

# CompTIA Linux+ XK0-005 Reference Guide

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*Get the knowledge and skills you need to  
become a Linux certified professional*

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**Philip Inshanally**



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**Dedicated to**

*My Creator:*

*GOD Almighty*

*&*

*My loving Son Matthew Zach Inshanally*

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## Preface

The CompTIA Linux+ is a certification program offered by CompTIA, a non-profit trade association that provides vendor-neutral IT certifications. The Linux+ certification is designed to validate the skills and knowledge of IT professionals who work with the Linux operating system.

The Linux+ certification is suitable for individuals who want to demonstrate their proficiency in Linux administration, system configuration, maintenance, and basic networking. It is often pursued by those seeking to build a career in Linux system administration or other IT roles that involve working with Linux-based systems.

With this book, you will gain the necessary knowledge and skillset required for achieving the CompTIA Linux+ certification. I hope you will find this book informative and helpful.

**Chapter 1: Introduction to Linux Environment** - This chapter explains everything needed for the reader to understand the Linux File Hierarchy System (FHS), navigating between the directories, viewing configuration files, etc. It introduces various methods of identifying and locating hardware information from within the terminal environments. Furthermore, this chapter also explains and illustrates the Grand Unified Bootloader 2.

**Chapter 2: Files, Directories, and Storage** - This chapter presents various methods of file compression and focuses on various ways to manipulate files and directories from within the terminal environment. Furthermore, this chapter explains various ways of managing storage.

**Chapter 3: Processes, Services and Network Configuration** - This chapter covers various ways for identifying and managing process(s). Next, this chapter focuses on handling services from within the terminal environment, such as: starting and stopping process(s) / daemon(s), and the service vs systemctl command. Furthermore, this chapter covers network configuration both from within the Desktop and terminal environment.

**Chapter 4: Managing Modules and Software** - This chapter allows the reader to learn various methods of managing modules from within the terminal environment. Furthermore, this chapter places heavy emphasis on software management.

**Chapter 5: User and Password Management** - The reader will learn various methods for managing users, such as adding, removing, and updating user properties, etc. Next, this chapter focuses on group management and password management.

**Chapter 6: Firewall, Remote Access and SELinux** - The reader will learn to configure various methods of TCP wrappers, firewalld, and iptables, among others. Next, this chapter focuses on remote access, and the reader will learn to configure remote access. Furthermore, the reader will learn to configure SELinux, which provides an extra layer of access control and enforcement.

**Chapter 7: Shell Scripting and Containers** - This chapter explains shell scripting in detail, starting with the basic structure of a script, then moving on to the for loop, while loop, and conditionals. Furthermore, this chapter covers containers in depth, such as Linux containers (LXC), Docker.

**Chapter 8: Configuration Management with YAML, JSON and Ansible** - This chapter is dedicated to configuration management. First, this chapter focuses on YAML or YAML Ain't Markup Language. Next, the reader will learn to manage configuration using JavaScript Object Notation (JSON). Furthermore, the reader will learn Ansible for configuration management.

**Chapter 9: Troubleshooting Network and System Issues** - This chapter explains various methods of troubleshooting. First, this chapter focuses on network troubleshooting, tools such as ping, ping6, traceroute, traceroute6, to name a few. Next, the reader will learn to troubleshoot common memory issues using tools such as free, top, among others. Following this, the reader will learn to troubleshoot hard disk problems using commands such as smartctl, iotop, to name a few. Furthermore, the reader will learn how to troubleshoot common boot issues by examining various log files and using commands such as fsck, mount, and many more.

**Chapter 10: Mock Exams** - The reader will be presented with two mock exams. The format of the questions is multiple choice in both mock exams. Furthermore, the questions cover materials learned throughout this book.



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# CHAPTER 1

# Introduction to Linux Environment

## Introduction

In this chapter, we will learn about the Linux **Filesystem Hierarchy Standard (FHS)** directories. Next, we will look for ways to obtain hardware information from the terminal environment. Finally, we will wrap this chapter with GRUB2.

## Structure

This chapter will discuss the following topics:

- Filesystem hierarchy standard
- Finding hardware information
- Grand Unified Bootloader 2

## Objectives

By the end of this chapter, you will be able to understand filesystem structure. You will become accustomed to directories and how they are used. It will be easier for you to locate hardware. Grand Unified Bootloader 2 will also be introduced to you through this chapter.

## Filesystem hierarchy standard

When the term FHS is referenced, think of directory structure. You will find on almost all the Linux distributions, the FHS is identical. It defines the directory structure and content in UNIX-like operating systems such as Linux distros.

The need for a standardized filesystem hierarchy arose from the diverse nature of early Unix systems, where file organization varied significantly across different implementations. The FHS project was initiated in the early 1990s by the *Free Standards Group* (now the Linux Foundation) to address this issue. Its primary objective was to establish a typical structure simplifying software development, administration, and package management across Linux distributions.

