<u>Presentation to U3A - Linux Introduction</u>

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<u>What is Linux?</u>   **<u>https://en.wikipedia.org/wiki/Linux</u>**
<u>https://www.iotforall.com/linux-operating-system-iot-devices/</u>

In simple terms, Linux is an operating system which was developed to be a home-built version of UNIX, one of the first operating systems which could be run on different brands of mainframe computers with quite different types of hardware.

Linux has developed to the extent that it is the leading operating system on servers and other big iron systems such as mainframe computers, and the only OS used on TOP500 supercomputers (since November 2017, having gradually eliminated all competitors). It is used by around 2.3 percent of desktop computers. The Chromebook, which runs the Linux kernel-based Chrome OS, dominates the US K–12 education market.

In the mid 2000's, Linux was quickly seen as a good building block for smartphones, as it provided an out-of-the-box modern, full-featured Operating System with very good device driver support, and that was considered both scalable for the new generation of devices and had the added benefit of being royalty free. It is now becoming very common in IoT devices, such as smart watches/refrigerators, home controllers, etc. etc.

BTW, Tux is a penguin character and the official brand character of the Linux kernel. Originally created as an entry to a Linux logo competition, Tux is the most commonly used icon for Linux, although different Linux distributions depict Tux in various styles. The character is used in many other Linux programs and as a general symbol of Linux.

Linus Torvalds, the creator of the Linux kernel, was said to have a fixation with penguins, following a bite from what he claimed was a "ferocious" fairy penguin while on a professional visit to Australia in 1993.

<u>History of Linux</u>

UNIX itself originated as a research project at AT&T Bell Labs in 1969 by Ken Thompson and Dennis Ritchie, and was also one of the first multiuser and multitasking Operating System in the world. It was originally developed in several different versions for various hardware platforms (Sun Sparc, Power PC, Motorola, HP RISC Processors).

The road to Linux arguably began in 1984, when Richard Stallman, a gifted student and brilliant programmer at MIT, organized the Free Software Foundation (FSF), which created free (that is, open-source) software - any funding received going to volunteers who wrote/led the development of the software whicgh was dictated by need/demand for UNIX modules, THE standard industry OS. Thus founding the GNU foundation, an acronym for "GNUs not UNIX."

In 1991, Linus Torvalds, a graduate at the University of Helsinki, unable to afford a Unix computer + software, created the beginnings of a UNIX-like system which was able to run on the increasingly more powerful Intel 386 processor used on home computers.

Writing an operating system is no small task. Even after six months of hard work, Torvalds had made very little progress toward the general utility of the system. He posted what he had to the Internet — and found that many people shared his interest and curiosity.

Before long, some of the brightest minds around the world were contributing to Linus's project by adding enhancements or fixing bugs (errors in the code). This was also an opportunity for the Stallman and the GNU foundation which was also seeking to develop its own UNIX-like OS. So began a long collaboration, which led to the establishment of Linux.

The basic structure of Linux OS consists of:
HARDWARE
  Kernel Software + Drivers
    Other software + Drivers
      Terminal or Graphical User Interface

The Linux kernel is different from that of OS X and Windows because it includes drivers **at the kernel level** which means that printers, video cards etc are supported "out of the box." This means that kernel development must be a continuous process as new hardware and software are developed by manufacturers. Additional driver modules can be saved in the appropriate folder and then added to the kernel as part of the boot process, something not possible with Unix.

 Linux is also a modular SYSTEM, meaning each level can be substituted for another, which is not possible **to the same extent** in Windows or Mac OS.
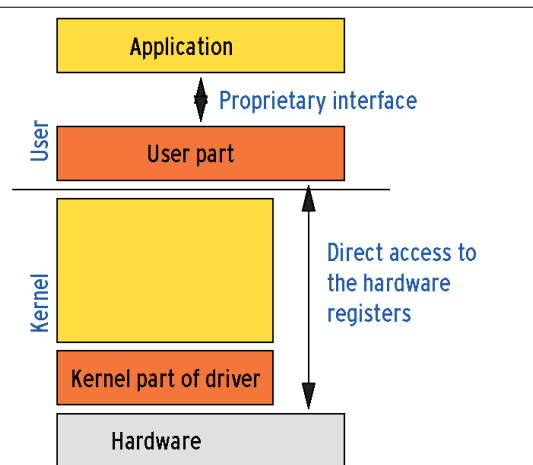
All Linux OS components consist of files. The kernel is contained in the vmlinuz file. Because of the modular nature you can potentially swap one kernel for another or customize your kernel by setting modules to load, or not load, during startup. This means that Linux can be setup to run a IOT refrigerator, mobile phone or even a supercomputer.

