Internal hardware devices

Internal hardware devices consist of four key components:

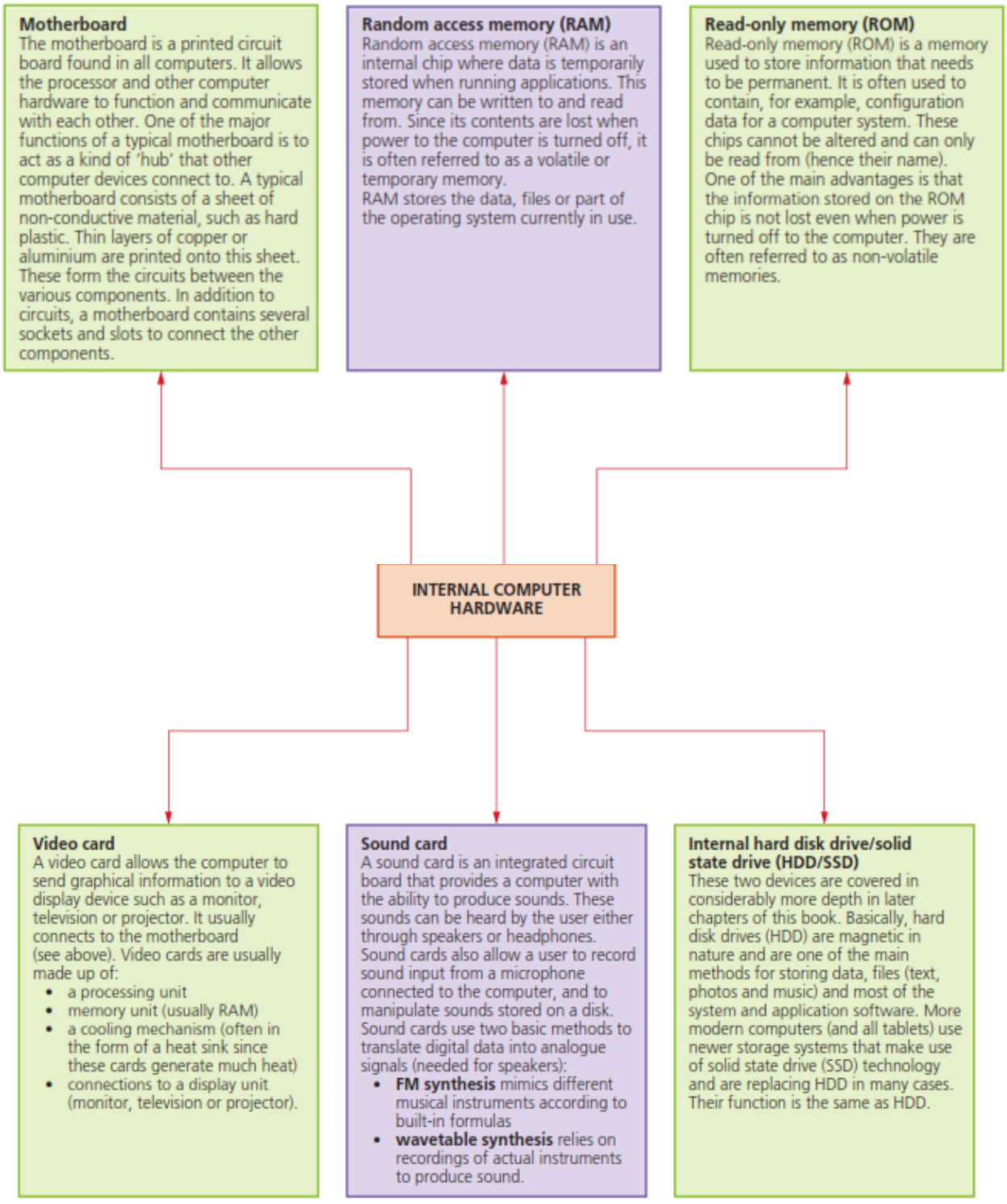
- the **central processing unit (CPU)**, contained on the motherboard
- **internal hard disk drive**
- **random access memory (RAM)**
- **read-only memory (ROM)**.

The **central processing unit (CPU)** is the part of the computer that interprets and executes the commands from the computer hardware and software. It is normally part of the computer motherboard. CPUs used to be made up of discrete components and numerous small integrated circuits; these were combined together on one or more circuit board(s). However, due to modern manufacturing techniques, the CPU is now referred to as a **microprocessor**. This is a single integrated circuit which is at the heart of most PCs and is also found in many household devices and equipment where some control or monitoring is needed (for example, the engine management system in a car).
The CPU is made up of a control unit, which controls the input and output devices; an arithmetic and logic unit (ALU), which carries out calculations and makes logical decisions; and the immediate access store (RAM).

The **internal hard disk drive (HDD)** or **solid state drive (SSD)** is the computer's main internal storage; this is where the applications software, disk operating system and files (for example, text, photos or music) are stored. The main advantage of these storage devices is the fast data transfer/access times and their large capacity to store data.

Random access memory (RAM) is an internal chip where data is temporarily stored when running applications. This memory can be written to and read from. Since its contents are lost when power to the computer is turned off, it is often referred to as a volatile or temporary memory.

Read-only memory (ROM) is a memory used to store information that needs to be permanent. It is often used to contain, for example, configuration data for a computer system. These chips cannot be altered and can only be read from (hence their name). One of the main advantages is that the information stored on the ROM chip is not lost even when power to the computer is turned off. They are often referred to as non-volatile memories. It is worth noting that ROM also contains some coding known as the **boot file**. This code tells the computer what to do when it first starts up; it is often referred to as the **BIOS (basic input/output system)**. When the computer is turned on, the BIOS carries out a hardware check to find out if all the devices are present and whether they are functional. Then it loads the **operating system** into the RAM. The BIOS stores the date, time and system configuration in a non-volatile chip called a **CMOS (complementary metal oxide semiconductor)** – this is usually battery powered.


