مدونة المناهج السعودية

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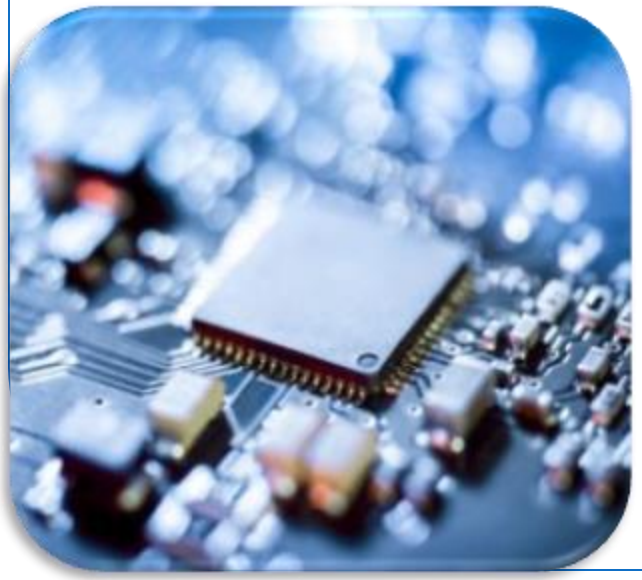
الموقع التعليمي لجميع المراحل الدراسية

في المملكة العربية السعودية

Chapter one



Parts Of A Computer

1.1 Computer Architecture for Computer Scientists:

- Computer science is the systematic study of the structure and behavior of computational system.
- Including the theory.
- Design of software structures.
- Computer scientists design and analyze algorithms to solve computationally intensive problems.
- Computer scientists **use** mathematics to find the solution to a problem.
- An algorithm is a sequence of steps required to implement a solution using given resources.

1.1 Computer Architecture for Computer Scientists:

The success depends on three things, developing the solution:

- Theory (i.e. Mathematics).
- Understanding the Tools (i.e. Computers).
- Mastering the implementation Techniques (i.e. Programming).

1.1 Computer Architecture for Computer Scientists:

Components of Computer Science:

- Theory : Theory of computation, algorithms and data structures.
- Tools : Computer elements and architecture.
- Techniques : Programming methodology and languages.

1.2 Processor:

- A computer is used for mathematical computations and calculations.
- The primary component responsible for these computations is called a processor or a microprocessor.
- A processor has two main functions.
    - Data path.
    - Control unit.

