

LPI Certification Self-Study Guide

by David Horton

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The LPI Self-Study Guide is intended to provide a quick and inexpensive method for experienced Linux users to prepare for Linux Professional Institute (LPI) certification exams 101 and 102. The LPI Self-Study Guide is not a beginner's course and makes no attempt to teach any of the subject matter in detail. Instead the study guide provides a structured method for quickly absorbing the knowledge required by the exam objectives. Links to external references and documentation are provided for key terms and concepts and there are practice questions with answers at the end of each chapter.

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Introduction

1. About The Author

David Horton holds a Masters of Science in Information Systems from Roosevelt University, Chicago, Illinois USA as well as being LPIC-1 certified. He has been working with Linux systems since 1995.

2. Disclaimer

Using this document in no way guarantees that you will pass the LPI exams. This document is provided as-is with no warranty of any kind, either expressed or implied, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Use the concepts, examples and information at your own risk. The author(s) do not take any responsibility for damages that may arise from the use of this document.

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4. Making Contributions

It is the author's wish that the practice questions be written and maintained by LPI certified persons. If you are LPI certified and would like to submit practice questions, please contact the author.

All Linux enthusiasts are welcome to submit references, point out errors and suggest improvements.

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Part I. General Information

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Chapter 1. Exam Preparation Methods

David Horton

1.1. Is The Self-Study Guide Right For You?

Self-study is not the easiest method of preparing for an exam. Look at the following checklist to help determine if the self-study guide is right for you.

- I am motivated, self-diciplined and good at managing my time.
- I prefer to learn things on my own rather than having someone teach me.
- I hold certifications from other vendors.
- I have used self-study to prepare for other certification tests and have been successful.
- I feel comfortable interacting with Linux using the command-line and often prefer it over a graphical user interface.
- I have used more than one Linux distribution.
- I am viewed as a Linux expert by my peers.
- I have visited LPI's web site [<http://www.lpi.org/>] and I feel comfortable with the exam objectives [<http://www.lpi.org/en/lpic.html>].

If you can answer yes to the majority of these questions self-study may be a good test preparation method for you. If you answered yes to less than half of the questions you may want to explore other, more formalized test preparation methods.

1.2. Alternatives To This Guide

If you are not confident in your ability to pass the LPI exams using this self-study guide you may want to find another test preparation option. There are many resources listed on LPI's web site [<http://www.lpi.org/en/preparation.html>].

Even if you are a self-study guru it is always a good idea to use a variety of sources for test preparation.

1.3. Study Groups

No matter if you choose self-study or formal classroom education it is smart to study in a group. Not only can you learn from others, but you can also reinforce your own knowledge by teaching. You may want to form a study group in your school or as part of your local Linux Users Group. There are also on-line study groups at the LPI Forums website [<http://www.lpiforums.com/>].

Chapter 2. Test Taking Tips

David Horton

2.1. Understanding the Test Format

When taking any exam it is important to understand the exam format prior to sitting down to take the test. This way you can be sure that you are being tested on your knowledge of the test material and not your understanding, or lack of understanding, of the test format.

The Linux Professional Institute (LPI) certification exams consist of fifty-one to seventy-three multiple choice and fill in the blank questions. The actual number of questions depends on which exam you are taking. LPI's exams are similar to computer-based exams from other vendors. If you have ever taken a Novell, Microsoft or Cisco certification test you will probably be very comfortable with the LPI exam format.

2.1.1. Types Of Questions You Will Encounter

LPI exam questions can be broken down into three basic types.

- Questions with fill in the blank answers
- Multiple choice questions with multiple correct answers
- Multiple choice questions with a single correct answer

All of the questions have a "mark for review option" that allows you to return to a question before finishing the exam. Mark for review is discussed in more detail in the next section.

Of the three types of questions, fill in the blank questions are probably the most challenging. There is no guessing, you must know the correct answer and enter it precisely. Be sure to read these questions very carefully and enter exactly what is asked for. Consider the following sample question:

```
System account information such as user ID and group ID is stored
in which file? (give the full path)
```

The correct answer is `/etc/passwd`. An answer such as `passwd` is incorrect since the question clearly states that the full path should be given. This may seem like a trivial thing, but when you are under the stress of an exam situation it is tempting to rush to conclusions and not read the question fully. If you are not one-hundred percent sure that your answer is correct it is best to mark the question for review.

After dealing with fill in the blank questions you might think that multiple choice questions would be easy. None of the LPI questions is designed to be easy, but multiple choice does give you some advantage. Usually you can tackle a multiple choice question in small steps. Take a look at the following sample question:

```
Which of the following are valid IP addresses for use on the
Internet? (choose two)
_ 192.16.15.211
_ 172.18.200.16
_ 68.143.255.10
_ 125.264.1.132
```

If you know the answer right away that is great, but if not there is a simple procedure you can follow to increase your chances of arriving at the correct answer.

The first thing you should do is to determine the type of multiple choice question. This sample question is a multiple answer type. You can figure this out by the fact that the question says, "choose two" and that the computer will allow you to select more than one answer.

Once the type of question is determined, the second step is to rule out any obviously wrong answers. In the case of the example above the fourth answer can be ruled out immediately, because 264 is above the valid range of values for an octet. (Octets are eight bits and can only be 0 - 255.)

At this point there are still three plausible looking answers and the question states that only two are correct. As a third step, re-read the question. Do not skim, but rather read slowly and deliberately looking for any information that may offer additional clues. The key phrase in the sample question is "for use on the Internet." This should tell you that the second answer is incorrect, because 172.18.200.16 belongs to the "class B reserved" range of addresses and cannot be used on the Internet.

The only remaining answers are the first and third choices. Since the question asks for two answers these should both be checked. If you are still unsure mark the question for review.

The other type of question you will encounter on the LPI exam is multiple choice single answer. These questions have one and only one correct answer. You can narrow down the field of potential correct answers using the same three steps as described for the multiple choice multiple answer questions, just know that in the end there can be only one correct answer. And if there is any doubt do not hesitate to mark the question for review.

2.1.2. Taking Advantage Of "Mark For Review"

In the previous section it was mentioned that questions should be marked for review if you are not one-hundred percent sure of the answer. This can be very beneficial. Marking questions allows you budget your time better by not spending too long on any one question. There is also the possibility that a later question will help you recall an elusive answer. This is particularly helpful for fill in the blank answers.

