

The background is a solid blue color. A white horizontal bar is at the top. On the left side, there is a large, light blue geometric shape with a white border, resembling a stylized 'L' or a corner. The text is positioned to the right of this shape.

Computer Processors (PART-1)

Features of A Computer Processor

- A processor is also referred to as a microprocessor or a central processing unit (CPU)
- It is the main chip in a computer system
- It is located on an integrated circuit (IC), a silicon chip on a motherboard
- Multi-core processors have two, three or four processors on a single chip



CPU Manufacturers

- There are many brands and types of processors. Main manufacturers include:
 - Intel (Pentium, Centrino)
 - AMD (Athlon, Turion)
 - DEC
 - Fujitsu
 - Hitachi
 - IBM
 - Motorola
 - Sun Microsystems
 - Zilog



Functions of a CPU

- A processor performs the following functions:
 - Mathematical operations - addition, subtraction, multiplication and division
 - Logic operations – it compares data and makes decisions
 - Processes data
 - Exchanges data with other components and peripherals
 - Moves data from one memory location to another

Components of a CPU

- The main elements of a processor are:
 - Arithmetic and logic unit (ALU)
 - Control unit (CU)
 - Immediate access store (IAS)
 - Clock
 - Transistors – a transistor acts as a switch turning a signal on or off

Arithmetic and Logic Unit

- This is where the computer processes instructions
- It consists of two sections:
 - **Arithmetic section** - which performs calculations on data e.g. addition
 - **Logic section** – which deals with logic and comparisons, e.g. it works out if a value is greater, less than or equal to another value

Control Unit

- The Control Unit performs three main tasks:
 - Controls and monitors hardware attached to a computer system to ensure that commands given to it by application software are used, e.g. checks that instructions are sent to a printer accurately
 - Controls input and output of data so that instructions are sent accurately to the correct component at the correct time
 - Controls the flow of data within the processor – the fetch-execute-decode cycle

Immediate Access Store

- Holds data and programs required by the CU
- The processor reads data and programs kept in backing storage, e.g. hard disk and stores them temporarily in the IAS memory
- This is done because backing storage (e.g. the hard disk) is too slow to run applications directly

Performance Factors of a CPU

- Four factors affect a CPU's performance:
 - Type of processor
 - Clock speed
 - Cores
 - Cache size

Types of Processors

- The two main types of processor are:
 - Complex Instruction Set Computing (CISC) – used in most desktop and laptop computers
 - Reduced Instruction Set Computing (RISC) – used in smartphones and tablets (use the ARM processor)

Let's take a look at the differences between the two processors

Differences between CISC and RISC Processors

CISC

- Larger in size
- Hundreds of instructions
- More complex instruction set
- Perform more intensive tasks
- Use more power
- Cost more to manufacture

RISC

- Smaller in size
- Fewer instructions
- More efficient at performing simpler tasks
- Lower clock speeds
- Perform simple tasks quicker than CISC
- Energy efficient
- Cheaper to manufacture

Clock Speed

- The speed of a CPU is referred to as the *clock rate* and this controls how fast instructions are performed
- It is measured in *megahertz (MHz)* or *Gigahertz (GHz)*
 - 1 MHz - 1 million cycles a second
 - 1 GHz - 1 billion cycles a second

Cores

- A core contains an ALU, CU and registers
- A computer can have 2 (dual), 4 (quad) or more cores
- Multiple programs can run simultaneously if a computer has multiple cores

Cache Size

- Refers to a small amount of memory which is a part of a CPU
- The CU checks cache for instructions before it requests data from RAM
- Transfers to and from cache quicker than to and from RAM
- Cache can be graded as:
 - **Level 1 (L1)** - part of a CPU
 - **Level 2 (L2)** - larger than L1, located between CPU and RAM but sometimes located on the CPU with L1
 - **Level 3 (L3)** - larger than L1, located between CPU and RAM
 - Increased L2 and L3 results in a faster computer

Registers

- A register is temporary storage and part of a CPU
- It may hold may hold instructions, storage addresses or bit sequences or characters
- Types include:
 - **Program counter (PC)** - keeps check of the order of instructions and holds the address of the next instruction to be fetched
 - **Instruction register (IR)** - fetches instructions from the program counter (PC) and holds each instruction as it is executed by the processor
 - **Accumulator** - holds the results of processing
 - **Memory address register (MAR)** - holds the active address
 - **Memory data register (MDR)** - holds the data that is fetched from or is sent to RAM

The Role of Buses

- A bus connects a CPU to other components
- It moves instructions and data
- A bus speed is measured in MHz
- It sends 8, 16 or 32 bits at a time
- The ***system bus or front-side bus (FSB)*** connects a CPU to memory
- CPU cores share L2 and L3 cache across the FSB
- L2 cache is also connected via the **back-side bus (BSB)**
- The BSB is faster than the FSB

Address Bus and Data Bus

- The FSB contains two types of bus:
 - An **address bus** - sends data in one direction only, from the CPU to RAM and sends an address of the location where data needs to be sent
 - A **data bus** - sends data in two directions either to memory or receives data from memory

The Fetch-Execute-Decode Cycle

- Software commands are executed by the fetch-execute-decode cycle
- Program instructions are sent to RAM
- Each instruction is then sent to the CPU
- An instruction is decoded and processed by the CPU
- This is performed until each instruction is executed

Let's look at each step of the cycle

The Fetch-Execute-Decode Cycle

- Stages of the Machine Cycle
- The series of steps that are carried out during the Machine Cycle are the:
 1. Fetch Stage
 2. Decode Stage
 3. Execution Stage
 4. Storing

Fetch

- The CPU fetches data and instructions from RAM and stores them in its registers
- The CPU places the address of the next instruction to be fetched, on the address bus
- Data from the address then moves from RAM into the CPU via the data bus

Decode

- The CPU decodes the instruction that has been sent from RAM
- The CPU has been designed to decode specific instructions (instruction set)

Execute

- An instruction is executed in the CPU's ALU
- The result of the processing is stored in a register called the accumulator
- Then it is stored in RAM or used in another CPU operation
- Once the execution is complete, the CPU begins another cycle

Storing

- The Control Unit or Arithmetic Logic Unit then place the result from the execution stage into memory.

Fetch-Execute-Decode

