



LINUX_

AN INTRODUCTION TO LINUX

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BEFORE WE BEGIN

COMMANDS

All commands in the following guide are highlighted inside grey boxes with the command as it should be typed in the left and the description on the right. All commands are case sensitive and are dependent on having the correct number of spaces / characters. Please be sure to copy it exactly.

```
ping -c 5 -n 10.203.1.5
```

Ping the IP Address 10.203.1.5
for a count of 5 (-c 5), outputting
numerical values only (-n)

SPECIAL CHARACTERS

Be aware of special characters and don't get them confused with standard letters.

| = this is the Pipe character, used to pipe output from one command into another.

To type Pipe, use Shift + \ (located on the left side of the keyboard, next to the shift key)

Example Command: `man -k directory | grep ls`

USERNAMES

Throughout this document, the username 'msai135' is referred to as a sample account. When you are working through this document, you should use your username in place of 'msai135'.

BEYOND THIS WORKBOOK

There is more included in this worksheet than you can accomplish in the session time allotted. This is so you can continue your study of Linux outside of the session, using this workbook as your starting point. Even if you do not have access to a Linux environment to work with, you should still be able to read through and gain knowledge and understanding from the examples in this workbook.

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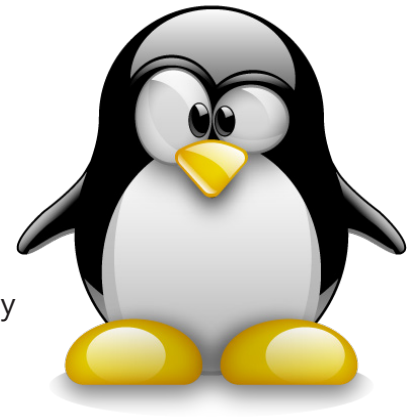
WHAT IS LINUX?

Linux is an operating system, much like Microsoft Windows or Apple Mac OS. Unlike other mainstream Operating Systems, Linux is made freely available and is Open Source.

A (VERY) BRIEF HISTORY OF LINUX

Back in August of 1991, a student from Finland began a post to the comp.os.minix newsgroup with the words:

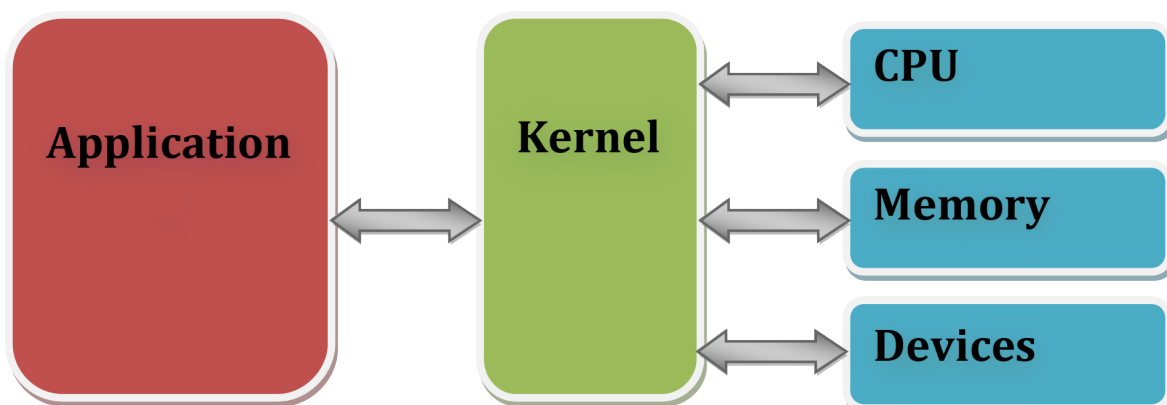
```
Hello everybody out there using minix -  
I'm doing a (free) operating system (just a  
hobby, won't be big and professional like gnu)  
for 386(486) AT clones.
```



The student was Linus Torvalds, and the “hobby” he spoke of eventually became what we know today as Linux.

A full-featured POSIX-like (Portable Operating System Interface Unix) operating system, Linux has been developed not just by Linus, but by hundreds of programmers around the world.

This massive, world-wide development effort is largely uncoordinated. Sure, Linus calls the shots where the kernel is concerned, but Linux is more than just the kernel. There’s no management infrastructure; a student in Russia gets a new motherboard, and writes a driver to support a neat feature the motherboard has. A system administrator in Maryland needs backup software, writes it, and gives it away to anyone that needs it. The right things just seem to happen at the right time.