1.2 Processor:

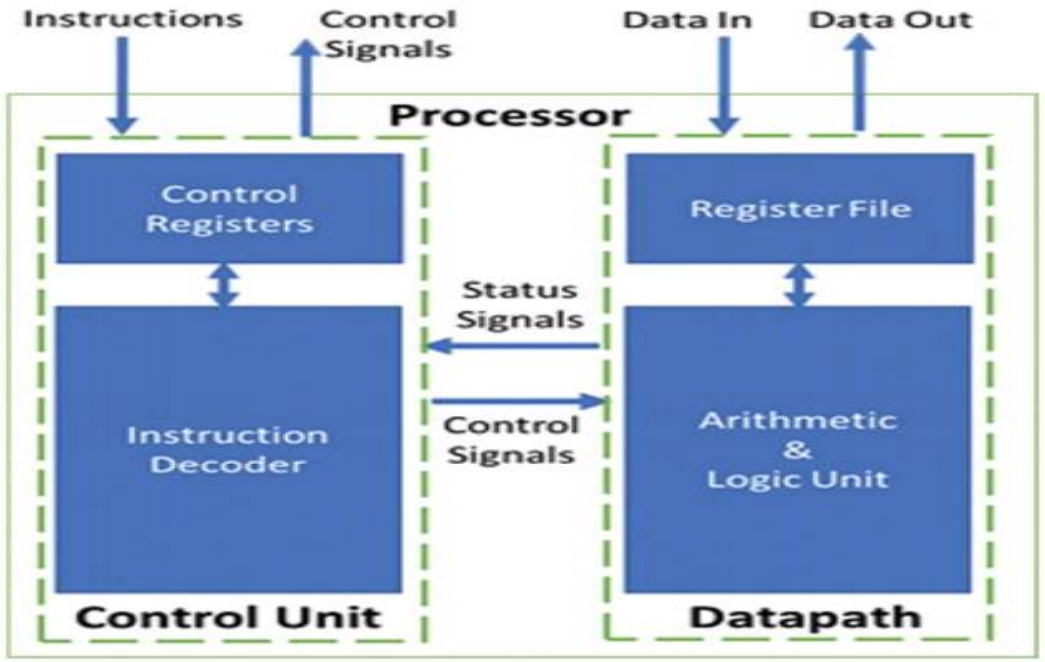


Figure 1- 2 Main components of a microprocessor

1.2 Processor:

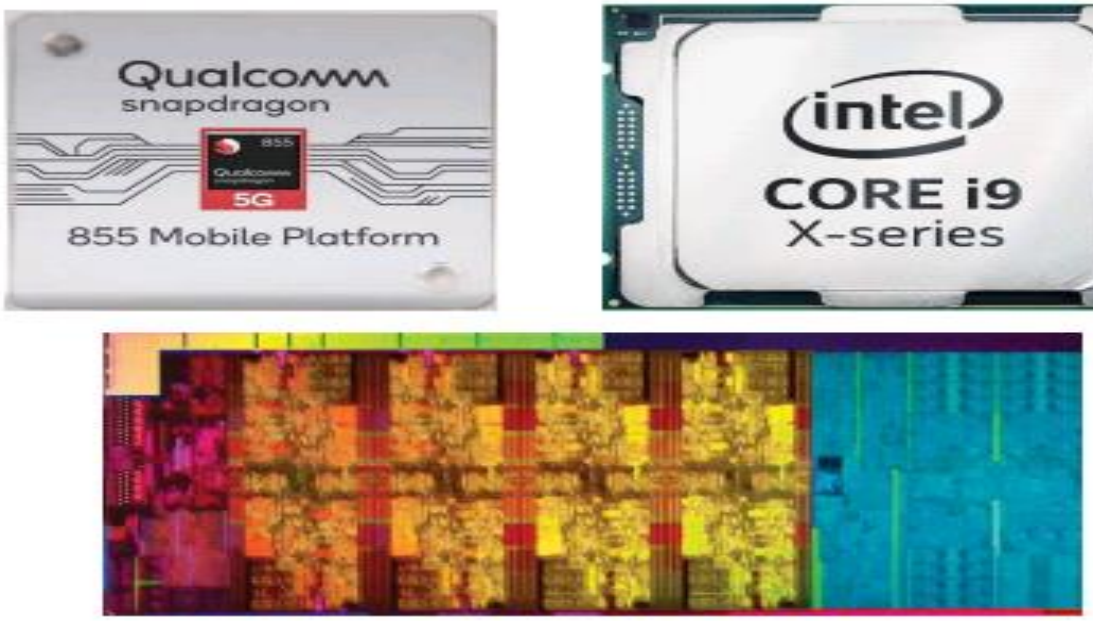


Figure 1- 4 Example of processors, the Qualcomm Snapdragon and the Intel Core i9. The die photograph of the Intel Core i9 showing the internal mechanisms of an 8-core processor with a cache and an integrated Graphics Processing Unit.

1.2.1 Data Path:

First function of Processor consists of two main components:

- **Arithmetic and Logical Unit (ALU):**
  - It has the ability to perform different mathematical operations on numbers.(+,-,*,/)
  - Comparing the magnitude of numbers.
  - To find if they are equal or if one number is larger than the other.
  - It can also compute all the logical operations.(OR, AND, XOR, NOT)
- **Register File:**

  A register file is the small memory component used to hold the data temporarily for the ALU.

1.2.2 Control Unit:

Second function of Processor is also consist of two components:

- **Control Register:**
  - The control registers are part of very small memory component.
  - Which receives instructions that need to be executed.
- **Instruction decoder:**
  - The instruction decoder then determines what the instruction means.
  - What needs to be done for the instruction to be executed.

1.2.2 Control Unit:

```
01:    READ    #Keyboard, RF1;
02:    READ    #Keyboard, RF2;
03:    ADD     RF1, RF2, RF3;
04:    WRITE   RF3, #Screen
```

01:	READ	#Keyboard,	RF1;
Instruction Number / Address	Operation	Data Source	Data Destination

Figure 1- 3 Example set of instructions and the instruction format.

1.2.3 32-bit vs 64 –bit Architecture:

32-bit	64-bit
A processor whose registers have a size of 32 bits is called a **32-bit processor architecture.**	While a processor whose registers have a size of 64 bits is called a **64-bit processor architecture.**

- Some processors used for simple applications are still 8-bits or 16-bits.
- But most high-performance processors used in scientific applications are 128-bit architectures.
- The bit size of a processor **determines** the magnitude of integers that it can process.

1.3 Instruction Set Architecture:

- To use a processor, it is important to know the instructions that it understands.
- The complete list of instructions that a processor can understand and execute is called its **instruction set** or **instruction set architecture (ISA).**

Different processors have different capabilities, which means they can execute different sets of instructions.