Motherboard
The motherboard is a printed circuit board found in all computers. It allows the processor and other computer hardware to function and communicate with each other. One of the major functions of a typical motherboard is to act as a kind of 'hub' that other computer devices connect to. A typical motherboard consists of a sheet of non-conductive material, such as hard plastic. Thin layers of copper or aluminium are printed onto this sheet. These form the circuits between the various components. In addition to circuits, a motherboard contains several sockets and slots to connect the other components.
Random access memory (RAM)
Random access memory (RAM) is an internal chip where data is temporarily stored when running applications. This memory can be written to and read from. Since its contents are lost when power to the computer is turned off, it is often referred to as a volatile or temporary memory.
RAM stores the data, files or part of the operating system currently in use.
Read-only memory (ROM)
Read-only memory (ROM) is a memory used to store information that needs to be permanent. It is often used to contain, for example, configuration data for a computer system. These chips cannot be altered and can only be read from (hence their name).
One of the main advantages is that the information stored on the ROM chip is not lost even when power is turned off to the computer. They are often referred to as non-volatile memories.
INTERNAL COMPUTER HARDWARE
Video card
A video card allows the computer to send graphical information to a video display device such as a monitor, television or projector. It usually connects to the motherboard (see above). Video cards are usually made up of:
• a processing unit
• memory unit (usually RAM)
• a cooling mechanism (often in the form of a heat sink since these cards generate much heat)
• connections to a display unit (monitor, television or projector).
Sound card
A sound card is an integrated circuit board that provides a computer with the ability to produce sounds. These sounds can be heard by the user either through speakers or headphones.
Sound cards also allow a user to record sound input from a microphone connected to the computer, and to manipulate sounds stored on a disk.
Sound cards use two basic methods to translate digital data into analogue signals (needed for speakers):
• FM synthesis mimics different musical instruments according to built-in formulas
• wavetable synthesis relies on recordings of actual instruments to produce sound.
Internal hard disk drive/solid state drive (HDD/SSD)
These two devices are covered in considerably more depth in later chapters of this book. Basically, hard disk drives (HDD) are magnetic in nature and are one of the main methods for storing data, files (text, photos and music) and most of the system and application software. More modern computers (and all tablets) use newer storage systems that make use of solid state drive (SSD) technology and are replacing HDD in many cases. Their function is the same as HDD.

Input and output devices

Input Devices

Keyboards

Alphanumeric Keyboard

A very common, **general purpose**, input device that allows **text** (abc…), **numbers** (123…) and **symbols** (%$@...) to be entered into a computer.

A keyboard is simply a set of buttons. Each button has a symbol assigned.

Numeric Keypad

A small keyboard that only has **numbers**.

Used to enter **numeric data** into computers such as those in ATMs.

Most computer keyboards have a numeric keypad on the right side, and most mobile phones (there are also computers) have a one for entering phone numbers, etc.

PIN Pad

This is a device with a **numeric keypad** used to enter a person's **Personal Identity Number** (PIN) e.g. when paying with a credit card.

PIN pads are also found on electronic door **locks** – you enter a PIN to unlock the door.

Pointing Devices

These devices are used to move an on-screen pointer or cursor (usually an arrow). They are commonly used with Graphical User Interfaces (GUI).

Mouse

A **pointing** device found on most PCs. Sensors on the bottom of the mouse detect when the mouse is moved. Data about this movement is sent to the computer.

Often used to control the pointer in a **GUI**.

Touchpad / Trackpad

A **pointing** device found on most **laptops**. Used instead of a mouse since it takes up **less space**. The user moves a finger across the touch pad and this movement data is sent to the computer.

Usually used to control the pointer in a **GUI**.

Trackball / Tracker Ball

This **pointing** device is not moved about like a mouse, instead it has a **large ball** that the user spins. Data about which direction the ball is spun is passed to the computer.

It can be used to control a **GUI** pointer.

Tracker balls are often used by people with **limited movement** (disabled) or by the **very young** since they are **easier to use** than a mouse.

Touch Screen

A touch screen is an alternative to a separate pointing device. With a touch screen the user selects items on the screen by **touching** the surface. This makes touch screen systems very **intuitive** and **simple to use**.

Often used for **information terminals** in public places e.g. libraries or museums where mice or keyboards may be stolen or damaged.

Graphics Tablet

A **pointing** device often used by **designers** and **artists** to allow **natural hand movements** to be input to **graphics** applications.

A stylus is held like a pen and moved over the surface of the tablet. Data about the stylus movements are sent to the computer.

Since it is so like using a pen, it is very easy to create '**hand-drawn**' sketches.

Joystick / Joypad

Used mainly for playing **games**. The user moves the joystick left/right, forward/back and data about these movements are sent to the computer.

Small joysticks can also be found on some **mobile phones**.

Light Pen

A light pen is a device used as a **pointing** device or to '**write**' on the **screen** of a computer.

Light pens are **rarely used** today since graphics tablets and high-quality touch screens provide similar functionality.

Audio/Visual Devices

Scanner

A device that 'scans' **images**, book pages, etc.

Scanning is basically taking a close-up photograph (just very slowly and with great detail). The scanned image data is passed to the computer.

The most common type of scanner is the **flat-bed** scanner which has a glass plate on which the item to be scanned is placed. The item is illuminated and an image of it is captured by a moving scan 'head'.

Scanned images can be further processed once inside the computer, e.g. **OCR** of printed text.

Digital Camera

A device that captures **digital photographs**.

Most digital cameras do not directly input data into a computer - they store photographs on **memory cards**. The photographs can later be **transferred** to a computer.

A modern digital camera can capture 10 Megapixels or more per photograph - that's 10,000,000 coloured dots (pixels) in every photo!

Video Camera

A device that captures **moving images**, or **video**.

Like a digital camera, most video cameras do not directly input data into a computer – the captured movies are stored on **video-tape** or **memory cards** and later **transferred** to a computer.

However, there are some situations where video cameras do feed video data directly into a computer: **television production** and **video-conferencing**. In these situations the video data is required in real-time.

Web Cam

This is a very **basic video camera** used to feed **live video** into a computer.

The video data from a web cam is **low quality** compared to a full video camera. However it is good enough for **web chats** (e.g. using a messenger application such as MSN Messenger or Skype).

Usually a web cam is clipped to the top of a monitor, but many laptops now have web cams built into the edge of the screen.

Microphone

An input device that converts **sound** into a signal that can be fed into a computer.

The signal from a microphone is usually **analogue** so, before it can be processed by a computer, it must be converted into digital data. An **Analogue-to-Digital Convertor (ADC)** is used for this (usually built into the computer's sound card)

Many headphones now come with microphones to allow them to be used with chat and phone applications.

Card Readers

Magnetic Strip Reader

Many plastic cards, such as credit cards, have a **strip of material that can be magnetized** on the back. Data can be stored here in the form of **magnetized dots**.

Usually the **data stored on this strip** in the same **data shown on the front** of the card (e.g. the credit card number, expiry date and customer name).

The stripe allows this data to be input to a computer system **faster** and **more accurately** than by typing it in.

A magnetic strip/stripe reader is used to read the data from the stripe. This is usually done by '**swiping**' the card through a slot on the reader.

Smart Card / 'Chip' Reader

Modern credit cards and ID cards don't use a magnetic strip. Instead they have a tiny '**chip**' of computer **memory** embedded inside them. (These cards are often referred to as **smart cards**.)

