Linux Academy

Linux Essentials Certification

Overview / The Linux Essentials Exam

Welcome:

- What is the LPI Linux Essentials Certification?
  - Vendor-Neutral program by the Linux Professional Institute
  - It is the first stop course before the professional certifications by LPI
  - It is an outstanding course for new users to Linux

In order to pass the Linux Essentials Certification:

- Working knowledge of computer hardware
- Understand the concepts of processes, programs, and the components of an operating system
- Understanding of open source applications within the workplace and how they relate to traditional closed source equivalents
- How to navigate within the Linux desktop and know where to go in case you need help
- Be able to work from the command line to manage files
- Use a basic command line editor

lpi.org specific weight values and objective topics:

- TOPIC 1: The Linux community and a career in open source (Weight: 7)
- TOPIC 2: Finding your way on a Linux system (Weight: 8)
- TOPIC 3: The power of the command line (Weight: 10)
- TOPIC 4: The Linux operating system (Weight: 8)
- TOPIC 5: Security and file permissions (Weight: 7)

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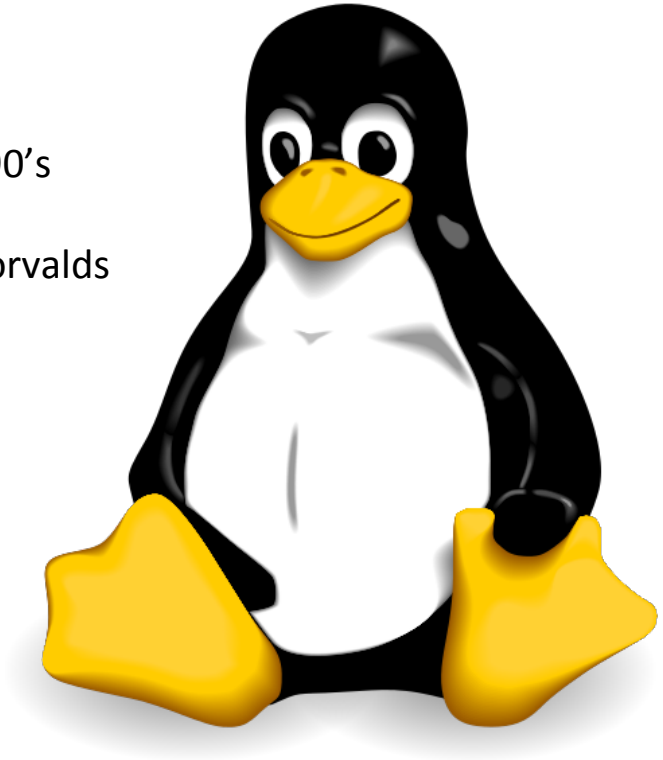
A Linux Introductory

- Created in the early 1990's
- Was created by Linus Torvalds
- Free of charge



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Open Source Philosophy

- So why would Linux just be given away?
- GNU – ‘Gnu’s Not Unix!’
- GNU/Linux
- FSF – Free Software Foundation
- GNU C Compiler - gcc

- Linus Torvalds was heavily influenced by the GNU project in which his first Linux kernel was released under the GPL
- GPL – General Public License
  - Requires that the source code remain freely available to anyone who might want it

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Distributions

- Linux has many different distributions
- Each distribution has a Linux kernel, utilities and configurations
- You can think about Linux distributions as you think about ice cream brands
- Another comparison would be different car manufacturers

- What what could make up a full blown Linux distribution?
  - Linux kernel
  - Core Unix tools
  - Supplemental Software
  - Startup scripts
  - Installers

- A few different Linux Distributions:
  - CENTOS
  - DEBIAN
  - FEDORA
  - GENTOO
  - OPENSUSE
  - REDHAT
  - SLACKWARE
  - SUSE
  - UBUNTU

- What distribution is right for our project?
  - Is the system going to be for desktop or server use?
  - If this is for production then a commercial distribution might be best for your needs.
  - Does your system hardware support the distribution of choice?

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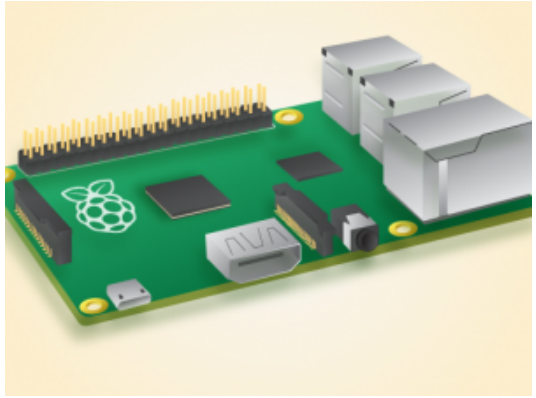
Embedded Systems

- Wikipedia.org says that “Operating systems based on the Linux kernel are used in embedded systems such as consumer electronics (such as set-top boxes, smart TVs, in-vehicle infotainment (IVI), networking equipment (such as wireless routers), machine control, industrial automation, navigation equipment, spacecraft flight software, and medical instruments in general).”

Android is a mobile operating system based on the Linux kernel that is being developed by Google.

Another example of an embedded Linux setup is from the Debian Linux distribution. It has created a Linux kernel that is embedded to the Raspberry Pi device.

Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables peoples of all ages to explore computers, and learn how to program in languages such as Python.



Linux can be found embedded in a lot of different cable provider's TV set-top boxes around the world.

Android is now showing up on these boxes such as the Google TV which in itself is another form or type of embedded Linux system.

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Using the Linux Academy Lab Servers

- You can use our Linux Essentials lab server that is available to you for this course
- This is configured especially for this course
- It is accessible via SSH
- You can even use the X Windows GUI on this server by utilizing via VNC

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Installing CentOS 7 with VirtualBox

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Desktop Applications

Linux as a desktop

- KDE
- LXDE
- UNITY
- XFCE

Linux desktop applications

- OpenOffice.org
- Calibre Office
- Audacity
- Thunderbird
- GIMP
- Pidgin
- Blender

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Server Applications

- Linux runs some of the most powerful server applications today
- Linux server applications actually run most of the websites that you might visit

Applications listen and bind on IP addresses via network ports

10.10.30.112:80
10.10.30.112:443

Think of ports as the extension to a telephone number

Common Network Ports:

PORT#	Protocol	Server Applications
22	SSH	OpenSSH
23	TELNET	telnetd
25	SMTP	PostFix, Sendmail
53	DNS	Bind, named
67	BOOTP	dnsmasq, dhcpd
80	HTTP	Apache
443	HTTPS	Apache

Server applications continued

- Apache
- MySQL
- MONO
- CUPS
- POSTFIX

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Mobile Applications

- Mobile applications like apps on Android phones and tablets
- Apps can either be free or have a small fee
- Apps are downloaded and installed via the Android marketplace
- Android based apps are different than desktop based apps as they are specific for the Android mobile platform

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Development Languages

- Open Source Software Development
  - Software Development Models
    - Cathedral Model
    - The Bazaar Model

- Some popular open source development languages
  - Java
  - C and C++
  - JavaScript
  - Python
  - Ruby
  - Perl
  - PHP

- Compiled languages
- Interpreted languages
- Assembly language programming

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Package Management Tools and Repositories

- What is package management?
  - Package management can differ from one distribution to the next
  - Installing Linux applications and programs is similar but very different than Windows
- Most applications and programs require what is known as library packages
- Linux package files are unlike Windows installers and are not programs
- Packages actually rely on other programs in order to install the software

- What is a package?
  - Dependency information
  - Version information
  - Architecture information
  - Binary packages are packages that have an executable built from source

- You can actually compile and install software from the source code yourself manually without using a packaging tool

- Package tool software keeps a database of information about the installed applications including the locations of the files that were placed on the Linux file system during that package installation.

