Chapter two Hardware and software

Instructor: Mr Oluyemi F.M

Learning objective

- Define hardware
- Evaluate internal and external hardware devices
- Explain the purpose of and evaluate storage devices
- Explain the purpose of input and output devices
- Evaluate input, storage and output devices for a given task
- Define software
- Evaluate different types of software
- Explain the purpose of system software
- Evaluate application soft ware
- Evaluate user interfaces
- Describe utility soft ware
- Compare custom-written and off-the-shelf soft ware
- Describe and evaluate a compiler and interpreter

Key Terms

KEY TERMS

Hardware: a physical component of a computer system

Device: a hardware component of a computer system consisting of electronic components

Output device: a device used to communicate data or information from a computer system

Storage device: a device used to store data onto a storage medium

Input device: a device that allows data to be entered into a computer system

Storage medium: the medium on which data is stored

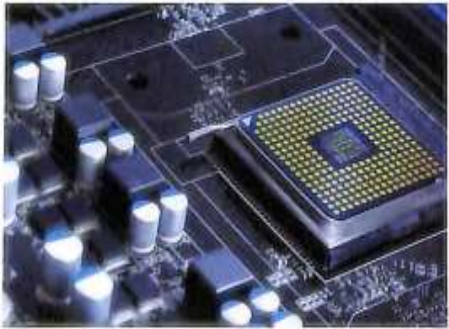**Volatile:** data is lost when there is no power

Non-volatile: data remains when there is no power

Hardware Device

- An item of hardware is a physical component that forms part of a computer system. Items of hardware are often known as devices because they comprise electronic components . Hardware devices can be internal to the computer system (such as the central processing unit, memory or motherboard) or they can be external to the computer system (such as the monitor, keyboard or mouse).

- Hardware is categorised into input, output and storage devices. Input devices allow data to be sent to a computer (e.g. keyboard). Output devices allow the communication of data/information from a computer (e.g. monitor). Storage devices store data onto a storage medium so that it can be used at a later time .

Internal Hardware Devices
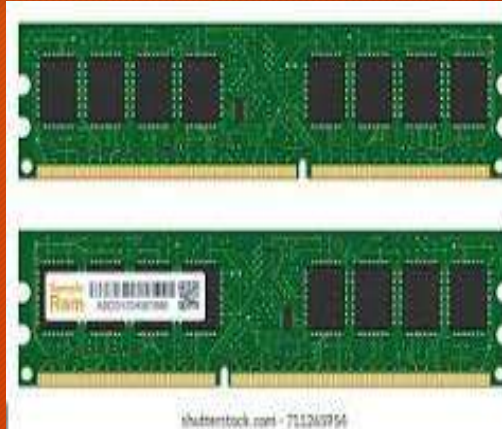

Central processing unit

Motherboard

shutterstock.com · 711269764

re 2.03 - A graphics card.

Access arm

Disk (platter)

Read-write head

Figure 2.04 - A hard disk.

CPU

- The central processing unit (CPU) is the brain of a computer. It is the part of the computer that carries out calculations, executes instructions and processes data. It includes the arithmetic logic unit (ALU) and control unit (CU).

- The ALU performs calculations and logical operations. The CU runs the fetch-execute cycle which fetches instructions from memory and executes them. Input data is taken from input devices (such as a keyboard) or storage and processed by the CPU, which produces output data that can be stored or sent to an output device (such as a monitor). CPUs usually consist of multiple cores . Each core is a separate processor, so a quad-core CPU has four processors. Processors are measured by the number of instructions they can process per second (hertz). A 3GHz (gigahertz) processor can process up to 3 billion instructions per second .

RAM (Random Access Memory)

- Random access memory (RAM) is memory that is used to store currently active programs and data. The more RAM that is available to the computer, the more data and programs can be used at the same time.

- This is particularly important in multi tasking environments, when several programs may be open at the same time. When the RAM becomes full, programs or data that are no longer active will be removed to make space for new programs or data. If the RAM becomes full and there are no inactive programs or data to remove, then an area of secondary storage (e.g. hard disc drive (HDD) or solid state drive (SSD)) known as virtual memory is used to expand the amount of memory available to the CPU.

Virtual Memory

- Virtual memory is an operating system technique that creates the illusion of a large, contiguous memory space for applications by combining physical RAM with secondary storage (like a hard drive or SSD). When RAM is full, inactive data is moved (swapped) to the virtual memory on the disk, freeing up RAM for actively used data. This allows the computer to run more applications and larger programs than its physical RAM would otherwise allow, though it slows down performance due to the slower access speed of hard drive or SSD virtual memory compared to RAM.

RAM cont...

- RAM is volatile , which means the content of the memory is lost if there is no power to the RAM. When you are using a computer and experience a power cut, this is why the data you are currently using is lost unless it has recently been saved to secondary sto rage. Read only memory Read only memory (ROM) is memory that, once it has been written to, can no longer be changed .

