Welcome To:
Module 1

Introduction to Linux

What is Operating System?

As per Wikipedia

An operating system is system software that manages computer hardware and software resources, and provides common services for computer programs

In simple words

An operating system (OS) is software that acts as a middleman or a bridge between computer hardware and the computer user. It provides a user interface and controls the computer hardware so that software can function

Types of Operating Systems:

1. **Desktop Operating Systems**, e.g., Microsoft Windows, macOS, and Linux such as Ubuntu
2. **Server Operating Systems**, e.g., Windows Server, Linux distributions like CentOS, Red Hat Enterprise Linux
3. **Mobile Operating Systems**, e.g., Android, iOS, Windows Mobile
4. **Embedded Operating Systems** used in devices like routers, smart TVs, automobiles, home appliances etc.
5. **Real-Time Operating Systems (RTOS)** used in critical systems like medical equipment, car ECUs, aerospace, defense, network firewalls, home security system etc.

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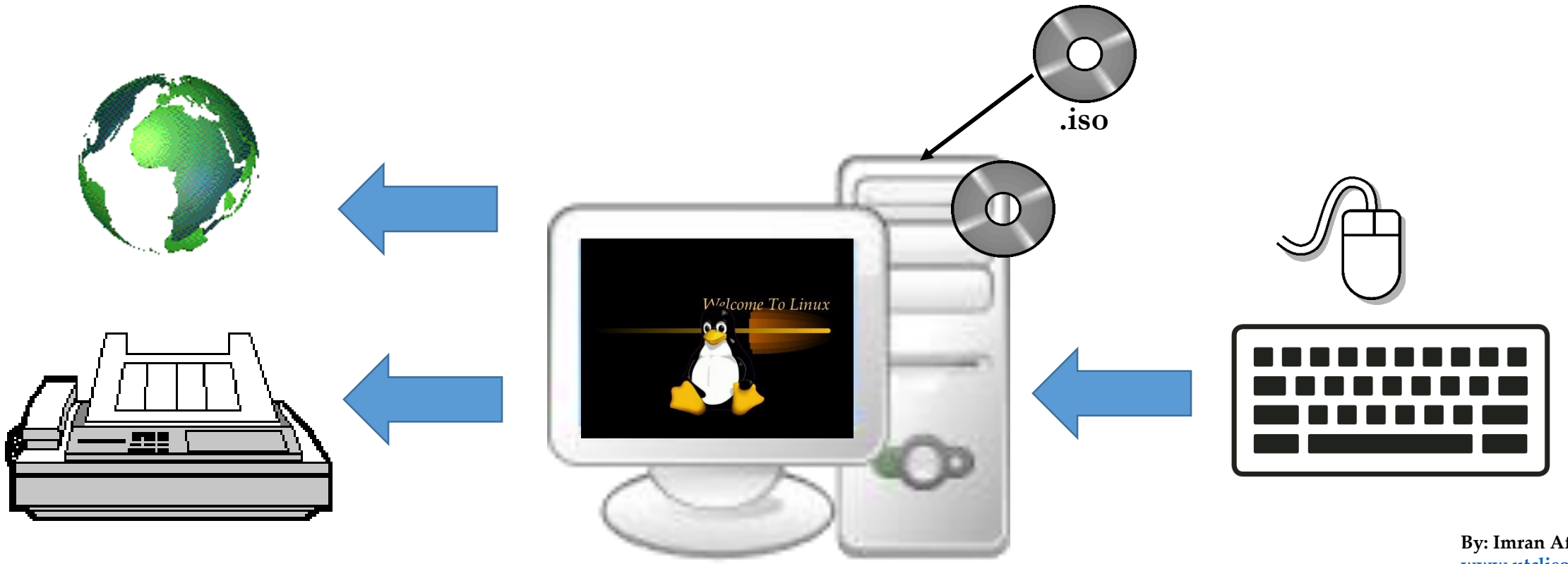
What is Linux?

- Linux, in simple terms, is a free and open-source operating system
- It's similar to Windows and macOS, but it's different in several ways
- Linux is very popular for its stability, security, and flexibility. It can be modified and distributed by anyone, which has led to many different versions, known as "distributions," and each distribution is tailored for different uses
- Its open-source nature means that a community of developers and users contribute to its development



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What is Linux?

Why Learn Linux or its importance?

- Widely used in servers and cloud computing
- Free software philosophy
- Strong command line interface
- Faster processing
- Enhanced security
- Customization because of open-source nature
- Community support
- Understanding of other operating systems
- Career opportunities.

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Linux vs. Unix

- Origins and Development:
  - Unix: Originated in the 1970s at AT&T's Bell Labs. It was developed by Ken Thompson, Dennis Ritchie, and others
  - Linux: Created in the early 1990s by Linus Torvalds. It's free and open-source, meaning its source code can be used, modified, and distributed by anyone
- OS Distribution:
  - Unix: Solaris, HP-UX, AIX. BSD etc.
  - Linux: Red Hat, CentOS, Fedora, Ubuntu, SUSE, Kali etc.
- Licensing and Cost:
  - Unix: Generally requires a paid license, especially for commercial use
  - Linux: Free to use, modify, and distribute
- Community and Development:
  - Unix: Development and updates are controlled by the owning organization
  - Linux: Maintained and developed by a global community of developers
- Hardware Support:
  - Unix: Traditionally supports less hardware variety compared to Linux
  - Linux: Known for its broad hardware support, including both traditional PCs and servers as well as embedded devices.

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Linux Flavors

"Linux flavors" = "Linux distributions" = or "distros" for short

- Ubuntu
- Fedora
- Debian
- Red Hat Enterprise Linux (RHEL)
- CentOS
- Arch Linux
- openSUSE
- Linux Mint
- Gentoo
- Slackware
- Alpine Linux
- Kali Linux

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Linux Users

Linux is used by a wide range of **users** and **organizations** due to its versatility, stability, and open-source nature.

- Developers
- Educational institutions
- Government agencies
- Enterprise and businesses
- Tech companies
- Cloud and web servers
- Supercomputers and research facilities
- Telecommunications and networking
- Media and entertainment

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Linux Vs. Windows

	Linux	Windows
Price	Free	$$$
Ease	Not user-friendly	User friendly
Reliability	Very reliable. Often runs for months or years	Often requires reboot
Software	Mostly enterprise level softwares	Much larger selection of softwares e.g. office, games, utlities etc.
Multi-tasking	Best for multi-tasking	Multi-tasking is avaliable but with very high cpu or memory resources
Security	Very secure	Some what secure
Open source	Open to public	No an open source OS

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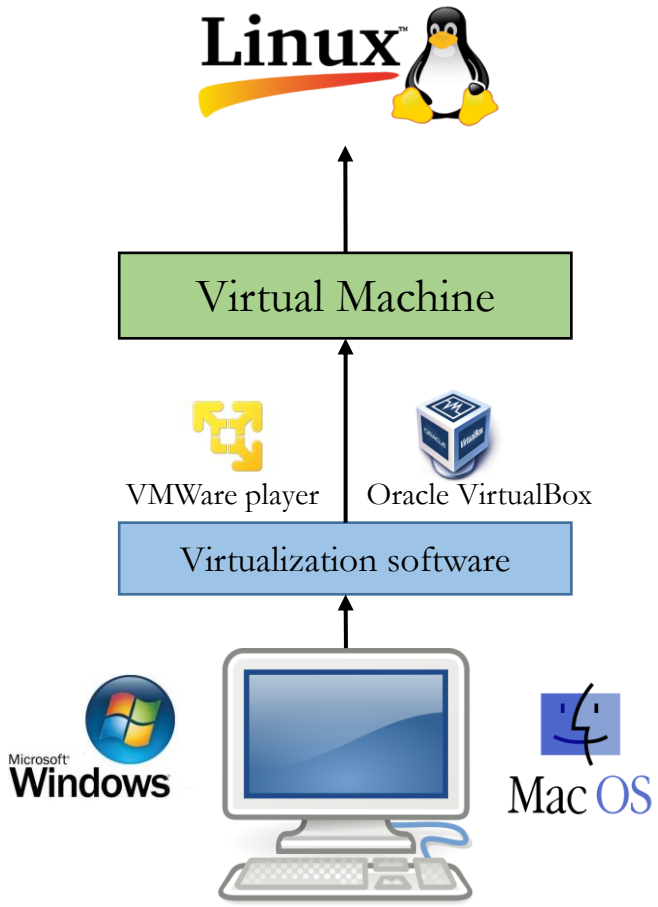
Welcome To:
Module 2

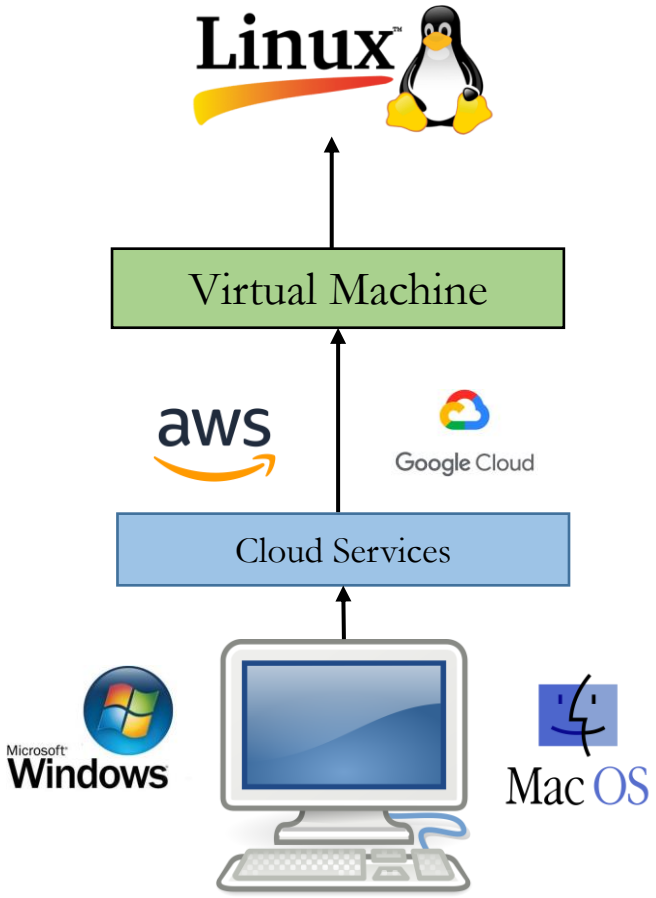
Download, Install and Configure Linux

Lab Design

Option 1



Option 2



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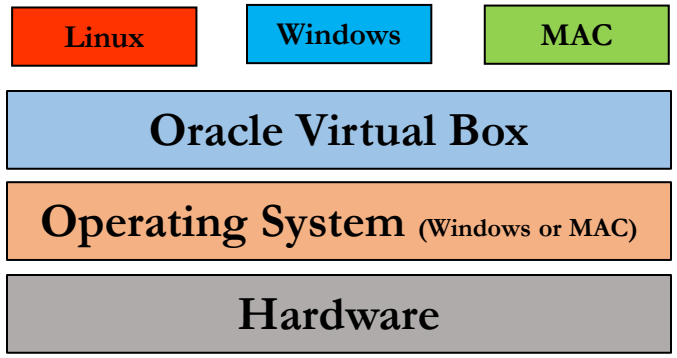
What is Oracle VirtualBox?

- VirtualBox is a free and open-source hypervisor for x86 computers currently being developed by Oracle Corporation

- It installs on your existing Intel or AMD-based computers, whether they are running Windows, Mac, Linux or Solaris operating systems. It extends the capabilities of your existing computer so that it can run multiple operating systems on one hardware at the same time



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Oracle Virtual Box
Download and Installation

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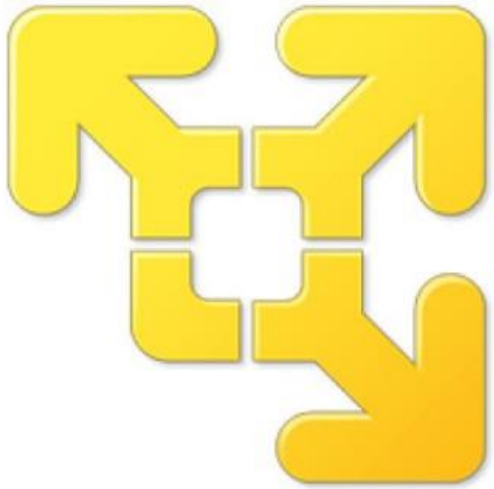
VMWare Workstation Player



Download, Installation and Configuration

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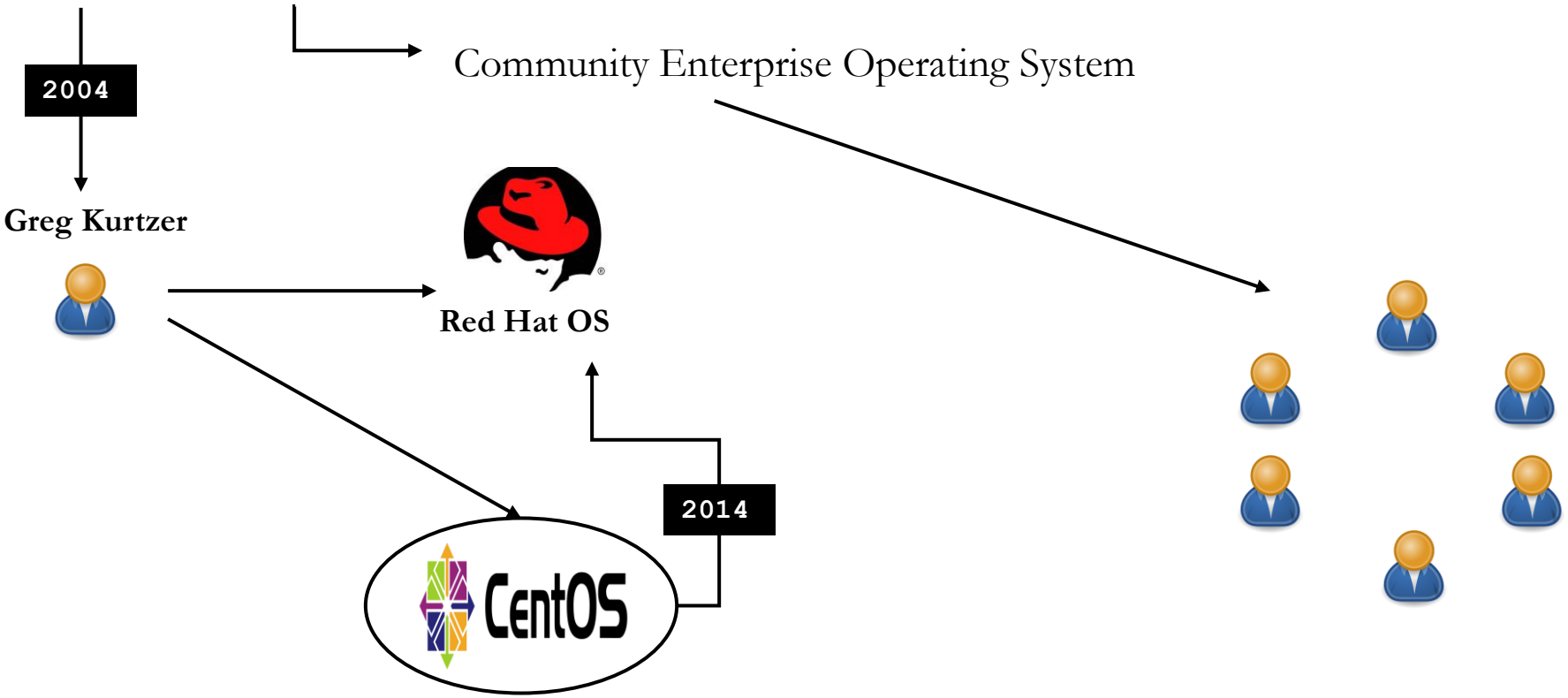
CentOS vs. CentOS Stream

- Brief history of CentOS



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CentOS vs. CentOS Stream

Before Feb 2021

Fedora → RHEL → CentOS

After Feb 2021

Fedora → CentOS Stream → RHEL

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CentOS vs. CentOS Stream

Question???

Is it worth learning CentOS

*** **ABSOLUTELY** ***

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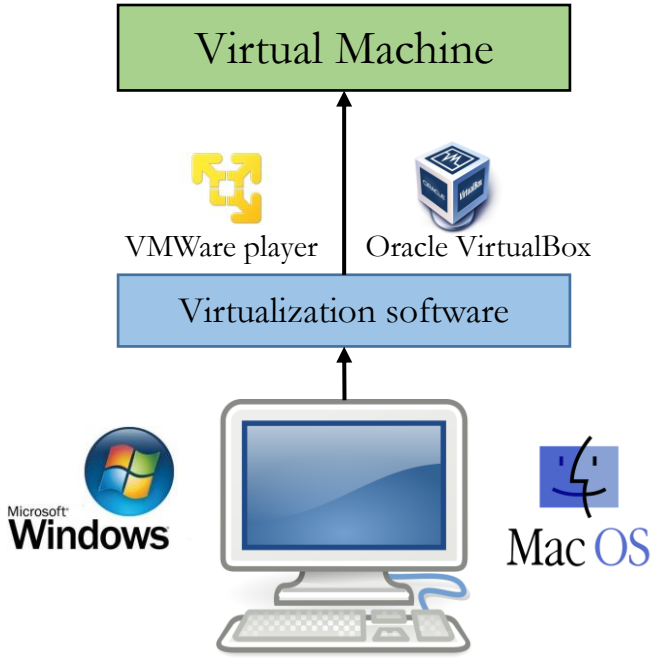
Create Virtual Machine



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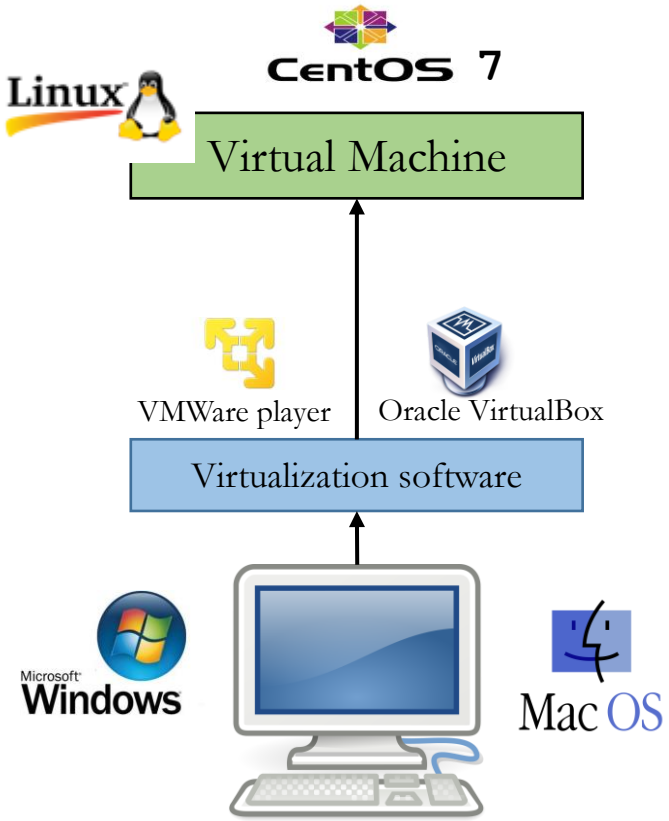
Download and Install Linux (CentOS 7)

- You can use Ubuntu/Kali or any Linux OS (CentOS = Recommended)
- 80% of the Corporate world uses RHEL

- Regarding CentOS version
  - CentOS 7
  - CentOS 8 Stream
  - CentOS 9 Stream



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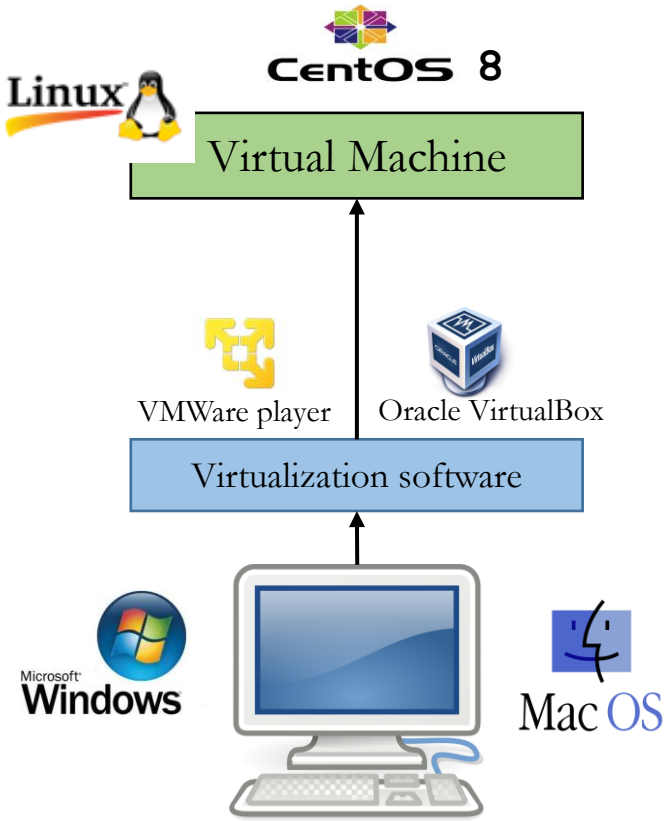
Download and Install Linux (CentOS 8)

Skip…
Go back

- Create a VM
- Download CentOS 8 Stream ISO
- Install CentOS 8 Stream



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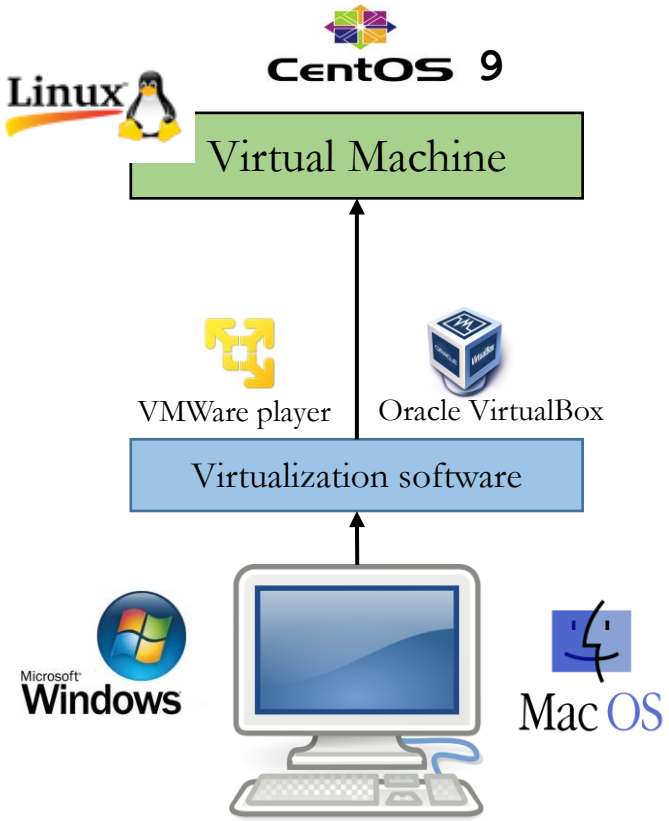
Download and Install Linux (CentOS 9 Stream)

Go back…

- Create a VM
- Download CentOS 9 Stream ISO
- Install CentOS 9 Stream



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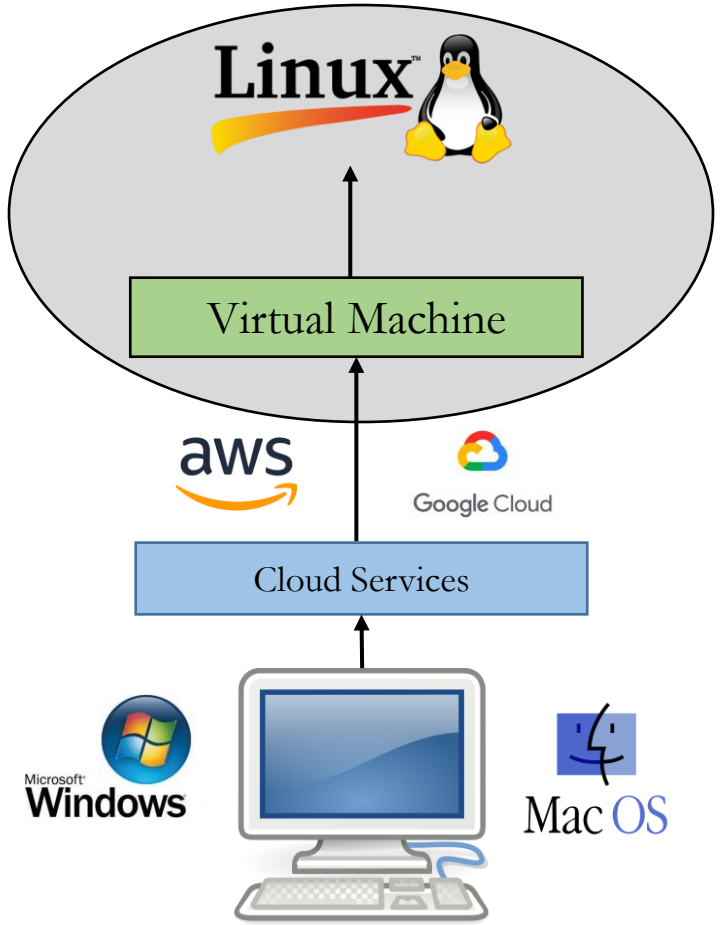
Install Linux on Cloud

Option 2

Skip…



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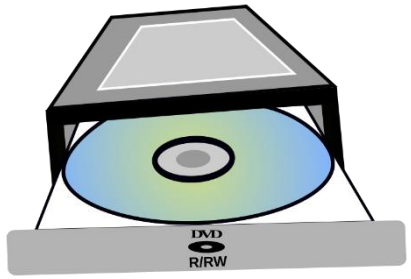
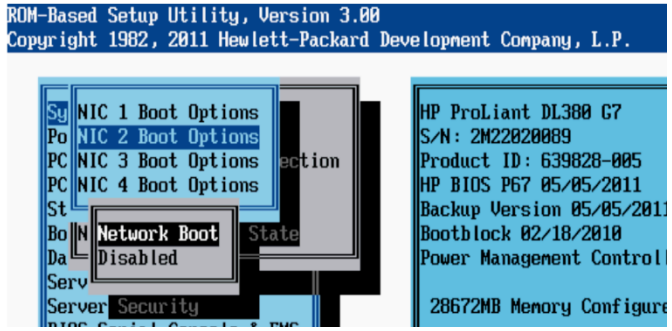
Different Ways to Install OS





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NEXT LESSON

Redhat Linux Installation

OPTIONAL

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Redhat Linux Installation

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VirtualBox SNAPSHOTS

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Linux Ubuntu Installation

OPTIONAL

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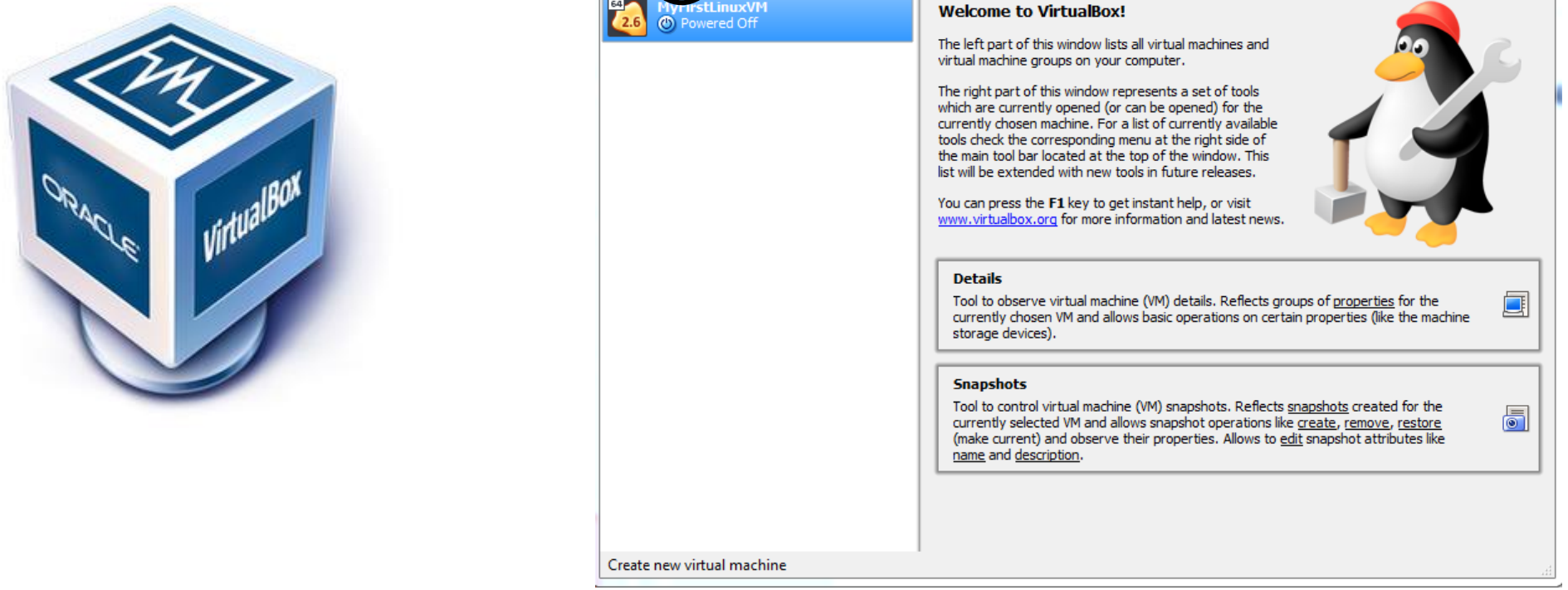
Oracle Virtual Machine Management



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Keyboard Keys Used in Linux

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Welcome To:
Module 3

System Access and File System

Important Things to Remember in Linux

- Linux has super-user account called root
  - root is the most powerful account that can create, modify, delete accounts and make changes to system configuration files
- Linux is case-sensitive system
  - **ABC** is **NOT** same as **abc**
- Avoid using spaces when creating files and directories
- Linux kernel is not an operating system. It is a small software within Linux operating system that takes commands from users and pass them to system hardware or peripherals
- Linux is mostly CLI not GUI
- Linux is very flexible as compared to other operating systems.

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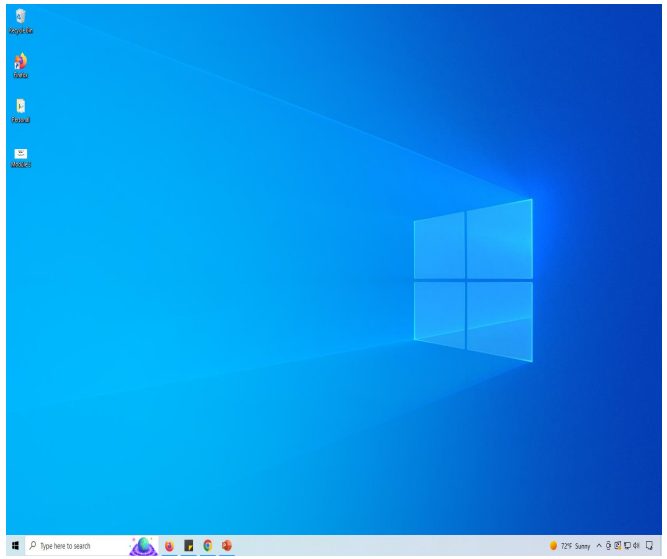
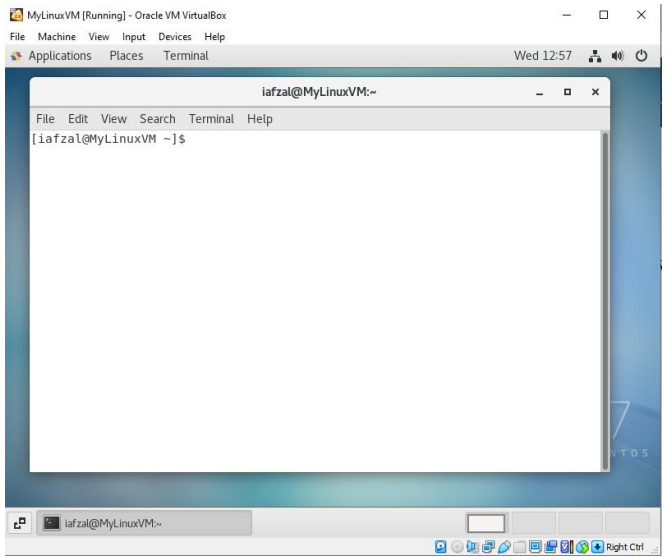
Access to Linux System

There are 2 types of access
1. Console
2. Remote

The console is a direct access to an operating system when it is connected through VGA, HDMI, DVI etc.





