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LPI AND COMPTIA CERTIFICATION

IN THIS APPENDIX

Linux Essentials	1190
Certification Exam 1 Objectives:	
LX0-101	1204
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This book is used as the adopted text in many college classes. Because students who take these classes often seek LPI or CompTIA certification, instructors have asked for a mapping of certification objectives to the material covered in this book. This book fully covers LPI's Linux Essentials certification learning goals and provides extensive coverage of CompTIA's Linux+ exam objectives. This appendix maps these learning goals and exam objectives to pages in this book. The following icons are used throughout the book to mark the places where learning goals and exam objectives are discussed.

LE This icon indicates coverage of a topic in the LPI's Linux Essentials certification learning goals.

LPI This icon indicates coverage of a topic in the CompTIA's Linux+ exam objectives.

LE+ This icon indicates coverage of a topic in the CompTIA's Linux+ exam objectives and a topic in the LPI's Linux Essentials certification learning goals.

MORE INFORMATION

LPI Linux Essentials: www.lpi.org/linux-certifications/introductory-programs/linux-essentials

LPI Certification Exams: www.lpi.org/linux-certifications/programs/lpic-1

CompTIA Exams: certification.comptia.org/getCertified/certifications/linux.aspx

CompTIA and LPI partnership: www.lpi.org/linux-certifications/partnership-programs/comptia

LINUX ESSENTIALS

TOPIC 1: THE LINUX COMMUNITY AND A CAREER IN OPEN SOURCE

1.1 LINUX EVOLUTION AND POPULAR OPERATING SYSTEMS

DESCRIPTION: KNOWLEDGE OF LINUX DEVELOPMENT AND MAJOR DISTRIBUTIONS

Key Knowledge Areas

Open Source Philosophy

- ▶ Open-Source Software and Licensing page 6

Distributions

- ▶ Distribution page 6

Embedded Systems

- ▶ Embedded and mobile Linux page 6

Partial List of Used Files, Terms, and Utilities

Android

- ▶ Embedded and mobile Linux page 6

Debian

- ▶ Distribution page 6

CentOS

- ▶ CentOS page 33

1.2 MAJOR OPEN SOURCE APPLICATIONS

DESCRIPTION: AWARENESS OF MAJOR APPLICATIONS AND THEIR USES

Key Knowledge Areas

Desktop Applications

- ▶ Desktop applications page 1151

Server Applications

- ▶ DHCP: Configures Network Interfaces page 491
- ▶ Chapter 13: Printing with CUPS page 555
- ▶ Chapter 18: OpenSSH: Secure Network Communication page 685
- ▶ Chapter 19: FTP: Transferring Files Across a Network page 713
- ▶ Chapter 20: sendmail: Setting Up Mail Servers, Clients, and More page 739
- ▶ Chapter 21: NIS and LDAP page 769
- ▶ Chapter 22: NFS: Sharing Directory Hierarchies page 801

- ▶ Chapter 23: Samba: Linux and Windows File and Printer Sharing page 827
- ▶ Chapter 24: DNS/BIND: Tracking Domain Names and Addresses page 851
- ▶ Chapter 26: Apache (**httpd**): Setting Up a Web Server page 931

Mobile Applications

- ▶ Embedded and mobile Linux page 6

Development Languages

- ▶ Chapter 27: Programming the Bourne Again Shell (bash) page 981
- ▶ Chapter 28: The Python Programming Language page 1081
- ▶ Chapter 29: The MariaDB SQL Database Management System page 1113

Package Management Tools and repositories

- ▶ Chapter 12: Finding, Downloading, and Installing Software page 531
- ▶ Appendix D: Keeping the System Up-to-Date Using apt-get page 1183

Partial List of Used Files, Terms, and Utilities

OpenOffice.org, LibreOffice, Thunderbird, Firefox, Blender, Gimp, Audacity, ImageMagick

- ▶ Desktop applications page 1151

Apache, MySQL, PostgreSQL

- ▶ Chapter 26: Apache (**httpd**): Setting Up a Web Server page 931
- ▶ Chapter 29: The MariaDB SQL Database Management System page 1113
- ▶ Programming languages page 1152

NFS, Samba, OpenLDAP, Postfix, DNS, DHCP

- ▶ Chapter 22: NFS: Sharing Directory Hierarchies page 801
- ▶ Chapter 23: Samba: Linux and Windows File and Printer Sharing page 827
- ▶ LDAP page 786
- ▶ Postfix page 742
- ▶ Chapter 24: DNS/BIND: Tracking Domain Names and Addresses page 851
- ▶ DHCP: Configures Network Interfaces page 491

C, Perl, shell, Python, PHP

- ▶ Chapter 27: Programming the Bourne Again Shell (bash) page 981
- ▶ Chapter 28: The Python Programming Language page 1081
- ▶ Programming languages page 1152

1.3 UNDERSTANDING OPEN SOURCE SOFTWARE AND LICENSING

DESCRIPTION: OPEN COMMUNITIES AND LICENSING OPEN SOURCE SOFTWARE FOR BUSINESS

Key Knowledge Areas

Licensing

- ▶ Open-Source Software and Licensing page 6

Free Software Foundation (FSF), Open Source Initiative (OSI)

- ▶ GNU Project page 3
- ▶ Linux Is More than a Kernel page 6
- ▶ FOSS/FLOSS page 7
- ▶ GNOME and KDE page 17

Partial List of Used Files, Terms, and Utilities

GPL, BSD, Creative Commons

- ▶ GPL page 5
- ▶ Berkeley UNIX (BSD) page 3
- ▶ Creative Commons page 1245 (Glossary)

Free Software, Open Source Software, FOSS, FLOSS

- ▶ FOSS/FLOSS page 7

Open Source business models

- ▶ Making money page 7

1.4 ICT SKILLS AND WORKING IN LINUX

DESCRIPTION: BASIC INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) SKILLS AND WORKING IN LINUX

Key Knowledge Areas

Desktop Skills

- ▶ Chapter 4: Introduction to Fedora and Red Hat Enterprise Linux page 89

Getting to the Command Line

- ▶ Working from the Command Line page 119
- ▶ Chapter 7: The Linux Utilities page 215

Industry uses of Linux, Cloud Computing, and Virtualization

- ▶ Chapter 17: Setting Up Virtual Machines Locally and in the Cloud page 659

Partial List of Used Files, Terms, and Utilities

Using a browser, privacy concerns, configuration options, searching the Web, and saving content

- ▶ Firefox: www.mozilla.org/en-US/firefox/central
- ▶ Chrome: www.google.com/intl/en/chrome/browser/features.html
- ▶ Opera: www.opera.com

Terminal and Console

- ▶ Using a Virtual Console page 121

Password issues

- ▶ Users: Changing Your Account Type and Password (GUI) page 112
- ▶ Password Security page 136
- ▶ passwd: Changing Your Password (CLI) page 137
- ▶ Passwords page 625

Privacy issues and tools

- ▶ Search the Web for **browser privacy**
- ▶ Mozilla: support.mozilla.org/en-US/kb/private-browsing-browse-web-without-saving-info
- ▶ lifelacker.com/the-best-browser-extensions-that-protect-your-privacy-479408034

Use of common open-source applications in presentations and projects

- ▶ Desktop Applications page 1151

TOPIC 2: FINDING YOUR WAY ON A LINUX SYSTEM

2.1 COMMAND LINE BASICS

DESCRIPTION: BASICS OF USING THE LINUX COMMAND LINE

Key Knowledge Areas

Basic shell

- ▶ Working from the Command Line page 119
- ▶ Chapter 5: The Shell page 141

Formatting commands

- ▶ The Command Line page 144

Working with Options

- ▶ Options page 145

Variables

- ▶ Parameters and Variables page 352
- ▶ Variables page 1031

Globbering

- ▶ Filename Generation/Pathname Expansion page 165
- ▶ Pathname Expansion page 412

Quoting

- ▶ Special Characters page 142
- ▶ Quoting the \$ page 354
- ▶ Quotation marks page 412

Partial List of Used Files, Terms, and Utilities

echo

- ▶ echo: Displays Arguments page 219
- ▶ **echo -e** page 1009

history

- ▶ History page 376

PATH env variable

- ▶ Set **PATH** in **.bash_profile** page 331
- ▶ **PATH**: Where the Shell Looks for Programs page 359

which

- ▶ which page 255

Nice to Know

Substitutions

- ▶ Command Substitution page 410

||, &&, and ; control operators

- ▶ Lists page 162
- ▶ ; and NEWLINE Separate Commands page 341
- ▶ && and || Boolean Control Operators page 343

2.2 USING THE COMMAND LINE TO GET HELP

DESCRIPTION: RUNNING HELP COMMANDS AND NAVIGATION OF THE VARIOUS HELP SYSTEMS

Key Knowledge Areas

man

- ▶ man: Displays the System Manual page 128

info

- ▶ info: Displays Information About Utilities page 131

Partial List of Used Files, Terms, and Utilities

man

- ▶ man: Displays the System Manual page 128

info

- ▶ info: Displays Information About Utilities page 131

man pages

- ▶ man: Displays the System Manual page 128

/usr/share/doc

- ▶ **/usr/share/doc** page 134

locate

- ▶ locate: Searches for a File page 256

Nice to Know

apropos, whatis, whereis

- ▶ apropos: Searches for a Keyword page 130
- ▶ whatis page 130
- ▶ whereis page 255

2.3 USING DIRECTORIES AND LISTING FILES

DESCRIPTION: NAVIGATION OF HOME AND SYSTEM DIRECTORIES AND LISTING FILES IN VARIOUS LOCATIONS

Key Knowledge Areas

Files, directories

- ▶ Ordinary Files and Directory Files page 177

Hidden files and directories

- ▶ Hidden Filenames page 180

Home

- ▶ Your Home Directory page 143

Absolute and relative paths

- ▶ Absolute Pathnames page 181
- ▶ Relative Pathnames page 182

Partial List of Used Files, Terms, and Utilities

Common options for ls

- ▶ Options page 221

Recursive listings

- ▶ Recursive page 222

cd

- ▶ cd: Changes to Another Working Directory page 185

. and ..

