



# LINUX ESSENTIALS FOR CYBERSECURITY

WILLIAM "BO" ROTHWELL  
DENISE KINSEY, PhD

# Linux Essentials for Cybersecurity

**William “Bo” Rothwell**

**Denise Kinsey**



**Pearson**

# Linux Essentials for Cybersecurity

## Table of Contents

Cover

Title Page

Copyright Page

Table of Contents

Introduction

Part I: Introducing Linux

Chapter 1 Distributions and Key Components

Introducing Linux

Linux Distributions

Shells

GUI Software

Installing Linux

Which Distro?

Native or Virtual Machine?

Installing a Distro

Summary

Key Terms

Review Questions

Chapter 2 Working on the Command Line

File Management

The Linux Filesystem

Command Execution

The pwd Command

The cd Command

The ls Command

File Globbing

The file Command

The less Command

The head Command

# Table of Contents

- The tail Command
- The mdkir Command
- The cp Command
- The mv Command
- The rm Command
- The rmdir Command
- The touch Command

## Shell Features

- Shell Variables
  - echo
  - set
  - unset
- The PS1 Variable
- The PATH Variable
- Environment Variables
  - env
- Initialization Files
- Alias
- Command History
- History Variables
- The .bash\_history File
- Redirecting Input and Output
- Piping
- Subcommands

## Advanced Commands

- The find Command
- Regular Expressions
- The grep Command
- The sed Command
- Compression Commands
  - The tar Command
  - The gzip Command
  - The gunzip Command
  - The bzip2 Command
  - The xz Command

## Summary

- Key Terms

# Table of Contents

Review Questions

## Chapter 3 Getting Help

### Man Pages

Man Page Components

Man Page Sections

Man Page Locations

### Command Help Options

The help Command

The info Command

The /usr/share/doc Directory

Internet Resources

### Summary

Key terms

Review Questions

## Chapter 4 Editing Files

### The vi Editor

What Is vim?

Essential vi Commands

Use Basic vi Modes

Entering the Insert Mode

Movement Commands

Repeater Modifiers

Undoing

Copying, Deleting, and Pasting

Finding Text

Find and Replace

Saving and Quitting

Expand Your vi Knowledge

### Additional Editors

Emacs

gedit and kwrite

nano and joe

lime and bluefish

### Summary

Key Terms

Review Questions

# Table of Contents

## Chapter 5 When Things Go Wrong

### The Science of Troubleshooting

- Step 1: Gathering Information
- Step 2: Determine the Likely Cause
- Step 3: Document Your Plan of Attack (POA)
- Step 4: Perform the Actions
- Steps 5 and 6: Is the Problem Solved?
- Step 7: Are There Other Problems?
- Step 8: Store the Documentation
- Step 9: Prevent Future Problems

### Notifying Users

- Pre- and Post-login Messages
- The /etc/issue File
- The /etc/issue.net File
- Additional Pre-login Messages
- The /etc/motd File
- Broadcasting Messages
- The wall Command
- The shutdown Command

### Summary

- Review Questions

## Part II: User and Group Accounts

### Chapter 6 Managing Group Accounts

#### What Are Groups Used For?

- Primary versus Secondary Groups
- The /etc/group File
- Special Groups
- User Private Groups
- The /etc/gshadow File

#### Managing Groups

- Creating Groups
- Modifying Groups
- Deleting Groups
- Adding Users to Groups
- Group Administrators