Once you have finished the last question on the exam you will be given a chance to revisit any marked questions. Take a look at the exam time clock and decide how much time you can afford to spend on each marked item. Trust your instincts when reviewing questions as many times your first choice is often the best choice. If an obvious answer is still not coming to you try to narrow down the selections if it is a multiple choice question. If all else fails take a guess. Guessing always gives better odds than simply leaving the question blank.

2.2. Managing Test Anxiety

No matter how long you have been using Linux or how much you study, you will be nervous on the day of the exam. Too much anxiety can work against you so it is important to take steps to minimize your stress level. There are several things you can do to calm yourself before the test.

2.2.1. In The Days Before The Exam

Before the exam day, try some of these tips.

- Study in a group if possible. Tutoring others is a great way to reinforce your own knowledge.
- Use more than one study aid. This guide is only one of many ways to prepare for the LPI exams. Additional resources can be found on the LPI web site [<http://www.lpi.org>].
- Consider taking the exam as part of an LPI exam lab. LPI offers exam sessions at certain Linux events at substantially discounted prices. Putting up \$25 for an exam at an event is not nearly as stressful as gambling \$100 at

a testing center. Check the LPI web site [<http://www.lpi.org>] for details on exams lab events.

- Work with your body's natural clock. If you are a morning person schedule your exam early. If you are not a morning person schedule your exam in the afternoon.
- Make sure you know how to get to your testing location and how long it will take you to get there.
- Be sure you are properly prepared. If you feel you have not studied enough it may be possible to postpone the exam. Be sure to check with your testing center at least twenty-four hours in advance to see if this is an option.

2.2.2. On The Day Of The Exam

The following tips may help you manage your stress level on the day of the exam.

- Double-check the testing center rules and be sure to have proper ID with you.
- Make sure you are well rested and have had something to eat and drink before the test.
- If you are addicted to caffeine or nicotine be sure to get your fix before the exam.
- Arrive at the testing center early. Take time to decompress by walking the halls or visiting the water cooler. Take care of any bodily functions.
- Take time to adjust your chair and keyboard before clicking the exam start button.
- Try to relax by taking several deep breaths in through your nose and exhaling slowly and completely through your mouth.
- Visualize yourself passing the exam.

Part II. Exam 101

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Chapter 3. Hardware & Architecture

David Horton

3.1. A Brief Look At The Objectives

Successful completion of the Hardware & Architecture section of the LPI exam requires familiarity with Personal Computer (PC) [\[http://en.wikipedia.org/wiki/Personal_computer\]](http://en.wikipedia.org/wiki/Personal_computer) expansion cards [\[http://en.wikipedia.org/wiki/Expansion_card\]](http://en.wikipedia.org/wiki/Expansion_card) and peripherals [\[http://en.wikipedia.org/wiki/Peripherals\]](http://en.wikipedia.org/wiki/Peripherals) and how those devices interact with the system BIOS [\[http://en.wikipedia.org/wiki/BIOS\]](http://en.wikipedia.org/wiki/BIOS) and the Linux Kernel [\[http://en.wikipedia.org/wiki/Linux_Kernel\]](http://en.wikipedia.org/wiki/Linux_Kernel). This includes understanding the difference between Industry Standard Architecture (ISA) [\[http://en.wikipedia.org/wiki/Industry_Standard_Architecture\]](http://en.wikipedia.org/wiki/Industry_Standard_Architecture) and Peripheral Component Interconnect PCI [\[http://en.wikipedia.org/wiki/Peripheral_Component_Interconnect\]](http://en.wikipedia.org/wiki/Peripheral_Component_Interconnect) as well as what interrupts (IRQs) [\[http://en.wikipedia.org/wiki/Interrupt\]](http://en.wikipedia.org/wiki/Interrupt), Input/Output (I/O) ports [\[http://en.wikipedia.org/wiki/Io_port\]](http://en.wikipedia.org/wiki/Io_port) and Direct Memory Access (DMA) channels [\[http://en.wikipedia.org/wiki/Direct_memory_access\]](http://en.wikipedia.org/wiki/Direct_memory_access) are used for. If you are the type of person whose PC spends as much time with the cover off as it does with the cover on you probably have a good head start on the preceding items. You will also need to know about Small Computer Systems Interface (SCSI) [\[http://en.wikipedia.org/wiki/SCSI\]](http://en.wikipedia.org/wiki/SCSI) and Universal Serial Bus (USB) [\[http://en.wikipedia.org/wiki/USB\]](http://en.wikipedia.org/wiki/USB) architectures, which are perhaps more difficult subjects. SCSI is more commonly used in high-end servers and may not be familiar to PC users. USB although more common in PC's is relatively new feature in the Linux kernel.

3.2. Ports, Interrupts and DMA

Expansion cards communicate with the PC using three basic methods, i/o ports, interrupts and DMA. The Linux kernel must keep track of these communication resources in order to properly interact with the expansion cards. The system administrator can see the kernel's view of i/o ports, interrupts and DMA channels by looking in the proc filesystem. There are three files in particular to note.

- `/proc/ioports`
- `/proc/interrupts`
- `/proc/dma`

All of these files can be viewed using the `cat` command. For example, `cat /proc/ioports` will show the the i/o ports used by the system. Take a moment to become familiar with the contents of these files. See if you can identify the various devices in your PC. Below are some excerpts from the three files from a typical PC:

```
bash$ head -5 /proc/ioports
0000-001f : dma1
0020-003f : pic1
0040-005f : timer
0060-006f : keyboard
0070-007f : rtc

bash$ head -5 /proc/interrupts
CPU0
 0:   204783      XT-PIC  timer
 1:    2410      XT-PIC  keyboard
 2:         0      XT-PIC  cascade
 5:    4004      XT-PIC  aic7xxx

bash$ cat /proc/dma
4: cascade
```

Most modern expansion cards have their resources assigned automatically using plug-and-play (PnP) [<http://en.wikipedia.org/wiki/Plug-n-play>] technology and it is rare to find a card that requires manual configuration. The way resources are assigned to a card depends upon which bus technology it uses. All PCI cards are designed to be plug-and-play and are assigned resources by the PC's BIOS during boot-up. The results of the configuration can be viewed using the **lspci** [<http://unixhelp.ed.ac.uk/CGI/man-cgi?lspci+8>] command. Older ISA cards may need to have their resources assigned by the operating system rather than the BIOS. Linux systems use the **isapnp** [<http://www.roestock.demon.co.uk/isapnptools/isapnp.8.html>] command and the corresponding `/etc/isapnp.conf` [<http://www.roestock.demon.co.uk/isapnptools/isapnp.conf.5.html>] file to set up ISA plug-and-play cards. The **pnpdump** [<http://www.roestock.demon.co.uk/isapnptools/pnpdump.8.html>] command queries ISA plug-and-play cards to find their desired resource configuration and its output can be used to construct the `/etc/pnp.conf` file.

