# MICROPROCESSOR

## Lecture 3
## Primary Memory and Storage Memory

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# Computer Memory

- **Definition**:
  - It refers to the storage area of the computer where all the data and instructions are stored.
- Computer memory is divided into **two types**:
  - **Primary memory**
  - **Secondary memory**

# Storage Capacity

- **Definition** :
  - It refers to the amount of data that can be stored in a storage device.
- The basic units to measure storage capacity of computer memory are **bit and bytes.**
- **Bit** – The data entered into a computer is first **converted** into **0's** and **1's** for computer to understand.
- This **0's and 1's** are called **Binary Digits** abbreviated as **bit**.
- **Nibble** – It is a collection of **4 bits**.
- **Byte** – It is made up of **8 bits of information**. **The byte** is the amount of memory required to store a single character.
- Other units of memory are **KB,MB,GB and TB**.
- To **convert** MB to GB, **simply divide the MB by 1024**. To **go back** from GB to MB, **multiply the GB by 1024**. The process of converting from megabytes to gigabytes is the same for all units of memory.

# Primary Memory

- **Primary memory** is computer memory that is accessed directly by the CPU.
- This includes several types of memory, such as the processor cache and system ROM. However, in most cases, primary memory refers to system RAM.
- There are two types of it:
  - **RAM**
  - **ROM**

# RAM

- **Random Access Memory** allows stored data to be accessed directly by CPU in any random order.
- It is so called ***random access*** as data and instructions can read from or written into RAM in random order.
  - **For example, to read data stored in memory location 11111111, RAM does not need to scan all the memory locations starting from 00000000 index.**
- It stores temporary data of currently running applications and play vital role in computers operation.
- It is a Volatile Memory i.e. the data vanishes/erased when the power supply is cut off.
- These are of multiple types of **RAM** and we will focus on **only two:**
  - **SRAM**
  - **DRAM**

# DRAM (Dynamic random access memory)

- This is a Random Access Memory that **stores each bit of data in a separate capacitor.**
- The capacitor can be either charged or discharged; these two states are taken to represent the two values of bit, that **are 0 and 1**.
- Main characteristics of capacitors is that **they leaks electric charge gradually**. This will result in turning back the **1 state gradually to 0 state** *i.e. data may get lost in long run.*
- Because of this, ***there is need of extra power supply for DRAMs*** using **extra circuit**. **Extra circuit** is known as **refresh circuit** and **process** of providing electricity is known as **refreshing**.

# SRAM (Static Random Access Memory)

- SRAM is a type of semiconductor memory that uses **bistable latching circuitry (flip-flop) and transistors to store each bit.**
- **Volatile** in the conventional sense that data is eventually lost when the memory is not powered.
- It is **faster** than the DRAM as it uses **a six transistor configuration.**
- In this the direction of current depicts the value 0 or 1.
- It is **expensive** than DRAM
- **This memory need not to be refreshed frequently.**

# ROM(Read Only Memory)

- The DATA stored in Read Only Memory **cannot be modified easily** i.e. can be modified only slowly or with difficulty.
- It is **non-volatile memory** i.e. it does not lose data when the power is cut off.
- Its various types are :
  - **PROM**
  - **EPROM**
  - **EEPROM**

# PROM (Programmable Read Only Memory)

- On Programmable Read Only Memory the **Data can be written only once**.
- It is Manufactured as a blank memory and then the data is written on it , also called as **Burning the PROM.**
- If you look at the contents of an unprogrammed PROM, the data is made up entirely of 1's.
- The process of writing your data to the PROM involves a special piece of equipment called **a PROM burner.**
- The device programmer writes data to the device one word at a time by **applying an electrical charge to the input pins of the chip**. Once a PROM has been programmed in this way, its contents can never be changed.
- If the code or data stored in the PROM must be changed, the current device must be **discarded**. As a result, PROMs are also known as **one-time programmable (OTP) devices**.

# EPROM (Erasable Programmable Read Only Memory)

- An **EPROM** is programmed in exactly the same manner as a PROM. However, **EPROMs can be erased and reprogrammed repeatedly**.
- **To erase an EPROM**, ***you simply expose the device to a strong source of ultraviolet light***. (A window in the top of the device allows the light to reach the silicon.)
- By doing this, you essentially reset the entire chip to its **initial-unprogrammed-state.**
- Though **more expensive than PROMs**, *their ability to be reprogrammed* makes EPROMs an essential part of the software development and testing process as well rather than only for startup instructions.

