

Part II

# *Linux+ Study Guide*

*A guide and template to study for the Linux+  
LXO-104 exam.*

Produced by

**PHOENIX**TS

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# Introduction to Part II

## *How to Interpret and Use the Guide*

Part I of the Linux+ study guide established the foundation for understanding how to utilize this document. Part II continues where part I left off by covering the LXO-104 exam objectives published by CompTIA. The main topic areas include networking configuration and troubleshooting, writing scripts, automating administrative tasks, SQL databases, and security fundamentals in Linux. This is a large guide that requires prior knowledge and experience with the subject matter.

### ***How to Engage ~***

Use the document to guide your studies. Read, practice, and make notes within the document (adjacent space provided). Nothing replaces the learning experience of creating your own notes for studying. Research even goes far enough to suggest that handwritten notes are better for learning than typing.

Remember that when using new commands, rely on man pages before practicing.

***Caveats ~*** This document does not stand as an all-inclusive resource for preparing for the exam and does not replace and/or compensate for training or administration experience.



**Exam Objective**

*Shells, Scripting, and  
Data Management*



# Customize and Use Shell Environment

You should have a thorough understanding of the purpose of environment variables. Know how to change environment variables via user and global configuration files. Also, know how to make temporary and persistent changes with environment variables as well. Be capable of describing reasons to customize the shell environment for individual users or groups.

As described by the official CompTIA Linux+ objectives, you should know how to:

1. Use Bash functions for command sequences
2. Configure skeleton directories for new users
3. Set and unset environment variables at login or when launching new shells

## **Commands:**

env  
printenv  
export  
set  
unset  
alias  
unalias  
bind

## **Files and Directories:**

/etc/bash/bashrc  
/etc/profile  
~/.bash\_profile  
~/.bash\_login  
~/.bash\_logout  
~/.bashrc  
~/.profile  
/etc/inputrc

## **Concepts and Terms:**

Aliases, Persistent vs Non-Persistent Changes, Functions, Lists, Skeleton Directories, Environment Variables, DISPLAY, EDITOR, PATH, HOME, HOSTNAME, LANG, LD\_LIBRARY\_PATH, PS1, MAIL, PAGER, PWD, SHELL, TERM, TZ, USER, Global and User Files, BASH Functions.

## **Challenge Questions:**

1. If user and global configuration files vary, which takes precedence?
2. What are three reasons logout scripts are necessary (~/.bash\_logout)?

## **Additional Resources:**

3. Bash Guide for Beginners - <http://tldp.org/LDP/Bash-Beginners-Guide/html/>
4. Advanced Bash-Scripting Guide - <http://tldp.org/LDP/abs/html/>

# Edit and Write Shell Scripts

You should have an understanding of Bash scripting syntax, including the shebang line, tests, loops, lists, and functions. Know various methods for executing Bash shell scripts.

As described by the official CompTIA Linux+ objectives, you should know how to:

1. Manage the location, ownership, execution, and SUID script rights
2. Use command substitution
3. Test return values for success/failure depending on commands

## **Commands:**

sh  
bash  
chmod  
test  
source  
declare  
shift  
seq  
break  
exec  
read



## **Concepts and Terms:**

SUID and SGID bits, shebang, hashbang, pound bang line, user defined variables, positional parameter variables, Conditional Expressions, if-then Statement, else, if-then-else Statement, elif, case Statement, While Loops, Until Loops, For Loops, Lists and List Operators, Functions,

## **Challenge Questions:**

1. What commands are commonly used in scripts?
2. Do you need to set a script's SUID and SGID bits?
3. What condition types can the test command evaluate?

## **Additional Resources:**

4. Advanced Bash-Scripting Guide - <http://tldp.org/LDP/abs/html/>

# SQL Data Management

You should have familiarity with accessing, storing, updating, modifying, and retrieving data from databases with Structured Query Language (SQL) in an administrative capacity. Know common SQL commands, SQL data types, Where conditions, and how to combine data from tables.