Data can be **stored** in this memory and **read back** using a 'chip' reader.

A card is inserted into the reader where metal contacts connect to the **metal pads** on the front face of the card. The reader can then **access the memory chip** and the **data** stored on it.

Smart cards can **store much more data** than magnetic strip cards, e.g. an ID smart card would store not only the owner's name and card number, but might also have a digital image of the person.

Satellite TV decoders use smart cards to store which channels a user has paid for. The data is **encrypted** so that it is not easy to alter (you can't add new channels without paying!)

Many types of card use this system: **id** cards, **phone** cards, **credit** cards, **door security** cards, etc.

Reading Text/Codes

All data can be input to a computer using a keyboard, but this would often be a slow process, and mistakes would be made. Sometimes speed and accuracy is required.

MICR Reader

Magnetic Ink Character Recognition (**MICR**) is a technology that allows details from **bank cheques** to be read into a computer **quickly** and **accurately**.

The **cheque number** and **bank account** number are printed at the bottom of each bank cheque in **special magnetic ink** using a **special font**. These numbers can be detected by an **MICR reader**.

OMR Scanner

Optical Mark Recognition (**OMR**) is a technology that allows the data from a **multiple-choice** type form to be read **quickly** and **accurately** into a computer.

Special OMR forms are used which have spaces that can be **coloured in** (usually using a pencil). These **marks** can then be **detected** by an **OMR scanner**.

Common uses of OMR are **multiple-choice exam** answer sheets and **lottery number** forms.

OCR Scanner

Optical Character Recognition (**OCR**) is a software technology that can **convert images of text into an actual text file** that can then be edited, e.g. using word-processing software). The result is just as if the text had been typed in by hand.

OCR is typically used after a page of a book has been **scanned**. The scanned **image** of the page is then **analyzed** by the **OCR software** which looks for recognizable **letter shapes** and generates a matching text file.

Advanced OCR software can recognize normal **handwriting** as well as printed text - this is usually called **handwriting recognition**.

Barcode Reader / Scanner

A barcode is simply a **numeric code** represented as a series of **lines**.

These lines can be read by a **barcode reader/scanner**.

The most common use of barcode readers is at **Point-of-Sale** (**POS**) in a shop. The **code** for each item to be purchased needs to be entered into the computer. Reading the **barcode** is far **quicker** and more **accurate** than **typing** in each code using a keypad.

Barcode can be found on many other items that have numeric codes which have to be read quickly and accurately - for example ID cards.

Sensors

A normal PC has no way of knowing what is happening in the real world around it. It doesn't know if it is light or dark, hot or cold, quiet or noisy. How do we know what is happening around us? We use our eyes, our ears, our mouth, our nose and our skin - our **senses**. A normal PC has no senses, but we can give it some: We can connect **sensors** to it...

A **sensor** is a device that **converts** a **real-world property** (e.g. temperature) into **data** that a computer can **process**.

Examples of sensors and the properties they detect are...

Sensor	What it Detects
Temperature	Temperature
Light	Light / dark
Pressure	Pressure (e.g. someone standing on it)
Moisture	Dampness / dryness
Water-level	How full / empty a container is
Movement	Movement nearby

Proximity	How close / far something is
Switch or **button**	If something is touching / pressing it

A sensor measures a specific property data and sends a signal to the computer. Usually this is an **analogue** signal so it needs to be converted into **digital** data for the computer to process. This is done using by an **Analogue-to-Digital Converter** (ADC).

Sensors are used extensively in **monitoring / measuring / data logging systems**, and also in **computer control systems**.

Remote Control

These devices are very common. They send data signals each time a button is pressed using infrared or radio signals.

The signals can control a computer from some distance. They are often used to control a presentation slideshow.

Output Devices

Audio/Visual Devices

CRT Monitor

A monitor displays text and image data passed to it by the computer.

A cathode-ray tube (CRT) monitor is the type that has been around for years and is large and boxy.

CRT monitors are heavy and they take up a lot of desk space. They have largely been replaced by flat-screen monitors. However some are still used in the design industry since the colour accuracy and brightness of CRT monitors is excellent, and designers need to see true-to-life colours.

Also, CRT monitors are generally cheaper than flat-screen monitors.

Flat-Screen Monitor (TFT or LCD)

Over the past few years, as they have come down in price, flat-screen displays have replaced CRT monitors.

Flat-screen monitors are light in weight and they take up very little desk space.

Modern flat-screen monitors have a picture quality that is as good as CRT monitors.

Digital / Multimedia Projector

Digital projectors are used in situations when a **very large viewing area** is required, for example during **presentations**, for **advertising**, or in your home for **watching movies**.

A projector connects to a computer, a DVD player or a satellite receiver just like an ordinary monitor. The image is produced inside the device and then projected out through a large lens, using a powerful light source.

Speakers

If you want to hear **music** or **sounds** from your computer, you will have to attach speakers. They convert electrical signals into **sound waves**.

Speakers are essential for applications such as **music editing**, **video conferencing**, watching **movies**, etc.

Printing/Plotting Devices

Dot Matrix Printer

A dot-matrix printer is named after the pattern (a grid or 'matrix') of dots used when creating the paper printout.

These dots are formed by tiny pins in the printer's print head that hit an inked ribbon against the paper leaving marks. As the print head moves along it leaves a pattern of dots behind it which can form letters, images, etc.

Dot matrix printers often use continuous stationary: long, continuous strips of paper (rather than separate sheets of A4 like ink-jet and laser printers use).

After printing, the printout is torn off from the long strip.

Dot-matrix print quality is poor, the printers are noisy, and there are much better printing systems available today. However, the dot-matrix printers are still used in certain situations:

Since the pins actually hit the paper, several 'carbon-copies' can be printed in one go. An example of this is airline tickets which have several duplicate pages, all printed in one go.

The print mechanism is very cheap, and the inked ribbons last for a long time. So, where cheap, low-quality printouts are required, dot-matrix printers are used. An example is shop receipts.

InkJet Printer

Cheap, high-quality, full-colour printing became available during the 1980s due to the development of ink-jet printers.

These printers have a similar print-head mechanism to a dot-matrix printer. The print-head passes left and right across the paper. However, instead of using pins to hit inky marks onto the paper, the ink-jet squirts tiny droplets of ink onto the surface of the paper. Several coloured inks can be used to produce full-colour printouts.

The droplets of ink come from tiny holes (the jets) which are less than the width of a human hair in size. Each droplet creates a tiny dot on the paper. Since the dots are so small, the quality of the printout is excellent (1200 dots-per-inch are possible). This is perfect for photographs.

