Linux Operating System Class26

Introduction to operating

what is an operating system?

every computer is made up of some hardware like cpu , memory and storage etc and all the program running on the computer need to use this hardware resources

so application use operating system as an intermidiary to talk to the hardware so the operating system interact with the hardware as well as the application

operating systems will also manage resources amongst applications

What are the task of an operating system?

1. Process management(Processor), a process is a small unit that execute on a computer for example opening a new browser tap is a process for a example if a computer has only 1 cpu it can handly only one process/task at a time but now we have multiple cpu or multi core computers now e.g Dual-Core = 2 CPU's Quad-Core = 4CPU's (4cpu or 4 processors) the more cpu your computer has the faster the application will work because they can execute this processes in parallel

2. Memory management (RAM=Rapid Access Memory) when ever you start and application that application need some data(memory) so that it can work

3. Storage (Hardrive of a computer): this is the secondary memory for persisting Data long-term

NB active working data is store in RAM and once you are done the data is save in storage ies the Hardrive for longterm data persistence

Operating system stores information in a structured way in folders or directory in linux-operating system the file system is structured in a tree form with the Root folder and sub-directories

4. Management of I/O Devices like Monitor, keyboard, mouse ,Printers , USB etc

5. Security and Networkong: in term of security operation system is responsible for managing users and their permissions because we can have multiple user in one computer and each user

will have a username and password to login and have thier own space to install application save file etc Users also have permissions.

Networking like assigning port and IP addresses etc are also task of an operating system.

Operating System Components:

- ***Kernel***: this is the heart of every Operating System use to manage the Hardware components(CPU , MEMORY,RAM) so the Kernel of the operating system interact with the Applications Layer and the Hardware layer

A kernel is a program which consist of device drivers

Linix Operating system is based on Linux Kernel while MacOS operating system is based on Darwin

There are three main operating system:

1. Linux

2. Windows

3. MacOS

Note that each operating system have many version because the evolve over time and get better.

Note that over half of all the server use world wide are using linux as an operating sytem

Knowing linux is a must for a DevOps engineer because many DevOps task involve working with servers, installing and configuring things on the them

Ubuntu is the most popular linux Distribution.

Introduction to virtualization and virtual machine

- what is virtualization and what is a virtual machine?

- Why is virtualization useful?

- Main concepts of how Virtualization works?

with virtualization you can install another operating system on top of another operating system for example you can install a linux Operating system on top of a windows operating system

Vitualization can be achieved using a Hypervisor.

Hypervisor is a technology that allows hosting multiple virtual computer on a physical computer on top of the operating system that you already install

Example of hypervisor is VitualBox from Oracle which is Open-source and works on all operating system.

So virtualBox will let you create a virtual machine on your windows computer by using the Host operating system hardware resource (vitual cpu , RAM ,Storage) for the virtual machine.

- hypervisor could be of different types:

- ***Type 2*** Hypervisor also call HOSTED Hypervisors are use in personal computers Hardware ---> host OS ---> hypervisor ---> Guest OS

- ***Type 1*** Hypervisor are call Bare Metal hypervisors this because the hypervisor is install on the Hardware not on the host OS and the Guest machine install on the Hardware

example of type one Hypervisors are:

- VMWARE

- ESXi

- Microsoft Hyper-v

Big company and big cloud platform use type 1 hypervisor to create and run their infratructure

so when you create a virtual machine on AWS or Google cloud platform you are creating this virtual machine on a physical server

Advantages of type 1 hypervisor are as follows:

1. efficient usage of hardware resources

2. Abstraction of OS from the hardware

why are companies adopting Virtualization?

Before virtualization: when a company had a server where they have install maybe a database or Jenkins they will manage it themself by installing an Operating system directly on it and start installing their applications on the Operating system like installing and configuring Jenkins or installling database application etc.

The consequence is that when an Operating system is install directly on a hardware without that Hypervisor in between, the Operating system is then ***Tightly coupled*** to the hardware this means if the hardware component of the computer fails like the hardisk or the motherboard fails and the componenet cannot be replace this mean the whole computer will be useless and the Operating system and the application you install and configure on it and all the data will be gone so relying on this one physical box means ***one point of failure*** and therefore high risk of losing all services running on that machine.

With Vitualization: your Operating system is a portable file that you can move around and this files are virtual machine images so this portable file or the image will have the OS and all the application on it (jenkins and database etc) document and everything will be inside the portable file and you can make copies and backup of the OS image call snapshot.

So if something happens you can take the snapshot of the OS image and run it on a defferent computer with Hypervisor on it.

This bring security, portability and Not dependent on any physical server.