- Two common package systems that are usually used today
  - RPM
  - Debian

- Linux distributions typically have their own package types. Therefore you can not install an RPM based package on a Debian distribution out of the box.

- Package managers at one point had to download source locally and then be installed

- Modern distributions now offer network based tools that use software repositories

- How does a usual software install work on Linux?
  - Issue the install command for the program
  - The software then locates any dependencies it might need and then notifies you if those additional software dependencies need to be installed
  - Approve the software to be installed and continue the process
  - The software then downloads the packages that might be needed
  - Finally the software then installs

Distributions and package format:

Distribution	Package Format
CentOS	RPM
Debian	Debian
Ubuntu	Debian
Arch	pacman
Fedora	RPM
Red Hat	RPM
Slackware	tarballs
Gentoo	ebuild
Suse Enterprise	RPM
openSUSE	RPM

- What about upgrading software?
  - Most of the modern distributions check periodically for any updates to packages installed
  - You may then be notified of the software needing to be updated
  - You then approve the updates and they are upgraded automatically

- Managing RPM based systems
  - Distributions that use RPM packages use the local files with the text-mode rpm command to install
  - In order to use online network repositories, other tools exist
    - Red Hat, CentOS, Fedora
      - Text mode YUM
      - GUI based front end versions like YUMEX
    - SUSE Enterprise, openSUSE
      - zyper for command line
      - YAST for GUI based installs
    - Mandriva – uses a text mode tool known as urpmi and then for GUI RPMDRAKE

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Hands on – Package Management

- Hands on

We are not going to take a look at the differences of the command line for Red Hat based distributions

- RPM based – YUM
- Debian based – APT

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Licensing

- Licensing
  - Software is a type of intellectual property
  - Open source beginnings
    - Free Software Foundation (FSF)
    - Open Source Initiative (OSI)
    - Creative Commons

- Copyrights and Software
  - A copyright is a legalized right to copy something
  - Most countries are signatories of what is known as the Berne Convention
    - The Berne Convention is an international treaty that requires countries to recognize the other countries copyrights

- Software Trademarks and Patents

- Patents: are the very idea of a copyrighted work
  - Example: if you invented something, you can get it patented

A patent is a set of exclusive rights granted by a sovereign state to the inventor or assignee for a limited period of time in exchange for detailed public disclosure of an invention

- Trademarks:

The essential function of a trademark is to exclusively identify the commercial source or origin of products or services, so a trademark, properly called, indicated source or serves as a badge of origin. In other words, trademarks serve to identify a particular business as the source of goods or services. The use of a trademark in this way is known as trademark use.

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- Commercial Software and Shareware Software
  - Commercial software is a software that is developed with the intent to sell that software as a profit.
  - Shareware software is similar to commercial software except at the copyright and legal perspectives.
  - Freeware is like shareware but the software is always free and has no cost involved.


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

- General Public License (GPL)
  - The license used by the Linux kernel
  - Free Software Foundation (FSF)
    - Founded by Richard Stallman 1985
    - Driving force behind the Gnu's Not Unix (GNU) project

"Free as in Speech, Not Free as in Beer"

- Free Software Foundation
  - Defined by four software freedoms:
    - Freedom to use the software for any purpose
    - Freedom to examine the source code and modify it as you see fit
    - Freedom to redistribute the software
    - Freedom to redistribute your modified software

- Free Software and the GPL (Legal Expressions)
  - This is known as the GNU GPL
  - There are two versions used today
    - GPLv2
    - GPLv3
  - Version 1 of the GPL is rarely used today
  - The Lesser GPL known as LGPL

- The Open Source Initiative
- The Open Source Initiative (OSI) was founded in 1998 by Bruce Perens and Eric Raymond
- The approach of the Free Software Foundation (FSF) seemed threatening to some businesses
    - Because of this, the Open Source Initiative (OSI) creators designed organizations as a way to advocate free software. They created this and used the term “open source” to soften what the Free Software Foundation (FSF) uses in a moral imperative.

- Open Source Development methods for software that harness the power of distributed peer review and the transparency of process. The promise of open source is better quality, higher reliability, more flexibility, lower cost, and an end to proprietary lock-in.

- Some of the licenses that fall under the OSI umbrella:
  - GPL
  - LGPL

- But also includes:
  - Apache
  - MIT
  - BSD
  - FreeBSD
  - BSD
  - MPL2 (mozilla)
  - NCSA
  - OpenLDAP
  - PublicDomain
  - PHP License

- New Code idea
  - GPL and FSF

  0r

  - MIT and OSI

- (FOSS) Free and Open Source Software
  - Computer software that can be classified as both free software and open-source software. That is, anyone with this license is free to use, copy, study, and modify the software in any way.
  - The source code is shared so that people are encouraged to voluntarily improve the design of the software.
  - This is in contrast to proprietary software, where the software is under restrictive copyright and source code is usually hidden from the users.

- (FLOSS) Free Libre Open Source Software
  - Was used in 2001 as a project acronym by Rishav Aiyer Ghosh for Free/ Libre/Open-Source software
  - “FLOSS” aimed to avoid taking sides in the debate over whether it was better to say “free software” or to say “open-source software”.

- Defining Open Source Software
  - The OSI has ten principles that were derived from those expressed by the Debian GNU/Linux developers

- Permission to derive works
- Respect for source code integrity
- No discrimination against persons or groups
- No discrimination against fields of endeavor
- Automatic license distribution
- Lack of product specificity
- Lack of restrictions on other software
- Technology neutrality

- Creative Commons

The creative commons was founded by Lawrence Lessig

A Creative Commons (CC) license is one of several public copyright licenses that enable the free distribution of an otherwise copyrighted work. A (CC) license is used when an author wants to give people the right to share, use, and build upon a work they have created. (CC) provides an author flexibility (for example, they might choose to allow only non-commercial uses of the open work) and protects the people who use or redistribute that work if they abide by the conditions specified in the author's word license.

- The (FSF) and the (OSI) are dedicated to promoting software freedoms. The creative commons goals, however, are broader as the licenses are aimed at things like audio recordings, textual works, and so on. Not just computer programs.

- The major open source licenses are:
  - BSD
  - MIT
  - Apache
  - Artistic
  - NPL
  - MPL

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Open Source Business Models

- Open source licensing in a business world?
  Many approaches to making a profit:
  - Dual licensing
  - Multiple products
  - Open source drivers
  - Bounties
  - Donations

- Open source licensing can be complex

- The FSF, OSI, and the Creative Commons all promote the freedom, awareness, and structure around open source.

- (FSF) Free Software Foundation
- (OSI) Open Source Initiative
- (CC) Creative Commons
- (FOSS) Free and Open Source Software
- (FLOSS) Free/Libre Open Source Software

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Desktop Skills

- Information and community technology skills (ICT)

- Where is Linux found and used?
  - Lots of places!