Ink-jet printers are very quiet in use. Since they have so few moving parts they are also cheap to manufacture and thus cheap to purchase. However, the ink is very expensive to buy (this is how the printer companies make their profits!) so the printers are expensive to use.

Laser Printer

Laser printers are very complex devices, and thus expensive to buy. However they are very cheap to use. This is because they produce marks on paper using a fine dust called toner which is relatively cheap to buy. A single toner cartridge will often last for 5,000-10,000 pages of printing.

The laser printer uses a complex system, involving a laser, to make the toner stick to the required parts of the paper. (This system is very different to a dot-matrix or ink-jet, and you don't need to know the details.)

The laser and toner system allows very fast printing compared to other printers (just a few seconds per page).

Laser printers are very common in offices since they print very quickly, are cheap to use and are reasonably quiet.

Plotter

Plotters create hard-copy in a very different way to printers. Instead of building up text and images from tiny dots, plotters draw on the paper using a pen.

The pens are held in an arm which can lift the pen up or down, and which can move across the paper. The arm and pen create a drawing just like a human could, but much more accurately and more quickly.

Different coloured pens can be used to produce coloured line drawings.

Plotters are often used by designers and architects since they work with huge pieces of paper, far bigger than anything a normal printer could work with.

Control Actuators

A normal PC has no way of affecting what is happening around it. It can't turn on the lights, or make the room hotter. How do we change what is happening around us? We use our muscles to move things, press things, lift things, etc. (and we can also make sound using our voice).

A normal PC has no muscles, but we can give it some. In fact we can give it the ability to do lots of things by connecting a range of actuators to it.

An actuator is a device, controlled by a computer, that can affect the real-world.

Examples of actuators, and what they can do are...

Actuator	What it Can Do
Light bulb or LED	Creates light
Heater	Increases temperature
Cooling Unit	Decreases temperature
Motor	Spins things around
Pump	Pushes water / air through pipes
Buzzer / Bell / Siren	Creates noise

Actuators are used extensively in computer control systems.

Motor

Motors can provide movement.

For example, the motor in a washing machine can be controlled by a computer - it is switched on when the clothes are loaded for washing and switched off at the end of the wash.

Computer-controlled motors are also found in microwave ovens (to turn the food around) and air-conditioning units (to drive the fan)

Pumps

A pump is basically a motor attached to a device that can push water or air along pipes. When the motor is switched on, water or air flows along the pipes to places it is needed.

Pumps are used in many places: as part of watering systems in greenhouses, in factories, etc.

Buzzer

Buzzers can provide noise.

For example, the buzzer in a microwave oven can be switched on by the controlling computer when the food is cooked.

Louder noises can be made using a siren or an electric bell, for example in a burglar alarm system.

Lights

Light bulbs and LEDs can be used to provide light, or to indicate something.

For example, computer-controlled lights are used in traffic lights, at music concerts. Lights are used in car dashboards to show if any of the systems in the car have problems.

Heaters / Coolers

Heaters can provide heat, and coolers can cool things down.

A computer can switch a heater on or off when needed to keep a room or a greenhouse at the correct temperature during winter.

A computer can switch a cooling unit on or off to keep a room at the correct temperature during hot weather, or to keep food fresh.

Compiler and Interpreter

What is a Compiler?

A compiler is a software program that transforms high-level source code that is written by a developer in a high-level programming language into a low level object code (binary code) in machine language, which can be understood by the processor. The process of converting high-level programming into machine language is known as compilation.

What is an Interpreter?

An interpreter transforms or interprets a high-level programming code into code that can be understood by the machine (machine code) or into an intermediate language that can be easily executed as well. The interpreter reads each statement of code and then converts or executes it directly.

Difference between Compiler and Interpreter

	COMPILER	INTERPRETER
1	Compiler works on the complete program at once. It takes the **entire program** as input.	Interpreter program works line-by-line. It takes **one statement at a time** as input.
2	Compiler generates intermediate code, called the **object code or machine code.**	Interpreter does not generate intermediate object code or machine code.
3	Compiler executes conditional control statements (like if-else and switch-case) and logical constructs **faster than interpreter.**	Interpreter execute conditional control statements at a much **slower speed.**
4	**Compiled programs take more memory** because the entire object code has to reside in memory.	Interpreter does not generate intermediate object code. As a result, **interpreted programs are more memory efficient.**
5	Compile once and run anytime. Compiled program does not need to be compiled every time.	Interpreted programs are interpreted line-by-line every time they are run.
6	Errors are reported after the **entire program is checked** for syntactical and other errors.	Error is reported as soon as the first error is encountered. Rest of the program will not be checked until the existing error is removed.
7	A compiled language is more difficult to debug.	Debugging is easy because interpreter stops and reports errors as it encounters them.

8	Compiler does not allow a program to run until it is completely error-free.	Interpreter runs the program from first line and stops execution only if it encounters an error.
9	Compiled languages are more efficient but difficult to debug.	Interpreted languages are less efficient but easier to debug. This makes such languages an ideal choice for new students.
10	**Examples** of programming languages that use compilers: C, C++, COBOL	**Examples** of programming languages that use interpreters: BASIC, Visual Basic, Python, Ruby, PHP, Perl, MATLAB, Lisp

Data Storage

When we talk about ‘storing’ data, we mean putting the data in a known place. We can later come back to that place and get our data back again.

‘Writing’ data or ‘saving’ data are other ways of saying ‘storing’ data.

‘Reading’ data, ‘retrieving’ data or ‘opening’ a file are ways of saying that we are getting our data back from its storage location.

Main Memory

Main memory (sometimes known as internal memory or primary storage) is another name for RAM (and ROM).

Main memory is usually used to store data temporarily. In the case of RAM, it is volatile (this means that when power is switched off all of the data in the memory disappears).

Main memory is used to store data whilst it is being processed by the CPU. Data can be put into memory, and read back from it, very quickly.

Backing Storage

Backing storage (sometimes known as secondary storage) is the name for all other data storage devices in a computer, hard-drive etc.

Backing storage is usually non-volatile, so it is generally used to store data for a long time.

Storage Media and Devices

The device that actually holds the data is known as the storage medium ('media' is the plural).

The device that saves data onto the storage medium, or reads data from it, is known as the storage device.