A BRIEF HISTORY OF LINUX

1969

1971 to 1973

1974 to 1975

1978

1979

1980

1981

1982

1983

1984

1985

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1989

1990

1991

1992

1993

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1995

1996

1997

1998

1999

2000

2001 to 2004

2005

2006 to 2007

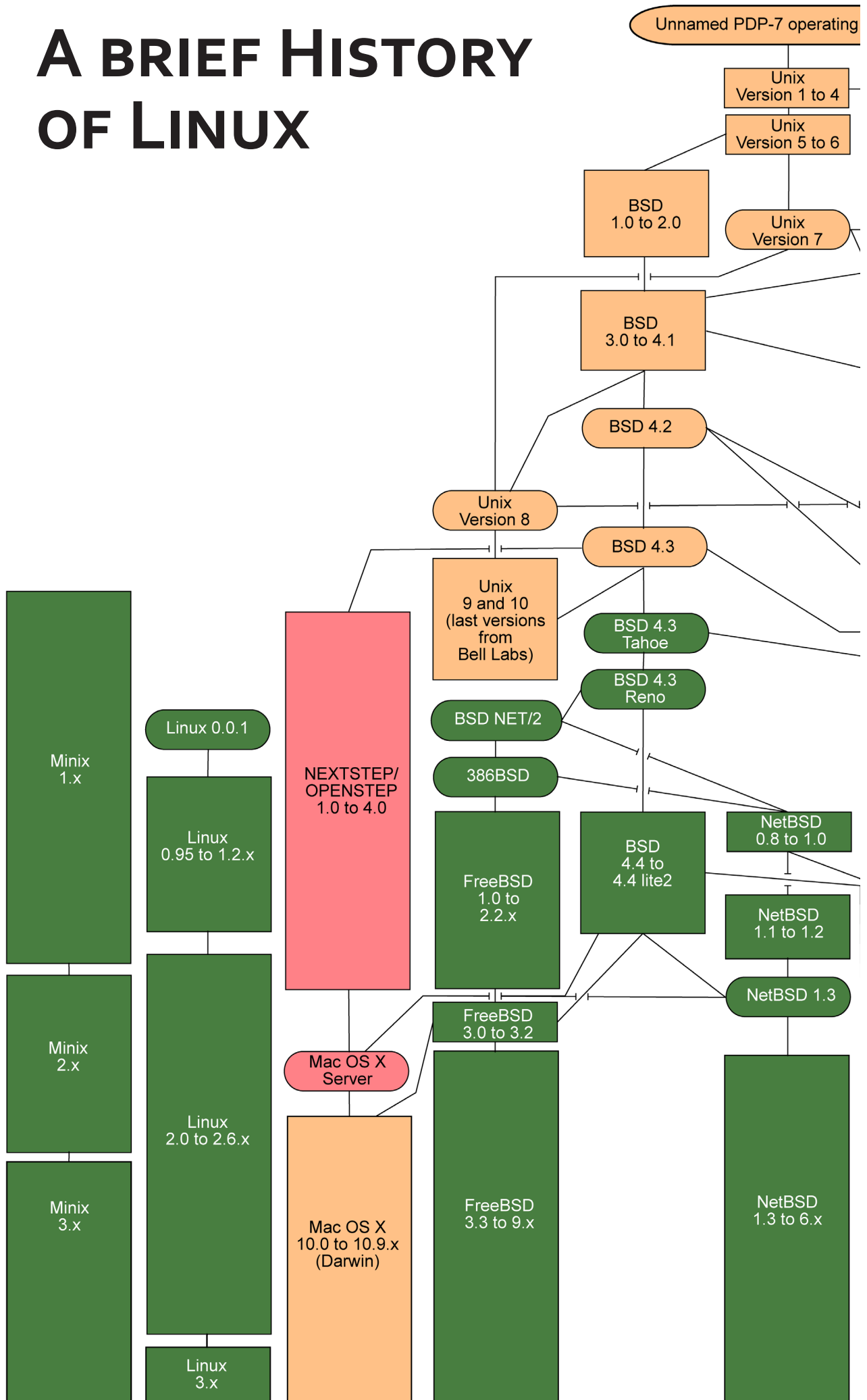
2008

2009

2010

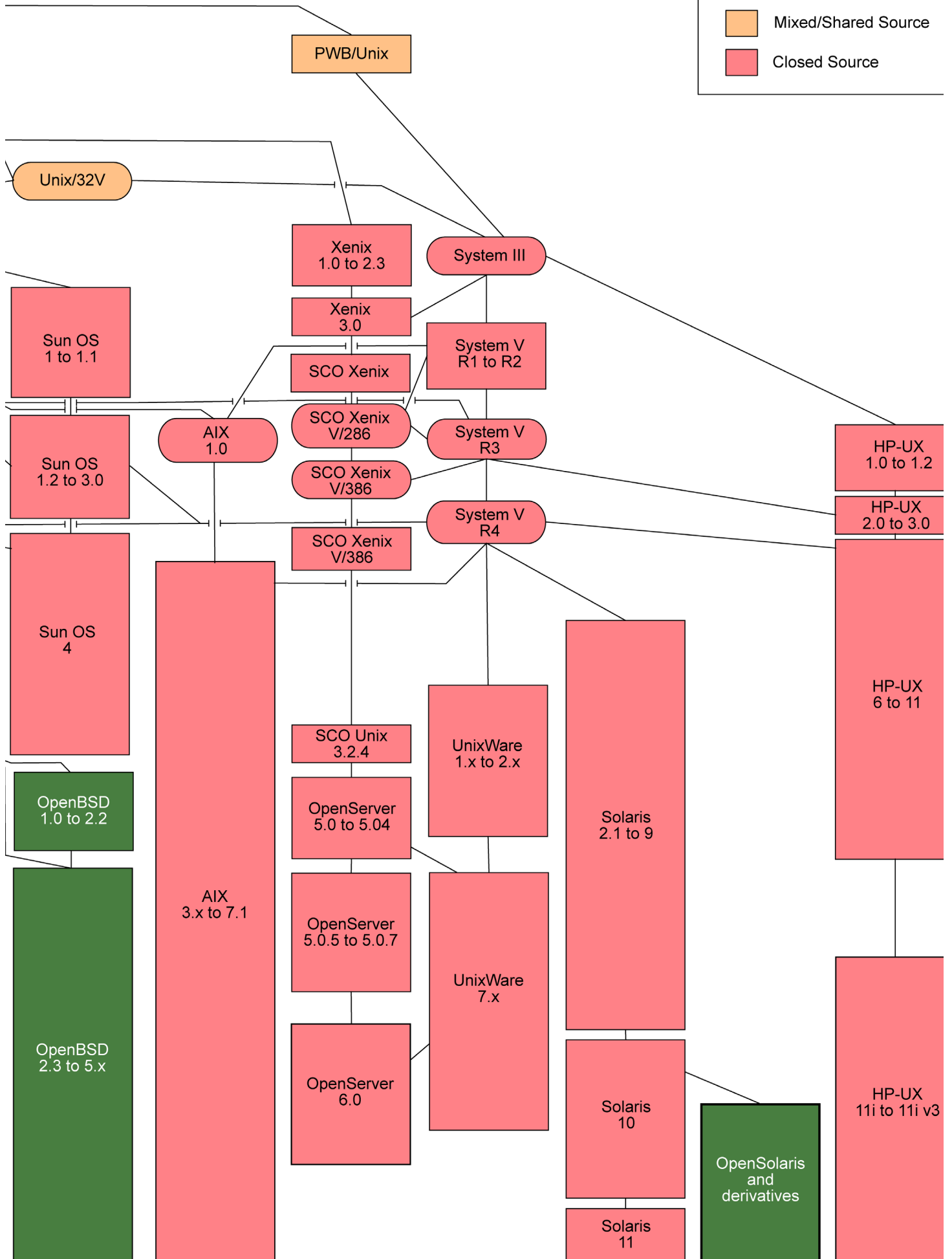
2011

2012 to 2013



system

- Open Source
- Mixed/Shared Source
- Closed Source



DIFFERENT LINUX DISTRIBUTIONS

Different distributions of Linux exist because different people all have different opinions on what is most important. Each distribution represents the diverse choice of a group of individuals. As you can see from the previous Linux Distribution Timeline, each distro originates from somewhere. Many distributions have a colourful and interesting history, most of which can be discovered from a little reading on the homepage of the distro in question.

Most modern day distros spring from 'core' distributions, such as Redhat and Debian, however some distros merge over time, or diverge where mandates and opinions have differed.

Below are the major distributions that you are likely to run across. All have their positive and negative points, and all have a different focus.

Debian – A distribution based on Stability.



Debian pride themselves on testing each and every package in the OS with every other package.

This ensures no conflicts, and no issues of stability. This approach does sometimes slow progress, with packages in the Debian distro being behind current versions. Debian is a popular server Operating System due to its stability, and has multiple flavours designed purely for devices as an integrated OS

Ubuntu – Designed to be friendly to the average user, and the best desktop operating system that it can be.



Ubuntu is based on Debian, and has a number of forks, including Kubuntu, Edubuntu, and Xubuntu. Today, Ubuntu (and its derivatives) is one of the more popular Linux Desktop operating system, and is currently in use on home computers, servers, business, education, government, and charity machines.

SUSE – Incorporating many features and aspects of Redhat, SUSE



was a popular choice on Desktops, with its acquisition by Novell in 2003. Novell quickly used the OS to launch a counter-offensive against Microsoft, offering a paid-for support scheme similar to that of RedHat, giving companies an enterprise level OS with enterprise level support, but with the flexibility and low implementation and maintenance costs of Linux. A free home version of SUSE (OpenSUSE) was released by Novell during the acquisition, drawing a parallel with CentOS / Fedora from Redhat. In 2006, Novell signed a controversial agreement with Microsoft to improve interoperability between Novel SUSE & Microsoft Windows.

Redhat – Redhat is known for its RPM (Redhat



Package Manager) installation system, and for their goal to provide a stable, supported, and viable alternative to Microsoft Server operating systems. Offering paid-for support packages with its operating systems, Redhat makes for an attractive desktop and server platform for business. Redhat was originally available for free with support packages being an optional extra for those that required it, but has now become a pay-for only product. Redhat are allowed to continue this practice as long as (un-compiled) source code remains freely available.

Today, Redhat finds its home in various businesses, education establishments, and government facilities.

Two major forks sprang from this restriction on the availability of Redhat:

CentOS – focusing on creating a free



'Redhat Server' based OS to use on dedicated server hardware. When Redhat became a pay-for product, CentOS became a very popular OS among the desktop Redhat community.

Fedora – 'Redhat Desktop' based OS,



designed to run on all desktop and mobile machines. Upon the move to a pay-for scheme, many Redhat users moved to Fedora, allowing them to retain their familiarity with the OS, and the support for their pre-written configuration files and installation files.

Other Distributions – There are lots and lots of Linux distributions out there. The best way to find out about each and every distro is to visit the homepages for each one, and read up on their features and benefits.

