Unit - I

1.1 Introduction

The most important principle of Open Source software is freedom of rights. The principle is listed as follows

1. Free to run the software
2. Free to share the software
3. Free to study the software
4. Free to modify the software

In this free refers to freedom.

1.1.1 Need of Open Source

The main need for a software to be open source is that. If the software is open source then the user/programmer can easily understand the source code. Once a person understand the working principle of a software then it is possible to improve the software. The factors that contribute to the need of open source software are

- Lack of Innovation - To change an existing software to satisfy the current needs first it the software has to be understood clearly. If a software is not open source, it is not possible to make improvements to it as its source code is not available to study.
- Lack of Freedom - If the source code of a software is not available means the software is controlling the user. Because the software decides what has to be done and the software cannot be modified according to our needs.

1.1.2 Advantages of Open Sources

Advantages of Open Source software are listed below

- Reliability - When compared to other software Open Source software is reliable. This is because of the community of developers who monitor the software for error and rectify the error at an early stage.
- Stability - Open source software is stable software when compared to other software. The features in the software can be used or blocked according to the need of the user.
- Accountability - As the Source Code is available in a open source software. The user can verify the code to monitor if the code is performing any unwanted action within the system and block it if necessary.
- Cost - Open Source Software is free of cost. Anyone can download it and use it.
- Flexibility and Freedom - The important advantage of Open source software is that the source code is available with the user. This allows the user to make changes according to their needs. This freedom is not available in proprietary software. Proprietary software provides only the features that are given by the developer.

1.1.3 Applications

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1.1.4 FOSS

Free and Open Source Software is a software that is developed by community of developers. This community consists of various programmers who collaborate to develop a software. Source code of a OSS is distributed under GNU license, this allows anyone to understand and make changes in the code according to their need. Free in FOSS not only denotes zero cost but also indicates that the user has no restriction in using the software according to their need.

1.1.5 FOSS Usage

Free Open Source Software provides an alternative for almost all types of computer software. This enables the user to use the software without any cost associated with it. Some of the important uses of FOSS are

- Server Software - Apache is a open source server software with unique features. This server is a free software and it doesnot have the problems associated with microsoft IIS server.
- Applicaiton Development - To develop an application there are variour open source programming language available. Some of the Open source programming languages are PHP, Perl, Python.

Main aspect of this programming languages are the code needed to develop any software is freely available.

- Desktop - In a desktop computer windows OS can be replaced by an open source OS. Open source OS can provide a malware and virus free environment for the desktop system.
- Multimedia - Open Source software such as audacity and openshot are available for audio and video editing. These software have all the functionalities provided in a proprietary software.

1.1.6 Free Software Movement

During the initial stage of computer development (1960 - 1970) the concept of open source license is not present. This is because all the source code of the software were available at that time was open to everyone.

In 1980's a software is considered as an intellectual property. This prevented the developer to give the source code of the software to the user. First company to implement this is IBM during February 1983. During this period AT & T sold UNIX OS as a separate entity of the computer. This prompted the user to pay more for a computer system that comes with UNIX OS.

During late 1983, Richard Stallman started GNU project. Main objective of the GNU project is develop an OS that can be used by anyone without any restriction. Also the source code to be made available to user so that they can make changes according to their needs.

GUN is a recursive acronym, it's full form is "GNU's Not Unix". The intention of developing GNU project is that it must be similar to that of UNIX OS but it should be free. Richard Stallman developed Free Software Foundation in 1984..

GNU projects main purpose is to develop free software. To develop an OS a kernel and an envelope is needed. Kernel is used to connect software and hardware. Where as envelope is accessed by the user. In the GNU project envelope was created and perfectly working, but kernel was not working properly. In 1991 a student named Linus Benedict Torvalds created an OS called "minix". GNU project used the kernel developed for minix and used it to develop linux OS. Linux is totally new OS which doesnot contain any code from UNIX OS.

1.1.7 Commercial Aspects of open source movement

Commercial aspects of open source movement discuss the details about how a company that develops open source software will earn from it. A company earns money by selling the software that they have developed. When a software is provided as open source the company cannot earn by selling it, but they can earn money by providing complimentary services. Complimentary service are services such as training, technical support, consultation and certification.

FOSS product are available for free, so the number of users will always be very high compared to that of a proprietary software. Company can sell the complimentary services to the users and earn money.

A company that provides FOSS can give complimentary services at a much reduced cost when compared to that of a company that provides proprietary software. The reason behind this is that, there is no cost associated with FOSS software.

