

RAM – Random Access Memory

- Volatile memory – data is lost when the computer is turned off.
- Called random access because data can be directly written to or read from any location.
- Used to hold data and instructions that are currently in use.
- The more RAM a computer has, the more data it can hold simultaneously.

Von Neumann Architecture

- Key elements:
- Data and instructions are stored in binary.
 - Data and instructions are stored together in **RAM**.
 - Instructions are fetched from **RAM** one at a time in order
 - The **CPU** decodes and executes an instruction, before fetching the next instruction
 - The cycle continues until no more instructions are available
- A CPU using Von Neumann architecture have five special registers
- **Program counter** - holds the memory address of the next instruction to be fetched.
 - **Memory address register (MAR)** - holds the address of the current instruction.
 - **Memory data register (MDR)** - holds the content at the address held in the MAR.
 - **Current instruction register (CIR)** - holds the instruction that is currently being decoded and executed
 - **Accumulator (ACC)** - holds the results of processing

The fetch-decode-execute Cycle

1. The memory address held in the program counter is copied into the MAR.
2. The address in the program counter is then incremented - or increased - by one. The program counter now holds the address of the next instruction to be fetched.
3. The processor sends a signal containing the address of the instruction to be fetched along the address bus to the computer's memory.
4. The instruction held in that memory address is sent along the data bus to the MDR.
5. The instruction held in the MDR is copied into the CIR.
6. The instruction held in the CIR is decoded and then executed. The results of processing are stored in the ACC.
7. The cycle then returns to step one.



Programming Languages

- Low Level Languages** – very close to computer language, hard for humans to understand
- Machine code**
CPU understands machine code can directly execute it.
Consists of 0s and 1s only.
Very difficult to learn, write and debug.
- Assembly Language**
Also known as Assembly Code
Uses mnemonics (abbreviations)
Easier for humans to understand and program but still difficult
Must be translated into Machine Code for execution
Commonly used to program device drivers
- High Level Languages** – easier for humans to understand, using English like words and phrases.
Much easier to learn, write and debug.
Examples include Python, Java and C

Developing Robust Software

- What threats will the code face?
 - Are security features like usernames and passwords needed?
 - How will patches be installed and the code updated?
 - Is encryption needed?
 - Does the code need to create an audit trail?
- Audit Trail** - a record of what has been done and who or what did it.
- Code Review** – a check of code by other programmers.

Topic 3 – Computers

	Compilers	Interpreters
Advantage	<ul style="list-style-type: none"> ▪ Translates the whole code in one go into Machine Code. ▪ Optimise the code ▪ Used at the end of development when code is finished ▪ Create error reports and object code 	<ul style="list-style-type: none"> ▪ Translate and execute source code ▪ Work line by line. ▪ Syntax is checked ▪ If code is correct it is executed ▪ If code is incorrect interpreting is stopped.
	<ul style="list-style-type: none"> ▪ Compiled programs run quickly and without needing additional software. ▪ Programs are supplied as executables which cannot be modified. ▪ Optimise code so it runs quickly and uses less memory. 	<ul style="list-style-type: none"> ▪ Instructions are executed as soon as they are translated. ▪ Instructions are not stored for later so less memory is needed. ▪ Errors can be quickly spotted.
Disadvantages	<ul style="list-style-type: none"> ▪ Because the source code is translated as a whole, more memory is needed. ▪ Requires a working space for the compiler to perform the translation. ▪ Do not spot errors. ▪ Code must be re-compiled if changed. ▪ Code compiled on one platform will not run on another. 	<ul style="list-style-type: none"> ▪ The CPU must wait for each instruction to be translated so execution is slower. ▪ Code is translated each time it is run. ▪ Do not produce an executable file that can be distributed ▪ Do not optimise code.

- ### Embedded Systems
- A small computer which includes hardware and software, designed to control a specific device.
 - Forms a part of a larger device such as a washing machine.
 - Can perform only a limited number of tasks.
 - Have several advantages:
 - Cheaper to design and build.
 - Require less power.
 - Do not need much processing power.