  - Server rooms and data centers around the world
  - Cloud computing
  - Embedded devices like Android, TiVo, and GPS
  - Airport signage, the mars rover, and so much more

- We can also use Linux on our desktop
- Many different desktop managers are available
- Office productivity suites
- Web browsers
- File saving
- Terminal

- KDE
  - The K Desktop Environment is one of the most popular desktop environments for Linux
  - It is the default desktop environment for Mandriva and SUSE distributions

- LXDE
  - The Lightweight X11 Desktop Environment is, as its full name suggest, intended to consume few resources and works well on older modest computer hardware

- XFCE
  - This desktop environment was originally modeled as a commercial desktop environment and provides more customization than that of GNOME or KDE.

- Launching programs
  - Most desktop environments provide several ways to launch programs.

- Desktop menus
  - Many desktop environments provide menus along a top, bottom, or the side edges of the screen

- Panels
  - Some desktop environments enable you to place icons in the same area of the desktop

- Context menus
  - You can sometimes right-click in an unused part of the screen to obtain a context menu with a variety of options

- Terminals
  - You can launch a program called a terminal, which provides a text-mode user interface inside a window

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Desktop Skills Hands On

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Getting to the Command Line

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Industry Uses of Linux, Cloud Computing and Virtualization

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Basic Shell

- Shell
  - A shell is just a command line interpreter that allows us to type commands at our keyboard and those commands are actually sent to the operating system kernel

- There are several different shells available
- Some of the more popular ones are:
  - sh - Bourne shell
  - bash - Bourne again shell
  - csh - C shell
  - tsch - tsch shell
  - zsh - Z shell
  - ksh - Korn shell

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Command Line Syntax

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Variables

- A **variable** is just a placeholder for another value.
  These can be used in scripts for example later on.

- Variables live in the areas of your systems RAM that is reserved to store whatever values you want to put in it. It is like a container in memory.

- An **Environment** is just a set of variables that are used in configuring system computing environments.

- There are **USER DEFINED** variables and **SYSTEM DEFINED** variables.

- Tilda key (~) ← it is the key to the left of your number 1 key and below the esc key

- Common Environment Variables

Env Variables	Default Values
BASH and SHELL	/bin/bash
CPU	spec to your system
DISPLAY	the local video card monitor
ENV	/etc/bash.bashrc
EUID	the UID number of current user
HISTFILE	1000
HOME	current users home directory
HOST and HOSTNAME	systems assigned hostname

- Common Environment Variables

Env Variables	Default Values
LOGNAME	username of current user
MAIL	/var/spool/mail/username OR /var/mail/username
MANPTH	distribution dependent
OLDPWD	prior current directory
OSTYPE	Linux
PATH	distribution dependent
PSI	distribution dependent
PWD	depends on current directory within
USER and USERNAME	username of the current user

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Globbing

- Globbing
  - ? A question mark is for a single character
    - Example:
      - T??XT.txt or ??ST.txt
  - * An asterisk matches any character or set of characters, including no character
    - Example:
      - *.txt

- Globbing

```
$ ls *.txt          # list all text files; the * symbol means zero or more characters
$ ls test*

$ ls ?.txt          # list text files with the 1 character name
$ ls ????.txt       # list text files with 4 character names

$ ls [A-Z]*.txt     # list text files that start with a capital letter
$ ls [a-z]*.txt     # list text files that start with a lower-case letter
```

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Quoting

- Quoting
  - Double quote
    - Substitutes the value of variables and commands
    - Example: echo “Username is $USER”

    The above will print what the current username
  - Single quote
    - This preserves the literal meaning of each character of a given string
    - This will turn off the (special) meanings of all characters
    - Example: echo ‘Username is $USER’

    The above example will print/echo the literal Username of $USER

- Quoting
  - Backslash
    - This takes away, or removes the (special) meaning from a single character and can be used as an escape character
    - If we did not have the \ character before $5.00 here it would try and interpret the following command as a variable

    $ echo “The cheeseburger is going to ost you $5.00”
    The cheeseburger is going to cost you .00

    But if we used the \ we can negate our special character
    $ echo “The cheeseburger is going to cost you \$5.00”
    The cheeseburger is going to cost you $5.00

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Formatting Commands

- Formatting commands

Operation for a Linux command can be thought of in three ways

- First the computer waits for user input
- Secondly the user selects a command and enters it via the keyboard or mouse
- Finally the computer then executes the command

[stephen@linuxacademy1~]# ls

[stephen@linuxacademy1~]# pwd

[stephen@linuxacdemy1~1]# cd

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Working With Options

- Linux command parameters can be divided in to two types
  - Parameters with a dash (“-”) are called options
  - Parameters with no leading dash are called arguments

- Formatting commands conceptually looks like this
  - command - “what to do?”
  - options - “How to do it?”
  - arguments - “What to do with it?”

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Man

- The Linux man pages
  - Linux manual for commands, configuration file and more
  - Linux man pages are not meant as a tutorial
  - Man pages are reference-like format

Man pages are broken down in to 9 sections

Section number	Description
1	Executable programs and shell commands
2	System calls provided by the kernel
3	Library calls provided by the program libraries
4	Device file (usually stored in /dev)
5	File formats
6	Games
7	Miscellaneous (macro packages, conventions, and so on)
8	System administration commands (programs run mostly or exclusively by root)
9	Kernel routines

- Man pages are organized like so:
  - Name
  - Synopsis
  - Description
  - Options
  - Files
  - See Also
  - Bugs
  - History
  - Author

Using less key commands to navigate MAN pages:

H or h	displays help
Page Down, spacebar, Ctrl+V, Ctrl+F	moves down one screen
Page Up, Esc+V, Ctrl+B	moves up one screen
Down Arrow, Enter, Ctrl+N, Ctrl+E, Ctrl+j	moves down one line
Up Arrow, y, Ctrl+y, +P, +K	moves up one line
/pattern	searches forward (pattern)
?pattern	searches backward on (pattern)
n or /	repeat the previous search
Q or Q or ZZ	quits

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Info

- Info pages are similar to man pages but the goal is to support functions in which man can not.
- Most notable, hyperlinks and info pages support them where man does not.
- You can use info to even read man pages if you so wish.

Navigating using the info utility:

?	Displays help info
N	Moves to the next nodes in a linked series or level
P	Moves back in a series or level
U	Moves up one level in the mode hierarchy
Arrow keys	Moves the curser around the screen to select links
Page Up, Page Down	These keys scroll up and down within a single node
Enter	Moves to a new node once you select it
L	Displays the last info page you read
T	Displays the top page for a topic
Q	Exits from the info page system

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Other ways to get help

- Other ways to get help
  - README files
    - README, readme.txt

- Other ways to get help
  - The README for unzipped sources are usually found in:
    - /usr/doc/packagename
    - /usr/share/doc/packagename
    - /usr/share/doc/packages/packagename

- Other ways to get help
  - if you are using an RPM-based Linux distribution, you can actually use the RPM tool to locate documentation
    - Example

    rpm -ql packagename | grep doc

- Utilities to read different file formats

File extensions	Programs to read them
.1 - .9	man, info, less
.gz or .bz2	gunzip, bunzip2 then less
.txt	less and ANY text editor vi,vim
.html .htm	Any Web Browser
.odt	LibreOffice, OpenOffice.org, any other word app
.pdf	xpdf, Adobe Reader
.tif, .png, .jpg	Gimp

- Other ways to get help
  - We can also get documentation online
  - Google for endless amounts of tutorials, Web Forums, user groups like here at the Linux Academy in our awesome community

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Windows, Mac, and Linux Differences

- Windows
  - Uses proprietary applications

- Windows
  - Uses proprietary applications
  - Active Directory

- Windows
  - Uses proprietary applications
  - Active Directory
  - Microsoft SQL

- Apple (OSX)
  - Has their own hardware and software

- Apple (OSX)
  - Has their own hardware and software
  - Tight integration within its own ecosystem

- Apple (OSX)
  - Has their own hardware and software
  - Tight integration within its own ecosystem
  - Security- extremely difficult to lock down and manage

- LINUX
  - Desktop is freeing and personal

- LINUX
  - Desktop is freeing and personal
  - Server room flexibility

- LINUX
  - Desktop is freeing and personal
  - Server room flexibility
  - Seen everywhere in the mobile world (Android)

- GUI and CLI?
  - All of these operating systems have GUI's and CLI's

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  - Windows can have both GUI and CLI. Can use PowerShell to manage it via CLI.