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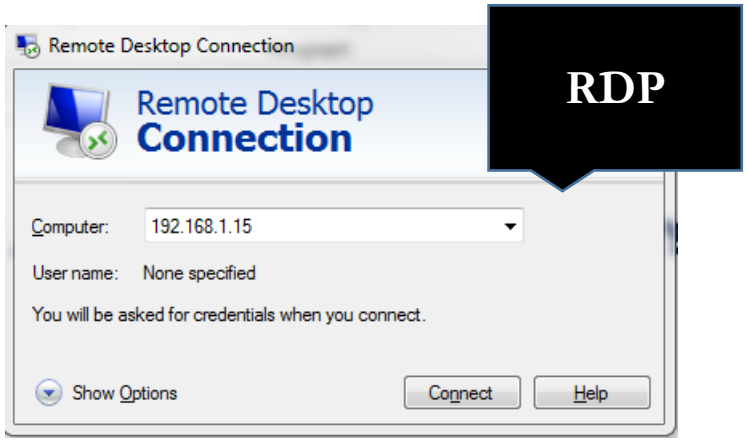
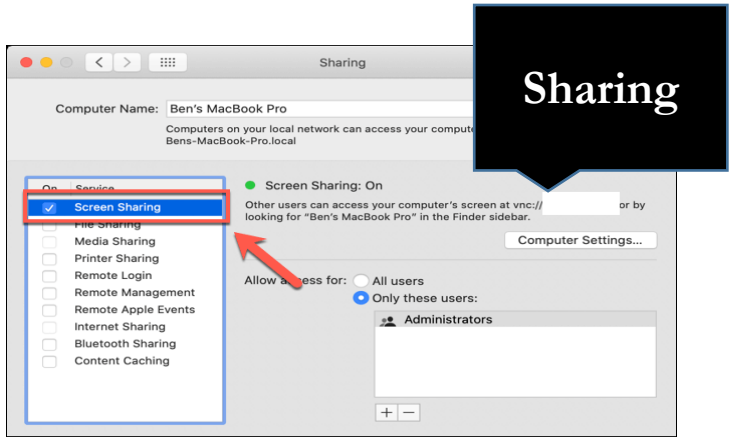
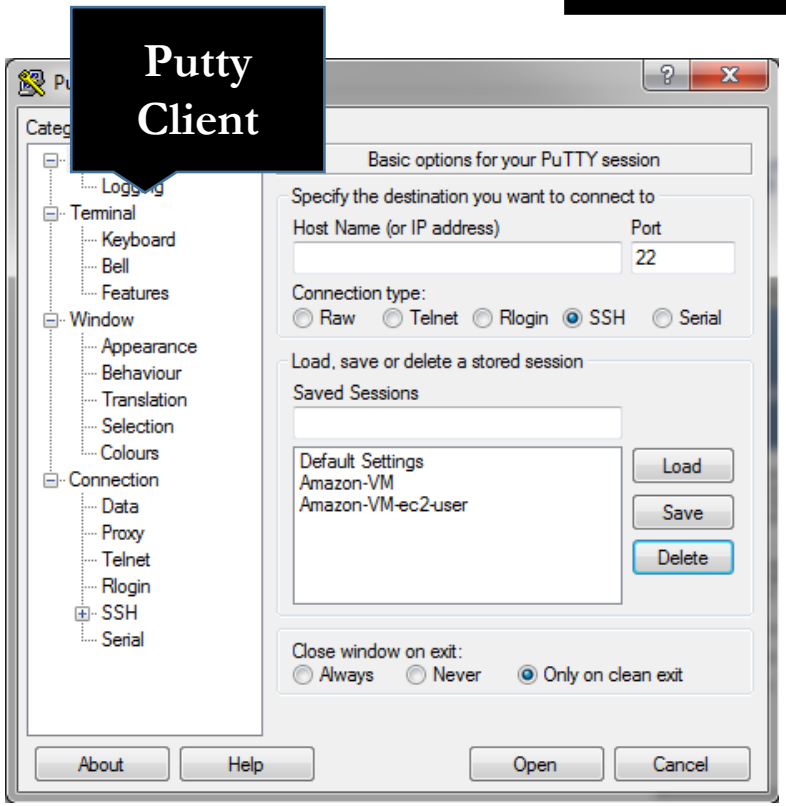
Access to Linux System

The 2nd type of access is remote where you connect to your operating system remotely over the network







Linux to Linux
SSH 192.168.1.5

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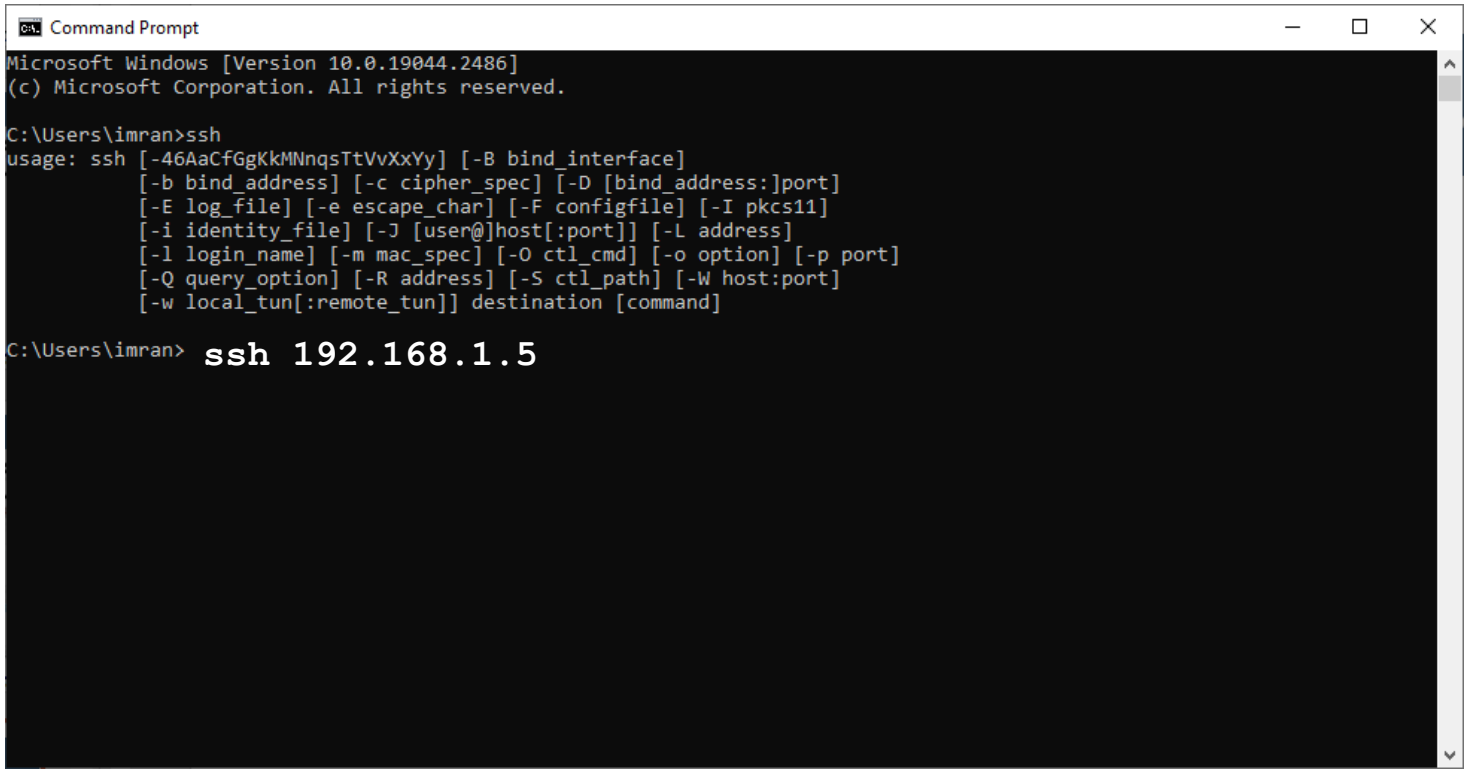
Access to Linux System

Important:

Windows 10 or newer version

SSH built-in client



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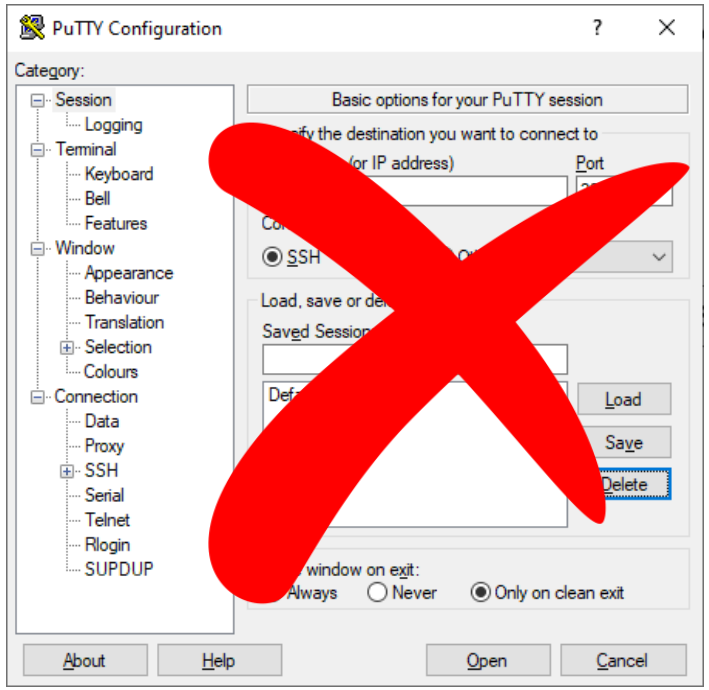
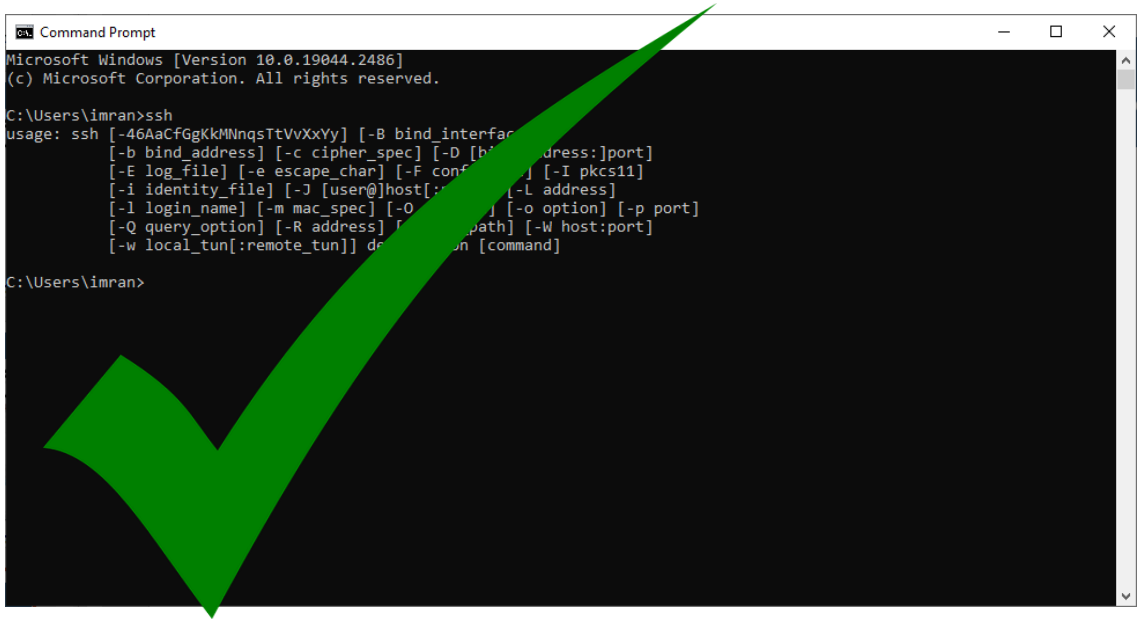
Download and Install Putty

If you are using Windows 10 or newer version

then you do **NOT** have to download or install Putty





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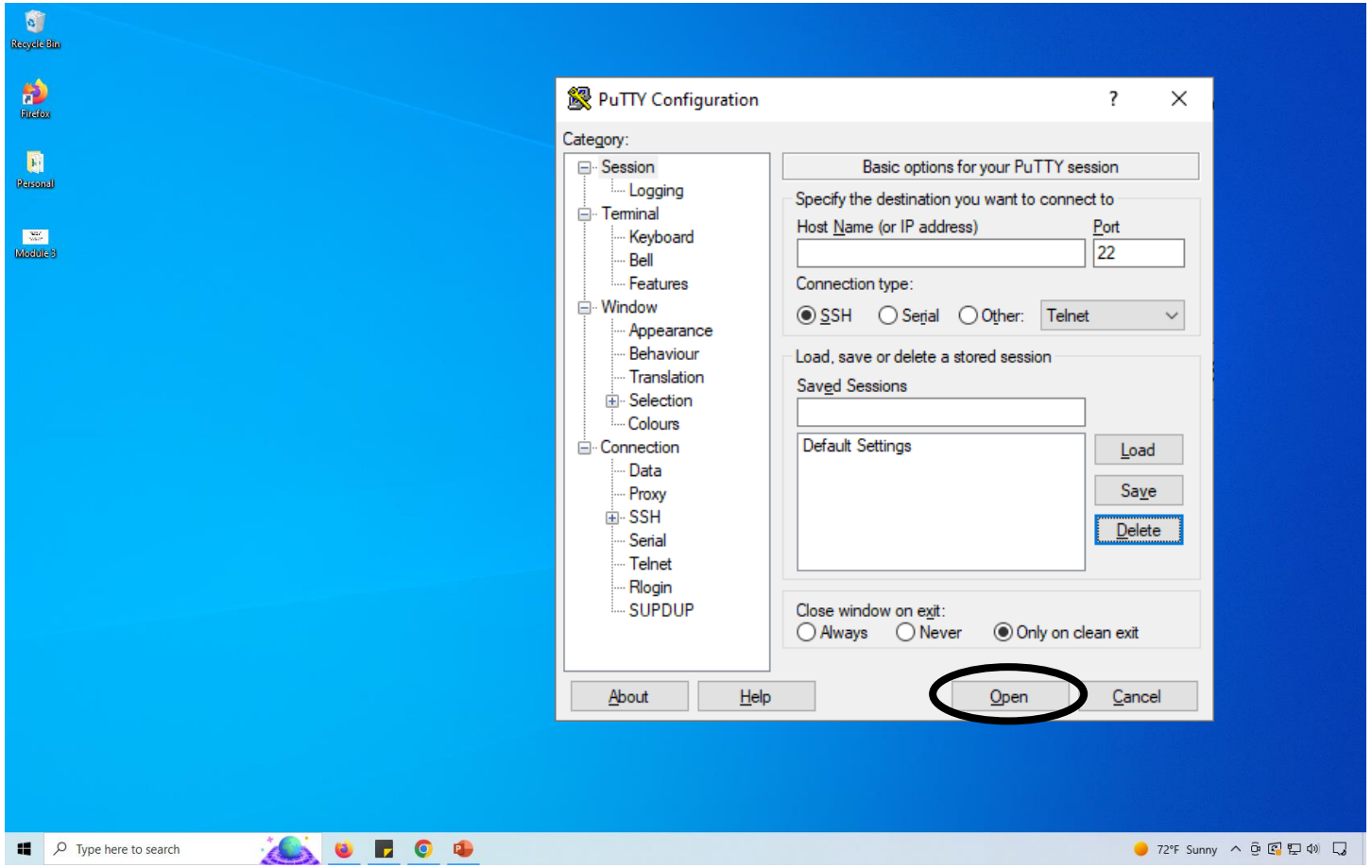
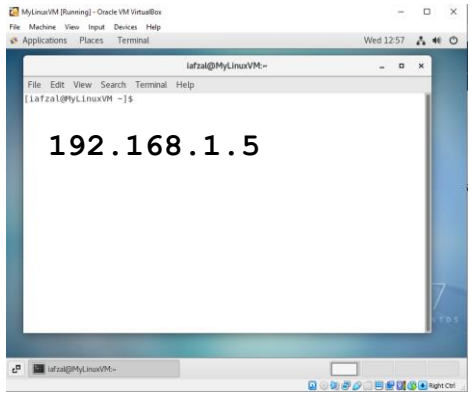
Download and Install Putty

Putty is a software which allows you to connect from a Windows system to Linux system remotely





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Access to Linux from MAC

- Open a terminal on your MAC
- Run the following command
  - **`# ssh -l iafzal 192.168.1.5`**

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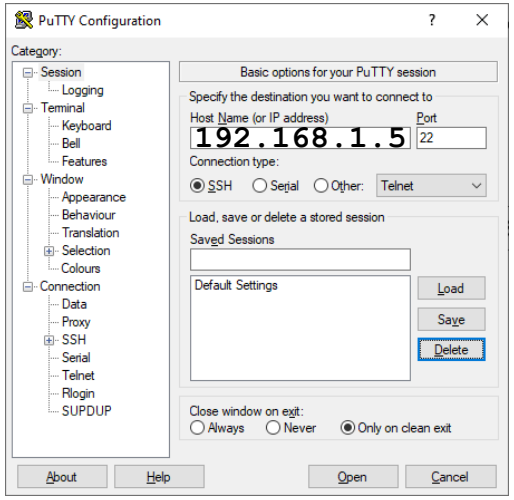
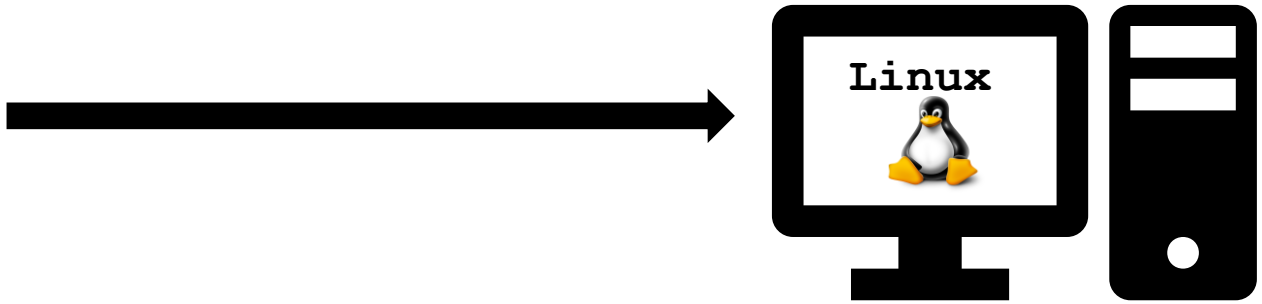
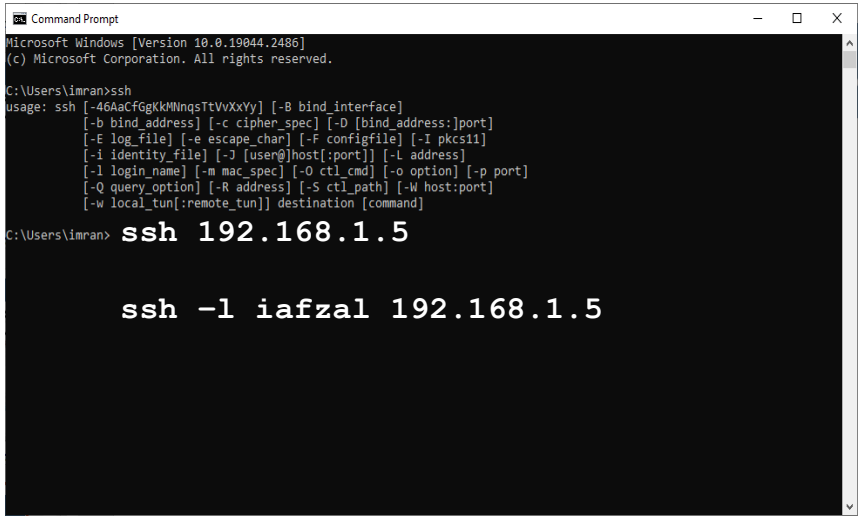
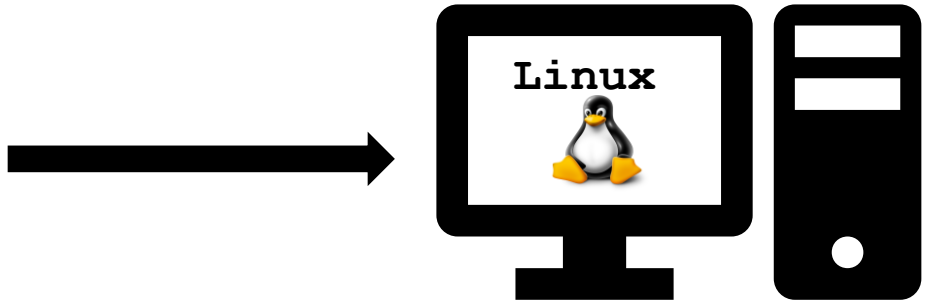
Access Linux via Putty or SSH









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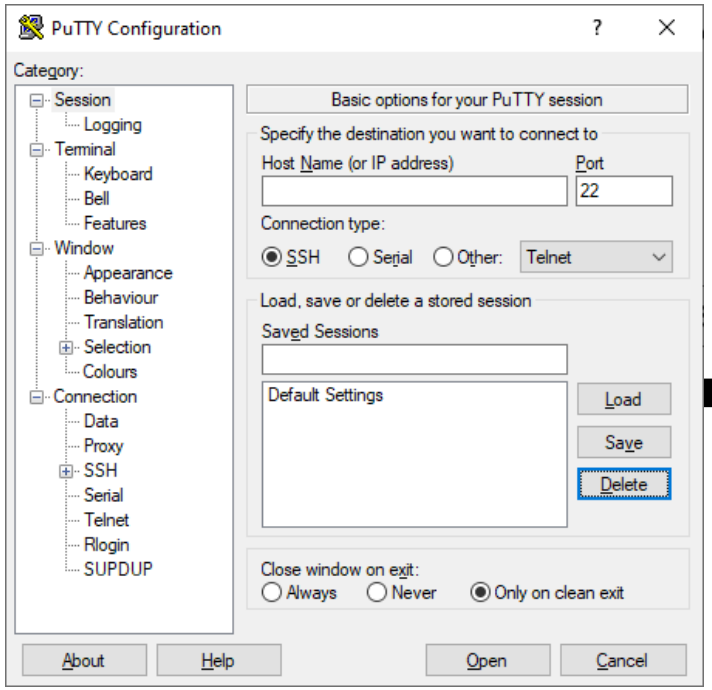
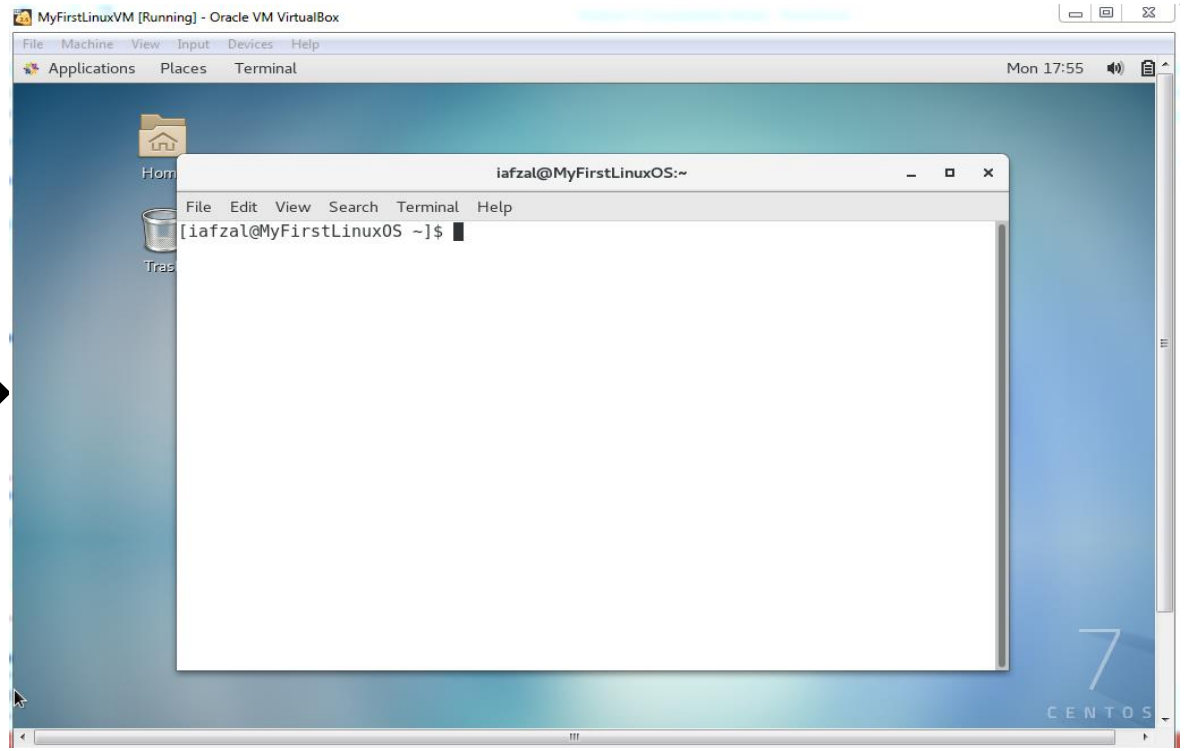
Access to Linux via Putty





- The newer version of CentOS might not have the **`ifconfig`** command, therefore, use "**`ip addr`**" command instead
- To use **`ifconfig`** in 7.5 or later version then run = "**`yum install net-tools`**"

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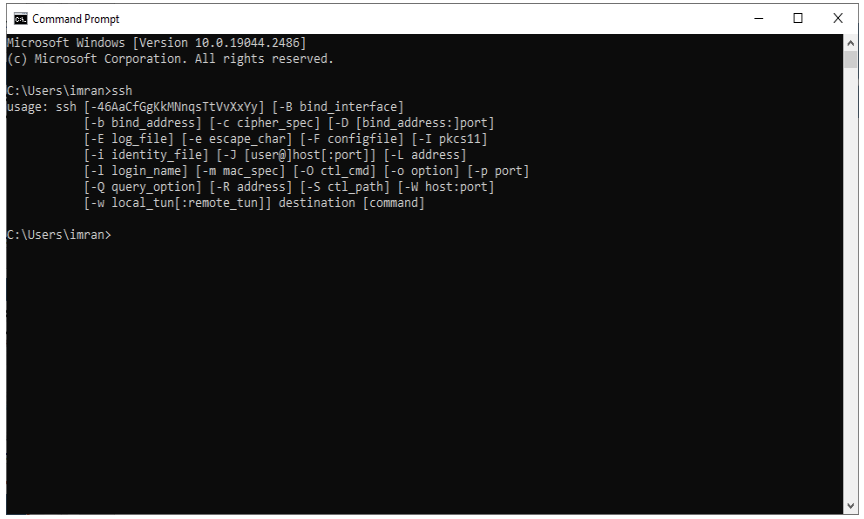
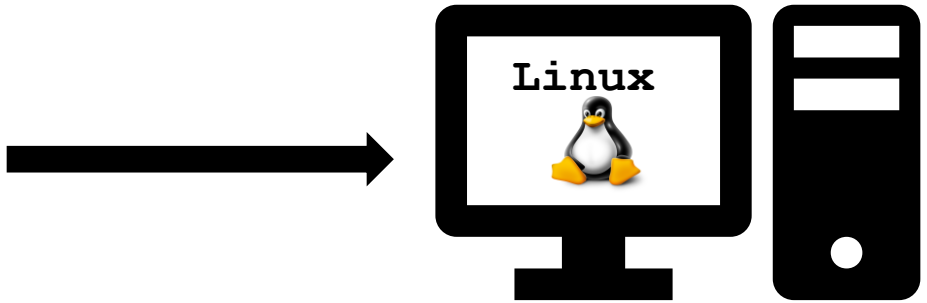
Access to Linux via SSH





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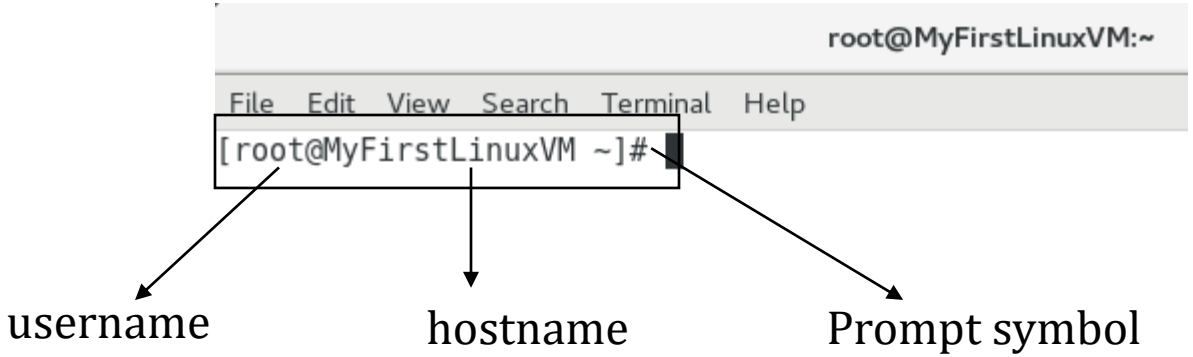
Command Prompts and Getting Prompts Back

- What are command prompts?
  - A command prompt, also referred to simply as a prompt, is a short text at the start of the command line followed by prompt symbol on a command line interface



- To get your prompt back
  - **`Ctrl + c`**

Introduction to Filesystem

- What is a Filesystem?
  - It is a system used by an operating system to manage files. The system controls how data is saved or retrieved

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Introduction to Filesystem

- What is a Filesystem?
  - It is a system used by an operating system to manage files. The system controls how data is saved or retrieved

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Introduction to Filesystem

- Operating system stores files and directories in an organized and structured way
  - System configuration file = Folder A
  - User files = Folder B
  - Log files = Folder C
  - Commands or scripts = Folder D and so on

- There are many different types of filesystems. In general, improvements have been made to filesystems with new releases of operating systems and each new filesystem has been given a different name
  - e.g. **ext3, ext4, xfs, NTFS, FAT etc.**

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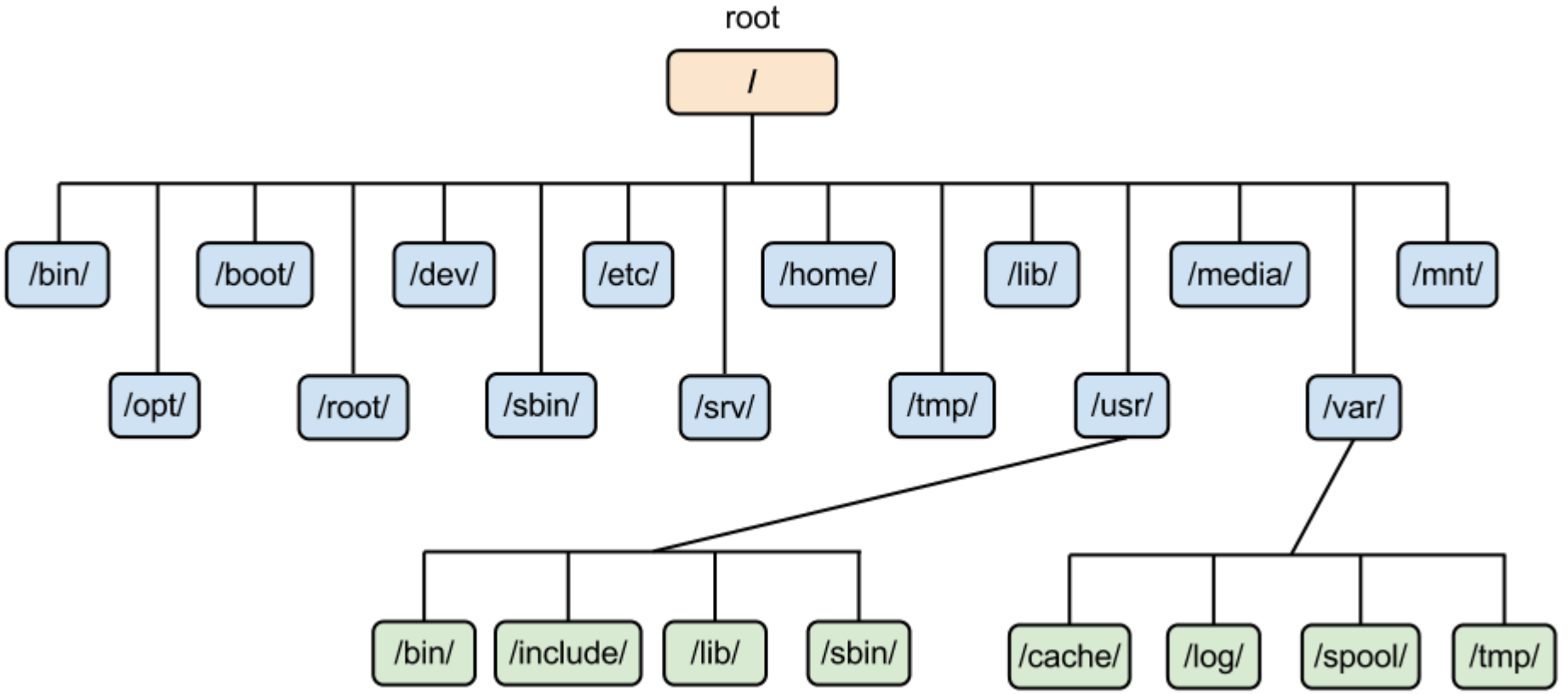
File System Structure



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File System Structure and its Description

/boot	Contains file that is used by the boot loader (grub.cfg)
/root	root user home directory. It is not same as /
/dev	System devices (e.g. disk, cdrom, speakers, flashdrive, keyboard etc.)
/etc	Configuration files
/bin → /usr/bin	Everyday user commands
/sbin → /usr/sbin	System/filesystem commands
/opt	Optional add-on applications (Not part of OS apps)
/proc	Running processes (Only exist in Memory)
/lib → usr/lib	C programming library files needed by commands and apps **strace -e open pwd**
/tmp	Directory for temporary files
/home	Directory for user
/var	System logs
/run	System daemons that start very early (e.g. systemd and udev) to store temporary runtime files like PID files
/mnt	To mount external filesystem. (e.g. NFS)
/media	For cdrom mounts.

