Overview of Topic:
Processors, I/O/S and components of a computer

- The structure and function of the CPU
- Registers
- The FDE cycle
- The performance of a CPU
- Different types of processor
- CISC, RISC, multicore and parallel systems
- Input, output and storage

Learning Aims

- The structure and function of the CPU
- ALU, CU, registers and buses

Key Terms

Technical Terms

Hardware
Software
Peripherals
Input
Output
CPU
Main memory (RAM)
Registers

Specific Vocab

Load
Store
Instructions
Data
Programs
Processing
Throughput
Architecture
Contents

What is a computer?

A computer is made up of 'hardware' and 'software'.

These work together to make up a complete computer system.

This computer system can then process instructions and data using the brain of the computer, known as the Central Processing Unit (CPU).

Hardware, software and peripherals

Hardware	**Software**
is anything that is physical, that you can touch Examples: keyboard, a web cam, a stick of RAM, a CPU chip or a pen drive.	are the programs (or sets of instructions) that make the hardware do useful things. Examples: word processing program operating system web browser Virus checker

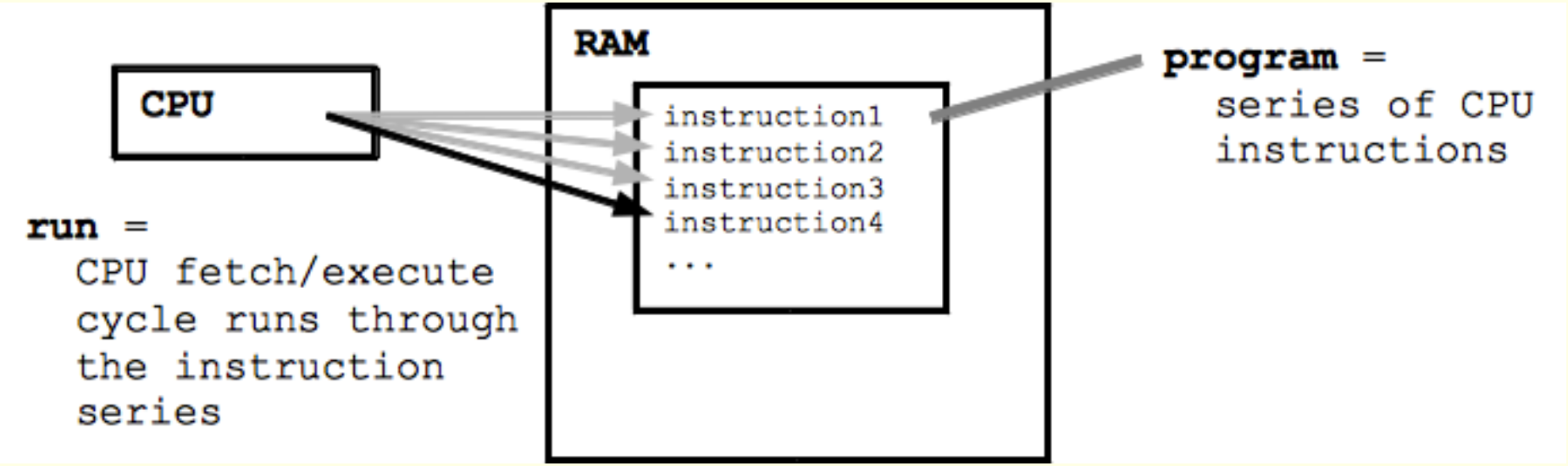
What is a peripheral?

Simply any piece of hardware that you can connect to the computer. Normally, you would do this by plugging it into somewhere on the outside of your computer system, such as a USB port or by using a wireless connection such such as Bluetooth.

When you plug a peripheral into your computer, you are making a direct connection from the peripheral to the CPU, so it can be used.