3.3. IDE Disks and LBA

Exploration of the `/proc/ide` directory reveals information about IDE devices present in the system. Of particular interest is the `/proc/ide/hda` directory since it contains information about the first, bootable IDE hard disk in the system. Two files in the `/proc/ide/hda` directory, `capacity` and `geometry`, are used to describe the size of the hard disk. The example below shows the contents of the files for an 80G hard disk.

```
bash# cat /proc/ide/hda/geometry
physical    38322/16/255
logical     9732/255/63

bash# cat /proc/ide/hda/capacity
156355584
```

The output of `geometry` shows the size in a cylinder/head/sector (CHS) format while `capacity` shows the size in logical block addressing (LBA) format. The older CHS format is limited to 1024 cylinders and can only describe disks up to 8G in size. Because of this limitation modern hard disks are almost always described using LBA. The Linux kernel uses LBA exclusively and provides the CHS parameters in `geometry` for informational purposes only. Because the operating system uses LBA it is important that the PC BIOS also be configured to use LBA.

3.4. SCSI Devices

In addition to IDE many high-performance systems use SCSI. Typical SCSI devices attached to a Linux system include hard drives, cd-roms and tape drives, but there can be others as well. All SCSI devices must be attached a SCSI Host Adapter [http://en.wikipedia.org/wiki/Host_adapter] in order to interact with the system. The SCSI adapter is responsible for handling communication between the SCSI devices and the Linux kernel. Information about the host adapter and the devices attached to it will appear in the `proc` filesystem under the `/proc/scsi` directory. The following example shows a typical `/proc/scsi` directory.

```
bash# ls -F /proc/scsi
aic7xxx/  scsi
```

The directory `aic7xxx` contains information about the configuration of the host adapter (an Adaptec 2940 in this case.) There are many manufacturers of SCSI host adapters so the name and contents of the directory will vary depending on the particular setup.

There is also a file named `/proc/scsi/scsi` that shows all SCSI devices as seen by the Linux kernel. An example is shown below.

```
bash# cat /proc/scsi/scsi
Attached devices:
Host: scsi0 Channel: 00 Id: 00 Lun: 00
  Vendor: IBM      Model: DNES-309170W   Rev: SA30
  Type:   Direct-Access      ANSI SCSI revision: 03
Host: scsi0 Channel: 00 Id: 04 Lun: 00
  Vendor: PHILIPS  Model: CDD2600       Rev: 1.07
```

```

Type:      CD-ROM                      ANSI SCSI revision: 02
Host: scsi0 Channel: 00 Id: 05 Lun: 00
Vendor: IOMEGA Model: ZIP 100          Rev: E.03
Type:      Direct-Access                ANSI SCSI revision: 02
Host: scsi0 Channel: 00 Id: 06 Lun: 00
Vendor: HP Model: HP35480A            Rev: 1009
Type:      Sequential-Access            ANSI SCSI revision: 02

```

Take a moment to look at the information contained in the file. Notice how each device on the SCSI bus has its own unique SCSI ID number. Hard disks are generally given lower SCSI ID's than CD-ROM's and tape drives and ID 0 is reserved for the bootable hard disk.

When accessing SCSI devices in Linux it is done using nodes in the `/dev` directory just like any other piece of hardware. Referring to the example above the IBM hard disk would be accessed as `/dev/sda` while the Iomega Zip disk is `/dev/sdb`. The Philips CD-ROM is `/dev/sr0` and the HP tape drive is `/dev/st0`.

3.5. USB Devices

Support for USB first appeared in Linux kernel version 2.2 and became much more robust in kernel version 2.4. USB is very similar to SCSI in many respects. The system has a USB host controller which functions much like a SCSI host adapter and USB storage devices appear as SCSI disks in the `/dev` directory.

In order for USB devices to be recognized there must be USB support in the kernel either compiled in or loaded as a module. In the case of a modular kernel the files required for basic USB support are as follows.

- `usbcore.o`
- `usb-uhci.o` or `usb-ohci.o` depending on the motherboard manufacturer.

The kernel will also need to have modules loaded for the particular USB device being used. For example `acm.o` for USB modems and `usb-storage.o` for storage devices like USB hard drives and USB CD-ROMs.

Many times it is also necessary to include hotplug support in the kernel because most USB devices are designed to be added and removed from the system without requiring a reboot. There is also a userspace program `/sbin/hotplug` [<http://www.die.net/doc/linux/man/man8/hotplug.8.html>] that helps the kernel deal with dynamically adding and removing USB devices. `/sbin/hotplug` does this by looking for a shell script (also called an agent) in the `/etc/hotplug` directory with the same name as the USB device being added or removed. The agent is responsible for handling the particulars of adding and removing the device.

3.6. Modems and Sound Cards

Modems and sound cards are given special attention on the LPI exam since they can be slightly more complicated than other types of hardware.

Modems have extra requirements to work properly with Linux and these are listed below.

- The modem must NOT be a winmodem. [<http://en.wikipedia.org/wiki/Winmodem>]
- The modem must have the serial port set to the correct speed with `setserial` [<http://unixhelp.ed.ac.uk/CGI/man-cgi?setserial+8>].

In addition to setting up modem hardware the LPI exam also covers setting up a Point-to-Point Protocol (PPP) [http://en.wikipedia.org/wiki/Point-to-Point_Protocol] connection to an Internet provider. DSL and Cable modem users may want to refresh their memories by skimming the `pppd` [<http://annys.eines.info/cgi-bin/man/man2html?8+pppd>] and `chat` [<http://annys.eines.info/cgi-bin/man/man2html?8+chat>] man pages or the PPP-HOWTO

[<http://www.tldp.org/HOWTO/PPP-HOWTO/index.html>].