So the virtualization concept is very powerful, this is the reason why you see it everywhere in IT.

This has completely change the ware we work so whether you are a cloud Engineer, System administrator, DevOps Engineer or software Developer you need to understand virtualization because you will be working with virtual machine.

Linux File System

WE have to look at how linux work and we will start by learning the linux filesystem/directory structure

The linux file system is a hierarchical tree structure

1. ***Root folder(directory) /***

Is the top level of the directory hierarchy and inside the root folder we have a couple of folders which each has its purpose and inside the folders we have other sub folders and file

2. ***/home directory***

Contain personal directories for user this is where all non-root linux user spaces are located so each linux user will have it own space in a home directory except for the root user who has its own folder separate.

The _/home directory_ is one of the most important folder you have to know in linux in addition to the program and files that only your user need to see there are also programs that need to be available system wide system wide means this program are install on a computer and available to all the users on that computer so they are not on the home directory of the user they are on the outter level outside the home directory an available for all users of your computer, and this could be application or linux command available for the whole system and for all the users. this are located in /bin

3. ***/bin directory:***

The bin (binaries) contain essential binary executable (programs) needed for booting and repairing the system.

Binary is a computer-readable format so all the commands are in a binary file

4. ***/sbin directory:***

Contain system binaries typically for root or administrative tasks.

5. ***/lib***

or libraries folders holds the libraries for those binaries for those commands

6. ***/usr***

meaning user, this contain user utilities and application

7. ***/opt***

meaning optional folder this is another location where third party application are install

note that all this directories or folders are read only meaning you cannot change or modify them

8. ***/boot***

for booting the system which contain boot loader files, including the kernel

9. ***/etc***

stores system configuration and script for different applications

10. ***/dev***

meaning devices this is the location where the devices connected to the computer will actually stored like mouse, keyboard, external device etc

11. ***/var***

meaning variable this store logs files where the system writes data during the course of its operation if you wanted to see your system logs they are located in /var/log

/var/cache contain cache data from application programs

12. ***/tmp***

meaning temporary files

13. ***/mnt***

for manually mounting file system to your operating system we have the mount folder

- to see the content of our directory we run the command

```
ls
```

- to see all file and directory including hidden files

```
ls -a
```

Hidden Files

hidden files and folders are authomatically generated by different applications and they all start with a dot (.) so they are also call dotfiles

this hiddens files are created by application to store configuration and script etc.

the operating system can generate some of this hidden file specifically for your user like .ssh , .config, .profile

Basic Linux commands to be executed in a command line interface

Graphical User Interface (GUI) vs. Command line Interface (CLI)

GUI = A Graphical User Interface here we have graphical elements that we can interact with like buttons, its visual

CLI = Command Line Interface, where users type in commands and see the results printed on the screen/Terminal

terminal = this is the application for displaying and working with command line interface

The GUI and CLI are basically two different interfaces that we as operating system users interact with the operating system

note that on a personal computer we have both GUI and CLI whereas on servers we have only CLI and no GUI

As a DevOps Engineer you will be working with server so you need this skill

command line interface in

Basic Linux Command

- to create a file in linux for example if i want to create a file called _enginners-list_

```
touch engineer-list
```

```

- This file call _engineer-list_ is empty if i want to add names of engineers in the file

- add the following content in the file

| number | name |

| --- | --- |

| 1 | peter |

| 2 | jame |

| 3 | paola |

| 4 | jane |

| 5 | carelle |

```

vi engineer-list

```

- to read the content of  the file run the command

```

cat engineer-list

```

- to create a folder or a directory for example if i want to create a directory with name _devops_

```
mkdir devops
```

- change directory into _devops_

```
ls devops
```

```
cd devops
```
```

- create another file inside the _devops_ directory

```
touch cloud-engineer-list.txt
```

pwd: print working directory is use to display folder that you are currently working in

```
PWD
```

ls: list folders and files

```
ls
```

cd: change directory and the command is cd [DirectoryName]

```

cd

```

cd .. : take me one level up a directory

```

cd ..