Role of CPU

- The CPU processes data according to sets of instructions, or programs, written by programmers.
- All the programs that have been **loaded** onto a computer are **stored** on the **hard disk**.
- When one needs to be used, a copy of that program is made and put into RAM.
- The CPU then works with this program in RAM.
- The CPU cannot directly work with any programs or data held on a storage medium such as a hard drive or pen drive.
- If it wants to use them, it first has to move them into RAM.



Stored programs

- In 1945, the mathematician and physicist John von Neumann, working at the University of Princeton USA, published a paper about the computer he and his team had designed and built.

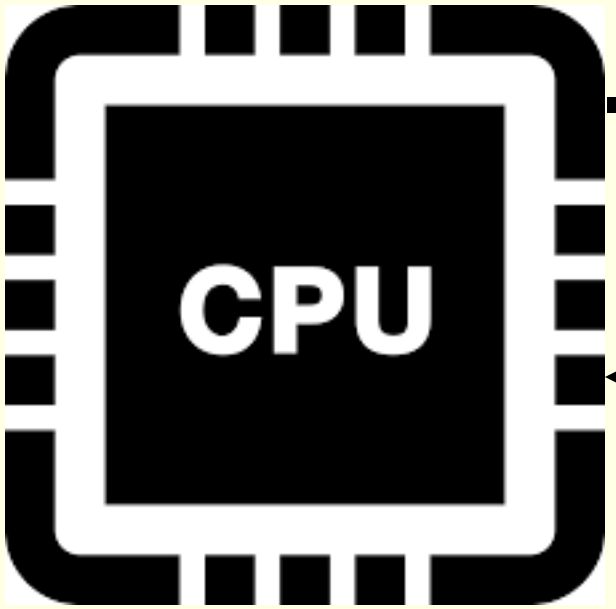
- It was the first computer that used the basic component architecture we recognise in modern computers.

- **He identified that data and programs could be stored in the same memory known as the stored program concept**

Stored Program Concept

Storing instructions and data in main memory
Instructions are then fetched from memory, decoded and executed by the processor.

Storing Instructions and data



Memory Address	
0001	LOAD 0101
0010	ADD 0110
0011	STORE 0111
0100	STOP
0101	23
0110	12
0111	

Main Memory

Purpose of Main memory

Also described as:

- Random Access Memory (RAM)
- primary memory
- Immediate Access Store (IAS)

The place where **programs** and the **data** that is needed by programs are held, ready to be fetched then decoded and executed by the CPU.

The operating system, the programs you are **currently** using and any data you are currently using are worked on by the CPU from the main memory, not from storage.

The CPU does not work directly with storage devices, only the main memory.

Main memory is made up of lots of individual **'memory' locations**, each capable of storing a **byte of data**.

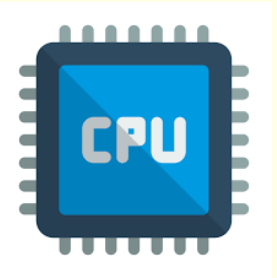
Example

Open an application or a file

moved from storage on your hard disk

main memory

CPU



save work

moved from the main memory

storage device

CPU

The Central Processing Unit, or CPU, is the central part of a computer, the brain that does all of the computations. Because the CPU performs many different functions, you need to divide it up into its main parts to understand it. Only then can you successfully describe what it does.

There are four component parts that need a mention.

These are:

Arithmetic Logic Unit (known as the ALU).
Control Unit
Registers
Main memory

ALU

The Arithmetic Logic Unit is that part of the CPU that does all the calculations. It has electronic circuits that can manipulate data in various ways.

It has three main functions.

Perform **arithmetic calculations** on data. For example, it can add and subtract two numbers together or multiply and divide numbers (in binary, of course).	Perform **logical operations** on data. These are computations that involve, for example, the use of AND, OR and NOT.	**Hold data** it has already worked on, ready to be sent out. **Hold data** that has been fetched, ready to be processed. Acts as the pathway for all input and output operations, acting as the **gateway between the processor and external devices.**

Control Unit

This part of the CPU is responsible for managing how instructions are executed.