For end-users, there is a bewildering array of Linux distributions tailored for a variety of purposes and variations on a theme. These can be as seen on the Distrowatch website: https://distrowatch.com

Some original Core Linux Distributions are seen at right, from which most distributions are derived. Each tend to have have their own software repositories and mechanisms to download. Descriptions of the most popular distros can be found on the distrowatch site at: https://distrowatch.com/search.php?ostype=All&category=All&origin=All&basedon=All&notbasedon=None&desktop=All&architecture=All&package=All&rolling=All&isosize=All&netinstall=All&language=All&defaultinit=All&status=Active#simple

Table 1-1	Core Linux Distributions	
Distribution	**Where to Find It**	**Description**
Slackware	www.slackware.com	One of the original Linux distribution sets, popular with Linux geeks.
Red Hat	www.redhat.com	A commercial business distribution used mainly for Internet servers.
Fedora	www.fedoraproject.org	A spinoff from Red Hat, designed for home use.
Gentoo	www.gentoo.org	A distribution designed for advanced Linux users, containing only Linux source code.
Mandriva	www.mandriva.com	Designed mainly for home use (previously called Mandrake).
openSuSe	www.opensuse.org	Different distributions for business and home use (now owned by Novell).
Debian	www.debian.org	Popular with Linux experts and commercial Linux product developers.

Note: Debian has been utilised in the Raspberry Pi with great effect and popularity.

The original Linux interface was a CLI (terminal) process, which meant that a huge number of commands needed to be mastered in order to perform simple tasks.

In recent years, windows managers and GUIs of various flavors have been developed which appeal to everyday users, Windows refugees and specialist users such as network managers. Many use Live CD/DVDs (or Live USBs) for testing and evaluation – see (3) below.

Many of the earliest/most common Linux distributions enjoy huge support and have many users/contributors/followers, although the situation is continually changing.

Table 1-2	Linux LiveCD Distributions	
Distribution	**Where to Find It**	**Description**
Knoppix	www.knoppix.net	A German Linux distribution, the first Linux LiveCD developed.
SimplyMEPIS	www.mepis.org	Designed for beginning home Linux users.
PCLinuxOS	www.pclinuxos.com	Full-blown Linux desktop workstation on a single CD.
Ubuntu	www.ubuntu.com	A worldwide Linux project, designed for many languages.
Slax	www.slax.org	A live Linux CD based on a subset of the Slackware Linux distribution.
Puppy Linux	www.puppylinux.org	A full-featured Linux distribution designed for older computers.

Note:
SimplyMepis is now superceded by Antix (32 bit) or MxLinux (64 bit), the latter becoming most popular in recent times.

Many other distinctions separate Linux from other operating systems:

1)   Instead of using a license to restrict use of the software, Linux is licensed under the unique and ingenious GNU General Public License -that Linux uses ensures that the software will always be open to anyone. No company can ever own or dictate the way in which you use or modify Linux — although they can have their own individual copyrights and trademarks on their various brands of it, such as Red Hat and Novell.

2)   Linux is developed and maintained by a worldwide team of volunteer and paid programmers working together over the Internet. Kernel development is still under the control of Linus Torvalds, who has had questionable interpersonal skills. Graphical User Interfaces and applications are many and varied. This variation is both a strength and a weakness. While new ways to use Linux can be developed, apps for one OS may not work on another.

3)   Many Linux distros can be easily be run for testing/evaluation without changing the host operating system, including the boot sector. Nothing is installed on the computer, as the OS just uses RAM. However, this can be a slow process when files are read from a CD/DVD.