By: Imran Afzal
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Navigating File System

- When navigating a UNIX filesystem, there are a few important commands:

  "cd"

  "pwd"

  "ls"

- "cd" stands for change directory. It is the primary command for moving you around the filesystem.
- "pwd" stands for print working directory. It tells you where you current location is.
- "ls" stands for list. It lists all the directories/files within a current working directory
- Using of TAB key to auto-complete

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Linux File or Directory Properties

Each file or directory in Linux has detail information or properties

Type	# of Links	Owner	Group	Size	Month	Day	Time	Name
drwxr-xr-x.	21	root	root	4096	Feb	27	13:33	var
lrwxrwxrwx.	1	root	root	7	Feb	27	13:15	bin
-rw-r—r--	1	root	root	0	Mar	2	11:15	testfile

The second column is the number of hard links to the file. For a directory, the number of hard links is the number of immediate subdirectories it has plus its parent directory and itself

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Linux File Types

File Symbol	Meaning
-	Regular file
d	Directory
l	link
c	Special file or device file
s	socket
p	Named pipe
b	Block device

What is Root?

- There are 3 types of root on Linux system
  1. Root account: root is an account or a username on Linux machine and it is the most powerful account which has access to all commands and files

  2. Root as /: the very first directory in Linux is also referred as root directory

  3. Root home directory: the root user account also has a directory located in /root which is called root home directory

Changing Password

- You should change your initial password as soon as you login

Command = **passwd userid**

Old password: - enter your current password

New password: - enter your new password

Retype new password: - re-enter your new password

File System Paths

- There are two paths to navigate to a filesystem
  - ✓ Absolute Path
  - ✓ Relative Path

- An absolute path always begins with a "/". This indicates that the path starts at the root directory. An example of an absolute path is

  cd /var/log/httpd

- A relative path does not begin with a "/". It identifies a location relative to your current position. An example of a relative path is:

  cd /var

  cd log

  cd httpd

Creating Files and Directories

- Creating Files
  - ✓**`touch`**
  - ✓**`cp`**
  - ✓**`vi`**

- Creating Directories
  - ✓**`mkdir`**

Copying Directories

- Command to copy a directory
  - **`cp`**

- To copy a directory on Linux, you have to execute the “cp” command with the “-R” option for recursive and specify the source and destination directories to be copied
  - **`cp -R <source_folder> <destination_folder>`**

Find Files and Directories

- Two main commands are used to find files/directories
  - find
  - locate

Difference Between find and locate

- **locate** uses a prebuilt database, which should be regularly updated, while **find** iterates over a filesystem to locate files. Thus, locate is much faster than find , but can be inaccurate if the database (can be seen as a cache) is not updated

- To update locate database run **updatedb**

WildCards

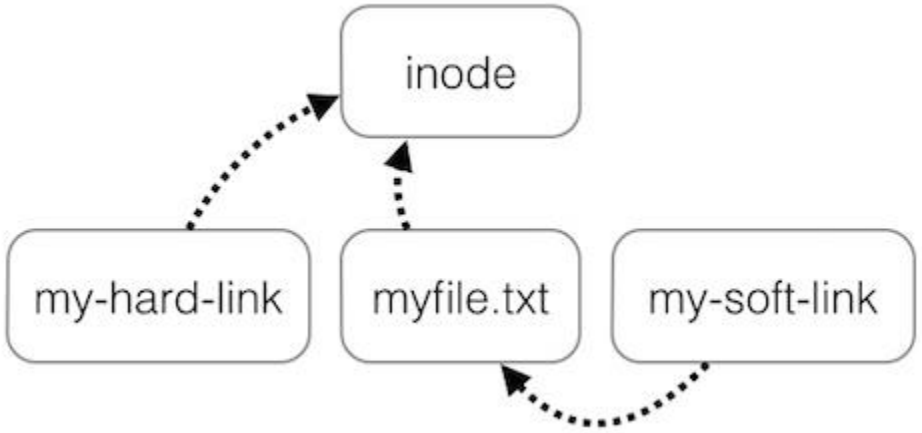
- A wildcard is a character that can be used as a substitute for any of a class of characters in a search

  - * - represents zero or more characters
  - ? - represents a single character
  - [] - represents a range of characters

Soft and Hard Links

- inode = Pointer or number of a file on the hard disk
- Soft Link = Link will be removed if file is removed or renamed
- Hard Link = Deleting renaming or moving the original file will not affect the hard link

  - ln
  - ln -s



Welcome To:
Module 4

Linux Fundamentals

Commands Syntax

- Command options and arguments

Commands typically have the syntax:

command option(s) argument(s)

Options:

Modify the way that a command works

Usually consist of a hyphen or dash followed by a single letter

Some commands accept multiple options which can usually be grouped together after a single hyphen

Arguments:

Most commands are used together with one or more arguments

Some commands assume a default argument if none is supplied

Arguments are optional for some commands and required by others

File Permissions

- UNIX is a multi-user system. Every file and directory in your account can be protected from or made accessible to other users by changing its access permissions. Every user has responsibility for controlling access to their files.

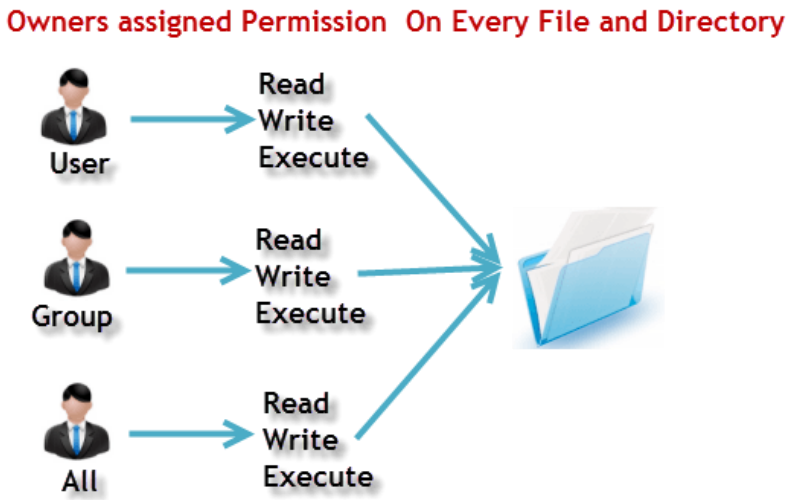
- Permissions for a file or directory may be restricted to by types
- There are 3 type of permissions
  - r - read
  - w - write
  - x - exeawke = running a program
- Each permission (rwx) can be controlled at three levels:
  - u - user = yourself
  - g - group = can be people in the same project
  - o - other = everyone on the system
- File or Directory permission can be displayed by running ls –l command
  - -rwxrwxrwx
- Command to change permission
  - chmod

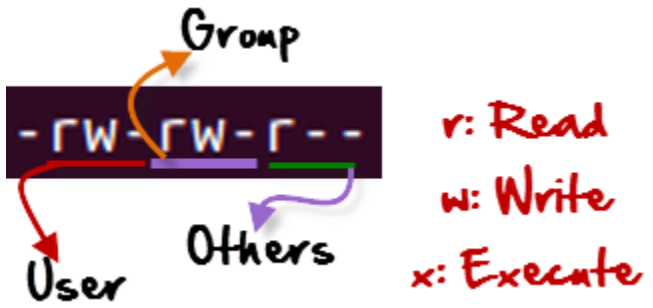
Permission Using Numeric Mode

- Permission to a file and directory can also be assigned numerically
  - **`chmod ugo+r FILE`**

  OR
  - **`chmod 444 FILE`**

`-r--r--r--`





Permission Using Numeric Mode

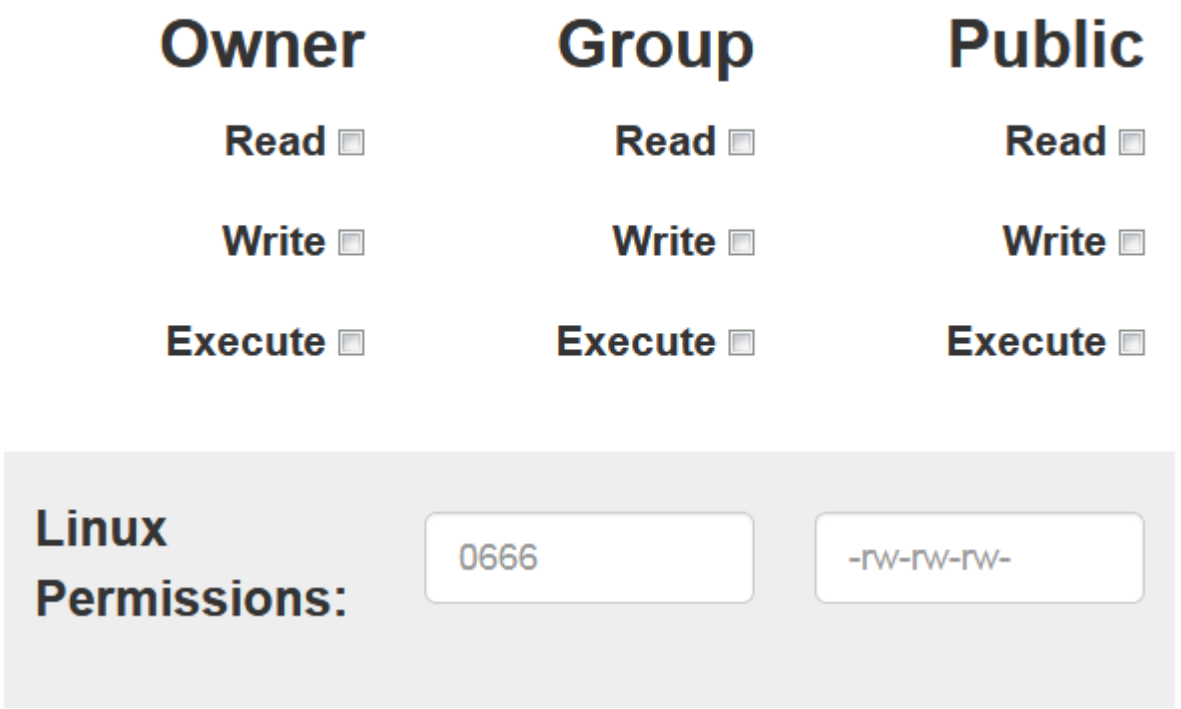
- The table below assigns numbers to permissions types

Number	Permission Type	Symbol
0	No Permission	---
1	Execute	--x
2	Write	-w-
3	Execute + Write	-wx
4	Read	r--
5	Read + Execute	r-x
6	Read +Write	rw-
7	Read + Write +Execute	rwx

- chmod 764 FILE

Permission Using Numeric Mode

- Online calculators can be used as well



File Ownership

- There are 2 owners of a file or directory
  - User and group
- Command to change file ownership
  - chown and chgrp
    - chown changes the ownership of a file
    - chgrp changes the group ownership of a file
- Recursive ownership change option (Cascade)
  - -R

Help Commands

- There are 3 types of help commands
  - **`whatis`** `command`
  - `command` **`--help`**
  - **`man`** `command`

TAB Completion and Up Arrow

- Hitting TAB key completes the available commands, files or directories
  - **`chm TAB`**
  - **`ls j<TAB>`**
  - **`cd Des<TAB>`**

- Hitting up arrow key on the keyboard returns the last command ran.

Adding Text to Files (Redirects)

- 3 Simple ways to add text to a file
  - **`vi`**
  - **`Redirect command output > or >>`**
  - **`echo > or >>`**

Input and Output Redirects

- There are 3 redirects in Linux
  1. Standard input (**`stdin`**) and it has file descriptor number as 0
  2. Standard output (**`stdout`**) and it has file descriptor number as 1
  3. Standard error (**`stderr`**) and it has file descriptor number as 2

- Output (**stdout**) - 1
  - By default when running a command its output goes to the terminal
  - The output of a command can be routed to a file using > symbol
    - E.g. **`ls -l > listings`**
      `pwd > findpath`
  - If using the same file for additional output or to append to the same file then use >>
    - E.g. **`ls -la >> listings`**
      `echo "Hello World"  >> findpath.`

Input and Output Redirects

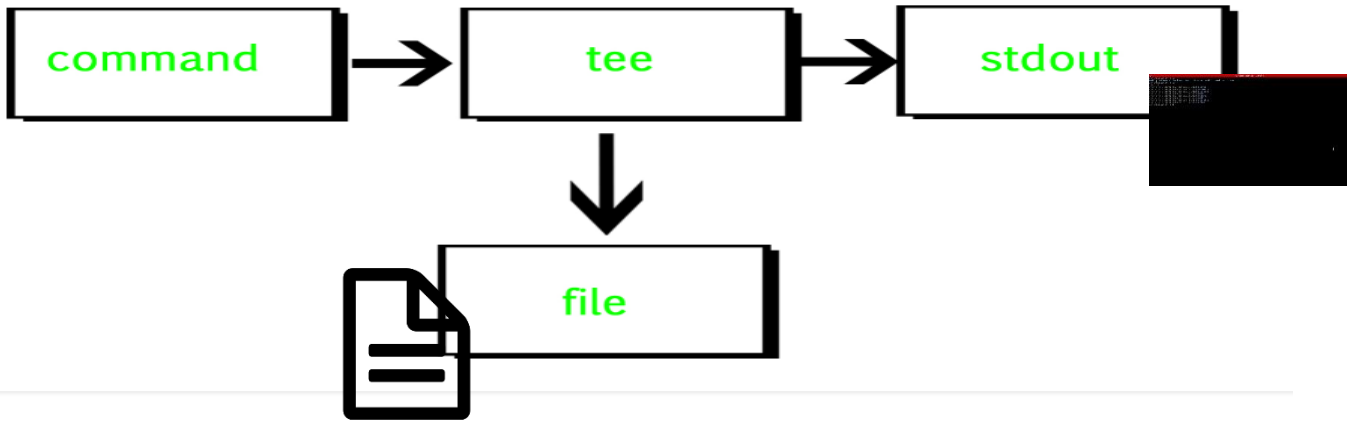
- Input (**stdin**) - 0
  - Input is used when feeding file contents to a file
    - E.g. **`cat < listings`**
      `mail –s "Office memo" allusers@abc.com < memoletter`

- Error (**stderr)** - 2
  - When a command is executed we use a keyboard and that is also considered (stdin -0)
  - That command output goes on the monitor and that output is (stdout – 1)
  - If the command produced any error on the screen then it is considered (stderr – 2)
    - We can use redirects to route errors from the screen
      - E.g **`ls –l /root 2> errorfile`**
        `telnet localhost 2> errorfile.`

Standard Output to a File (tee)

- “tee” command is used to store and view (both at the same time) the output of any command

- The command is named after the T-splitter used in plumbing. It basically breaks the output of a program so that it can be both displayed and saved in a file. It does both the tasks simultaneously, copies the result into the specified files or variables and also display the result.



Pipes

- A pipe is used by the shell to connect the output of one command directly to the input of another command.

The symbol for a pipe is the vertical bar (|). The command syntax is:

```
command1 [arguments]  |  command2 [arguments]
```

Pipes

```
ls -l          |          more
```

File Maintenance Commands

- `cp`
- `rm`
- `mv`
- `mkdir`
- `rmdir or rm -r`
- `chgrp`
- `chown`

File Display Commands

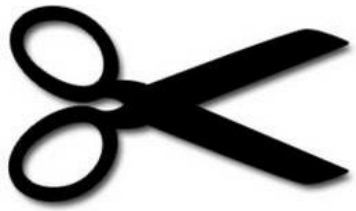
- `cat`
- `more`
- `less`
- `head`
- `tail`

Filters / Text Processors Commands

- `cut`
- `awk`
- `grep and egrep`
- `sort`
- `uniq`
- `wc`

`cut` - Text Processors Commands

`cut`



- cut is a command line utility that allows you to cut parts of lines from specified files or piped data and print the result to standard output. It can be used to cut parts of a line by delimiter, byte position, and character

• **`cut filename`**	=	Does not work
• **`cut --version`**	=	Check version
• **`cut -c1 filename`**	=	List one character
• **`cut -c1,2,4`**	=	Pick and chose character
• **`cut -c1-3 filename`**	=	List range of characters
• **`cut -c1-3,6-8 filename`**	=	List specific range of characters
• **`cut -b1-3 filename`**	=	List by byte size
• **`cut -d: -f 6 /etc/passwd`**	=	List first 6th column separated by :
• **`cut -d: -f 6-7 /etc/passwd`**	=	List first 6 and 7th column separated by :
• **`ls -l | cut -c2-4`**	=	Only print user permissions of files/dir

awk - Text Processors Commands

awk

- awk is a utility/language designed for data extraction. Most of the time it is used to extract fields from a file or from an output

- `awk --version` = Check version
- `awk '{print $1}' file` = List 1st field from a file
- `ls -l | awk '{print $1,$3}'` = List 1 and 3rd field of ls –l output
- `ls -l | awk '{print $NF}'` = Last field of the output
- `awk '/Jerry/ {print}' file` = Search for a specific word
- `awk -F: '{print $1}' /etc/passwd` = Ouput only 1st field of /etc/passwd
- `echo "Hello Tom" | awk '{$2="Adam"; print $0}'` = Replace words field words
- `cat file | awk '{$2="Imran"; print $0}'` = Replace words field words
- `awk 'length($0) > 15' file` = Get lines that have more than 15 byte size
- `ls -l | awk '{if($9 == "seinfeld") print $0;}'` = Get the field matching seinfeld in /home/iafzal
- `ls -l | awk '{print NF}'` = Number of fields.

grep/egrep - Text Processors Commands

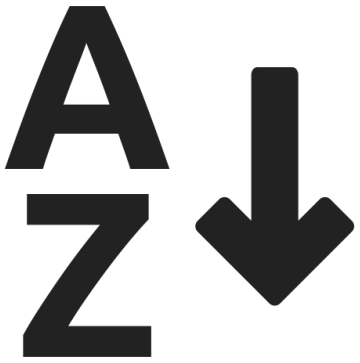
- What is grep?
  - The grep command which stands for “global regular expression print,” processes text line by line and prints any lines which match a specified pattern

- **grep --version OR grep --help** = Check version or help
- **grep keyword file** = Search for a keyword from a file
- **grep -c keyword file** = Search for a keyword and count
- **grep -i KEYword file** = Search for a keyword ignore case-sensitive
- **grep -n keyword file** = Display the matched lines and their line numbers
- **grep -v keyword file** = Display everything but keyword
- **grep keyword file | awk '{print $1}'** = Search for a keyword and then only give the 1st field
- **ls -l | grep Desktop** = Search for a keyword and then only give the 1st field

- **egrep -i "keyword|keyword2" file** = Search for 2 keywords.

`sort/uniq` - Text Processors Commands

- What are sort and uniq commands?
  - Sort command sorts in alphabetical order
  - Uniq command filters out the repeated or duplicate lines



- **`sort --version OR sort --help`** = Check version or help
- **`sort file`** = Sorts file in alphabetical order
- **`sort -r file`** = Sort in reverse alphabetical order
- **`sort -k2 file`** = Sort by field number

- **`uniq file`** = Removes duplicates
- **`sort file | uniq`** = Always sort first before using uniq their line numbers
- **`sort file | uniq -c`** = Sort first then uniq and list count
- **`sort file | uniq -d`** = Only show repeated lines.

wc - Text Processors Commands

- What is **wc** command?
  - The command reads either standard input or a list of files and generates: **newline count, word count, and byte count**

- **`wc --version OR wc --help`** = Check version or help
- **`wc file`** = Check file line count, word count and byte count
- **`wc -l file`** = Get the number of lines in a file
- **`wc -w file`** = Get the number of words in a file
- **`wc -b file`** = Get the number of bytes in a file
- **`wc DIRECTORY`** = NOT allowed
- **`ls -l | wc -l`** = Number of files
- **`grep keyword | wc -l`** = Number of keyword lines.

Compare Files

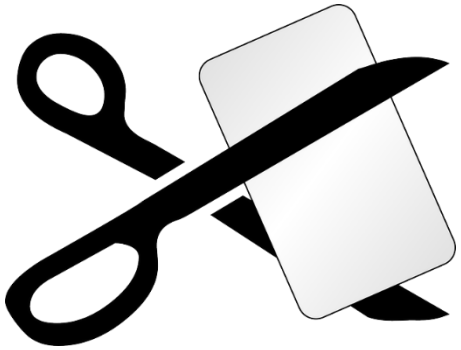
- **diff** (Line by line)
- **cmp** (Byte by byte)

Compress and un-Compress Files

- `tar`
- `gzip`
- `gzip –d OR gunzip`

Truncate File Size (truncate)

- The Linux **`truncate`** command is often used to shrink or extend the size of a file to the specified size



- Command
  - **`truncate –s 10 filename`**

By: Imran Afzal

Combining and Splitting Files

- Multiple files can be combined into one and
- One file can be split into multiple files

  - `cat file1 file2 file3 > file4`
  - `split file4`

  - `e.g. split -l 300 file.txt childfile`

  Split file.txt into 300 lines per file and output to childfileaa, childfileab and childfileac

Linux vs. Windows Commands

Command Description	Windows	Linux
Listing of a directory	dir	ls -l
Rename a file	ren	mv
Copy a file	copy	cp
Move file	move	mv
Clear screen	**cls**	clear
Delete file	del	rm
Compare contents of files	fc	diff
Search for a word/string in a file	find	grep
Display command help	**command /?**	man command
Displays your location in the file system	**chdir**	pwd
Displays the time	**time**	date

Welcome To:
Module 5

Linux System Administration

Linux File Editor

- A text editor is a program which enables you to create and manipulate data (text) in a Linux file

- There are several standard text editors available on most Linux systems
  - **vi - Visual editor**
  - **ed - Standard line editor**
  - **ex - Extended line editor**
  - **emacs - A full screen editor**
  - **pico - Beginner's editor**
  - **vim - Advance version of vi**

- Our editor = vi (available in almost every Linux distribution)

Introduction to vi Editor

- vi supplies commands for:
  - Inserting and deleting text
  - Replacing text
  - Moving around the file
  - Finding and substituting strings
  - Cutting and pasting text

- Most common keys:
  - **`i – insert`**
  - **`Esc – Escape out of any mode`**
  - **`r – replace`**
  - **`d – delete`**
  - **`:q! – quit without saving`**
  - **`:wq! – quit and save`**

Difference Between vi and vim Editor

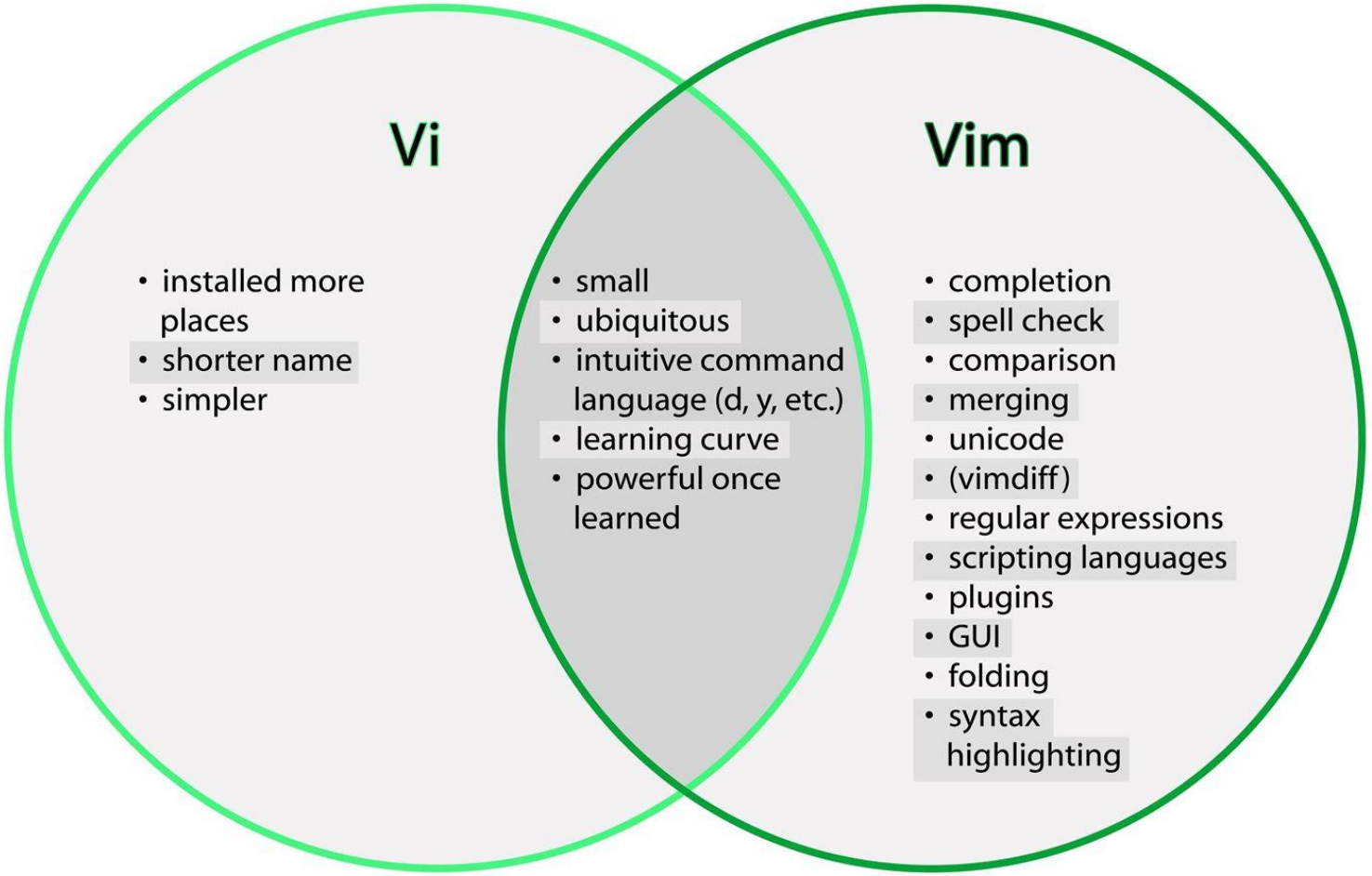
- As far as functionality is concerned, both editors work in the same manner. Which editor you choose is a matter of personal choice. Some people recommend learning the vim editor instead of the vi editor. Due to added features, learning and using vim editor is much easier than the vi editor.

- Since vim is based on the vi, when you will learn how to use the vim editor, you will automatically learn how to use the vi editor.

- vim has all the features as vi with some excellent addition

- There's also a comprehensive help system and lots of customization options available.

Difference Between vi and vim Editor



“vim” Interactive Learning Tools

- There are many websites that offer free vim interactive training:
  - https://www.openvim.com/
  - http://www.vimgenius.com
  - https://vim-adventures.com/ (Games)

“sed” Command

- Replace a string in a file with a newstring
- Find and delete a line
- Remove empty lines
- Remove the first or n lines in a file
- To replace tabs with spaces
- Show defined lines from a file
- Substitute within vi editor
- And much more…

User Account Management

Commands

- useradd
- groupadd
- userdel
- groupdel
- usermod

Files

- /etc/passwd
- /etc/group
- /etc/shadow

Example:

```
useradd -g superheros -s /bin/bash -c “user description” -m -d
/home/spiderman spiderman
```

The /etc/login.def File

- The chage command – per user
  - **Example**

```
chage [-m mindays] [-M maxdays] [-d lastday] [-I inactive] [-E
expiredate] [-W warndays] user
```

- File = /etc/login.def
  - PASS_MAX_DAYS 99999
  - PASS_MIN_DAYS 0
  - PASS_MIN_LEN 5
  - PASS_WARN_AGE 7

The chage Command

- The chage command – per user
  - **Example**

```
chage [-d lastday] [-m mindays] [-M maxdays] [-W warndays] [-I
inactive] [-E expiredate] user
```

-d = 3. Last password change (lastchanged) : Days since Jan 1, 1970 that password was last changed
-m = 4. Minimum : The minimum number of days required between password changes i.e. the number of days left before the user is allowed to change his/her password
-M = 5. Maximum : The maximum number of days the password is valid (after that user is forced to change his/her password)
-W = 6. Warn : The number of days before password is to expire that user is warned that his/her password must be changed
-I = 7. Inactive : The number of days after password expires that account is disabled
-E = 8. Expire : days since Jan 1, 1970 that account is disabled i.e. an absolute date specifying when the login may no longer be used.

