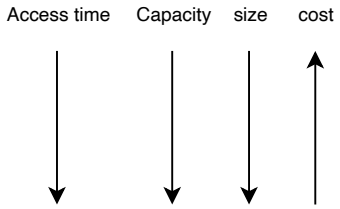
ALevel CS C03 Hardware(1)

Computer three major area of operation capability:
1. the processing of data
2. the storage of data
3. the input and output of data

Data Storage:

Component	Category
Register	Processor component
Cache memory	Primary storage
Main memory	Primary storage
Hard disk	Secondary storage
Auxiliary storage	Secondary storage



Choosing a storage medium:

integral part of the system, which the user cannot normally get access	hard disk solid-state drive
individual item, can be inserted into a drive	floppy disk optical disc magnetic tape cartridge
peripheral device, can be connected to the system when needed	hard drive memory stick memory card
portable item, can carry around with them for attaching to different systems	flash memory stick floppy disk optical disc
remote from the system, possibly accessible via a network connection;	cloud storage magnetic tape RAID SAN

Primary memory

RAM:
1. SRAM
2. DRAM

ROM
1. PROM
2. EPROM
3. EEPROM

Secondary storage

hard disk driver(HDD)

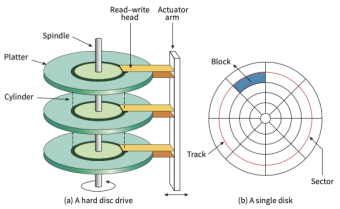
solid state driver(SSD)

removable devices
1. DVD/CD/Blu-ray
2. flash memory stick
3. hard disk driver

Data output:
1. screen display
2. hardcopy using a printer or plotter
3. virtual headset display
4. a speaker
5. writing to any of the data storage devices described earlier
6. transmission on a network link.

Data input:
1. keyboard or keypad entry by a user
2. user interaction with a screen using screen icons or menus; possibly using a pointing device and possibly involving the use of a touch screen
3. a user using a game controller
4. a user using a scanner
5. a user using a microphone in tandem with voice recognition software
6. reading from any of the storage devices described earlier
7. transmission on a network link.

Magnetic media:
For either type of magnetic medium the interaction with it is controlled by a read head and a write head.



1. there is more than one **platter** (**disk**)
2. each platter has a **read–write head** for each side
3. the platters **spin in unison (all together and at the same speed)**
4. the **read–write heads** are attached to **actuator arms** which allow the heads to move over the surfaces of the platters
5. the motion of each read–write head is synchronised with the motion of the other heads
6. a **cushion of air** ensures that a head does not touch a platter surface.

Embedded System:
An embedded system must still contain a processor, memory and an I/O capability.
If these are constructed on one chip this is called a **microcontroller**.

advantage:
1. they are special-purpose, possibly performing only a single function.
2. Mass production of an embedded system brings economies of scale

disadvantage:
1. programming was difficult because the memory space available to store a program was limited.
2. if errors were found following installation then new chips had to be manufactured and used to replace the faulty ones.

Random-access memory(RAM): volatile memory that can be read from or written to any number of times

RAM feature:
1. **direct-access memory**: any byte of data stored can be accessed without affecting the other bytes stored.
2. **read–write memory**: RAM can be repeatedly read from or written to.
3. **volatile**: when the computer system is switched off the contents of the memory are lost.

Dynamic RAM(DRAM): constructed from capacitors that leak electricity and therefore need regularly recharging (every few milliseconds) to maintain the identity of the data stored.

Static RAM(SRAM): constructed from flip-flops that continue to store data indefinitely while the computer system is switched on.

