SKILLSEA

Module 6 Computer Science

6.3 Computer System Architecture

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Introduction

- The lesson develops computer terminology with focus on the computer architecture and introduces a range of new terms.

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Learning Outcomes

- 6.3. Computer System Architecture

At the completion of the session, students will be able to

- 1. Recognise the fundamental hardware components that make up a computer's hardware and the role of each of these components
- 2. Draw a simple block diagram of a CPU and explain each function
- 3. Explain the use of multi-core processors

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Recalling

- In Sessions 6.1 and 6.2 covered the

- Requirements of a computer system
- Representation of data
- Considered Machine Code and Assembly Language

Recap - Data

- The word 'data' has been used several times now in the context of the computer receiving input data, generating data and outputting data.
- A computer can only work with information that is presented to it in a very strictly controlled format as we saw in lesson 6.2
- When information is in this format it is called data.
- Quite simply, a computer cannot perform its task if the information it needs has not been **transformed into the required data form**.

Question

- What where the key FUNCTIONS of computer system?

- What where the main REQUIREMENTS for a computer system?

Recall the Key Functions of a computer

Following are the core functions of a computer system −

- A computer accepts the **command** and/or data as an **input** given by the user.
- A computer follows the **instructions** and **stores** the **data** given by the user.
- A computer processes the **data** as per the **instructions** given by the user.
- A computer gives the desirable results in the form of **output**.

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Requirement for a computer system

- Input (or loading) of data and/or instructions
- Manipulation/processing of data (Execution)
- Giving output (i.e. management of an output result)
- In computer system, data needs to be arranged in an orderly and systematic form.
- Recall the main datatypes

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Hardware

- As we saw in Lesson 6.1 Hardware comprises of the equipment that helps in the working system of the computer.
- Following are some of the different types of hardware components (which have specific functions and are commonly found on board ship)
  - **Monitor** − It displays (visual) the result.
  - **CPU** − It is the Central Processing Unit that controls the computer's functions and transmits data.
  - **Motherboard** − It is mainly accountable to establish communication between components and transmission of information.
  - **Memory**
    - **RAM** − It is the Random Access Memory and responsible for the storage of programs that are currently running and also stores data temporarily.
    - **ROM –** Read only memory is a type of non-volatile memory. Data stored in ROM cannot be electronically modified .
  - **Storage devices** *(Hard Disk Drive (HDD) or Solid State Drive (SSD) Floppy Disk Drive Optical disks, USB Storage etc.)*

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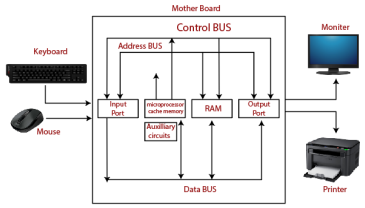
Main parts of a PC

- Processor.
- Main Memory.
- Secondary Memory.
- Input Devices.
- Output Devices.



Components of a Computer System

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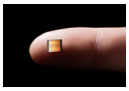
The microprocessor

- The term **microprocessor** was introduced when processors were first made on a single silicon chip, with the prefix 'micro' emphasising their small size.
- Microprocessor is a controlling unit of a micro-computer
- Today, however, the fact that a processor can be made on a single silicon chip is taken for granted and the term 'microprocessor' is not so often used.
- More generally use the term 'processor' is used.



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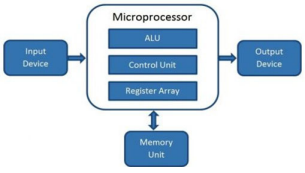
Main components in a processor



- ALU – Arithmetic Logic Unit
- Control Unit
- Registry Array
- Input/Output
- Memory Storage

TASK

- SKETCH THE DIAGRAM AND LABEL

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Processor functions

- The processor is a controlling unit of a micro-computer, fabricated on a small chip capable of performing ALU (Arithmetic Logic Unit) operations and communicating with the other devices connected to it.
- The processor consists of
  - **ALU**, performs arithmetical and logical operations on the data received from the memory or an input device
  - **Register array and Accumulator.** , which consists of registers identified by letters e.g. B, C, D, E, H, L with an Accumulator
  - **The control unit** controls the flow of data and instructions within the processor.

