

Christine Bresnahan and Richard Blum

LPIC-2

**Linux Professional Institute
Certification**

STUDY GUIDE

Second Edition

EXAM 201 AND EXAM 202

Covers 100% of exam objectives, including the Linux boot process, maintaining the system, kernel components, configuring RAID, basic network configuration, mail systems, basic DNS services, and much more...

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LPIC-2

Study Guide

Second Edition



LPIC-2: Linux Professional Institute Certification

Study Guide
Exam 201 and Exam 202
Second Edition



Christine Bresnahan
Richard Blum

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To those looking to further their knowledge of Linux. “A wise man is full of strength, and a man of knowledge enhances his might.” Prov 24:5 (ESV)

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About the Authors

Christine Bresnahan started working with computers more than 25 years ago in the IT industry as a systems administrator. Christine is an adjunct professor at Ivy Tech Community College, where she teaches Linux certification and Python programming classes. She also writes books and produces instructional resources for the classroom.

Richard Blum has worked in the IT industry for more than 25 years as both a system and network administrator, and he has published numerous Linux and open source books. Rich is an online instructor for Linux and web programming courses that are used by colleges and universities across the United States. When he is not being a computer nerd, Rich enjoys spending time with his wife, Barbara, and his two daughters, Katie and Jessica.

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Introduction

Welcome to the *LPIC-2: Linux Professional Institute Certification Study Guide*. If you used our *LPIC-1: Linux Professional Institute Certification Study Guide* to study for your LPIC-1 exam, welcome back! We're glad that you decided to stay with us for your LPIC-2 study resources.

Just like our LPIC-1 Study Guide, this book contains detailed explanations for all of the LPIC-2 exam objectives, along with example questions, flashcards for self-study, and practice questions. The purpose of this book is to help you pass both of the LPIC-2 exams, 201 and 202. These exams cover more advanced topics than the LPIC-1 exam, such as the Linux kernel, system startup, filesystems, network operations, DNS servers, web servers, file servers, email servers, network client management, and security. This book will walk you through all of these topics, helping prepare you for the LPIC-2 exam questions.

LPI's Certification Program

The purpose of the Linux Professional Institute's (LPI) LPIC-2 program is to define the basic knowledge required to administer small to medium-sized mixed (Microsoft and Linux) networks, focusing on the Linux operating system. The program guides professionals wishing to build on knowledge gained from the LPIC-1 program.

It is expected that you have already passed the LPI Linux Essentials (optional) exam and the LPIC-1 (or CompTIA Linux+) exam and have at least five years' experience in administering a Linux server(s) in a mixed network environment.

The successful LPIC-2 candidate should have at a minimum knowledge and experience concerning the following topics:

- Administering multiple Linux servers
- Advising management on computerization and purchasing
- Planning and managing a small, mixed-network environment, which includes the following:
 - LAN server:
 - Client management
 - DHCP
 - DNS
 - NFS
 - Samba
 - Internet gateway:
 - Firewall
 - Mail

- OpenSSH
- VPN
- Web cache/proxy
- Internet server:
 - FTP server
 - Web server
 - Web server with a reverse proxy
- Team supervision skills

If you've already passed the LPIC-1 exam, you've proven to the world that you're proficient with the basic operation of Linux, along with the basic Linux commands. But don't stop there. When you pass the LPIC-2 exam, that will demonstrate that you have the skills that companies look for when hiring Linux administrators. Having the LPIC-2 certification validates your skills, and it helps prepare you for working with Linux servers in a commercial environment.

How to Become Certified

The LPIC-2 certification is available to anyone who has an active LPIC-1 certification and who passes the two required exams: 201 and 202.

To take an LPI exam, you must first register with LPI to obtain an LPI ID number (if you already did this for the LPIC-1 exam, you must use your existing LPI ID number for the LPIC-2 exam). If you need to register, you can do this online at <https://cs.lpi.org/cafe/xamman/register>. LPI will email your LPI ID number to you. With that you can log into the LPI Marketplace to purchase an exam voucher.