#### Summary

# Table of Contents

Key Terms

Review Questions

## Chapter 7 Managing User Accounts

### The Importance of User Accounts

User Account Information

The /etc/passwd File

Special Users

The /etc/shadow File

### Managing Users

Creating Users

Setting the Account Password

Using Defaults

Using Skel Directories

Modifying Users

Managing GECOS

Deleting Users

Restricted Shell Accounts

### Network-Based User Accounts

#### Using su and sudo

#### Restricting User Accounts

PAM Categories

PAM Control Values

PAM Modules

Using PAM to Alter the Password Policy

#### Summary

Key Terms

Review Questions

## Chapter 8 Develop an Account Security Policy

### Introducing Kali Linux

### Security Principles

### Creating a Security Policy

### Securing Accounts

Physical Security

Educating Users

Account Security

User Account Names

# Table of Contents

- Users with No Password
- Preventing a User from Changing a Password
- Application Accounts
- Enabling Process Accounting
- Avoiding Commands Being Run as the Superuser

## Security Tools

- The john and Johnny Tools
- The hydra tool

## Summary

- Review Questions

## Part III: File and Data Storage

### Chapter 9 File Permissions

#### Standard Permissions

- Viewing Permissions
- Files Versus Directories
- Changing Permissions

#### Default Permissions

#### Special Permissions

- SUID
- SGID
- Sticky Bit

#### Access Control Lists (ACLs)

- The mask Value
- Default ACLs

#### Changing Ownership

- chown
- chgrp

#### File Attributes

#### Introduction to SELinux

- Users Create Security Holes
- Daemon Processes Create Security Holes
- SELinux Essentials
- Security Context
- SELinux Conclusion

## Summary

- Key Terms



# Table of Contents

Review Questions

## Chapter 10 Manage Local Storage: Essentials

### Filesystem Essentials

Partitions

Filesystems

Why So Many Partitions/Filesystems?

Which Partitions/Filesystems Should Be Created?

### Filesystem Types

Managing Partitions

MBR

GPT

Creating MBR Partitions

Creating MBR Partitions

Creating Filesystems

Ext-Based Filesystem Tools

fsck.\*

dumpe2fs

tune2fs

debugfs

Xfs-Based Filesystem Tools

xfsdump and xfsrestore

xfs\_info

xfs\_check and xfs\_repair

### Additional Filesystem Tools

du

df

### Mounting Filesystems

The umount Command

The mount Command

Mounting Filesystems Manually

Problems Unmounting Filesystems

Mounting Filesystems Automatically

Device Descriptors

Mount Options

Mounting Removable Media

Swap Space

Creating Swap Devices

# Table of Contents

## Summary

Key Terms

Review Questions

## Chapter 11 Manage Local Storage: Advanced Features

### Encrypted Filesystems

### Managing autofs

### Logical Volume Manager

Logical Volume Manager Concepts

Advantages of LVM on a System with a Single Drive

LVM Essentials

Extents

Logical Volumes

Device Naming

Using Logical Volumes and Additional LVM Commands

Displaying LVM Information

Additional LVM Commands

Resizing Logical Volumes

LVM Snapshots

### Disk Quotas

Setting Up a Disk Quota for a Filesystem

Editing, Checking, and Generating User Quota Reports

quotaon

edquota

quota

repquota

### Hard and Soft Links

Why Use Links?

Creating Links

Displaying Linked Files

## Summary

Key Terms

Review Questions

## Chapter 12 Manage Network Storage

### Samba

SAMBA Configuration

The [global] Section

# Table of Contents

- The [homes] Section
- The [printers] Section
- Custom Shares
- SAMBA Server
- SAMBA Accounts
- Mapping Local Accounts
- Accessing SAMBA Servers
- Mounting SAMBA Shares

## Network File System

- Configuring an NFS Server
- The /etc/exports File
- User ID Mapping
- NFS Server Processes
- Understanding portmap
- NFS Server Commands
- Configuring an NFS Client
- iSCSI
- Target Configuration
- Initiator Configuration

## Summary

- Key Terms
- Review Questions

## Chapter 13 Develop a Storage Security Policy

### Developing the Plan

### Backing Up Data

- Creating a Backup Strategy
- What Needs to Be Backed Up?
- How Often?
- Full or Incremental?
- Where Will the Backup Be Stored?
- What Backup Tool Will Be Used?
- Standard Backup Utilities
- The dd Command
- The tar Command
- The rsync Command
- Third-party Backup Utilities
- Amanda