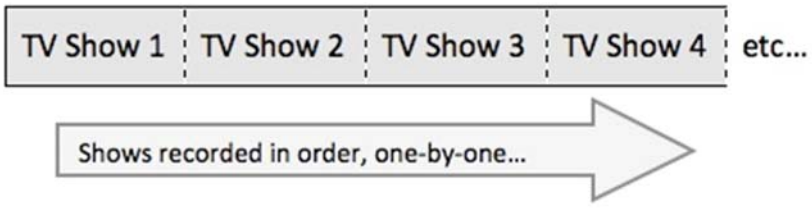
Sometimes the storage medium is a fixed (permanent) part of the storage device, e.g. the magnetic coated discs built into a hard drive

Sometimes the storage medium is removable from the device, e.g. a CD-ROM can be taken out of a CD drive.

Serial / Sequential Access

A serial (or sequential) access storage device is one that stores files one-by-one in a sequence.

A non-computer serial access device that will be familiar to you is a VHS videotape. Because video is stored on a long piece of tape, when TV shows are recorded onto the tape, they go on one-by-one, in order.



If you want to watch a show that you recorded earlier, you have to rewind / fast-forward through all other shows until you find it.

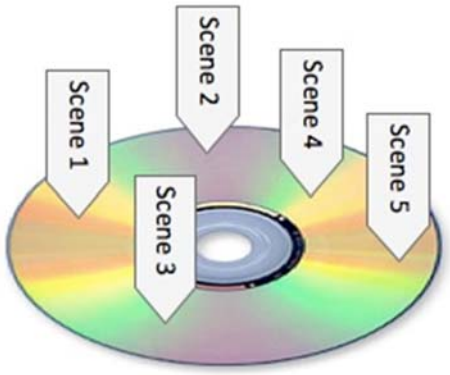
The shows are only accessible in the same order that you recorded them. This type of one-by-one storage and access is called serial access.

Direct / Random Access

A direct (or 'random') access storage device is one that stores files so that they can be instantly accessed - there is no need to search through other files to get to the one you want.

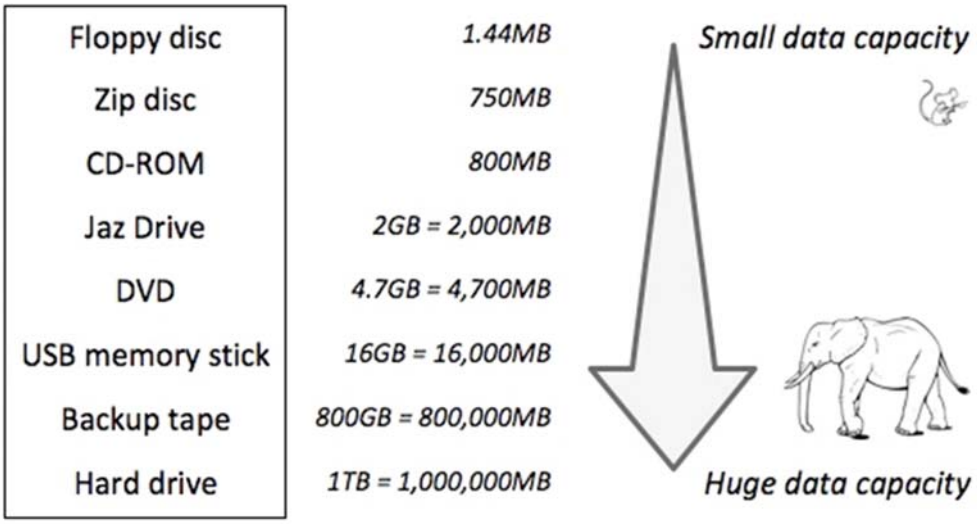
An example of a direct access device would be a DVD movie. Unlike the VHS videotape movie, you can jump to any scene on a DVD.

All parts of the DVD are directly accessible. This type of file storage is called direct access.



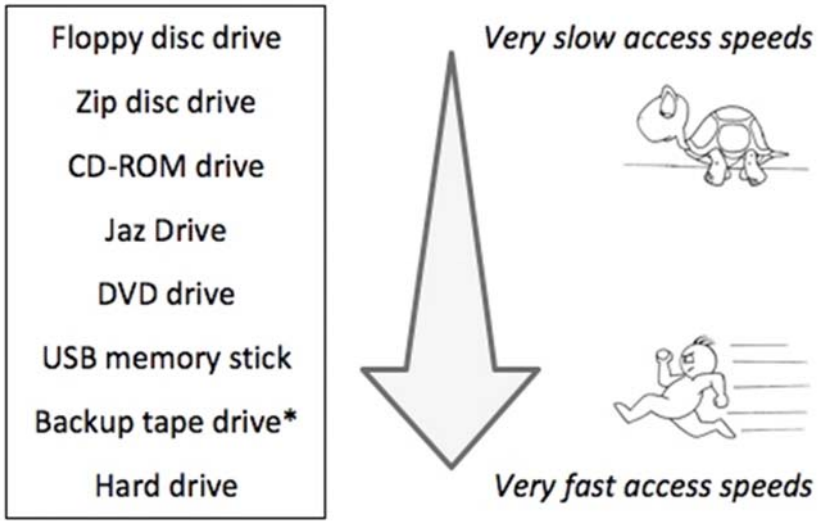
Data Storage Capacity

Some storage media can only store a very limited amount of data, whilst others can store vast amounts.



Data Access Speeds

Some storage devices can access data very quickly, whilst others are extremely slow.



Magnetic Storage Media/Devices

Why Magnetic?

Magnetic storage media and devices store data in the form of tiny **magnetised dots**. These dots are created, read and erased using magnetic fields created by very tiny **electromagnets**.

In the case of magnetic tape the dots are arranged along the length of a **long plastic strip** which has been coated with a magnetisable layer (audio and video tapes use a similar technology).

In the case of magnetic **discs** (e.g. floppy disc or hard-drive), the dots are arranged in **circles** on the surface of a **plastic, metal or glass** disc that has a magnetisable coating.

Hard Drives

Hard-drives have a **very large storage capacity** (up to 4TB). They can be used to store vast amounts of data. Hard-drives are **random access** devices and can be used to store all types of files, including **huge files** such as movies. Data **access speeds** are **very fast**.

Data is stored inside a hard-drive on rotating metal or glass discs (called ‘platters’).

Fixed Hard Drive

A hard-drive **built into the case** of a computer is known as 'fixed'. Almost every computer has a fixed hard-drive.

Fixed hard-drives act as the **main backing storage device** for almost all computers since they provide almost instant access to files (**random access** and **high access speeds**).

Portable Hard Drive

A portable hard-drive is one that is placed into a **small case** along with some electronics that allow the hard-drive to be accessed using a **USB** or similar connection.

Portable hard-drives allow very **large amounts of data** to be **transported** from computer to computer.

Magnetic Tape

Magnetic tape is a **large capacity**, **serial access** medium. Because it is a serial access medium, accessing individual files on a tape is **slow**.