- ▶ The . and .. Directory Entries page 186

home and ~

- ▶ Your Home Directory page 143
- ▶ ~ (Tilde) in Pathnames page 182
- ▶ Tilde (~) page 359
- ▶ Tilde Expansion page 407

2.4 CREATING, MOVING, AND DELETING FILES

DESCRIPTION: CREATE, MOVE, AND DELETE FILES AND DIRECTORIES UNDER THE HOME DIRECTORY

Key Knowledge Areas

Files and directories

- ▶ Ordinary Files and Directory Files page 177

Case sensitivity

- ▶ Case sensitivity page 179

Simple globbing and quoting

- ▶ Filename Generation/Pathname Expansion page 165
- ▶ Pathname Expansion page 412
- ▶ Special Characters page 166
- ▶ Quoting the \$ page 394
- ▶ Quotation marks page 452

Partial List of Used Files, Terms, and Utilities

mv, cp, rm, touch

- ▶ mv: Moves a Directory page 188
- ▶ mv: Renames or Moves a File page 237
- ▶ mv, cp: Move or Copy Files page 187
- ▶ cp: Copies Files page 224
- ▶ rm: Removes a Link page 208
- ▶ rm: Removes a File (Deletes a Link) page 222
- ▶ touch: Changes File Modification and Access Times page 243

mkdir, rmdir

- ▶ mkdir: Creates a Directory page 184
- ▶ rmdir: Deletes a Directory page 186

TOPIC 3: THE POWER OF THE COMMAND LINE

3.1 ARCHIVING FILES ON THE COMMAND LINE

DESCRIPTION: ARCHIVING FILES IN THE USER HOME DIRECTORY

Key Knowledge Areas

Files, directories

- ▶ Ordinary Files and Directory Files page 177

Archives, compression

- ▶ Compressing and Archiving Files page 245

Partial List of Used Files, Terms, and Utilities

tar

- ▶ tar: Stores or Extracts Files to/from an Archive File page 249
- ▶ tar: Archives Files page 603

Common tar options

- ▶ Options page 249
- ▶ Modifiers page 251

gzip, bzip2

- ▶ xz, bzip2, and gzip: Compress and Decompress Files page 245

zip, unzip

- ▶ zip page 249
- ▶ unzip page 249

Nice to Know

Extracting individual files from archives

- ▶ Extract page 250

3.2 SEARCHING AND EXTRACTING DATA FROM FILES

DESCRIPTION: SEARCH AND EXTRACT DATA FROM FILES IN THE HOME DIRECTORY

Key Knowledge Areas

Command line pipes

- ▶ Pipelines page 158

I/O redirection

- ▶ Redirection page 153

Partial POSIX Regular Expressions (., [], *, ?)

- ▶ Appendix A: Regular Expressions page 1139

Partial List of Used Files, Terms, and Utilities

find

- ▶ find: Finds Files Based on Criteria page 229

grep

- ▶ grep: Searches for a Pattern in Files page 232

less

- ▶ less Is more: Display a Text File One Screen at a Time page 220

head, tail

- ▶ head: Displays the Beginning of a File page 235
- ▶ tail: Displays the Last Part of a File page 241

sort

- ▶ sort: Sorts and/or Merges Files page 239

cut

- ▶ cut: Selects Characters or Fields from Input Lines page 225

wc

- ▶ wc: Displays the Number of Lines, Words, and Bytes in Files page 244

Nice to Know

Partial POSIX Basic Regular Expressions ([^], ^, \$)

- ▶ Appendix A: Regular Expressions page 1139

Partial POSIX Extended Regular Expressions (+, (, |)

- ▶ Appendix A: Regular Expressions page 1139

xargs

- ▶ xargs: Converts Standard Input to Command Lines page 260

3.3 TURNING COMMANDS INTO A SCRIPT

DESCRIPTION: TURNING REPETITIVE COMMANDS INTO SIMPLE SCRIPTS

Key Knowledge Areas

Basic text editing

- ▶ Tutorial: Using vim to Create and Edit a File page 262
- ▶ Tutorial: Using nano to Create and Edit a File page 270

Basic shell scripting

- ▶ Writing and Executing a Basic Shell Script page 127

Partial List of Used Files, Terms, and Utilities

/bin/sh

- ▶ sh Shell page 328

Variables

- ▶ Parameters and Variables page 352
- ▶ Variables page 1031

Arguments

- ▶ Arguments page 145

for loops

- ▶ **for...in** page 995
- ▶ **for** page 997

echo

- ▶ echo: Displays Arguments page 219
- ▶ **echo -e** page 1009

Exit status

- ▶ **\$?** : Exit Status page 1029

Nice to Know

pico, nano, vi (only basics for creating scripts)

- ▶ pico, see Desktop applications page 1151
- ▶ Tutorial: Using vim to Create and Edit a File page 262
- ▶ Tutorial: Using nano to Create and Edit a File page 270

bash

- ▶ Chapter 5: The Shell page 141
- ▶ Chapter 9: The Bourne Again Shell (bash) page 327
- ▶ Chapter 27: Programming the Bourne Again Shell (bash) page 981

if, while, case statements

- ▶ **if...then** page 983
- ▶ **if...then...else** page 987
- ▶ **if...then...elif** page 989
- ▶ **for...in** page 995

read and test, and [commands

- ▶ read: Accepts User Input page 1041
- ▶ test builtin page 983
- ▶ [] is a synonym for test page 986
- ▶ test builtin page 1000

TOPIC 4: THE LINUX OPERATING SYSTEM

4.1 CHOOSING AN OPERATING SYSTEM

DESCRIPTION: KNOWLEDGE OF MAJOR OPERATING SYSTEMS AND LINUX DISTRIBUTIONS

Key Knowledge Areas

Windows, Mac, Linux differences

- ▶ Choosing an Operating System page 19

Distribution life cycle management

- ▶ Fedora, RHEL, and CentOS page 33

Partial List of Used Files, Terms, and Utilities

GUI versus command line, desktop configuration

- ▶ Choosing an Operating System page 19

Maintenance cycles, Beta and Stable

- ▶ beta release page 1239 (Glossary)
- ▶ stable release page 1274 (Glossary)

4.2 UNDERSTANDING COMPUTER HARDWARE

DESCRIPTION: FAMILIARITY WITH THE COMPONENTS THAT GO INTO BUILDING DESKTOP AND SERVER COMPUTERS

Key Knowledge Areas

Hardware

- ▶ Requirements page 30

Partial List of Used Files, Terms, and Utilities

Hard drives and partitions, motherboards, processors, power supplies, optical drives, peripherals

- ▶ Setting Up the Hard Disk page 36
- ▶ motherboard page 1261 (Glossary)
- ▶ Processor Architecture page 31
- ▶ power supply page 1267 (Glossary)
- ▶ optical drive page 1264 (Glossary)
- ▶ Peripheral, see device page 1246 (Glossary)

Display types

- ▶ Interfaces: Installer and Installed System page 32
- ▶ Working from the Command Line page 119
- ▶ ASCII terminal page 1237 (Glossary)
- ▶ graphical display page 1251 (Glossary)

Drivers

- ▶ Device files page 515
- ▶ Block and Character Devices page 518
- ▶ device driver page 1246 (Glossary)

4.3 WHERE DATA IS STORED

DESCRIPTION: WHERE VARIOUS TYPES OF INFORMATION ARE STORED ON A LINUX SYSTEM

Key Knowledge Areas

Kernel

- ▶ Chapter 14: Building a Linux Kernel page 579
- ▶ kernel page 1257 (Glossary)

Processes

- ▶ Process page 150
- ▶ Processes page 373
- ▶ ps page 466
- ▶ process page 1267 (Glossary)

syslog, klog, dmesg

- ▶ **rsyslogd**: Logs System Messages page 620
- ▶ **klogd**: deprecated; www.linuxjournal.com/article/4058
- ▶ dmesg: Displays Kernel Messages page 595

/lib, /usr/lib, /etc, /var/log

- ▶ **/lib** page 190
- ▶ **/lib64** page 190
- ▶ **/usr/lib** page 190
- ▶ **/usr/lib64** page 191
- ▶ **/etc** page 190
- ▶ **/etc** page 506
- ▶ **/var/log** page 191
- ▶ **/var/log** page 514
- ▶ Log Files and Mail for **root** page 626