Basis for comparison	SRAM	DRAM
Speed	Faster	Slower
Size	Small	Large
Cost	Expensive	Cheap
Used in	Cache memory	Main memory
Density	less dense	highly dense
Construction	Complex	Simple, few transistors
power consumption	Low	High

Read-only memory (ROM): non-volatile memory that cannot be written to but can be read from any number of times

ROM feature:
1. **read-only**: cannot be written to when in use within the computer system.
2. **non-volatile**: not lost when the computer system is switched off

ROM usage:
1. storing the bootstrap program

Four different types of ROM:
1. **simplest type of ROM**: programs or data are installed as part of the manufacturing process. If different contents are needed the chip must be replaced.
2. **Programmable ROM(PROM)**: The system builder installs the program or data into the chips. the program or data once installed cannot be changed.
3. **Erasable PROM (EPROM)**: The installed data or program can be erased (using ultraviolet light) and new data or a new program can be installed. However, this reprogramming usually requires the chip to be removed from the circuit.
4. **Electrically Erasable PROM (EEPROM)**: an electrical signal can be used to remove existing data. This has the major advantage that the chip can remain in the circuit while the contents are changed. However, the chip is still used as read-only.

Buffer: a temporary storage created for data transmitted from one part of the system to another which functions as a queue

DRAM	SRAM
1. consists of a number of transistors and capacitors 2. needs to be **constantly refreshed** 3. **less expensive** to manufacture than SRAM 4. has a **higher memory** capacity than SRAM 5. **main memory** is constructed from DRAM 6. consumes **more power** than SRAM under reasonable levels of access, as it needs to be constantly refreshed	1. uses flip-flops to hold each bit of memory 2. does not need to be constantly refreshed 3. has a **faster data access** time than DRAM 4. **processor memory cache** makes use of SRAM 5. if accessed at a high frequency, power usage can exceed that of DRAM

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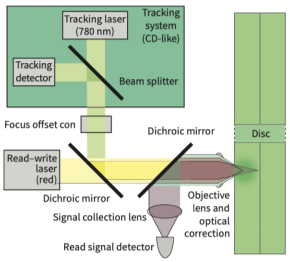
Optical media:
feature for the process of reading data from the disc:



1. The optical disc has one spiral track running from the inner extreme of the surface to the outer edge.
2. During operation, the disc spins.
3. Simultaneously the laser moves across ensuring that it is continuously focused on the spiral track.
4. The track on the surface of the disc has what are referred to as 'pits' and 'lands'.
5. The laser beam is reflected from the surface of the disc.
6. The difference between the reflection from a pit compared to that from a land can be detected.
7. This difference in the intensity of the light the detector receives can be interpreted as either a 1 or a 0 to allow a binary code to be read from the disc.

Laser printers: used to produce working, solid objects. The solid object is built up layer by layer using materials such as powdered resin, powdered metal, paper or ceramic.

Colour laser printers use four toner cartridges – blue, cyan, magenta and black.
1. data from the document is sent to a **printer driver**
2. printer driver ensures that the data is in a format that the chosen printer can understand
3. check is made by the printer driver to ensure that the chosen printer is available to print
4. data is sent to the printer and stored in a temporary memory known as a **printer buffer**
5. **printing drum given a positive charge.** As this drum rotates, a laser beam scans across it removing the positive charge in certain areas, leaving negatively charged areas which exactly match the text/images of the page to be printed
6. **drum is coated with positively charged toner** (powdered ink). Since the toner is positively charged, it **only sticks to the negatively charged parts of the drum**
7. negatively charged sheet of paper is rolled over the drum
8. **toner on the drum sticks to the paper** to produce an exact copy of the page sent to the printer
9. to prevent the paper sticking to the drum, the electric charge on the paper is removed after one rotation of the drum
10. the paper goes through a **fuser (a set of heated rollers)**, where the heat melts the ink so that it fixes permanently to the paper
11. a discharge lamp removes all the electric charge from the drum so it is ready to print the next page

Screens: LCD, LED, OLED(organic light emitting diode)
OLED does not need back light. LCD needs back light.
OLED allows for very thin screens
Screen displays are based on the **pixel** (the smallest picture element) concept where each screen pixel is **made up of three sub-pixels, which are red, green and blue.**
The greater the number of pixels on a screen, the greater is the **screen resolution**
Touch screen: Capacitive and Resistive
Capacitive: a rigid surface above a conductive layer that undergoes a change in electrical state when a finger touches the screen
Capacitive benefits:
1. Medium **cost technology**.
2. Screen visibility is good even in strong sunlight.
3. Permits **multi-touch capability**.
4. Screen is very **durable**; it takes a major impact to break the glass.

