

# The Operating System Linux

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## **Abstract**

One of my current computing interests is networking with Linux and so I am going to talk mainly about the Networking features of Linux.

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# 1 Introduction

## 1.1 Background of operating systems

In general most would say that the first PC operating system was MS-DOS in 1981, but of course this is just the microsoft view. The first operating systems are difficult to define, if we think of an operating system as the layer of software that interacts between hardware and software this makes it easier, using this simple definition we can the first operating systems as those that came as built in programming languages such as COBOL in the early 1960's.

It is later when VDU's where introduced that operating systems became more interactive, by th 1970's computer programs became to big to fit into economical amounts of ram so swapping and virtual memory was introduced so that "cheaper" backing stores hard disks, tapes and floppy disks could be used. As we moved to the 80's GUI (Graphical User Interfaces) developed these used the WIMP (Windows Icon Mouse Pointer) Interface, along with this was one of the other biggest parts of todays computer society this is of course the basis of the internet - networking, during the later 1980's communications standards where layed down and in the 1990's this lead to the adoption of networking for distributed computing.

## 1.2 Linux

The linux operating system is of course based on heavily on the Unix opearting system, It all started when in 1991 Linus Torvalds, who was an undergraduate student at the University of Helsinki, got a brand new IBM 386 PC. He was dissatisfied with the operating system that came with the hardware, and wanted to run a version of Unix, unfortunately all the versions of Unix that he had looked at were highly expensive, But Linus was determined that he wanted to write a new version of Unix for his machine, and so decides to send a message across the internet asking for programmers to help him. The people who responded formed a teamed of talneted programmers to tackle the problem.

Obviously as time went on more programmers became involved and so they formed the core operating system (the kernel) and of course this was called Linux. The thing that made Linux different from other operating systems is that in the early stages of development Linus Torvalds made all the source code freely available and although each of the authors control

the rights for their own code, all decided to give away freely what they had created so others can build it. This concept was a concept created by the Free Software Foundation.

As the source code was freely available other programmers decided to add to the Linux kernel and create different systems to install the software on to a computer system and created distributions.

### 1.3 Distributions

Of course some added to this and charged for these additional programs, But under the GNU Public License the source code was freely distributable but had to be identified and distributed free of charge. Distributions were available in different ways some via the Internet and FTP servers, while some are available on CD-ROMs for a moderate distributing fee. Some popular distributions are Debian, RedHat, SuSe, Mandrake, Slackware and Corel. Linux over time has built up many many programs have become somewhat overloaded with available tools and software, in recent times most distributions come with a Package Manager (or RPM database) and most programs and applications are distributed as RPM's.

### 1.4 Platforms

Further that the availability of the source code has led to the development of the kernel and applications for other operating platforms this means that Linux is not just Intel X86 - 32-bit Intel Complicated Instruction Set Computer (CISC) to the Alpha - 64-bit Reduced Instruction Set Computer (RISC), other ports of Linux have been to the PowerPC, MIPS, SPARC, Motorola, StrongARM and HP/PA. The PowerPC is of course the processor that all recent Apple Macintosh's have been based on including the Imac, G3 and G4. The Linux kernel also handles Symmetric Multiprocessing (SMP), this is where there is more than one processor within a system, further to this Linux can also handle clustering where by multiple systems use their resources to process data this means that instead of replacing processors for faster processor you simply add extra servers and share the processing load, this is also referred to as load balancing.

## 2 File System

The Linux file system is somewhat different to those used on Windows and Macintosh computers, Linux files are of course very much like Unix files. A file is usually made up of two parts of information the filename and the location of the file (the directory). Linux use a tree directory structure so that you can have many files and many directories all nested, of course directories can be nested within another directory and files can occur in any directory. All files on Linux are organised into a single structure as opposed to the stucture of DOS and Windows of many structures under different a structure of driver letters.

### 2.1 Comparing of Linux and DOS File Systems

**An MS-DOS file system** This has a multiple structure so new drives/partitons are added as new letters this of course limits the system to only 26 letters.

