Central Processing Unit:

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Pictures from: CourseBook,
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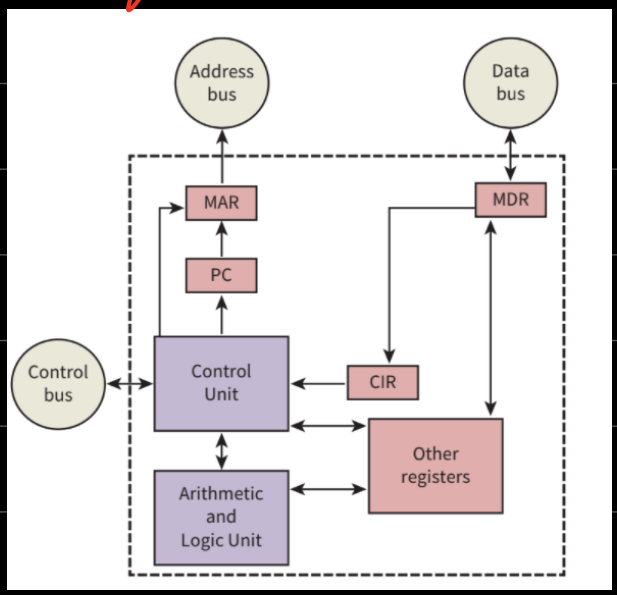
Von Neumann Model:

Features of Von Neumann Model:

→ Central Processing Unit
→ A processor able to access memory directly
→ Computer memories that could store programs as well as data.
→ Stored programs made up of instructions that could be executed in sequential order.



Components of the CPU:

→ Arithmetic Logic Unit(ALU):

Allows arithmetic or logic operations to be carried out.
The Accumulator (ACC) is a temporary register used when carrying out

ALU operations.

→ Control Unit (CU):

The CU reads instructions from the memory, the instruction is then interpreted. Using this process signals are generated to tell the other components their jobs. The Control Unit also ensures synchronization of data flow and program instructions throughout the computer.

→ System Clock:

A system clock is used to produce timing signals on the control bus to ensure the synchronization that takes place.

→ Immediate Access STORE (IAS):

The IAS holds all the data and the programs that the CPU needs to access. IAS is also known as the RAM of the computer, CPU can directly access the RAM and the RAM is considerably faster than Secondary storage.

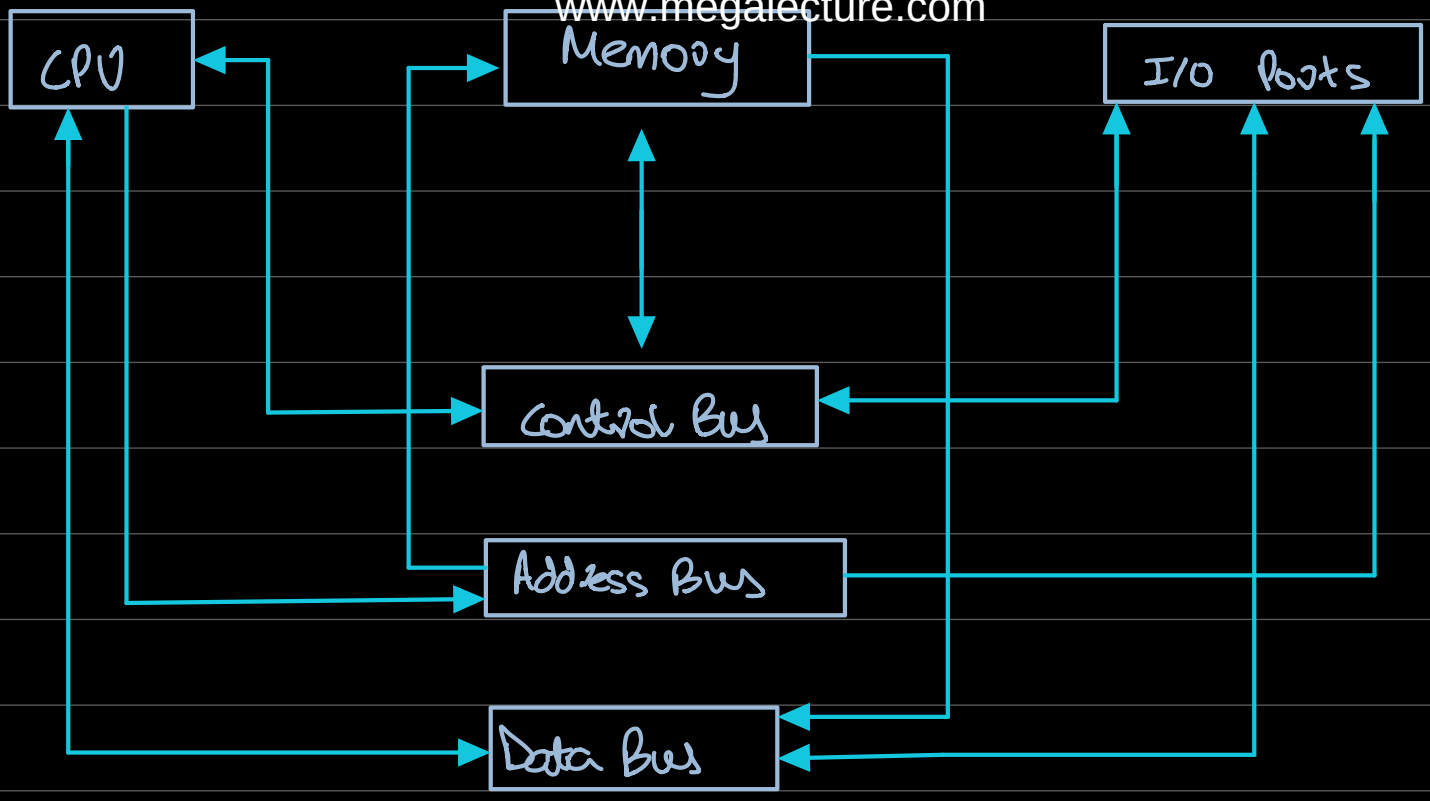
REGISTERS:

