CHAPTER

1 An Introduction to Linux

What is Linux?

Welcome to the study of the essentials of Linux Operating System! This operating system has become more popular recently and is gaining increased momentum due to several reasons. One such is that Linux has features that are comparable or better than other proprietary operating systems. With the availability of several advanced applications based on Linux, the use of this operating system has increased. More and more applications are being deployed in Linux platform in this era of burgeoning IT growth. Stability, support, increased availability of skills and resource pools, and the application maturity, along with lower cost of ownership make this operating system acceptable in an increased level in different sectors. In this chapter we will be discussing the salient features of Linux operating system, its strengths and weaknesses and the history of its development.

About Operating Systems

Computer is an electronic device capable of performing several computing and mathematical operations. Computers are also used for playing games, viewing pictures and photos, watching movies and for hearing audios. Browsing the Internet, sending and receiving mails, chatting, exchanging ideas and socialising are also now possible with the use of computers. And, computers need some basic software or program to do all these activities. The job of this basic software is to manage these varied activities and to control the various associated operations. These types of basic software that are needed to control the different activities are called **system software** or **operating systems**. System software makes the working of computers easy. System software also control the operations of the CD drive, enable the use of modems and other peripherals connected to the computer. They help computer users to create files and folders, copy files and run applications. In other words, operating systems perform different management operations such as file management, memory management, device management and process management.

Several types of operating systems have evolved through the past several years. Earlier, operating systems were characterized by their limited capacities and reduced features. New operating systems are available with several advanced features. Some operating systems are developed for certain special uses. Presently, operating systems are classified based on their ability, area of use, working environments and the like. Some of the classifications of operating systems are real time operating systems, server operating systems, single user operating systems, multi user operating systems and so on. Operating systems are now used also in mobile phones, PDAs (Personal Digital Assistants), music players, game consoles, digital cameras and several other gadgets. In these devices operating system software are embedded in the hardware. Unix, Windows, Solaris, Mac are some of the operating systems currently available for desktop systems. Linux is an operating system that has established a firm presence in industry, for the deployment of business-oriented as well as other common applications. It is used in a variety of hardware platforms.

Free and Open Source Software

The demands of consumers as well as enterprises are ever increasing with the increase in the Information Technology (IT) usage. IT solutions are required to satisfy their different needs. It is quite natural that a single solution provider cannot produce all the needed solutions. Due to this, IT environments of today have become complex with different solutions from different vendors. This is leading to different issues related to difficulties in cross platform compatibility, data integration, sharing of objects between applications and single sign on facility. Interoperability between platforms as well as sharing objects between applications have become a necessity, as these help to reduce cost and complexity of the IT environments and the cost of owning them. The solutions for these issues, available now are in different forms such as free software types, freeware types, open source types and proprietary types.

Open source, freeware and free software are now available for anyone and for any use. These are also available for any purpose including specialized jobs. Freeware and free software are different from each other. *Freeware software* is a type of software that is available free of cost and these can be easily distributed without any restrictions. There are no license agreements for freeware software.

The definition of free software is given by the Free Software Foundation (FSF). But in *free software*, the meaning of the word free is different and it does not mean that the software is available at zero cost. The term free in free software is used to indicate the different freedoms offered to the software user. Free software user is provided with the complete freedom to run the software for any purpose, freedom to study the working of the software, freedom for adapting the software to different needs, freedom to redistribute copies, freedom to improve the software and for releasing improved versions of the software. To improve the software and to adapt it to different needs, the source code of the free software must be easily available. While releasing new versions or after modifying the software, it is very essential that no restrictions negating the original freedoms must be imposed on the free software. Any software can be treated as free software, if the users are provided with all the above freedoms. Being free to do the above things means that it is not necessary to ask or pay for permissions to do such things.

The concept of free software is not a new thing. It existed even at the time of the development of the first computer itself. In the initial period all the software was available as free software. Earlier computer users were scientists and developers, and they did not consider the software as a business asset. So there were no restrictions in copying the software or modifying it. But the main difficulty was the lack of standardization between different software. As a result, software worked in a system based on a particular architecture could not run in another machine having a different architecture. When computers were begun to be used for commercial activities, some restrictions were began to be imposed on the use of software. This led to the charging of different fees for the use of the software, as the business people started to treat software as a business asset along with the hardware. In order to overcome the difficulties associated with the restrictions in using different software, in 1983, Richard Matthew Stallman started the GNU or Gnu Not Unix Project. This project was aimed to spread the message of using free software and to develop a free operating system similar to but different from the Unix operating system. In continuation of this project, later in 1985, Free Software Foundation (FSF) was formed. One of the primary goals of this foundation was the development of a free and open computer operating system and application software that can be used and shared among different users with complete freedom. The face of the African animal gnu was chosen as the logo (see Figure 1.1) of this project.

Figure 1.1 GNU Project Logo.

With the activities of the Free Software Foundation and the GNU project, several types of free software were made available. The GNU text editor Emacs and the GNU C compiler GCC were the very successful initial software. Two other notable developments were the Berkley Software Distribution (BSD), which is a reimplementation of the Unix operating system and the X Window system, a free, network transparent graphical computing environment. The work progressed and by the year 1990 many of the components of a free operating system named GNU operating system, except the kernel, were developed. Development of the kernel—called as **Hurd**—was found to be very difficult. In 1992 Linux kernel was made available under the GNU General Public License (GPL). GNU operating system used the Linux kernel and developed a complete operating system and in this way the free operating system GNU/Linux was created.

Open source software means that the source code of the software is openly available. This is contrary to proprietary software, where the source code is kept secret. Open source software license provides certain license to end users. This license provides the right to access the source code of the software, make copies of the software and distribute

it and make improvement to the software. So anyone can distribute or sell the software. Also anybody can modify the software to suit his needs, and can provide support to users for the software. Open source software is developed collectively and hence these are transparent due to which bug fixing is easy. These types of software are continuously modified and improved by adding new features and facilities. As a result, these types of software also have a better quality. Software rewriting is eliminated in open source software though these types of software encourage software reuse. Also, sharing the code increases the credibility of the software. Open source types of software are developed by communities of developers who distribute the code without any charge and donate their labour to debug, improve and modify the software. Also, since voluntary developers are not driven by any commercial interest and hence their interest for adding features to the software is low. The motivation behind this type of voluntary activity is different such as the need for a new piece of software, increased knowledge requirement and so on.

Parallel software development and debugging are other notable features of open source software development process and due to these, open source software are available at lesser prices. Usually open source software are sold for a price, which is attributed towards the cost of user manuals or for providing technical support or towards the charge for copying the software and the cost of copy disks.

Linux happens to be the first name that comes to people when speaking about free and open source software. But Linux is not the only software that is available in this category. Gedit is a lightweight free text editor and can be found in many Linux distributions, BSD and Unix systems. This editor software supports most standard editing features and has a powerful plug-in system for adding new features. For graphic based applications, one of the most commonly used applications is Gimp. Several image manipulations can be done using this software. Gimp is free and is available in different versions for different operating systems.

Internet applications include applications for browsing the Internet, mail applications and messaging services. Mozilla Firefox, Mozilla Thunderbird, Iceweasel, Gaim, Evolution are some of the commonly used applications for different Internet based activities. MySQL is an open source database application available for different platforms. Besides these, there are several other open source software that are used as firewalls, IDS and so on. These are free software and are available in different versions suitable for different operating systems. Also these applications work integrated with several others of this kind. An absolutely free, open, feature-rich multi-platform office productivity suite is OpenOffice.org suite. The user interface and the different functionality of this suite are very similar to other commercial products like Microsoft Office. Besides these, several programming languages are also available under this category. Python is an easy to learn and a powerful programming language. It has a high-level data structure and a simple but effective approach for object-oriented programming. This is an ideal language for scripting and rapid application development in many areas on most platforms. Apache web server is an open source software that has emerged as the most popular web server. Now several educational tools for different activities are also available as free software. These tools are aimed for children of different age groups. These different software are having simple and easy to use user interfaces and these work in an interactive and easy style. Users can adapt the software, improve them and share the software with others.

Besides the different advantages of open source software discussed earlier, these types of software offer several other advantages also. Open source software has changed the ways of developing software applications. These types of software reduce the tight coupling between the application and the platform on which these are deployed. When using open source software, cost does not escalate with the scaling up of business. Cost of licensing for open source is less when compared to proprietary type software. Open source software provide safeguard against forced future hardware upgrading. Maintenance cost associated with open source software is also less. Due to these reasons, the *total cost of ownership* (TCO) and the *total cost of acquisition* (TCA) are less for open source applications. With the increased use of free and open source software, the cost of commercial software will tend to fall. However, adoption of open source software has not increased much as expected due to several reasons. One reason is the lack of awareness about the advantages of using open source software. For example, though several open source and free software are having features that are comparable or some times superior to that offered by proprietary or closed source software they are not widely used. Another reason of less popularity of open source software is the less user friendly interfaces offered by such software. But new releases of Linux applications are having better user friendly graphic interfaces. Still, more applications in open source types of category are to be developed. Skill shortages in the use of free and open source software, lack of support, product immaturity are some other reasons for the less popularity of open source software. Open source software allows a broader perspective when comes to its support. Proprietary software vendors insist that customers avail the support from them or from authorized service vendors only. But the support option for open source software is different. Different vendors provide support and the vendors compete for support contracts, as the source code is available for anybody. This has also become a source of revenue for support service persons and firms. Apart from the commercial support, several support channels are available for open source applications.

Many open source software projects are currently running in several places. The widely accepted open source software that has emerged as the platform of choice among the users, instead of proprietary software, is Linux. Linux has emerged as a *de facto* standard in several academic institutions and commercial establishments. Due to low cost solutions, Linux is gaining support from government in different countries around the world. Low cost, flexible license requirements, high level security, absence of proprietary vendor requirements, general stability and usability are some other features that are making Linux a demanding operating system worldwide.

Origin of Linux

As is known, operating systems are essential for the working of computers. DOS was the once dominated computer operating system. But the source code of DOS was not made available by the developers of the operating system. Along with DOS, another operating system available was Unix. Unix was developed in 1969 and was developed using C programming language. Unix was different from other operating systems available at that time and Unix offered several advantages. Unix made it possible for

different software to work on any hardware. Previously this was not possible owing to the lack of standards. The major attraction of Unix was that it created standards on which independent hardware and software manufacturers could work. Unix could work on a wide range of machines irrespective of the architecture or configuration. Another feature of Unix operating system was the ability for networking. This ability helped computers to interconnect themselves as well as to connect to the Internet. Due to these added features several derivatives of this operating system such as Sun OS Solaris, BSD (Berkely Software Distribution) and so on were soon developed. BSD was released as free and open source software and the license allowed the use of the operating system for any commercial purpose.

With the commercialization of Unix, the practice of distributing source code along with the software came to an end. The increased price of Unix and the difficult user interfaces kept Unix away from users. Efforts to develop a low cost operating system progressed and this led to the development of Minix. Andrew S Tanenbaum, a Dutch Professor, wrote this operating system to teach the students about the inner working of operating systems and the source code was freely distributed. Minix was developed for educational use and was released under BSD license. This operating system was written in C programming language and assembly language. Thus, for the first time, the code for an operating system was made available. Along with Minix, another operating system released was GNU (Gnu's Not Linux). Both these operating systems were similar to Unix but used no code from Unix. These operating systems provided only limited abilities and more features were to be included for the effective working so as to function as a true and complete operating system.