C:

```
\DOS
 \DOCUMENTS
 \WINDOWS
          \SYSTEM
 \IOSUBSYS
```

D:

```
\MP3
 \FUNNY
          \PICS
 \VARIOUS
 \GAMES
```

**A Linux File System** This has a single stucture so new drives/partitions can be added any where with in this single system they are usually added (mounted) in /mnt, obviously this has a infinite possiblities for numbers of drives as a driving could be added (mounted) into a drive.

```
/usr
```

```
  /local
```

```
    /games
```

```
/home
  /jon
/documents
/mnt
  /cdrom
  /floppy
```

Further to this many of the commands and syntax that are use in dos can be repeated in linux there are only a few variations including;

- ls is used in addition to the dos command.
- dir although dir does exist as a linux command.
- rm is used instead of delete, del or deltree.

### 3 Permissions

This is the biggest difference between the MS-DOS and the Linux filesystem while MS-DOS only has a simple set of permissions i.e. Read Only, Hidden, System, and Archive, while under linux its a little bit more complicated but of course the added complication means that it is a lot more flexible and secure. The first and easiest system to understand is the ownership permission, where every file on the system has an owner and a group, most of the time the owner and the group, will match i.e. the owner will be in the group.

### 4 Networking

As stated earlier one of the biggest revolutions of operating systems and of computers in general in the 1990's was networking, the development of the Internet and TCP/IP as the standard protocol for the Internet has lead to the increasing number, size and development of Computer Networking. Unix is a highly network oriented operating system and obviously as Linux is based on Unix it has adopted many of its features as a Multi-User network operating system.

## 4.1 TCP/IP

TCP/IP is a Platform Independent protocol this means that it unlike Protocols such as Microsoft's Netbeui protocol, and in some respects Novell's IPX/SPX protocol, this means that TCP/IP will run on any operating system because of the open nature of the standard. It also allows other network applications to run on top of it this is because it is based on the OSI Model which allows a layer for applications, this means that network applications can be transmitted over the TCP/IP system. It is also a Network Hardware Independent again because of the use of the OSI Model

In the following section I will be describing some of the different networking applications that are available with most Linux distributions.

## 4.2 NIS

As Linux is a multiuser operating system, it is important that some files are accessible to every user, while others such as applications and configuration files (especially password files) are only available to the system administrator (sometimes referred to as the Superuser) on top of this each file has access rights. Furthermore networking means that in order to access data across machines you must have the accounts on each machine.

This is further more complicated as we have File ownership and permissions to deal with, obviously the inbuilt feature is that the creator of a file will in fact become the owner of that file, most can only write data to their home - the home is basically your personal folder on a system. Permissions are a set of rules specifying who can perform operations on a file. Ownership is set into users and groups (multiples of users) and Permissions such as Read, Write or Execute.

## 4.3 NFS - Network File System

NFS is the system used to share files and printers between computers running Linux (and Unix). NFS isn't directly supported by Apple Macintosh or Microsoft Windows based computer systems, but these can use NFS with additional Client software. Although later I will be discussing ways in which Linux can share files with Apple Macintosh and Microsoft Windows based computers.

### 4.3.1 Servers and Clients

Similar to most Internet and Network services, NFS consists of two sections Server and Client, The NFS server exports certain directory or folders to the network, While the NFS client, allows authenticated users to mount these exported directories to their file systems. NFS also has the ability to act as a peer to peer networking system, this means that all clients have equal status and that some may be run as servers, but these servers will not be dedicated servers.

### 4.3.2 NFS Good or Bad

NFS obviously has some advantages it can allow users to access shared data on one filesystem and so means that a backup only has to be done on one central file server also shared drives are always utilized better than local drives as more users can share the space or resource such as an expensive printer, sharing allow applications to be installed in a central share so thus reduce time spent installing upgrades to packages. Of course NFS is not all good and it does have some problems these are of course of security advantages such as unauthorized users gain access to integral parts of the system, this can occur if the NFS server is not configure correctly. Fault tolerance if a network fault occurs it is somewhat difficult to resume NF's connections on the fly and so often a reboot of all systems connect to server may ne to be done of course this is not always practical. NFS is part of the linux kernel and as the kernel is always being updated there are some difficulties such as that documentation is sometimes old or invalid.