Tapes are used where **large amounts of data** need to be stored, but where quick access to individual files is not required. A typical use is for **data back-up** (lots of data, but rarely only accessed in an emergency)

Tapes are also used in some **batch-processing** applications (e.g. to hold the list of data that will be processed).

Removable Media Magnetic Discs

Floppy Disc

A **removable**, **portable**, **cheap**, **low-capacity** (1.44MB) storage medium. Floppy discs are **random access** devices used for transfer **small amounts of data** between computers, or to back-up small files, etc. Access times are **slow**.

Almost every PC used to have a floppy disc drive. These are **obsolete** now, having been replaced by higher capacity technology such as CD-ROMs, DVDs and USB memory sticks.

Zip Disc

A **removable** and **portable** storage medium, similar in appearance to a floppy disk, but with a much **higher capacity** (100MB, 250MB or 750MB).

Zip discs are **random access** devices which were used for data back-up or moving **large files** between computers.

Another **obsolete** storage device, zip discs were a popular replacement for floppy discs for a few years, but they never caught on fully before being superseded by cheaper media like CD-ROMs and CD-Rs.

Jazz Disc

A **removable** and **portable** storage medium based on hard-drive technology, with a **large capacity** (1GB or 2GB).

Jazz discs are **random access** devices which were used for data **back-up** or moving **large files** between computers.

Discs were **expensive** to buy and **not very reliable**.

Like the Zip disc, this system never really caught on and was superseded by far cheaper and more reliable and cheaper technology.

Optical Storage Media/Devices

Why 'Optical'?

Optical storage devices save data as patterns of **dots** that can be read using **light**. A **laser beam** is the usual light source.

The data on the storage medium is read by bouncing the laser beam off the surface of the medium. If the beam hits a dot it is **reflected** back differently to how it would be if there were no dots. This difference can be detected, so the data can be read.

Dots can be created using the laser beam (for media that is **writable** such as CD-Rs). The beam is used in a high-power mode to actually mark the surface of the medium, making a dot. This process is known as '**burning**' data onto a disc.

Read-Only Optical Discs

Read-only optical discs have data written onto them when they are **manufactured**. This data **cannot be changed**.

CD-ROM

Compact Disc - Read-Only Memory (CD-ROM) discs can hold around**800MB** of data. The data cannot be altered (non-volatile), so cannot be accidently deleted. CD-ROMs are **random-access** devices.

CD-ROMs are used to **distribute** all sorts of data: **software** (e.g. office applications or games), **music**, electronic **books** (e.g. an encyclopedia with sound and video.)

DVD-ROM

Digital Versatile Disc - Read-Only Memory (DVD-ROM) discs can hold around **4.7GB** of data (a dual-layer DVD can hold twice that). DVD-ROMs are **random-access** devices.

DVD-ROMs are used in the same way as CD-ROMs (see above) but, since they can hold more data, they are also used to store high-quality **video**.

High Capacity Optical Discs

Blu-Ray

Blu-Ray disks are a recent replacement for DVDs. A Blu-Ray disc can hold **25 - 50GB** of data (a dual-layer Blu-Ray disc can hold twice that). Blu-Ray discs are **random-access** devices.

Blu-Ray discs are used in the same way as DVD-ROMs (see above) but, since they can hold more data, they are also used to store very high-quality, **high-definition (HD) video**.

HD DVD

High-density DVD (HD-DVD) discs can hold around **15GB** of data (a dual-layer HD-DVD can hold twice that). HD-DVDs are **random-access** devices.

HD-DVD discs are used in the same way as DVD-ROMs (see above) but, since they can hold more data, they are also used to store very high-quality, **high-definition (HD) video**.

Recordable Optical Discs

Recordable optical discs can have **data written** onto them ('**burnt**') by a computer user using a special disc drive (a disc '**burner**').

CD-R and DVD-R

CD-Recordable (CD-R) and DVD-recordable (DVD-R) discs can have **data burnt** onto them, but **not erased**. You can keep adding data **until the disc is full**, but you cannot remove any data or re-use a full disc.

CD-RW and DVD-RW

CD-ReWritable (CD-RW) and DVD-ReWritable (DVD-RW) discs, unlike CD-Rs and DVD-Rs, can have **data burnt** onto them and **also erased** so that the discs can be **re-used**.

DVD-RAM

DVD-Random Access Memory (DVD-RAM) discs are a type of **re-writable** DVD. They often come in a floppy-disc style **case** (to protect the disc).

DVD-RAM discs have a similar capacity to a normal DVD, holding**4.7GB** of data. DVD-RAM discs are **random-access** devices.

DVD-RAM discs are used in many **camcorders** (video recording cameras).

The discs are much higher quality than normal DVD-RWs and can reliably store data for up to 30 years. This means that they are often used for video and data **back-up** and **archiving**.

Solid-State Storage Devices

'Solid-State'?

The term ‘solid-state’ essentially means ‘no moving parts’.

Solid-state storage devices are based on **electronic circuits** with **no moving parts** (no reels of tape, no spinning discs, no laser beams, etc.)

Solid-state storage devices store data using a special type of **memory** called **flash memory**...

Flash Memory

Flash memory is a type of Electronically-Erasable Programmable Read-Only Memory (**EEPROM**). Flash memory is **non-volatile** (like ROM) but the data stored in it can also be **erased** or **changed** (like RAM).

Flash memory can be found in many data storage devices...

USB Memory Sticks

Memory sticks (or ‘thumb-drives’) have made many other forms of portable storage almost obsolete (why burn a CD or DVD when you can more easily copy your files onto a memory stick?).

Memory sticks are **non-volatile**, **random-access** storage devices.

Each of these small devices has some **flash memory** connected to a **USB interface**. Plug it into your computer and it appears as a drive. You can then add files, erase files, etc. You can use it to **move any type of file** between computers.

Flash memory used to be very expensive, but in recent years it has become much **cheaper** and you can now buy a 16GB memory stick for just a few dollars.

Memory Cards

Many of our digital devices (**cameras**, **mobile phones**, **MP3 players**, etc.) require **compact**, **non-volatile** data storage. Flash memory cards provide this and come in a variety of shapes and sizes.

One of the most common formats used by digital cameras is the SD Card. The cards store the digital images taken by the camera.

Mobile phones contain a Subscriber Identity Module (**SIM**) card that contains the phone's number, the phonebook numbers, text messages, etc.

Many phones also have extra memory cards to store music, video, photos, etc. (e.g Tiny Micro-SD cards).