The important thing to remember; is that all Linux distributions are more or less the same underneath. The commands you will learn in this introduction can be used with any of the above distros with the same affect. Some distros have proprietary commands that only work in that distro (such as 'rpm' and 'dpkg' etc), however these are clearly documented by the creators.

With so many distros, the trick is to find the one that works for you, and stick with it. Here in the ISG, we recommend Ubuntu for Desktops, and Debian for servers, however the reasoning behind your choice of OS will be different from ours. Linux gives you freedom by giving you choice.

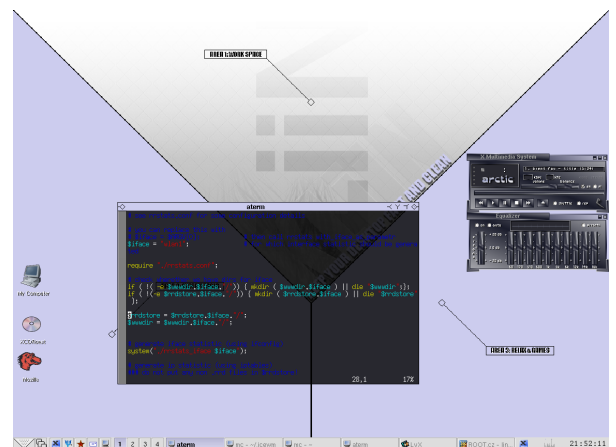
DIFFERENT LINUX DESKTOP INTERFACES

There are two primary desktop interfaces in the Linux world that you are likely to encounter. GNOME and KDE. These are known as Window Managers. Below the Window Manager sits the actual desktop environment - X11. The Window Managers give the Desktop Interface its look and feel.

Like with the different Linux Distributions, whichever Desktop interface you choose is dependent on which you prefer, and which one fits your specific purpose.

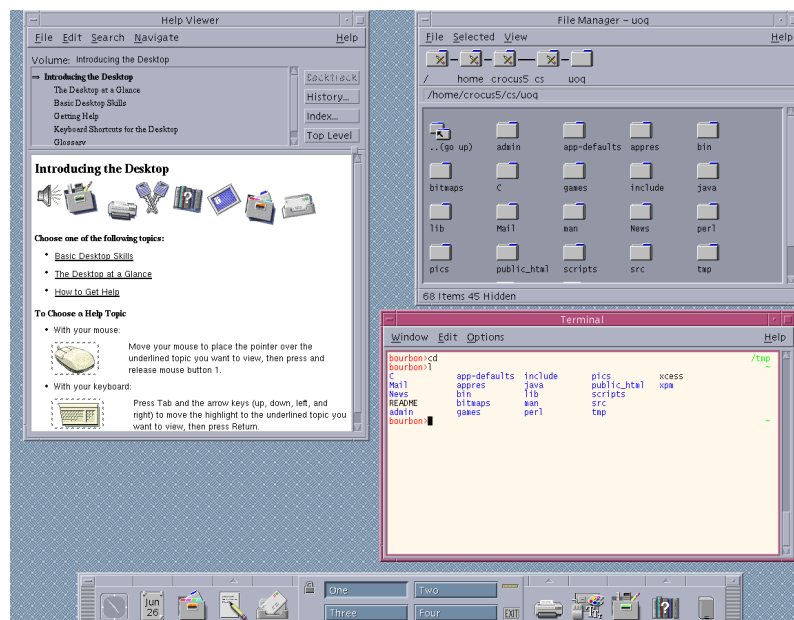
XFce

XFce is a lightweight desktop environment for UNIX platforms. It is similar to the commercial CDE, and is now based on the GTK+ toolkit.



CDE - A BLAST FROM THE PAST

CDE (Common Desktop Environment) is a commercial Graphical User Interface for UNIX and various other flavors, which was jointly developed by Hewlett Packard, IBM, Novell and Sun Microsystems. The Window Manager for CDE is dtwm (pictured right)

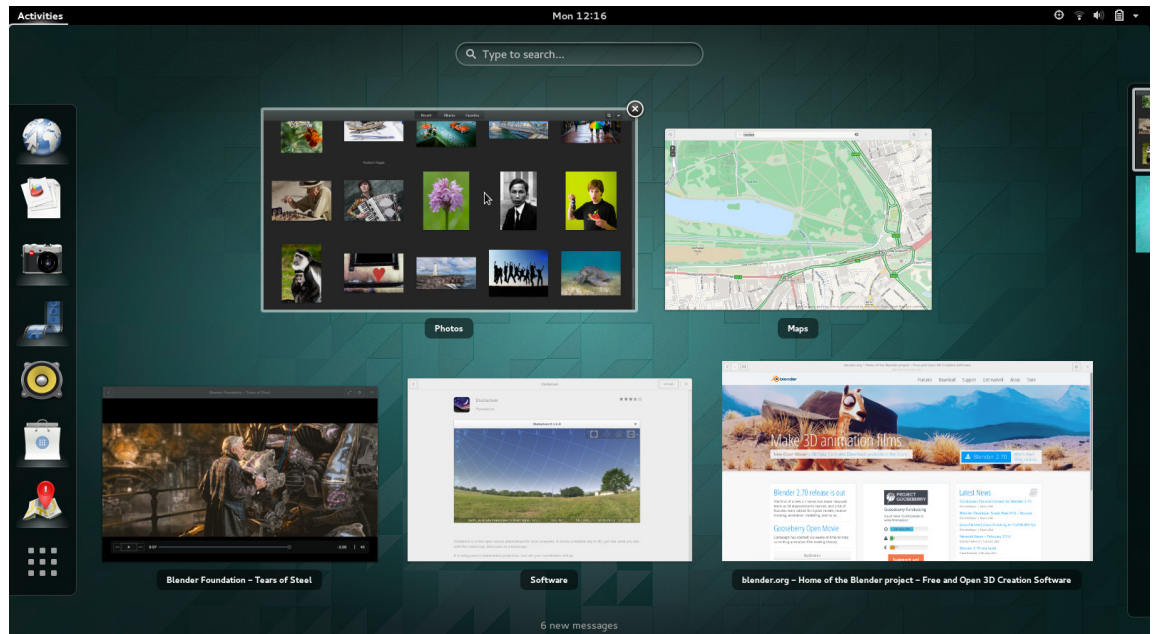


OTHERS

- FluxBox
- BlackBox
- Sawfish
- LXDE
- EDE
- JD4X
- AfterStep
- Metacity
- AmiWM
- SCWM
- FVWM
- MWM