Capacitive drawbacks:
1. Only allows use of bare fingers as the form of input; although the latest screens permit the use of a special stylus to be used.

Resistive:a flexible surface that causes contact between electrically resistive layers beneath when touched
Resistive benefits:
1. Relatively **inexpensive** technology.
2. Possible to use bare fingers, gloved fingers or stylus to carry out an input operation.

Resistive drawbacks:
1. Screen **visibility is poor in strong sunlight.**
2. Does **not permit multi-touch capability.**
3. Screen durability is only fair; it is vulnerable to scratches and the screen wears out through time.

Solid-state media: no moving parts and all data is retrieved at the same rate. **flash memory(use NAND)** and **EEPROM(use NOR)**.
1. are **more reliable** (no moving parts to go wrong)
2. are considerably lighter (which makes them suitable for laptops)
3. do not have to 'get up to speed' before they work properly
4. have a lower power consumption
5. run **much cooler** than HDDs (both these points again make them very suitable for laptop computers)
6. are very **thin** (because they have no moving parts)
7.access data considerably faster.

Inkjet printers:
Inkjet printers are made up of:
1. a **print head** consisting of nozzles that spray droplets of ink onto the paper to form characters
2. an **ink cartridge or cartridges**; either one cartridge for each colour (blue, yellow and magenta) and a black cartridge, or one single cartridge containing all three colours and black (note: some systems use six colours)
3. a **stepper motor and belt** which moves the print head assembly across the page from side to side
4. a **paper feed** which automatically feeds the printer with pages as they are required.

Inkjet printer step:
1. data from the document is sent to a printer driver
2. printer driver ensures that the data is in a format that the chosen printer can understand
3. check is made by the printer driver to ensure that the chosen printer is available to print
4. data is sent to the printer and stored in a temporary memory known as a printer buffer
5. a sheet of paper is fed into the main body of the printer. A **sensor detects** whether paper is available in the paper feed tray – if it is out of paper (or the paper is jammed), an error message is sent back to the computer
6. as the sheet of paper is fed through the printer, the **print head moves from side to side across the paper** printing the text or image. The four ink colours are sprayed in their exact amounts to produce the desired final colour
7. at the end of each full pass of the print head, the paper is advanced very slightly to allow the next line to be printed. This continues until the whole page has been printed
8. if there is more data in the printer buffer, then the whole process from stage 5 is **repeated until the buffer is empty**
9. once the printer buffer is empty, the printer sends an interrupt to the processor in the computer, which is a request for more data to be sent to the printer. The process continues until the whole of the document has been printed

3D printers: Laser printers use dry powder ink rather than liquid ink and make use of the properties of static electricity to produce the text and images.
3D printers use **additive manufacturing** (the object is built up layer by layer); this is in contrast to the more traditional method of **subtractive manufacturing** (removal of material to make the object).
3D printer step:
1. A 3D design is created in a suitable computer-aided design (CAD) package.
2. The design is split into layers.
3. The data for the first layer is transmitted to the 3D printer.
4. the 3D printer uses a nozzle to squirt material on to the printer bed to create a physical layer to match the design.
5. This process is repeated for successive layers.
6. it has to be cured in some way to ensure that the layers are stuck together and the material has been converted to the form required for the finished product.

3D printer type:
1. **Direct 3D printing**: uses inkjet technology;
2. **Binder 3D printing**; uses two passes for each of the layers; the first pass sprays dry powder and then on the second pass a binder (a type of glue) is sprayed to form a solid layer.
3. Newer technologies use **lasers and UV light** to harden liquid polymers; this further increases the diversity of products which can be made.

