

Roderick W. Smith

LPIC-1

**Linux Professional Institute
Certification**


STUDY GUIDE

Third Edition

EXAMS 101 AND 102

Includes Real-World Scenarios, Hands-On Exercises,
and Access to Exam Prep Software Featuring:

- + Custom Test Engine
- + Over 300 Sample Questions
- + Electronic Flashcards

 SYBEX

SERIOUS SKILLS.



LPIC-1

Linux Professional Institute Certification

Study Guide
Third Edition



LPIC-1

Linux Professional Institute Certification

Study Guide
Third Edition



Roderick W. Smith



John Wiley & Sons, Inc.

Senior Acquisitions Editor: Jeff Kellum
Development Editor: Alexa Murphy
Technical Editors: Ross Brunson and Kevin Glendenning, FOSSter.com
Production Editor: Eric Charbonneau
Copy Editor: Kim Wimpsett
Editorial Manager: Pete Gaughan
Production Manager: Tim Tate
Vice President and Executive Group Publisher: Richard Swadley
Vice President and Publisher: Neil Edde
Media Project Manager 1: Laura Moss-Hollister
Media Associate Producer: Doug Kuhn
Media Quality Assurance: Josh Frank
Book Designer: Judy Fung
Proofreader: Candace Cunningham
Indexer: Ted Laux
Project Coordinator, Cover: Katherine Crocker
Cover Designer: Ryan Sneed
Copyright © 2013 by John Wiley & Sons, Inc., Indianapolis, Indiana
Published simultaneously in Canada
ISBN: 978-1-118-49563-6
ISBN: 978-1-118-52648-4 (ebk.)
ISBN: 978-1-118-57047-0 (ebk.)
ISBN: 978-1-118-57055-5 (ebk.)

No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning or otherwise, except as permitted under Sections 107 or 108 of the 1976 United States Copyright Act, without either the prior written permission of the Publisher, or authorization through payment of the appropriate per-copy fee to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, (978) 750-8400, fax (978) 646-8600. Requests to the Publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, (201) 748-6011, fax (201) 748-6008, or online at www.wiley.com/go/permissions.

Limit of Liability/Disclaimer of Warranty: The publisher and the author make no representations or warranties with respect to the accuracy or completeness of the contents of this work and specifically disclaim all warranties, including without limitation warranties of fitness for a particular purpose. No warranty may be created or extended by sales or promotional materials. The advice and strategies contained herein may not be suitable for every situation. This work is sold with the understanding that the publisher is not engaged in rendering legal, accounting, or other professional services. If professional assistance is required, the services of a competent professional person should be sought. Neither the publisher nor the author shall be liable for damages arising herefrom. The fact that an organization or Web site is referred to in this work as a citation and/or a potential source of further information does not mean that the author or the publisher endorses the information the organization or Web site may provide or recommendations it may make. Further, readers should be aware that Internet Web sites listed in this work may have changed or disappeared between when this work was written and when it is read.

For general information on our other products and services or to obtain technical support, please contact our Customer Care Department within the U.S. at (877) 762-2974, outside the U.S. at (317) 572-3993 or fax (317) 572-4002.

Wiley publishes in a variety of print and electronic formats and by print-on-demand. Some material included with standard print versions of this book may not be included in e-books or in print-on-demand. If this book refers to media such as a CD or DVD that is not included in the version you purchased, you may download this material at <http://booksupport.wiley.com>. For more information about Wiley products, visit www.wiley.com.

Library of Congress Control Number: 2012951869

TRADEMARKS: Wiley, the Wiley logo, and the Sybex logo are trademarks or registered trademarks of John Wiley & Sons, Inc. and/or its affiliates, in the United States and other countries, and may not be used without written permission. All other trademarks are the property of their respective owners. John Wiley & Sons, Inc., is not associated with any product or vendor mentioned in this book.

10 9 8 7 6 5 4 3 2 1

Dear Reader,

Thank you for choosing *LPIC-1: Linux Professional Institute Certification Study Guide, Third Edition*. This book is part of a family of premium-quality Sybex books, all of which are written by outstanding authors who combine practical experience with a gift for teaching.