Switch Users and sudo Access

Commands

- su - username
- sudo command
- visudo

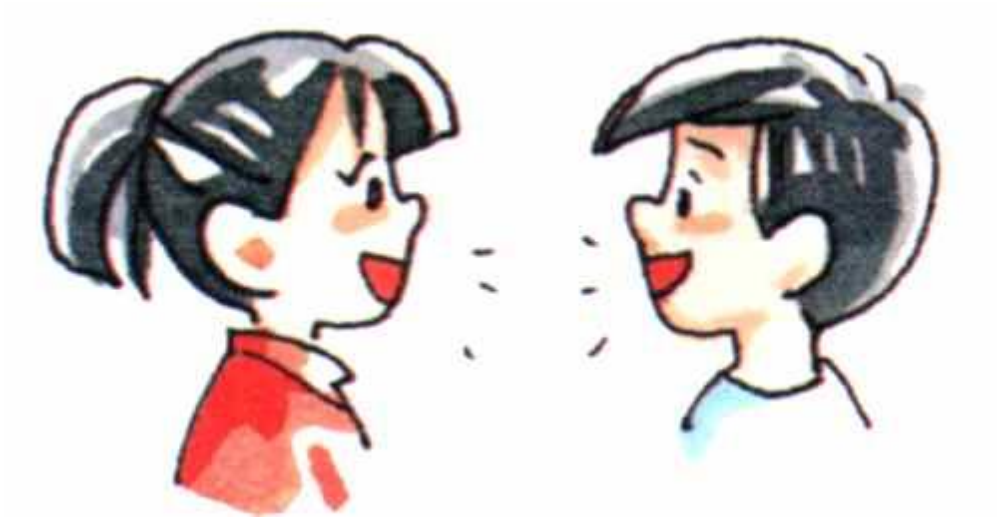
File

- /etc/sudoers

Monitor Users

- `who`
- `last`
- `w`
- `finger`
- `id`

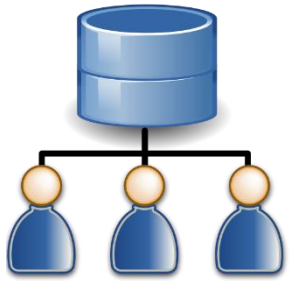
Talking to Users

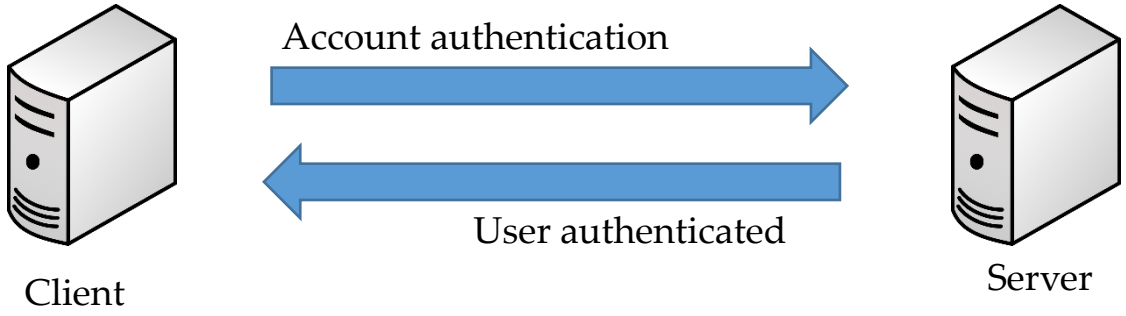


- users
- wall
- write

Linux Account Authentication

- Types of Accounts
  - Local accounts
  - Domain/Directory accounts





- Windows = Active Directory
- Linux = LDAP?

Difference between Active Directory, LDAP, IDM, WinBIND, OpenLDAP etc.

- Active Directory = Microsoft
- IDM = Identity Manager
- WinBIND = Used in Linux to communicate with Windows (Samba)
- OpenLDAP (open source)
- IBM Directory Server
- JumpCloud
- LDAP = Lightweight Directory Access Protocol

System Utility Commands

- `date`
- `uptime`
- `hostname`
- `uname`
- `which`
- `cal`
- `bc`

By: Imran Afzal

Processes and Jobs

- Application = Service
- Script
- Process
- Daemon
- Threads
- Job

Process / Services Commands

- systemctl or service
- ps
- top
- kill
- crontab
- at.

By: Imran Afzal

systemctl command

- systemctl command is a new tool to control system services
- It is available in version 7 and later and it replaces the **service** command

- Usage example:

```
systemctl start|stop|status servicename.service      (firewalld)
systemctl enable servicename.service
systemctl restart|reload servicename.service
systemctl list-units --all
```

The output has the following columns:

- **UNIT**: The `systemd` unit name
- **LOAD**: Whether the unit's configuration has been parsed by `systemd`. The configuration of loaded units is kept in memory.
- **ACTIVE**: A summary state about whether the unit is active. This is usually a fairly basic way to tell if the unit has started successfully or not.
- **SUB**: This is a lower-level state that indicates more detailed information about the unit. This often varies by unit type, state, and the actual method in which the unit runs.
- **DESCRIPTION**: A short textual description of what the unit is/does.

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`systemctl` command

- To add a service under systemctl management:

  Create a unit file in **`/etc/systemd/system/servicename.service`**

- To control system with systemctl

```
systemctl poweroff
systemctl halt
systemctl reboot
```

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“ps” command

- **ps** command stands for process status and it displays all the currently running processes in the Linux system

Usage examples:

- **ps** = Shows the processes of the current shell

PID = the unique process ID
TTY = terminal type that the user logged-in to
TIME = amount of CPU in minutes and seconds that the process has been running
CMD = name of the command

- **ps -e** = Shows all running processes
- **ps aux** = Shows all running processes in BSD format
- **ps -ef** = Shows all running processes in full format listing *(Most commonly used)*
- **ps -u username** = Shows all processes by username.

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“top” command

- top command is used to show the Linux processes and it provides a real-time view of the running system
- This command shows the summary information of the system and the list of processes or threads which are currently managed by the Linux Kernel
- When the top command is executed then it goes into interactive mode and you can exit out by hitting **`q`**

- **`Usage: top`**

PID: Shows task’s unique process id
USER: Username of owner of task
PR: The “PR” field shows the scheduling priority of the process from the perspective of the kernel
NI: Represents a Nice Value of task. A Negative nice value implies higher priority, and positive Nice value means lower priority.
VIRT: Total virtual memory used by the task
RES: Memory consumed by the process in RAM
SHR: Represents the amount of shared memory used by a task
S: This field shows the process state in the single-letter form
%CPU: Represents the CPU usage
%MEM: Shows the Memory usage of task
TIME+: CPU Time, the same as ‘TIME’, but reflecting more granularity through hundredths of a second.

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“top” command

- **`top -u iafzal`** = shows tasks/processes by user owned
- **`top then press c`** = shows commands absolute path
- **`top then press k`** = kill a process by PID within top session
- **`top then M and P`** = To sort all Linux running processes by Memory usage

Please note:
Top command refreshes the information every 3 seconds

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“kill” command

- **kill** command is used to terminate processes manually
- It sends a signal which ultimately terminates or kills a particular process or group of processes

Usage:
kill [OPTION] [PID]
OPTION = Signal name or signal number/ID
PID = Process ID

kill -l	=	to get a list of all signal names or signal number

Most used signals are:

kill PID	=	Kill a process with default signal
kill -1	=	Restart
kill -2	=	Interrupt from the keyboard just like Ctrl C
kill -9	=	Forcefully kill the process
kill -15	=	Kill a process gracefully

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“kill” command

- Other similar kill commands are:
  killall
  pkill

“crontab” command

- Crontab command is used to schedule tasks

Usage:

- **crontab -e** = Edit the crontab
- **crontab -l** = List the crontab entries
- **crontab -r** = Remove the crontab
- **crond** = crontab daemon/service that manages scheduling
- **systemctl status crond** = To manage the crond service

```
┌──────────────── minute (0 - 59)
│ ┌────────────── hour (0 - 23)
│ │ ┌──────────── day of the month (1 - 31)
│ │ │ ┌────────── month (1 - 12)
│ │ │ │ ┌──────── day of the week (0 - 6) (Sunday to Saturday;
│ │ │ │ │                                  7 is also Sunday on some systems)
│ │ │ │ │
* * * * * <command to execute>
```

- Create crontab entry by scheduling a task:

crontab -e

schedule, echo “This is my first crontab entry” > crontab-entry

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“at” command

- at command is like crontab which allows you to schedule jobs but only once
- When the command is run it will enter interactive mode and you can get out by pressing **`Ctrl D`**

Usage:

- **`at HH:MM PM`** = Schedule a job
- **`atq`** = List the at entries
- **`atrm #`** = Remove at entry
- **`atd`** = at daemon/service that manages scheduling
- **`systemctl status atd`** = To manage the atd service

- Create at entry by scheduling a task:

```
at 4:45PM → enter
echo “This is my first at entry” > at-entry
Crtl D
```

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“at” command

Other future scheduling format:

- **`at 2:45 AM 101621`** = Schedule a job to run on Oct 16th, 2021 at 2:45am
- **`at 4PM + 4 days`** = Schedule a job at 4pm four days from now
- **`at now +5 hours`** = Schedule a job to run five hours from now
- **`at 8:00 AM Sun`** = Schedule a job to 8am on coming Sunday
- **`at 10:00 AM next month`** = Schedule a job to 10am next month

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Additional Cron Jobs

- By default, there are 4 different types of cronjobs
  - Hourly
  - Daily
  - Weekly
  - Monthly
- All the above crons are setup in
  - **/etc/cron.___** (directory)
- The timing for each are set in
  - **/etc/anacrontab** -- except hourly
- For hourly
  - **/etc/cron.d/0hourly**

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Process Management

- Background = Ctrl-z, jobs and bg
- Foreground = fg
- Run process even after exit = nohup process &

  OR = nohup process > /dev/null 2>&1 &
- Kill a process by name = pkill
- Process priority = nice (e.g. nice –n 5 process)

  The niceness scale goes from -20 to 19. The lower the number more priority that task gets
- Process monitoring = top
- List process = ps.

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System Monitoring

- `top`
- `df`
- `dmesg`
- `iostat 1`
- `netstat`
- `free`
- `cat /proc/cpuinfo`
- `cat /proc/meminfo`

By: Imran Afzal

Log Monitoring

Another and most important way of system administration is log monitor

Log Directory = **`/var/log`**

- **`boot`**
- **`chronyd = NTP`**
- **`cron`**
- **`maillog`**
- **`secure`**
- **`messages`**
- **`httpd`**

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System Maintenance Commands

- `shutdown`
- `init 0-7`
- `reboot`
- `halt`

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Changing System Hostname

- `hostnamectl - set-hostname newhostname`

- `Version 7 = Edit /etc/hostname`
- `Version 6 = Edit /etc/sysconfig/network`

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Finding System Information

- `cat /etc/redhat-release`
- `uname -a`
- `dmidecode`

System Architecture

- **Differences between a 32-bit and 64-bit CPU**

A big difference between 32-bit processors and 64-bit processors is the number of calculations per second they can perform, which affects the speed at which they can complete tasks. 64-bit processors can come in dual core, quad core, six core, and eight core versions for home computing. Multiple cores allow for an increased number of calculations per second that can be performed, which can increase the processing power and help make a computer run faster. Software programs that require many calculations to function smoothly can operate faster and more efficiently on the multi-core 64-bit processors

- **Linux = arch**
- **Windows = My computer → Properties**

Terminal Control Keys

Several key combinations on your keyboard usually have a special effect on the terminal.

These "control" (CTRL) keys are accomplished by holding the CTRL key while typing the second key.
For example, CTRL-c means to hold the CTRL key while you type the letter "c".

The most common control keys are listed below:

- **CTRL-u - erase everything you've typed on the command line**
- **CTRL-c - stop/kill a command**
- **CTRL-z - suspend a command**
- **CTRL-d - exit from an interactive program (signals end of data).**

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Terminal Commands

- **`clear`**

Clears your screen

- **`exit`**

Exit out of the shell, terminal or a user session

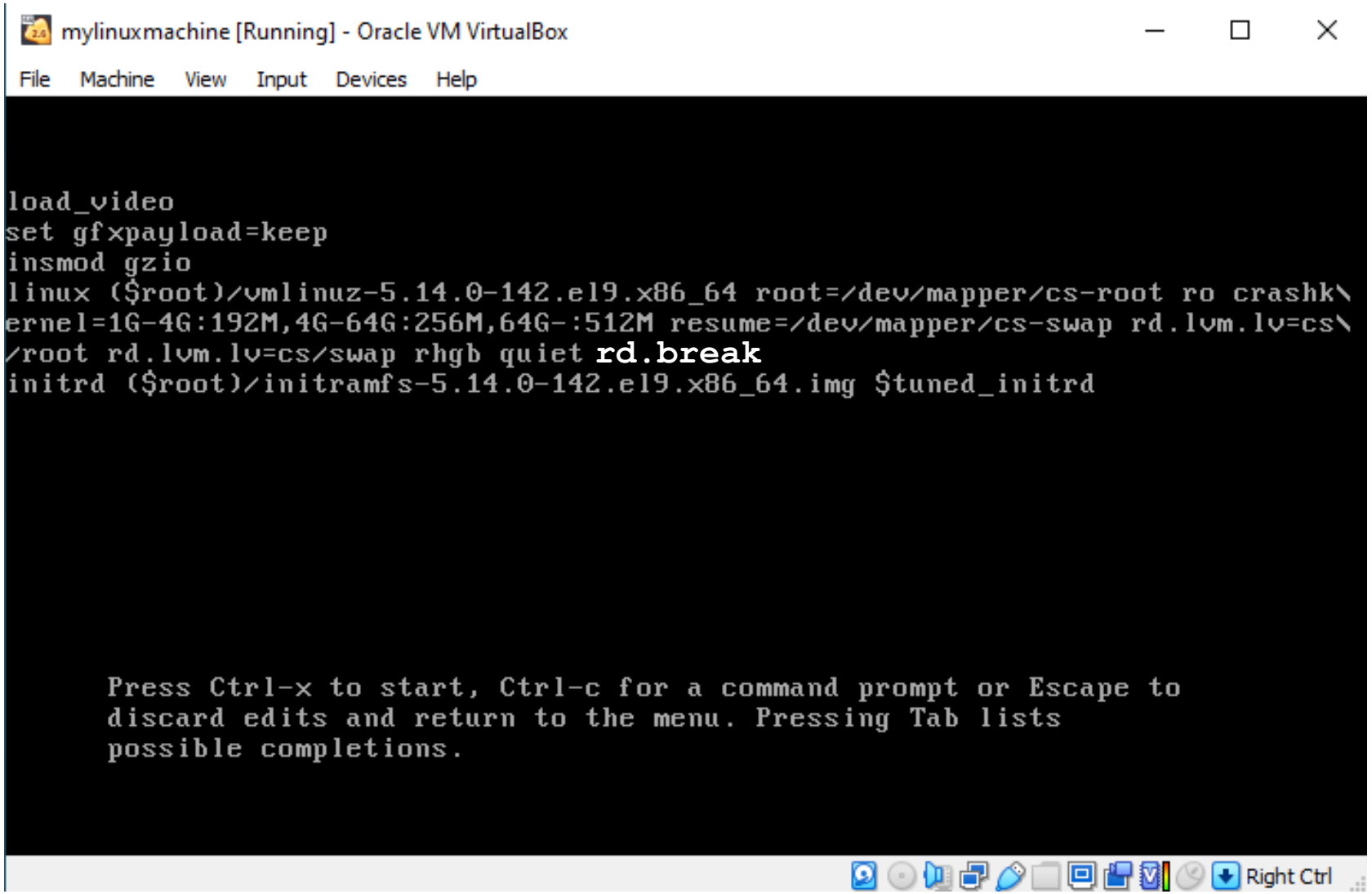
- **`script`**

The script command stores terminal activities in a log file that can be named by a user, when a name is not provided by a user, the default file name, typescript is used

Recover Root Password

- Restart your computer
- Edit grub
- Change password
- reboot

CentOS / Red Hat 9

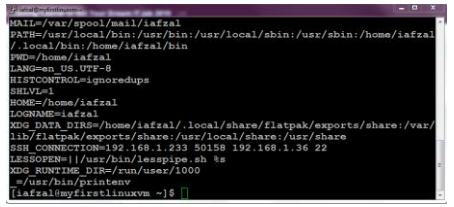


SOS Report

- What is SOS Report?
  - Collect and package diagnostic and support data
- Package name
  - sos-version
- Command
  - sosreport

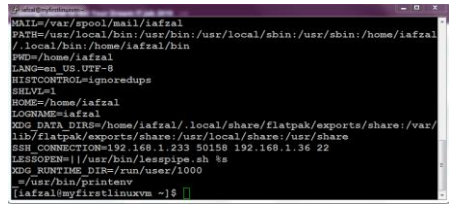
Environment Variables

- What are environment variables?
  - An environment variable is a dynamic-named value that can affect the way running processes will behave on a computer. They are part of the environment in which a process runs.
  - In simple words: set of defined rules and values to build an environment
  - E.g.



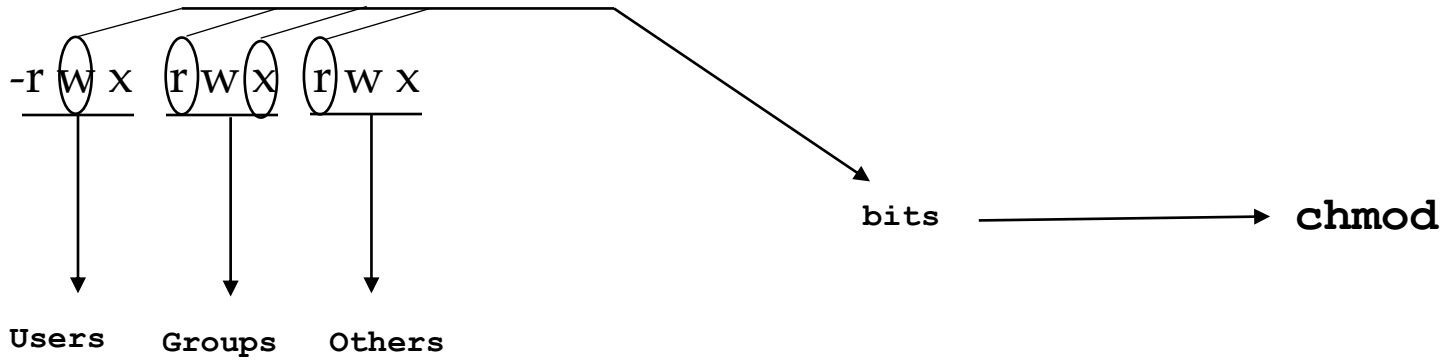
Environment Variables

- To view all environment variables
  - **printevn OR env**
- To view ONE environment variable
  - **echo $SHELL**
- To set the environment variables
  - **export TEST=1**
  - **echo $TEST**
- To set environment variable permanently
  - **vi .bashrc**
  - **TEST='123'**
  - **export TEST**
- To set global environment variable permanently
  - **vi /etc/profile or /etc/bashrc**
  - **Test='123'**
  - **export TEST**



Special Permissions with `setuid, setgid and sticky bit`

- All permissions on a file or directory are referred as bits



Not actual commands

- There are 3 additional permissions in Linux
  - **`setuid`**: bit tells Linux to run a program with the effective user id of the owner instead of the executor: *(e.g.* **`passwd`** *command)* → **`/etc/shadow`**
  - **`setgid`**: bit tells Linux to run a program with the effective group id of the owner instead of the executor: *(e.g.* **`locate`** *or* **`wall`** *command)*

    Please note: This bit is present for only files which have executable permissions

  - **`sticky bit`**: a bit set on files/directories that allows only the owner or root to delete those files

Special Permissions with `setuid, setgid and sticky bit`

- To assign special permissions at the user level
  - **`chmod u+s xyz.sh`**
- To assign special permissions at the group level
  - **`chmod g+s xyz.sh`**
- To remove special permissions at the user or group level
  - **`chmod u-s xyz.sh`**
  - **`chmod g-s xyz.sh`**

Please note:
These bits work on c programming executables not on bash shell scripts

- To find all executables in Linux with setuid and setgid permissions
  - **`find / -perm /6000 -type f`**

Sticky bit

- It is assigned to the last bit of permissions

  -r w x r w x r w t

- Why? Example of **`/tmp`** directory

Special Permissions with `setuid, setgid and sticky bit`

Lab exercise:

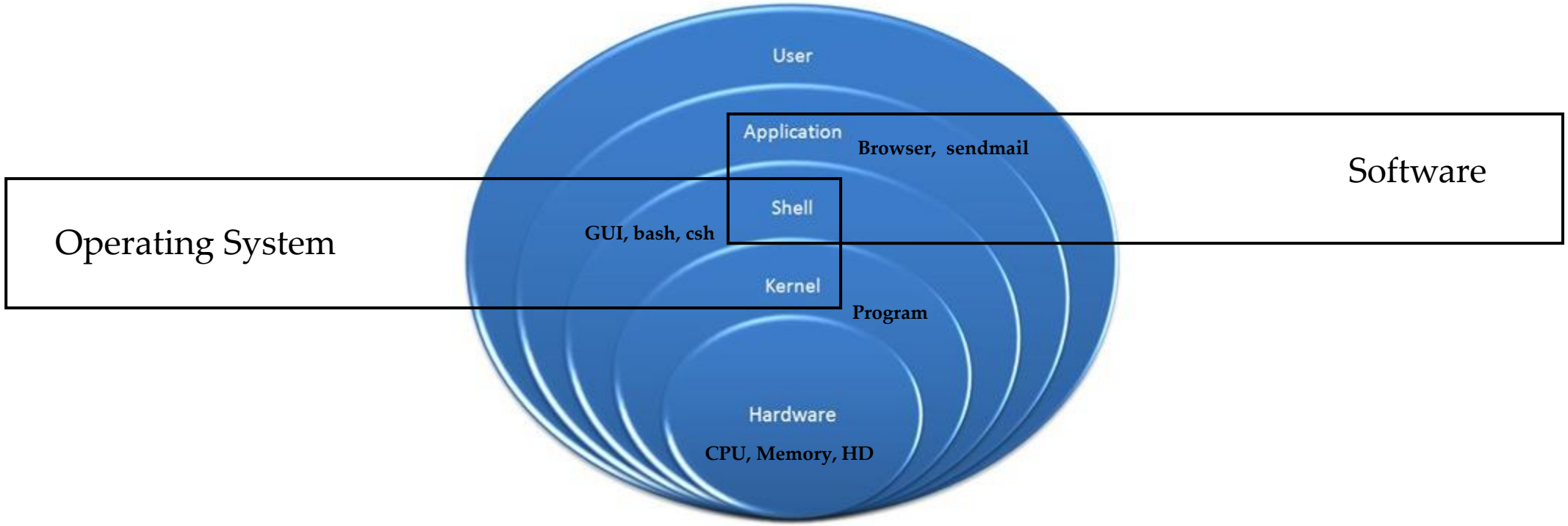
- Become root and create a directory allinone in / = **`mkdir /allinone`**
- Assign all rwx permissions to that directory = **`chmod 777 /allinone`**
- Become iafzal and create directory inside of /allinone = **`mkdir imrandir`**
- Give all rwx permissions to that directory = **`chmod 777 imrandir`**
- Create 3 files in that directory = **`touch a b c`**
- Open another terminal and login as spiderman
- Go to /allinone directory and delete imrandir directory = **`rm –rf imrandir`**
  - *You will see the directory is deleted*
- Now become root again and assign sticky bit permission to /allinone = **`chmod +t /allinone`**
- Become iafzal and create directory again inside of /allinone = **`mkdir imrandir`**
- Give all rwx permissions to that directory = **`chmod 777 imrandir`**
- Create 3 files in that directory = **`touch a b c`**
- Become spiderman user again
- Go to /allinone directory and try to delete imrandir directory = **`rm –rf imrandir`**
  - *Now as spiderman you cannot delete the directory*

Welcome To:
Module 6

Shell Scripting

Linux Kernel

- What is a Kernel?
  - Interface between hardware and Software



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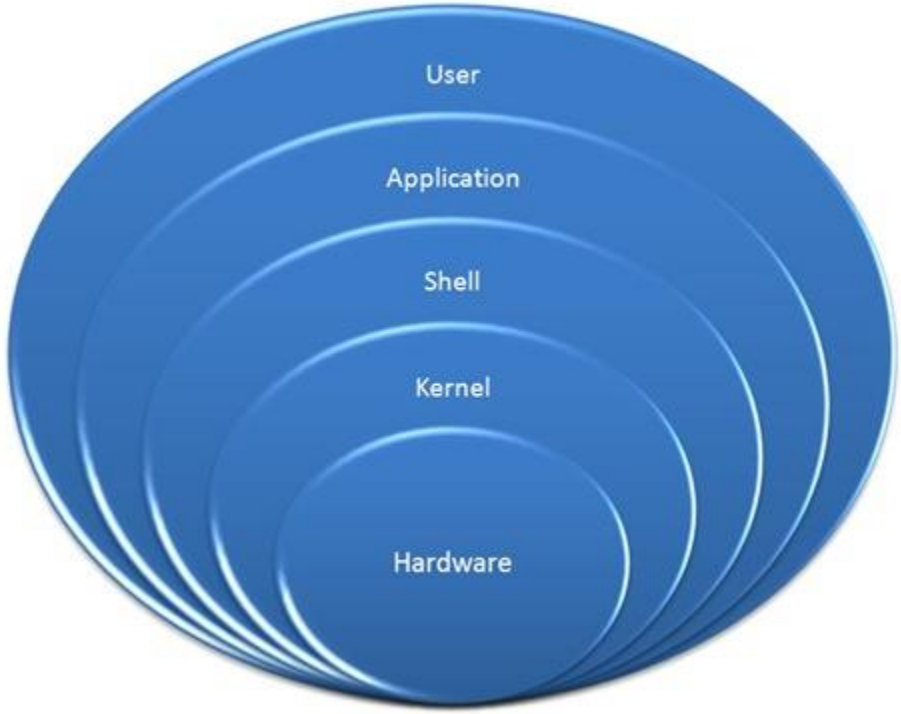
Introduction to Shell

- What is a Shell?
  - Its like a container
  - Interface between users and Kernel/OS
  - CLI is a Shell

- Find your Shell
  - echo $0
  - Available Shells “cat /etc/shells”
  - Your Shell? /etc/passwd



- Windows GUI is a shell
- Linux KDE GUI is a shell
- Linux sh, bash etc. is a shell

By: Imran Afzal

Types of Shell

- sh
- bash
- ksh
- csh

Starting a Shell

- Type shell name e.g. csh
- Type exit to exit out of shell

Shell Scripting

- What is a Shell Script?

  A shell script is an executable file containing multiple shell commands that are executed sequentially. The file can contain:

  - Shell (**`#!/bin/bash`**)
  - Comments (**`# comments`**)
  - Commands (**`echo, cp, grep etc.`**)
  - Statements (**`if, while, for`** etc.)

- Shell script should have executable permissions (e.g. **`-rwx r-x r-x`**)
- Shell script has to be called from absolute path (e.g **`/home/userdir/script.bash`**)
- If called from current location then **`./script.bash`**

By: Imran Afzal

Shell Script – Basic Scripts

- Output to screen using “echo”
- Creating tasks
  - Telling your id, current location, your files/directories, system info
  - Creating files or directories
  - Output to a file “>”
- Filters/Text processors through scripts (**`cut, awk, grep, sort, uniq, wc`**)

Input and Output of Script

- Create script to take input from the user

```
read
echo
```

if-then Scripts

- If then statement

```
If this happens      = do this
Otherwise            = do that
```

For Loop Scripts

- For loops

```
Keep running until specified number of variable
e.g: variable = 10 then run the script 10 times
OR
     variable = green, blue, red (then run the
     script 3 times for each color.
```

do-while Scripts

- do while

The while statement continually executes a block of statements while a particular condition is true or met

e.g: Run a script until 2pm

```
while [ condition ]
do
        command1
        command2
        commandN
done
```

Case Statement Scripts

- Case

```
If option a is selected  = do this
If option b is selected  = do this
If option c is selected  = do this.
```

Check Other Servers Connectivity

- A script to check the status of remote hosts

By: Imran Afzal

Aliases

- Aliases is a very popular command that is used to cut down on lengthy and repetitive commands

```
alias ls="ls -al“
alias pl=“pwd; ls”
alias tell=“whoami; hostname; pwd”
alias dir="ls -l | grep ^d"
alias lmar=“ls -l | grep Mar”
alias wpa= "chmod a+w"
alias d="df -h | awk '{print \$6}' | cut -c1-4"
```

Creating User or Global Aliases

- User = Applies only to a specific user profile
- Global = Applies to everyone who has account on the system

- User = **`/home/user/.bashrc`**
- Global = **`/etc/bashrc`**

```
alias hh="hostname"
```

Shell History

- `Command "history"`

Welcome To:
Module 7

Networking, Services and System Updates

Internet Access to VM

- Open **Virtualbox Manager**
- Select the machine you cannot get internet on in the left pane
- Click the **Settings** button in the top menu
- Click **Network** in the left pane in the settings window
- Switched to **Bridged Adaptor** in the **Attached to** drop-down menu
- Hit **OK** to save your changes
- Start your VM

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Network Components

- IP
- Subnet mask
- Gateway
- Static vs. DHCP

- Interface
- Interface MAC.

Network Files and Commands

- Interface Detection
- Assigning an IP address
- Interface configuration files
  - /etc/nsswitch.conf
  - /etc/hostname
  - /etc/sysconfig/network
  - /etc/sysconfig/network-scripts/ifcfg-nic
  - /etc/resolv.conf

- Network Commands
  - **`ping`**
  - **`ifconfig`**
  - **`ifup or ifdown`**
  - **`netstat`**
  - **`tcpdump`**

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NIC Information

NIC = Network Interface Card

Example:

```
ethtool enp0s3
```

Other NICs

`lo` = The loopback device is a special interface that your computer uses to communicate with itself. It is used mainly for diagnostics and troubleshooting, and to connect to servers running on the local machine

`virb0` = The virbr0, or "Virtual Bridge 0" interface is used for NAT (Network Address Translation). Virtual environments sometimes use it to connect to the outside network

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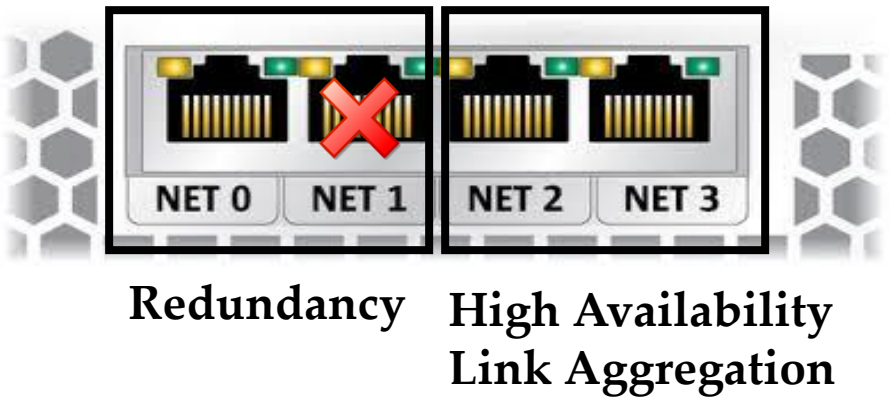
NIC Bonding

NIC = Network Interface Card (PC or laptop)

NIC(Network Interface Card) bonding is also known as Network bonding. It can be defined as the aggregation or combination of multiple NIC into a single bond interface.

