Unit 2, Assignment 1

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T1, P1 - Components

Motherboard

The motherboard (alternatively, 'mainboard') is the large circuit board that most everything interfaces with. It contains the socket for the CPU and varying slots and connections for other components.
Motherboards come in varying sizes ('form factors') and have varying capabilities. The most important consideration is which CPUs are supported. Motherboards are available from brands such as ASUS, Gigabyte, ASRock and MSI.

CPU

The central processing unit (CPU, or 'processor') is essentially the brain of a computer. It carries out simple instructions very quickly. Contains small amount of cache, described below.
In a consumer system, the two most popular CPU brands are Intel and AMD. Each use different sockets.

Power Supply (PSU)

The power supply converts mains voltage from the wall (AC) to several channels of power for each component (DC).
The amount of power a PSU can supply is dictated by the wattage. An office PC may only need a 200W unit, whereas a high-end gaming computer may need in excess of 1000W to power every component.
Reputable power supply brands include Seasonic, Corsair and EVGA.

Cooling Methods

Many components – particularly the CPU and GPU – produce a large amount of heat when under load. All cooling solutions place a metal heatsink on top of the chip, with a layer of thermal paste to aid heat transfer. Air cooling makes use of a fan directly on the heatsink to dissipate heat. Water-cooling employs a radiator that works in a similar way to that of a car, with a pump moving water around. Cooing systems are available from companies such as Noctua, EVGA and Corsair.

Storage

- **Hard Disk Drives** (HDDs) are mechanical devices that have many metal platters inside. These platters are coated with magnetic material which is magnetised or demagnetised by heads while they are spinning at high speed. While slower than newer SSDs, they come in larger capacities and often cost significantly less. Hard Disk

Storage brands include Western Digital, Seagate, Toshiba and HGST.
- **Solid State Storage** (SSDs) devices store data without any moving parts, making them more resilient than HDDs. They are also faster and have lower access times (latency), however larger capacity drives are very expensive when compared with HDDs. SSD brands include Western Digital, Samsung and Micron.
- **Magnetic** storage stores data using magnetic charges. Aside from hard drives, other examples would be tape (such as LTO or audio cassette) and floppy disks.
- **Optical** storage is read with a laser, with data stored physically as differences in colour or texture. CDs, DVDs and Blu-Rays are all examples of optical media.

Ports

Externally, most ports are found on the back of the motherboard (in the case of a desktop):

- **USB**—Universal Serial Bus for connecting external devices. Varying connector types – A/B/C. Differing versions – USB 2 at 480Mbps maximum, USB 3.2 at 20Gbps maximum, USB 4 at 40Gbps maximum.
- **HDMI/Display Port/DVI**—For connecting higher resolutions displays digitally. HDMI can additionally supply audio and ethernet along the same cable.
- **VGA**—For connecting lower resolution displays with an analogue connection
- **2.5/3.5mm**—Audio jacks for input/output of sound.
- **Kensington Lock**—For securing a device to a desk
- **Serial/Parallel Ports**—Legacy connectors for expansion. Serial is still sometimes used as a terminal interface.
- **eSATA**—External SATA is used for connecting storage devices externally.
- **Ethernet**—For wired networking. Connected to a NIC (built-in or on an expansion card). 100MbE, 1GbE, 2.5GbE, 10GbE

On a motherboard, there are many other ports and connections too:

- **24-pin Mobo/Aux Power**—Provides 12V power to the motherboard and some components connected to it
- **8/4-pin CPU**—Provides power for the CPU
- **SATA Power**—Provides power to SATA storage drives as well as some accessories
- **Molex**—Provides power for older storage drives as well as legacy accessories

- **PWM Power**—Controllable, variable volage connector used for fans
- **PCI Power**—Used for powering more powerful expansion cards, such as gaming GPUs
- **M.2**—Connection for 'gum stick' sized expansion devices (mainly storage); uses varying protocols (PCIe, NVMe or SATA)
- **SATA**—Serial ATA is for storage devices. Version 1 (150) supports speeds of up to 1.5GB/s, Version 2 (300) supports speeds of up to 3Gb/s and Version 3 (600) supports speeds of up to 6Gb/s.
- **IDE/PATA**—Parallel ATA is used for legacy storage devices. Maximum speeds are around 133MB/s which is significantly slower than SATA.
- **Expansion Slots**—PCI, PCIe, AGP (Legacy)

ROM

Read-only-Memory is data storage that cannot be randomly written to. An example of ROM being used is the computer's firmware and BIOS, though this can be updated to solve bugs and issues by re-flashing the entire chip.