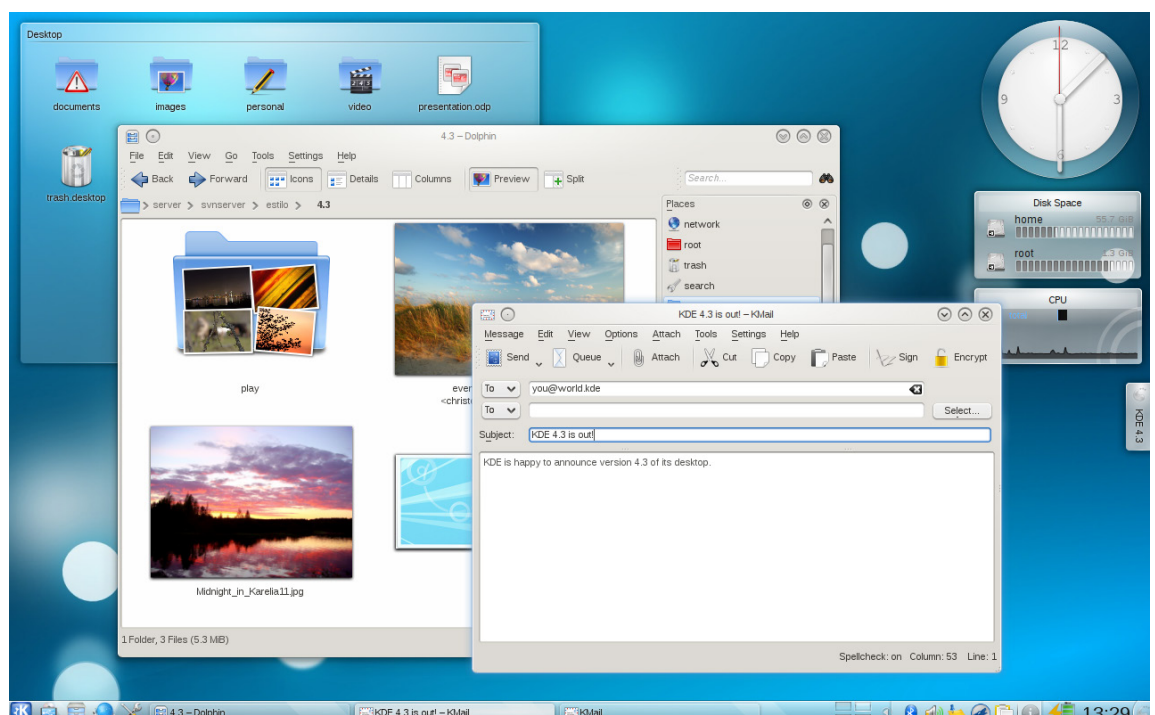
GNOME

GNOME is the default Window Manager for Redhat and Ubuntu, and the one that you will be using on the Linux Terminal Server. The GNOME (pronounced "Gah-NOME") project's aim is to build a complete, user-friendly desktop based entirely on free software. It is not a window manager, and in fact has to be run in conjunction with a window manager. GNOME has advanced rapidly and is now very popular, particularly on the Linux platform.



KDE

KDE is a modern network transparent desktop environment which uses the Qt cross-platform GUI toolkit. It contains a base set of applications such as a window manager (called kwm), web browser, instant messenger, and integrated help system, all with a consistent look and feel, and translations for over 50 languages.



WHAT IS LINUX USED FOR TODAY?

Today, Linux has found a home on smartphones (Android, Meego, Moblin, Maemo, Zaurus), Network Appliances (NAS, Firewall, Load Balancing), TVs, Laptops, Netbooks, Desktops, Servers, Games Consoles...

Linux is usable in every area that Microsoft Windows is, and many more.

Some noteworthy products using Linux today:



- Android phones – Manufactured by HTC, Sony, Motorola, Samsung, Acer, & more
- Netgear ReadyNAS Series
- Synology DiskStation NAS series
- Nokia Meego smartphones – Runs Meego, originally based on Debian BusyBox
- TiVo DVR – America's most popular Digital Video Recording, also used by Virgin Media
- Linksys WRT54G* Routers – The most popular router for home-modders.
- Sony BRAVIA TVs
- Samsung TVs (Most models)
- Panasonic Viera TVs – New models such as the G20 now use FreeBSD
- Archos tablets / media players
- GP2X Handheld Games Consoles
- Pleo – Animatronic dinosaur robot toy



BEFORE WE GET STARTED

WHY THE COMMAND PROMPT?


Why would we use a command prompt over the Graphic User Interface that we all know and love? The reason is simple: Control. A command prompt gives us greater control and flexibility over the system or software we are creating. We have no way of knowing if configuring a service using a graphical user interface is doing exactly what we want it to, or if it's doing something that its interpreted as what we want. In the world of security, the risk is not worth taking.

The command line can be used if you wanted to perform a task multiple times. You could script the command, and then run the script, making sure that the command run is 100% accurate. If you wanted to run a command once a year, you would probably use the CLI (Command Line Interface) over the GUI (Graphic User Interface). GUI's will change, and documentation will need

updating regularly. The CLI is a more static environment, requiring little to no documentation changes.

While you are studying the ISG course, you will be asked to use certain tools and commands from within Linux. These tools are usually run from the command line. Most people today will be brought up with computers only knowing how to use a WIMP (Window Icon Menu Pointer) interface. People rarely understand how to interact with the computer when we take away the mouse and limit them to a Command Line Interface. This guide has been written to help eliminate at least some of the confusion associated with text-based interfaces. As part of your grounding in the world of Information Security, you will increasingly be expected to interact with systems in a more direct way.

SOME BRIEF WARNINGS

-  The command line interface is case-sensitive. It does understand the difference between a lower case t and an upper case T – Check what you're typing as one wrong character can cause a lot of problems.
- Unlike in Windows, Linux has no magic 'Undo' command, and no safety net that is the Recycle Bin. Anything that you execute (run) in the command prompt would need to be fixed manually. Double Check EVERY command that you type, to make sure it is correct. The command line is a very powerful tool, and it requires a little more finesse and learning than the GUI (Graphic User Interface).

REMEMBER: If you delete something, it is gone! Check everything *BEFORE* you press enter!

IMPORTANT: EVERYTHING in Linux is Case Sensitive. This is important when typing commands!

ACCESSING THE LINUX COMMAND PROMPT

To begin working through this guide, you will need to establish a connection to a Linux server. Please refer to the guide: 'Connecting to the ISG Linux Terminal Server (Saturn)' guide as issued by the Information Security Group. Establish a connection to Saturn (saturn.isg.rhul.ac.uk) using PuTTY as detailed in the guide.

IMPORTANT: During password entry, you will not see any characters (e.g: '*') appear – this is normal behaviour for Linux. - Passwords are Case Sensitive!

INTRODUCTION TO THE COMMAND LINE INTERFACE

Once you have successfully logged in, you will be presented with the Command Line Interface, also known as the 'Command Prompt'.

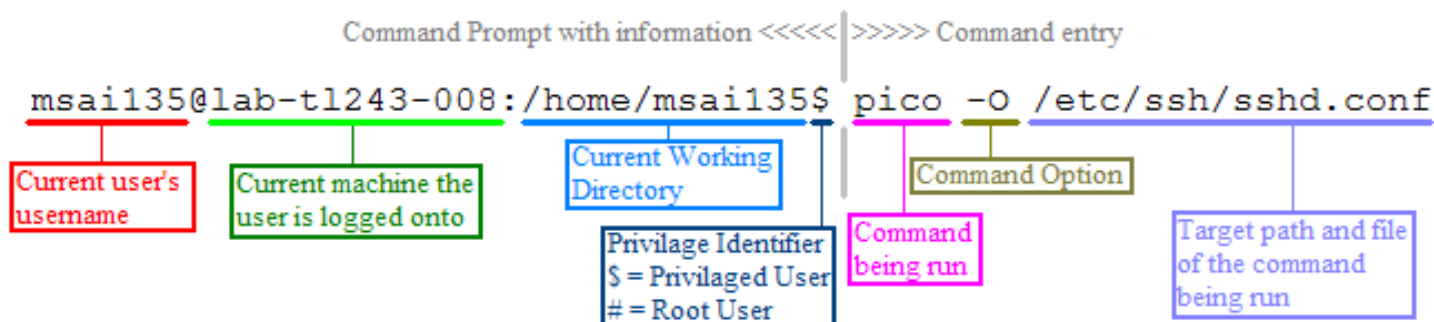
The prompt should read:

`<username>@<computer>:<path>$`

so for example;

`msai135@lab-tl243-008:/home/msai135$`

The anatomy of a command line interface is as follows:



i IF YOU GET LOST: The Tilde (~) icon is used to represent your home directory. If you ever need to get back home, you can type the following to return to your home directory