## 4.4 Samba

Samba is the name that has been given to a suite of tools that are available for Linux, which allow it to provide to and use networking services of Microsoft Windows based computers, Samba is based of the microsoft SMB protocol and in later releases this is call the CIFS protocol. Of course Samba can be used to share files between Linux and Windows computer but of course works equally as well with Linux only networks. The underlying parts of the Windows Networking system are of a series of industry standard developed by IBM, Intel and other companies; below are the different standards used to allow networking of Windows computers.



Samba is currently the Linux implementation of SMB it originates from an Australian programmer called Andrew Tridgell who wanted to utilize space on his Unix server back in 1990, but using is Windows PC, unfortunately theres was nothing to do this so he decided to write samba. Andrew released samba to the internet for people to download but of course at first samba was slow and inefficient, today samba is a very large open source project many programmers are involved with it. Samba's homepage is [www.samba.org](http://www.samba.org).

#### 4.4.1 NetBIOS

Netbios (Network Basic Input Output System) is a break off an effect led by IBM during the 1980's to write networking protocols for personal computers, NetBIOS basically enables a way for network workstations to identify themselves, NetBIOS itself defines an API (Application Programming Interface) so that applications interact with NetBIOS, NetBIOS will then interact with one of three network protocols; these can be any of the following; Novell IPX, Microsoft NetBEUI or TCP/IP. NetBIOS will when running wiht one of these protocols establish part of the OSI reference model. Under Samba the NetBIOS daemon (program) is nmbd.

#### 4.4.2 SMB

SMB (Server Message Blocks) this is a collaboration between Intel and Microsoft. This is the part of the system that runs as the application it interacts between applications and NetBIOS, SMB allows user the perform file management on a network filesystem as they would on their local filesystem (such example is where you have for instance a drive letter P: which is mapped to a network drive), In recent times Microsoft has renamed SMB to CIFS (Common Internet File System) as it trys to enhance and extend the protocol and this is what is used in Microsoft Windows 2000, its is of course backwards compatible with SMB. Under Samba the SMB daemon (program) is smbd.

#### 4.4.3 Advantages of SMB

SMB has many advantages especially over firstly it allows the sharing of both files and of printers it provides user authentication so that user rights can be checked and it provides name resolution (the conversion of names to numbers) SMB is organised and can provide all its services using the following organistation

#### 4.4.4 Workgroups and Domains

All computers using SMB have to belong to a workgroup or domain (this is not like an internet domain it is a domain only for SMB) a Workgroup is a set of computers all of equal status although some may act as dedicated servers this is usually used for peer-to-peer networking of several workstations,

Domains are a set of computers again all can act as peer-to-peer machines but in order to become part of the domain they must be validated by a server which is usually dedicated to this task. Microsoft developed domains as part of Windows NT and Samba has to adopt this concept either when it joins a domain or acts as a domain server, basically the main server on a Windows NT domain is called a domain controller it controls all computers that login to it, Samba has only recently been able to support Windows NT/2000 domains but has supported Windows 3.11/95/98/ME domains for sometime.

#### 4.4.5 Shares

All resources that are made available using the SMB protocol are defined as a share, Shares can be created on a user computer and of course on dedicated servers, there are two types of authentication used to validate the user;

- Share-level authentication - This is where each resource or share is given a password and anyone can access this share simply by entering the password, It is visible to anyone logged into the workgroup and is extremely poor security, This has been known to be exploited by hackers in recent times, so is obviously not a very secure method, although the Samba is noticeably more secure than Windows at share level authentication.
- User-level authentication - This is where access to shares is restricted depending on username and password, User can determine which users have access and which don't this is commonly used in domains as the server validates the username and password and so the computer simply makes requests to the domain server to validate username and passwords.

#### 4.4.6 Workstation Names

In SMB networking, the name space is flat, which means that every computer must have its own unique name and in addition each share has a name, the

standard convention for SMB network names and share names is as follows;

```
\\workstation\share
```

#### 4.4.7 Browsing

In SMB networking, browsing refers to the process by which each computer on the network displays its self and its shares, this machine is then listed to a list of hosts and is maintained by broadcasts, eventually a machine will detect each machine on the network.

Active machines lists are maintained by a machine referred to as the master browser, which will be one of the computers on the network that by election maintains a list of computer names, the specific computer is decided by the computer as they are all given an OS Level which reflects their operating system so a Windows NT or Samba machine will have a higher OS Level than a Windows 95 Workstation, of course this can be altered with Samba and by setting this figure higher it will always win this election.