It's main purpose is to provide high availability and redundancy



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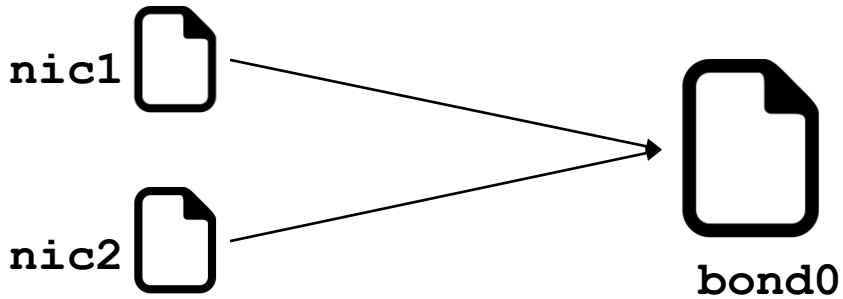
NIC Bonding Procedure

- modprobe bonding
- modinfo bonding
- Create /etc/sysconfig/network-scripts/ifcfg-bond0
- Edit /etc/sysconfig/network-scripts/ethernet1
- Edit /etc/sysconfig/network-scripts/ethernet2



- Restart network = systemctl restart network

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New Network Utilities

What we will learn in this lecture…

- Getting started with **NetworkManager**
- Network configuration methods
  - **`nmtui`**
  - **`nmcli`**
  - **`nm-connection-editor`**
  - **`GNOME Settings.`**

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New Network Utilities

✓ Getting started with `NetworkManager`

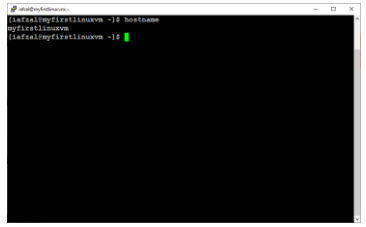
- NetworkManager is a service that provides set of tools designed specifically to make it easier to manage the networking configuration on Linux systems and is the default network management service on RHEL 8
- It makes network management easier
- It provides easy setup of connection to the user
- NetworkManager offers management through different tools such as **`GUI, nmtui, and nmcli.`**

New Network Utilities

✓ Network configuration methods

- **`nmcli`** – Short for network manager command line interface. This tool is useful when access to a graphical environment is not available and can also be used within scripts to make network configuration changes
- **`nmtui`** – Short for network manager text user interface. This tool can be run within any terminal window and allows changes to be made by making menu selections and entering data
- **`nm-connection-editor`** - A full graphical management tool providing access to most of the NetworkManager configuration options. It can only be accessed through the desktop or console
- **`GNOME Settings`** - The network screen of the GNOME desktop settings application allows basic network management tasks to be performed

- Let's practice in our Linux machine…



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Manage Linux Networking

✓ Using nmcli to configure static IP

- `# nmcli device` *(Get the listing of network interface)*
- `# nmcli connection modify enp0s3 ipv4.addresses 10.253.1.211/24`
- `# nmcli connection modify enp0s3 ipv4.gateway 10.253.1.1`
- `# nmcli connection modify enp0s3 ipv4.method manual`
- `# nmcli connection modify enp0s3 ipv4.dns 8.8.8.8`
- `# nmcli connection down enp0s3 && nmcli connection up enp0s3`
- `# ip address show enp0s3`

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Manage Linux Networking

✓ Adding secondary static IP using nmcli

- `# nmcli device status`
- `# nmcli connection show –active`
- `# ifconfig`
- `# nmcli connection modify enp0s3 +ipv4.addresses 10.0.0.211/24`
- `# nmcli connection reload`
- `# systemctl reboot`
- `# ip address show`

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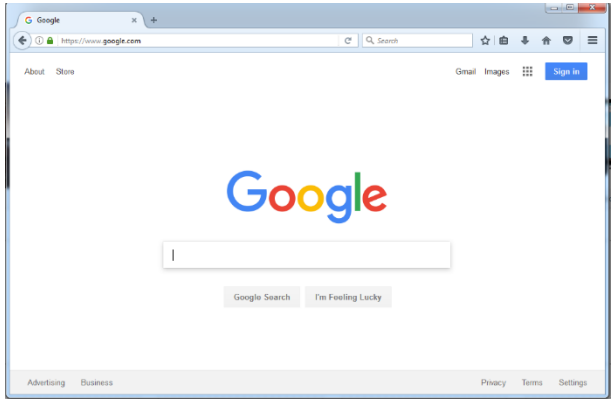
System Updates and Repos

- yum (CentOS), apt-get (other Linux)
- rpm (Redhat Package Manager)

Download Files or Apps

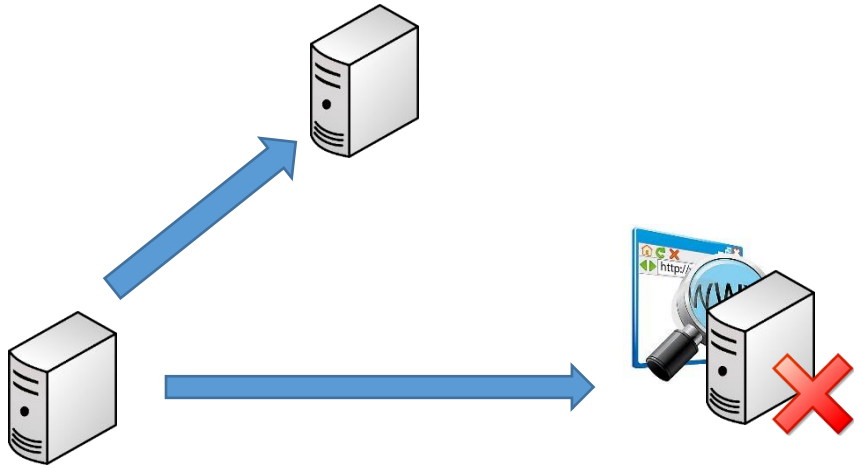
- Example of Windows browser



- Linux = **wget**

- Example in Linux:

wget http://website.com/filename



- **Why???**

Most of the servers in corporate environment do **NOT** have internet access

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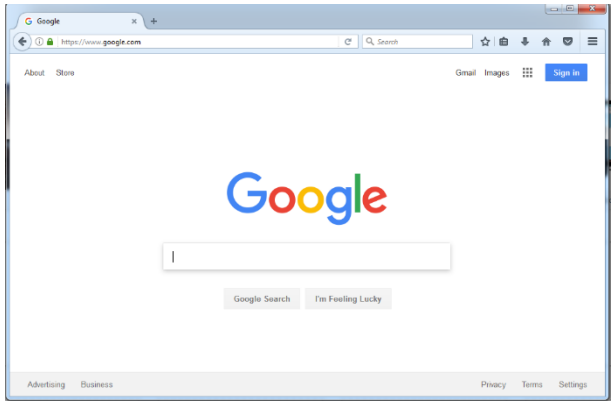
curl and ping Commands

- Example of Windows browser



- Linux = **curl**
- **Linux = ping**

- Example in Linux:

```
curl http://website.com/filename
curl -O http://website.com/filename

ping www.google.com
```

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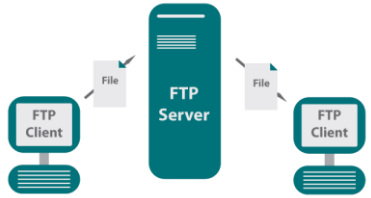
FTP – File Transfer Protocol

- The File Transfer Protocol is a standard network protocol used for the transfer of computer files between a client and server on a computer network. FTP is built on a client-server model architecture using separate control and data connections between the client and the server. *(Wikipedia)*



- Protocol = Set of rules used by computers to communicate

- Default FTP Port = 21

- For this lecture we need 2 Linux machines
  - **`Client = MyFirstLinuxVM`**
  - **`Server = LinuxCentOS7`**

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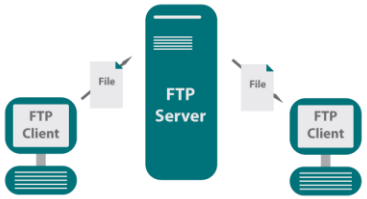
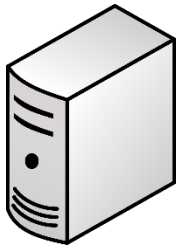
FTP – File Transfer Protocol



Client = A



FTP

Server = B

ftpd = 21

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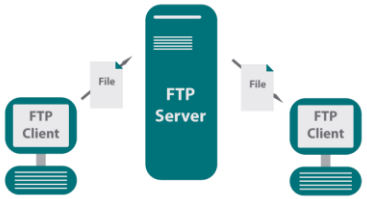
www.utclisolutions.com

FTP – File Transfer Protocol

- **Install and Configure FTP on the remote server**
  - **# Become root**
  - **# rpm -qa | grep ftp**
  - **# ping www.google.com**
  - **# yum install vsftpd**
  - **# vi /etc/vsftpd/vsftpd.conf** ***(make a copy first)***



  - Find the following lines and make the changes as shown below:
  - ## Disable anonymous login ##
    - ***anonymous_enable=NO***

  - ## Uncomment ##
    - ***ascii_upload_enable=YES***
    - ***ascii_download_enable=YES***

  - ## Uncomment - Enter your Welcome message - This is optional ##
    - ***ftpd_banner=Welcome to UNIXMEN FTP service.***

  - ## Add at the end of this file ##
    - ***use_localtime=YES***

  - **# systemctl start vsftpd**
  - **# systemctl enable vsftpd**
  - **# systemctl stop firewalld**
  - **# systemctl disable firewalld**
  - **# useradd iafzal** *(if the user does not exist).*

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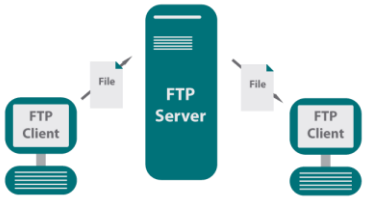
FTP – File Transfer Protocol



- **Install FTP client on the client server**
  - `# Become root`
  - `# yum install ftp`
  - `# su – iafzal`
  - `$ touch kruger`

  - **Commands to transfer file to the FTP server:**
  - `ftp 192.168.1.x`
  - `Enter username and password`
  - `bi`
  - `hash`
  - `put kruger`
  - `bye.`

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SCP – Secure Copy Protocol

- The Secure Copy Protocol or “SCP” helps to transfer computer files securely from a local to a remote host. It is somewhat similar to the File Transfer Protocol “FTP”, but it adds security and authentication
- Protocol = Set of rules used by computers to communicate
- Default SCP Port = 22 (same as SSH)
- For this lecture we need 2 Linux machines
  - **`Client = MyFirstLinuxVM`**
  - **`Server = LinuxCentOS7`**

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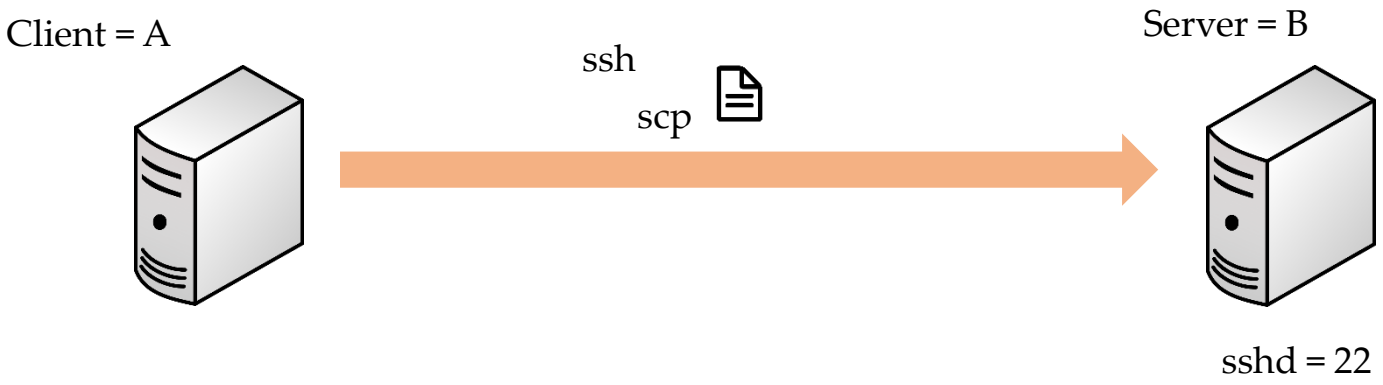
SCP – Secure Copy



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SCP – Secure Copy

- **SCP commands to transfer file to the remote server:**
  - `Login as yourself (iafzal)`
  - `touch jack`
  - `scp jack iafzal@192.168.1.x:/home/iafzal`
  - `Enter username and password`

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rsync – Remote Synchronization

- **rsync** is a utility for efficiently transferring and synchronizing files within the same computer or to a remote computer by comparing the modification times and sizes of files

- rsync is a lot faster than ftp or scp
- This utility is mostly used to backup the files and directories from one server to another
- Default rsync Port = 22 (same as SSH)
- For this lecture we need 2 Linux machines
  - **`Client = MyFirstLinuxVM`**
  - **`Server = LinuxCentOS7`**

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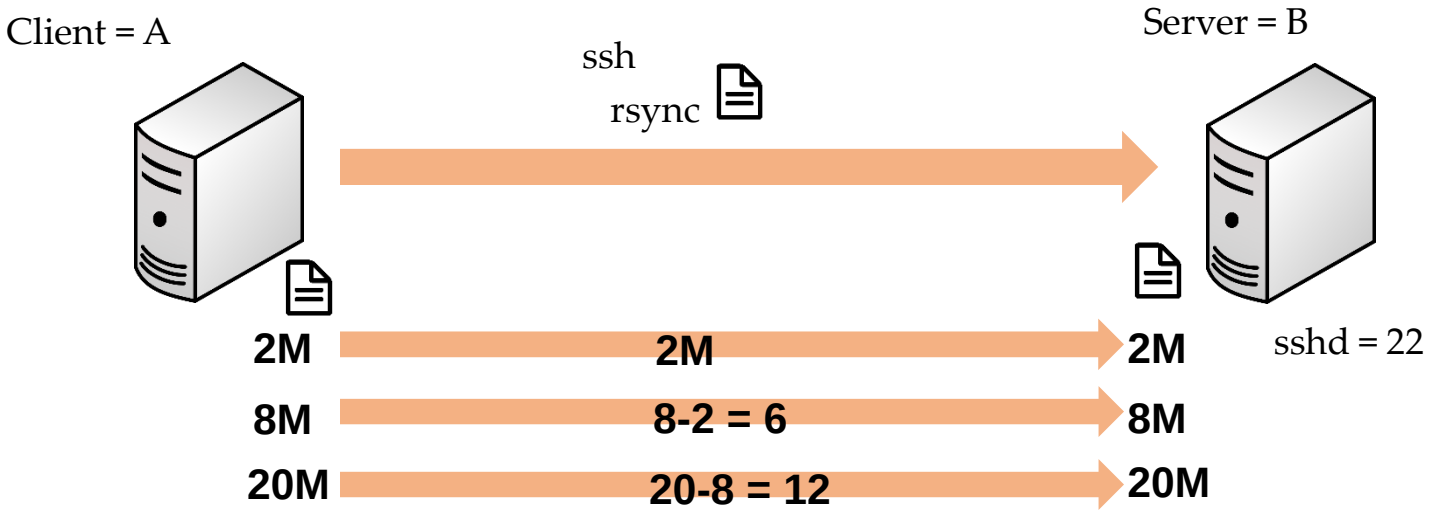
rsync – Remote Synchronization



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rsync – Remote Synchronization

- **Basic syntax of rsync command**
  - `# rsync options source destination`

- **Install rsync in your Linux machine** *(check if it already exists)*
  - `# yum install rsync` *(On CentOS/Redhat based systems)*
  - `# apt-get install rsync` *(On Ubuntu/Debian based systems)*

- **rsync a file on a local machine**
  - `$ tar cvf backup.tar .` *(tar the entire home directory (/home/iafzal)*
  - `$ mkdir /tmp/backups`
  - `$ rsync -zvh backup.tar /tmp/backups/`

- **rsync a directory on a local machine**
  - `$ rsync -azvh /home/iafzal /tmp/backups/`

- **rsync a file to a remote machine**
  - `$ mkdir /tmp/backups` *(create /tmp/backups dir on remote server)*
  - `$ rsync -avz backup.tar iafzal@192.168.1.x:/tmp/backups`

- **rsync a file from a remote machine**
  - `$ touch serverfile`
  - `$ rsync -avzh iafzal@192.168.1.x:/home/iafzal/serverfile /tmp/backups`

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System Upgrade/Patch Management

- Two type of upgrades
  - Major version = 5, 6, 7
  - Minor version = 7.3 to 7.4

Major version = yum command 

Minor version = yum update 

Example:

```
yum update -y
```

yum update vs. upgrade

upgrade = delete packages 

update = preserve 

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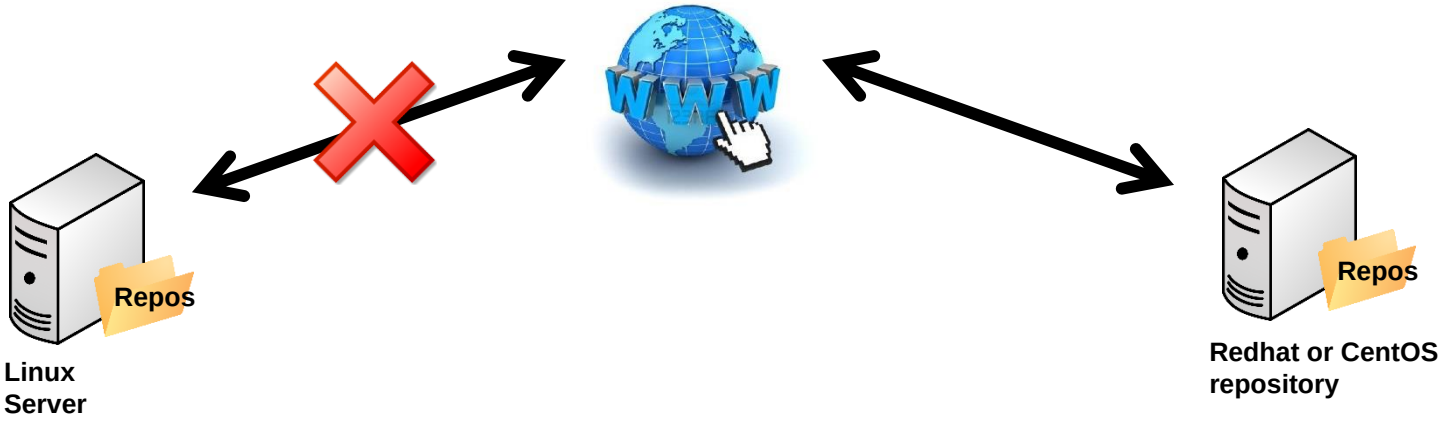
Create Local Repository from DVD

- What is local repository?



- Command
  `createrepo`

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Advance Package Management

- Installing packages
- Upgrading
- Deleting
- View package details information
- Identify source or location information
- Packages configuration files

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Rollback Updates and Patches

- Virtual machine
- Physical machine

- Rollback a package or patch
  - **`yum install <package-name>`**
  - **`yum history undo <id>`**

- Rollback an update
  - Downgrading a system to minor version (ex: RHEL7.1 to RHEL7.0) is not recommended as this might leave the system in undesired or unstable state

  - **`yum update`**= Update will preserve them
  - **`yum upgrade`** = Upgrade will delete obsolete packages
  - **`yum history undo <id>`**

By: Imran Afzal

SSH and Telnet

- Telnet = Un-secured connection between computers
- SSH = Secured

- Two type of packages for most of the services
  - Client package
  - Server package

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DNS = Domain Name System

- Purpose?

  Hostname to IP (A Record)

  IP to Hostname (PTR Record)

  Hostname to Hostname (CNAME Record)

- Files

  /etc/named.conf

  /var/named

- Service

  systemctl restart named

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Download, Install and Configure DNS

- Create a snapshot of your virtual machine
- Setup:
  - Master DNS
  - Secondary or Slave DNS
  - Client

- Domain Name = lab.local
- IP address = My local IP address on enp0s3

- Install DNS package
  - `yum install bind bind-utils -y`
- Configure DNS **(Summary)**
  - `Modify /etc/named.conf`
  - `Create two zone files (forward.lab and reverse.lab)`
  - `Modify DNS file permissions and start the service`

- Revert back to snapshot

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Hostname/IP Lookup

- Commands used for DNS lookup
  - **`nslookup`**
  - **`dig`**

NTP

- **Purpose?**

  Time synchronization

- **File**

  /etc/ntp.conf

- **Service**

  systemctl restart ntpd

- **Command**

  ntpq

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chronyd

- Purpose? = Time synchronization
- Package name = chronyd
- Configuration file = /etc/chronyd.conf
- Log file = /var/log/chrony
- Service = systemctl start/restart chronyd
- Program command = chronyd.

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New System Utility Command (`timedatectl`)

- The **`timedatectl`** command is a new utility for RHEL/CentOS 7/8 based distributions, which comes as a part of the systemd system and service manager
- It is a replacement for old traditional **`date`** command
- The **`timedatectl`** command shows/change date, time, and timezone
- It synchronizes the time with NTP server as well
  - You can either use **`chronyd`** or **`ntpd`** and make the ntp setting in **`timedatectl`** as **`yes`**
  - Or you can use **`systemd-timesyncd`** daemon to synchronize time which is a replacement for ntpd and chronyd

Please note:

Redhat/CentOS does not provide this daemon in its standard repo. You will have to download it separately.

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New System Utility Command `(timedatectl)`

Lab exercise:

- To check time status
  - **`timedatectl`**
- To view all available time zones
  - **`timedatectl list-timezones`**
- To set the time zone
  - **`timedatectl set-timezone "America/New_York"`**
- To set date
  - **`timedatectl set-time YYYY-MM-DD`**
- To set date and time
  - **`timedatectl set-time '2015-11-20 16:14:50'`**
- To start automatic time synchronization with a remote NTP server
  - **`timedatectl set-ntp true.`**

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Sendmail - OLD

- **Purpose?**

  Send and receive emails

- **Files**

  /etc/mail/sendmail.mc

  /etc/mail/sendmail.cf

  /etc/mail

- **Service**

  systemctl restart sendmail

- **Command**

  mail –s “subject line” email@mydomain.com

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Sendmail

- **Sendmail** is a program in Linux operating systems that allows systems administrator to send email from the Linux system

- It uses SMTP (Simple Mail Transfer Protocol)
- SMTP port = 25

- It attempts to deliver the mail to the intended recipient immediately and, if the recipient is not present, it queues messages for later delivery.

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Sendmail

- Sendmail installation and configuration
  - **# su –** *(Login as root)*
  - **# rpm –qa | grep sendmail** *(verify if it is already installed)*
  - **# yum install sendmail sendmail-cf**
  - **# vi /etc/mail/sendmail.mc**
  - **# systemctl start sendmail**
  - **# systemctl enable sendmail**
  - **# systemctl stop firewalld**
  - **# systemctl disable firewalld**

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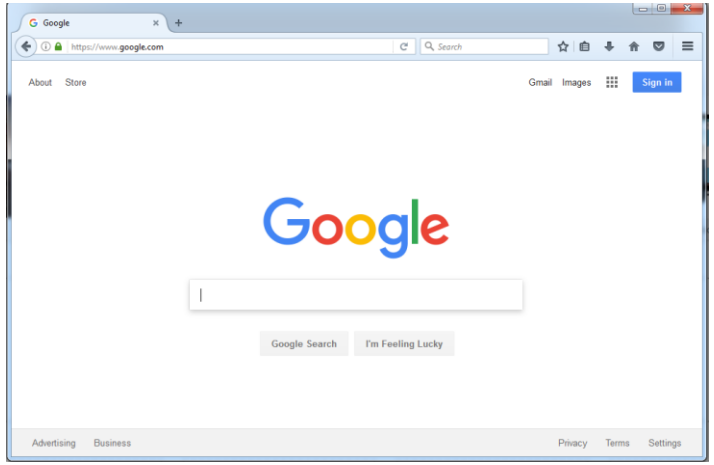
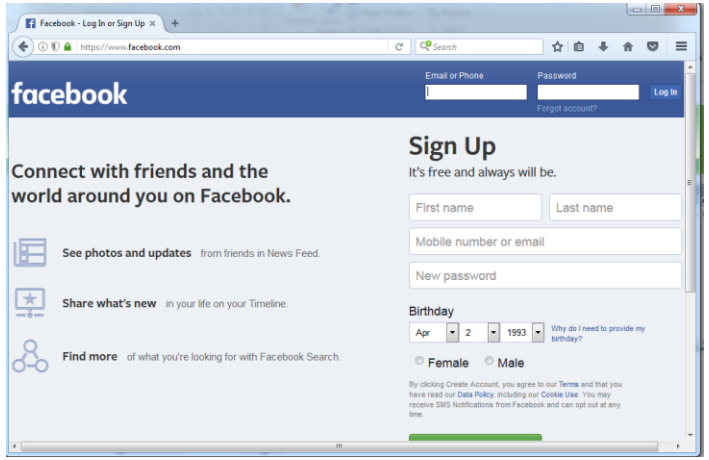
Web Server (httpd)

- Purpose = Serve webpages





- Service or Package name = **`httpd`**
- Files = **`/etc/httpd/conf/httpd.conf`**
  = **`/var/www/html/index.html`**
- Log Files = **`/var/log/httpd/`**
- Service

```
systemctl restart httpd
systemctl enable httpd
```

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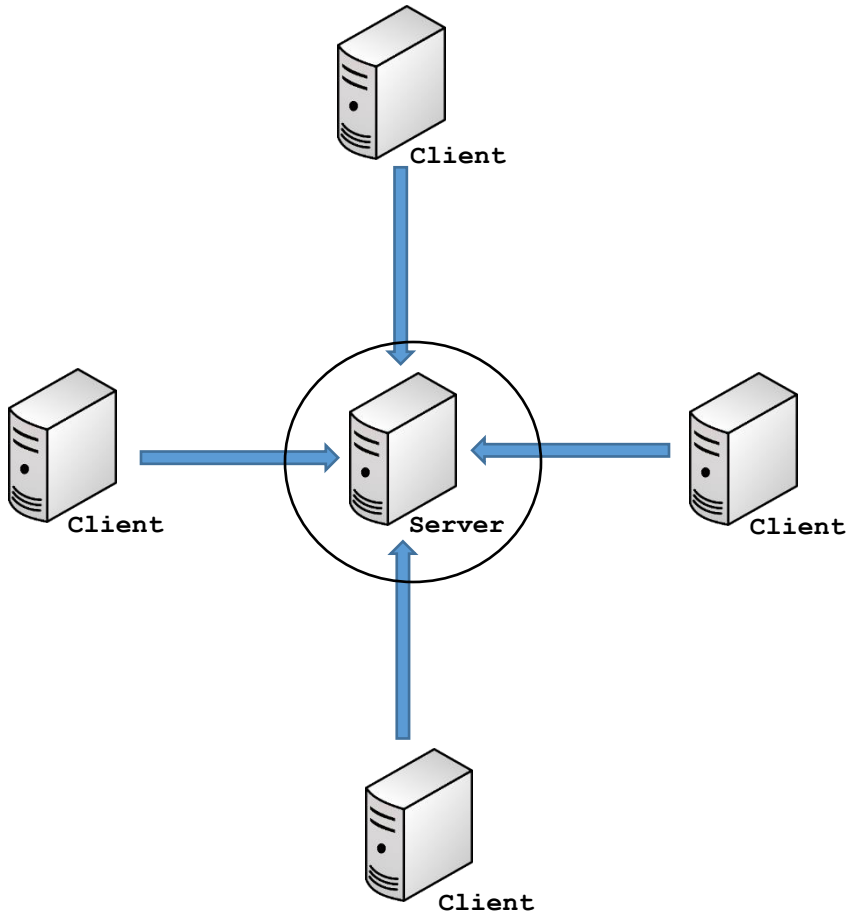
Central Logger (rsyslog)

- Purpose = Generate logs or collect logs from other servers
- Service or package name = **`rsyslog`**
- Configuration file= **`/etc/syslog.conf`**
- Service

```
systemctl restart rsyslog
systemctl enable rsyslog
```



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Linux OS Hardening

- User Account
- Remove un-wanted packages
- Stop un-used Services
- Check on Listening Ports
- Secure SSH Configuration
- Enable Firewall (iptables/firewalld)
- Enable SELinux
- Change Listening Services Port Numbers
- Keep your OS up to date (security patching)

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OpenLDAP Installation

- What is OpenLDAP?
- OpenLDAP Service
  - `slapd`
- Start or stop the service
  - `systemctl start slapd`
  - `systemctl enable slapd`
- Configuration Files
  - `/etc/openldap/slapd.d`

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Trace Network Traffic (traceroute)

- The traceroute command is used in Linux to map the journey that a packet of information undertakes from its source to its destination. One use for traceroute is to locate when data loss occurs throughout a network, which could signify a node that's down.
- Because each hop in the record reflects a new server or router between the originating PC and the intended target, reviewing the results of a traceroute scan also lets you identify slow points that may adversely affect your network traffic.

- Example

```
# traceroute www.google.com
```

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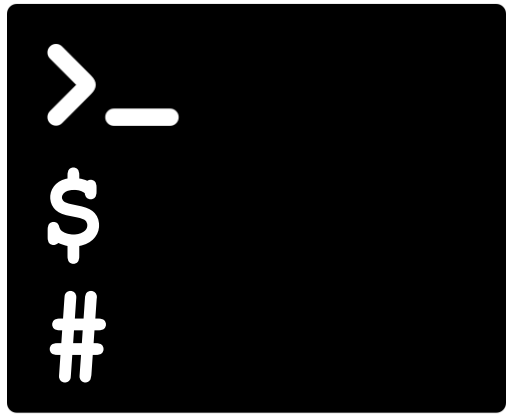
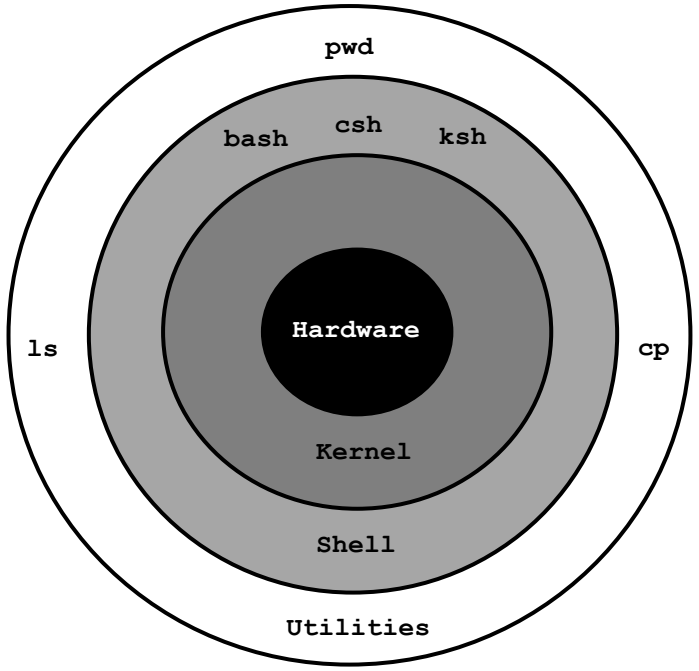
Configure and Secure SSH

- **SSH**
  - SSH stands for secure shell

provides you with an interface to the Linux system. It takes in your commands and translate them to kernel to manage hardware





- Open SSH is a package/software
- Its service daemon is sshd
- SSH port # 22

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Configure and Secure SSH

- SSH itself is secure, meaning communication through SSH is always encrypted, but there should be some additional configuration can be done to make it more secure
- Following are the most common configuration an administrator should take to secure SSH

✓ **Configure Idle Timeout Interval**

Avoid having an unattended SSH session, you can set an Idle timeout interval

- Become root
- Edit your **`/etc/ssh/sshd_config`** file and add the following line:
- **`ClientAliveInterval 600`**
- **`ClientAliveCountMax 0`**
- **`# systemctl restart sshd`**

The idle timeout interval you are setting is in seconds (600 secs = 10 minutes). Once the interval has passed, the idle user will be automatically logged out

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Configure and Secure SSH

- ✓ **Disable root login**

  Disabling root login should be one of the measures you should take when setting up the system for the first time. It disable any user to login to the system with root account

  - Become root
  - Edit your **`/etc/ssh/sshd_config`** file and replace PermitRootLogin yes to no
  - **`PermitRootLogin no`**
  - **`# systemctl restart sshd`**

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Configure and Secure SSH

✓ **Disable Empty Passwords**

You need to prevent remote logins from accounts with empty passwords for added security.