Sound cards are typically difficult to configure because they use many different resources (i/o ports, interrupts & DMA channels) making it more likely that some sort of resource conflict will occur. To aid the installation of sound cards there is a utility called **sndconfig** [<http://olympus.het.brown.edu/cgi-bin/man2html?sndconfig+8>] that is included with some distributions. **sndconfig** works with plug-and-play utilities like `pnpdump` to automatically probe the system for a PnP sound card and determine the correct parameters. There is also a `--noautoconfig` option to allow users to manually enter settings for the card.

3.7. Practice Questions

You can gauge your familiarity with the subject of Hardware & Architecture by answering the practice questions below.

1. You are working with your hardware vendor's technical support people to troubleshoot a network card problem. The technical support representative wants to know which IRQ channel the card is using. Which file would tell you the IRQ channel for the card?
 - A. `/proc/interrupts`
 - B. `/proc/ioports`
 - C. `/proc/irqs`
 - D. `/proc/sysconfig`
2. You are providing telephone support to a novice user at a remote location, because the dial-in modem is not working. When you ask the user to tell you what port the modem is connected to he says, "COM1." What is the Linux device that corresponds to COM1? (provide the full path)
3. Management has finally approved the budget for you to buy your first high-capacity SCSI tape drive and SCSI host adapter. You install the host adapter in PCI slot 4 and set the tape drive's SCSI ID to 5. What Linux device would you use to access the new tape drive?
 - A. `/dev/st0`
 - B. `/dev/st1`
 - C. `/dev/st4`
 - D. `/dev/st5`
4. In which file would you look to find the base address of your system's sound card?
 - A. `/proc/sysconfig`
 - B. `/proc/ioports`
 - C. `/proc/interrupts`
 - D. `/proc/base`
5. What is the name of the file that contains information about direct memory access channels and the devices as-

sociated with them? (give the full path)

6. You have just purchased a 56kbps external modem and attached it to the PC serial port labeled COM2. Communication with the modem is not working and `/proc/ioprots` shows no serial devices. What might be the cause?
 - A. The serial port is disabled in the BIOS
 - B. The modem is turned off
 - C. COM2 is reserved for serial mice
 - D. The `setserial` command was not run properly at start-up

7. What BIOS feature can be turned on to enable the BIOS to access hard disks larger than 8 gigabytes?
 - A. CHS
 - B. LBA
 - C. PIO
 - D. DMA

8. Which of the following utilities can be used to create the configuration file `isapnp.conf`?
 - A. `lspci`
 - B. `isapnp`
 - C. `lsmode`
 - D. `pnpdump`

9. In which kernel version were USB devices were first supported?

10. Which of the following kernel modules is required for USB? (choose 2)
 - A. `hotplug.o`
 - B. `usbcore.o`
 - C. `usb-uhci.o`
 - D. `usbmgr.o`

11. What is the name of the daemon that Linux systems use to establish a Point-to-Point connection? (specify the command name only with no options)

12. Which program can be used in conjunction with Point-to-Point connections to execute modem connection scripts non-interactively.

- A. minicom
- B. chat
- C. pscript
- D. uucico

3.8. Answers To Practice Questions

1. The correct answer is A, `/proc/interrupts` shows IRQ lines and the devices using them. Answer B is incorrect because `/proc/ioports` will give the base address for the NIC card, not the IRQ. Answers C and D both refer to nonexistent files.
2. The correct answer is `/dev/ttyS0`. Remember that Linux numbers devices starting from zero.
3. The correct answer is A, `/dev/st0`. Answer B is incorrect because `/dev/st1` refers to the *second* SCSI tape drive and the question states that this is the *first* SCSI tape drive. Answers C and D are trying to trick you into thinking that the the device number is determined by the PCI slot number or the SCSI ID, but this is not the case.
4. The correct answer is B, `/proc/ioports`. Answer C is incorrect because `/proc/interrupts` gives the IRQ channels used by the system. Answers A and D both refer to nonexistent files.
5. The correct answer is `/proc/dma`.
6. The correct answer is A, the modem is disabled in the BIOS. Answer B is incorrect because the modem is external and powering it off would not prevent the serial port device from appearing in `/proc/ioports`. Answer C is complete fiction as Linux does not reserve serial ports. Answer D is incorrect since `setserial` is used to set parameters such as handshaking and speed and not to enable or disable devices.
7. The correct answer is B, LBA. LBA stands for Logical Block Addressing and allows the BIOS to access larger disks than could be accessed with the older CHS, or Cylinder Head Sector addressing. Answer A is incorrect for reasons just described. Answer C and D are incorrect because PIO and Ultra DMA both describe methods of data transfer, not data addressing.
8. Answer D is correct, `pnpdump` can be used to create the `isapnp.conf` file. Answer A, `lspci` gives information about devices on the PCI bus, not the ISA bus. The `isapnp` command cannot be used to generate its own configuration file so answer B is incorrect. Answer C, `lsmod`, is incorrect since this utility is used for listing kernel modules.
9. The correct answer is kernel 2.2. USB was not supported in kernels prior to this.
10. The correct answers are B and C. USB requires the modules `usbcore.o` and `usb-uhci.o`. Other motherboards might require `usb-ohci.o` in place of `usb-uhci.o` so do not be surprised if this is on the exam. Answers A and D are incorrect, because `hotplug.o` and `usbmgr.o` do not exist as modules. However, you will see `/etc/hotplug` and `/etc/usbmgr` directories which are used with USB.
11. The correct answer is `pppd`.
12. The correct answer is B, `chat` is used to run non-interactive login scripts for ppp connections. Answer A is incorrect, `minicom` is an *interactive* program. Answer C is a fictitious program. Answer D is incorrect, `uucico` is used for `uucp` not `ppp`.

3.9. Additional Resources

Listed below are some documents that may be helpful when preparing for the Hardware & Architecture portion of the LPI 101 exam.