      Some options include:
a)   Live CD/DVD – runs the full OS without saving changes to the OS
It requires a disc image to be burnt to a CD/DVD which can be done in Windows.
Most CD/DVD burning tools have this facility.
This is the easiest option for beginners and usually works very well.

A Live USB can also be made but required more sophisticated software.
Windows versions of Lili, Etcher, Rufus or Unetbootin are required.
This is a somewhat harder option for beginners as results can vary.

b)   Installation of Linux on a virtual machine hosted by Windows or Linux
Requires a working installation of VirtualBox or similar
Results can vary, and the speed of the guest OS can be slower.

c)   FULL install on a USB which allows changes and portability
Programs such as Lili, Etcher, Rufus or UnetBootin are required.
The success of these installations on USB vary

d)   A FRUGAL install in some special cases
(A Frugal install does not use a whole partition, but utilises an expandable file system)
see   – http://fedoraproject.org/wiki/FedoraLiveCD
           – http://www.debian.org/CD/live/
            -- https://puppylinux.org/wikka/Frugal
           – https://mxlinux.org/wiki/system/frugal-installation/
Generally these are more specialized and can require modifications to the bootloader script.

e)   Direct loading of a disc image in ISO format
A **much more** specialized approach requiring modifications to the bootloader script.

4)   Linux distros have sprouted into the hundreds, each with its own developers and end-point users. This makes the selection of a suitable starting point difficult for the novice.

Distrowatch enables a beginner to see what is popular and one can easily navigate to the disc image download site. Most distros are now tending toward 64 bit only, but there are exceptions. See https://distrowatch.com

Note the most common distros include long-term varieties such as Manjaro, Mint, Ubunbtu, Debian, and Fedora. Most of these can be used as a Live DVD and when installed are intended to dual-booted with Windows. This process usually works flawlessly, but it is hard to reverse. Many distros have large numbers of supporters, but especially Ubuntu and some of its derivatives. Google your problem and you will find many others with answers.

MX_Linux is a newcomer which is derived from antiX. It is designed to be installed on a USB and has a high degree of portability. It is unique in many respects, and has an outstanding USB installer. While (probably) popular for these reasons, it is technically complex to use all of the purported features.

Manjaro and Mint are arguably the most user friendly distros which tend to be attractive to Windows refugees. PCLinuxOS is also an end-user distro, but apparently not as well developed.

Page Hit Ranking

Data span:
Last 6 months
Go

Rank	Distribution	HPD*
1	Manjaro	3629▾
2	MX Linux	3351▴
3	Mint	2175▾
4	elementary	1819▾
5	Ubuntu	1388▴
6	Debian	1224▴
7	Fedora	957–
8	Solus	915▴
9	openSUSE	813–
10	Zorin	704▴
11	ReactOS	651–
12	KDE neon	625–
13	CentOS	618–
14	deepin	610▴
15	antiX	581–
16	Arch	575▾
17	Antergos	520▴
18	Kali	500▾

5)   Linux runs on many platforms, including Intel, AMD, Apple, SUN, Xbox and so on.

6)   Many Linux distros are quite specialized, such as:

Ubuntu Studio	Audio/Graphics programs pre-loaded
ReactOS	Setup to run Windows programs (without WINE)
Scientific Linux	Setup by Fermi Labs for scientific calculations (support soon ending)
Red Flag Linux	Developed in China and optimized for the Chinese market.
Red Star Linux	Developed by the North Korean government
Raspberian	Developed for Raspberry Pi from Debian
Clonezilla	Disc cloning/repair software
Lakka	Retro gaming platform
antiX / MXLinux	Streamlined, but full featured Linux for USB flash drive installation

Many others can be found at https://en.wikipedia.org/wiki/List_of_Linux_distributions

Use of the Command Line

The earliest Linux distros used the command line almost exclusively, with a few GUI applications available. Much of what you can do on a Linux OS can be done through the command line if you know the syntax. Linux CLI commands are very similar to Windows as both OS are derived from UNIX. The command set varies according to the kernel, but the most common is BASH which is a shell language embedded in the kernel. It can be a very efficient way to achieve a result without using a GUI application, and can be very fast for repeated or batch processes.   But you need to remember the commands...