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Commands

Searching and Extracting Data from Files

- cat — displays the contents of a text file
- less — reads a file
- head/tail — reads 10 first lines of a file or last 10 lines of a file
- find — locates files on a system
- grep — searches a string on our file
- sort — organizes text in a file
- cut — manipulates data by columns
- wc — can be used to do a word count on a file etc

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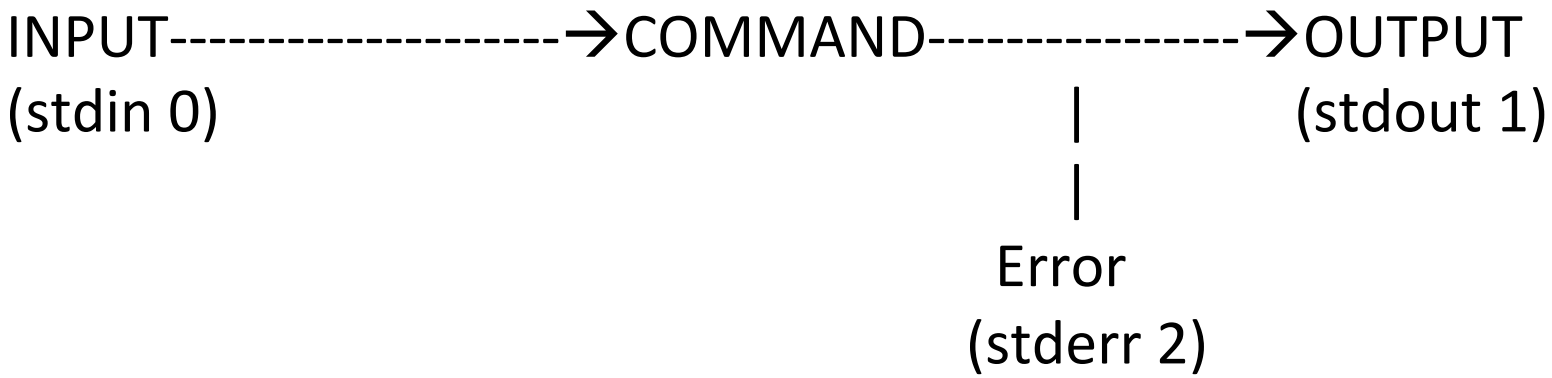
Command Line Pipes

Searching and Extracting Data from Files

- **stdin**
  - This means we have standard input
- **stdout**
  - This means we have standard output
- **stderr**
  - This file descriptor stands for standard error


INPUT
(stdin 0)
COMMAND
OUTPUT
(stdout 1)
Error
(stderr 2)

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I/O re-direction

Searching and Extracting Data from Files

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Regular Expressions (reg-ex)
Searching and Extracting Data from Files

Regular Expressions:

*	Matches any character of	file*
.	Any single character	
?	Matches zero or one of the proceeding characters	f?le
^	Matches expression if it appears at the beginning	^file
$	Matches expression if it appears at the end	file$
[nnn]	Matches any one character between the braces	[abc]
[^nnn]	Matches any expression that doesn't contain any one of the characters specified	
	[^abc] Will not match a, b, or c	
[n-n]	Matches any single character	
[1-10]	Any character between 1 and 1, or 0	
[ser]	Matching s, and then e, and then r	

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Turning Commands into a Script
Basic Shell Scripting

- Scripts need an interpreter
  - /bin/sh (rarely used these days original Bash Shell)
  - /bin/bash (Bourne Again Shell)

  This is where we will run almost all of our scripts in Linux

- Variables

$ANYNAME

- Arguments:

$1 → First Argument
$2 → Second Argument
$? → Exit Code/Status (variable that stores 0 or non 0 numbers depending on If the previous statement was successful or not)

#!	(shebang)
/bin/bash	The Bourne Again Shell
Variables	We can pass variables or create **Arguments** to pass to scripts
Arguments	Options we can pass to our scripts that can also be **Variables**
echo	prints/echo's what we tell echo to print to the screen
for	loops through and iterates through data for us
if	used for conditional coding based on exit status code for example
Exit	Exit or stop a script function

&& = AND

|| = OR

Syntax using &&:

Syntax using ||:

Syntax using both &&, II:

 # rm file1.txt && echo “File was deleted” || echo “File was NOT deleted”
File was deleted

if/then

```
if condition then
        command
else
        command
fi
```

Options for if/then/else

-d	Checks to see if the specified directory exist
-e	Checks to see if the specified file exist
-f	Checks to see if the specified file exist and it's a regular file
-G	Checks to see if the specified file exist and it's owned by a specific group
-h or -L	Checks to see if the specified file exist and if it is a symbolic link
-O	Checks to see if the specified file exist and if it is owned by a specific UID
-r	Checks to see if the specified file exist and if the read permission is granted
-w	Checks to see if the specified file exist and if the write permission is granted
-x	Checks to see if the specified file exist and of the execute permissions is granted

- **Looping Structures**

“while loop” “until loop” “for loop”

- While loops, execute over and over until a specified condition is no longer true.

Structure:

while *condition*
do
script command
done

- Until loops, run over and over as long as the condition is false and as soon as it the condition is true it will stop.

Structure:

```
until condition
do
        script command
done
```

- For loop, will loop a specified number of times.

- Three options for creating a number sequence with seq:
  - If specify a single value, the sequence starts at one, increments by one, and ends at the specified value.
  - If specify two values, the sequence starts at the first value, increments by one, and ends at the second value.
  - If specify three values, the sequence starts at the first value, increments by the second value, and ends at the third value.

  - Example:
    - seq 5 15

    This would create a sequence of numbers that starts at 5, increments by 1 and ends at 15.

- Using seq in a for loop:

```
for i in ‘seq 15’
        do
                echo “The current number in the sequence is $1.”
        done
exit 0
```

Linux Essentials Certification

Archiving Files on the Command Line

Archiving, Compression

Gzip	Bzip2	Zip
gzip	bzip2	zip
gunzip	bunzip	unzip

tar

tar -cf	**(creates file)**	**file.tar**
tar -xf	**(extracts file)**	**file.tar**

- We can also call on the compression algorithm when using the tar utility with option flags
  - tar with compression
    - tar -zcf (gzip) file.tar.gz or file.tgz
    - tar -jcf (bzip2) file.tar.bz2 or file.tb2

Linux Essentials Certification

Turning Commands into a Script
Basic Shell Scripting

Linux Essentials Certification

Archiving Files on the Command Line

Files, Directories

- Tar
  - A Linux utility that archives things. It does not compress or compact files. It just sticks all the files together in to one file.