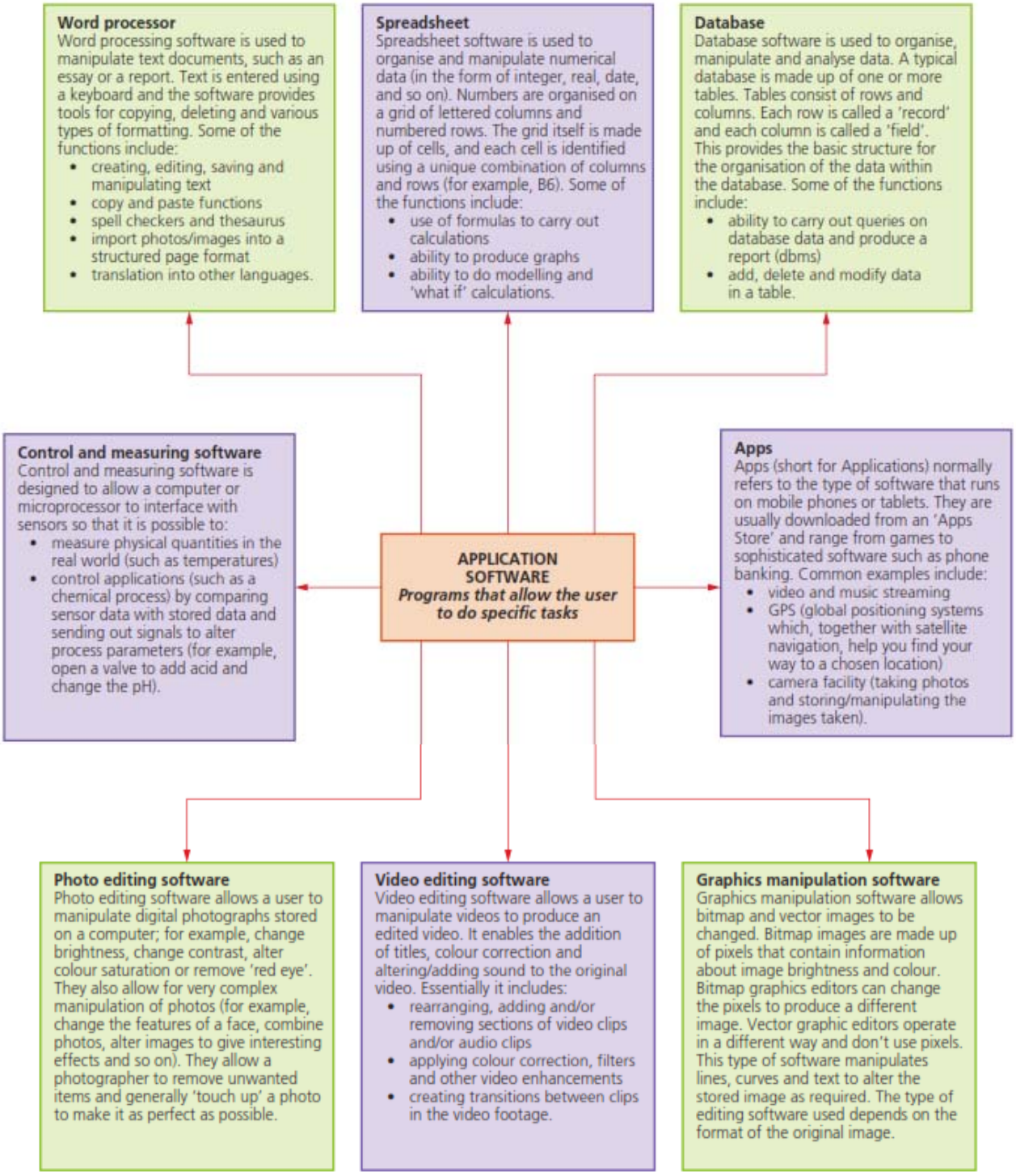
Smart Cards

Many credit cards (e.g. '**chip-and-pin**' cards), door entry cards, satellite TV cards, etc. have replaced the very limited storage of the magnetic strip (the dark strip on the back of older cards) with **flash memory**. This is more **reliable** and has a much **larger storage capacity**.

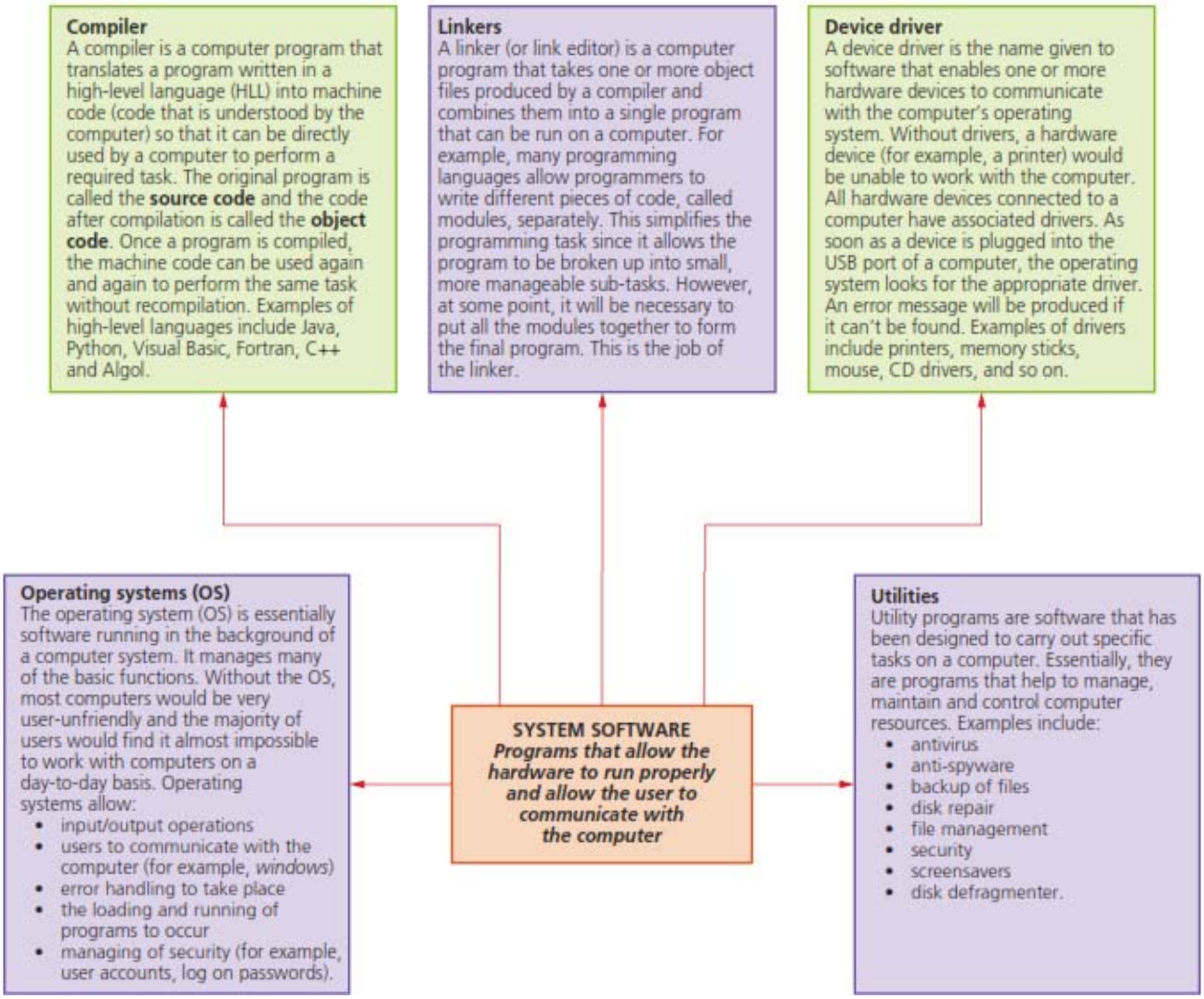
Cards with flash memory are called **smart cards**.