As described by the official CompTIA Linux+ objectives, you should know how to:

1. Use the core SQL commands for data manipulation

## **SQL Commands:**

INSERT

UPDATE

SELECT

JOIN

FROM

USE

CREATE TABLE

SHOW TABLES

SET

WHERE

GROUP BY

ORDER BY

## **Concepts and Terms:**

SQL, Relational Databases, Rows (Tuples), Columns (Fields or Attributes), SQL Data Types (INTEGER, SMALLINT, DECIMAL, NUMERIC, FLOAT, DOUBLE PRECISION, DATETIME, DATE, TIME, CHAR, VARCHAR, ENUM, SET), MySQL, PostgreSQL, SQLite, WHERE Conditions

## **Challenge Questions:**

1. How do you combine data from different tables if there are no matching fields?
2. How do you create a database and table in MySQL?

## **Additional Resources:**

3. Free Books for Learning SQL on Github - <https://github.com/vhf/free-programming-books/blob/master/free-programming-books.md#sql-implementation-agnostic>



**Exam Objective**

# *User Interfaces and Desktops*



# Install and Configure X11

You should have a solid understanding of the X window configuration file formatting rules and minor exceptions. Know varying options (depending on the distributions and usage of runlevels) to test configuration modifications. Know the differences between the X Core Font and Xft Font systems. Even though most situations do not require this, understand the process for configuring an X font server.

As described by the official CompTIA Linux+ objectives, you should know how to:

1. Verify the video and monitor supported by the X window system

## **Commands:**

```
startx  
xhost  
mkfontscale  
mkfontdir  
ttmkfdir  
type1inst  
xset  
xfontsel  
xwininfo  
xdpyinfo
```

## **Files and Directories:**

/etc/X11/xorg.conf  
/usr/share/fonts (or /usr/share/X11/fonts)  
fonts.dir  
/etc/X11/fs/config

## **Concepts and Terms:**

DISPLAY, X Font Server, X Core Font System, Bitmap Fonts, Outline Fonts, Adobe PostScript Type 1 Fonts, TrueType Fonts, X Logical Font Description (XLFD), X Font Path, Xft Font System, fc-cache XFree86, X.org-X11, Data Display Channel, Video Cards, Monitors, Refresh Rates, Resolution, Color Depth, ServerLayout, Wayland

## **Challenge Questions:**

1. What advantages does the Xft font system have over the X core fonts?

# Display Managers

You should know the differences between display managers for the main Linux distributions. Be capable of installing, configuring, starting, stopping, enabling, and disabling the common display managers. Have familiarity with the X remote access options, including options for enabling or disabling remote access, tunneling, and using xhost and SSH protocol.

As described by the official CompTIA Linux+ objectives, you should know how to:

1. Configure and enable LightDM and other related display managers
2. Modify the display manager greeting

## **Commands:**

systemctl enable (disable, start, or stop options)

xhost

ssh

## **Files and Directories :**

/etc/lightdm

/etc/X11/xdm/xdm-config (xdm interchangeable with other display managers)

/etc/X11/xdm/Xaccess

/etc/X11/xdm/Xresources

/etc/X11/gdm

/etc/sshd\_config

## **Concepts and Terms:**

XDMCP, LightDM, XDM, GDM, KDM, MDM, SSH Protocol, Tunneling, Virtual Network Computing (VNC)

## **Challenge Questions:**

1. How would you configure a Linux system to launch a remote X program on another system?
2. Describe the differences between X servers and X clients? How does each function, especially for remote access?
3. How would you enable tunneling with SSH?



# X Accessibility

Even though you may not need to edit these settings, it is imperative to have an understanding of the various accessibility capabilities and features available on most Linux systems. Most of the options are available through the GUI desktop or system settings.

As described by the official CompTIA Linux+ objectives, you should know how to:

1. Make adjustments for visual settings and switch to high contrast or larger font desktop themes.
2. Adjust accessibility configuration options through GUI tools.
3. Adjust keyboard settings with AccessX.