  - Traditionally Tar was actually used to create tape archives. We used it to archive data onto old tape backups. Tar actually stand for “Tape Archive”.

Linux Essentials Certification

Distribution Life Cycle Management

- Design
- Develop
- Deploy
- Manage
- Retire

Distribution Life Cycle Management

RHEL	Fedora	SLES	OpenSUSE	Debian	Ubuntu (lts)
10 yrs	1 year	7 yrs	18 Months	3-4 yrs	5 yrs

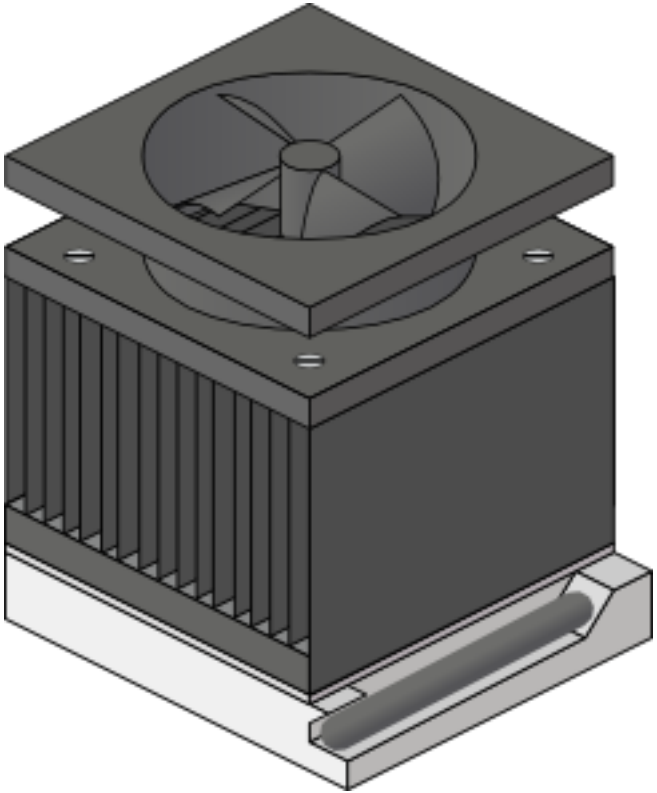
Distribution Release Cycle Management

RHEL	Fedora	SLES	OpenSUSE	Debian	Ubuntu
3-4 yrs	6 mth.	3-4 yrs	8 mth.	2 yrs	2 mth

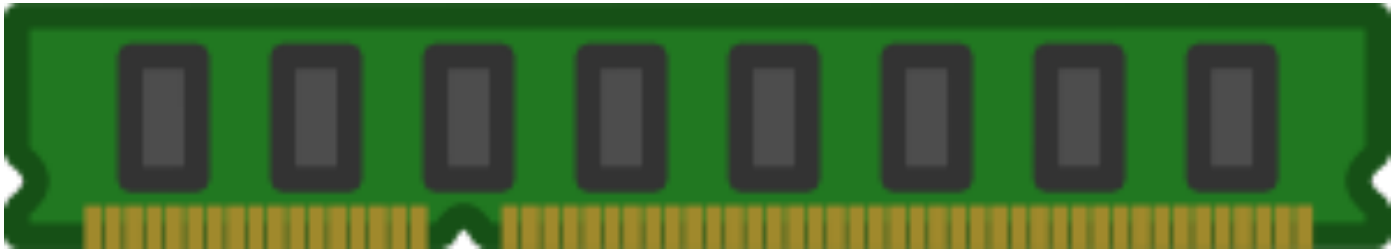
Linux Essentials Certification

Hardware

Processor “cpu”



RAM “random-access memory”



Graphics Card

Motherboard

Power Supply

Hard disks

Optical drives

Display

Linux Essentials Certification

Root and Standard Users

Linux Essentials Certification

System Users

Linux Essentials Certification

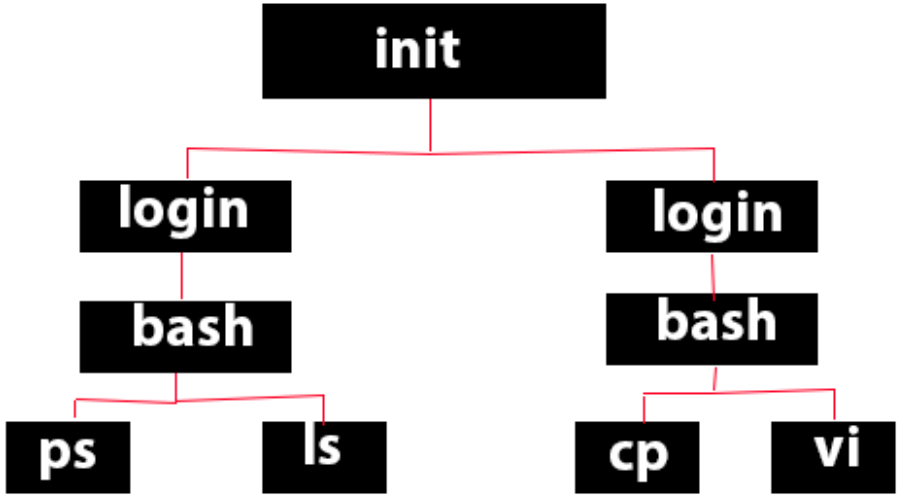
Kernel

- Kernel
  - The Linux kernel is a Unix-like operating system
  - Linux was developed and created by Linus Torvalds

- Kernel
  - The Linux kernel is the core of any Linux installation
  - The kernel is responsible for managing every other piece of software on a running Linux computer

- Kernel
  - To maintain order on a chaotic Linux system of processes, the kernel imposes order by using hierarchy
  - When the system boots, typically one process called the init process starts up the /sbin/init that in turn manages child processes

- A small subset of the many processes that could be running:



Linux Essentials Certification

Processes

- Every process has an associated process id (PID)
- Every parent process has a parent id (PPID)
- We can identify these PIDS and PPIDS with tools like ps

- Top can also provide load average (a measure of the demand on CPU) by applications.

- For Example:
  - A load average of 0 is a system that no programs are demanding CPU time.
  - A system average of 1 is a system with one program running a CPU intensive task.
  - A system that has higher load averages on a single CPU system reflect programs competing for available CPU time.
  - On a system that has multiple processors or CPU cores, load averages can reach the number of CPUs or cores before competing for CPU time even begins. A load average, for example, of 4.0 on a system with a quad core processor reflects processes demanding exactly as much CPU time as the computer has available.