Sybex was founded in 1976. More than 30 years later, we're still committed to producing consistently exceptional books. With each of our titles, we're working hard to set a new standard for the industry. From the paper we print on to the authors we work with, our goal is to bring you the best books available.

I hope you see all that reflected in these pages. I'd be very interested to hear your comments and get your feedback on how we're doing. Feel free to let me know what you think about this or any other Sybex book by sending me an email at nedde@wiley.com. If you think you've found a technical error in this book, please visit <http://sybex.custhelp.com>. Customer feedback is critical to our efforts at Sybex.

Best regards,

A handwritten signature in black ink, appearing to read 'Neil Edde', written over a light gray background.

Neil Edde
Vice President and Publisher
Sybex, an Imprint of Wiley

Acknowledgments

Although this book bears my name as author, many other people contributed to its creation. Without their help, this book wouldn't exist, or at best would exist in a lesser form. Jeff Kellum was the acquisitions editor and so helped get the book started. Alexa Murphy, the developmental editor, and Eric Charbonneau, the production editor, oversaw the book as it progressed through all its stages. Ross Brunson and Kevin Glendenning were the technical editors who checked the text for technical errors and omissions — but any mistakes that remain are my own. Kim Wimpsett, the copy editor, helped keep the text grammatical and understandable. The proofreader, Candace Cunningham, checked the text for typos. I'd also like to thank Neil Salkind and others at Studio B, who helped connect me with Wiley to write this book.

About the Author

Roderick W. Smith is a Linux consultant and author. He has written more than 20 books on Linux, FreeBSD, and computer networking, including *Linux Essentials*, the *LPIC-2 Study Guide*, and *Linux Administrator Street Smarts* (all from Sybex). He can be reached at rodsmith@rodsbooks.com.

Contents at a Glance

<i>Introduction</i>		<i>xxiii</i>
<i>Exam Objectives</i>		<i>xxix</i>
- <i>Exam 101 Objectives</i>		<i>xxix</i>
- <i>Exam 102 Objectives</i>		<i>xxxv</i>
<i>Assessment Test</i>		<i>xli</i>
<i>Answers to the Assessment Test</i>		<i>xlviii</i>
Part I	Exam 101	1
Chapter 1	Exploring Linux Command-Line Tools	3
Chapter 2	Managing Software	45
Chapter 3	Configuring Hardware	105
Chapter 4	Managing Files	175
Chapter 5	Booting Linux and Editing Files	223
Part II	Exam 102	265
Chapter 6	Configuring the X Window System, Localization, and Printing	267
Chapter 7	Administering the System	329
Chapter 8	Configuring Basic Networking	381
Chapter 9	Writing Scripts, Configuring Email, and Using Databases	425
Chapter 10	Securing Your System	473
Appendix A	Answers to Review Questions	517
Appendix B	About the Additional Study Tools	553
<i>Index</i>		<i>557</i>

Contents

<i>Introduction</i>	<i>xxiii</i>
<i>Exam Objectives</i>	<i>xxix</i>
- <i>Exam 101 Objectives</i>	<i>xxix</i>
- <i>Exam 102 Objectives</i>	<i>xxxv</i>
<i>Assessment Test</i>	<i>xli</i>
<i>Answers to the Assessment Test</i>	<i>xlviii</i>

Part I	Exam 101	1
Chapter 1	Exploring Linux Command-Line Tools	3
	Understanding Command-Line Basics	4
	Exploring Your Linux Shell Options	4
	Using a Shell	5
	Exploring Shell Configuration	12
	Using Environment Variables	12
	Getting Help	13
	Using Streams, Redirection, and Pipes	14
	Exploring Types of Streams	15
	Redirecting Input and Output	15
	Piping Data Between Programs	17
	Generating Command Lines	18
	Processing Text Using Filters	19
	File-Combining Commands	19
	File-Transforming Commands	21
	File-Formatting Commands	25
	File-Viewing Commands	28
	File-Summarizing Commands	30
	Using Regular Expressions	32
	Understanding Regular Expressions	32
	Using <i>grep</i>	33
	Using <i>sed</i>	35
	Summary	37
	Exam Essentials	38
	Review Questions	39