The exams are administered by Pearson VUE. The exam can be taken at any Pearson VUE testing center. If you pass, you will get a certificate in the mail saying that you have passed. Call (877) 619-2096 for Pearson VUE contact information.

To register for the exam with Pearson VUE, go to <http://www.vue.com>. Enter the exam voucher number that you received from the LPI Marketplace, and schedule the time and place to take the exam.

Who Should Buy This Book

Anyone who wants to pass the LPIC-2 certification exams may benefit from this book. You should already have a basic knowledge of Linux, as covered by the LPIC-1 exam material. If not, you should start with our *LPIC-1: Linux Professional Institute Study Guide* book and then move on to this book. This book focuses on the more advanced Linux topics covered by the LPIC-2 201 and 202 exams. Once you obtain your certification, this book

will continue to be useful by serving as a handy resource for information on installing and maintaining Linux servers.

Even if you don't plan to take the LPIC-2 exams, this book makes an excellent resource for understanding advanced Linux server topics. It covers topics such as creating your own web server, email server, and file server. These skills are required by Linux administrators in small and medium-sized network environments.

This book is written with the assumption that you have a basic knowledge of Linux. You should be familiar with how Linux works and be able to work in the Linux command line, including the core commands such as `ls`, `cp`, `mv`, `cat`, `less`, `ps`, `free`, and `uptime`. You should also already know how to install a default Linux distribution environment, because that is not covered in this book.



You'll need a Linux system with which to practice and perform the chapter activities. Any Linux desktop or server distribution will work for the activities in this book; however, we focus on the Ubuntu and CentOS Linux desktop distributions for our examples.

How This Book Is Organized

This book consists of 12 chapters plus supplementary information: an online glossary, this introduction, and the assessment test after the introduction.

Part I of the book, Chapters 1 through 6, covers the LPIC-2 201 exam topics. Part II, Chapters 7 through 12, covers the 202 exam topics. Each chapter begins with a list of the exam objectives that are covered in that chapter. However, the book doesn't cover the objectives in order.

Part I: The LPI 201 Exam

Chapter 1: Starting a System This chapter covers how Linux boots from the system BIOS. It discusses the Linux bootloader program and how to create a dual-boot Linux environment.

Chapter 2: Maintaining the System This chapter describes how to install and manage resources on a Linux system. It also covers how to back up Linux systems and communicate with system users to warn of system issues or downtime.

Chapter 3: Mastering the Kernel This chapter focuses on the core of the Linux system—the kernel. It walks you through how to install a custom kernel, as well as how to create and maintain kernel modules required to support the hardware on your Linux system.

Chapter 4: Managing the Filesystem This chapter explores the different Linux filesystems and how to manage and maintain them, as well as how to troubleshoot them when problems occur.

Chapter 5: Administering Advanced Storage Devices This chapter takes a look at two of the more advanced storage methods used in Linux environments. It focuses on how to use RAID devices in Linux, either as hardware devices or using a software RAID emulator. It also demonstrates how to implement a Logical Volume Manager in a Linux environment.

Chapter 6: Navigating Network Services This chapter takes a deeper look at how Linux interacts in a network environment. It covers how to use the Linux command-line commands to set up a network interface and how to troubleshoot basic network problems.

Part II: The LPI 202 Exam

Chapter 7: Organizing Email Services This chapter examines how to run an Internet email server using Linux. It covers the two most popular email servers—sendmail and Postfix, as well as walking you through how to use the most popular Linux email client packages—Courier and Dovecot.

Chapter 8: Directing DNS This chapter covers the basics of the DNS system and how to configure your Linux server to offer DNS services on your network.

Chapter 9: Offering Web Services This chapter covers how to run your own web server using a Linux server. It discusses how to install and manage the Apache web server—the most popular web server on the Internet. It also covers the nginx web server, a newer up-and-coming web server that’s quickly gaining in popularity. Also, this chapter dives into the basics of Squid, a popular web proxy server used by many companies as a web firewall to block users from accessing inappropriate websites.

