustments, such as changing the priority of a particular process. Let's say that you have a custom application running on your system. You can use the renice command to give that particular process higher priority on the CPU.

Syntax: renice <priority> [options]

Options:

- p	PID	Changes process priority for a particular PID
- u	user	Changes process priority for a particular user(s)

The priority values range from -20 (first priority) to 20 (dead last priority). Only the root user may set processes to use a priority under 0. Going back to the example, you can give the application extra priority by using the following:

renice -2 3874

This command changes the application process (3874) to have better priority than its default priority of 0. Knowing how to work with system processes and extract information from your system will help you become a better system administrator. It can also help you troubleshoot faster on the Red Hat exams.

In the next section, we look at job scheduling, which can be combined with some of the commands just covered to automate system monitoring.

Automation with cron and at

In any operating system, it is possible to create jobs that you want to reoccur. This process, known as *job scheduling*, is usually done based on user-defined jobs. For Red Hat, this process is handled by the cron service, which can be used to schedule tasks (also called *jobs*). By default, Red Hat comes with a set of predefined jobs that occur on the system (hourly, daily, weekly, monthly, and with arbitrary periodicity). As an administrator, however, you can define your own jobs and allow your users to create them as well.

Step 1. Although the cron package is installed by default, check to make sure it is installed on your system:

```
# rpm -qa | grep cron
cronie-1.4.4-2.el6.x86_64
cronie-anacron-1.4.4-2.el6.x86_64
crontabs-1.10-32.1.el6.noarch
```

MIGRATION TIP

In RHEL5, the cron package was called vixie-cron, which has been replaced in RHEL6 with cronie.

Step 3. Verify that the cron service is currently running:
service crond status crond (pid 2239) is running...
Step 4. Also verify that the service is set to start when the system boots:
chkconfig --list crond crond 0:off 1:off 2:on 3:on 4:on 5:on 6:off

To start working with cron, you first need to look at the two config files that control access to the cron service. These two files are:

/etc/cron.allow /etc/cron.deny

The /etc/cron.allow file:

- If it exists, only these users are allowed (cron.deny is ignored).
- If it doesn't exist, all users except cron.deny are permitted.

The /etc/cron.deny file:

If it exists and is empty, all users are allowed (Red Hat Default).

For both files:

If neither file exists, root only.

EXAM TIP

The rules surrounding these two files can be kind of confusing at first, so you might want to create some sample jobs to gain a better understanding of how changing these two files affects the permissions of the cron service.

Creating cron Jobs

The default setting for Red Hat allows any user to create a cron job. As the root user, you also have the ability to edit and remove any cron job you want. Let's jump into creating a cron job for the system. You can use the crontab command to create, edit, and delete jobs.

Syntax: crontab [-u user] [option]

Options:

- e	Edits	the	user's	crontab	

- -1 Lists the user's crontab
- -r Deletes the user's crontab
- -i Prompts before deleting the user's crontab

Before you start using the crontab command, however, you should look over the format it uses so you understand how to create and edit cron jobs. Each user has her own crontab file in /var/spool/cron (the file for each user is created only after the user creates her first cron job), based on the username of each user. Any "allow" actions taken by the cron service are logged to /var/log/cron.

View the /etc/crontab file to understand its syntax:

```
# grep ^# /etc/crontab
# For details see man 4 crontabs
# Example of job definition:
# ..... minute (0 - 59)
# ! ..... hour (0 - 23)
# ! .... day of month (1 - 31)
# ! .... month (1 - 12) OR jan,feb,mar,apr ....
# ! .... day of week (0 - 6) (Sunday=0 or 7) OR sun,mon,tue,etc.
# ! .... i .... day of week (0 - 6) (Sunday=0 or 7) OR sun,mon,tue,etc.
```

This file clearly spells out the values that can exist in each field. You must make sure that you provide a value for each field; otherwise, the crontab will not be created. You can also define step values by using */<number to step by>. For example, you could put */5 in the minute field to mean every fifth minute.

The best way to understand these fields is to create a crontab file and make some sample jobs. Using a text editor, create the following file in the /tmp directory.