This was the time when developers were actively involved in discussions related to the development of open source software. In 1991 Linus Trovalds, a student of Helsinki University developed an initial operating system and posted to newsgroups for feedbacks and discussions. Actually this was the initial version of the kernel used for the development of Linux operating system. With some modification, based on the discussions at newsgroups, an initial version of Linux 0.01 was released in mid September and was put on the Net. This was the beginning of the evolution of Linux operating system. Depending on user requirements new versions of Linux operating system were released from time to time. But all these versions were in skeleton forms only. The main difficulty with the different versions is that these versions provided support for only a limited number of hardware components, such as hard disks, keyboards or monitor types. Soon, the different versions were made available through different *ftp* sites. This type of different distributions of the software enabled hundreds of developers to work on the source code and to provide several worthy modifications. The efforts made by several developers led to the release of Linux for actual use in computers. Linus Trovalds later came to be known as the father of Linux operating system. He adopted the penguin nicknamed as Tux as the Linux mascot (see Figure 1.2). Later, Linux community adopted Tux as the mascot of Linux kernel and majority of people associate Linux with Tux. Tux can be seen in Linux related websites and along with Linux products and applications.

Soon Linux was included under GNU General Public License (GPL) making the source code freely available for copying, studying as well as for editing purposes. GNU operating system used this Linux kernel to develop a complete operating system and thus the free operating system GNU/Linux was formed. After this, several commercial vendors

entered the scene for developing advanced operating systems. With the introduction of graphical interfaces such as KDE and X-Window, the popularity of Linux operating system also increased. Different vendors added several noteworthy features and made the software in a distributable format, ready for distribution. Red Hat and Debian were the first two vendors who entered the scene for distributing Linux. Even today newer and newer versions of Linux are being released periodically and hundreds of different Linux versions are currently available to users.

Figure 1.2 Tux–Linux mascot.

Linux Kernel

The central nervous system of Linux operating system is the kernel. The kernel is responsible for running the entire system. It is responsible for all the basic functions performed by the operating system. Kernel provides a set of services and APIs on top of the hardware for the application to use. Kernel manages memory, controls different devices, execute commands, handles different errors and so on. The kernel is under constant revision and development by the Linux community. Due to this constant revision process, always a stable Linux version as well as an experimental version of Linux will be available. With every revision, new and new features are incorporated to the Linux kernel. Thousands of lines of codes are modified and tested before a new stable version of Linux is released for use. A full featured Linux kernel that provided the abilities for the management of different resources of the system was Linux 2.4. Later versions added several new features to this initial Linux version. The added features provided additional strength to the kernel. Also, the newly added functions and operations provided a better standardized environment. Support for new hardware components, increased concurrent processes and users, support for large number of users and groups, better scalability are some of the notable features available in newer kernels. Support for powerful hardware, increased memory, additional hardware controllers, increased networking hardware, large file size are their other salient features. All these features are making Linux more matured in operations and working and more acceptable in different segments.

Linux kernel is developed in a modular architecture. Modular architecture means that the kernel is built using several modules or subsystems. Basically there will be a core that is made up of the minimum code for running the system. This kernel performs

different functions of the operating system such as device management, memory management, process management and file management with the support of the core. All these management processes are performed using several advanced functions such as process and thread creation, inter process communication mechanism, interrupt handling, security file system, networking and so on. Different device drivers, protocols and other components are glued to this core as per requirements. These different components perform different tasks such as reading files, drive disks and the like. This type of modular architecture helps in an efficient working of the operating system by loading the system faster and using the minimum memory. It can be seen that whenever new versions of applications are released, requirement of memory is high when compared to previous versions. But the modular architecture of Linux helps to keep the additional memory requirements less for new versions.

Basically Linux kernel is made up of several device drivers. Device drivers are file systems through which users and programs interact with the hardware and other connected devices. These drivers are written to work in a variety of platforms. Support for new processors and new architectures are included in new kernel versions which provide support for almost all devices connected to the Linux system. Basically a tree like architecture is followed in Linux operating system for different device drivers. Instead of putting all device drivers in a single directory, Linux groups the drivers based on controllers. This type of architecture separates drivers for different platforms and for different devices. Also, the number of available namespaces is increased due to this architecture. The tree arrangement can be seen by exploring the system. This arrangement offers a greater reliability and the different machine specific drivers can be added to the core of the kernel efficiently. Interrupt handling functions performed by the kernel helps to control different hardware systems. This is done by setting priorities for interrupts, enabling and disabling interrupts and scheduling interrupts. At the starting time, different hardware checking is done and the drivers are loaded and interrupts are set as required.

Bus architecture of computers is responsible for the efficient working of internal as well as external devices connected to them. Commonly used bus architectures are known by names such as ISA, PCI, MCA, USB and so on. New buses have additional features when compared to earlier bus architectures. Linux provide support to these architectures including support for plug and play devices inserted to the above mentioned buses as well as to those devices connected to serial buses and external buses. Several devices such as keyboards, mouse, speakers, printers, scanners and so on can be connected to the system using USB (Universal Serial Bus) and Linux supports this architecture efficiently. Also a number of I/O devices are supported by Linux kernel. Different devices that are supported include IDE, SCSI and SATA disk drives. Newer versions provide support for increased numbers of controllers. Different floppy disks, tapes, DVDs and CDs are also supported by Linux kernel. Direct low level device addressing ability helps this operating system to communicate directly with different devices. It helps data to be written direct to the disk thereby minimizing the loss of data in the event of any failure. Support for RAID devices and multiple disks working together for redundant storage and speedy data access helps in the safe storage and retrieval of data in different computing environments. Linux kernel also supports serial ports and parallel ports, modems, sound cards, TV and radio tuners and a variety of video cards.

Support for different file systems suitable for different platforms is another feature provided by Linux kernels. Different systems use different types of file systems namely FAT, FAT32, NTFS, VFAT, HPPS and so on. Support for different file systems helps in the seamless operation of Linux systems in hybrid environments. Support for different partition tables is another feature offered by Linux. This feature makes the operating system to read from any partition table. To manage memory, kernel provides support for a large memory address space, memory mapping and demand mapping. Several processes and threads can be created cheaply and easily using the Linux kernel. Also the kernel helps to share different files, memory and processes. Communication between processes and applications are also done efficiently by the kernel.

A complete implementation of networking protocols such as TCP, IP, UDP, NetBEUI and so on are included with the kernel. As a result, the kernel provides enough support for networking and making communication with the Internet, easily. Linux kernel supports several new networking devices and offers several networking functions. Firewalls, packet filters and the like have become common components of Linux kernels. These features help the easy integration of new as well as old components in networks. Protocols for messaging, mail operations as well as other common Internet services were included from earlier versions of Linux. The ability of Linux operating system to process HTTP requests makes the Internet accessing an easy process. Program loader portion of Linux kernel helps to associate different files to the correct application. This helps in the easy opening of files and to run programs easily. Availability of documentation is another feature of Linux kernel. Detailed documentation files provide necessary support for running the operating system.

Linux Features

Linux operating system is based on Unix and its several features are adapted from Unix. Linux is compatible with the new popular industry trends such as virtualization and cloud computing. Several popular applications including BI, CRM, ERP, database and middleware are now deployed in Linux platform. Linux has emerged as a low cost alternative for different uses. Different features of Linux operating system can be explained under different groups as follows:

Free and Inexpensive

Linux versions are available as free distributions and can be downloaded free from the Internet. Paid distributions of Linux are available at reduced prices. Linux is available under General Public License (GPL), which requires free distribution of the source code. All patches and updates are also available under this license. This license provides freedom to copy and modify the software without any restrictions. Also the modified versions are distributed under the same license as the original one. Besides these advantages, several applications working in Linux operating system are available either as free or under GPL. Such Linux applications can be downloaded from different Internet sites. Updates of several applications can also be downloaded and can be used free.

Stable and Flexible

Linux operating system has matured into a reliable, robust and stable operating system. Linux is flexible, as it is an open source operating system. High availability, fail over solutions, increased manageability and better storage enhancements are the major features of this operating system. Flexibility of Linux systems is increased with the help of tools and applications that provide facilities for configuring the system for different users. Different tasks can be scheduled differently and can be configured to activate at the set time. Different companies test Linux to ensure hardware compatibility and hardware deployment and Linux is found to be stable in several hardware components. Also, the security of Linux is better when compared to other operating systems. Virus attacks in Linux are less when compared to proprietary operating systems. Virus propagation mainly takes place through pirated copies. Linux can be obtained directly from official websites of distributors and hence the authenticity can be verified. Moreover, the source code is available for verification and if required, the code can be compiled for creating a new version of the operating system. For Windows operating system, innumerable numbers of security software are available and several security patches are released frequently. But in the case of Linux it is not so. This difference is because several user groups are constantly updating Linux software by adding new features and facilities. Security holes are fixed easily during the updating processes. Moreover, the kernel and file systems of Linux are derived from the secure Unix operating system. Hence the security offered by Linux is strong. Besides these, Linux distributions are now made available with a default anti virus software for scanning the system and for detection and removal of viruses from the system.

Fast and Reliable

Linux operating system is fast and so it can manage different resources efficiently and effectively. One reason for the increased speed is the low memory requirement due to its modular architecture. Linux has the ability to add new modules as and when required and to release the resources after the use. Linux is equipped with several added features to increase the reliability of the system. The backup option provided by several Linux distributions offers facilities for simple backing up as well as backup restoration of machine contents in an easy manner. By setting different options, the system backup can be set to take place automatically in different styles such as daily backup, weekly backup, incremental backup, full backup and so on. System monitoring facility provided by several distributions helps to make a close monitoring of the functions of the system. The system monitor application available in Linux systems displays the basic system information. The application also monitors system processes, usage of system resources and file systems. It is also possible to modify the behavior of the system using this application. System testing application available with several Linux distributions enables the testing of different hardware components and to report any errors. Using this facility it is possible to check the system for errors and thereby the performance of the system can be improved.

Easier to Use

Graphical interfaces in Linux offers several facilities for ease of use. A number of graphical interfaces, each having a different layout, can be chosen by the user for installation. To make the interface more attractive, options are available for customization. For quick access, applications can be placed as shortcuts in the desktop or can be added to the panel. Drag and drop functionality, point and click facility are some of the features of graphic user interfaces. Forward and backward buttons help to navigate through forward and backward windows at ease. Using the single click option, files and folders can be opened by single clicking of the mouse. Different operations including the complex tasks of system administration can be done using a number of mouse clicks, when using graphic interfaces. Different graphic environments are customizable and offer different kinds of working environments. Linux installs most of the necessary drivers during the time of its initialization and hence new devices can be added easily. So restarting of the computer after installing device drivers is not necessary. Proprietary hardware drivers can be installed in Linux systems with little effort.