Chapter 10: Sharing Files This chapter discusses how to use your Linux server as a file server in a local network. It covers using both FTP and NFS to serve files, as well as the popular Samba package to serve files to Microsoft Windows clients on a network.

Chapter 11: Managing Network Clients This chapter explores how to use a Linux server to provide basic network services to clients on a local network. It shows how to create a DHCP server for serving dynamic IP addresses, how to create an LDAP server for providing simple network directory services, and how to use PAM to provide authentication services to local applications.

Chapter 12: Setting Up System Security This chapter explores some ways to use your Linux server security in a network environment. It covers using the `iptables` program as a firewall, OpenSSH for remote communication with clients, and OpenVPN to provide a secure tunnel for remote clients to get to your network.

At the end of each chapter, you’ll find a couple of elements that you can use to prepare for the exam:

Exam Essentials This section summarizes important information that was covered in the chapter. You should be able to perform each of the tasks or convey the information requested.

Review Questions Each chapter concludes with 20 review questions. You should answer these questions and check your answers against the ones provided after the questions. If

you can't answer at least 80 percent of these questions correctly, go back and review the chapter, or at least those sections that seem to be giving you difficulty.



The review questions, assessment test, and other testing elements included with this book are *not* derived from the actual exam questions, so don't memorize the answers to these questions and assume that doing so will enable you to pass the exam. You should learn the underlying topic, as described in the text of the book. This will let you answer the questions provided with this book *and* pass the exam. Learning the underlying topic is also the approach that will serve you best in the workplace—the ultimate goal of a certification.

To get the most out of this book, you should read each chapter from start to finish and then check your memory and understanding with the end-of-chapter elements. Even if you're already familiar with a topic, you should skim the chapter; Linux is complex enough that there are often multiple ways to accomplish a task, so you may learn something even if you're already competent in an area.

Interactive Online Learning Environment and Test Bank

The authors have worked hard to provide some really great tools to help you with your certification process. The interactive online learning environment that accompanies the *LPIC-2: Linux Professional Institute Certification Study Guide: Exam 201 and Exam 202* provides a test bank with study tools to help you prepare for the certification exams—and increase your chances of passing them the first time! The test bank includes the following:

Sample Tests All of the questions in this book are included, including the assessment test at the end of this introduction and the 240 questions from the review sections at the end of each chapter. In addition, there are two 72-question practice exams. Use these questions to test your knowledge of the study guide material. The online test bank runs on multiple devices.

Electronic Flashcards The online text bank includes over 300 flashcards specifically written to hit you hard, so don't get discouraged if you don't ace your way through them at first. They're there to ensure that you're really ready for the exams. And no worries—armed with the review questions, practice exams, and flashcards, you'll be more than prepared when exam day comes. Questions are provided in digital flashcard format (a question followed by a single correct answer). You can use the flashcards to reinforce your learning and provide last-minute test prep before the exam.

Glossary In addition, a glossary of key terms from this book is available as a fully searchable PDF.



Readers can access these tools by visiting <http://www.wiley.com/go/sybextestprep>.

Conventions Used in This Book

This book uses certain typographic styles in order to help you quickly identify important information and to avoid confusion over the meaning of words such as on-screen prompts. In particular, look for the following styles:

- *Italicized text* indicates key terms that are described at length the first time they are used in a chapter. (Italics are also used for emphasis.)
- A **monospaced font** indicates the contents of configuration files, messages displayed at a text-mode Linux shell prompt, filenames, text-mode command names, and Internet URLs.
- *Italicized monospaced text* indicates a variable—information that differs from one system or command run to another, such as the name of a client computer or a process ID number.
- **Bold monospaced text** is information that you're to type into the computer, usually at a Linux shell prompt. This text can also be italicized to indicate that you should substitute an appropriate value for your system. (When isolated on their own lines, commands are preceded by non-bold monospaced \$ or # command prompts, denoting regular user or system administrator use, respectively.)