# Table of Contents

Bacula

Summary

Key Terms

Review Questions

## Part IV: Automation

### Chapter 14 crontab and at

Using crontab

Configure User Access to the cron Service

/etc/crontab

/etc/anacrontab

Using at

atq

atrm

Configure User Access to at Services

Summary

Key Terms

Review Questions

### Chapter 15 Scripting

Linux Programming

BASH Shell Scripting

Perl Scripting

Python Scripting

Basics of BASH Scripting

Conditional Expressions

Integer Comparisons

File Test Comparisons

Flow Control Statements

The while Loop

The for Loop

Loop Control

The case Statement

User Interaction

Using Command Substitution

Additional Information

Summary

# Table of Contents

Key Terms

Review Questions

## Chapter 16 Common Automation Tasks

### Exploring Scripts that Already Exist on Your System

The /etc/cron.\* Directories

logrotate

man-db.cron

mlocate

Repositories

### Creating Your Own Automation Scripts

#### Summary

Key Terms

Review Questions

## Chapter 17 Develop an Automation Security Policy

### Securing crontab and at

### Securing BASH Scripts

Access to Scripts

Script Contents

Dealing with Data

Shell Settings

Shell Style

#### Summary

Review Questions

## Part V: Networking

### Chapter 18 Networking Basics

#### Network Terminology

#### IPv4 Versus IPv6

#### IPv4 Addresses

Determining a Network Address from an IP Address and Subnet

Private IP Addresses

#### Common Protocol Suites

#### Network Ports

#### Summary

Key Terms

Review Questions

# **Table of Contents**

## **Chapter 19 Network Configuration**

### **Ethernet Network Interfaces**

- Displaying Ethernet Port Configurations
- Changing Ethernet Port Settings
- Network Configuration Tools
- The arp Command
- The route Command
- The ip Command
- The hostname Command
- The host Command
- The dig Command
- The netstat Command

### **Persistent Network Configurations**

- The /etc/hostname File (Universal)
- The /etc/hosts File (Universal)
- The /etc/resolv.conf File (Universal)
- The /etc/nsswitch.conf File (Universal)
- The /etc/sysctl.conf File (Universal)
- The /etc/sysconfig/network File (Red Hat)
- The /etc/sysconfig/network-scripts/ifcfg-interface-name Files (Red Hat)
- The /etc/network/interfaces File (Debian)