Partial List of Used Files, Terms, and Utilities

Programs, libraries, packages and package databases, system configuration

- ▶ **/lib** page 190
- ▶ **/lib64** page 190
- ▶ **/usr/lib** page 190
- ▶ **/usr/lib64** page 191
- ▶ **/usr/bin** page 190
- ▶ **/usr/sbin** page 190
- ▶ **/etc** page 190
- ▶ **/etc** page 506
- ▶ library page 1258 (Glossary)
- ▶ Software package page 532
- ▶ PMS page 532
- ▶ Software package formats page 532
- ▶ Repositories page 533

Processes and process tables, memory addresses, system messaging, and logging

- ▶ Process page 150
- ▶ Processes page 373
- ▶ ps page 466
- ▶ dmesg: Displays Kernel Messages page 595
- ▶ **rsyslogd**: Logs System Messages page 620
- ▶ D-BUS page 898
- ▶ process page 1267 (Glossary)

ps, top, free

- ▶ Process Identification page 374
- ▶ ps page 466
- ▶ top: Lists Processes Using the Most Resources page 612
- ▶ free: Displays Memory Usage Information page 253

4.4 YOUR COMPUTER ON THE NETWORK

DESCRIPTION: QUERYING VITAL NETWORKING SETTINGS AND DETERMINING THE BASIC REQUIREMENTS FOR A COMPUTER ON A LOCAL AREA NETWORK (LAN)

Key Knowledge Areas

Internet, network, routers

- ▶ Internet page 280
- ▶ Introduction to Networking page 280
- ▶ Internetworking Through Gateways and Routers page 287

Domain Name Service

- ▶ Chapter 24: DNS/BIND: Tracking Domain Names and Addresses page 851

Network configuration

- ▶ Chapter 16: Configuring and Monitoring a LAN page 631

Partial List of Used Files, Terms, and Utilities

route

- ▶ deprecated (route man page): see ip man page, **route** object instead

resolv.conf

- ▶ **/etc/resolv.conf** page 510

IPv4, IPv6

- ▶ IPv4 page 292
- ▶ IPv6 page 293

ifconfig

- ▶ deprecated: (ifconfig man page): see ip man page, **addr** and **link** objects instead

netstat

- ▶ netstat: see the netstat man page and wikipedia.org/wiki/netstat

ping

- ▶ ping: Tests a Network Connection page 305

Nice to Know

ssh

- ▶ ssh: Logs in or Executes Commands on a Remote System page 693

dig

- ▶ host and dig: Query Internet Nameservers page 307
- ▶ dig page 861
- ▶ dig page 862

TOPIC 5: SECURITY AND FILE PERMISSIONS**5.1 BASIC SECURITY AND IDENTIFYING USER TYPES****DESCRIPTION: VARIOUS TYPES OF USERS ON A LINUX SYSTEM****Key Knowledge Areas**

Root and Standard Users

- ▶ Running Commands with **root** Privileges page 422
- ▶ The Special Powers of a Privileged User page 422
- ▶ Gaining **root** Privileges page 423
- ▶ Real UID Versus Effective UID page 425

System users

- ▶ **/etc/passwd** page 508

Partial List of Used Files, Terms, and Utilities**/etc/passwd, /etc/group**

- ▶ **/etc/passwd** page 508
- ▶ **/etc/group** page 506

id, who, w

- ▶ id page 426
- ▶ who: Lists Users on the System page 254
- ▶ who, whoami page 426
- ▶ w: Lists Users on the System page 254

sudo

- ▶ Using sudo to Gain **root** Privileges page 428

Nice to Know

su

- ▶ Using su to Gain **root** Privileges page 425

5.2 CREATING USERS AND GROUPS**DESCRIPTION: CREATING USERS AND GROUPS ON A LINUX SYSTEM****Key Knowledge Areas**

User and group commands

- ▶ useradd: Adds a User Account page 600
- ▶ groupadd: Adds a Group page 601
- ▶ usermod: Modifies a User Account page 601
- ▶ userdel: Removes a User Account page 600
- ▶ groupdel and groupmod: Remove and Modify a Group page 601

User IDs

- ▶ Real UID Versus Effective UID page 425
- ▶ **/etc/passwd** page 508
- ▶ user ID page 1279 (Glossary)

Partial List of Used Files, Terms, and Utilities**/etc/passwd, /etc/shadow, /etc/group**

- ▶ **/etc/passwd** page 508
- ▶ **/etc/shadow** page 511
- ▶ **/etc/group** page 506

id, last

- ▶ id page 426
- ▶ last: see the last man page

useradd, groupadd

- ▶ useradd: Adds a User Account page 600
- ▶ groupadd: Adds a Group page 601

passwd

- ▶ Users: Changing Your Account Type and Password (GUI) page 112
- ▶ passwd: Changing Your Password (CLI) page 137

Nice to Know

usermod, userdel

- ▶ usermod: Modifies a User Account page 601
- ▶ userdel: Removes a User Account page 600

groupmod, groupdel

- ▶ groupdel and groupmod: Remove and Modify a Group page 601

5.3 MANAGING FILE PERMISSIONS AND OWNERSHIP**DESCRIPTION: UNDERSTANDING AND MANIPULATING FILE PERMISSIONS AND OWNERSHIP SETTINGS****Key Knowledge Areas**

File/directory permissions and owners

- ▶ Access Permissions page 191

Partial List of Used Files, Terms, and Utilities**ls -l**

- ▶ **ls -l**: Displays Permissions page 191

chmod, chown

- ▶ chmod: Changes File Access Permissions page 193
- ▶ chmod: Makes a File Executable page 337
- ▶ chown: Changes File Ownership page 195

Nice to Know

chgrp

- ▶ chgrp: Changes File Group Association page 195

5.4 SPECIAL DIRECTORIES AND FILES**DESCRIPTION: SPECIAL DIRECTORIES AND FILES ON A LINUX SYSTEM INCLUDING SPECIAL PERMISSIONS****Key Knowledge Areas**

System files, libraries

- ▶ Important Standard Directories and Files page 189
- ▶ library page 1258 (Glossary)

Symbolic links

- ▶ Symbolic Links page 206
- ▶ Symbolic links page 515
- ▶ symbolic link page 1276 (Glossary)

Partial List of Used Files, Terms, and Utilities**/etc, /var**

- ▶ **/etc** page 190
- ▶ **/etc** page 506
- ▶ **/var** page 41
- ▶ **/var** page 191

/tmp, /var/tmp and Sticky Bit

- ▶ **/tmp** page 190
- ▶ **/var** page 191
- ▶ Sticky bit page 196
- ▶ sticky bit page 1275 (Glossary)

ls -d

- ▶ Directory page 221

ln -s

- ▶ Size page 222

Nice to Know

Hard links

- ▶ Hard Links page 204

Setuid/Setgid

- ▶ Setuid and Setgid Permissions page 196
- ▶ Setuid file page 424

- ▶ Setuid files page 626
- ▶ setuid page 1272 (Glossary)
- ▶ setgid page 1272 (Glossary)

CERTIFICATION EXAM 1

OBJECTIVES: LX0-101

101 SYSTEM ARCHITECTURE

101.1 DETERMINE AND CONFIGURE HARDWARE SETTINGS

Enable and disable integrated peripherals

Configure systems with or without external peripherals such as keyboards

Differentiate between the various types of mass storage devices

- ▶ **/dev** page 503

Set the correct hardware ID for different devices, especially the boot device

Know the differences between coldplug and hotplug devices

- ▶ Hotplug page 516

Determine hardware resources for devices

Tools and utilities to list various hardware information (e.g., lsusb, lspci, etc.)

- ▶ dmesg: Displays Kernel Messages page 595
- ▶ lspci: Lists PCI Information page 635
- ▶ lsblk: Lists Block Device Information page 635
- ▶ lshw: Lists Hardware Information page 636
- ▶ lsusb: Lists USB Devices page 636

Tools and utilities to manipulate USB devices

- ▶ Writing to a USB Flash Drive page 50

Conceptual understanding of sysfs, udev, hald, dbus

- ▶ udev page 516
- ▶ D-BUS page 898

Partial List of Used Files, Terms, and Utilities

/sys

- ▶ **/sys** page 190
- ▶ **/sys** page 514
- ▶ **/sys** page 516

/proc

- ▶ **/proc** page 190
- ▶ **/proc** page 512
- ▶ **proc** page 520

/dev

- ▶ Device file page 152
- ▶ **/dev** page 190

- ▶ **/dev** page 503
- ▶ Device files page 515

modprobe

- ▶ modprobe page 589

lsmod

- ▶ lsmod page 589

lspci

- ▶ lspci: Lists PCI Information page 635

lsusb

- ▶ lsusb: Lists USB Devices page 636

101.2 BOOT THE SYSTEM

Provide common commands to the boot loader and options to the kernel at boot time

- ▶ Modifying Boot Parameters (Options) page 70
- ▶ GRUB: The Linux Boot Loader page 590

Demonstrate knowledge of the boot sequence from BIOS to boot completion

- ▶ BIOS setup page 31
- ▶ CMOS page 31
- ▶ Booting the System page 450
- ▶ GRUB: The Linux Boot Loader page 590
- ▶ BIOS page 590
- ▶ BIOS page 1239 (Glossary)