## **Concepts and Terms:**

GOK, Caribou, Emacspeak, Braille Display (BRLTTY), On-Screen Keyboard, kmag, Orca, Mouse Gestures, Screen Magnifier, Screen Reader, High Contrast Desktop Themes, Slow Keys, Bounce Keys, Toggle Keys, Sticky Keys, Keyboard Repeat Rate, Mouse Keys, Assistive Technology (AT)

## **Challenge Questions:**

1. Do you know how to check if the current Linux kernel version supports a Braille display?



**Exam Objective**

# *Administrative Tasks*



# Users and Groups

Smart security starts with prudent, clearly defined, and efficient user and group management. You should be well-versed in all aspects of administering users and groups, including the tools for adding, modifying, and deleting users and groups (files as well). Know how to employ various user management options, such as account expiration dates, default or primary groups for users, UIDs, or providing specified skeleton directories for new users.

As described by the official CompTIA Linux+ objectives, you should know how to:

1. Manage special purpose and limited accounts. Also, know the common purposes/reasons for creating these account types.
2. Manage user/group information in group databases.

## **Commands:**

useradd  
userdel  
usermod  
groupadd  
groupdel  
groupmod  
passwd  
gpasswd  
chage  
chgrp  
chown  
getent

## **Files and Directories:**

/etc/skel  
/etc/passwd  
/etc/shadow  
/etc/group  
/etc/nsswitch.conf

## **Concepts and Terms:**

Users, Groups, UID, GID, Skeleton Directory, Daemon User Accounts,

## **Challenge Questions:**

1. Can superusers change ordinary user passwords without knowing the actual password?
2. What is the critical difference between the /etc/passwd and /etc/shadow files?

# Automate System Tasks

You should have an understanding of the differences between system and user cron jobs. Know when it is appropriate to employ anacron versus cron for specific tasks.

As described by the official CompTIA Linux+ objectives, you should know how to:

1. Configure cron, anacron, and at jobs
2. Configure ordinary user access for cron jobs

## **Commands:**

crontab  
at  
atq  
atrm  
anacron

## **Files and Directories:**

/etc/crontab  
/etc/cron.allow  
/etc/cron.deny  
/etc/cron.d  
/etc/cron.hourly  
/etc/cron.daily  
/etc/cron.weekly  
/etc/cron.monthly  
/var/spool/cron  
/etc/anacrontab  
/etc/at.allow  
/etc/at.deny  
/usr/sbin/cron  
/usr/bin/crontab

## **Concepts and Terms:**

cron, anacron, jobs, run-parts, cronloop, user vs. System cron jobs, atd  
daemon

## **Challenge Questions:**

1. Is anacron or cron better for performing hourly jobs?
2. What is the default editor for the crontab file?
3. Do you need to provide the username when creating a user cron job?
4. How would you restrict specific users from creating cron jobs?

# Localization and Internalization

You should have an understanding of how to query and set local time. You should understand the relevance of linking and environment variables for configuring time zones and local times.

## **Commands:**

tzselect  
tzconf  
iconv  
date  
locale  
tzsetp  
ln



## **Files and Directories**

/etc/localtime

/etc/timezone

/usr/bin/locale

/usr/share/zoneinfo

## **Concepts and Terms:**

LANG, TZ, LC, LC\_ALL, Unicode, UTF-8, ASCII, ISO-8859, Coordinated Universal Time (UTC), std

## **Challenge Questions:**

1. What environment variables enable you to temporarily change the system locale? How would you execute this action?
2. When would you need to use the iconv command?

## **Instructor Tip:**



**Exam Objective**

*Essential System  
Services*



# Localization and Internationalization

You should be able to describe the differences between the hardware and software clocks, including the tools and methods for setting each. You should have an understanding of how the NTP server and client relationship works. You should know how to potentially configure NTP clients to point the correct NTP server. Also, you should be capable of setting the system time, date, and time zone with appropriate command line tools.