### **Network Troubleshooting Commands**

- The ping Command
- The traceroute Command
- The netcat Command

### **Access to Wireless Networks**

- The iwconfig Command
- The iwlist Command

### **Summary**

- Key Terms
- Review Questions

## **Chapter 20 Network Service Configuration: Essential Services**

### **DNS Servers**

- Essential Terms
- How Name Resolution Works
- Basic BIND Configuration

# Table of Contents

The /etc/named.conf File

The allow-query Setting

Additional /etc/named.conf Settings

## Zone Files

Zone File Basics

Zone File Entries in the /etc/named.conf File

Zone File Syntax

Zone Record Types

The SOA Record Type

The Address Record Type

The Canonical Name Type

The Name Server Record Type

The Mail eXchange Record Type

The Pointer Record Type

Putting It All Together

Slave BIND Servers

Testing the DNS Server

The dig Command

## Securing BIND

Sending BIND to Jail

Creating the chroot Directory and Files

Configuring named to Start in the Jail

Split BIND Configuration

Transaction Signatures

The dnssec-keygen Command

The dnssec-signzone Command

## DHCP Server

DHCP Configuration Basics

The ddns-update-style and ignore client-updates Directives

The subnet Directive

Configuring Static Hosts

DHCP Log Files

## Email Servers

SMTP Basics

Configuring Postfix

Postfix Configuration File

Important Postfix Settings

# Table of Contents

Aliases

Postfix Virtual Domains

## Managing Local Email Delivery

procmail Basics

procmail Rules

procmail Examples

mbox and Maildir Formats

## Remote Email Delivery

IMAP and POP Essentials

The Dovecot Server

## Summary

Key Terms

Review Questions

## Chapter 21 Network Service Configuration: Web Services

### Apache Web Server

#### Basic Apache Web Server Configuration

Starting the Apache Web Server

Apache Web Server Log Files

Enable Scripting

#### Apache Web Server Security

Essential Settings

User Authentication

#### Virtual Hosts

Configuring IP-Based Virtual Hosts

Configuring Name-Based Virtual Hosts

#### HTTPS

SSL Essentials

SSL Issues

Self-Signing

#### SSL and Apache

SSL Server Certificate

Apache SSL Directives

#### Proxy Servers

Tunneling Proxy

Forward Proxy

Reverse Proxy



# Table of Contents

- Squid Basics
- Squid Access Rules
- Built-In ACLs
- Understanding the Squid Rules
- Nginx Configuration
- Client Configuration

## Summary

- Key Terms
- Review Questions

## Chapter 22 Connecting to Remote Systems

### LDAP

- Key LDAP Terms
- The slapd.conf File
- Customizing Your LDAP Domain
- Configuring Logging
- Configuring the Database Directory
- Starting the LDAP Server
- OpenLDAP Objects
- OpenLDAP Schemas
- OpenLDAP Database Changes
- Using the ldapdelete Command
- Using the ldapsearch Command
- Using the ldappasswd Command
- Connecting to an LDAP Server

### FTP Servers

- Configuring vsftpd
- Anonymous FTP
- Limiting User Accounts
- Additional Settings
- Connecting to an FTP server
- Active versus Passive Mode

### Secure Shell

- Configuring the Secure Shell Server
- Basic Configuration Settings
- Settings That Affect User Access
- Secure Shell Client Commands
- The ssh\_config File

# Table of Contents

- The ssh Command
- The scp and sftp Commands
- Advanced SSH Features

## Summary

- Key Terms
- Review Questions

## Chapter 23 Develop a Network Security Policy

### Kernel Parameters

- The /etc/sysctl.conf File
- Ignoring ping Requests
- Ignoring Broadcast Requests
- Enabling TCP SYN Protection
- Disabling IP Source Routing

### TCP Wrappers

### Network Time Protocol

- Setting the System Clock Manually
- Setting the System Time Zone Manually
- Setting the System Date Using NTP

## Summary

- Key Terms
- Review Questions

## Part VI: Process and Log Administration

### Chapter 24 Process Control

#### Viewing Processes

- The ps Command
- The pgrep Command
- The top Command
- The uptime Command
- The free Command

#### Running Processes

- Pausing and Restarting Processes

#### Killing Processes

- The kill Command
- The pkill Command
- The killall Command
- The xkill Command

# Table of Contents

The nohup Command

Process Priority

The nice Command

The renice Command

Summary

Key Terms

Review Questions

## Chapter 25 System Logging

Syslog

The syslogd Daemon

The /var/log Directory

The /etc/syslog.conf File

The /etc/rsyslog.conf File

Creating Your Own /etc/syslog.conf Entry

Adding an Entry

Using the logger Command

The logrotate Command

The /etc/logrotate.conf File

The journalctl Command

The /etc/systemd/journald.conf file

Summary

Key Terms

Review Questions

## Part VII: Software Management

### Chapter 26 Red HatBased Software Management

Red Hat Packages

How to Obtain Packages

The /var/lib/rpm Directory

Using the rpm Command

Listing rpm Information

Viewing Package Dependencies

Package Listing Tricks

Installing Packages with rpm

Before You Install That Package

Removing Packages with rpm

rpm2cpio

# Table of Contents

## The yum Command

- Repositories
- Accessing a Repo
- Creating a Repo
- Using the yum Command
- Displaying Package Information with yum
- Software Groups
- Installing Software with yum
- Removing Software with yum
- Using yum Plug-Ins

