

# Central Processing Unit (CPU)

## Central Processing Unit Architecture

### Von Neumann Architecture

• 3 main parts:

① Memory

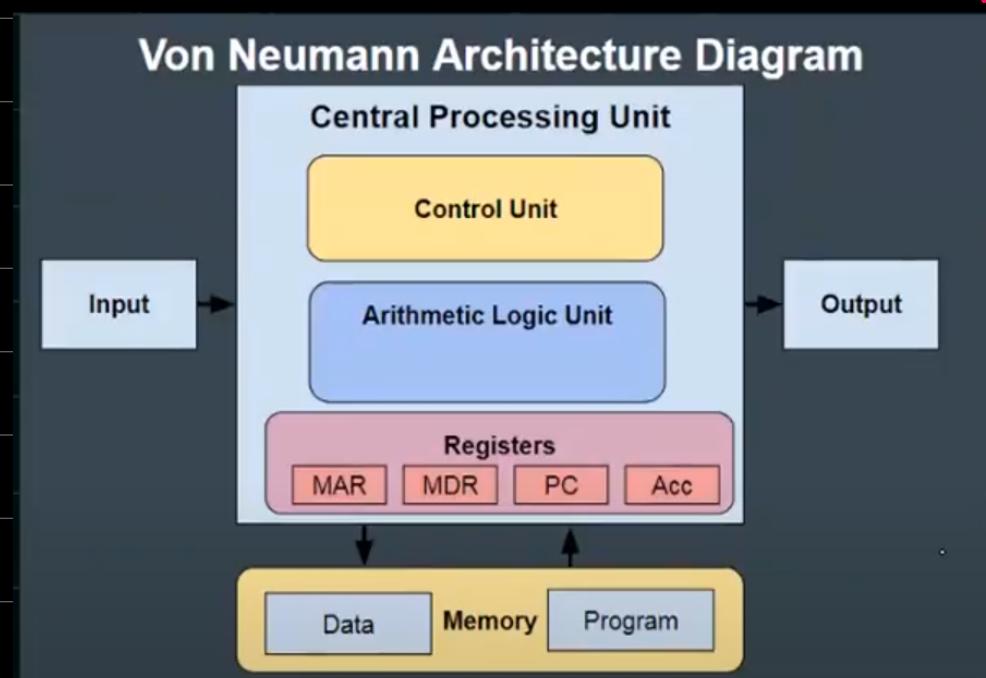
② CPU

③ Input/Output

devices

• Program and data stored together

• The von neumann architecture consists of single, shared memory for program and data



Note:

Just for  
reference, do  
not draw

# Control Unit

- Directs and co-ordinates other parts of computer system
- Controls operations of computer system
- Fetches computer instructions
- Decodes each instruction
- Executes these instructions

# Arithmetic Logic Unit

- A unit which performs arithmetic operations
- and bit shifting operation
- Logic operations (AND, OR, XOR)
- Designed to perform integer calculations

**Operand:** Part of the computer instruction which specifies what data is to be processed

**opcode:** Is the instruction that is executed by the CPU

# Registers

- Small piece of memory
  - Part of the processor
  - Temporary storage of data which is about to or has been processed
- 
- Memory is much slower in speed as compared to CPU, so registers are used. program is loaded into registers and CPU executes the instructions from registers

Q- Difference b/w general purpose and special purpose registers?

- General purpose registers holds the temporary data while performing different operations
- Special purpose registers holds the status of a program.

# Special Purpose Registers

Memory Address	MAR	MDR	CIR	PC
400 : 42	memory address register	Memory Data register	Current instruction register	Program Counter
401 : 40	401	40	ADD	403
402 : 54	· data can be anything			
403 : INC				
404 : ADD				

Program Counter: Stores the address of the next instruction to be fetched

MAR: Stores memory address where data is to be read from or written to

MDR: Stores data that has just been read from the memory or about to be written to

CIR: Stores the instruction that is currently being executed

IX: (Index Register) used for indirect addressing

ACC: (Accumulator) is the register where data is worked on. (General Purpose Register)

Status Register: Is interpreted as independent flags, each flag is set depending on an event.