#### 4.4.8 Name Resolution

SMB can use the browsing system above to locate other systems on the network, but of course this is inefficient. To provide a more effective means of listing of the computers on the network microsoft developed WINS (Windows Internet Name Service) this is very similar to DNS which is used to resolve internet names. When WINS is enabled on a server on a network, the WINS server contains a database containing all the computers on the network and then creates a master list, each machine then refers to the WINS server to resolve these host names and IP numbers.

### 4.5 Other Network Applications

A quick run through of some other Linux Network Applications

#### 4.5.1 Apache

Apache is a Web server that allows the display of http or https webpages. The first Apache server was developed in 1995 at the NCSA (National Centre for Supercomputing Applications), Apache got its somewhat strange name

because of its need for software updates and fixes to the original NCSA Web Server (“A PatCHy sErver”). Apache is an open source project and is widely used especially by Internet Service provider, because of its free available open source code, it is also cheaper to implement with no license unlike Microsoft Internet Information Server.

#### **4.5.2 Telnet**

Telnet this is a text based server that allows you to connect to a machine and to operate a session on that machine, It will give you a console windows similar to that found in Linux and will give you a session on that server this means that Linux machines can be remote controlled using telnet.

#### **4.5.3 FTP**

FTP or file transfer protocol is heavily used for the transfer of files and uploads of webpages, it is quicker at transferring files compared with other methods for example Samba. FTP allows you to see files on a remote computer as though they were on your local computer. Most Linux installations come with at least one FTP server, the most common FTP server with Linux distrubtion is Wu-ftp this is the Washington University FTP Daemon, Wu-ftp 2.4 was released in 1994 and there were no updates made to this until 1999 because of its reliability.

#### **4.5.4 Appletalk**

AppleTalk is Apple Computer’s protocol suite for local area networking, similar to NFS and SMB, it is a protocol that runs on top of the networking components. AppleTalk is supported under linux but unfortunately it is not as well developed as Samba and lacks the documentation and support that Samba has through its website, the Appletalk daemon is called netatalk.

#### **4.5.5 PPP**

Linux can of course function as a PPP (point-to-point protocol) server and client, PPP is that method by which most narrowband (modem) users of the internet connection to their ISP (Internet Service provider), linux can use PPP as a connection to the internet and can act as a dial-in server so that clients can connect to the server using a modem and a phone line.

### 4.5.6 Firewalls and Gateways

Linux has built-in firewall rules which allow traffic to be monitored and rules to be set to reject or accept data depending on its source the daemon used to control this under linux is called ipchains and its requires a lot of setting up to allow your machine to protect your from the internet, although once setup it is usually very effective. Linux can also be used as a gateway to the internet on almost any type of internet connection and also as a proxy server to cache and restrict access to webpages.

### 4.5.7 DHCP

A DHCP server (Domain Host Control Protocol) is a machine that allocates IP address from a range of IP address to machines on a network, each machine makes a request for an IP address and the server allocates one for a period of time (a lease), once the computer has finished with the address it releases it back to the server, It is used in situations where there are more machines that IP address and it also allows you to configure option such as the default gateway. The server with linux is called DHCPd (DHCP Daemon).

## 5 Conclusion

Linux has a very good collection of network tools as of course it is heavily based on the Unix operating system. In this report I have highlighted some of the areas of the networking tools with linux, but of course linux does contain so many useful networking tools, it would be difficult to explain them all with in a single report as most books do not contain information about all of the Linux networking tools.

Linux is gaining a rapid response from computer enthusiasts and is heavily used by users of broadband internet as a firewall and gateway, More and more companies are using linux as an alternative to Windows NT, Windows 2000 and even Unix, because of its freeware availability. Many companies including Internet Service Providers see Linux as a really reliable and cheap alternative to Unix, I personally work for an Internet Service Provider who have gone from using Sun workstations with Unix to using Compaq Servers with Linux inorder to save money at their Data Centres and POP's (Point-of-Presence), and so if the industry is happy with Linux it will not be long before even more consumers take on Linux as their operating system.

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