Check boot events in the log file

- ▶ dmesg: Displays Kernel Messages page 595

Partial List of Used Files, Terms, and Utilities

/var/log/messages

- ▶ **/var/log/messages** page 514
- ▶ **/var/log/messages** page 622
- ▶ Log Files and Mail for **root** page 626
- ▶ **/var/log/messages** page 627

dmesg

- ▶ dmesg: Displays Kernel Messages page 595

BIOS

- ▶ BIOS setup page 31
- ▶ BIOS page 590
- ▶ BIOS page 1239 (Glossary)

boot loader

- ▶ GRUB: The Linux Boot Loader page 590

kernel

- ▶ Chapter 14: Building a Linux Kernel page 579
- ▶ kernel page 1257 (Glossary)

init

- ▶ **init** daemon page 374

- ▶ The **systemd init** Daemon page 438
- ▶ SysVinit (**rc**) Scripts: Start and Stop System Services page 448
- ▶ **systemd init** daemon page 450

101.3 CHANGE RUNLEVELS AND SHUTDOWN OR REBOOT SYSTEM

Set the default runlevel

- ▶ Setting the Persistent Runlevel page 444
- ▶ **/etc/inittab** page 508

Change between runlevels including single-user mode

- ▶ Changing the Current Runlevel page 445
- ▶ **telinit** page 449
- ▶ Booting the System to Single-User/Rescue Mode page 450
- ▶ Going to Graphical Multiuser Mode page 452

Shutdown and reboot from the command line

- ▶ Bringing the System Down page 454

Alert users before switching runlevels or other major system events

Properly terminate processes

- ▶ **kill**: Aborting a Background Job page 164
- ▶ **kill**: Sends a Signal to a Process page 465
- ▶ **killall**: Kills a Command page 467
- ▶ **pkill**: Kills a Command page 468
- ▶ **kill**: Aborts a Process page 1050

Partial List of Used Files, Terms, and Utilities

/etc/inittab

- ▶ **/etc/inittab** page 508

shutdown

- ▶ Bringing the System Down page 454

init

- ▶ **init** daemon page 374
- ▶ The **systemd init** Daemon page 438
- ▶ SysVinit (**rc**) Scripts: Start and Stop System Services page 448
- ▶ **systemd init** daemon page 450

/etc/init.d

- ▶ SysVinit (**rc**) Scripts: Start and Stop System Services page 448

telinit

- ▶ **telinit** page 449

102 LINUX INSTALLATION AND PACKAGE MANAGEMENT

102.1 DESIGN HARD DISK LAYOUT

Allocate filesystems and swap space to separate partitions or disks

- ▶ Setting Up the Hard Disk page 36

Tailor the design to the intended use of the system

- ▶ Planning the Installation page 29

Ensure the **/boot** partition conforms to the hardware architecture requirements for booting

- ▶ Where to put the **/boot** partition page 41
- ▶ LBA addressing mode and the **/boot** partition page 590

Partial List of Used Files, Terms, and Utilities

/ (root) filesystem

- ▶ **/** (root) page 40
- ▶ **/** (root) page 181
- ▶ **/** page 189
- ▶ root filesystem page 1271 (Glossary)

/var filesystem

- ▶ **/var** page 41
- ▶ **/var** page 191

/home filesystem

- ▶ **/home** page 41
- ▶ **/home** page 190

swap space

- ▶ (swap) page 40
- ▶ swap page 513
- ▶ swap space page 1276 (Glossary)

mount points

- ▶ Mount Points page 38
- ▶ Mount point page 521

partitions

- ▶ Partitions page 36
- ▶ Partition table page 36
- ▶ Primary, Extended, and Logical Partitions page 37
- ▶ Default Partitioning page 39
- ▶ Manual Partitioning: Planning Partitions page 39
- ▶ Example minimum partition sizes page 42
- ▶ Manual/Custom Partitioning page 74
- ▶ partition page 1265 (Glossary)

102.2 INSTALL A BOOT MANAGER

Providing alternative boot locations and backup boot options

Install and configure a boot loader such as GRUB

- ▶ GRUB: The Linux Boot Loader page 590

Interact with the boot loader

- ▶ Booting the System to Single-User/Rescue Mode page 450

Partial List of Used Files, Terms, and Utilities

/boot/grub/menu.lst

- ▶ Configuring GRUB page 591

grub-install

- ▶ grub2-install: Installs the MBR and GRUB Files page 594

MBR

- ▶ Reinstalling the MBR page 456
- ▶ MBR page 590
- ▶ grub2-install: Installs the MBR and GRUB Files page 594

superblock

- ▶ superblock page 1276 (Glossary)

/etc/lilo.conf

lilo

102.3 MANAGE SHARED LIBRARIES

Identify shared libraries

- ▶ ldd page 487

Identify the typical locations of system libraries

Load shared libraries

Partial List of Used Files, Terms, and Utilities

ldd

- ▶ ldd & libwrap page 486
- ▶ ldd page 487

ldconfig

/etc/ld.so.conf

LD_LIBRARY_PATH

102.4 USE DEBIAN PACKAGE MANAGEMENT

Install, upgrade, and uninstall Debian binary packages

- ▶ Using apt-get to Install, Remove, and Update Packages page 1184

Find packages containing specific files or libraries which may or may not be installed

Obtain package information like version, content, dependencies, package integrity, and installation status (whether or not the package is installed)

Partial List of Used Files, Terms, and Utilities

/etc/apt/sources.list

- ▶ **sources.list**: Specifies Repositories for apt-get to Search page 1187

dpkg

- ▶ apt-get and dpkg page 1184

dpkg-reconfigure

apt-get

- ▶ Using apt-get to Install, Remove, and Update Packages page 1184
- ▶ Using apt-get to Upgrade the System page 1185
- ▶ Other apt-get Commands page 1186

apt-cache

aptitude

102.5 USE RPM AND YUM PACKAGE MANAGEMENT

See *Chapter 12: Finding, Downloading, and Installing Software* page 531

Install, re-install, upgrade, and remove packages using RPM and YUM

- ▶ JumpStart: Installing and Removing Software Packages Using yum page 534
- ▶ Updating Packages page 538
- ▶ RPM: The RPM Package Manager page 546
- ▶ Installing, Upgrading, and Removing Packages page 548

Obtain information on RPM packages such as version, status, dependencies, integrity, and signatures

- ▶ Querying Packages and Files page 547

Determine what files a package provides, as well as find which package a specific file comes from

- ▶ Finding the Package That Holds an Application or File You Need page 536
- ▶ Querying Packages and Files page 547

Partial List of Used Files, Terms, and Utilities

rpm

- ▶ RPM: The RPM Package Manager page 546
- ▶ Querying Packages and Files page 547

rpm2cpio

/etc/yum.conf

- ▶ **yum.conf**: Configures yum page 541

/etc/yum.repos.d/

- ▶ yum Repositories page 542

yum

- ▶ yum page 533
- ▶ JumpStart: Installing and Removing Software Packages Using yum page 534
- ▶ Finding the Package That Holds an Application or File You Need page 536
- ▶ yum: Keeps the System Up-to-Date page 538

yumdownloader

- ▶ Downloading RPM Package Files with yumdownloader page 540
- ▶ yumdownloader page 582

103 GNU AND UNIX COMMANDS

103.1 WORK ON THE COMMAND LINE

See *Chapter 5: The Shell* page 141

See *Chapter 9: The Bourne Again Shell (bash)* page 327

See *Chapter 7: The Linux Utilities* page 215

See *Chapter 27: Programming the Bourne Again Shell (bash)* page 981

Use single shell commands and one line command sequences to perform basic tasks on the command line

- ▶ Chapter 5: The Shell page 141
- ▶ Chapter 7: The Linux Utilities page 215
- ▶ Chapter 9: The Bourne Again Shell (bash) page 327

Use and modify the shell environment including defining, referencing, and exporting environment variables

- ▶ Parameters and Variables page 352
- ▶ Variables page 1031

Use and edit command history

- ▶ History page 376

Invoke commands inside and outside the defined path

- ▶ Absolute versus relative pathnames page 149
- ▶ **PATH**: Where the Shell Looks for Programs page 359

Partial List of Used Files, Terms, and Utilities

. (dot)

- ▶ . (Dot) or source: Runs a Startup File in the Current Shell page 332
- ▶ exec versus . (dot) page 1045

bash

- ▶ Chapter 5: The Shell page 141
- ▶ Chapter 9: The Bourne Again Shell (bash) page 327
- ▶ Chapter 27: Programming the Bourne Again Shell (bash) page 981

echo

- ▶ echo: Displays Arguments page 219
- ▶ **echo -e** page 1009

env

- ▶ env: Runs a Program in a Modified Environment page 1035

exec

- ▶ Opening a File Descriptor page 1017
- ▶ Duplicating a File Descriptor page 1017
- ▶ exec: Executes a Command or Redirects File Descriptors page 1045

export

- ▶ declare: Lists and Assigns Attributes to Variables page 357
- ▶ readonly and export page 357
- ▶ export: Puts Variables in the Environment page 1032

pwd

- ▶ pwd page 143

set

- ▶ **set ±o**: Turns Shell Features On and Off page 400
- ▶ set: Initializes Positional Parameters page 1024

unset

- ▶ unset: Removes a Variable page 356

man

- ▶ man: Displays the System Manual page 128

uname

- ▶ uname: Displays System Information page 470

history

- ▶ History page 376

103.2 PROCESS TEXT STREAMS USING FILTERS

Send text files and output streams through text utility filters to modify the output using standard UNIX commands found in the GNU **textutils** package