Robust Programming and Application Environments

Highly robust and capable programming environments are available in Linux. Different software are available as free and are covered under the GNU Public License. Compilers for C, C++ languages, assembler, Perl, Python are available in Linux operating system. Scripts in Linux operating system are similar to batch files in Windows systems, but they perform better. Scripts provide abilities to automate different processes. Office productivity tools, e-mail solutions, Web applications, database systems and middleware applications are some of the common applications bundled along with Linux operating system. Bundling helps users as well as vendors since these bundled applications provide guaranteed solutions. Thus the time spent for deploying necessary solutions is reduced. Also the user is freed from paying the license fee for different solutions. These bundled applications ensure the availability of readymade and cost effective solutions. Typically, Web servers, FTP servers, mail servers, disk and print servers are available as bundled applications along with Linux operating system.

Built-in Networking Ability and Easy Access to the Internet

Another important feature of Linux operating system is the built-in networking ability. Networking allows the sharing of files and devices connected in networks. Also, a single Internet connection can be shared among different networked computers. The Internet is based on Unix and the different protocols used in the Internet are developed from Unix operating system. Naturally Internet connectivity and networking of systems can be done easily when using Linux. It is to be noted that majority of web servers are running under Linux operating system. Most Linux distributions are provided with a web browser for surfing the Net. Applications for using other Internet services such as mail management, chat services, messaging and so on are also available in different Linux distributions. Latest versions of almost all these applications can be downloaded from the web free.

Offline viewing of web pages help to view the downloaded web contents at convenient time of the user.

Increased Returns

Linux deployments have increased recently since business organizations are interested in reducing investments on existing IT infrastructure and to extract maximum Return on Investments (ROI). Total Cost of Ownership (TCO) of a system is made up of the cost for owning the software, procuring the hardware, cost of maintenance and cost for administering the system. With Linux, getting maximum ROI is possible in an easy manner, as Linux has proved to be very cost-effective and easily maintainable. Linux runs speedily and efficiently on several architecture in which Windows operating systems cannot run. Installation of newer versions of Windows operating system requires new machines with increased power and large memory. RAM, CPU, disk, audio, video and the like are also obligatory for installing new Windows versions. This type of forced hardware upgrading for the Windows systems makes it essential to replace the operational machines. But this is not the case with Linux. Requirements for Linux operating system are less and hence this system can work effectively in older machines. Thus, the use of Linux operating system means less capital investment and the cost of hardware distributing over several years. Moreover several low cost solutions are now available for Linux operating systems. Linux brings high end capabilities at lower cost when compared to proprietary solutions and hence Linux is found to be more affordable.

Multi User and Multi Tasking Ability

Linux is a true multi user and multi tasking operating system. Unix operating system from which Linux was developed is a multi tasking and multi user operating system. This ability helps several users to work simultaneously as well as to perform several tasks at the same time, so also, when using Linux operating system.

Entertaining and Educative

Several applications available for Linux operating system help in the running of audio, video as well as other multimedia files. Use of applications helps in the viewing of live and streaming multimedia files. Support for CD, DVD and other media help to play high quality digital audio and video files in Linux. Support for TV and radio tuner cards help to watch television shows as well as to hear radio broadcasts. Now several games are installed by default, while installing Linux operating system. These games make Linux more entertaining. Availability of several educational applications suited to students of different groups as well as different standards is another noteworthy feature of Linux.

Readily Available Help

Help option can be seen included with several Linux versions. Availability of content sensitive help is a major feature of different Linux distributions. These files help in troubleshooting and solving different problems. Exhaustive manual pages are provided with several new releases. These manual pages are divided into different sections for ease of use. The typical Help window shown in Figure 1.3 provides an idea of the help facility in manual forms available in different Linux versions. Help is available under different heads. Easy and powerful search option and easy navigation between manual pages are the other features of Linux manual pages.

Figure 1.3 Manual Page in Linux.

Help for different applications are also available by clicking the Help menu available in the menu bar of different Linux applications. Clicking the menu displays a window showing the list of headings available. Clicking the heading opens the linked file having the necessary explanations for the selected item. Also, majority of Linux applications are provided with an instant pop up help tip window when the cursor is placed above buttons or icons. Another form of help available in Linux operating system is the presence of several HOWTO files. These files are available for almost all topics and these files are stored in compressed forms. Extracting the compressed files to a folder makes the files readable. Figure 1.4 shows a set of such help files available with a Linux distribution.

Apart from the built-in help option, commercial support is also offered by several vendors as well as support enterprises. Different Linux distributors provide commercial support to Linux in different ways such as network support (software and updates), basic support (24×7 global bases) and premier support (life time). To provide speedy support,

Figure 1.4 Compressed HOWTO Help Files in Linux.

some Linux distributors invite users to register their machines online. Help is also available from several websites. Besides these options, support to Linux is also provided by several Linux User Groups spread in different regions. These Linux user groups are known in short as LUGs. Help can also be obtained from developers spread around the world through discussions or by e-mails. Support for community driven Linux is available from the members of the community.

Linux Distributions

Linux was first made available under the GNU General Public License and this operating system was distributed along with the source code. Several communities modified the source code for different needs. This led to the release of different Linux versions. Different Linux versions are built on the same kernel (32 bit or 64 bit, features enabled or disabled). Different versions of Linux are known in general as Linux distributions or Linux distros, in short. Distribution is a specific edition of Linux. Distribution is made up of the Linux kernel, windows management system, desktop environment and a set of software. It is estimated that more than 300 distributions of Linux are currently available. All the distributions have the same basic features and utilities. These different distributions usually differ in fonts, styles and the method of presentation. Some of the Linux distributions are developed for specific uses. Thus a wider choice and vibrancy for selection of Linux distribution is currently available. With more distributions entering the market, there is tight competition and each distributor tries to incorporate added features.

Basically Linux distributions are available in two types. One is the paid type and the other is the free distribution type. Paid type distribution is also known as commercial distribution while the free type is known as community version. Payment to commercial Linux distributions are made for the added features included with the basic software. Free distributions help to increase the customer base of Linux. For mission critical applications paid Linux distributions are preferred. Some vendors release the commercial version along with the community version. Red Hat Linux and Novell's SUSE Linux are examples of commercial distributions. Debian and Fedora are examples of free Linux distributions. CentOS is an example of a community compiled enterprise Linux distribution. Red Hat Linux and Fedora are released by the same vendor with different terms and conditions. Open SUSE and commercial SUSE are the two different types of Linux released by the same vendor. Releasing the same software with different sets of terms and conditions is called dual licensing and this licensing model offers the user the liberty to choose the type of software, based on the terms and conditions.

Depending on the nature of application, Linux distributions are mainly divided into two versions namely desktop version and server version. Server versions are further divided depending on requirements such as its suitability for use in mainframes systems and for advanced platforms. Several features of Linux make it perform better as a server operating system. One of the features is the reliability of the operating system. Repeated crashing and system failures are very rare in Linux. Access to source code of the operating system helps in the easy deployment of patches, fixes and repairs. Clustering ability of Linux ensures a continuous operation as well as proper backup. Clustering also helps to get a higher computer power. Linux servers offer a low cost hosting space for web publishing.

Linux Opportunities

Use of Linux across the globe in business segments as well as in government sectors is increasing. This operating system has emerged as a strong operating system and is maturing after each version. This operating system is mainly used for operations like web hosting, software development, device embedding and so on. With the addition of increased technical features such as virtualization, real time computing and the like more and more applications are now deployed in Linux. For developing mobile applications also, Linux is widely used. To satisfy the variety of requirements, Linux is available in different platforms such as desktops, servers, mainframes, mobile systems and so on. Simplicity, cost effectiveness, reliability, stability, performance and ease of use are some of the factors that make Linux very attractive for desktops. It provides support for new devices and new hardware easily. Internet solutions, Java and web integration also help Linux to be used widely in desktops.

With the increased use of Linux, the requirements of Linux professionals have also increased. At the basic level, Linux professionals are required for providing technical support, installation and maintenance of Linux systems, troubleshooting, code debugging and the like. Software development in Linux platform is done using languages such as C++, Java, Perl, Python, Ruby on Rails and so on. For web hosting and maintenance

CHAPTER 2

Linux Distributions and Installation

Introduction

As stated in the previous chapter, over three hundred different Linux distributions are currently available. Some of these distributions are used as general purpose operating systems while certain others are designed for certain specific applications. Commercial versions of Linux operating system are distributed in different storage media. Free Linux versions can be downloaded from the web and can be installed. A version of Linux operating system runs direct from storage media such as CD, DVD or thumb drive and this media can be used to boot computers from Linux operating system. In this chapter we will be discussing the salient features of some common Linux distributions, followed by a detailed discussion of the different steps for installing Linux operating system.

About Linux Distributions

Different Linux distributions are evolved one after the other and are derived from the same kernel. Hence there exists a parent child relationship between several distributions. Depending on the type of installation files of the distribution, Linux distributions are divided into two groups namely rpm based distributions and deb (Debian) based distributions. This type of classification is significant during the installation of Linux when text commands are used for installation, since the two groups use different commands for installation. With the emergence of graphical interfaces, this type of classification lost its significance, since different distributions can be installed using a number of mouse clicks. Red Hat Linux and its derivatives are classified as *rpm* based distributions. Some of the distributions that can be included under this group are Fedora, Mandriva, CentOS, SUSE and the like. Debian distributions and their derivatives namely Ubuntu, Knoppix, Damn Small Linux, Linux Mint belong to the second group.

The working of the system as well as the arrangement of files for both types of distributions is identical. Several icons can be seen on the desktop for both types of distributions. Right clicking on the empty part of the desktop opens up a menu with several options. Different software installed by default in Linux systems are grouped on the basis of their tasks. These different groups are related to applications, games, desktop

configuration and so on. Clicking the task name opens up new windows displaying further newer options and finally the required application can be activated by proceeding forward and clicking on the application. In several distributions, the programs displayed as icons can be activated by double clicking the icon. Switching between different desktops—called workspaces—is possible in all Linux distributions. All distributions have File Manager application for managing files, web browser for browsing the Internet, e-mail applications and several other applications for audio, video operations.

RPM Based Distributions

Red Hat Linux operating system is the Linux version distributed by Red Hat. This is available as desktop and server versions. This is a commercial enterprise level distribution. This operating system can work in different types of computers such as desktops, servers as well as in computers having different architectures and processors. Several applications for office productivity, web browsing, mailing operations and games are installed by default, while installing this type of distributions. Applications for photo and image manipulations and networking are also available with this operating system. Encryption facility, firewall, multi language support are the other features available with this type of distribution.

Fedora Linux is an operating system developed under Fedora project sponsored by Red Hat. This is a robust and matured operating system. The installer of Fedora Linux is known as Anaconda. This operating system has several default applications. New versions are released with added features. New release of this distribution comes with different desktop environments namely GNOME, KDE, LXDE and so on. Support for audio, video and other *multimedia* files are also available with this distribution. Support for webcams and wireless networking is also available in new versions.

Another distribution based on *rpm* is Mandriva Linux. Earlier, this distribution was known as Mandrake Linux. This is also based on Red Hat and is commercially backed. It is one of the most common and popular Linux distributions.

SUSE Linux is a commercial Linux version and is very secure. Free version of this distribution is known as OpenSUSE Linux. This is a common and popular operating system and is *rpm* based. The operating system uses yum for resolving dependencies. Upgrades to this distribution are released regularly. Different desktop environments can be selected at the time of installation.