A register is a temporary storage area built into the CPU. Registers can be special purpose or general purpose.

- ★ Current Instruction Register (CIR) : Stores the current instruction that is being decoded and executed.
- ★ Index Register (IR) : Used when carrying out Index addressing operations in Assembly Language.
- ★ Memory Address Register (MAR) : Stores the address of the memory location currently being read from or written to.
- ★ Memory Data Register (MDR) : Stores data which has just been read from memory or data which is just about to be written to memory.
- ★ Program Counter (PC) : Stores the address where the next instruction to be read can be found.
- ★ Status Register (SR) : Contains bits which can be set or cleared according to operation.

SYSTEM BUSES:

System Buses are used in computers as a parallel transmission component; each wire transmits one bit of data.



① Address Bus:

The Address Bus carries addresses throughout the computer system. The bus is unidirectional, meaning it travels in one direction only. The wider the bus the more addresses that can be transferred through the address bus.

② Data Bus:

The Data Bus is bidirectional (allows data to be transferred in both directions.) The Data bus transfers the data between components. The wider the bus the larger the word length that can be transported.

③ Control Bus:

The control Bus is also bidirectional. It carries signals from the control unit to all the other components. Usually 8-bits wide since only carries control signals.

Components and their impacts on computer performance:

① System Clock:

→ The clock speed of a system determines the minimum time interval between processing and execution of consecutive instruction.

→ By increasing the clockspeed and the clockcycles / frequency, we are able to process and execute more instructions within the same period. → known as 'overclocking'

↳ As a result, the processing speed of the system increase, however, we cannot conclude that the overall performance of the system improves solely based on this.

② Address / Data Bus:

→ As mentioned previously, the width of the address bus and the databus are also important in deciding a computers performance, as they control how many addresses are directly accessible & how many bits of data can be

transmitted at once.

③ Cache Memory:

→ Cache memory is similar to RAM in that it stores the currently required data and instructions.

→ When a processor reads the memory, it first checks the cache memory and then the RAM.

→ The benefit of using cache memory is that since it uses SRAM as compared to the DRAM that's used by RAM memory, it has a faster access time and can improve computer performance.

④ Number of Cores:

→ Another way to improve computer performance is to increase the number of cores

↳ A single core is made up of a CU, an ALU and all standard registers.

→ However, the increase in performance is not proportional to the increase in number of cores.

↳ For example, doubling the number of cores from 2 to 4 doesnot mean that the performance will also double.