- It is permanent and it is non-volatile , which means that when there is no power to the computer, the contents of the ROM will be retained. This is because it is powered by a small long-life battery

ROM (Read Only Memory)

Read only memory (ROM) is memory that, once it has been written to, the contents are difficult to be changed . It is a permanent memory and it is non-volatile, which means that when there is no power to the computer, the contents of the ROM will be still retained.

The ROM contains a small computer program called BIOS (basic input/output system) which a computer's microprocessor uses to start up the computer system after it is powered on.

ROMs are slso used to store the firmware for digital devices like mobile phones, game consoles and home appliances like ACs, washing machines, microwave ovens, etc.

Types of ROM

There are four main types of ROM:

- Masked Read Only Memory (MROM),
- Programmable Read Only Memory (PROM),
- Erasable Programmable Read Only Memory (EPROM),
- Electrically Erasable Programmable Read Only Memory (EEPROM).

Types of ROM

- Mask ROM is a read-only memory whose contents are programmed by the integrated circuit manufacturer (rather than by the user). The desired memory contents are furnished by the customer to the device manufacturer.

- PROM full form is programmable read-only memory. It is a type of non-volatile computer memory. This means that once data has been written to PROM, it cannot be erased. PROM is used to store programs or firmware for microcontrollers and other digital devices.

Types of ROM cont..

- EPROM, form of computer memory that does not lose its content when the power supply is cut off and that can be erased and reused. EPROMs are generally employed for programs designed for repeated use but that can be upgraded with a later version of a program.

- EEPROM (electrically erasable programmable read-only memory) is a user-modifiable ROM. It can be erased and reprogrammed (written to) repeatedly by applying an electrical voltage that is higher than normal. However,EEPROM is a type of non-volatile ROM that enables individual bytes of data to be erased and reprogrammed. That is why EEPROM chips are known as byte

Class Activity one

- Let us have four group(1,2,3,4)
- Group 1,2 we tell us two purpose of PROM
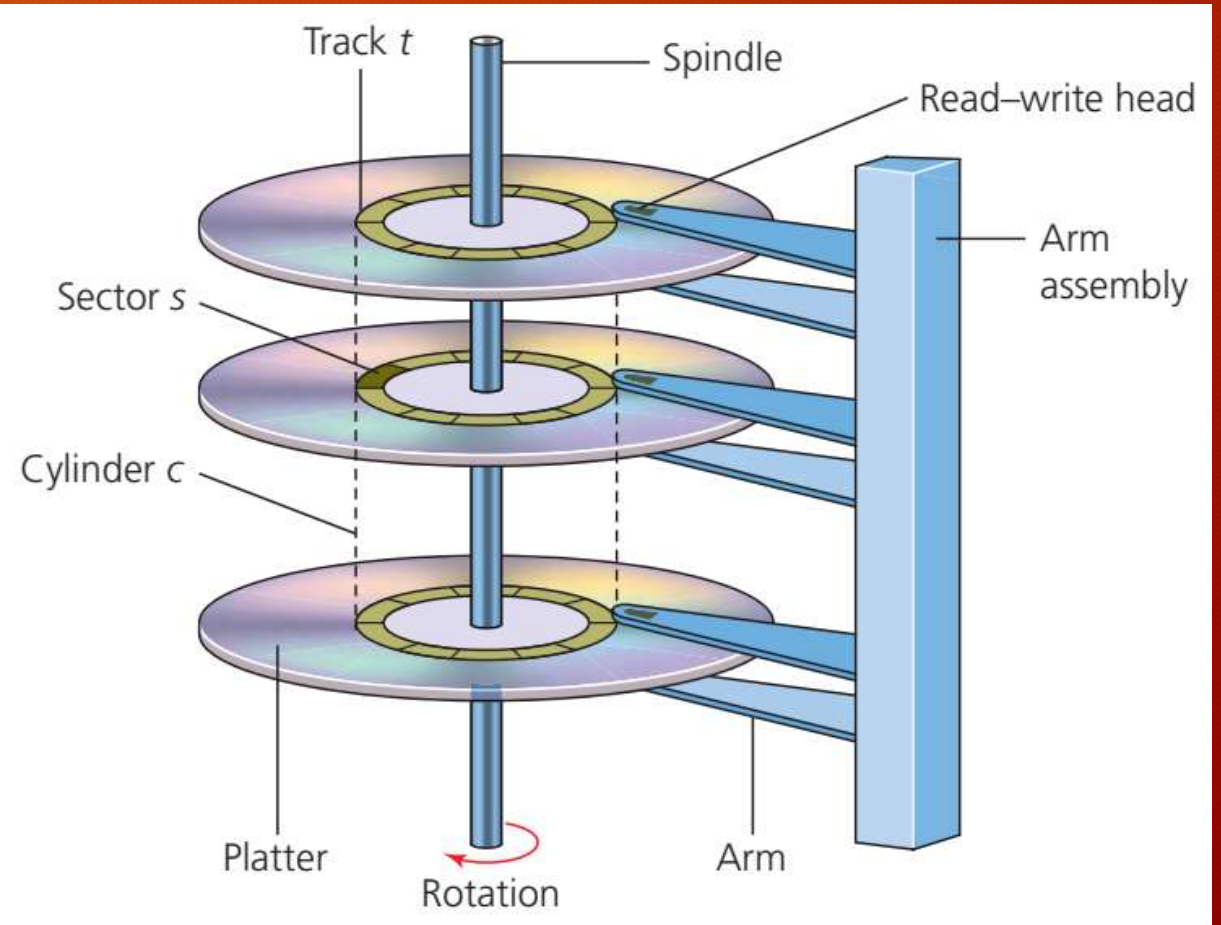- Group 3,4 we tell us two purpose of EPROM