- ▶ Redirection page 153
- ▶ Pipelines page 158
- ▶ Filters page 161

Partial List of Used Files, Terms, and Utilities

cat

- ▶ cat: Joins and Displays Files page 216
- ▶ cat page 152
- ▶ Redirection page 153

cut

- ▶ cut: Selects Characters or Fields from Input Lines page 225

expand

fmt

head

- ▶ head: Displays the Beginning of a File page 235

od

join

nl

paste

pr

sed

sort

- ▶ sort: Sorts and/or Merges Files page 239

split

tail

- ▶ tail: Displays the Last Part of a File page 241

tr

- ▶ tr page 159
- ▶ tr page 260

unexpand

uniq

wc

- ▶ wc: Displays the Number of Lines, Words, and Bytes in Files page 244

103.3 PERFORM BASIC FILE MANAGEMENT

Copy, move, and remove files and directories individually

- ▶ rmdir: Deletes a Directory page 186
- ▶ mv, cp: Move or Copy Files page 187
- ▶ mv: Moves a Directory page 188
- ▶ rm: Removes a Link page 208
- ▶ rm: Removes a File (Deletes a Link) page 222
- ▶ cp: Copies Files page 224
- ▶ mv: Renames or Moves a File page 237

Copy multiple files and directories recursively

- ▶ cp: Copies Files page 224

Remove files and directories recursively

- ▶ rm: Removes a File (Deletes a Link) page 222

Use simple and advanced wildcard specifications in commands

- ▶ Filename Generation/Pathname Expansion page 165
- ▶ Pathname Expansion page 412

Using find to locate and act on files based on type, size, or time

- ▶ find: Finds Files Based on Criteria page 229

Usage of tar, cpio, and dd

- ▶ tar: Stores or Extracts Files to/from an Archive File page 249
- ▶ tar: Archives Files page 603
- ▶ cpio: Archives Files page 605

Partial List of Used Files, Terms, and Utilities

cp

- ▶ mv, cp: Move or Copy Files page 187
- ▶ cp: Copies Files page 224

find

- ▶ find: Finds Files Based on Criteria page 229

mkdir

- ▶ mkdir: Creates a Directory page 184

mv

- ▶ mv: Moves a Directory page 188
- ▶ mv: Renames or Moves a File page 237
- ▶ mv, cp: Move or Copy Files page 187

ls

- ▶ ls -l: Displays Permissions page 191
- ▶ ls: Displays Information About Files page 221

rm

- ▶ rm: Removes a Link page 208
- ▶ rm: Removes a File (Deletes a Link) page 222

rmdir

- ▶ rmdir: Deletes a Directory page 186

touch

- ▶ touch: Changes File Modification and Access Times page 243

tar

- ▶ tar: Stores or Extracts Files to/from an Archive File page 249
- ▶ tar: Archives Files page 603

cpio

- ▶ cpio: Archives Files page 605

dd**file**

- ▶ file: Displays the Classification of a File page 229

gzip

- ▶ xz, bzip2, and gzip: Compress and Decompress Files page 245

gunzip

- ▶ unxz bunzip2 gunzip page 248

bzip2

- ▶ xz, bzip2, and gzip: Compress and Decompress Files page 245

file globbing

- ▶ Filename Generation/Pathname Expansion page 165
- ▶ Pathname Expansion page 412

103.4 USE STREAMS, PIPES, AND REDIRECTS

Redirecting standard input, standard output, and standard error

- ▶ Redirecting Standard Output page 154
- ▶ Redirecting Standard Input page 155
- ▶ Redirecting Standard Error page 333
- ▶ redirection page 1269 (Glossary)
- ▶ standard input page 1274 (Glossary)
- ▶ standard output page 1275 (Glossary)
- ▶ standard error page 1274 (Glossary)

Pipe the output of one command to the input of another command

- ▶ Pipelines page 158
- ▶ Filters page 161
- ▶ filter page 1250 (Glossary)
- ▶ pipeline page 1266 (Glossary)

Use the output of one command as arguments to another command

- ▶ xargs: Converts Standard Input to Command Lines page 260

Send output to both stdout and a file

- ▶ tee page 162

Partial List of Used Files, Terms, and Utilities

tee

- ▶ tee page 162

xargs

- ▶ xargs: Converts Standard Input to Command Lines page 260

103.5 CREATE, MONITOR, AND KILL PROCESSES

Run jobs in the foreground and background

- ▶ Running a Command in the Background page 163
- ▶ Moving a Job from the Foreground to the Background page 164
- ▶ Background process page 375
- ▶ background process page 1238 (Glossary)
- ▶ foreground process page 1250 (Glossary)

Signal a program to continue running after logout

Monitor active processes

- ▶ Process Identification page 374
- ▶ ps page 374
- ▶ ps page 466

Select and sort processes for display

- ▶ Process Identification page 374
- ▶ ps page 466
- ▶ top: Lists Processes Using the Most Resources page 612

Send signals to processes

- ▶ Aborting Execution page 123
- ▶ kill: Aborting a Background Job page 164
- ▶ kill: Sends a Signal to a Process page 465
- ▶ killall: Kills a Command page 467
- ▶ pkill: Kills a Command page 468
- ▶ Signals page 1047

Partial List of Used Files, Terms, and Utilities

&

- ▶ Running a Command in the Background page 163
- ▶ Background process page 375
- ▶ background process page 1238 (Glossary)
- ▶ foreground process page 1250 (Glossary)

bg

- ▶ Moving a Job from the Foreground to the Background page 164
- ▶ bg: Sends a Job to the Background page 348
- ▶ background process page 1238 (Glossary)

fg

- ▶ Foreground page 163
- ▶ Moving a Job from the Foreground to the Background page 164
- ▶ fg: Brings a Job to the Foreground page 347
- ▶ foreground process page 1250 (Glossary)

jobs

- ▶ Determining the number of a job using jobs page 164
- ▶ jobs: Lists Jobs page 346

kill

- ▶ kill: Aborting a Background Job page 164
- ▶ kill: Sends a Signal to a Process page 465

nohup

ps

- ▶ Process Identification page 374
- ▶ ps page 466

top

- ▶ top: Lists Processes Using the Most Resources page 612

free

- ▶ free: Displays Memory Usage Information page 253

uptime

- ▶ uptime: Displays System Load and Duration Information page 253

killall

- ▶ killall: Kills a Command page 467

103.6 MODIFY PROCESS EXECUTION PRIORITIES

Know the default priority of a job that is created

- ▶ Process Identification page 374
- ▶ ps page 466
- ▶ top: Lists Processes Using the Most Resources page 612

Run a program with higher or lower priority than the default

Change the priority of a running process

Partial List of Used Files, Terms, and Utilities

nice

ps

- ▶ Process Identification page 374
- ▶ ps page 466

renice

top

- ▶ top: Lists Processes Using the Most Resources page 612

103.7 SEARCH TEXT FILES USING REGULAR EXPRESSIONS

See *Appendix A: Regular Expressions* page 1139

Create simple regular expressions containing several notational elements

- ▶ Appendix A: Regular Expressions page 1139
- ▶ Regular Expressions page 1101 (Python)

Use regular expression tools to perform searches through a filesystem or file content

- ▶ See *preceding entry*.

Partial List of Used Files, Terms, and Utilities

grep

- ▶ grep: Searches for a Pattern in Files page 232

egrep

- ▶ Extended regular expression page 233

fgrep

sed

regex(7)

103.8 PERFORM BASIC FILE EDITING OPERATIONS USING VI

A Practical Guide to Fedora and Red Hat Enterprise Linux, Seventh Edition *covers the vim editor. All commands discussed here are compatible between vi and vim.*

Tutorial: Using vim to Create and Edit a File page 262

Navigate a document using vi

- ▶ Moving the Cursor page 268

Use basic vi modes

- ▶ Command and Input Modes page 264

Insert, edit, delete, copy, and find text

- ▶ Entering Text page 265
- ▶ Deleting Text page 268
- ▶ Correcting Text page 268

Partial List of Used Files, Terms, and Utilities

vi

- ▶ Tutorial: Using vim to Create and Edit a File page 262

/, ?

h, j, k, l

- ▶ Moving the Cursor page 268

i, o, a

- ▶ Entering Text page 265
- ▶ Entering Additional Text page 268

c, d, p, y, dd, yy

- ▶ Deleting Text page 268

ZZ, :w!, :q!, :e!