Deb Based Distributions

Debian/GNU Linux is a comprehensive and non-commercial Linux distribution. Debian is a volunteer based Linux distribution. The package is deb based and the dependency resolver is apt-get. This Linux version supports systems of different architecture. It has two desktop environments—Gnu Network Object Model Environment (GNOME) and K Desktop Environment (KDE). Several distributions are derived from Debian. This distribution has regular new releases.

Ubuntu Linux is an easy to use Linux version. Ubuntu operating system has two versions—the desktop version and the server version. This operating system is derived from Debian Linux. Ubuntu is an African word and it means humanity to others. Two

types of graphic user interfaces namely GNOME and KDE are available for Ubuntu. The version in which K desktop environment is used is known as Kubuntu. Kubuntu is also an African word and it means towards humanity. Open office applications, web browser, messaging application, text and graphic editor, mail client and games are installed by default. This operating system also provides support for a number of languages.

Knoppix Linux is one of the first distributions that came with a live CD distribution. Live CD can boot from itself and operate through RAM. This is one of the most popular Linux distributions. This is a deb based operating system. Damn Small Linux is a small Linux distribution having a small size of just 50 MB. The distribution is freely available and the latest version can be downloaded from the web. This distribution can also run from a CD and from within the Windows operating system. To create a live CD, the image file having an extension of .iso is to be downloaded from the web. To install the Windows version, unzip the compressed files by double clicking on it. The decompressed files are stored in a folder. Double clicking the Windows batch file runs the application. Firefox web browser is available in this distribution. Other applications available in DS Linux are Sylpheed—the e-mail program similar to Outlook Express in the Windows platform, XMMS (X Multimedia System)—cross platform multimedia player, text editors such as Beaver and Vim, graphics application Xpaint. Office productivity tools such as PDF viewer, calculator, calendar, dictionary and so on are also available.

Using Linux Distributions

Different Linux distributions are used differently. Live distributions of Linux copied in a CD or DVD can be used for loading the operating system (booting), without installing the operating system in the hard disk of the computer. Another way of using Linux is to use the entire hard disk of the computer for installing Linux so that the system can boot from the hard disk. Linux can also be installed in a computer in which another operating system is already installed so that both the operating systems can coexist and the booting operating system can be selected from the menu option displayed at the commencement of booting process. The difficulty with this type of installation is that for booting to another operating system it is necessary to restart the computer and to select the new operating system from the menu displayed, at the time of starting the computer. Virtualization technology enables the installation of different operating systems simultaneously in the same computer, completely in isolation. This technology makes the hardware to appear to be exclusively available for each operating system. Special applications allow the creation of virtual machines in computers and Linux can be installed in these virtual machines also. When an operating system is installed in the virtual machine, it is not necessary to restart the machine to boot to the operating system installed in the virtual machine.

When Linux is installed in computers in which another operating system is already installed, new installations will be done in separate partitions. Partitions are actually file systems that control the storage of files and folders in the hard disk of the computer. When a file is stored or an application is installed in the hard disk, the data is stored in small sized units known as clusters. Cluster size is different for different systems and this is controlled by the size of the partition as well as the file system used by the system. MS-DOS (Disk Operating System) and earlier Windows operating systems used

CHAPTER

5

Managing Linux Files and Folders

Introduction

Basic features and properties of Linux desktop environments and the basic Linux operations were discussed in earlier chapters. In this chapter we will be studying the basic steps for creating Linux files and folders and their management. Basics of file systems and file manager applications and the basic file and directory operations are also discussed in this chapter.

Linux Files and Folders

Files store information in an electronic form. Files hold different types of information. From the user's point of view, files form the basic constituent of the computer system. Files can be seen anywhere in the computer system and these appear in different forms and in different types. Files are essential for running the operating system as well as do any meaningful operation in the system. Files in computer systems are identified by their names. While naming computer files it is usual to give a meaningful name to the files so that the content of the file is easily understood from its name itself. Different operating systems have different rules for naming computer files. These rules are related to the maximum number of characters that can be used in the file name, use of special characters in the file name and the like. New versions of Linux operating system allows file names with several characters with more than one word separated by space character. It is important that the same file name must not be given to more than one file. Linux system treats lower case as well as upper case letters differently. So files with the same name, but using different letter cases are considered as different files. However, certain special characters are not allowed in file names.

File names have a set of characters used as file name extension. File name extension is the set of characters appearing after the period (.) character in the file name. Several applications store the created files with file names having a standard file name extension, by default. From the standard file name extension of a file, it is possible to understand some features of the file such as the type of the file, the application used for creating the file and the data contained in the file. For example, a file having the file name extension *odt* indicates that the file is in ODF Text Document format. OpenOffice.org Writer is the application used to create the file and the file is a document file. A file saved with the

file name extension *jpg* indicates that the file contains image and it is saved in JPEG format and an image editor application can open the file. Similarly audio files, video files, spreadsheet files, presentation files, text files, compressed files all have standard file name extensions based on the applications used to create such files.

Storing all the files in one place in the computer system without any planning or arrangement makes it difficult to locate the required file from the storage. The condition becomes severe when there are hundreds of files to be stored in the computer system. Presence of files with identical names and similar file name extensions make it difficult to locate the correct file from the heap. Under such conditions, it is better to store the files in different locations. Files are grouped based on their type or use and are stored in different locations. This type of storage helps in locating the required file easily. The need for storing files in a structured and neat manner led to the emergence of the concept of folders. Folders can be treated as containers for files. Usually different users create their own folders and store the files created by them in their own folders. Depending on the requirements several folders can be created within a folder and files can be stored in these folders also. Such type of arrangement of folders is common in computer systems and this has become a standard storage arrangement for storing related files. For example, files connected with correspondences are stored in a folder named 'correspondence'. Picture files are stored in another folder named 'picture', audio files are stored separately and so on.

The terms directory and folder mean the same thing and are used interchangeably. Similar to files, folders are also identified by their names. Rules for naming files are applied for naming folders also. A Folder can contain several files or no files at all. Folders can also contain several sub folders or no sub folders. Folders created within a folder are known as *sub folders* or *subdirectories*. The folder in which the user is working is known as the *current directory*. Any directory below the current directory is called *sub folder* or *subdirectory*. The directory above the current directory is called as *parent directory*.

Figure 5.1 Use of Different Icons for Representing Files and Folders.

Linux operating system treats folders as files. So files and folders within the same folder must have different names. In graphical system used by Linux, files and folders are represented differently using different icons and this different type of representation is essential to distinguish between these two. Also Linux uses different icons to represent different types of files. Thus text files, image files, web files are all represented using different types of icons. The different types of icons used for representation for files and folders are clear from the screen display shown in Figure 5.1.

Paths and Path Names

In a computer system it is possible to find several folders. Each folder may contain several sub folders as well as many files. To locate any file in the system it is necessary to specify the exact path where the file resides in the memory. Simply providing the file name means that the file is located in the directory where the user is located at that time. The concept of paths and path names will be clearer by considering the entire storage space of the system as a single large storage unit. This large storage unit is usually known as root and this is denoted as a single slash character (/). Several folders can be created in the root folder and these are the storage compartments of the root storage space. Each of the partitions can be partitioned further to get several sub folders. The organization described is illustrated in Figure 5.2 and studying the figure and understanding the explanations below provide better understanding of folders and paths.

As can be seen in the figure, the root is at the top level. The root folder is partitioned into a number of folders namely *letters, klj, picture, home* and *personal*. These folders lie just below the root partition. These folders are represented as */letters, /klj, /picture, /home* and */personal*, respectively. The representation indicates the exact paths of the folders and is known as path names. Folders named *klj* and *personal* are having two sub folders beneath each one. Folders named *office* and *personal* lie below the folder *klj*. The exact path names of these two folders are written as */klj/office*, and */klj/personal* respectively. Both the sub folders store one file each and the names of files are written below the folder name. Sub folders to home folder are *klj* and *jac* and their exact path names are given as */home/klj*, and */home/jac* respectively. The names of files stored in the sub folders are written below the name of the folder. Folders named *friend1* and *friend2* lie as sub folders to the parent folder named *personal* and their exact path names are given as */personal/friend1* and */personal/friend2*. Similarly the exact path names to folders *old* and *new* can be given as */home/klj/old*, and */home/klj/new*. This is a hierarchical representation of files and folders in the storage and this type of representation is known as a file tree, shown here as Figure 5.2.

Figure 5.2 A File Tree.

Names given to files and folders located with in a folder must be different. Also different sub folders of a folder must be named differently. But sub folders of different parent folders can use the same name. As stated earlier, files can be stored in any of the folders in the storage space. Files in different folders can use the same file name. For example, as can be seen in the figure, the same file *letter1.txt* is stored in two different folders. This is possible since different folders represent different storage locations. The concept is clear from their exact path names. The exact path names of these two files are

/klj/office/letter1.txt

and */klj/personal/letter1.txt*

When a user logs into the system, the user is automatically placed in the home folder of the user. Home folder of any user is located as the sub folder to the /home folder. For example, when the user klj logs into the system, the user is placed in the folder */home/klj*. During this time */home/klj* is the current directory of the user klj. The user klj can address the file in jac folder as */home/jac/b.odt*. When the user jac logs into the system, the user is placed in */home/jac* folder. During this time */home/jac* is the current directory of the user jac. The user jac specifies the file in klj directory as */home/klj/a.odt*.

Exact path names denote the exact locations where files are stored. Such path names are also known as absolute path names. In path names, the first slash indicates the root folder. Following slashes separate the names of different sub folders. File name appears as the last item in path names. Using the exact path names to identify the files requires typing long path names. To shorten path names, it is usual to specify the path names relative to the current working directory of the user. Such path names are called relative path names. Consider the file tree shown already in Figure 5.2. Suppose the user working in the directory */home/klj* requires specifying the file *let.txt* stored in the sub folder named *old*. The path can be specified in two ways as follows:

/home/klj/old/let.txt

and *./old/let.txt*

Both the path names identify the same file. The first path name is the absolute path name whereas the second path name is the relative path name. In the relative path name a dot character is used to indicate the current position of the user and the path name begins with a dot. In a similar manner, to refer to a parent directory above the current directory, a user uses two dot characters in relative path names.

Linux System File Structure

Different types of files can be seen in Linux operating system. Files in Linux operating system are classified as ordinary files, regular files, directory files and special files. Ordinary files include a variety of file types like application files, data files, document files etc. Application files are usually executable files and using these files different applications are executed. There are applications for performing tasks like word processing, doing calculations, browsing the Internet, managing mails, doing image manipulations and so on. Data files store different types of data and these files can be image files, audio files, video files or simply text files. Document files store multiple

types of information such as text, drawings, images and so on. Directory files are related to different directories of the system and these store information related to different directories. Linux special files are device driver files, link files or similar other types of files. Different physical entities are also represented as files in Linux. Thus, printers, modems and other devices are represented as files. Using special files, the operating system can control different devices connected to the system. Such special files used to control devices are known as device driver files. Device driver files are essential for proper communication between the operating system and the connected devices. Links are the second names given to a file. Creating links to files enables different users to use the same file thereby preventing the creation of multiple copies of the file for use by different users.