# EEPROM (Electrically Erasable Programmable Read Only Memory)

- **EEPROM** is a special type of PROM that can be **erased** by **exposing it to an electric charge**.
- Like other ROM it retains its memory even if the power is switched off.
- Data is written or erased **one byte at a time**
- EEPROMS are electrically-erasable-and-programmable. Internally, they are similar to EPROMs, but the erase operation is accomplished **electrically**, rather than by exposure to ultraviolet light.
- Any byte within an EEPROM may be erased and rewritten. Once written, the new data will remain in the device forever-or at least until it is electrically erased.
- The primary tradeoff for this improved functionality is *higher cost*, though *write cycles are also significantly longer than writes to a RAM*. So, you would not want to use an EEPROM for your main system memory.

# External Storage

- **Secondary memory** refers to the external storage device which can be used to store data or information permanently. It is also known as **auxiliary memory**.
- There are two types of secondary memory
  - **Fixed**
  - **Removable.**

# Hard Disks

- **A hard disk is a storage device with one or more inflexible, circular platters that use magnetic particles to store data.**
- It is typically enclosed in an airtight case to protect it from contamination.
- **Hard disks** within system units are called **fixed disks** as they **are not portable**.
- **Storage capacities for personal computer** hard disks range from **160 GB to 2 TB or more**.
- **Home users store various types of files on hard disks**, such as documents, emails, photos, music, and videos.
- **Businesses** use hard disks to store financial records, customer data, payroll, presentations, and other essential documents.
- Traditional hard disks use **longitudinal recording, aligning magnetic particles horizontally.**
- **Perpendicular recording aligns particles vertically**, enabling much greater storage capacity—up to 10 times more than longitudinal recording.
- **Hard disks** are **read/write media, allowing unlimited reading and writing of data.**

# Hard Disks

**To what degree are hard disk capacities increasing?**


**Figure 6-3** The hard disk in a desktop computer is enclosed inside an airtight, sealed case inside the system unit. (In this and other hard disk photos in the book, the top plate is removed from the hard disk for illustration purposes.)