Some examples of BASH usage in the terminal include:

```
ls                    display a list of files in the current working directory
cd <directory>         change directories (location/folders)
fsck <partition>      checks a <partition>  eg sda2 for errors and corrects
cat <textfile>         prints content of <textfile> on the screen
pwd                   display present working directory
exit                   leave this terminal session
man <command>      read man pages for <command>
info <command>       read Info pages for <command>
ifconfig              show internet connection data
time  <command>     runs <command> and then shows the time taken to execute
```

Often there are options or "switches" following the command to modify results
```
        eg ping -c n < IP>      pings <IP address> n times
```

This line of code gets the Brisbane weather: curl wttr.in/Brisbane
Convert and re-scale a jpeg to png format   ffmpeg -i input.jpeg -qscale:v 2 output.png
This converts a .tiff file to text using OCR   tesseract file_in.tiff   file_out.txt

BASH can also be used for coding, eg to rotate by 90 degrees all .JPG photos in a directory and save into a rotated_photos folder (an application called ImageMagick must be installed for this work):

```
cd <file pathway into the required directory>
mkdir -p rotated_photos
        for f in *.JPG
        do
        convert -rotate 90 $f rotated_photos/$f
        done
```

The following script rips audio tracks from a CD and converts them to WAVE files, then compresses them to MP3 files at 160kbps using the LAME codec. It is very fast.

```
#!/bin/sh                # This denotes that the file contents are a shell script
cd /mnt/sdb1/CDRIP       #  Set Destination folder for ripped WAVE and MP3 files
cdparanoia -B            #  Rip all tracks from CD into separate .wav files

        for i in *.wav;        #  Batch Convert all Wave files to MP3s in same folder
        do
        avconv -i "$i" -codec:a libmp3lame -b:a 160k "${i%.*}.mp3"
        done
```

Usually, such a program is saved as a text file which can then be run or executed in a variety of ways.

More information about BASH can be found at:
 https://www.tldp.org/LDP/Bash-Beginners-Guide/Bash-Beginners-Guide.pdf

Features of Everyday Linux Distributions   eg Mint, Zorin, Manjaro, Ubuntu, OpenSuse

- Software is completely free – though you can choose to make a donation
- The installation / dual-boot software usually runs flawlessly
- Customization of appearance and operation is extensive
- Main main distros are fully developed and run smoothly
- Extensive software already installed, including office, browsers, media players
- Software is downloaded from a small number of trusted repositories
- Runs OOTB for Internet, Printers, WiFi and net file transfer
- Online help forums and newsletters
- Popular Windows apps often have linux equivalents or replacements

  eg Digikam, Krita, FotoXX, VLC, LibreOffice, Chrome,
- Increasing use of portable apps / appimages (64bit) / containers
- Many Windows programs can run under WINE (Windows emulator) see https://appdb.winehq.org/
- VirtualBox runs well in Linux and is easily set up
- Linux is arguably less likely to be infected by malware – many users do not use antivirus software
- Updating is a short process under the control of the user

Some Downsides of Using Linux

- Each major distro has its own learning curve and processes
- The kernels are continually being developed, so a user should use up-to-date distros
- Most applications run well, but are not always pretty
- Some CLI usage is almost inevitable in everyday usage, eg loading new programs

  eg sudo apt-get install tesserat-ocr
- Linux GUIs are arguably not as sophisticated as Windows 10
- It is a steep learning curve to adjust from Windows to any version of Linux
- The file structure in Linux is different from, and more complex than, Windows
- Package managers can be slow to update and run
- Some troubleshooting is inevitable the longer a distro is run

- If a distro is "broken" it is may be difficult to fix

  (although newer Ubuntu variants have a fold-back / restore point feature)

- Like Windows, a Linux system can become cluttered and slower over time

- Dual booting Windows/Linux changes the boot system (effectively) permanently

- A lack of dependencies in some distros can cause applications to fail at run-time

- Getting sound to work in Linux can be more complex than with Windows

Use of Puppy Linux as an Alternate Way to Run Linux

Some of the disadvantages listed above can be overcome with a special distro developed by Barry Kauler, a now retired Electronic Engineering Lecturer – see http://bkhome.org.