- The Linux kernel documentation contains a useful file called `devices.txt`. This file contains information about virtually every device one could expect to find in the `/dev` directory. Kernel documentation is generally found in the `/usr/src/linux/Documentation` directory.
- The [Large-Disk-HOWTO](http://www.ibiblio.org/pub/Linux/docs/HOWTO/other-formats/html_single/Large-Disk-HOWTO.html) [http://www.ibiblio.org/pub/Linux/docs/HOWTO/other-formats/html_single/Large-Disk-HOWTO.html] does a good job of describing LBA, CHS and 1024 cylinder limitations.
- The [SCSI-2.4-HOWTO](http://www.ibiblio.org/pub/Linux/docs/HOWTO/other-formats/html_single/SCSI-2.4-HOWTO.html) [http://www.ibiblio.org/pub/Linux/docs/HOWTO/other-formats/html_single/SCSI-2.4-HOWTO.html] goes into great detail about the Linux SCSI implementation.
- The Linux USB web site maintains an FAQ [http://www.linux-usb.org/FAQ.html] that covers using USB devices with Linux.
- Modems and sound cards are covered in the older, but still relevant [PPP-HOWTO](http://www.ibiblio.org/pub/Linux/docs/HOWTO/other-formats/html_single/PPP-HOWTO.html) [http://www.ibiblio.org/pub/Linux/docs/HOWTO/other-formats/html_single/PPP-HOWTO.html] and [Sound-HOWTO](http://www.ibiblio.org/pub/Linux/docs/HOWTO/other-formats/html_single/Sound-HOWTO.html) [http://www.ibiblio.org/pub/Linux/docs/HOWTO/other-formats/html_single/Sound-HOWTO.html].

Chapter 4. Linux Installation & Package Management

It should be noted that there are currently two versions of LPI exam 101, one for RPM packages and one for Debian packages. You will only see questions for one or the other, not both.

4.1. Practice Questions

1. You are planning a new Linux installation with separate partitions for `/`, `/boot`, `/tmp` and `/usr`. Which of the following filesystems will be the largest?
 - A. `/`
 - B. `/boot`
 - C. `/tmp`
 - D. `/usr`
2. What is the configuration file for LILO? (give the full path)
3. What is the directory that contains configuration files for GRUB? (give the full path)
4. You have accidentally deleted the file `/usr/lib/libm.so`. It needs to be re-installed, but you cannot remember what package it comes from. Which of the following commands would help you find the package that contains `libm.so`?
 - A. `rpm -qf libm.so`
 - B. `rpm -e libm.so`
 - C. `rpm -ivh libm.so`
 - D. `rpm -qi libm.so`
5. Version 1.7 of your favorite web browser has just been released as an RPM package. You would like to install it while automatically un-installing any other versions. Which RPM command will allow you to install a new version of an RPM while automatically un-installing other versions?
 - A. `rpm --install`
 - B. `rpm --upgrade`
 - C. `rpm --verify`
 - D. `rpm --erase`
6. What function will be performed by the command `rpm -ivh foo.rpm`?

- A. Verification of the files in `foo.rpm`
 - B. Recalculation of the MD5 hash value for `foo.rpm`
 - C. Installation of the package `foo.rpm`
 - D. Verification of the signature for `foo.rpm`
7. You have just downloaded the latest binary version of your favorite streaming audio server in a tarball called `llama-i386.tar.gz`. Which command could you use to extract the contents of `llama-i386.tar.gz`? (choose 2)
- A. `tar -zxf llama-i386.tar.gz`
 - B. `tar -xf llama-i386.tar.gz | gunzip -c`
 - C. `gunzip -c llama-i386.tar.gz | tar xf -`
 - D. `gunzip -c | tar xf - llama-i386.tar.gz`
8. You have just installed the new `wizbang-2.0` library and added its library path to `/etc/ld.so.conf`. What command should be run after adding the new library path to `ld.so.conf`?

4.2. Answers To Practice Questions

1. Of the partitions listed `/usr` will need to be the largest, so D is the correct answer. Answers A, B and C are incorrect, because the space requirements for `/boot` and `/tmp` are small when compared to `/usr`.
2. LILO's configuration file is `/etc/lilo.conf`.
3. GRUB keeps configuration files in the `/boot/grub` directory.
4. The correct answer is A, **`rpm -qf`** will query a file to find out which package it came from. Answer B is incorrect because **`rpm -e`** is used to erase packages and cannot be used to find individual files. Answer C is incorrect since **`rpm -ivh`** is used to install packages, it has nothing to do with finding individual files. Answer D is incorrect because **`rpm -qi`** is used to query packages for information, not individual files.
5. The correct answer is B, **`rpm --upgrade`** will install the new version of an RPM and then un-install any other version. Answer A is incorrect, because while **`rpm --install`** will *install* a package it will not *un-install* other versions. Answer C is incorrect, because **`rpm --verify`** does not install or remove packages. Answer D is incorrect, **`rpm --erase`** removes packages.
6. The correct answer is C, **`rpm -ivh foo.rpm`** will install the package `foo.rpm`. More specifically it will install verbosely with hash marks to indicate the installation progress. Answer B is incorrect, do not confuse hash *marks* with hash *values*. Answer D is incorrect as signatures verification is performed with **`rpm --checksig`**.
7. The correct answers are A and C. Both **`tar -zxf llama-i386.tar.gz`** and **`gunzip -c llama-i386.tar.gz | tar xf -`** will extract the contents of the `llama-i386.tar.gz` tarball. Answer B is incorrect, because it reverses the order of things by attempting to un-tar before decompressing. Answer D is incorrect, because the filename argument is in the wrong place and therefore **`gunzip`** will not pipe anything meaningful to **`tar`**.
8. The **`ldconfig`** command should be run after adding new library paths to `/etc/ld.so.conf`.

4.3. References

4.3.1. Disk Layout

See the Partition HOWTO [<http://www.tldp.org/HOWTO/Partition/index.html>] from The Linux Documentation Project [<http://www.tldp.org/>]. Browse the man pages for **fdisk**(8) and **mount**(8). View the contents of `/etc/fstab` on a Linux system and see the man page for `fstab`(5). Skim the installation manual for your favorite Linux distribution paying special attention to any sections that cover disk partitioning.

4.3.2. RPM Package Management

See the man page for **rpm**(8). Make a habit of performing package management from the command-line rather than using GUI tools so you can get hands on experience.