Chapter 2	Managing Software	45
	Package Concepts	46
	Using RPM	48
	RPM Distributions and Conventions	48
	The <i>rpm</i> Command Set	51
	Extracting Data from RPMs	54
	Using Yum	55
	RPM and Yum Configuration Files	59
	RPM Compared to Other Package Formats	60
	Using Debian Packages	61
	Debian Distributions and Conventions	61
	The <i>dpkg</i> Command Set	62
	Using <i>apt-cache</i>	65
	Using <i>apt-get</i>	65
	Using <i>dselect</i> , <i>aptitude</i> , and Synaptic	69
	Reconfiguring Packages	71
	Debian Packages Compared to Other Package Formats	71
	Configuring Debian Package Tools	72
	Converting Between Package Formats	73
	Package Dependencies and Conflicts	75
	Real and Imagined Package Dependency Problems	75
	Workarounds for Package Dependency Problems	76
	Startup Script Problems	78
	Managing Shared Libraries	79
	Library Principles	79
	Locating Library Files	81
	Library Management Commands	83
	Managing Processes	85
	Understanding the Kernel: The First Process	85
	Examining Process Lists	86
	Understanding Foreground and Background Processes	92
	Managing Process Priorities	93
	Killing Processes	94
	Summary	96
	Exam Essentials	96
	Review Questions	98
Chapter 3	Configuring Hardware	105
	Configuring the Firmware and Core Hardware	106
	Understanding the Role of the Firmware	106
	IRQs	110
	I/O Addresses	113
	DMA Addresses	114

Boot Disks and Geometry Settings	114	
Coldplug and Hotplug Devices	117	
Configuring Expansion Cards	118	
Configuring PCI Cards	118	
Learning about Kernel Modules	120	
Loading Kernel Modules	121	
Removing Kernel Modules	123	
Configuring USB Devices	124	
USB Basics	124	
Linux USB Drivers	125	
USB Manager Applications	126	
Configuring Hard Disks	126	
Configuring PATA Disks	127	
Configuring SATA Disks	128	
Configuring SCSI Disks	128	
Configuring External Disks	130	
Designing a Hard Disk Layout	130	
Why Partition?	130	
Understanding Partitioning Systems	131	
An Alternative to Partitions: LVM	134	
Mount Points	134	
Common Partitions and Filesystem Layouts	135	
Creating Partitions and Filesystems	136	
Partitioning a Disk	137	
Preparing a Partition for Use	141	
Maintaining Filesystem Health	148	
Tuning Filesystems	148	
Maintaining a Journal	152	
Checking Filesystems	153	
Monitoring Disk Use	155	
Mounting and Unmounting Filesystems	158	
Temporarily Mounting or Unmounting Filesystems	159	
Permanently Mounting Filesystems	164	
Summary	166	
Exam Essentials	167	
Review Questions	169	
Chapter 4	Managing Files	175
Using File Management Commands	176	
File Naming and Wildcard Expansion Rules	176	
File Commands	178	
File Archiving Commands	183	
Managing Links	190	
Directory Commands	191	

Managing File Ownership	192	
Assessing File Ownership	192	
Changing a File's Owner	193	
Changing a File's Group	194	
Controlling Access to Files	194	
Understanding Permissions	194	
Changing a File's Mode	199	
Setting the Default Mode and Group	202	
Changing File Attributes	204	
Managing Disk Quotas	205	
Enabling Quota Support	205	
Setting Quotas for Users	206	
Locating Files	207	
The FHS	207	
Tools for Locating Files	211	
Summary	215	
Exam Essentials	216	
Review Questions	218	
Chapter 5	Booting Linux and Editing Files	223
Installing Boot Loaders	224	
Boot Loader Principles	225	
Using GRUB Legacy as the Boot Loader	228	
Using GRUB 2 as the Boot Loader	234	
Using Alternative Boot Loaders	236	
Understanding the Boot Process	237	
Extracting Information about the Boot Process	238	
Locating and Interpreting Boot Messages	238	
The Boot Process	239	
Dealing with Runlevels and the Initialization Process	240	
Runlevel Functions	240	
Identifying the Services in a Runlevel	241	
Managing Runlevel Services	243	
Checking Your Runlevel	245	
Changing Runlevels on a Running System	246	
Using Alternative Boot Systems	249	
Configuring Upstart	249	
Using systemd	251	
Editing Files with Vi	252	
Understanding Vi Modes	252	
Exploring Basic Text-Editing Procedures	253	
Saving Changes	256	
Summary	256	
Exam Essentials	257	
Review Questions	259	