`cd ~`

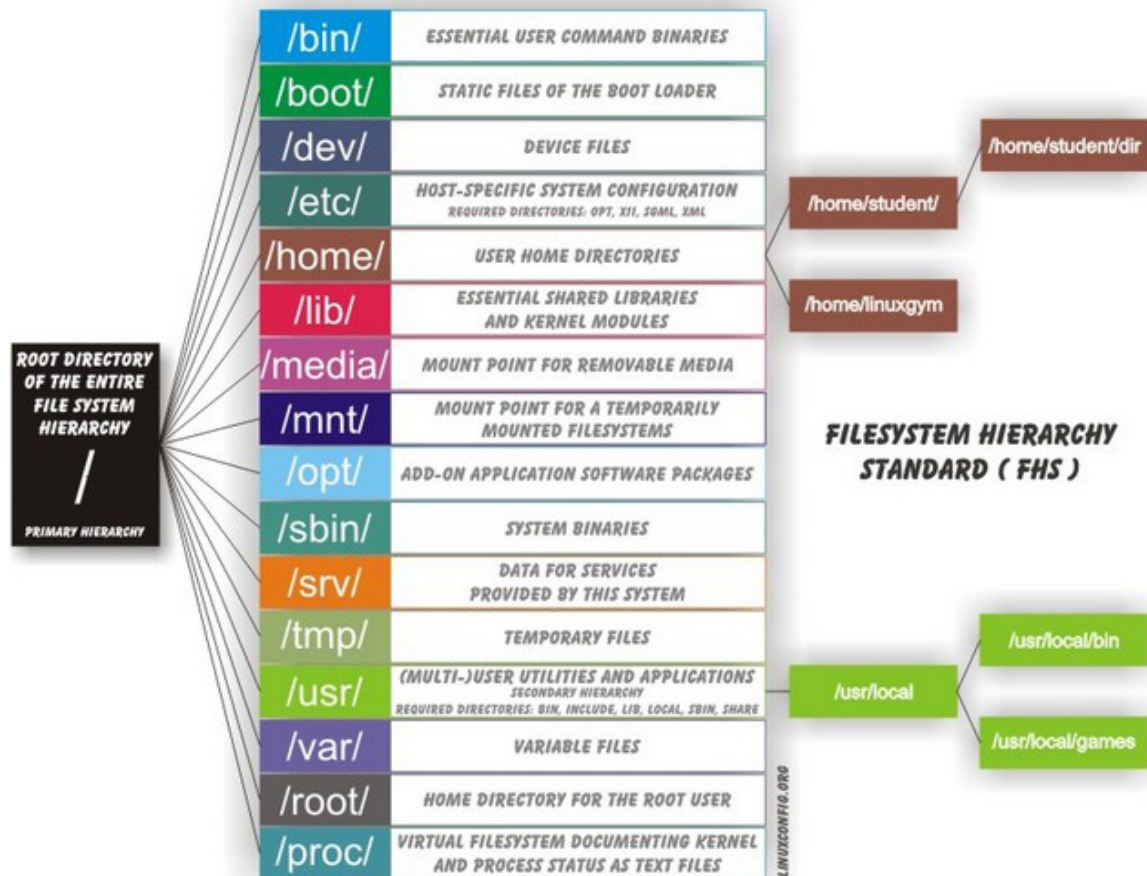
The ~ parameter can be passed in a string of commands, as you will see further on, to directly access the Home directory when you are in other parts of the system.

On most systems, your home directory should be `/home/<username>/`, however on some centrally managed or network systems, your home path could be different. Run `'cd ~'` to change directory to your home directory, then `'pwd'` to find the full path of your home directory.

THE LINUX FILESYSTEM

The linux File System is different to that of Windows, in that the File System is not represented by Hard Drives and CD Drives like c:\ & d:\ etc. Instead, the whole system is represented by the root directory, or '/'. Files, folders, and drives, all exist within this.

Within '/', exists a standard core directory structure:



The folder you operate in 95% of the time, is '~', which usually equates to '/home/<username>' (See previous page for notes on the location of your home directory and how to find it), e.g: '/home/msai135/'.

Even devices exist as files within a Unix system. They are located in '/dev/'. If you insert a CD, the drive will be mounted to '/media/cdrom'. Some systems do this automatically, however sometimes this needs to be done manually. An example command to run to do this would be: 'mount /dev/sdb1 /media/cdrom'. This would allow you to access the CD-ROM by browsing '/media/cdrom/'. Before ejecting the disk, you would exit from the mounted directory, then run 'umount /media/cdrom', and then eject the disk from the computer. Some systems will respond to the command 'eject' for CD-ROMs, automatically unmounting and ejecting the drive in one command.

USB Sticks, Memory Cards, and Hard Disks are all mounted in the same way, having a corresponding '/dev/<filename>' file, and a location to mount it to. This could be in '/home/<username>/Storage', or in '/mnt'. It makes no difference to Linux, making it a very flexible and scalable OS.

THE COMMAND LINE INTERFACE (CLI)

The Command Line Interface is the most important interface to learn for Linux. Linux users will often be asked to perform commands through the use of the CLI, and not through a GUI. As many of the ISG courses require the use of a CLI, it is important that you are comfortable with working with it. To this end, we will work through all of the following exercises using the CLI, and not the GUI. However, all of the following 'can' be accomplished through the GUI. Running the same commands on the CLI will give you a better understanding of how Linux works behind the scenes, and allow you to appreciate the complexities of the system.

IMPORTANT: The following practical exercises have been written with the user 'msai135' as an example. When attempting the following commands for yourself, please substitute 'msai135' for your own username which has been pre-issued to you by Royal Holloway University. This username should consist of four letters and three numbers.

NAVIGATING THE FILE SYSTEM

First we need to learn how to move around the Linux file system. At this point you should already have logged into the Linux Environment using PuTTY.

Once you have logged in, the directory you are currently in is your home directory. Each user is given their own local home directory which is independent from everyone else's. For example, if your username is 'msai135' then the path to your home directory will be /nas/ganymede/msc/home/msai135. You can confirm this location by typing the following command

`pwd`

'pwd' or 'print working directory' is a useful command to check the full path of where you are currently located within the Linux File System.

This can save you from getting lost, or as a confirmation that you are working in the correct directory.

This home directory cannot be accessed by others, and nothing that you do within this directory can have a system-wide effect.

IMPORTANT: Your Home Directory on Saturn is different to that on a Linux Machine you would setup / configure yourself. Your regular home path would be /home/<username>, however because the ISG use Network Storage, we map your network home path to /nas/ganymede/home/msc/<username>

Now we will move to the root directory / and then run a command to list all directories inside of it.

<code>cd ~</code>	Changes Directory to your home directory (denoted by ~)
<code>pwd</code>	Print the current working directory - You should be in /nas/ganymede/home/msc/msai135 (where msai135 is your own username)
<code>cd /</code>	The command 'cd' stands for 'change directory'. This is used to move to different directories, and can be used with absolute or relative paths. / tells the system to navigate to the root directory of the filing system, irrespective of your current working directory.
<code>pwd</code>	Print the current Working Directory

You can also move deeper into the file system using relative paths:

<code>cd ~</code>	First, return to your home directory
<code>pwd</code>	Print the current working directory to check out location.
<code>ls</code>	This will print (display on screen) a list of files and folders stored in the current working directory. In this instance, we're printing the contents of your Home Directory.

You will see a list of folders and files appear. This is the current contents of your home directory. We are going to move into the directory 'Desktop' using a relative path.

<code>cd Desktop</code>	This changes the current working directory to 'Desktop', which is located in your current working directory IMPORTANT: All Commands are Case Sensitive!
<code>pwd</code>	Print the current working directory to check out location.

Now we will return to your home directory and use commands to move around using relative and absolute paths.

<code>cd ~</code>	Changes Directory to your home directory (denoted by ~)
<code>pwd</code>	Print the current working directory - You should be in /home/msai135 (where msai135 is your own username)
<code>cd /nas/ganymede/home/msc</code>	Changes directory using an absolute path. the '/' denotes the root of the filing system.
<code>pwd</code>	Print the current Working Directory to confirm your current location
<code>cd ~</code>	Return to your home directory
<code>pwd</code>	Print the current Working Directory to confirm your current location
<code>cd ~/Desktop</code>	Change Directory to your Desktop folder, which is absolute to the root(/) of the system.
<code>pwd</code>	Print the current working directory to confirm your current location
<code>cd ../</code>	The ../ tells the system to navigate up exactly one level, relative to your current working directory.
<code>pwd</code>	Print the current working directory to confirm your current location

As you can see, you can chain different folders together to move between many levels in a single command.