Different files used by Linux operating system are also arranged in a hierarchical manner. Files in the operating system are arranged in different folders. Depending on the number of applications installed and the configuration of the computer, each of the folders can contain several files and many sub folders. Root folder is at the top in the hierarchy. All the files and folders of Linux system are included in this folder. Root directory has several sub folders named as bin, boot, dev, etc, temp, home and so on. Each folder stores some particular types of files intended for a particular use. The folder named *bin* stores all binary files. Bin is the short form for binary. For storing boot files, *boot* folder is used. Device files necessary for the proper working of attached peripherals are stored in the folder named *dev*. The folder named *etc* stores different files for configuring the system and devices. The folder named *temp* is a temporary folder and this folder stores temporary files. Files stored in this folder are deleted after use. Different users of the system are included in the *home* folder. Depending on the number of users, the home folder has several sub folders. Files created by a user are stored in different sub folders of the folder of the user. Library files required for running the system are stored in the *lib* folder. Besides the above discussed sub folders there are several other sub folders also. Details of other folders can be obtained by examining the system using a file manager application, which will be discussed later in this chapter. Folder arrangement of Linux files is clear from Figure 5.3. To get a better understanding of the hierarchical arrangement of Linux files, this line diagram is more helpful.

Figure 5.3 Hierarchical Files Arrangement in Linux.

Files and Folders Properties

A general idea about files or folders in Linux system can be obtained from the icon and studying the file name extension. More information regarding the file or folder is obtained by right clicking on the file or the folder icon and selecting the option *Properties* from the pop-up menu displayed on the screen. Selecting this option displays the *Properties* window as shown in Figure 5.4. Properties window has a title bar

Figure 5.4 Properties Window of (i) File, and (ii) Folder.

containing the name of the file. This window has six tabs named *Basic, Emblems, Permissions, Open With, Notes* and *Image*. For a folder, the *properties* window displays different tabs named as *Basic, Emblems, Permissions, Notes* and *Share*. Opening the first tab named as *Basic* displays a general description of the properties of the selected file or the folder. Name of the file or folder, type of the file, its content, size, exact location in the system where the file is stored, and the like can be obtained by opening this tab. Selecting the *Emblems* tab displays a number of emblems and the user can select an appropriate emblem from the list to represent the file or folder.

Permissions to use the file or the folder are the important properties associated with them. There are three kinds of permissions that a user can have for files or folders. These are the permissions to read the file, write or edit the file and to execute the file. For directories, the different permissions are for listing the contents of the directory, creating and removing files in the directory and for accessing files from the directory. Since Linux is a multi user operating system, this type of access permission is essential to control the access and use of files by different users logged into the system. There are additional permissions available to Linux files and folders. But these are required only for power users. Opening the tab named *Permissions* displays the details of permissions available to the file or folder. The display is as shown in Figure 5.5. Users of Linux operating system are divided into three categories namely owner of the file, other users including the group of the owner and all other users. Each Linux file is assigned to an owner and a group when the file is created. Usually, by default, the owner is the creator or the current user and the group is the group of the directory in which the file is created. But this varies with the operating system and the way of creating files. Different Linux users have different powers or abilities and opening this tab gives provision to set different access permission options.

Figure 5.5 Permission Options for (i) File and (ii) Folder.

Linux makes use of two ways for viewing the contents of files and folders. One way is to double click the file or folder icon. When the folder icon is double clicked, the folder is opened in a file browser window and the content of the folder is displayed in the opened window. As stated earlier, folders can remain empty or may contain one or more files or sub folders. Different icons are used to represent different types of files and folders and this help to distinguish between files and folders in the folder. A second way of viewing the folder content is to right click on the folder icon and then choosing the open option from the displayed pop-up menu. In a similar way, to view the contents of a file, its icon is double clicked. The selected file is opened using the default application configured for opening the selected file type. It is possible to set the default application for opening any file in Linux system. For example, consider a text file. Linux provides option to configure the system such that all text files can be opened using a text editor like *gedit* or using a word processor application like *OpenOffice.org Writer* application. The *Open with* option available in the file properties window helps to configure the system, as discussed above. Opening this tab displays the list of installed applications using which the file can be opened. Select the ideal application from this list. This step makes all files of the same type to use the selected application for opening them.

Instead of double clicking the icon, right clicking the file icon also provides an option to select an application for opening the file. The list of options available when the file or folder icon is right clicked, is displayed in Figure 5.8, later in this chapter. Here two menus can be seen. The first pop-up menu is the menu displayed when a text file is right clicked. In this case, text files are configured to open with *gedit* application and this is the first option displayed on the pop-up menu. Selecting the option to *Open with Other Application* displays the list of installed applications and the user can select the required one from the list. Similarly, for a folder, the first option is the default one and this simply opens the folder. If another application is to be selected for opening the folder the same is done by selecting the option from the menu.

Creating Files and Folders

Empty files can be created in the desktop or in any folder by right clicking on the free space in the desktop or in the folder. When this is done in GNOME, a pop-up menu is displayed on the desktop as shown in Figure 5.6. The menu has several elements. Select the option *Create Document*. This opens another window. From the newly displayed sub menu option, select the option *Empty File*. This option creates a new text file and the file icon appears with the default file name *new file*. To add content to the *file*, double click the file icon. The created file is opened in the default text editor. Additions or modifications to the contents can be made and finally the file can be saved. To create a folder below the current folder, select the first option *Create Folder* from the list. A new folder is created and an icon appears with the default folder named as *untitled folder*. The folder name is written in a text box and the user can give a new name to the folder at this instant, if required, by typing the new name. Folders can be renamed later also at any time.

Figure 5.6 Creating Files in GNOME.

When working in KDE, right clicking on the empty space displays a pop-up window as shown in Figure 5.7. Select the option *Create New* from the list. This displays another window. Here more options are available. A folder can be created by selecting the first option *Folder* from the list. A list of different file types are listed in the menu and depending on the type of file to be created, the user can choose any option from the list.

Figure 5.7 Creating Files in KDE.

Managing Files and Folders

There are several management operations associated with files and folders in Linux operating system. These are opening, moving, copying, deleting, and renaming files. Since folders are also special types of files, different management operations applicable to Linux files are also applicable to folders also. All the operations on files and folders are done by choosing the required option from the pop-up menu, when the file or folder icon is right clicked. The pop-up menu displayed when the file icon and the folder icon are right clicked is slightly different and these two pop-up menus are as shown in Figure 5.8. The first options of this menu are related to the opening of the selected files or folders. Files can be opened using the default application or a using another application. To open with the default application, select the first option. To use another application from the displayed list of applications, select the option *Open with Other Application*. A list of applications is displayed. Select the application from the list and proceed to finish the process.

Figure 5.8 Right Click Pop-up Menu for a (i) Text file and a (ii) Folder.

Using the copying process, a file or folder can be copied from one location to another location. To copy a file or folder, first right click the file or folder icon and select the option *Copy* from the pop-up menu. When this is done, the selected file is copied by the mouse. After copying the file, move to the target location and open the target folder. Right click on the empty space in the target folder and select the option *Paste* from the pop-up menu to paste the copied file in the target location. Some Linux versions show the option as *Paste URL*, as shown in Figure 5.9. The shortcut keys ctrl+V can be used for pasting the object.

Working in a similar way, any file or folder can be copied from one location to another location. To move a file from one location to the target location, select the option

Cut instead of *Copy* in the first step. Copy operation creates a copy of the file in the new location whereas cut operation moves the file from the original location to the new location. If a file or folder having the same name as the copied one is remaining in the target location, a window appears on the screen asking for overwriting the existing files or merging folders. Copying or moving takes place if a confirmation is given. Pasting several objects to the folder makes the folder surface cluttered and unordered. Clicking the option *icons* from the window provides option to arrange the objects in an ordered manner sorted based on the different parameters.

Figure 5.9 Selecting Option for Pasting File or Folder.

A new name can be given to a file or folder by the renaming process. To rename the file or folder, select the option *Rename* from the displayed pop-up menu. When this is done, the name of the selected file or folder is displayed in a text box and the user can type the new name in the text box. After typing the new name, click the mouse button. The name of the selected object is changed to the given new name. Renaming process can also be done by right clicking the file icon and selecting the *Properties* option. In the new window displayed, a new name to the file can be given by selecting the tab named *Basic* and typing the new name in the text box. After typing the new name, close the window. The file is renamed. In a similar way folders can also be renamed.

To delete a file or folder, select the file or folder and press the *Delete* key of the keyboard. The same thing can be achieved by right clicking the icon and choosing the option *Move to Trash* from the options. The deleted files are moved to the trash folder. The contents of this folder can be viewed by opening the trash folder icon. In several Linux distributions trash folder can be seen on the desktop. Moving the file to the trash folder does not delete the object permanently. Files available in trash folder can be restored to their previous state and to the previous location by the restore option. Restore option can be selected from the list displayed when the deleted object icon is right clicked. For permanently deleting the deleted files, select the option to *empty trash* or *delete permanently*. Selecting this option displays a conformation window as shown in Figure 5.10. Clicking the *Empty Trash* button removes the deleted files permanently from the computer storage.

Figure 5.10 Confirmation Window for Emptying Trash Folder.

Linking files for different users is another basic file operation done in Linux. Linking files helps in making multiple copies of a file for use by different users. This is a major advantage. By linking, the same file can be used by several users and the changes made by each can be viewed in the same file. To link a file, right click on the file name and select the option *Make Link*. Executing this option creates another file and it will be marked as a linked file. A linked file is represented by an icon with an arrow mark and hence linked files can be easily identified from the icons.

Compress option available in the menu helps to compress the selected file or folder in a suitable compression format. Different compression formats such as ar, jar, zip and the like can be used for compressing. The option can be selected from the drop-down list as can be seen in Figure 5.11. Compressed file name and the location for its storage can be typed in the text boxes. The other options provide facility to set password for the compressed file and to encrypt the file content. After giving the required details, click the *Create* button to compress the selected file.

Figure 5.11 Compress window.

Searching for Files

Another common file and folder operation available in this operating system is the searching for files, folders and documents. The search option is available in the *Places* menu at the Linux desktop. Selecting this option opens a new window. In the new window, type the name of the folder, file or document to be located, in the text box provided for this purpose. The searching operation can be done on the entire system or in specific folders or selected devices only. This option can be selected in the folder name box. Facilities for using further options for more specificity are also available. After typing the details, click the *Find* button to start searching for the required items. Search for files is made in the specified directory as well as in the subdirectories of the directory. The details of located files are displayed in the *Search results* text box appearing at the bottom of the window, as displayed in Figure 5.12.

Figure 5.12 Search for Files Window.

Use of wild cards in search name text provides an easy way to search for files or folders having identical names. Also, if the correct file or folder name for searching is not known, use of wild card characters helps in displaying files with the same or similar names. Wild card characters are used along with partial file names. Linux operating system supports the use of three wild card characters namely question mark - ?, asterisk - * and square brackets - []. The question mark character is used to indicate a single character. Asterisk character is used to indicate a set of characters including zero character. Square bracket is used to indicate more than one character, especially a range of values to choose. The search is case sensitive in the sense that capital letters and small letters are treated differently for making the search. More than one wild card character can be used in the search string. Results of the search are displayed in the *Search results* list box. If the search does not find any files that match the search criteria, the application displays the message *No files found* in the results list box.