Types of Software

Application software:



System software:



Utility software:

Disk compression utilities

Disk compression tools do the job of compressing or decompressing data on the drive, so that there is more space for additional data to be stored.

Disk checkers and cleaners

These utilities check the hard drive for any damaged or unnecessary files and delete them for efficient hard disk functioning. These tools are good for increasing the speed of a slow computer.

Antivirus software

There are many different antivirus software available to purchase on the market and even some free versions for download. They protect your computer against any viruses which may attempt to get on your computer.

Backup utilities

As the name suggests, these data backup tools are used to copy all information and provide it, when required, such as in case of disk failure or file corruption.

Operating systems:

To enable computer systems to function and to allow users to communicate with computer systems, special software known as **operating systems (OS)** have been developed. The general tasks for a typical operating system include:

- control the operation of the input, output and backing storage devices
- supervise loading, running and storage of applications programs
- deal with errors that occur in application programs
- maintain security of the whole computer system
- maintain a computer log (which details computer usage)
- allow communication between the user and the computer system (user interface).

User interfaces

Command line interface (CLI)

Command line interface (CLI) requires a user to type in instructions to choose options from menus, open software and so on. There are often a number of commands that need to be typed in, for example, to save or load a file. The user therefore has to learn a number of commands just to carry out basic operations. Having to key in these commands every time an operation has to be carried out is also slow. However, the advantage of CLI is that the user is in direct communication with the computer and is not restricted to a number of predetermined options.

Graphical user interface (GUI)

Graphical user interface (GUI) allows the user to interact with a computer (or MP3 player, gaming device, mobile phone, and so on) using pictures or *icons* (symbols) rather than having to type in a number of commands.

GUIs use various technologies and devices to provide the user interface. One of the most common is **WIMP (windows icons menu and pointing device)**, which was developed for use on personal computers (PCs). Here a mouse is used to control a cursor and icons are selected to open/run windows. Each window contains an application, and modern computer systems allow several windows to be open at the same time. A windows manager looks after the interaction between windows, the applications and windowing system (which handles the pointing devices and the cursor's position).

In recent years, devices such as **touch-screen** phones use **post-WIMP** interaction, where fingers are in contact with the screen allowing actions such as *pinching* and *rotating*, which would be difficult to do using a single pointer and device such as a mouse.

Summary of the main differences between CLI and GUI

Interface	Advantages	Disadvantages
Command line interface (CLI)	• the user is in direct communication with the computer • the user is not restricted to a number of predetermined options • it is possible to alter computer configuration settings	• the user needs to learn a number of commands to carry out basic operations • all commands need to be typed in, which takes time and can be error prone • each command must be typed in using the correct format, spelling, and so on • more difficult to edit once commands entered
Graphical user interface (GUI)	• the user doesn't need to learn any commands • it is more user-friendly; icons are used to represent applications • a pointing device (such as a mouse) is used to click on an icon to launch the application – this is simpler than typing in commands	• uses up considerably more computer memory than a CLI interface • the user is limited to the icons provided on the screen • needs an operating system, such as Windows, to operate, which uses up considerable memory

Dialogue interface

This is a way of interacting with your environment by means of the spoken word.

For example; many modern cars have a dialogue interface to allow control of the radio and mobile phone whilst driving. The driver simply says a certain command word such as 'Radio 2' whilst the car is in 'listening mode'. The computer controlling the interface will make sense of the command and take action, switching the radio to radio 2.

Another example might be in a 'smart home' where the user can control the temperature, light intensity, sound systems or curtains being closed by the use of spoken commands.

In order for these interfaces to work effectively they need to be 'trained' with the user. This involves the user speaking the commands until the system accepts the command and reacts appropriately.

Once training is complete the system becomes quite reliable in understanding the user commands. However, noise in the background can be a problem and may interfere with the interface understanding the command. Dialogue interfaces often have a limited vocabulary.

Gesture based interface

Gestural UI refers to using specific gestures, like scrolling, pinching, and tapping to operate an interface. Gestural user interface and gesture recognition technology has evolved from very basic motions and applications to the complex, and it is now part of everyday life for a huge number of people. As this technology continues to evolve, the future possibilities are also incredibly exciting.

Smartphones and Tablets

Currently, smartphones and tablets are the most common place everyday consumers can find gestural UI. From Apple iPhones to the Samsung Galaxy, the vast majority of contemporary phones incorporate some elements of gesture UI, from swiping and scrolling, which is common to most phones and tablets, to orientation recognition.

The Samsung Galaxy S4 is an example of one smartphone that has taken gesture UI a step further. The phone tracks and recognizes your eye movement and automatically scrolls down as your eyes reach the bottom of the page.

Gaming

Gaming is another area where gesture UI is already commonplace. The Xbox 360 and Xbox One consoles, for example, use the Kinect system to track player movements via cameras and sensors. The PlayStation 3 and 4 consoles use PlayStation Play in a similar manner, while the Nintendo Wii and Wii U use motion sensors and remote controls to track player gestures and movement.

Medicine

In the world of medicine, the future of the gestural user interface is very promising. One of the most notable innovations is the introduction of gestural UI in surgery. Plans include a hand gesture recognition system that enables surgeons to review images and patient records during surgery. The ability to manipulate the interface via non-touch gestures reduces surgery time, as surgeons won't be forced to exit the operating theater to access traditional computer terminals.