The command you ran was 'cd ../' The '../' part of this is the path that you are moving to. This is what is known as a relative path, as you moved up one level (to /home) relative to your starting position (from /home/msai135).

WORKING WITH FILES

First, create a directory (i.e. folder) for today's session, move to it, and verify where you are:

<code>cd ~</code>	Change directory to your home directory
<code>mkdir unixintro</code>	Make directory 'unixintro'
<code>cd unixintro</code>	Change directory to 'unixintro'

Now copy some files to it and get a directory listing. Be careful with your typing, and don't ignore error messages!

<code>cp /usr/share/unixintro/* .</code>	Copy all the files in a directory to the current working directory. Asterisk (*) means 'all files'. Dot (.) means 'current working directory'. IMPORTANT: There is a space between the Asterisk (*) and the Dot(.)
<code>ls</code>	List all files in the current working directory

The command 'ls' simply lists the contents of the directory you are in.

Now to learn how to rename files and delete them.

<code>cp phonebook junk</code>	Copy file (or folder) phonebook to junk
<code>mv junk junk2</code>	Move a file (in this instance, we're moving the file 'junk' to 'junk2', effectively renaming it.
<code>ls</code>	List all files in the current working directory
<code>rm junk2</code>	Remove the file (or folder) junk2
<code>ls</code>	List all files in the current working directory

EXECUTING COMMANDS

For upcoming labs and courses, you will require many different commands. Probably the most basic of these is 'ping '. Try running the following command to ping the ISG-Student File Server (Mercury) located at 10.203.1.5

```
ping -c 5 -n 10.203.1.5
```

Ping the IP Address 10.203.1.5
for a count of 5 (-c 5), outputting
numerical values only (-n)

WHAT IS 'PING'?

The command you just ran, 'ping', is a command designed to test the connectivity between two networked computers. Simply put, the ping command sends ICMP packets from your computer to the target computer (in this case, 10.203.1.5), which then returns the packets to your computer. Your computer measures the journey time of each individual packet, deriving metrics from this, thus giving you useful information about the network connection and possibly the machine you're 'pinging'.

EXAMPLE

```
tundra:~ msai135$ ping -c 5 -n 10.203.1.5
PING 10.203.1.5 (10.203.1.5): 56 data bytes
64 bytes from 10.203.1.5: icmp_seq=0 ttl=63 time=0.536 ms
64 bytes from 10.203.1.5: icmp_seq=1 ttl=63 time=0.562 ms
64 bytes from 10.203.1.5: icmp_seq=2 ttl=63 time=0.645 ms
64 bytes from 10.203.1.5: icmp_seq=3 ttl=63 time=0.668 ms
64 bytes from 10.203.1.5: icmp_seq=4 ttl=63 time=0.640 ms

--- 10.203.1.5 ping statistics ---
5 packets transmitted, 5 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 0.536/0.610/0.668/0.052 ms
tundra:~ msai135$
```

IMPROVING YOUR PRODUCTIVITY IN THE CLI

Working within the confines of the Command Line Interface can sometimes be frustrating. The lack of a 'copy / paste' menu on the right click of the mouse can be a major headache when it comes to repeating commands

TAB-TO-COMPLETE

If you begin typing a command or path in the CLI, you can 'auto-complete' this by pressing the 'tab' key. For example, if you want to navigate to '/etc/samba/', you can just type '/et' and then hit tab, which will auto-complete it to '/etc/'. You can then append 'sam' and hit tab, and it will auto-complete to '/etc/samba/'. This is incredibly useful when accomplishing tasks quickly.

If the command does not complete after a single tab, press it again and the system will display a list of options that matches what you have entered so far.

EDITING A COMMAND

You can use the Left (back) and Right (forward) arrows on the keyboard to move backwards and forwards through a typed command. Very useful if you want to modify something right at the beginning of the long line you just typed.

HISTORY

At any point, you can recall previous commands that you typed by using the Up and Down arrows on the keyboard. Up goes back through the commands you've used, in reverse order going back into the past. Down brings you back to the present until you reach a blank line to input a new command.

Your history is stored in '~/.bash_history' .

You can view it by running the command `cat ~/.bash_history`

Your history does not store the output from the terminal, nor your interaction with any programs or applications that have been run - only the commands that you inputted straight into the command line are stored.

GETTING HELP AND SEARCHING

The behaviour of many commands can be modified by using 'switches' or 'arguments'. These are described in the online manuals (man-pages), which can be read using the 'man ' command. Information is also available about programming libraries and other operating system features.

To advance through the text, use the Page Up & Page Down keys. Type 'h' to discover more sophisticated commands, and type 'q' to quit the man page.

`ls -l`

Get a list of files and folders in long format - now you need to know how to interpret it...

`man ls`

Opens the man (User Manual) page for the 'ls' command. Read this to find out how to interpret the output.

If you're not sure what manual page you want to see, you can use the `-k` option:

`man -k <keyword>`

Replace <keyword> with your search term. Once you have found your desired man page you can go ahead and open it like before...

`man <result>`

Replace <result> with the desired result from your previous search. This will open the man page.

Sometimes `-k` will give you a surprisingly long list of results. So long that it will scroll off the screen. You can scroll back up the screen by using Shift + Page Up & Shift + Page Down. Another method of reading all the results is to pipe(`|`) the results into 'less'. Try the following commands:

`clear`

This will clear the visible terminal of all previous output. You can still return to the previous screen by using Shift + Page Up / Page Down to scroll back through the terminal.

`man -k directory`

This will search for a keyword that displays lots of results. By piping this output to another command, we can filter these results.

`man -k directory | less`

Use the `|` character to try piping the output into less - see what happens.

With the '`| less`' pipe invoked, the output from the '`man -k directory`' part of the command gets piped into less, which then displays it on the screen. You will notice that at the end of the list, there is a blank line with ':' displayed. You can now use the return or spacebar key to move down through the list. Type 'q' at any time to return to the command prompt.

Piping output from one command into another is a very useful way of working at the command prompt. It can allow you to output the results of a command into a file, or even allow you to search through the output for a specific string. Let's try looking for the same man pages again, but this time we will redirect the output to the Linux search system 'grep', and search for a specific line of text.

```
clear
```

Clear all previous output

```
man -k directory | grep ls
```

This pipes the output from the man-k command into grep. In this instance, we have told grep to search for the string 'ls'

NOTE: Pipe (|) is not a capital 'i'

As you can see, now only a few results are displayed. Only the results from 'man -k directory' containing that search string 'ls' are displayed, and the lines not meeting the search criteria are discarded.

Grep can be useful when searching through a long list of files/folders for one specific entry, or when working with any large amounts of data. In this case, we simply used it to filter search results. Using the command 'man -k directory | grep <keyword>', try searching for some other keywords, replacing <keyword> with the word of your choice. For example: run, NT, ACL, ln.

NEED MORE HELP?

If at any point you require more help than the 'man' pages can provide, there are a number of other resources. One of these resources is 'TLDP' (The Linux Documentation Project). Not only does this contain a copy of all the man pages, but there are Howto, guides, and FAQs on various Linux-related subjects. Take a look at <http://www.tldp.org> in your own time.

By far, the best source of information for Linux is 'Google'. If you are ever stuck, try Googling for the solution. You will always feel a greater sense of accomplishment if you solve a problem yourself. Never underestimate forums or newsgroups. While a solution may not immediately be apparent (especially from the first few posts), the users that have posted will normally work toward a solution, and the forum is a very good way of finding out what has worked and not worked previously.