Other means by which FOSS software earns money can be compared to the business model used by Android OS. In an Android OS almost all the services and functionalities are given as free to the user, in order to earn revenue google collects the personal information of every user using the Android OS. With the information about a person google can suggest advertisements based on the users behaviour.

1.1.8 Certification courses issues

Open Source Softwares are being used in almost all important systems, such as health care, finance, government and defence. Software certification process decides the quality and authenticity of a software. Some of the important issues in certification courses are

- Certifications are vendor-centric
- Certifications life cycle is short
- Certifications are not real-world oriented
- Certification have been devalued
- No oversight body

1.1.9 Applications of Open Sources

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1.2 Open Source Software Operating Systems

Operating System is a special software that works as a bridge between the user and the underlying hardware. An user cannot access the hardware of a system without the use of OS. OS manages multiple softwares that are installed on the computer system. As of now almost 90% of the computer in the world is installed with Microsoft Windows OS. Windows OS is a proprietary OS, to use this OS on a computer the user has to buy a license from Microsoft.

An alternative to this is the use of Open Source Operating System. A Open Source Operating System is provided to the user free of cost. As the source code of the OS is available to the user it is possible to change the features of the OS according to their needs. One of the most important Open Source OS is LINUX OS.

1.2.1 LINUX

LINUX is an OS similar to that of windows and iOS. LINUX OS supports Graphical User Interface and also has softwares similar to that of word processor, video player, etc.. The main difference between other OS and LINUX is that LINUX is an Open Source OS. The Source code of the OS can be viewed and changes can be made. Using the LINUX kernal there are many OS distributions available, some of the OS are

- Ubuntu Linux
- Linux Mint
- Arch Linux
- Deepin
- Debian

1.2.2 Features of Linux

- **Multiuser Capability**: This allows more than one user to access the resource such as memory, hard disk of a system.
- **Multitasking**: This is the ability to execute more than one software at the same time. This is done by CPU time sharing.
- **Portability**: Portability doesnot mention the size of the OS. Portability means the ability to install the OS on any hardware. For example the OS can be installed on intel hardware and also on AMG hardware.
- **Security**: The OS provides security in three ways, they are authentication (by the use of username and password), authorization (providing permission to perform read, write and execute), encryption (hide the content of a file so that it cannot be read easily)
- **Live CD/USB**: All the Linux distribution has this feature. By using this feature a user can use the OS without installing it on the system. The OS is loaded in a USB drive or CD which is used to run the OS
- **Graphical User Interface**: During the initial development of LINUX OS, it supported only command line operations similar to that of DOS. In the latest version of the LINUX OS GUI is made as the default mode of operation.

- **Stability**: When compared to other OS LINUX is a stable OS. Stable in the sense it does not crash.
- **Performance**: LINUX has high performance when compared to other OS. It is the reason for using LINUX OS for handling multiple users.
- **Open Source**: Linux is a open source OS. This allows the user to change the features of the OS according to their needs.
- **Application Support**: Linux supports a separate repository to store all the software that is supported in it. To install a software the system needs internet connection to access the repository.
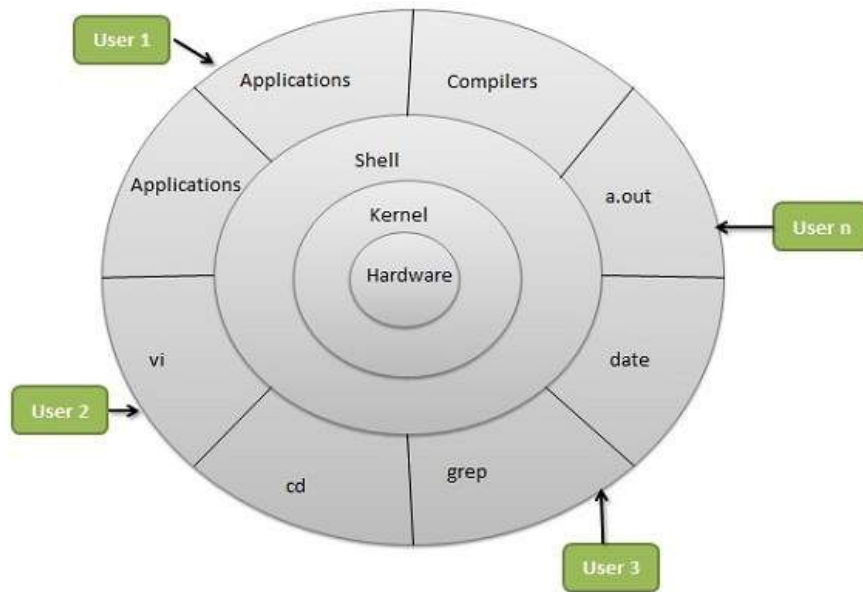
1.2.3 Linux Architecture