RAM

Random Access Memory is where a computer stores data that is currently processing or is likely to need soon. RAM is volatile, which means when power is lost its contents do not remain.
Contains DRAM chips (dynamic RAM) which have a higher latency than SRAM chips found in CPUs, though they are significantly less expensive since they require continual refreshing. Sizes per stick (module) is between 2 and 512GB. DRAM chip brands include Micron and Samsung.

Cache

Cache is even faster than RAM and stores the information that the CPU is currently dealing with. All modern CPUs will have cache built in.
Contains SRAM (static RAM) chips, which are more expensive than DRAM since they do not require continual refreshing.

Specialist Expansion Cards

Used to add or improve functionality of the computer.

- **GPUs**
  The graphics processing unit (GPU) creates and outputs a video signal. Commonly, one is built into the CPU; this is called 'integrated' graphics. For more graphical horsepower—for running games or 3D modelling, for example—a 'dedicated' separate GPU

may be desired. GPUs may have their own dedicated bank of memory.
- **NIC**
  Network Interface Cards add or improve the networking capabilities of a computer.
- **Sound Cards**
  Sound Cards add or improve the sound output capabilities of a computer. Not so common nowadays, since most motherboards have audio output built in.

T2 – Operating Systems

P2 - What is an Operating System?

An operating system provides the base upon which applications and programs run.
For the user, it provides an interface – a textual CLI (command line interface) or a GUI (graphical user interface).
For developers, it provides APIs (programming interfaces) for common tasks shared amongst many programs, such as writing files and displaying graphics.

A computer is essentially inoperable without an operating system installed.

M1 - Operating System Comparison

Peripheral Management & Drivers

- **Windows:** Windows 10 comes bundled with a large selection of device drivers, allowing many devices and peripherals to be 'plug-and-play' (work without any configuration). Devices requiring additional drivers often provide an easy-to-use installer program. Third-party drivers may, however, be out-of-date and cause system instability or expose security problems.
- **Ubuntu Linux:** Like Windows, Linux Distributions support a large variety of hardware out-of-the-box. However, support for many devices is lacking since companies do not deem support for Linux OSes a priority. This has led to the creation of unofficial open-source drivers for many pieces of hardware, such as Nvidia GPUs.

Security & Protection

- **Windows** comes with a built-in antivirus solution – Windows Security. It also has a built-in firewall solution. Both of these programs have a graphical interface that is easy-to-use. Windows Security checks all downloaded files and provides real-time scanning. Through a OneDrive cloud subscription, it also

provides robust ransomware protection through file versioning in the cloud.

- **Ubuntu** relies on the built-in firewall in the Linux Kernel. By default, it has no GUI configuration utility, and all changes must be made in the terminal. Most GUI utilities created to interface with it are far from user-friendly.
  Ubuntu does not come with a dedicated antivirus program – instead, programs installed from its software store are sandboxed and only allowed access to certain parts of the system that the user grants them access to.

File Management

- **Windows:** Primarily, Windows 10 makes use of the NTFS file system. Introduced in 1993 with Windows NT 3.1, it has been updated to support volumes and file-sizes of up to 8PB in size. It has support for individual file/folder permissions and access control. Additionally, the file system can be encrypted using BitLocker. Graphical file management is done using Windows Explorer.
- **Ubuntu** uses the ext4 file system by default. This is much newer and more efficient than NTFS, introduced in 2008. It can support volume sizes of up to 1EiB and individual files of up to 16TiB. Optionally, Ubuntu can use newer filesystems such as btrfs, among others.
  Volumes can also be encrypted and support applying permissions based on user/group.