When Googling, remember to put exactly what you're looking for. It is recommended that you put your linux distro into the search string, as some problems and solutions may be distro-specific. Another key word to use is 'howto'. If you are looking for a guide, this can provide the best results. Try it by Googling for; 'linux dhcp howto' in your free time, and take a look at the results. After (and only) after you have exhausted ALL other avenues for help, ask someone. People are more willing to help if you have tried to solve things yourself.

REMEMBER: Always try to help yourself first by researching the problem!

CREATING FILES

Please note: To complete this exercise, you must have completed the previous exercises, and have a directory called 'unixintro' in your home directory

<code>cd ~</code>	Changes Directory to your home directory (denoted by ~)
<code>pwd</code>	Print the current working directory - You should be in /home/msai135 (where msai135 is your own username)
<code>touch unixintro/sample.txt</code>	Create a Text file in the folder 'unixintro' called sample.txt
<code>cd unixintro</code>	Change your Working Directory to 'unixintro'
<code>ls -la</code>	List the contents of the working directory. What does '-la' do?
<code>echo "Hello World" > sample.txt</code>	Write the text "Hello World" to the file you created (sample.txt)
<code>cat sample.txt</code>	Concatenate (read) the file 'sample.txt'. 'cat' will print the contents.

In this exercise, we created a new file called 'sample.txt', and then wrote the text 'Hello World' to it. This was done using the command 'echo'. 'echo' will print whatever text you feed into it. Try it now on the command line by typing: 'echo "Hello everyone" '. This will print 'Hello everyone' on the command line. To write this text to a file, we redirected the output using the '>' option. This redirected the example text 'Hello World' into the file called 'sample.txt'. Once we did this, we then read the contents of the file by using the 'cat' command (short for concatenate).

Try running the command again, but this time replace 'Hello World' with some text of your own. Make sure to write to the file 'sample.txt'. Remember; if you use spaces in a command, you must encapsulate that section of the command in speech-marks (") (as per the example).

Now cat the file. What do you notice?

The words 'Hello World' have now vanished and been replaced with the text you inputted. This is not very useful if we want to 'append' (add) text to the file. This time, run the command again (with different text), but instead of a single '>' use two: '>>'. Now 'cat' the file again. This time you should see that the text was added to the bottom of the file.

Play around with the 'echo' command, and use the 'man' pages to find out more about it.

PERMISSIONS AND OWNERSHIP

WARNING: Please read through this entire section BEFORE attempting it. Altering the permissions of the contents of your home directory could remove access for yourself, meaning that a Systems Administrator has to come along and fix them.

Permissions in Microsoft Windows are a little easier to understand and configure than those in Linux. In Windows, you simply right click on a file or folder and specify the username and what permissions you would like for it. The bonus with this is that you can have as many different permissions for as many different groups or individual users that you want (this is achievable in Linux through the use of ACL's, although this is much more advanced)

In Linux, things are generally a little more restrictive. A file or folder only has three user categories: User, Group, Other. Each user category can only have three sorts of permission applied to it. Read, Write, Execute. You can see some existing permissions by running the following commands:

```
cd ~
```

Change your working directory to your home directory.

```
man -k directory
```

Print the current working directory - You should be in /home/msai135 (where msai135 is your own username)

```
ls -la
```

Runs the 'List directory contents' command with the arguments 'long list format' (l) and 'all' (a).

Once you run this command you should see something like the following:

```
msai135@saturn:~$ ls -la
total 36
drwx----- 6 msai135 Domain Users 4096 2011-09-08 16:29 .
drwxr-xr-x 4 root      root          0 2011-09-12 12:08 ..
-rw----- 1 msai135 Domain Users   27 2011-09-08 16:29 .bash_history
-rw-r--r-- 1 msai135 Domain Users  220 2006-07-05 17:39 .bash_logout
-rw-r--r-- 1 msai135 Domain Users  414 2006-07-05 17:39 .bash_profile
-rw-r--r-- 1 msai135 Domain Users 2227 2006-07-05 17:39 .bashrc
drwx----- 2 msai135 Domain Users 4096 2011-09-08 14:46 .cache
drwx----- 2 msai135 Domain Users 4096 2009-09-18 16:30 Desktop
drwxr-xr-x 3 msai135 Domain Users 4096 2007-01-03 19:14 .kde
drwxr-xr-x 3 msai135 Domain Users 4096 2009-09-18 16:51 .nautilus
msai135@saturn:~$
```

This might initially look confusing, so let's break this down...

Permissions

of
Links

Owner
(User)

Group

Size
(bytes)

Modification
date and time

Name

The command just run

msail35@saturn:~\$ ls -la

total 36

Output of the 'ls -la'
command.

```
drwx----- 6 msail35 Domain Users 4096 2011-09-08 16:29 .
drwxr-xr-x  4 root  0 2011-09-12 12:08 ..
-rw----- 1 msail35 Domain Users 27 2011-09-08 16:29 .bash_history
-rw-r--r-- 1 msail35 Domain Users 220 2006-07-05 17:39 .bash_logout
-rw-r--r-- 1 msail35 Domain Users 414 2006-07-05 17:39 .bash_profile
-rw-r--r-- 1 msail35 Domain Users 2227 2006-07-05 17:39 .bashrc
drwx----- 2 msail35 Domain Users 4096 2011-09-08 14:46 .cache
drwx----- 2 msail35 Domain Users 4096 2009-09-18 16:30 Desktop
drwxr-xr-x  3 msail35 Domain Users 4096 2007-01-03 19:14 .kde
drwxr-xr-x  3 msail35 Domain Users 4096 2009-09-18 16:51 .nautilus
msail35@saturn:~$
```

Command prompt

Type

User

Group

Permissions

Permissions

Permissions

User Permissions – The permissions that the specified user has for a particular file

Group Permissions – The permissions that a specified group has for a particular file

Other Permissions – Permissions that everyone else has for a particular file

Key

d = Directory

r = read

w = write

x = execute (run)

Type	User	Group	Other
d	rwX	---	---
d	rwX	r-X	r-X
-	rw-	---	---
-	rw-	r--	r--
-	rw-	r--	r--
-	rw-	r--	r--
d	rwX	---	---
d	rwX	r-X	r-X
d	rwX	r-X	r-X

SETTING PERMISSIONS

Permissions can be set on a file or folder using two simple methods. The two methods available are The Binary Method, and The Symbolic Method. Choose the one that is easiest for you.

USING THE BINARY METHOD

Through the binary method, each permission is assigned a binary value and added together to give a three digit number, one digit for each party (user, group, other). The end result will be something along the lines of 'chmod 755 test.sh', which assigns the permissions of User=Read, Write Execute; Group=Read, Execute; Other=Read, Execute. The binary values for each permission are Execute=1, Write=2, Read=4. If you wanted to assign a party read and write only permissions, then it would be a total of 6, while a party with permissions of read only would be 4. E.g:

To change a file called 'phonebook' (located in the same folder you are currently inside) to User=RWX, Group=RX, Other=R (as above), you would therefore run the command 'chmod 754 phonebook' . Lets try this now:

	<u>u</u>	<u>g</u>	<u>o</u>
	7	5	4
	/		\
<u>access</u>	<u>r</u> <u>w</u> <u>x</u>	<u>r</u> <u>w</u> <u>x</u>	<u>r</u> <u>w</u> <u>x</u>
<u>binary</u>	4 2 1	4 2 1	4 2 1
<u>enabled</u>	1 1 1	1 0 1	1 0 0
<u>result</u>	4 2 1	4 0 1	4 0 0
<u>total</u>	7	5	4

```
cd ~/unixintro
```

Changes Directory to 'unixintro', located inside your home directory

```
pwd
```

Print the current working directory and check it's correct.

```
ls -la
```

List the contents of the working directory
Make a note of the original permissions for 'phonebook' - you will need to restore them!

```
cat phonebook
```

Read the contents of the file 'phonebook'

```
chmod 044 phonebook
```

Change permissions of 'phonebook'

```
cat phonebook
```

Now try to read the file 'phonebook'. What happened?