- Become root
- Edit your **`/etc/ssh/sshd_config`** file and remove # from the following line
- **`PermitEmptyPasswords no`**
- **`# systemctl restart sshd`**

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Configure and Secure SSH

✓ **Limit Users' SSH Access**

To provide another layer of security, you should limit your SSH logins to only certain users who need remote access

- Become root
- Edit your **`/etc/ssh/sshd_config`** file and add
- **`AllowUsers user1 user2`**
- **`# systemctl restart sshd`**

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Configure and Secure SSH

✓ **Use a different port**

By default SSH port runs on 22. Most hackers looking for any open SSH servers will look for port 22 and changing can make the system much more secure

- Become root
- Edit your **`/etc/ssh/sshd_config`** file and remove # from the following line and change the port number
- **`Port 22`**
- **`# systemctl restart sshd`**

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Configure and Secure SSH

- ✓ **SSH-Keys - Access Remote Server without Password**

Watch the next video

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Configure and Secure SSH

Access Remote Server without Password (SSH-Keys)

- Two reasons to access a remote machine
  - Repetitive logins
  - Automation through scripts

- Keys are generated at user level
  - iafzal
  - root

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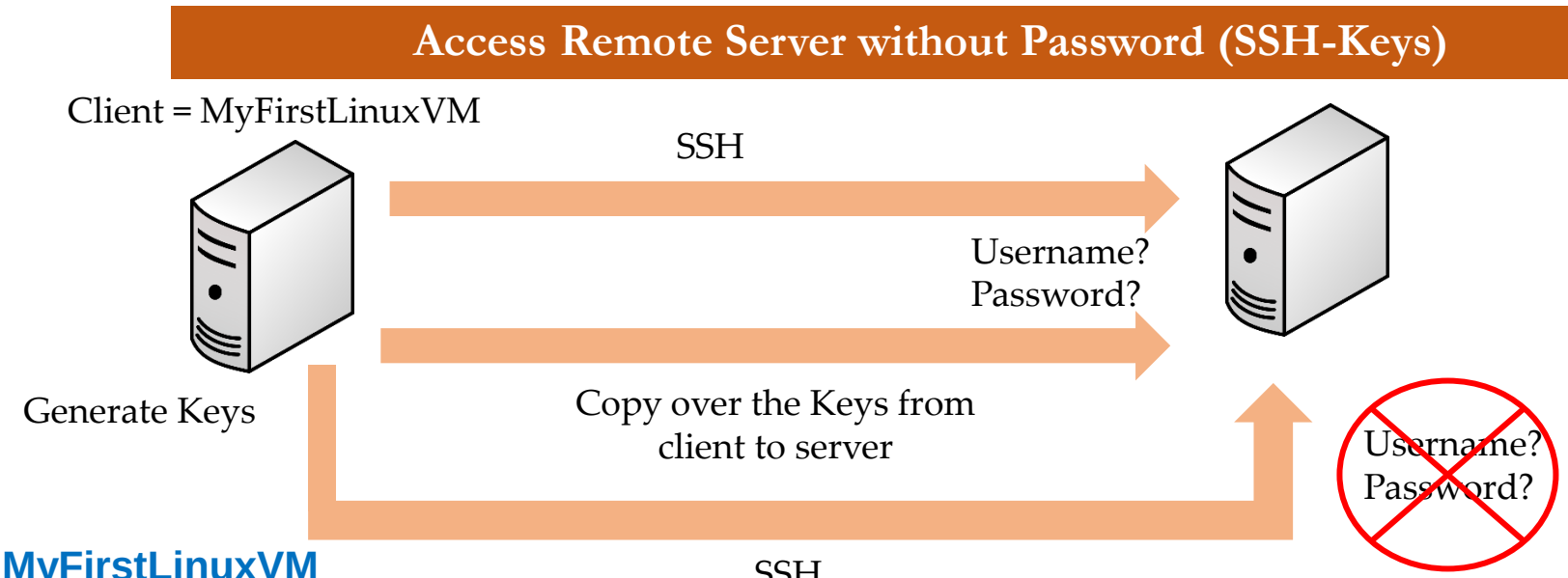
Configure and Secure SSH



Client = MyFirstLinuxVM

Step 1 — Generate the Key

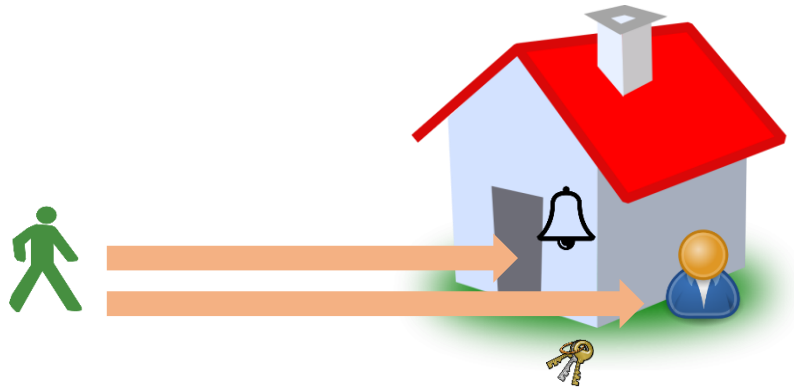
```
# ssh-keygen
```

Step 2 — Copy the Key to the server

```
# ssh-copy-id root@192.168.1.x
```

Step 3 — Login from client to server

```
# ssh root@192.168.1.x
# ssh -l root 192.168.1.x
```



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SSH without a Password

- SSH is a secure way to login from host A to host B
- Repetitive tasks require login without a password

What we will learn…

- How to generate SSH keys on the server
- Add SSH keys to the client
- Verify by logging through SSH.

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Access Remote Server without Password (SSH-Keys)

- Two reasons to access a remote machine
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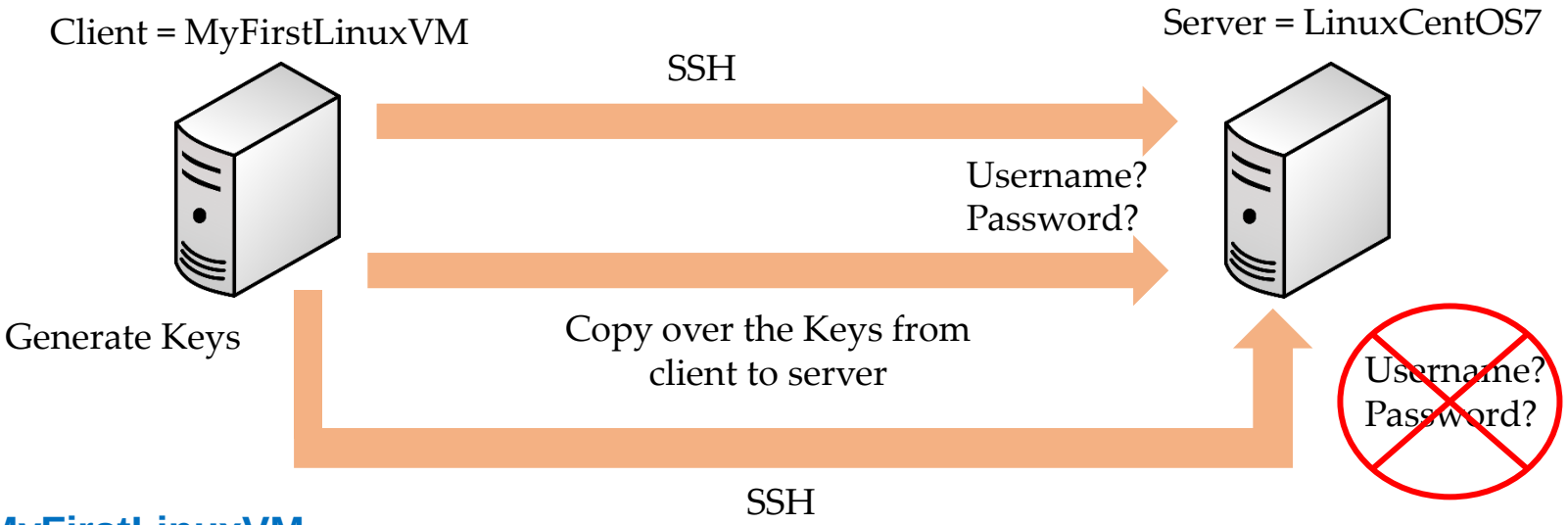
Access Remote Server without Password (SSH-Keys)



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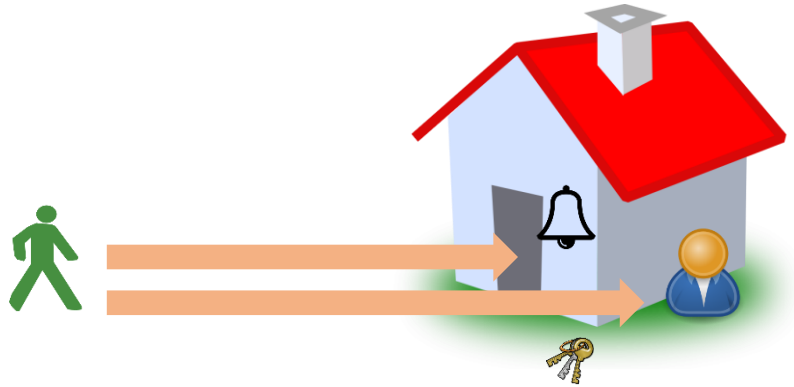

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Cockpit

- Cockpit is a server administration tool sponsored by Red Hat, focused on providing a modern-looking and user-friendly interface to manage and administer servers
- Cockpit is the easy-to-use, integrated, glanceable, and open web-based interface for your servers
- The application is available in most of the Linux distributions such as, CentOS, Redhat, Ubuntu and Fedora
- It is installed in Redhat 8 by default and it is optional in version 7
- It can monitor system resources, add or remove accounts, monitor system usage, shut down the system and perform quite a few other tasks all through a very accessible web connection

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Install, Configure and Manage Cockpit

- Check for network connectivity
  - **`ping www.google.com`**
- Install cockpit package as root
  - **`yum/dnf install cockpit -y`** *(For RH or CentOS)*
  - **`apt-get install cockpit`** *(For Ubuntu)*
- Start and enable the service
  - **`systemctl start|enable cockpit`**
- Check the status of the service
  - **`systemctl status cockpit`**
- Access the web-interface
  - **`https://192.168.1.x:9090`**

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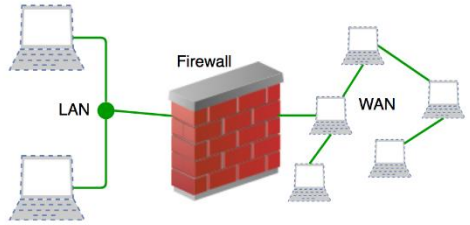
Introduction to Firewall

- What is Firewall
  - A wall that prevents the spread of fire
  - When data moves in and out of a server its packet information is tested against the firewall rules to see if it should be allowed or not
  - In simple words, a firewall is like a watchman, a bouncer, or a shield that has a set of rules given and based on that rule they decide who can enter and leave
  - There are 2 type of firewalls in IT
    - Software = Runs on operating system
    - Hardware = A dedicated appliance with firewall software



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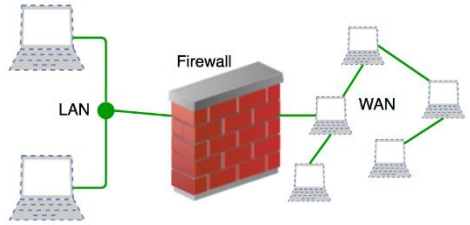
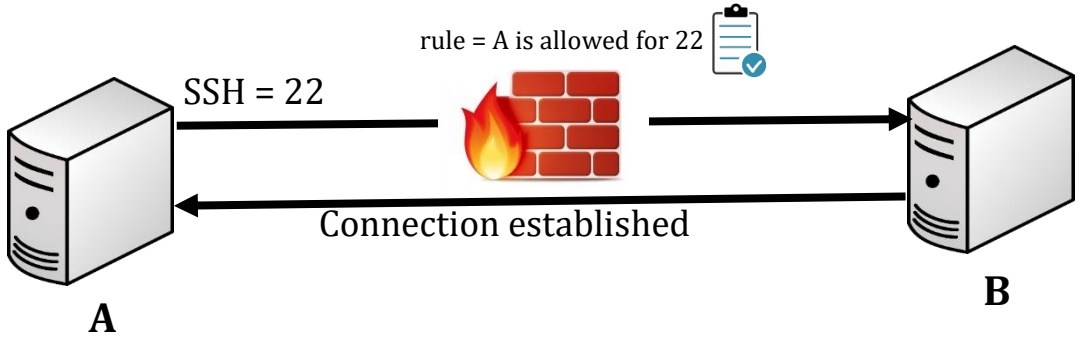
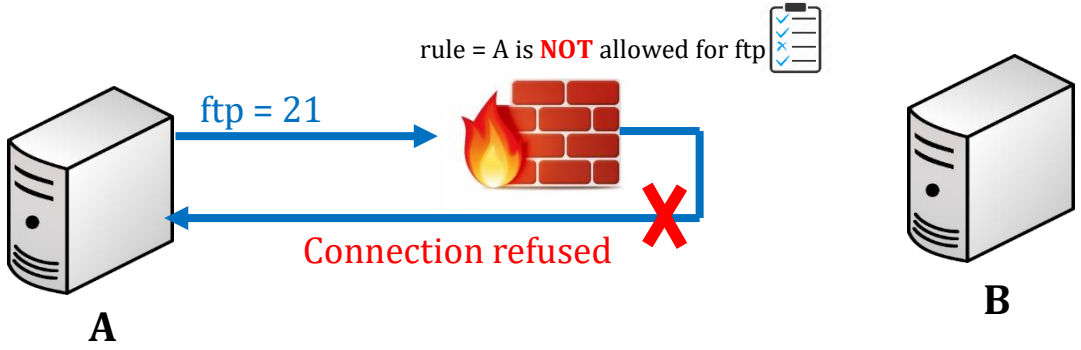
Introduction to Firewall







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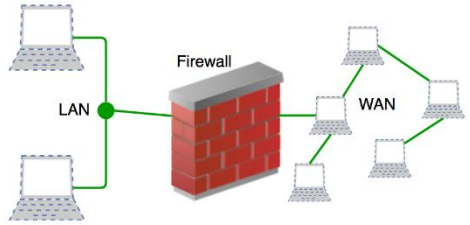
Firewall *(iptables – tables, chains and targets)*

- There are 2 tools to manage firewall in most of the Linux distributions
  - iptables = For older Linux versions but still widely used
  - firewalld = For newer versions like 7 and up



- You can run one or the other
  - In this lecture we will work with **iptables** to manage firewall

  - Before working with iptables make sure firewalld is not running and disable it
    - **`service OR systemctl stop firewalld`** = To stop the service
    - **`systemctl disable firewalld`** = To prevent from starting at boot time
    - **`systemctl mask firewalld`** = To prevent it from running by other programs

  - Now check if you have iptables-services package installed
    - **`rpm –qa | grep iptables-services`**
    - **`yum install iptables-services -`** *If not installed then*

  - Start the service
    - **`systemctl start iptables`**
    - **`systemctl enable iptables`**

  - To check the iptables rules
    - **`iptables –L`**

  - To flush iptables.
    - **`iptables -F`**

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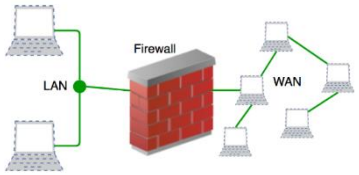
Firewall *(iptables – tables, chains and targets)*



- The function of iptables tool is packet filtering
- The packet filtering mechanism is organized into three different kinds of structures: **tables,** **chains** and **targets**

1. **`tables`** = table is something that allows you to process packets in specific ways. There are 4 different types of tables, **filter**, mangle, nat and raw

2. **`chains`** = The chains are attached to tables, These chains allow you to inspect traffic at various points. There are 3 main chains used in iptables
   - INPUT = incoming traffic
   - FORWARD = going to a router, from one device to another
   - OUTPUT = outgoing traffic
     - chains allow you to filter traffic by adding rules to them
     - Rule = if traffic is coming from `192.168.1.35` then go to defined target

3. **`targets`** = target decides the fate of a packet, such as allowing or rejecting it. There are 3 different type of targets
   - ACCEPT = connection accepted
   - REJECT = Send reject response
   - DROP = drop connection without sending any response

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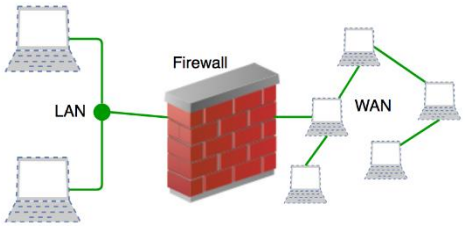
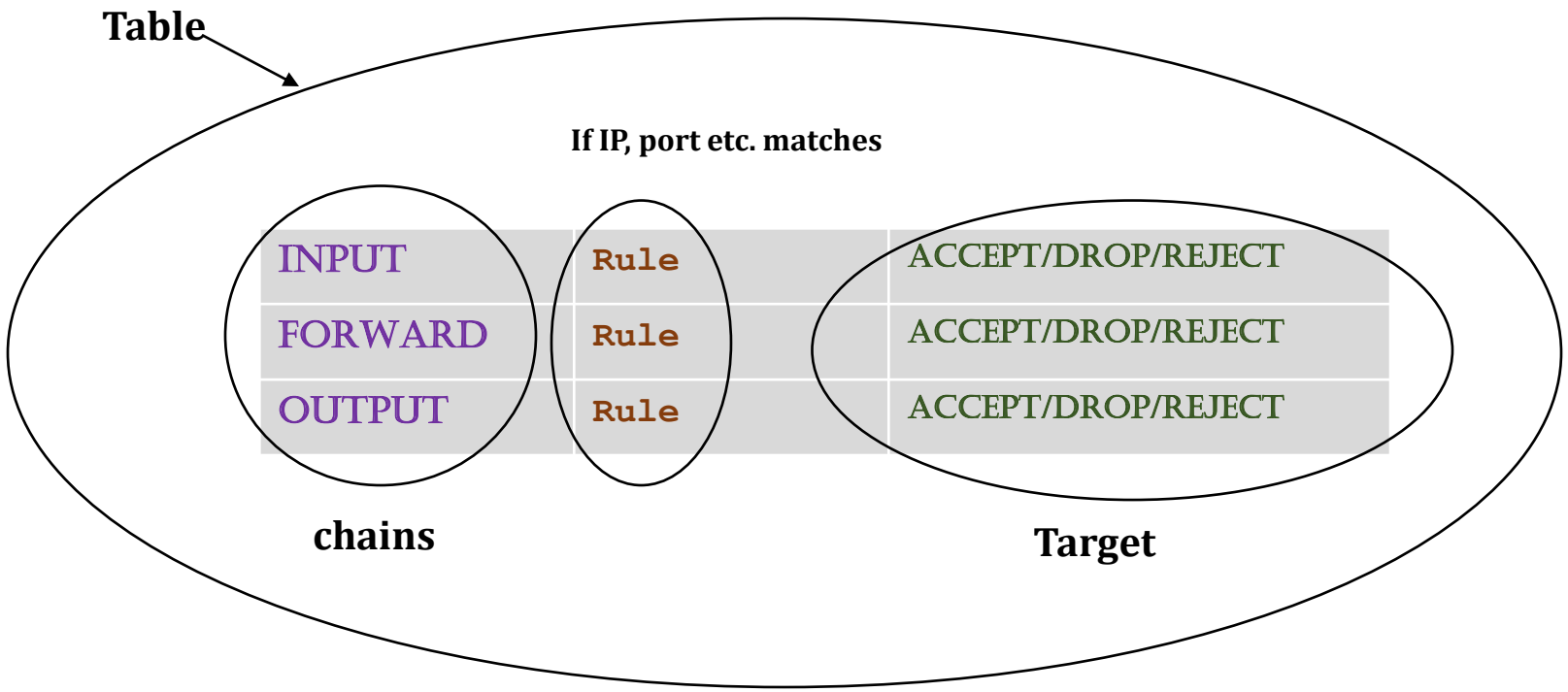
Firewall *(iptables – tables, chains and targets)*

Let's draw it out:





- To check the iptables rules
  - `iptables -L`

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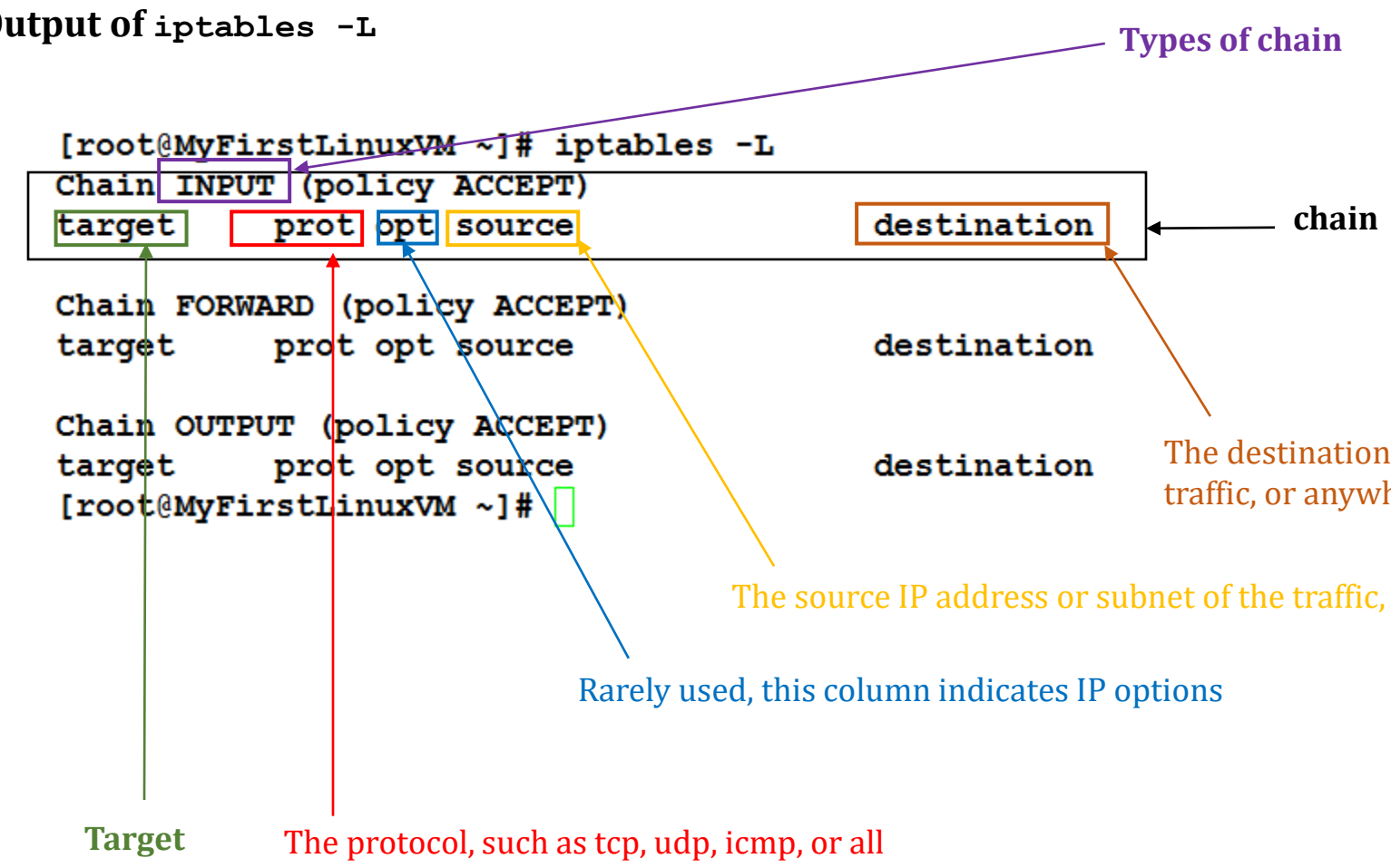
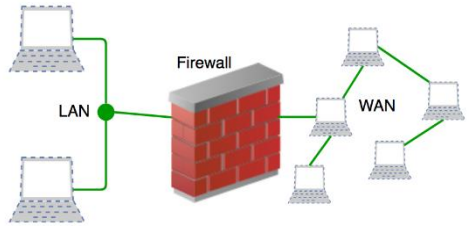
Firewall *(iptables – tables, chains and targets)*

Output of `iptables -L`





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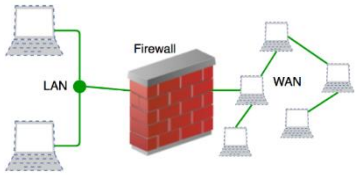
Firewall *(iptables – practical examples)*



- Drop all traffic coming from a specific IP (192.168.0.25)
  - `iptables –A INPUT –s 192.168.0.25 –j DROP`
- Drop all traffic coming from a range of IPs (192.168.0.0)
  - `iptables –A INPUT –s 192.168.0.0/24 –j DROP`
- List all rules in a table by line numbers
  - `iptables –L --line-numbers`
- Delete a specific rule by line number
  - `iptables –D INPUT 1`
- To flush the entire chain
  - `iptables –F`
- To block a specific protocol with rejection (e.g. ICMP)
  - `iptables -A INPUT -p icmp -j REJECT`
- To block a specific protocol without rejection (e.g. ICMP)
  - `iptables -A INPUT -p icmp -j DROP`
- To block a specific port # (e.g. http port 80)
  - `iptables -A INPUT -p tcp --dport 80 -j DROP`

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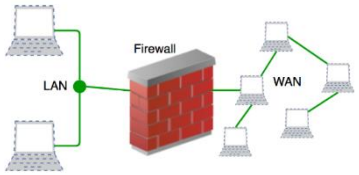
Linux Firewall *(iptables – practical examples)*

Practical:



- Block connection to a network interface
  - **`iptables -A INPUT -i enps03 -s 192.168.0.25 -j DROP`**
- Drop all traffic going to www.facebook.com
  - **`host -t a www.facebook.com` = find IP address**
  - **`iptables –A OUTPUT –d 31.13.71.36 –j DROP`**
- Block all outgoing traffic to a network range
  - **`iptables –A OUTPUT –d 31.13.71.0/24 –j DROP`**
- Block all incoming traffic except SSH
  - **`iptables -A INPUT -p tcp --dport 22 -j ACCEPT`**
  - **`iptables -P INPUT DROP`**
- After making all the changes save the iptables. Again make sure firewalld is not running
  - **`iptables-save`** = The file is save in /etc/sysconfig/iptables
- iptables saved file can also be restored
  - **`iptables-restore /LOCATION/FILENAME`**
- By default everything is logged in
  - **`/var/log/messages`**

- IMPORTANT: The iptables read the rules in sequence
  - DROP first then it will drop all without going to the next one
  - So make sure to ACCEPT first with –I option instead of -A

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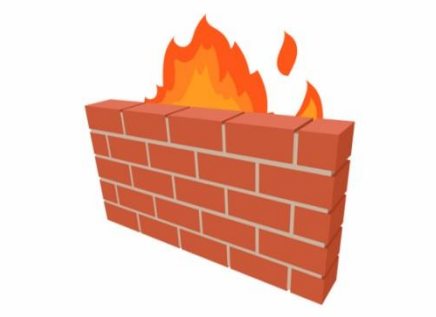
Firewall *(firewalld)*



- Firewalld works the same way as iptables but of course it has it own commands
  - **`firewall-cmd`**
- It has a few pre-defined service rules that are very easy to turn on and off
  - **`Services such as: NFS, NTP, HTTPD etc.`**
- Firewalld also has the following:
  - **`Table`**
  - **`Chains`**
  - **`Rules`**
  - **`Targets`**

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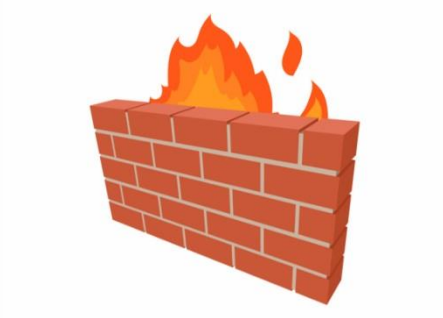
Firewall *(firewalld)*



- You can run one or the other
  - iptables or firewalld

- Make sure iptables is stopped, disabled and mask
  - **`systemctl stop iptables`**
  - **`systemctl disable iptables`**
  - **`systemctl mask iptables`**

- Now check if filewalld package is installed
  - **`rpm –qa | grep firewalld`**

- Start firewalld
  - **`systemctl start/enable firewalld`**

- Check the rule of firewalld
  - **`firewall-cmd --list-all`**

- Get the listing of all services firewalld is aware of:
  - **`firewall-cmd --get-services`**

- To make firewalld re-read the configuration added
  - **`firewall-cmd --reload`**

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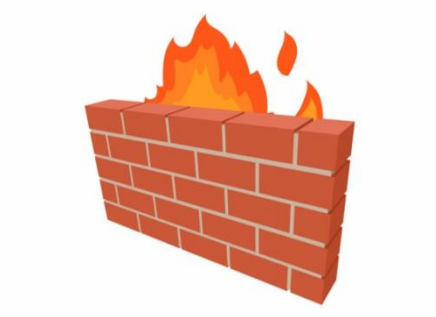
Firewall *(firewalld – Practical Examples)*



- The firewalld has multiple zone, to get a list of all zones
  - **`firewall-cmd --get-zones`**
- To get a list of active zones
  - **`firewall-cmd --get-active-zones`**
- To get firewall rules for public zone
  - **`firewall-cmd --zone=public --list-all`**

    OR
  - **`firewall-cmd --list-all`**
- All services are pre-defined by firewalld. What if you want to add a 3rd party service
  - **`/usr/lib/firewalld/services/allservices.xml`**
  - **`Simply cp any .xml file and change the service and port number`**

```
[root@MyFirstLinuxVM services]# cat test.xml
<?xml version="1.0" encoding="utf-8"?>
<service>
  <short>SSH</short>
  <description>To login</description>
  <port protocol="tcp" port="22"/>
</service>
[root@MyFirstLinuxVM services]#
```

Version of XML

Service

Service

Port

Description

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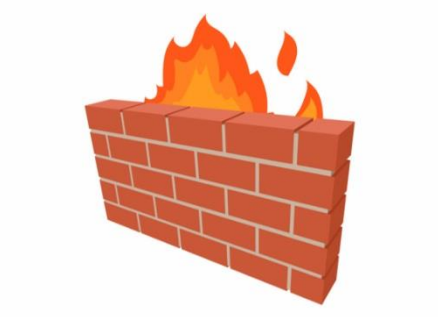
Firewall *(firewalld – Practical Examples)*



- To add a service (http)
  - **`firewall-cmd --add-service=http`**
- To remove a service
  - **`firewall-cmd --remove-service=http`**
- To reload the firewalld configuration
  - **`firewall-cmd --reload`**
- To add or remove a service permanently
  - **`firewall-cmd --add-service=http --permanent`**
  - **`firewall-cmd --remove-service=http --permanent`**
- To add a service that is not pre-defined by firewalld
  - **`/usr/lib/firewalld/services/allservices.xml`**
  - **`Simply cp any .xml file sap.xml and change the service and port number (32)`**
  - **`systemctl restart firewalld`**
  - **`firewall-cmd --get-services`** **`(to verify new service)`**
  - **`Firewall-cmd --add-service=sap`**

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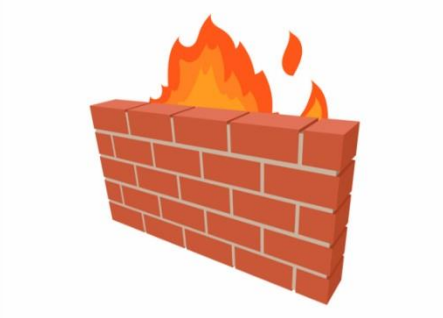
Firewall *(firewalld – Practical Examples)*



- To add a port
  - **`firewall-cmd --add-port=1110/tcp`**
- To remove a port
  - **`firewall-cmd --remove-port=1110/tcp`**
- To reject incoming traffic from an IP address
  - **`firewall-cmd --add-rich-rule='rule family="ipv4" source address="192.168.0.25" reject'`**
- To block and unblock ICMP incoming traffic
  - **`firewall-cmd --add-icmp-block-inversion`**
  - **`firewall-cmd --remove-icmp-block-inversion`**
- To block outgoing traffic to a specific website/IP address
  - **`host -t a www.facebook.com = find IP address`**
  - **`firewall-cmd --direct --add-rule ipv4 filter OUTPUT 0 -d 31.13.71.36 -j DROP`**

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Tune System Performance

Linux system comes fined tunned by default when you install, however there are a few tweaks that can be done based on system performance and application requirements

In this lesson we will learn…

- Optimize system performance by selecting a tuning profile managed by the **`tuned`** daemon
- Prioritize or de-prioritize specific processes with the **`nice`** and **`renice`** commands

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Tune System Performance

What is tuned?