## Key principles of the FHS

The FHS is guided by several fundamental principles that shape its design and implementation. These principles include:

- **Filesystem hierarchy:** The FHS defines a consistent structure for organizing files and directories. It categorizes them based on purpose, ensuring each component has a specific role within the hierarchy.
- **Compatibility:** The FHS aims to maintain compatibility across different Linux distributions. By adhering to the standard, software developers and administrators can create and manage applications that work seamlessly across various systems.
- **Compliance:** Linux distributions seeking FHS compliance must adhere to specific guidelines to ensure consistent placement of files and directories. This promotes portability and simplifies the packaging and installation of software.

Across the various Linux Distros, the configuration files will usually be in the exact location regardless of Linux distribution (the **/etc** directory). This makes developing software for Linux much more accessible since software developers do not have to write different versions of applications for each distribution.

In the FHS environment, the files and directories appear under the root directory (**/**); this root directory is the parent of all other directories and sits at the top of the FHS.

A list of the commonly used directories across Linux distros is as follows:

- **/:** The root directory, this is the top-level directory. It is the parent for all other directories.
- **/root/:** The home directory of the root user.

- **/boot**: It contains files relating to system boot, such as the bootloader configurations, kernel images, and initial RAM disk (initram) files.
- **/bin**: The critical executable files that are necessary for system operations.
- **/dev**: It contains device files like hard disks or CD-ROMs.
- **/sbin**: It is similar to **/bin** but contains programs generally run by the root user.
- **/etc**: It contains configuration files.
- **/home**: This is the user's home directory.
- **/lib**: It contains libraries on 32-bit systems.
- **/lib64**: It contains libraries on 64-bit systems.
- **/media**: It is the mount point for removable media, usually used for auto-mounting external media.
- **/mnt**: It is the mount point for removable media manually.
- **/usr**: It contains most user utilities (**/usr/bin/**, **/usr/lib/**, etc.).
- **/var**: This contains the various files such as logs (auth, syslog), web server content, and package cache.
- **/tmp**: This contains temporary files created by programs.
- **/proc**: A virtual filesystem containing various runtime information such as devices, bus, interrupts, CPU, RAM, etc.

Now, let us look at the directories at the terminal using Ubuntu and Centos distributions.

The root (**/**) directory resides at the top of the directory structure. Using Ubuntu, let us check out our current working directory using the **pwd** command. Consider *Figure 1.1*:

```
philip@philip-virtual-machine:/$ pwd
/
philip@philip-virtual-machine:/$
```

*Figure 1.1: Present working directory*

Now, let us check the content of the root (/) directory using the **ls** command.

Consider Figure 1.2:

```

philip@philip-virtual-machine:/$ ls
bin  dev  lib  libx32  mnt  root  snap  sys  var
boot etc  lib32 lost+found opt  run  srv  tmp
cdrom home lib64 media  proc sbin  swapfile usr
philip@philip-virtual-machine:/$ ls -l
total 2191440
lrwxrwxrwx 1 root root          7 May 23 13:29 bin -> usr/bin
drwxr-xr-x 4 root root      4096 Jun  1 14:09 boot
drwxrwxr-x 2 root root      4096 May 23 13:30 cdrom
drwxr-xr-x 19 root root     4220 Aug  9 12:23 dev
drwxr-xr-x 129 root root    12288 Jun  1 14:10 etc
drwxr-xr-x 3 root root      4096 May 23 13:31 home
lrwxrwxrwx 1 root root          7 May 23 13:29 lib -> usr/lib
lrwxrwxrwx 1 root root          9 May 23 13:29 lib32 -> usr/lib32
lrwxrwxrwx 1 root root          9 May 23 13:29 lib64 -> usr/lib64
lrwxrwxrwx 1 root root         10 May 23 13:29 libx32 -> usr/libx32
drwx----- 2 root root    16384 May 23 13:29 lost+found
drwxr-xr-x 3 root root      4096 May 23 13:57 media
drwxr-xr-x 2 root root      4096 Feb 22 23:57 mnt
drwxr-xr-x 2 root root      4096 Feb 22 23:57 opt
dr-xr-xr-x 345 root root        0 Aug  9 10:47 proc
drwx----- 4 root root      4096 May 29 13:14 root
drwxr-xr-x 33 root root      860 Aug  9 10:51 run
lrwxrwxrwx 1 root root          8 May 23 13:29 sbin -> usr/sbin
drwxr-xr-x 13 root root      4096 May 29 10:45 snap
drwxr-xr-x 2 root root      4096 Feb 22 23:57 srv
-rw----- 1 root root 2243952640 May 23 13:29 swapfile
dr-xr-xr-x 13 root root        0 Aug  9 10:47 sys
drwxrwxrwt 19 root root      4096 Aug  9 12:25 tmp
drwxr-xr-x 14 root root      4096 Feb 22 23:57 usr
drwxr-xr-x 14 root root      4096 Feb 23 00:02 var
philip@philip-virtual-machine:/$

```

Figure 1.2: Output of the **ls** command

We can see that the root (/) directory contains a range of other directories. For a hierarchical view, let us leverage the **tree** with the **-d** option (directory) command.