## **Commands:**

hwclock  
date  
ping  
netdate  
ntpd  
ntpdate  
nptq

## **Files and Directories:**

`/var/lib/ntp`  
`/etc/ntp.conf`

## **Concepts and Terms:**

Hardware clock, software clock, wall clock time, Network Time Protocol (NTP), atomic clocks, ntpd, pool.npt.org, insane time

## **Challenge Questions:**

1. Can you describe how the Network Time Protocol (NTP) is structured and functions (hint – tiered hierarchy)?
2. When choosing an NTP source, what should be the most important criteria?
3. How does the NTP server daemon function when choosing between multiple server pools in the `/etc/ntp.conf` configuration file?
4. If the NTP daemon is not running, what type of error message may you encounter?

# System Logging

Maintaining and reviewing system log files is a critical responsibility for administrators. You should be able to demonstrate a strong grasp of the system logging daemons, configuration options, journaling, the benefits of the journalctl tool, and how to configure logrotate.

## **Commands:**

journalctl  
Tail -f  
logger  
tail  
grep

## **Files:**

/var/log  
syslog.conf  
/etc/logrotate.conf  
/etc/logrotate.d  
/var/log/journal  
/etc/systemd/journald.conf

## **Concepts and Terms:**

Klogd, logger, journalctl, logrotate, syslog daemon, system vs. User journal data

## **Challenge Questions:**

1. Describe the purpose and function of syslogd and klogd.
2. Describe the different types of facility parameters in the syslogd configuration file.
3. For security measures, why is it imperative to review syslogd files?
4. What advantages does the systemd journal system provide over syslogd?

# Mail Transfer Agents (MTAs)

You should know how MTA servers create, transfer, and deliver email. Be able to describe the differences between the common MTA servers such as Sendmail, Postfix, Exim, and Qmail. You should have familiarity with using the mail and mailq tools. Be able to explain the relevance of email aliases and how to employ the newaliases command.

## **Commands:**

mail  
mailq  
postqueue  
runq  
newaliases

## **Files and Directories :**

/var/spool/mail  
~/.forward  
/etc/aliases

## **Concepts and Terms:**

Simple Mail Transfer Protocol (SMTP), Mail Transfer Agents (MTAs), POP and IMAP servers, MUA, MSA< MDA, Sendmail, Postfix, Exim, Qmail, email aliases, postmaster

## **Challenge Questions:**

1. Can you read email stored on remote POP or IMAP servers with the mail program?
2. Why would or wouldn't you read mail as root or create a postmaster aliases for the root account?
3. Give several reasons why it is beneficial to edit a user's ~/.forward file to forward their email messages to another username or computer? How would configure the email forwarding?



# Printer Management and Tools

Even though manual configuration from the terminal is not often necessary, you should have familiarity with editing and adding or removing printers from the cups configuration files. You should be familiar with managing printers and print jobs from the CUPS web interface at <http://localhost:631>. You should understand the how to configure printing from computers outside of the local network. Familiarize yourself with common printing issues and troubleshooting solutions.

## **Commands:**

- lpr
- lpd
- lpq
- lprm
- lpc
- lpmove
- cupsenable
- cupsdisable

## **Files and Directories:**

/var/spool/cups  
/etc/cups/cupsd.conf  
/etc/cups/printers.conf  
/etc/cups/ppd

## **Concepts and Terms:**

CUPS, GhostScript, PostScript, smart filter, PPD files, Internet Printing Protocol (IPP), Gutenprint drivers, CUPS DDK

## **Challenge Questions:**

1. How would you acquire the correct PPD file for a new printer not recognized by CUPS when attempting to configure the printer?
2. How does GhostScript, smart filters, and PostScript work together to prepare files for printing?



**Exam Objective**

*Networking  
Fundamentals*



# Internet Protocols

You should be capable of describing the network protocol stack, specifically the different layers and corresponding protocols. You should understand the differences between ICMP, TCP, and UDP. Know the main differences between IPv4 and IPv6 addressing, including the addressing structures and the enhancements IPv6 provides. You should have a firm grasp on the common UDP and TCP port numbers and examples of their purpose.