- ▶ Ending the Editing Session page 269

104 DEVICES, LINUX FILESYSTEMS, FILESYSTEM HIERARCHY STANDARD**104.1 CREATE PARTITIONS AND FILESYSTEMS**

Use various mkfs commands to set up partitions and create various filesystems such as:

ext2

- ▶ ext2 page 519
- ▶ ext2 to ext3 page 527

ext3

- ▶ **ext3** page 519
- ▶ **ext3** to **ext2** page 527

xfs

- ▶ The XFS Filesystem page 527

reiserfs v3

- ▶ **reiserfs** page 520

vfat

- ▶ **vfat** page 520

Partial List of Used Files, Terms, and Utilities

fdisk

- ▶ fdisk: see the fdisk man page
- ▶ See also parted: Reports on and Partitions a Hard Disk page 614

mkfs

- ▶ mkfs: Creates a Filesystem page 467

mkswap

- ▶ **swap** page 513

104.2 MAINTAIN THE INTEGRITY OF FILESYSTEMS

Verify the integrity of filesystems

- ▶ fsck: Checks Filesystem Integrity page 525

Monitor free space and inodes

- ▶ df: shows where directory hierarchies are mounted page 804

Repair simple filesystem problems

- ▶ fsck: Checks Filesystem Integrity page 525

Partial List of Used Files, Terms, and Utilities

du

- ▶ du: Displays Disk Usage Information page 523

df

- ▶ df: shows where directory hierarchies are mounted page 804

fsck

- ▶ fsck: Checks Filesystem Integrity page 525

e2fsck

mke2fs

debugfs

dumpe2fs

tune2fs

- ▶ tune2fs: Changes Filesystem Parameters page 526

xfs tools (such as xfs_metadump and xfs_info)

104.3 CONTROL MOUNTING AND UNMOUNTING OF FILESYSTEMS

Manually mount and unmount filesystems

- ▶ mount: Mounts a Filesystem page 520
- ▶ umount: Unmounts a Filesystem page 523
- ▶ mount: Mounts a Directory Hierarchy page 807
- ▶ Mounting Shares page 834

Configure filesystem mounting on bootup

- ▶ **fstab**: Keeps Track of Filesystems page 524
- ▶ **fstab** file page 807
- ▶ **/etc/fstab**: Mounts Directory Hierarchies Automatically page 811

Configure user mountable removable filesystems

- ▶ Mount Options page 522

Partial List of Used Files, Terms, and Utilities

/etc/fstab

- ▶ **fstab**: Keeps Track of Filesystems page 524
- ▶ **fstab** file page 807
- ▶ **/etc/fstab**: Mounts Directory Hierarchies Automatically page 811

/media

mount

- ▶ mount: Mounts a Filesystem page 520
- ▶ mount: Mounts a Directory Hierarchy page 807
- ▶ Mounting Shares page 834

umount

- ▶ umount: Unmounts a Filesystem page 523

104.4 MANAGE DISK QUOTAS

Set up a disk quota for a filesystem

- ▶ Disk Quota System page 629

Edit, check, and generate user quota reports

- quota and repquota page 629

Partial List of Used Files, Terms, and Utilities

quota

- ▶ quota and repquota page 629

edquota

- ▶ edquota and quotaon page 629

repquota

- ▶ quota and repquota page 629

quotaon

- ▶ edquota and quotaon page 629

104.5 MANAGE FILE PERMISSIONS AND OWNERSHIP

Manage access permissions on regular and special files as well as directories

- ▶ chmod: Changes File Access Permissions page 193

- ▶ chmod: Makes a File Executable page 337

Use access modes such as suid, sgid, and the sticky bit to maintain security

- ▶ Setuid and Setgid Permissions page 196
- ▶ Setuid file page 424
- ▶ Setuid files page 626
- ▶ setuid page 1272 (Glossary)
- ▶ setgid page 1272 (Glossary)

Know how to change the file creation mask

- ▶ umask: Specifies the File Permission Mask page 469

Use the group field to grant file access to group members

- ▶ **ls -l**: Displays Permissions page 191
- ▶ chmod: Changes File Access Permissions page 193
- ▶ **/etc/group** page 506

Partial List of Used Files, Terms, and Utilities

chmod

- ▶ chmod: Changes File Access Permissions page 193
- ▶ chmod: Makes a File Executable page 337

umask

- ▶ umask: Specifies the File Permission Mask page 469

chown

- ▶ chown: Changes File Ownership page 195

chgrp

- ▶ chgrp: Changes File Group Association page 195

104.6 CREATE AND CHANGE HARD AND SYMBOLIC LINKS

Create links

- ▶ ln: Creates a Hard Link page 204
- ▶ ln: Creates Symbolic Links page 207

Identify hard and/or softlinks

- ▶ ls and link counts page 206
- ▶ ls and inodes page 206
- ▶ hard link page 1252 (Glossary)
- ▶ link page 1258 (Glossary)
- ▶ symbolic link page 1276 (Glossary)

Copying versus linking files

- ▶ cp Versus ln page 205

Use links to support system administration tasks

- ▶ ln: Creates a Hard Link page 204
- ▶ ln: Creates Symbolic Links page 207

Partial List of Used Files, Terms, and Utilities

ln

- ▶ ln: Creates a Hard Link page 204
- ▶ ln: Creates Symbolic Links page 207

104.7 FIND SYSTEM FILES AND PLACE FILES IN THE CORRECT LOCATION

Understand the correct locations of files under the FHS

- ▶ Important Standard Directories and Files page 189
- ▶ Important Files and Directories page 502

Find files and commands on a Linux system

- ▶ whereis page 255
- ▶ locate: Searches for a File page 256

Know the location and purpose of important files and directories as defined in the FHS

- ▶ Important Standard Directories and Files page 189
- ▶ Important Files and Directories page 502

Partial List of Used Files, Terms, and Utilities

find

- ▶ find: Finds Files Based on Criteria page 229

locate

- ▶ locate: Searches for a File page 256

updatedb

- ▶ updatedb page 256

whereis

- ▶ whereis page 255

which

- ▶ which page 255

type

- ▶ type: Displays Information About a Command page 1041

/etc/updatedb.conf

CERTIFICATION EXAM 2

OBJECTIVES: LX0-102

105 SHELLS, SCRIPTING, AND DATA MANAGEMENT

105.1 CUSTOMIZE AND USE THE SHELL ENVIRONMENT

See *Chapter 9: The Bourne Again Shell (bash)* page 327

Set environment variables (e.g., **PATH**) at login or when spawning a new shell

- ▶ Startup Files page 329
- ▶ Set **PATH** in **.bash_profile** page 331
- ▶ Keyword variables page 353
- ▶ Keyword Variables page 358

Write bash functions for frequently used sequences of commands

- ▶ Functions page 396
- ▶ Variables in Functions page 1039

Maintain skeleton directories for new user accounts

- ▶ useradd: Adds a User Account page 600

Set command search path with the proper directory

- ▶ **PATH**: Where the Shell Looks for Programs page 359

Partial List of Used Files, Terms, and Utilities

/etc/profile

- ▶ **/etc/profile** page 330
- ▶ **/etc/profile** and **/etc/profile.d** page 509

env

- ▶ env: Runs a Program in a Modified Environment page 1035

export

- ▶ declare: Lists and Assigns Attributes to Variables page 357
- ▶ export: Puts Variables in the Environment page 1032

set

- ▶ **set ±o**: Turns Shell Features On and Off page 400
- ▶ set: Initializes Positional Parameters page 1024

unset

- ▶ unset: Removes a Variable page 356

~/.bash_profile

- ▶ **.bash_profile**, **.bash_login**, and **.profile** page 330
- ▶ **~/.bash_profile** page 502

~/.bash_login

- ▶ **.bash_profile**, **.bash_login**, and **.profile** page 330

~/.profile

- ▶ **.bash_profile**, **.bash_login**, and **.profile** page 330

~/.bashrc

- ▶ **.bashrc** page 331
- ▶ **~/.bashrc** page 502

~/.bash_logout

- ▶ **.bash_logout** page 330

functions

- ▶ Functions page 396
- ▶ Variables in Functions page 1039

alias

- ▶ Aliases page 392
- ▶ Alias Substitution page 404

lists

- ▶ Lists page 162

105.2 CUSTOMIZE OR WRITE SIMPLE SCRIPTS

See Chapter 9: *The Bourne Again Shell (bash)* page 327

See Chapter 27: *Programming the Bourne Again Shell (bash)* page 981

Use standard sh syntax (loops, tests)

- ▶ Control Structures page 982

Use command substitution

- ▶ Command Substitution page 410

Test return values for success or failure or other information provided by a command

- ▶ test builtin page 983
- ▶ [] is a synonym for test page 986
- ▶ test builtin page 1000