ROM in our mobile phone is what_____ then, state the reason from your own point of view (group 1,2)

BIOS stand form what_____the the type of ROM that host BIOS is what_____ state the reason from your own point of view

Hard disk drive

- A hard disk drive (HDD) is a type of computer secondary storage device that uses spinning magnetic disks called platters to store data.

Hardisk

Hard disk cont…

- A hard disk is made up of disks (platters), the read and writes heads which are held in place by an arm (actuator), and the spindle which holds platters together. The platters are coated with magnetic materials on both sides for data storage. The actuator makes sure that the read and write head moves to the disk location where data need to be read or written to.

- The platters are divided into tracks and sectors which are used to define locations where data is stored . The more tracks and sectors the higher the disk capacity.
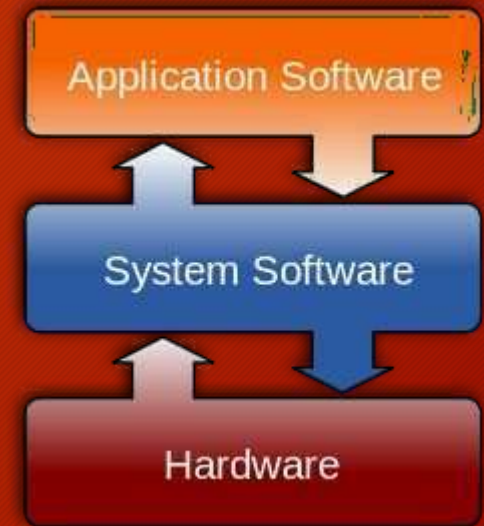
SSD(Solid State Drive)

- Solid state drive A solid state drive (SSD) is another secondary storage device that is non-volatile. However, there are no moving parts and the data is stored onto flash memory. It is also not necessary to store data in the same cylinder in order to maximise access speed as the data can be stored anywhere on the flash memory and access speeds will not be affected. SSDs are also non -magnetic and so are not susceptible to damage from to close, strong magnetic fields. In 2015, SSDs could store up to 8TB, but due to the newer technology were far more expensive than HDDs and were more common in capacities of 128, 256 or 512 GB.

- SSDs have access speeds of around 400 -600 MBps (two to three times faster than a HDD). This means they are used in higher performance computer s. A frequent compromise between speed, capacity and price is to have a smaller SSD to store the operating system and softwa re (for speed of access) and use a larger HDD to store data.

- SSDs also require a lot less power than HDDs and so are preferred in laptop and tab let computers.

APPLICATION SOFTWARE

- An application software is any software designed to perform specific user-defined tasks on a computer system. Examples include: MS Office programs like MS Word, MS Excel, MS PowerPoint, etc as well web browsers, media players, etc.

SYSTEM SOFTWARE

- **System software** refers to the programs that manage and control a computer's hardware and application software. Examples of system software are **compilers**, **interpreters**, **linkers**, anti-virus software, **device drivers**, operating systems and utilities (aka utility programs).

COMPILERS

- A compiler is software (a program) that processes statements written in a high level programming language and converts them into machine language or code that a computer's processor understands and can execute. In other words, it translates a high-level language program called source code into an executable file called object code. The compiled program is then run directly without the need for the compiler to be present.

- When a program is compiled, the whole source code is translated into the executable file at once which can then be distributed to customers and individual computers for installation. The whole program is translated in one go before it is executed.

- As it is in an executable format, it can only run on operating systems for which the compiler has translated it.

- For example, programs that have been compiled for Windows will not work on Linux unless they are compiled again for Linux. The same situation exists with mobile phone and tablet operating systems.

A program written in Python

```python
total = 0
count = 0

while count < 10:
    num = int(input("Enter a number: \n"))
    if num>=1 and num<=10:
        total = total + num
        count = count + 1
    else:
        print("Invalid number. Re-enter a number.")

print("The total is:" + str(total))
```

COMPILERS

- Most software that runs on computers is in machine code, which is stored in binary form within the computer. Machine code consists of the instructions that computers understand and each instruction is actually a number written in binary. Unfortunately, programmers who write the software for computer users find it difficult to use machine code for programming purposes. So programmers write programs using high level language like Python, Java, JavaScript, C++, etc.