# System Clock

- Every computer contains an internal clock which regulates the rate at which the instructions are executed.
- CPU requires a fixed number of clock cycles to execute each instruction
- Used to synchronize all the operations

Q- How data is transferred b/w various components of the comp. system?

## Data Bus:

- Carries data b/w processor and memory which is currently being processed
- Bi-directional bus
- Used to exchange data

## Address Bus:

- Uni-directional Bus
- that carries signals related to memory address
- B/w processor and memory

## Control Bus:

- Transmits signals b/w control unit and other components
- Bi-directional bus.

## Factors affecting The Computer Performance

### Data bus Width:

- The width of a bus determines the number of bits that can be simultaneously transferred.
- Increasing the width of a data bus increases number of bits that can be transferred
- Hence improves processing speed as fewer transfers are needed

### Clock Speed:

- One F-E cycle is run on each clock pulse
- So the clock speed dictates the number of instructions that can be run per second
- The faster the clock speed the more instructions can be run per second, so

the processing speed would increase.

### Cache Memory:

- Can also improve processor performance, it is similar to RAM, cache uses SRAM, so they have faster access time as there is no need to keep refreshing
- Cache memory stores frequently used operations and data that needs to be accessed faster.

### Number of Cores:

- Each core processes one instruction per clock pulse.
- More cores mean that sequence of instructions can be split up b/w them and so more than one instruction is executed per clock pulse.
- More cores decreases the time taken to complete the task.

# Ports

- Acts as an interface b/w computers and other peripheral devices.
- Female part of connection

## Benefits of connecting Peripheral Devices via USB Port

Fast Data transfer: Use when transferring large files such as video files

Automatic connection / Plug and Play: No need to install separate drivers.

USB is an industrial Standard: All new comps are equipped with USB port.

Devices may be powered / charged through USB: External devices can be charged while working at the computer.

# High Definition Multimedia Interface (HDMI)

- Helps to connect more monitors
- HDMI ports allow to output both audio and video signals
- They support high definition signals
- Faster Data transfer
- HDMI increases the bandwidth making it possible to supply the necessary data for high quality sound and visual affects



## Advantages of HDMI:

- Current standard for modern televisions and monitors
- Allows a very fast data transfer rate
- Improved Security, helps prevent piracy by the help of HDCP
- Supports modern digital system.

## Disadvantages of HDMI:

- Not a very robust connection (easy to break connection when simply moving devices)

• Limited cable length

## Video Graphics Array

Advantages of VGA:

- Simpler technology
- Only one standard available
- Easy to split the signals and connect a number of devices from one source
- The connection is very secure
- VGA supports a higher refresh rate

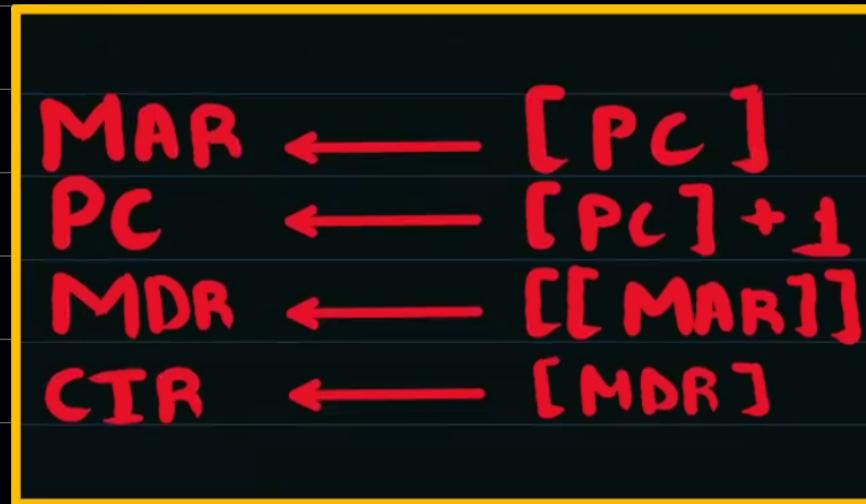


Disadvantages of VGA:

- It does not support audio
- Outdated as modern laptops and comps rarely have a VGA port.
- Easy to bend pins when making connections.