Now restore the original permissions and try again

USING THE SYMBOLIC METHOD

Using the Symbolic Method, you can set permissions exactly like you do using the Binary method. The only difference is you use a verbose way of setting the permissions instead of a mathematical way. To do set the same permissions as in the Binary Method example, we would use the commands: 'chmod u=rwx,g=rx,o=r test.sh'. You can work out how to build the command up each time using a very simple table. Note that in the example above we have used commas (,) to separate each permissions for each party.

Which party?		What to do?		Which permissions?	
u	user	+	add this permission	r	read
g	group	-	remove this permission	w	write
o	other	=	set exactly this permission	x	execute
a	all				

Some other examples of chmod using the Symbolic method are as follows:

<code>-rw-r--r-- msai135 Domain Users</code>	<code>echo.java</code>
<code>-rw-r--r-- msai135 Domain Users</code>	<code>hello.c</code>
<code>-rw-r--r-- msai135 Domain Users</code>	<code>phonebook</code>

Before	<code>-rw-r--r-- echo.java</code>	<code>-rw-r--r-- searchfor.c</code>	<code>-rw-r--r-- phonebook</code>
Command	<code>chmod o=rw echo.java</code>	<code>chmod g= searchfor.c</code>	<code>chmod og=rwx phonebook</code>
After	<code>-rw-r--rw- echo.java</code>	<code>-rw----r-- searchfor.c</code>	<code>-rw-rwxrwx phonebook</code>

Lets try this using the same example as in the binary method.

<code>cd ~/unixintro</code>	Changes Directory to 'unixintro', located inside your home directory
<code>pwd</code>	Print the current working directory and check it's correct.
<code>ls -la</code>	List the contents of the working directory Make a note of the original permissions for 'phonebook' - you will need to restore them!
<code>cat phonebook</code>	Read the contents of the file 'phonebook'
<code>chmod u=,g=r,o=r phonebook</code>	Change permissions of 'phonebook'
<code>cat phonebook</code>	Now try to read the file 'phonebook'. What happened? Now restore the original permissions and try again

CHANGING OWNER AND GROUP

WARNING - DO NOT ATTEMPT THIS! – If you change the permissions of your own files you will not be able to recover them!

In order to change the owner and group of a file, the commands 'chown' and 'chgrp' are used. To change the owner and group simultaneously, one can simply issue the 'chown' command, specifying a group after the username separated by a colon (:) .

If we attempt to change the ownership of a file to something other than ourselves, then we could potentially lose the ability to manage it (delete, move, rename, etc).

<u>-rw-r--r--</u> msai135 Domain Users	echo.java
<u>-rw-r--r--</u> msai135 Domain Users	<u>hello.c</u>
<u>-rw-r--r--</u> msai135 Domain Users	phonebook

Command	<u>chown</u> root <u>hello.c</u>	<u>chgrp</u> "Domain Admins" echo.java	<u>chown</u> <u>www-data:www-data</u> phonebook
Effect	Change owner of file ' <u>hello.c</u> ' from 'msai135' to 'root'	Change group of file 'echo.java' from 'Domain Users' to 'Domain Admins'. Not the speech marks allowing you to use spaces in the group name	Change the owner and group of file 'phonebook' to be www-data. Note that this command has simultaneously changed the user and group

Changing permissions on files can be problematic if you do not have super-user (admin / root) access to the system you are working on, and will generally result in a rather annoyed Systems Administrator having to fix permissions on the changed files.

EDITING FILES

NANO (FORMERLY PICO)

'echo ' is a very useful command if we want to add text to a file, however it cannot be used to modify an existing file. For this, we have to use a text editor. The two standard text editors in Linux are 'vim' and 'pico ' (now known as 'nano'). 'vim ' (also known as 'vi' (vee-eye)) is a rather hardcore text editor, which is remarkably non-user-friendly. It is the preferred text editor by the highly experienced of console users; however it is very complicated to learn. Feel free to read up on 'vim' in your own time by looking at its 'man' page and looking online for help. For today, we will learn to use 'pico ' to modify the contents of a file.

Pico is very much like 'Notepad' but without a mouse. All commands are executed through the use of the keyboard, using the <CTRL> key modifier. It can be used to edit virtually any kind of text file from the command line, and is frequently used to configure services after they have been installed.



This is a standard (blank) Pico window, as you will see if you run the command 'pico ' from the command prompt. At the bottom of the screen, there are commands with a '^' symbol in front. These are the commands that can be used. The '^' shows that you need to hold down the Control (Ctrl) key, and then press the corresponding letter of the command you wish to use. For Example: Ctrl+X will exit Pico and return you to the Command Line.

NANO QUICK REFERENCE

USEFUL COMMANDS TO RESEARCH AND TRY

- ssh – Secure Shell – used to remote control a system via the command prompt
- scp – Secure Copy – used to transfer files between computers over SSH
- cat – Concatenate – used to print a view the contents of a file.
- chmod – Change file mode bits – used to change permissions of a file for user, group & other
- chown – Change Owner – used to change the user ownership of a file
- chgrp – Change Group – used to change the group ownership of a file
- gzip – Gunzip – file compression / decompression command for the .gz format
- tar – file compression / decompression command for the .tar format
- sudo – command to gain root access to a system (useful when combine with su. e.g: 'sudo su')
- lynx – console-based web-browser
- alpine / pine – an email client
- nano – text editor (See previous pages for a brief How-to)
- vim – advanced text editor – not for the faint hearted (try the command 'vimtutor')
- ping – Sends ICMP ECHO_REQUEST to network hosts to determine their connectivity status
- nc – netcat, used to listen / send TCP & UDP packets
- nmap – Network Mapper – Tool for network exploration & Security auditing – Very involved
- telnet – basic (unencrypted) method of controlling a system. Useful for interrogating ports

SOME SIMPLE PROJECTS TO ATTEMPT

- Bash Scripting
- Building a Fileserver using SMB (Samba) / CIFS
- Building a Router using IP-Tables (Tip: IP-Masquerade How-to)
- Building a Webserver using a LAMP platform (Linux / Apache / MySQL / PHP)

USEFUL LINKS

<http://tldp.org>

The Linux Documentation Project – Number one go-to place for How-to guides and FAQ's

<http://www.tuxfiles.org/linuxhelp/shell.html>

TuxFiles Linux Help – The Shell, Terminology

http://www.freesoftwaremagazine.com/articles/command_line_intro

Free Software Magazine – Beginners' Introduction to the GNU/Linux Command Line

<http://www.unixguide.net/linux/linuxshortcuts.shtml>

Linux Newbie Guide – Shortcuts & Commands

http://dsl.org/cookbook/cookbook_5.html

The Linux Cookbook – Chapter 5, The Shell

OTHER THINGS TO TRY

A great way of learning Linux is to install it onto one of your own computers. This could be a desktop or a laptop.

If you are unfamiliar with Linux, I would not recommend attempting this on your main computer, but on older equipment that you may own. If you make a mistake during the installation, you could erase your data and operating system from your computer – not something you want if you've only got one computer to use.

In the ISG / Maths Department, we recommend and support Ubuntu Linux. We use the 12.04 LTS (Long Term Support) Distribution; which has proven very stable and reliable for our requirements. This can be downloaded from www.ubuntu.com, burnt to a CD, then installed onto a computer. Of course, the ISG Linux Terminal Server will always be available. While you won't be able to install your own software, you are free to explore the system and try out commands. You will not be able to cause any damage to the system, so don't be afraid of breaking things. Just make sure you've backed up your own documents first, just in case...

Introduction to Linux

by Tristan Findley

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