- ### Operating Systems
- File management**
- Allows users to find and manage data stored by the computer.
 - Data is stored in files, within folders, within drives.
 - Assigns metadata to files including date created, date modified, last date accessed
- Process management**
- Allows users to run applications such as web browsers or word processors.
 - Multiprogramming enables several programs to run at the same time.
 - Each program is made up of instructions. When running, they are called a process.
 - Allocates use of the main memory and the CPU between processes.
 - A scheduler is used to time the different processes.
- Peripheral Management**
- Manages input and output between peripherals and a process.
 - Data is transferred between input devices, the CPU, and output devices.
 - Uses device drivers to communicate with devices.
- User Management**
- Individual users can be created and deleted.
 - Allows more than one person to use a computer with their own files and settings.
 - Access levels control user access to systems for security.

- ### Secondary Storage
- Used to store programs and data for longer term when the computer is switched off
 - Non-volatile – data is retained with the computer is switched off.
 - Not all computers require secondary storage.
 - Embedded computers such as a watch do not need to store data when power is turned off.
- Magnetic devices**
- Use magnetic fields to magnetise individual sections of a spinning disk.
 - Each section represents one bit.
 - A read/write head moves across its surface.
 - Fairly cheap, high in capacity and durable.
 - Susceptible to damage if dropped.
 - Vulnerable to magnetic fields.
- Optical Devices**
- Use a laser to scan the surface of a spinning disc.
 - The disc surface is divided into tracks, with each track containing flats and hollows.
 - The flat areas are known as lands and the hollows as pits.
 - Lands reflects the laser light back; pits scatter the beam.
 - ROM (Read Only Media) cannot be overwritten. Used for music, films, software and games.
 - Read (R) media is blank, can only be written to once, but read many times.
 - Read/write (RW) media can be written to more than once.
- Solid State Devices**
- Use flash memory to store data indefinitely.
 - Have faster access times than other devices
 - Because they have no moving parts, are more durable.
 - More expensive so tend to be smaller in capacity.
 - Require little power, so used where battery life is a consideration.
 - Portable due to their small size and durability.

- ### Utility Software
- File Repair**
- Corrupt files can sometimes be repaired.
 - Can detect and recover physical errors on the disk and mark damaged sections as unavailable.
- Backups**
- A copy of data is known as a backup.
 - These allow damaged or deleted data to be restored.
 - Full backups include every file. This requires a lot of storage and time.
 - Incremental backups include new and changed files since the last backup.
- Data Compression**
- Reduces the size of a file using algorithms.
 - Smaller files are easier to transmit.
 - Allows more files to be stored in the same space.
- Defragmentation**
- Files on a disk are broken down into a series of segments.
 - When files are deleted, the segments where they were stored are made available for new files.
 - The new file may need more segments than the old, and so the segments allocated to it are not together on the disk. This is known as fragmentation.
 - A fragmented disk takes longer to read from and write to, making the computer slower.
 - Defragmentation software rearranges the segments so that they are stored next to each other.
- Anti-Malware**
- Protects against viruses, spyware, and other unwanted software.
 - Scans the system to identifies potential viruses.
 - Will attempt to delete or fix potential threats once they have been identified.
 - Runs either when activated or automatically at a specified date and time.

- ### CPU – Central Processing Unit
- Control Unit (CU)**
Fetches, decodes, and manages the execution of instructions
Issues control signals to control hardware
Moves data around the system
- Arithmetic Logic Unit (ALU)**
Performs arithmetic and logical operations. Where calculations are done and where decisions are made.
- Registers**
Small amounts of high speed memory in the CPU.
Used to store small amounts of data that are needed during processing.
- Cache**
A small amount of high speed memory In the CPU.
Used to temporarily hold data the CPU will reuse.
Allows for faster processing since as the CPU need not wait for data to be fetched from RAM.
- Clock**
Used to coordinate all the computer's components.
Sends out a regular electrical pulse to do this. The frequency of the pulses = clock speed, measured in hertz.
Higher clock speed = greater number of instructions which can be performed at a time.
- Buses**
High speed internal connections. Used to send control signals and data between the processor and other components.
- Address bus - carries memory addresses from the CPU to other components.
 - Data bus - carries data between the CPU and other components.
 - Control bus - carries control signals from the CPU to other components.