1.3.1 Types of Instructions:

ISA defines the types of instructions supported by the processor. Operations they perform the instructions are typically classified into three types.

- Arithmetic / Logic Instructions.
- Data Transfer Instructions.
- Branch & Jump Instructions.

1.3.1 Types of Instructions:

- **Arithmetic / Logic Instructions:**
  - These instructions perform various Arithmetic & Logical operations on one or more operands.
  - E.g.: ADD, SUB, XOR etc.
- **Data Transfer Instructions:**
  - These instructions are responsible for the transfer of instructions from memory to the processor registers & vise versa.
  - E.g.: MOV, LOAD.
- **Branch & Jump Instructions:**
  - These instructions are responsible for breaking the sequential flow of instructions & jumping to instructions at various other locations.
  - E.g. JMP, JZ.

1.3.2 RISC vs CISC:

- An ISA may consist of simple instructions capable of performing one basic operation.
- Complex instructions capable of performing multiple operations in a single instruction.

RISC	CISC
An ISA that implements basic operations is called a Reduced Instruction Set Computer (RISC).	Whereas an ISA that implement complex operations is called a Complex Instruction Set Computer (CISC).
RISC ISA only requires simple hardware, resulting in small-sized inexpensive processors.	CISC ISA results in higher performance but requires more expensive hardware.

1.3.2 RISC vs CISC:

RISC	CISC
01: READ #Keyboard, RF1; 02: READ #Keyboard, RF2; 03: ADD RF1, RF2, RF3; 04: WRITE RF3, #Screen	01: ADD #Keyboard1, #Keyboard2, #Screen

Figure 1 - 5 Comparison of RISC vs CISC instructions performing the same function.

1.4 Memory:

- All processors need supporting components to work.
- The most important among these components is memory.
- Memory is known but several names, including:
    - Main Memory.
    - Internal Memory.
    - Working Memory.
    - Memory core.
    - Random-Access Memory (RAM).
- Memory is needed by all computers.
- The processor calls instructions and data from the computer's memory.

1.4.1 Volatile vs. Non-Volatile Memory:

Volatile Memory	Non-Volatile Memory
Volatile memory stores the data as long as power is available.	Non-volatile memory keeps its data even when the power is turned off.
But as soon as the power is turned off, the memory losses whatever was stored in it.	Typically, access to such memory is slow.
Thus , this is temporary memory.	However new data can be stored on it and is held until new data gets stored.

1.4.2 Main Memory:

- **Random Access Memory (RAM)** is the working memory of a computer system.
- It stores input data, intermediate results, programs, and other information temporarily.
- The processor gets all the instructions from RAM and stores all its data in it.
- RAM can be read and written on, and is usually volatile.

Figure 1-6 A DRAM-based module used for Main Memory (RAM)

1.4.3 BIOS:

- There are some programs and instructions which the computer needs whenever it turns on.
- These are called **Basic Input Output System (BIOS)** instructions.
- **Read-only Memory (ROM)** is permanent memory.
- ROM is non-volatile.
- Its contents are typically written when the computer is built, but in modern computers.
- The user can change the contents using special software.

1.4.4 Address Space:

- How much memory can be connected to a processor depends on the bit-size of the processor.
- Also known as its Address Space.
- In practice, not all addresses are allocated to RAM.
- Some addresses are reserved for input/ output devices.

1.4.5 Principle of locality:

- An important property of software programs regularly exploited in computer systems is called the **Principle of locality.**
- A program typically spends 90% of its execution time in only 10% of the code.
- An implication of locality is that we can predict with reasonable accuracy what instructions and data.
- A program will use in the near future based on its accesses in the recent past.

1.4.6 Memory Hierarchy and Cache:

- **A general rule of thumb:**

- Any hardware that is physically placed closer to the processor is faster.
- More expensive than hardware which is placed farther away.
- This leads to hierarchies based on memory of different sizes and speeds.