For better understanding of the use of wild card characters, some examples of using the wild card characters can now be discussed. Suppose in the name box, the search name *test?* is typed and the *Find* button is clicked. The system searches for items having names beginning with test and having one more additional character after test. Using the above mentioned search option locates items with names like test1, test5, testp, tests and so on are displayed, if available. But the command will not search for item having the name test. If the search is made for test*, all items having names beginning with test are located and displayed. This search option searches also for files with the name test. Using the search string *.[ch] in the name box searches for all files that are having an extension of .c or .h. If the search string is given as *.[a–g], the system searches for files having names ending with .a, .b, .c, .d, .e, .f and .g. Thus a range can be specified.

As can be seen in Figure 5.12, a search for items having names beginning with *bin* is made. The search option is made to locate for files in the entire file system. The details of located files are displayed in the search results window. To stop the search at any time, click the *Stop* button. To open a file displayed in the search results box, right click on the file name and choose the option to open or simply double click on the file name. In a similar way folders can also be opened. To save the results of the last search, right click in the results list and choose *Save Results As*. Type the name of the file to which the results is to be saved and then click *Save* button.

By default, searching for files will perform a quick search using the *locate* command followed by a more thorough second search using the *find* command. The locate command is faster because it uses a database of information about files. Additional options for searching files on the system can be set by selecting more options text and adding more information for the search option. Using the options help to locate files that are modified within a time period and having a specified file size. Different options also searches for files that are owned by the user or group, having names that do not contain the string that is entered.

Linux File System

A file system is necessary to manage file storage in disks, their retrieval from storage locations as well as in their manipulations. As discussed earlier, the file system used by the operating system plays a major role in the performance of the operating system. Different operating systems use different types of file system formats. Extended file system, reiser file system, high performance file system, virtual file system, NTFS, XFS, FAT, LVM and so on are some of the common file systems used by different operating systems. Extended family of file systems is the most commonly used Linux file system. Current versions of Linux operating system uses a file system known as ext4 or the fourth extended file system. This is the improved version of the previous file system known as third extended file system or ext3 file system. The major characteristics of this file system are bigger file system size, larger file size, faster file system checking and the like.

Ext4 file system makes use of 48 bit block addressing scheme. So this file system can address 2^{48} (2 raised to 48) blocks. So this file system can have a maximum file system size of 1 EB (Exa Byte) and a maximum file size of 16 TB (Tera Byte). *Ext3* file system

allowed a maximum of 32,0000 sub folders in a single folder. But in ext4 file system there is no restriction on the number of sub directories. So theoretically an unlimited number of sub directories can be created in a single folder. But this is limited by the size of the storage disk. Large files are stored in computer in several blocks. A mapping is necessary to address files stored in several blocks. If the size of the block is less, the number of blocks will be large and hence a large meta data is required for mapping. Extents is a way to reduce the meta data necessary to address large files. Extents reduce the meta data by efficiently representing the blocks and combining them. When using *ext4* file system, large files can be represented by using two extents. This helps in reducing file system overheads also. Multi-block allocation of blocks for writing files is another feature of fourth extended file system. In the ext3 file system only one block is allocated per call. The improved allocation feature of *ext4* helps in reducing fragmentation and saving CPU cycles. Thus a lot of overhead is avoided thereby improving the performance. File system checking process of *ext4* is fast since unused parts of the disks are skipped from the checking process.

Linux File Managers

File managers in Linux operating system provide simple and integrated ways in managing files and applications of Linux system. File managers can be used to perform a variety of activities such as creating folders and documents, organizing files into folders, displaying files and folders, searching and managing files, running scripts and launching applications, customizing the appearance of files and folders, opening locations in the computer, writing data to CD or DVD, installing and removing fonts, managing the desktop etc. File managers control different file activities, control hardware, switch between users and keep flow of data between users.

File managers always run when working the system. If required, file manager applications can be activated either from the menu appearing at the top panel in GNOME desktop or by double clicking any folder icon on the Linux desktop. Different Linux distributions have different file manager programs. In GNOME, file manager application is available in the list of tools displayed when *System Tools* is selected from the list appearing on opening *Applications* menu. File manager available in majority GNOME versions is known as Nautilus and for KDE it is either Konqueror or Dolphin. Dolphin aims to improve usability at the user interface level. Dolphin focuses only on being a file manager whereas Konqueror is a universal viewer of many file types. The display of Nautilus File Manager window is shown in Figure 5.13.

File manager window is similar to the file browser window. The default interface of the file manager window is made up of title bar, menu bar, *tool bar*, location bar, workspace, information panel, status bar etc. This layout varies with the distributions and the versions installed. The location bar displays the path to the current folder. Workspace shows the contents of the current folder. Status bar shows the data related to the status of the selected file or the selected folder. When no file is selected, the status bar shows the number of files and folders in the current folder. The bar also shows the amount of used storage space as well as the maximum storage space available on the mount point.

Figure 5.13 Nautilus File Manager Window.

The selected folder name is displayed on the title bar. The file manager window has two panes—left pane displaying different folders, and the right pane showing the contents of the folders selected on the left pane. Home folder of the user, Trash, File System and different removable media are displayed as folders in the file manager window. The desktop is also displayed as a folder. Selecting this folder displays the contents of the desktop on the right pane. In the file manager window, the root folder is indicated as a square button. When *File System* is selected on the left pane of the file manager window, details of the hierarchical arrangement of files in the file system is displayed on the right pane. The display is as shown in Figure 5.14. The hierarchical arrangement of files and folders in Linux file system was described earlier with the help of a line diagram.

Figure 5.14 Hierarchical File Arrangement of Linux File System.

Several options are available on clicking the menu in the menu bar and the options help in the management of files and folders. Options are also available in the *File* menu for creating empty files and folders. The different options available for the Dolphin File Manager is shown in Figure 5.15.

Figure 5.15 Menu options in Dolphin File Manager.

New folders and files can be created, files and folders can be renamed and can be deleted by selecting the appropriate menu options. Instead of selecting the menu options, keyboard shortcut can also be used. Creating folder option creates a folder below the current folder. By default, Linux assigns the name untitled folder to the newly created folder. Subsequent folders are named untitled folder 1, untitled folder 2 and so on.

Several view options can be set using the options available when opening *View* menu. Usually, there are three viewing modes such as icons, details, and columns. A preview is also available for each of these options. The *Icons* view shows the contents of the folder by representing files with different file icons and folders by folder icons. The typical display is as shown in Figure 5.16. The folder icon is defined by the icon theme currently used, and this can be changed. Selecting *Details* view lists the contents along with additional information. The additional information for the default Dolphin configuration is the size of the file and the date it was last modified. Additional information can be displayed by right clicking on the column header and selecting the required information to be displayed. *Columns* view allows multiple levels of the folder structure to be viewed. *Preview* view is similar to the *Icons* view. The difference is that in the *Preview* view, wherever possible, previews of the files are shown. For text documents the first 14 lines are displayed and for image file types such as JPG, PNG, XCF, SVG etc, a small image is displayed. Dolphin is also capable of displaying a preview of HTML and PDF files. The size of the previews can be modified using configuration options.

Figure 5.16 Viewing the Folder Contents as Icons in Dolphin File Manager.

By default, Linux displays the contents in a systematic sorted style. First, folders are arranged in the alphabetic order. After this, the files appear sorted in an alphabetic style. But users can arrange the display of the contents in different styles. This is possible by selecting the option *View* from the menu and choosing the option *Arrange Items*. This action displays a new window which has the option to set the arrangement style as based on name, size, type, manually and so on. An option is also available to arrange the contents in the reverse alphabetic style as well as in a compact form. When viewing the details as a list, sorting arrangement can be varied by clicking the column headings. Different file as well as folder attributes can also be changed.

File managers are capable of displaying hidden files and folders available in the selected folder. Hidden files and folders can be distinguished from other files and folders by the colour used. Usually hidden files and folders are fainter than normal files and folders. Hidden files and folders are displayed by selecting the option to view hidden files. File managers can sort the contents of the current folder in a number of ways such as by name, date, size and in descending order. For sorting process select the option from the *View* menu. The process is clear from Figure 5.17. The *Information* panel shows extended information about the selected file. The details are listed just below the large preview of the file.

Figure 5.17 Sorting Options in Dolphin File Manager.

CHAPTER

6

Linux Administration Basics

Introduction

Linux administration jobs include a lot of operations necessary for carrying out different normal or routine operations. These operations range from some simple tasks to more complex operations. The administration jobs mainly include installating new software, adding new hardware, checking the system, testing different operations, adding new users and groups, downloading software, and so on. These operations are done using different tools that are installed when Linux is installed. In this chapter we will study the basic operations necessary for administering a Linux system and the different tools used for administering.

Administrator Powers

A Linux system will be having several users, and Linux treats different users differently. Out of the different users, the superuser is the most powerful user. Superuser is also known as the root user or the administrator user. This user is created at the time of installation of the operating system and has a separate password known as the administrator password. Administration operations can be performed only by authentication using the administrator password. Administrator user has unlimited powers. Administrator user has access to all parts of the system including different file systems. Different system administration tasks are performed by the administrator user. All the commands can be used by the administrator user, whereas other users can execute only certain commands, depending on the rights granted. Local as well as remote systems can be mounted by the root user. The superuser can control the system usage and set different configurations. The superuser can modify the essential parts of the system including the setting of different languages for menus and windows. Different log files can be viewed by the administrator user. Superuser can create new users by assigning user names and passwords as well as can change the names and passwords of existing users. Superuser can view as well as edit files created by other users of the system. In multi-boot systems, the superuser can set the boot operating system. The root user is having a special terminal window prompt denoted as #. Different administration operations are done from *System* menu in GNOME

desktop. When opened, this menu displays two options—*Preferences* and *Administration*. Different administration options are available by selecting *Administration* option. Different options available for the administrator for GNOME desktop is displayed in Figure 6.1. New Linux versions provide more administration options. Also the options differ with different distributions. When the administrator option is activated, the system prompts for the administrator password, since authentication is required to perform administration actions. Proceeding further stages for administration operations is possible only after giving the correct administrator password.

Figure 6.1 Administration Operations in Ubuntu Linux.

Administering Time and Date

The simplest administration operation when using Linux operating system is the administration of time and date. The time administration tool available with Linux distribution allows setting the time, date and timezone of the system. This tool also allows setting any time server to synchronize with the local time server. When the *Time and Date* tool is launched, it displays the *Time and Date Settings* window as shown in Figure 6.2. Clicking the button—*Click to make changes*—seen at the bottom of the window helps in making a selection of the date in the calendar and the user can make necessary changes. Using the different options available, the administrator user can set different changes.

Figure 6.2 Time and Date Settings Window.

To save the changes made by the administrator, click the *save* button. The system prompts for the administrator password and the changes are saved when the correct password is given. The process is simple and can be easily done with little effort.