Consider Figure 1.3:

```

philip@philip-virtual-machine:/$ tree -d
├── bin -> usr/bin
├── boot
│   ├── efi [error opening dir]
│   └── grub
│       ├── fonts
│       ├── i386-pc
│       ├── locale
│       └── x86_64-efi
├── cdrom
├── dev
│   ├── block
│   ├── bsg
│   └── bus
│       └── usb
│           ├── 001
│           └── 002
├── char
├── cpu
│   ├── 0
│   └── 1
├── disk
│   ├── by-id
│   ├── by-label
│   ├── by-partlabel
│   ├── by-partuuid
│   ├── by-path
│   ├── by-uuid
│   └── dma_heap
├── dri
│   └── by-path
└── fd -> /proc/self/fd

```

Figure 1.3: Output of the **tree** command with **-d** option

Switch to our Centos system and check the root (/) directory.

Consider *Figure 1.4*:

```
philip@localhost/
[philip@localhost ~]$ pwd
/
[philip@localhost ~]$ ls
afs  boot  etc  lib  media  opt  root  sbin  sys  usr
bin  dev  home  lib64  mnt  proc  run  srv  tmp  var
[philip@localhost ~]$
```

*Figure 1.4: Output of the ls command with a similar structure*

As shown above, the structure is similar. Let us use the **tree** command with the **-d** option for a hierarchical view. Consider *Figure 1.5*:

```
.
├── afs
├── bin -> usr/bin
├── boot
│   ├── efi
│   │   └── EFI
│   │       └── centos [error opening dir]
│   ├── grub2 [error opening dir]
│   ├── loader
│   │   └── entries [error opening dir]
├── dev
│   ├── block
│   ├── bsg
│   ├── bus
│   │   └── usb
│   │       ├── 001
│   │       └── 002
│   ├── char
│   ├── cpu
│   │   ├── 0
│   │   └── 1
│   ├── cs
│   ├── disk
│   │   ├── by-diskseq
│   │   ├── by-id
│   │   ├── by-label
│   │   ├── by-partuuid
│   │   ├── by-path
│   │   └── by-uuid
│   └── dma_heap
└── :
```

*Figure 1.5: Output of the tree command with the -d option for a hierarchical view*

Now, look at the content of the `/bin` directory using the `ls` command. We will see a variety of commands which are a part of the operating system. Consider *Figure 1.6*:

```
philip@philip-virtual-machine:/bin$ pwd
/bin
philip@philip-virtual-machine:/bin$ ls
['
aa-enabled          mkzftree
aa-exec            mmcli
aa-features-abi    mokutil
aconnect           monitor-sensor
acpi_listen        more
add-apt-repository mount
addpart            mountpoint
airscan-discover   mousetweaks
alsabat            mscompress
alsaloop           msexpand
alsamixer          mt
alsatplg           mt-gnu
alsaucm            mtr
amidi              mtr-packet
amixer             mv
apg               namei
apgbfm            nano
aplay             nautilus
aplaymidi          nautilus-autorun-software
apport-bug         nautilus-sendto
apport-cli         nawk
apport-collect    nc
apport-unpack     nc.openbsd
appres            neqn
appstreamcli      netcat
apropos           networkctl
apt               networkd-dispatcher
apt-add-repository newgrp
                  ngettext
```

*Figure 1.6: Output of `ls` command with the `bin` directory*

In contrast, in the `/usr` directory, you will notice some similarities inside the `/usr/bin` directory. However, the `/bin` is part of the core operating system and must be accessible before the `/usr` directory gets mounted. Consider *Figure 1.7*:

```
philip@philip-virtual-machine:/usr$ pwd
/usr
philip@philip-virtual-machine:/usr$ ls
bin  games  include  lib  lib32  lib64  libexec  libx32  local  sbin  share  src
philip@philip-virtual-machine:/usr$ ls /usr/bin
['
aa-enabled          mkzftree
aa-exec            mmcli
aa-features-abi    mokutil
aconnect           monitor-sensor
acpi_listen        more
add-apt-repository mount
addpart            mountpoint
airscan-discover   mousetweaks
alsabat            mscompress
alsaloop           msexpand
alsamixer          mt
alsatplg           mt-gnu
alsaucm            mtr
amidi              mtr-packet
amixer             mv
apg               namei
apgbfm            nano
aplay             nautilus
aplaymidi          nautilus-autorun-software
apport-bug         nautilus-sendto
apport-cli         nawk
apport-collect    nc
apport-unpack     nc.openbsd
appres            neqn
appstreamcli      netcat
apropos           networkctl
                  networkd-dispatcher
```

*Figure 1.7: Contents of the `/usr/bin` directory*