- Tuned pronounced as tune-d
- **Tune** is for system tuning and **d** is for daemon
- It is **systemd** service that is used to tune Linux system performance
- It is installed in CentOS/Redhat version 7 and 8 by default
- **tuned** package name is **tuned**
- The **tuned** service comes with pre-defined profiles and settings *(List of profile will be discussed in the next page)*
- Based on selected profile the **tuned** service automictically adjust system to get the best performance. E.g. **tuned** will adjust networking if you are downloading a large file or it will adjust IO settings if it detects high storage read/write
- The tuned daemon applies system settings when the service starts or upon selection of a new tuning profile.

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Tune System Performance (`tuned` profiles)

Tuned profile	Purpose
balanced	deal for systems that require a compromise between power saving and performance
desktop	Derived from the balanced profile. Provides faster response of interactive applications
Throughput-performance	Tunes the system for maximum throughput
Latency-performance	Ideal for server systems that require low latency at the expense of power consumption
network-latency	Derived from the latency-performance profile. It enables additional network tuning parameters to provide low network latency
Network-throughput	Derived from the throughput-performance profile. Additional network tuning parameters are applied for maximum network throughput
powersave	Tunes the system for maximum power saving
oracle	Optimized for Oracle database loads based on the throughput-performance profile
virtual-guest	Tunes the system for maximum performance if it runs on a virtual machine
virtual-host	Tunes the system for maximum performance if it acts as a host for virtual machines

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Tune System Performance

- Check if tuned package has been installed
  `rpm -qa | grep tuned`
- Install tuned package if NOT installed already
  `yum install tuned`
- Check **`tuned`** service status
  `systemctl status|enable|start tuned`
  `systemctl enable tuned` *(To enable at boot time)*
- Command to change setting for tuned daemon
  `tuned-adm`
- To check which profile is active
  `tuned-adm active`
- To list available profiles
  `tuned-adm list`.

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Tune System Performance

- To change to desired profile

  `tuned-adm profile profile-name`

- Check for tuned recommendation

  `tuned-adm recommend`

- Turn off tuned setting daemon

  `tuned-adm off`

- Change profile through web console

  Login to https://192.168.1.x:9090

  Overview → Configuration → Performance profile

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Tune System Performance (nice/renince)

- Another way of keeping your system fine-tuned is by prioritizing processes through **`nice`** and **`renice`** command
- If a server has 1 CPU then it can execute **1** computation/process at a time as they come in *(first come first served)* while other processes must wait
- With **`nice`** and **`renice`** commands we can make the system to give preference to certain processes than others
- This priority can be set at 40 different levels
- The nice level values range from -20 (highest priority) to 19 (lowest priority) and by default, processes inherit their nice level from their parent, which is usually 0.

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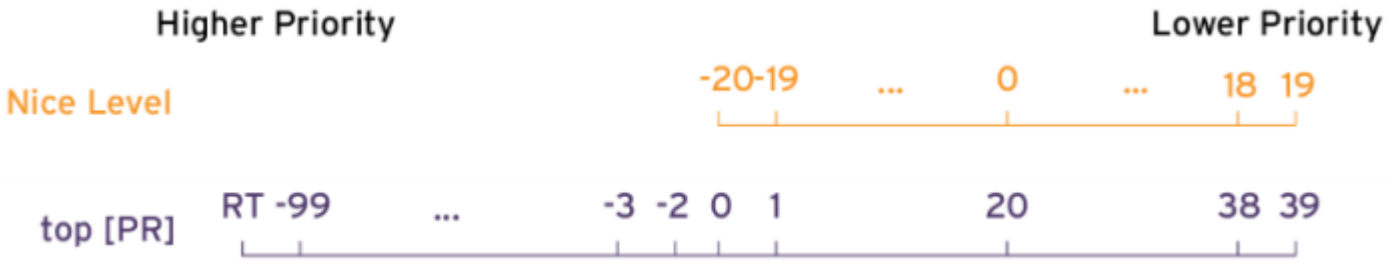
Tune System Performance (nice/renince)

- To check process priority

```
top
```



Nice value is a user-space and priority PR is the process's actual priority that use by Linux kernel. In Linux system priorities are 0 to 139 in which 0 to 99 for real time and 100 to 139 for users

- Process priority can be viewed through ps command as well with the right options

```
$ ps axo pid,comm,nice,cls --sort=-nice
```

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Tune System Performance (nice/renince)

- To set the process priority

```
nice –n # process-name
e.g. nice –n -15 top
```

- To change the process priority

```
renice –n # process-name
e.g. renice –n 12 PID.
```

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Run Containers

What is a Container?

- The term container and the concept came from the shipping container

- These containers are shipped from city to city and country to country
- No matter which part of the world you go to, you will find these containers with the exact same measurements… **YOU KNOW WHY???**
- Because around the world all docks, trucks, ships and warehouses are built to easily transport and store them

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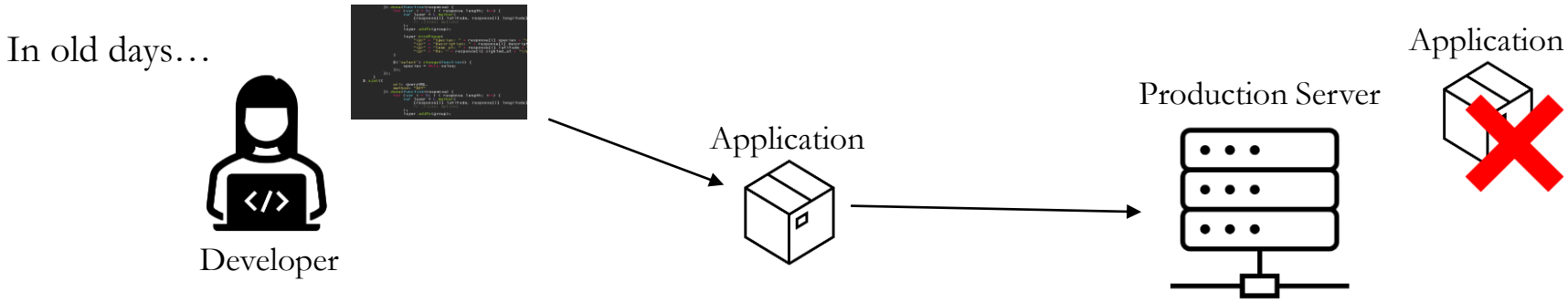
Run Containers

What is a Container?

Now when we are talking about containers in IT we are fulfilling somewhat similar purpose



- Then came the container technology which allowed developers or programmer to test and build applications on any computer just by putting it in a container *(bundled in with the software code, libraries and configuration files)* and then run on another computer regardless of its architecture
- You can move the application anywhere without moving its OS just like moving the actual physical container anywhere that would fit on any dockyard, truck, ship or warehouse
- An OS can run single or multiple containers at the same time

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Run Containers

What is a Container?

Now when we are talking about containers in IT we are fulfilling somewhat similar purpose

Please Note:

Container technology is mostly used by developers or programmers who write codes to build applications

As a system administrator your job is to install, configure and manage them.

container anywhere that would fit on any dockyard, truck, ship or warehouse

- An OS can run single or multiple containers at the same time

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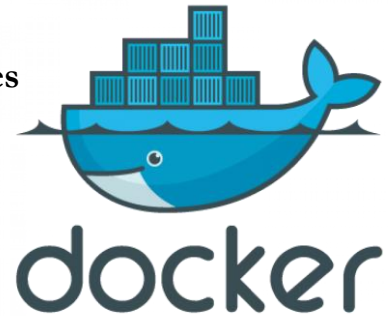
Run Containers

What are the Container Software?

Developed by:
Solomon Hykes



Released on:
March 20th 2013

- Docker is the software used to create and manage containers
- Just like any other package, docker can be installed on your Linux system and its service or daemon can be controlled through native Linux service management tool

Developed by:
Red Hat

Released on:
August 2018

podman

- Podman is an alternative to docker
- Docker is not supported in RHEL 8
- It is daemon less, open source, Linux-native tool designed to develop, manage, and run containers.

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Run Containers

Getting Familiar with Redhat Container Technology

Red Hat provides a set of command-line tools that can operate without a container engine, these include:

- **podman** - for directly managing pods and container images (run, stop, start, ps, attach, etc.)
- **buildah** - for building, pushing, and signing container images
- **skopeo** - for copying, inspecting, deleting, and signing images
- **runc** - for providing container run and build features to podman and buildah
- **crun** - an optional runtime that can be configured and gives greater flexibility, control, and security for rootless containers.

Getting Familiar with podman Container Technology

When you hear about containers then you should know the following terms as well

- **images** – containers can be created through images and containers can be converted to images
- **pods** – Group of containers deployed together on the host. In the podman logo there are 3 seals grouped together as a pod.

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Run Containers

Building, Running and Managing Containers

To install podman

- **`yum/dnf install podman -y`**
- **`yum install docker -y`** *(For dockers)*

Creating alias to docker

- **`alias docker=podman`**

Check podman version

- **`podman -v`**

Getting help

- **`podman --help or man podman`**

Check podman environment and registry/repository information

- **`podman info`** *(If you are trying to load a container image, then it will look at the local machine and then go through each registry by the order listed)*

To search a specific image in repository.

- **`podman search httpd`**

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Run Containers

Building, Running and Managing Containers

To list any previously downloaded podman images

- **`podman images`**

To download available images

- **`podman pull docker.io/library/httpd`**
- **`podman images`** *(Check downloaded image status)*

To list podman running containers

- **`podman ps`**

To run a downloaded httpd containers

- **`podman run -dt -p 8080:80/tcp docker.io/library/httpd`**
  `(d=detach, t=get the tty shell, p=port)`
- **`podman ps`** **`or`** ***Check httpd through web browser***

To view podman logs.

- **`podman logs –l`**

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Run Containers

Building, Running and Managing Containers

To stop a running container

- **`podman stop con-name`** *(con-name from podman ps command)*
- **`podman ps`** *(To list running containers)*

To run a multiple containers of httpd by changing the port #

- **`podman run -dt -p 8081:80/tcp docker.io/library/httpd`**
- **`podman run -dt -p 8082:80/tcp docker.io/library/httpd`**
- **`podman ps`**

To stop and start a previously running container

- **`podman stop|start con-name`**

To create a new container from the downloaded image

- **`podman create --name httpd-con docker.io/library/httpd`**

To start the newly created container.

- **`podman start httpd-con`**

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www.utclisolutions.com

Run Containers

Building, Running and Managing Containers

Manage containers through systemd

- First you have to generate a unit file
  - **`podman generate systemd --new --files --name httpd-con`**
- Copy it systemd directory
  - **`cp /root/container-httpd.service /etc/systemd/system`**
- Enable the service
  - **`systemctl enable container-httpd-con.service`**
- Start the service.
  - **`systemctl start container-httpd-con.service`**

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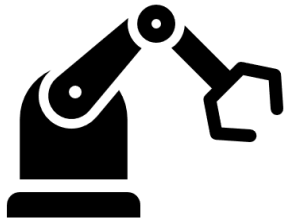
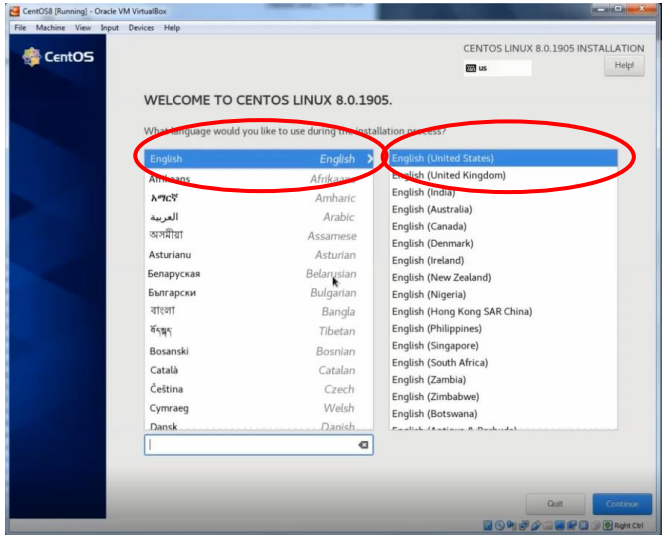
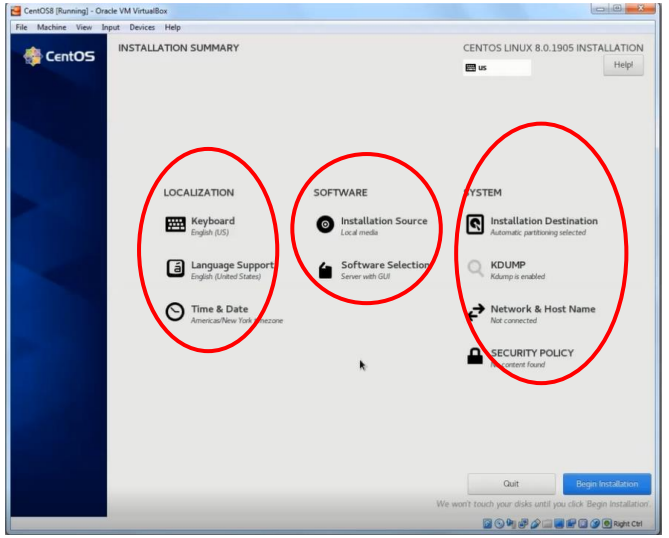
Kickstart (Automate Linux Installation)



- Kickstart is a method to automate the Linux installation without the need for any intervention from the user

- With the help of kickstart you can automate questions that are asked during the installation. e.g.
  - Language and time zone
  - How the drives should be partitioned
  - Which packages should be installed etc.





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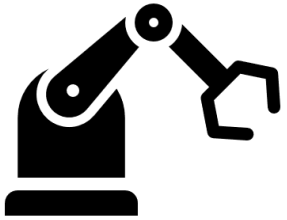
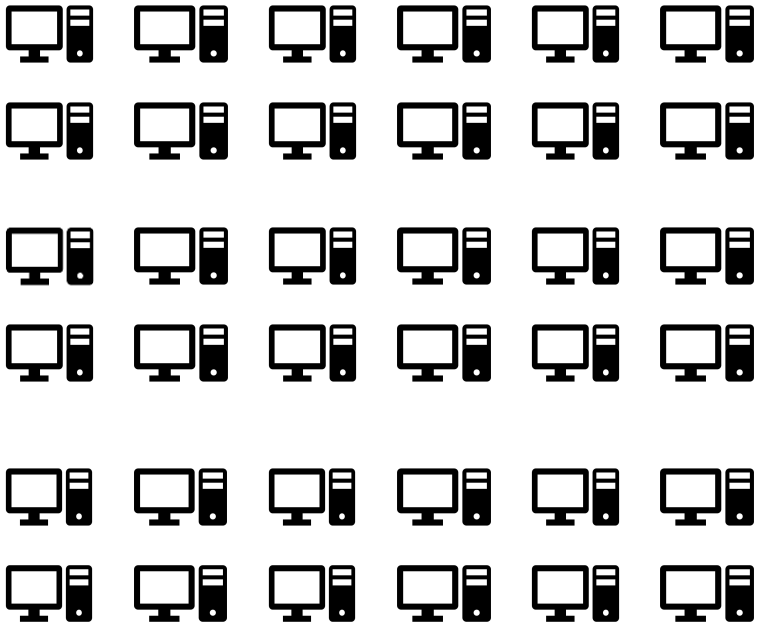
Kickstart (Automate Linux Installation)

- Purpose?





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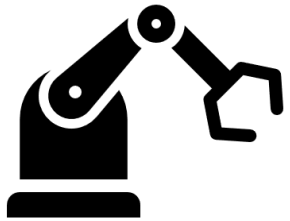
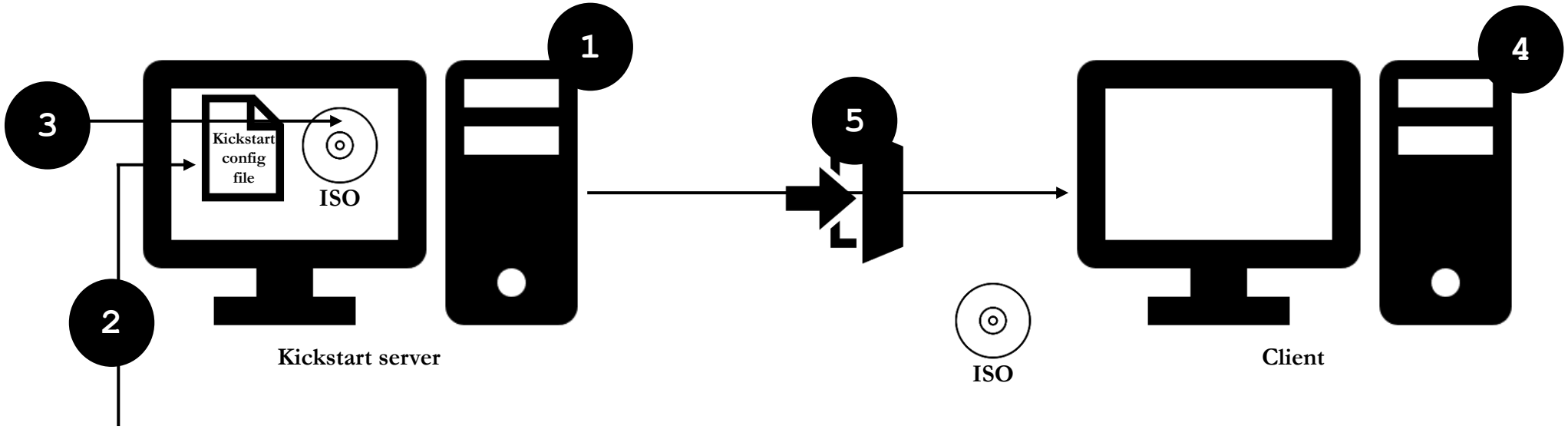
Kickstart (Automate Linux Installation)



- To use Kickstart, you must:
  1. Choose a Kickstart server and create/edit a Kickstart file
  2. Make the Kickstart file available on a network location
  3. Make the installation source available
  4. Make boot media available for client which will be used to begin the installation
  5. Start the Kickstart installation



Network = NFS, FTP, HTTP, or HTTPS

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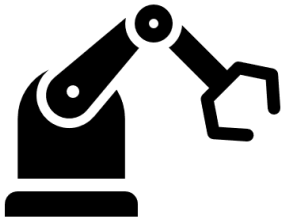
Kickstart (Automate Linux Installation)



- CentOS/Redhat 7
  - Kickstart program can be downloaded which allows you to define parameters through the GUI
    - **`yum install system-config-kickstart`**
  - Or you can use the installation kickstart file which was created during the first installation (**`anaconda-ks.cfg`**)

- CentOS/Redhat 8
  - There is no GUI available to edit the file

- Why changed?
  - Most systems are virtual and templates can be used
  - Automation software are in used such as Anisble.

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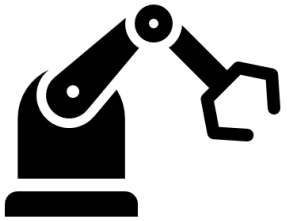
Kickstart (Automate Linux Installation)

- **Step by step procedure for Kickstart**



1. Identify the server

2. Take a snapshot of the server

3. Install kickstart configurator (for version 7)
   - **`yum install system-config-kickstart`**

4. Start the kickstart file configurator and define parameters **OR** use the **`/root/anaconda-ks.cfg`**
   - **`system-config-kickstart`** (To start the configurator)
   - We will use anaconda installation kickstart file and change the hostname only

5. Make sure httpd package is installed, if not then install the package and start the httpd service
   - **`rpm -qa | grep http`**
   - **`yum/dnf install httpd`**
   - **`systemctl start httpd`**
   - **`systemctl enable httpd.`**

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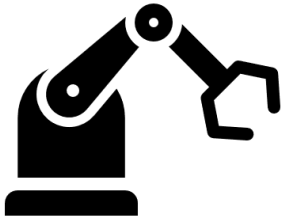
Kickstart (Automate Linux Installation)

6. Copy kickstart file to httpd directory and change the permissions
   - `cp /root/anaconda-ks.cfg /var/www/html`
   - `chmod a+r /var/www/html/anaconda-ks.cfg`
   - `systemctl stop|disable firewalld`
   - `Check file through browser on another PC http://192.168.1.x/anaconda-ks.cfg`



7. Create a new VM and attach the CentOS iso image

8. Change the network adapter to Bridged adapter

9. Hit Esc

10. `boot: linux ks=http://192.168.1.x/anaconda-ks.cfg`
    `For NFS →  boot: linux inst.ks=nfs:192.168.1.x:/rhel8`

11. Wait and enjoy the automated installation

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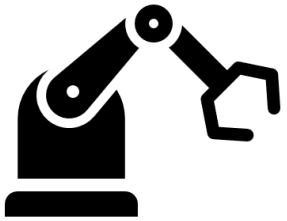
Kickstart (Automate Linux Installation)

Kickstart for clients with static IP



```
boot: linux ks=http://server.example.com/ks.cfg ksdevice=eth0 IP:192.168.1.50
netmask=255.255.255.0 gateway=192.168.1.1
```

Where:

`ksdevice` = is the network adapter of the client

`IP` = IP you are assigning to the client

`netmask` = Subnet mask for the client

`gateway` = Gateway IP address for the client

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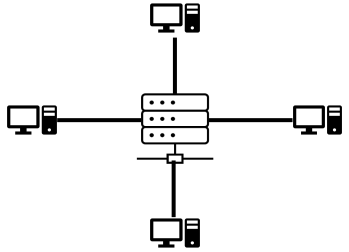
DHCP

In this video I will show you how to setup DHCP server conceptually because if you want to setup DHCP server on your Linux machine then you will have to re-configure your router/modem in your home which can route DHCP traffic to your new DHCP server.
Reconfiguring router/modem will make all your devices at home lose the network connectivity



- DHCP stands for Dynamic Host Configuration Protocol
- In order to communicate over the network, a computer needs to have an IP address
- DHCP server is responsible to automatically assign IP addresses to servers, laptops, desktops, and other devices on the network

- Wait a second…
  - Right now in our home how IPs are assigned to our devices?
    - Answer → The router or gateway given to you by your ISP provider
  - How IPs are assigned in corporate world?
    - Answer → Dedicated routers run DHCP service to assign IPs on the network

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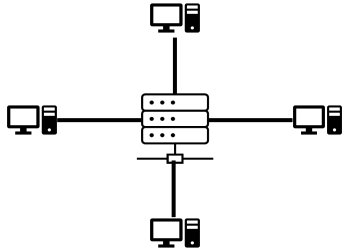
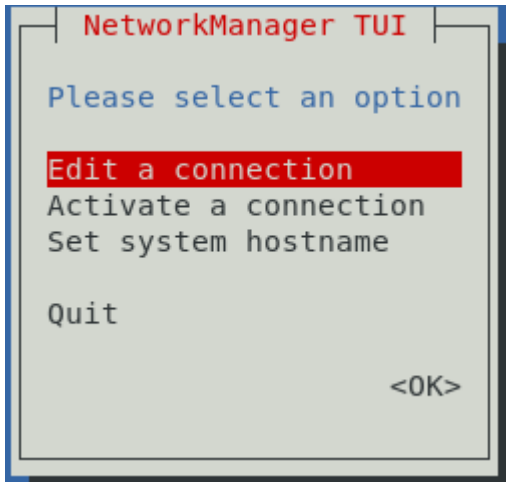
DHCP

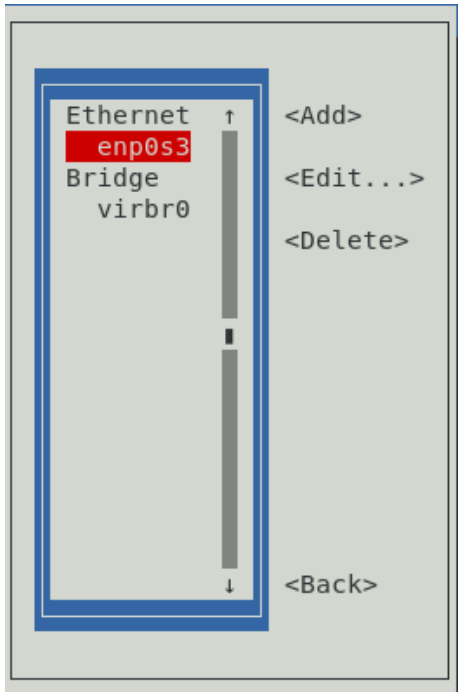


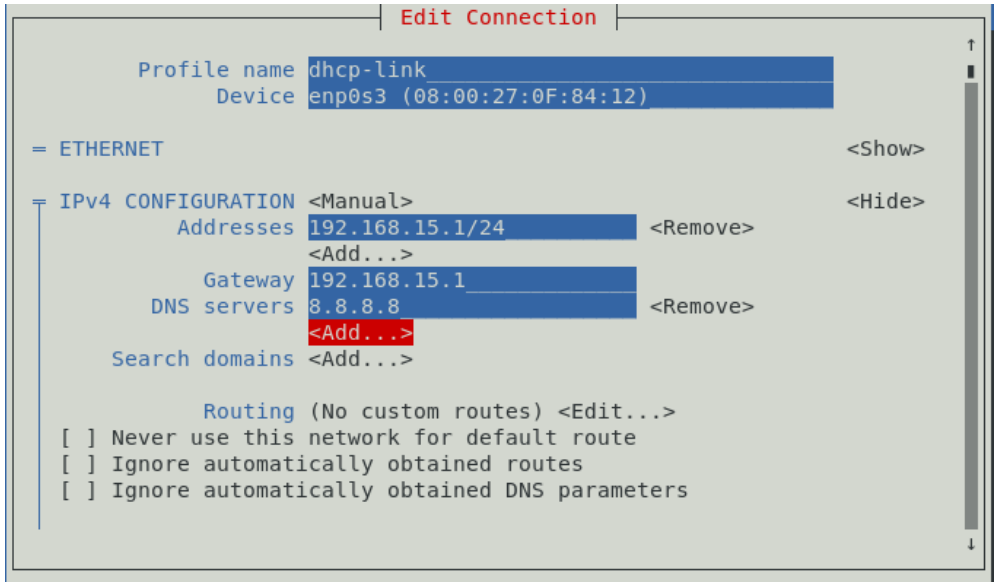
Step by steps instructions

- Pick a server to be your DHCP and take a snapshot

- Assign a static IP to the DHCP server
  - **`vi /etc/sysconfig/network/enp0s3`**
  - Or simply run **`nmtui`** command to use GUI based network tool







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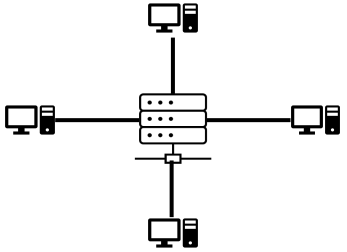
DHCP



- Install dhcp server package
  - **`yum install dhcp`** (version 7)
  - **`dnf install dhcp-server`** (version 8)

- Edit the configuration file with desired parameters
  - **`vi /etc/dhcp/dhcp.conf`**
  - **`cp /usr/share/doc/dhcp-x.x.x/dhcpd.conf.example /etc/dhcp/dhcpd.conf`**

```
#
# DHCP Server Configuration file.
#   see /usr/share/doc/dhcp-server/dhcpd.conf.example
#   see dhcpd.conf(5) man page
#
default-lease-time 600;
max-lease-time 7200;

ddns-update-style none;
authoritative;

subnet 192.168.15.0 netmask 255.255.255.0 {
        range 192.168.15.50 192.168.15.200;
        option routers 192.168.15.1;
        option subnet-mask 255.255.255.0;
        option domain-name-servers 8.8.8.8, 8.8.4.4;
}
~
~
~
```

- The DHCP server will reserve the IP address for at least 10 minutes
- The DHCP server will reserve the IP address for a max of 2 hours
- Defines the subnet range of 256 addresses
- Defines the DHCP range assignment of 150 addresses
- Routers defines the default gateway
- Defines the default subnet mask that will be assigned to each host
- Defines the DNS nameservers which will be assigned to each host.

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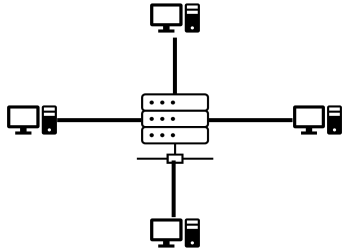
DHCP



- Start dhcpd service
  - **`systemctl start dhcpd`**
  - **`systemctl enable dhcp`**
- Disable **`firewalld`** or allow dhcp port over firewall
  - **`systemctl stop firewalld`**
  - **`OR`**
  - **`firewall-cmd --add-service=dhcp –permanent`**
  - **`firewall-cmd –reload`**
- Switch DHCP service from your router/modem to your new DHCP server
  - **`Login to your ISP provided router`**
  - **`Disable dhcp and enable forwarding to the new dhcp server.`**

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Welcome To:
Module 8

Disk Management and Run Levels

System Run Level

- System Run Levels

Main Run level

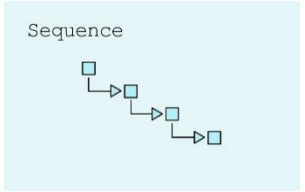
- 0 Shut down (or halt) the system
- 1 Single-user mode; usually aliased as s or S
- 6 Reboot the system

Other Run levels

- 2 Multiuser mode without networking
- 3 Multiuser mode with networking
- 5 Multiuser mode with networking and GUI.

Linux Boot Process

Linux Boot Process (Newer Versions)



- The boot sequence changes in CentOS/Redhat 7 and above
- **systemd** is the new service manager in CentOS/RHEL 7 that manages the boot sequence
- It is backward compatible with SysV init scripts used by previous versions of RedHat Linux including RHEL 6
- Every system administrator needs to understand the boot process of an OS in order to troubleshoot effectively

Linux Boot Process (Newer Versions)

BIOS = Basic Input and Output Setting (firmware interface)

POST = Power-On Self-Test started

MBR = Master Boot Record

Information saved in the first sector of a hard disk that indicates where the GRUB2 is located so it can be loaded in computer RAM

GRUB2 = Grand Unified Boot Loader v2

Loads Linux kernel

/boot/grub2/grub.cfg

Kernel = Core of Operating System

Loads required drivers from initrd.img

Starts the first OS process (systemd)

Systemd = System Daemon (PID # 1)

It then starts all the required processes

Reads = /etc/systemd/system/default.target to bring the system to the run-level

Total of 7 run-levels (0 thru 6)

Message of the Day

- Message of the day file location
  - `/etc/motd`

Customize Message of the Day

- Once again, message of the day is the first message users will see when they login to the Linux machine

- Steps:
  - Create a new file in **`/etc/profile.d/motd.sh`**
  - Add desired commands in motd.sh file
  - Modify the **`/etc/ssh/sshd_config`** file to edit **`#PrintMotd yes`** to **`PrintMotd no`**
  - Restart sshd service
    - **`systemctl restart sshd.service`**

Disk Partition

- Commands for disk partition
  - **`df`**
  - **`fdisk`**

Adding Disk and Creating Partition

- Purpose? = Out of Space, Additional Apps etc.

- Commands for disk partition
  - **`df`**
  - **`fdisk`**

Computer Storage

- Local Storage
  - RAM, HDD, SSD, etc.