## Additional Tools

## Summary

- Key Terms
- Review Questions

## Chapter 27 Debian-Based Software Management

### Managing Packages with dpkg

- Listing Package Information with dpkg
- Installing Software with dpkg
- Reconfiguring Software with dpkg
- Extracting Files from a Debian Package
- Removing Packages with the dpkg Command

### Managing Packages with APT

- APT Repositories
- Creating a Source Repository

### Listing Package Information with APT Commands

- Installing Packages with APT Commands
- Removing Packages with APT Commands
- Additional APT Features

## Summary

- Key Terms
- Review Questions

## Chapter 28 System Booting

### Phases of the Boot Process

- The BIOS/UEFI Phase
- The Bootloader Phase
- The Kernel Phase

# Table of Contents

The Post-Kernel Phase

## GRUB

Legacy GRUB Configuration

Changing Legacy GRUB During Boot

Booting to Single-User Mode in Legacy GRUB

Securing Legacy GRUB

GRUB 2 Configuration

Saving GRUB 2 Changes

GRUB 2 Titles

Booting to Single-User Mode in GRUB 2

Securing GRUB 2

## Kernel Components

Kernel Documentation

Tweaking the Kernel

Kernel Images

Kernel Modules

Module Files

Listing Modules That Are Loaded

Loading Modules into Memory

Unloading Modules from Memory

Listing Module Information

The /proc/sys Filesystem

## The init Phase

Configuring Systemd

Using Service Units

Using Target Units

## Summary

Key Terms

Review Questions

## Chapter 29 Develop a Software Management Security Policy

### Ensuring Software Security

Keep Packages Up to Date

Consider Removing Unnecessary Packages

Ensure You Install from Trusted Sources

CVE

Distribution-Specific Security Alerts

xinetd

# Table of Contents

## Summary

Key Terms

Review Questions

## Part VIII: Security Tasks

### Chapter 30 Footprinting

Understanding Footprinting

Common Footprinting Tools

The nmap Command

The netstat Command

The lsof Command

The nc Command

The tcpdump Command

Additional Utilities

Kali Linux Utilities

Essential Information Gathering

DNS Analysis Tools

Host Identification Tools

OSINT Tools

Route Analysis Tools

## Summary

Key Terms

Review Questions

### Chapter 31 Firewalls

Introduction to Firewalls

Essentials of the iptables Command

Overview of Filtering Packets

Important Terms

Using iptables to Filter Incoming Packets

Filtering by Protocol

Multiple Criteria

Filtering Based on Destination

Changing the Default Policy

Revisiting the Original Rules

Saving the Rules

Using iptables to Filter Outgoing Packets

# Table of Contents

Implementing NAT

Summary

Key Terms

Review Questions

## Chapter 32 Intrusion Detection

Introduction to Intrusion Detection Tools

Determining If a Security Breach Has Occurred

Taking Action

Intrusion Detection Network Tools

The netstat Command

The nmap Command

The tcpdump Command

Intrusion Detection File Tools

Modifying the /etc/passwd and /etc/shadow Files to Create a Backdoor

Creating an SUID Program to Create a Backdoor

Incorporating File-Change Tools in the Intrusion Detection Plan

Additional Intrusion Detection Tools

Summary

Key Terms

Review Questions

## Chapter 33 Additional Security Tasks

The fail2ban Service

OpenVPN

Configuring the Certificate Authority

Generating the VPN Server Certificate

Generating the VPN Client Certificate

Setting Up the Basic Server

Setting Up the Basic Client

gpg

Security Alert Services

Summary

Key Terms

Review Questions

Appendix A: Answers to Review Questions

Appendix B: Resource Guide

# Table of Contents

## Glossary

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

R

S

T

U

V

W

X

Z

## Index