Perform conditional mailing to the superuser

Correctly select the script interpreter through the shebang (!) line

- ▶ #! Specifies a Shell page 338

Manage the location, ownership, execution, and suid-rights of scripts

- ▶ Listing setuid files page 458

Partial List of Used Files, Terms, and Utilities

for

- ▶ **for...in** page 995
- ▶ **for** page 997

while

- ▶ **while** page 999

test

- ▶ test builtin page 983
- ▶ [] is a synonym for test page 986
- ▶ test builtin page 1000

if

- ▶ **if...then** page 983
- ▶ **if...then...else** page 987
- ▶ **if...then...elif** page 989

read

- ▶ read: Accepts User Input page 1041

seq

- ▶ seq page 407

105.3 SQL DATA MANAGEMENT

See Chapter 29: The MariaDB SQL Database Management System page 1113

Use of basic SQL commands

- ▶ Notes page 1114

Perform basic data manipulation

- ▶ Examples page 1123

Partial List of Used Files, Terms, and Utilities

insert

- ▶ INSERT INTO page 1125

update

- ▶ UPDATE page 1128

select

- ▶ Retrieving Data page 1126
- ▶ Joins page 1130

delete

- ▶ DELETE FROM page 1128

from

- ▶ DELETE FROM page 1128

where

- ▶ WHERE page 1127

group by

order by

- ▶ ORDER BY page 1126

join

- ▶ Joins page 1130

106 USER INTERFACES AND DESKTOPS

106.1 INSTALL AND CONFIGURE X11

See X Window System page 459

Verify that the video card and monitor are supported by an X server

- Displays page 109

Awareness of the X font server

Basic understanding and knowledge of the X Window configuration file

Partial List of Used Files, Terms, and Utilities

/etc/X11/xorg.conf

xhost

- ▶ xhost Grants Access to a Display page 461

DISPLAY

- ▶ The **DISPLAY** Variable page 462

xwininfo

xdpyinfo

X

- ▶ X Window System page 459

106.2 SET UP A DISPLAY MANAGER

Turn the display manager on or off

Change the display manager greeting

Change default color depth for the display manager

Configure display managers for use by X-stations

Partial List of Used Files, Terms, and Utilities

/etc/inittab

- ▶ **/etc/inittab** page 508

xdm configuration files

kdm configuration files

gdm configuration files

- ▶ Graphical login page 453
- ▶ The **Xorg -nolisten tcp** Option page 460

106.3 ACCESSIBILITY

Keyboard Accessibility Settings (AccessX?)

Visual Settings and Themes

Assistive Technology (ATs)

Partial List of Used Files, Terms, and Utilities

Sticky/Repeat Keys

Slow/Bounce/Toggle Keys

Mouse Keys

High Contrast/Large Print Desktop Themes

Screen Reader

Braille Display

Screen Magnifier

On-Screen Keyboard

Gestures (used at login, for example gdm)

Orca

GOK

emacspeak

107 ADMINISTRATIVE TASKS

107.1 MANAGE USER AND GROUP ACCOUNTS AND RELATED SYSTEM FILES

Add, modify, and remove users and groups

- ▶ **system-config-users**: Manages User Accounts page 598
- ▶ **Managing User Accounts from the Command Line** page 600

Manage user/group info in password/group databases

- ▶ **Modifying a User** page 600
- ▶ **Working with Groups** page 600

- ▶ usermod: Modifies a User Account page 601
- ▶ groupdel and groupmod: Remove and Modify a Group page 601
- ▶ chage page 601

Create and manage special purpose and limited accounts

Partial List of Used Files, Terms, and Utilities

/etc/passwd

- ▶ **/etc/passwd** page 508

/etc/shadow

- ▶ **/etc/shadow** page 511

/etc/group

- ▶ **/etc/group** page 506

/etc/skel

- ▶ **/etc/skel** page 600

chage

- ▶ chage page 601

groupadd

- ▶ groupadd: Adds a Group page 601

groupdel

- ▶ groupdel and groupmod: Remove and Modify a Group page 601

groupmod

- ▶ groupdel and groupmod: Remove and Modify a Group page 601

passwd

- ▶ Users: Changing Your Account Type and Password (GUI) page 112
- ▶ passwd: Changing Your Password (CLI) page 137

useradd

- ▶ useradd: Adds a User Account page 600

userdel

- ▶ userdel: Removes a User Account page 600

usermod

- ▶ usermod: Modifies a User Account page 601

107.2 AUTOMATE SYSTEM ADMINISTRATION TASKS BY SCHEDULING JOBS

Manage **cron** and **at** jobs

- ▶ **crond** and **anacron**: Schedule Routine Tasks page 607
- ▶ **at**: Runs Occasional Tasks page 611

Configure user access to **cron** and **at** services

- ▶ **/etc/at.allow**, **/etc/at.deny**, **/etc/cron.allow**, and **/etc/cron.deny** page 506

Partial List of Used Files, Terms, and Utilities

/etc/cron.{d,daily,hourly,monthly,weekly}

- ▶ Crontab Files page 607

/etc/at.deny

- ▶ **/etc/at.allow**, **/etc/at.deny**, **/etc/cron.allow**, and **/etc/cron.deny** page 506

/etc/at.allow

- ▶ **/etc/at.allow**, **/etc/at.deny**, **/etc/cron.allow**, and **/etc/cron.deny** page 506

/etc/crontab

- ▶ **/etc/crontab** page 608

/etc/cron.allow

- ▶ **/etc/at.allow**, **/etc/at.deny**, **/etc/cron.allow**, and **/etc/cron.deny** page 506

/etc/cron.deny

- ▶ **/etc/at.allow**, **/etc/at.deny**, **/etc/cron.allow**, and **/etc/cron.deny** page 506

/var/spool/cron/*

- ▶ Crontab Files page 607

crontab

- ▶ User crontab files page 608
- ▶ **crond** and anacron: Schedule Routine Tasks page 607

at

- ▶ at: Runs Occasional Tasks page 611

atq

atrm

107.3 LOCALIZATION AND INTERNATIONALIZATION

Locale settings

- ▶ Locale page 368
- ▶ locale page 1258 (Glossary)

Time zone settings

- ▶ tzconfig page 372
- ▶ tzselect page 372
- ▶ **/etc/timezone** page 372

Partial List of Used Files, Terms, and Utilities**/etc/timezone**

- ▶ **/etc/timezone** page 372

/etc/localtime

- ▶ **/etc/localtime** page 373

/usr/share/zoneinfo

- ▶ **/usr/share/zoneinfo** page 372

Environment variables:

- ▶ **LC_**: Locale Variables page 368
- ▶ Environment Variables page 1032

/usr/bin/locale

- ▶ locale: Displays Locale Information page 369

tzselect

- ▶ tzselect page 372

tzconfig

- ▶ tzconfig page 372

date

- ▶ date: Displays the System Time and Date page 218

iconv

UTF-8

- ▶ LC_: Locale Variables page 368
- ▶ UTF-8 page 1279 (Glossary)

ISO-8859

- ▶ LC_: Locale Variables page 368

ASCII

- ▶ ASCII page 1237 (Glossary)

Unicode

- ▶ Unicode page 1279 (Glossary)

108 ESSENTIAL SYSTEM SERVICES

108.1 MAINTAIN SYSTEM TIME

Set the system date and time

- ▶ timedatectl: Reports on and Sets the System Clock page 613

Set the hardware clock to the correct time in UTC

Configure the correct time zone

- ▶ Time page 371

Basic NTP configuration

Knowledge of using the pool.ntp.org service

Partial List of Used Files, Terms, and Utilities

/usr/share/zoneinfo

- ▶ /usr/share/zoneinfo page 372

/etc/timezone

- ▶ /etc/timezone page 372

/etc/localtime

- ▶ /etc/localtime page 373

/etc/ntp.conf

date

- ▶ date: Displays the System Time and Date page 218
- ▶ timedatectl: Reports on and Sets the System Clock page 613

hwclock

ntpd

ntpdate

pool.ntp.org

108.2 SYSTEM LOGGING

Syslog configuration files

- ▶ rsyslog.conf page 620

syslog

- ▶ **rsyslogd**: Logs System Messages page 620

standard facilities, priorities, and actions

- ▶ Selectors page 620
- ▶ Facilities page 620
- ▶ Priorities page 620
- ▶ Actions page 621

Partial List of Used Files, Terms, and Utilities**syslog.conf**

- ▶ **rsyslog.conf** page 620

syslogd

- ▶ **rsyslogd**: Logs System Messages page 620

klogd

logger

108.3 MAIL TRANSFER AGENT (MTA) BASICS

See *Chapter 20: sendmail: Setting Up Mail Servers, Clients, and More* page 739

Create e-mail aliases

- ▶ **/etc/aliases** page 746

Configure e-mail forwarding

- ▶ **~/.forward** page 747

Knowledge of commonly available MTA programs (Postfix, **sendmail**, Qmail, **exim**) (no configuration)

- ▶ Alternatives to sendmail page 741

Partial List of Used Files, Terms, and Utilities**~/.forward**

- ▶ **~/.forward** page 747

sendmail emulation layer commands

newaliases

- ▶ newaliases page 747

mail

mailq

- ▶ mailq page 748

Postfix

- ▶ Postfix page 742

sendmail

- ▶ Introduction to **sendmail** page 740
- ▶ Setting Up a **sendmail** Mail Server page 742
- ▶ JumpStart I: Configuring **sendmail** on a Client page 743
- ▶ JumpStart II: Configuring **sendmail** on a Server page 744
- ▶ Working with **sendmail** Messages page 745
- ▶ Configuring **sendmail** page 748

exim

- ▶ **exim4** page 742

qmail

- ▶ Qmail page 742

108.4 MANAGE PRINTERS AND PRINTING

See Chapter 13: Printing with CUPS page 555

Basic CUPS configuration (for local and remote printers)

- ▶ The System Configures a Local Printer Automatically page 558
- ▶ JumpStart I: Configuring a Printer Using system-config-printer page 558
- ▶ JumpStart II: Setting Up a Local or Remote Printer page 560
- ▶ Working with the CUPS Web Interface page 565
- ▶ Configuring Printers page 566