INTERPRETERS

- An interpreter translates the high-level language program one statement, or line, at a time into an intermediate form, which it then executes. It continues translating the program until the first error is met, at which point it stops. This means that errors are located by the programmer, exactly where they occur. Unlike a compiled program, an interpreted program can be transferred between computers with different operating systems because it remains in the form of source code, but it needs to be translated in each computer it is moved to. This takes more time than with a compiler, but it means that the program can be distributed regardless of the processor or operating system (OS) of the computer.

COMPILER AND INTERPRETER DIFFERENCES

Compiler	Interpreter
Translates source code into object code all at once in advance of execution.	Translates source code into **Intermediate code** one line at a time.
Compiled object code will only work on the operating system it has been compiled for.	Source code can be translated into object code for more than one operating system.
Object code is ready to be executed without delay.	Object code has to be generated, so additional time is added to the execution time.
Compiling can take a long time, which is not appropriate for on-the-fly testing.	Only the required code needs to be interpreted, so this is efficient for on-the-fly testing.

LINKERS

- A **linker** also known as **link editor** is a system program that combines object files or modules that have been created using a compiler into one single executable file. Most programs are written in modular form. That is to say, a number of programmers, write separate pieces of code, or modules that form the required program when combined, which has the advantage of saving time than if one person wrote the whole code although it is still possible for one person to write all the modules. If there is an error only that module has to be corrected. A linker is used to combine different modules of object code into one single executable code program or software.

OPERATING SYSTEMS (OS)

- An OS is system software that manages computer hardware and software resources as well as the interaction with device drivers. The OS also acts as an interface between an application program and the computer hardware, so that an application program can communicate with the hardware. To sum up, an operating system interacts with application software, device drivers and hardware to manage a computer's resources, such as the processor, RAM, storage space, and peripherals.

- Before an operating system (OS) is loaded the computer has to boot up. Booting up a computer is starting it up by loading the BIOS. BIOS is a small program stored in ROM and is the Basic Input/Output System for the computer which executes during boot-up. It checks whether various devices are present before loading the OS.