Customisation

- **Windows** allows fairly limited customisability by default. Beyond changing the accent colour and the layout of items in the taskbar, there are not many settings to be changed. However, due to Windows' ubiquity, there are thousands of third-party programs available that modify system files to tweak everything from the font to the style of window borders.
- **Ubuntu** uses the Gnome 'desktop environment' by default, which – similar to Windows – does not afford many visual customisation options. Users have the option of installing 'tweaks' which modify the desktop in varying ways, or they can optionally choose an entire new graphical user environment which may offer more theming options.

Portable Media Support

- **Windows** provides support for reading and writing NTFS, FAT, FAT-32 and exFAT formatted external drives. Additional programs are required to interface with other filesystems.

- **Ubuntu** can read/write many 'Linux-native' filesystems by default – ext4, btrfs. Additionally, it can read and write to FAT/FAT-32 formatted drives.
  Write support for NTFS and exFAT require the installation of additional tools, since they are both proprietary filesystems.

Stability & Reliability

- **Windows** is famed for its poor update management – often restarting itself to apply updates at inconvenient times without asking. While this has improved in later versions, the legacy still remains. Overall, Windows is a stable system, however most users will install many third-party applications and drivers that often hamper performance and stability of the system.
- **Ubuntu:** Linux distributions are known for being very stable, which is why they are used so commonly on critical server machines. Despite this, however, poorly written drivers can still cause problems. Unlike Windows, updates to most every piece of software can be done in-place (without restarting the system).

Enterprise Management

- **Windows** is able to join a Microsoft Active Directory Domain for federated users and management. Group policy can be applied to change system settings and apply restrictions to every pre-installed program as well as third-party ones.
- **Ubuntu** touts itself as an Enterprise-friendly distribution as well. Through an open-source reimplementation, it can also join AD Domains, however group policy and file-sharing will not work seamlessly. Ubuntu can additionally be an LDAP client, meaning one does not have to use a Microsoft domain server. Ubuntu offers a cloud portal for remotely updating and managing an organisation's computers and servers.

Program Compatibility & Installation

- **Windows 10** can support nearly every program made for Windows since Windows XP, released in 2001. This is because it includes a lot of legacy APIs and tools that older programs rely on. Being the desktop operating system with the most market share, most companies will develop a Windows version of their programs and games.
- **Ubuntu** has a large repository of software, and many popular programs are available. However, due to its limited market share, there is little incentive for large companies to develop their applications for the operating system. Programs such as the Adobe professional media suite are unavailable. Compatibility layers such

as WINE aim to allow Windows programs to run by emulating Windows APIs they rely on, however this is not a perfect solution.

Cost & Support

- **Windows** is paid software, though its cost is often bundled in with the price of new computers where it is pre-installed. There are several home editions (starting at £140), with slightly different feature sets and an Enterprise version for education and business use, as well as a server version. Microsoft offers limited technical support to end-users, however to businesses they have both subscription plans and pay-per-incident plans.
- **Ubuntu**'s parent company, Canonical, offers enterprise support through their Ubuntu Advantage program. They offer support for the operating system as well as many popular enterprise programs. For non-enterprise customers, support is found via community forums ran by volunteers. This means support is often very knowledgeable, but difficult to follow and slow to respond.
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T3 (P3) – Software Utilities

Virus Protection

Anti-virus utilities are software tools used to scan for and remove viruses. Often, they will scan downloaded files and run periodic scheduled scans. Examples of antivirus utilities include Avast, Norton, Malwarebytes and the built-in Windows Security program.

Firewalls

Firewalls are used to filter the network traffic in and out of a computer. They often inspect data packets and block them based on protocol, port, source/destination and application. As an example, the built-in Windows Firewall blocks inter-PC traffic on WiFi networks marked as 'public:' those in a coffee shop or at a railway station.

Clean-up Tools

Clean-up utilities aim to remove any temporary, unneeded files left behind by programs during normal use, such as web-browser caches. Their main purpose is to free up storage space if a user is running out of space on a drive.
Other clean-up tools are designed for protecting user data. These will do things such as clearing web-browser history and cookies, as well as any debug logs and etc.

Examples of this type of software include CCleaner and BleachBit. Windows also has a tool built in, called Disk Clean-up.