- Top's common option keys:
  - k kills a process
  - q quits top
  - r change a process priority
  - s changes the display's update rate in seconds
  - p sorts the display on CPU usage (also default view)
  - m sorts the display on memory usage

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syslog, klog, dmesg

Linux Essentials Certification

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

- Data locations:
  - /lib — Linked library files used by binaries in /bin and /usr/bin
  - /usr/lib — Linked library files used by binaries in /bin and /usr/bin
  - /etc — Configuration files for our Linux operating system
  - /var/log — Log files for our Linux operating system

Linux Essentials Certification

Files, Directories

Linux Essentials Certification

The Linux File System

- The role of the Linux file system
  - Where data is stored on a storage device within a certain manner
    - Data is organized and easily located
    - Data can be saved in a persistent manner
    - Data integrity is preserved
    - Data can be retrieved for a user at a later point in time

- The Linux file system and the file system hierarchy standard (FHS)
  - The Linux file system uses a hierarchy structure to organize data
  - Linux systems have a standard in which the root directory always has several of the same sub-directories in a certain order of fashion

- **/etc** contains text-based configuration files used by the system as well as services running on the system. We can edit these files with a text editor and then customize how Linux behaves in different manners.

  - **/etc/aliases** Contains a table used to redirect all to local users
  - **/etc/exports** Configured file systems to be exported to remove NFS clients
  - **/etc/fstab** Lists the partitions and file systems that will be automatically mounted when we boot our Linux system
  - **/etc/ftpusers** Controls users access to FTP service running on a Linux system
  - **/etc/group** Contains local group definitions
  - **/etc/grub.conf** Contains configuration parameters for the init process
  - **/etc/hosts** Contains a list of hostname to IP address mappings that we can use to resolve certain hostnames
  - **/etc/inittab** Contains configuration parameters for the init process
  - **/etc/init.d** Subdirectory that contains startup scripts for services installed on the system. RedHat/Centos system- these are located at /etc/rc.d/init.d/

- **/etc/passwd** Linux systems user accounts file
- **/etc/shadow** Contains encrypted password for our user accounts
- **/etc/resolve.conf** Where we specify what DNS server and domain suffix our system is going to use
- **/etc/X11/** Has the X windows configuration files

- Linux file disk file systems
  - ext2

- Linux file disk file systems
  - ext2
  - ext3

- Linux file disk file systems
  - ext2
  - ext3
  - Reiser

- Linux file disk file systems
  - ext2
  - ext3
  - Reiser
  - ext4

Linux Essentials Certification

Hidden files and Directories

- Linux is a tree-structured file system of both directories and files
  - Single root: /
  - Current working directory

Linux Essentials Certification

Absolute and Relative Paths

Linux Essentials Certification

Home

Linux Essentials Certification

Files and Directories

Linux Essentials Certification

Case Sensitivity

Linux Essentials Certification

Simple Globbing and Quoting

- “ The double quote
  - The double quote (“quote”) protects everything enclosed between two double quote marks except $,’,” and \
  - Use the double quotes when you want only variables and command substitutions

- \ The backslash
  - The backslash (\) alters the special meaning of the ‘ and “
    - example: It will escape or cancel the special meaning of the next character

- \a alert (bell)
- \b backspace
- \e an escape character
- \f form feed
- \n new line
- \t horizontal tab
- \v vertical tab
- \\ backslash
- \’ single quote
- \nnn the eight-bit character whose value is the octal value nnn (one to three digits)
- \xHH the eight-bit character whose value is hexadecimal value HH (one to two digits)
- \cx a control-x character

- We use the -e option of the echo command to enable interpretation of backslash escapes
  - Now to the command line for examples!

Linux Essentials Certification

Simple Globbing and Quoting

Linux Essentials Certification

Root and Standard Users

Linux Essentials Certification

System Users

Linux Essentials Certification

System Users

Linux Essentials Certification

Users IDs

Linux Essentials Certification

Creating Users

Linux Essentials Certification

Creating Groups

Linux Essentials Certification

Symbolic Links

Linux Essentials Certification

File/Directory permissions and owners

Permissions, USER, Group, Other
drwxrwxr-x. 2 user user
-rwxrwxr-x. 2 user user

d	=	directory
-	=	file

r	=	read
w	=	write
x	=	execute

- rwx rwx rwx
  421 421 421
  7 7 7

-rwxr-xr-x

- On directories, X means that we can cd (change directories) in to it.
- On files, X means you can execute it

- Octal notations:

- rwx rwx rwx
  421 421 421
  7 7 7

R = 4
W = 2
X = 1
Total = 7

- Octal notation adding:

-rw-r--r--
420 4 4
6 4 4 = 644

- Octal notation adding:

  -rw-r--r--
  420 4 4
  6 4 4 = 644

- Setting permissions using the octal notation:

  chmod 555 filename
  or
  chmod ugo+w (this adds write permissions to the user, group, and other)

- Before you can change the permissions of a file, you first either need to already be the owner of a file or you need to be the root account
    - To change the ownership of a file we can use the chown command:
        - chown username.groupname filename
        - chown stephen.accounting filename.txt

- Removing permissions:
  - chmod o-r filename.txt (we removed the read permission from the others)
  - chmod g-w filename.txt (we removed the write permission from the groups)
  - chmod u-r filename.txt (we removed the read permission from the user)

- Adding permissions:
  - chmod o+r filename.txt (we added the read permission from the others)
  - chmod g+w filename.txt (we added the write permission from the groups)
  - chmod u+r filename.txt (we added the read permission from the user)

- Adding permissions with octals:

- This means we are giving user Read and Write and no Execute
- Read for Group and no Write and no Execute
- And for Other we are giving no Write and no Execute but we are giving Read

chmod 644 filename.txt

R = 4
W = 2
X = 1

Linux Essentials Certification

Special Files/Directory

Sticky Bit

- Special directories and files
  - Previous lessons we learned about directories like /etc, /lib, and /usr/lib

- Special directories and files
  - /var
    - Contains files that change often such as mail, logs, etc
  - /var/tmp
    - Contains files that do not get deleted on reboot
  - /tmp
    - Contains temporary files that do get deleted on reboot

- The problem with temporary folders that have permissions of 777
  - Example: rwx rwx rwx
  - The caveat:
  - Other users on the system could delete other user's files and vice versa!

- Sticky bit to the rescue
    - We can add a sticky bit to a folder which makes it so that only users that create their own files and folders can delete theirs and not other users- even if the folder has 777 (rwx rwx rwx)

Linux Essentials Certification

Internet, Network, Routers

- Domain Controller
- Database Server
- DHCP Server
- Web Server
- E-Mail Server
- File and Print Server
- Packet-filtering, stateful, or even application-level firewalls
- Proxy Server
- Content Filter Server
- Router

- Networking Basics
  - Networks use protocols to talk to one another (think of a protocol as a language)
  - Computer Systems need to speak the same language to send and receive data

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  - IP Protocol:
    - A networking protocol used on the internet
    - Works with other protocols such as TCP (Transmission Control Protocol)
    - Works with the UDP (User Datagram Protocol)

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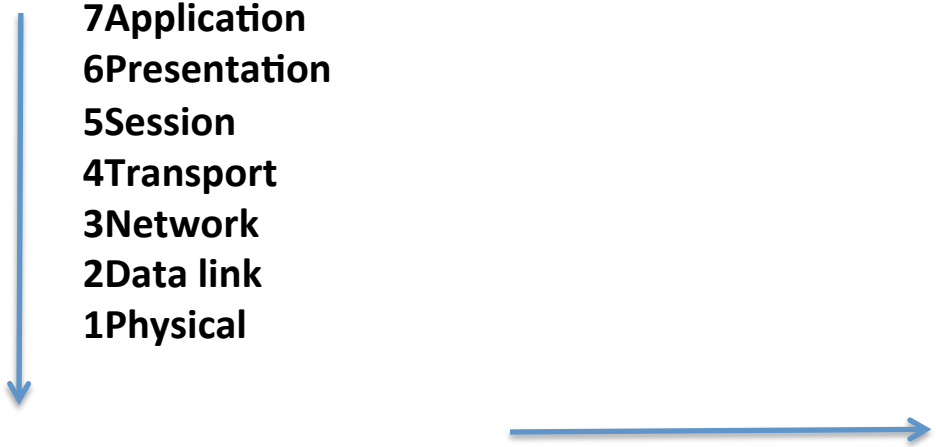
  - IP Protocol:
    - A networking protocol used on the internet
    - Works with other protocols such as TCP (Transmission Control Protocol)
    - Works with the UDP (User Datagram Protocol)
  - The OSI reference model breaks down the overall communication process into specific task.
    - The OSI model has 7 layers