Sample script for cron:

```
# nano /tmp/sample_script
#!/bin/bash
#
# Send a msg to all users on the console
#
wall "Hello World"
```

Save the file and set the following permissions:

chmod 775 /tmp/sample_script

Now create a cron job to launch the sample script. Because you are using the root user account, you can create a crontab for the normal user account user01.

```
Step 1. Set up user01's crontab:
    # crontab -u user01 -e
Step 2. Add the following line:
    * * * * /tmp/sample_script
```

Step 3. Save the file and quit the editor.

Because you are using * in every field to test, in about 60 seconds you will see the script execute, and it should display "Hello World" on your screen.

EXAM TIP

The crontab file uses the vi editor to make changes to itself. If you aren't familiar with this editor, be aware that the input commands are slightly different from that of nano or emacs. Make sure you know how to use the vi editor for the Red Hat exams.

Obviously, you don't want messages every 60 seconds on your system, but you get the idea of how cron and crontab should work. Let's list the current jobs that user01 has set up, and you should see the job just created (do this just for verification purposes).

Step 4. List the current cron jobs of user01:

crontab -u user01 -l
* * * * * /tmp/sample_script

You can now edit the crontab again to remove the single line, effectively deleting that individual job, or you can just delete the user's crontab entirely.

- Step 5. To remove a user's crontab jobs, use the following command: # crontab -u user01 -r
- **Step 6.** You can verify the activity on different crontabs by...wait for it...looking at the log files!

```
# tail /var/log/cron
Sep 10 09:08:01 new-host crond[4213]: (user01) CMD
(/tmp/sample script)
Sep 10 09:08:38 new-host crontab[4220]: (root) LIST (user01)
Sep 10 09:09:01 new-host crond[4224]: (user01) CMD
(/tmp/sample script)
Sep 10 09:10:01 new-host crond[4230]: (user01) CMD
(/tmp/sample script)
Sep 10 09:11:01 new-host crond[4236]: (user01) CMD
(/tmp/sample script)
Sep 10 09:12:01 new-host crond[4242]: (user01) CMD
(/tmp/sample script)
Sep 10 09:13:01 new-host crond[4248]: (user01) CMD
(/tmp/sample script)
Sep 10 09:13:06 new-host crontab[4251]: (root) LIST (user01)
Sep 10 09:14:01 new-host crond[4253]: (user01) CMD
(/tmp/sample_script)
Sep 10 09:14:15 new-host crontab[4258]: (root) DELETE (user01)
```

You can see that the cron service is executing the /tmp/sample_script file, and you can see the action after you deleted it. The process of creating crontabs and scheduling jobs is the same for all users on the system, including the root user.

MIGRATION TIP

In RHEL5, the /etc/crontab file was used as the root user's crontab. This crontab followed a different format from that of all other system users. The /etc/crontab file has an extra field between the last time field and command field. In this extra field, you must specify which user you want the job to run as.

Here is what the /etc/crontab file looks like for RHEL5 systems:

```
# cat /etc/crontab
SHELL=/bin/bash
PATH=/sbin:/bin:/usr/sbin:/usr/bin
MAILTO=root
HOME=/
# run-parts
01 * * * * root run-parts /etc/cron.hourly
02 4 * * * root run-parts /etc/cron.daily
22 4 * * 0 root run-parts /etc/cron.weekly
42 4 1 * * root run-parts /etc/cron.monthly
```

Here, the root user is defined to run the specified commands. This user field is now optional in RHEL6.

What do you think happens if you set up cron jobs to run during the night (say, to run some reports) and you shut down the system right before you go home? Well, it turns out that there is another great feature of cron. The /etc/anacrontab file defines jobs that should be run every time the system is started. If your system is turned off during the time that a cron job should have run, when the system boots again, the cron service will call /etc/anacrontab to make sure that all missed cron jobs are run.