# Hard Disks

- **Characteristics of a hard disk include:**

Capacity

Platters

Read/Write Heads

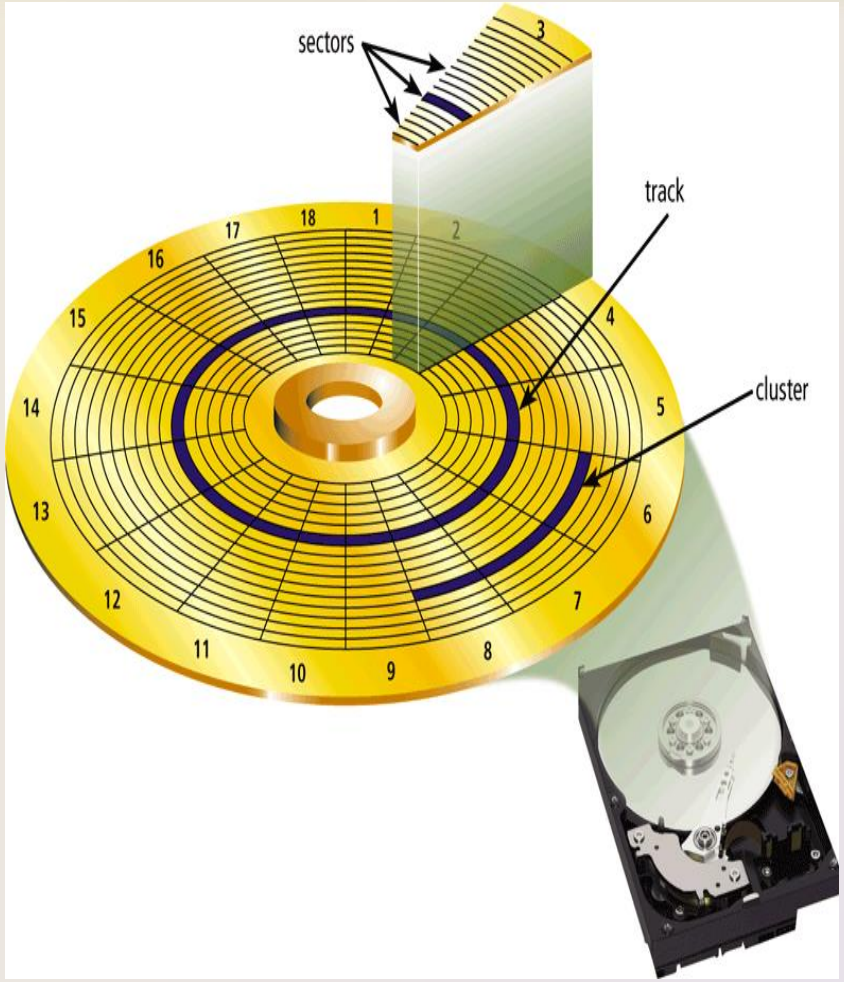
Cylinders

Sectors and Tracks

Revolutions per Minute

Transfer Rate

Access Time

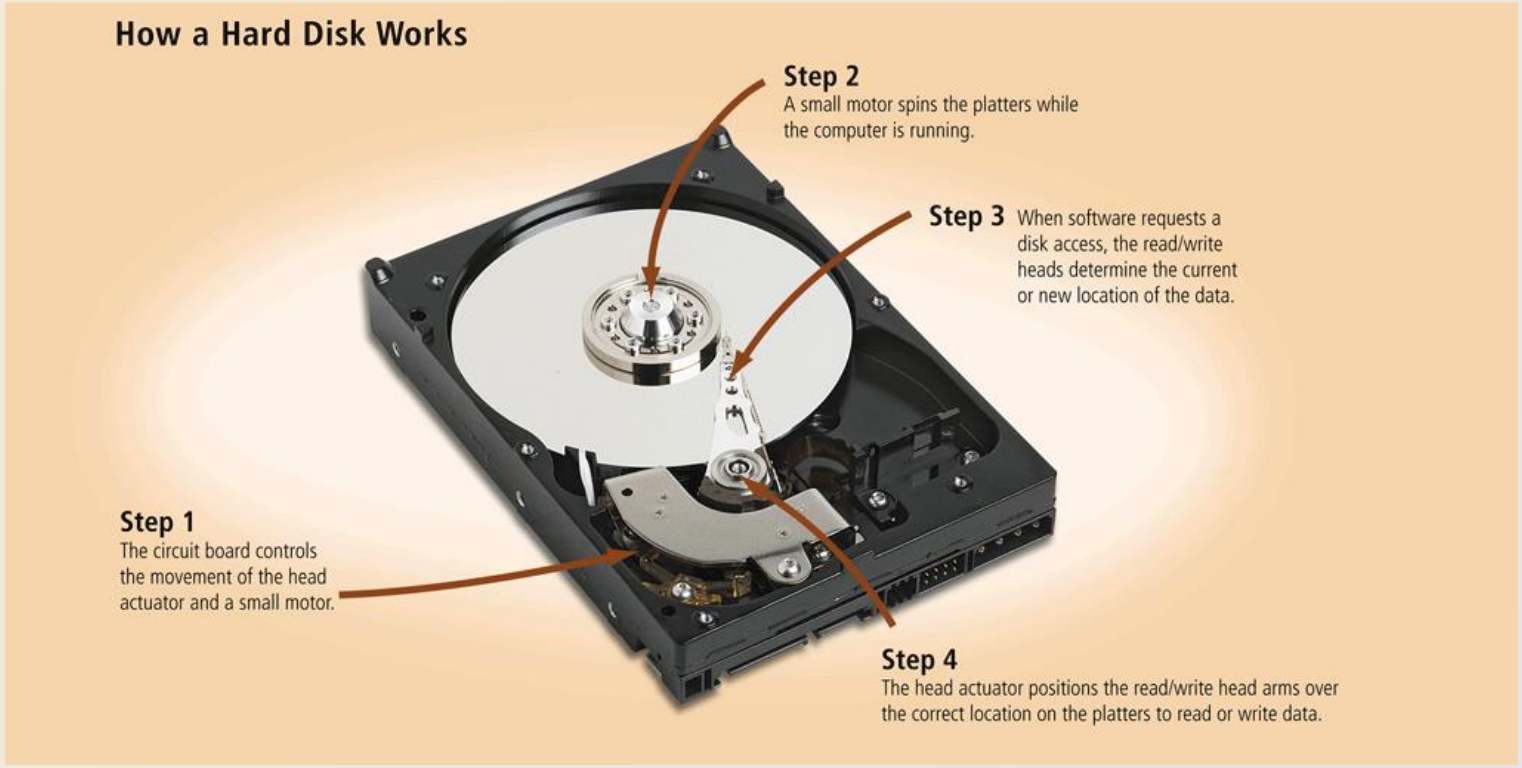


# Characteristics of a Hard Disk

- **Capacity**: A hard disk's capacity depends on whether it uses **longitudinal** or **perpendicular** recording, **the number of platters**, and the **composition of the magnetic coating**.
- **Platters**: Made of materials like *aluminum, glass, or ceramic*, platters are coated with an alloy that allows magnetic recording. They are typically about **3.5 inches in diameter for desktop computers** and **2.5 inches or smaller for mobile devices**.
- **Read/Write Heads**: Each side of a platter has a **read/write head** that magnetically records or reads data. The heads are mounted on arms that move to access data on the platters.
- **Cylinders**: This refers to a vertical section of tracks across all platters. A single movement of the read/write heads can access the same track across all platters within a cylinder.
- **Sectors and Tracks**: Data is stored in circular tracks, divided into pie-shaped sections called sectors. Each sector typically **stores 512** bytes of data.