Manage user print queues

- ▶ Managing Print Queues page 572

Troubleshoot general printing problems

Add and remove jobs from configured printer queues

- ▶ BSD and System V command-line print utilities page 574

Partial List of Used Files, Terms, and Utilities

CUPS configuration files, tools, and utilities

- ▶ JumpStart I: Configuring a Printer Using system-config-printer page 558
- ▶ Working with the CUPS Web Interface page 565
- ▶ Sharing CUPS Printers page 572

/etc/cups

- ▶ Example lpadmin Commands page 570

lpd legacy interface (lpr, lprm, lpq)

- ▶ Traditional UNIX Printing page 573

109 NETWORKING FUNDAMENTALS

See Chapter 8: Networking and the Internet page 279

109.1 FUNDAMENTALS OF INTERNET PROTOCOLS

See Network Protocols page 290

Demonstrate an understanding of network masks

- ▶ Subnet mask page 298
- ▶ network mask page 1263 (Glossary)

Knowledge of the differences between private and public “dotted quad” IP Addresses

- ▶ Private address space page 637
- ▶ private address space page 1267 (Glossary)

Setting a default route

Knowledge about common TCP and UDP ports (20, 21, 22, 23, 25, 53, 80, 110, 119, 139, 143, 161, 443, 465, 993, 995)

- ▶ Each chapter covering a server discusses which ports that server uses.
- ▶ Ports page 312
- ▶ port page 1266 (Glossary)

Knowledge about the differences and major features of UDP, TCP, and ICMP

- ▶ UDP page 290
- ▶ UDP: User Datagram Protocol page 292
- ▶ TCP page 290
- ▶ TCP: Transmission Control Protocol page 291
- ▶ ping: Tests a Network Connection page 305
- ▶ UDP page 1278 (Glossary)
- ▶ TCP page 1276 (Glossary)
- ▶ ICMP page 1254 (Glossary)

Knowledge of the major differences between IPv4 and IPv6

- ▶ IPv4 page 292
- ▶ IPv6 page 293

Partial List of Used Files, Terms, and Utilities

/etc/services

- ▶ Network Services page 313
- ▶ **/etc/services** page 511

ftp

- ▶ Chapter 19: FTP: Transferring Files Across a Network page 713

telnet

- ▶ telnet: Logs In on a Remote System page 303

host

- ▶ host and dig: Query Internet Nameservers page 307

ping

- ▶ ping: Tests a Network Connection page 305

dig

- ▶ host and dig: Query Internet Nameservers page 307
- ▶ dig page 861
- ▶ dig page 862

traceroute

- ▶ traceroute: Traces a Route over the Internet page 306

tracepath

109.2 BASIC NETWORK CONFIGURATION

Manually and automatically configure network interfaces

- ▶ Configuring the Systems page 636
- ▶ NetworkManager: Configures Network Connections page 637

Basic TCP/IP host configuration

Partial List of Used Files, Terms, and Utilities

/etc/hostname

- ▶ **/etc/hostname** page 507

/etc/hosts

- ▶ Hostnames page 300
- ▶ **/etc/hosts** page 507

/etc/resolv.conf

- ▶ **/etc/resolv.conf** page 510

/etc/nsswitch.conf

- ▶ **nsswitch.conf**: Which Service to Look at First page 495

ifconfig

ifup

ifdown

route

ping

- ▶ ping: Tests a Network Connection page 305

109.3 BASIC NETWORK TROUBLESHOOTING

Manually and automatically configure network interfaces and routing tables to include adding, starting, stopping, restarting, deleting, or reconfiguring network interfaces

Change, view, or configure the routing table and correct an improperly set default route manually

Debug problems associated with the network configuration

Partial List of Used Files, Terms, and Utilities

ifconfig

ifup

ifdown

route

host

- ▶ host and dig: Query Internet Nameservers page 307

hostname

- ▶ hostname: Displays the System Name page 219
- ▶ **/etc/sysconfig/network** page 511

dig

- ▶ host and dig: Query Internet Nameservers page 307
- ▶ dig page 861
- ▶ dig page 862

netstat

ping

- ▶ ping: Tests a Network Connection page 305

traceroute

- ▶ traceroute: Traces a Route over the Internet page 306

109.4 CONFIGURE CLIENT SIDE DNS

See *Chapter 24: DNS/BIND: Tracking Domain Names and Addresses* page 851

Demonstrate the use of DNS on the local system

- ▶ JumpStart I: Setting Up a DNS Cache page 866

Modify the order in which name resolution is done

- ▶ Resolver page 854

Partial List of Used Files, Terms, and Utilities

/etc/hosts

- ▶ Hostnames page 300
- ▶ **/etc/hosts** page 507

/etc/resolv.conf

- ▶ **/etc/resolv.conf** page 510

/etc/nsswitch.conf

- ▶ **nsswitch.conf**: Which Service to Look at First page 495

110 SECURITY

110.1 PERFORM SECURITY ADMINISTRATION TASKS

Audit a system to find files with the suid/sgid bit set

- ▶ Listing setuid files page 458
- ▶ Listing setgid files page 459

Set or change user passwords and password aging information

- ▶ Users: Changing Your Account Type and Password (GUI) page 112
- ▶ passwd: Changing Your Password (CLI) page 137
- ▶ Modifying a User page 600
- ▶ chage page 601

Being able to use nmap and netstat to discover open ports on a system

Set up limits on user logins, processes, and memory usage

Basic sudo configuration and usage

- ▶ Using sudo to Gain **root** Privileges page 428

Partial List of Used Files, Terms, and Utilities

find

- ▶ find: Finds Files Based on Criteria page 229

passwd

- ▶ Users: Changing Your Account Type and Password (GUI) page 112
- ▶ passwd: Changing Your Password (CLI) page 137

lsuf

- ▶ lsuf: Finds Open Files page 624

nmap
chage
 ▶ chage page 601
netstat
sudo
 ▶ Using sudo to Gain **root** Privileges page 428
/etc/sudoers
 ▶ **sudoers**: Configuring sudo page 433
su
 ▶ Using su to Gain **root** Privileges page 425
usermod
 ▶ usermod: Modifies a User Account page 601
ulimit

110.2 SET UP HOST SECURITY

Awareness of shadow passwords and how they work

- ▶ **/etc/shadow** page 511

Turn off network services not in use

- ▶ Configuring Daemons (Services) page 445
- ▶ service page 443
- ▶ chkconfig and service page 445
- ▶ system-config-services: Configures Services page 447

Understand the role of TCP wrappers

- ▶ TCP Wrappers: Secure a Server (**hosts.allow** and **hosts.deny**) page 485

Partial List of Used Files, Terms, and Utilities

/etc/nologin

- ▶ Going to Single-User Mode page 454

/etc/passwd

- ▶ **/etc/passwd** page 508

/etc/shadow

- ▶ **/etc/shadow** page 511

/etc/xinetd.d/* [deprecated]

/etc/xinetd.conf [deprecated]

/etc/inetd.d/* [deprecated]

/etc/inetd.conf [deprecated]

/etc/inittab

- ▶ **/etc/inittab** page 508

/etc/init.d/*

- ▶ SysVinit (**rc**) Scripts: Start and Stop System Services page 448

/etc/hosts.allow

- ▶ **hosts.allow** and **hosts.deny** page 486

/etc/hosts.deny

- ▶ **hosts.allow** and **hosts.deny** page 486

110.3 SECURING DATA WITH ENCRYPTION

Perform basic OpenSSH 2 client configuration and usage

- ▶ Configuring OpenSSH Clients page 690
- ▶ Running the ssh, scp, and sftp OpenSSH Clients page 689

Understand the role of OpenSSH 2 server host keys

- ▶ How OpenSSH Works page 687
- ▶ Authorized Keys: Automatic Login page 700

Perform basic GnuPG configuration and usage

- ▶ Tutorial: Using GPG to Secure a File page 1169

Understand SSH port tunnels (including X11 tunnels)

- ▶ Tunneling/Port Forwarding page 707

Partial List of Used Files, Terms, and Utilities

ssh

- ▶ ssh: Logs in or Executes Commands on a Remote System page 693

ssh-keygen

- ▶ ssh-keygen page 701

ssh-agent

- ▶ ssh-agent: Holds Your Private Keys page 703

ssh-add

- ▶ ssh-add page 703

~/.ssh/id_rsa and **id_rsa.pub**

- ▶ **id_rsa id_rsa.pub** page 689
- ▶ **id_rsa** and **id_rsa.pub** page 701

~/.ssh/id_dsa and **id_dsa.pub**

- ▶ **id_dsa id_dsa.pub** page 689

/etc/ssh/ssh_host_rsa_key and **ssh_host_rsa_key.pub**

- ▶ **ssh_host_rsa_key, ssh_host_rsa_key.pub** page 688

/etc/ssh/ssh_host_dsa_key and **ssh_host_dsa_key.pub**

- ▶ **ssh_host_dsa_key, ssh_host_dsa_key.pub** page 688

~/.ssh/authorized_keys

- ▶ **authorized_keys** page 688

/etc/ssh_known_hosts

- ▶ **ssh_known_hosts** page 692

gpg

- ▶ GnuPG/PGP page 1160
- ▶ Tutorial: Using GPG to Secure a File page 1169

~/.gnupg/*

- ▶ **~/.gnupg** page 1170