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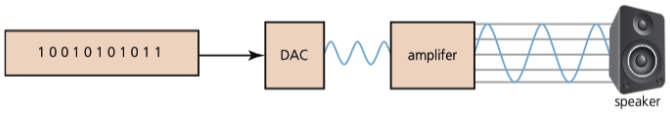
Speakers:
speakers step:
1. The digital data is first passed through a **digital to analogue converter (DAC)** where it is converted into an electric current.
2. This is then passed through an **amplifier** (since the current generated by the DAC will be small) to create a current large enough to drive a loudspeaker.
3. This electric current is then fed to a loudspeaker where it is **converted into sound**.

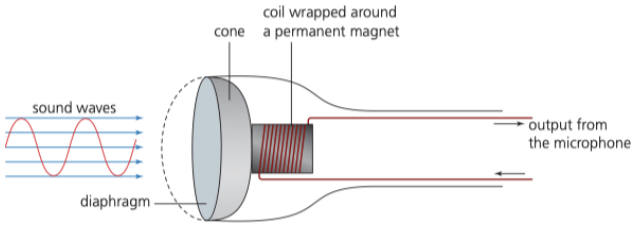


Keyboard: allow user to input a text. The key press has to be converted to a character code, which is transmitted to the processor.
keyboard work details:
1. the keyboard has electrical circuitry together with its own microprocessor and a ROM chip
2. The keys are positioned above a key matrix, which consists of a set of rows of wires and another set of columns of wires.
3. Pressing a key causes contact at one of the points where wires cross.
4. The microprocessor continuously tests to see if any electrical circuit involving a row wire and a column wire has become closed.
5. When the microprocessor recognises that a circuit has become closed, it can identify the particular intersection (wire crossing point) that is causing this.
6. The processor then uses data stored in the ROM to identify the character code relating to the key associated with that intersection and sends this character to the screen .

Monitoring: collection, recording, and reporting of project information that is of importance to the project manager and other relevant stakeholders.
Control: uses the monitored data and information to bring actual performance into agreement with the plan.
Sensors: Sensors are input devices which read or measure physical properties, such as temperature, pressure, acidity, and so on.
1. Real data is analogue in nature
2. ADC(analogue to digital)
3. used in both monitoring and control applications.
Actuator: a hardware device that receives a signal from a computer and adjusts the setting of a controlling device
feedback devices are used as part of a closed-loop system. A control system monitors an output, and then sends this output information back to the system as a feedback signal, which it uses to compare the actual output with the forecasted one.

sensor	Example applications
temperature	1. control a central heating system 2. control/monitor temperature in a greenhouse
pressure	1. detect intruders in a burglar alarm system 2. check weight (such as the weight of a vehicle) 3. monitor/control a process where gas pressure is important
infrared	1. turn on windscreen wipers on a car when it rains 2. detect an intruder in a burglar alarm system 3. count people entering or leaving a building
sound	1. pick up noise levels (such as footsteps or breaking glass) in a burglar alarm system 2. detect noise of liquids dripping from a pipe

Microphones: **analogue to digital converter (ADC)**
microphone steps:
1. When sound is created, it causes **the air to vibrate**.
2. When a **diaphragm** in the microphone picks up the air vibrations, the diaphragm also begins to vibrate.
3. A **copper coil** is wrapped around a permanent magnet and the coil is connected to the diaphragm using a cone. As the diaphragm vibrates, the cone moves in and out causing **the copper coil to move backwards and forwards**.
4. This forwards and backwards motion causes the magnetic field around the permanent magnet to be disturbed, inducing **an electric current.**
5. The electric current is then either amplified or sent to a recording device. The electric current is **analogue** in nature.



Virtual headset: give the user the feeling of being there.
1. Video is sent from a computer to the headset
2. Two feeds are sent to an LCD/OLED display. lenses placed between the eyes and the screen allow for focusing and reshaping of the image/video for each eye, thus giving a 3D effect and adding to the realism.
3. Most headsets use 110° field of view which is enough to give a pseudo 360° surround image/video.
4. As the user moves their head (up and down or left to right), a series of sensors and/or LEDs measure this movement, which allows the image/video on the screen to react to the user's head movements
5. Headsets also use binaural sound (surround sound) so that the speaker output appears to come from behind, from the side or from a distance, giving very realistic 3D sound.
6. Some headsets also use infrared sensors to monitor eye movement