Linux OS consist of three parts
- Kernel - This is the most important part of the LINUX OS. Kernel has all the modules needed to run the OS. These modules are used to access the underlying hardware of the system.
- System Library - System libraries are special functions or programs using which application programs or system utilities accesses Kernel's features.
- System Utility - System Utility programs are responsible to do specialized, individual level tasks.
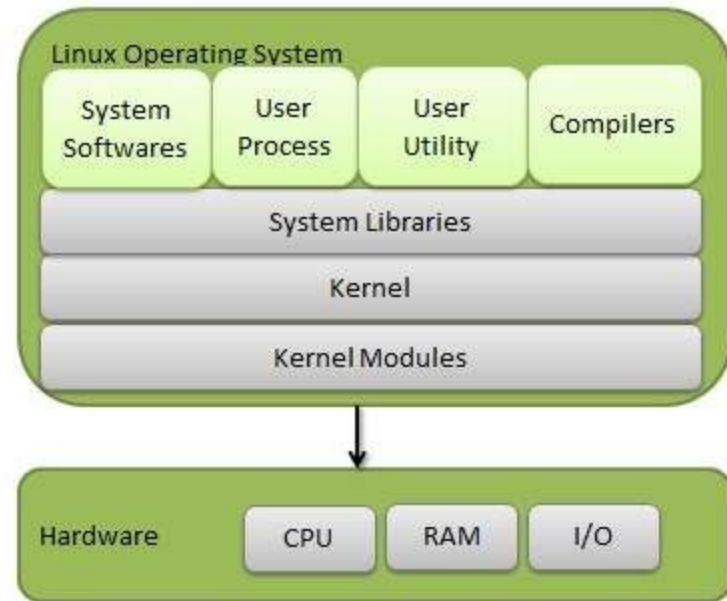
In LINUX OS a code can be executed in any of the two modes available, Kernel mode or user mode. Kernel component code executes in a special privileged mode called kernel mode. This mode allows the program to access all resources of the computer without any restriction. Support code which is not required to run in kernel mode is in System Library. User programs and other system programs works in User Mode which has no access to system hardware and kernel code. User programs/ utilities use System libraries to access Kernel functions to get system's low level tasks.

Linux architecture consist of four layer, they are

- Hardware Layer - This layer consists of all the peripheral devices. Peripheral Devices are RAM, CPU, Hard disk, CD drive.
- Kernel -This is the core component of the LINUX OS. This layer interacts directly with the components in the hardware layer.
- Shell - This is an interface to the kernel. This hides the complexity of the kernel's functions to the user. The shell takes a command from the user and executes the underlying kernel functions.
- Utilities - Utility programs that provide the user most of the functionalities of an operating systems..

1.2.4 Advanced Concepts

Linux OS has the following advanced concepts

- Scheduling
- Time Accounting
- Personalities
- Cloning and Backup
- Linux Signals
- Development with Linux

Scheduling

Scheduling is the process of allowing multiple applications to run at the same time in a CPU. This is called as multitasking. There are two types of scheduling preemptive and non-preemptive.

In Preemptive Scheduling the OS allots time for each available process to be executed on the CPU, once the the allotted time is over on the CPU the current process is removed from the CPU and the next process is executed. For example if two process such as word and audio player are running on a computer simultaneously, the OS will allot a time say 3ms for each process to be executed on the CPU. First word will be executed on the CPU for 3ms and then audio player will be executed on the CPU for 3ms. This process continues until a process is closed.This makes the user believe that the two softwares are executed at the same time.

In Non-Preemptive scheduling the OS does not allot time for the process to be executed. In this each process is allotted the CPU until its

execution gets completed, once the execution is complete the next process is executed on the CPU.

Linux process scheduling is classified into three types

- Realtime FIFO - This scheduling process works based on the priority of the process. In this scheduling when a process starts execution in the CPU its execution is continued until there comes a new process which has a priority higher than the process that is executing on the CPU. By this if a low priority process is executed in the CPU and if a high priority process comes then the low priority process execution is stopped, the process with high priority is executed on the CPU. The main drawback of this scheduling is that if there are many high priority process coming then the process with low priority does not get the time needed to execute on the CPU.