1.4.6 Memory Hierarchy and Cache:

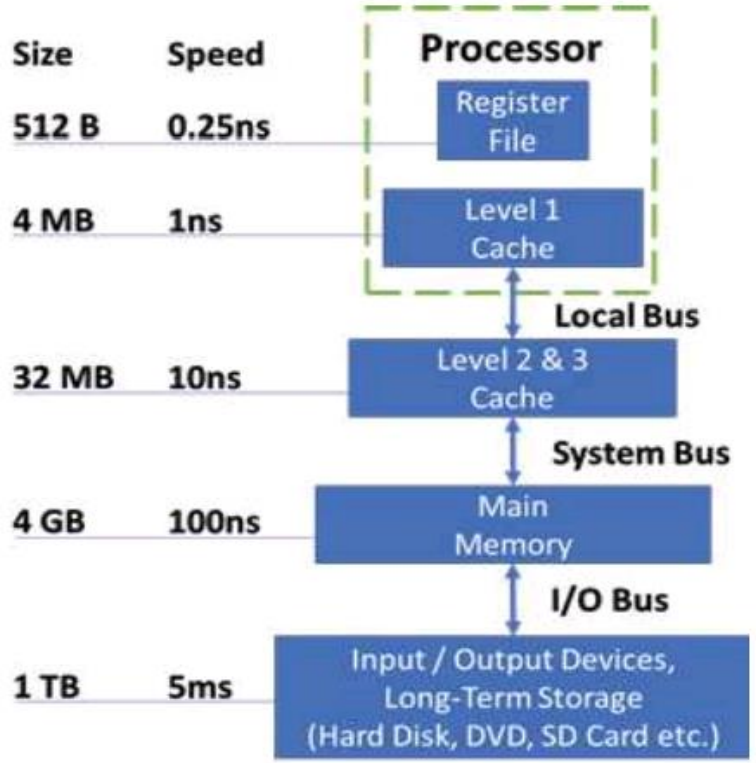


Figure 1-7 Memory Hierarchy with multi-level cache and long-term storage. The register file and level-1 cache are physically located on the processor die.

1.5 Storage:

- Storage is the type of memory.
- But is radically different from the main memory.
- It refers to a kind of non-volatile long term memory.
- Which is not directly addressable by the processor but is accessed through an input/output device interface.

1.5.1 Magnetic Hard Disk:

Magnetic Hard disk Drives (HDD) are most widely used as online/ active storage for desktop computers.

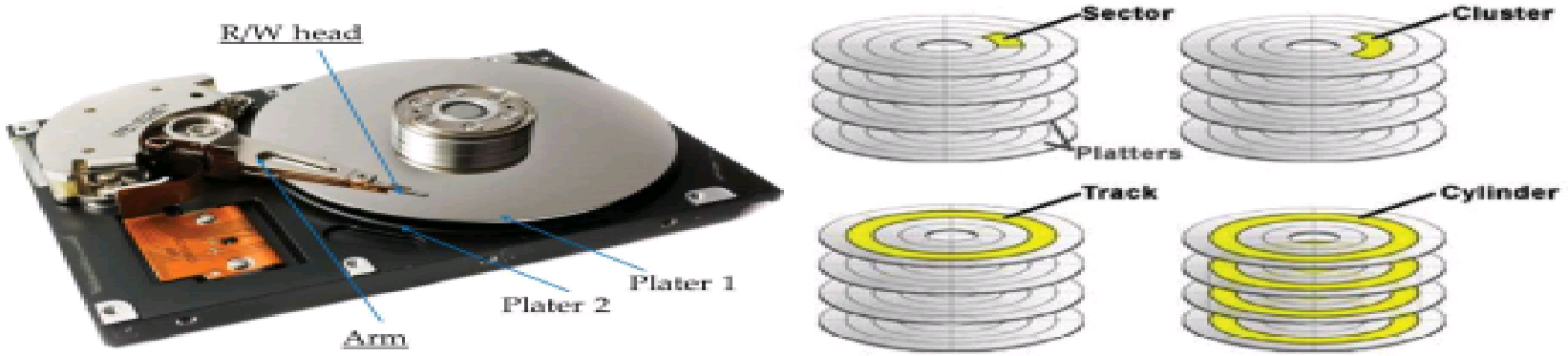


Figure 1-8 A magnetic hard disk consisting of multiple platters and read-write heads. The storage is organized into cylinders, tracks, clusters and sectors which are read sequentially.

1.5.2 Magnetic Tape:

- Magnetic Tape has been used for data storage for a long time.
- It still used extensively for archival purposes.
- It provides very dense storage capacity and has longer shelf life then hard disks.

Figure 1-9 Magnetic tapes are still used extensively for archival purposes. They provide very dense storage capacity and have a long shelf life.

1.5.3 Solid State Drive:

- **Solid state drives (SSD)** are the newest mass-storage devices which have several advantages.
- They provide high data rates, fast access, have no moving parts.
- thus, they provide longer life and higher reliability.
- SSD is based on non-volatile flash memory, which stores data using transistors.

Figure 1-9 Solid State Drive and its internal circuitry showing NAND flash.