Chapter 5. GNU & Unix Commands

5.1. Practice Questions

- Given the command `ls | tee dir`, where will the directory listing be sent?
 - To standard output and to standard error
 - To standard output and to a file called tee
 - To standard output and to a file called dir
 - To a file called tee and to a file called dir
- A prospective employer is asking you to send a text file describing your qualifications in two-hundred words or less. What command will allow you to count the number of words in your text file?
- Which command will add the directory `/opt/bin` to the end of your BASH shell's search path?
 - `PATH=$PATH:/opt/bin`
 - `PATH=`cat $PATH /opt/bin``
 - `PATH=/opt/bin`
 - `PATH="PATH:/opt/bin"`
- The command `unset FOO` does what?
 - Makes `$FOO` equal to zero
 - Makes `$FOO` equal to a null string
 - Removes any attributes assigned to `FOO` by `typeset`
 - Removes the shell variable `FOO`
- Which of the following will send the standard error of `mkdir /tmp/foo` to `/dev/null`?
 - `mkdir /tmp/foo </dev/null`
 - `mkdir /tmp/foo >/dev/null`
 - `mkdir /tmp/foo 1>/dev/null`
 - `mkdir /tmp/foo 2>/dev/null`
- Which of the following will display the string "oops" when the command `mkdir /tmp/bar` fails?

- A. `mkdir /tmp/bar && echo "oops"`
 - B. `mkdir /tmp/bar || echo "oops"`
 - C. `mkdir /tmp/bar ; echo "oops"`
 - D. `mkdir /tmp/bar | echo "oops"`
7. What is the default signal for the **kill** command if no signal is specified as a command-line option?
- A. `SIGHUP`
 - B. `SIGINT`
 - C. `SIGKILL`
 - D. `SIGTERM`
8. What signal can be used with the **kill** command to end processes that do not respond to the default signal?
- A. `SIGHUP`
 - B. `SIGINT`
 - C. `SIGKILL`
 - D. `SIGTERM`
9. What command can be used to start a program with a lower scheduling priority?
10. Which of the following commands can be used to change the scheduling priority of a running process? (choose two)
- A. `kill`
 - B. `ps`
 - C. `renice`
 - D. `top`

5.2. Answers To Practice Questions

1. The command `ls | tee dir` will send a directory listing to standard output and to the file called `dir`, so the correct answer is C. Answer A is wrong because the `tee` command does not send anything to standard error. Answer B is incorrect, because pipes send output to commands, not files. Answer D is incorrect, the proper way to send `ls` output to multiple files would be `ls | tee file1 file2`.
2. The `wc` command allows you to count the number of words in a text file.

3. The correct answer is A. Answer B is incorrect because **cat** is used to concatenate files, not variables and strings. Answer C is incorrect, it will ignore the previous PATH and set PATH to /opt/bin only. Answer D is incorrect because there is no \$ in front of PATH to indicate it is a variable.
4. The correct answer is D, the command **unset FOO** removes the shell variable FOO. Answers A and B are incorrect since they refer to assigning values which is not what unset does. Answer C is incorrect since variable attributes are removed by using **typeset** with a plus instead of a minus in front of the attribute.
5. The correct answer is D, **command 2>/dev/null** redirects standard error to /dev/null. Remember the file descriptor for standard error is 2. Answer A is incorrect since it redirects standard input. Answers B and C both redirect standard output and are incorrect as well.
6. The correct answer is B, **command || echo "oops"** will display the string "oops" if command should fail. Answer A is incorrect since it will display "oops" when command is *successful*. Answer C is incorrect since it will display "oops" regardless of the success or failure of command. Answer D is incorrect, since a single "|" character is a pipeline not a compound command operator.
7. The default signal for the **kill** command is SIGTERM.
8. SIGKILL or -9 can be used when processes do not respond to the default SIGTERM.
9. The **nice** command can be used to start programs with lower scheduling priority. It can also be used to start programs with a higher priority, but only the superuser can do this.
10. The **renice** and **top** commands, answers C and D, can be used to change the priority of a running process. Answer A is incorrect, because **kill** is used to send signals to a process not change its scheduling priority. Answer B is incorrect, because **ps** only shows processes and cannot manipulate them.

5.3. References

The commands you can expect to see on the exam are listed on LPI's web site [<http://www.lpi.org/>] under Exam 101: Detailed Objectives [http://www.lpi.org/en/obj_101.html]. Be sure that you understand all of these commands.

5.3.1. Commands

Be sure that you are familiar with all of the commands listed for Topic 103 of the 101 exam objectives [http://www.lpi.org/en/obj_101.html]. Use the Linux manual pages [<http://techpubs.sgi.com/tpl.cgi/linux/man/>] and The GNU Linux Tools Summary [<http://www.karakas-online.de/gnu-linux-tools-summary/>] to help you learn about various commands you are unfamiliar with. Practice using the commands to perform various tasks on your system. If you are studying in a group make up sample tasks as challenges to the other group members.

5.3.2. Pipelines, Redirection and Compound Commands

See the BASH man page and info page for more information about how to redirect input, output and standard error as well as compound commands. Log into a Linux system and try entering commands like the answers shown above. Enter both correct and incorrect answers and view the results.

5.3.3. Processes and Priorities

See the man pages for ps(1), kill(1), nice(1), renice(1), signal(7) and top(1). Be sure you understand the difference between **nice** and **renice** and when it is appropriate to use one instead of the other. Pay attention to the priority adjustment numbers that can be used with **nice** and **renice** particularly what range of numbers is higher and which users are allowed to set higher priorities.

5.3.4. Foo and Bar

For more information on *foo* and *bar* refer to the wikipedia entry for foobar [<http://en.wikipedia.org/wiki/Foobar>]. To the author's knowledge the LPI exams do not feature any questions that use the terms *foo* or *bar*. However, many Linux references use these terms in examples and you may encounter them when studying.

Chapter 6. Devices, Linux Filesystems, Filesystem Hierarchy Standard

6.1. Practice Questions

1. Which of the following commands can be used to create an ext2 (second extended) filesystem? (choose 2)
 - A. `ext2fs`
 - B. `mke2fs`
 - C. `mkfs.e2fs`
 - D. `mkfs.ext2`
2. The command `e2fsck` can be used to check which of the following types of filesystems? (choose 2)
 - A. `ext2`
 - B. `ext3`
 - C. `jfs`
 - D. `vfat`

6.2. Answers To Practice Questions

1. The correct answers are B and D, ext2 filesystems can be created with either `mke2fs` or `mkfs.ext2` commands. These are not actually two different programs, but rather `mkfs.ext2` is a link to `mke2fs`. Answers A and C are both incorrect as they refer to plausible looking but non-existent programs.
2. The correct answers are A and B, `e2fsck` can be used to check both ext2 (second extended) and ext3 (third extended) filesystems. Answers C and D are incorrect as jfs filesystems are checked with `jfs_fsck` and vfat filesystems are checked with `dosfsck`.