```

using the cd command i can navigate my file system going up and downd

mkdir [DirectoryName] : this command will make a directory

```

mkdir devops

```

file Option Operation

touch [FileName]: this create a file

```

touch engineer-backup

```

rm [FileName]: this will Delete the file

```

rm engineer-backup

```

rm -r [DirectoryName]: this will Delete the directory recursively

(any sub directory that is inside the main directory)

```

rm -r devops

```

rmdir [DirectoryName]: Delete and empty directory

```

rmdir class26

```

clear: clean up the terminal

```

clear

```

tail [fileName] : show last 10 lines of a file

```

tail myscript.txt

```

head [fileName] : show first 10 lines of a file

```

head myscript.txt

```

echo : print what was written in the terminal

```

echo "i am very happy with my study"
```

```

**navigating to the root folder**

cd / : navigate to the root folder and when you type [pwd] enter you see that you are in the root folder when you type [ls] it shows you the different folder in the root folder

```
cd /
pwd
ls
```

NB everything in linux is represented as a file (text document, picture, directories, devices like printers, keyboard, USB, CD ) this permit them to be copied move from one place to another etc

**Navigating into the filesystem**

cd /usr/local/bin : this move you to the bin directory

```
cd /usr/local/bin
```
```

cd ../.. : move two hierarchy up

```

cd ../..

```

From anywhere in your file system you can specify an absolute path of any location

Absolute path is a term that is use for describing the full or complete path of any location

cd [absolute path] : move to any location by providing the full path

cd ~ : this takes us to our home directory from anywhere

```

cd ~

```

mv [FileName] [new_FileName] : rename the file to the new filename

```

mv myscript.txtx myscript-backup.txt

```

cp -r [DirectoryName] [New_DirectoryName] : this will copy

DirectoryName to New_DirectoryName

```

cp -r devops devops-backup

```

cp [FileName] [New_FileName] : this will copy the FileName to New_FileName

```

cp file.txt myfile.txt

```

redirect (>) : add a content to a new file or replace existing

content in a file

```

echo "it is a good" > mycript.css

```

apend (>>) : add content into a file

```
```

echo "i an doing great" >> mycript.css

```

sudo su - [Username] : this will switch from one user to another user

ls /home : shows the different users in a system

```

ls /home

```

cat [FileName] disply the content of a file

```

cat myscript.txt

```

ls -R [DirectoryName] : this display all the directories inside the DirectoryName with their content

```

ls -R devops

```

history: Give a list of all the past commands typed in the current terminal session, this is important if you want to remember what you did in the command line
```

history 20 : last 20 commands

```

history 20

```

***DISPLAYING OS INFORMATION**

you can use command line interface to display some really useful information about the operating system

uname -a : show operating system and kernel information

```

uname -a

```

cat /etc/os-relese : show the OS distribution and version

```

cat /etc/os-release

```

lscpu : display information about cpu

df -h : display information about storage/hard disk

```
df -h
```

lsmem : display information about the memory

```
lsmem
```

free -m : display information about memory

```
free -m
```

swap: Swap space in Linux is a dedicated area on the disk that acts as an overflow space for the system's physical memory (RAM). When the physical memory is fully utilized, the system moves inactive pages from the RAM to the swap space, thereby freeing up RAM for active processes. This mechanism helps in managing memory efficiently, especially when the system is under heavy load.

NETWORK COMMAND

- nslookup: Queries DNS to obtain domain name or IP address mapping

```
nslookup facebook.com
```

- dig : Queries DNS servers for information

```
dig facebook.com
```

- ps aux: command in Linux is used to display information about all running processes on the system.

```

ps aux

```

- ps aux | grep

- ifconfig: Used to configure and display network interface parameters.

```

curl ifconfig.io

```

- ping: Checks the network connectivity between the host and the specified network node.

```

ping facebook.com

```

- netstart -tulp: Displays network connections, routing tables, interface statistics

netstart -tuln

- curl: Transfers data from or to a server using various protocols.

```

curl link to download

```

- wget: Retrieves files from the web.

```

wget linked to download

```

DISPLAYING OPERATING INFORMATION

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uname -a
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```

lsmem : display information about the memory

```
lsmem
```

free -m : display information about memory

```
 free -m
```

check disk pace and swap space
```

```

free -h

```

EXECUTING COMMAND AS SUPERUSER

This command can only be executed by a superuser, a regular non root user cannot execute such command

sudo adduser [UserName] = this add a linux new user to the group

```

sudo adduser

```

ls /home : to verify if the new user was added

```

ls /home

```

sudo : this allows regular users to run programs with the security privileges of the superuser or root

sudo su - : this will switch user from regular user to root user

```

sudo su -

```

sudo addgroup devops: this will create the devops group

```

sudo addgroup devops

```

su - [UserName] : will switch you from the current user to the new user