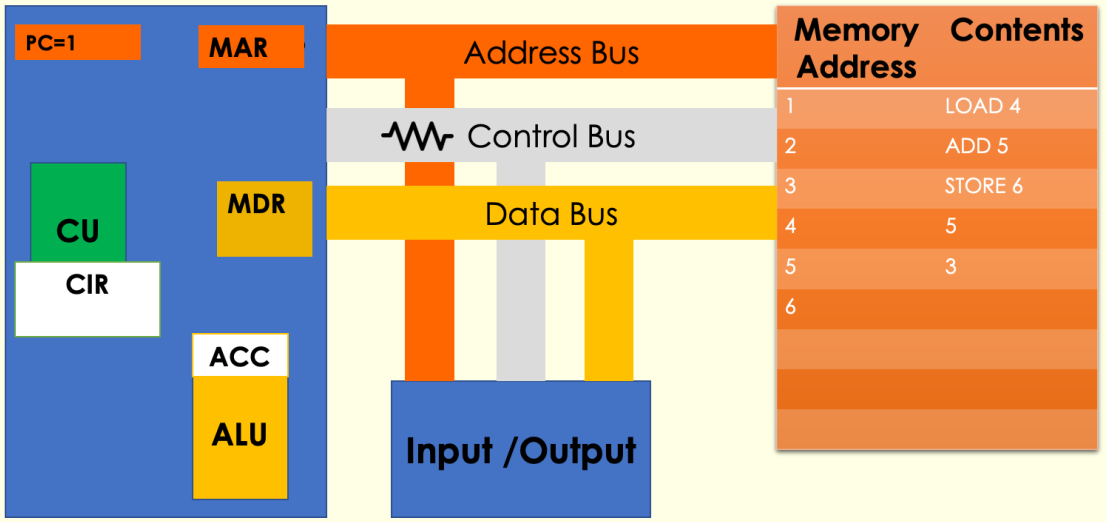
1. **Decode** an instruction
2. The **Control Unit** directs the flow of data and instructions within the CPU.
3. It send control signals to coordinate the operations of the **ALU**, **memory**, **and input/output devices** so that instructions are carried out in the correct sequence.

What can you remember?

Clock:
Regular electrical pulse which synchronises all the components.

Clock speed:
number of instructions that can be performed in any given moment of time.

Address bus
Carries memory addresses from the processor to other components such as RAM and input/output devices.



Registers
are small amounts of high speed *memory* contained within the CPU.

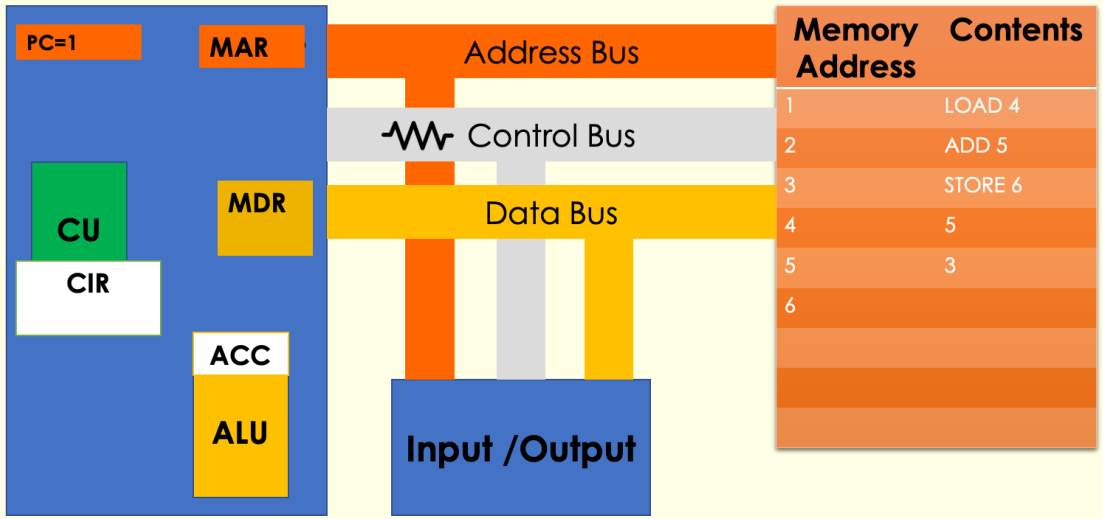
Data bus
carries the actual data between the processor and other components.