6.3. References

See the Description sections of the `e2fsck(8)` and `mke2fs(8)` man pages for more information about the similarities between ext2 and ext3 filesystems and the utilities used with them.

Chapter 7. The X Window System

7.1. Practice Questions

7.2. Answers To Practice Questions

7.3. References

Part III. Exam 102

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Chapter 8. Kernel

8.1. Practice Questions

1. The system is experiencing network connectivity problems and you have been called in to troubleshoot the situation. You suspect that the kernel module for the ethernet card did not load properly during start-up. What command would you use to find out if the module is currently loaded?
2. You have just downloaded the source code for kernel 2.4.26 and unpacked it into `/usr/src`. After changing directory to `/usr/src/linux-2.4.26`, what is the next command you might run.
 - A. `make install`
 - B. `./configure --prefix=/boot`
 - C. `make menuconfig`
 - D. `lilo`

8.2. Answers To Practice Questions

1. **lsmod** would be the correct command to show modules that are currently loaded.
2. Answer C, **make menuconfig**, is the correct answer. Answer A is incorrect since the kernel's Makefile does not have an `install` target. Answer B is incorrect since the kernel does not use the `autoconfig` system. Answer D installs the LILO boot loader, it does not do anything to the kernel.

8.3. References

Chapter 9. Boot, Initialization, Shutdown and Runlevels

9.1. Practice Questions

1. Your `/etc/inittab` file has a line that reads `"id:1:initdefault:"` What mode will the system enter when it is booted?
 - A. Single user mode
 - B. Non-network multi-user mode
 - C. Network multi-user mode
 - D. Multi-user GUI mode
2. According to the Linux Standard Base (LSB) specification, runlevel 3 is reserved for which of the following system states?
 - A. Single user mode
 - B. Non-network multi-user mode
 - C. Network multi-user mode
 - D. Multi-user GUI mode
3. You have edited your `/etc/inittab` and changed the line `"id:5:initdefault:"` to read `"su:5:initdefault"`. What will be the runlevel on the next reboot?
 - A. 0
 - B. 1
 - C. 5
 - D. None, the `init` daemon will prompt for the runlevel before finishing boot-up.
4. What command can be used to replay messages that were displayed while the Linux kernel was kernel booting?

9.2. Answers to Practice Questions

1. Answer A is correct since runlevel 1 is single-user mode. Answer B, C and D are incorrect. According to the Linux Standard Base specification, non-networked multi-user mode is runlevel 2, networked multi-user mode is runlevel 3 and multi-user GUI mode is runlevel 5.
2. The correct answer is C, runlevel 3 is network multi-user mode on an LSB compliant system. Single user mode

is runlevel 1, non-network multi-user mode is runlevel 2 and multi-user GUI mode is runlevel 5.

3. Runlevel 5, answer C, is correct. Answer A, runlevel 0, is for system halt. Although answer B may be tempting it is incorrect. The label of "su" makes no difference in the runlevel, everything is determined by the number "5". Answer D is incorrect since the system will only prompt for a runlevel if `initdefault` is missing.
4. The `dmesg` command will allow you to print the kernel ring-buffer which contains the kernel's boot messages.

9.3. References

For an in-depth reference see the From PowerUp To BASH Prompt HOWTO [<http://www.tldp.org/HOWTO/From-PowerUp-To-Bash-Prompt-HOWTO.html>] from The Linux Documentation Project [<http://www.tldp.org/>]. Also skim the run levels section of the linux standard base [<http://www.linuxbase.org/spec/>] specification document.

Chapter 10. Printing

10.1. Practice Questions

1. Which of the following commands can be used to show the status of a print queue? (choose two)
 - A. `lpr`
 - B. `lpq`
 - C. `lpc`
 - D. `lpd`
2. Which command can be used to remove a print job from a queue?
3. It is time to close down the computer lab and you would like to stop anyone from printing any last minute reports. Which command allows you to disable all printers?

10.2. Answers To Practice Questions

1. The correct answers are B and C. Both **lpq** and **lpc** can be used to show the status of print queues. Answer A is incorrect, because **lpr** is only used to submit jobs. Answer D is incorrect, **lpd** is the line printer daemon that runs in the background.
2. The correct answer is **lprm**.
3. The correct answer is **lpc**.

10.3. References

For information of printing see the man pages for **lpc**, **lpd**, **lpq**, **lpr** and **lprm**. For a more in-depth discussion of Linux printing see Patrick Powell's LPRng reference manual available from the LPRng home page [<http://www.lprng.org/>].

Chapter 11. Documentation

11.1. Practice Questions

1. The command **man -k passwd** gives the same results as which one of the following commands:
 - A. `whatis passwd`
 - B. `apropos passwd`
 - C. `passwd --help`
 - D. `info passwd`

11.2. Answers To Practice Questions

1. The correct answer is B, **man -k** and **apropos** are equivalent. Answer A is incorrect, **whatis** is the same as **man -f**. Answer C is incorrect, **passwd --help** gives a brief listing of command-line options and is unrelated to man pages. Answer D is incorrect, info pages are part of a different documentation tool.

11.3. References

See the manual page for the **man** command.

Chapter 12. Shells, Scripting, Programming and Compiling

12.1. Practice Questions

12.2. Answers To Practice Questions

12.3. References

Chapter 13. Administrative Tasks

13.1. Practice Questions

13.2. Answers To Practice Questions

13.3. References

Chapter 14. Networking Fundamentals

David Horton

14.1. A Brief Look At The Objectives

To be successful with the network fundamentals section of the LPI exam candidates should possess a good working knowledge of Internet Protocol (IP) [http://en.wikipedia.org/wiki/Internet_Protocol] (version 4) networking. This includes understanding the concepts of address classes [http://en.wikipedia.org/wiki/Classful_network], subnets [<http://en.wikipedia.org/wiki/Subnetwork>] and private IP address [http://en.wikipedia.org/wiki/Private_IP_address] ranges. It is also necessary to know port numbers [http://en.wikipedia.org/wiki/List_of_well-known_ports_%28computing%29] for popular network services and common protocols [http://en.wikipedia.org/wiki/Internet_protocol_suite] like Transmission Control Protocol (TCP) [http://en.wikipedia.org/wiki/Transmission_Control_Protocol], User Datagram Protocol (UDP) [http://en.wikipedia.org/wiki/User_Datagram_Protocol] and Internet Control Message Protocol (ICMP) [http://en.wikipedia.org/wiki/Internet_Control_Message_Protocol]. This section of the exam will also cover commands and configuration files associated with networking as well as utilities for troubleshooting connectivity.