- Realtime Round Robin - In this scheduling timeslice is used. Timeslice is the process of allotting a fixed time for all the process to be executed on the CPU. Once a process uses the allotted time on the CPU then the next process in line will be executed and so on. In this scheduling if a high priority process comes then it is allowed to execute on the CPU for the allotted time.

- Others (Timesharing) - In this type of scheduling only timesharing is used for process execution. This does not consider priority for scheduling.

Time Accounting

Time accounting is used to monitor the activities performed by a user in the LINUX OS. To monitor the user psacct or acct application is used. Using this application the behaviour and the resources used by the users can be monitored. The important commands used to monitor the user in these applications are

- ac command: This command give the time the user has used the system from login to logout.

Display total connect time

ac

total   1814.03

Display totals for each day

ac -d

Sep 17 total   5.23

Sep 18 total   15.20

…...

Sep 24 total   3.21

Sep 25 total   2.27

Display time totals for each user

ac -p

   root   1645.18

tecmint   168.96

total   1814.14

- lastcomm command: This command display the information about the last command that is executed by a user

  To display the last command used by the user Mani the following command is used.

  # lastcomm Mani

su		Mani pts/0	0.00 secs Wed Feb 13 15:56
ls		Mani pts/0	0.00 secs Wed Feb 13 15:56
ls		Mani pts/0	0.00 secs Wed Feb 13 15:56
ls		Mani pts/0	0.00 secs Wed Feb 13 15:56
bash	F	Mani pts/0	0.00 secs Wed Feb 13 15:56
id		Mani pts/0	0.00 secs Wed

  Search Logs for Commands - To search for the usage of a particular command by a user in the system the following command is used

  # lastcomm ls

ls	tecmint pts/0	0.00 secs Wed Feb 13 15:56
ls	tecmint pts/0	0.00 secs Wed

- sa command: This command is used to summarize all the commands that are used by all the users of the system.

  # sa

8	1.05re	0.00cp	1064k	man
2	10.08re	0.00cp	2562k	sshd

12	0.00re	0.00cp	1298k	psacct
2	0.00re	0.00cp	1575k	troff
8	1.05re	0.00cp	1064k	man

In this 1.05re denotes the real time clock minutes

0.00cp denotes the time taken to execute on the CPU

1064k denotes the cpu-time average core usage

Man is the command that is used

- accton command: This command is used to turn on or turn off the accounting functionality in the LINUX system.

Personalities

Linux OS allows execution of programs developed for execution on other OS. The only condition for this is that the program developed for the Linux OS and other OS should be compiled for the same hardware. For example a program compile in Intel Core i5 processor for other OS can be executed on the Linux OS running on Intel Core i5 processor. To do this Linux uses two options

- Emulated Execution: This method is used to execute programs that contains non-POSIX compliant system calls..
- Native Execution: This method is used to execute programs that contain POSIX compliant system calls.

Few Personalities supported by the Linux kernel

Personality	Operating system
PER_LINUX	Standard execution domain
PER_SVR4	System V Release 4
PER_SCOSVR3	SCO Unix Version 3.2

PER_ISCR4   Interactive Unix

PER_BSD BSD   Unix

PER_SUNOS   SunOS

Cloning and Backup your Linux system

Clonesys is a shell script which is used to get the image of the linux OS. This image can be used to create bootable CD/DVD. Using this CD/DVDயின் it is possible to install a exact replica of the Linux OS that has been copied. This is used to create an image of the information contained within the Linux OS and it is not used to take backup of user data.

Using clonesys script

1. Check the Configuration: This is the first step in creating an Linux image. In the clonesys tool the file "config.ini" contains the values of global variables. The values in this file decide the configuration of the tool. This tool creates an archive of the file system. The "backup.ini" file is used to mention the files that are to be present in the archive. To mention a particular module to be loaded on the system boot time, the required information is provided in "moremodules.list" file.

2. Run the cloning script: By executing the "clonesys.sh" script the ISO image file is generated. The content of this ISO file is decided by the values given in "config.ini" file.

3. Test the CD: The CD written using the generated ISO file will be a bootable CD. This CD can be used to recover a Linux OS that has been crashed.

Backing up and restoring data

In any system to protect the data that is stored in it, it is necessary to take backup of the data at a particular time interval. When an error occurs on the system the backup is used to restore the lost data. In general to take backup tape drive, removable disk drives and CD-R/DVD-R are used. The commands used to take Backup and perform restore operation are given below.