Control bus

carries control signals from the processor to other components.

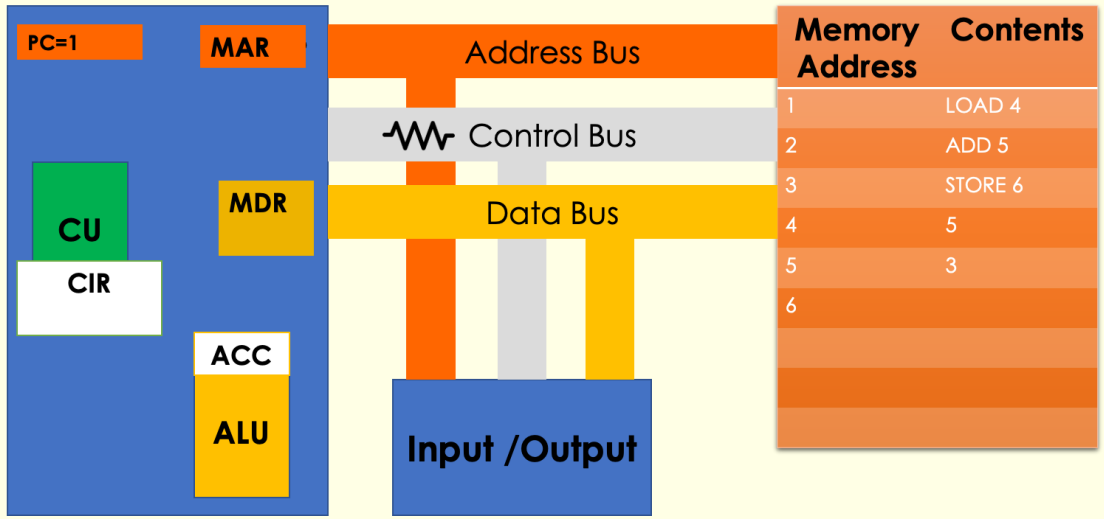
Registers

- Type of memory that can be accessed very quickly compared to other types of memory.
- The contents hold are needed by the CPU to run each program instruction during a 'fetch-decode-execute cycle' or they can be used to hold values that are generated as part of the ALU working on data.
- There are a number of very special registers that do very specific jobs.



CPU Registers - Registers are small areas of memory in the CPU

- **Program Counter** – keeps track of where the CPU is in the program. Points to the next instruction in the cycle.
- **Memory Address Register (MAR)** – holds the address of the instruction to be fetched.
- **Memory Data Register (MDR)** – stores the instruction about to be executed.
- **Accumulator** – stores the most recent result of processing.
- **Current instruction register (CIR)** - instruction to be executed



ALU

Computer architectures use registers including the accumulator.

Describe the purpose of the accumulator. [2]

Temporary storage for data being processed during calculations

I/O in processor used as a buffer

A **buffer** is a temporary storage area used to hold data while it is being transferred from one place to another.

Input/Output (I/O) buffering is a process that uses a buffer to store data temporarily while it's being transferred between the processor and other devices.

Data, address and control busses

A bus is a set of parallel wires / channels connecting two or more independent components of a computer system in order to pass signals between them.