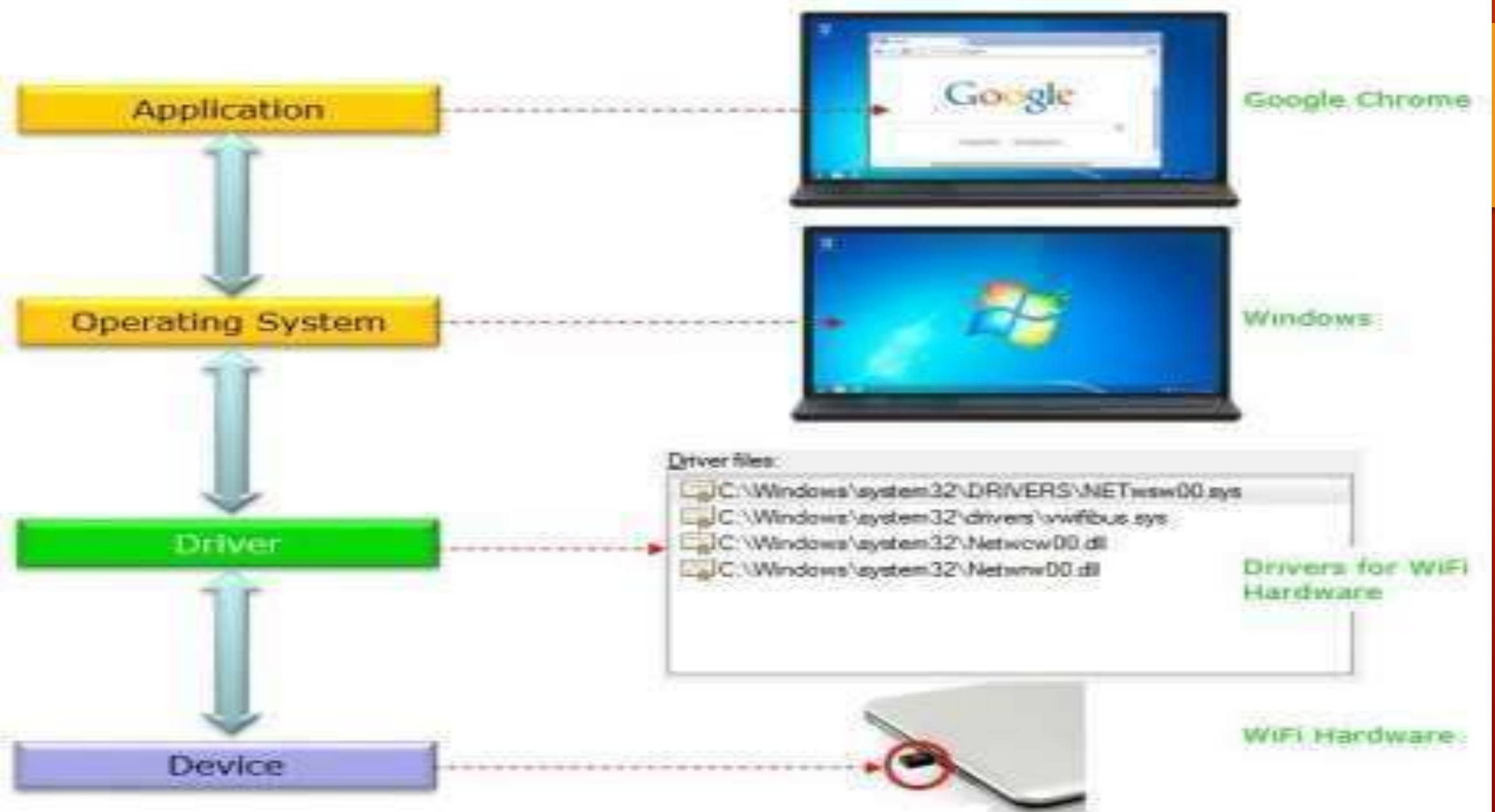# FUNCTIONS OF THE OPERATING SYSTEMS

- Memory management: One of the major functions of an operating system is to manage the computer's memory. The OS allocates a particular part of RAM for each program, whether it is an application, system software or a utility that is running. It needs to make sure that instructions and data from one program do not spread into another program's memory allocation, otherwise data can get corrupted and the computer could crash.

- Responding to input devices such as when a key is pressed on the keyboard. The OS responds to input devices in order to receive and manage data. It does this by communicating with the device driver so that it can receive data from the input device.

- Sending data and instructions to output devices such as printer. It also uses device drivers when it sends data or instructions to the printer to print a document.

- File management: The OS manages the opening (loading) and closing of files on storage devices such as hard disk drive, SSD, etc. It knows the names of each file and exactly where they are stored on the hard disk It also keeps a record of any empty spaces on the medium so that it knows where new files can be stored.

- Processor management: The OS must allocate processor time to each running task or program fairly, so that all tasks or programs get a reasonable amount of time for processing.

- User logon and security: When a user logs in to a system, it is the OS that deals with this. It authenticates the user by comparing the password they entered with the one stored on the system and if it matches it allows log on, otherwise it prevents log on.

TASK

Microsoft Windows is an example of an operating system. Find at least two other operating systems used by desktop computers and at least three operating systems used by mobile phones or tablets.

DEVICE DRIVERS

- A device driver is a small program that enables the operating system (OS) and application software to communicate with a hardware device. It is used to send customized instructions to a specific hardware. One example is a printer driver which acts as an interface between the OS (or any application software that is running) and the printer. The user, through the application, might want to print information. The application tells the printer driver and the printer driver tells the printer. This, in effect, allows the user to have control of the device. Other devices which need drivers are sound cards, monitors, mice, SSDs, network cards, keyboards, disk drives and many other items of hardware.

UTILITY PROGRAMS

- **Utility software** is a type of system software that is needed to help maintain a computer system operations and its devices. A basic set of utility programs is often supplied with the OS, most of which help to manage files and their associated storage devices. However, users can sometimes feel the need to get additional utilities which perhaps the OS does not possess such as a printer driver. Much of the work a computer does revolves around the use of files of data so it is no surprise that it needs a number of programs that deal with file handling. Without utility software, the computer would not function properly. Utility software is required to manage the allocation of computer memory in order to improve the computer's performance and so that users can customise the appearance of their desktop.

TYPES OF UTILITY SOFTWARE

- Types of utility program include:
- Antivirus program
- Backup utility
- Disk defragmenter
- Formatting utillty
- Delete utility
- Data compression utility
- etc

ANTIVIRUS PROGRAM

- **Anti-virus software** can be a program or set of programs whose function is to detect and remove viruses and other malware. It monitors a computer in a bid to prevent attacks from many types of **malware** (malicious software) such as viruses, **worms**, Trojan horses, spyware, ransomware, etc. It is important to keep anti-virus software up to date because new viruses and other types of malware appear at frequent intervals and older versions of anti-virus will not detect these.

BACKUP UTILITY

- **Back-up software** is a program that is used to keep copies of files from a computer. The back-up is an exact duplicate of the files. It can be used for restoring the original files, should the original files become corrupted or deleted, accidentally or deliberately. Backup software allows the user to select the time and type of back-up they want and how regularly the back-up is to take place. Data files can be backed up to cloud storage or external storage devices.

DISK DEFRAGMENTER

- When a file of data is stored on a disk, it may consist of several blocks. There may not be enough blank or empty sectors next to each other to store all the blocks together which means they have to be spread out across the disk. The file is now said to be fragmented.