In addition to these text conventions, which can apply to individual words or entire paragraphs, a few conventions highlight segments of text:



A note indicates information that's useful or interesting but that's somewhat peripheral to the main text. A note might be relevant to a small number of networks, for instance, or it may refer to an outdated feature.



A tip provides information that can save you time or frustration and that may not be entirely obvious. A tip might describe how to get around a limitation or how to use a feature to perform an unusual task.



Warnings describe potential pitfalls or dangers. If you fail to heed a warning, you may end up spending a lot of time recovering from a bug, or you may even end up restoring your entire system from scratch.

Sidebar

A sidebar is like a note but longer. The information in a sidebar is useful, but it doesn't fit into the main flow of the text.

**Real World Scenario****Real World Scenario**

A real world scenario is a type of sidebar that describes a task or example that's particularly grounded in the real world. This may be a situation the authors or someone the authors know has encountered, or it may be advice on how to work around problems that are common in real, working Linux environments.

EXERCISE

An exercise is a procedure that you should try on your own computer to help you learn about the material in the chapter. Don't limit yourself to the procedures described in the exercises, though! Try other commands and procedures to really learn about Linux.

The Exam Objectives

Behind every computer industry exam, you can be sure to find exam objectives—the broad topics in which exam developers want to ensure your competency. The official exam objectives are listed here. (They're also printed at the start of the chapters in which they're covered.)



Exam objectives are subject to change at any time without prior notice and at LPI's sole discretion. Please visit LPI's website (<http://www.lpi.org>) for the most current listing of exam objectives.

Exam 201 Objectives

The following are the areas in which you must be proficient in order to pass the 201 exam. This exam is broken into seven topics (200–206), each of which has two or three objectives. Each objective has an associated weight that reflects its importance to the exam as a whole. The seven main topics are listed here:

Subject Area

200 Capacity Planning

201 Linux Kernel

202 System Startup

203 Filesystem and Devices

204 Advanced Storage Device Administration

205 Networking Configuration

206 System Maintenance

200 Capacity Planning

200.1 Measure and Troubleshoot Resource Usage

- Measure CPU usage.
- Measure memory usage.
- Measure disk I/O.
- Measure network I/O.
- Measure firewalling and routing throughput.
- Map client bandwidth usage.
- Match/correlate system symptoms with likely problems.
- Estimate throughput and identify bottlenecks in a system including networking.

200.2 Predict Future Resource Needs

- Use monitoring and measurement tools to monitor IT infrastructure usage.
- Predict capacity break point of a configuration.
- Observe growth rate of capacity usage.

- Graph the trend of capacity usage.
- Awareness of monitoring solutions such as Icinga2, Nagios, collectd, MRTG, and Cacti

201 Linux Kernel

201.1 Kernel Components

- Kernel 2.6.x, 3.x and 4.x documentation
- The `/usr/src/linux/` kernel directory
- Creating a kernel using `zImage`
- Creating a kernel using `bzImage`
- Using `xz` compression to compress the kernel

201.2 Compiling a Linux Kernel

- The `/usr/src/linux/` directory
- Kernel Makefiles
- Kernel 2.6.x, 3.x, and 4.x make targets
- Customize the current kernel configuration.
- Build a new kernel and appropriate kernel modules.
- Install a new kernel and any modules.
- Ensure that the boot manager can locate the new kernel and associated files.
- Module configuration files
- Use DKMS to compile kernel modules.
- Awareness of `dracut`

201.3 Kernel Runtime Management and Troubleshooting

- Use command-line utilities to get information about the currently running kernel and kernel modules.
- Manually load and unload kernel modules.
- Determine when modules can be unloaded.
- Determine what parameters a module accepts.
- Configure the system to load modules by names other than their file name.
- `/proc` filesystem
- Content of `/`, `/boot/`, and `/lib/modules/`
- Tools and utilities to analyze information about the available hardware
- `udev` rules

202 System Startup

202.1 Customizing System Startup

- Systemd
- SysV init
- Linux Standard Base Specification (LSB)

202.2 System Recovery

- BIOS and UEFI
- NVMe booting
- GRUB version 2 and Legacy
- Grub shell
- Boot loader start and handoff to kernel
- Kernel loading
- Hardware initialization and setup
- Daemon/service initialization and setup
- Know the different bootloader install locations on a hard disk or removable device.
- Overwrite standard bootloader options and using boot loader shells.
- Use systemd rescue and emergency modes.