- **Revolutions per Minute (RPM)**: This indicates the speed at which platters rotate. **Higher RPM allows for faster data access.**
- **Transfer Rate**: The speed at which data moves to and from the hard disk.
- **Access Time**: The duration it takes for the read/write head to locate data on the disk.

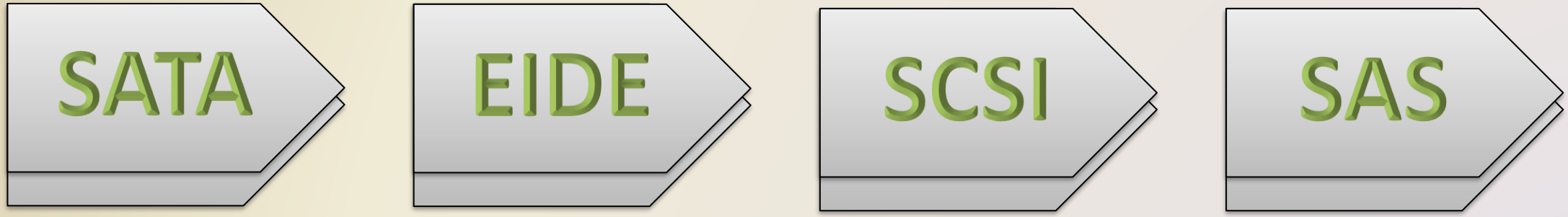
# How a Hard Disk works?

- **High-Speed Spin**: Platters spin at 5,400–15,000 rpm for **instant access** to data stored across the disk.
- **Power-Saving**: Disks slow or stop spinning when idle to save power.
- **Air Cushion**: Spinning creates an air cushion, keeping the read/write head from touching the platter.
- **Tiny distance**: The head floats **two millionths of an inch** above the platter.



# Hard Disk Controllers

- **Disk controller**
  - consists of a special-purpose chip and electronic circuits.
  - control the transfer of data, instructions, and information from a disk to and from the system bus and other components of the computer



# QUIZ YOURSELF

- **Activity: Find the true statement below. Then, rewrite the remaining false statements so that they are true.**