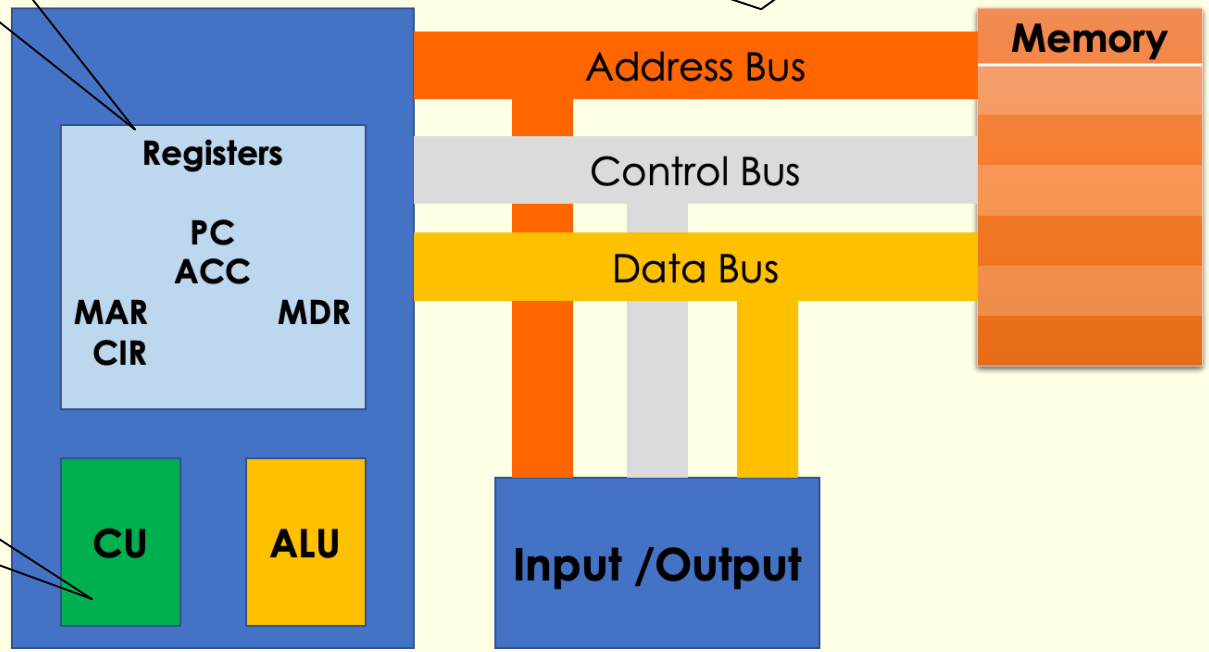
Control Bus	Data Bus	Address Bus
■ Control signals are **sent** along the control bus ■ E.g. Memory Read, Memory Write ■ This instructs which data will be travelling to/from memory.	■ **Carries** Data/Instructions from Main Memory to the Processor (or from other secondary storage devices) to the processor. ■ Bi-Directional (two way) ■ Data can be read/written	■ **Carries** addresses from the Processor to main memory ■ It is one direction (Uni-Directional) ■ The processor generates an address

Registers
Registers: provide fast, temporary storage, e.g. registers for designated functions, such as holding the results of operations, holding instructions, and holding other data

Buses
- Address: holds the address of the memory location involved in the instruction
- Data: holds the value to be read from or written to memory
- Control: carries signals from the control unit to other components to coordinate operations

Main Memory
a collection of storage locations

Control Unit
Control unit: decodes instructions received from main memory and provides a signal to coordinate operations



ALU
performs arithmetic and logical operations

- **Program Counter** – keeps track of where the CPU is in the program. Points to the next instruction in the cycle.
- **Memory Address Register (MAR)** – holds the address of the instruction to be fetched.
- **Memory Data Register (MDR)** – stores the instruction about to be executed.
- **Accumulator** – stores the most recent result of processing.
- **Current instruction register (CIR)** - The instruction to be decoded is held here.