Writing to CD/DVD

Writing to a CD or DVD is very useful for backing up important documents and files. For this, the computer must have a CD or DVD writer. Application for writing files to a CD or DVD is available in all Linux distributions. CD or DVD Creator is the application available in several distributions. This is having a graphical interface and can be easily used. When the application is launched, the opening window is displayed as shown in Figure 6.3.

The first step for writing to CD or DVD is to choose the files. Required files and folders for writing to the media can be selected by navigating along the places listed on the left pane of the window. Selecting the folder on the left pane displays the contents on the right pane. The file manager provides a special folder for files and folders to write to a CD or DVD. Drag the files and folders for writing to the CD/DVD Creator folder. After inserting the CD or DVD in the drive click the *Write to Disc* button or choose the option *Write to CD/DVD* from *File* menu. A *Write to Disc* dialog is displayed. Set values for options such as disk name, write speed and click the button to write to the disk. It is possible to copy a CD or DVD, either to another disc or to an image file stored on the computer. To copy a CD or DVD, first insert the CD or DVD in the drive. Right click on the CD icon and choose the option to copy the disk. This step opens the *Write to Disc* dialog window. If there is only one drive with write capabilities, the process will first create a disc image file on the computer. It will then eject the original disk, and ask to change it for a blank disk. Writing takes place after inserting the disk.

Figure 6.3 CD/DVD Creator Application Window.

Disk Usage Analyzer

Tools for analyzing disk usage are available in several operating systems. A commonly available tool in several Linux distributions is *Disk Usage Analyzer*. When the application is launched, the opening window is displayed as shown in Figure 6.4.

Figure 6.4 Disk Usage Analyzer Window.

Folder and file wise memory usage can be obtained from the list. The details are arranged in a tabular format along with the size occupied by each item. A representation of the usage in a graphical format is also displayed on the right side. By studying the occupied memory, it is possible to get an estimate of memory size that can be reclaimed by deleting some unused applications or outdated files.

Monitoring the System

The *System Monitor* application available with different Linux distributions enables to display the basic information about the system. This application monitors system processes, usage of system resources and file systems. The application can be used to modify the behavior of the system also. When the tool is activated, a window having four tabbed sections named *System, Processes, Resources* and *File Systems* is displayed on the screen. The display is as shown in Figure 6.5.

Figure 6.5 System Monitor Window.

When the *System* tab is opened, various basic information about the computer's hardware, software and the system status are displayed. Active processes and how various processes are related to one another can be obtained by opening the *Processes* tab. This tool also provides detailed information about individual processes, and enables to control the various active processes. It is possible to stop, start or make priority changes

to different processes taking place. The current usage of different system resources such as CPU, memory, network usage can be obtained from the *Resources* tab. This can be seen in a graphical form also. File *Systems* tab lists all mounted file systems along with basic information about each one.

Managing Drives and Media

For managing drives and media, a disk utility application is also installed in Linux operating system. This application provides information about the drive as well as the different storage media connected to the system and provides options for mounting or dismounting the volume, checking file system, editing and deleting partitions as well as for formatting volume. A facility for measuring the performance of the drive is also available in some applications.

Figure 6.6 Disk Utility Application Window.

Disk Utility is the name of one such type of application available in Ubuntu Linux versions. The typical display of the screen, when launched, is as shown in Figure 6.6. As we can see here, the window is divided into two portions. Left portion provides the details of the different storage media available. On selecting any of the media, more details are displayed on the right pane. A number of buttons are provided in the right pane and clicking the button performs the operation stated below the button. The common operations possible include formatting the drive, checking the file system, benchmarking, editing and deleting partitions and so on. In the figure, the option *CD / DVD Drive* is selected on the left pane and the various corresponding options appear on the right pane. Clicking the option to open the CD / DVD application activates *Brasero* application. This is the application for

creating and copying CD and DVD. The application allows burning data to CD or DVD, burn audio CD, copy CD and DVD, create video DVD, create image files, erase CD and DVD and check the integrity of discs and disc images. Suitable option can be selected by clicking the required button from the window. To burn data to a CD, click the button for copying data. This step opens another window and the user can select the required files for writing to CD. After selecting the files click the button to write to CD and proceed to finish the process. A cover editor for CD and DVD is also available with this application. Using *plug-ins*, it is possible to get additional advantages of using this application.

Creating and Editing Disk Partitions

An important job for a system administrator is the creation and editing of disk partitions. Different applications are available in different Linux distributions for this purpose. The application available in the GNOME version of Ubuntu distribution is GParted. The name stands for GNOME Partition editor. This partition tool supports many file systems and is having a friendly user interface. This partition editor enables the creation, reorganization, and deletion of disk partitions. Also the application enables to change the partition organization on a disk device, while preserving the contents of the partition. Enabling and disabling partition flags such as boot and hidden is also done by this application. Under normal circumstances, editing the partitions can cause loss of data. But this partition application is designed in such a way so as to edit the partitions with reduced risk of data loss. The risk of data loss can be reduced by not mounting partitions outside of the application.

Figure 6.7 shows the display of the GParted opening window. As seen in the figure, this tool displays the details of partitions in the disk. Details of the partitions of the hard

Figure 6.7 Gparted Disk Partition Application in Action.

disks displayed include partition name, file system used, mount point, size, used and empty memory sizes and flags. Operations on the selected partition can be done by right clicking the mouse and selecting the option from the pop-up menu or by selecting the option from the menu in the menu bar of the application. Another facility available with this application is the error checking of file system. Formatting the partition to any supported file system is also possible using this tool.

System Testing

Linux keeps a database of different hardware components. Applications are installed in Linux to test the system and to give a report, if required. By studying the summary report, it is possible to ensure that the system is working properly. Launching the tool for testing the system opens a new window displaying all the hardware components attached to the system. In Ubuntu distribution the screen display is as shown in Figure 6.8.

Figure 6.8 System Testing Window in Ubuntu Linux.

The tool tests each component one after another in a continuous manner. Procedure for testing the component is stated in the window. Clicking the button to test the component performs a testing of the selected component. Moving to next screens provides facility to test other hardware components also. Working in a similar manner all hardware components can be tested for their working.

Boot-Up Manager

Several services are started during the booting up of Linux operating system. These services help in managing different activities such as live CD installer, update virus database, X Window system infrastructure, bluetooth services, hard drive temperature monitoring facility, scanner service, print job management and many other services. These services are very essential for carrying out normal computer activities. There are several other services available in the system that are not activated automatically during the booting time. These services need to be activated, only if required. In certain circumstances it also becomes necessary to deactivate some of the running services. Boot-Up Manager is a graphical tool that provides facilities for starting or stopping services as well as for configuring applications to start at boot time. When this tool is activated, it displays the graphical window as shown in Figure 6.9.

Figure 6.9 Boot-Up Manager Window.

A list of applications with descriptions and working status are displayed in this window. Applications that are running have a tick mark in the square box seen on the left side while those applications that are yet to start do not have the tick mark in the square box. Right clicking on the application displays the option to activate or deactivate the selected application, depending on whether the application is in deactivated or in activated state. Thus running applications can be stopped and applications that are yet to start can be activated.

Making Startup USB Disk

USB Startup Disk Creator is an utility available in several Linux versions. This utility creates an image of the operating system in an USB medium. This image is known as a

Live USB. Live USB can be used to install Linux on the computer for running Linux without affecting the system hardware. There are several advantages of using live versions. Less wastage is one advantage, as a live USB disk can be overwritten easily. Changes made to the USB disk are saved, unlike a Live CD and hence there is persistence. It provides a safe computing environment as it is possible to boot the computer from a live USB disk to protect the system when accessing unsecured public networks or testing unstable functionality. To make a live USB disk, plug the device to the USB drive of the system and make sure that the system recognizes the disk. Launch the application from the menu. This opens a new window as shown in Figure 6.10. Under the source disc image option, specify the image. The image from a CD can also be used for creating the live USB disk. After setting different options, click *Make Startup Disk* button. This step creates the required startup disk. The USB can be safely removed and can be used as a live USB for booting the system. To boot from the live USB disk, set the boot option to the disk and power on the computer. The system boots from the USB disk.

Figure 6.10 Make Startup Disk Window.

Viewing Log Files

Log viewer applications are available in all Linux distributions. One of the log viewer applications available in several Linux versions is *System Log Viewer*. This is a graphical

and menu-driven viewer and can view and monitor different system logs. *System Log Viewer* is useful because it provides an easier, more user-friendly display of different event logs. With the help of a monitoring mechanism, this application continuously monitors crucial logs. Also *System Log Viewer* comes with functions that can be used to manage the logs, including a log monitor and log statistics display.

When the application is launched for the first time, the application displays several log files by default. Opened logs are listed on the left side of the application window. Details of the log selected in this list are displayed on the right side window. By default, *System Log Viewer* monitors every opened log. Log information is displayed in the status bar and this includes the number of lines in the log, size of the log in bytes, date the log was last modified. The log can be copied if required and pasted to another editor.

Installing New Languages

During the installation of the operating system, a language is selected for installation purpose. The availability of translations or writing helps can differ between languages. If a new language support is required later, this can be added by the administrator user. The administrator can select a language from the list of available languages in the list. It is also possible to remove an installed language from the system. The advantage of installing different languages is that different users can choose the required language in their language settings. Installing more languages helps to set the required language for displaying menus and windows in the system. Languages for startup and login screens can also be set using suitably. Display for numbers, dates and currency amounts can be set using the new language. The changes take effect only after the next logging in to the system.

Downloading Applications and Installing New Releases

Several Linux application software are available for downloading from the Internet. The software available is of different types. These are available as community supported or canonical supported open source, in the form of proprietary software or in the form of licensed software. These different software are stored in different servers located at different places. Also several *http* and *ftp* servers archive Linux resources, which can be downloaded and can be used freely.

Ubuntu Linux distribution provides a tool for software downloading from websites and for checking whether the installed software has new releases available. Software Sources is the tool used for this purpose. When this tool is launched, it displays a window as shown in Figure 6.11. Different options can be set for software downloading by opening different tabs appearing in this window.

New and updated Linux versions are released regularly. To use new Linux versions the system is to be updated. System updating involves the downloading and installation of the latest updates of the applications and packages used in the Linux version. Different updates are available from different sources. Using the above tool it is possible to configure the system such that updating takes place automatically at the set time intervals such as daily, on alternate days, weekly updates and so on. If the system is working in online

mode, the updating takes place at the set time intervals automatically. If new Linux releases are available in a CD or DVD medium, the updating process can be also done using the medium instead of downloading from website.

Figure 6.11 Software Sources Window.

A virtual catalog of several free applications suited for Ubuntu distribution is available in *Ubuntu Software Center*. When launching this tool, a window as shown in Figure 6.12 is displayed.

Clicking the link *Installed Software* appearing on the left pane of the window displays the list of installed software in the system. Selecting *Get Free Software* on the left pane displays a list of departments on the right pane. Here different software are grouped under different departments or categories. Double clicking the icons of departments displays a list of available applications under the selected category. Suitable application can be selected from the list. The selected application can be installed with the click of a mouse button. An Internet connection is necessary to install an application available in this list. To install a particular application available in the list, first locate the application using the *search* option. Click the application and then click the arrow button to go to the screen of the program. Click the button for installing the software. The time taken for installation depends on the size of the software and the speed of Internet connection. Once installed, its name appears in the *Applications* menu in the same category in which the application is listed in the Software Center. Working in this way, applications under different categories can be installed. To remove an installed application, first locate the application in the list. Select the application and then click the *Remove* button appearing in the window.