# Fetch Execute Cycle

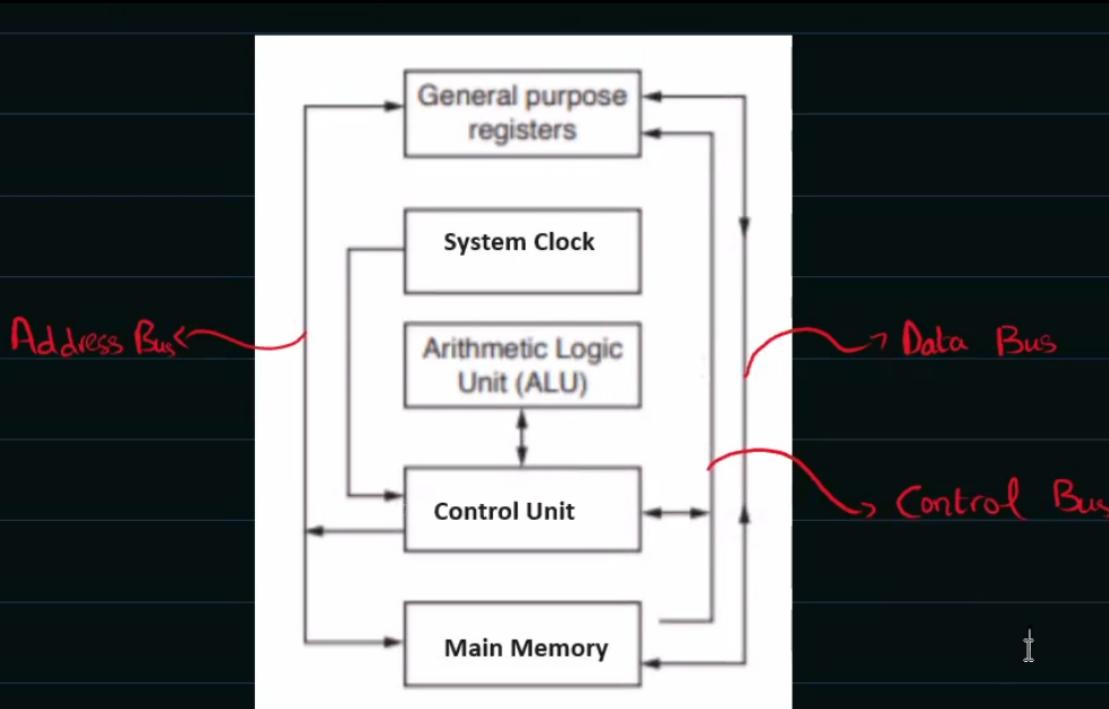
- PC holds the address of the next instruction to be fetched
- The address in program counter is copied to MAR
- Program counter is incremented
- The instruction is copied from address in MAR to MDR
- Then instruction from MDR is copied to CIR.



Q- The third Instruction  $[[\text{MAR}]]$  has double brackets. State the purpose of double brackets.

- The content of MAR is an address, it is the contents of that address which is transferred to MDR.

# Components and Buses inside a typical Computer



key points for Pic question.

- ALU and control unit will have direct bi-directional connection ←→
- Main memory will have direct connection with general purpose register. ←→
- System clock will have uni-directional connection →
- Data bus is bi-directional ↔. It will only have connection with memory and general purpose register
- Control Bus is uni-directional

- Address bus will be connected from main memory and GPR and will also have connection with control unit.

## Concept Of Interrupt

Q- What is meant by interrupt?

- A signal from a source / device
- telling the processor that its attention is needed

• Hardware Interrupt: Printer out of paper

No CD in drive

• Software Interrupt:

- Run-time error
- A running program needs input

Q- Explain how processor handles interrupts?

- At the start of each fetch-execute cycle the processor checks for interrupt.

- Check if an interrupt flag is set
- Processor identifies source of interrupt
- Processor checks for priority of interrupt
- If interrupt priority is high enough, then lower priority interrupts are disabled
- Processor saves current contents of registers.
- Processor calls ISR (Interrupt Service Routine)
- Address of ISR is loaded into PC
- When servicing of interrupt is complete, processor restores registers.
- Lower priority interrupts are re-enabled
- Processor continues F.E cycle.

Q- Give three different events that can generate an interrupt.

- Hardware faults
- Software errors
- I/O requests