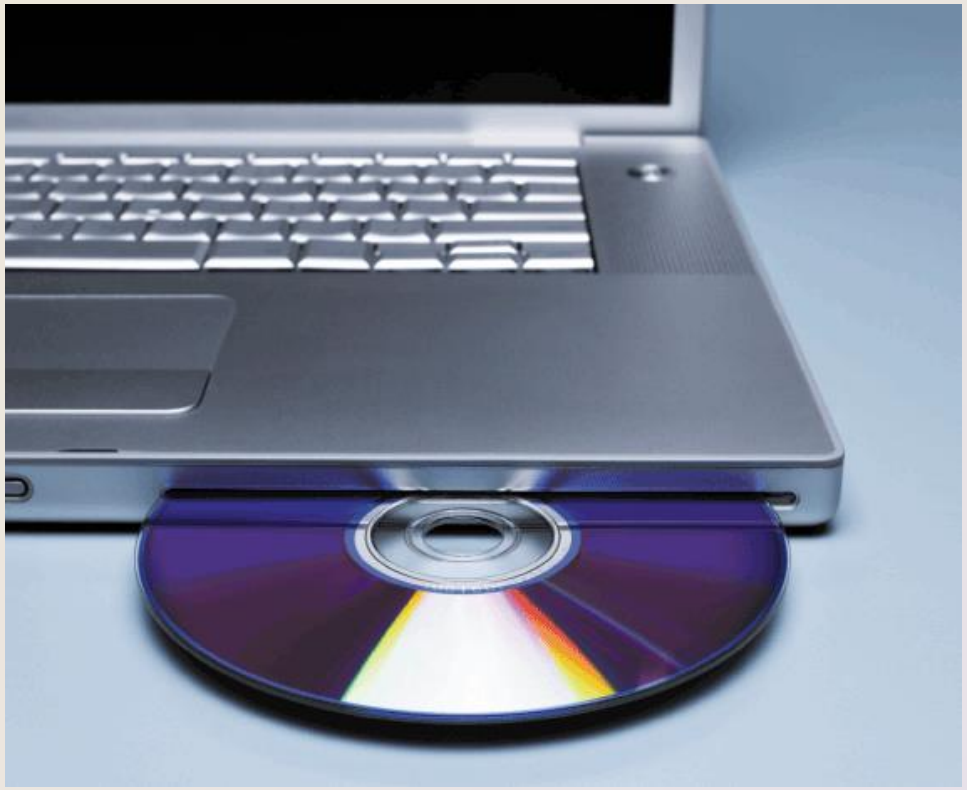
1. Hard disks contain one or more inflexible, circular platters that magnetically store data, instructions, and information.
2. SATA is a hard disk interface that uses parallel signals to transfer data, instructions, and information.
3. Storage media is the computer hardware that records and/or retrieves items to and from a storage device.
4. Users can move an internal hard disk from computer to computer as needed by connecting the disk to a USB port or FireWire port on the system unit.

# Solid State Drive (SSD)


- **Solid State Drive (SSD):**
  - Uses flash memory to store data.
  - Sizes: 3.5 inches, 2.5 inches, and 1.8 inches.
  - Common in servers, desktops, laptops, portable media players, and digital video cameras.
  - Storage capacity: 16 GB to 256 GB and beyond.
- **Advantages of SSDs**:
  - Faster access time: 0.1 ms, over 80 times faster than hard disks.
  - Higher transfer rates than comparable hard disks.
  - Lower heat and power consumption than hard disks.
  - Long lifespan: Projected to last over 50 years, compared to hard disks' 3–5 years.
- **Disadvantages of SSDs**:
  - Higher failure rate than hard disks.
  - Higher cost per gigabyte, though prices are decreasing over time.

# Optical Discs

- An **optical disc** consists of a flat, round, portable disc made of metal, plastic, and lacquer that is written and read by a laser
- **Typically store software, data, digital photos, movies, and music**
- Some optical disc formats are **read only**, meaning users **cannot write (save)** on the media.
- Others are **read/write**, which allows users to save on the disc just as they save on a hard disk.



# CD-ROM

- **CD-ROM (Compact Disc Read-Only Memory):**
  - Type of optical disc; can be read but not written to or erased.
  - Called "read-only" because data is written by the manufacturer and cannot be modified.
- **Single-Session Disc:**
  - Data is written all at once, with no further additions possible.
  - Commonly used by software manufacturers to distribute programs.
- **Storage Capacity:**
  - Holds between 650 MB and 1 GB of data.
- **CD-ROM Drive Compatibility:**
  - Insert into a CD-ROM drive or player to read.
  - Can also play audio CDs due to shared laser technology.

# THANK YOU ☺