Let's look at the /etc/anacrontab file:

```
# cat anacrontab
SHELL=/bin/sh
PATH=/sbin:/bin:/usr/sbin:/usr/bin
MAILTO=root
# the maximal random delay added to the base delay of the jobs
RANDOM DELAY=45
# the jobs will be started during the following hours only
START HOURS RANGE=3-22
#period in days delay in minutes job-identifier command
1
      5
              cron.daily nice run-parts /etc/cron.daily
       25
7
               cron.weekly
                                     nice run-parts /etc/cron.weekly
@monthly 45 cron.monthly
                                      nice run-parts /etc/cron.monthly
```

The comments in this file make it easy to understand how jobs are defined. If your system is constantly on and you don't require anacron to be run, you can uninstall the cronie-anacron package, which controls just the anacron commands for the cron service.

MIGRATION TIP

In RHEL5, anacron was a separate service from cron. The anacron service alone was called when the system booted and similarly ran the /etc/anacrontab file. This file looks similar to the RHEL6 version without any comments:

```
# cat anacrontab
SHELL=/bin/sh
PATH=/sbin:/bin:/usr/sbin:/usr/bin
MAILTO=root
        65
1
                 cron.daily
                                           run-parts /etc/cron.daily
7
        70
                 cron.weekly
                                           run-parts /etc/cron.weekly
30
        75
                 cron.monthlv
                                           run-parts /etc/cron.monthly
```

For RHEL5, you need to ensure that this service is set to run when the system boots in order for it to be effective:

```
# chkconfig anacron - list
anacron 0:off 1:off 2:on 3:on 4:on 5:on 6:off
```

MIGRATION TIP

In RHEL5, you also need to disable SELinux protection for the cron service to function properly. Although we haven't covered SELinux yet, you can use the following steps to configure it:

Step 1. Query the required Boolean values:

```
# getsebool -a | grep crond
crond disable trans --> off
```

Step 2. Change the values to allow incoming logs:

```
# setsebool -P crond_disable_trans=1
```

Step 3. Verify the preceding Booleans have been changed:

getsebool -a | grep crond
crond disable trans --> on

Single Jobs with at

Although you can use the cron service to schedule jobs that you want to occur more than once, you can use a service called atd for single-instance jobs.

Step 1. As with any service thus far, you need to verify that the package is installed:

```
# rpm -qa | grep ^at
at-3.1.10-42.el6.x86_64
```

Step 2. Check that the service is currently running:

service atd status
atd (pid 2300) is running...

Step 3. Finally, verify that the service is set to start on system boot:

chkconfig --list atd
atd 0:off 1:off 2:off 3:on 4:on 5:on
6:off

The atd service uses two files in the same manner that cron does to control access to the service. These files are

/etc/at.allow /etc/at.deny The /etc/at.allow file:

- If it exists, only these users are allowed (at.deny is ignored).
- If it doesn't exist, all users except at.deny are permitted.

The /etc/at.deny file:

■ If it exists and is empty, all users are allowed (Red Hat default).

For both files:

■ If neither file exists, root only.

The atd service also includes a single command, at, that is used to set up the jobs you want to run.

Syntax: at [options]

Options:

-1	Lists all jobs in the queue
-d ID	Removes a job from the queue
- m	Sends mail to the user when the job is complete
-f FILE	Reads input from the file
- V	Shows the time the job will be executed

The at command enables you to specify a time in many different formats, making it really flexible. Let's look at a few examples of the time formats you can use:

```
# at 9am
# at now + 3 days
# at 1:30 3/22/10
```

After you specify a time, your command prompt changes:

at 10:07am at> Now you just need to enter any commands that you want to execute for your job at the specified time. You can finish by pressing Ctrl+D to end the command input and send the job to the queue:

```
# at 10:07am
at>
at> wall "Hello World"
at> <EOT>
```

Now that a job is queued, let's view what the file that holds this job looks like.

Step 1. Query the /var/spool/at directory for jobs:

```
# ls /var/spool/at
a000010147997f spool
```

Unlike with the cron service, the names of the at jobs aren't really meaningful. Instead of viewing the directory that holds the at jobs, you might find it easier to list the jobs waiting to be run like you did with the cron service.