14.2. IP Basics

14.3. IP Ports and Protocols

Making connections to internet services requires knowing more than just an IP address. There is also a proper port number and protocol that must be used. Most end-users are blissfully unaware of this fact because the operating system takes care of the mundane details.

For Linux systems the `/etc/services` file is responsible for translating a service name, like FTP or telnet, into port numbers, like 21 or 23. An excerpt of `/etc/services` is show below.

```
bash$ sed -n 43,51p /etc/services
ftp      21/tcp
ftp      21/udp      fsp fspd
ssh      22/tcp      # SSH Remote Login Protocol
ssh      22/udp      # SSH Remote Login Protocol
telnet   23/tcp
telnet   23/udp
# 24 - private mail system
smtp     25/tcp      mail
smtp     25/udp      mail
```

Some of the well-known port numbers that may appear on the exam are listed below. Take time to memorize this entire list.

- 20 - File Transfer Protocol (FTP) data
- 21 - File Transfer Protocol (FTP) control
- 23 - Telnet
- 25 - Simple Mail Transfer Protocol (SMTP)
- 53 - Domain Name Service (DNS)

- 80 - HyperText Transfer Protocol (HTTP)
- 110 - Post Office Protocol version 3 (POP3)
- 119 - Network News Transport Protocol (NNTP)
- 139 - NetBIOS Session Service
- 143 - Internet Message Access Protocol (IMAP)
- 161 - Simple Network Management Protocol (SNMP)

In addition to the ip address and port number that are needed to make a connection to an internet service it is also necessary to use the correct protocol. This is another detail that is transparent to the end user, because it is handled by the operating system. Information about the protocols used with IP are kept in the `/etc/protocols` file. An excerpt is shown below.

```
bash$ sed -n -e 12,19p -e 30p /etc/protocols
ip      0      IP          # internet protocol, pseudo protocol number
#hopopt 0      HOPOPT     # hop-by-hop options for ipv6
icmp    1      ICMP       # internet control message protocol
igmp    2      IGMP       # internet group management protocol
ggp     3      GGP        # gateway-gateway protocol
ipencap 4      IP-ENCAP   # IP encapsulated in IP (officially ``IP'')
st      5      ST         # ST datagram mode
tcp     6      TCP        # transmission control protocol
udp     17     UDP        # user datagram protocol
```

Common protocols include TCP, UDP and ICMP. There are actually a great number of protocols, but these three are the most prevalent. TCP is used to handle the underlying data streams for web, email, news and almost every other popular network application. That does not mean that UDP and ICMP are not important however. While TCP is good at providing reliable, error-free data UDP is used for applications where speed or simplicity is more important than reliability. Applications like DNS lookups and SNMP use the UDP protocol. ICMP is used for utilities such as **ping** and **traceroute**. If you have ever seen the `destination host unreachable` message, this is ICMP in action.

14.4. Network Configuration

14.5. Network Troubleshooting

14.6. PPP Configuration

14.7. Practice Questions

1. Given an IP address of 192.168.12.17 and a subnet mask of 255.255.255.0, what is the network portion of the address?
2. Given the CIDR address format of 172.16.10.1/24, what is the network mask in dotted-quad notation?
 - A. 255.0.0.0

- B. 255.255.0.0
 - C. 255.255.255.0
 - D. 255.255.255.255
3. During a freak electrical storm both the primary and secondary DNS servers on your network were simultaneously struck by lightning and are no longer operational. In the absence of name servers which file can be used to do domain name to IP address lookups? (give the full path)
4. The loopback address, 127.0.0.1, is which class of IP address?
- A. Class A
 - B. Class B
 - C. Class C
 - D. Class D
5. Your company's Internet connection is down and you have been called in to investigate. You would like to know if the fault lies with one of the routers on your LAN or if there is a problem with a router on your ISP's network. Which command would you use to quickly determine the location of problem?
6. An entry such as the following is found in which file? (give the complete path)
- ```
smtp 25/tcp # simple mail transport protocol
```
7. Several of your company's employees have asked for the ability to check their work email from home via the Internet. You have configured an IMAP daemon to accommodate them. On which port does IMAP communicate?
- A. 23
  - B. 25
  - C. 110
  - D. 143
8. The DHCP server for your LAN has a failed power supply and it will take 24 hours for the new part to arrive. Which command can be used to manually configure IP addresses until the DHCP server can be repaired?
- A. netstat
  - B. ipconfig
  - C. ifconfig
  - D. inetcfg

9. In an effort to maintain a well-documented network environment you want to do periodic checks of network activity on your server. Which command will let you view active network connections? (specify the command without any command-line options.)

## 14.8. Answers To Practice Questions

1. The correct answer is 192.168.12.0.
2. Answer C is correct, /24 in CIDR notation means a 24-bit mask. Each octet in an IP address has 8 bits and the decimal equivalent of eight bits all set to 1 is 255. So answer A is equivalent to /8 in CIDR notation, answer B is the same as /16 and answer D is /32.
3. The correct answer is `/etc/hosts`.
4. The correct answer is Class A, any address with a first octet that is less than 128 is considered to be a Class A address.
5. The correct answer is **traceroute**. While you might be tempted to use **ping**, this would require you to ping each router individually and does not *quickly* determine where the problem is.
6. The correct answer is `/etc/services`.
7. The IMAP protocol uses port 143 so D is the correct answer. Ports 23, 25 and 110 are used for telnet, smtp and pop3, respectively.
8. Answer C, **ifconfig** is correct. **netstat** is used to view network connections, not configure interfaces. **ipconfig** and **inetcfg** are both commands used by other operating systems.
9. The correct answer is **netstat**.

## 14.9. Additional References

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# **Chapter 15. Networking Services**

## **15.1. Practice Questions**

## **15.2. Answers To Practice Questions**

## **15.3. References**

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# **Chapter 16. Security**

## **16.1. Practice Questions**

## **16.2. Answers To Practice Questions**

## **16.3. References**