- Cp command: cp command is used to take backup of certain files or an entire directory tree on a removable disk. The steps to take backup are given below.
  - First a mount point is created
    #mkdir /mnt/removable
  - A Removable disk is mounted on the system and if it is formatted in FAT/NTFS windows formatting it is re-formatted into VFAT file format.
    #mount –t vfat /dev/hdc /mnt/removable
  - To copy the files in the removable disk the cp command is used. In this R option is used to copy the entire directory tree. V option is used to show the list of files that are being copied.
    #cp   –R   –V   /var/www/mypage.html   /home/you /mnt/removable
  - Finally once the file are copied on the removable disk, it is unmounted
    #unmount /mnt/removable

- Tar command: tar(tape archive) command is used to take backup of large volumes of data.

  #tar –c –v –f dest /path1 [/path2…]

  –c option tells tar to create a backup

  –v option causes tar to display the name of eachfile as it is backed up.

  Dest is used to denote the device in which the backup is to be stored.

  /dev/st0 – First SCSI magnetic tape drive

  /dev/st1 – Second SCSI magnetic tape drive

  /dev/ht0 – First IDE magnetic tape drive

  /dev/ht1 – Second IDE magnetic tape drive

Restoring tar backups

The following format is used to restore the data that is backuped using Tar command

tar -x -v -f source [pattern…]

–x option tells tar you want to extract from a backup.

–v option displays the name of each file as it is restored.

Pattern mentions the names of the files that are to be restored, if nothing is given in pattern then all the files in the tar are restored

Linux backup utilities

Some of the backup utilities available in Linux are

1. Fwbackups: This utility is designed to be used in a easy manner. This utility has the facility to take time based and remote system backup.

2. Mondorescue: This is a free backup and rescue software. This is used to take backup on personal computer, workstation and server. The main feature of this software is that if an error occurs during the backup process, it is possible ot recover from it.

3. Amanda: Amands is the short form of Advanced Maryland Automatic Network Disk Archiver. This backup tool works on the principle of client/server model. In this a single backup server can be used to store backup of multiple client systems.

4. Bacula: This is a powerful open source backup tool. This is designed to be used in large organizations. This tool is hard to be used as it has many options and functionalities that are essential for large organizational backups.

5. Rsync: This backup software have many features. This software has features such as incremental backup, local and remote backup, preserve file permission and ownership. Rsync is a command line tool, The GUI based version of Rsync is Grsync.

Linux signals

In linux Signals are software interrupts, This inform the OS that an important event has occurred in the program. This event may be a simple user request or any illegal memory. In Linux the program has to work according to the signal that it receives. Some of the important linux signals are given below,

Signal Name   Number   Description

SIGHUP	1	Hangup (POSIX)
SIGINT	2	Terminal interrupt (ANSI)
SIGQUIT	3	Terminal quit (POSIX)
SIGFPE	8	Floating point exception (ANSI)
SIGKILL	9	Kill(can't be caught or ignored) (POSIX)
SIGALRM	14	Alarm clock (POSIX)
SIGTERM	15	Termination (ANSI)

Development with Linux

An integrated development environment(IDE) is an application that is used to develop software by the programmer. In general an IDE consists of source code editor, debugger, compiler/interpreter and build automation tools. A good IDE is the one that can enable a programmer to develop an application without any error in a faster manner.

Some of the IDE's used in Linux are

- Anjuta: This IDE is created for the GNOME project. This IDE supports c, c++, java, javascript, python and vala programming languages. This has project management, application wizard, interactive debugger, source editor, version control and GUI designer.
- Eclipse: This is a java based IDE. This IDE has support to various programming languages.
- KDevelop: This is a cross-platform IDE. This is used to develop softwares in C, C++, Python, QML/Javascript and PHP language.

- Netbeans IDE: This is the authorized IDE for developing java based applications. This has features such as smart code editing, efficient project management, etc...
- CodeLite: This IDE is similar to that of KDevelop cross-platform IDE. This is used to develop programs in C, C++, Python and Javascript language.

Review Questions

Part - A

1. What is FOSS.
2. Write the various LINUX distributions available.
3. What is scheduling?
4. What is Backup?
5. What is cloning?

Part - B

1. Write the need of Open source.
2. Write short note on FOSS usage
3. Discuss about Linux architecture.
4. Explain various scheduling methods available in linux.
5. Write about linux backup and restore operations.

Part - C

1. Write the advantages of Open sources.
2. Explain in detail about Free software movement.
3. Write the applications of Open sources.
4. Write the features of linux.
5. Explain in detail about time accounting.

6. Explain in detail about Linux advanced concepts.