## **Commands:**

ping  
ifconfig  
ip  
host  
dig  
nslookup  
whois

## **Files and Directories:**

/etc/services  
/etc/hosts  
/etc/networks

## **Concepts and Terms:**

TCP/IP, network protocol stack, PCI (or PCIe), PLIP, Ethernet, token ring, Localtalk, FDDI, HPPI, fiber channel, Wi-Fi, Cat-5, Cat-5e, 802.11a, 802.11b, 802.11g, 802.11n, switches, hubs, Network protocol stack, application layer, Internet layer (layer 2), transport layer (layer 3), DNS, IPv6, SLAAC, DHCP, DHCPv6, ICMP, ICMPv6, UDP, TCP, NFS, SMTP, HTTP, FTP, MAC, Address Resolution Protocol (ARP), Neighbor Discovery Protocol (NDP), link-local addresses, global addresses, Network Address Translation (NAT), network masks, subnetting, Classless Inter-Domain Routing (CIDR), dotted quad notation and addresses, IPV4 network classes, broadcasting data, hostnames, privileged vs unprivileged ports

## **Challenge Questions:**

1. What is the difference between full and half-duplex transmission in switches and hubs?
2. Explain how the network protocol stack functions?

# Network Configuration

You should know the tools and methods for manually and automatically configuring networks. You should have a fundamental comprehension of configuration for DHCP, static IP addresses, hostnames, and routing. You should know the correct command line and GUI tools for network configuration.

## **Commands:**

ping  
ip  
ifconfig  
route  
hostname  
ifup  
ifdown  
dhcpcd  
pump  
dhclient

## **Files and Directories:**

/etc/services  
/etc/hosts  
/etc/hostnames  
/etc/networks  
/etc/nsswitch.conf  
/etc/network/interfaces

## **Concepts and Terms:**

DHCP, static IP addresses, default route, Network Information System (NIS), YaST, system-config-network

## **Challenge Questions:**

1. In the system fails to auto-detect the network card, what command line tool do you use to manually load the network driver module?
2. What file would you enable routing? (Include the correct file to edit, option, and additional details)

# Network Troubleshooting

You should have familiarity with using network troubleshooting tools to identify and resolve common issues. You should know how to manually and automatically configure IP tables, default route, and routing tables.

## **Commands:**

dig  
ping  
ping6  
host  
hostname  
route  
tracert  
tracert6  
tracertop  
tracertop6  
netstat  
netcat  
tcpdump



## **Files and Directories:**

/etc/services

## **Concepts and Terms:**

Telnet, File Transfer Protocol (FTP)

## **Challenge Questions:**

1. How would a specific router configuration render traceroute useless? What details would indicate that this issue occurred.
2. What information can you gather with tcpdump?
3. What security risks come with using Telnet and FTP?

# Configure DNS Clients

You should know how Domain Name System (DNS) functions. Know how to manually look up hostname information by querying DNS servers. You should understand the steps for configuring local name resolution, querying and using remote DNS servers, and editing the configuration for name resolution. This entails a solid grasp on the `/etc/hosts` file format of IP addresses, hostnames, and aliases.

## **Commands:**

host  
whois  
nslookup  
dig  
getent

## **Files and d**

/etc/networks  
/etc/nsswitch.conf  
/etc/hosts  
/etc/resolv.conf

## **Concepts and Terms:**

Domain Name System (DNS)

## **Challenge Questions:**

1. When may it be unnecessary to use DNS for setting up hostnames?  
What's the alternative method in this situation?
2. What tools or methods must you use to query DNS info manually via non-DNS tools?
3. How would you check to if DNS is configured correctly?