The Puppy Linux OS consists of a **LAYERED** file structure, which adds to the already layered structure if the Linux OS. This allows a substantial level of flexibility in operation and modes of installation. Arguably, there is no other distro quite like it. The distribution is based on a very cut-down version of Ubuntu, recent editions boasting up-to-date kernels.

While Puppy Linux can run most applications written for Ubuntu and can be used for almost all everyday tasks, there are often times where special tweaks are required to make applications work. This makes the distro more suited for those prepared to experiment and explore challenges. Perhaps nerds, geeks, Linux aficionados and persons wanting something different are the target audience.

Having said that, the OS runs blisteringly fast on even older computers, and can be run from a USB flash drive, as the OS (typically 300-500Mb) runs in RAM. It can run with as little as 500Mb of RAM, but 2Gb of RAM is recommended if a modern browser is being used. It is a fully portable distro if setup for that purpose on a USB.

Some quotes about PL include:

The tahr 6.0 stuff, as I've said on here before, is still the battleship of the entire Puppy Army (in my opinion). it is rock-solid, not one problem ever appears (on any of my machines, for that matter) & just runs like crazy despite what I throw at it and/or do to it. http://www.murga-linux.com/puppy/viewtopic.php?t=112725

I've been using Puppy for several years, and it just gets better! The latest version is no exception (Puppy Linux BionicPup 8.0 64bit). It's the easiest thing in the world to upgrade, and I can quickly & easily back up all my documents, settings and downloads in a couple of clicks. The default installation includes a wealth of software, and a handy "Quick Pet" panel to download other popular applications. Plus, it's Ubuntu-compatible - and as Puppy is so compact and runs in RAM, you can get everything you want without the bloat of a full-fat distro. I try other distros from time to time, but keep coming home to Puppy as I've found it fast and reliable. The forum is full of knowledgeable and helpful folk, if you get stuck or need advice, but for everyday purposes, Puppy just boots and lets you get on with what you want to do.
https://www.distrowatch.com/dwres.php?resource=ratings&distro=puppy

Puppy Linux is the fastest and best OS in the world and my primary OS. It beats Windows, 7 and 10, by a mile, not to mentioned Macintosh OSX. This is a bold statement but I have a top of the line Mac and it is true. It also works great with netbooks and old computers as the requirements are small. I have not had

Windows installed on any of my computers for years. My whole family uses Linux and my artistic wife remarks, why would anyone not use Linux, it is stable and easy. http://learnfast.biz/puppy-linux-best-operating-system/

State	Folder/file	Puppy Linux LAYERS
		Notes
FIXED	vmlinuz	(Virtual Machine) Linux kernel
	initrd.gz	Initial RAM disc in gunzip compressed format loaded at boot
	puppy_15.12.sfs zdrv_15.12.sfs	Usually two or more squash files containing system folders, standard applications and user files
UPDATE/ SAVE	Puppysave Puppy.sfs	A save folder / directory storing any changes (ext/2/3/4) A savefile in .sfs format (FAT32)
APPLICATIONS	PeasyScale	JPEG resizer – One of many applications built in to the OS.
User-Installed – Linux OS app files	vlc.pet	.pet files obtained from the Puppy Package Manager which contain application software + dependencies. Once installed and saved they are a permanent feature of the OS, but can be removed. Can only be run on Puppy OS
	speedtest-cli.deb	.deb files are similar to .pet files but can be run on any Debian based Linux
User-Installed – Windows OS	Office_2012.exe Irfan.exe	Windows applications which can be installed under WINE or run directly from the excutable Windows file. Easily installed, run and removed once WINE is running.
User-run – Executable Scripts		Text files containing scripts written in BASH which can be run from the terminal.
MODULAR APPLICATIONS		
SFS	Libre-office.sfs Digikam.sfs Google-Chrome.sfs	Application packages in a (compressed) squash file system format. They can be loaded at boot, when the OS is running. Either way they are (usually) fully integrated into the menu system. Use of these packages keeps the savefile small and hence keeps save-file time to a minimum.
PORTABLE	Palemoon browser Portable Wine	Portable applications run from a folder which can be integrated into the menu system. See http://sourceforge.net/projects/portable/files/