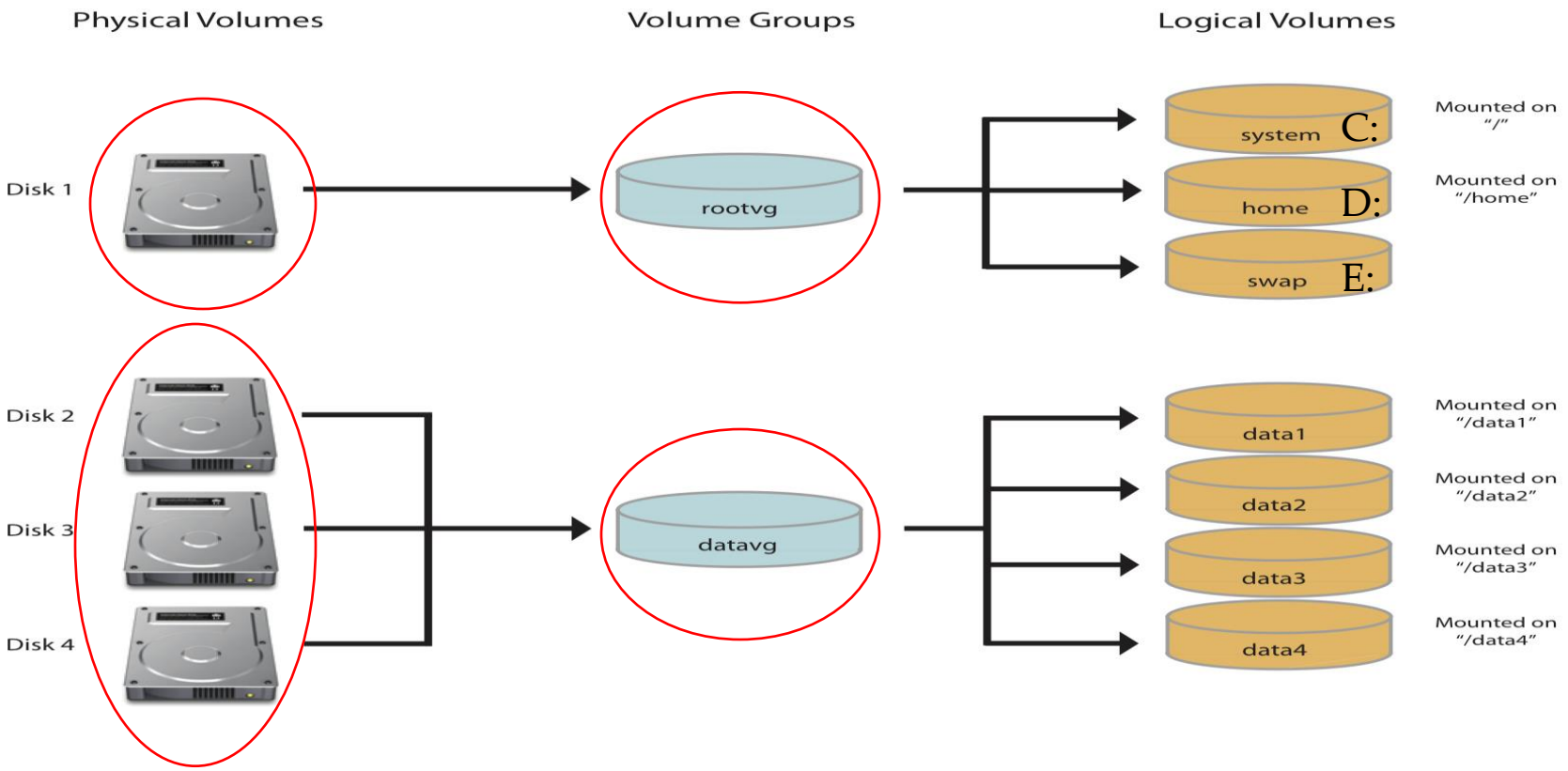
- DAS (Direct Attached Storage)
  - CD/DVD, USB flash drive, external disk directly attached with USB or other cables

- SAN (Storage Area Network)
  - Storage attached through iSCSI or fiber cable

- NAS (Network Attached Storage)
  - Storage attached over network (TCP/IP)
  - E.g. Samba, NFS etc.

Logical Volume Management (LVM)

- LVM allows disks to be combined together

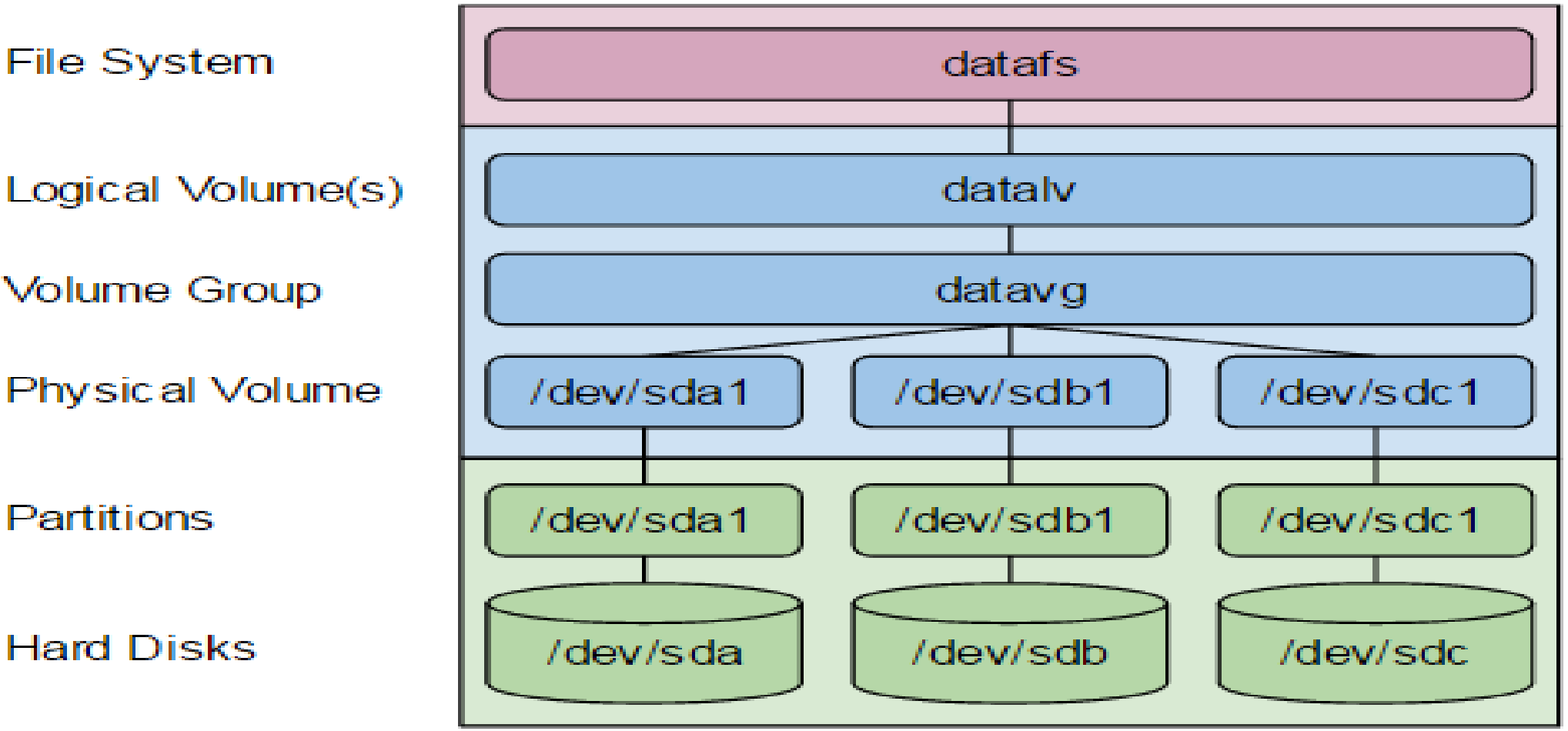


LVM Configuration During Install

- Install Linux CentOS with LVM configuration

By: Imran Afzal

Add Disk and Create LVM Partition



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Add and Extend Disk using LVM

/oracle = 1.0G
/oracle = Full

Few Options:

- Delete older files to free up disk space
- Add new physical disk mount to /oracle2
- Create a new virtual disk and mount to /oracle2
- Or extend /oracle through LVM.

By: Imran Afzal

Add/Extend Swap Space

- What is swap? – CentOS.org

  Swap space in Linux is used when the amount of physical memory (RAM) is full. If the system needs more memory resources and the RAM is full, inactive pages in memory are moved to the swap space. While swap space can help machines with a small amount of RAM, it should not be considered a replacement for more RAM. Swap space is located on hard drives, which have a slower access time than physical memory

- Recommended swap size = Twice the size of RAM

  M = Amount of RAM in GB, and S = Amount of swap in GB, then

  If M < 2
  then S = M *2
  Else S = M + 2

- Commands
  - dd
  - mkswap
  - swapon or swapoff

By: Imran Afzal

Implement Advanced Storage Features

- Red Hat 8 introduces the next generation volume management solution called Stratis
- It uses thin provisioning by default
- It combines the process of creating logical volume management (LVM) and creation of filesystems into one management
- In LVM if a filesystem system gets full you will have to extend it manually whereas stratis extends the filesystem automatically if it has available space in its pool

In this lesson we will learn…

- How to manage multiple storage layers using Stratis local storage management

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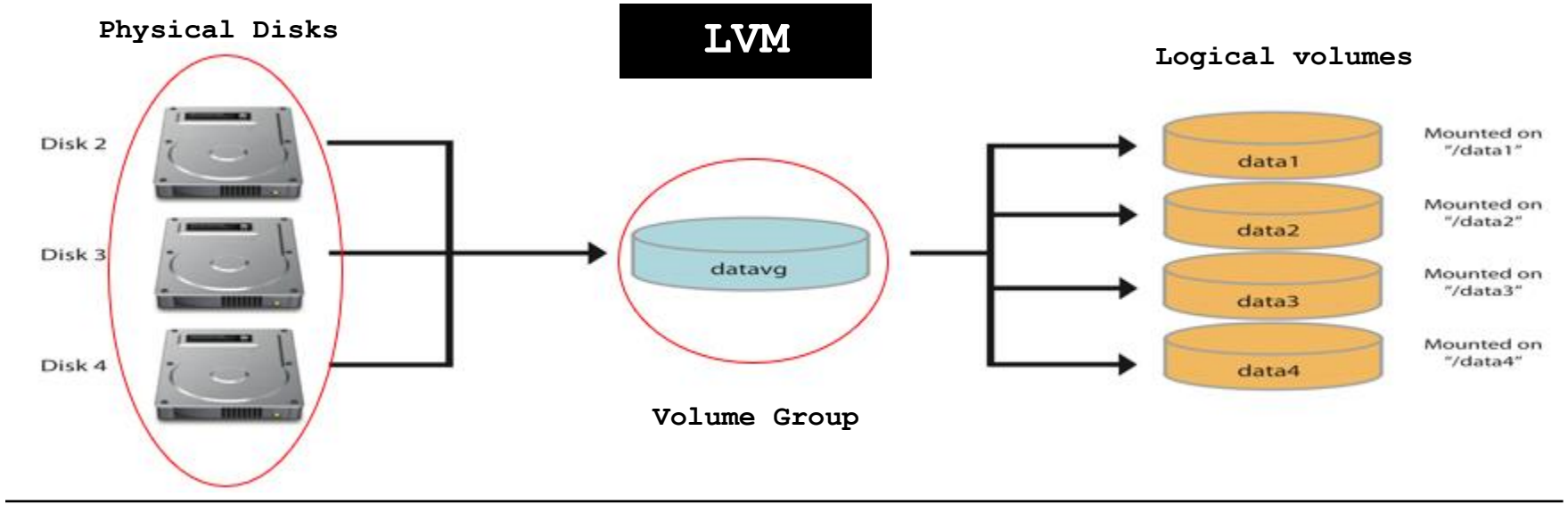
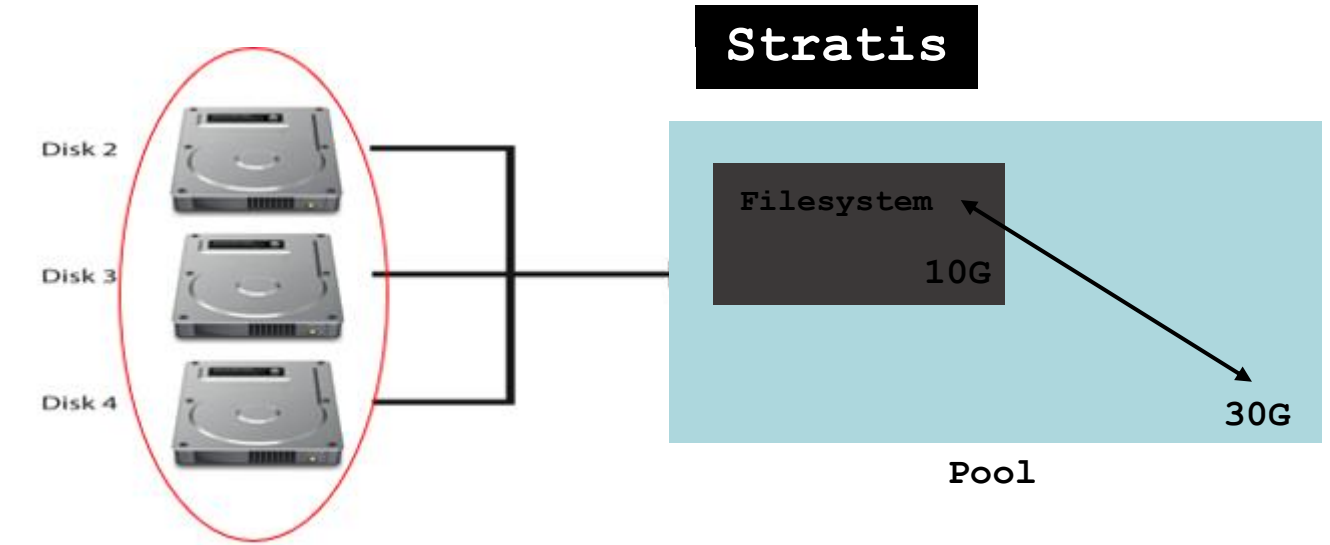
www.utclisolutions.com

Implement Advanced Storage Features





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Implement Advanced Storage Features

- Install Statris package

```
yum/dnf install stratis-cli stratisd
```

- Enable and start Statris service

```
systemctl enable|start stratisd
```

- Add 2 x 5G new disks from virtualization software and verify at the OS level

```
Oracle virtualbox storage setting
lsblk
```

- Create a new stratis pool and verify

```
stratis pool create pool1 /dev/sdb
stratis pool list
```

- Extend the pool

```
stratis pool add-data pool1 /dev/sdc
stratis pool list
```

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www.utclisolutions.com

Implement Advanced Storage Features

- Create a new filesystem using stratis

```
stratis filesystem create pool1 fs1
stratis filesystem list
```

(Filesystem will start with 546 MB)

- Create a directory for mount point and mount filesystem

```
mkdir /bigdata
mount /dev/stratis/pool1/fs1 /bigdata
lsblk
```

- Create a snapshot of your filesystem

```
startis filesystem snapshot pool1 fs1 fs1-snap
stratis filesystem list
```

- Add the entry to /etc/fstab to mount at boot

```
UUID="asf-0887afgdja-" /bigdata xfs defaults,x-
systemd.requires=stratisd.service 0 0
```

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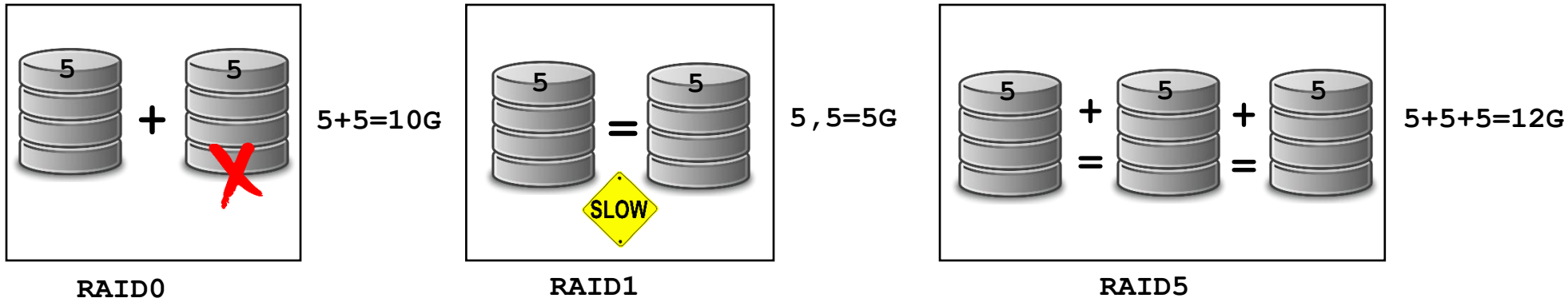
RAID

- RAID (Redundant Array of Independent Disks)

- Type of RAID
  - **RAID0**
  - **RAID1**
  - **RAID5**



By: Imran Afzal

File System Check (fsck and xfs_repair)

- Linux fsck utility is used to check and repair Linux filesystems (**`ext2`**, **`ext3`**, **`ext4`**, **`etc`**.)
- Linux xfs_repair utility is used to check and repair Linux filesystems for **`xfs`** filesystem type
- Depending on when was the last time a file system was checked, the system runs the fsck during boot time to check whether the filesystem is in consistent state
- System administrator could also run it manually when there is a problem with the filesystems
- Make sure to execute the fsck on an **unmounted** file systems to avoid any data corruption issues.

File System Check (fsck and xfs_repair)…

- Force a filesystem check even if it's clean using option –f
- Attempt to fix detected problems automatically using option -y
- The xfs_repair utility is highly scalable and is designed to repair even very large file systems with many inodes efficiently. Unlike other Linux file systems, xfs_repair does not run at boot time
- The following are the possible **exit codes** for fsck command

  - 0 – No errors
  - 1 – Filesystem errors corrected
  - 2 – System should be rebooted
  - 4 – Filesystem errors left uncorrected
  - 8 – Operational error
  - 16 – Usage or syntax error
  - 32 – Fsck canceled by user request
  - 128 – Shared-library error

System Backup (dd Command)

5 Different Types of Backups

1. System backup (entire image using tools such as acronis, Veeam, Commvault etc.)
2. Application backup (3rd party application backup solution)
3. Database backup (Oracle dataguard, SQL backup etc.)
4. Filesystem backup (tar, gzip directoris etc.)
5. Disk backup or disk cloning (dd command)

- dd is a command-line utility for Unix and Unix-like operating systems whose primary purpose is to convert and copy files
- As a result, dd can be used for tasks such as backing up the boot sector of a hard drive, and obtaining a fixed amount of random data
- Please note the source and destination disk should be the same size

By: Imran Afzal

System Backup (dd Command)…

- To backup or clone an entire hard disk to another hard disk connected to the same system, execute the dd command as shown

```
# dd if=<source file name> of=<target file name> [Options]
# dd if=/dev/sda of=/dev/sdb
```

- To backup/copy the disk partition

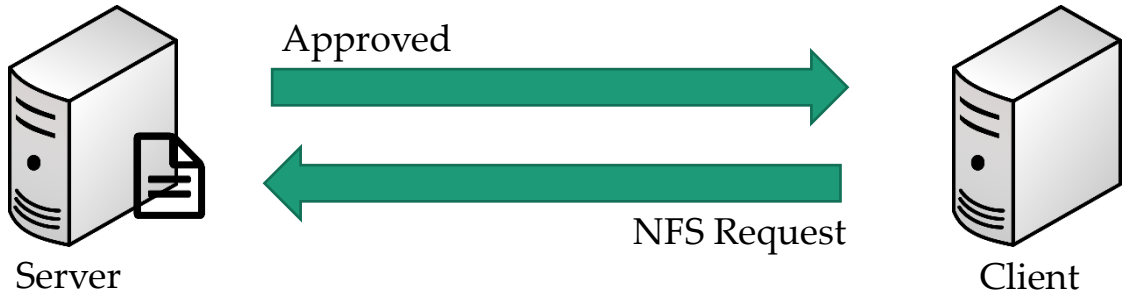
```
# dd if =/dev/sda1 of=/root/sda1.img
```

- Restoring this image file to other machine after copying the .img

```
# dd if=/root/sda1.img of=/dev/sdb3
```

Network File System (NFS)

- NFS stands for Network File System, a file system developed by Sun Microsystems, Inc.
- It is a client/server system that allows users to access files across a network and treat them as if they resided in a local file directory
- For example, if you were using a computer linked to a second computer via NFS, you could access files on the second computer as if they resided in a directory on the first computer. This is accomplished through the processes of exporting (the process by which an NFS server provides remote clients with access to its files) and mounting (the process by which client map NFS shared filesystem)



Network File System (NFS)…

Steps for NFS Server Configuration

- Install NFS packages

  # yum install nfs-utils libnfsidmap ***(most likely they are installed)***

- Once the packages are installed, enable and start NFS services

  # systemctl enable rpcbind

  # systemctl enable nfs-server

  # systemctl start rpcbind, nfs-server, rpc-statd, nfs-idmapd

- Create NFS share directory and assign permissions

  # mkdir /mypretzels

  # chmod a+rwx /mypretzels

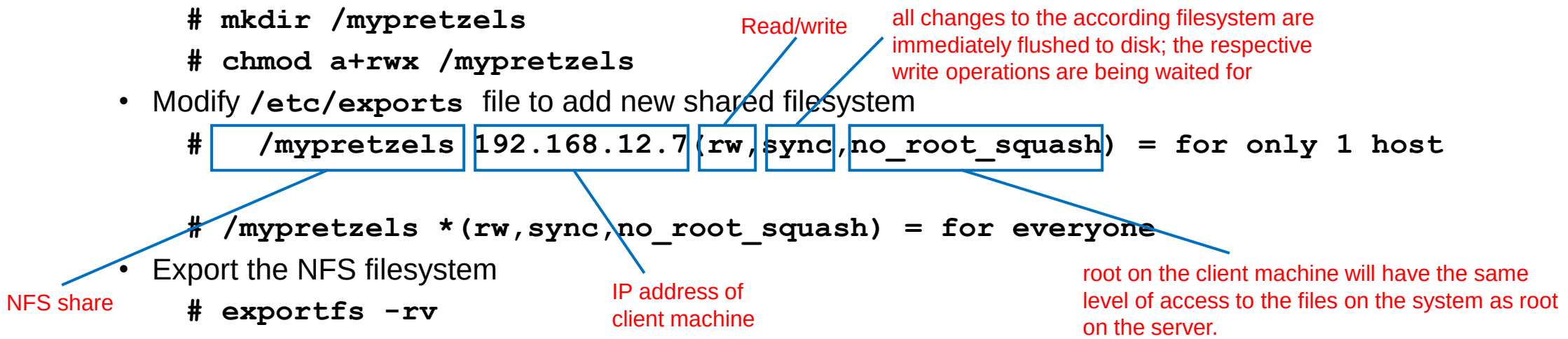
- Modify **/etc/exports** file to add new shared filesystem

  # /mypretzels 192.168.12.7(rw,sync,no_root_squash) = for only 1 host

  # /mypretzels *(rw,sync,no_root_squash) = for everyone

- Export the NFS filesystem

  # exportfs -rv



Network File System (NFS)…

Steps for NFS Client Configuration

- Install NFS packages

  ```
  # yum install nfs-utils rpcbind
  ```

- Once the packages are installed enable and start rpcbind service

  ```
  # systemctl rpcbind start
  ```

- Make sure firewalld or iptables stopped (if running)

  ```
  # ps –ef | egrep “firewall|iptable”
  ```

- Show mount from the NFS server

  ```
  # showmount -e 192.168.1.5 (NFS Server IP)
  ```

- Create a mount point

  ```
  # mkdir /mnt/kramer
  ```

- Mount the NFS filesystem

  ```
  # mount 192.168.1.5:/mypretzels /mnt/kramer
  ```

- Verify mounted filesystem

  ```
  # df –h
  ```

- To unmount

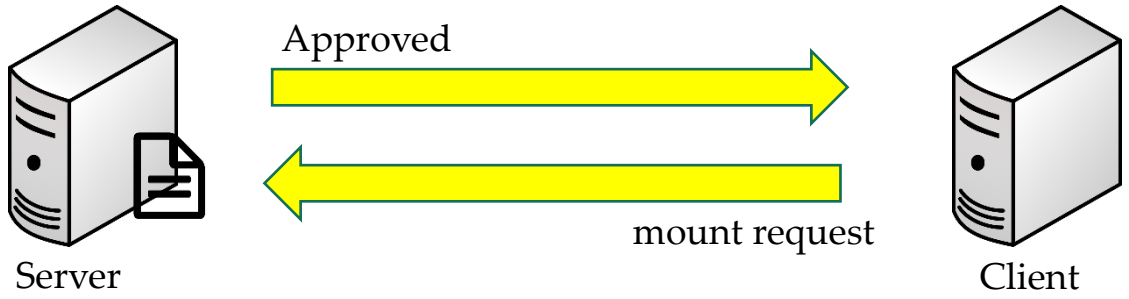
  ```
  # umount /mnt/kramer
  ```

Samba

- Samba is a Linux tool or utility that allows sharing for Linux resources such as files and printers to with other operating systems

- It works exactly like NFS but the difference is NFS shares within Linux or Unix like system whereas Samba shares with other OS (e.g. Windows, MAC etc.)

- For example, computer "A" shares its filesystem with computer "B" using Samba then computer "B" will see that shared filesystem as if it is mounted as the local filesystem



Samba (smb vs. CIFS)

- Samba shares its filesystem through a protocol called **SMB** (Server Message Block) which was invented by IBM

- Another protocol used to share Samba is through **CIFS** (Common Internet File System) invented by Microsoft and NMB (NetBios Named Server)

- **CIFS** became the extension of **SMB** and now Microsoft has introduced newer version of SMB v2 and v3 that are mostly used in the industry

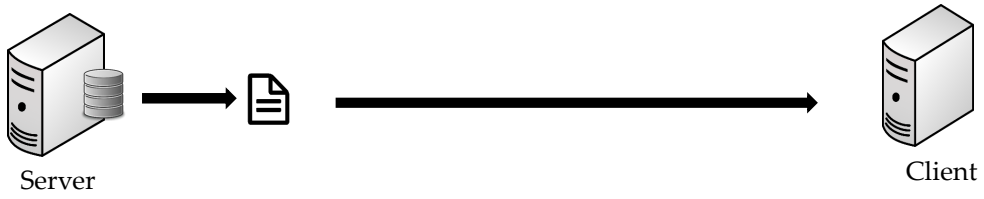
- In simple term, most people, when they use either SMB or CIFS, are talking about the same exact thing

Samba Installation and Configuration

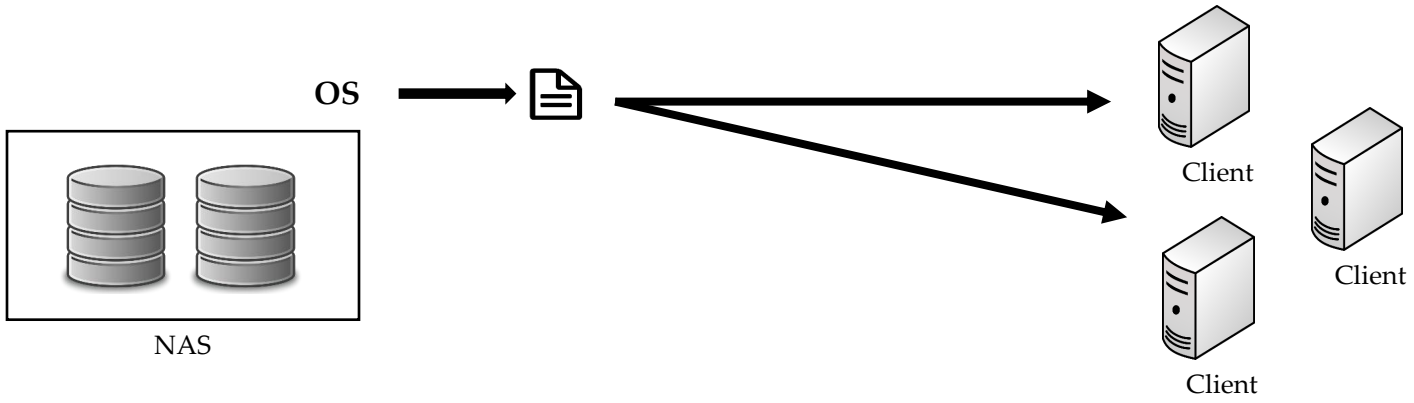
- Take snapshot of your VM
- Install samba packages
- Enable samba to be allowed through firewall (Only if you have firewall running)
- Disable firewall
- Create Samba share directory and assign permissions
- Also change the SELinux security context for the samba shared directory
- Or disable SELinux
- Modify **/etc/samba/smb.conf** file to add new shared filesystem
- Verify the setting
- Once the packages are installed, enable and start **Samba** services (smb and nmb)
- Mount Samba share on Windows client
- Mount Samba share on Linux client
- Additional instructions on creating secure Samba share.

NAS Device for NFS or Samba

- A storage can be carved on a Linux server, and it can be shared with another Linux machine through NFS or to a Windows machine through Samba service



- NFS/Samba or any NAS service can be setup through a dedicated NAS device



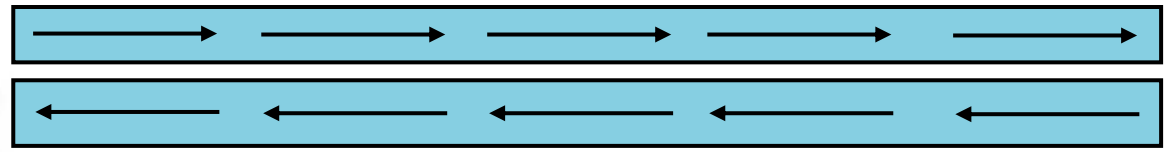
NAS Device for NFS or Samba

- In this video we will learn…
  - Physical layout of a NAS device
  - Setup, configure and manage NAS device
  - Create shared filesystem (NFS and Samba)
  - Mount shared folder from the NAS device to Linux and Windows

SATA and SAS

- **SATA** Stands for Serial Advanced Technology Attachment and **SAS** stands for Serial Attached SCSI (SCSI Stands for Small Computer System Interface, typically pronounced as “scuzzy”)
- Both SAS and SATA utilize serial communication. Serial communication means that the highway has both lanes

Parallel communication



Serial communication

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SATA and SAS

- The main difference between them is that SAS drives are faster and more reliable than SATA drives

- SAS is generally more expensive, and it's better suited for use in servers or in processing-heavy computer workstations. SATA is less expensive, and it's better suited for desktop file storage

- In a SATA cable, all 4 wires are placed within the same cable. In a SAS cable, the 4 wires are separated into 2 different cables

Why divide the wires between 2 cables???

- So you can connect more devices to one another. With a SATA cable, you can only link the motherboard and the storage drive. You could hook up an expansion device, but that takes up valuable room inside your computer.
- With a SAS cable, you can hook up the motherboard to both a storage drive and another piece of hardware that has SAS connectors.

Here's what the highways look like, metaphorically:

- **SATA cable:** Los Angeles to San Francisco
- **SAS cable:** Los Angeles to San Francisco or Los Angeles to Las Vegas

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Difference Between CentOS/RHEL 7 and 8

- Red Hat Enterprise Linux 8 (RHEL 8) is now available for production use with lots of developer-friendly capabilities
- RHEL 8 official release by Red Hat Inc, was announced on **May 7, 2019**
- I will cover only what is changed and what you should in terms of my Linux course

	RHEL 8	**RHEL 7**
General Availability Date	14-Nov-18	10-Jun-14
Code Name	Ootpa	Maipo
Kernel Version	4.18	3.10.0-123
End of Support	May-2029	30-Jun-2024
Last Minor Release	8.x	7.7
Network Time Synchronization	Only Chrony	Chrony and ntpd
GUI Interface (Desktop)	Gnome 3.28	Gnome 3
Default Database	MySQL 8.0, MariaDB 10.3, PostgreSQL 10 and 9.6, and Redis 5.0	MariaDB

Difference Between CentOS/RHEL 7 and 8

	RHEL 8	RHEL 7
Default Firewall	Firewalld, it uses nftables framework in the backend	Firewalld, it uses Iptables framework in the backend
Max Supported (Individual) File & Filesystem Size	XFS= 1024TB	XFS= 500TB
Package Management	By default both are installed, YUM symbolic link to DNF	By default only YUM and DNF can be installed from the Extra repo
Max. RAM Supported	24 TB on x86_64 architecture	12 TB on x86_64 architecture