Part II	Exam 102	265
Chapter 6	Configuring the X Window System, Localization, and Printing	267
	Configuring Basic X Features	268
	X Server Options for Linux	268
	Methods of Configuring X	270
	X Configuration Options	273
	Obtaining X Display Information	281
	Configuring X Fonts	283
	Font Technologies and Formats	284
	Configuring X Core Fonts	284
	Configuring a Font Server	287
	Configuring Xft Fonts	288
	Managing GUI Logins	289
	The X GUI Login System	289
	Running an XDMCP Server	290
	Configuring an XDMCP Server	292
	Using X for Remote Access	294
	X Client-Server Principles	294
	Using Remote X Clients	295
	X Accessibility	297
	Keyboard and Mouse Accessibility Issues	297
	Screen Display Settings	300
	Using Additional Assistive Technologies	301
	Configuring Localization and Internationalization	302
	Setting Your Time Zone	302
	Querying and Setting Your Locale	305
	Configuring Printing	308
	Conceptualizing the Linux Printing Architecture	309
	Understanding PostScript and Ghostscript	310
	Running a Printing System	311
	Configuring CUPS	312
	Monitoring and Controlling the Print Queue	318
	Summary	322
	Exam Essentials	322
	Review Questions	324
Chapter 7	Administering the System	329
	Managing Users and Groups	330
	Understanding Users and Groups	330
	Configuring User Accounts	333
	Configuring Groups	344
	Tuning User and System Environments	348
	Using System Log Files	349

	Understanding <i>syslogd</i>	350
	Setting Logging Options	350
	Manually Logging Data	352
	Rotating Log Files	353
	Reviewing Log File Contents	356
	Maintaining the System Time	358
	Linux Time Concepts	358
	Manually Setting the Time	359
	Using NTP	360
	Running Jobs in the Future	366
	Understanding the Role of <i>cron</i>	367
	Creating System <i>cron</i> Jobs	367
	Creating User <i>cron</i> Jobs	369
	Using <i>anacron</i>	371
	Using <i>at</i>	373
	Summary	374
	Exam Essentials	375
	Review Questions	376
Chapter 8	Configuring Basic Networking	381
	Understanding TCP/IP Networking	382
	Knowing the Basic Functions of Network Hardware	382
	Investigating Types of Network Hardware	383
	Understanding Network Packets	385
	Understanding Network Protocol Stacks	385
	Knowing TCP/IP Protocol Types	387
	Understanding Network Addressing	389
	Using Network Addresses	389
	Resolving Hostnames	395
	Network Ports	398
	Configuring Linux for a Local Network	402
	Network Hardware Configuration	402
	Configuring with DHCP	402
	Configuring with a Static IP Address	403
	Configuring Routing	406
	Using GUI Configuration Tools	408
	Using the <i>ifup</i> and <i>ifdown</i> Commands	408
	Configuring Hostnames	409
	Diagnosing Network Connections	411
	Testing Basic Connectivity	412
	Tracing a Route	412
	Checking Network Status	413
	Examining Raw Network Traffic	414
	Using Additional Tools	415

	Summary	418
	Exam Essentials	418
	Review Questions	420
Chapter 9	Writing Scripts, Configuring Email, and Using Databases	425
	Managing the Shell Environment	426
	Reviewing Environment Variables	426
	Understanding Common Environment Variables	427
	Using Aliases	431
	Modifying Shell Configuration Files	431
	Writing Scripts	433
	Beginning a Shell Script	434
	Using Commands	435
	Using Variables	437
	Using Conditional Expressions	440
	Using Loops	442
	Using Functions	443
	Managing Email	445
	Understanding Email	445
	Choosing Email Software	447
	Working with Email	448
	Securing Your Email Server	452
	Managing Data with SQL	453
	Picking a SQL Package	453
	Understanding SQL Basics	454
	Using MySQL	456
	Summary	465
	Exam Essentials	465
	Review Questions	467
Chapter 10	Securing Your System	473
	Administering Network Security	474
	Using Super Server Restrictions	475
	Disabling Unused Servers	481
	Administering Local Security	488
	Securing Passwords	488
	Limiting <i>root</i> Access	492
	Setting Login, Process, and Memory Limits	493
	Locating SUID/SGID Files	495
	Configuring SSH	497
	SSH Basics	497
	Setting SSH Options for Your Computer	498
	SSH Security Considerations	505