→ This is because we need to consider the different cores now having to communicate with each other as well (which takes time).

↳ In a dual core system, each core only needs to communicate with one other core, whereas in a quad core system, each core needs to communicate with 3 other cores, which takes up processing power and time.

Computer Ports:

Input and Output devices are connected via ports.

① USB Ports:

→ Asynchronous serial data transmission method.

→ Standard method of transferring data.

→ USB cable consists of four-wired shielded cables, two wires for power and earth and two for data transmission.

Pros of USB	Cons of USB
→ Devices plugged into the computer are automatically detected and device drivers are automatically loaded up.	→ The maximum cable length is approximately 5m.
→ Newer USB standards are backwards compatible.	→ Transmission rate USB type A = 500 mbits/s

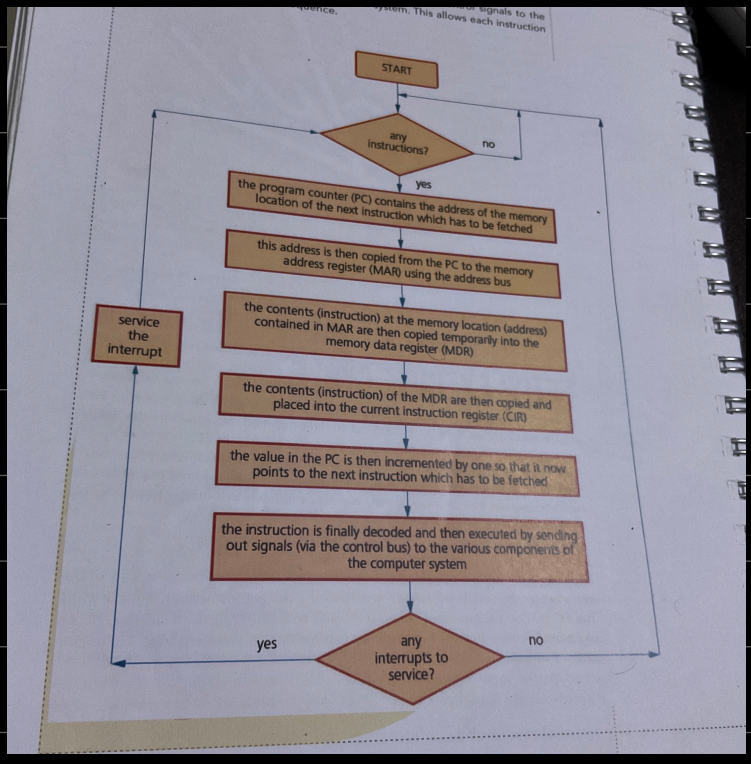
USB type C = 10 gbits/s.

→ Several different transmission rates supported.

High-Definition Multimedia Interface (HDMI) AND Video Graphics Array (VGA)

Type of Cable	Pros	Cons
(1) HDMI	→ The current standard for modern screens. → Allows for a very fast data transfer rate → Improved security → Supports modern digital systems.	→ Not a very robust connection. → Limited cable length to retain signal strength. → There are multiple connection standards.
(2) VGA	→ Only one standard available → It is easy to split the connection	→ Outdated analogue technology → The cable must be of high grade to ensure good undistorted signal → It is very easy to bend the pins when connecting.

Fetch - Execute Cycle:



Register Transfer Notation:

1. MAR ← [PC] — Contents of PC copied to MAR.
2. PC ← [PC] + 1 — PC is incremented by 1.
3. MDR ← [[MAR]] — Data stored at address shown in MAR is copied into MDR
4. CIR ← [MDR] — Contents of MDR copied into the CIR.

Double brackets are used in line 3 because it is not MAR contents being copied into the MDR but it is the data stored at the address stored in the MAR.

Interrupts :

An interrupt is a signal sent from a device or from software to the processor. This causes the processor to temporarily stop what it is doing and service the interrupt.

How interrupts are handled during the fetch execute cycle:

At the end of the fetch execute cycle the processor checks for interrupts. The computer is checked for an interrupt flag. The processor identifies the source of interrupt and then checks for the priority of the interrupt. If the interrupt priority is above the current task, then processor saves the contents of the current registers and calls the interrupt handler that services the interrupts. When the service is complete the contents of the registers are restored, and processor continues with fetch execute.