202.3 Alternate Bootloaders

- SYSLINUX, ISOLINUX, PXELINUX
- Understanding of PXE for both BIOS and UEFI
- Awareness of systemd-boot and U-Boot

203 Filesystem and Devices

203.1 Operating the Linux Filesystem

- The concept of the fstab configuration
- Tools and utilities for handling swap partitions and files
- Use of UUIDs for identifying and mounting file systems
- Understanding of systemd mount units

203.2 Maintaining a Linux Filesystem

- Tools and utilities to manipulate an ext2, ext3, and ext4 filesystem
- Tools and utilities to perform basic Btrfs operations, including subvolumes and snapshots

- Tools and utilities to manipulate XFS
- Awareness of ZFS

203.3 Creating and Configuring Filesystem Options

- autofs configuration files
- Understanding of automount units
- UDF and ISO9660 tools and utilities
- Awareness of other CD-ROM filesystems (HFS)
- Awareness of CD-ROM filesystem extensions (Joliet, Rock Ridge, El Torito)
- Basic feature knowledge of data encryption (dm-crypt / LUKS)

204 Advanced Storage Device Administration

204.1 Configuring RAID

- Software RAID configuration files and utilities
- The mdadm program
- The mdadm.conf configuration file
- The /proc/mdstat file
- Using partition type 0xFD

204.2 Adjusting Storage Device Access

- Tools and utilities to configure DMA for IDE devices including ATAPI and SATA
- Tools and utilities to configure Solid State Drives including AHCI and NVMe
- Tools and utilities to manipulate or analyze system resources (e.g., interrupts)
- Awareness of sdparm command and its uses
- Tools and utilities for iSCSI
- Awareness of SAN, including relevant protocols (AoE, FCoE)

204.3 Logical Volume Manager

- Tools in the LVM suite
- Resizing, renaming, creating, and removing logical volumes, volume groups, and physical volumes
- Creating and maintaining snapshots
- Activating volume groups

205 Networking Configuration

205.1 Basic Networking Configuration

- Utilities to configure and manipulate ethernet network interfaces
- Configuring basic access to wireless networks

205.2 Advanced Network Configuration

- Utilities to manipulate routing tables
- Utilities to configure and manipulate ethernet network interfaces
- Utilities to analyze the status of the network devices
- Utilities to monitor and analyze the TCP/IP traffic

205.3 Troubleshooting Network Issues

- Location and content of access restriction files
- Utilities to configure and manipulate ethernet network interfaces
- Utilities to manage routing tables
- Utilities to list network states
- Utilities to gain information about the network configuration
- Methods of information about the recognized and used hardware devices
- System initialization files and their contents (Systemd and SysV init)
- Awareness of NetworkManager and its impact on network configuration

206 System Maintenance

206.1 Make and Install Programs from Source

- Unpack source code using common compression and archive utilities.
- Understand basics of invoking make to compile programs.
- Apply parameters to a configure script.
- Know where sources are stored by default.

206.2 Backup Operations

- Knowledge about directories that have to be include in backups
- Awareness of network backup solutions such as Amanda, Bacula, Bareos, and BackupPC
- Knowledge of the benefits and drawbacks of tapes, CDR, disk, or other backup media
- Perform partial and manual backups.

- Verify the integrity of backup files.
- Partially or fully restore backups.

206.3 Notify Users on System-Related Issues

- Automate communication with users through logon messages.
- Inform active users of system maintenance.