Step 2. View the currently queued jobs using the at command:

> # at -1 2010-10-27 10:07 a root 1

Step 3. You can also use the atq command for the exact same results:

> # atg 2010-10-27 10:07 a root 1

You can see one job currently in the queue was sent by the root user and is waiting to run at 10:07 a.m. Instead of typing out all the jobs you might want to run, you could also use the -f option to specify a file containing a list of commands that you want executed instead:

at -f cmds_file 11pm

When you put jobs in the queue, notice that they are given ID numbers. This information is important in case there is a job that you want to delete from the queue.

Step 4. Add a temporary job to the queue:

1

cd ~ # touch test_job && chmod 775 test_job # at -f test_job 11pm

Step 5. Verify that the job made it to the queue:

> # atq 2010-12-04 23:00 a root

- Step 6. Delete the job from the queue: # at -d 1
- Step 7. You can also use the atrm command to achieve the same results: # atrm 1
- **Step 8.** Verify that the job is truly gone:

atq

You should now be able to schedule single jobs and reoccurring jobs. Job management is important in making sure that your system runs smoothly. It also helps when you're automating tasks so you don't have to do them every day.

Summary

Knowing how to work with logs and where to look for information is critical when you're troubleshooting the system. A centralized syslog server helps in many ways with making log collection and management easier. You can also use tools such as ps and top to look into resource issues that the system may be having. In this chapter, we looked at the cron and atd services, each of which can be used for scheduling jobs. Using these tools, you can help track down problems that arise and look for trends of reoccurring issues. In the next chapter, we look at the kernel, the brains behind the Red Hat operating system.

Review Questions

- 1. What option can you change in the rsyslog config file to accept remote logs (acting as a centralized logging server)?
- 2. What two commands are special for dealing with user login events?
- **3.** Can you name the two commands that can be used to view the free space on the system?
- 4. What command can you use to view system processes and their CPU usage?
- 5. The at command is used to schedule reoccurring system jobs. True or False?
- 6. What happens to jobs that are scheduled to run while the system is off?
- 7. What command can be used to view the queue for at service jobs?
- 8. What is the top command used for?

Answers to Review Questions

- Uncomment the following line in the /etc/rsyslog.conf file: #\$ModLoad imudp.so #\$UDPServerRun 514
- 2. The lastlog and faillog commands are used to view user login-related events?
- 3. The du and df commands are used to view available space on the system.
- 4. Use the ps command to view processes and their CPU usage.
- **5.** False. The at command is used to schedule one-time-only jobs. The cron service handles reoccurring system jobs.
- 6. When the system starts up again, the cron service will run any jobs that were missed while the system was off. On Red Hat Enterprise Linux 5, the anacron service handles this functionality.
- **7.** atq
- 8. Use the top command to view CPU and memory usage.

Lab 9

Task 1 – Centralized Logging

- **Step 1.** Set up a centralized log server on RHEL02 using the following guidelines:
 - **a.** The server must accept logs from all clients on the 172.168.1.0/ 24 subnet.
 - **b.** All security logs should remain local to the system that they are on.
 - **c.** Only /var/log/messages and /var/log/dmesg should be forwarded to the centralized server.
- **Step 2.** Set up each server or client system in the lab to forward the appropriate logs to RHEL02.

The task is complete when all logs are set up correctly and the centralized log server (RHEL02) is collecting the correct logs.

Task 2 – System Monitoring

Step 1. Create a BASH script on RHEL01 using the following guidelines:

- **a.** The script must output the ps aux command to a file called system_mon located in the /opt directory.
- **b.** The script must output the amount of free memory to a file called system_mon located in the /opt directory.
- **c.** The script must append the date to the system_mon file.

The task is complete when the script records the necessary information in the required file and the file is named correctly.

Task 3 – Scheduling Jobs

Perform the following tasks on RHEL01:

- **Step 1.** Set up a cron job to execute every day at noon. The job should execute the script that you created in Task 2.
- **Step 2.** Create a single job to occur 10 minutes from now that will output the date and time to all users who are logged in to the system.

The task is complete when all jobs have been scheduled and they execute successfully.



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