APPIMAGES	Openshot Video	Appimages run as an executable file containing all required dependencies. They are designed to run on most Linux OS, and are effectively stand-alone executable files. Most are written for 64 bit OS, however. See https://appimage.github.io/apps/ and https://www.appimagehub.com/ and https://github.com/AppImage/AppImageKit/wiki/AppImages
User-run – **Executable Scripts**		Text files containing scripts written in BASH which can be run from the terminal.
VIRTUAL **MEMORY**	Pup.swp	Swap-file (folder) used when < 2G RAM is available

See   http://puppylinux.com/
          http://puppylinux.com/history.html
          http://bkhome.org/news/
          http://puppylinux.com/family-tree.html

Other Features of Puppy Linux

Easy to run from a Live-CD
Efficient, fast, package manager
Numerous lightweight software applications come with base installations
Runs OS VirtualBox very fast
Windows applications under WINE usually run much faster than under Windows on the same computer
Optional Save: Automatic frequent saves / Save changes at shutdown only / Save changes on demand
Backup of savefolder is a matter of copy and paste
Can utilize differing partition formats – FAT32, EXT2, 3 and 4 for security
32 and 64 bit variants are available- see http://puppylinux.com/
(32 bit OS can be run on 64 bit machines)
32 bit applications can usually be run in 64 bit OS with an additional 32 bit compatibility module
Kernels can be updated/changed
Enthusiastic knowledgeable forum contributors   (http://murga-linux.com/puppy/)
Easy to multi-boot many OS on one USB flash drive
Many instances of a distro can be run using separate savefolders,
          eg for testing or using specialized applications which are large in size (~200+Mb+):
          eg: KODI, KRITA, VBOX, KICAD, GIMP, DIGIKAM
Remastering is relatively straightforward, so you can DIY Puppy-Linux distro
Hence there are hundreds of Puppy Linux variants – see https://archive.org/details/puppylinux
Official distros usually work without major issues – see http://puppylinux.com (and below)
Bootloaders cope very well with Legacy (pre-UEFI) and most UEFI firmware
Puppy Linux can be installed alongside of an existing OS, either as Frugal (Folder) or Full (partition)
Dual boot Installation software is effective and safe, but may not be easily reversed
USB installation (frugal and full) is easy and safe if you have the basic knowledge and the right software

Downsides of Using Puppy Linux

Requires knowledge of GRUG2 scripts for some installation modes
Other than official distros can fail or lack dependencies
Users need to be hands on when things don't work
As a cut down version of a major distro (400Mb cf 2.5Gb), not all features are present
Some additional features require specialized information, eg sound utilization
Sound may not work at all in some applications requiring it
Fewer Linux applications work OOTB compared with the full distros such as Ubuntu.
The GUI is less sophisticated compared with the big distros such as Linux Mint.
Applications meant for one PL variation may not work on another due to differing dependencies
Each major version has its own repositories and ways of doing things

Official Packages – Puppy Linux – see http://puppylinux.com

Official Release	Bits	Latest Version	Download link
Ubuntu Bionic	32-bit	BionicPup32 8.0	Main - Mirror - Checksum
Ubuntu Bionic 64	64-bit	BionicPup64 8.0	Main - Mirror - Checksum
Ubuntu Xenial	32-bit	XenialPup 7.5	Main - Mirror - Checksum
Ubuntu Xenial 64	64-bit	XenialPup64 7.5	Main - Mirror - Checksum
Slackware 14.1	32-bit	Slacko Puppy 6.3.2	Main - Mirror - Checksum
Slackware64 14.1	64-bit	Slacko64 Puppy 6.3.2	Main - Mirror - Checksum
Ubuntu Tahr	32-bit	Tahrpup 6.0.5	Main - Mirror - Checksum
Ubuntu Tahr 64	64-bit	Tahrpup64 6.0.5	Main - Mirror - Checksum
FatDog64	64-bit	FatDog64_800	(Unofficial, but significant)
Quirky Puppy	64-bit	Quirky Xerus 8.1.2	(Unofficial, but significant - runs on Raspberry Pi)