Figure 6.12 Get Free Software.

Installing Packages

Several Linux software applications are bundled as packages. A single application can even exist in several packages. Package manager applications available in Linux operating system enables the installation, upgrading and removal of software from computers as well as the management of already installed software. The advantage of using the package installation is that all the required files will be available and it is required only to place the files in correct locations. All applications reuse the functionality of other applications or libraries and hence most packages depend on other packages. So it is necessary to install the packages in an ordered manner. Package manager application resolves dependencies automatically.

Linux packages are mainly available in two types namely RPM packages and DEB packages. RPM stands for Red Hat Package Manager and DEB stands for Debian. These packages can be identified by their file names extensions. These files are executable files for Linux operating system. Several of these packages can be downloaded from the Internet. The packages are also distributed through different storage media. To install a packaged file, the first step is to copy the files in the local folder. After copying the files, double click the file for installation of the package. Necessary permission to execute the file must be available for installing the package. The installation takes place only if all the dependencies are satisfied. Otherwise an error window will appear. Usually, packages are tested for a particular Linux distribution for dependency management for the effective working of the application. Dependency management in one distribution does not indicate the effective dependency management in another distribution or in another version. Installation of RPM based packages in Debian based distributions is not simple as it requires some additional packages for conversion from one type package to another type.

Another method for installing Linux packages is the use of Linux Package Manager applications for installing packages. Package Managers install, remove, configure, upgrade and downgrade single and multiple packages. They also manage package repositories, search packages using different attributes, select packages by status, sort packages and so on. RPM based and Debian based distributions use two different package managers for package installation. But both package managers appear identical and work in a similar manner. In Mandriva Linux distribution, the package manager is launched by selecting the *Install & Remove Software* option displayed in the list when *Applications* menu is opened. The option is also available by navigating through *System > Administration*. When the option is selected, a new window is displayed, as shown in Figure 6.13.

Figure 6.13 Software Management Window of Mandriva Linux.

This new window is the Software Management window and this window lists all the installed applications, categorized under different groups. Browse the group to get the list of applications available under the group. Installed applications are indicated with a tick mark on the square box at the beginning of the package name. Right clicking on the application displays more details about the selected package in the description box. To install a new package, click on the square box. This step opens a new window which displays a summary of additional memory needed. Click the *OK* button for confirmation of installation. Installation process starts and asks for inserting the medium on the drive. Insert the medium and click *OK* button. The package is installed and the name of the application appears under a group in the *Applications* menu, in which the package was displayed.

To remove the installed software, first locate the software in the package list in the *Software Management* window. Remove the tick mark in the square box appearing on the left of the name of the application by clicking on the square box. Click the *Apply* button appearing on the bottom of the window. This step opens a new window in which a summary is displayed. Proceed by clicking the *OK* button to remove the software.

Ubuntu Linux distribution makes use of *Synaptic Package Manager*, as the package manager for installing packages. To install packages using this package manager, activate the application by selecting *System* from the menu bar and choosing *Administration* option and then *Synaptic Package Manager*. The opening window of the package manager looks like the one shown in Figure 6.14.

Figure 6.14 Synaptic Package Manager Window in Ubuntu Linux.

Similar to any window, this window has a title bar, menu bar, tool bar and so on. Opening the menu bar displays a set of options. Toolbar displays a number of icons for providing main actions. The window is mainly divided into a left pane and a right pane. Depending on the selection of category made on the left pane (category selector window), the corresponding details of available and known packages will be displayed on the right pane. The installed packages are indicated by a dark square at the beginning of their names where as packages that are yet to be installed are indicated by a white square at the beginning of their names. Right click on the name of the package. A short description of the selected package will be displayed in the bottom right pane (description field).

Installed applications can be marked for removal or upgrading, while those are yet to be installed can be marked for installation, from the options displayed on the pop-up window. Options can also be set by opening *Edit* menu of the application. Different menu options are for reloading the packages as well as for marking upgrades of packages. After making changes, save the changes by clicking the *Apply* button on the tool bar. Clicking the *Reload* button on the tool bar reloads the packages from Internet sites, if the computer is working online. Otherwise a downloading error will appear on the screen and the process will come to a halt. Packages are made available through so called *repositories*. Repositories can be located on different media such as CD/DVD, local hard disk, the Web (http, ftp) or in remote file systems. A repository contains the packages and along with them, an index that provides basic information about the packages, such as the required dependencies and short description.

To remove a package, first mark the package for removal. For this, double click on the name of the installed package in the package list. Click on the status icon of the package and choose the option for removing the package. Save and apply the changes. This step opens another window as shown in Figure 6.15. This is the confirmation window and asks for the confirmation of selected packages. A summary of packages removed and the memory that can be reclaimed are also displayed in this window. Clicking the *Apply* button removes the selected packages from the system.

Figure 6.15 Summary Window—for Removing Packages.

Source codes of several applications can be downloaded from the Internet and the source code can be compiled to get the binary form of the application. Several applications for Linux operating system are available in different Internet sites as well as distributed in different storage media. Many of the applications are available in compressed or zipped formats. These are the common methods of distributing open source software. Such types of software work on different platforms as well as in different distributions. The normal way of installing such Linux applications is to download the application to the local folder and to double click the compressed or zipped file to extract the component files and to install them in the system. These files will be having a file name extension *ar*, which means that it is an archived file. Depending on the application used for compressing the file, the files can also have name extensions like *.gz*, indicating that it is a zipped file. Double clicking the compressed file opens the archive manager, which helps to extract the compressed files. The typical display of the window is shown in Figure 6.16.

Figure 6.16 Archive Manager Window—for Extracting Compressed Files.

As seen in the figure, the name of the location or the folder to which the unpacking of the compressed file is to be done is specified in the text box. After typing the location, click the *Extract* button, to extract the compressed files to the named folder. After extracting the files, the application can be executed by double clicking the executable file. Usually a *readme* file is created in the folder and this file guides in the further installation of the software.

Apart from the above types of installation methods, the packages can be installed by executing different Linux commands at the Linux prompt. This will be discussed later.

Setting Up and Managing Computer Networks

Configuring computer networks and their management are important Linux administration functions. Several tools for configuring and managing computer networks are installed by default during the installation of Linux operating system. Using the different tools it is possible to set up a new network, edit network connections as well as remove a network connection.

In GNOME desktops a network icon is displayed on the top panel. Right click on this icon and select the option *Configure Network* from the displayed list. This operation starts the *Network & Internet Configuration* wizard. The first screen displays the list of different connections available for configuring (See Figure 6.17).

Figure 6.17 Network & Internet Configuration Wizard in Action.

The different connections can be wired network, wireless network, using cable modem etc. For setting up a wired network, choose the option *Wired (Ethernet)* from the list and click the *Next* button. The computer detects the Ethernet interface available and its name is displayed in the next window. Configuring the protocol for connection can be made either automatically or manually. Select the manual configuration option and move to the next window. The new window displayed as shown in Figure 6.18.

The IP settings are done in this new window. Set the IP address and netmask for the computer. In this window the IP address is given as 192.168.4.2 and netmask as 255.255.255.0. Click the *Next* button and proceed further and finish the processes. The same step is to be done in all the computers connected in the network. The IP addresses used in different computers must be like 192.168.4.3, 192.168.4.4, and so on. The netmask used must be 255.255.255.0 in all the member computers in the network. Once the

Figure 6.18 Setting IP Address for Networking.

configuration is finished a connection is established between the networked computers by clicking the button for establishing connection. Using suitable tools or text commands it is possible to check whether a connection is established between the computers. For Ubuntu Linux also, the same steps are to be followed for setting up a network.

Adding Printers

Linux operating system allows adding new hardware to the system. Using this facility, it is possible to add printers, modems, scanners and the like. For a successful hardware installation it is necessary to install the required software as well as to set different configuration parameters of the hardware. Configuring the devices is done with the help of device driver files. Installing device driver files adds new features. Linux operating system configures most of the devices automatically. But certain devices require proprietary drivers to be installed for their working. This is because the drivers for those devices are not freely available, as the manufacturers of the devices have not released the hardware details. Device drivers for any device are usually provided by the manufacturer and this is available along with the device. To add a new driver, locate the device driver file from the list displayed in the window when the hardware driver tool is launched from the menu. Press the *activate* button to enable the driver. The driver may have to be downloaded from the Internet. The computer is required to be restarted for the changes to take effect.

To install the printer software in the system, select the option *Printing*. This opens the printer configuration window as shown in Figure 6.19. To add a printer, connect the

Figure 6.19 Printer Configuration Window.

printer to the computer and switch on the device. Click the *New* button in the configuration window. The system checks for new printers connected to the computer and installs the necessary printer software.

Manual intervention is necessary to identify the printer and for setting different parameters. Different configuration steps for a printer involve assigning port, setting time limits and the like. After selecting the parameters, proceed to install the printer by clicking the *OK* button. If the printer is successfully installed, its icon appears in the window as shown in Figure 6.20. In this way more printers can be added to the system. Right clicking on the printer icon displays a pop-up window and the user can select different options for setting different printer configurations. Double clicking the icon displays the printer properties window and it is possible to set different configuration options for the printer, in this window.

Figure 6.20 Successful Printer Installation.

Backing Up Files

Backing up of files is an important administrator function. The backed up files are used for restoring the system to the previous state whenever the system fails. Linux installs tools for simple backups of the system. Tools for restoration of the system are also installed by default. When the system backup tool is launched, the window as shown in Figure 6.21 appears on the screen.

As seen from Figure 6.21, it is possible to set different options for availing system backups. Certain files can be excluded and some can be included. Location for storing backup files can also be specified. For regular backups, time also can be set. All the options are set from the options available by opening different tabs of the window. To backup the system manually, click the button for backing up files. This step backs up the files in the selected location. The backed up files can be used to restore the system.

Figure 6.21 Configuring for Backing Up the System.

Managing Users and Groups

A major function of Linux administrator is the management of users and groups of the system. User and group management jobs involve adding and deleting users and groups. During the installation of Linux, the administrator user is created. Other users are created and the passwords are assigned by the administrator user. When the tool for managing users and groups is launched, it opens a window titled *Users Settings* and this window displays the details of current users and groups.

To add a new user, click the button *Add User* displayed on the right side. This step opens a new window titled *New user account*, above the previous window, as shown in Figure 6.22.

Figure 6.22 Users Settings Window in Ubuntu Linux.

The window has a number of tabs and opening each tab displays a set of options for user configuring. Opening the first displays a number of text boxes for typing the details of the new user. After typing the details, click the *OK* button to add the new user. A user can be deleted by selecting the user from the list and then clicking the *Delete* button. Several other user configuration options can also be set using this tool. Users are added to different groups. Users belonging to different groups have different powers and abilities. Managing user groups involve adding new groups, adding users to groups, deleting groups and so on. All the operations are menu driven and can be easily completed with some mouse clicks.