- When data is no longer needed it is deleted from the disk, which leaves some empty sectors. **Defragmentation software** is used to organise the data on the disk by moving the data blocks around to bring all the parts of a file together so they are contiguous. As a result, data retrieval is made easier and quicker. With fragmented files it takes longer for the read-write heads to move over the surfaces to find all the different fragments of files than if the data is held in sequence. In addition, the software provides additional areas of free space and more storage capacity

FILE COPYING UTILITY

- **File copying** is creating a duplicate copy of an existing file. The copy will have exactly the same content as the original.

DELETE UTILITY

- The **delete utility** is a piece of software which deletes files stored on a computer by moving it to the recycle bin or deleting it permanently. When a file is "permanently" deleted, the delete utility deletes the pointers that tell the OS where to find the file. The OS now considers the sectors where the file was stored as free and available for the writing of fresh data. Until new data is written to the space the file occupies, users can still retrieve the data using specialized software.

DATA COMPRESSION UTILITY

- **Data compression** is the modifying of data so that it occupies less storage space on a disk. It can be lossless or lossy. **Lossless compression** is where, after compression, the compressed file does not lose any quality i.e. the quality is the same as the original file before compression. If the file is converted back into its original state, there will be no loss of a single bit (binary digit) of data. When the lossless compression software sees a repeated sequence of bits it replaces the repeated sequences with a special character which indicates what is being repeated and how many times. This type of compression is normally used with spreadsheets, databases and word-processed files, where the loss of just one bit could change the meaning completely. **Lossy compression** permanently deletes data bits that are unnecessary, such as the background in a **frame** of a video which might not change over several frames. Lossy compression is commonly used with images and sound, where the loss of some data bits would have little effect. **JPEG** is an image file format that supports lossy image compression. Formats such as **GIF** and **PNG** use lossless compression.

DATA COMPRESSION UTILITY

- An advantage of data compression is that it means data can be transmitted more quickly over a network or the internet. Another advantage is that it saves storage space on a disk or SSD. Consequently, administrators spend less money and less time on storage. It also allows the streaming of high definition (HD) videos which would ordinarily occupy a great deal of bandwidth and memory.

- There are disadvantages however, such as the fact that data compression software uses a lot of computer memory during the compression process. Another disadvantage is that the process of loading or opening a compressed file takes a lot longer than opening the original. Also, lossy compression causes a slight lowering of the quality of the resulting sound and video files.

FORMATTING UTILITY

- **Disk formatting** is the configuring of a data storage medium such as a hard disk or SSD for initial use. It can be performed on a disk that already has files on it, but all those files would be erased. Disk formatting is usually carried out on a new disk or on an existing disk if a new OS has to be installed.

CUSTOM-WRITTEN SOFTWARE AND OFF-THE-SHELF SOFTWARE

- When a company installs a new computer system, it will need to obtain application software, whether it is for producing word-processed documents, keeping databases of employee records or producing invoices. However, many companies discover that finding the most appropriate software for them can prove difficult. If a wrong decision is made, they may need to keep modifying their system or even have to abandon the software and start again. Generally, there are two choices: either buy **off-the-shelf software** or ask someone to create **custom-written software**.

CUSTOM-WRITTEN SOFTWARE

- When a company installs a new computer system, it will need to obtain application software, whether it is for producing word-processed documents, keeping databases of employee records or producing invoices. However, many companies discover that finding the most appropriate software for them can prove difficult. If a wrong decision is made, they may need to keep modifying their system or even have to abandon the software and start again. Generally, there are two choices: either buy **off-the-shelf software** or ask someone to create **custom-written software**.