Defragmentation

Defragmentation tools aim to optimise the location of data on a hard disk drive. Over the course of normal use, the filesystem may not be able to all the data for a file or a group of files continuously. This results in the drive needing to dart back and forth across its platters to retrieve all the data for a single file. Defragmentation tools such as the built-in Windows utility and Defraggler are available.
Newer solid-state flash-based storage mediums do not require defragmenting, since all data across the drive can be accessed in the same amount of time; there is no seeking to find it.

Drive Formatting

Formatting a drive means to recreate or remove the partition(s) on a storage device. This means that an operating system will not be able to understand how to write data to it. Formatting often does not remove any data; it simply renders it inaccessible. To completely remove data, it is necessary to use a tool such as DBAN. Windows includes a drive partitioning tool and there are third-party utilities available such as GParted, Paragon and MiniTool.

T4 (D1) – Improving System Performance

There are many utilities available that one can install that help improve system performance.

Overclocking Utilities

One way of improving system performance, is utilities that overclock system components such as the CPU, RAM and GPU. This means to run them faster than they were originally intended. This may cause instability and damage to components but has a performance benefit since more instructions can be carried out more often.

An example of such utilities is MSI Afterburner. Using this tool, you can overclock your GPU and its memory to give a performance boost for gaming.

Process Priorities

Another method of increasing performance, specifically in games, is using a process management tool.

Windows includes a utility called the Xbox Game Bar. This increases game performance by reducing the priority of other programs and tasks running in the background, dedicating more computer resources to the game.

This can also be performed from the Task Manager in Windows in the details tab.

Clean-Up Tools

Another way of improving system performance is by using a clean-up tool. Temporary files are unlikely to slow down your computer, however unnecessary software running in the background from start-up can often reduce performance.

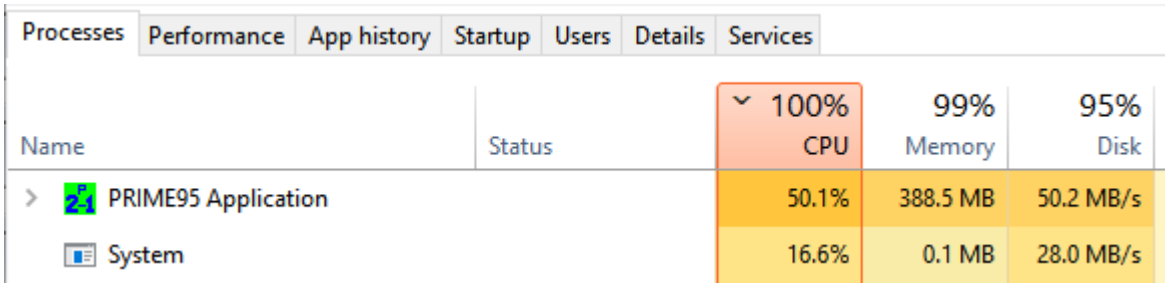
Software such as BleachBit and IOBit Uninstaller are mass-uninstallers that allow one to quickly remove software they no longer require.

Windows also includes a tool for removing temporary and redundant files, however removing some of these (such as update cache files), may actually *reduce* performance.

Anti-Malware/Anti-Virus

Anti-Malware tools such as MalwareBytes, Avast and Bitdefender can be used to remove viruses. Viruses, malware and bugs often take up a significant amount of computer resources.

An example of these would be a rouge cryptocurrency miner running in the background. This would slow down the performance of the computer and significantly hinder the usage of other programs.



An example of a program taking up significant system resources

Defragmenting

As mentioned previously, defragmenting a hard disk drive can make the access of data more performant. This is since defragmenting makes sure that data is stored more efficiently on the drive, requiring the drive head to move less distance over the platters.

Keeping up to Date

Another method of keeping your system performant is ensuring that all programs are up to date, as well as the operating system.

Newer versions of software may patch issues, performance troubles or make the underlying code more efficient. On top of this, updates may patch important security vulnerabilities which can be exploited by malicious parties.

Visual Effects & Animation

Disabling flashy visual effects and animations in the operating system can make the system feel more responsive during use.

In Windows 10 and 11, animations can be turned off in the Settings app, which disables animations such as the one when you minimise an application; instead minimising the application instantly.