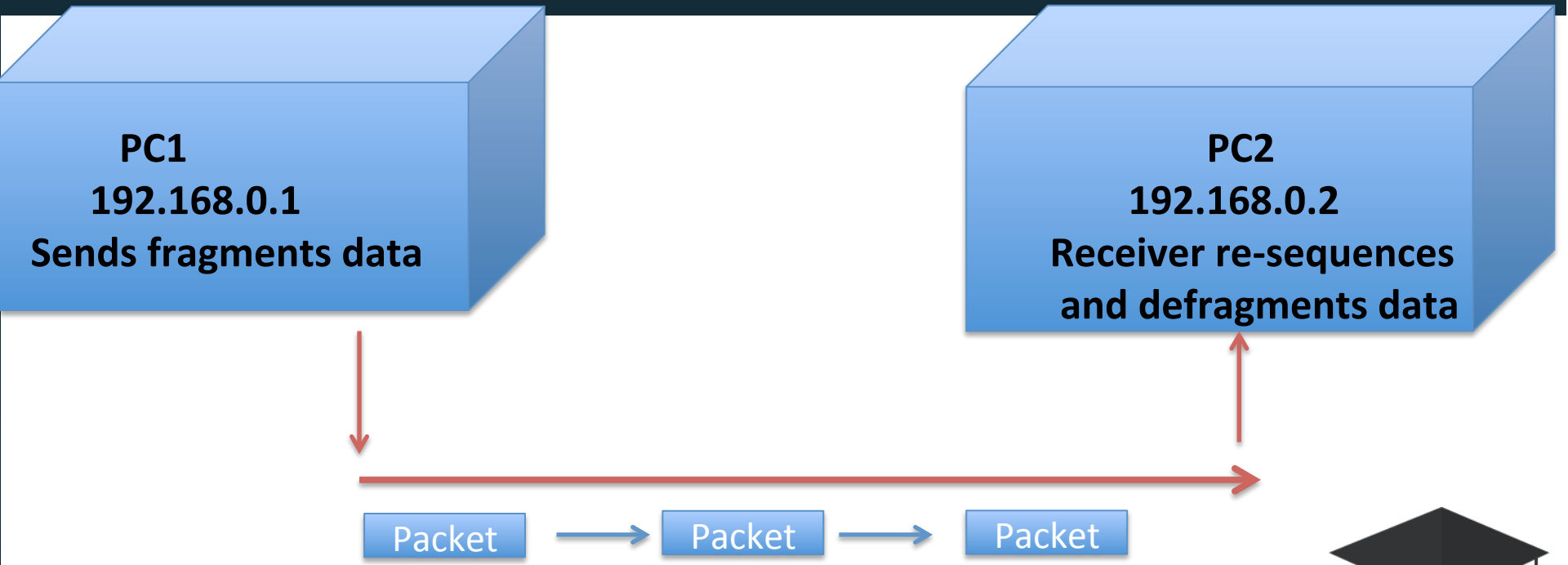
PC1

7Application
6Presentation
5Session
4Transport
3Network
2Data link
1Physical



PC2

7Application
6Presentation
5Session
4Transport
3Network
2Data link
1Physical



Fragments Transferred on network Media

- The entire picture of the IP protocol and the transmission control protocol:

TCP/IP

- TCP ensures data exchanged between two network hosts is exchanged reliably
  - Typical upper-layer applications that use TCP are:
    - Web Servers
    - E-Mail Servers
    - FTP Servers

- UDP - User Datagram Protocol
  - UDP is a connectionless protocol
  - UDP packets are sent unacknowledged
  - Applications that can tolerate less reliability can use UDP
  - Typical upper-layer applications that use UDP are:
    - Streaming audio
    - VoIP

- ICMP - Internet Control Message Protocol
  - ICMP is for testing and verifying network communication between hosts

- Ports
  - TCP and UDP both provide ports for upper layer protocols
  - Port numbers range from 0 up to 65536 for each individual IP address

- Well known PORTS
- range 0-1023

20 and 21	FTP
23	Telnet
25	SMTP
80	HTTP
110	POP3
137, 138, 139	NetBIOS
443	HTTPS

- Registered ports
- Range 1024-49151
    - Organizations can program their own network service and then apply for a registered port number to be assigned to it

- Dynamic PORTS
- Range 49152-65535
    - Dynamic ports are available for use by any network service

- Every host on an IP-based network must have a unique IP address assigned to it
- Different than the MAC address in which the MAC address never changes and is burned in (hard coded) to the network board
- IP addresses consist of four numbers, separated by periods
    - 10.10.0.1
    - 192.168.0.1
    - 172.16.5.1
- In this decimal notation, each number must be between 0 and 255
- Example:
    - Invalid IP address 256.257.1.1 (can't use greater than 255)
    - Invalid IP address 10.10.1 (must use four values)

- Each number in the address is an eight-bit binary number, called an octet.
- Each octet of a binary number can be represented by 0's and 1's
- Example: The IP address 192.168.1.1 in binary:
  - 11000000.10101000.00000007.00000001

192. 168 .1 .1 Decimal
11000000.10101000.00000001.00000001 Binary

11000000 = 128 + 64 = 192
10101000 = 128 + 32 + 8 = 168
00000001 = 1 = 1
00000001 = 1 = 1

Conversion Tool

Bits 1=	128
Bits 2=	64
Bits 3=	32
Bits 4=	16
Bits 5=	8
Bits 6=	4
Bits 7=	2
Bit 8 =	1

- To address the issue with IPV4 and the available IP addresses available a new IP version was created known as IPV6
  - IPV4 is a 32 bit IP scheme
  - IPV6 is a 128 bit IP scheme
- IPV6 are composed of four-character hexadecimal number separated by colons
  - Example:

    FE80:0000:0000:0000:0202:B3FF:FE1E:8329

- Private IP address ranges:
  - 10.0.0.0-10.255.255.255 (Class A)
  - 172.16.0.0-172.31.255.255 (Class B)
  - 192.168.0.0-192.168.255.255 (Class C)

- NAT - Network Address Translation

- We use a NAT router that creates a “private’ IP address space on our LAN with multiple devices and computers but the outside, “the router,” has only 1 “Public” IP address in which the internal network gets “translated” through.