OFF-THE-SHELF SOFTWARE

- This is software which already exists and is available straight away, ready for use. If the company with a new computer system is a smaller company, it may turn to one of the large software companies that already produce business software packages, for example invoicing software, accounting software, payroll software and other programs which are available to all businesses, organisations and the general public. Such programs may provide features that many users want, such as text editing, accounting functions and mail merge. The drawback is that in trying to cater for a wide range of users, there may be a substantial number of features that the purchasing company does not need, such as trigonometric functions or engineering functions. The software may therefore need to be adapted for the company's own specific purpose, which can mean that it occupies a large amount of storage space. Unlike custom-written software, it will not be owned by the purchasing company and even if adapted for it, it will not be able to sell it to other companies.
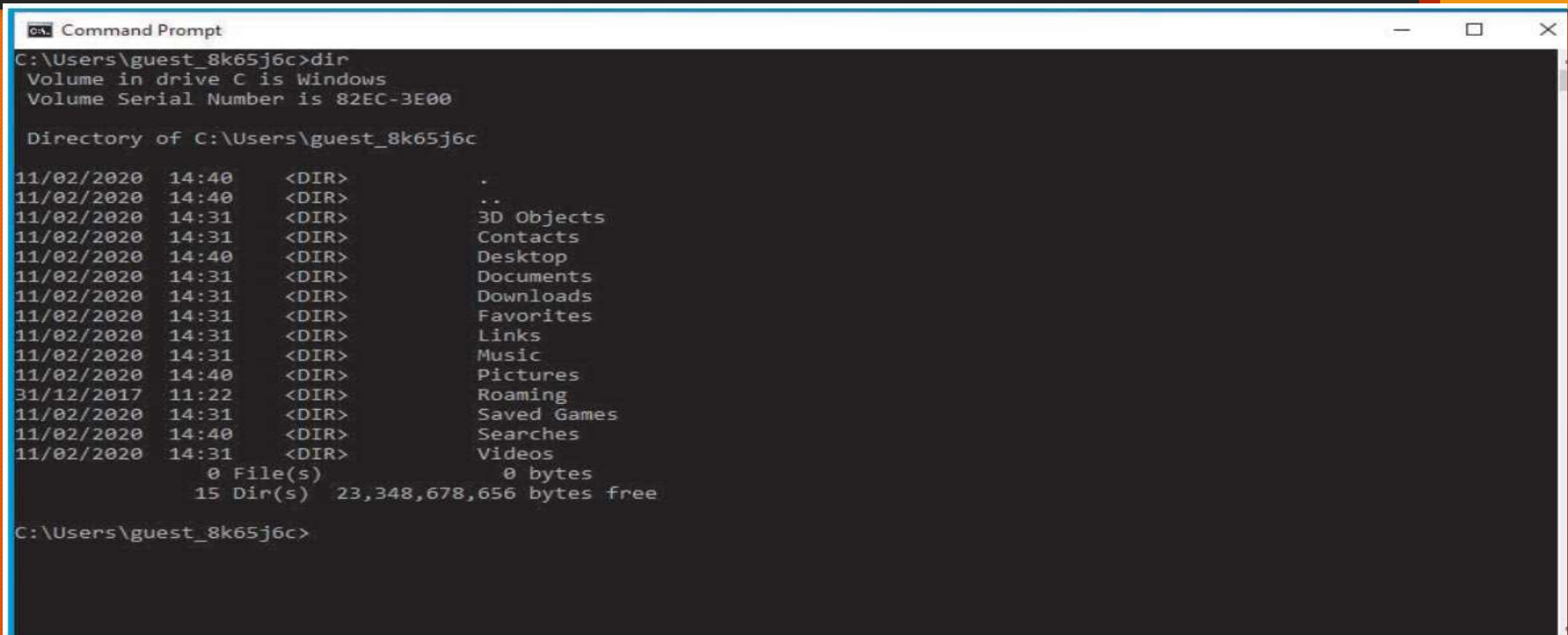
USER INTERFACES

- A **user interface** is the means by which the computer system interacts with the user. It enables the user, with the help of input devices, to communicate with the computer and then, via the OS, communicate with a piece of software or any output device. A good user interface is one which allows the user to perform this communication without encountering any problems; it needs to be user-friendly. It should also be intuitive; users should be able to predict what will happen if they take a certain action, for example if a button on a user interface looks like a button in real life (such as the on/off button on a computer), a user should be able to press it and get a response. The four major user interfaces available are the **command line interface (CLI)**, **graphical user interface (GUI)**, **dialogue interface** and **gesture-based interface.**

COMMAND LINE INTERFACE

- The command line interface (CLI) is a means of interacting with a computer using commands in the form of successive lines of text. The computer system will respond by producing results in a text format.

- Normally, a prompt appears on the screen to which the user responds by typing a command. The output from the computer could be to produce a list or take some other action. In the early days of computing, the CLI was the only way a user could get the computer to run software or carry out tasks. This type of user interface is rarely used today except by software developers, system administrators and more advanced users. Most individuals use a graphical user interface (GUI) when communicating with their computers. However, even within a GUI it is still possible to access a CLI.

- CLIs use very little memory so they are useful in old systems or for maintenance of very small systems/devices (e.g. engine management systems).

- They are also useful for technical users who need to carry out complex operations which cannot be performed using more user-friendly interfaces.

- However, CLIs can be difficult to learn and use because users have to learn and remember all the commands, and errors are easily made when entering those commands.