Raspberry Pi

See https://www.raspberrypi.org/help/what-%20is-a-raspberry-pi/

A well known end-user application for Linux is the Raspberry Pi - a low cost, credit-card sized computer utilizing the AMD64 processor which is optimized for mobile devices.
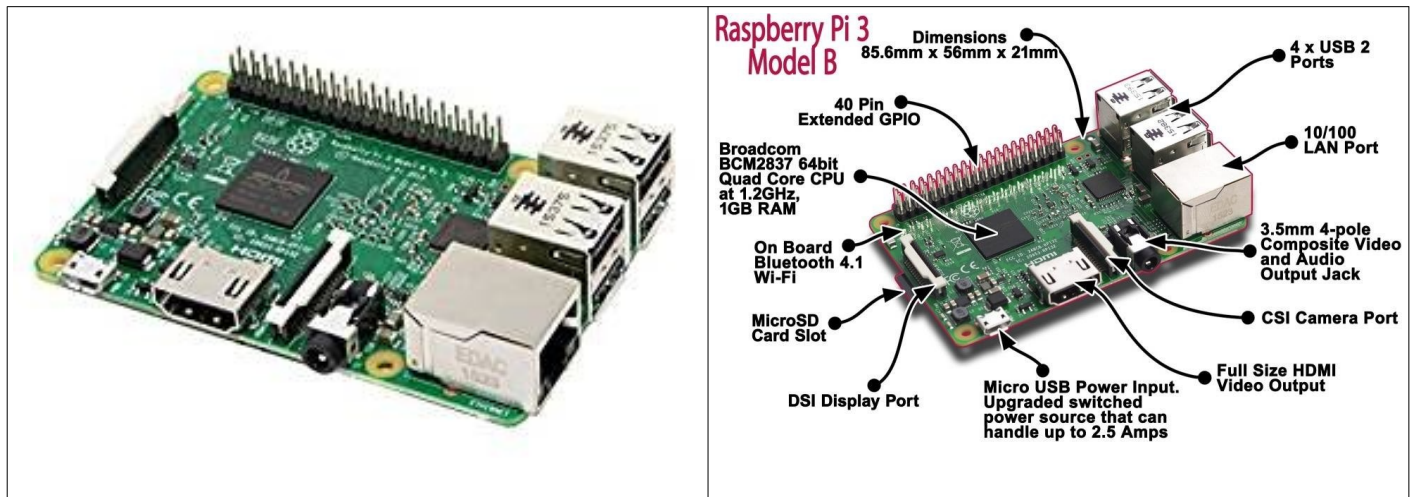
The Raspberry Pi project was designed to encourage British schoolchildren to re-engage with computers and coding, a facility lost when hobby computers such as the Sinclair disappeared from the market. Running a special version of Linux (Rasberian) it can run most Linux software, although speed, memory constraints and cheap hardware limit its function. A variety of models have now been introduced including some able to run Windows 10. Models from as low as $25 are available from Australian suppliers.

According to the promoters, Raspberry Pi "has the ability to interact with the outside world, and has been used in a wide array of digital maker projects, from music machines and parent detectors to weather stations and tweeting birdhouses with infra-red cameras. We want to see the Raspberry Pi being used by kids all over the world to learn to program and understand how computers work."   Numerous add-ons have been marketed for a variety of purposes which facilitate real-world inter-connectivity, such as cameras, sensors, controller boards and LCD displays. See Jaycar or Altronics.

While the GUI and hardware are easy to set up and use, some (significant?) knowledge of Linux is required to really use this device to its full potential, and may not necessarily the best platform to begin learning Linux.

Other References

History of Raspberry Pi

https://subscription.packtpub.com/book/hardware_and_creative/9781784397975/1/ch01lvl1sec08/history-and-background-of-the-raspberry-pi

A Simple End-user Introduction to Puppy Linux:

https://www.how2shout.com/tools/puppy-linux-tahr-6-0-5-review.html