Exam 202 Objectives

The 202 exam comprises six topics (207–212), each of which contains two to five objectives. The six major topics are these:

Subject Area

207 Domain Name Server

208 HTTP Services

209 File Sharing

210 Network Client Management

211 E-Mail Services

212 System Security

207 Domain Name Server

207.1 Basic DNS Server Configuration

- BIND 9.x configuration files, terms and utilities
- Defining the location of the BIND zone files in BIND configuration files
- Reloading modified configuration and zone files
- Awareness of dnsmasq, djbdns, and PowerDNS as alternate name servers

207.2 Create and Maintain DNS Zones

- BIND 9 configuration files, terms, and utilities
- Utilities to request information from the DNS server

- Layout, content and file location of the BIND zone files
- Various methods to add a new host in the zone files, including reverse zones

207.3 Securing a DNS Server

- BIND 9 configuration files
- Configuring BIND to run in a chroot jail
- Split configuration of BIND using the forwarders statement
- Configuring and using transaction signatures (TSIG)
- Awareness of DNSSEC and basic tools
- Awareness of DANE and related records

208 HTTP Services

208.1 Basic Apache Configuration

- Apache 2.4 configuration files, terms, and utilities
- Apache log files configuration and content
- Access restriction methods and files
- mod_perl and PHP configuration
- Client user authentication files and utilities
- Configuration of maximum requests, minimum and maximum servers and clients
- Apache 2.4 virtual host implementation (with and without dedicated IP addresses)
- Using redirect statements in Apache's configuration files to customize file access

208.2 Apache Configuration for HTTPS

- SSL configuration files, tools, and utilities
- Generate a server private key and CSR for a commercial CA
- Generate a self-signed certificate
- Install the key and certificate, including intermediate CAs
- Configure Virtual Hosting using SNI
- Awareness of the issues with Virtual Hosting and use of SSL
- Security issues in SSL use, disable insecure protocols and ciphers

208.3 Implementing Squid as a Caching Proxy

- Squid 3.x configuration files, terms, and utilities
- Access restriction methods

- Client user authentication methods
- Layout and content of ACL in the Squid configuration files

208.4 Implementing Nginx as a Web Server and a Reverse Proxy

- Nginx installation and configuration
- Using Nginx as a reverse proxy
- Basic Web server

209 File Sharing

209.1 Samba Server Configuration

- Samba 4 documentation
- Samba 4 configuration files
- Samba 4 tools and utilities and daemons
- Mounting CIFS shares on Linux
- Mapping Windows usernames to Linux usernames
- User-Level Share-Level and AD security

209.2 NFS Server Configuration

- NFS version 3 configuration files
- NFS tools and utilities
- Access restrictions to certain hosts and/or subnets
- Mount options on server and client
- TCP Wrappers
- Awareness of NFSv4

210 Network Client Management

210.1 DHCP Configuration

- DHCP configuration files, terms, and utilities
- Subnet and dynamically-allocated range setup

210.2 PAM authentication

- PAM configuration files, terms, and utilities
- passwd and shadow passwords

210.3 LDAP Client Usage

- LDAP utilities for data management and queries
- Change user passwords
- Querying the LDAP directory

210.4 Configuring an OpenLDAP Server

- OpenLDAP
- Directory based configuration
- Access Control
- Distinguished Names
- Changetype Operations
- Schemas and Whitepages
- Directories
- Object IDs, Attributes and Classes

211 E-mail Services

211.1 Using E-mail Servers

- Configuration files for postfix
- Basic TLS configuration for postfix
- Basic knowledge of the SMTP protocol
- Awareness of sendmail and exim

211.2 Managing E-Mail Delivery

- Understanding of Sieve functionality, syntax, and operators
- Use Sieve to filter and sort mail with respect to sender, recipient(s), headers, and size
- Awareness of procmail

211.3 Managing Mailbox Access

- Dovecot IMAP and POP3 configuration and administration
- Basic TLS configuration for Dovecot
- Awareness of Courier