COMMAND LINE INTERFACE
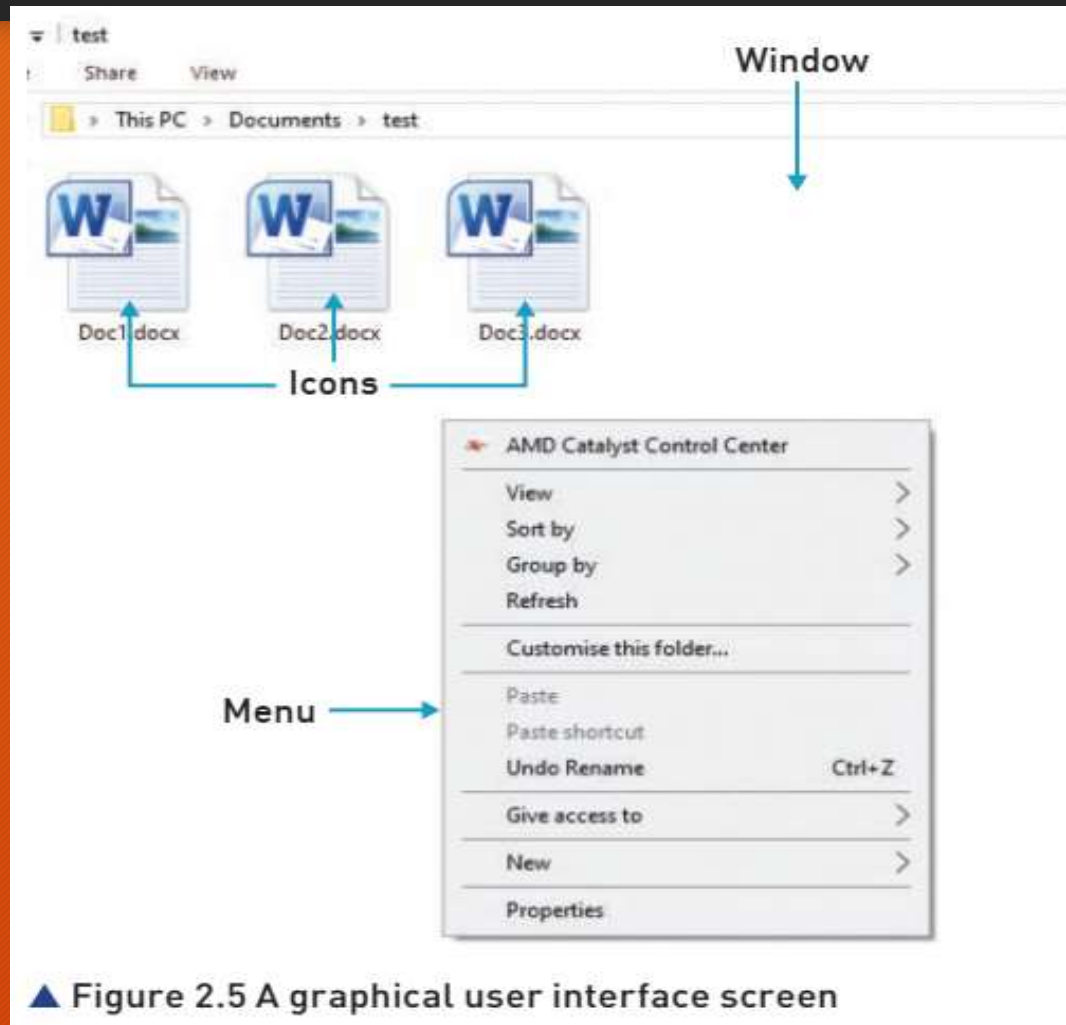

▲ Figure 2.4 A command line interface screen

GRAPHICAL USER INTERFACE

- Instead of typing in commands like in CLI, the GUI uses windows, icons, menus and pointers, collectively known as a 'WIMP' interface, to carry out commands, such as opening, deleting, and moving files. Technically speaking, a WIMP interface is only a subset of GUI and requires input devices such as a keyboard and mouse, whereas other types of GUI use different input devices such as a touchscreen.

GRAPHICAL USER INTERFACE

▲ Figure 2.5 A graphical user interface screen

DIALOGUE INTERFACE

- A dialogue interface allows a user to communicate with a computer or device using their voice. The computer is able to use speech-recognition software to convert the spoken word into commands it can understand. Many cars have such a system whereby the driver is able to control their phone or radio without touching them. For example the driver is able to initiate a phone call by saying 'phone Graham' or switch a particular radio channel on by saying the name of the channel. Laptops and PCs often come with voice control these days. The user is able to load and run software packages and files by speaking into a microphone and saying the commands. The computer or device responds with spoken words after the required text has been converted into speech. It requires the device to learn the way the speaker talks by asking the user to repeat certain sentences until it has 'learnt' the way they speak. It can, however, become quite capable of understanding simple commands. Noise in the background while the user is speaking and the ability to recognise only a limited vocabulary can cause problems.

GESTURE BASED INTERFACE

- A gesture-based interface is designed to interpret human gestures and convert these into commands. Gestures can be made with any part of the body, but it is usually the face or hand that makes the gestures the computer can interpret. An example of where this type of interface is used is in 'smart' homes where a gesture can turn on the lights, for example. In this area of IT, a gesture can be said to be any physical movement, large or small, that can be interpreted by a computer. Examples of these are the pointing of a finger, nodding the head, or a wave of the hand. These types of gestures can be understood by a computer. First of all, a camera in conjunction with an infrared sensor detects the movements being made in front of it. The computer, using a special type of software, searches through all the gestures it has stored in a database to match it with the input. Each stored gesture is linked to a specific command which is then executed after the gesture has been matched.

ACTIVITY

1 Write down **two** advantages of using a GUI rather than a CLI.
2 Write down **two** disadvantages of using a gesture-based interface rather than a dialogue interface.