	Using GPG	506
	Generating Keys	506
	Importing Keys	507
	Revoking a Key	508
	Encrypting and Decrypting Data	508
	Signing Messages and Verifying Signatures	509
	Summary	510
	Exam Essentials	510
	Review Questions	512
Appendix A	Answers to Review Questions	517
	Chapter 1: Exploring Linux Command-Line Tools	518
	Chapter 2: Managing Software	521
	Chapter 3: Configuring Hardware	524
	Chapter 4: Managing Files	528
	Chapter 5: Booting Linux and Editing Files	531
	Chapter 6: Configuring the X Window System, Localization, and Printing	534
	Chapter 7: Administering the System	538
	Chapter 8: Configuring Basic Networking	542
	Chapter 9: Writing Scripts, Configuring Email, and Using Databases	546
	Chapter 10: Securing Your System	549
Appendix B	About the Additional Study Tools	553
	Additional Study Tools	554
	Sybex Test Engine	554
	Electronic Flashcards	554
	PDF of Glossary of Terms	554
	Adobe Reader	554
	System Requirements	555
	Using the Study Tools	555
	Troubleshooting	556
	Customer Care	556
	<i>Index</i>	557

Table of Exercises

Exercise 1.1	Editing Commands	11
Exercise 2.1	Managing Packages Using RPM	57
Exercise 2.2	Managing Debian Packages.	68
Exercise 3.1	Creating Filesystems	146
Exercise 4.1	Modifying Ownership and Permissions.	201
Exercise 4.2	Locating Files	215
Exercise 5.1	Changing Runlevels	248
Exercise 6.1	Printing with Linux	321
Exercise 7.1	Creating User Accounts	338
Exercise 7.2	Creating User cron Jobs	370
Exercise 8.1	Practice Resolving Hostnames	396
Exercise 8.2	Configuring a Network Connection	409
Exercise 9.1	Changing Your bash Prompt	430
Exercise 9.2	Creating a Simple Script	444
Exercise 9.3	Creating a SQL Database	460
Exercise 10.1	Monitor Network Port Use.	482

- [The Associate for free](#)
- [read online *My Simple Italian: 100 inspired recipes from one of Britain's best Italian chefs*](#)
- [read **Cascadia's Fault: The Earthquake and Tsunami That Could Devastate North America**](#)
- [read Shadowmage \(Twilight of Kerberos, Book 1\) pdf, azw \(kindle\)](#)
- [French Riviera and Its Artists: Art, Literature, Love, and Life on the C te d'Azur pdf, azw \(kindle\)](#)
- [The Concise Routledge Encyclopedia of the Documentary Film pdf, azw \(kindle\), epub, doc, mobi](#)

- <http://www.wybohaas.com/freebooks/The-4-Disciplines-of-Execution--Achieving-Your-Wildly-Important-Goals.pdf>
- <http://flog.co.id/library/My-Simple-Italian--100-inspired-recipes-from-one-of-Britain-s-best-Italian-chefs.pdf>
- <http://academialanguagebar.com/?ebooks/Cascadia-s-Fault--The-Earthquake-and-Tsunami-That-Could-Devastate-North-America.pdf>
- <http://fortune-touko.com/library/Data-Algorithms--Recipes-for-Scaling-Up-with-Hadoop-and-Spark.pdf>
- <http://www.cafesystemcanarias.com/books/50-Great-Myths-of-Popular-Psychology--Shattering-Widespread-Misconceptions-about-Human-Behavior.pdf>
- <http://schrolf.de/books/Vegetarian-Cooking-for-Everyone.pdf>