1.5.3 Solid State Drive:

- **Address Bus:**
  - It is used to transfer data between devices.
  - The devices are identified by the hardware **address** of the physical memory (the physical **address**).
- **Data Bus:**
  - A **data bus** is a system within a computer or device, consisting of a connector or set of wires, that provides transportation for **data.**
  - A **data bus** is also called:
    - Processor bus.
    - Front side bus.
    - Back side bus.

1.5.3 Solid State Drive:

- **Control Bus:**
  - A **control bus** is a computer bus that is used by the CPU to communicate with devices that are contained within the computer.

- If the large number of devices is connected to the bus, performance will suffer with two main reason:
  - Firstly, more devices attached to the generally results in greater bus length, & hence greater propagation delay.
  - This delay determines the time it takes for devices to coordinate the use of the bus.

1.5.3 Solid State Drive:

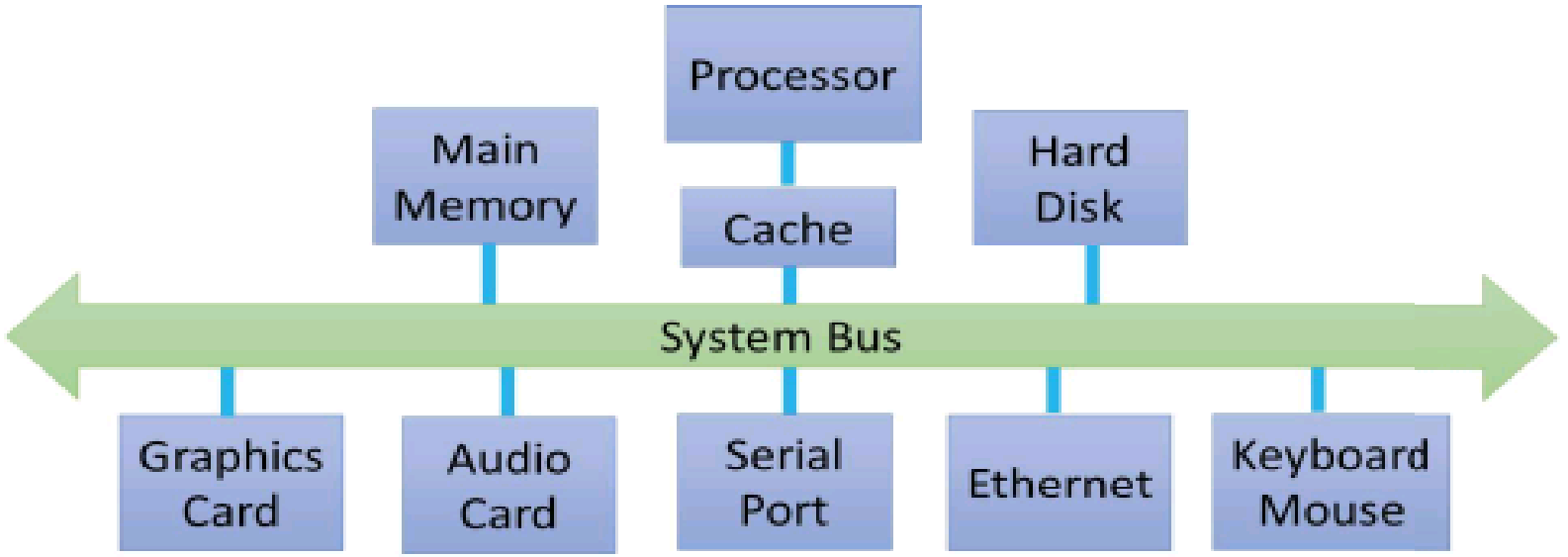


Figure 1-13 A basic system bus connecting the processor, main memory and all input-output devices and peripherals.

1.6 Computer Concepts:

- Computer science is the study of both computer hardware and software design.
- The study of computer science has many branches. Including:
  - Artificial intelligence.
  - Software engineering.
  - Programming.
  - Computer graphics.
- There are several concepts associated with modern computers.
- That becomes relevant when considering the performance of a system.

1.6.1 Clock Speed, Bus Speed, & Instruction Per Speed:

- Clock speed is the speed at which the data is passed from one component to another in a computer system.
- The bus speed dictates the rate at which data can enter and leaves the processor chips.
- Instructions-per-speed is the number of instructions a processor can process in one second.

1.6.2 Cache Size:

- **Cache** is a high-speed access area that can be a reserved section of main memory.
- **Cache** is a temporary storage area where website data is stored.
- **Disk caching** is used to access commonly accessed data.
- Size of the cache has a direct impact on the performance of a computer system.

Task one

- in the textbook, chapter one: pages(43 and 44):
  - Please solve all multiple-chose questions. Then tear the pages to submit them to your lecturer .