**Exam Objective**

*Security*



# Security Administration

Security remains a top priority for administrators in all work environments. Admins should have a thorough understanding of all elements impacting security risks, including the management of users and group permissions, password management features, and performing system audits (for SUID and SGID bit sets). You should know the differences and implications of using su versus sudo. Also, pay attention to defining limits on user processes and memory. This enables finer control of the user environments and allows admins to identify irregularities or system issues. Since Linux is a multiuser network-based operating system, it is imperative to have a solid grasp on network monitoring tools such nmap, Nessus, and even employing the various auditing capabilities that come with running Kali Linux.

## **Commands:**

- lsof
- netstat
- nmap
- find
- passwd
- usermod
- su
- sudo
- who, w, last
- ulimit
- chage
- chown
- fuser

## **Files:**

/etc/sudoers  
/var/run/utmp  
/var/log/wtmp  
/var/log/btmp  
/etc/security/limits.conf

## **Concepts and Terms:**

Sudo, superuser, super servers, Nessus, Kali Linux, Pluggable Authentication Modules (PAM)

## **Challenge Questions:**

1. How do you identify and disable unused servers?
2. What nmap options would enable you to identify available network services and open network ports?
3. Explain why a repudiation environment (can log in as root) creates a security issue.
4. What command would you use (and how would you use it) to audit the system to identify SUID and SGID bit sets?

# Host Security

You should understand and be able to describe the critical distinctions between the `/etc/passwd` and `/etc/shadow` files for password management.

## **Commands:**

iptables  
nftables  
passwd  
gpasswd

## **Files and Directories:**

/etc/passwd  
/etc/shadow  
/etc/xinitd  
/etc/xinitd.conf  
/etc/nologin  
/etc/inittab  
/etc/init.d  
/etc/inetd.conf  
/etc/xinetd.conf  
/etc/hosts.allow  
/etc/hosts.deny

## **Concepts and Terms:**

TCP wrappers, libwrap inetd, xinetd, Uncomplicated Firewall Utility (ufw), shadow passwords

## **Challenge Questions:**

1. How do you identify and disable unused servers?
2. Compose a list of best practices for passwords for users under your management. Also, what tools and methods would you use to enforce a password policy.



# Data Security and Encryption

You should understand the various features of GPG for encrypting and decrypting data, digital signing and verifying file signatures, generating, exporting, importing, and revoking public and private keys. Know how to configure and employ an OpenSSH server, including host keys.

## **Commands:**

ssh  
ssh-keygen  
ssh-agent  
ssh-add  
scp  
gpg  
gpg2

## **Files and Directories:**

/etc/hosts.allow  
/etc/hosts.deny  
/etc/ssh\_known\_hosts  
/etc/ssh/sshd\_config  
~/.ssh/authorized\_keys  
/etc/ssh/ssh\_host\_rsa\_key  
/etc/ssh/ssh\_host\_dsa\_key  
/etc/ssh/id\_rsa.pub  
/etc/ssh/id\_dsa.pub  
/bin/sh  
~/.gnupg

## **Concepts and Terms:**

OpenSSH, private and public keys, X11 Forwarding and Port Tunnels, SSH port tunnels, TCP wrappers, tunneling, firewalls, GNU Privacy Guard (GPG), keyring, keyserver, key block

## **Challenge Questions:**

1. What are the cons of using encryption with SSH?
2. Describe how SSH port tunnels work?
3. What are important measures to take to avoid SSH security issues? (hint – disable X forwarding)
4. What steps would you take to revoke keys?

# Additional Resources

*Read, Practice, Repeat.*

*This is a duplicate page found in Part I of the study guide. We provided it again as a reminder to utilize these helpful resources for learning and studying.*

**YouTube** ~ The article, "[9 Youtube Channels to Learn Linux Online](#)" outlines great YouTube channels for learning about Linux administration.

**Live on the Command Line** ~ The most effective way to gaining proficiency with the topics, concepts, commands, and filesystem involves practicing on a Linux command line. Navigate files, change directories, launch and close GUI applications, even use [Linux text-based web browsers](#).

# *Linux+ Training*

Learn under the guidance of experience Linux+ instructors who understand the exams and what it takes to pass.

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