Main tasks of the processor

- The microprocessor follows a simple sequence:
- **Fetch, Decode, and then Execute.**
- Initially, the instructions are stored in the memory in a sequential order. The microprocessor fetches those instructions from the memory, then decodes it and executes those instructions till STOP instruction is reached.
- Later, it sends the result in **binary to the output port**. Between these processes, the register stores the temporarily data and ALU performs the computing functions.

List of Terms Used in a Microprocessor

There are a number of frequently used terms in a microprocessor −

- **Instruction Set** − It is the set of instructions that the microprocessor can understand.
- **Bandwidth** − It is the number of bits processed in a single instruction.
- **Clock Speed** − It determines the number of operations per second the processor can perform. It is expressed in megahertz (MHz) or gigahertz (GHz).It is also known as Clock Rate.
- **Word Length** − It depends upon the width of internal data bus, registers, ALU, etc.
  - An 8-bit microprocessor can process 8-bit data at a time. The word length ranges from 4 bits to 64 bits depending upon the type of the microcomputer.

Recap on Datatypes

Data Types – The microprocessor has multiple data type formats

- Binary,
- ASCII,

- BCD, Binary Coded Decimal
- Signed and unsigned numbers.

Use of Binary Coded Decimal

The use of BCD can be summarised as follows:

- Although BCD takes more space and more time than standard binary arithmetic.
- It is used extensively in applications that deal with currency because floating point representations are inherently inexact.
- Database management systems offer a variety of numeric storage options; “Decimal” means that numbers are stored internally either as BCD or as fixed-point integers
- BCD offers a relatively easy way to get around size limitations on integer arithmetic.

BCD Example

- How is Deanery 3 coded?

- How is Deanery 8 coded?

Decimal	Binary
0	0000
1	0001
2	0010
3	????
4	0100
5	0101
6	0110
7	0111
8	????
9	1001

TASK

- How many bits would be required to encode decimal numbers 0 to 9999 in straight binary and BCD codes?
- What would be the BCD equivalent of decimal 27 in 16-bit representation?

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Answer

- Total number of decimals to be represented=10 000=104 = 213 29.
- Therefore, the number of bits required for straight binary encoding = 14.
- The number of bits required for BCD encoding = 16.
- The BCD equivalent of 27 in 16-bit representation = **0000000000100111**.

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Multi-core processor

- A multi-core processor is a 'processor' that contains two or more independent processors called cores.
- Each core performs the usual functions of loading data and instructions and executing the instructions on the data but instructions can be shared between each of the cores and run at the same time, increasing the overall speed of programs, provided that they are written in such a way to allow for this to happen.
- **Question** – would running a processor with four cores all working simultaneously make a program run four times as fast??

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Processor coordination

- Although intuitive, running four cores does not make the processor four times as fast.
- Each core requires to have a share of the data.
- Instructions have to be moved from the shared main memory into its local memory where the instructions are executed on the data.
- The machine code program has to be written in such a way that a task can be split up into independent sub-tasks, each of which can be completed by a core, and then if necessary, reassembled into a final solution.
- This process of coordination is a small additional task for the computer to perform. Hence you do not get the full benefit of the extra cores.

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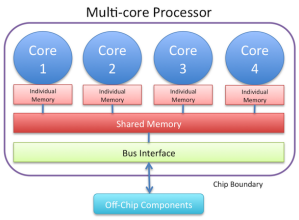
Simple Architecture of a multicore processor

- A core processor



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Ship example

- Data logger

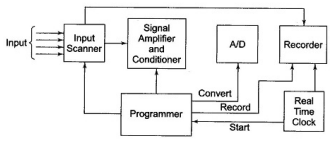

Fig. 17.24 Block Diagram of a Data Logger

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Summary

- Developed an understanding of the main components of a PC
- Investigated the terms and functions of a processor (CPU)
- Considered Lesson 6.4 develops an understanding of High level programming languages

Self assessment quiz

- Note – develop an online interactive quiz or multiple choice selection.
- Example follows

Suggestive Self Assessment

Activity

- Draw and label the main component parts of a PC
- Draw and label a block diagram of the main parts of a processor (CPU)
- Differentiate between RAM and ROM
- Explain why a multicore processor cannot run a a full multiple of the speed of the number of cores.
- What is the benefit of using BCD rather than straight binary representation?

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