Public Internet
|
Public Network
(NAT Router) Public IP 72.23.130.135 Private IP 192.168.0.1
|
LAN
| |
PC1 192.168.0.10 PC2 192.168.0.15

- Private IP address ranges:
  - 10.0.0.0-10.255.255.255 (Class A)
  - 172.16.0.0-172.31.255.255 (Class B)
  - 192.168.0.0-192.168.255.255 (Class C)

128 + 64 + 32 + 16 +8 + 4 + 2 + 1 = 255
No decimal value of the octet can exceed 255

Conversion Tool	
Bits 1=	128
Bits 2=	64
Bits 3=	32
Bits 4=	16
Bits 5=	8
Bits 6=	4
Bits 7=	2
Bit 8 =	1

- Some IP addresses are reserved and can't be assigned to a host
- You can't use the last octet in a host address
- This is reserved for the address of the network segment itself that the host resides on

- Example:
  - 10.10.1.15 host address has the broadcast address of 10.10.1.0

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|
Public Network
(NAT Router) Public IP 72.23.130.135 Private IP 192.168.0.1
|
LAN
| |
PC1 192.168.0.10 PC2 192.168.0.15

- Subnet Mask
    - Network vs. node with our IP address

      (Network 192.168..1).(1 node)

    - (Network 11000000.10101000.00000001). (00000000 Node) 192.168.1.1
    - (Network 11111111.11111111.11111111). (00000000 Node) 255.255.255.0

- Subnet Mask
    - Class A subnet mask:
        - First octet must be between 1 and 126
        - First octet is the network address
        - Last three octets of the address is the node address
        - Default subnet mask class A

        255.0.0.0
        - Class A allows 126 total possible network
        - Class A can offer 16.7 million possible node addresses

- Subnet Mask
    - Class B Subnet Mask:
        - First octet must be between 128 and 192
        - First two octets are the network address
        - Last two octets of the address is the node address
        - Default subnet mask class B

        255.255.0.0
        - Class B allows 16,384 total possible networks
        - Class B can offer 65,534 possible node addresses

- Subnet Mask
    - Class C Subnet Mask:
        - First octet must be between 192 and 223
        - First three octets are the network address
        - Last octet of the address is the node address
        - Default subnet mask class C
        255.255.255.0
        - Class C allows 2,097,152 total possible networks
        - Class C can offer 254 possible node addresses (limited host)

Linux Essentials Certification

Domain Name Service and the Default Gateway (Network Router)

- When looking up a URL or domain names, we have to translate that domain name in to the IP address of a web server:
    - www.linuxacademy.com to 54.165.61.14 and 54.164.230.15
    - DNS servers translate domain names in to IP addresses

- Subnet mask can be typed in shorthand:
  192.168.1.1/24 – indicated that 24 bits are used for the subnet mask
  192.168.1.1 255.255.255.0

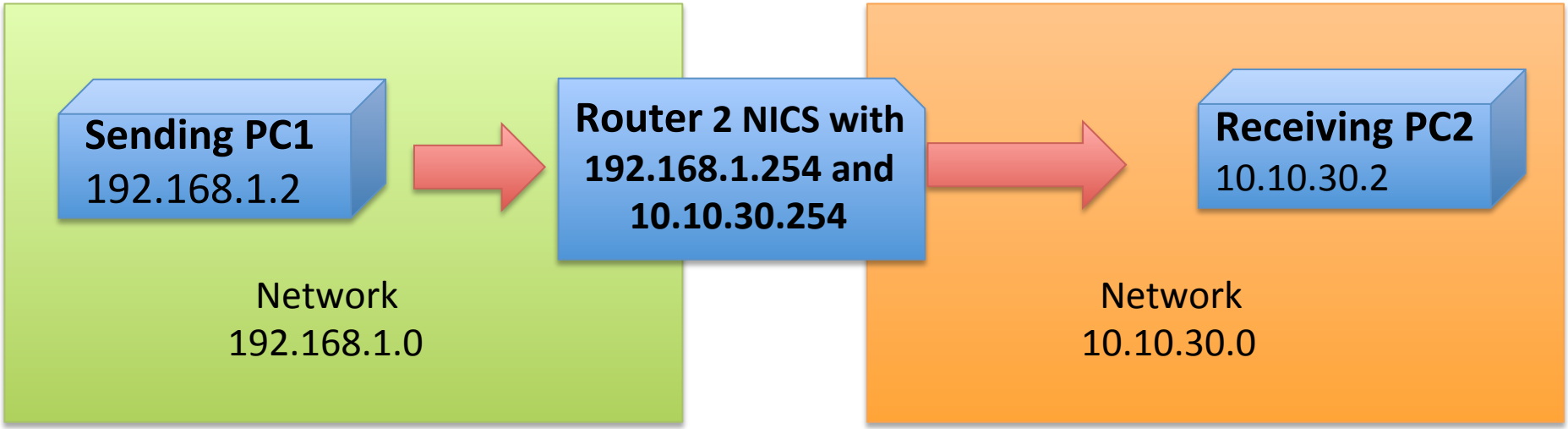
- Partial subnet:
  - You do not have to use the default subnet mask.
    - Example: A class A address could use only part of an octet for the address such as 255.255.252.0

  - For PC3 to speak with PC2 and PC1, we need a router because it is a different subnet. Without this route, PC3 (using subnet mask of 255.255.252.0) can not communicate to the other hosts using 255.255.255.0

PC1	PC2	PC3
192.168.1.1	192.168.1.2	192.168.1.3
255.255.255.0	255.255.255.0	255.255.252.0

- When looking up a URL or domain names, we have to translate that domain name in to the IP address of a web server:
    - www.linuxacademy.com to 54.165.61.14 and 54.164.230.15
    - DNS servers translate domain names in to IP addresses

```
[root@stephen1 ~]# dig www.linuxacademy.copm

; <<>> DiG 9.9.4-RedHat-9.9.4-14.el7_0.1 <<>> www.linuxacademy.copm
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NXDOMAIN, id: 26797
;; flags: qr rd ra; QUERY: 1, ANSWER: 0, AUTHORITY: 1, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;www.linuxacademy.copm.          IN      A

;; AUTHORITY SECTION:
.                       10800   IN      SOA     a.root-servers.net. nstld.verisign-grs.com. 2015030501 1800 900 604800 86400

;; Query time: 2 msec
;; SERVER: 172.31.0.2#53(172.31.0.2)
;; WHEN: Thu Mar 05 22:04:26 UTC 2015
;; MSG SIZE  rcvd: 125

[root@stephen1 ~]#
```



In this example, we have a router that is able to direct sending traffic from the 192.168.1.0 network segment to the 10.10.30.0 network segment.

Linux Essentials Certification

Network Configuration

- A few important network tools:
  - ping — Testing of connectivity of a remote network device
  - dig — Allows us to lookup IP addresses for DNS names
  - netstat — List network connections, routing info, NIC info
  - route — Current route/net settings
  - traceroute — Traces the route a packet takes
  - ifconfig — Current network settings
  - ip addr — Current IP address and network settings

- /etc/resolv.conf (FILE)
  - This is where our DNS server information is stored

Linux Essentials Certification

Industry Uses of Linux, Cloud Computing and Virtualization

- Industry uses of the Linux OS
  - Web servers
  - Mobile application servers
  - SQL Servers

- Industry uses of the Linux OS
  - Cloud computing:
    - Google Apps
    - Web-based email
    - Dropbox
    - Evernote
    - etc

- Virtualization is the creation of a virtual OS through a virtualization software that is known as the hypervisor
- This allows us to virtualize an OS in another computer/OS known as the host
- The virtualized OS's that live on this host are known as the guest OS
    - Virtualization Software:
        - VirtualBox
        - VMWare
        - QEMU
        - XEN

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