```

su - ubuntu

```

PACKAGE MANAGER / INSTALLATION OF SOFTWARE ON LINUX

A package manager is a tool or system that automates the process of installing, updating, configuring, and removing software packages on a system. It simplifies the management of software by handling dependencies, ensuring proper installation, and providing an easy way to uninstall or upgrade software components.

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we are looking on how to install software application on linux

In linux we install most software application using a package manager tool even though we have exception but 90% of the packages will be install using package manager tools

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What is a package manager?

what is a software package?: this is a compressed archive which contain all the files that are required by a specific software to run

software application usually have dependencies, they depend on other software to run.

The package manager will do the following:

1. downloads, installs or updates existing software from a repository

2. ensures the integrity and authenticity of the package

3. easy upgrading of the software

in every linux distribution a package manager is already included in every linux distribution

ubuntu linux distribution has a package manager call APT and for Redhat the package manager is YUM

APT: Advanced Package Tool this have command to install, uninstall and upgrade packages

apt search <package_name> : this will search for a given package

sudo apt search openjdk : to search all the java version packages that are available

```
sudo apt search openjdk
```

apt install <package_name> : install a given package

apt install <package_name1> <package_name2> : install multiple packages with one command

apt remove <package_name> : remove installed packages

VI and VIM Text Editor

Vi and Vim are text editor that we use in command line interface

1. why do we need a command line Text Editor like vim or vi?

2. how do we write or edit a file in the command line,

linux command line has a built-In text editor call **vi** or it more modern version call **vim** with this text editor you can write in its like a normal text editor.

you need to know the specific text editor command to know how to work with the text editor

USE CASES TO USE TEXT EDITOR IN CLI

You may want to edit a file to change a configuration like kubernetes configuration files faster to create and edit a file at the same time using VI and VIM

the vi editor is pre-install with the linux operating system

to create text and move in to a text editor

vi [FileName] : create a file an open it in a text editor

```

vi file.txt

```

vim or vi editor has two mode:

1. The Default mode OR the Command mode (it is call a command mode because what you type is interpreted as a command): in this mode you cannot edit the text, but you can navigate, search, Delete, Undo etc

2. The insert mode or the Edit mode: in this mode you can enter text and type

To switch from command mode to edit mode you will have to type:

press i key = Switch to Insert Mode to type a text

```
i
```

press esc key = switch from Insert mode to command mode

```
esc
```

type :wq = Write file to disk and quit Vim

```
:wq
```

type :q! = Quit vim without saving the changes

```

:q!

```

switch to command mode then type dd = Delete the entire line

```

dd

```

=====pipe and grep==========

grep = is a linus command use to filter and sort out a particular word

history | grep sudo = this will filter the print out all word with sudo

history | grep "sudo chmod" = this will filter and print out the word sudo chmod

we can use the grep command to find phrases in specific file content

====REDIRECTS IN LINUX==========

We can redirects the result of a command execution into a file and save it for later use

redirect > = it take the output from the previous command and sends it to a file

history | grep sudo > log.txt

append >> = this will add more content to a file

cat log.txt > log2.txt

history | grep rm >> log2.txt

if you are collecting logs of a program then it become very important to use pipe and redirects

=========Users and Permissions========

This is one of the core concept in linux operating system users and permissions

- User Accounts

- Groups $ Ownership and File Permissions

- Linux Commands for managing Users and their permissions

-we have to understand how permission works and how to give users and groups defferent permission to work with files and do things in the system

There are three categories of users we may have in a linux system:

1. Root User(superuser) (Superuser Account) - this user has unristricted access/permissions to the whole system for administrative task in the system you need to login as a root user to execute commands

2. Regular or standard User(User Account) that we create to login to the system : each regular or standard user will have it own dedicated space eg john

/home/john

3. Service User (service Account) to run different service eg apache , mysql and each such service will get its own user which will start it own service e.g mysql user will start mysql application

so such service will not be started by a root user or a regular user but rather they will have a dedicated mysql user or apache user that will start the application,

because this make sure that each application is isolated from each other in terms of permission and insure better security. and this is a best practice in server management to run the services with their own dedicated user.

Running a service with root user is very bad because this will create a lot of security issues.

========EXECUTING COMMAND AS SUPERUSER==========

This command can only be executed by a superuser a regular non root user cannot execute such command

sudo adduser [UserName] = this add a linux new user to the group

ls /home : to verify if the new user was added

sudo : this allows regular users to run programs with the security privileges of the superuser or root

sudo addgroup devops: this will create the devops group

su - [UserName] : will switch you from the current user to the new user

sudo adduser [UserName] = to create a new user

cat /etc/passwd = to see the user created , note that when we create a user using useradd by default it create a group for the user with the same name as the user

adduser

addgroup

deluser

delgroup

sudo passwd [username] = will change the password of a user

su - [username] = login as username where su is short for substitute or switch user

su - = Login as root without specifying any user be default it root